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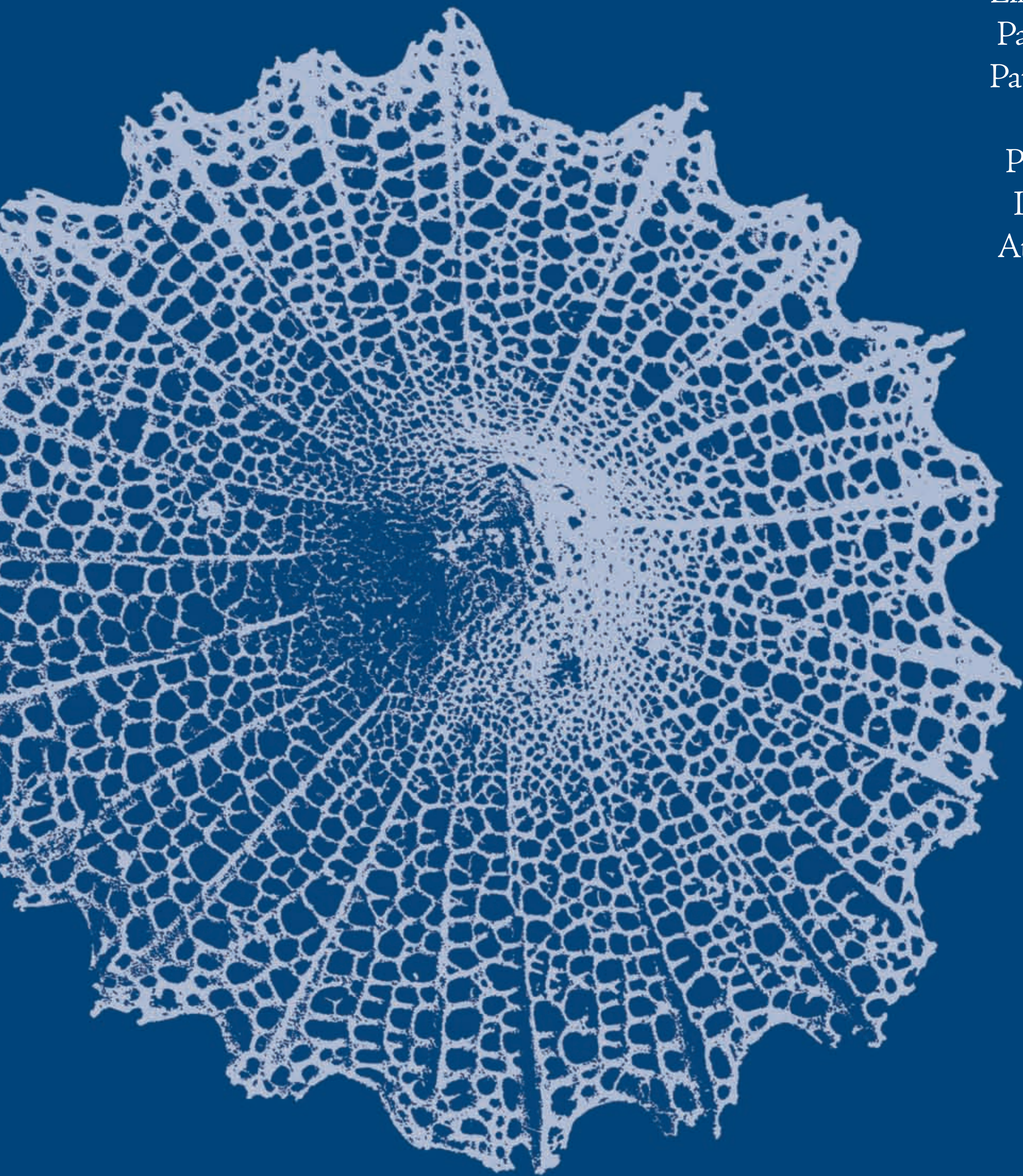

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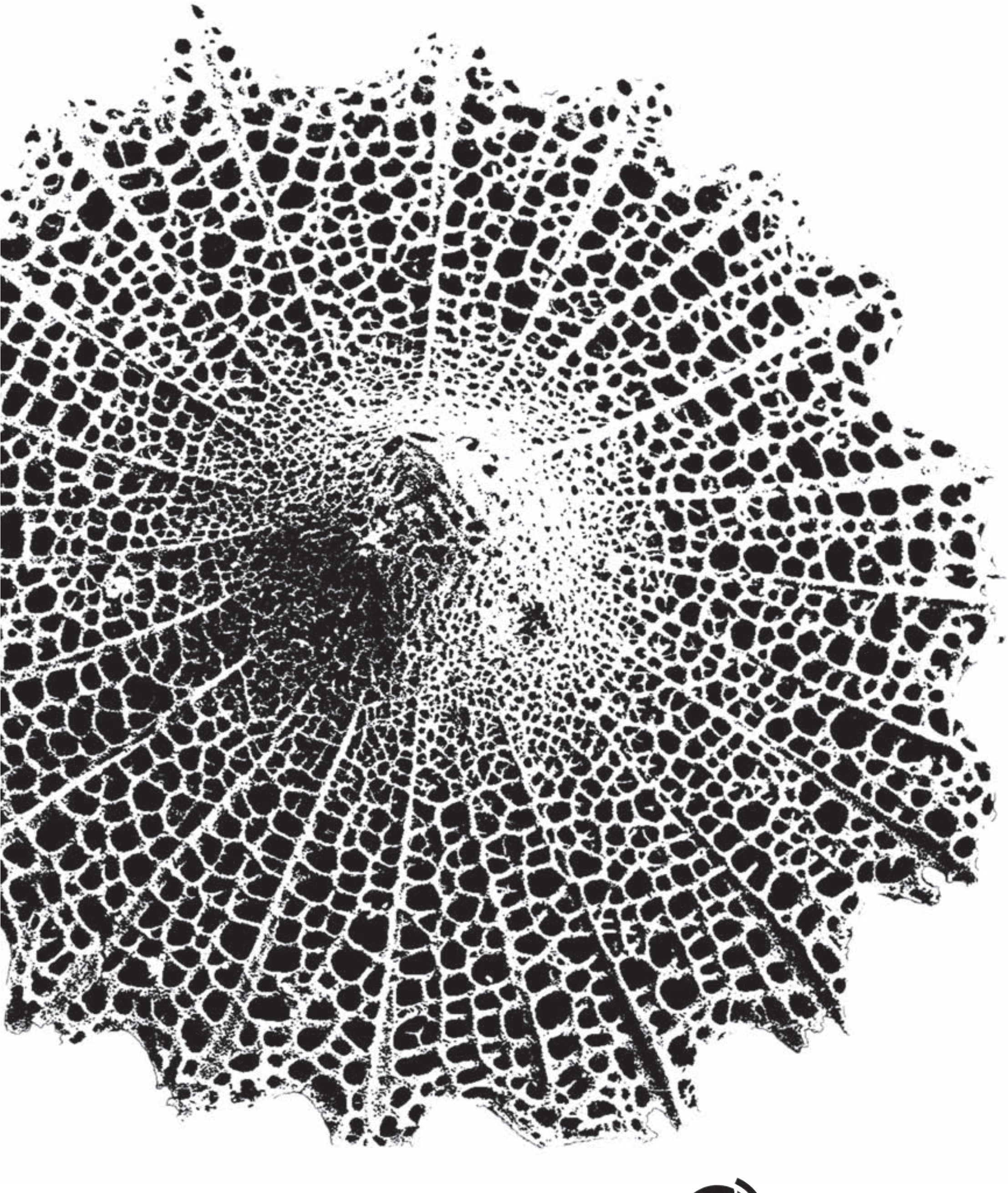

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2006

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Ljubljana, 2006

On the cover: *Citriduma* De Wever
The spatial vessel on the front cover reveals why radiolarians allow us to travel to pleasurable places which are like dreams even though they are firmly anchored in the reality of the radiolarian world, where Paulian Dumitrica reigns as a master (*Citriduma* is an anagram of his name).

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CONTENTS

Abstract

This volume comprises a catalogue of 90 genera, 274 species and 13 subspecies of Pliensbachian, Toarcian and Aalenian Radiolaria. Two genera, 37 species and 3 subspecies are new formal descriptions, 24 species are described in open nomenclature. Each taxon is presented with a complete and up-to-date synonymy, original description and original remarks (translated into English where necessary), subsequent emendations, remarks by the authors of this catalogue, and etymology. Descriptions of species/subspecies further contain the original measurements, type locality, and data on geographic distribution. Plates illustrate the holotype and one or several specimens from our material, from different paleogeographic realms where possible. The material was collected from 30 measured sections in the Circum-Pacific belt (Baja California Peninsula, Oregon, British Columbia, Japan) and the Tethyan realm (Oman, Turkey, Slovenia, Austria). Abbreviated locality information and a list of all treated taxa are given in the last two chapters.

Povzetek

Knjiga je katalog 90 rodov, 274 vrst in 13 podvrst pliensbachijskih, toarcijskih in aalenijskih radiolarijev. Dva rodova, 37 vrst in 3 podvrste so formalno opisani novi taksoni, 24 vrst je opisanih v odprti nomenklaturi. Vsak takson je predstavljen z vso dosedanjo sinonimiko, originalnim opisom in originalnimi opombami (v prevodu, če originalni jezik ni angleščina), poznejšimi revizijami, pripombami avtorjev tega kataloga in etimologijo. Opisi vrst in podvrst vsebujejo še originalne meritve, ime tipične lokalitete in podatke o geografski razširjenosti. Vsaka vrsta ali podvrsta je predstavljena s samostojno tablo, na kateri so slike holotipa in več primerkov iz naših vzorcev. Kjer je mogoče, so ilustrirani primerki z različnih paleogeografskih območij. Vzorci so bili pobrani na 30 profilih, posnetih v cirkumpacifiškem pasu (Kalifornijski polotok, Oregon, Britanska Kolumbija, Japonska) in v območju Tetide (Oman, Turčija, Slovenija, Avstrija). Dodatek na koncu knjige vsebuje kratek opis vzorčevanih profilov in seznam vseh obravnavanih taksonov.

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Š. Goričan further thanks French colleagues Jean Marcoux, Cécile Robin, François Guillocheau and François Béchennec, who invited her to participate in CNRS projects in Oman, where the most complete Tethyan Pliensbachian to Aalenian radiolarian-bearing successions are exposed. She is also grateful to her students Petra Meglič, Nevenka Šorli and Mojca Zega, who processed several hundred radiolarian samples, some of which were used for this publication.

E.S. Carter thanks the Geological Survey of Canada (GSC,Vancouver) for providing field, sample processing and SEM support, and for providing earlier collections made by B.E.B. Cameron. She is especially grateful to Howard Tipper ('Tip') (GSC, deceased 2005) whose passionate interest in the paleontology of the Pliensbachian provided encouragement and support for this work (contract no. 23254-00532/001/XSB) together with ammonite identifications and zonal assignments. She also thanks Paul Smith (University of British Columbia) for continuing to provide ammonite support.

P. Dumitrica thanks Kuei-Yu Yeh, Emile Pessagno and Isamu Hattori for providing residues with extraordinarily well-preserved radiolarians from Oregon and Japan. His field trips in Oman for collecting samples and studies of the radiolarian fauna from the Hamrat Duru Basin (processing of samples and illustration of specimens with SEM) were supported by the Swiss National Foundation (project No. 2000 – 050681) and carried out at the Institute of Geological Sciences at the University of Bern. He would like to especially thank Ingo Blechschmidt, with whom he collaborated during all field trips and the time of radiolarian study.

Illustrations of holotypes and other specimens in our previous works have been reproduced from original publications. These are indicated in the plate captions by reference to the author(s), year, plate and figure numbers of the original publication. We are thankful for permissions granted by the following journals/institutions:

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- The Palaeontological Society of Japan.

We especially wish to thank Jean Pierre Caulet for allowing us to use the RadWorld relational database, a "work in progress" prepared by himself, Catherine Nigrini and Annika Sanfilippo. He constantly provided us with the latest version of this database containing original and subsequent descriptions of numerous radiolarian genera and their type species, thus sparing us much re-typing for the present publication.

We are indebted to all Slovenian colleagues who participated in the final preparation of this catalogue. Dragica Turnšek and Simon Pirc read the manuscript and gave valuable suggestions in the final stages of work. Tina Zajc helped in preparation of plates, Robert Križmančič designed the cover, and Adrijan Košir prepared the final graphic design and page setting of the entire book.

1. INTRODUCTION

1.1. Objectives of this publication

The main goal of this catalogue is to present a set of uniformly and precisely defined radiolarian species that will serve as a coherent taxonomic base to establish a global radiolarian zonation for three Jurassic stages: the Pliensbachian, Toarcian, and Aalenian. Earliest Jurassic (Hettangian and Sinemurian) and Middle to Late Jurassic radiolarians have been studied extensively but Pliensbachian to Toarcian faunas are less well known taxonomically, and especially biochronologically. Aalenian radiolarians are included in order to connect the top of the studied interval with the base of the global low-latitude radiolarian zonation of Baumgartner et al. (1995b).

Pliensbachian, Toarcian and early Aalenian radiolarians have hitherto been systematically studied mostly from the Circum-Pacific belt: western North America (Pessagno & Whalen, 1982; Yeh, 1987a, b; Carter et al., 1988; Cordey, 1998; Whalen & Carter, 2002), Japan (Hori, 1988, 1990, 1997; Sashida, 1988; Hori & Otsuka, 1989; Matsuoka, 1991, 2004; Yao, 1997), and the Philippines (Yeh & Cheng, 1996, 1998). Only a few localities are described from the Tethyan realm s.s.: Turkey (Pessagno & Poisson, 1981; De Wever, 1981b, c, 1982a, b), Oman (De Wever et al., 1990), and Slovenia (Goričan et al., 2003). It should also be noted that most of the published taxonomic work is based on a few excellently preserved but isolated samples (e.g. Yeh, 1987a, b; Pessagno & Poisson, 1981; De Wever, 1981b, c, 1982a, b) whereas few continuous sections suitable for biochronological studies have been analyzed thus far. The existing radiolarian zonations for the Pliensbachian to Aalenian time interval (Pessagno et al., 1987b; Carter et al., 1988; Hori, 1990) are local and mainly characterized by a low-resolution potential (Fig. 1.1). The only high-resolution range chart has been constructed for Queen Charlotte Islands (Carter et al., 1988) but contains two rather long discontinuities in the early Pliensbachian and early Toarcian.

The construction of a global radiolarian zonation for the Pliensbachian to Aalenian interval is essential for future zonation of the entire Jurassic. Because of this recognized need and because some of us were currently studying rich assemblages of this age, we initiated a joint international project under the framework of INTERRAD (International Association of Radiolarian Paleontologists). The Pliensbachian to Aalenian Working Group was formed in 2000 during the 9th INTERRAD Meeting in Blairsden, California. During two one-week meetings, held in 2001 and 2002 at the Ivan Rakovec Institute of Paleontology

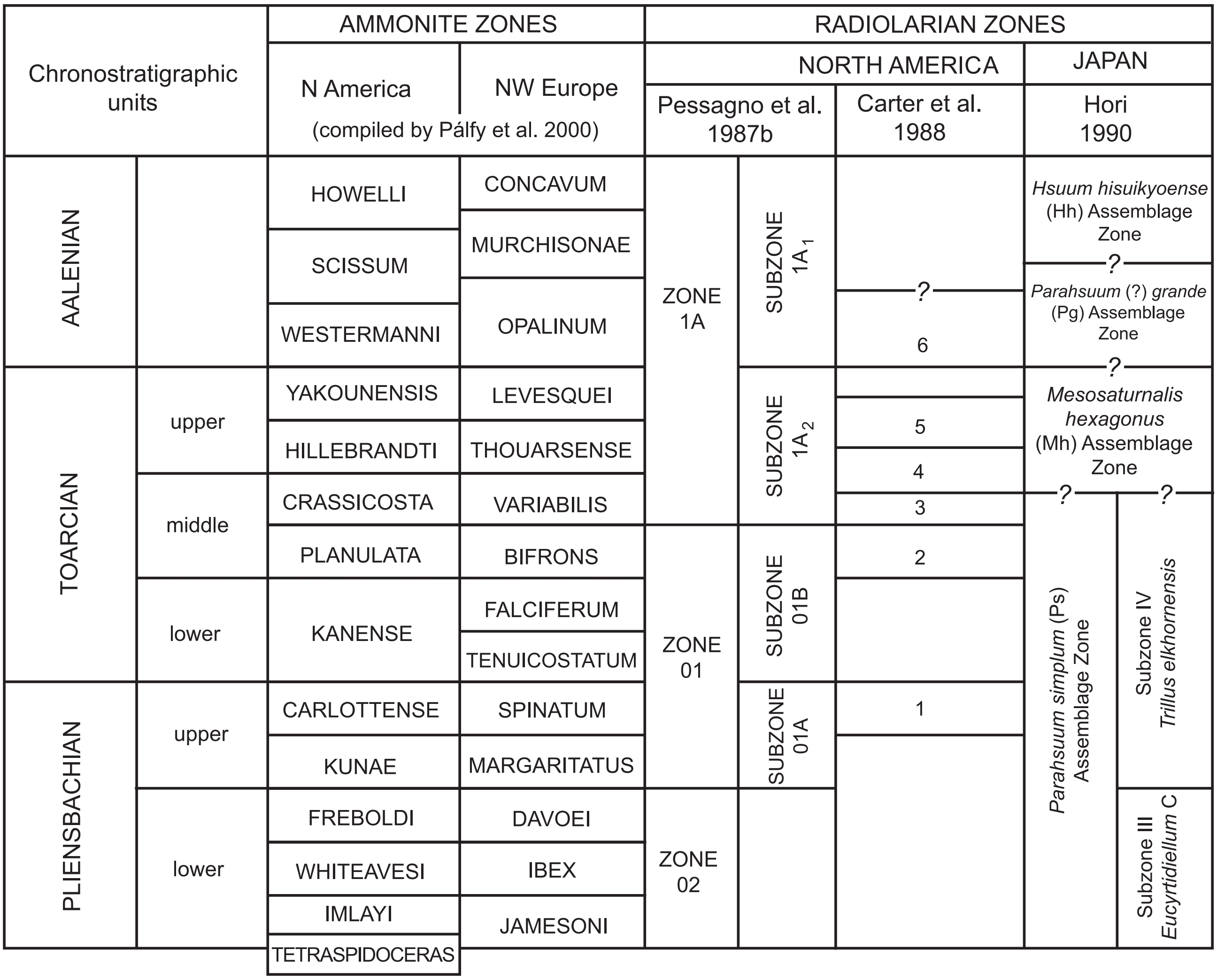


Fig. 1.1. State of the art in Pliensbachian to Aalenian radiolarian biochronology. Radiolarian biozones are tied to standard ammonite zones.

ZRC SAZU, Ljubljana, we agreed upon radiolarian taxa and stratigraphic sections to be included in the zonation. Moreover, a provisional range chart was calculated with BioGraph computer program which is based on the Unitary Association Method (UA) (Guex, 1977, 1991; Savary & Guex, 1999). The preliminary information was presented at two congresses - 6th International Symposium on the Jurassic System (September 2002, Palermo) and 10th INTERRAD Meeting (September 2003, Lausanne). Editing of systematics was compiled during September 2004 at Carters' home in Sisters, Oregon, and concluded during October 2005 in Ljubljana.

The present catalogue is the first publication of our collaborative research. It is a synthesis of previous knowledge on the taxonomy of Pliensbachian to Aalenian species complemented by actualized definitions and further remarks, where necessary. In order to provide a complete set of potentially important species, some newly described species were added. The illustrated material comes from 30 measured sections in the Circum-Pacific belt (Baja California Sur, Oregon, British Columbia, Japan) and the Tethyan realm (Oman, Turkey, Slovenia, Austria) (Fig. 1.2).

The final goal of our joint project is to construct a radiolarian zonation that will span the missing interval between the well-established Hettangian to Sinemurian (Carter et al., 1998) and Middle Jurassic to Lower Cretaceous (Baumgartner et al., 1995b) radiolarian biozones. The range chart will be published in a separate paper.

1.2. Organization of chapters

The organization of our work and of this book was inspired by INTERRAD Jurassic-Cretaceous Working Group, whose publication (Baumgartner et al., 1995c) has during ten years of application proven to be an extremely useful reference tool, indispensable in systematic and especially biostratigraphic studies.

The main part of this book is Chapter 2 Systematics, arranged in alphabetical order of genera and species. In addition to obligatory headings, such as synonymy, description, and remarks, a paragraph with known occurrences is added in order to increase the applicability

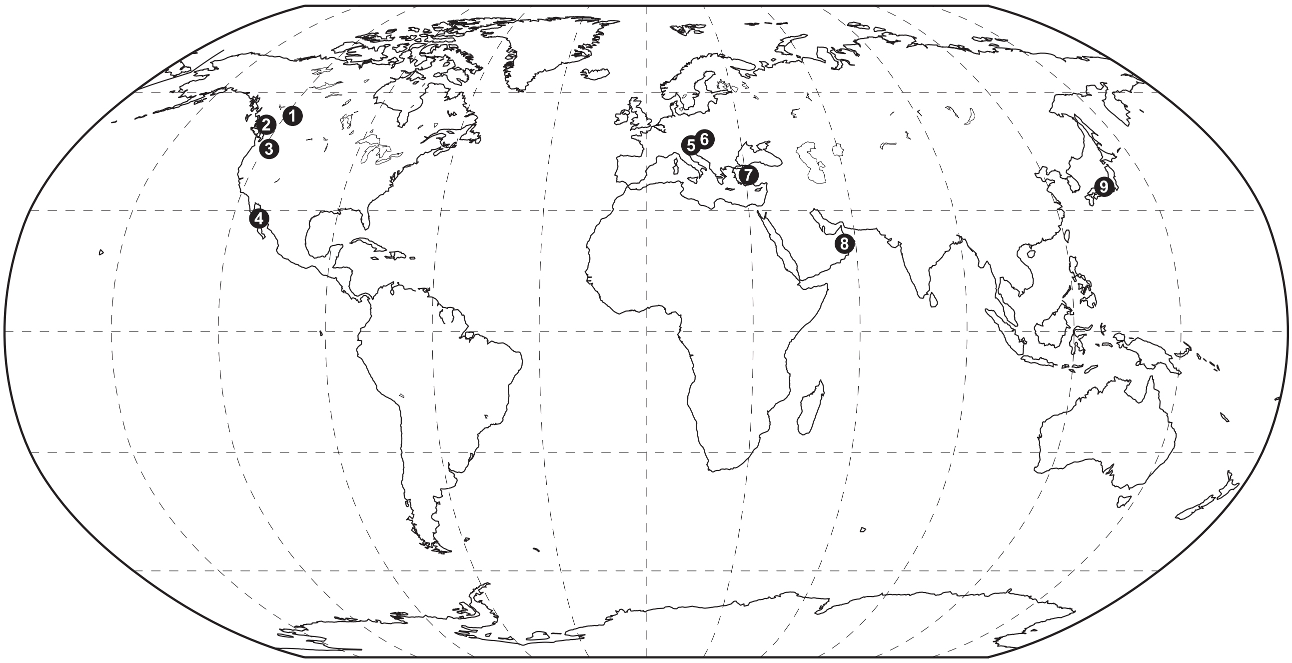


Fig. 1.2. World map with localities studied by the Pliensbachian to Aalenian Working Group.

1 – NBC. Northeastern British Columbia (Williston Lake)
2 – QCI. Queen Charlotte Islands (from north to south: Graham, Maude, Moresby, Louise and Kunga islands)
3 – OR. Oregon (Izee - Paulina and Izee - John Day roads)
4 – BCS. Baja California Sur (Punta San Hipólito)
5 – SI. Slovenia: Julian Alps (Mt. Mangart)
6 – AT. Austria: Northern Calcareous Alps (Teltschengraben)
7 – TR. Turkey: Taurus Mountains, Gümüslu Allochthon (Gümüslu village)
8 – OM. Oman, Hawasina Nappes: Hamrat Duru Group (Wadi Mu'aydin, Jabal Safra, Al Sawad, Wadi Saal, Al Kashbah Mt., Sabt), Al Aridh Group (Al Aridh village, Jabal Buwaydah), Umar Group (Humadiyin)
9 – JP. Japan: Mino Terrane (Inuyama, Nanjo, Mt. Norikuradake, Gujo-Hachiman, Kamiaso areas), Chichibu Terrane (Kuma area)

of the database for paleobiogeographic studies. The number of Pliensbachian and Toarcian species included here is far greater than that of the Aalenian representatives, because many Aalenian species have already been included in the catalogue of Baumgartner et al. (1995a). Only those typical Middle Jurassic species needing revision, completion of synonymy or additional illustrations reappear in this book. The stratigraphic ranges of taxa are not indicated because this portion of the project has not been completed yet.

Chapter 3 contains basic data on all localities where studied material was collected. When the Pliensbachian to Aalenian Working Group was created in 2000, a few localities integrated in this book were fully described (Carter et al., 1988; De Wever, 1981b, c, 1982a, b) and since that time some other papers have been published (Whalen & Carter, 2002; Goričan et al., 2003; Matsuoka, 2004). Detailed descriptions of remaining localities and their radiolarian inventory (e.g. Pliensbachian of Queen Charlotte Islands, Pliensbachian to Aalenian of Oman) are in preparation and will be published as individual papers in the near future. Herein, only the location, a short description of lithology and the overall stratigraphic range of the studied successions are given. Stratigraphically important co-occurring fossils are indicated and the original publication is cited, if available.

Chapter 4 is an index of all taxa treated in the catalogue. In order to allow an easy search, the list of species appears in three different arrangements. The same list is sorted in alphabetical order of genera (Chapter 4.1.), alphabetical order of species (Chapter 4.2.), and ascending order of alphanumerical species codes (Chapter 4.3.).

2. SYSTEMATICS

2.1. Concepts of systematics and limitations

The main purpose of this catalogue is to provide precise clues for doubtless identification of taxa that are useful for global biochronology. The concept of species is basically the same as that in Baumgartner et al. (1995a). Some morphotypes with narrow delimitations were combined into more broadly defined species. If morphological characteristics of a taxon are narrowly defined but clearly distinguishable in well-preserved material, we used such a taxon as a subspecies. In this case the corresponding species is denominated with *sensu lato* and has a separate entry in the database, so that in poorly-preserved material species identification is at least possible. On the other hand, when a selected species contains a continuum of variabilities, we called it species group without further subdivison.

Generic level taxonomy was not the prime concern of this book. Some long ago described genera (e.g. *Stichocapsa* Haeckel 1881) certainly need thorough revision but this would necessitate more detailed taxonomic and phylogenetic studies, which were beyond the scope of this catalogue. More modern descriptions were, nevertheless, carefully examined and emended, if necessary. A clear actualized definition was considered especially important for those genera having their first or last occurrence in the Pliensbachian to Aalenian interval and may therefore be used for biochronology at generic level.

We recently discovered that some genera included in this catalogue (*Atalanta*, *Beatricea*, *Canutus*, and *Thurstonia*) are homonyms of other genera described long ago. The resolution of this problem is not within the scope of this publication and will be addressed in the future by individual authors.

Suprageneric classification is deliberately ignored in this book; for this information the reader is referred to De Wever et al. (2001).

2.2. Notes for user

The included taxa are treated in alphabetical order of genera and species. The following headings are used to define a taxon:

Taxon code: Species and subspecies are coded. This code has no significance in taxonomy but is required by the BioGraph computer program for range-chart calculation. Some species have been used previously in the calculation of other range charts (Baumgartner et al., 1995b; Carter et al., 1998); their codes are unchanged. The codes used by Carter et al. (1998) and the ones newly designated in this book are composed of three letters and two digits, while the species codes defined by Baumgartner et al. (1995a, b) have four digits.

Synonymy: All synonyms appear in chronological order. Doubtful synonymy is preceded by "?", taxa explicitly excluded from a particular synonymy are preceded by "not".

Type designation: This heading designates holotype and paratypes in the description of new species/subspecies.

Original description: This heading gives the original description by the author of the taxon. Original descriptions in languages other than English are translated. Because the description is an authentic copy from the original publication, this heading may be called ***Original diagnosis*** or split into Original diagnosis plus Original description.

Emended definition (description): Gives subsequent emendations with the reference to the publication cited. If no publication is cited, this means that the taxon is emended herein.

Original remarks are the remarks by the author of the taxon. If in the original publication only a reference to remarks under another taxon is given, the remarks under the latter taxon are also provided.

Further remarks are mostly remarks by the authors of this catalogue. In a few cases, relevant previously published comments are given and the source is cited.

Measurements are the measurements from the original publication.

Etymology makes reference to the origin of the formal name of the taxon.

Type locality states the type locality of individual species and subspecies.

Included species/subspecies: This heading appears with genera and species *sensu lato*, and gives a list of species or subspecies treated in this catalogue. Names are preceded by codes.

Occurrence: This heading gives a list of previously known plus our 'new' localities for each species/subspecies. Only broader regions and not individual locations are listed. Names of lithostratigraphic units are indicated, when available. The occurrence of the holotype always appears as the first on the list.

Plates: Each species/subspecies has its plate that is numbered with the code of the taxon. The plates show the holotype (for formal taxa) and one or several illustrations, from more than one locality if possible. Magnification is indicated in the plate caption and scale bars are added. The figure caption indicates for each figure, the following: country code (e.g. QCI), sample number (e.g. 99-CNA-MI-10), and photograph/specimen number (e.g. GSC 34567). The figure number of the holotype is followed by (H), author, year, plate, and figure of original illustration. The same indication is given for figures previously used in other publications by the authors of this catalogue. Permissions granted for reproduction of the illustrations are gratefully acknowledged.

List of country codes used in the figure captions:
AT = Austria
BCS = Baja California Sur, Mexico
JP = Japan
NBC = Northeastern British Columbia, Canada
OM = Oman
OR = Oregon, USA
QCI = Queen Charlotte Islands, British Columbia, Canada
SI = Slovenia
TR = Turkey

Repository: The holotypes and paratypes of newly described species are stored in the authors' collections. Repository numbers correspond to specimen numbers, indicated in plate captions.

2.3. Systematic description of genera and species

Genus: *Acaeniotylopsis* Kito & De Wever 1994

Type species: *Acaeniotylopsis triacanthus* Kito & De Wever 1994

Synonymy:
1994 *Acaeniotylopsis* n. gen. – Kito & De Wever, p. 130.

Original description: Test composed of spherical or subspherical shell with some radial spines, a medullary shell and microsphere. Cortical shell comprises massive nodes connected to each other by short bars. Outer medullary shell is spherical and is connected to cortical shell by several strong triradiate radial beams and by numerous thin secondary radial beams, which join nodes on cortical shell. Primary beams merge into spines. Inner medullary shell polyhedral.

Original remarks: The genus differs from *Acaeniotyle* Foreman 1973 by the absence of perforated mammae on the cortical shell, by a cortical shell composed of bars with nodes and by the presence of the primary radial beams.

Further remarks: The genus also differs structurally from *Acaeniotyle* in having a double medullary shell with a true microsphere whereas the medullary shell of *Acaeniotyle* is, by its size, closer to the macrosphere in the sense of Hollande and Enjumet (1960). The genus differs essentially from *Acaeniotyle* in having a double medullary shell, and primary radial spines.

Etymology: *Acaeniotyle* + *-opsis* (masculine), in reference to a similar morphology to *Acaeniotyle* Foreman.

Included species:
2001 *Acaeniotylopsis ghostensis* (Carter) 1988
4066 *Acaeniotylopsis triacanthus* Kito & De Wever 1994

Acaeniotylopsis ghostensis (Carter) 1988

Species code: 2001

Synonymy:

1988 *Acaeniotyle* (?) *ghostensis* Carter n. sp. – Carter et al., p. 33, pl. 9, fig. 6.
1994 *Acaeniotylopsis ghostensis* (Carter) – Kito & De Wever, p. 132, pl. 1, figs. 7-8.
1995a *Acaeniotylopsis ghostensis* (Carter) – Baumgartner et al., p. 56, pl. 2001, figs. 1-2.
1997 *Acaeniotylopsis ghostensis* (Carter) – Yao, pl. 3, fig. 102.

Original diagnosis: Test subspherical and slightly flattened with 3 long, sturdy, tribladed spines. Surface of cortical shell covered with strong, slightly perforate nodes.

Original description: Test subspherical, flattened in plane of equatorial spines. Nodes on cortical shell strong, moderately spaced with somewhat flattened distal surfaces (tops); surfaces with fine perforations, some bearing remnants of fine central spines. Nodes connected by strong bars that form circular, elliptical and subtriangular pores. Spines tribladed and long (entire ones greater than 3/4 diameter of test) carrying narrow rounded ridges and wider grooves; complete spines are pointed. First medullary shell has small irregular pore frames connected to cortical shell by radial beams. Radial beams (3) are strong, triradiate and continuous with each primary spine; beams of lesser strength are attached to cortical shell at base of nodes.

Original remarks: Genus queried; the form described is doubtfully assigned to this genus because nodes are smaller, knob-like rather than rounded, and have fewer perforations, and all are much older.

Further remarks: By Kito & De Wever (1994): Our specimens have longer radial spines than the specimens of the original description. The microsphere was not described in the original description, but external features and internal structure of type specimens are completely identical with our material.

Measurements (μm):
Based on 13 specimens.

	HT	Av.	Min.	Max.
Diameter of test	146	145	175	139
Length of longest spine	121	108	145	82

Etymology: Named for Ghost Creek, north of the type locality.

Type locality: GSC locality C-080597. Toarcian of Phantom Creek Formation, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands; Italy; Japan.

Acaeniotylopsis triacanthus Kito & De Wever 1994

Species code: 4066

Synonymy:

1989 *Acaeniotyle* (?) sp. 1 – Kito, p. 95, pl. 3, figs. 1-5, 8-9.
1991 *Acaeniotyle* sp. B. – Tonielli, p. 21, pl. 1, fig. 20.
1991 *Acaeniotyle* ? sp. A – Carter & Jakobs, p. 342, pl. 2, fig. 8.
1994 *Acaeniotylopsis triacanthus* n. sp. - Kito & De Wever, p. 132, pl. 1, figs. 4-6, 9-11; pl. 3, figs. 5a-b, 6.
1995a *Acaeniotylopsis variatus triacanthus* Kito & De Wever – Baumgartner et al., p. 58, pl. 4066, figs. 1-7.
1997 *Acaeniotylopsis v. triacanthus* Kito & De Wever – Yao, pl. 3, fig. 104.

Original description: Test composed of a spherical or subspherical cortical shell with three strong radial spines; one outer and one inner medullary shell. Cortical shell constituted of massive nodes connected by short bars. Pores are small, polygonal or circular. Three radial spines are arranged in a plane at about 120 degrees. Radial spines possess three wide grooves (primary grooves) alternating with three narrow grooves (secondary grooves). A short spine on each ridge arises at the end of the radial spine and provides a clove-like tip. Outer medullary shell is spherical and connected to cortical shell by three triradate primary beams and thin secondary beams. Inner medullary shell is polygonal, composed of pentagonal pore frames.

Original remarks: This species differs from *Acaeniotyle diaphorogona variata* Ozvoldova 1979 in the construction of the cortical shell. The cortical shell lacks perforated mammae. The species also differs from *Acaeniotylopsis ghostensis* (Carter) in the aspect of its cortical shell and in having branched spines.

Measurements (μm):
Based on 13 specimens.

	HT	Av.	Min.	Max.
Diameter of cortical shell	189	160	128	204
Length of spine A	206	-	-	-
Length of spine B	187	159	111	222
Length of spine C	193	-	-	-

Etymology: From the Greek *tri-* (three) + *acanthus* (spine).

Type locality: Sample S69, Contrada la Ferta, Sicily, Italy.

Occurrence: Italy; Japan; Phantom Creek Formation, Queen Charlotte Islands.

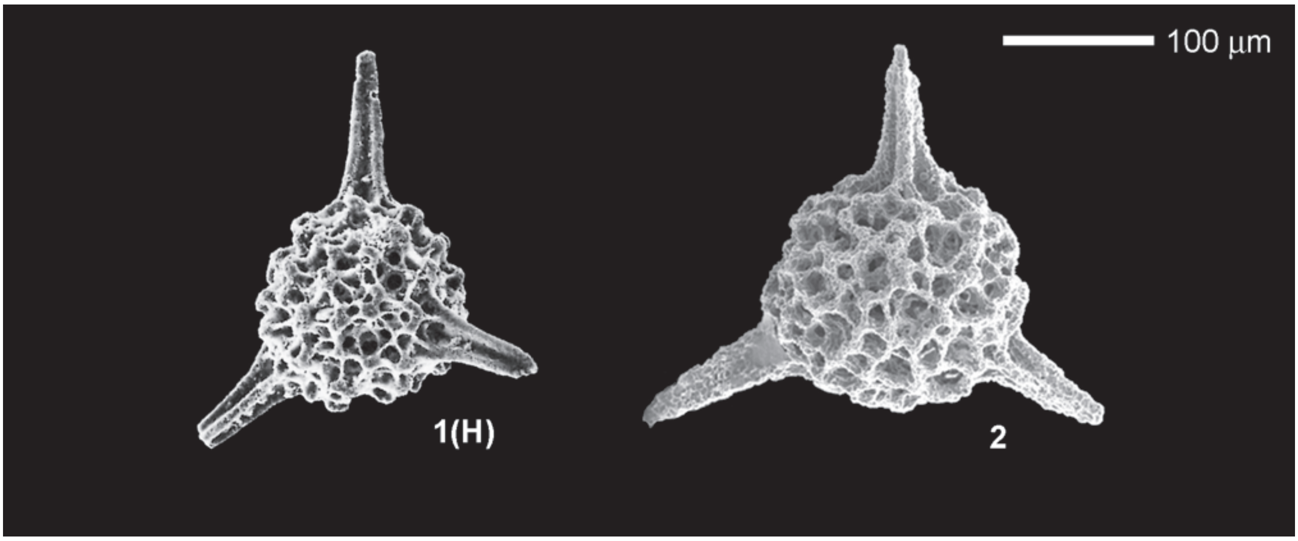


Plate 2001. ***Acaeniotylopsis ghostensis*** **(Carter).** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 9, fig. 6. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128704.

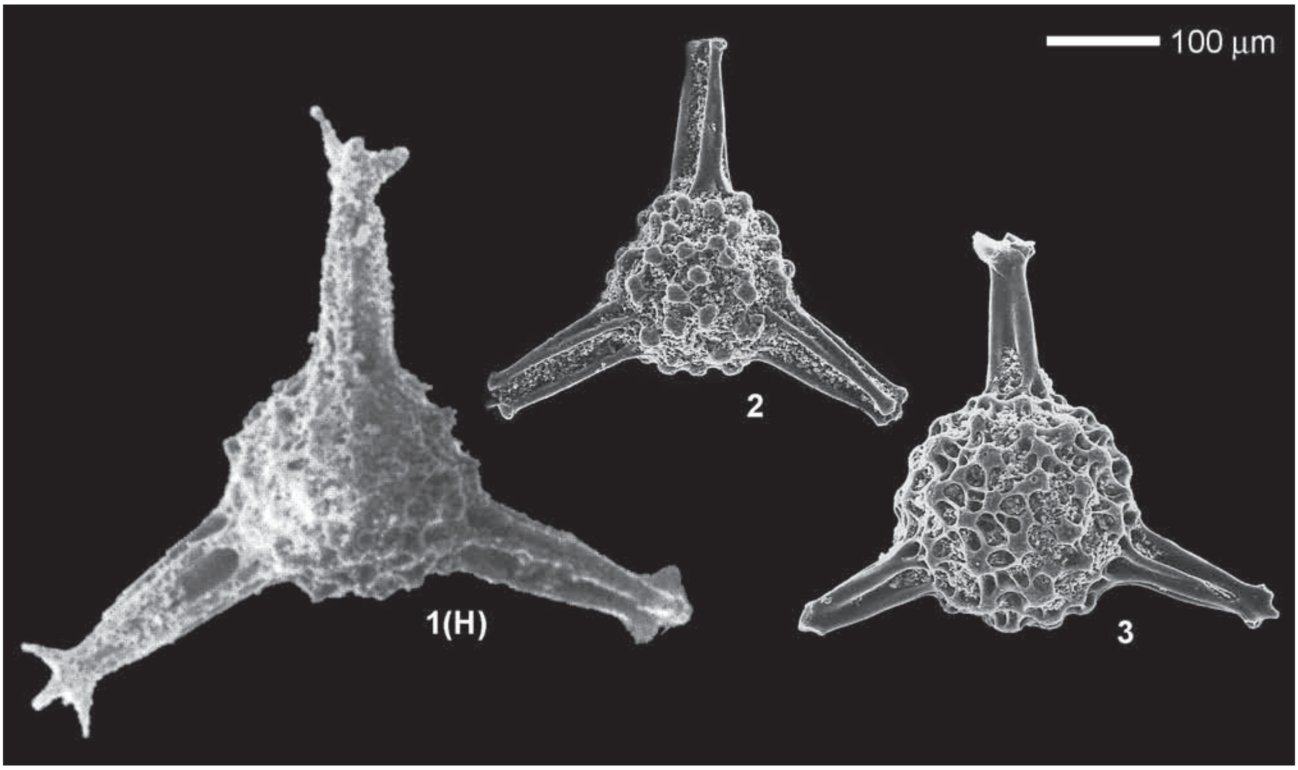


Plate 4066. ***Acaeniotylopsis triacanthus*** **Kito & De Wever.** Magnification x150. **Fig. 1(H).** Kito & De Wever 1994, pl. 1, fig. 11. **Fig. 2.** Carter & Jakobs 1991, pl. 2, fig. 11. **Fig. 3.** Baumgartner et al. 1995a, pl. 4066, fig. 3.

Genus: *Anaticapitula* Dumitrica & Zügel 2003

Type species: *Anaticapitula clauda* Dumitrica & Zügel 2003

Synonymy:

2003 *Anaticapitula* n. gen. – Dumitrica & Zügel, p. 52.

Original description: Highly ovate dicyrtid test with bladed apical horn and thorax prolonged into a thin-walled terminal tube. Cephalis and thorax continuous externally, without collar stricture. Initial spicule with A, V, D, two L, two l, and a long Ax. Cephalis and thorax with a superimposed network of strong ridges. With or without feet representing external extensions of L and D. Feet, when present, with an outer blade and two lateral blades.

Original remarks: By its general shape and the tubular prolongation of the thorax this genus shows characters in common with the genus *Rhopalosyringium* Campbell & Clark, 1944. A comparable axobate was illustrated by De Wever (1982) in the Lower Jurassic species *Ovum pertusum* De Wever, 1982. *Jacus* (?) *anatiformis* De Wever, 1982, described from the lower Pliensbachian of Turkey, is also almost identical to *A. pennata* n. gen., n. sp. and, although De Wever (1982) did not mention the presence of Ax in his species, a small light-grey spot opposite to the ventral spine, representing probably a small Ax, is visible in a broken specimen figured by him (De Wever 1982; pl. 11, fig. 13). *Jacus* (?) *italicus* Jud, 1994 described from the Lower Cretaceous (Jud 1994) has a morphology similar to *J.* (?) *anatiformis* and should also be assigned to the genus *Anaticapitula* n. gen.

From *Napora*, *Anaticapitula* n. gen. differs by having a well developed Ax in the initial spicule, thorax continuous with the velum, no crown of spines on the apical horn, and a much larger cephalis.

Etymology: From the Latin *anas*: duck; and *capitulus*: small head. Feminine gender.

Included species:

JAC02 *Anaticapitula anatiformis* (De Wever) 1982a
JAC04 *Anaticapitula omanensis* Dumitrica n. sp.

Anaticapitula anatiformis (De Wever) 1982a

Species code: JAC02

Synonymy:

1982 *Bisphaerocephalina* (?) sp. – Imoto et al., pl. 1, fig. 10.
1982a *Jacus* ? *anatiformis* n. sp. – De Wever, p. 205, pl. 11, figs. 10-15.
1982b *Jacus* ? *anatiformis* De Wever – De Wever, p. 343, pl. 54, figs. 1-5; pl. 58, figs. 1, 2, 6.
1984 *Jacus* sp. A – Murchey, pl. 2, fig. 29.
1984 *Jacus* sp. B – Murchey, pl. 2, fig. 28.
1987 *Jacus* sp. A – Hattori, pl. 11, fig. 7.
1987 *Jacus* sp. D – Hattori, pl. 11, fig. 8.
1989 *Jacus* sp. A – Hattori, pl. 5, fig. I.
1989 *Jacus*? sp. B – Hattori, pl. 5, fig. J.
1990 *Jacus anatiformis* De Wever – De Wever et al., pl. 3, fig. 10.
1998 *Jacus* ? *anatiformis* De Wever – Whalen & Carter, p. 74, pl. 18, figs. 13, 14, 17, 18, 19, 27.
1997 *Thetis* sp. B – Yao, pl. 10, fig. 467.
1998 *Jacus* ? *anatiformis* De Wever – Yeh & Cheng, p. 32, pl. 6, fig. 10.
2001 *Jacus* cf. *anatiformis* De Wever – Gawlick et al., pl. 2, fig. 16.
2001 *Jacus anatiformis* De Wever – Gawlick et al., pl. 5, fig. 19.
2002 *Jacus* ? *anatiformis* De Wever – Hori & Wakita, pl. 3, fig. 7.
2002 *Jacus* ? *anatiformis* De Wever – Whalen & Carter, p. 138, pl. 16, fig. 18.
2002 *Anaticapitula anatiformis* (De Wever) – Tekin, p. 191, pl. 5, fig. 8.
2003 *Jacus* ? aff. *anatiformis* De Wever – Goričan et al., p. 296, pl. 4, figs. 5-6.
2003 *Jacus* ? sp. – Goričan et al., p. 296, pl. 4, fig. 7.
2004 *Anaticapitula* (?) sp. – Matsuoka, fig. 144.
2004 *Anaticapitula* (?) *anatiformis* (De Wever) – Matsuoka, fig. 145.

Original description: Form with two segments, a strong apical horn, three diverging feet on thorax and a free subcylindrical velum.

Apical horn triradiate along most of length, but some specimens with a rounded end. Hemispherical cephalis imperforate, smooth, with small pustules or with strong longitudinal wrinkles. A round pore, rather large, prolongs cephalic spine V. Thorax roughly tetrahedral in form with lateral edges extending in three feet. Wall composed of two superimposed irregular latticed networks: a delicate inner one and a coarse outer one. Thorax extends in a subcylindrical velum with a thin wall and tiny irregular pores.

Original remarks: This form is tentatively assigned to this genus because of the relationship between the velum and feet: whether the velum is free from the feet or bound to them could be considered a generic criterion, but it seems hasty to me in our present stage of knowledge.

This form resembles *Lithomelissa amazon* Foreman (1968, p. 26) but is distinguished from it by its slender appearance proximally. It differs also from all other species of *Lithomelissa* by the lack of an axial spine (Ax).

The observation of different layers and their disposition on the thorax and velum suggests the same growth pattern as described by Petrushevskaya M.G. (1962) for Cenozoic forms: development of thoracic wall, then proximal part of velum, and lastly, the simultaneous development of a proximal external layer on the thorax-velum suture zone and distal part of velum.

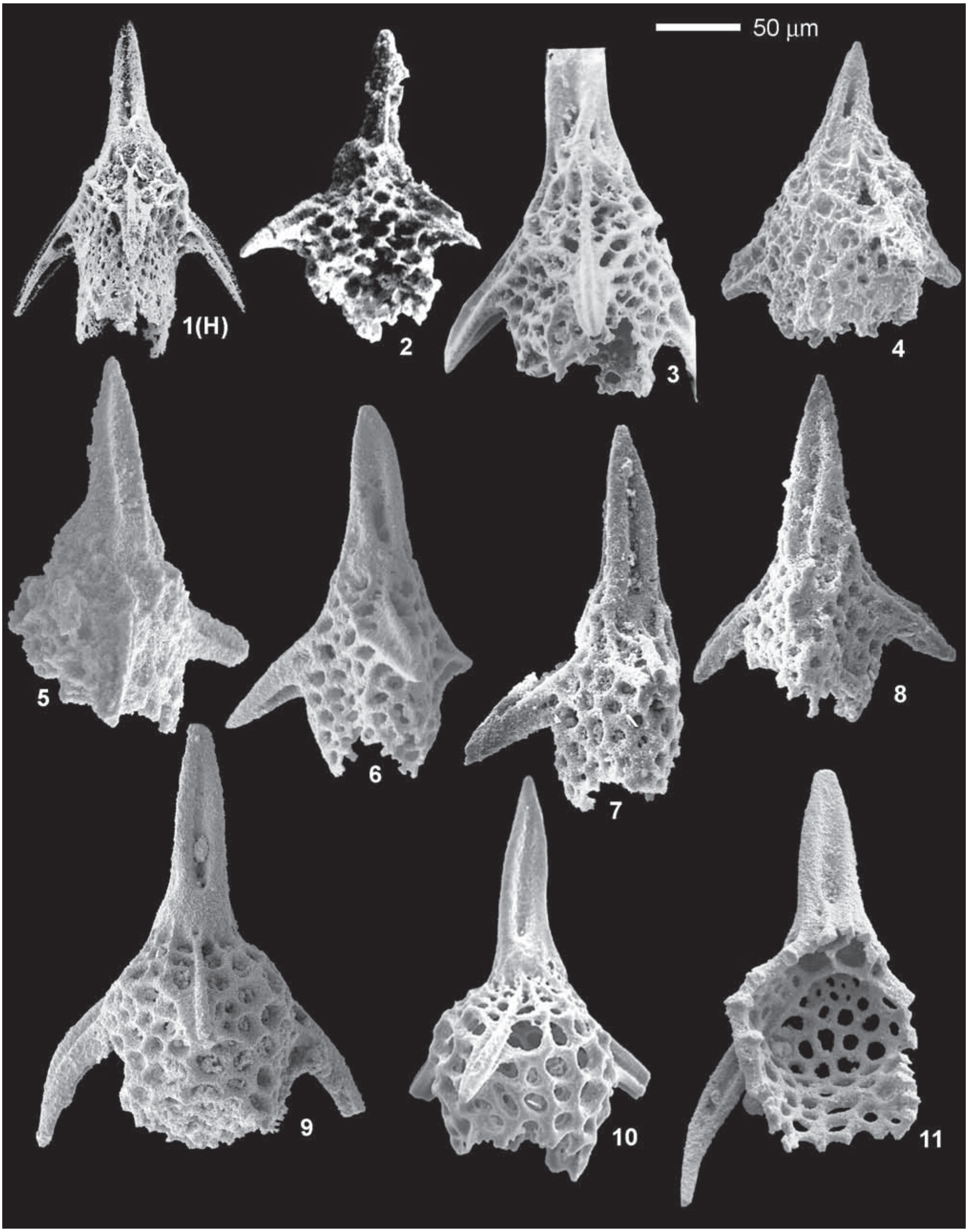


Plate JAC02. *Anaticapitula anatiformis* (De Wever). Magnification x300. **Fig. 1(H).** De Wever 1982a, pl. 11, fig. 10. **Fig. 2.** JP, IJIII12. **Fig. 3.** Whalen & Carter 2002, pl. 16, fig. 18. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128815. **Fig. 5.** OM, Haliw-038-R08-26. **Fig. 6.** OM, BR706-R05-01. **Fig. 7.** Goričan et al. 2003, pl. 4, fig. 5. **Fig. 8.** Goričan et al. 2003, pl. 4, fig. 6. **Fig. 9.** OM, BR706-R12-14. **Fig. 10.** QCI, GSC loc. C-175306, GSC 128816. **Fig. 11.** OM, BR706-R05-14.

This species differs from *J. coronatus, J. clatratus* and *J. isa* by its free velum.

Further remarks: This species may easily be assigned to the genus *Anaticapitula* (Dumitrica & Zügel, 2003) by the two-layered, thick-walled cephalis and thorax, and the tubular distal extension of the thorax. This species is structurally close to *Anaticapitula clauda* Dumitrica & Zügel.

A large variety of forms are now included in *Anaticapitula anatiformis*. These forms differ in length of feet and structure of thoracic wall, which can be two-layered and irregular as in the holotype, or simple, composed of large uniform polygonal pore frames.

Measurements (µm):
Based on 11 specimens.

	Av.	Min.	Max.
Length of apical horn	82	67	100
Width of thorax	84	75	100
Total length (including velum and apical horn)	238	200	290

Etymology: From Latin *anas*, *-atis*, duck and *formis* form. In a form of a duck, by resemblence to the appearance of duck in flight.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Sandilands and Ghost Creek formations, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Dürrnberg Formation, Austria; Skrile Formation, Slovenia; Hocaköy Radiolarite, Turkey; Musallah Formation, Oman; Liminangcong Chert, Philippines; Japan.

Anaticapitula omanensis Dumitrica n. sp.

Species code: JAC04

Synonymy:
1989 *Thetis* spp. – Hattori, pl. 7, figs. E-G.
1997 *Thetis* sp. D – Yao, pl. 10, fig. 469.
2004 *Anaticapitula* (?) sp. – Matsuoka, fig. 142.

Type designation: Holotype specimen BR1121-R08-17 from sample BR 1121, Guwayza Formation, Tawi Sadh Member, Wadi Mu'aydin, Oman.

Diagnosis: Test small, subrhombic in outline with a three-bladed pointed apical horn and short spines D, Lr and Ll.

Description: Test small, pyramidal in the upper half, inverted conical in the lower half. Cephalis globular, imperforate, lower part covered by ribs extending from outer layer of thorax. Apical horn long, three-bladed, gently pointed. Thorax much larger than cephalis, inflated in the middle part where it bears three short laterally-downward directed spines. Spines distally three-bladed, proximally multi-bladed with secondary blades representing prolongations of the intervening bars of the external layer of the thoracic wall. Collar stricture indistinct or slightly visible by a change in outline. Beyond the level of the three spines, thorax decreases gradually in diameter and terminates irregularly. This part of thorax approximally equal in length to the portion between top of cephalis and the level of the three spines. Pores of thorax irregular in size, shape and arrangement; intervening bars of the outer layer usually forming ribs in various directions.

Remarks: *Anaticapitula omanensis* differs from *A. anatiformis* in having much shorter D and L spines; the conical part of thorax is also shorter and inverted.

Measurements (µm):
Based on 9 specimens.

	HT	Min.	Max.
Maximum length of shell with apical horn	170	170	209
Length of apical horn	53	50	70
Diameter of thorax at the level of the three spines	87	85	88

Etymology: From its occurrence in Oman.

Type locality: Sample BR 1121, Guwayza Formation, Tawi Sadh Member, Wadi Mu'aydin, Oman.

Occurrence: Guwayza Formation, Tawi Sadh Member, Oman; Mino Terrane, Japan.

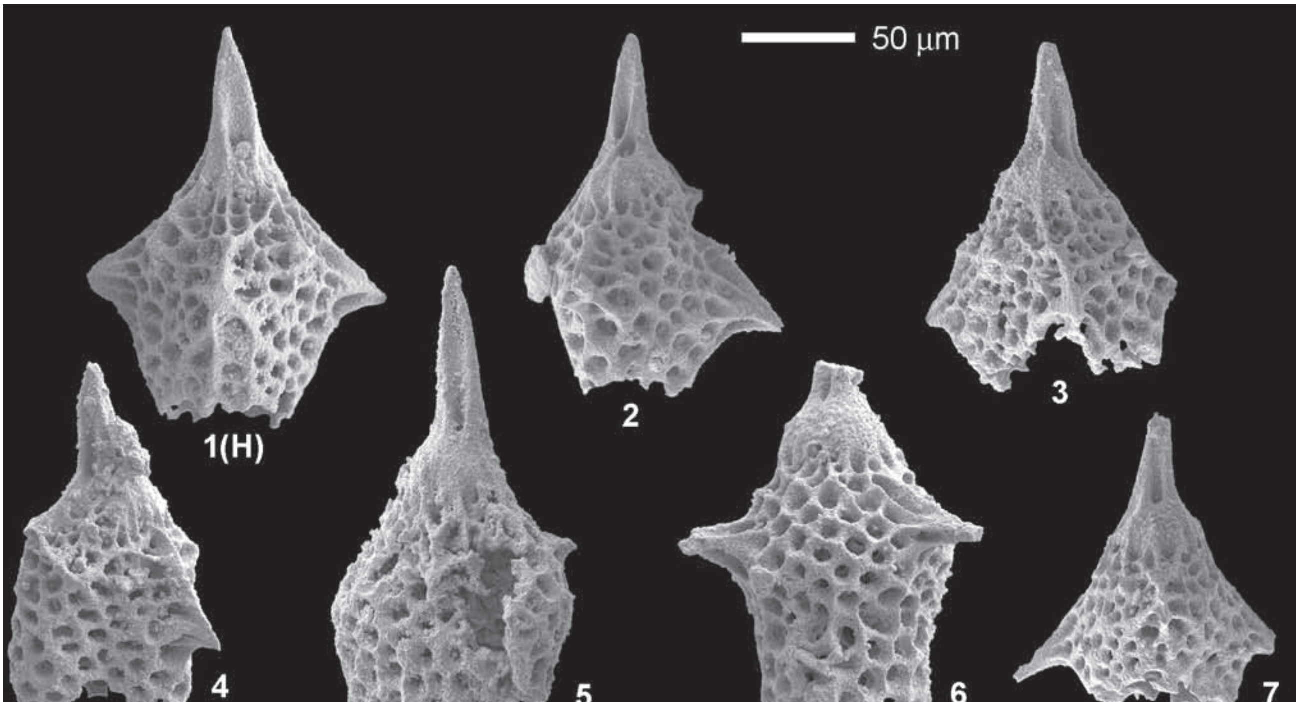


Plate JAC04. ***Anaticapitula omanensis*** **Dumitrica n. sp.** Magnification x300. **Fig. 1(H).** OM, BR1121-R08-17. **Fig. 2.** OM, BR1121-R06-13. **Fig. 3**. OM, BR1121-R08-15. **Fig. 4.** OM, BR1121-R07-03. **Fig. 5.** OM, BR1122-R02-12. **Fig. 6.** OM, BR1121-R08-08. **Fig. 7.** OM, BR1121-R10-01.

Genus: ***Archaeodictyomitra*** Pessagno 1976, emend. Pessagno 1977b

Type species: *Archaeodictyomitra squinaboli* Pessagno 1976

Synonymy:

1976 *Archaeodictymitra* n. gen. – Pessagno 1976, p. 49.
1977b *Archaeodictyomitra* Pessagno – Pessagno, p. 41.
1987b *Combusta* n. gen. – Yeh, p. 60.
1995a *Archaeodictyomitra* Pessagno – Baumgartner et al., p. 96.

Original description: Test conical, non-lobate, becoming somewhat spindle-shaped in unbroken or mature forms; cephalis, thorax, abdomen, and post-abdominal chambers covered by linearly arranged continuous costae which converge in the area of the cephalis and thorax; pores distributed in single row between costae, entirely relict on earlier chambers and observable only on etched or eroded specimens.

Emended definition: By Pessagno (1977b): Definition as in Pessagno (1976), but including forms with constrictions; constrictions not occurring at joints.

Original remarks: *Archaeodictyomitra* n. gen., differs from *Dictyomitra* Zittel by being non-lobate in outline and lacking well-developed strictures; and by possessing relict pores and lacking primary pores. It differs from *Diplostrobus* Squinabol for the reasons cited above and by lacking an apical horn.

Only a few of the many potential species known to be assignable to this genus have been described from Jurassic and Cretaceous strata. »*Dictyomitra*« *margarita* Aliev, 1961, from the Lower Cretaceous of Russia is definitely assignable to *Archaeodictyomitra.*

Further remarks: *Combusta* Yeh is herein considered a junior synonym of *Archaeodictyomitra* Pessagno because there is no structural difference between the two genera. Both lack an apical horn and constrictions or have only very weak constrictions at joints; both possess longitudinal costae with a row of pores in the intercostal depressions, and a distal aperture.

Included species:

ADM01 *Archaeodictyomitra munda* (Yeh) 1987b
ADM02 *Archaeodictyomitra* sp. A
ADM03 *Archaeodictyomitra* sp. B

Archaeodictyomitra munda (Yeh) 1987b

Species code: ADM01

Synonymy:

1987b *Combusta munda* n. sp. – Yeh, p. 61, pl. 20, figs. 6-7, 11, 17; pl. 28, figs. 8, 25.
1987b *Combusta* sp. A – Yeh, p. 61, pl. 20, fig. 10.
1987b *Combusta* sp. B – Yeh, p. 61, pl. 28, figs. 9, 16.
2003 *Parahsuum* spp. – Goričan et al., p. 296, pl. 5, fig. 14 only.
2003 *Archaeodictyomitra* sp. sensu Kojima et al. 1991 – Kashiwagi & Kurimoto, pl. 3, fig. 11.
2004 *Archaeodictyomitra munda* (Yeh) – Matsuoka, fig. 187.

Original description: Test as with genus, with seven to nine post-abdominal chambers. Cephalis medium in size, dome-shaped. Cephalis, thorax, and abdomen sparsely perforate. Post-abdominal chambers with one row of small pore frames between adjacent costae. Costae moderately thick, merging apically. About twelve costae visible laterally.

Further remarks: Distally more inflated forms (*Combusta* sp. A of Yeh, 1987b) and forms with slight constrictions (*Combusta* sp. B of Yeh, 1987b) are regarded as intraspecific variability of *Archaeodictyomitra munda* (Yeh).

Measurements (µm):
Ten specimens measured.

	Length of test (max.)	Width of test (max.)
HT	200	94
Mean	195	90
Max.	200	94
Min.	190	85

Etymology: *Mundus-a-um* (Latin, adj.) = elegant.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde and Snowshoe formations of east-central Oregon; Fannin Formation, Queen Charlotte Islands; Skrile Formation, Slovenia; Japan.

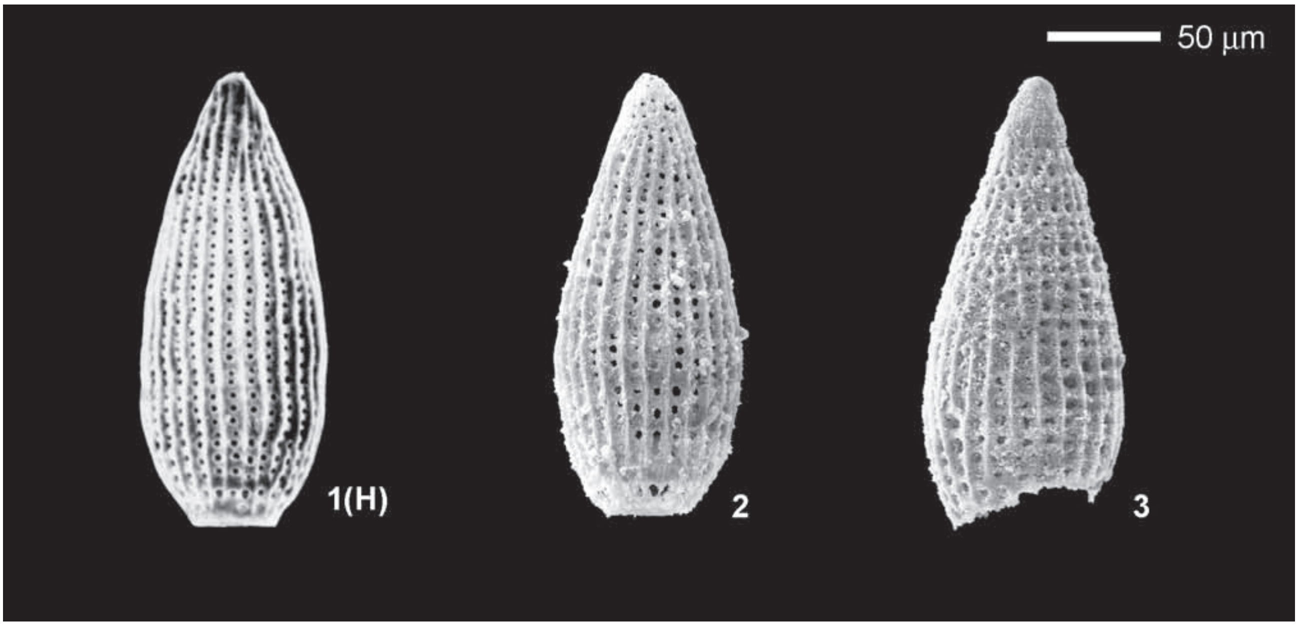


Plate ADM01. *Archaeodictyomitra munda* (Yeh). Magnification x300. **Fig. 1(H).** Yeh 1987b, pl. 19, fig. 11. **Fig. 2.** Matsuoka 2004, fig. 187. **Fig. 3.** Goričan et al. 2003, pl. 5, fig. 14.

Archaeodictyomitra sp. A
Species code: ADM02

Synonymy:
1989 *Lupherium* ? sp. C – Hattori, pl. 16, fig. D.
2004 *Archaeodictyomitra* sp. – Matsuoka, fig. 186.

Remarks: Test spindle-shaped with cephalis, thorax, abdomen and an undetermined number of post abdominal chambers that gradually increase in width as added. Narrow, linearly arranged costae, 12-14 arranged over test; costae converging apically. Single row of pores between costae; pores relict on early chambers becoming more open distally.

This is one of the oldest species of *Archaeodictyomitra* (earliest Pliensbachian) and may be ancestral to *A. munda* (Yeh). *A.* sp. A is smaller (length <150μm) than *A. munda* and the final chamber/s are not constricted.

Occurrence: Ghost Creek Formation, Queen Charlotte Islands; Mino Terrane, Japan.

Archaeodictyomitra sp. B
Species code: ADM03

***Remarks*:** Test large, narrowly conical apically becoming almost tubular toward aperture. Coarse linearly arranged costae (12-14) on exterior of test; costae with rounded edges. Cephalis and thorax covered with a heavy layer of microgranular silica.

***Occurrence*:** Fannin Formation, Queen Charlotte Islands.

Genus: *Archaeohagiastrum* Baumgartner 1984
Type species: *Archaeohagiastrum munitum* Baumgartner 1984

Synonymy:
1984 *Archaeohagiastrum* n. gen – Baumgartner, p. 758

Original description: Test composed of four rays, placed at right angles and of about equal length. The rays are formed of a primary beam, three primary canals and six external beams.

Original remarks: The rays of *Archaeohagiastrum* correspond to the medullary rays of the more evolved hagiastrins and represent the simplest possible hagiastrid structure. It was referred to as ancestor of *Hagiastrum* in Baumgartner (1980, Textfig. 7 and p. 284). *Tetraporobracchia* Kozur and Mostler 1979 has the same ray structure but rays are arranged along tetraedric or cubic axes. *Archaeotriastrum* De Wever 1981b has a similar ray structure but has three rays. Because of its simple ray structure this genus is tentatively included with the hagiastrins. It should, together with *Archaeotriastrum,* be assigned to a new subfamily ancestral to the Hagiastrinae.

Etymology: From the Greek *archaeo* = ancient, ancestral form to *Hagiastrum.*

Included species:
3149 *Archaeohagiastrum longipes* Baumgartner 1995
3271 *Archaeohagiastrum munitum* Baumgartner 1984
HAG01 *Archaeohagiastrum oregonense* (Yeh) 1987b
HAG02 *Archaeohagiastrum pobi* Whalen & Carter 1998

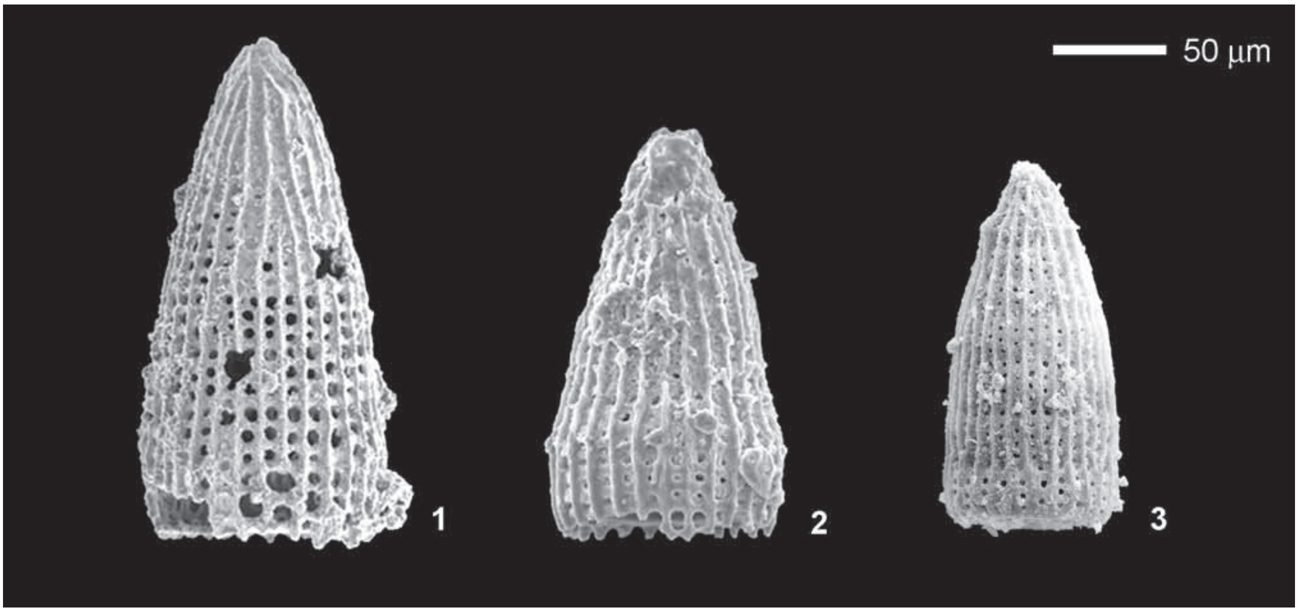


Plate ADM02. ***Archaeodictyomitra* sp. A.** Magnification x300. **Fig. 1.** QCI, C-080612, GSC 128708. **Fig. 2.** QCI, GSC loc. C-305388, GSC 128709. **Fig. 3**. Matsuoka 2004, fig. 186.

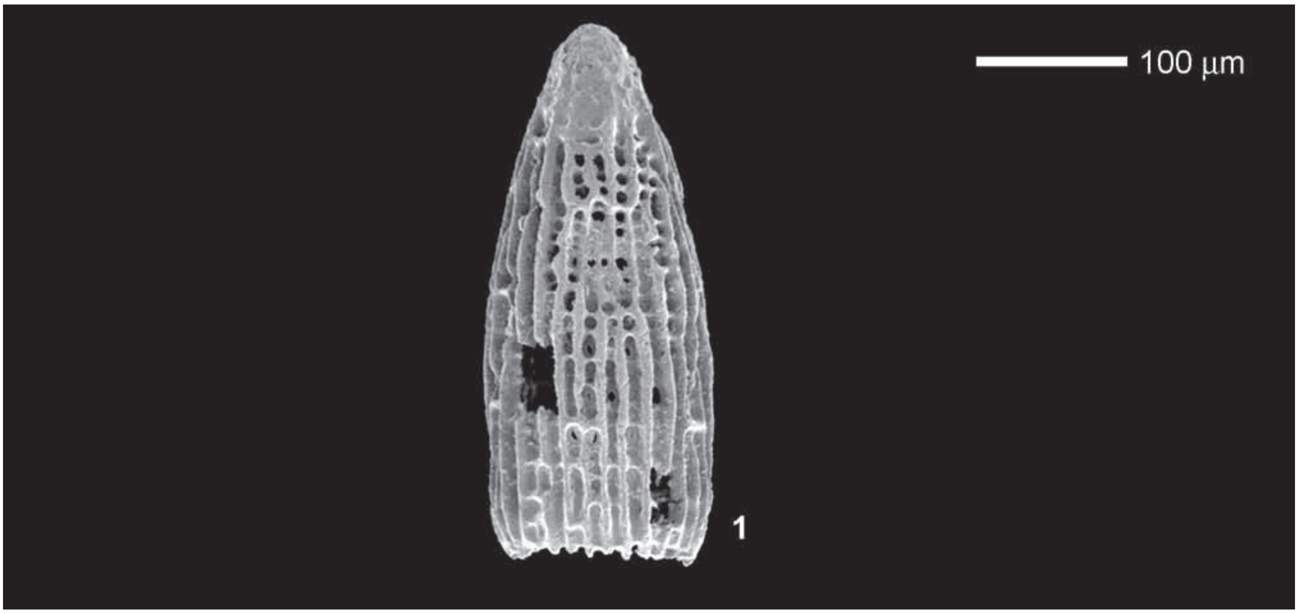


Plate ADM03. ***Archaeodictyomitra* sp. B.** Magnification x200. **Fig. 1.** QCI, GSC loc. C-140495, GSC 128710.

Archaeohagiastrum longipes Baumgartner 1995

Species code: 3149

Synonymy:

1982 *Tetratrabs* sp. - Kishida & Sugano 1982, pl. 6, fig. 11.
1987 *Archaeohagiastrum* sp. A – Hattori, pl. 3, figs. 3-4.
1988 *Archaeohagiastrum* sp. A – Hattori, pl. 5, fig. B.
1988 *Tetratrabs* sp. aff. *T. gratiosa* Baumgartner – Carter et al., p. 30, pl. 7, fig. 10.
1989 *Archaeohagiastrum* sp. – Hattori, pl. 4, fig. F.
1989 *Archaeohagiastrum* sp. A – Hattori, pl. 25, fig. F.
1991 *Tetratrabs* sp. aff. *T. zealis* (Ozvoldova) – Carter & Jakobs, p. 344, pl. 2, fig. 7.
1995a *Archaeohagiastrum longipes* Baumgartner n. sp. – Baumgartner et al., p. 106, pl. 3149, figs. 1-6.
1996 *Archaeohagiastrum* sp. A – Yeh & Cheng, p. 96, pl. 1, fig. 2; pl. 8, figs. 6, 7, 12.
1997 *Archaeohagiastrum longipes* Baumgartner – Yao, pl. 7, fig. 334.

Original description: Form with four smooth slender rays of about equal length about at right angles, constructed as with genus. One row of large circular pores between each external beam. Beam cross-section hexagonal. Central area small, smooth, with small, irregular pores or with 4-7 small nodes. Lateral beams are continuous around the central area. The external beams of rays are smooth or slightly nodose. Ray tip sometimes slightly thickened, with short three-bladed central spine.

Original remarks: This species differs from *A. munitum* by distincly longer and slenderer rays and a generally less nodose test surface. Central knobs are present but much less developed than with *A. munitum.*

Measurements (μm):
Based on 7 specimens.

	HT	av.	min.	max.
Length of rays AX	208	210	192	218
Length of rays BX	198	-	-	-
Length of rays CX	195	-	-	-
Length of rays DX	-	-	-	-
Width of rays	41	45	33	47
Width of central area	70	75	65	82

Etymology: *Longipes*, latin for "long-footed" named for its long rays compared to the type species of this genus.

Type locality: Sample OR 554, Snowshoe Formation, East-Central Oregon.

Occurrence: Snowshoe Formation, east-central Oregon; Phantom Creek Formation, Queen Charlotte Islands; Italy; Dürrnberg Formation, Austria; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines; Japan.

Archaeohagiastrum munitum Baumgartner 1984

Species code: 3271

Synonymy:

1982 *Crucella* sp. A – Sashida et al., pl. 1, fig. 9.
1982 *Tetratrabs* sp. B – Wakita, pl. 5, fig. 4.
1984 *Archaeohagiastrum munitum* n. sp. – Baumgartner, p. 759, pl. 2, figs. 9-13.
1985 *Archaeohagiastrum munitum* Baumgartner – Nagai, pl. 2, figs. 5-5a.
1985 *Archaeohagiastrum munitum* Baumgartner – Yamamoto et al., p. 34, pl. 3, figs. 7a-b.
1988 *Tetraditryma* sp. B – Carter et al., p. 31, pl. 16, fig. 8.
1990 *Archaeohagiastrum munitum* Baumgartner – Kito et al. 1990, pl. 1, fig. 6.
1994 *Archaeohagiastrum munitum* Baumgartner – Goričan, p. 62, pl. 5, fig. 14.
1995a *Archaeohagiastrum munitum* Baumgartner – Baumgartner et al., p. 108, pl. 3271, figs. 1-6.
1997 *Archaeohagiastrum munitum* Baumgartner – Yao, pl. 7, fig. 335.

Original description: Small form with four smooth to nodose rays of about equal length constructed as with genus. Central area small, occupied by four to five broad, highly raised, connected nodes, which alternate with four pores placed at the proximal termination of the median beams. The fifth node is central or slightly excentric and fused to one of the corner nodes. A nearly centrally placed pore often occurs. Lateral beams are continuous around the central area. The external beams of rays are slightly to strongly nodose, nodes increase in size towards central area and are sometimes connected by a blade like ridge. Ray tip blunt or with short central spine of round cross section.

Original remarks: *A. munitum* differs from other yet undescribed species of this genus by being distinctly smaller and by having a strongly nodose test.

Measurements (μm):
Based on 7 specimens.

	min.	max.	av.	HT
Length of rays AX:	114	-	-	-
Length of rays BX:	120	-	-	-
Length of rays CX:	108	-	-	-
Length of rays DX:	111	95	87	120
Width of rays:	51	42	35	51
Maximum length of spines:	66	48	28	66
Width of central nodose area:	65	60	47	76

Etymology: *Munitum*: fortified, protected (Latin), referring to the nodose surface of test and central area.

Type locality: Blake Bahama Basin, West Atlantic (DSDP Leg 71, Site 534).

Occurrence: Worldwide.

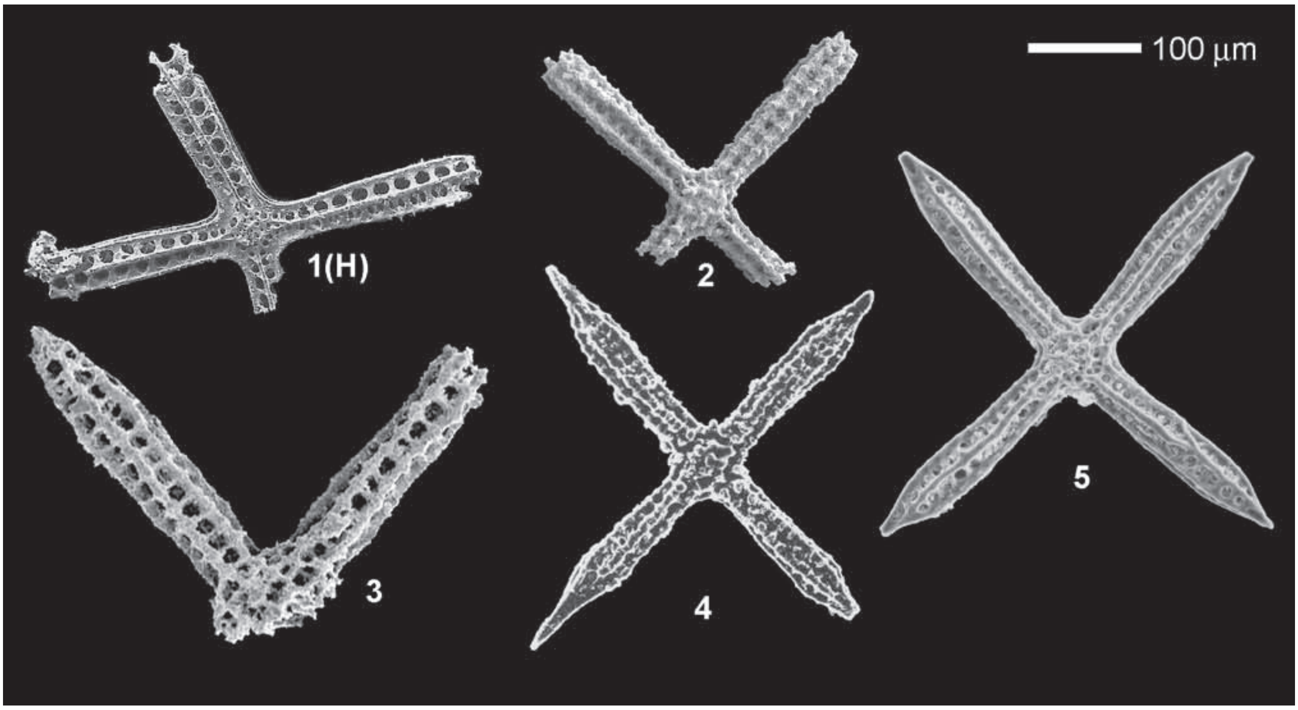


Plate 3149. *Archaeohagiastrum longipes* Baumgartner. Magnification x150. **Fig. 1(H).** Baumgartner et al. 1995a, pl. 3149, fig. 4. **Fig. 2**. OM, BR871-R03-07. **Fig. 3**. AT, BMW21-31. **Fig. 4.** Carter et al. 1988, pl. 7, fig. 10. **Fig. 5.** Carter & Jakobs 1991, pl. 2, fig. 7.

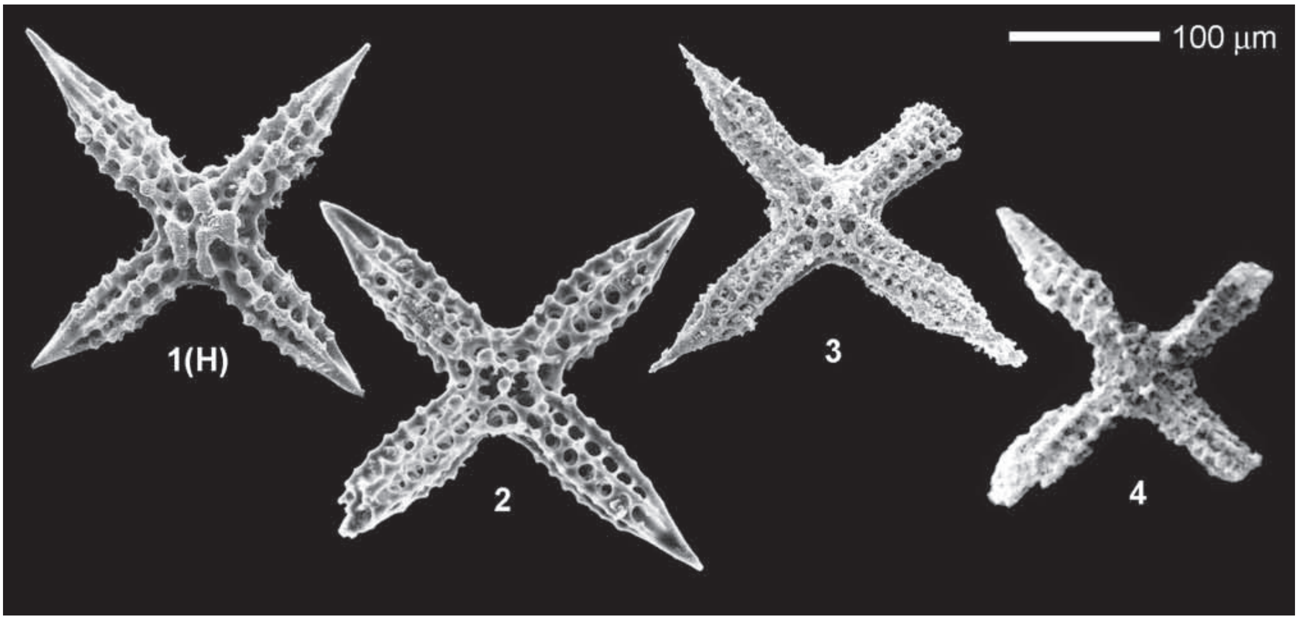


Plate 3271. *Archaeohagiastrum munitum* Baumgartner. Magnification x200. **Fig. 1(H).** Baumgartner 1984, pl. 2, fig. 9. **Fig. 2.** Carter et al. 1988, pl. 16, fig. 8. **Fig. 3.** JP, MNA-10, MA11555. **Fig. 4.** JP, NK9-62.

Archaeohagiastrum oregonense (Yeh) 1987b

Species code: HAG01

Synonymy:

1987 *Tetraditryma* sp. A – Hattori, pl. 3, fig. 1.

1987b *Higumastra oregonensis* n. sp. – Yeh, p. 26, pl. 8 figs. 7, 15, 20; pl. 23, fig. 16; pl. 29, figs. 11, 18.

1990 *Higumastra oregonensis* Yeh – Nagai, pl. 5, fig. 2.

1998 *Archaeohagiastrum* sp. aff. *A. pobi* n. sp. – Whalen & Carter, p. 45, pl. 10, figs. 1, 6, 10, 13, 17.

Original description: Rays relatively uniform in width, elongate, with short massive primary spines. Primary spines triradiate proximally, circular in cross section distally. Central area small, square in outline. Rays nearly equal in length, comprised of three rows of tetragonal pore frames. Central area of cortical shell consisting of pentagonal and hexagonal pore frames quadrilaterally arranged. Pore frames larger on rays; all pore frames without prominent nodes at vertices. Test with or without patagium.

Measurements (μm):

Ten specimens measured.

	Length of ray	Width of ray	Width of central area	Length of spine
HT	92	31	61	30
Mean	95	28	58	42
Max.	101	31	61	45
Min.	78	24	54	30

Type locality: Locality 600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde and Snowshoe formations, Oregon; Sandilands Formation, Queen Charlotte Islands; Japan.

Archaeohagiastrum pobi Whalen & Carter 1998

Species code: HAG02

Synonymy:

1998 *Archaeohagiastrum pobi* n. sp. – Whalen & Carter, p. 44, pl. 10, figs. 3, 4, 5, 9.

1998 *Pseudocrucella* sp. A – Cordey, p. 70, pl. 20, fig. 1.

Original description: Test composed of four short rays at right angles, terminating in very long, massive, triradiate spines. Each ray comprised of an internal primary beam, three primary canals and six external beams. External spine ridges and grooves part of integral geometry of four-rayed test. Longitudinal beams developed on edges of each spine ridge (two per spine, totaling six beams); transverse bars connecting these beams creating linear rows of fairly regular pore frames, most tetragonal (four to fine horizontal rows of pores per ray). Large raised elliptical to subrectangular nodes aligned perpendicular to beams; nodes located at vertices of external beams and transverse bars. Three hagiastrid canals formed by transverse bars spanning the deeply grooved spine ridges. Central area large, composed mostly of triangular pore frames with large subrounded nodes at vertices. Spines very long with broad, rounded ridges and deep rounded grooves.

Original remarks: Baumgartner (1980, p. 284) wrote, "An early Sinemurian sample (QC 549) contains 3 types of hagiastrids. One of them, a possible ancestor of *Hagiastrum*, has a central area similar to the *Emiluvia*-like forms" (=*Udalia* in this paper) "and possesses 3 primary canals and 6 external beams. It seems possible that this form is the first hagiastrid and has evolved from *Emiluvia*-like forms by developing transverse bars between raised ridges of primary spines and thus enclosing primary grooves to form primary canals". We believe the two species of *Archaeohagiastrum* discussed and illustrated here conform to this statement. *Archaeohagiastrum pobi* n. sp. differs from *A. munitum* Baumgartner by the arrangement of pores and/or nodes in the central area and by having much longer spines. See *A.* sp. aff. *A. pobi* n. sp. for further comparison.

Measurements (μm):

Based on 9 specimens.

	Length of longest ray	Width of widest ray	Length of longest spine
HT	134	50	260
Max.	134	64	260
Min.	94	41	103
Mean	114	50	170

Etymology: Species name formed by an arbitrary combination of letters (ICZN, 1985, p. 109, Appendix D, pt. V, Recommendation 26). Species named in honour of Dr. Peter O. Baumgartner (POB), Université de Lausanne who investigated the early history of the hagiastrids (Baumgartner, 1980) and whose ideas have led us to the description of the earliest species of *Archaeohagiastrum* and *Hagiastrum*.

Type locality: Locality 89-CNA-KUH-8, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia, Canada.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; Bridge River Complex, British Columbia.

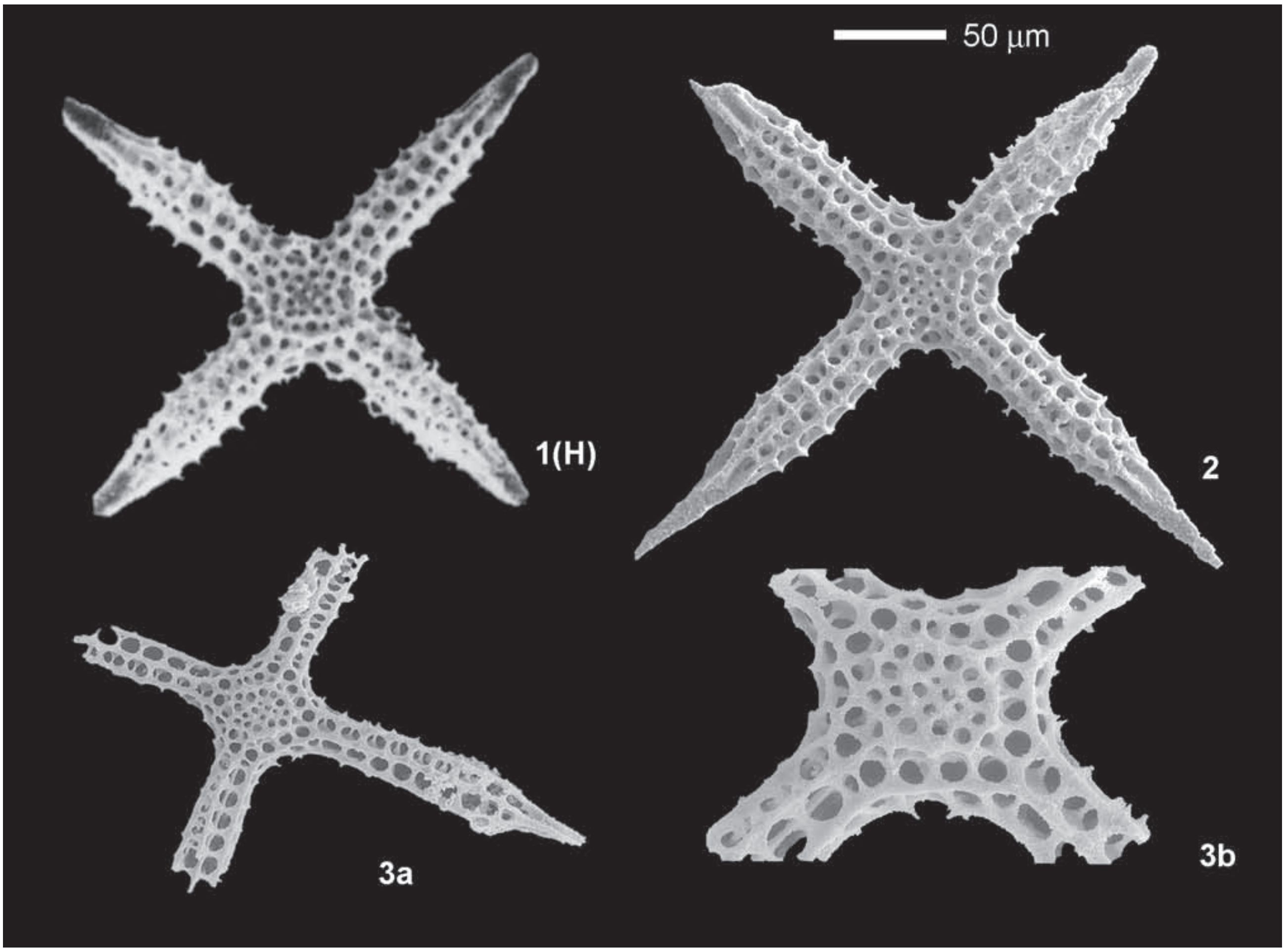


Plate HAG01. ***Archaeohagiastrum oregonense*** **(Yeh).** Magnification x300, except Fig. 3b x600. **Fig. 1(H).** Yeh 1987b, pl. 8, fig. 7. **Fig. 2.** OR600A-R03-11. **Fig. 3.** OR, OR600A, Fig. 3a. R1-1311b, Fig. 3b. R1-1311a.

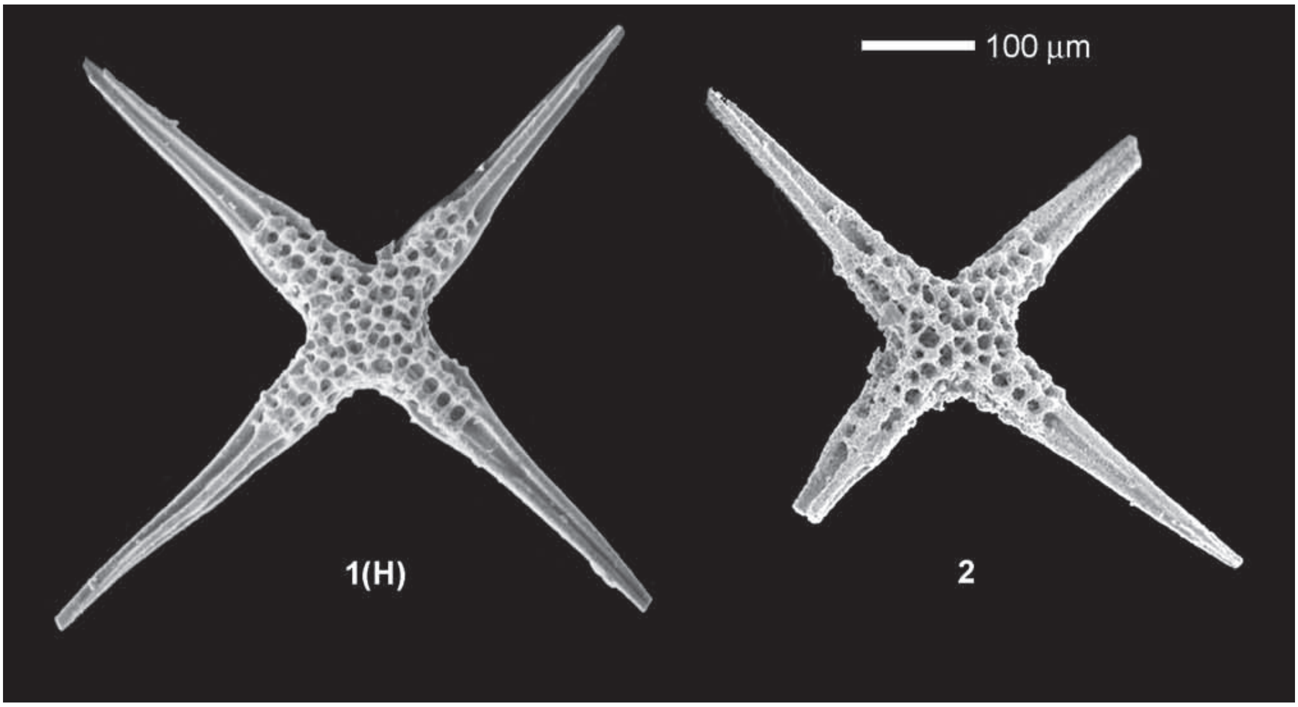


Plate HAG02. ***Archaeohagiastrum pobi*** **Whalen & Carter.** Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 10, fig. 3. **Fig. 2.** QCI, GSC loc. C-305417, GSC 128801.

Genus: ***Archaeospongoprunum*** Pessagno 1973

Type species: *Archaeospongoprunum venadoense* Pessagno 1973

Synonymy:

1973 *Archaeospongoprunum* n. gen. – Pessagno, p. 57.

Original description: Test cylindrical, ellipsoidal, or ellipsoidal and lobate with two polar spines; polar spines triradiate or tetraradiate in axial section with longitudinally or spirally arranged ridges alternating with grooves. Spongy meshwork comprised of polygonal pore frames arranged in concentric layers.

Original remarks: *Archaeospongoprunum,* n. gen., differs from *Spongoprunum* Haeckel by possessing polar spines with longitudinal grooves separated by longitudinal ridges. A number of species of *Archaeospongoprunum* have grooves and ridges that assume a spiral rather than a longitudinal arrangement.

Included species:

ASP01 *Archaeospongoprunum coyotense* Whalen & Carter 2002

Archaeospongoprunum coyotense Whalen and Carter 2002

Species code: ASP01

Synonymy:

1987 ?*Archaeospongoprunum* spp. – Hattori, pl. 22, fig. 8.
1989 *Archaeospongoprunum* sp. – Hattori & Sakamoto, pl. 18, fig. L.
2002 *Archaeospongoprunum coyotense* n. sp. – Whalen & Carter, p. 110, pl. 4, figs. 1, 2, 6, 7, 10.

Original description: Test elongated along polar axis, cylindrical in shape; test surface planiform where it joins polar spines. Meshwork moderately coarse, composed of large, irregularly shaped and distributed pentagonal pore frames. Polar spines massive, triradiate in axial section with narrow, rounded longitudinal ridges and steep-sided, longitudinal grooves; longitudinal ridges sometimes split along proximal margin (see holotype).

Original remarks: *Archaeospongoprunum coyotense* n. sp., is distinguished from *A. bipartitum* Pessagno 1973, by having stronger triradiate spines, more irregular pore frames and the absence of a sulcus. *A. coyotense* n. sp. is similar to *Archaeospongoprunum* sp. B (pl. 5, no. 199) and *A.* sp. B2 (pl. 5, no. 201) of Yao 1997; it differs from the former in having more tapering spines, and from the latter in having a more cylindrical test.

Measurements (μm):

(Refer to text-figure 7 of Whalen & Carter, 2002).

(n) = number of specimens measured

AA'(9)	A'S'(8)	AS(8)	BB'(9)	cc'(9)	dd'(9)	
120	180	53	101	38	38	HT
165	206	195	131	38	38	Max.
120	143	105	90	23	26	Min.
142	165	141	107	31	33	Mean

Etymology: This species is named for Estero de Coyote located to the southeast of the type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Japan.

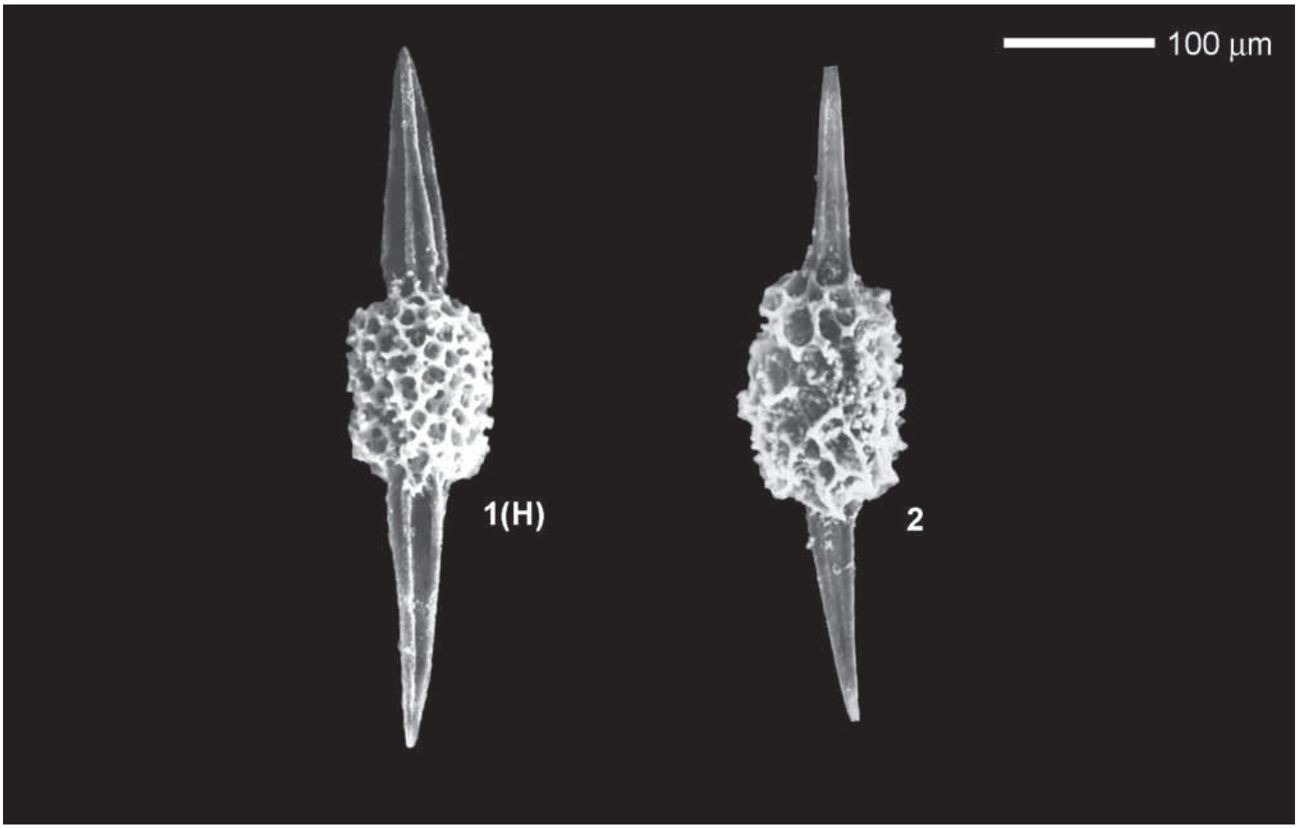


Plate ASP01. *Archaeospongoprunum coyotense* Whalen & Carter. Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 4, fig. 1. **Fig. 2.** Whalen & Carter 2002, pl. 4, fig. 2.

Genus: *Archaeotritrabs* Steiger 1992, emend. Jud 1994

Type species: *Archaeotritrabs gracilis* Steiger 1992

Synonymy:

1992 *Archaeotritrabs* n. gen. – Steiger, p. 40.
1994 *Archaeotritrabs* Steiger emend. – Jud, p. 64.
1995a *Archaeotritrabs* Steiger emend. Jud – Baumgartner et al., p. 112.

Original description: Hagiastrid with three arms composed of 6 longitudinal ribs, which generate a hexagonal cross section of the arms. The longitudinal ribs are noddy. Between them 6 rows of simple pore frames occur. The arm tips increase in width and have a rounded to trapezoidal contour. The arm tips can have spines.

Emended description: By Jud (1994): Test three-rayed. Rays of equal length, composed of 8 beams. Cross-section of rays rectangular to octogonal. Beams connected with one another by bars forming rectangular pores on the upper and lower sides of the test, and rectangular to trapezoidal pores on the lateral sides. Ray tips inflated, with small, polygonal pore-frames and usually with spines.

Original remarks: The genus *Archaeotritrabs* differs from the genera of the subfamiliy of the Tritrabinae by having simple pore rows between longitudinal ribs. After Baumgartner (1980) the Tritrabinae are defined by double pore rows. It is questionable whether these forms can be related to the Tritrabinae on the base of the hexagonal cross section of the arms. The morphological range of the group should be extended in the sense of having simple pore rows. Otherwise a new subfamily should be created to include simple pore rows on the same level as double pore rows. Because of the rare material this is actually impossible.

Further remarks: By Jud (1994): The genus was described as possessing 6 longitudinal beams on each ray. This interpretation is a result of insufficient observation of the lateral parts of the rays. Specimens unquestionably assignable to *A. gracilis* Steiger occurring in our material prove that this species has 8 beams and that the rays have a subrectangular cross-section. Moreover, cross-sections show that the rays have 4 channels and not 3, as characteristic of *Tritrabs* (P. Dumitrica, personal communication, and pl. 4, fig. 7).

Etymology: Greek: *archaios* – old. Designation signifying that it is the probable ancestor of the genus *Tritrabs*.

Included species:

ATT01 *Archaeotritrabs hattorii* Dumitrica n. sp.

Archaeotritrabs hattorii Dumitrica n. sp.

Species code: ATT01

Synonymy:

1985 *Homoeoparonaella* sp. B – Nagai, pl. 1, figs. 5, 5a.
1987 *Homoeoparonaella* sp. O – Hattori, pl. 3, figs. 16, 17.
1987 *Tritrabs* (?) sp. C – Hattori, pl. 3, fig. 18.
1989 *Tritrabs* spp. – Hattori, pl. 38, fig. B.

Type designation: Holotype pl. ATT01, fig. 3, sample BR871, chert of Tawi Sadh Member reworked in the Guwayza Formation, Al Khashbah Mountains, Oman.

Description: Rays equal in length, slender, spindle-shaped, increasing slowly in diameter up to the distal third, then decreasing to terminate in a pointed tip. Sometimes there are 2 lateral spines in the equatorial plane originating in the transverse ridges of lateral faces. Rays approximately octagonal in cross-section, with 8 rows of pores separated by 8 longitudinal beams. Pore frames rectangular but of two types: those on oblique faces are simple whereas those on upper, lower and lateral faces have high transverse ridges and 2 pores in each rectangle separated by the branches of the primary ray which form the 4 canals. One row usually offset with pore frames of neighbouring rows. All vertices of pore frames pointed. Central area large and triangular outlined by three beams that connect the two longitudinal beams on the face of each ray.

Remarks: *Archaeotritrabs hattorii* differs from *A. gracilis* Steiger in having spindle-shaped rays with pointed tips, and lacks nodes on rays. The triangular area in the center of shell is a characteristic also known in *Tritrabs casmaliaensis* (Pessagno). In the latter species the triangle has one cortical beam in each corner, whereas *A. hattorii* has two. All other characteristics, except the microsphere, differ in these two species. The central part of the test of *A. hattorii* is very thin, the cortical shell in the center of the triangular area includes the top and the bottom of the microsphere as illustrated for *Tritrabs* and the Tritrabidae (Dumitrica in De Wever et al., 2001).

Measurements (µm):
Based on 4 specimens.

	HT	Min.	Max.
Length of rays from the center to the distal end	140	115	140
Maximum diameter of rays	32	22	47

Etymology: The species is named for Dr. Isamu Hattori, Geological Laboratory, Fukui University, Japan, to honour his valuable contribution to the knowledge of Jurassic radiolarians of Japan.

Type locality: Sample BR871, chert of Tawi Sadh Member reworked in the Guwayza Formation, Al Khashbah Mountains, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Oman; Mino Terrane, central Japan.

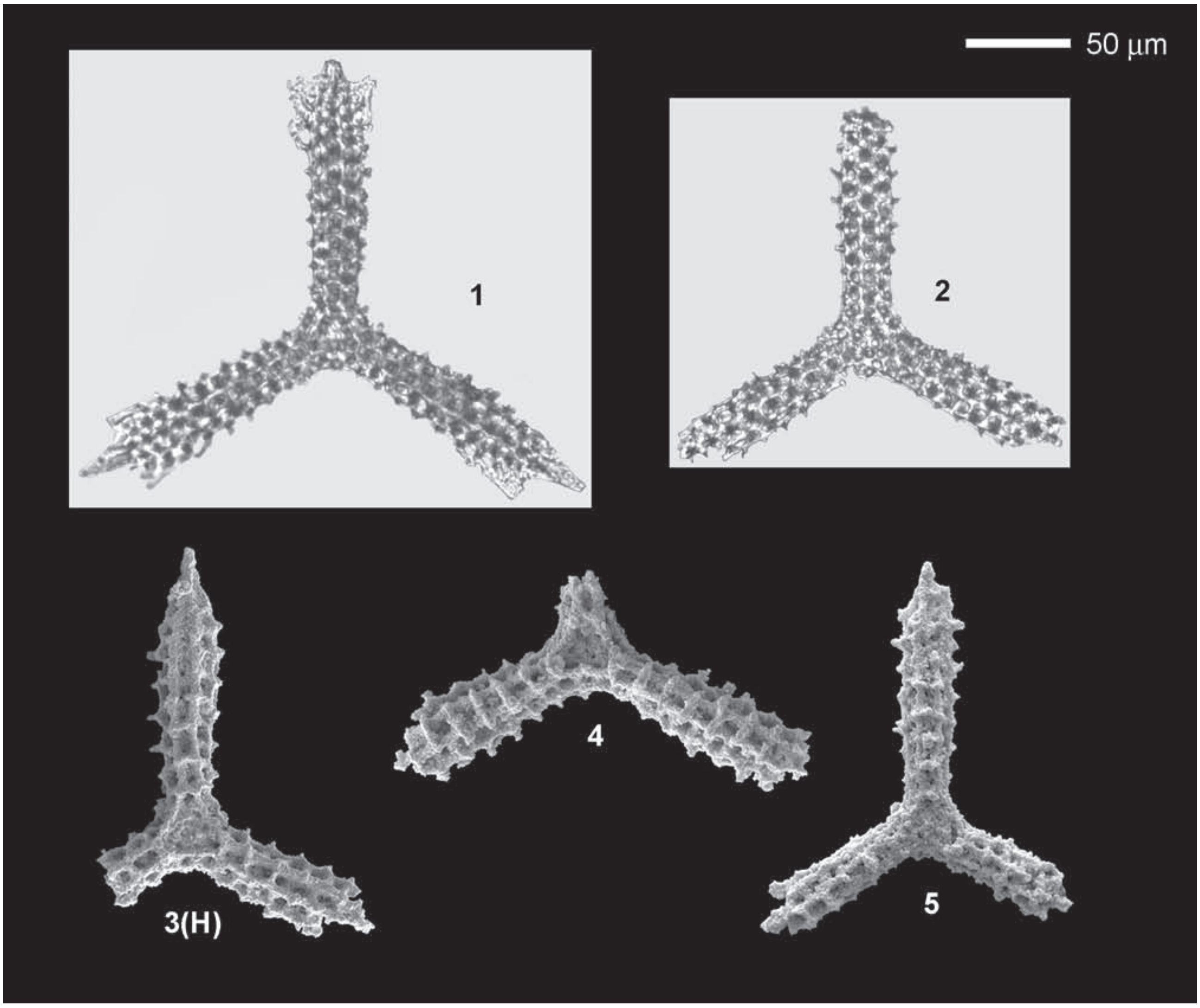


Plate ATT01. *Archaeotritrabs hattorii* Dumitrica n. sp. Magnification x300. **Fig. 1.** JP, Nanjo Massif, IH84120461. **Fig. 2.** JP**,** Nanjo Massif, IH84120461. **Fig. 3(H).** OM, BR871-R09-12. **Fig. 4**. OM, BR871-R04-14. **Fig. 5.** OM, BR871-R04-15.

Genus: *Ares* De Wever 1982a

Type species: *Ares armatus* De Wever 1982a

Synonymy:

1982a *Ares* n. gen. – De Wever, p. 202.
1986 *Parares* n. gen – Takemura, p. 46.

Original description: Form with three very strong spines, recurved or not, corresponding to the extensions of the cephalic spines A, V, and D. Six collar pores of variable size; the largest are the cardinal pores, the smallest are the jugular pores. Collar structure not plane, jugular and especially cervical pores are oblique to the cardinal pores. Spines A and V free, spine D attached to the shell by bridges. Cephalis small, hemispherical. Thorax robust with two spines as extensions of D and V. Pores of the flared post-thoracic part (abdomen ?, velum ?) distributed in more or less regular longitudinal rows.

Original remarks: This genus differs from *Dictyoceras*, some species of which resemble *A. armatus* n. sp., in having two thoracic arms (extensions of V and D) instead of three. It is distinguished from other genera by these two characteristic arms.

Further remarks: Species lacking an apical horn or having only a very short one were assigned to *Parares* by Takemura (1986). These species were later included in the genus *Ares*, with *Parares* considered a junior synonym (Baumgartner et al., 1995a), since the length of the apical horn is not considered a generic character. In fact if we take into account the range of the species as known thus far and the morphology one can see that the evolution of the genus followed a trend towards reduction of the apical horn and eventually its disappearance together with exaggerated development of the ventral spine. During this evolution the ventral spine changed its position and shape from obliquely downward directed and straight (in the Sinemurian species *A. moresbyensis* Whalen & Carter and *A. sutherlandi* Whalen & Carter) to obliquely upward directed and recurved (in the Toarcian species *A. avirostrum* n. sp. and the Aalenian-Bajocian species *A. cylindricus* Takemura). Its exaggerated development pushed the cephalis to the dorsal side of the apex of shell. In this process the apical horn changed also its position from practically axial (in the Sinemurian species) to dorso-apical. During the Pliensbachian the apical horn and ventral spine are already almost symmetrically curved and displaced from the shell axis (*A. cuniculiformis* n. sp.) and during the Toarcian the apical horn is already shorter than the ventral spine (*A. avirostrum* n. sp.).

Etymology: Ares is the Greek War God, son of Zeus and Hera, who was involved in the Trojan war when his daughter Penthesilea was killed by Achilles.

Included species and subspecies:

ARS03 *Ares armatus* De Wever 1982a
ARS07 *Ares avirostrum* Dumitrica & Matsuoka n. sp.
ARS06 *Ares cuniculiformis* Dumitrica & Whalen n. sp.
4061 *Ares cylindricus* s.l. (Takemura) 1986
3001 *Ares cylindricus cylindricus* (Takemura) 1986
4032 *Ares cylindricus flexuosus* (Takemura) 1986
ARS04 *Ares mexicoensis* Whalen & Carter 2002
ARS01 *Ares moresbyensis* Whalen & Carter 1998
ARS02 *Ares sutherlandi* Whalen & Carter 1998
ARS08 *Ares takemurai* Dumitrica & Matsuoka n. sp.
4008 *Ares* sp. A sensu Baumgartner et al. 1995a

Ares armatus De Wever 1982a

Species code: ARS03

Synonymy:

1982a *Ares armatus* n. sp. – De Wever, p. 203, pl. 10, figs. 1-4.
1982a *Ares* sp. 1 – De Wever, p. 203, pl. 10, figs. 5, 6.
1982b *Ares armatus* De Wever – De Wever, p. 335, pl. 51, figs. 2, 4, 5, 8.
1982b *Ares* sp. 1 – De Wever, p. 336, pl. 52, figs. 1, 2.
2004 *Ares armatus* De Wever – Matsuoka, fig. 131.

Original description: Cephalis small, spherical, not perforated, with an irregular, slightly pustulate surface. Apical horn curved towards the frontal side, triradiate; grooves correspond to the location of the secondary lateral (l) and vertical (V) spines of the cephalic skeleton. Thorax has an irregular surface, because of ribs between pores. Thoracic pores and post-thoracic pores circular, closely similar in size. Pores often subdivided by a star-shaped lattice. Vertical spine free, sub-rectilinear, triradiate; one ridge attached to the cephalis-thorax junction, prolongs the V spine. Dorsal spines triradiate, slightly curved, and linked to the shell by latticed bridges. Post-thoracic part (velum or abdomen ?) forms a perforated veil which extends the thorax. Circular pores quincuncially distributed on longitudinal rows. Post-thoracic part has a stricture before a distal widening.

Original remarks: This species differs from *Ares* sp. by having a partly vertical apical horn, well-differentiated thorax with larger pores, a sub-rectilinear vertical spine, and narrowing on the post-thoracic part close to the thorax.

Measurements (µm):

	HT	Av.	Min.	Max.
total length (apical horn included)	205	206	200	220
length of cephalis + thorax + post-thoracic part	140	135	100	160
cephalis length	20	21	20	24
cephalis width	30	29	25	33
thorax length	30	30	30	32
thorax width	70	72	70	80
approx. length of the curved apical horn	155	150		
length of vertical spines	125		120	160
length of dorsal spine	130		130	140

Etymology: From the Latin *armatus, -a, -um*, adj. = armed. Refering to martial look that evokes an Antiquity soldier.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Nanjo Massif, Mino Terrane, central Japan.

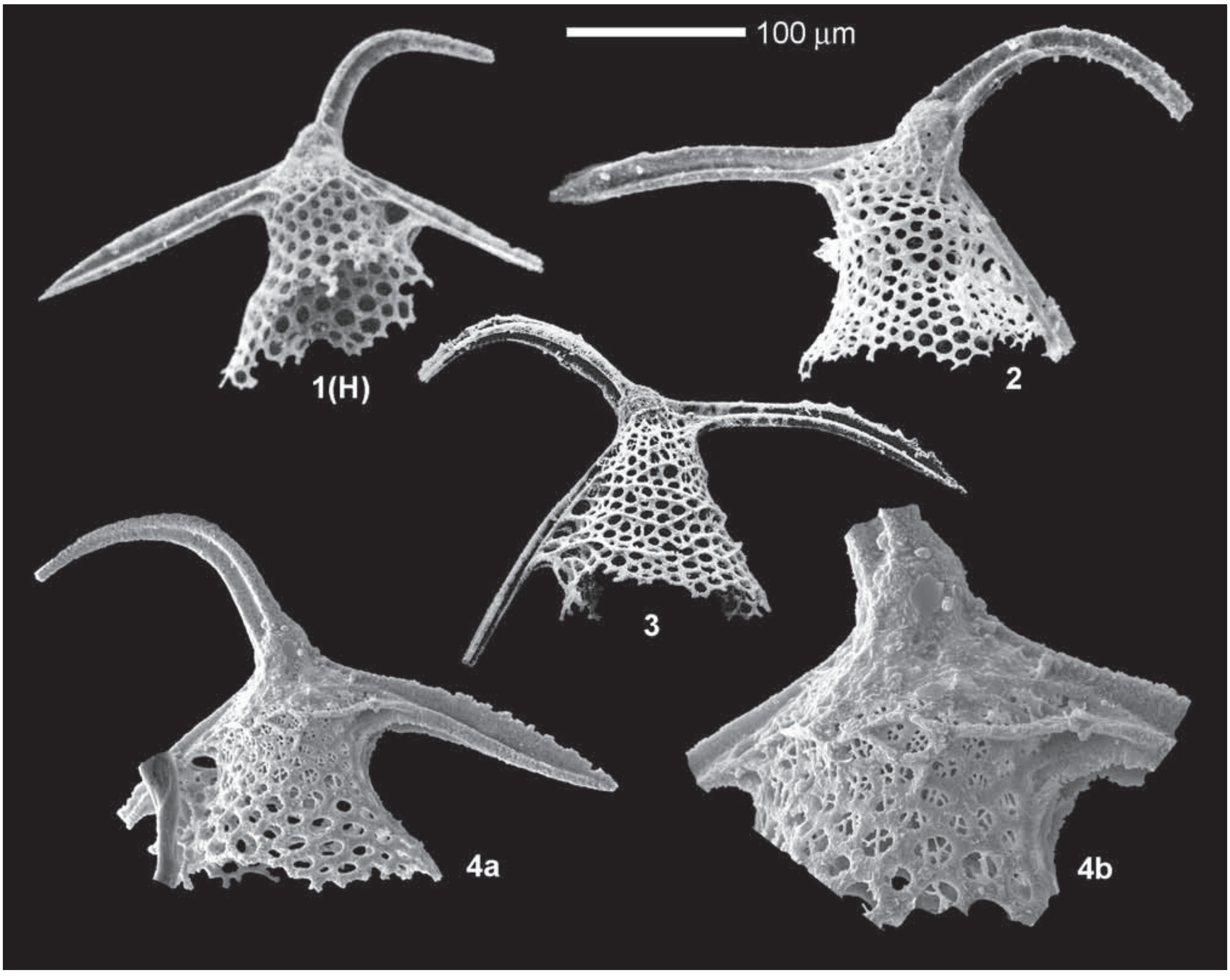


Plate ARS03. *Ares armatus* De Wever. Magnification x250, except Fig. 4b x500. **Fig. 1(H).** De Wever 1982a, pl. 10, fig. 4. **Fig. 2**. Matsuoka 2004, fig. 131. **Fig. 3.** De Wever 1982a, pl. 10, fig. 5. **Fig. 4a, b.** TR, 1662D-R11a, b.

Ares avirostrum Dumitrica & Matsuoka n. sp.

Species code: ARS07

Synonymy:

? 1987 *Cuniculiformis* sp. D – Hattori, pl. 20, fig. 14.
1989 *Ares* spp. – Hattori, pl. 34, figs. L, M.
2004 *Ares* sp. – Matsuoka, fig. 132.

Type designation: Holotype specimen MA 13750 from sample MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Diagnosis: A species of *Ares* with apical horn much shorter than ventral spine; dorsal spine straight running along thorax, and thorax campanulate with thick, undulate distal end.

Description: Test conical with a slight constriction at the middle of thorax resulting in a campanulate shape. Cephalis small, poreless, displaced on the dorsal side of the apical part of shell. Ventral spine long, curved, and bladed. Apical horn much shorter than ventral spine; obliquely upward directed and slightly curved when longer. Dorsal spine straight, thin, circular in cross section beyond thorax; it is longer than the thorax and tangential to it. Pores of thorax quincuncially arranged, pore frames usually hexagonal, increasing in size distally. Distal end of thorax expanded, thick, and undulate.

Remarks: *Ares avirostrum* n. sp. differs from all the other species of the genus so far known in that the distal part of thorax is clearly delineated. It is morphologically intermediate between *A. cuniculiformis* n. sp. and *A. cylindricus* Takemura. From the former it differs in having a much shorter apical horn; from the latter it differs in having a rather long apical horn and a straight dorsal spine, which is adjacent to the wall of thorax. *A. avirostrum* is very close to *Ares takemurai* n. sp. but differs in being slightly more slender and the distal part of thorax is constricted and built of intervening bars that become thinner and thinner. *Ares* sp. A of Baumgartner et al. (1995a) differs from *Ares avirostrum* n. sp. in having a more robust and curved dorsal spine and a narrower thorax.

Measurement (μm):
Based on 15 specimens.

Dimensions	HT	Min.	Max.
Length of test without spines	167	160	200
Diameter of thorax	161	140	197
Length of apical horn	48	30	63
Length of ventral spine	173	100	173

Etymology: From the Latin *avis* – bird and *rostrum* – beak; noun.

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, central Japan (Matsuoka, 2004).

Occurrence: Mino Terrane, Japan; Tawi Sadh Member, Guwayza Formation, Oman; Fernie Formation, NE British Columbia.

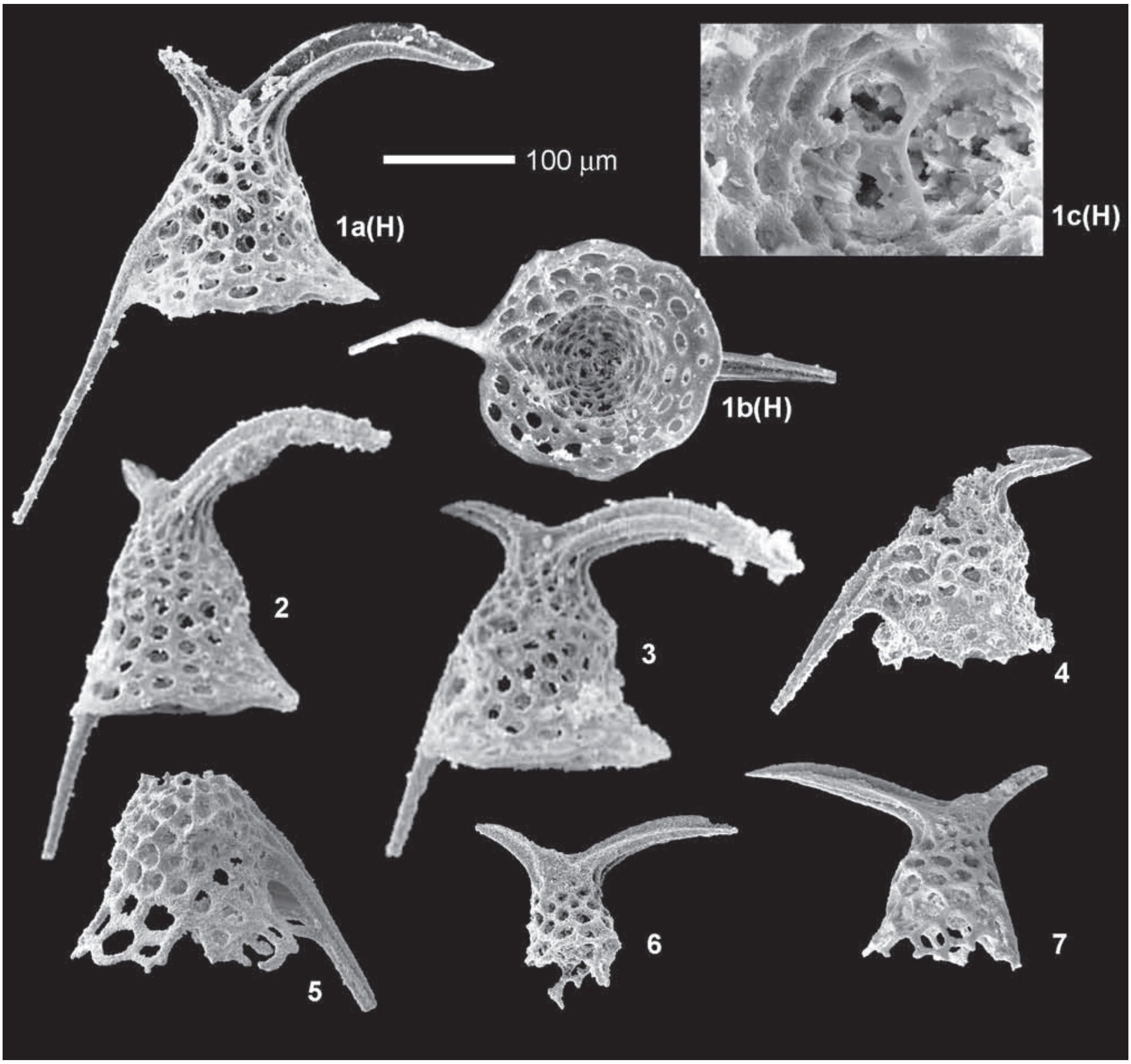


Plate ARS07. ***Ares avirostrum*** **Dumitrica & Matsuoka n. sp.** Magnification x200, except Fig. 1c(H) x800. **Fig. 1(H).** JP MNA-10. Fig. 1a(H). Matsuoka 2004, fig. 132. Fig. 1b(H). MA13749. Fig. 1c(H). MA13748. **Fig. 2.** JP, MNA-10, MA13771. **Fig. 3.** JP, MNA-10, MA13778. **Fig. 4.** NBC, GSC loc. C-305813, GSC 111805. **Fig. 5.** OM, BR871-R07-20. **Fig. 6.** OM, BR524-R05-09. **Fig. 7.** OM, BR528-R10-11.

Ares cuniculiformis Dumitrica & Whalen n. sp.

Species code: ARS06

Synonymy:

? 1987 *Cuniculiformis* sp. A – Hattori, pl. 20, fig. 11.
? 1987 *Cuniculiformis* sp. B – Hattori, pl. 20, fig. 12.
? 1989 Gen. 2, sp. 1 – Hattori, pl. 21, fig. K.
? 1997 *Ares* sp. A0 – Yao, pl. 8, fig. 382.

Type designation: Specimen figs. 1 and 1a, stub 1662D-R03-13, sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Diagnosis: A species of *Ares* with a conical test, A and V spines relatively equal and recurved, and D spine long, over twice length of test.

Description: Test high-conical with elliptical or rounded polygonal pores. Cephalis small, poreless situated on the dorsal side of the apical part of test, surface weakly pustulate. Apical and ventral spines robust, bladed, recurved and slightly dissimilar, usually slightly shorter than D spine and may be more curved. D spine downwardly directed, slightly curved, running along thorax and continuing a long distance beyond.

Remarks: *A. cuniculiformis* n. sp. resembles *A. armatus* De Wever, with which it partly co-occurs, but it differs in having a narrower test, A and V spines are relatively equal in length and both are recurved. There is a slight difference between this species from the Pliensbachian (Turkey and Baja California) and the species from the lower Toarcian (Japan). In the former (and especially the holotype) the apical horn is almost of the same length as the ventral horn, whereas in the latter, the apical horn is shorter. They are probably part of the phylogenetical lineage that gave rise to *A. cylindricus* Takemura.

***Measurements* (µm):**
Based on 4 specimens.

	HT	Min.	Max.
Length of test excluding spines	187	119	187
Length of ventral spine	153	117	153
Length of apical horn	147	50	147
Maximum diameter of thorax	120	75	130

Etymology: From the Latin *cuniculus* – hare and *forma*– shape; noun.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; San Hipólito Formation, Baja California Sur.

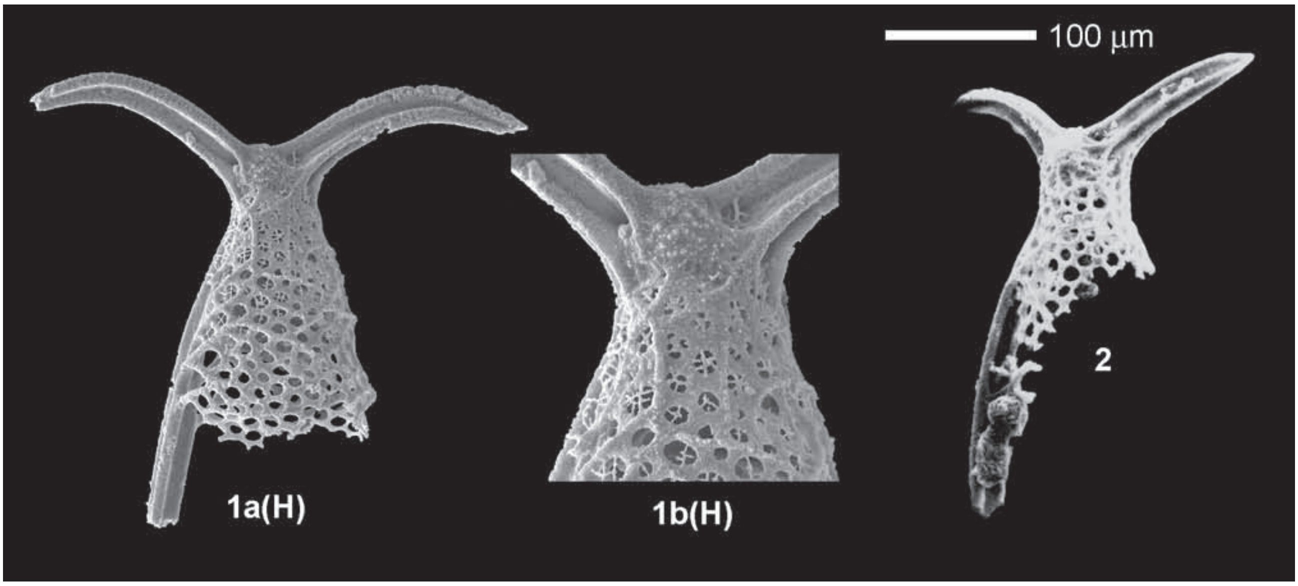


Plate ARS06. ***Ares cuniculiformis*** **Dumitrica & Whalen n. sp.** Magnification x200, except fig. 1b(H) x400.
Fig. 1(H)a, b. TR, 1662D-R03-13a, b. **Fig. 2.** BCS, BPW30.

***Ares cylindricus* s.l.** (Takemura) 1986
Species code: 4061

Synonymy:
1986 *Parares cylindricus* n. sp. – Takemura, p. 46, pl. 4, figs. 3-7.
1986 *Parares flexuosus* n. sp. – Takemura, p. 47, pl. 4, figs. 8-11.
? 1986 *Nassellaria* gen. et sp. indet. C in Yao et al. 1982 – De Wever & Cordey, pl. 1, fig. 11.
1987 *Parares* (?) aff. *P. cylindricus* Takemura – Hattori, pl. 20, fig. 9.
1995a *Ares cylindricus* (Takemura) – Baumgartner et al., p. 116.

See also subspecies.

Included subspecies.
3001 *Ares cylindricus cylindricus* (Takemura) 1986
4032 *Ares cylindricus flexuosus* (Takemura) 1986

Ares cylindricus cylindricus (Takemura) 1986
Species code: 3001

Synonymy:
1986 *Parares cylindricus* n. sp. – Takemura, p. 46, pl. 4, figs. 3-7.
1987 *Parares* (?) aff. *P. cylindricus* Takemura – Hattori, pl. 20, fig. 9.
1989 *Parares cylindricus* Takemura – Kito, p. 204, pl. 23, fig. 11.
1995a *Ares cylindricus cylindricus* (Takemura) – Baumgartner et al., p. 116, pl. 3001, figs. 1-4.
1997 *Ares cylindricus cylindricus* (Takemura) – Yao, pl. 8, fig. 385.

Original description: Cephalis small, poreless and spherical, with well developed and triradiate vertical spine. Vertical spine curved downward and in some specimens, slightly curved upward distally. Thorax cylindrical and long, with elliptical pores arranged longitudinally and hexagonally. No apertural ring at the end of the thorax. Dorsal spine strong and triradiate, about twice as long as thorax. Dorsal spine curved slightly proximally and distally straight and slightly twisted anticlockwisely. Some bars connecting dorsal spine and thoracic wall at several points in some specimens.

Original remarks: *Parares cylindricus* n. sp. differs from *P. flexuous* n. sp. in cylindrical thorax and distally straight dorsal spine.

Measurements (μm):
Based on 10 specimens.

	Min.	Max.
Length of shell including two spines	470	610
Height of cephalo-thorax	185	270
Maximum width of shell including two spines	345	465
Width of thorax	105	135

Etymology: The species name, *cylindricus*, cylindrical in English is derived from the shape of thorax.

Type locality: Sample TKN-105, Komami, Yamato village, Gifu Prefecture, central Japan.

Occurrence: Japan, Italy.

Ares cylindricus flexuosus (Takemura) 1986
Species code: 4032

Synonymy:
1986 *Parares flexuous* n. sp. – Takemura, p. 47, pl. 4, figs. 8-11.
1989 *Parares flexuous* Takemura – Kito, p. 204, pl. 23, fig. 12.
1995a *Ares cylindricus flexuosus* (Takemura) – Baumgartner et al., p. 118, pl. 4032, figs. 1-3.
1997 *Ares cylindricus flexuosus* (Takemura) – Yao, pl. 8, fig. 388.

Original description: Cephalis small, spherical and poreless, with stout and triradiate vertical spine, which is curved downward distally. Thorax conical to subconical and slightly narrow distally, without apertural ring. Thoracic pores spherical to ellipsoidal, usually arranged longitudinally and hexagonally. Dorsal spine which is twisted anticlockwisely strong, triradiate and remarkably curved downwardly.

Original remarks: *Parares flexuous* n.sp. is distinguished from *P. cylindricus* by its conical to subconical thorax and markedly curved dorsal spine.

Further remarks: By Baumgartner et al. (1995a): The name *flexuous* is emended (I.C.Z.N., art.33a (I)) into *flexuosus,* which is the correct Latin name.

Measurements (μm):
Based on 4 specimens.

	Min.	Max.
Length of shell including two spines	280	335
Height of cephalo-thorax	145	175
Maximum width of shell including two spines	360	420
Width of thorax	100	110

Etymology: The species name, *flexuosus,* means bending, derived from its curved dorsal spine.

Type locality: Sample TKN-105, Komami, Yamato Village, Gifu Prefecture, central Japan.

Occurrence: Japan, Italy.

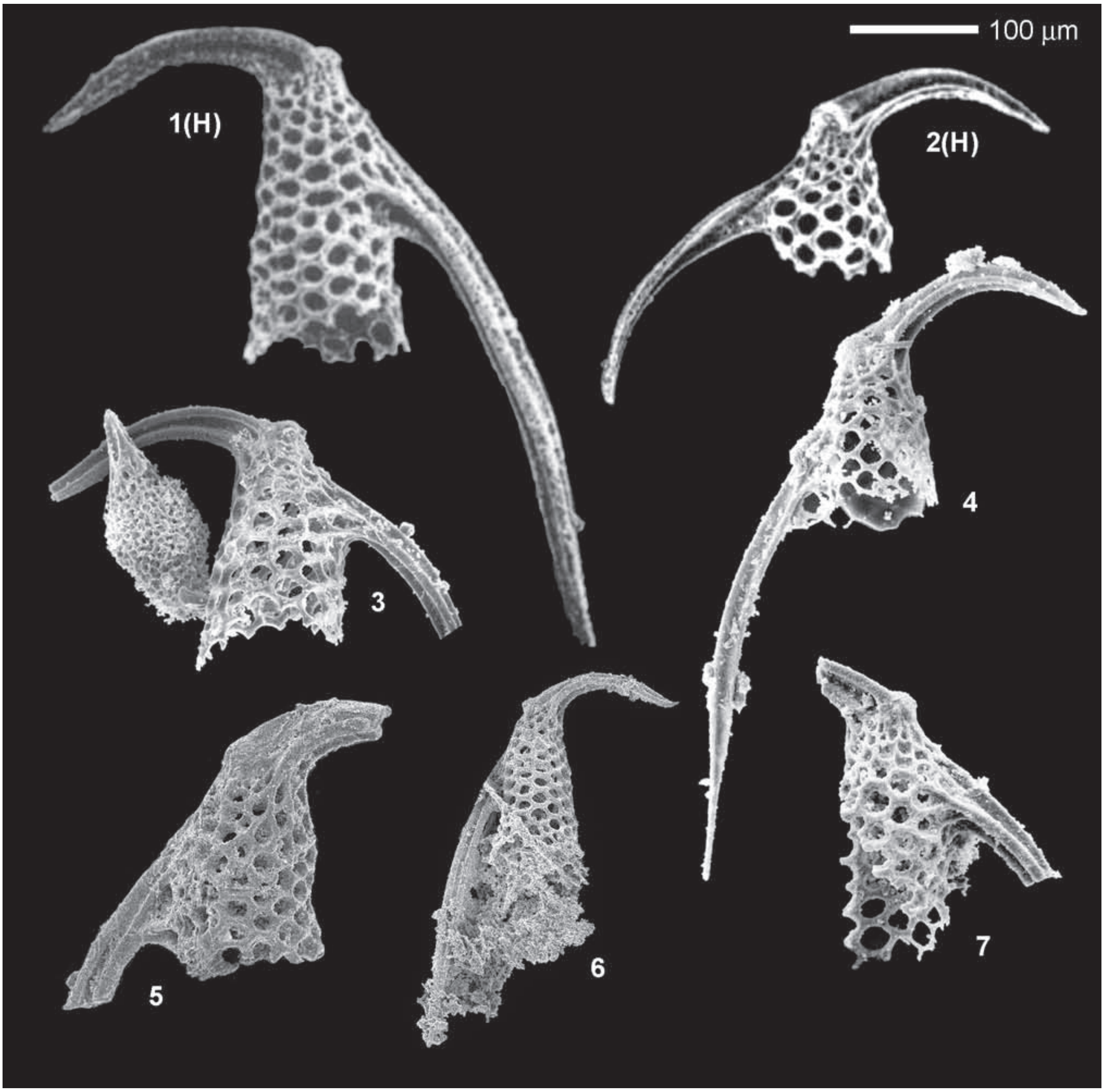


Plate 4061. ***Ares cylindricus*** **s.l. (Takemura).** Magnification x200. **Fig. 1(H).** ***Ares cylindricus cylindricus*** **(Takemura)** 1986, pl. 4, fig. 4. **Fig 2(H).** ***Ares cylindricus flexuosus*** **(Takemura)** 1986, pl. 4, fig. 8. **Fig. 3**. JP, MIN-1, MA09001. **Fig. 4.** JP, MKM-1, MA10325. **Fig. 5.** JP,GUH39-14, RH676. **Fig. 6.** JP, GUH39-11, RH673. **Fig. 7.** JP, MIN-10, MA09917.

Ares mexicoensis Whalen & Carter 2002

Species code: ARS04

Synonymy:

1984 *Ares* sp. – Whalen & Pessagno, pl. 1, fig. 11.

2002 *Ares mexicoensis* n. sp. – Whalen & Carter, p. 140, pl. 15, figs. 5, 12; pl. 18, figs. 6, 9.

Original description: Small, dome-shaped cephalis with massive apical horn; cephalis mostly imperforate with some small pores near base. Horn triradiate in axial section with narrow, rounded, longitudinal ridges and broad, longitudinal grooves. Thorax gradually increasing in width distally; meshwork on thorax composed of irregular pentagonal and tetragonal pore frames (mostly pentagonal) becoming slightly larger distally. Thoracic arms massive, gently curving downward with one arm slightly longer than other; shorter arm positioned higher on thorax at base of cephalis; arms triradiate in axial section with narrow, longitudinal ridges alternating with steep-sided longitudinal grooves; narrow, transverse thoracic ridges, formed by a slight alignment of the pore frames, continue onto arms, joining with longitudinal ridges.

Original remarks: *Ares mexicoensis* n. sp., is distinguished from *A. armatus* De Wever 1982, in having a shorter cephalic horn and thoracic arms, larger pore frames on the thorax, and a steeper-sided thorax; with its sturdy arms and horn *Ares mexicoensis* n. sp. is a more robust species than *Ares moresbyensis* Whalen and Carter 1998.

Measurements (μm):

Based on 14 specimens.

Length (excludes horn)	Length of long arm	Length of short arm	
150	128 (broken)	128	HT
150	210	150	Max.
105	135	105	Min.
134	169	133	Mean

Etymology: This species is named for the United States of Mexico.

Type locality: Sample BPW80-30, San Hipólito Formation, Punta San Hipólito, Vizcaino Peninsula, Baja California.

Occurrence: San Hipólito Formation, Baja California Sur; Fannin Formation, Queen Charlotte Islands; Tawi Sadh Member, Guwayza Formation, Oman.

Ares moresbyensis Whalen & Carter 1998

Species code: ARS01

Synonymy:

Not 1984 *Ares* sp. – Whalen & Pessagno, pl. 1, figs. 11, 12.

1998 *Ares moresbyensis* n. sp. – Whalen & Carter, p. 75, pl. 21, figs. 1, 2, 11; pl. 27, figs. 2, 8.

Original description: Test with small, dome-shaped cephalis and prominent tapering horn; horn approximately equal in length to thorax, triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves; horn not aligned exactly with long axis of test. Cephalis with small to medium polygonal pore frames sometimes obscured by a layer of microgranular silica. Thorax elongate, trapezoidal in outline with large, pentagonal, hexagonal, and circular pore frames. Two prominent spines attached to thorax at base of cephalis at 45º angle with long axis of test; spines tapering distally, triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves; near base of cephalis, longitudinal ridges extend onto thorax forming prominent transverse ridges. One spine slightly longer and more massive than other; longer spines equal to length of thorax.

Original remarks: The larger, more irregularly shaped thoracic pore frames of *Ares moresbyensis* n. sp. distinguish it from *A. sutherlandi* n. sp.

Measurements (μm):

(n) = number of specimens measured.

Length (excluding horn) (6)	Width of thorax (6)	Maximum length of short arm (5)	
105	71	90	HT
120	75	120	Max.
90	71	68	Min.
112	75	92	Mean

Etymology: This species is named for Moresby Island, Queen Charlotte Islands, British Columbia, located to the west of the type locality.

Type locality: Sample QC-675, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

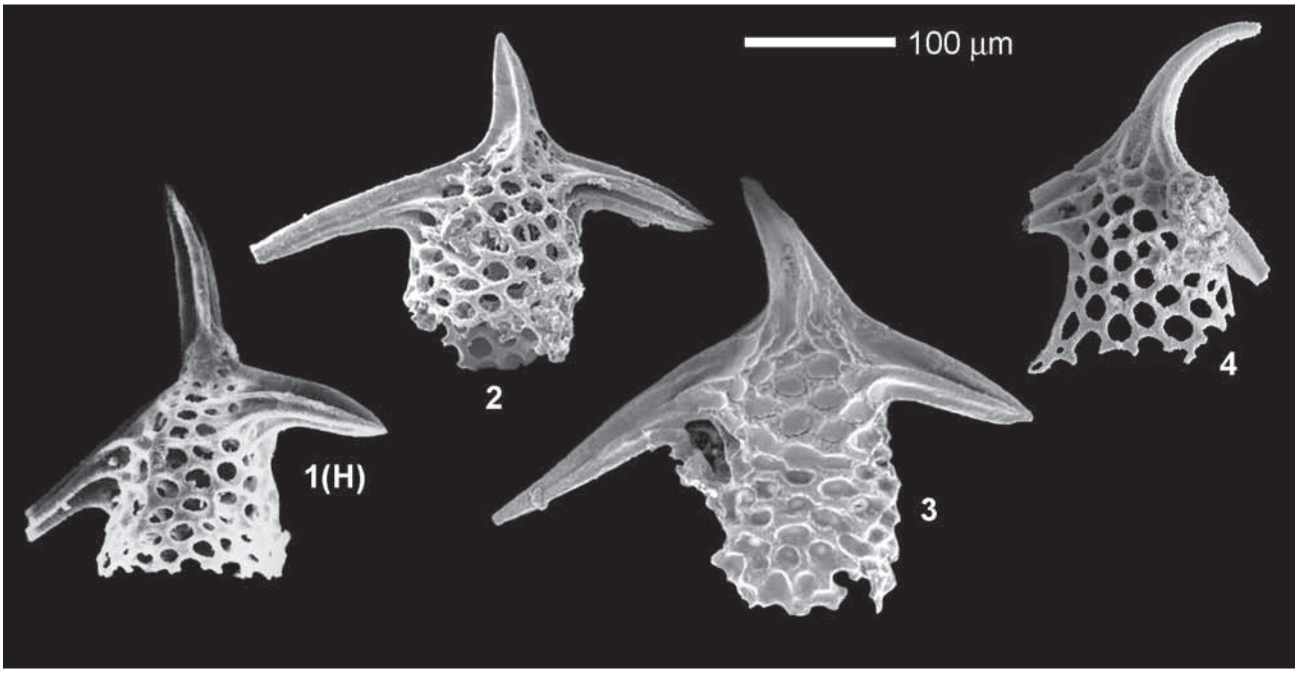


Plate ARS04. ***Ares mexicoensis*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 15, fig. 5. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128706. **Fig. 3.** QCI, GSC loc. C-140495, GSC 128707. **Fig. 4.** OM, BR485-R20-10.

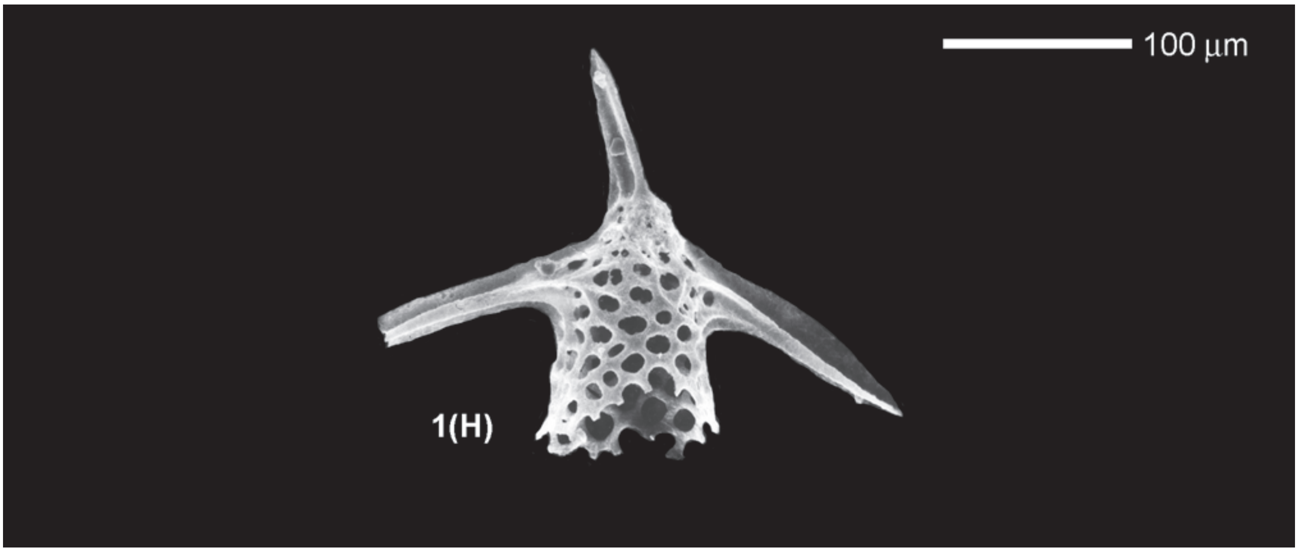


Plate ARS01. ***Ares moresbyensis*** **Whalen & Carter.** Magnification x250. **Fig. 1(H).** Carter et al. 1998, pl. 21, fig. 1.

Ares sutherlandi Whalen & Carter 1998

Species code: ARS02

Synonymy:

1984 *Ares* sp. – Whalen & Pessagno, pl. 1, fig. 12.
1998 *Ares sutherlandi* n. sp. – Whalen & Carter, p. 76, pl. 21, figs. 3, 16; pl. 27, figs. 1, 7.
2002 *Ares* sp. A – Whalen & Carter, p. 142, pl. 15, figs. 6, 13.

Original description: Test with small, dome-shaped cephalis with prominent broad, tapering horn; horn approximately one-half length of cephalis and thorax combined, triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves. Cephalis with variably-sized pore frames usually partially obscured by layer of microgranular silica. Thorax elongate, cylindrical, with irregularly arranged small- to medium-sized polygonal (mostly pentagonal) pore frames; thoracic pore frames sometimes partially masked by an outer layer of irregular, polygonal pore frames. Two prominent spines attached to thorax and base of cephalis; spines triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves. Larger, more robust spine forming an approximate 55° angle with long axis of test; larger spines bonded to thorax by approximately four narrow, linear ridges which extend from longitudinal ridge of spine and continue obliquely across proximal part of test; smaller spine at 40° to long axis of test.

Original remarks: See remarks under *A. moresbyensis* n. sp.

Measurements (μm):
(n) = number of specimens measured.

Length (excluding horn) (6)	Width of thorax (6)	Maximum length of short arm (5)	
109	75	90	HT
120	75	90	Max.
83	75	60	Min.
97	75	75	Mean

Etymology: This species is named in honor of A. Sutherland Brown (British Columbia Department of Mines and Petroleum Resources, Vancouver, B.C.) who first mapped the entire Queen Charlotte Archipelago and provided a detailed account of the geology.

Type locality: Sample QC-675, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur.

Ares takemurai Dumitrica & Matsuoka n. sp.

Species code: ARS08

Synonymy:

? 1987 *Parares* (?) sp. A – Hattori, pl. 20, fig. 8.
1987 *Parares* (?) sp. C – Hattori, pl. 20, fig. 10.
1989 *Ares* sp. A – Hattori, pl. 3, fig. K.
1989 *Parares* (?) spp. – Hattori, pl. 3, fig. M, not fig. L.
2004 *Ares* sp. – Matsuoka, fig. 133.

Type designation: Holotype specimen MA 13779 from sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Diagnosis: A species of *Ares* with thorax constricted medially as well as distally. Apical horn much shorter than V spine, D very long and straight.

Description: Test conical, two-segmented with a slight constriction in the middle part of thorax. Cephalis small, poreless, displaced on the dorsal side of the apical part of shell. Ventral spine long, curved, and bladed. Apical horn much shorter than ventral spine, obliquely directed upward and slightly curved. Dorsal spine straight, thin, very long, one to two times length of thorax, circular in cross section beyond thorax, three-bladed on the tangential portion. Pores of thorax quincuncially arranged, pore frames usually hexagonal, increasing in size distally. Distal half of thorax expanded, convex in outline, constricted terminally and built of intervening bars that become ever thinner. Distal border irregular.

Remarks: *Ares takemurai* n. sp. is very close to *A. avirostrum* n. sp.: the A, V and D spines and proximal half of thorax are morphologically similar, the only major difference is the shape of the distal half of thorax. This part is expanded with a clear-cut border in *A. avirostrum*, whereas in *A. takemurai* the distal half of thorax is also expanded, but the terminal part is constricted and made of intervening bars that become ever thinner.

Measurements (μm):
Based on 11 specimens

Dimensions	HT	Min.	Max.
Length of test excluding spines	170	95	190
Length of ventral spine	170	75	180
Length of apical horn	70	40	70
Length of dorsal spine	390	90	400
Maximum diameter of thorax	160	85	160

Etymology: The species is named for Dr. Atsushi Takemura, Hygoyo University of Teacher Education, Japan, to honour his valuable contribution to the taxonomy of Jurassic Radiolaria.

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Occurrence: Nanjo Massif, Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

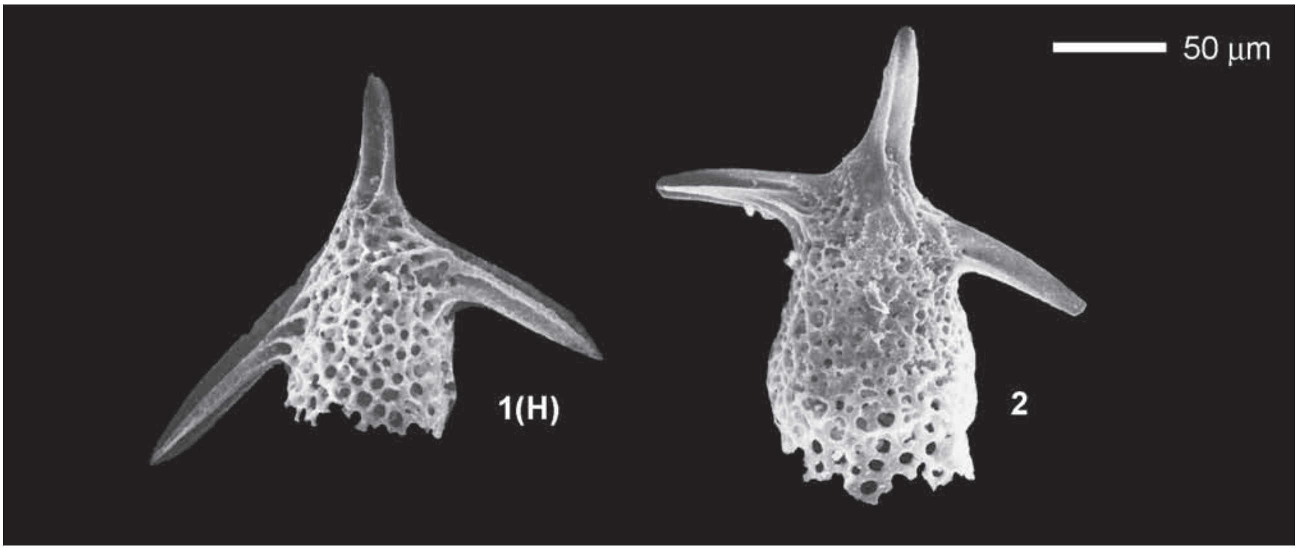


Plate ARS02. ***Ares sutherlandi*** **Whalen & Carter.** Magnification x300. **Fig. 1(H)**. Carter et al. 1998, pl. 21, fig. 3. **Fig. 2.** Whalen & Carter 2002, pl. 15, fig. 6.

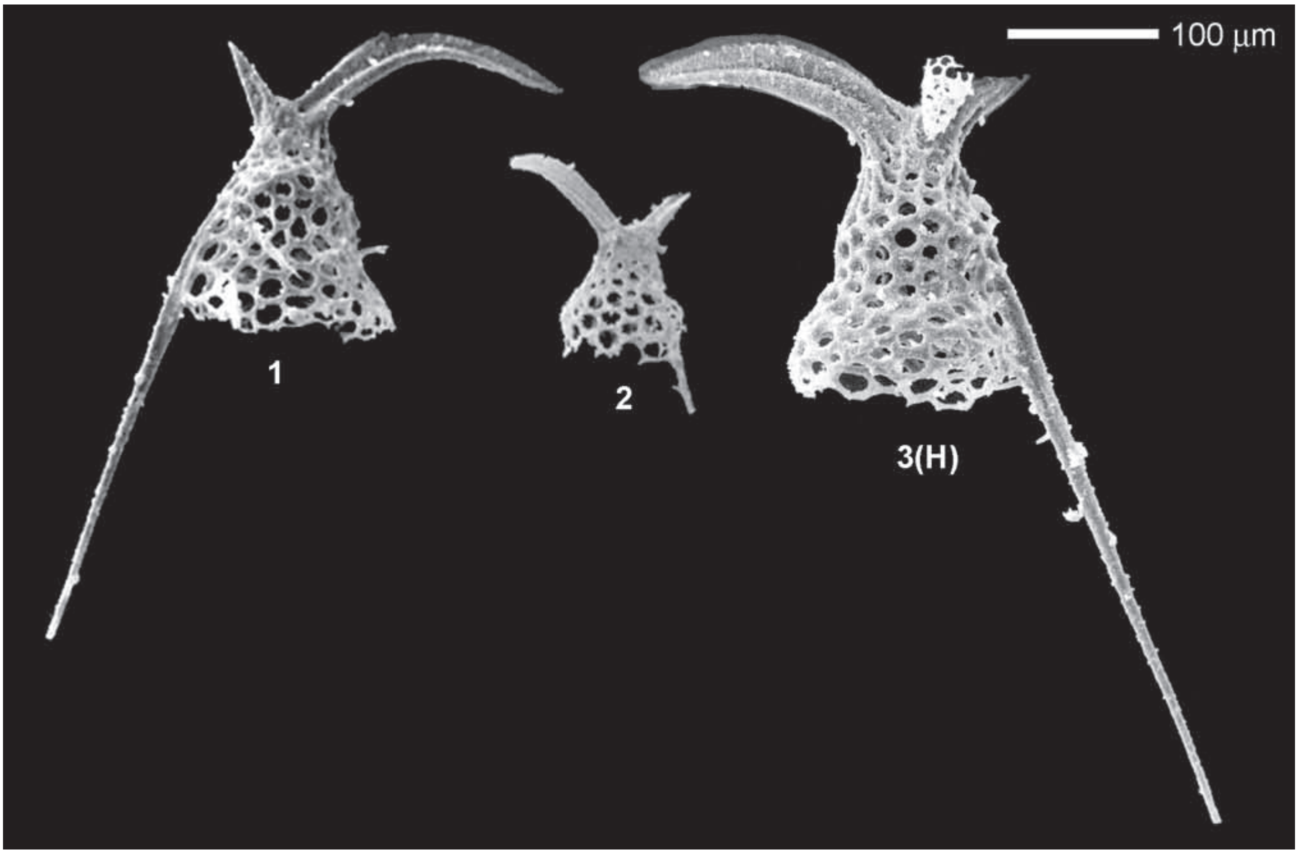


Plate ARS08. ***Ares takemurai*** **Dumitrica & Matsuoka n. sp.** Magnification x200. **Fig. 1.** JP, MNA-10, MA13743. **Fig. 2.** JP, MNA-10, MA13608. **Fig. 3(H).** Matsuoka 2004, fig. 133.

***Ares* sp. A** sensu Baumgartner et al. 1995a

Species code: 4008

Synonymy:

1982 Nassellaria D (in Yao et al., 1982) – Matsuda & Isozaki, pl. 1, fig. 21.
1986 *Parares* sp. – Takemura, p. 47, pl. 4, fig. 12.
1987 *Parares* (?) sp. A – Hattori, pl. 20, fig. 8.
1990 *Ares* ? sp. D – Hori, Fig. 8.25.
1995a *Ares* sp. A – Baumgartner et al., p. 118, pl. 4008, fig. 1.
1996 *Ares* sp. A – Yeh & Cheng, p. 118, pl. 2, fig. 8; pl. 7, figs. 1, 2, 12.
1997 *Ares* sp. A Baumgartner et al. – Yao, pl. 8, fig. 387.
1997 *Ares* ? sp. D of Yao – Hori, pl. 1, fig. 11.

Original remarks: This species differs from *A. cylindricus* by having a short triradiate apical horn.

Occurrence: Mino Terrane, Japan; Liminangcong Chert, Philippines.

Genus: ***Atalanta*** Cordey & Carter 1996

Type species: *Atalanta emmela* Cordey & Carter 1996

Synonymy:

1996 *Atalanta* n. gen. – Cordey & Carter, p. 446.

Original diagnosis: Multicyrtid nassellarian. Proximal part of test smooth, without ornamentation. Two rows of pore frames per segment; pores regularly aligned transversely and obliquely, not longitudinally.

Original description: Multicyrtid test conical and may be constricted distally. Cephalis nonperforate with a horn. Proximal part of test smooth without ornamentation. Postabdominal segments have two transverse rows of circular pores arranged hexagonally. Pores regularly aligned transversely and obliquely, not longitudinally. Proximal segments show no development of transverse ridges. More distally, segment junctions thicken to form transverse ridges that show a slight to moderately exaggerated zig-zag outline. Nodes more or less well developed at pore frame intersections. Depending on species and (or) preservation, the conical test may be constricted distally.

Original remarks: *Atalanta* n. gen. differs from *Wrangellium* Pessagno and Whalen (1982) by possessing hexagonal pore frames that are not aligned longitudinally. It differs from *Triversus* Takemura (1986) in lacking an amphipyndax-type cephalic skeletal structure and in possessing two, rather than three, rows of pores per chamber. *Atalanta* n. gen. differs from *Proparvicingula* Carter (1993), *Parvicingula* Pessagno (1977), and *Ristola* Pessagno & Whalen (1982) by possessing two rows of pores between circumferential ridges instead of three, and further differs from *Proparvicingula* Carter in having a single rather than double test wall. *Atalanta* n. gen. differs from *Pseudoristola* Yeh (1987b) by possessing well-developed circumferential ridges on postabdominal chambers, and the final chamber is open rather than bulbous and closed. Comparisons with *Nitrader* n. gen are developed under that genus.

Remarks under *Nitrader* n. gen.: *Nitrader* has clear external affinities with *Atalanta* n. gen., as both possess two rows of offset pores set in hexagonal pore frames arranged between two circumferential ridges, and both have an apical horn. Nevertheless, the pore arrangement of *Nitrader* is different from *Atalanta* in that the pores are H-linked on each side of transverse ridges. The structure of the proximal chambers also differs: *Atalanta* has a smooth proximal portion with no clear signs of segmentation, whereas *Nitrader* develops an external ornamentation composed of a rugose network of segmentation similar to *Proparvicingula* Carter, a new genus recently described from the Rhaetian of the Queen Charlotte Islands (Carter 1993). This suggests that *Nitrader* n. gen. could be an intermediate form between *Proparvicingula* Carter and *Atalanta* n. gen.

Etymology: *Atalanta* is an arbitrary combination of letters (ICZN 1985, article 11b (iii), p. 20).

Included species:

ATA02 *Atalanta emmela* Cordey & Carter 1996

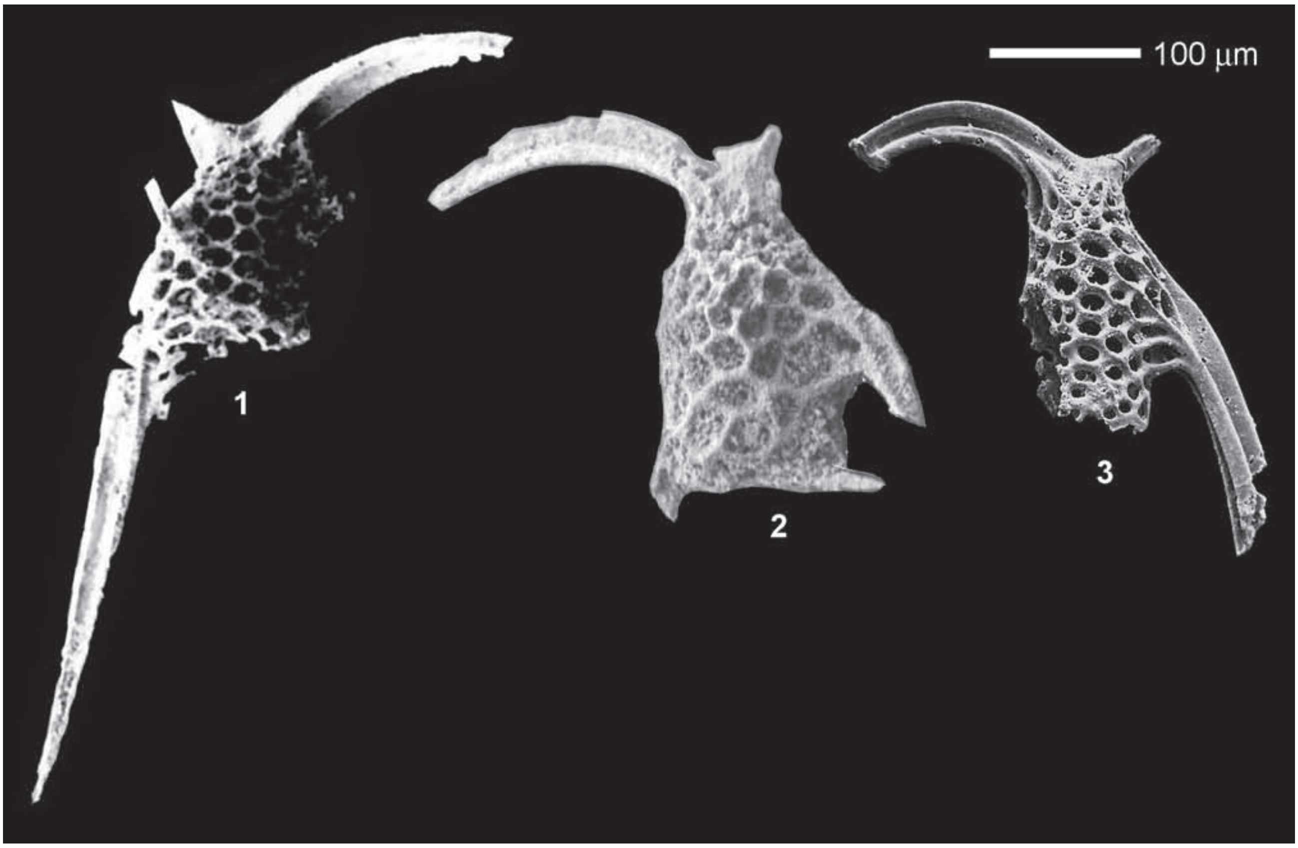


Plate 4008. ***Ares*** **sp. A sensu Baumgartner et al.** Magnification x200. **Fig. 1.** JP, IYII 12-50. **Fig. 2.** JP, Hori 1990, fig. 8.25. **Fig. 3.** Baumgartner et al. 1995a, pl. 4088, fig. 1.

Atalanta emmela Cordey & Carter 1996

Species code: ATA02

Synonymy:

1991 Gen. indet. Z sp. A – Tipper et al., pl. 8, fig. 8.
1996 *Atalanta emmela* n. gen., n. sp. – Cordey & Carter, p. 447, pl. 1, figs. 1-3.
1998 *Atalanta emmela* Cordey & Carter – Cordey, p. 126, pl. 25, fig. 1.
1998 *Atalanta emmela* Cordey & Carter – Whalen & Carter, p. 67, pl. 24, fig. 13.
2001 *Atalanta emmela* Cordey & Carter – Gawlick et al., pl. 2, fig. 22.
2002 *Atalanta emmela* Cordey & Carter – Whalen & Carter, p. 128, pl. 16, figs. 1, 8.
2002 *Atalanta emmela* Cordey & Carter – Tekin, p. 190, pl. 4, figs. 10, 11.

Original diagnosis: Multicyrtid nassellarian, conical. Cephalis with simple horn. Proximal part of test smooth, without ornamentation.

Original description: Multicyrtid test, conical. Cephalis nonperforate with a horn of medium length disposed asymmetrically. Proximal part of test smooth, without ornamentation. Post-abdominal segments have two transverse rows of circular pores arranged in hexagonal pore frames. Proximal segments show no development of transverse ridges. Transverse ridges begin to develop at one-third to one-half of total length of test at junctions between segments; ridges formed by a thickening of the pore frames. Nodes more or less well-developed at pore frame intersections. Width of segments increases regularly towards the distal aperture.

Original remarks: *Atalanta emmela,* n. sp., differs from *Atalanta epaphrodita,* n. sp., in possessing a single horn, more weakly developed thickening of transverse ridges, and the test is not constricted distally.

Measurements (μm):
Based on 4 specimens.

	HT	Min.	Max.
Length of horn	35	30	40
Length of test, excluding horn	220	200	260
Maximum diameter of test	125	105	140

Etymology: From the greek *emmeles* meaning harmonious.

Type locality: GSC loc. C-150155, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; chert clast from Voght Creek conglomerate, south Intermontane Belt, British Columbia; San Hipólito Formation, Baja California Sur; Dürrnberg Formation, Austria; Hocaköy Radiolarite, Turkey.

Genus: *Bagotum* Pessagno & Whalen 1982

Type species: *Bagotum maudense* Pessagno & Whalen 1982

Synonymy:

1982 *Bagotum* n. gen. – Pessagno & Whalen, p. 117.

Original description: Test ellipsoidal; final post-abdominal chamber terminating in latticed, hemispherical cap. Cephalis lacking horn.

Original remarks: *Bagotum* n. gen., differs from *Stichocapsa* Rüst (1885, type species *S. jaspidea* Rüst, 1885) by displaying a thick, double-layered test, typically with more irregular pore frames. Furthermore, whereas the proximal part of the test of *Bagotum* is bluntly rounded or dome-shaped, that of *Stichocapsa* is conical. Both genera possess dome-shaped latticed caps on their final post-abdominal chambers. *Bagotum,* n. gen., differs from *Droltus* n. gen., by lacking a horn, being ellipsoidal rather than conical and by having a final post-abdominal chamber terminating in a latticed, dome-shaped cap.

Etymology: *Bagotum* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 40, p.113).

Included species:

BAG01 *Bagotum erraticum* Pessagno & Whalen 1982
BAG03 *Bagotum funiculum* Whalen & Carter 2002
BAG02 *Bagotum helmetense* Pessagno & Whalen 1982
BAG04 *Bagotum kimbroughi* Whalen & Carter 2002
BAG05 *Bagotum maudense* Pessagno & Whalen 1982
BAG06 *Bagotum modestum* Pessagno & Whalen 1982
BAG07 *Bagotum pseudoerraticum* Kishida & Hisada 1985

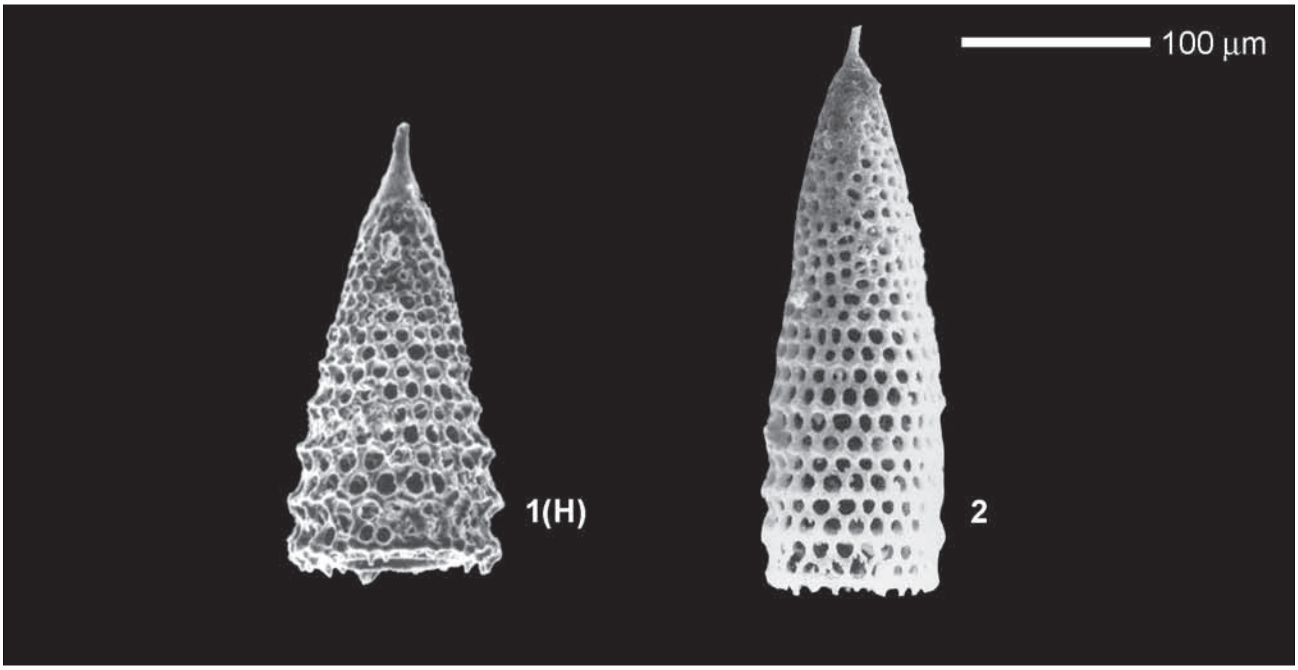


Plate ATA02. ***Atalanta emmela*** **Cordey & Carter.** Magnification x250. **Fig. 1(H).** Cordey & Carter 1996, pl. 1, fig. 2. **Fig. 2.** Whalen & Carter 2002, pl. 16, fig. 1.

Bagotum erraticum Pessagno & Whalen 1982

Species code: BAG01

***Synonymy*:**

1982 *Bagotum erraticum* n. sp. – Pessagno & Whalen, p. 117, pl. 1, fig. 10.

1988 *Bagotum* aff. *erraticum* Pessagno & Whalen – Li, pl. 1, fig. 3.

1995 *Bagotum erraticum* Pessagno & Whalen – Suzuki, pl. 8, fig. 1.

1998 *Bagotum* sp. cf. *B. erraticum* Pessagno & Whalen – Kashiwagi, pl. 2, figs. 6, 7.

2001 *Bagotum erraticum* Pessagno & Whalen – Gawlick et al., pl. 5, fig. 7.

Original description: Test inflated, broader distally than proximally, usually with four post-abdominal chambers. Cephalis hemispherical; remaining chambers trapezoidal in outline; final post-abdominal chamber with broad, dome-shaped cap. Post-abdominal chambers increasing slowly in length; increasing moderately rapidly in width proximally; final one or two post-abdominal chambers decreasing slightly in width. Proximal one-third of test with vermicular appearance due to presence of irregular, often elongate polygonal pore frames in outer layer. Remainder of test with more regular tetragonal (frequently square or rectangular) and pentagonal pore frames which sometimes are aligned longitudinally in rows.

Original remarks: *Bagotum erraticum*, n sp., is compared with *Bagotum maudense*, n. sp., under the latter species.

Further remarks: The more irregular pore frames and inflated distal portion of test distinguish this species from *Bagotum maudense* Pessagno & Whalen.

Measurements (µm):
Based on 11 specimens.

Length	Width (maximum)	
212.5	100	HT
225	112.5	Max.
175	87.5	Min.
194.7	99.7	Mean

Etymology: *Erraticus-a-um* (Latin, adj.) = erratic.

Type locality: Sample QC-549, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; Dürrnberg Formation, Austria; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman; Dengqen area, Tibet; Japan.

Bagotum funiculum Whalen & Carter 2002

Species code: BAG03

Synonymy:

1984 *Bagotum* spp. – Whalen & Pessagno, pl. 2, figs. 7, 8, 11.

2002 *Bagotum funiculum* n. sp. – Whalen & Carter, p. 114, pl. 9, figs, 5, 6, 9.

Original description: Test with approximately four post-abdominal chambers. Cephalis hemispherical with small spine; post-abdominal chambers trapezoidal in outline, gradually increasing in width; final post-abdominal chamber abruptly decreasing in width, terminating in closed dome-like cap. Post-abdominal chambers gradually increasing in height. Cephalis and thorax composed of small, irregularly shaped pore frames (circular and tetragonal) on outer latticed layer. Pore frames of outer latticed layer on first few post-abdominal chambers very irregularly distributed and shaped (circular, elongate, pentagonal, tetragonal). Pore frames of outer latticed layer on distal half of test composed of regular, square to rectangular pore frames with bars strongly aligned longitudinally.

Original remarks: *Bagotum funiculum* n. sp. is distinguished from *B. erraticum* Pessagno and Whalen 1982, by the more massive linear pore frames on the distal post-abdominal chambers.

Measurements (µm):
(n) = number of specimens measured

Length (4)	Width (max.) (5)	
240	150	HT
255	150	Max.
225	86	Min.
236	98	Mean

Etymology: *Funiculus, i* (Latin, m) = thin rope, cord, string.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Fannin Formation, Queen Charlotte Islands.

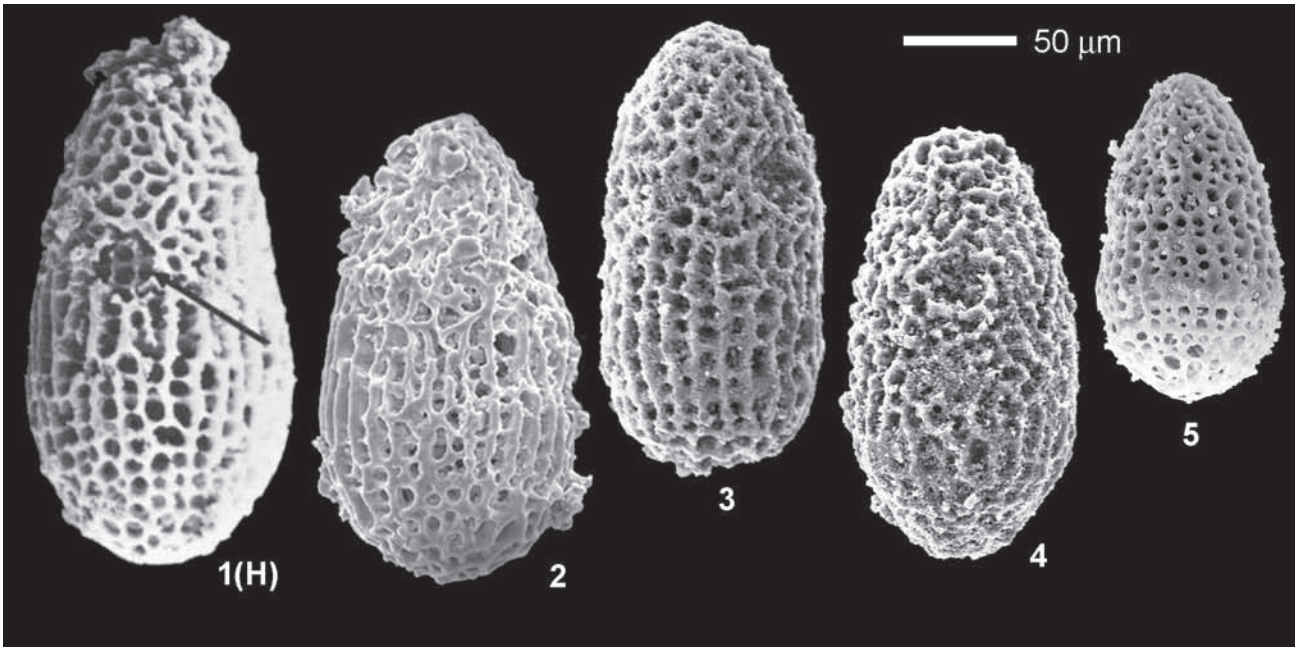


Plate BAG01. ***Bagotum erraticum*** **Pessagno & Whalen.** Magnification x300. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 1, fig. 10. **Fig. 2.** QCI, GSC loc. C-305388, GSC 128712. **Fig. 3.** OM-99-83, 011401. **Fig. 4.** OM-251, 021530. **Fig. 5.** JP, MNA-10, MA12232.

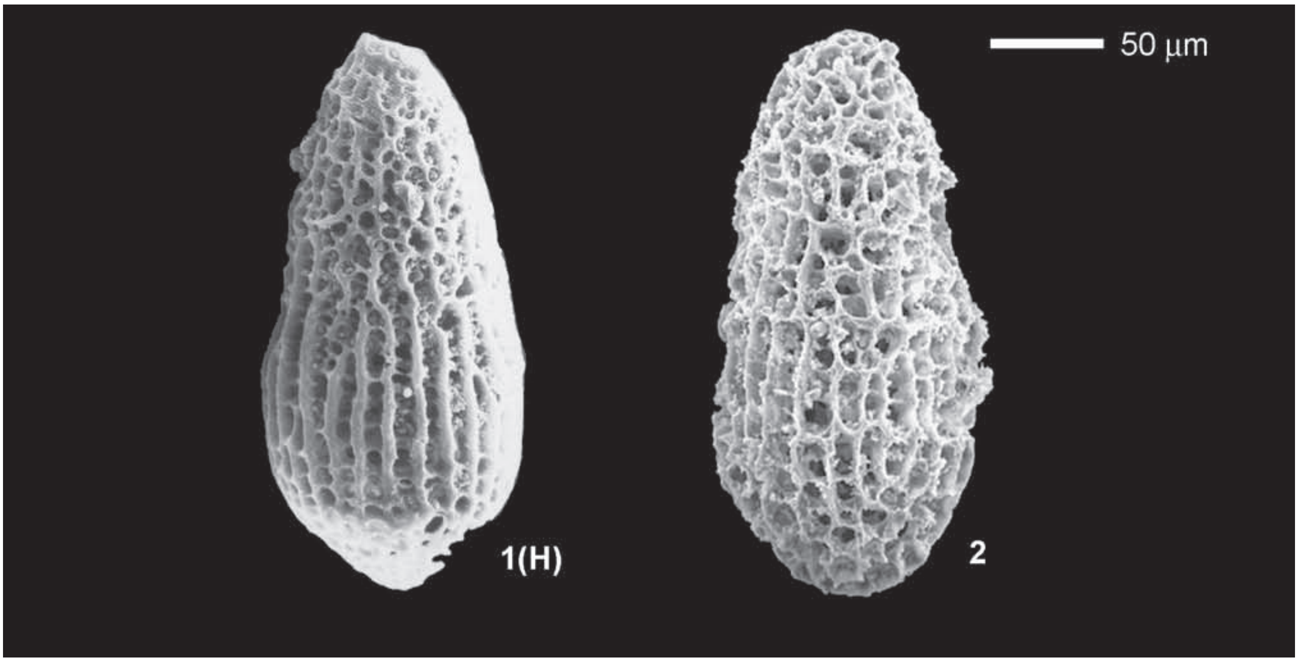


Plate BAG03. ***Bagotum funiculum*** **Whalen & Carter.** Magnification x300. **Fig. 1(H).** Whalen & Carter 2002, pl. 9, fig. 5. **Fig. 2.** QCI, GSC loc. C-175310, GSC 128713.

Bagotum helmetense Pessagno & Whalen 1982
Species code: BAG02

Synonymy:
1982 *Bagotum*? *helmetense* n. sp. – Pessagno & Whalen, p. 118, pl. 1, fig. 11; pl. 12, fig. 23.
1984 *Bagotum* spp. – Whalen & Pessagno, pl. 2, figs. 1, 2.
1993 *Bagotum* (?) *helmetense* Pessagno & Whalen – Kashiwagi & Yao, pl. 1, fig. 6.
1998 *Bagotum helmetense* Pessagno & Whalen – Whalen & Carter, p. 61, pl. 15, fig. 1; pl. 26, fig. 1.
1998 *Bagotum* (?) *helmetense* Pessagno & Whalen – Kashiwagi, pl. 2, fig. 4, not fig. 5.
2002 *Bagotum helmetense* Pessagno & Whalen – Whalen & Carter, p.114, pl. 10, figs. 1, 14.
2002 *Bagotum helmetense* Pessagno & Whalen – Tekin, p. 186, pl. 3, fig. 6.

Original description: Test as with genus, usually with six post-abdominal chambers. Cephalis hemispherical with small spine; post-abdominal chambers trapezoidal in outline. Proximal post-abdominal chambers gradually increasing in width; distal post-abdominal chambers gradually decreasing in width; domelike cap on final post-abdominal chamber with irregular tetragonal and pentagonal pore frames. Post-abdominal chambers gradually increasing in height. Cepahlis and thorax with small, irregularly shaped pore frames (circular and elongate) in outer latticed layer; larger, irregularly shaped polygonal pore frames (mostly elongate) in outer latticed layer of post-abdominal chambers. Pore frames of outer latticed layer not aligned on any portion of test.

Original remarks: *Bagotum* (?) *helmetense*, n. sp., differs from all other species of *Bagotum* by showing no linear arrangement of pore frames. Peculiar circular structure (diameter approximately 1/3 width of test) formed by pore frames of outer latticed layer obscured on some specimens; inner latticed layer of test exposed in center of circular structure.

Further remarks: The circular structure formed by pore frames of the outer latticed layer, that was first observed on upper Sinemurian bagotids from the Queen Charlotte Islands, is also observed on some specimens from Baja California Sur.

Measurements (µm):
Based on 10 specimens.

Length	Width (max.)	
175	80	HT
198	90	Max.
142	63	Min.
167.8	78.3	Mean

Etymology: *Bagotum helmetense*, n. sp., is named for Helmet Island, northwest of its type locality.

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Hocaköy Radiolarite, Turkey; Japan.

Bagotum kimbroughi Whalen & Carter 2002
Species code: BAG04

Synonymy:
1984 *Bagotum* spp. – Whalen & Pessagno, pl. 2, fig. 3-6.
1987 *Bagotum* aff. *B. maudense* – Hattori, pl. 15, fig. 3.
? 1987b *Drulanta* (?) sp. A – Yeh, pl. 4, fig. 27.
? 1987b *Drulanta* (?) sp. C – Yeh, p. 74, pl. 4, fig. 26.
1992 *Bagotum*? sp. – Sashida, pl. 1, fig. 18.
1998 *Bagotum* sp. C – Whalen & Carter, p. 62, pl. 15, fig. 3.
2002 *Bagotum kimbroughi* n. sp. – Whalen & Carter, p. 114, pl. 9, figs. 7, 8, 12-15; pl. 17, figs. 4, 5.

Original description: Test large, strong, usually with four to five post-abdominal chambers. Cephalis hemispherical; abdomen and post-abdominal chambers trapezoidal in outline. All post-abdominal chambers rapidly increasing in width distally till large, final post-abdominal chamber which terminates in dome-like cap; post-abdominal chambers gradually increasing in height distally. Cephalis and thorax with small, irregularly shaped pore frames in outer latticed layer; larger, regularly shaped tetragonal pore frames (square and rectangular) in outer latticed layer of post-abdominal chambers aligned in rows. Circular structure (diameter approximately one third width of test) observed in outer latticed layer of test; inner latticed layer exposed in center of circular structure.

Original remarks: The larger pore frames and the eccentric, ellipsoidal test of *Bagotum kimbroughi* n. sp., with its final post-abdominal chamber almost twice as wide as the thorax and abdomen, distinguish it from *B. modestum* Pessagno and Whalen. Circular structures similar to those reported on specimens of Bagotidae and Canutidae from the Sandilands and Ghost Creek formations, Queen Charlotte Islands, British Columbia.

Measurements (µm):
Based on 11 specimens.

Length	Width (max.)	
203	120	HT
248	135	Max.
180	120	Min.
203	127	Mean

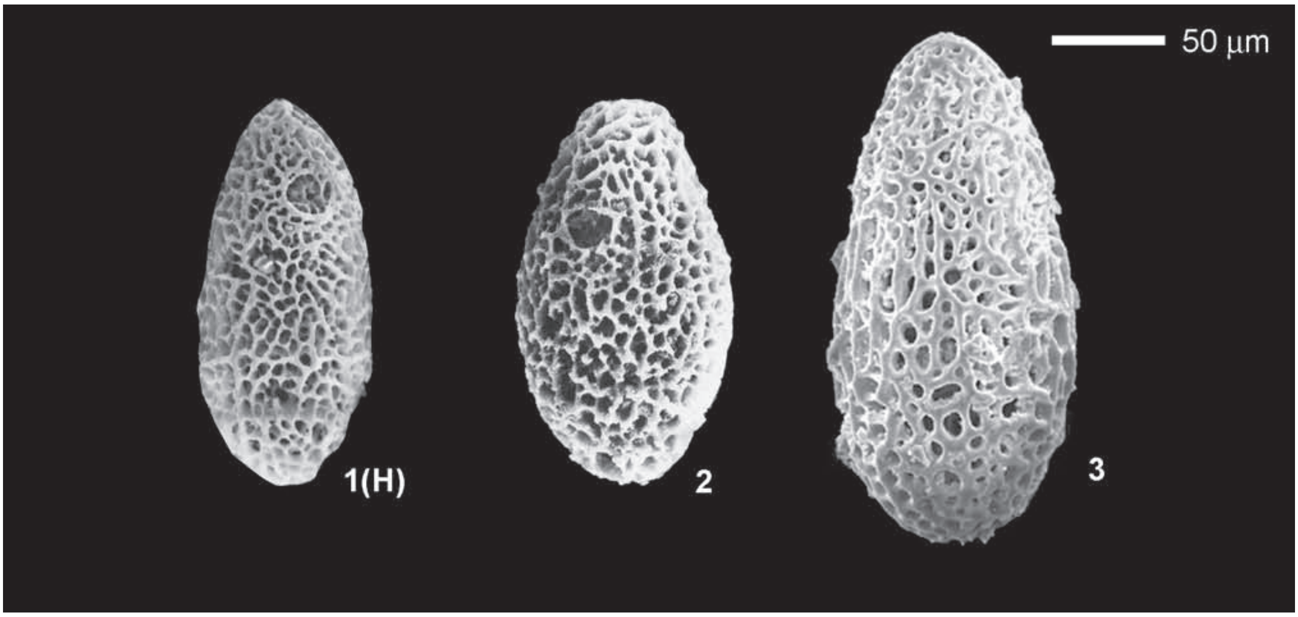


Plate BAG02. ***Bagotum helmetense*** **Pessagno & Whalen.** Magnification x300. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 1, fig. 11. **Fig. 2.** Whalen & Carter 2002, pl. 10, fig. 1. **Fig. 3.** QCI, GSC loc. C-305386, GSC 128714.

Etymology: This species is named for Dr. David Kimbrough (San Diego State University) a noted student of the Mesozoic rocks of the Vizcaino Peninsula and Cedros Island.

Type locality**:** Sample BPW80-30, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Sandilands Formation, Queen Charlotte Islands; Japan.

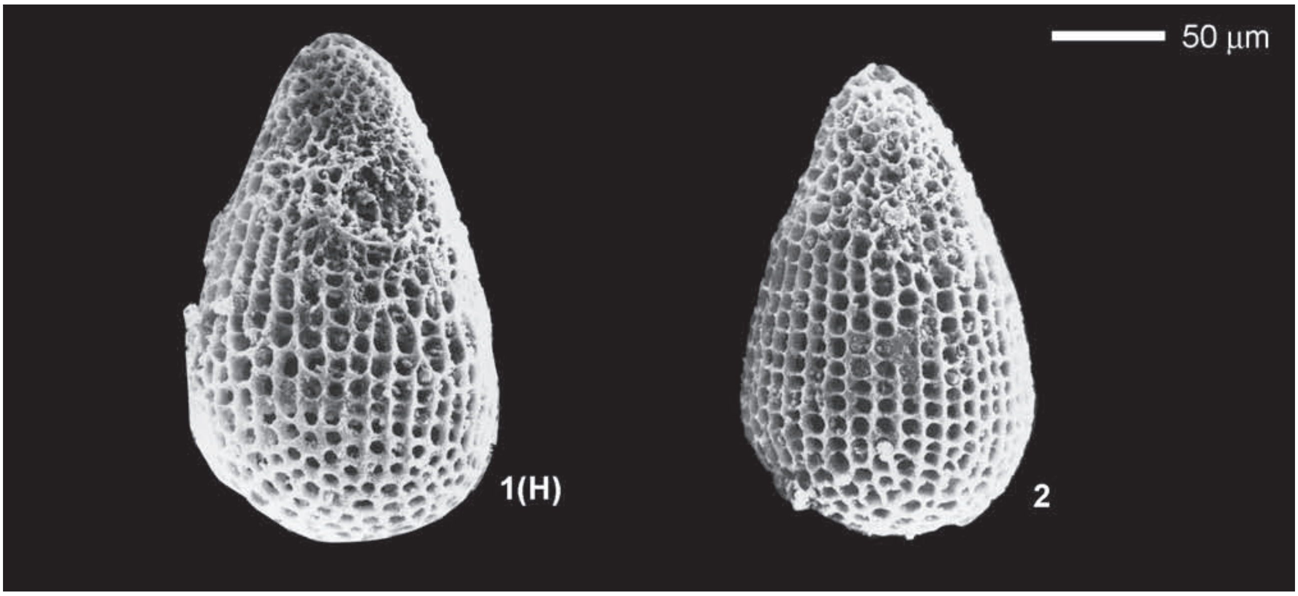


Plate BAG04 ***Bagotum kimbroughi*** **Whalen & Carter.** Magnification x300. **Fig. 1(H).** Whalen & Carter 2002, pl. 9, fig. 7. **Fig. 2.** Whalen & Carter 2002, pl. 9, fig. 8.

Bagotum maudense Pessagno & Whalen 1982

Species code: BAG05

Synonymy:

1982 *Bagotum maudense* n. sp. – Pessagno & Whalen, p. 118, pl. 3, figs. 6, 11, 20.

1984 *Bagotum* sp. aff. *B. modestum* Pessagno & Whalen – Murchey, pl. 1, fig. 29.

1987b *Bagotum* sp. aff. *B. maudense* Pessagno & Whalen – Yeh, p. 53, pl. 9, fig. 12; pl. 28, fig. 13.

1989 *Bagotum* sp. aff. *B. maudense* Pessagno & Whalen – Hattori, pl. 10, fig. K.

? 1996 *Bagotum modestum* Pessagno & Whalen – Pujana, p. 137, pl. 1, fig. 11.

1997 *Parahsuum maudense* (Pessagno & Whalen) – Yao, pl. 13, fig. 637.

1997 *Parahsuum* sp. NC2 – Yao, pl. 13, fig. 643.

1998 *Bagotum* sp. aff. *B. maudense* Pessagno & Whalen – Kashiwagi, pl. 1, fig. 4.

2001 *Bagotum maudense* Pessagno & Whalen – Gawlick et al., pl. 5, fig. 8.

Original description: Test relatively elongate, central portion nearly cylindrical. Cephalis hemispherical; remaining chambers trapezoidal in outline. Post-abdominal chambers gradually increasing in length; first one or two post-abdominal chambers increasing moderately rapidly in width; increasing more gradually in width medially in cylindrical portion of test; final one or two post-abdominal chambers decreasing in width. Cephalis and thorax with small irregular tetragonal and pentagonal pore frames; pore frames of other chambers a mixture of large pentagonal and tetragonal pore frames. Domelike cap on final post-abdominal chamber with relatively large, irregular tetragonal and pentagonal pore frames. Test typically with seven post-abdominal chambers.

Original remarks: *Bagotum maudense*, n. sp., differs from *B. erraticum*, n. sp., by having a slender, less inflated test that is centrally more cylindrical in character. Furthermore, *B. maudense* possesses a greater preponderance of linearly arranged square to rectangular pore frames.

Measurements (µm):

Based on 10 specimens.

Length	Width (max.)	
250	100	HT
287.5	130	Max.
210	90	Min.
219.25	108	Mean

Etymology: This species is named for Maude Island, its type locality.

Type locality: Sample QC 534, Fannin Formation (Maude Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Fannin Formation, Queen Charlotte Islands; Nicely and Hyde formations and Warm Springs member of the Snowshoe Formation, Oregon; Franciscan Complex, California; Sierra Chacaicó Formation, Argentina; Dürrnberg Formation, Austria; Japan.

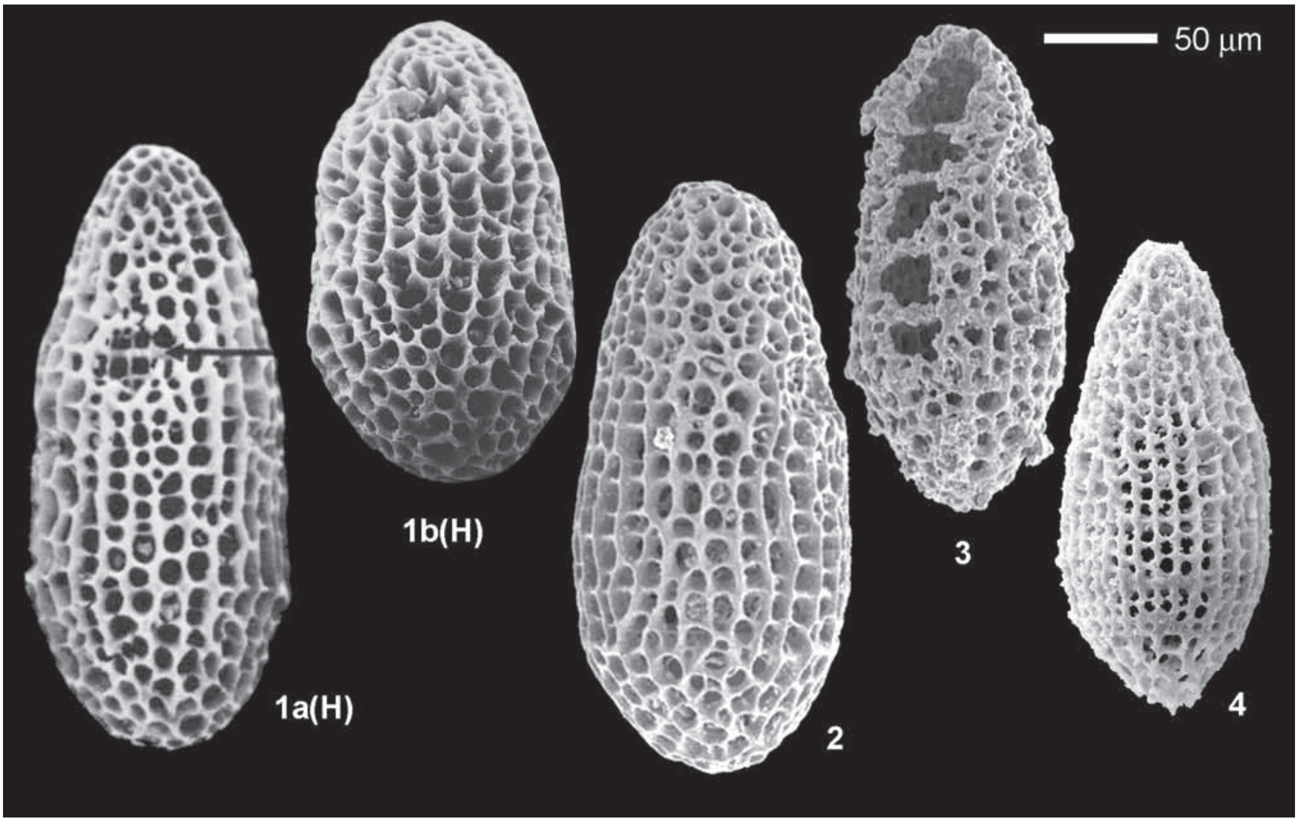


Plate BAG05. ***Bagotum maudense*** **Pessagno & Whalen.** Magnification x300. **Fig. 1a(H).** Pessagno & Whalen 1982, pl. 3, fig. 6. **Fig. 1b(H).** Pessagno & Whalen 1982, pl. 3, fig. 11. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128715. **Fig 3.** GSC loc. C-080612, GSC 128716. **Fig. 4.** JP, MNA-10, MA13268.

Bagotum modestum Pessagno & Whalen 1982

Species code: BAG06

Synonymy:

1982 *Bagotum modestum* n. sp. – Pessagno & Whalen, p. 120, pl. 3, fig. 7, 16, 17.
1984 *Bagotum* spp. – Whalen & Pessagno, pl. 2, fig. 9, 10.
1990 *Bagotum modestum* Pessagno & Whalen – Hori, Fig. 8.29.
1993 *Bagotum modestum* Pessagno & Whalen – Kashiwagi & Yao, pl. 1, fig. 8.
1998 *Bagotum modestum* Pessagno & Whalen – Kashiwagi, pl. 1, fig. 13
2002 *Bagotum modestum* Pessagno & Whalen – Whalen & Carter, p. 116, pl. 10, figs. 9, 11, 12.
2003 *Bagotum modestum* Pessagno & Whalen – Goričan et al., p. 296, pl. 5, fig. 22.
2004 *Lantus*? sp. – Hori, pl. 1, fig. 62 only.
2004 *Bagotum modestum* Pessagno & Whalen – Matsuoka, fig. 193.

Original description: Test broader distally than proximally, having six post-abdominal chambers. Cephalis moderately broad, hemispherical; remaining chambers trapezoidal in cross section. Post-abdominal chambers all with linearly arranged square to rectangular pore frames; chambers gradually increasing in length; all but last one or two post-abdominal chambers increasing moderately rapidly in width as added; final one or two post-abdominal chambers decreasing slightly in width as added. Dome-shaped cap covering final post-abdominal chamber with irregular polygonal pore frames.

Original remarks: *Bagotum modestum*, n. sp., differs from all other new species of *Bagotum* described herein by showing linearly arranged pore frames on all post-abdominal chambers.

Further remarks: Some specimens (pl. BAG06, figs. 5-9) have a well-differentiated proximal part, separated from the rest of the shell by a distinct constriction.

Measurements (μm):
Based on 9 specimens.

Length	Width (max.)	
200	100	HT
250	125	Max.
200	100	Min.
223.6	108.6	Mean

Etymology: *Modestus-a-um* (Latin, adj.) = moderate, orderly, restrained.

Type locality: Sample NSF 960, Franciscan Complex, California.

Occurrence: Franciscan Complex, California; San Hipólito Formation, Baja California Sur; Skrile Formation, Slovenia; Musallah Formation, Oman; Japan .

Plate BAG06. *Bagotum modestum* Pessagno & Whalen. Magification x300. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 3, fig. 7. **Fig. 2**. Matsuoka 2004, fig. 193. **Fig. 3.** Whalen & Carter 2002, pl. 10, fig. 9. **Fig. 4.** Goričan et al. 2003, pl. 5, fig. 22. **Fig. 5.** Hori 1990, fig. 8.29. **Fig. 6.** OM-00-252, 021730. **Fig. 7.** OM-00-118, 000611. **Fig. 8.** OM-00-252, 022015. **Fig. 9.** OM-00-252, 021725.

Bagotum pseudoerraticum Kishida & Hisada 1985
Species code: BAG07

Synonymy:
? 1983 *Bagotum* (?) sp. – Hattori & Yoshimura, pl. 8, fig. 6.
1985 *Bagotum pseudoerraticum* n. sp. – Kishida & Hisada, p. 113, pl. 2, figs. 1-5.
1992 *Bagotum* aff. *pseudoerraticum* Kishida & Hisada – Sashida, pl. 1, figs. 13-15, 17.
1998 *Bagotum* (?) *helmetense* Pessagno & Whalen – Kashiwagi, pl. 2, fig. 5, not fig. 4.
1998 *Bagotum pseudoerraticum* Kishida & Hisada – Kashiwagi, pl. 2, figs. 8, 9.
2002 *Bagotum* sp. A – Hori & Wakita, pl. 3, fig. 3.

Original diagnosis: Test inflated, usually made up of 7 chambers. Final post-abdominal chamber with dome-shaped cap. Outer layer of test with vermicular appearance.

Original description: Test inflated, usually with 4 post-abdominal chambers, 5th or 6th chamber broadest. Cephalis hemispherical. Remaining chambers trapezoidal in outline. Final post-abdominal chamber with dome-shaped cap. Thorax, abdomen and first post-abdominal chambers increasing slowly in height and increasing rapidly in width as added; distal 2 chambers decreasing slightly in height and width as added. Test with vermicular appearance due to presence of irregular, often elongate polygonal frames in outer layer. Inner layer of test with pores aligned longitudinally in rows.

Original remarks: *Bagotum pseudoerraticum* n. sp. differs from *Bagotum erraticum* Pessagno and Whalen 1982, in having vermicular appearance through the outer layer and more inflated test. It is likely that the latter gave rise to the former in early Early Jurassic.

Measurements (µm):
Based on 10 specimens.

Length	Width	
166	92	HT
166	105	Max.
153	88	Min.
161	97	Av.

Type locality: Locality 230, Ueno-mura area, Kanto Mountains, Central Japan.

Occurrence: Kanto Mountains, Japan; Ghost Creek Formation, Queen Charlotte Islands; Musallah Formation, Oman.

Genus: *Beatricea* Whalen & Carter 1998
Type species: *Beatricea christovalensis* Whalen & Carter 1998

Synonymy:
1998 *Beatricea* n. gen. – Whalen & Carter, p. 57.

Original description: Test small, circular to sub-rectangular in outline with four long spines in the same plane 90° apart. Cortical shell thick with planiform upper and lower surfaces each with variably sized central cavity; sides of cortical shell straight. Shell composed of numerous layers of small, irregularly shaped pore frames lacking concentric arrangement. Layers of pore frames much thicker on margins of test. Spines usually triradiate in axial section, rarely circular.

Original remarks: *Beatricea* n. gen. differs from *Praeorbiculiformella* Pessagno by always possessing four strong primary spines at 90˚ and in lacking concentrically arranged pore frames. *Beatricea* n. gen. differs from *Sophia* n. gen. and *Udalia* n. gen. in possessing irregularly arranged pore frames as well as a central cavity; *Beatricea* n. gen. further differs from *Sophia* n. gen. in lacking a central spicular network.

***Etymology*:** This genus is named for the ship C. P. R. *Princess Beatrice* a sailing vessel in the Queen Charlotte Islands in the early 1900s.

Included species:
ORB04 *Beatricea*? *argescens* (Cordey) 1998
PDC01 *Beatricea*? *baroni* (Cordey) 1998
SPI03 *Beatricea christovalensis* Whalen & Carter 1998
ORB07 *Beatricea sanpabloensis* (Whalen & Carter) 2002
CRU18 *Beatricea*? sp. A

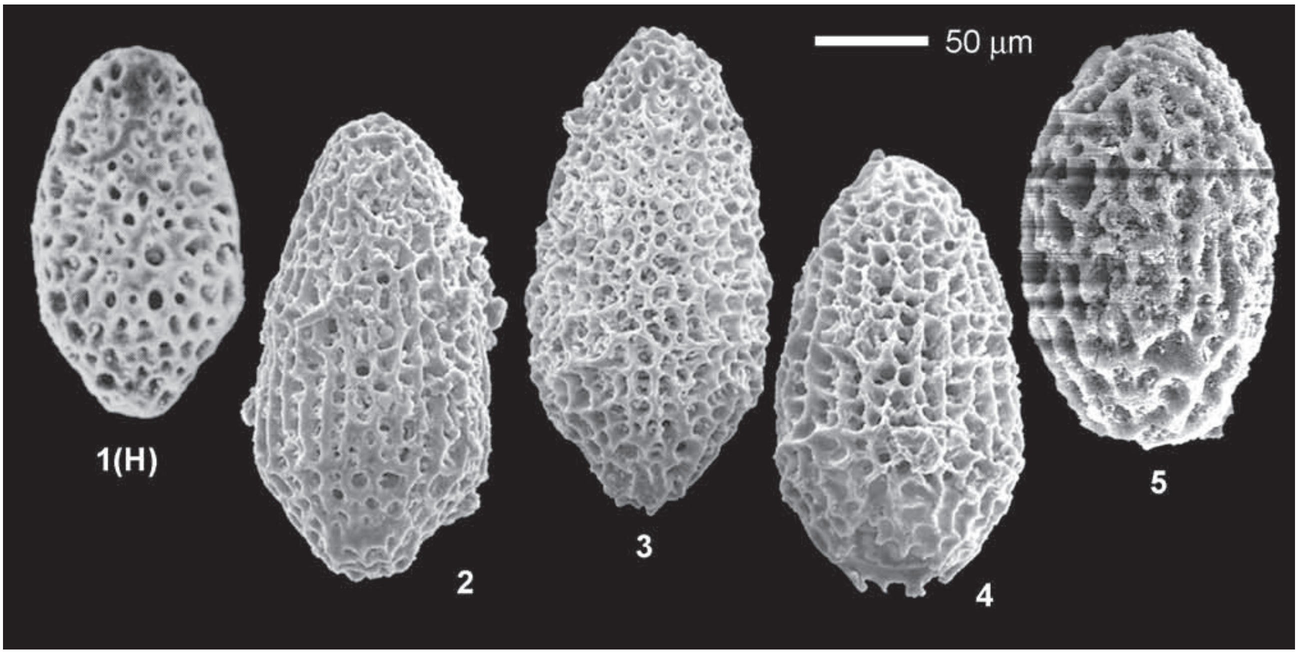


Plate BAG07. ***Bagotum pseudoerraticum*** **Kishida & Hisada.** Magnification x300. **Fig. 1(H).** Kishida & Hisada 1985, pl. 2, fig. 1. **Fig. 2.** QCI, GSC loc. C-305388, GSC 128717. **Fig. 3.** QCI, GSC loc. C-305388, GSC 128718. **Fig. 4.** QCI, GSC loc. C-304281, GSC 128719. **Fig. 5.** OM-00-254, 022133.

Beatricea? argescens (Cordey) 1998

Species code: ORB04

Synonymy:

1988 *Orbiculiforma* sp. A – Carter et al., p. 45, pl. 1, fig. 9.
1989 *Emiluvia* ? spp. – Hattori, pl. 2, fig. J.
1996 *Orbiculiforma* sp. A of Carter in Carter et al. – Hori et al., pl. 1, fig. 19.
1998 *Orbiculiforma argescens* n. sp. – Cordey, p. 94, pl. 21, figs. 6, 9, 11.

Original diagnosis: *Orbiculiforma* possessing four strong spines.

Original description: Thick test circular to subsquare in outline with four arms (one at each corner). Lower and upper surfaces planar. Test sides vertical to slightly concave. Cortical cavity deep and with smaller pores than those of external crown. Test with polygonal pore frames (pentagonal to hexagonal) with stout nodes at vertices. Four coplanar spines orthogonally disposed and circular in cross-section: sometimes elongated proximal pores, extending up to two-third length of spine.

Original remarks: This form resembles to *O. quadrata* Pessagno by its subsquare shape and four spines, but differs from it by its more massive skeleton and pore-frames and much longer, massive radial spines.

Further remarks: This species differs from *Beatricea christovalensis* Whalen & Carter by having a more square-shaped test and shorter spines. See also remarks under *B.*? *baroni* (Cordey) and *Beatricea*? sp. A.

Etymology: From Greek *argo*- shiny.

Type locality: Locality GSC C-300407, Bridge River Complex, Lake Carpenter, British Columbia.

Occurrence: Bridge River Complex, British Columbia; Fannin Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia; Japan; Newcastle Group, New Zealand.

Beatricea? baroni (Cordey) 1998

Species code: PDC01

Synonymy:

1998 *Pseudocrucella*? *baroni* n. sp. – Cordey, p. 70, pl. 20, fig. 5-7.
2002 *Pseudocrucella*? *baroni* Cordey – Whalen & Carter, p. 105, pl. 1, figs. 5, 6, 9, 10, 13, 14.

Original diagnosis: *Pseudocrucella*? with wide central zone, broad, short latticed arms, and long distal spines.

Original description: Test almost square, built with a latticed zone whose corners are prolonged with massive triradiate spines. Square zone corresponds to the development of four latticed arms externally constructed with cortical shell; the latter comprising several longitudinal beams (from three to four per lateral face), connected by transverse bars. Nodes observed at the intersection of bars and beams. Cortical shell absent on central part of test, revealing the medullary shell formed by small orthogonal pore frames. Latticed faces of arms concave. Long triradiate spines extend from arms.

Original remarks: *Pseudocrucella*? *baroni* differs from all other species of *Pseudocrucella* by a broad development of central zone, short latticed parts on arms and long distal spines.

This morphotype is questionably assigned to the genus *Pseudocrucella* because the latticed zones on the arms of *Pseudocrucella* are usually longer. The concavity of lateral faces suggests that this form cannot be assigned to the genus *Higumastra*.

Further remarks: This species differs from *Beatricea argescens* (Cordey) because the outer edges of the test between spines are concave, and the spines are longer and more developed.

Measurements (μm):
Based on 2 specimens.

	Min.	Max.	Av.
Total length of ray	80	110	95
Maximum width of rays	45	75	50
Diameter of central cavity	45	55	50

Etymology: Arbitrary combination of letters (ICZN, 1985, art. 11b(iii), p. 20).

Type locality: Locality GSC C-300407, Bridge River Complex, Lake Carpenter, British Columbia.

Occurrence: Bridge River and Hozameen complexes, British Columbia; San Hipólito Formation, Baja California Sur.

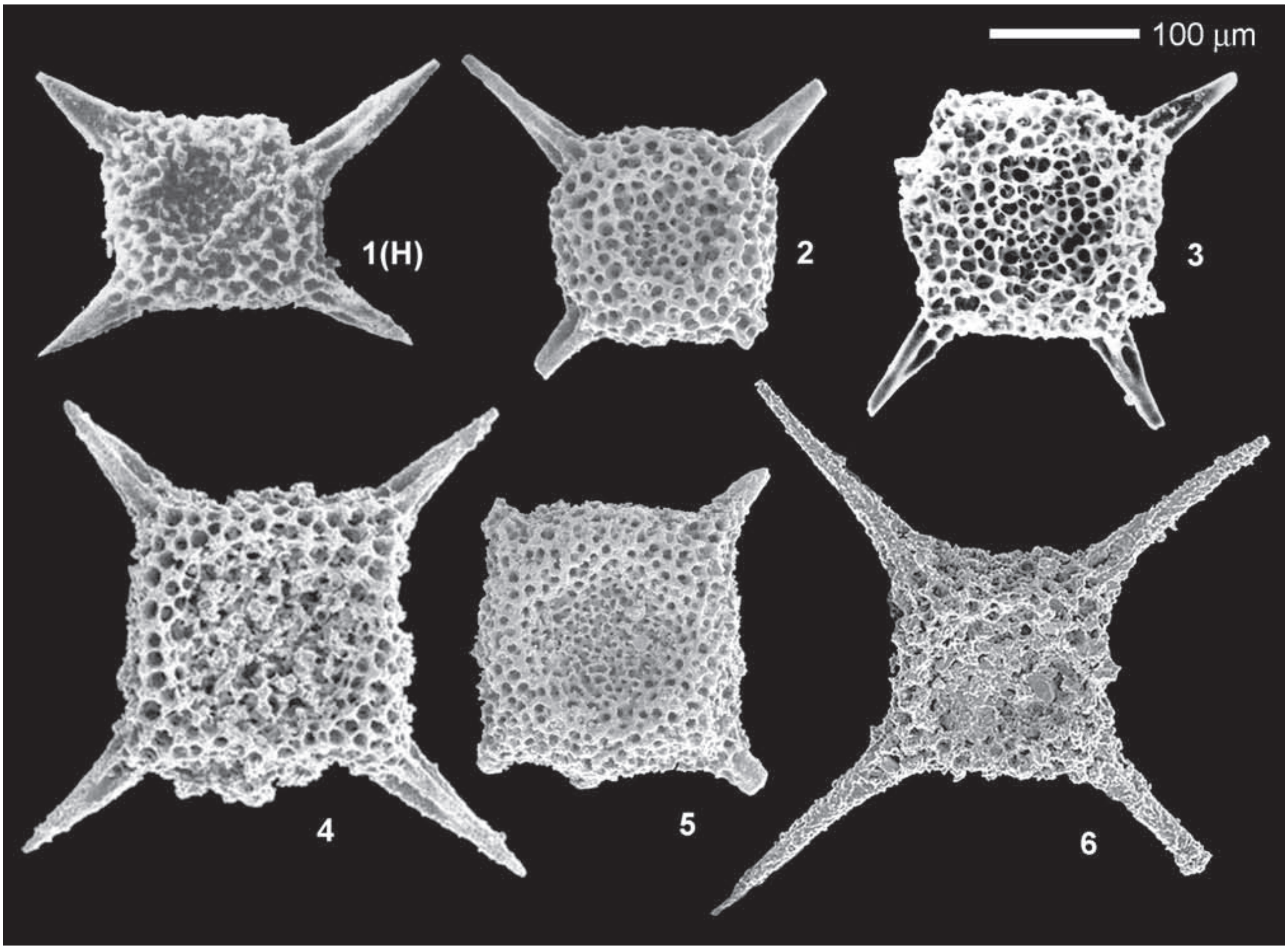


Plate ORB04. *Beatricea*? *argescens* (Cordey). Magnification x200. **Fig. 1(H).** Cordey 1998, pl. 21, fig. 6. **Fig. 2.** QCI, GSC loc. C-C-080611, GSC 111799. **Fig. 3.** Carter et al. 1988, pl. 1, fig. 9. **Fig. 4.** QCI, GSC loc. C-305417, GSC 111800. **Fig. 5.** QCI, GSC loc. C-080612, GSC 111801. **Fig. 6.** NBC, GSC loc. C-305208, GSC 111802.

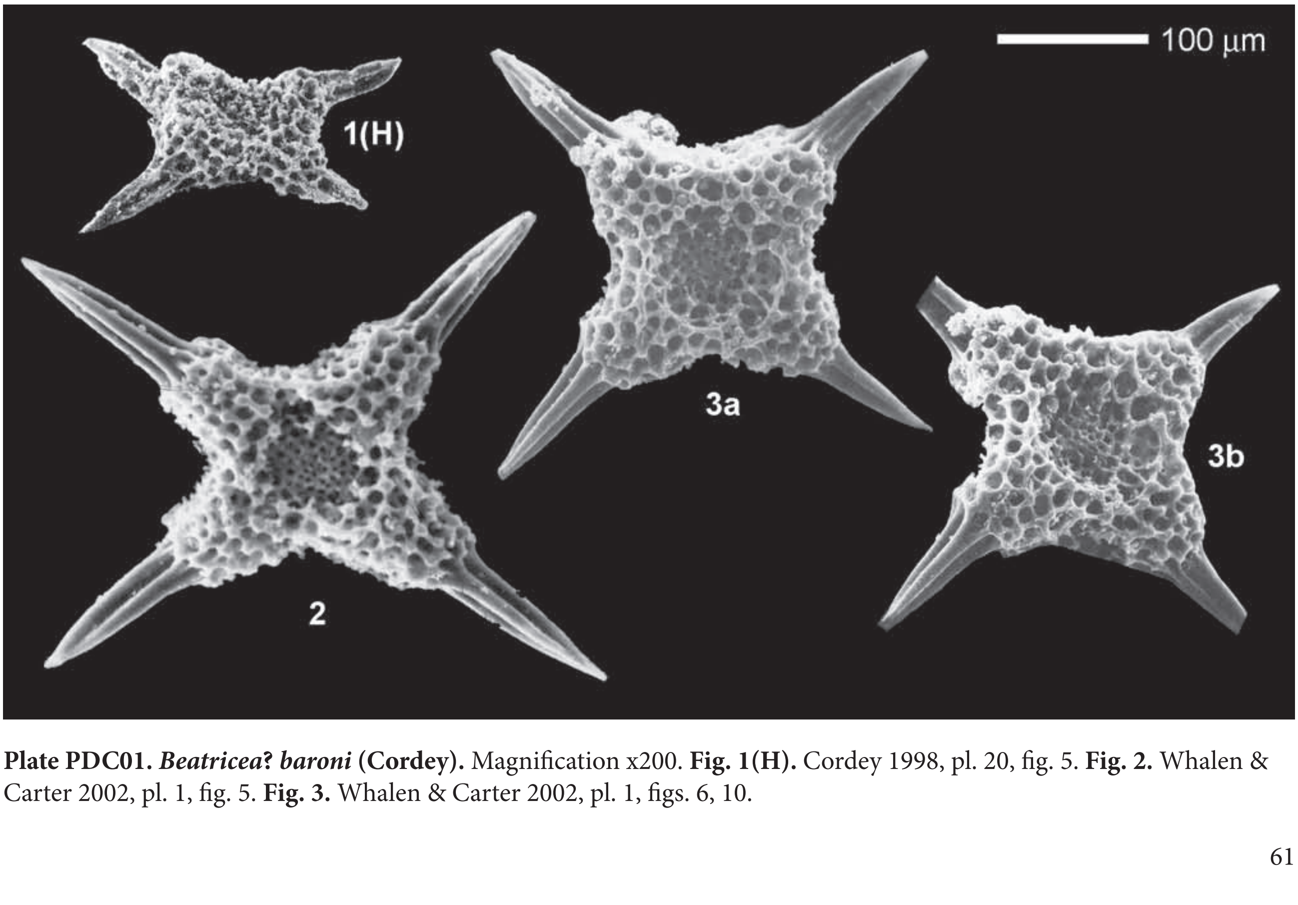


Plate PDC01. *Beatricea*? *baroni* (Cordey). Magnification x200. **Fig. 1(H).** Cordey 1998, pl. 20, fig. 5. **Fig. 2.** Whalen & Carter 2002, pl. 1, fig. 5. **Fig. 3.** Whalen & Carter 2002, pl. 1, figs. 6, 10.

Beatricea christovalensis Whalen & Carter 1998

Species code: SPI03

Synonymy:

1998 *Beatricea christovalensis* n. sp. – Whalen & Carter, p. 57, pl. 11, figs. 13, 14, 16-20, 22.
2002 *Beatricea christovalensis* Whalen & Carter – Suzuki et al., p. 175, figs. 6 G-H.
2002 *Beatricea christovalensis* Whalen & Carter – Tekin, p. 185, pl. 3, fig. 1.

Original description: Test small, sub-rectangular in outline with four, long prominent spines. Test thick with planiform upper and lower surfaces and straight sides. Cortical shell with irregularly shaped tetragonal and polygonal pore frames with very small nodes at pore frames vertices. Central cavity variable in size but usually about one-half diameter of cortical shell. Central area of test thinner than margins and often missing. Spines usually triradiate (rarely circular) in axial section with narrow longitudinal ridges and broad grooves sometimes showing torsion.

Original remarks: This is the first species of *Beatricea* n. gen. described from the Lower Jurassic of Queen Charlotte Islands. Several morphological features of this species are quite variable: the size and shape of cortical shell, the width of the central cavity, and the length of primary spines. For the present we have included all Hettangian and Sinemurian specimens in one widely variable species, *Beatricea christovalensis* n. sp. We recognize a possible relationship between *B. christovalensis* and Spumellarian indet. B but owing to our incomplete knowledge of the inner structure of both forms, their differences are not addressed in this paper.

Measurements (μm):
Based on 12 specimens.

Diameter of corticall shell	Diameter of central area	Length of primary spines (max.)	
225	124	237	HT
225	124	329	Max.
97	38	84	Min.
150	67	193	Mean

Etymology: This species is named for the San Christoval Range in Queen Charlotte Islands.

Type locality: Sample 89-CNA-KUG-1A, Sandilands Formation, Kunga Island, north side; Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Hocaköy Radiolarite, Turkey; Pucara Group, Peru.

Beatricea sanpabloensis (Whalen & Carter) 2002

Species code: ORB07

Synonymy:

1984 *Orbiculiforma* sp. – Whalen & Pessagno, pl. 1, fig.18.
2002 *Orbiculiformella sanpabloensis* n. sp. – Whalen & Carter, p. 109, pl. 1, figs. 1-2.

Original description: Test small, circular in outline with vertical sides and upper and lower surfaces of rim rounded. Test thick in proportion to diameter. Four to six primary peripheral spines, medium length, triradiate in axial section; very small subsidiary spines or spinules located between principal peripheral spines. Central cavity shallow almost one half diameter of test, with raised center. Meshwork primarily composed of large, irregularly shaped polygonal pore frames; meshwork distinctly finer in central cavity area.

Original remarks: The rounded top, bottom and rim surfaces of *Orbiculiformella sanpabloensis* n. sp. distinguish it from *O. trispinula* (Carter 1988) while the much shorter spines and larger central cavity distinguish it from *O. trispinosa* (Yeh 1987).

Measurements (μm):
Based on 7 specimens.

Width (Max.)	Width of central cavity (Max.)	
158	90	HT
225	135	Max.
158	75	Min.
194	103	Mean

Etymology: This species is named for Punta San Pablo located to the northwest of the type area.

Type locality: Sample SH-412-14, San Hipolito Formation, Baja California Sur, Mexico.

Occurrence: San Hipolito Formation, Baja California Sur; Fannin Formation, Queen Charlotte Islands.

***Beatricea*? sp. A**

Species code: CRU18

Synomnymy:

2002 *Crucella*? sp. A – Whalen & Carter, p. 107, pl. 1, figs. 4, 8, 12.

Remarks: The test outline of *Beatricea*? sp. A appears to be intermediate between *Beatricea*? *argescens* (Cordey) and *Beatricea*? *baroni* (Cordey).

Occurrence: San Hipólito Formation, Baja California Sur.

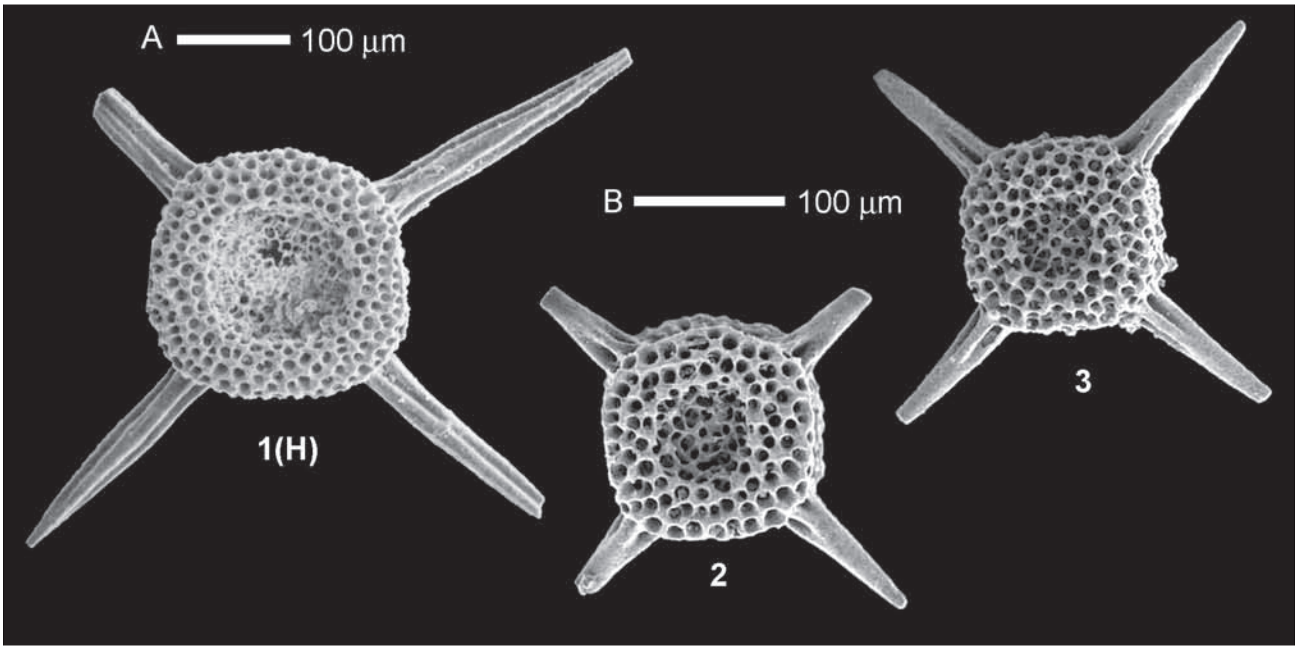


Plate SPI03. *Beatricea christovalensis* Whalen & Carter. Magnification: Fig. 1 x150 (scale bar A), Figs. 2, 3 x200 (scale bar B). **Fig. 1(H).** Carter et al. 1998, pl. 11, fig. 14. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128886. **Fig. 3.** QCI, GSC loc. C-304566, GSC 128887.

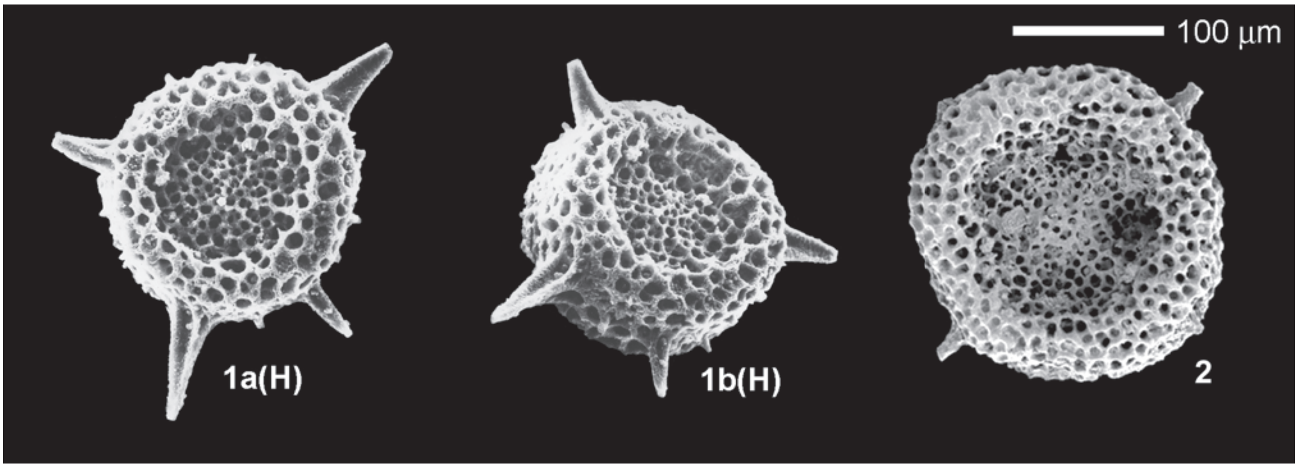


Plate ORB07. *Beatricea sanpabloensis* (Whalen & Carter). Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 1, figs. 1-2. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128850.

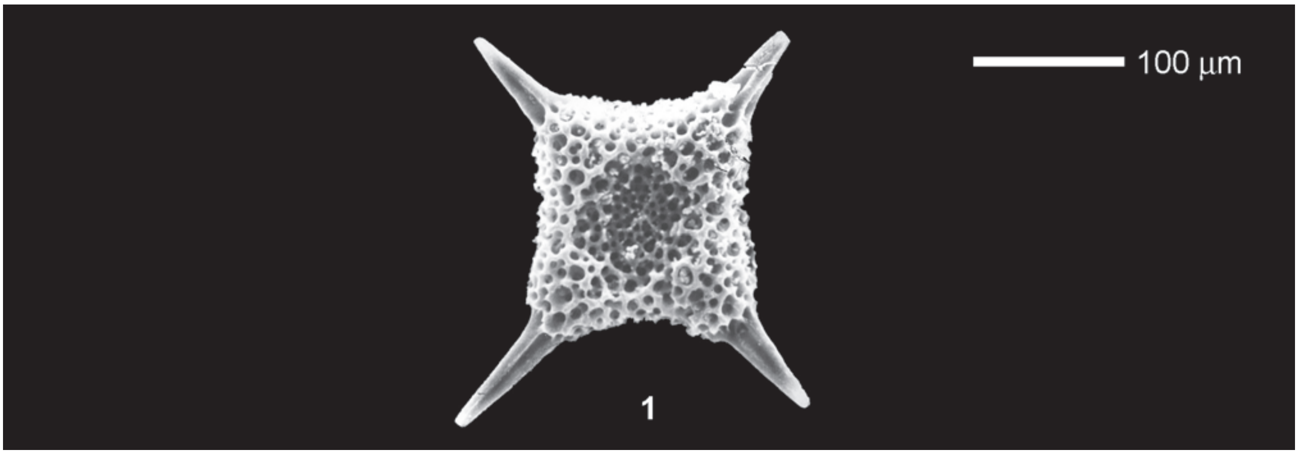


Plate CRU18. *Beatricea*? sp. A. Magnification x200. **Fig. 1**. Whalen & Carter 2002, pl. 1, fig. 4.

Genus: *Bernoullius* Baumgartner1984

Type species: *Eucyrtis* (?) *dicera* Baumgartner, in Baumgartner et al. 1980

Synonymy:

1984 *Bernoullius* n. gen. – Baumgartner, p. 759.

Original description: Spongodiscid spumellarian with distinct bilateral symmetry: A delicate, finely spongy main body of flattened egg-shape carries on the narrow end two symmetric, strongly developed, usually triradiate lateral spines and sometimes one central spine.

Original remarks: Because of the clear bilateral symmetry, the spines were interpreted as cephalic horns of a nassellarian by Baumgartner in Baumgartner et al. 1980. Well preserved specimens from DSDP Site 534A show that the spines are attached to a finely spongy body lacking any resemblance to nassellarian morphology. For most specimens, the spongy body is not as poorly preserved as spongy round mass at the base of the spines. Kozur & Mostler (1979, pl. 21, fig. 2) illustrated a Triassic form which possibly belongs to this genus.

Etymology: Dedicated to Daniel Bernoulli, Zurich, Switzerland, in honour of his contribution to the understanding of ancient passive continental margins in the Alpine-Mediterranean realm.

Included species:

3222 *Bernoullius delnortensis* Pessagno, Blome & Hull 1993
BER01 *Bernoullius saccideon* (Carter) 1988

Bernoullius delnortensis Pessagno, Blome & Hull 1993

Species code: 3222

Synonymy:

1987 *Bernoullius* sp. A – Goričan, p. 181, pl. 1, fig. 17.
1993 *Bernoullius delnortensis* Pessagno, Blome & Hull n. sp. – Pessagno et al., p. 120, pl. 1, figs. 4, 15, 26.
1994 *Bernoullius rectispinus* Kito, De Wever, Danelian & Cordey s.l. – Goričan, p. 63, pl. 8, figs. 7, 8, ?9, 11, 12 only.
1995a *Bernoullius rectispinus delnortensis* Pessagno, Blome & Hull – Baumgartner et al., p. 126, pl. 3222, figs. 1-4.
1997 *Bernoullius delnortensis* Pessagno, Blome & Hull – Hull, p. 16, pl. 1, fig. 2.
2004 *Bernoullius delnortensis* Pessagno, Blome & Hull – Matsuoka, fig. 2.

Original description: Test relatively slender, flaring slightly laterally away from spines. Primary spines straight, rather short and massive, triradiate in axial section with three longitudinal ridges alternating with three longitudinal grooves. Longitudinal grooves, narrow, deeply incised, gradually decreasing in width in a distal direction. Ridges wide proximally, becoming progressively narrower in a distal direction.

Original remarks: This form greatly resembles *Bernoullius* sp. A of Goričan (1987). It possesses straight, short, subequal spines with parallel sided, deeply incised grooves separating wide, longitudinal ridges which wedge out distally. *Bernoullius* sp. A of Gorican, however, possesses short spines which are nearly equal in length and are somewhat shorter than those of *B. delnortensis*. *B. delnortensis* differs from *B.* sp. A (herein) by having considerably shorter, wider, and more massive primary spines. *B. delnortensis* differs from *B. cristatus* Baumgartner (1984) by having spines which are straight and lack curved tips.

Further remarks: By Baumgartner et al. (1995a): This subspecies differs from *Bernoullius rectispinus rectispinus* by having smaller size. The species also differs from *Bernoullius dicera* and *B. cristatus* by having straight spines.

Measurements (μm):

Based on 4 specimens (see Pessagno et al., 1993 for explanation of system of measurements for this species).

	HT	av.	min.	max.
AA':	210	206	195	225
Sx:	165	130	105	165
S'x':	-	136	123	150
BB':	135	135	105	180
SS':	-	187	180	195

Etymology: This species is named for Del Norte County, California.

Type locality: Volcanopelagic strata above Josephine ophiolite, Smith River subterrane, Klamath Mountains, northwestern California.

Occurrence: Worldwide.

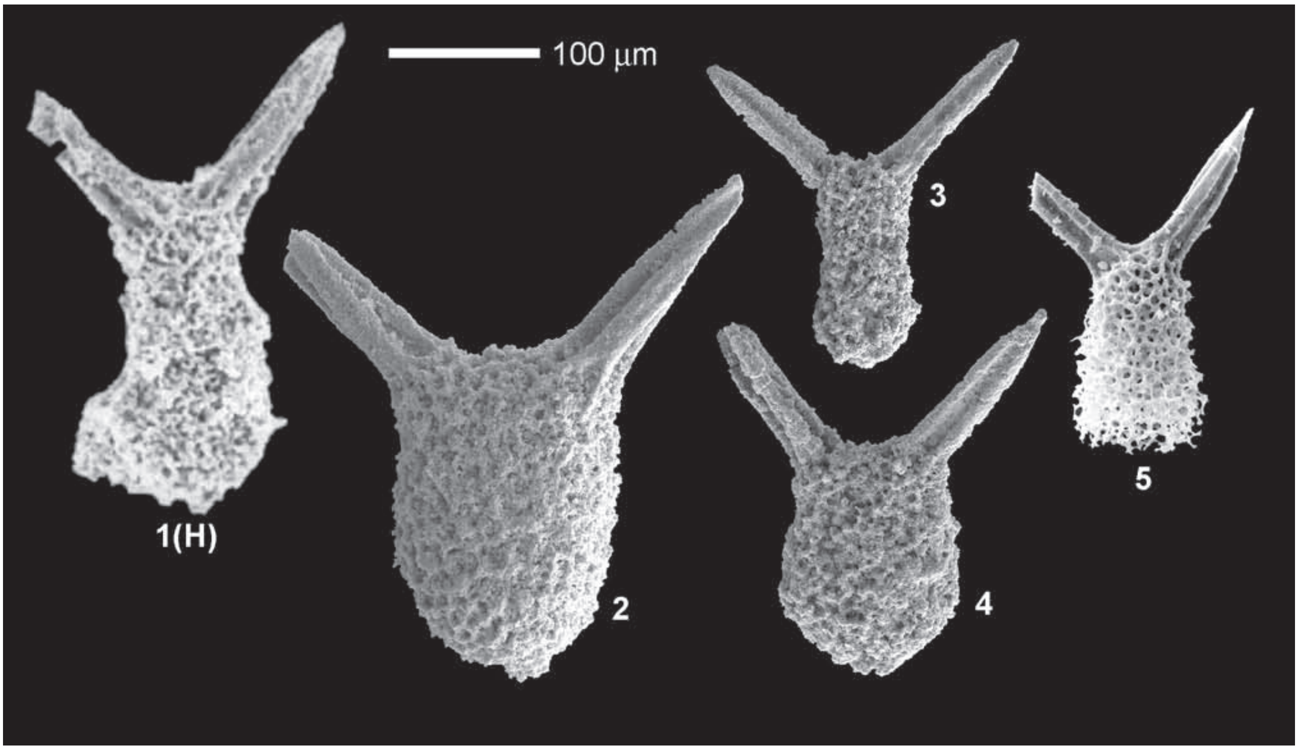


Plate 3222. ***Bernoullius delnortensis*** **Pessagno, Blome & Hull.** Magnification x200. **Fig. 1(H).** Pessagno et al. 1993, pl. 1, fig. 4. **Fig. 2.** OM, BR871-R02-11. **Fig. 3.** OM, BR871-R02-15. **Fig. 4.** OM, BR871-R02-16. **Fig. 5**. Matsuoka 2004, fig. 2.

Bernoullius saccideon (Carter) 1988
Species code: BER01

Synonymy:
1988 *Spongiostoma saccideon* Carter n. sp. – Carter et al., p. 46, pl. 12, figs. 4, 7, 10.
? 1988 *Spongiostoma* sp. A – Carter et al., p. 47, pl. 12, figs. 8, 9.

Original diagnosis: Test subcircular in outline, composed of two spongy concentric layers which gape open. Short hinge on one edge marked by two strong triradiate spines; periphery with a few very fine secondary spines.

Original description: Test as for genus; subcircular in outline. Hinge normally short and straight with a well defined, triradiate primary spine on either end. A few short and very fine, secondary spines radiating from the circular periphery have been noted on some tests.

Original remarks: Compared to *Spongiostoma* sp. A under that species. Common to very abundant in middle/upper Toarcian samples.

Measurements (μm):
Measurements are treated in a very preliminary manner as many of these specimens appear incomplete.
Based on 11 specimens.

	HT	Av.	Max.	Min.
Maximum diameter of test	121	207	250	160
Length of hinge (between centres at margin)	109	100	120	76
Length of longest spine	109	124	165	80

Etymology: Latin, *saccus* (n.), bag or pouch; saccideon = of sac-like appearance.

Type locality: GSC locality C-080583, Phantom Creek Formation, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands.

Genus: *Bipedis* De Wever 1982a
Type species: *Bipedis calvabovis* De Wever 1982a

Synonymy:
1982a *Bipedis* n. gen – De Wever, p. 192.

Original description: Form with two segments, with a strong apical horn and two or four feet. Cephalic skeleton with spines A, V, MB, L_l, L_r, l_l and l_r; spine D is absent. Apical horn is an extension of A spine. A cephalic opening exists at the prolongation of V spine. Two feet correspond to L_l and L_r, sometimes two smaller feet occur as external extensions of l_l and l_r.

Original remarks: When only two feet are present, they are not separated from each other by an angle of 180°, due to the respective locations of L_l and L_r spines on the cephalic skeleton. For practical reasons, I have placed this genus in the Pylentonemidae, although the absence of the D spine makes this placement uncertain.

Etymology: From the Latin *bi* = two, and *pes, pedis* = foot (form with two feet).

Included species:
BPD13 *Bipedis calvabovis* De Wever 1982a
BPD05 *Bipedis diadema* Whalen & Carter 1998
BPD14 *Bipedis fannini* Carter 1988
BPD15 *Bipedis japonicus* Hori n. sp.
BPD16 *Bipedis yaoi* Hori n. sp.

Bipedis calvabovis De Wever 1982a
Species code: BPD13

Synonymy:
1982a *Bipedis calvabovis* n. sp. – De Wever, p. 193, pl. 2, figs. 7-11.
1982b *Bipedis calvabovis* De Wever – De Wever, p. 337, pl. 52, figs. 5-9.
1982 *Bipedis calvabovis* De Wever – De Wever & Origlia-Devos, pl. 1, fig. J, ? figs. K, L.
2002 *Bipedis* sp. aff. *B. calvabovis* De Wever – Tekin, p. 192, pl. 5, fig. 10.

Original description: *Bipedis* with a strong apical horn and two lanceolate feet, triradiate in cross- section along their length. Cephalis smooth and imperforate proximally, smooth or longitudinally ribbed, perforate or not, distally. Cephalis with a small lateral opening protected by a perforate hood at the end of the V spine (Pl. 2, fig. 7, 8, 10, 11). The change in outline between the cephalis and thorax is sometimes very clear (Pl. 2, fig. 8) and sometimes not (Pl. 2, fig. 10). Cephalis and thorax cone-shaped. Thorax with small irregular pores in different specimens: large (Pl. 2, fig. 7) or small (Pl. 2, fig. 10). Cephalis and thorax more robust in specimens with smaller pores than in specimens with large pores. This could result from a more or less important (ontogenetical ?) development of an external silica layer as is the case in other forms.

Original remarks: A form close to *B. calvabovis* n. sp. was found but it has four feet instead of two.

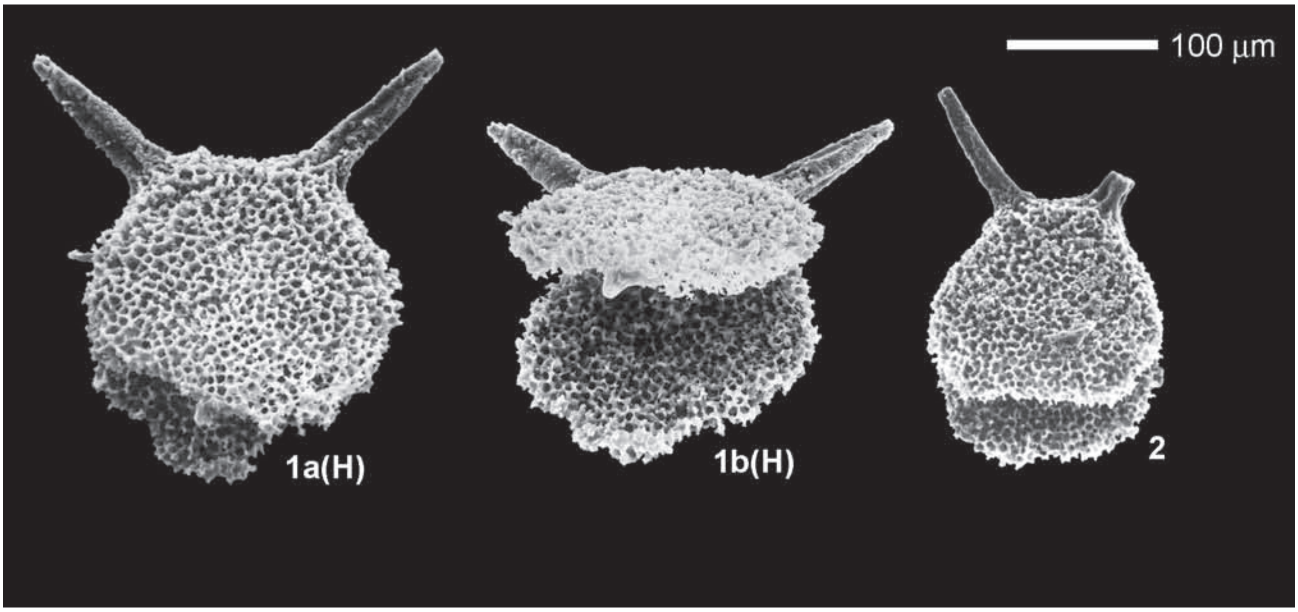


Plate BER01. ***Bernoullius saccideon*** **(Carter).** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 12, figs. 4, 10. **Fig. 2.** Carter et al. 1988, pl. 12, fig. 7.

Measurements (µm):
Based on 10 specimens.

	HT	Av.	Min.	Max.
Length apical horn	100	90	75	100
Cephalo-thorax length	100	103	90	125
Cephalo-thorax width	100	100	90	109
Length of feet	153	118	100	153

Etymology: From the Latin *calva, –ae* =skull; and *bos, bovis* = ox. For similarity with skull of bovids, when the apical horn is turned downwards.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon and Hocaköy Radiolarite, Turkey; Drimos Formation, Greece; Haliw (Aqil) Formation, Oman.

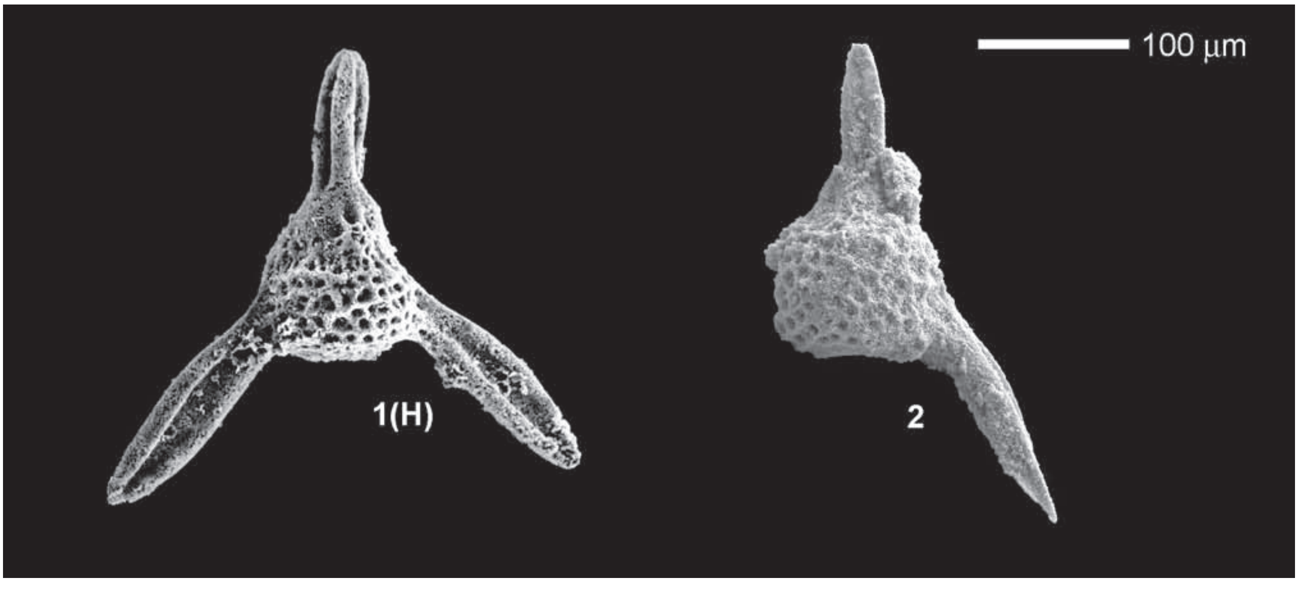


Plate BPD13. ***Bipedis calvabovis*** **De Wever.** Magnification x200. **Fig. 1(H).** De Wever 1982a, pl. 2, fig. 7. **Fig. 2.** OM, Haliw-038-R08-05.

Bipedis diadema Whalen & Carter 1998

Species code: BPD05

Synonymy:

1998 *Bipedis diadema* n. sp. – Whalen & Carter, p. 76, pl. 21, figs. 7-10, 13, 17; pl. 22, fig. 1; pl. 27, figs. 11, 12.

Original description: Test hemi-elliptical in outline with small hemispherical cephalis and medium-sized horn; horn usually triradiate in axial section proximally with narrow, rounded longitudinal ridges and broad grooves becoming rounded in axial section distally. Cephalis mostly smooth, imperforate, covered with thick, irregular layer of microgranular silica; some relict pores observed on cephalis where layer of microgranular silica is thinner. Both cephalis and thorax compressed in plane of feet. Thorax with mostly small, irregularly shaped pore frames with slight development of orientation transverse to long axis of the test. Test with two medium-sized feet, triradiate in axial section with narrow rounded ridges and broad grooves; feet curved slightly inward towards center of test; mouth elliptical in outline with prominent, broad imperforate band.

Original remarks: *Bipedis diadema* n. sp., is distinguished from all other species of *Bipedis* by the very wide imperforate band which rims the mouth, the hemi-elliptical outline, and the compressed thorax and cephalis.

Measurements (μm):
Based on 10 specimens.

Length (excluding horn)	Width (max.)	Length of feet (max.)	
105	90	75	HT
105	109	75	Max.
90	75	45	Min.
101	94	65	Mean

Etymology: *Diadema*, *atis* (Latin; neuter) = a royal headband, diadem.

Type locality: Sample QC 675. Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

Bipedis fannini Carter 1988

Species code: BPD14

Synonymy:
1988 *Bipedis fannini* Carter n. sp. – Carter et al., p. 61, pl. 2, figs. 7, 8.

Original diagnosis: Dicyrtid with small cephalis, globose thorax with roughened surface, long triradiate horn and two downward curving terminal feet.

Original description: Bilaterally symmetrical dicyrtid test. Cephalis medium-sized, spherical, sparsely perforate basally with long, tapering apical horn. Horn triradiate with deep grooves on basal half. Thorax large and globose with constricted circular aperture and two strong, triradiate downward curving terminal feet. Thorax with roughned surface composed of low nodes or tubercles surrounded by small circular to elliptical pores.

Original remarks: This species appears to be entirely new and differs significantly from all other known species of *Bipedis*. Rare at type locality, abundant in older Pliensbachian samples.

Measurements (μm):
Based on 9 specimens.

	HT	Av.	Max.	Min.
Height of cephalis and thorax	132	148	170	132
Maximum width of thorax	139	121	140	120
Length of apical horn	60	62	70	52
Length of feet	-	105	120	75

Etymology: Named in honour of John Fannin, curator of the provincial museum in Victoria, British Columbia, in the late 1800's.

Type locality: GSC locality C-080577, Fannin Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands and Williston Lake, north-east British Columbia.

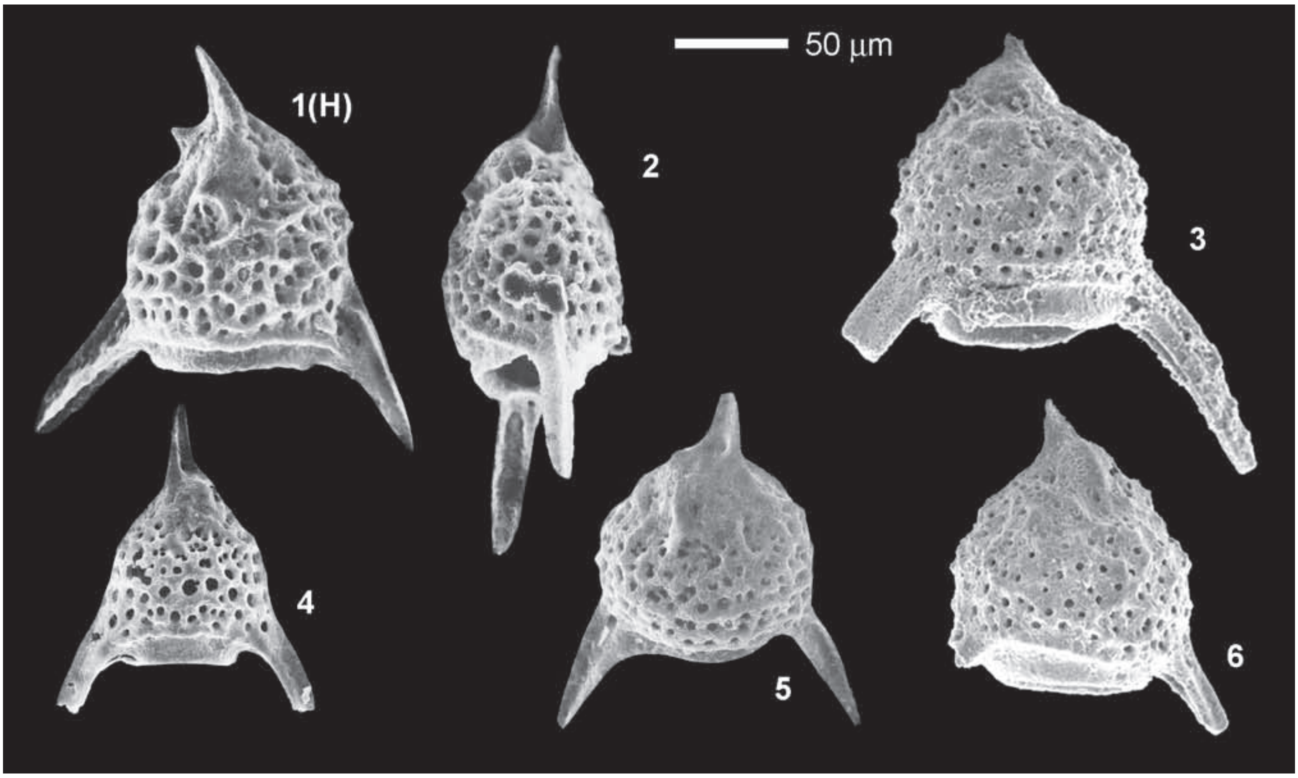


Plate BPD05. ***Bipedis diadema*** **Whalen & Carter.** Magnification x300. **Fig. 1(H).** Carter et al. 1998, pl. 21, fig. 7. **Fig. 2.** Carter et al. 1998, pl. 21, fig. 8. **Fig. 3.** QCI, GSC loc. C-080612, GSC 128711. **Fig. 4.** Carter et al. 1998, pl. 21, fig. 10. **Fig. 5.** Carter et al. 1998, pl. 21, fig. 9. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128720.

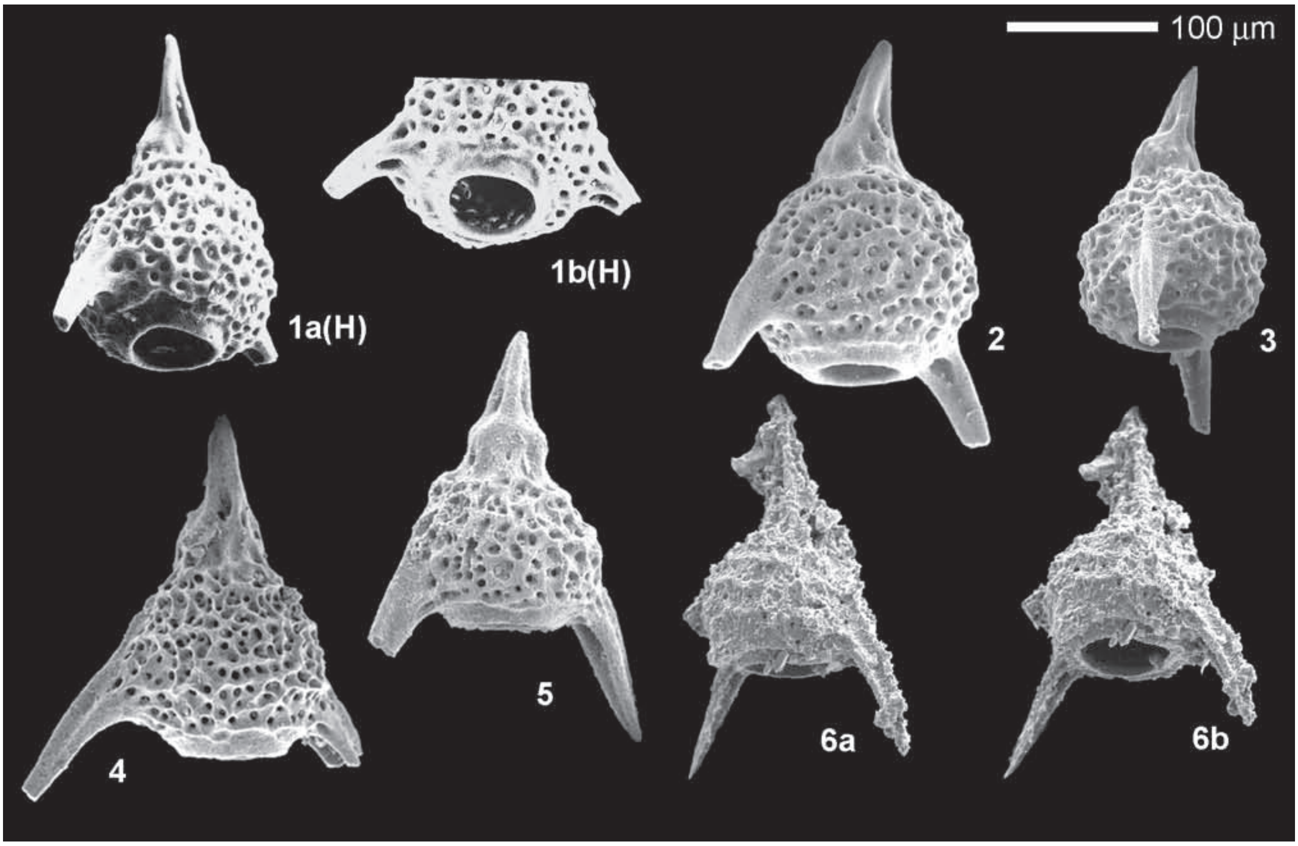


Plate BPD14. ***Bipedis fannini*** **Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 2, figs. 7-8. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128721. **Fig. 3.** QCI, GSC loc. C-080613, GSC 128889**. Fig. 4.** QCI, GSC loc. C-304566, GSC 128890**. Fig. 5.** QCI, GSC loc. C-080611, GSC 128891**. Fig. 6.** NBC, GSC loc. C-305813, GSC 128892**.**

Bipedis japonicus Hori n. sp.

Species code: BPD15

Synonymy:

1982 Nassellaria gen. and sp. indet. B – Yao et al., p. 41, pl. 2, fig.13.
1986 *Bipedis* sp. – Hori, p. 52, fig. 6-12.
1990 *Bipedis* sp. A – Hori, p. 581, fig. 8-12.
1993 *Bipedis* sp. – Fujii et al., p. 87, pl. 2, fig. 4.
1994 *Bipedis* sp. A – Matsuoka et al., pl. 5, fig. 14.
1997 *Bipedis horiae* n. sp. – Sugiyama, p. 145, fig. 39.10, not fig. 28.7.

Type designation: Holotype specimen no.Kb05-18 (pl. BPD15, fig. 1), sample Kb05, Katsuyama Section.

Description: Test dicyrtid with large dome-shaped cephalis and a long massive horn, triradiate in axial section. Cephalis smooth, imperforate at base of horn. Thorax large, relatively inflated, subspherical with fairly regular polygonal pore frames. Two wing-like feet attached at base of thorax; feet inwardly curving, triradiate in axial section. Narrow longitudinal ridges and broad grooves visible along side of thorax for most part. Large aperture at base of thorax.

Remarks: *Bipedis* sp. A of Hori (1990) was placed in synonymy with *Bipedis horiae* by Sugiyama (1997), but these two species are quite different in the shape of shell and feet. *Bipedis* sp. A of Hori (1990) is described herein as *Bipedis japonicus* n. sp., which is distinguished from *Bipedis horiae* Sugiyama by having very long stout feet and a strong horn. *B. japonicus* n. sp. differs from *Bipedis rotundus* Whalen and Carter by having long well-developed feet and horn, and a wider thorax with more regularly arranged pore frames.

Measurements (μm):

Based on 5 specimens.

	HT	Av.	Max.	Min.
Height of cephalis and thorax	147	130	147	120
Maximum width of thorax	146	144	153	133
Length of apical horn	107	99	113	84
Length of feet	134	140	153	133

Etymology: This species of *Bipedis* occurs mainly in Lower Jurassic strata of Japan.

Type locality: Kb05 (UFI3+183cm) UF (Katsuyama) section, Inuyama, Mino terrane, Japan.

Occurrence: Mino terrane, Japan.

Bipedis yaoi Hori n. sp.

Species code: BPD16

Synonymy:

1990 *Bipedis* sp. B – Hori, p. 581, fig. 8-13.
1990 *Bipedis* sp. A – Yao, p. 341, pl. 2, fig. 10.
1994 *Bipedis* sp. B – Matsuoka et al., p. 53, pl. 5, fig. 21.
2001 *Bipedis* sp. – Gawlick et al., pl. 6, fig. 9.
2005 *Bipedis* sp. – Hori, pl. 9, fig. 27.

Type designation: Holotype specimen no. IYII24-28 (pl. BPD16, fig. 1), sample IYII24, IY Section.

Description: Cephalis small and spherical with a long horn; horn triradiate or solid circular in axial section. Thorax large and spherical with fairly regularly arranged polygonal pore frames, a circular aperture and two long feet. Feet asymmetrical, straight or sometimes curving outward distally. Feet thin, blade-like in axial section proximally terminating with a solid spine.

Remarks: This species is distinguished from all other species of *Bipedis* by having a large almost spherical thorax. It is similar to *Bipedis hannai* Whalen and Carter 1998, but differs by having longer feet, a longer stout horn and larger shell. *B. yaoi* Hori n. sp. differs from *Bipedis japonicus* Hori n. sp. and *B. horiae* Sugiyama 1997 by having thin feet that are circular in cross section terminally, and a small circular aperture.

Measurements (μm):

Based on 12 specimens.

	HT	Av.	Max.	Min.
Height of cephalis and thorax	147	143	157	130
Maximum width of thorax	150	145	152	132
Length of apical horn	102	96	105	72
Length of feet	131	112	139	94
Diameter of aperture	77	79	89	68

Etymology**:** This species is named in honor of Akira Yao for his pioneering works on Lower Jurassic radiolarian fossils.

Type locality: IYII24 (IY Section), bedded chert sequences, Inuyama, Mino terrane, southwest Japan.

Occurrence*:*

Mino terrane, Japan; Dürrnberg Formation, Austria.

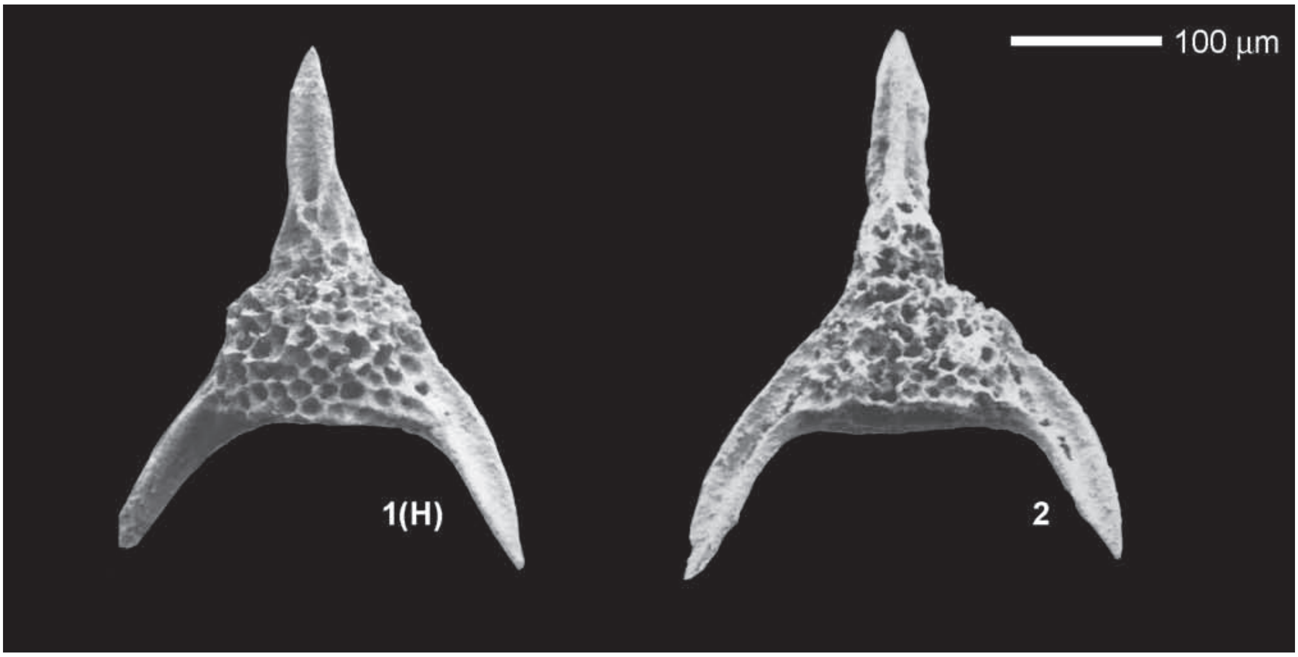


Plate BPD15. ***Bipedis japonicus*** **Hori n. sp.** Magnification x200. **Fig. 1(H).** JP, Kb05-18, RH(1) 1834.
Fig. 2. JP, Kb05-12, RH(1) 1832.

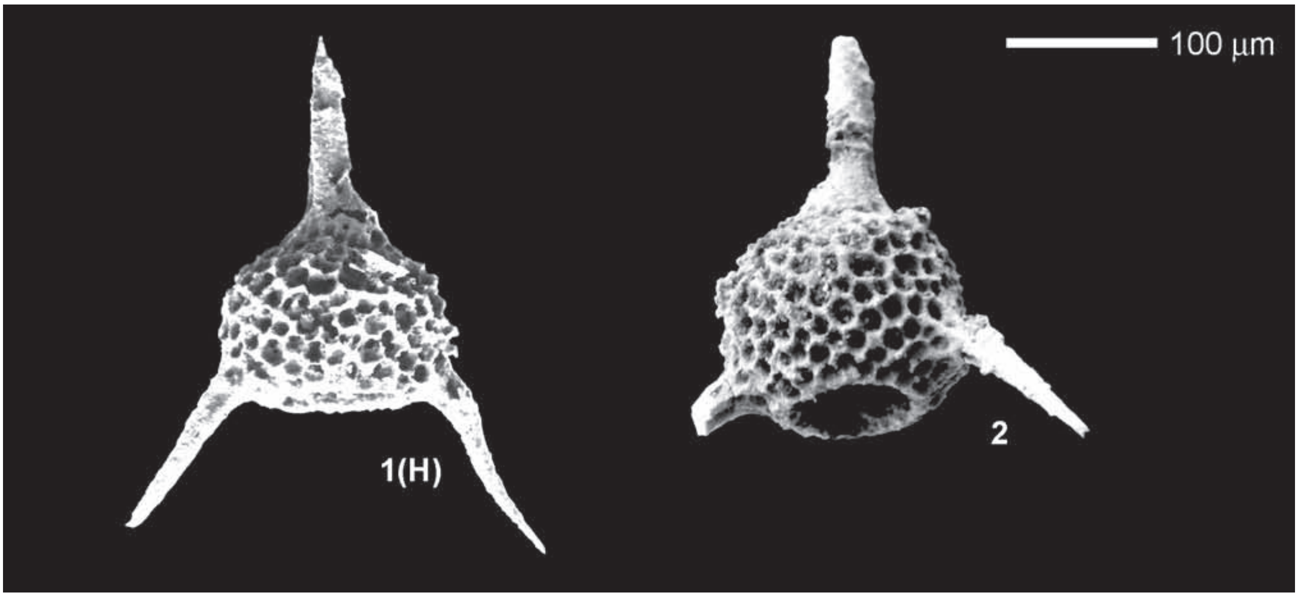


Plate BPD16. ***Bipedis yaoi*** **Hori n. sp.** Magnification x200. **Fig. 1(H).** Hori 1990, fig. 8.13. **Fig. 2.** JP, IYII24-29, RH(1) 1683.

Genus: *Bistarkum* Yeh 1987b

Type species: *Bistarkum rigidium* Yeh 1987b

Synonymy:

1971 *Amphibrachium* Haeckel emend. – Pessagno, p. 20.
1980 *Amphibrachium* Hertwig emend. – Baumgartner, p. 300.
1987b *Bistarkum* n. gen. – Yeh, p. 42.

Original description: Test medium to large in size, with two rays linearly aligned. Rays nearly equal in length, often terminated with expanded tips. Tips subcircular; elliptical in outline, or bifurcated. Meshwork of test comprised of sponge layers or regular (i.e., triangular) or irregular polygonal pore frames. Cross section of rays ellipsoidal, rectangular; or subrectangular in outline. Rays with or without spines at distal surface of tips or along sides of rays.

Original remarks: The name *Bistarkum* is introduced to avoid assigning species to *Amphibrachium* whose definition is obscured by poor descriptions and illustrations of its type species.

Etymology: *Bistarkum* is a name formed by an arbitrary combination of letters (ICZN, 1985, Appendix D, Pt. I.4 Recommendation 40, p.201).

Included species:

BIS04 *Bistarkum mangartense* Goričan, Šmuc & Baumgartner 2003
BIS02 *Bistarkum phantomense* (Carter) 1988
BIS01 *Bistarkum rigidium* Yeh 1987b
BIS03 *Bistarkum saginatum* Yeh 1987b

Bistarkum mangartense Goričan, Šmuc & Baumgartner 2003

Species code: BIS04

Synonymy:

1997 *Bistarkum* sp. A – Yao, pl. 6, fig. 265.
? 1997 *Bistarkum* sp. C0 – Yao, pl. 6, fig. 269.
2003 *Bistarkum mangartense* n. sp. – Goričan, Šmuc & Baumgartner, p. 293, pl. 2, figs. 7-10.
2004 *Bistarkum mangartense* Goričan, Šmuc & Baumgartner – Matsuoka, fig. 27.

Original description: Test ellipsoidal; cylindrical through most of its length and terminating with hemispherical ray tips. Rays circular in cross-section, central area not differentiated externally. Spongy meshwork very fine. Short spines, circular in cross-section, occur on the surface of well-preserved specimens. Spines more numerous at ray tips than in the middle part of the shell.

Original remarks: *Bistarkum mangartense* n. sp. differs from other *Bistarkum* species by its ellipsoidal shape without enlargement at ray tips. From *Bistarkum phantomense* (Carter) it differs also by being circular in cross-section. *Bistarkum* sp. C0 of Yao (1997) is questionably assigned to *Bistarkum mangartense*, because the shell seems more flattened, i.e. elliptical and not circular in cross-section.

Measurements (μm):
Based on 21 specimens.

	HT	Max.	Min.	Av.
Total length (excluding spines) L	153	225	126	190
Width (across the center) W	88	123	74	100
W/L ratio	0.57	0.70	0.36	0.53

Etymology: Named after type locality.

Type locality: Sample MM 21.70, Skrile Formation, Mt. Mangart in the Julian Alps, Slovenia.

Occurrence: Skrile Formation, Slovenia; Mino Terrane, Japan.

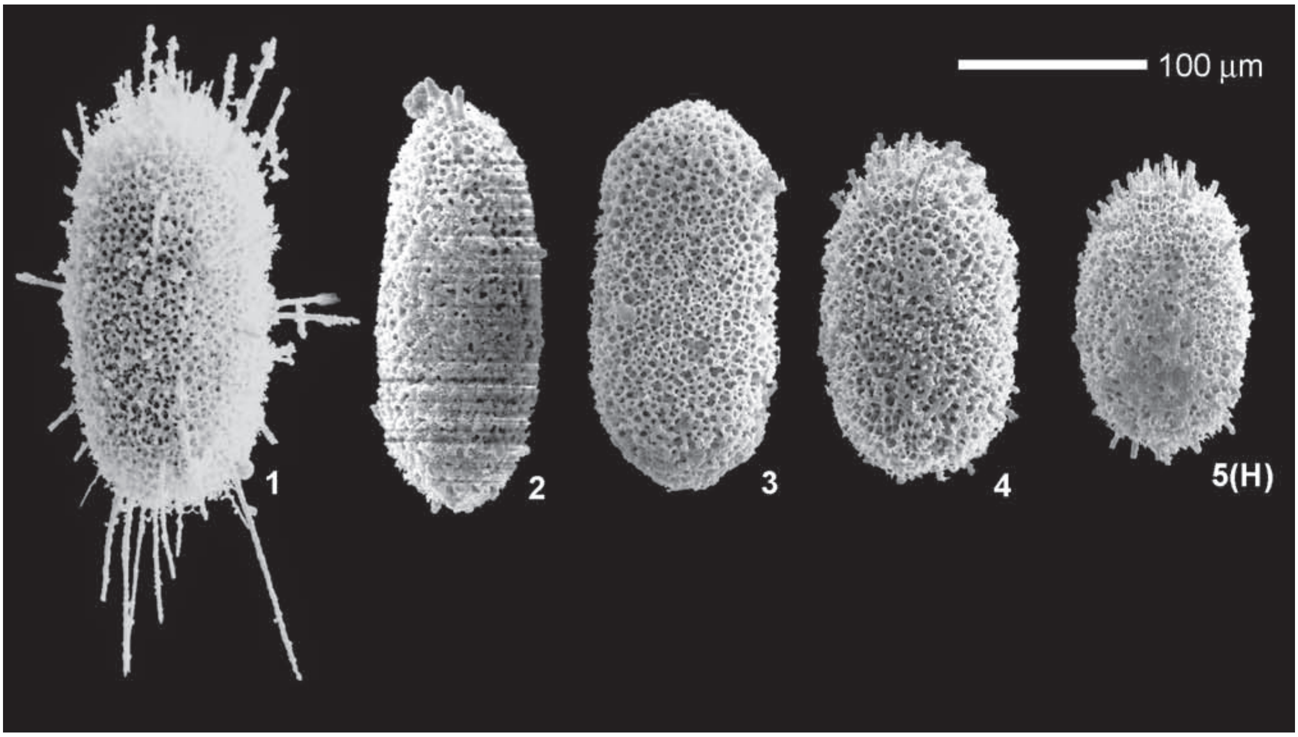


Plate BIS04. ***Bistarkum mangartense* Goričan, Šmuc & Baumgartner.** Magnification x250. **Fig. 1.** Matsuoka 2004, fig. 27. **Fig. 2.** SI, MM6.76, 000532. **Fig. 3.** Goričan et al. 2003, pl. 2, fig. 10. **Fig. 4.** Goričan et al. 2003, pl. 2, fig. 8. **Fig. 5(H).** Goričan et al. 2003, pl. 2, fig. 7.

Bistarkum phantomense (Carter) 1988

Species code: BIS02

Synonymy:

1988 *Amphibrachium* (?) *phantomensis* n. sp. – Carter et al., p. 39, pl. 12, fig. 1; figure 9.

1997 *Bistarkum* sp. C – Yao, pl. 6, fig. 267.

2003 *Bistarkum phantomense* (Carter) – Goričan et al., p. 295, pl. 2, figs. 13-16.

Original diagnosis: Two-rayed form with very fine, spongy meshwork. One or both rays variably bilobed.

Original description: Two-rayed patulibracchiid with very fine, layered spongy meshwork. Tips of rays widely expanded and rounded; may form either one large lobe or bifurcate to form two smaller lobes. On some bilobed specimens lobes become elongate, giving the test an almost three-rayed appearance. Rays equal in length, very short and wide, no defined central area. Spines on ray tips vary from a single central spine to numerous fine ones.

Original remarks: Genus is tentatively placed with *Amphibrachium* and queried because of the bilobed nature of ray tips. It is conceivable, however, that it is an extreme variant of *Paronaella spongiosa* n. sp. It is postulated that in the early late Toarcian a variant form of *Paronaella* had appeared (see Pl. 11, fig. 7); by the late Toarcian the figured two-layered bilobed form (*A.* (?) *phantomensis*) had evolved through enlargement of the primary ray and reduction of the secondary and tertiary rays to form a single bilobed ray.

Further remarks: We include also specimens with both rays almost symetrically developed. An indentation in the lobe of the ray tips can be very indistinct or absent. The rays are very short so that the shell sometimes appears only slightly constricted in the middle part. A weakly differentiated circular central area is observed in some specimens. *Bistarkum phantomense* differs from *Bistarkum saginatum* Yeh by having wider rays.

Measurements (μm):

Based on 11 specimens.

		HT	Av.	Max.	Min.
Length of ray	AX	130	137	170	125
	BX	135	140	170	125
Width of ray	cc'	166	185	280	140
	dd'	209	232	280	180

Etymology: Named for Phantom Creek, south of type locality.

Type locality: GSC locality C-080597, Phantom Creek Formation, Graham Island.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands, Guwayza Formation, Oman; Skrile Formation, Slovenia; Japan.

Bistarkum rigidium Yeh 1987b

Species code: BIS01

Synonymy:

1987b *Bistarkum rigidium* n. sp. – Yeh, p. 43, pl. 1, figs. 5, 17, pl. 22, figs. 1, 3, 7, 11.

1987b *Gorgansium rigidum* n. sp. – Yeh, pl. 30, fig. 13.

1987b *Bistarkum bifurcum* n. sp. – Yeh, p. 43, pl. 1, fig. 10; pl. 21, fig. 5; pl. 22, figs. 5-6.

1987b *Bistarkum* sp. cf. *G. bifurcum* n. sp. – Yeh, p. 43, pl. 9, fig. 13; pl. 21, fig. 11.

2004 *Bistarkum rigidium* Yeh – Matsuoka, fig. 22.

Original description: Rays about equal in length, medium of width, one ray usually slightly wider than the other; both rays terminating in large ellipsoidal tips. Width of tips about equal to length of ray shafts. Test comprised of small irregularly arranged polygonal pore frames without prominent small nodes at vertices. Several spines with circular cross-section and variable length occurring at distal surface of tips and sides of rays.

Original remarks: *Bistarkum rigidium* Yeh, n. sp., differs from *G. bifurcum* n. sp., by lacking bifurcate tips and by having a wider test.

Further remarks: *B. rigidium* Yeh and *B. bifurcum* Yeh are synonymized because a morphological continuum of forms with ellipsoidal to distictly bifurcating ray tips generally occurs in a single sample. Specimens with only moderately developed bifurcation (determined as *Bistarkum* cf. *bifurcum* by Yeh, 1987b) are the most common.

Measurements (μm):

System of measurement shown in text-figure 7 of Yeh (1987b). Ten specimens measured.

	LR	WR	WT	LT
HT	230	90	150	80
Mean	225	77	158	75
Max.	230	90	172	80
Min.	184	64	150	54

Etymology: *Rigidius-a-um* (Latin, adj.) = rigid.

Type locality: Sample OR-589D, Warm Springs member, Snowshoe Formation, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs m+ember of the Snowshoe Formation, Oregon; Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

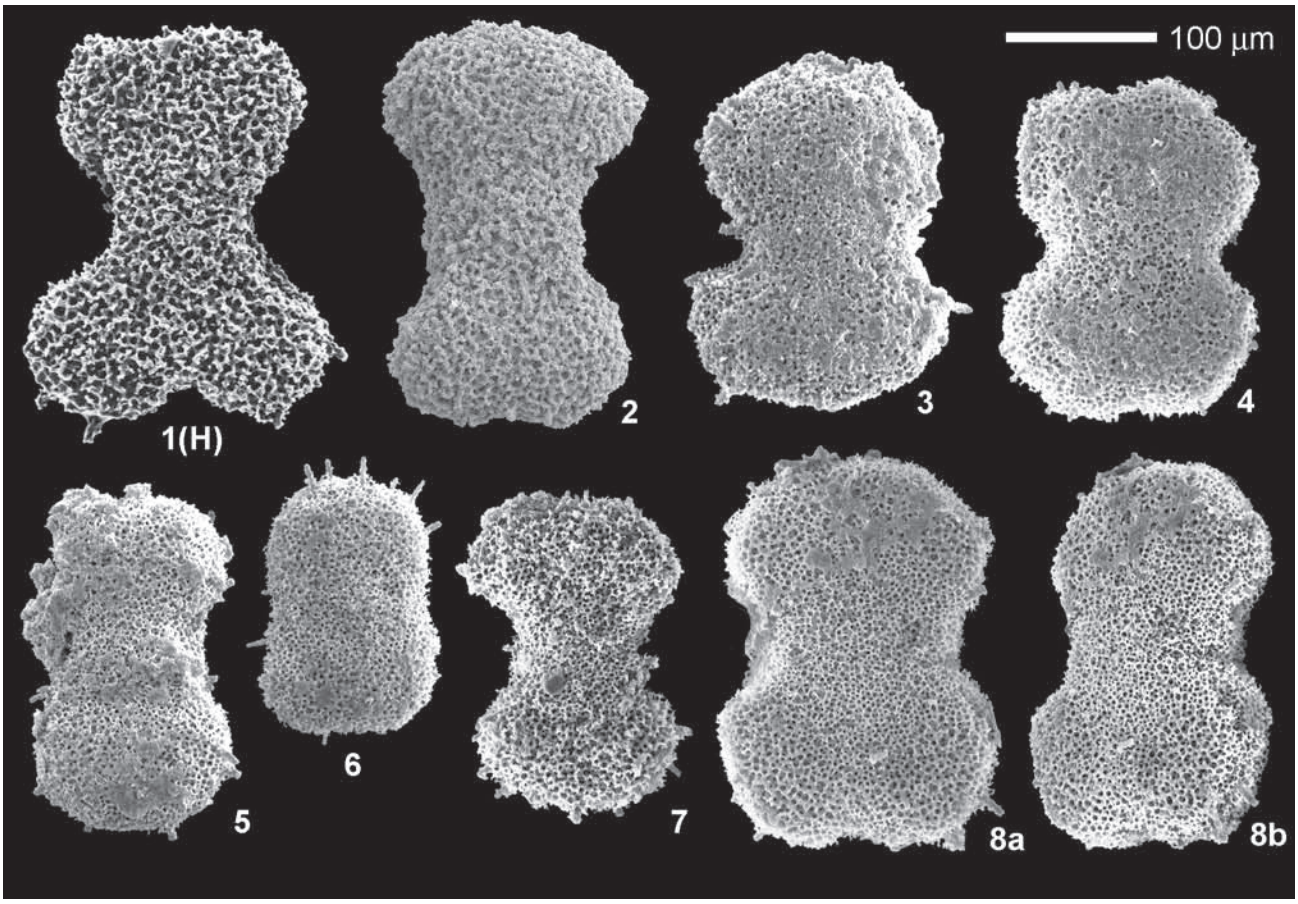


Plate BIS02. ***Bistarkum phantomense*** **(Carter).** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 12, fig. 1. **Fig. 2.** OM, BR871-R06-24. **Fig. 3.** SI, MM5.00, 010111. **Fig. 4.** SI, MM11.76, 010128. **Fig. 5.** Goričan et al. 2003, pl. 2, fig. 16. **Fig. 6.** Goričan et al. 2003, pl. 2, fig. 14a. **Fig. 7.** Goričan et al. 2003, pl. 2, fig. 15. **Fig. 8a.** Goričan et al. 2003, pl. 2, fig. 13. **Fig. 8b.** SI, MM11.76, 010127.

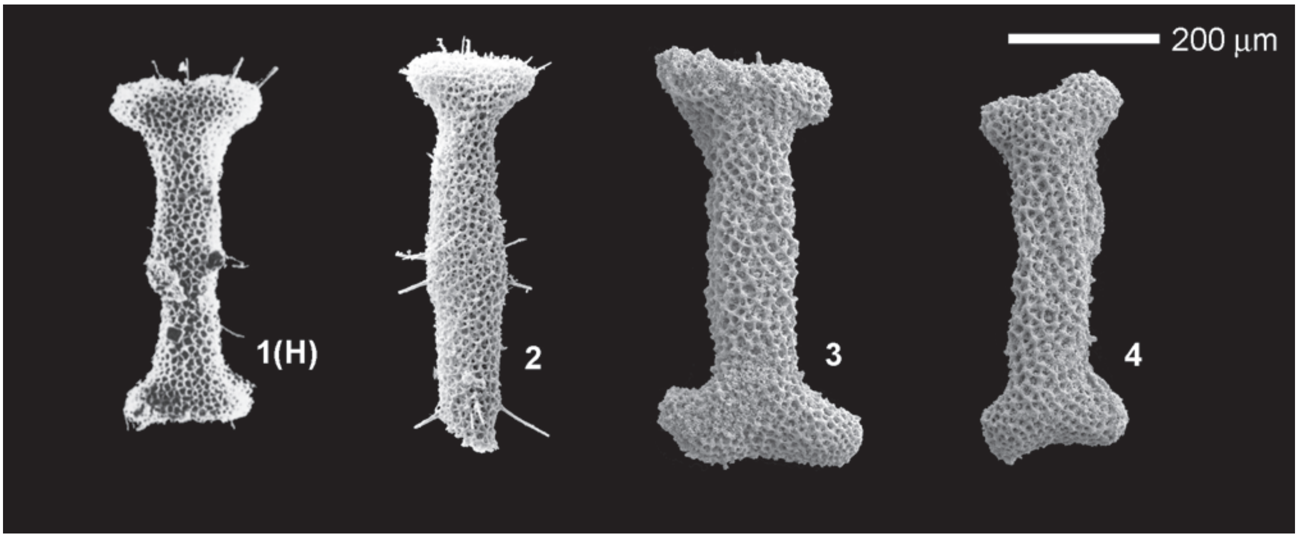


Plate BIS01. ***Bistarkum rigidium*** **Yeh.** Magnification x100. **Fig. 1(H).** Yeh 1987b, pl. 22, fig. 11. **Fig. 2.** Matsuoka 2004, fig. 22. **Fig. 3.** OM, BR1123-R05-03. **Fig. 4.** OM, BR1123-R05-02.

Bistarkum saginatum Yeh 1987b

Species code: BIS03

Synonymy:

? 1885 *Heliodiscus inchoatus* n. sp. – Rüst, p. 293 (23), pl. 29 (4), fig. 13.
1987b *Bistarkum saginatum* n. sp. – Yeh, p. 44, pl. 22, figs. 13, 16.
1988 ?*Heliodiscus inchoatus* Rüst – Carter et al., p. 38, pl. 12, figs. 2, 5.
2004 *Bistarkum saginatum* Yeh – Matsuoka, fig. 24.

Original description: Rays extremely short, wide, subellipsoidal in cross-section, with large subtriangular to hemispherical tips. Test comprised of nearly uniformly sized irregular polygonal pore frames. Pore frames without prominent nodes at vertices. Short spines occurring on distal surface of tips and sides of rays.

Original remarks: This species differs from other *Bistarkum* spp. in this report by having extremely large tips and by having short, massive rays.

Further remarks: ?*Heliodiscus inchoatus* Rüst, illustrated by Carter et al. (1988) appears to be the same species but with more expanded ray tips.

Measurements (μm):
System of measurements shown in text-figure 7 of Yeh (1987b). Ten specimens measured.

	LR	WR	WT	LT
HT	183	70	158	107
Mean	181	72	154	105
Max.	187	75	161	107
Min.	170	70	150	98

Etymology: *Saginatus-a-um* (Latin, adj.) = flattened.

Type locality: OR-589D, Warm Springs Member, Snowshoe Formation, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, east-central Oregon; Phantom Creek Formation, Graham Island, Queen Charlotte Islands; Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

Genus: ***Broctus*** Pessagno & Whalen 1982

Type species: *Broctus selwynensis* Pessagno & Whalen 1982

Synonymy:

1982 *Broctus* n. gen. – Pessagno & Whalen, p. 120.

Original description: Test as with family: spindle-shaped. Final post-abdominal chamber terminating in narrow, tubular structure (pl. 2, fig. 20) extending from aperture; cephalis lacking horn. Pore frames regular to irregular, tending to be more regular distally than proximally.

Original remarks: *Broctus* n. gen., differs from *Bagotum* n. gen. by being spindle-shaped instead of ellipsoidal and differs from *Bagotum, Droltus*, and *Noritus* by having a final post-abdominal chamber terminating in a narrow tubular structure.

Etymology: *Broctus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. VI, Recommendation 40, p.113).

Included species:

BRO02 *Broctus kuensis* Pessagno & Whalen 1982
BRO03 *Broctus ruesti* Yeh 1987b
BRO01 *Broctus selwynensis* Pessagno & Whalen 1982

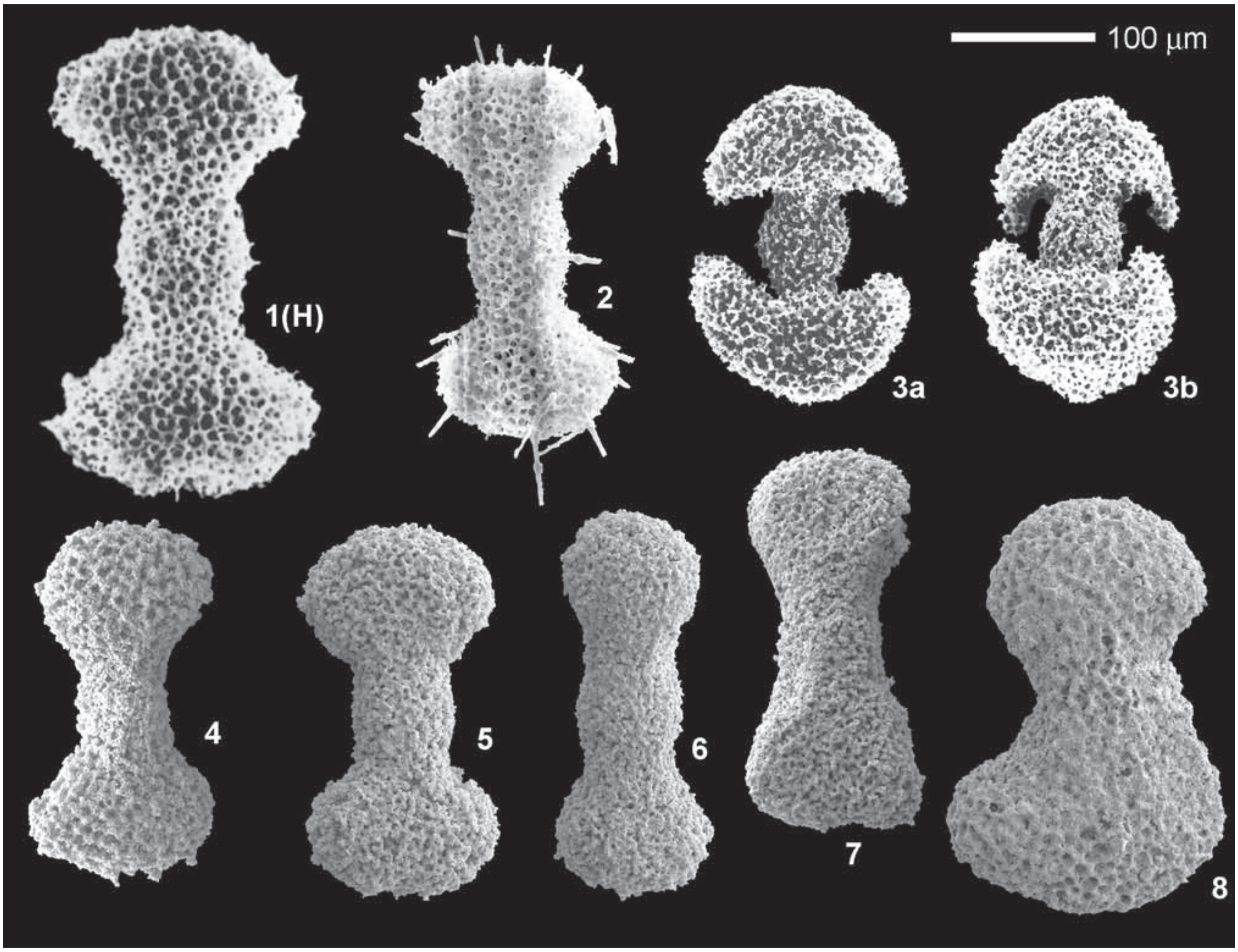


Plate BIS03. ***Bistarkum saginatum*** **Yeh.** Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 22, fig. 13. **Fig. 2.** Matsuoka 2004, fig. 24. **Fig. 3a,b.** Carter et al. 1988, pl. 12, figs. 2, 5. **Fig. 4.** OM, BR706-R02-13a. **Fig. 5.** OM, BR871-R01-01. **Fig. 6.** OM, BR871-R01-02. **Fig. 7.** OM, BR871-R02-06. **Fig. 8.** OM, BR706-R13-08.

Broctus kuensis Pessagno & Whalen 1982

Species code: BRO02

Synonymy:

1982 *Broctus kuensis* n. sp. – Pessagno & Whalen, p. 120, pl. 1, fig. 7; pl. 2, figs. 17, 21.

2002 *Broctus kuensis* Pessagno & Whalen – Tekin, p. 186, pl. 3, fig. 7.

Original description: Test as with genus, usually having six to seven post-abdominal chambers. Cephalis conical; thorax, abdomen, and post-abdominal chambers trapezoidal in cross section. Post-abdominal chambers increasing rapidly in width; last two post-abdominal chambers rapidly decreasing in width. Cephalis and thorax with small irregular, polygonal pore frames almost completely obscured by cover of microgranular silica. Abdomen and post-abdominal chambers composed of irregular tetragonal and pentagonal pore frames gradually increasing in size distally; final two post-abdominal chambers composed of larger, aligned, tetragonal (rectangular) pore frames.

Original remarks: See remarks under *B. selwynensis*, n. sp.

Measurements (μm):

Based on five specimens.

Length	Width (max.)	
245.0	100.0	HT
245.0	100.0	Max.
185.0	78.0	Min.
207.6	91.0	Mean

Etymology: *Broctus kuensis*, n. sp., is named for Kue Passage, west of its type locality.

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), north shore of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Hocaköy Radiolarite and Gümüslü Allochthon, Turkey.

Broctus ruesti Yeh 1987b

Species code: BRO03

Synonymy:

1987b *Broctus ruesti* n. sp. – Yeh, p. 54, pl. 4, figs. 1-3, 7, 21.

1987b *Broctus* sp. aff. *B. ruesti* n. sp. – Yeh, p. 54, pl. 4, fig. 6.

1987b *Broctus* sp. A – Yeh, p. 54, pl. 4, figs. 13, 25.

1987 *Canutus* (?) sp. A – Hattori, pl. 15, fig. 13.

1997 *Parahsuum* sp. B – Yao, pl. 14, fig. 657.

2004 *Broctus ruesti* Yeh – Ziabrev et al., Fig. 5-9.

Original description: Test spindle-shaped (conical when broken), with five to seven post-abdominal chambers. Cephalis small, hemispherical without horn. Chambers increasing gradually in length, rapidly in width as added. Final post-abdominal chamber terminating in narrow tubular extension. Test wall double-layered. Inner latticed wall consisting of regularly aligned square to rectangular pore frames. Outer layer of cephalis imperforate, covered with layer of microgranular silica. Thorax and subsequent chambers with massive costae and thin transverse bars forming rectangular pore frames overlapping on inner layer. Bars of outer layer fragile, often broken and leaving short remnants at costae. About eleven to thirteen costae visible laterally. Pore frames gradually increasing in size from thorax to final post-abdominal chamber then decreasing in size distally.

Original remarks: *Broctus ruesti* n. sp., differs from *B*. sp. A by having a narrower test with regular rectangular pore frames throughout the test rather than irregular pore frames on earlier chambers and regular pore frames on final post-abdominal chambers.

Further remarks: *Broctus ruesti* Yeh is similar to *Broctus selwynensis* Pessagno & Whalen in general shape of the test and linear arrangement of pores. These two species differ in the shape of the first segments: *B. ruesti* is pointed apically whereas *B. selwynensis* is rounded.

Note that our specimens of. *B. ruesti* (pl. BRO03, figs. 2-4) are considerably smaller than the type material.

Measurements (μm):

Ten specimens measured.

	Length (max.)	Width (max.)
HT	400	230
Mean	350	200
Max.	400	230
Min.	270	180

Etymology: This species is named for Dr. D. Ruest, in honor of his contribution to the study of Radiolaria.

Type locality: Sample OR-536J, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Fannin Formation, Queen Charlotte Islands; Musallah Formation, Oman; Japan; Bainang Terrane, Tibet.

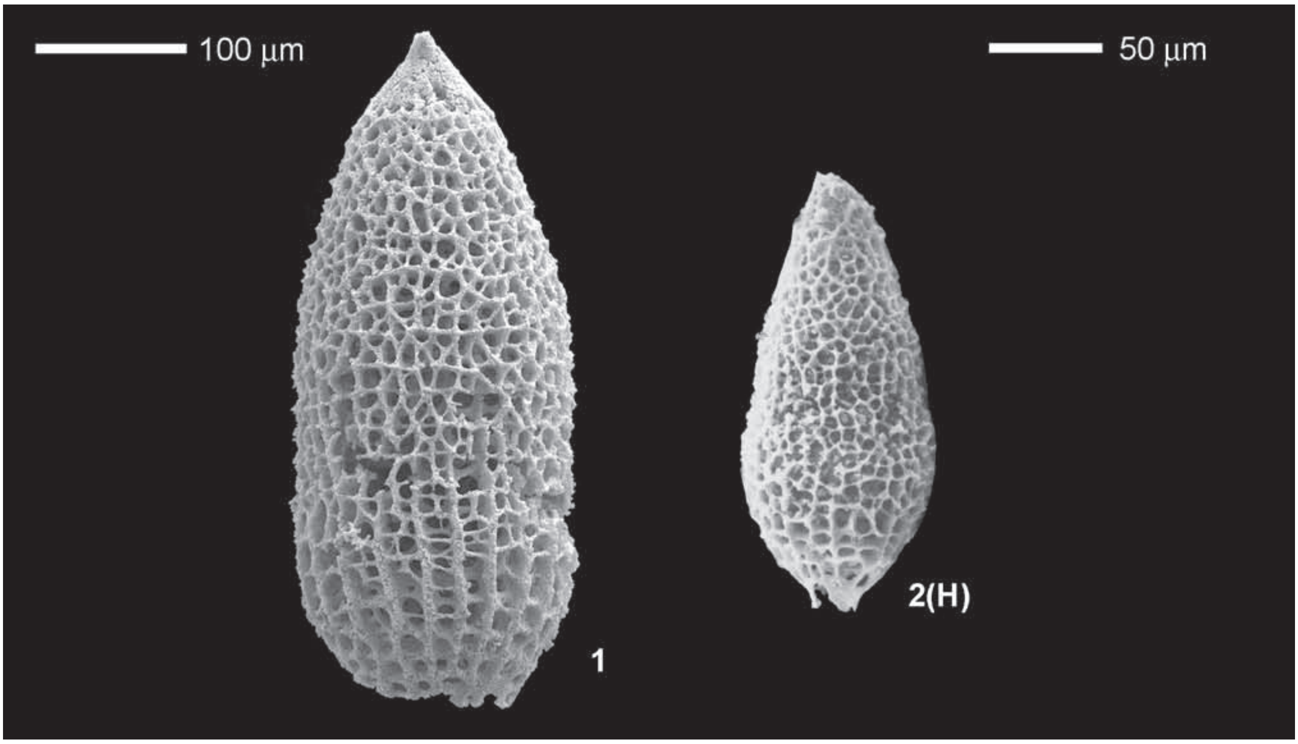


Plate BRO02. ***Broctus kuensis*** **Pessagno & Whalen.** Magnification Fig. 1 x200, Fig. 2 x300. **Fig. 1.** TR, 1662D-R01-07. **Fig. 2(H).** Pessagno & Whalen 1982, pl. 1, fig. 7.

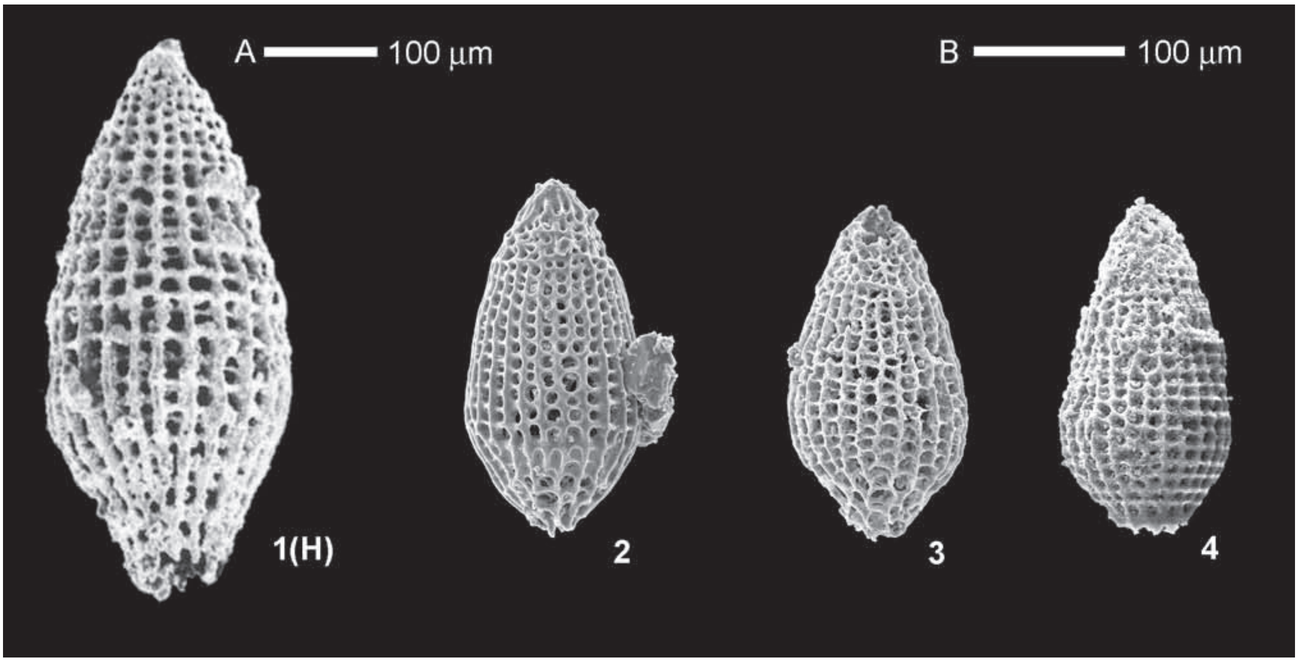


Plate BRO03. ***Broctus ruesti*** **Yeh.** Magnification Fig. 1 x 150 (scale bar A), Figs. 2-4 x200 (scale bar B). **Fig. 1(H).** Yeh 1987b, pl. 4, fig. 21. **Fig. 2.** QCI, GSC loc. C-304565, GSC 128893. **Fig. 3.** QCI, GSC loc. C-080610, GSC 128894. **Fig. 4.** OM-00-254, 022204.

Broctus selwynensis Pessagno & Whalen 1982
Species code: BRO01

Synonymy:
1982 *Broctus selwynensis* n. sp. – Pessagno & Whalen, p. 121, pl. 1, fig. 6; pl. 2, figs 18, 20; pl. 12, fig. 10.

Original description: Test as with genus, usually with seven or eight post-abdominal chambers. Cephalis hemispherical, imperforate. Abdomen and post-abdominal chambers increasing rapidly in width; last two post-abdominal chambers rapidly decreasing in width. Thorax, abdomen and post-abdominal chambers trapezoidal in cross section. Thorax, abdomen and proximal post-abdominal chambers with small, irregular polygonal pore frames in outer latticed layer; central part of test composed of more regular tetragonal (mostly rectangular) pore frames in outer latticed layer aligned in rows; final post-abdominal chamber and tubular structure composed of less regularly aligned tetragonal and pentagonal pore frames.

Original remarks: The aligned pore frames over the central portion of the test distinguishes *B. selwynensis,* n. sp., from *B. kuensis,* n. sp. The latter species does not show such a strong alignment of pore frames, except for the final two post-abdominal chambers.

Further remarks: See remarks under *Broctus ruesti* Yeh.

Measurements (μm):
Based on 10 specimens.

Length	Width (max.)	
237.5	107.5	HT
260.0	120.0	Max.
210.0	90.0	Min.
238.8	106.3	Mean

Etymology: *Broctus selwynensis* is named for Selwyn Inlet, northwest of its type locality.

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), north shore of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Williston Lake, NE British Columbia; Tawi Sadh Member of the Guwayza Formation and Haliw Formation, Oman.

Genus: ***Canoptum*** Pessagno 1979
Type species: *Canoptum poissoni* Pessagno, in Pessagno et al. 1979

Synonymy:
1979 *Canoptum* Pessagno n. gen. – Pessagno et al., p. 182.
1987a *Paracanoptum* n. gen. – Yeh, p. 67.
1987a *Neowrangellium* n. gen. – Yeh, p. 65.

Original description: Test spindle-shaped (often conical when broken) with dome-shaped cephalis lacking horn. Thorax and abdomen trapezoidal in outline. Post-abdominal segments subtrapezoidal in outline, separated from each other by rather broad, slightly perforate, circumferential ridges at the joints; pores on ridges circular to elliptical in shape, not set in pore frames. Ridges of inner layer considerably narrower. Area between a given ridges imperforate or sparsely perforate. Segments somewhat constricted between joints and circumferential ridges. Each postabdominal segment separated by partitions with large, circular apertures.

Original remarks: *Canoptum* n. gen., differs from *Spongocapsula* Pessagno in having a two-layered test wall lacking spongy meshwork. It differs from *Parvicingula* Pessagno in possessing a two-layered test with a microgranular outer layer lacking discrete pore frames.

Etymology: *Canoptum* is an arbitrary combination of letters (see ICZN, 1964. p. 113. recommendation 40).

Included species:
CAN12 *Canoptum anulatum* Pessagno & Poisson 1981
CAN13 *Canoptum artum* Yeh 1987b
CAN08 *Canoptum columbiaense* Whalen & Carter 1998
CAN09 *Canoptum dixoni* Pessagno & Whalen 1982
CAN11 *Canoptum margaritaense* Whalen & Carter 1998
CAN14 *Canoptum rugosum* Pessagno & Poisson 1981

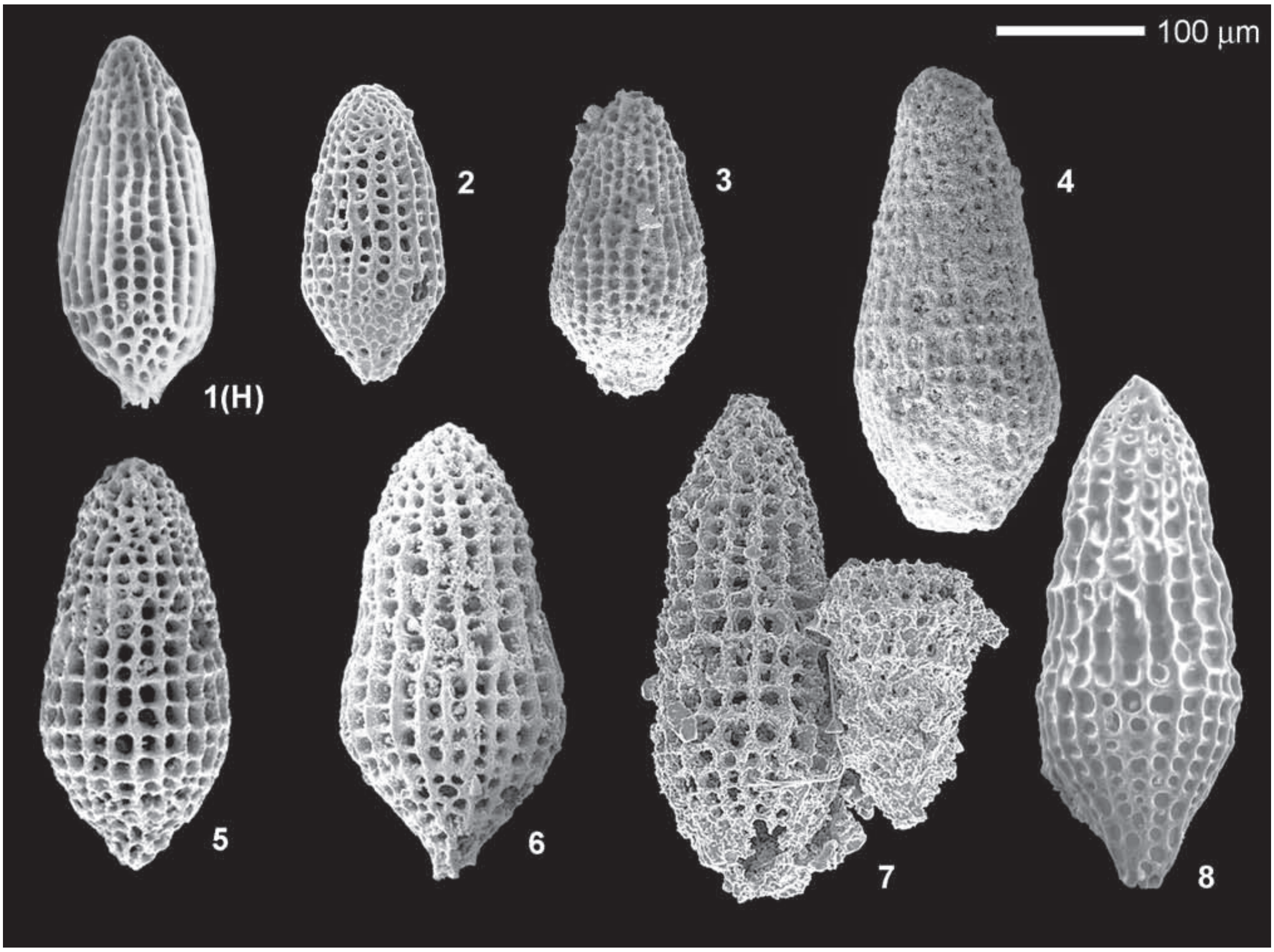


Plate BRO01. ***Broctus selwynensis*** **Pessagno & Whalen.** Magnification x200. **Fig. 1(H**). Pessagno & Whalen 1982, pl. 1, fig. 6. **Fig. 2.** QCI, GSC loc. C-140418, GSC 111806. **Fig. 3.** OM, BR1121-R10-14. **Fig. 4.** OM, Haliw-R03-05. **Fig. 5.** QCI, GSC loc. C- 080611, GSC 128722. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128723. **Fig. 7.** NBC, GSC loc. C-305208, GSC 128724. **Fig. 8.** QCI, GSC loc. C-140495, GSC 128725.

Canoptum anulatum Pessagno & Poisson 1981

Species code: CAN 12

Synonymy:

1981 *Canoptum anulatum* n. sp. – Pessagno & Poisson, p. 60, pl. 9, figs. 6-9, pl. 10, figs. 1-9.
1982 *Dictyomitrella* (?) sp. – Imoto et al., pl. 1, fig. 5.
1982 *Canoptum anulatum* Pessagno & Poisson – Pessagno & Whalen, p. 123, pl. 6, figs. 1-2.
1982 *Canoptum anulatum* Pessagno & Poisson – De Wever & Origlia-Devos, p. 1, fig. X.
1984 *Canoptum anulatum* Pessagno & Poisson – Murchey, pl. 1, fig. 32.
1984 *Canoptum anulatum* Pessagno & Poisson – Whalen & Pessagno, pl. 3, fig. 7.
1985 *Canoptum anulatum* Pessagno & Poisson – Kishida & Hisada, pl. 2, figs. 21-22.
1987a *Paracanoptum anulatum* (Pessagno & Poisson) – Yeh, p. 67, pl. 1, figs. 12, 13.
1987b *Paracanoptum anulatum* (Pessagno & Poisson) – Yeh, p. 58, pl. 4, fig. 28; pl. 15, fig. 4; pl. 27, fig. 1, 9, 11.
1987 *Canoptum anulatum* Pessagno & Poisson – Hattori, pl. 18, fig. 9.
1988 *Canoptum anulatum* Pessagno & Poisson – Carter et al., p. 50, pl. 5, figs. 9-10, 14.
1989 *Canoptum* sp. aff. *C. anulatum* Pessagno & Poisson – Hattori, pl. 14, fig. A, not fig. B.
1990 *Canoptum anulatum* Pessagno & Poisson – De Wever et al., pl. 4, fig. 5.
1992 *Paracanoptum anulatum* (Pessagno & Poisson) – Pessagno & Mizutani, pl. 99, fig. 3.
1997 *Canoptum anulatum* Pessagno & Poisson – Yao, pl. 12, fig. 574.
1998 *Paracanoptum anulatum* (Pessagno & Poisson) – Cordey, pl. 24, fig. 1-2, 11.
1998 *Canoptum anulatum* Pessagno & Poisson – Kashiwagi, pl. 1, fig. 15.
2002 *Canoptum anulatum* Pessagno & Poisson – Whalen & Carter, p. 118, pl. 10, fig. 5.
2004 *Canoptum anulatum* Pessagno & Poisson – Matsuoka, fig. 245.
2004 *Canoptum anulatum* Pessagno & Poisson – Ishida et al., pl. 5, fig. 9, 10.

Original description: Cephalis dome-shaped, lacking a horn. Subsequent chambers trapezoidal in outline, numerous; closely spaced except for final chambers. Post-abdominal chambers eleven to fifteen in number, separated by prominent circumferential ridges; ridges with short, discontinuous costae; approximately fifteen costae visible on a given ridge laterally. Short costae at right angles to circumferential ridges, forming linked-*H* pattern. Single small, circular pores occurring between two given costae and adjacent to ridge. Pores, ridges and costae usually buried by microgranular outer layer of shell material except when specimen is excessively etched. Pores in area between ridges usually elliptical in shape, set in linearly arranged, rectangular pore frames; usually buried by outer layer of shell material. Final two post-abdominal chambers (segments) decreasing in width, increasing in height; penultimate chamber often with tubular extension.

Original remarks: *Canoptum anulatum*, n. sp., possesses circumferential ridges that are significantly different from those of the type species of *Canoptum*, *C. poissoni* Pessagno (1979). The linked-*H* circumferential ridge structure displayed by *C. anulatum* is shared by a number of yet undescribed forms from the Lower Jurassic. Forms with this sort of structure have not been observed below the Hettangian. *C. anulatum* is tentatively included in *Canoptum* in this report. However, it may be desirable in the future to include it under a new genus.

C. anulatum also differs from *C. poissoni* by having a slender, more elongate test with more closely spaced post-abdominal chambers (segments).

Measurements (μm):
Based on seven specimens.

	HT	Min.	Max.
Length	310	310	435
Width	95	90	100

Etymology: *Anulatus-a-um* (Latin, adj.): beringed, ornamented with rings.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Bridge River Complex, and Fannin and Whiteaves formations, Queen Charlotte Islands; Nicely and Hyde formations, Warm Springs member of the Snowshoe Formation, Oregon; Franciscan Complex, California; San Hipólito Formation, Baja California Sur; Drimos Formation, Greece; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

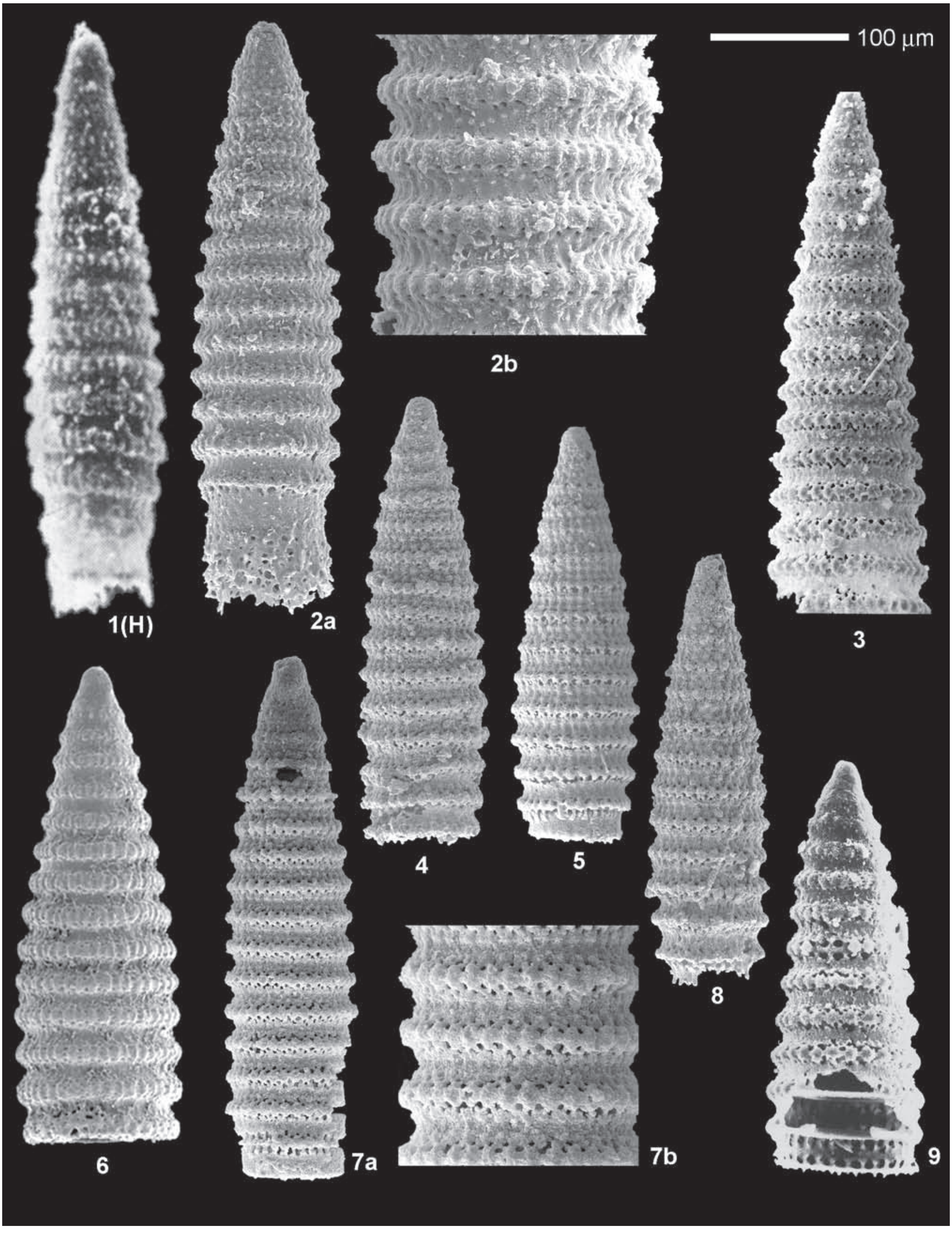


Plate CAN12. *Canoptum anulatum* Pessagno & Poisson. Magnification x250, except Figs. 2b and 7b x500. **Fig. 1(H).** Pessagno & Poisson 1981, pl. 9, fig. 6. **Fig. 2a,b.** TR, 1662D-R06-17. **Fig. 3.** JP, MNA-10, MA10776. **Fig. 4.** OM, BR1122-R01-04. **Fig. 5.** OM, BR682-R09-02. **Fig. 6.** QCI, GSC loc. C-140495, GSC 128726. **Fig. 7a,b.** OM, BR523-R01-10a, b. **Fig. 8.** OM, BR1122-R02-07. **Fig. 9.** Whalen & Carter 2002, pl. 10, fig. 5.

Canoptum artum Yeh 1987b

Species code: CAN13

Synonymy:

1987b *Canoptum artum* Yeh n. sp. – Yeh, p. 56, pl. 5, fig. 23; pl. 6, figs. 5, 19-20; pl. 14, fig. 9; pl. 27, fig. 4.
1987b *Canoptum* sp. aff. *C. artum* Yeh n. sp. – p. 57, pl. 27, figs. 2, 10., 24-25.
2004 *Canoptum artum* Yeh – Matsuoka, fig. 246.
2004 *Canoptum* sp. – Hori et al., pl. 6, figs. 21, 22.

Original description: Test wide, conical, with six to eight post-abdominal chambers. Cephalis conical to dome-shaped without horn. Cephalis, thorax, and abdomen imperforate, covered with layer of microgranular silica and separated from each other by one row of small pores. All post-abdominal chambers lobated, closely spaced, gradually increasing in width and length as added. Abdomen and subsequent chambers separated from each other by smooth, perforated circumferential ridges. Ridges usually with two to four rows of small irregular polygonal pore frames. Inner latticed layer of test comprised of larger, irregular polygonal pore frames, outer layer of microgranular silica imperforate at constricted median band of earlier post-abdominal chambers, perforated with small polygonal pore frames at final three or four post-abdominal chambers.

Original remarks: *Canoptum artum*, n. sp., differs from *Canoptum poissoni* Pessagno by having a wider test with a larger cephalis and more closely spaced post-abdominal chambers, and by having an outer layer of test wall more perforate on final post-abdominal chambers.

Further remarks: Note that the size of this species is quite variable. The length of the test ranges from 190 µm (pl. CAN13, fig. 8) to 450 µm (pl. CAN13, fig. 5).

Measurements (µm):
Ten specimens measured.

	Length (max.)	Width (max.)
HT	300	150
Mean	295	150
Max.	310	150
Min.	240	108

Etymology: *Artus-a-um* (Latin, adj.) = close, tight.

Type locality: OR-589D, Warm Springs member of the Snowshoe Formation, near Izee, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands; Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

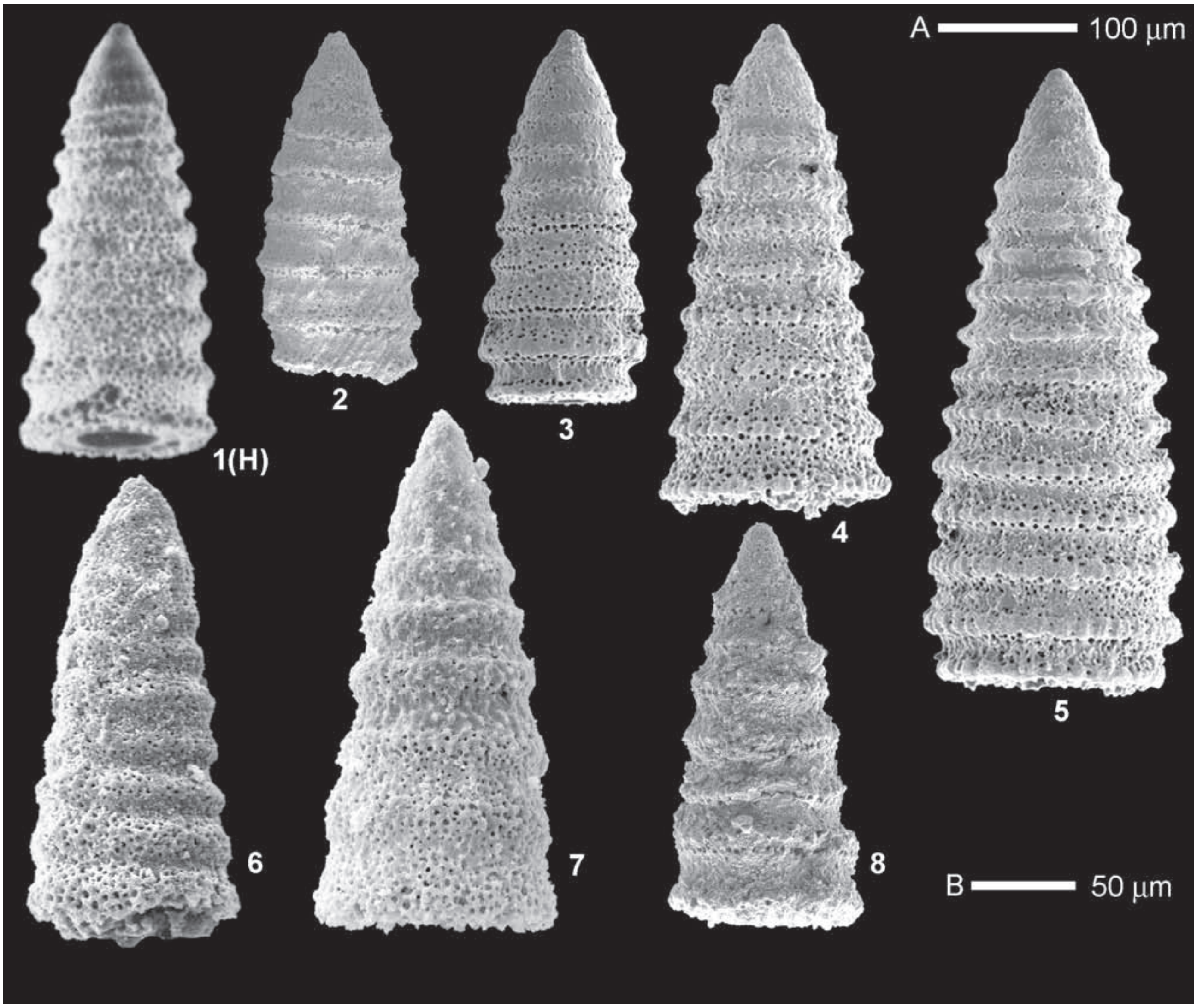


Plate CAN13. *Canoptum artum* Yeh. Magnification Figs. 1-5 x200 (scale bar A), Figs. 6-8 x300 (scale bar B). **Fig. 1(H).** Yeh 1987b, pl. 6, fig. 5. **Fig. 2.** OM, BR1121-R08-11. **Fig. 3.** QCI, GSC loc. C-304281, GSC 128727. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128728. **Fig. 5.** QCI, GSC loc. C-080612, GSC 128729. **Fig. 6.** OM-00-117, 021134. **Fig. 7.** JP, MNA-10, MA13392. **Fig. 8.** OM, BR1122-R02-07.

Canoptum columbiaense Whalen & Carter 1998
Species code: CAN08

Synonymy:
1998 *Canoptum columbiaense* n. sp. – Whalen & Carter, p. 64, pl. 15, figs 6, 10, 11, 15, 19.
1998 *Canoptum* sp. – Kashiwagi, pl. 2, fig. 12.
2002 *Canoptum dixoni* Pessagno & Whalen – Suzuki et al., p. 181, figs. 8 C-E, J-K.
? 2002 *Canoptum columbiaense* Whalen & Carter – Tekin, p. 189, pl. 4, fig. 5.

Original description: Test conical, usually with 10 to 11 post-abdominal chambers. Cephalis and thorax combined steeply conical, almost knob-like, with distinct break in slope from abdomen. Abdomen and post-abdominal chambers trapezoidal in outline, gradually increasing in width and height as added. Cephalis and thorax smooth, imperforate, covered by layer of microgranular silica. Post-abdominal chambers separated from each other and abdomen by moderately wide circumferential ridges alternating with constrictions. Inner latticed layer of post-abdominal chambers consisting of small, irregular polygonal pore frames exposed on circumferential ridges; layer of microgranular silica in constrictions mostly covering polygonal pore frames on proximal part of test; many pore frames exposed within constrictions on distal part of test.

Original remarks: *Canoptum columbiaense* n. sp. differs from *C. margaritaense* n. sp. by the absence of pronounced nodes on the circumferential ridges; and from *C. unicum* Pessagno and Whalen by the development of a thicker layer of microgranular silica in the constrictions and the shape of the cephalis.

Measurements (μm):
Based on 11 specimens.

Length	Width (max.)	
218	98	HT
259	120	Max.
195	90	Min.
232	108	Mean

Etymology: This species is named for the Province of British Columbia.

Type locality: Sample QC-676, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Pucara Group, Peru; Japan.

Canoptum dixoni Pessagno & Whalen 1982
Species code: CAN09

Synonymy:
1982 *Canoptum dixoni* Pessagno & Whalen n. sp. – Pessagno & Whalen, p. 124, pl. 2, fig. 1-2, 8-9, 14; pl. 12, fig. 2.
1988 *Canoptum anulatum* Pessagno & Poisson – Li, pl. 1, fig. 2.
1998 *Canoptum dixoni* Pessagno & Whalen – Whalen & Carter, p. 64, pl.17, fig. 1; pl. 26, fig. 5.
2002 *Canoptum dixoni* Pessagno & Whalen – Whalen & Carter, p. 118, pl. 10, figs. 3, 4.

Original description: Test as with genus; conical, usually with 12 to 14 post-abdominal chambers. Cephalis conical; thorax, abdomen, and post-abdominal chambers increasing gradually in width and height as added. Thorax, abdomen, and post-bdominal chambers trapezoidal in outline. Cephalis and thorax smooth, imperforate, covered by layer of microgranular silica. Cephalis, thorax, and abdomen together forming prominent area of test. Post-abdominal chambers separated from each other and abdomen by narrow circumferential ridges alternating with constrictions. Inner latticed layer of post-abdominal chambers consisting of small, irregular polygonal pore frames exposed on circumferential ridges; layer of microgranular silica in constrictions mostly covering polygonal pore frames, particularly on proximal portion of test (many more pores within constrictions remaining open distally). Distinctive beadlike structures on circumferentail ridges formed by raised areas of microgranular silica surrounded by small polygonal pores.

Original remarks: *Canoptum dixoni*, n. sp. is distinguished from other species of *Canoptum* by the beaded nature of its narrow circumferential ridges.

Measurements (μm):
Based on 7 specimens.

Length	Width (maximum)	
312.5	112.5	HT
360.0	120.0	Max.
312.5	100.0	Min.
339.7	110.5	Mean

Etymology: This species is named for Captain George Dixon who explored the Queen Charlotte Islands in 1787.

Type locality: QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), north shore of Kunga Island, Queen Charlotte Islands.

Occurrence: Sandilands formation, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Dengqen area, Tibet; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

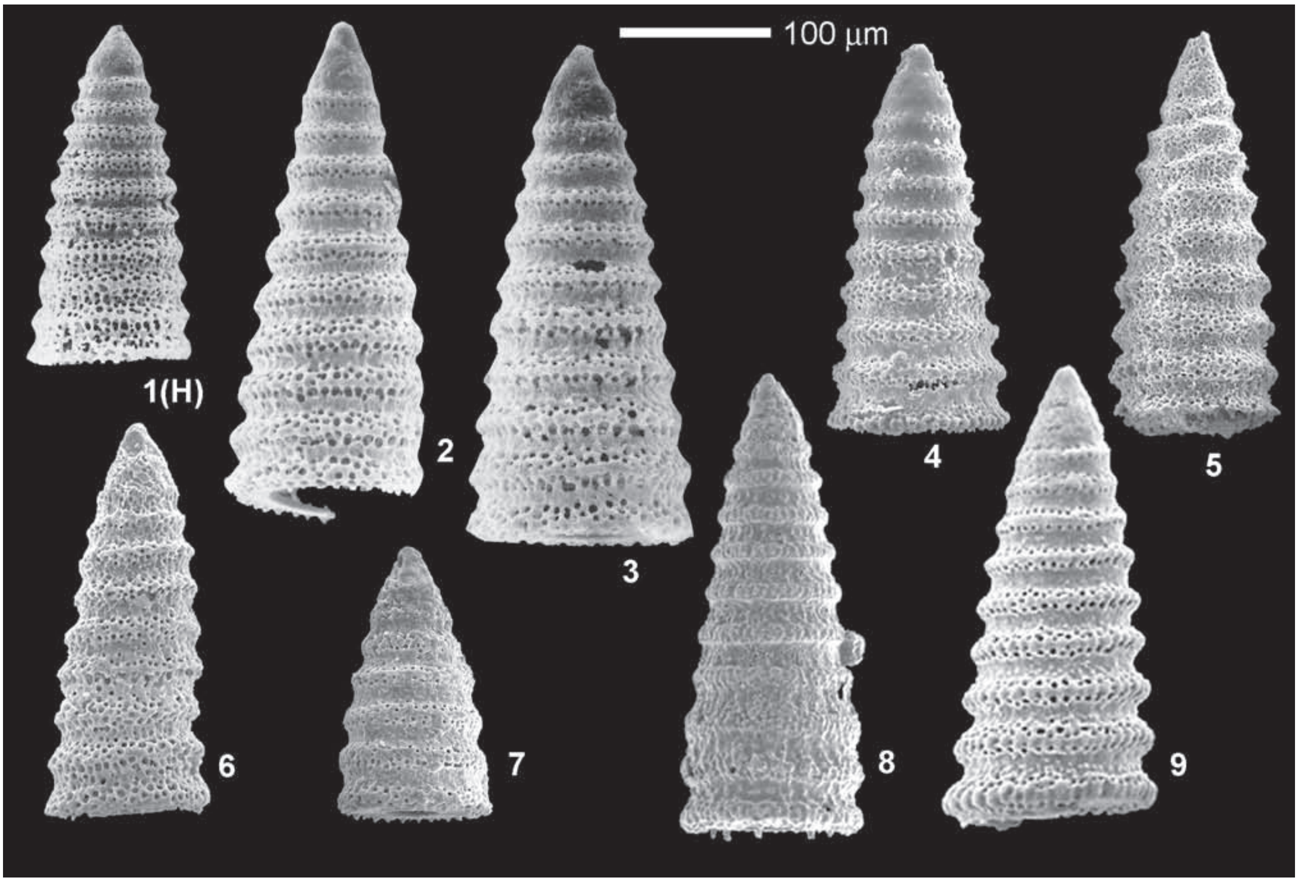


Plate CAN08. ***Canoptum columbiaense*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 15, fig. 6. **Fig. 2.** Carter et al. 1998, pl. 15, fig. 11. **Fig. 3.** Carter et al. 1998, pl. 15, fig. 10. **Fig. 4.** QCI, GSC loc. C-080613, GSC 128730. **Fig. 5.** QCI, GSC loc. C-304566, GSC 128731. **Fig. 6.** QCI, GSC loc. C-304565, GSC 128732. **Fig. 7.** QCI, GSC loc. C-304281, GSC 128733. **Fig. 8.** QCI, GSC loc. C-140495, GSC 128734. **Fig. 9.** QCI, GSC loc. C-175309, GSC 128735.

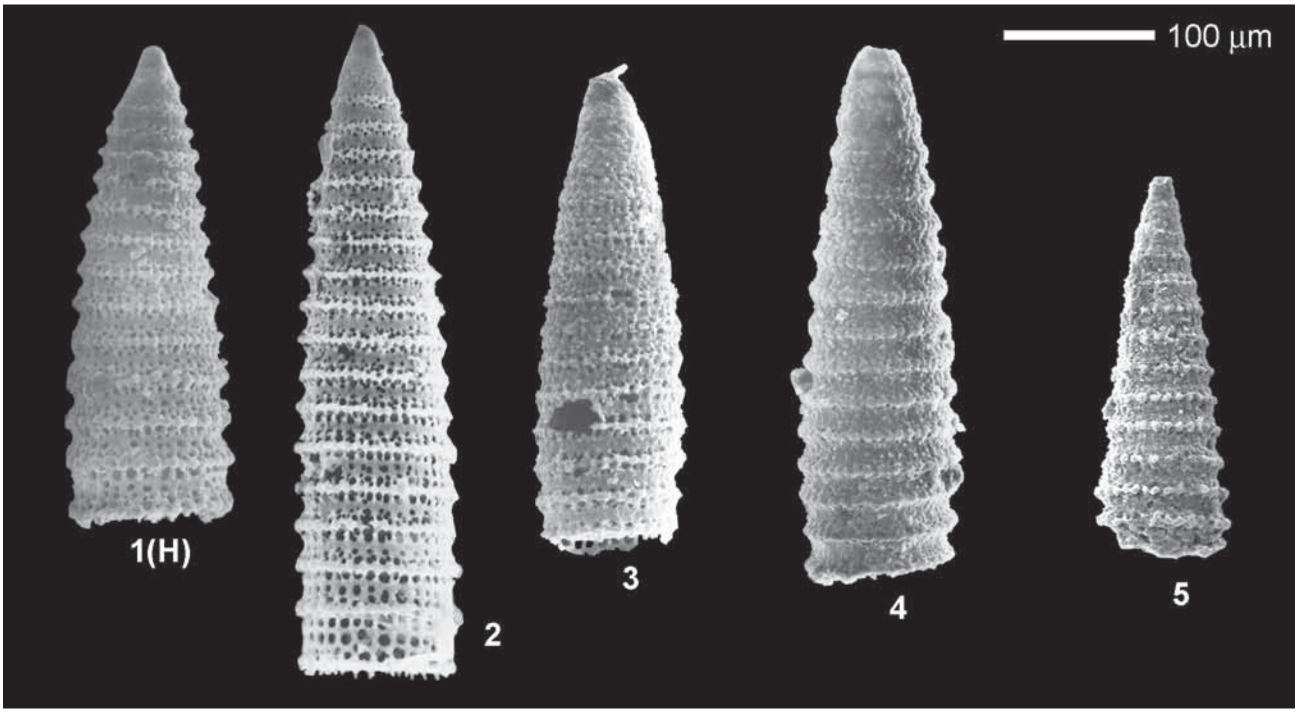


Plate CAN09. ***Canoptum dixoni*** **Pessagno & Whalen.** Magnification x200. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 2, fig. 1. **Fig. 2.** Pessagno & Whalen 1982, pl. 2, fig. 2. **Fig. 3.** Whalen & Carter 2002, pl. 10, fig. 3. **Fig. 4.** Whalen & Carter 2002, pl. 10, fig. 4. **Fig. 5.** OM-00-252, 021824.

Canoptum margaritaense Whalen & Carter 1998

Species code: CAN11

Synonymy:

1987 *Canoptum preanulatum* Pessagno & Whalen – Hattori, pl. 18, figs. 7, 8.

1987a *Neowrangellium pessagnoi* n. sp. – Yeh, p. 66, pl. 1, figs. 3, 4, ?10, 22, 23, ; not pl. 1, figs. 5-7, 11, 14.

1998 *Canoptum margaritaense* n. sp. – Whalen & Carter, p. 64, pl. 17, figs. 2, 3.

? 2002 *Canoptum margaritaense* Whalen & Carter – Tekin, p. 189, pl. 4, figs. 6, 7.

Original description: Test conical, lobulate, usually with 11 to 13 post-abdominal chambers. Cephalis conical; thorax, abdomen and post-abdominal chambers trapezoidal in outline, increasing gradually in width and height as added. Cephalis and thorax smooth, imperforate, covered by layer of micrgranular silica. Post-abdominal chambers separated from each other and abdomen by broad, nodose circumferential ridges alternating with constrictions; constrictions covered by thick layer of microgranular silica. Inner latticed layer of post-abdominal chambers usually obscured but when exposed, consisting of small, polygonal pore frames. H-linked pattern on circumferential ridges formed by raised nodes of microgranular silica surrounded by small polygonal pores.

Original remarks: The H-linked pattern on the circumferential ridges distinguish *Canoptum margaritaense* n. sp. from *C. dixoni* Pessagno and Whalen and *C. columbiaense* n. sp.

Further remarks: In this species we include forms without pores in the constrictions that are identical to the paratypes of *Neowrangellium pessagnoi* Yeh but differ from the holotype by lacking a horn.

Measurements (μm):

Based on 6 specimens.

Length	Width (max.)	
368	128	HT
368	128	Max.
225	83	Min.
287	101	Mean

Etymology: This species is named for Cape St. Margarita, the northern tip of the Queen Charlotte Islands.

Type locality: Sample QC-675, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Hyde Formation, Oregon.

Canoptum rugosum Pessagno & Poisson 1981

Species code: CAN14

Synonymy:

1981 *Canoptum rugosum* n. sp. – Pessagno and Poisson, p. 61, pl. 11, figs. 5-9; pl. 13, fig. 3; pl. 14, figs. 1-2.

1982 *Canoptum rugosum* Pessagno & Poisson – Pessagno and Whalen, p. 125, Pl. 6, Fig. 7.

1987 *Canoptum rugosum* Pessagno & Poisson – Hattori, pl. 18, figs. 10-12.

1988 *Canoptum rugosum* Pessagno & Poisson – Sashida, p. 23, pl. 2, figs. 13, 14, 22, 23.

1988 *Canoptum rugosum* Pessagno & Poisson – Li, pl. 1, fig. 1.

1989 *Canoptum rugosum* Pessagno & Poisson – Hattori, pl. 13, figs. F, G, H, I.

1995 *Canoptum rugosum* Pessagno & Poisson – Suzuki, pl. 8, fig. 2.

1998 *Canoptum rugosum* Pessagno & Whalen – Kashiwagi, pl. 1, fig. 16, pl. 2, fig. 11.

2003 *Canoptum rugosum* Pessagno & Poisson – Goričan et al., p. 297, pl. 5, fig. 11.

2003 *Canoptum* cf. *rugosum* Pessagno & Poisson – Kashiwagi & Kurimoto, pl. 3, fig. 14.

2004 *Canoptum rugosum* Pessagno & Poisson – Matsuoka, fig. 244.

2005 *Canoptum* sp. cf. *C. rugosum* Pessagno & Poisson – Kashiwagi et al., pl. 5, fig. 1.

Original description: Test as with genus. Cephalis hemispherical; post-cephalic chambers trapezoidal in ouline increasing relatively rapidly in width and height as added. Circumferential ridges absent between cephalis and thorax and between abdomen and thorax; present between abdomen and first post-abdominal chamber and each of subsequent four or five post-abdominal chambers. Circumferential ridge when stripped of outer layer of microgranular shell material displaying linked-*H* pattern identical to that described for *C. anulatum*, n. sp. Post-abdominal chambers constricted medially, giving rise to lobulate test outline. Inner layer of post-abdominal chambers comprised of two rows of massive tetragonal pore frames between circumferential ridges. Outer microgranular layer on well preserved specimens with rugose surface; rugosities probably a reflection of massive of inner layer.

Original remarks: *Canoptum rugosum*, n. sp., differs from *C. anulatum*, n. sp., (1) by having a shorter, broader test with one half to one third the number of post-abdominal chambers; (2) by having widely rather than closely spaced circumferential ridges; (3) by having post-abdominal chambers with a rugose surface; and so forth. Both species share the same linked-*H* circumferential ridge structure.

Measurements (μm):

Based on eight specimens.

	HT	Min.	Max.
Length	140	140	165
Width	75	65	95

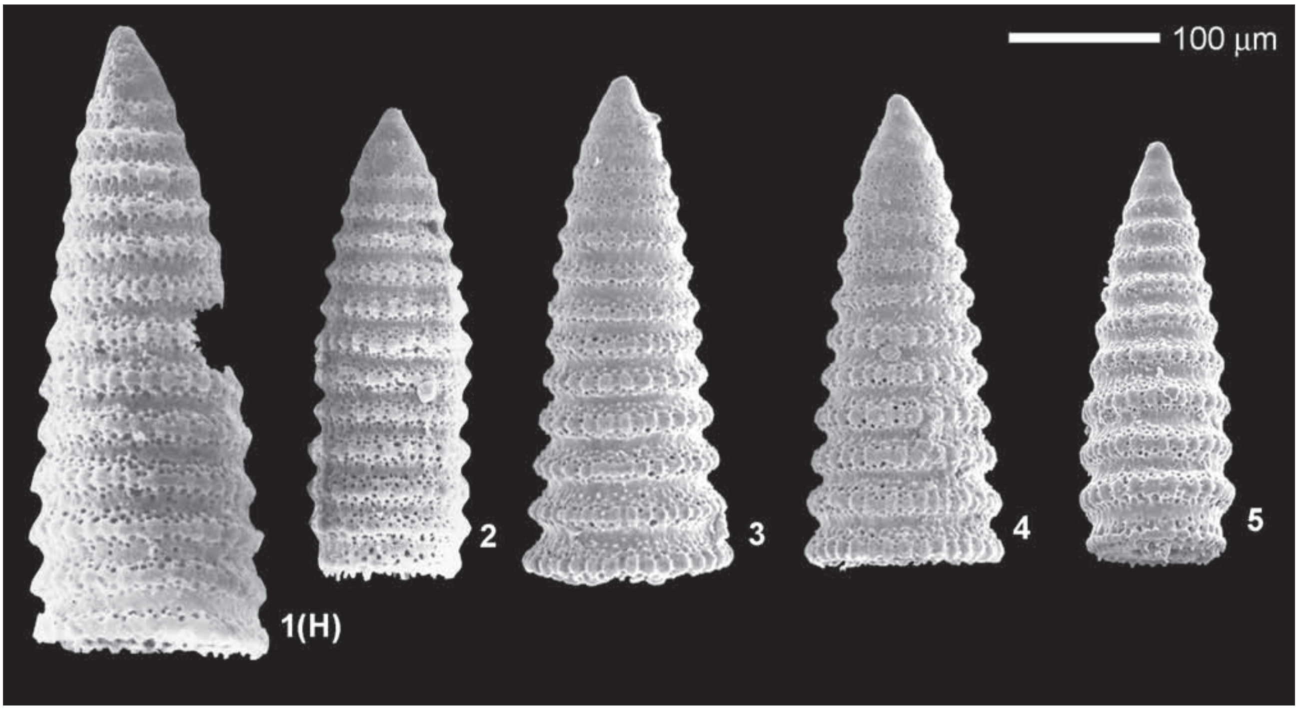


Plate CAN11. *Canoptum margaritaense* Whalen & Carter. Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 17, fig. 2. **Fig. 2.** Carter et al. 1998, pl. 17, fig. 3. **Fig. 3.** QCI, GSC loc. C-080611, GSC 128736. **Fig. 4.** QCI, GSC loc. C-080611, GSC 128737. **Fig. 5.** QCI, GSC loc. C-080610, GSC 128738.

Etymology: *Rugosus-a-um* (Latin, adj.): wrinkled.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Ghost Creek Formation, Queen Charlotte Islands; Skrile Formation, Slovenia; Dengqen area, Tibet; Japan; Musallah Formation, Oman.

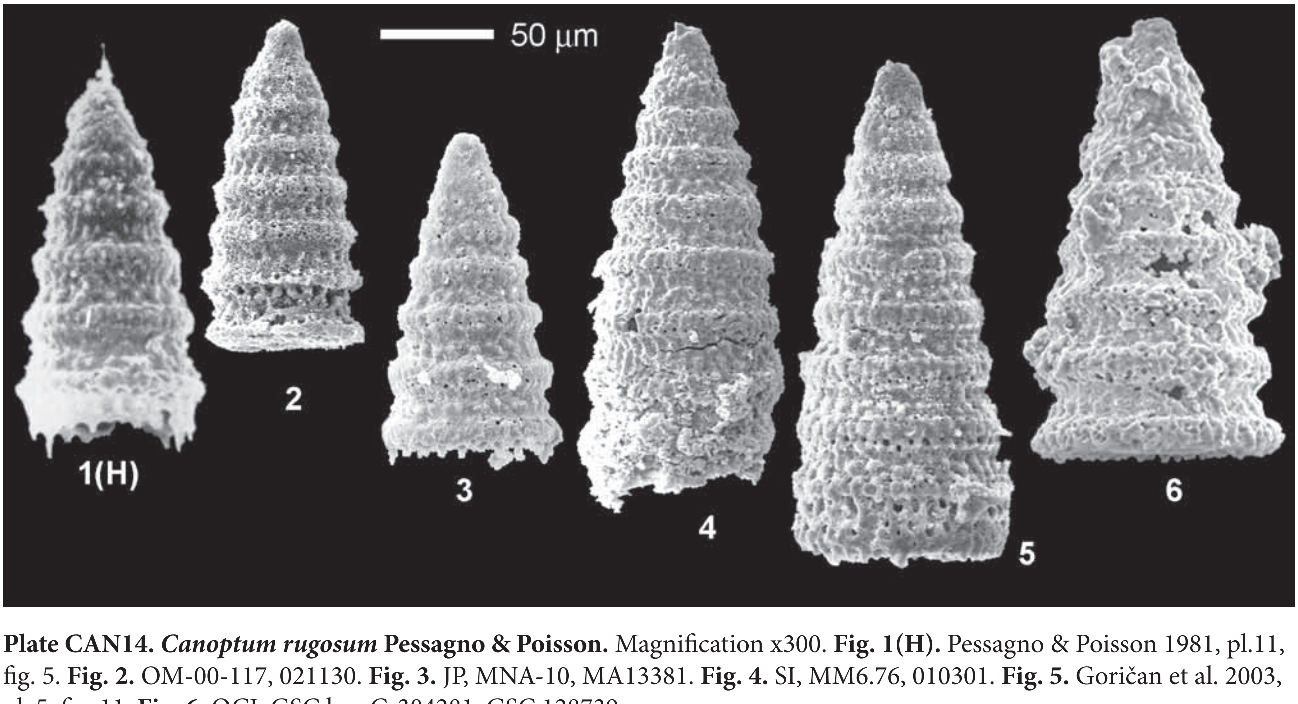


Plate CAN14. *Canoptum rugosum* Pessagno & Poisson. Magnification x300. **Fig. 1(H).** Pessagno & Poisson 1981, pl.11, fig. 5. **Fig. 2.** OM-00-117, 021130. **Fig. 3.** JP, MNA-10, MA13381. **Fig. 4.** SI, MM6.76, 010301. **Fig. 5.** Goričan et al. 2003, pl. 5, fig. 11. **Fig. 6.** QCI, GSC loc. C-304281, GSC 128739.

Genus: *Canutus* Pessagno & Whalen 1982

Type species: *Canutus tipperi* Pessagno & Whalen 1982

Synonymy:
1982 *Canutus* n. sp. – Pessagno & Whalen, p.127.

Original description: Test spindle-shaped to subconical; when spindle-shaped, often quite inflated. Cephalis without horn. Abdomen and post-abdominal chambers with two or three layers of fragile polygonal pore frames.

Original remarks: *Canutus* n. gen., differs from *Archaeodictyomitra* Pessagno by having a test with several latticed layers of pore frames, by developing pillar-like nodes, and by lacking costae.

Further remarks: Only the inflated spindle-shaped forms are considered to belong to *Canutus* Pessagno & Whalen, the subconical forms are now assigned to *Parahsuum* Yao. See also further remarks under genus *Parahsuum*.

Etymology: *Canutus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 40, p.113).

Included species:
CTS06 *Canutus baumgartneri* Yeh 1987b
CTS08 *Canutus diegoi* Whalen & Carter 2002
CTS09 *Canutus hainaensis* Pessagno & Whalen 1982
CTS10 *Canutus nitidus* Yeh 1987b
CTS15 *Canutus rennellensis* Carter n. sp.
CTS03 *Canutus rockfishensis* Pessagno & Whalen 1982
CTS12 *Canutus tipperi* gr. Pessagno & Whalen 1982
CTS16 *Canutus* sp. O

Canutus baumgartneri Yeh 1987b

Species code: CTS06

Synonymy:
1987b *Canutus baumgartneri* n. sp. – Yeh, p. 59, pl. 19, figs. 3-5, 9, 16-17, 20-21.

Original description: Test spindle-shaped, large, inflated, usually with five to six post-abdominal chambers. Cephalis hemispherical, covered with layer of microgranular silica. Thorax and subsequent chambers trapezoidal in outline, gradually increasing in width, final three post-abdominal chambers gradually decreasing in width. Test wall consisting of three layers. Inner latticed layer and intermediate (second) latticed layer comprised of medium size square to rectangular pore frames (pl. 19, figs. 4-5, 16, 21), outermost latticed layers consisting predominantly of triangular pore frames. Distal post-abdominal chambers often lacking outermost layer of meshwork and showing rectangular pore frames of inner latticed layer(s) (pl. 19, figs. 3, 20).

Original remarks: *Canutus baumgartneri*, n. sp. differs from *C. blomei* Pessagno & Whalen by having a less inflated test with less massive pore frames. It can be distinguished from *C. tipperi* Pessagno and Whalen by having a test with less massive pore frames and a less pointed cephalis.

Further remarks: *Canutus tipperi* and *C. blomei* are synonymized herein as the *C. tipperi* group. *C. baumgartneri* differs from this group mainly by having less massive, more irregularly-shaped pore frames. Lowest Pliensbachian representatives of this genus are more strongly spindle-shaped (almost closed at the bottom) and pore frames are even more irregular.

Measurements (μm):
Ten specimens measured.

	Length (max.)	Width (max.)
HT	367	227
Mean	370	228
Max.	380	230
Min.	363	225

Etymology: This species is named after Dr. P. O. Baumgartner, in honor of his studies on the Mesozoic Radiolaria.

Type locality: Sample OR-600D, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands.

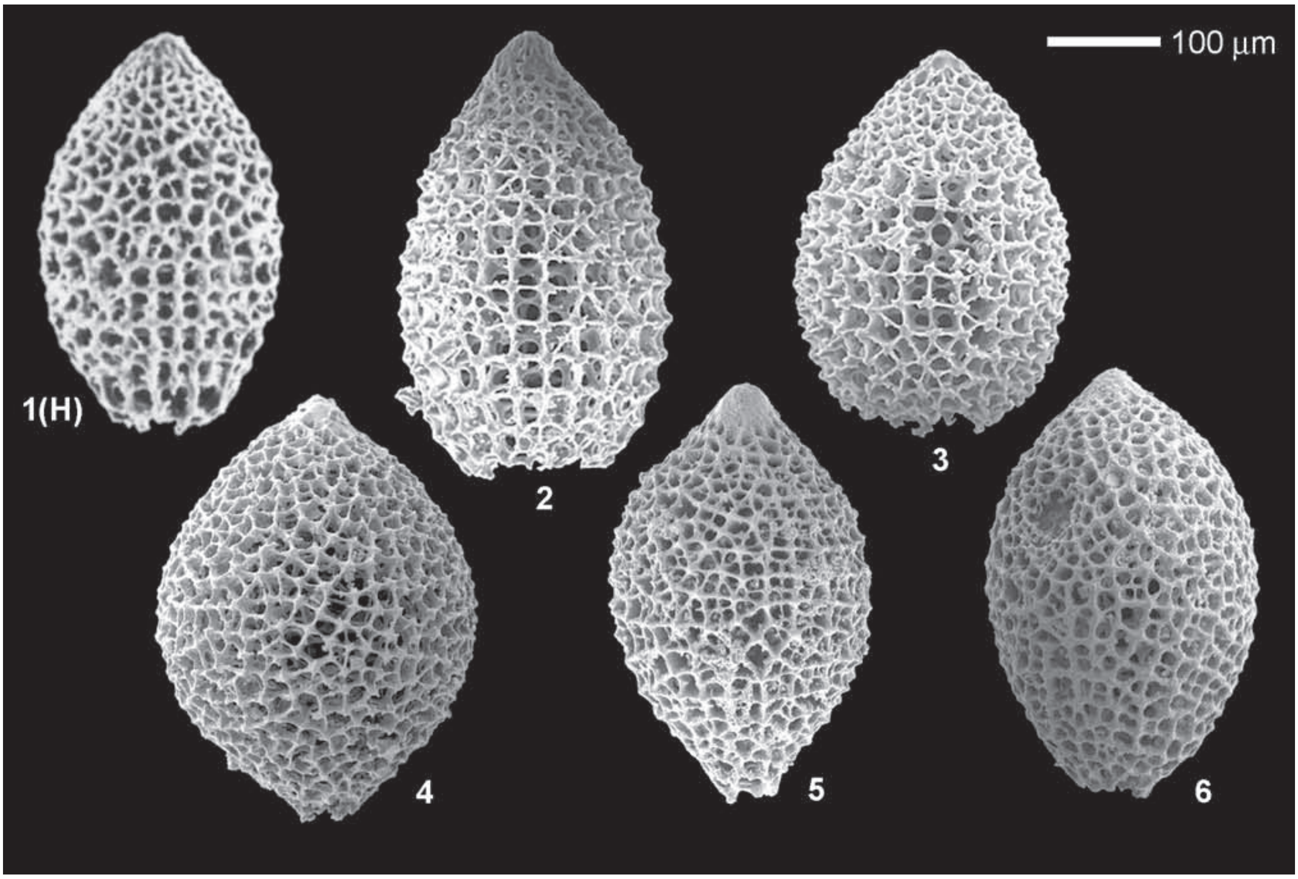


Plate CTS06. ***Canutus baumgartneri*** **Yeh.** Magnification x150. **Fig. 1(H).** Yeh 1987b, pl. 20, fig. 3. **Fig. 2.** QCI, GSC loc. C-304568, GSC 128770. **Fig. 3.** QCI, GSC loc. C-175306, GSC 128771. **Fig. 4.** QCI, GSC loc. C-304567, GSC 128772. **Fig. 5.** QCI, GSC loc. C-175311, GSC 128773. **Fig. 6** QCI, GSC loc. C-080611, GSC 128774.

Canutus diegoi Whalen & Carter 2002

Species code: CTS08

Synonymy:

1984 *Canutus*? sp. – Whalen & Pessagno, pl. 3, fig. 5, 6.
? 1987 *Canutus* (?) sp. K – Hattori, pl. 15, fig. 10.
2002 *Canutus diegoi* n. sp. – Whalen & Carter, p. 120, pl. 10, figs. 6, 10, 13, 16, 17; pl. 17, figs. 6, 7.

Original description: Test spindle shaped, slightly inflated with approximately six post-abdominal chambers; large, dome-shaped cephalis covered by layer of microgranular silica; thorax, abdomen and post-abdominal chambers trapezoidal in outline, gradually increasing in width; last few post-abdominal chambers gradually decreasing in width and terminating in a short, irregular tubular extension. Chambers gradually increasing in height till central post-abdominal chamber and then gradually decreasing in height. Cephalis, thorax, abdomen and post-abdominal chambers on proximal half of test with irregularly shaped pore frames in outer latticed layer; distal post-abdominal chambers composed of slightly more aligned tetragonal-pentagonal pore frames. Inner latticed layer of entire test composed of strong, rectangular pore frames.

Original remarks: The less inflated test and strongly tapering distal chamber distinguish this species from *Canutus rockfishensis* Pessagno and Whalen 1982.

Measurements (μm):
Based on 9 specimens.

Length	Width (Max.)	
225	120	HT
225	135	Max.
180	120	Min.
203	124	Mean

Etymology: *Canutus diegoi* n. sp., is named for Diego de Becerra, one of the early explorers of the Baja California Peninsula.

Type locality: Sample BPW80-30, San Hipólito Formation, Punta San Hipólito, Vizcaino Peninsula, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur.

Canutus hainaensis Pessagno & Whalen 1982

Species code: CTS09

Synonymy:

1982 *Canutus hainaensis* n. sp. – Pessagno & Whalen, p. 128, pl. 4, figs. 3-4; pl. 5, figs. 1, 13, 14, 16-18, 20; pl. 12, fig. 9.
1988 *Canutus hainaensis* Pessagno & Whalen – Carter et al., p. 51, pl. 3, figs. 10-11.
1992 *Canutus hainaensis* Pessagno & Whalen – Pessagno & Mizutani, pl. 99, figs. 5, 14, 19.

Original description: Test elongate, spindle-shaped, often large, with seven to nine post-abdominal chambers usually present. Cephalis conical, rounded apically; remaining chambers trapezoidal in cross section. Thorax, abdomen, and all but final two post-abdominal chambers increasing moderatly rapidly in width and more gradually in length as added. Final two post-abdominal chambers decreasing somewhat in width. Inner latticed layer of post-abdominal chambers consisting of square to rectangular pore frames with nodes at vertices; pore frames gradually increasing in size, becoming large on final post-abdominal chamber. Outer latticed layer (second layer) consisting of regular to irregular, commonly tetragonal (rectangular) and triangular pore frames. Outer latticed layer not developed on final chamber of well-preserved specimens; pore frames of inner layer with rudimentary nodes.

Original remarks: *Canutus hainaensis*, n. sp., is considerably more elongate and much less inflated than *C. tipperi*, n. sp. It also differs from *C. tipperi* by having a cephalis rounded rather than pointed apically and by having two rather than three layers of meshwork on its post-abdominal chambers.

Measurements (μm):
Based on 6 specimens.

Length	Width (max.)	
375.0	200.0	HT
400.0	200.0	Max.
300.0	160.0	Min.
357.5	177.9	Mean

Etymology: This species is named for Haina, an abandoned Indian village on the east shore of Maude Island.

Type locality: Sample QC 534, Ghost Creek Formation (Maude Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands.

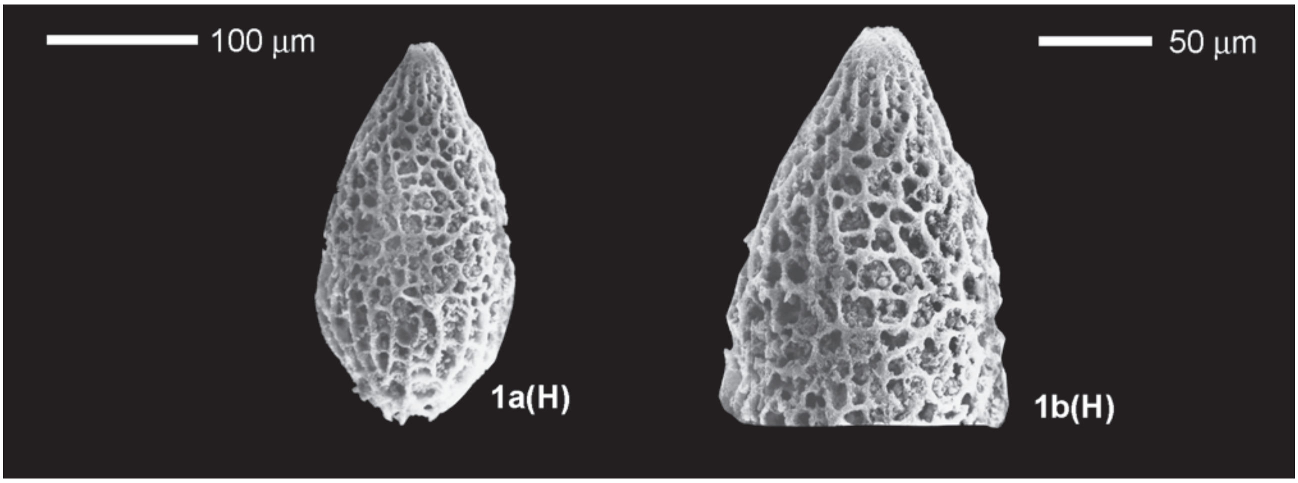


Plate CTS08. ***Canutus diegoi*** **Whalen & Carter.** Magnification Fig. 1a x200, Fig. 1b x300. **Fig. 1(H)a, b.** Whalen & Carter 2002, pl. 10, figs. 10, 13.

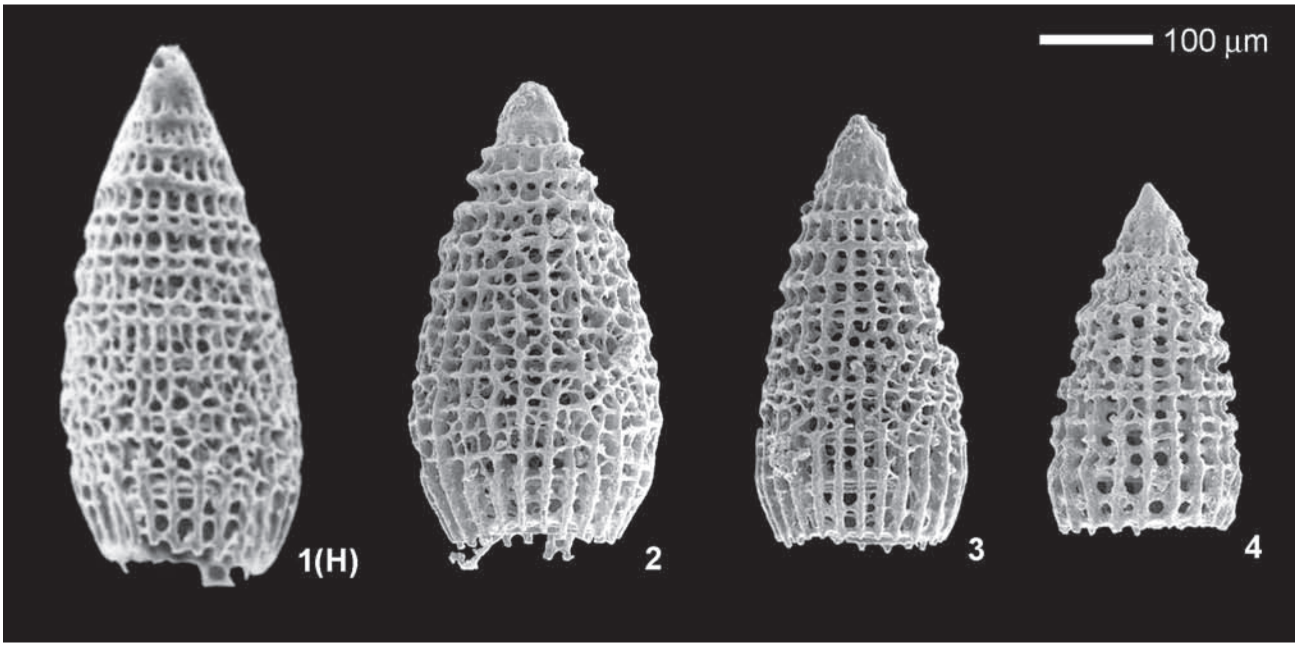


Plate CTS09. ***Canutus hainaensis*** **Pessagno & Whalen.** Magnification x150. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 4, fig. 3. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128775. **Fig. 3.** QCI, GSC loc. C-304567, GSC 128776. **Fig. 4.** QCI, GSC loc. C-175311, GSC 128895.

Canutus nitidus Yeh 1987b

Species code: CTS10

Synonymy:

1987b *Canutus nitidus* n. sp. – Yeh, p. 59, pl. 6, figs. 1, 17; pl. 19, figs. 1-2, 6, 11, 18-19.

1987b *Canutus* sp. aff. *C. nitidus* n. sp. – Yeh, p. 60, pl. 4, figs. 4-5, 22.

1988 *Canutus nitidus* Yeh – Carter et al., p. 50, pl. 3, figs. 5, 8, 12.

1988 *Canutus* sp. aff. *C. nitidus* Yeh – Carter et al., p. 51, pl. 3, fig. 6.

Original description: Test spindle-shaped, large, very inflated, usually with five to six post-abdominal chambers. Cephalis small, hemispherical, usually without rudimentary spine. Abdomen, thorax to second post-abdominal chamber rapidly increasing in width, remaining post-abdominal chambers rapidly decreasing in width. Cephalis covered with layer of microgranular silica, remaining chambers comprised of two inner layers of variable size of irregular polygonal pore frames (pl. 19, fig. 6), outer most layer of triangular pore frames. Pore frames thin in rims and thick in sides, with largest pores at middle portion of test, decreasing in size apically and distally. Final post-abdominal chamber terminating in narrow tubular extension.

Original remarks: *Canutus nitidus*, n. sp., differs from *C. baumgartneri* n. sp., by possessing a very inflated test with extremely small cephalis, and by having a test with two inner layers of variable sized irregular pore frames.

Further remarks: By Carter et al. (1988): The narrow tubular extension terminating the distalmost post-abdominal chamber, as described by Yeh (1987b, p. 59), has not been observed in any specimens.

Measurements (μm):

Ten specimens measured.

	Length (max.)	Width (max.)
HT	324	248
Mean	315	243
Max.	325	250
Min.	302	237

Etymology: *Nitidus-a-um* (Latin, adj.) = sleek, glittering.

Type locality: Sample OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Fannin Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia.

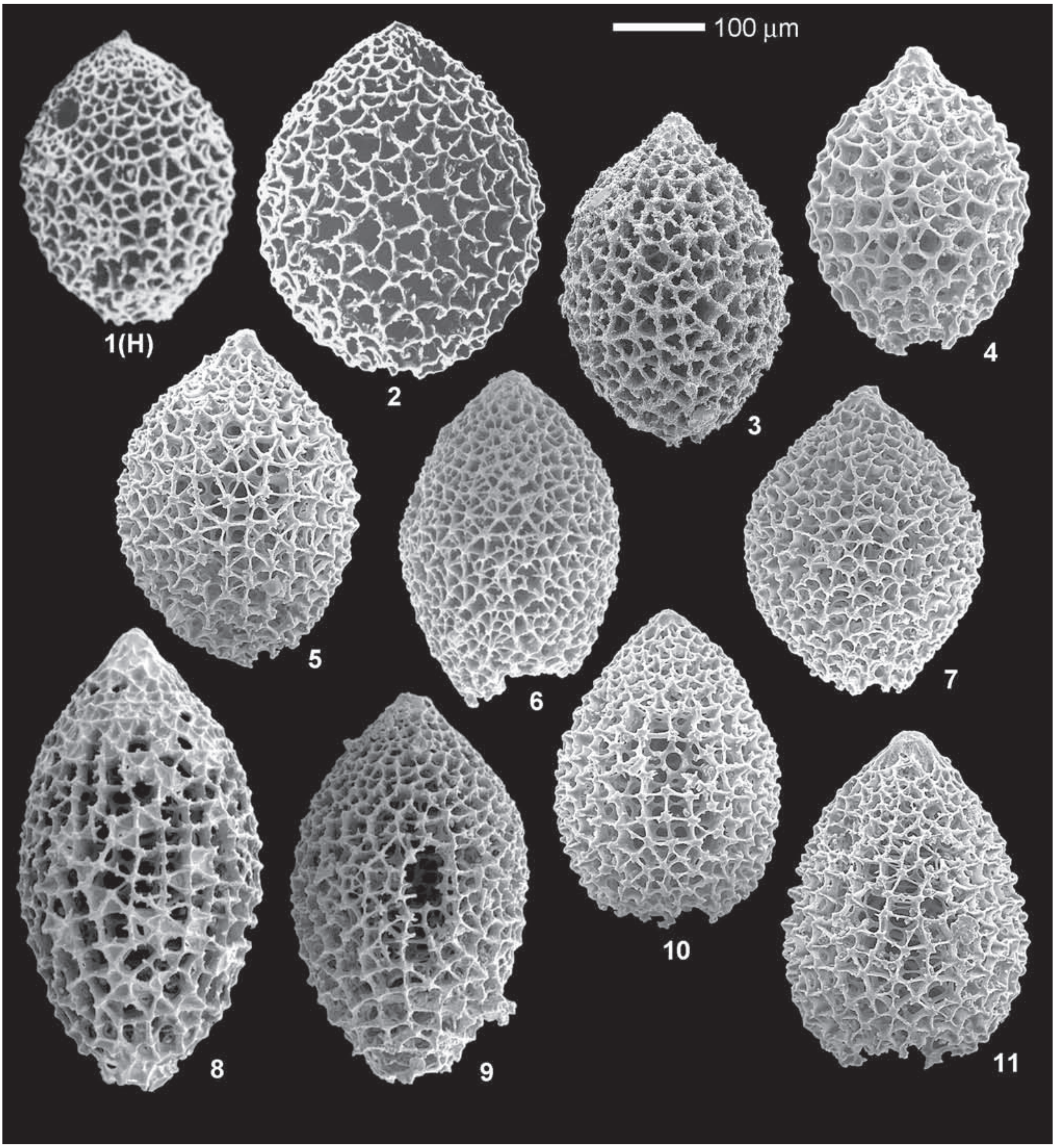


Plate CTS10. *Canutus nitidus* Yeh. Magnification x150. **Fig. 1(H).** Yeh 1987b, pl. 20, fig. 1. **Fig. 2.** Carter et al. 1988, pl. 3, fig. 5. **Fig. 3.** NBC, GSC loc. C-305208, GSC 128896. **Fig. 4.** QCI, GSC loc. C-175309, GSC 128897. **Fig. 5.** QCI, GSC loc. C-304567, GSC 128898. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128899. **Fig. 7.** QCI, GSC loc. C-175306, GSC 128900. **Fig. 8.** QCI, GSC loc. C-304567, GSC 128777. **Fig. 9.** QCI, GSC loc. C-304567, GSC 128778. **Fig. 10.** QCI, GSC loc. C-304567, GSC 128901. **Fig. 11.** QCI, GSC loc. C-304567, GSC 128902.

Canutus rennellensis Carter n. sp.

Species code: CTS15

***Synonymy*:**

1982 *Canutus blomei* n. sp. – Pessagno & Whalen, p. 127, pl. 3, fig. 14 only.
1996 *Canutus* sp. A - Pujana, p. 138, pl. 1, figs. 18, 19.
1996 *Canutus* sp. A of Carter – Pujana, p. 138, pl. 1, fig. 20.
2004 *Canutus* sp. – Matsuoka, fig. 211.

Type designation: Holotype GSC 111711 and paratype GSC 111712 from GSC loc. C-080612; Ghost Creek Formation (lower Pliensbachian).

Description: Test spindle-shaped, large, inflated, usually with five or six post-abdominal chambers. Cephalis hemispherical; thorax, abdomen and first few abdominal chambers rapidly increasing in width, last few post-abdominal chambers strongly decreasing in width. Apical portion of test fairly pointed and covered with a layer of microgranular silica. Pore frames on early chambers relatively small, irregularly-shaped and arranged; on medial chambers pore frames mainly tetragonal and aligned in rows, some with costae-like ridges between. Pore frames on distalmost chamber(s) smaller and irregular.

Remarks: *Canutus rennellensis* n. sp. differs from the *C. tipperi* group in having finer, more irregular meshwork, and distal chambers are more constricted. It differs from *C. baumgartneri* Yeh in having much finer meshwork and pore frames on distal post-abdominal chambers are aligned rather than irregular.

Measurements (μm):
Based on 6 specimens.

	HT	Max.	Min.	Mean
Length (excl. horn)	326	353	316	328
Maximum width	195	205	179	191

Etymology: Species named for the type locality at Rennell Junction, the confluence of logging roads leading north to Masset and west to Rennell Sound; Graham Island, Queen Charlotte Islands.

Type locality: Sample CAA-79-Ren-Phant, lms 1 (GSC loc. C-080611), Ghost Creek Formation, Rennell Junction section, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Sierra Chacaicó Formation, Argentina; Mino Terrane, Japan; Haliw (Aqil) and Musallah formations, Oman.

Canutus rockfishensis Pessagno & Whalen 1982

Species code: CTS03

Synonymy:

1982 *Canutus rockfishensis* n. sp. – Pessagno & Whalen, p. 129, pl. 2, figs. 4, 12, 15, 19; pl. 12, fig. 22.
1998 *Canutus rockfishensis* Pessagno & Whalen – Whalen & Carter, p. 65, pl. 17, fig. 18; pl. 26, fig. 8.
2002 *Canutus rockfishensis* Pessagno & Whalen – Suzuki et al., p. 184, fig. 9 I.

Original description: Test as with genus, spindle-shaped, large, moderately inflated, usually with seven post-abdominal chambers. Cephalis and thorax conical, mostly imperforate, composed of inner latticed layers of pore frames covered by an outer layer of microgranular silica. Abdomen and proximal post-abdominal chambers rapidly increasing in width, central two or three post-abdominal chambers gradually increasing in width; last two post-abdominal chambers rapidly decreasing in width; thorax, abdomen and post-abdominal chambers trapezoidal in cross section. All post-abdominal chambers increasing in height distally. Abdomen and most post-abdominal chambers composed of irregular pentagonal to tetragonal pore frames in outer latticed layer; last two post-abdominal chambers composed of aligned tetragonal (rectangular) pore frames. Inner latticed layer composed of rectangular pore frames.

Original remarks: *Canutus rockfishensis*, n. sp., differs from *C. blomei*, n. sp., by having a test which is not nearly so broad and by having post-abdominal chambers with two rather than three layers of latticed meshwork. Furthermore, most of the outer latticed layer of *C. rockfishensis* possesses irregular pore frames, whereas that of *C. blomei* possesses triangular pore frames.

Further remarks: The holotype of *Canutus blomei* Pessagno & Whalen is now assigned to *C. tipperi* Pessagno & Whalen while its paratype is assigned to *C. rennellensis* Carter n. sp. *C. rockfishensis* Pessagno & Whalen differs from both these species by having a much less inflated test.

Measurements (μm):
Based on 10 specimens.

Length	Width (maximum)	
222.5	125.0	HT
270.0	150.0	Max.
220.0	125.0	Min.
243.0	138.5	Mean

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Fannin formations, Queen Charlotte Islands; Nicely Formation, east-central Oregon; Pucara Group, Peru.

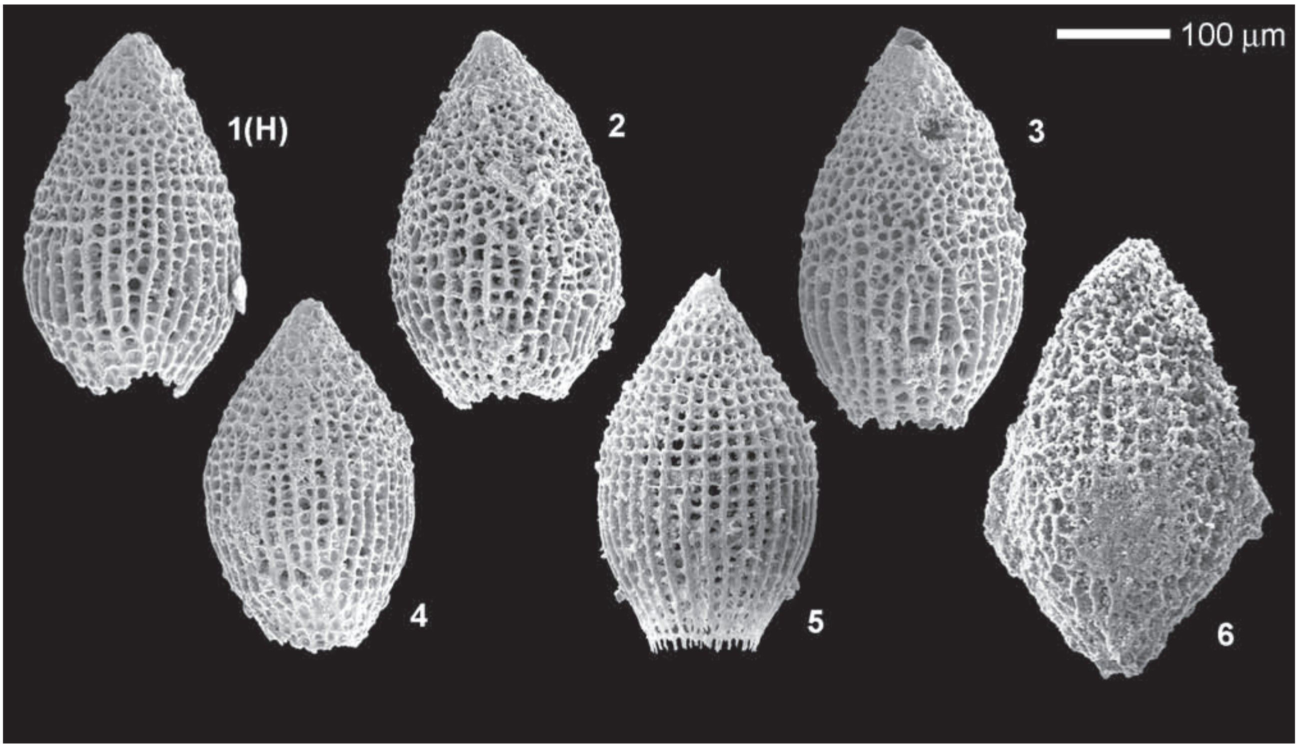


Plate CTS15. *Canutus rennellensis* Carter n. sp. Magnification x150. **Fig. 1(H).** QCI, GSC loc. C-080612, GSC 111711. **Fig. 2.** QCI, GSC loc. C-080612, GSC 128783. **Fig. 3.** QCI, GSC loc. C-304281, GSC 128784. **Fig. 4.** QCI, GSC loc. C-080612, GSC 111712. **Fig. 5.** JP, MNA-10, MA13048. **Fig. 6.** OM-00-118, 000604.

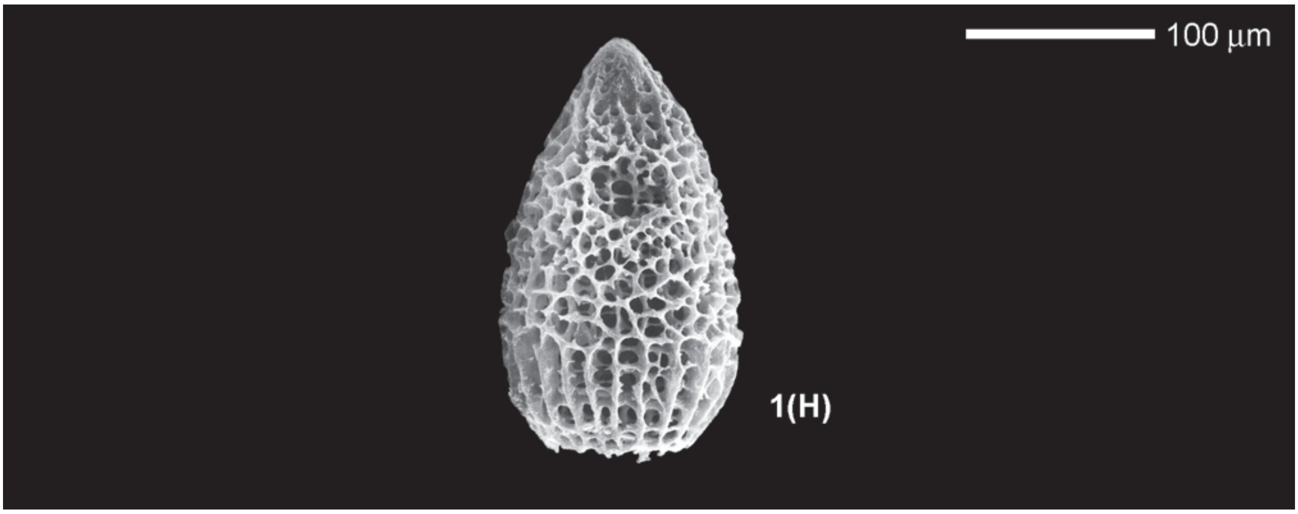


Plate CTS03. *Canutus rockfishensis* Pessagno & Whalen. Magnification x250. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 2, fig. 4.

***Canutus tipperi* gr.** Pessagno & Whalen 1982

Species code: CTS12

Synonymy:

1982 *Canutus tipperi* n. sp. – Pessagno & Whalen, p. 129, pl. 4, figs 7-9, 11, 12, 14-17; pl. 12, fig. 21.
1982 *Canutus blomei* n. sp. – Pessagno & Whalen, p. 127, pl. 3, figs. 13, 15 (not fig. 14); pl. 12, fig. 20.
1988 *Canutus tipperi* Pessagno & Whalen – Carter et al., p. 51, pl. 3, fig. 3.

Original description: Test spindle-shaped, pointed apically, large, inflated, usually with seven to nine post-abdominal chambers. Cephalis hemispherical; remaining chambers trapezoidal in cross section; cephalis and thorax with apically converging ridges on better preserved specimens. Abdomen and first three post-abdominal chambers rapidly increasing in height as added. Inner latticed layer and intermediate (second) latticed layer comprised of large square to rectangular pore frames (pl. 4, figs. 15, 17); outer latticed layer comprised predominantly of triangular pore frames. Final post-abdominal chamber of well-preserved specimens often lacking outer two layers of meshwork and showing only rudimentary development of nodes at pore frame vertices.

Original remarks: *Canutus tipperi* n. sp. is compared to *C. blomei* n. sp. under the latter species.

Original remarks under *C. blomei: Canutus blomei*, n. sp., appears closely related to *C. tipperi*, n. sp. It can be distinguished from *C. tipperi* by the less pointed and more rounded nature of the apical portion of the test. Furthermore, the test of *C. blomei* is more inflated and ellipsoidal in character than that of *C. tipperi*. In addition, its pore frames are more massive with less prominent nodes.

Further remarks: *Canutus tipperi* is an extremely large multicyrtid with distinctive pore structure, but recent studies of *Canutus* in over 80 Pliensbachian samples from Queen Charlotte Islands indicate that test morphology is quite variable. Basal Pliensbachian forms are small, less than half the size of the type species, others are elongate and less inflated, but all retain the typical massive rectangular pore structure of *C. tipperi*. The shape of the apical portion of the test is also variable, ranging from the fairly pointed shape of the holotype to the more hemispherical shape of the original holotype of *C. blomei* (the latter now synonymized with *C. tipperi*).

C. tipperi was originally recorded from the Rennell Junction member of the Fannin Formation (upper lower Pliensbachian) but is now known to appear in basal beds of the lower Pliensbachian Ghost Creek Formation and ranges throughout the entire Pliensbachian.

Measurements (μm):
Based on 6 specimens.

Length	Width (max.)	
475.0	200.0	HT
475.0	200.0	Max.
280.0	180.0	Min.
313.0	195.4	Mean

Etymology: This species is named for Dr. Howard W. Tipper, Geological Survey of Canada, in honor to his contributions to the study of the Jurassic ammonite biostratigraphy of the Queen Charlotte Islands.

Type locality: QC 532, Fannin Formation (Maude Formation in Pessagno & Whalen, 1982), Skidegate Inlet, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands, and Williston Lake, northeastern British Columbia.

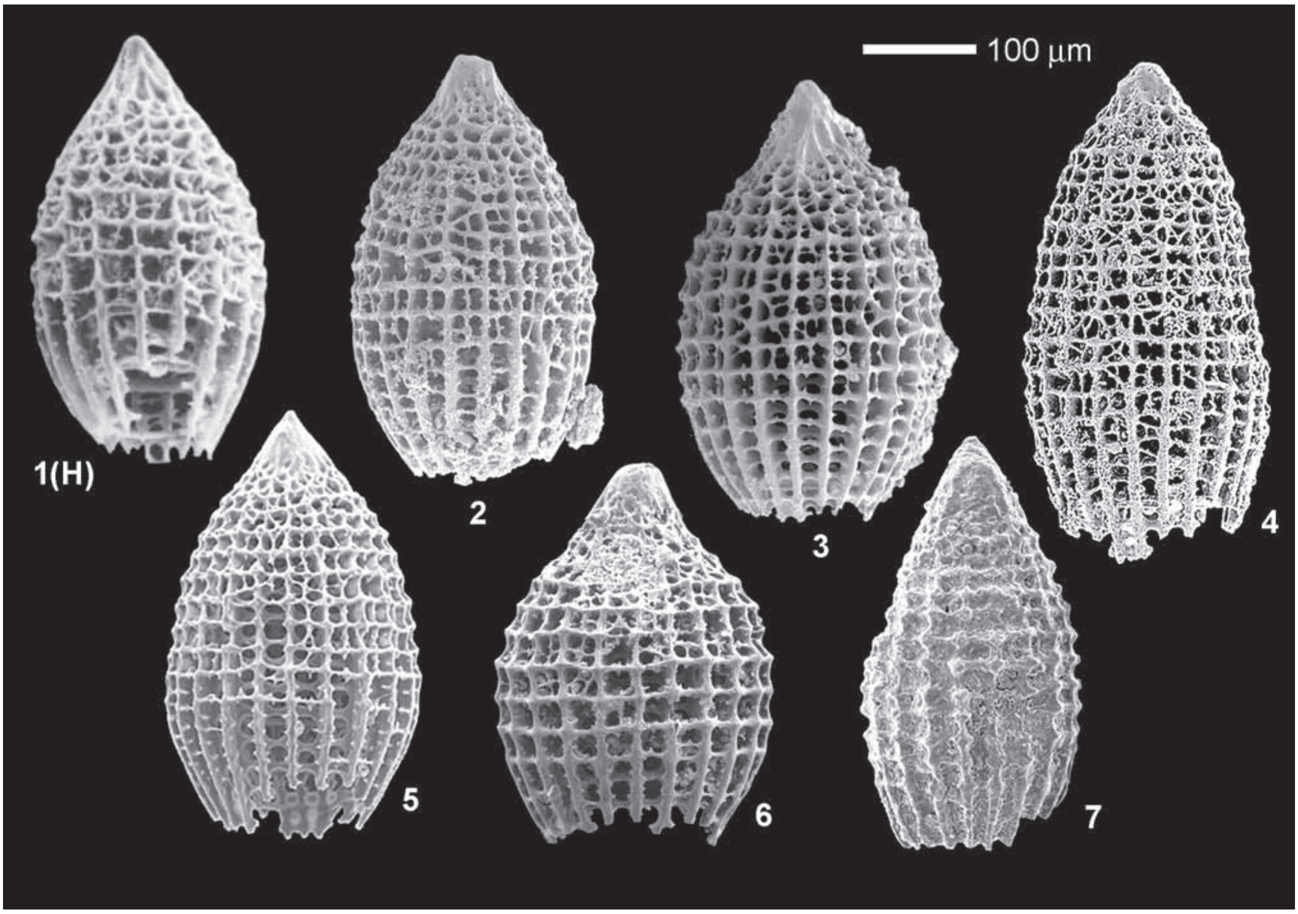


Plate CTS12. *Canutus tipperi* gr. Pessagno & Whalen. Magnification x150. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 4, fig. 7. **Fig. 2.** QCI, GSC loc. C-175311, GSC 128779. **Fig. 3.** QCI, GSC loc. C-175309, GSC 128780. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128781. **Fig. 5.** QCI, GSC loc. C-175309, GSC 128782. **Fig. 6.** Carter et al. 1988, pl. 3, fig. 3. **Fig. 7.** QCI, GSC loc. C-127867, GSC 128903.

Canutus sp. O
Species code: CTS16

Remarks: Test large, subconical to slightly spindle-shaped. Cephalis hemispherical, thorax and abdomen trapezoidal, post abdominal chambers gradually increasing in width as added Cephalis and thorax sparsely perforate covered with a layer of microgranular silica. Pore frames on initial post-abdominal chambers mostly irregular, on distal portion pore frames mainly tetragonal and aligned vertically. This species differs from *C. hainaensis* in having a more broadly conical shape with prominently aligned distal chambers.

Occurrence: Ghost Creek Formation, Queen Charlotte Islands; Musallah Formation, Oman.

Genus: *Carterwhalenia* Dumitrica n. gen.
Type species: *Saitoum* (?) *minai* Whalen & Carter 2002

Description: Test monocyrtid, hemispherical to subglobular with an initial spicule consisting of apical (A), dorsal (D), ventral (V), and primary lateral spines (Lr, Ll) originating in a short median bar (MB), and arches LL, LD, LV, AV, AL, and AD. A spine extended outside into apical horn, and D and L into feet. Apical horn and feet four-bladed and practically equal, at least in type species. Blades with a row of three or more pores decreasing in size distally. Pores aligned between the axis of apical horn and feet and the external border of blades. Ventral spine of initial spicule extended outside cephalic wall into a short bladed spine.

Remarks: *Carterwhalenia* n. gen. externally resembles *Saitulpus* Dumitrica & Zügel from which it differs structurally especially in missing the secondary lateral spines of the initial spicule. By this character it also resembles very much the Cenozoic genera *Euscenium* Haeckel, *Archiscenium* Haeckel, and *Pteroscenium* Haeckel. From each it differs in having four-bladed rather than three-bladed spines. *Carterwhalenia* is close to the Middle and Upper Jurassic genus *Turriseiffelus* Dumitrica & Zügel, in the structure of the initial spicule, apical horn, feet, and cephalic wall, but differs in having four-bladed, short apical horn and feet.

The pores of the blades of the apical horn and feet of this genus have the same origin as similar pores of the genera *Turriseiffelus*, *Pteroscenium* (e.g. *Pteroscenium pinnatum* Haeckel 1887, pl. 53, figs. 14-16), and *Arachnoplecta* Dumitrica & Zügel 2003. They appear as meshes among the axis of these spines, a bar forming the external margin of the blades and branches arising practically perpendicular from the axis of the spines. Usually these branches may extend into thorns outside the margin of the blades.

Until present the genus is represented only by its type species.

Etymology: The genus is named for my radiolarian colleagues E. S. Carter and P. A. Whalen to honour their valuable contribution to the knowledge of Upper Triassic and Lower Jurassic radiolarians.

Included species:
SUM03 *Carterwhalenia minai* (Whalen & Carter) 2002

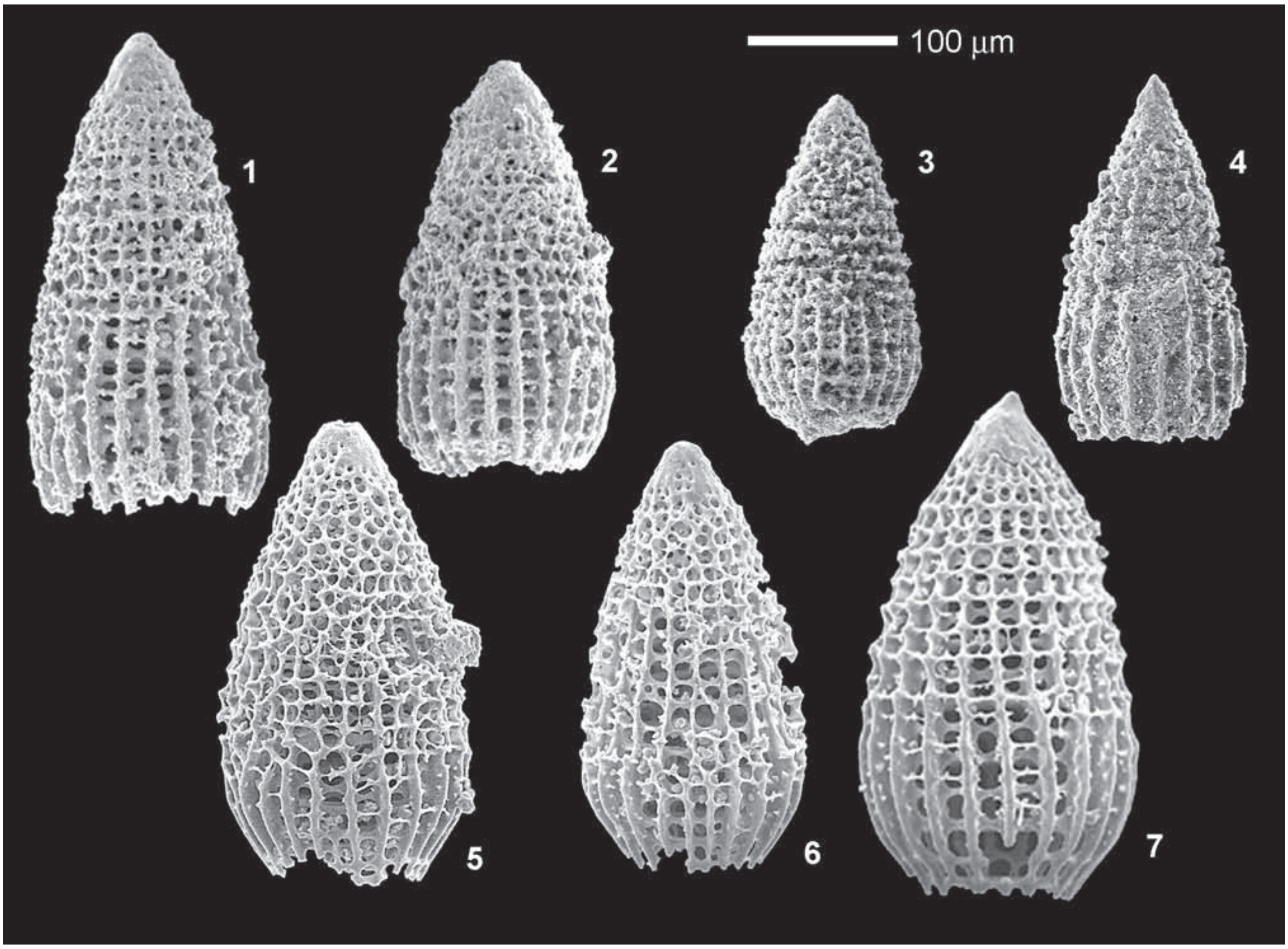


Plate CTS16. ***Canutus*** **sp. O.** Magnification x200. **Fig. 1.** QCI, GSC loc. C-175311, GSC 128785. **Fig. 2.** QCI, GSC loc. C-080612, GSC 128786. **Fig. 3.** OM-00-115, 023003. **Fig. 4.** OM-00-115, 023010. **Fig. 5.** QCI, GSC loc. C-175306, GSC 128787. **Fig. 6.** QCI, GSC loc. C-175306, GSC 128904. **Fig. 7.** QCI, GSC loc. C-175309, GSC 128905.

Carterwhalenia minai (Whalen & Carter) 2002
Species code: SUM03

Synonymy:
2002 *Saitoum*? *minai* n. sp. – Whalen & Carter, p. 130, pl. 12, figs. 7-9, 16, 17; pl. 13, fig. 10.

Original description: Test monocyrtid, sub-spherical in shape with massive apical horn and three feet. Horn triradiate in axial section with narrow, longitudinal ridges and broad grooves for most of length; elongated pores occasionally located at base of grooves of horn; horn circular in axial section distally, separated from triradiate portion by three to four short verticils; verticils aligned at right angles to long axis of horn; horn located off center of highest point on cephalic dome. Three massive feet triradiate in axial section for most of length, circular in axial section distally; triradiate and circular portions of feet separated by verticils aligned at right angles to long axis of feet; proximal part of feet sometimes with small pores piercing grooves. Imperforate border collar continuous with ridges of feet. Pore frames irregular, triangular to circular, sometimes appearing to radiate from a central point. V-spine prominently exposed on exterior of test at point half way between border collar and apex of test.

Original remarks: *Saitoum*? *minai* n. sp. is distinguished from other species of *Saitoum* by the massive, spiny triradiate apical horn and feet with verticils. This species differs from species of *Saitulpus* (Dumitrica and Zügel, in press) in that the V spine does not connect with the border collar.

Further remarks: An attentive look at the apical horn and feet of the type specimens (holotype and two paratypes) and of the two specimens herein presented from the Pliensbachian of Turkey (pl. SUM03, figs. 4a-b, 5a-b) shows that these external spines are four-bladed rather than three-bladed as originally mentioned and that the secondary lateral spines are completely missing.

***Measurements* (µm):**
(n) = number of specimens measured.

	Length (6) (excludes horn)	Width (5) (Max.)	Length of foot (7)
HT	98	90	90
Max.	105	113	105
Min.	83	90	75
Mean	92	104	87

Etymology: This species is named for F. Mina (Geólogos de Petróleos Mexicanos), one of the first geologists to study the rocks of the Vizcaino Peninsula, Baja California Sur.

Type locality: Sample BPW80-30, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Gümüslü Allochthon, Turkey.

Genus: ***Charlottea*** Whalen & Carter 1998
Type species: *Charlottea amurensis* Whalen & Carter 1998

Synonymy:
1998 *Charlottea* n. gen. – Whalen & Carter, p. 37.

Original description: Test with three prominent spines in same plane, equally spaced or with two spines closer together; spines triradiate in axial section, tapering distally. Cortical shell spherical to sub-spherical, sometimes triangular in outline with flattened upper and lower surfaces. Outer layer of pore frames on cortical shell irregularly shaped (usually tetragonal, triangular, pentagonal) and sized, with nodes at pore frame vertices; larger pores on cortical shell sometimes observed at base of spines.

Original remarks: The external morphology of *Charlottea* n. gen. and *Ferresium* Blome is very similar but the inner structure is different: *Charlottea* n. gen. contains an eccentric spicular meshwork occupying a large part of the central area of the test; *Ferresium* Blome contains a small microsphere surrounded by a loosely constructed inner spongy meshwork of bars and small arches (see Family Ferresidae of Carter 1993, p. 68). *Charlottea* n. gen., is distinguished from all other genera of the Subfamily Charlotteinae by having three straight spines in the same plane.

Further remarks: The families Perispyridiidae, Ferresiidae and the subfamily Charlotteinae are considered junior synonyms of the family Eptingiidae because they have a similar initial spicule, and three spines of the spicule extend outside of the test (De Wever et al., 2001).

Etymology: *Charlottea* n. gen., is named for the British ship *Queen Charlotte*, for which Captain George Dixon named the Queen Charlotte Islands in August of 1787.

Included species:
CHA02 *Charlottea amurensis* Whalen & Carter 1998
CHA09 *Charlottea hotaoensis* Carter n. sp.
CHA10 *Charlottea penderi* Carter n. sp.
CHA03 *Charlottea proprietatis* Whalen & Carter 1998
CHA05 *Charlottea triquetra* Whalen & Carter 1998
CHA07 *Charlottea* sp. A sensu Whalen & Carter 2002
CHA08 *Charlottea* sp. B
CHA11 *Charlottea* sp. C
XNM01 *Charlottea*? sp. Y

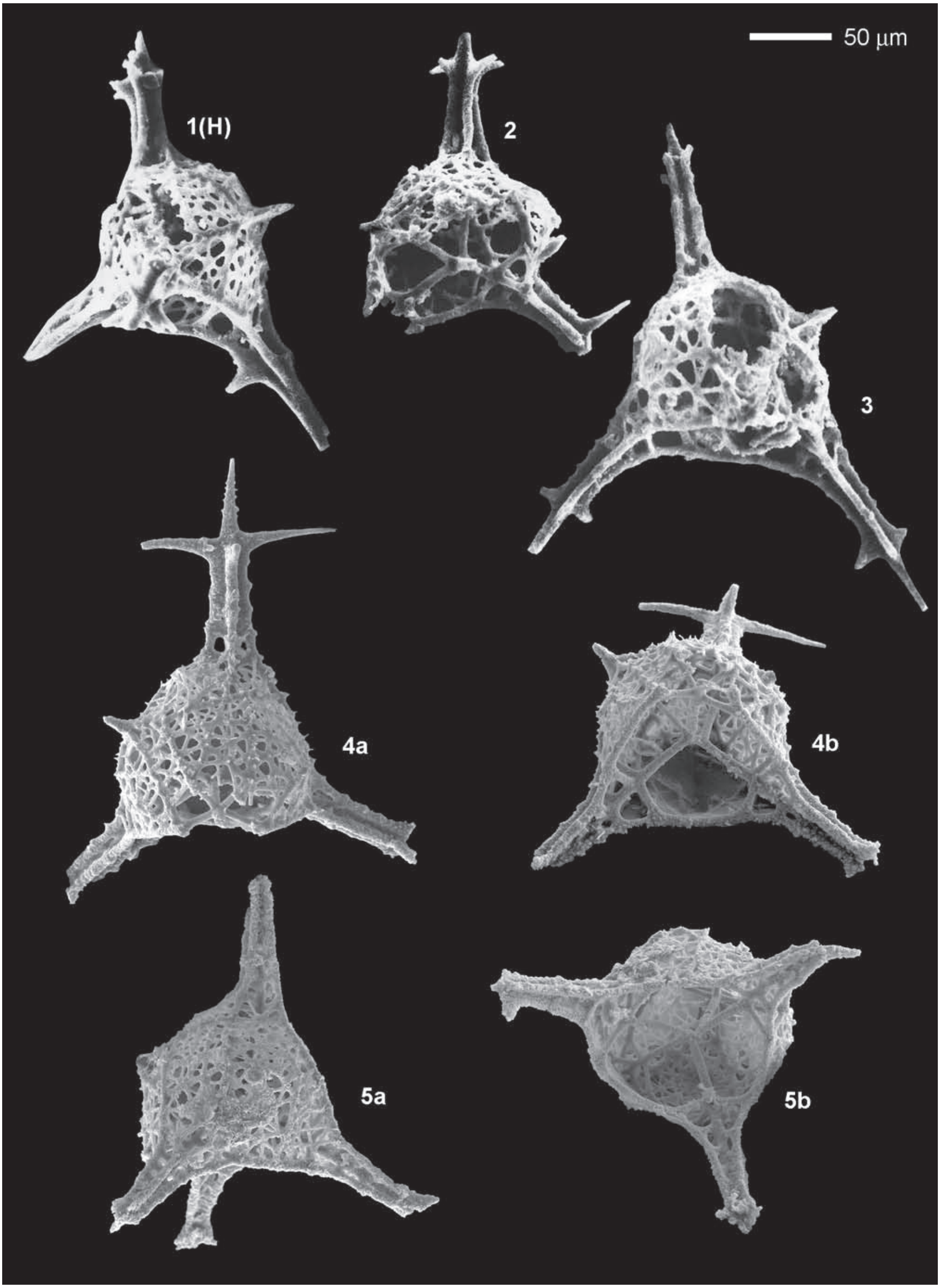


Plate SUM03. *Carterwhalenia minai* (Whalen & Carter). Magnification x300. **Fig. 1(H).** Whalen & Carter 2002, pl. 12, fig. 7. **Fig. 2.** Whalen & Carter 2002, pl. 12, fig. 9. **Fig. 3.** Whalen & Carter 2002, pl. 12, fig. 8. **Fig. 4a,b.** TR, 1662D-R07-10. **Fig. 5a,b.** TR, 1662D-R01-08.

Charlottea amurensis Whalen & Carter 1998

Species code: CHA02

Synonymy:

? 1989 *Acaeniotyle* spp. – Hattori, pl. 1, fig. G.
1998 *Charlottea amurensis* n. sp. – Whalen & Carter, p. 37, pl. 2, figs. 8, 9, 10; pl. 3, figs. 1, 2, 9.
2001 *Charlottea amurensis* Whalen & Carter – Gawlick et al., pl. 2, fig. 5.
2002 *Charlottea amurensis* Whalen & Carter – Suzuki et al., p. 168, figs. 4 H-J.

Original description: Test with medium-sized cortical shell and three moderately long spines. Cortical shell subspherical and somewhat compressed in plane of spines; cortical shell composed of medium-sized, irregularly shaped, tetragonal and triangular pore frames with prominent elongated nodes at pore frame vertices; pore frame bars much thinner in Y direction than Z direction (refer to Pl. 4, fig. 11 for measurement system); large pores sometimes located on cortical shell at base of spines. Internal spicular network composed of delicate pore frames with no difference in thickness between Y and Z direction and no apparent pattern or orientation. Spines tapering distally, usually shorter than diameter of cortical shell, triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves; spines evenly spaced around cortical shell.

Original remarks: The more delicate, elongated nodes and triradiate spines of *Charlottea amurensis* n. sp. distinguish it from *C. johnsoni* n. sp.

Measurements (μm):
Based on 7 specimens.

	HT	Max.	Min.	Mean
Maximum diameter of cortical shell	146	150	138	147
Maximum length of primary spines	105	120	75	95

Etymology: This species is named for Amur Rocks in Dana Passage, located to the northwest of the type locality.

Type locality: Sample QC-676, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Dürrnberg Formation, Austria; Pucara Group, Peru.

Charlottea hotaoensis Carter n. sp.

Species code: CHA09

Synonymy:

1989 *Protoperispyridium* ? spp. – Hattori, pl. 3, fig. G.
1997 *Perispyridium* sp. A02 – Yao, pl. 15, fig. 707.
2004 *Perispyridium* sp. – Matsuoka, fig. 184.

Type designation: Holotype GSC 111713 and paratype GSC 111714 from GSC loc. C-304566; Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

Description: Test with small cortical shell, triangular to subtriangular in outline and three medium-sized spines of equal length. Surface of cortical shell slightly convex with large subtriangular to irregularly shaped pore frames and deeply incised pores, sub-round in shape. Pore frame vertices usually with small to medium sized nodes; some groups of pore frames partly surrounded by massive raised ridges. Spines assymetrically arranged; two spines closer together than the third. Spines stout, triradiate and strongly tapering with narrow ridges and wide grooves.

Remarks: *Charlottea hotaoensis* n. sp. differs from *C. triquetra* Whalen & Carter in having a strongly triangular rather than subtriangular shell and less convex shell surfaces. It is likely that *C. hotaoensis* n. sp. is derived from *C. triquetra*. In our material, C. *triquetra* ranges from upper Sinemurian to basal Pliensbachian; *C. hotaoensis* n. sp. does not range below the Pliensbachian. This new species may also represent the transition between the two eptingiid genera, *Charlottea* and *Perispyridium.*

Measurements (μm):
Based on 5 specimens.

	HT	Max.	Min.	Mean
Diameter of cortical shell	132	153	123	132
Length of longest spine	80	126	56	93

Etymology: This species is named for the Haida village of Hotao on the southwest side of Maude Island, Queen Charlotte Islands, British Columbia.

Type locality: Sample 99-CNA-MI-9 (GSC loc. C-304566), Rennell Junction member of the Fannin Formation; Fannin Bay, south side of Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Mino Terrane, Japan.

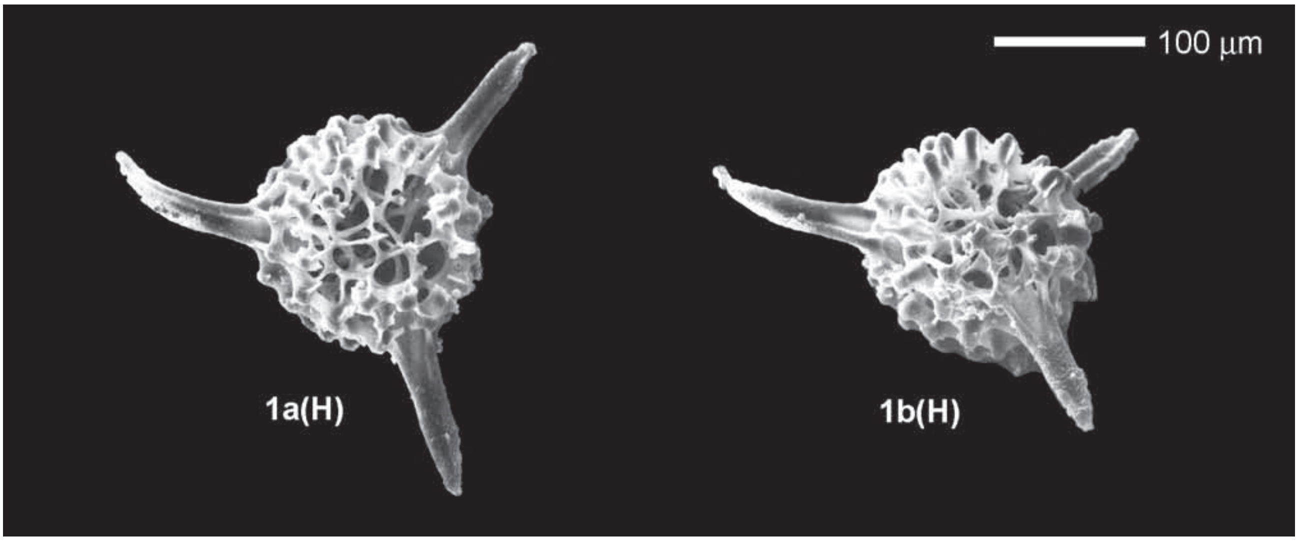


Plate CHA02. ***Charlottea amurensis*** **Whalen & Carter.** Magnification x200. **Fig. 1(H)a,b.** Carter et al. 1998, pl. 2, figs. 8, 9.

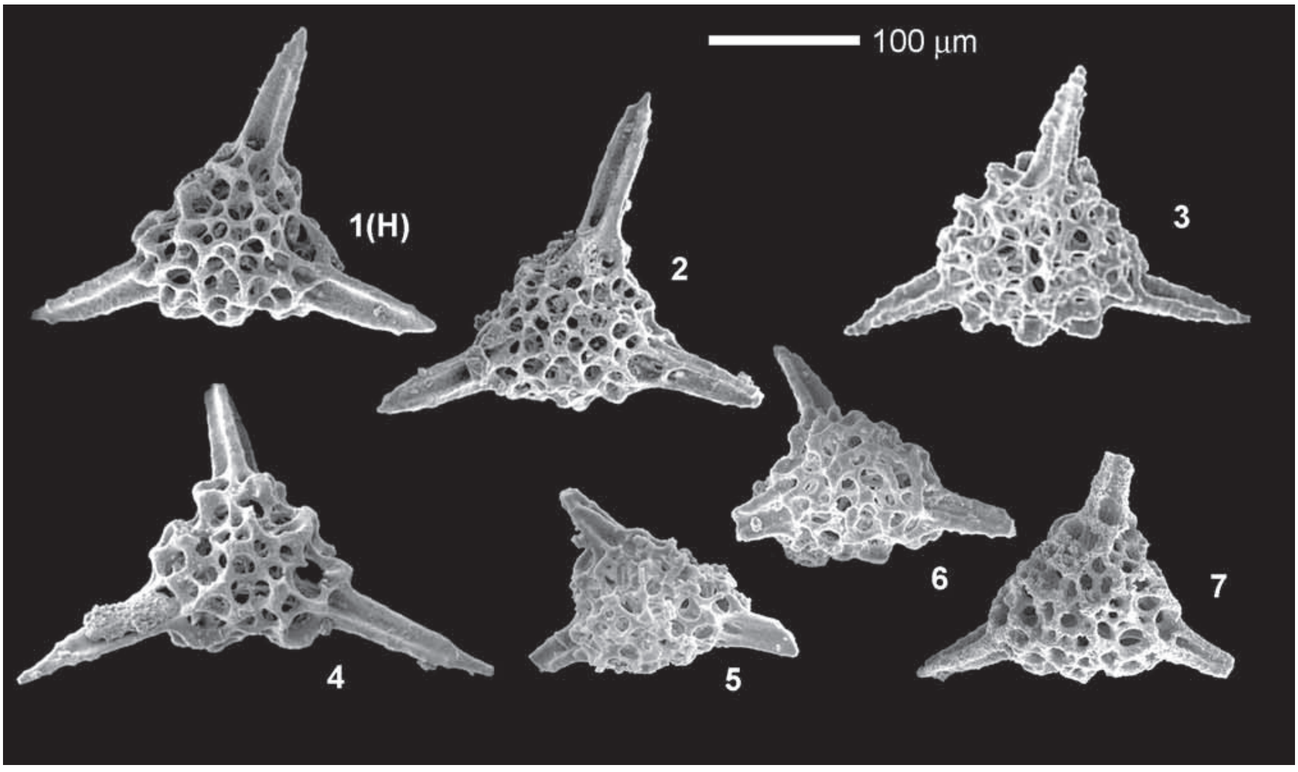


Plate CHA09. ***Charlottea hotaoensis*** **Carter n. sp.** Magnification x200. **Fig. 1(H).** GSC loc. C-304566, GSC 111713. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128742. **Fig. 3.** QCI, GSC loc. C-175306, GSC 128743. **Fig.4.** QCI, GSC loc. C-304566, GSC 111714. **Fig. 5.** QCI, GSC loc. C-305388, GSC 128744. **Fig. 6.** QCI, GSC loc. C-305388, GSC 128745. **Fig. 7.** QCI, GSC loc. C-175311, GSC 128746.

Charlottea penderi Carter n. sp.

Species code: CHA10

Type designation: Holotype GSC 111715 from GSC loc. C-080611, Ghost Creek Formation (lower Pliensbachian). Paratype GSC 111716 from GSC loc. C-304566, Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

***Description*:** Cortical shell generally subtriangular, somewhat fluted and irregular in outline with convex upper and lower surfaces and three medium-sized, strongly tapering spines. Surface of shell double layered; inner layer of pore frames variably-sized and irregular in shape. Outer layer of pore frames extremely variable in size (some quite enormous), irregular in shape; outer layer of pore frames with very large raised nodes some coalescing to form strong raised ridges. Pores subequal in size, irregular in shape. Primary spines equally distributed around shell; spines composed of very narrow ridges and wide deep grooves.

***Remarks*:** *Charlottea penderi* differs from *Charlottea hotaoensis* n. sp. in having an irregularly-shaped cortical shell with more convex surfaces, large raised nodes some forming ridges, and primary spines are more equally distributed around shell.

Measurements (μm):
Based on 6 specimens.

	HT	Max.	Min.	Mean
Diameter of cortical shell	137	167	110	140
Length of longest spine	84	100	73	85

***Etymology*:** This species is named after Captain Pender who originally named Maude Island during the 1866 survey.

***Type locality*:** Sample 99-CNA-MI-9 (GSC loc. C-304566), Rennell Junction member of the Fannin Formation; Fannin Bay, south side of Maude Island, Queen Charlotte Islands, British Columbia.

***Occurrence*:** Ghost Creek Formation, and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Fernie Formation, northeastern British Columbia.

Charlottea proprietatis Whalen & Carter 1998

Species code: CHA03

Synonymy:
1998 *Charlottea proprietatis* n. sp. – Whalen & Carter, p. 39, pl. 4, figs. 1, 6, 7, 8, 9, 10, 13.

Original description: Test with large, inflated cortical shell with three long, broad spines. Cortical shell subspherical in shape and subrectangular in outline with irregularly sized and shaped tetragonal and triangular pore frames with prominent, elongated nodes at pore frame vertices; pore frame bars thin in Y direction, much thicker in Z direction; larger pores usually located at base of spines. Internal spicular network composed of thin, coarsely interwoven pore frames with no apparent pattern or orientation. Spines triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves; spines evenly spaced around cortical shell.

Original remarks: The distinctive subrectangular outline of *Charlottea proprietatis* n. sp. distinguishes it from all other species of *Charlottea*.

Measurements (μm):

	HT	Max.	Min.	Mean
Maximum diameter of cortical shell (8 specimens measured)	180	180	150	161
Maximum length of primary spines (5 specimens measured)	120	221	120	188

Etymology: *Proprietas, atis* (Latin; noun) = a property, pecularity.

Type locality: Sample QC-675, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

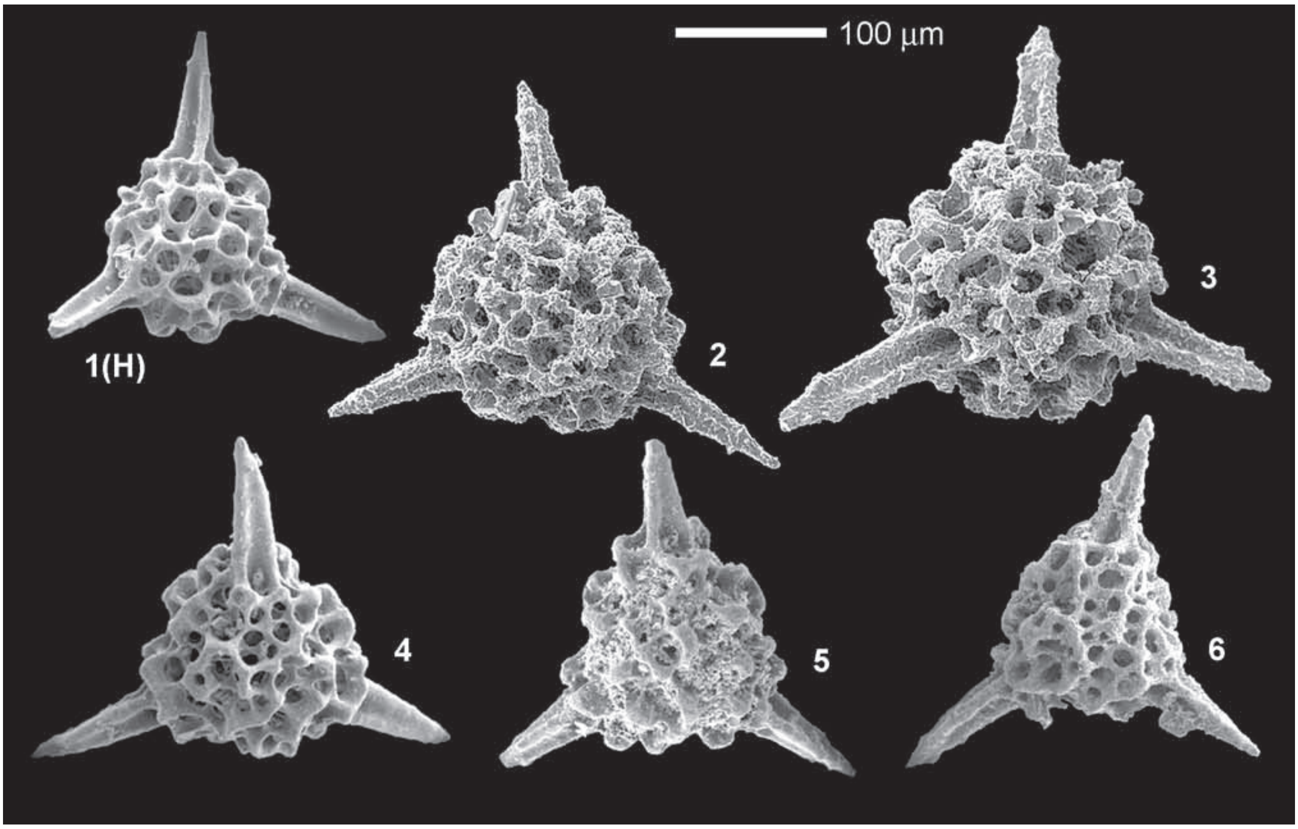


Plate CHA10. *Charlottea penderi* Carter n. sp. Magnification x200. **Fig. 1(H).** GSC loc. C-080611, GSC 111715. **Fig. 2.** NBC, GSC loc. C-305208, GSC 128747. **Fig. 3.** NBC, GSC loc. C-305208, GSC 128748. **Fig. 4.** GSC loc. C-304566, GSC 111716. **Fig. 5.** QCI, GSC loc. C-080611, GSC 128749. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128750.

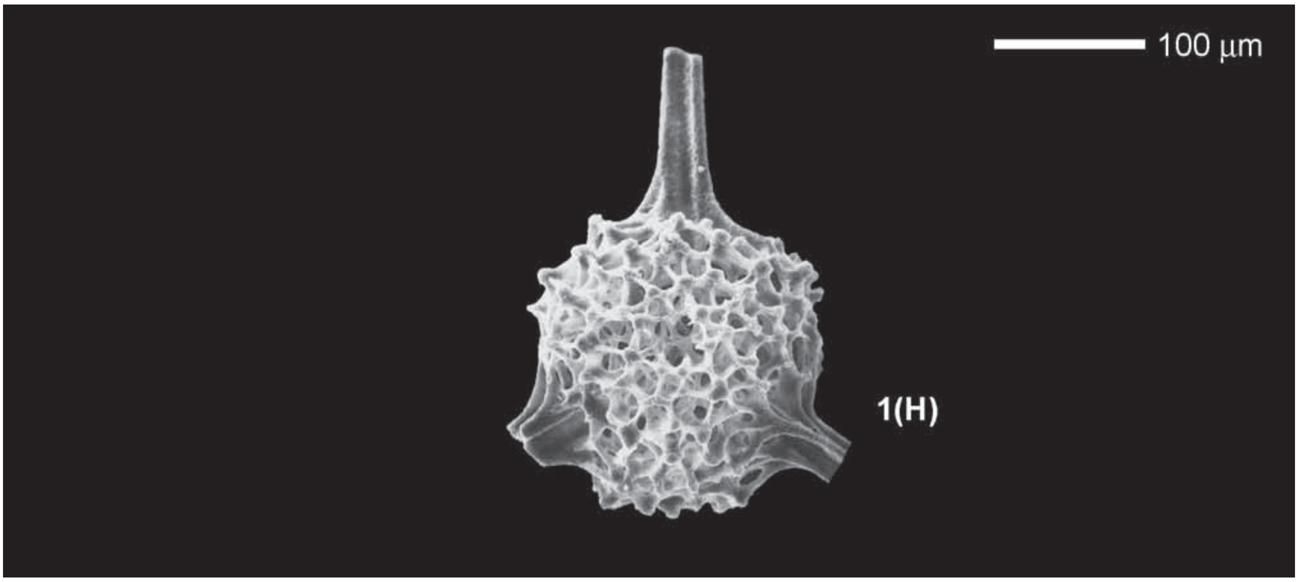


Plate CHA03. *Charlottea proprietatis* Whalen & Carter. Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 4, fig. 1.

Charlottea triquetra Whalen & Carter 1998

Species code: CHA05

Synonymy:

1998 *Charlottea triquetra* n. sp. – Whalen & Carter, p. 39, pl. 4, figs. 2, 3, 4, 5, 11, 14, 15.

Original description: Test with small, slightly elongated cortical shell compressed in plane of spines and three moderately long spines. Cortical shell with large, irregularly shaped and sized pentagonal and hexagonal pore frames with low, rounded nodes at pore frame vertices; pores irregularly sized (large and small), usually subcircular in outline. Internal spicular network composed of very delicate pore frames with no pattern or orientation. Spines triradiate in axial section with narrow, rounded longitudinal ridges and broad, rounded longitudinal grooves; spines usually shorter than or equal to long dimension of cortical shell; two spines closer together than third, sometimes curving inwards toward long axis of cortical shell.

Original remarks: The shorter, less massive spines and less prominent nodes of *C. triquetra* n. sp. distinguish it from *Charlottea* sp. C.

Measurements (μm):

	HT	Max.	Min.	Mean
Maximum diameter of cortical shell (6 specimens measured)	75	90	75	84
Maximum length of primary spines (5 specimens measured)	71	75	68	73

Etymology: *Triquetrus, a, um*, (Latin, adj.) = three cornered, triangular.

Type locality: Sample QC-677, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

Charlottea sp. A sensu Whalen & Carter 2002

Species code: CHA07

Synonymy:

2002 *Charlottea* sp. A – Whalen & Carter, p. 122, pl. 7, figs. 4, 5.

Original remarks: The pronounced torsion of the short, triradiate spines of *Charlottea* sp. A distinguishes it from *C. amurensis* Whalen and Carter 1998 and *C. harbridgensis* Whalen and Carter 1998.

Occurrence: San Hipólito Formation, Baja California Sur.

Charlottea sp. B

Species code: CHA08

***Remarks*:** Cortical shell similar in size and shape to *C. amurensis* Whalen & Carter, but spines are shorter and more robust with thin rounded ridges and deep grooves; distal ridges of spines with numerous small thorn-like protuberances.

***Occurrence*:** Sandilands and Ghost Creek formations, Queen Charlotte Islands; Baja California Sur.

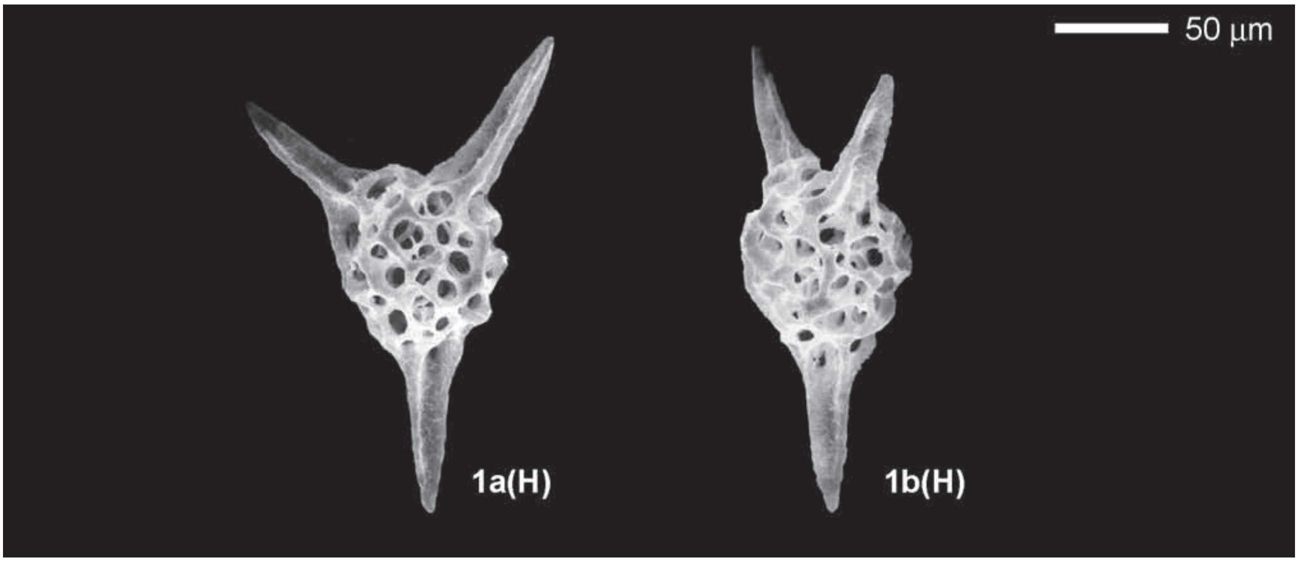


Plate CHA05. ***Charlottea triquetra*** **Whalen & Carter.** Magnification x300. **Fig. 1(H)a,b.** Carter et al. 1998, pl. 4, figs. 2, 3.

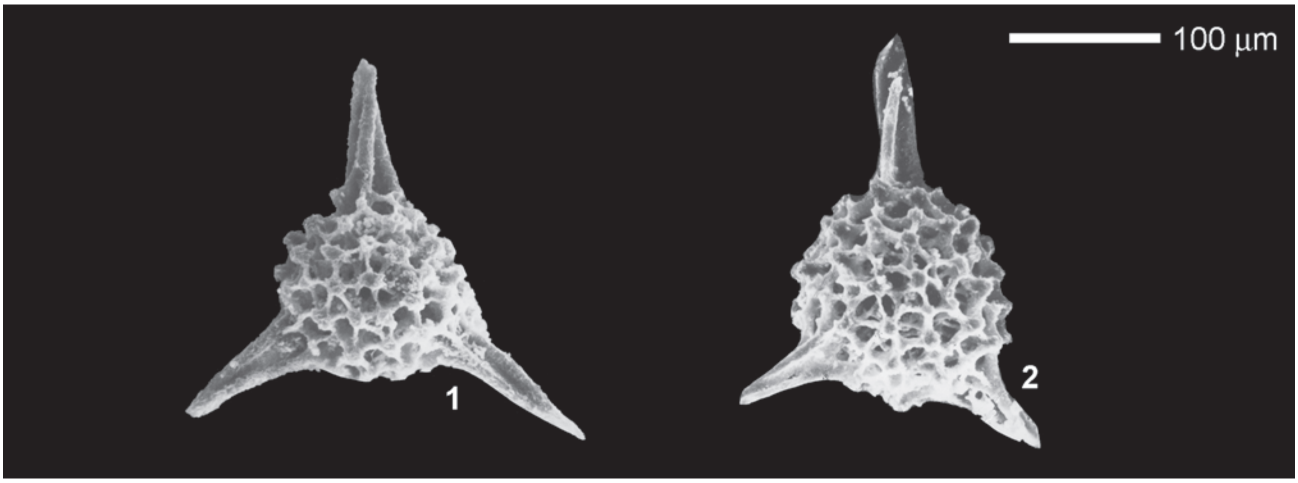


Plate CHA07. ***Charlottea*** **sp. A sensu Whalen & Carter.** Magnification x200. **Figs. 1-2.** Whalen & Carter 2002, pl. 7, figs. 4-5.

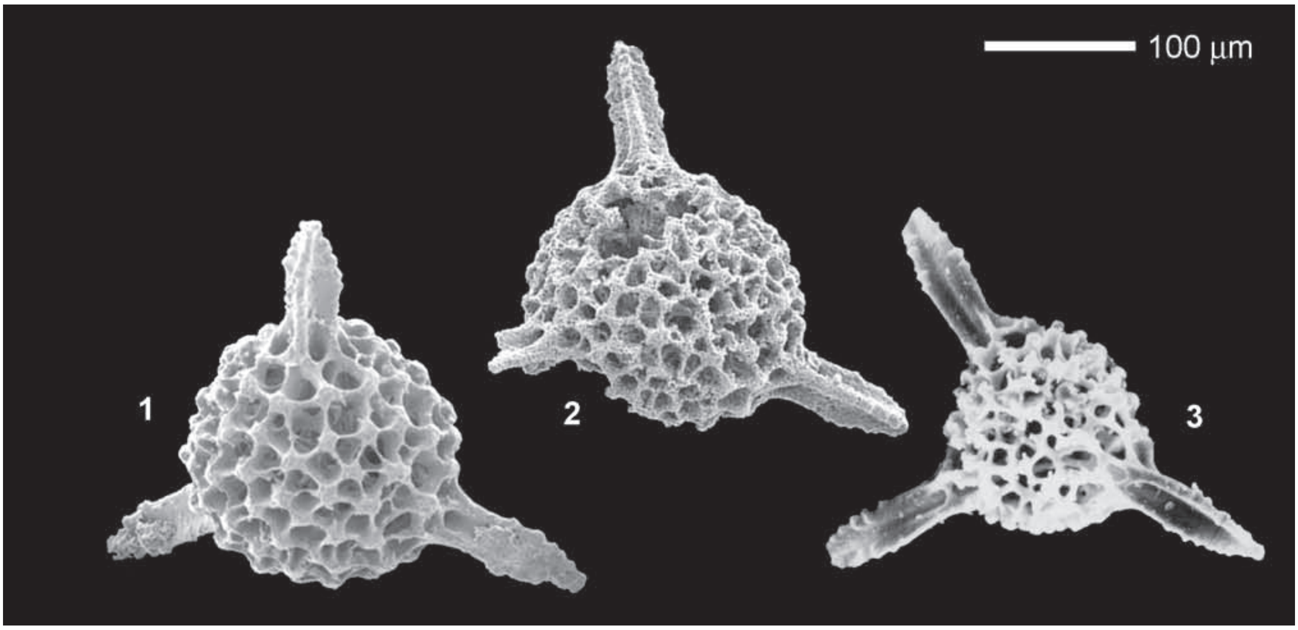


Plate CHA08. ***Charlottea*** **sp. B.** Magnification x200. **Fig. 1.** QCI, GSC loc. 304281, GSC 128740**. Fig. 2.** QCI, GSC loc. 305417, GSC 128741. **Fig. 3.** BCS, SH-412-14.

Charlottea sp. C

Species code: CHA11

***Remarks*:** Cortical shell subtriangular in shape, multilayered. Outer layer composed of densely packed triangular pore frames with large highly raised nodes at vertices. Spines short, thin and circular in axial section. Internal structure unknown.

***Occurrence*:** Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Fernie Formation, northeastern British Columbia.

Charlottea? sp. Y

Species code: XNM01

Synonymy:

1988 *Tripocyclia* (?) sp. A – Carter et al., p. 27, pl. 1, fig. 4.

Remarks: Large shell with three long straight spines. Shell thick, comprised of several layers of latticed pore frames; outer layer made up of medium-sized, irregularly shaped and arranged pore frames (mostly triangular, tetragonal and pentagonal); pore frames with small rounded nodes at vertices. Spines very long, usually broken; spines triradiate with wide rounded ridges and narrow deep grooves. Spines prolonged internally to the edges of a small microsphere.

This species is questionably assigned to *Charlottea* because pore frames on the thick-walled outer shell are smaller, more irregularly arranged, and lack the typical triangular pattern of *Charlottea*. Further study of the inner structure is needed to confirm genus identity.

Occurrence: Fannin Formation, Queen Charlotte Islands.

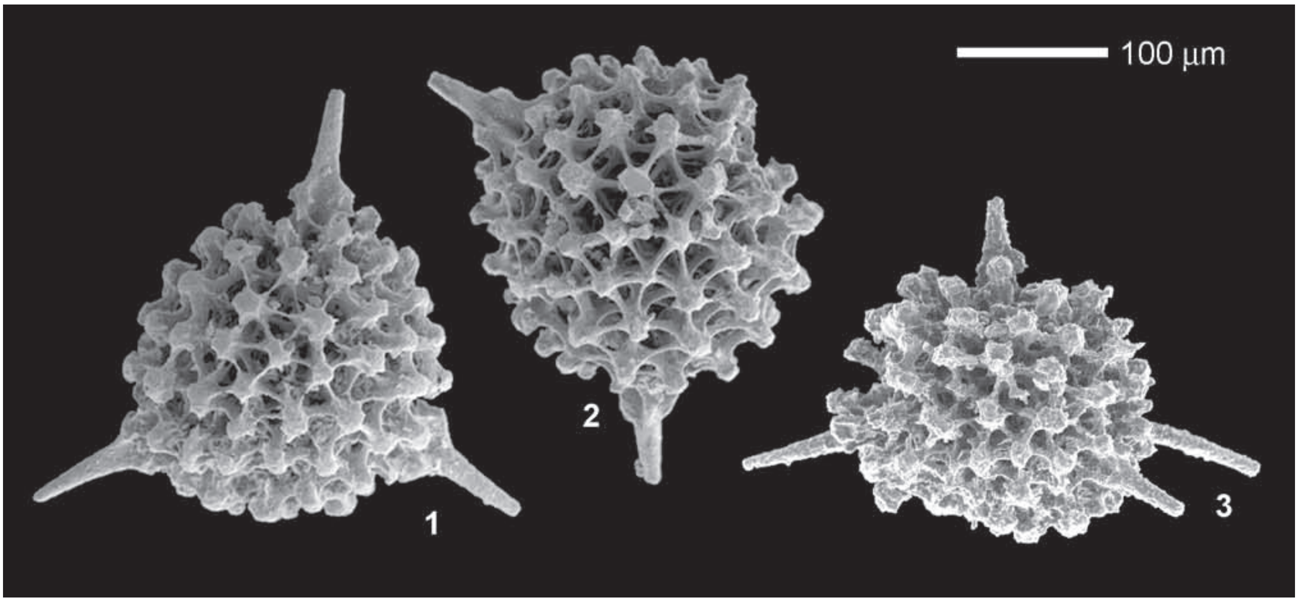


Plate CHA11 ***Charlottea*** **sp. C.** Magnification x200. **Fig. 1.** QCI, GSC loc. C-304566, GSC 111791. **Fig. 2.** QCI, GSC loc. C-304566-, GSC 111792. **Fig. 3.** NBC, GSC loc. C-305208, GSC 111793.

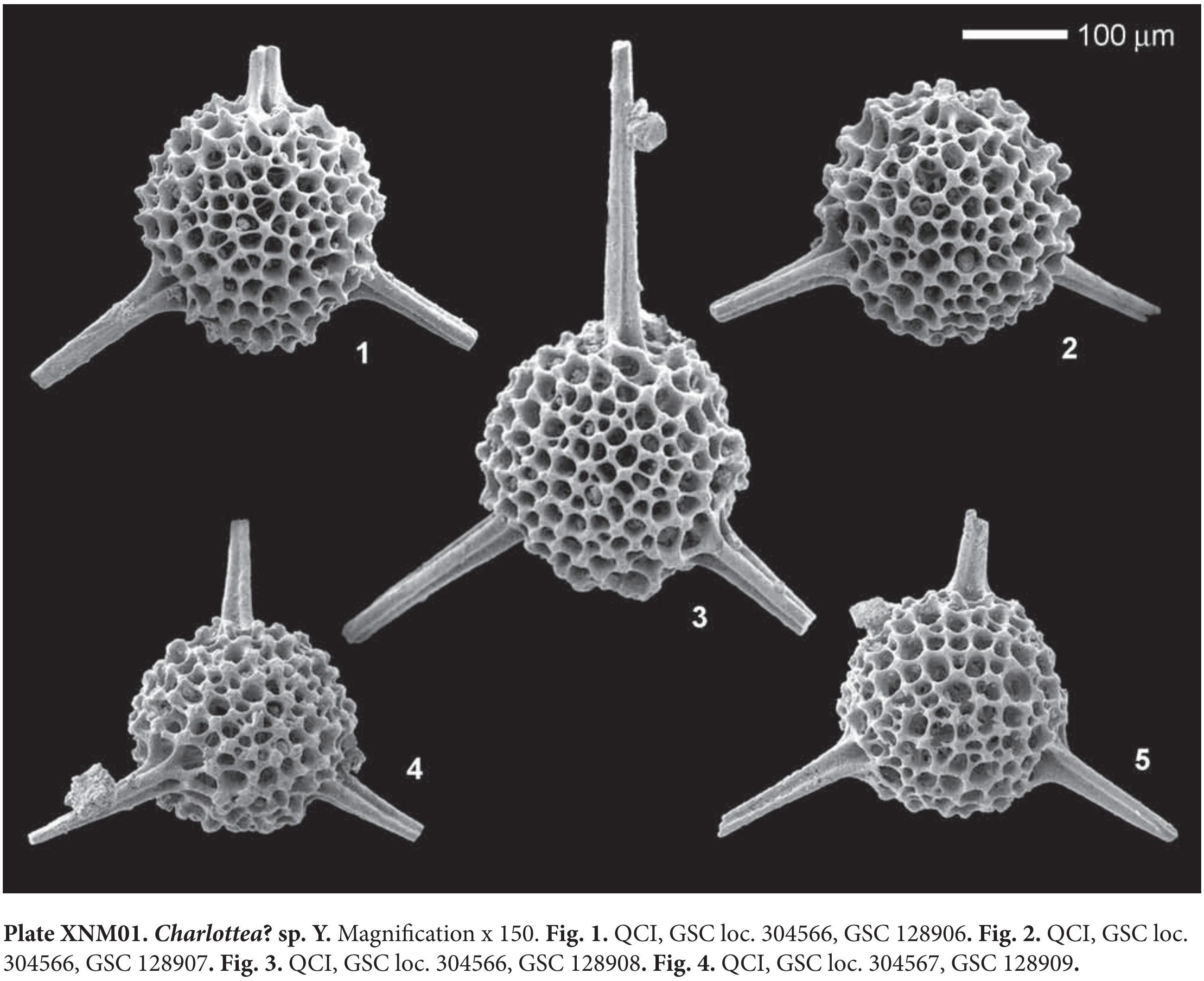


Plate XNM01. ***Charlottea*****? sp. Y.** Magnification x 150. **Fig. 1.** QCI, GSC loc. 304566, GSC 128906**. Fig. 2.** QCI, GSC loc. 304566, GSC 128907**. Fig. 3.** QCI, GSC loc. 304566, GSC 128908**. Fig. 4.** QCI, GSC loc. 304567, GSC 128909**.**
Fig. 5. QCI, GSC loc. 304566, GSC 128910**.**

Genus: *Citriduma* De Wever 1982a

Type species: *Citriduma radiotuba* De Wever 1982a

Synonymy:

1982a *Citriduma* n. gen – De Wever, p. 202.

Original description: Neosciadiocapsidae with a cephalic structure including 8 spines (A, V, D, MB, L_r, L_l, l_r and l_l). Location of cephalis on one side distinguishes the upper and a lower face. Cephalis hemispherical, with an apical horn and a lateral horn, respectively outgrowing from A and V spines of the cephalic skeleton. Thorax, closed in the lower part giving a discoidal shape to this genus; thorax bears lateral tubes.

Etymology: Anagram of P. Dumitrica (Bucarest), in honor to his meticulous work upon Mesozoic radiolarians.

Included species:

4033 *Citriduma hexaptera* (Conti & Marcucci) 1991

CIT05 *Citriduma radiotuba* De Wever 1982a

Citriduma hexaptera (Conti & Marcucci) 1991

Species code: 4033

Synonymy:

1987 Gn. sp. indet. – Hattori, pl. 23, figs. 18.

? 1989 Gen. sp. indet. – Hattori, pl. 17, fig. L.

1991 *Podocapsa* (?) *hexaptera* n. sp. – Conti and Marcucci, p. 803, pl. 3, figs. 12, 13, 14, 16, 17, 18.

1992 Unnamed 6-rayed livarellids – Yeh, pl. 3, fig. 6.

1995a *Podocapsa* (?) *hexaptera* Conti & Marcucci – Baumgartner et al., p. 428, pl. 4033, figs. 1-5.

1997 *Citriduma* sp. A – Yao, pl. 12, fig. 558.

2003 *Citriduma hexaptera* (Conti & Marcucci) – Goričan et al., p. 297, pl. 5, fig. 4.

2004 *Citriduma hexaptera* (Conti & Marcucci) – Matsuoka, fig. 128.

Original description: The shell shows two distinct parts: a hemispherical small proximal part without apparent segmental division but possibly including cephalis and thorax, and a large and flat abdomen with six porous wings, lacking a terminal tube. None of the available specimens show a horn on the proximal part referable to cephalis. The proximal part presents loosely scattered pores smaller than those of the abdomen and wings. The abdomen shows circular uniformly distributed pores. Six conical wings are seated along the equatorial zone of the abdomen: they show pores similar to those of abdomen.

Original remarks: This species differs from *P. amphitreptera* in the flat rather than globose shape of the distalmost segment, in having six equatorial wings and lacking a terminal tube. Its tentative assignment to genus *Podocapsa* is based on the presence of porous wings and of a broad distalmost segment.

Further remarks: By Goričan et al. (2003): *Citriduma hexaptera* differs from the Rhaetian *Citriduma asteroides* Carter, 1993 and *Citriduma* sp. C (Carter, 1993) by having a constant number of tubes (always six), longer tubes and smaller pores.

Measurements (μm):

Based on 5 specimens.

	Min.	Max.	HT
Length wings	90	160	100
Width wings	30	50	35
Diameter abdomen	125	200	135

Etymology: Greek, *hexa* = six plus *pteron* = wing.

Type locality: Ponte di Lagoscuro, Liguria, Italy.

Occurrence: Liguria, Italy; Skrile Formation, Slovenia; Japan; Warm Springs member of the Snowshoe Formation, Oregon; Tawi Sadh Member of the Guwayza Formation, Oman.

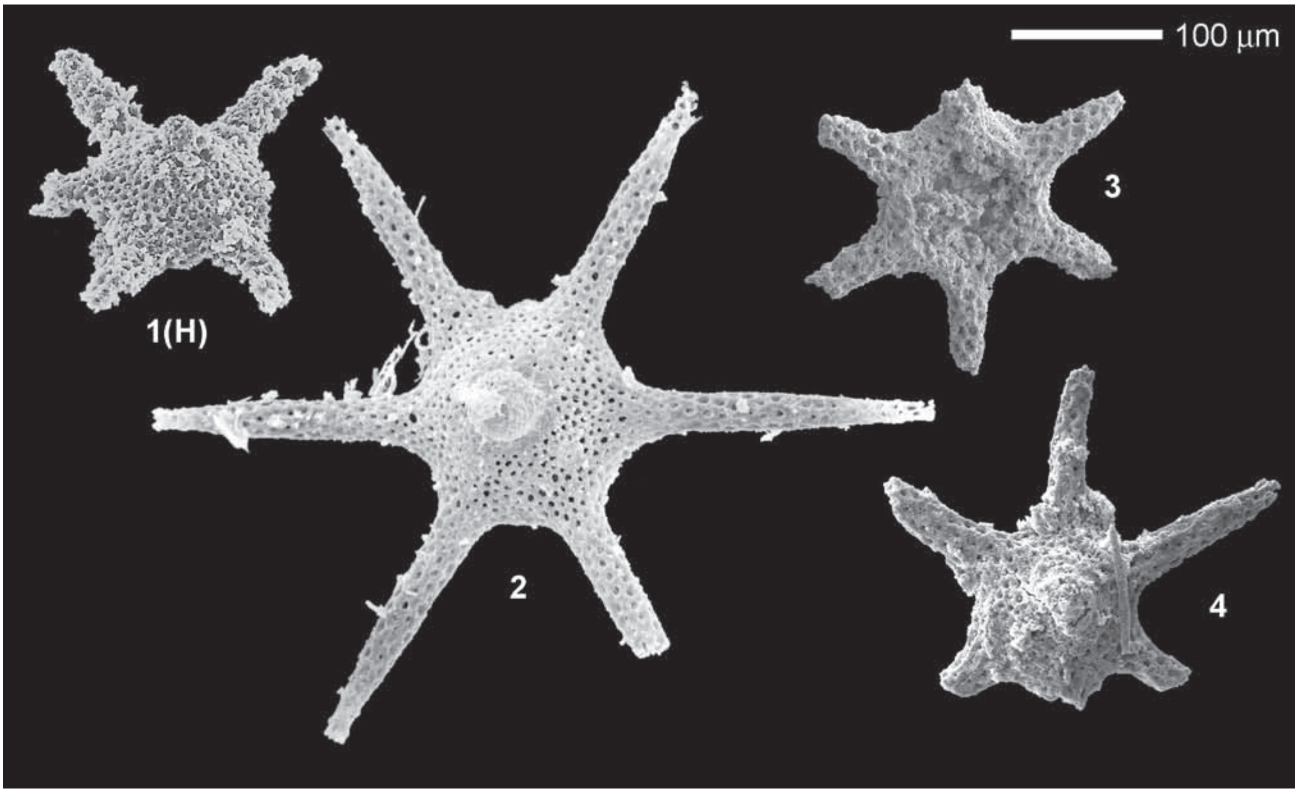


Plate 4033. *Citriduma hexaptera* (Conti & Marcucci). Magnification x200. **Fig. 1(H).** Conti & Marcucci 1991, pl. 3, fig. 12. **Fig. 2.** Matsuoka 2004, fig. 128. **Fig. 3.** OM, BR706-R12-16. **Fig. 4**. Goričan et al. 2003, pl. 5, fig. 4.

Citriduma radiotuba De Wever 1982a

Species code: CIT05

Synonymy:

1982a *Citriduma radiotuba* n. sp. – De Wever, p. 202, pl. 8, figs. 10-11; pl. 9, figs. 1-8.

1982b *Citriduma radiotuba* De Wever – De Wever, p. 285, pl. 39, figs. 1-5; pl. 40, figs. 1-7.

Original description: Discoidal dicyrtid fringed by numerous radial tubes. Location of cephalis on one side distinguishes the upper and a lower face. Cephalis hemispherical with an apical horn and a lateral horn, respectively outgrowing from A and V spines of the cephalic skeleton. Cephalis imperforate, covered with numerous spiny irregularities.

Thorax forms the largest part of the test. It is a biconvex disc laterally extended by twelve to twenty tubes. These tubes are situated on prolongation of ridges which originate at the base of the cephalis and may sometimes protrude outside the tubes (Pl. 9, fig. 3). Tubes are distally narrower and terminally closed, ending in a point.

One specimen shows, on the upper side of the disc near the cephalis and under the lateral spine, a horizontal opening whose significance is unknown. Near the cephalis, the thoracic wall is made of two latticed layers, closely linked by small pillars. Distally, these two latticed layers are interconnected and constitute a two-layered wall.

Interior of thorax hollow in the center but pillars exist between the upper and the lower face laterally. These pillars are in line with the radial ridges that are visible outside and inside the test.

Cephalis has spines typical of nassellarians; A and V extend outside as horns. D, L_l, L_r, l_l and l_r extended peripherally.

Measurements (μm):

Based on 6 specimens.

Width of thorax including tubes	Width of thorax without tubes	
609	418	HT
609	418	Max.
333	233	Min.
468	307	Mean

Etymology: From the Latin *radiare* = to radiate, and *tuba, -ae* = tube, pipe.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Fannin Formation, Queen Charlotte Islands.

Genus: *Crubus* Yeh 1987b

Type species: *Crubus chengi* Yeh 1987b (subsequent designation by Carter, in Carter et al., 1988)

Synonymy:

1987b *Crubus* n. gen – Yeh, p. 69.

1988 *Crubus* Yeh – Carter et al., p. 53.

Original description: Test as with family, conical to subcylindrical, with constrictions between joints. Cephalis conical, with horn. Cephalis and thorax usually sparsely perforate, covered with layer of microgranular silica. Outer layer of abdomen and first one or two post-abdominal chambers covered with small irregular polygonal pore frames, remaining chambers with costae superimposed between each row of pore frames.

Original remarks: *Crubus*, n. gen., differs from *Drulantus*, n. gen., by having a horn, and by having a lobated test with outer layer of test wall comprised of small irregular polygonal pore frames on the apical portion of the test.

Further remarks: By Carter et al. (1988): Yeh (1987) designated *Crubus robustus* Yeh, 1987 as the type species of the genus *Crubus*. However, in the original description of this species and in all Yeh's subsequent references to this taxon, the binominal name appears as *Crubus* (?) *robustus*. In the original description Yeh states »this species is questionably assigned to *Crubus* n. gen. because it lacks a horn«. Querying generic assignment of a type species invalidates that species as type (see Article 67C, ICZN, 1985). A new type species is herein designated that more clearly conforms to the generic description and is better documented.

Included species:

CRB01 *Crubus chengi* Yeh 1987b

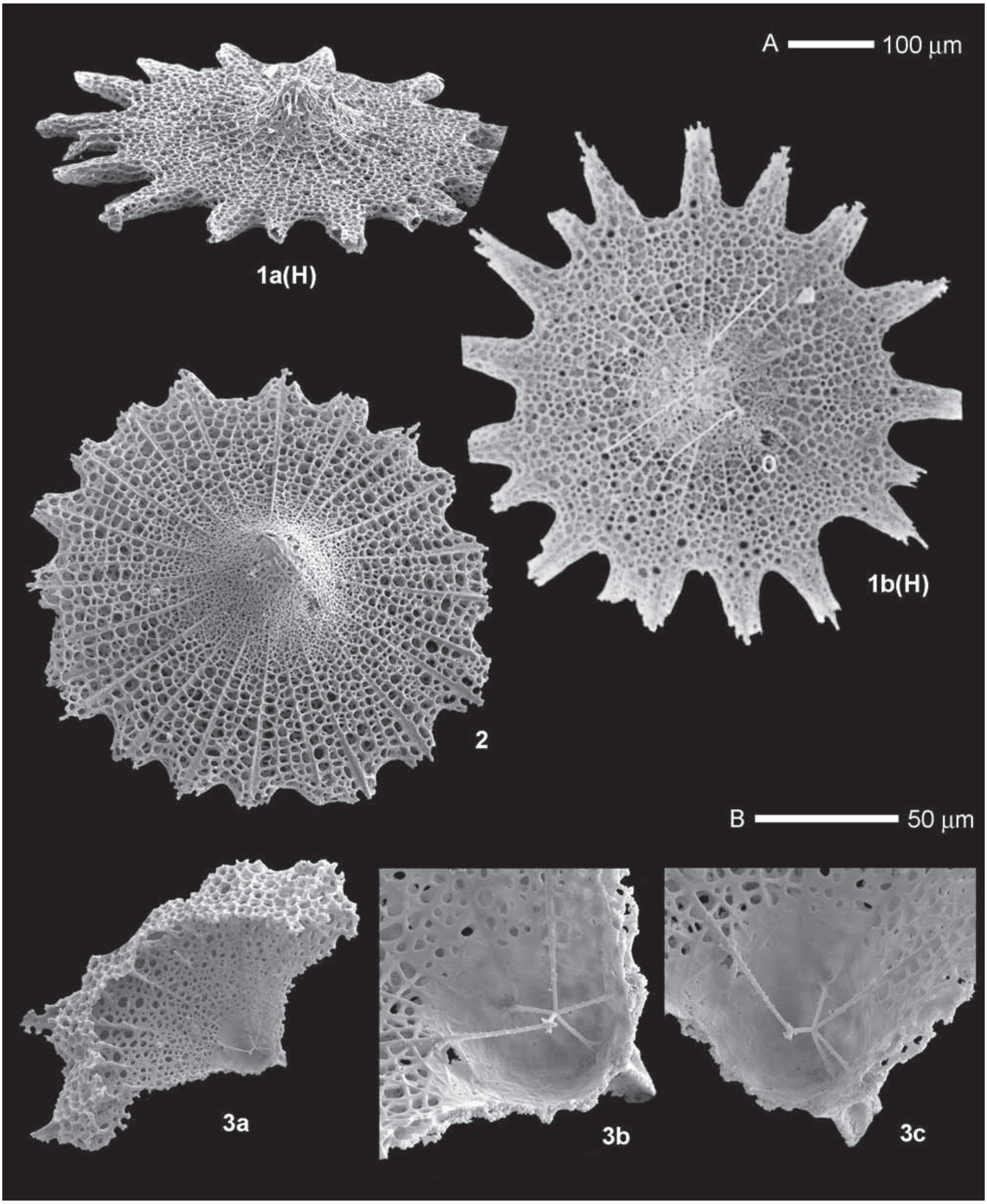


Plate CIT05. ***Citriduma radiotuba*** **De Wever.** Magnification x150 (scale bar A) except Figs. 3b-3c x500 (scale bar B). **Fig. 1(H)a,b.** De Wever 1982a, pl. 9, figs. 1, 3. **Fig. 2.** TR, 1662D-R02-05. **Fig. 3a,b,c.** TR, 1662D-R02-05.

Crubus chengi Yeh 1987b
Species code: CRB01

Synonymy:
1987b *Crubus chengi* n. sp. – Yeh, p. 69, pl. 18, figs. 13-15, 19-20, 24; pl. 19, figs. 7, 15.
1987b *Crubus firmus* n. sp. – Yeh, p. 69, pl. 18, figs. 12, 18.
1987b *Crubus* (?) *robustus* n. sp. – Yeh, p. 70, pl. 3, fig. 18; pl. 18, figs. 9, 10, 22.
1987b *Crubus* sp. A – Yeh, p. 70, pl. 18, figs. 11, 17.

Original description: Test wide, subcylindrical, usually with eight to ten post-abdominal chambers. Cephalis conical, with short massive rudimentary horn and covered with layer of microgranular silca. Thorax to second post-abdominal chambers covered by layer of massive, irregular polygonal pore frames. Costae moderately thick, about ten to twelve visible laterally.

Original remarks: *Crubus chengi* Yeh, n. sp., differs from *C.*(?) *robustus*, n. sp., by having a long, massive horn, and having a test with apical portion more pointed in nature. *Crubus chengi*, n. sp., differs from *C. firmus*, n. sp., by having a more cylindrical test with more massive horn on a smaller cephalis.

Further remarks: We consider that *Crubus chengi*, *C.*? *robustus*, *C. firmus*, and *C.* sp. A represent variation in a single species.

Measurements (μm):
Ten specimens measured.

	Length (max.)	Width (max.)
HT	287	143
Mean	280	140
Max.	287	143
Min.	272	130

Etymology: This species is named for Dr. Yen-Nien Cheng for his help on this project.

Type locality: Sample OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, Oregon; Fannin Formation, Queen Charlotte Islands.

Genus: ***Crucella*** Pessagno 1971
Type species: *Crucella messinae* Pessagno 1971

Synonymy:
1971 *Crucella* n. gen. – Pessagno, p. 52.

Original description: Test as with subfamily. Four rays, elliptical to rectangular in cross-section with polygonal meshwork arranged linearly to sublinearly; rays equal in length; tapering distally; terminating in centrally placed spines. Central area with polygonal (often triangular) meshwork; sometimes with a lacuna, with or without patagium.

Original remarks: *Crucella* n. gen., differs from *Hagiastrum* Haeckel (1) by possessing rays of nearly equal length; (2) by possessing rays with tapered rather than bulbous tips; and (3) by having prominent spine at the tip of each ray.

Etymology: From the Latin *crux* = cross.

Included species and subspecies:
CRU21 *Crucella angulosa* s.l. Carter 1988
CRU11 *Crucella angulosa angulosa* Carter 1988
CRU12 *Crucella angulosa longibrachiata* Carter n. ssp.
PDC02 *Crucella beata* (Yeh) 1987b
CRU22 *Crucella cavata* s.l. Whalen & Carter 1998
CRU10 *Crucella cavata cavata* Whalen & Carter 1998
CRU20 *Crucella cavata giganticava* Carter n. ssp.
CRU19 *Crucella cavata intermedicava* Carter n. ssp.
PDC05 *Crucella jadeae* Carter & Dumitrica n. sp.
CRU13 *Crucella mijo* De Wever 1981b
CRU14 *Crucella mirabunda* Whalen & Carter 2002
CRU15 *Crucella spongase* De Wever 1981b
CRU16 *Crucella squama* (Kozlova) 1971
3131 *Crucella theokaftensis* Baumgartner 1980

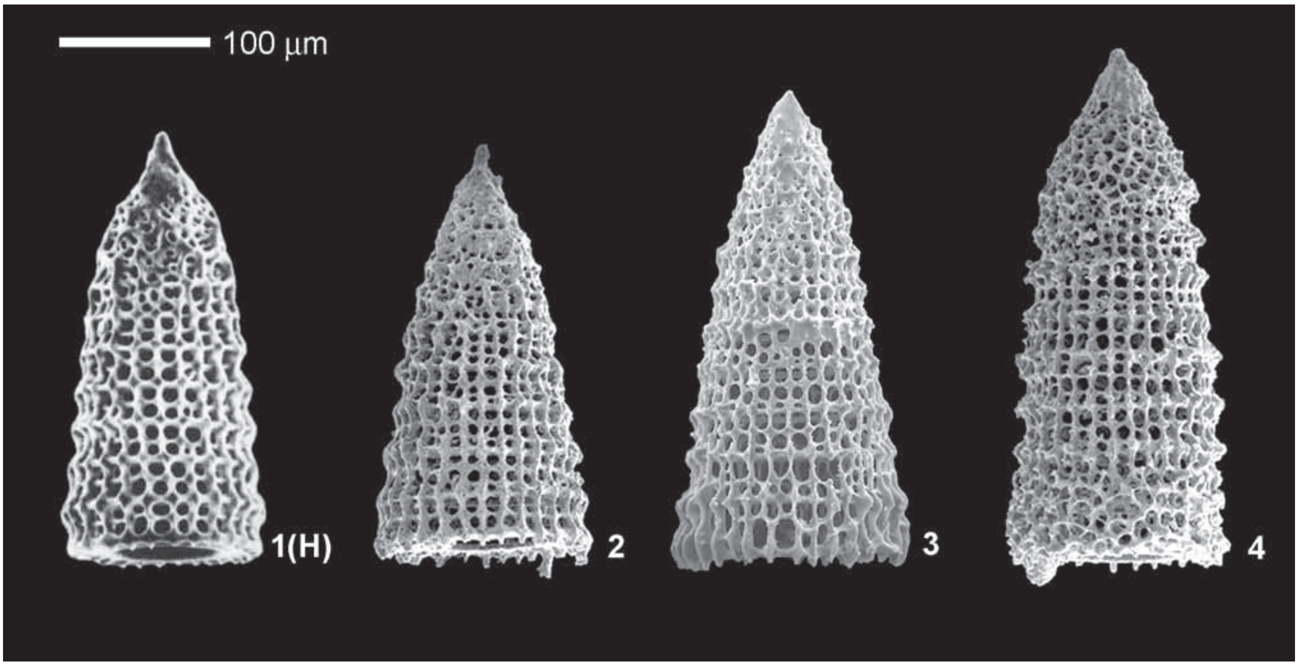


Plate CRB01. ***Crubus chengi*** **Yeh.** Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 18, fig. 15. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128752. **Fig. 3.** QCI, GSC loc. C-304567, GSC 128753. **Fig. 4.** QCI, GSC loc. C-304566, GSC 128754.

***Crucella angulosa* s.l.** Carter 1988
Species code: CRU21

Synonymy:
1988 *Crucella angulosa* Carter n. sp. – Carter et al., p. 43, pl. 4, figs. 11, 12.

See also subspecies.

Included subspecies:
CRU11 *Crucella angulosa angulosa* Carter 1988
CRU12 *Crucella angulosa longibrachiata* Carter n. ssp.

Crucella angulosa angulosa Carter 1988
Species code: CRU11

Synonymy:
1988 *Crucella angulosa* Carter n. sp. – Carter et al., p. 43, pl. 4, fig.11 only.
1998 *Pseudocrucella carpenterensis* n. sp. - Cordey, p. 69, pl. 19, figs. 3, 4.

Original diagnosis: Test cruciform. Rays medium to long and of uniform width, with long sturdy central spines.

Original description: Test cruciform with medium to long rays terminated by long central spines. Rays uniform in width, of more or less equal length, diverging abruptly from the central area. Pore frames irregular in size, shape and arrangement; composed of thin bars with small rounded pores at vertices. Rays rectangular in cross-section. Central spines have (three?) wide, rounded, longitudinal ridges alternating with wide, strong grooves.

Original remarks: This form, although extremely variable in ray length, bears no resemblance to any described species of *Crucella*. Indeed, the longer-rayed forms (e.g., Pl. 4, fig. 12), having finer bars and smaller nodes, may be found to represent another species when additional, better preserved specimens are found.

Measurements (μm):
Based on 10 specimens.

	HT	Av.	Max.	Min.
Length of ray	111	124	191	111
Width of ray	39	51	66	39
Length of longest spine	95	71	119	45

Etymology: Latin, *angulosus* (adj.), full of corners.

Type locality: GSC locality C-080577, Fannin Formation, Maude Island.

Occurrence: Ghost Creek, Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Fernie Formation, Williston Lake, NE British Columbia; Bridge River Complex, British Columbia.

Crucella angulosa longibrachiata Carter n. ssp.
Species code: CRU12

Synonymy:
1988 *Crucella angulosa* Carter n. sp. – Carter et al., p. 43, pl. 4, fig. 12, not fig. 11.

Type designation: Holotype GSC 111717 from GSC loc. C-305208, Fernie Formation (lower Pliensbachian).

Description: Test cruciform with long rays terminated by long central spines. Rays uniform in width, of more or less equal length. Pore frames irregular in size, shape and arrangement; composed of thin bars with small rounded pores at vertices. Rays rectangular in cross-section. Central spines with three wide, rounded, longitudinal ridges alternating with wide, strong grooves.

Remarks: This species differs from *C. angulosa angulosa* in always having much longer arms. *Crucella angulosa* Carter originally consisted of two distinctive morphotypes: one with short arms and one with much longer arms; these are now separated into subspecies.

Measurements (μm):
Based on 9 specimens.

	HT	Max.	Min.	Mean
Length of longest ray	126	158	112.5	136
Max. width of ray tips	65	75	47	59
Length of longest spine	203	214	150	221 (7)

Etymology: From the Latin: *longus, -a, -um* = long, and *brachium, i* = arm; *longibrachiatus, -a,- um* = with long arms; adjective.

Type locality: Sample 00-TD-HALL (GSC loc. C-305208), Fernie Formation, Black Bear ridge, Williston Lake, British Columbia

Occurrence: Fernie Formation, Williston Lake, NE British Columbia; Fannin Formation, Queen Charlotte Islands.

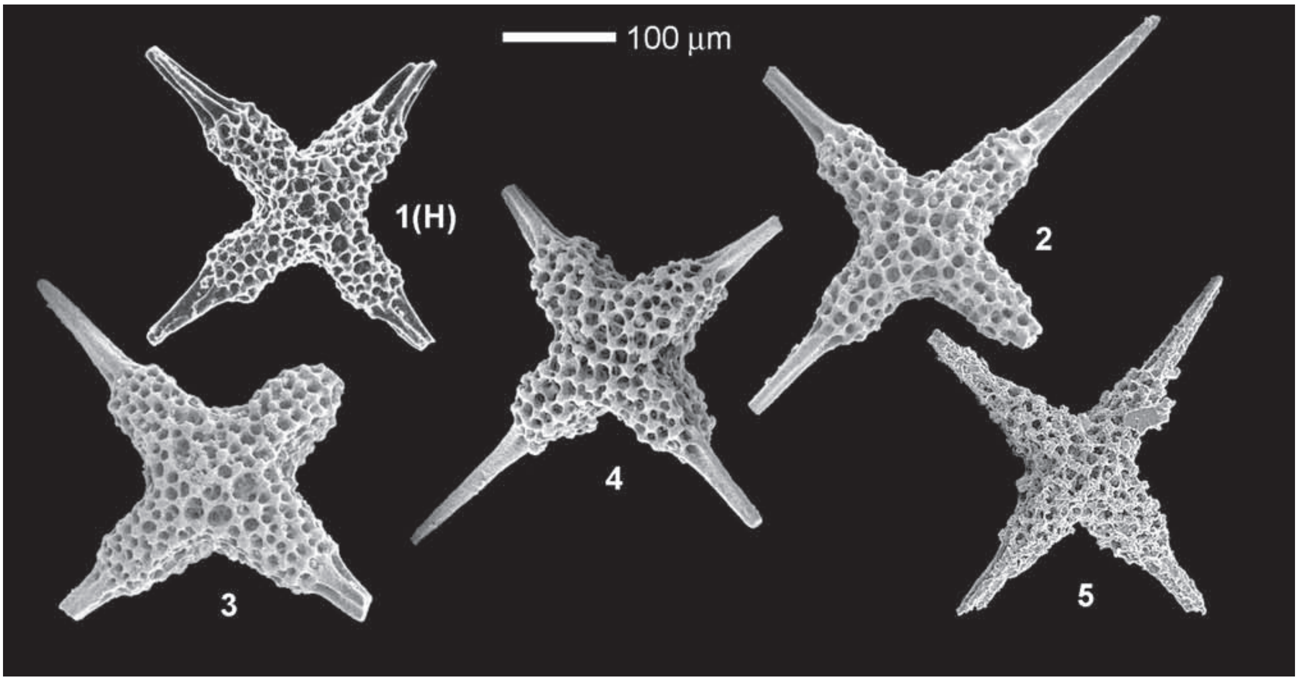


Plate CRU11. ***Crucella angulosa angulosa*** **Carter.** Magnification x150. **Fig. 1(H).** Carter et al. 1988, pl. 4, fig. 11. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128757. **Fig. 3.** QCI, GSC loc. C-080611, GSC 128755. **Fig. 4.** QCI, GSC loc. C-304566, GSC 128756. **Fig. 5.** NBC, GSC loc. C-305208, GSC 128758.

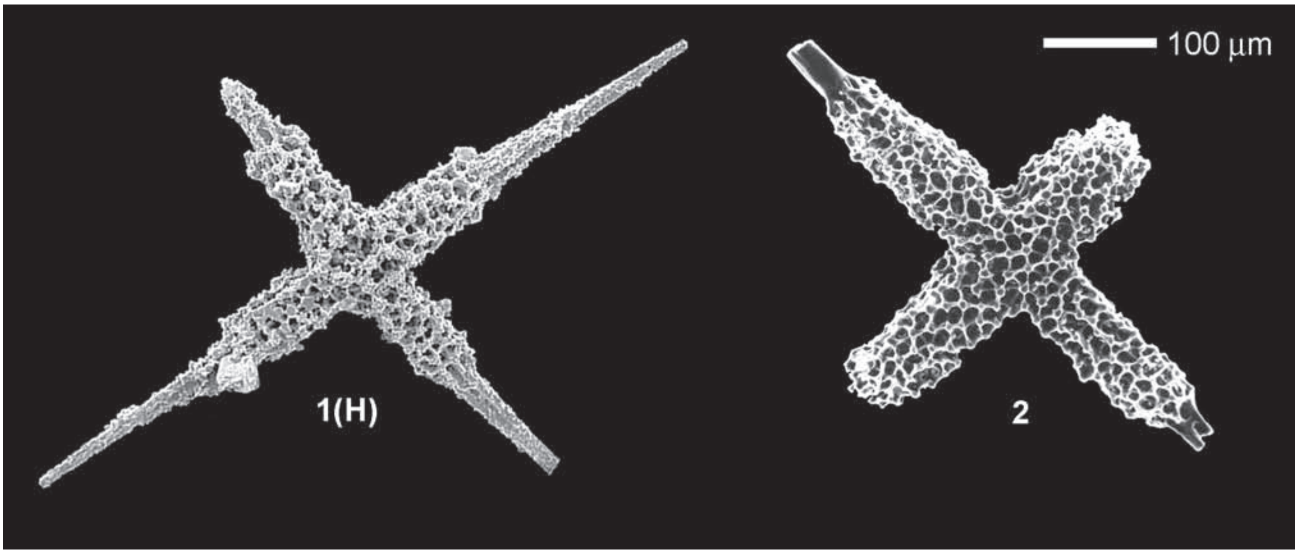


Plate CRU12. ***Crucella angulosa longibrachiata*** **Carter n. ssp.** Magnification x150. **Fig. 1(H).** NBC, GSC loc. C-305208, GSC 111717. **Fig. 2.** Carter et al. 1988, pl. 4, fig. 12.

Crucella beata (Yeh) 1987b

Species code: PDC02

Synonymy:

1987b *Pseudocrucella beata* n. sp. – Yeh, p. 28, pl. 2, figs. 11-12; pl. 23, figs. 10, 25.

Original description: Test thick with four wide rays. Rays subellipsoidal in cross section, medium in length, with five to six external beams and four to five sublinearly arranged rows of rectangular pore frames. Central area large with irregularly arranged subtriangular or rectangular pore frames. Primary spines medium in length, moderately thick, circular in axial section. Test with or without patagium.

Original remarks: *Pseudocrucella beata*, n. sp., differs from *P. jurassica*, n. sp., by having a wider test with rays which are ellipsoidal in axial section and by lacking a central cavity.

Measurements (μm):

Ten specimens measured.

	Length of ray	Width of ray at base	Width of central area	Length of spine
HT	108	84	130	86
Mean	105	82	131	88
Max.	108	84	134	103
Min.	103	80	130	83

Etymology: *Beatus-a-um* (Latin, adj.) = happy.

Type locality: Sample OR-536J, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Fannin Formation, Queen Charlotte Islands.

***Crucella cavata* s.l.** Whalen & Carter 1998

Species code: CRU22

Synonymy:

See subspecies.

Included subspecies:

CRU10 *Crucella cavata cavata* Whalen & Carter 1998
CRU20 *Crucella cavata giganticava* Carter n. ssp.
CRU19 *Crucella cavata intermedicava* Carter n. ssp.

Crucella cavata cavata Whalen & Carter 1998

Species code: CRU10

Synonymy:

1998 *Crucella cavata* n. sp. – Whalen & Carter, p. 49, pl. 12, figs. 15, 18, 19, 21, 22.

Original description: Test with large central area, four short rays expanded distally, each with a moderately long central spine. Rays wide, subrectangular in axial section with upper and lower planiform surfaces. Rays gradually widening to ray tips. Each ray with one long, massive spine, circular in axial section. Rays with irregularly sized and shaped polygonal pore frames with no development of external lineation; small nodes at pore frame vertices. Prominent circular lacuna in central area variable in size with sides sloping towards center.

Original remarks: The distinctive lacuna distinguishes *Crucella cavata* n. sp. from all other species of *Crucella* Pessagno in the Sandilands fauna.

Measurements (μm):

Number of specimens measured = (n)

Length of longest ray (12)	Maximum width of central area (12)	Width of ray tips (Max.) (12)	Length of longest spine (7)	
124	82	97	111	HT
225	82	122	150	Max.
124	54	79	94	Min.
180	69	101	128	Mean

Etymology: *Cavatus, a, um* (Latin; adj.) = hollowed out.

Type locality: Sample 86-OF-KUC-8, Sandilands Formation, north side of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

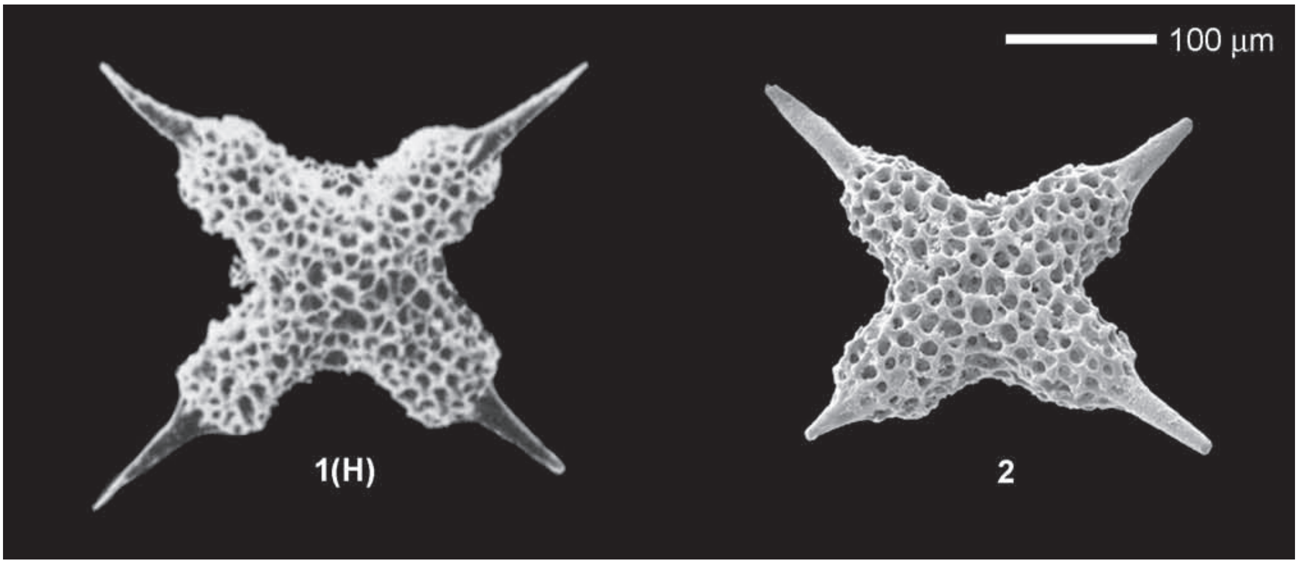


Plate PDC02. *Crucella beata* (Yeh). Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 23, fig. 10. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128759.

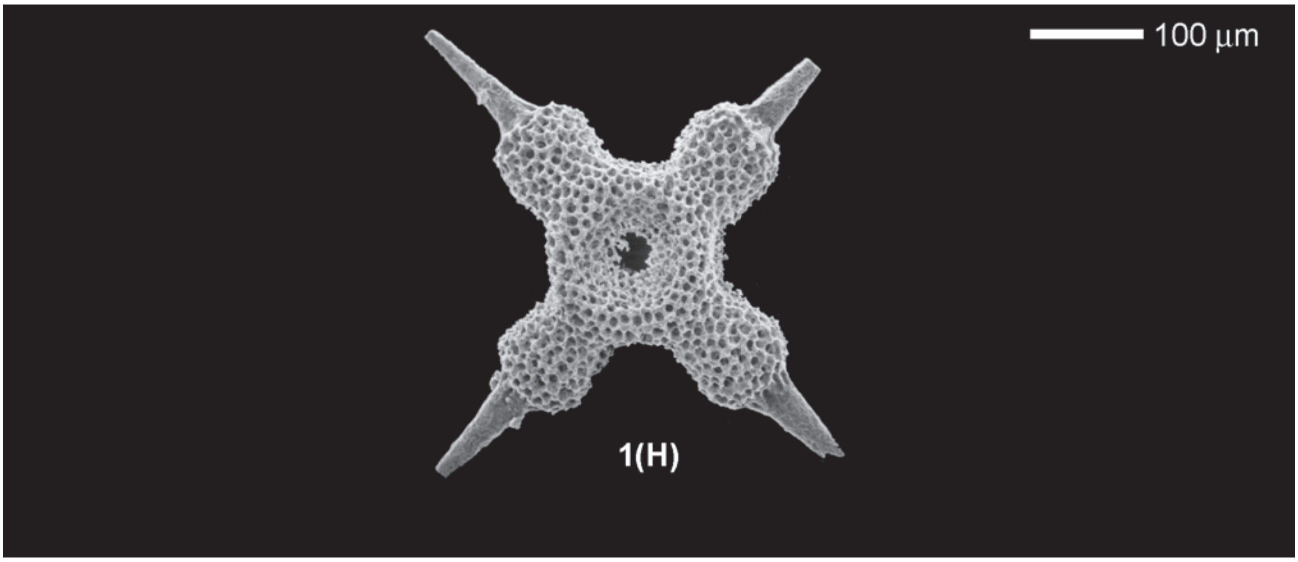


Plate CRU10. *Crucella cavata cavata* Whalen & Carter. Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 12, fig. 15.

Crucella cavata giganticava Carter n. ssp.

Species code: CRU20

Type designation: Holotype GSC 111718 from GSC loc. C-140413; Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

Description: Large cruciform test with massive deep lacuna and a short central spine on each ray tip. Rays wide, subrectangular in axial section, upper and lower surfaces planiform. Rays slightly expanded towards tips; tips rounded, not tapering. Pore frames surrounding and within central lacuna large, mostly triangular in shape with moderately large nodes at vertices; pore frames smaller towards ray tips. Lacuna occupying most the central area of test. Primary spines at ray tips short and rod-like.

Remarks: *Crucella cavata giganticava* n. ssp. differs from *C. cavata cavata* in having much larger, more regularly shaped pore frames with stronger nodes at vertices, and primary spines are smaller. Lacuna in *C. cavata giganticava* n. ssp. larger than in all other subspecies.

Measurements (µm):
Based on 6 specimens.

	HT	Max.	Min.	Mean
Length of longest ray	153	184	111	148
Max. width of ray tips	111	135	80	102
Max. width of central cavity	116	116	56	78
Length of longest spine	broken	111	58	78 (3)

Etymology: From Latin: *giganteus, -a, -um* = giant, gigantic and *cavus, -a, -um* = caved; adjective.

Type locality: North side Cumshewa Inlet, Moresby Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek Formation and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands.

Crucella cavata intermedicava Carter n. ssp.

Species code: CRU19

Type designation: Holotype GSC 128888 from GSC loc. C-080612; Ghost Creek Formation (lower Pliensbachian).

Description: Test with relatively small central area and four moderately long rays each with a strong central spine. Rays constant in width or just slightly expanded distally, subrectangular in axial section with upper and lower surfaces planiform. Each ray with one massive spine (usually broken), triradiate in axial section. Rays with small irregularly arranged pore frames, mostly triangular and tetragonal in shape; small nodes at pore frame vertices. Lacuna in central area variable in size, deep with steep sides.

Remarks: *Crucella cavata intermedicava* Carter n. ssp. differs from *C. cavata cavata* Whalen & Carter in possessing slimmer rays with slightly larger, more regularly arranged pore frames, and spines are triradiate rather than circular in axial section. Differs from *C. cavata giganticava* n. ssp. in having narrower rays, less massive pore frames, and a smaller lacuna.

Measurements (µm):
Based on 7 specimens.

	HT	Max.	Min.	Mean
Length of longest ray	108	168	112	133
Max. width of ray tips	72	72	47	62
Max. width of central area	55	61	37	48

Etymology: From Latin: *intermedius, -a, -um* = intermediate and *cavus, -a, -um* = caved; adjective.

Type locality: Sample CAA-80-T-7, lms. (GSC loc. C-080612), Ghost Creek Formation, Rennell Junction, Yakoun River area, central Graham Island, Queen Charlotte Islands.

Occurrence: Ghost Creek Formation, Queen Charlotte Islands; Musallah Formation, Oman.

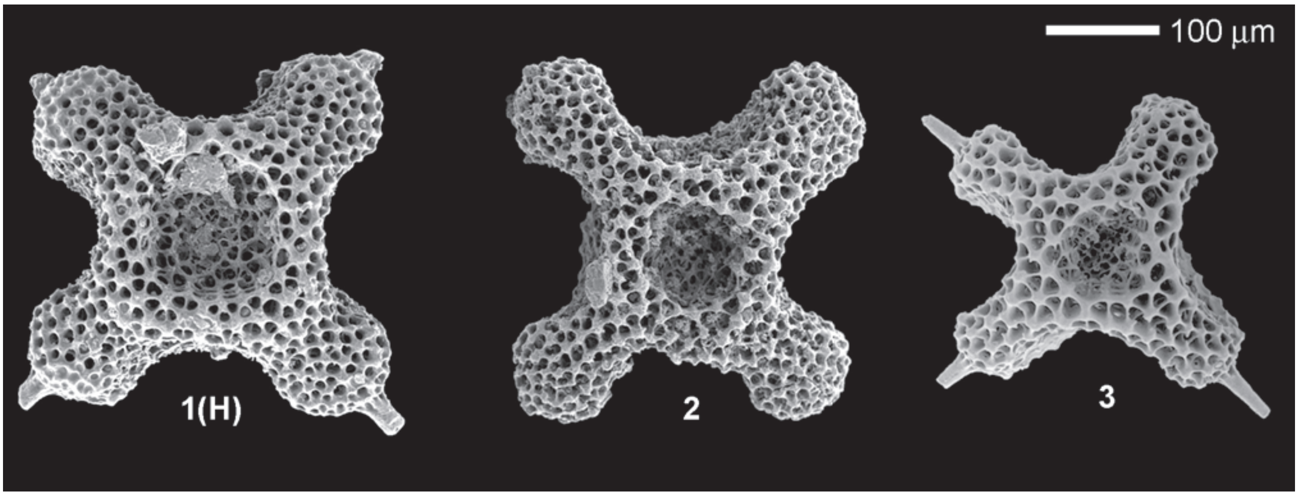


Plate CRU20. ***Crucella cavata giganticava*** **Carter n. ssp.** Magnification x150. **Fig. 1(H).** QCI, GSC loc. C-140413, GSC 111718. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128760. **Fig. 3.** QCI, GSC loc. C-304566, GSC 128761.

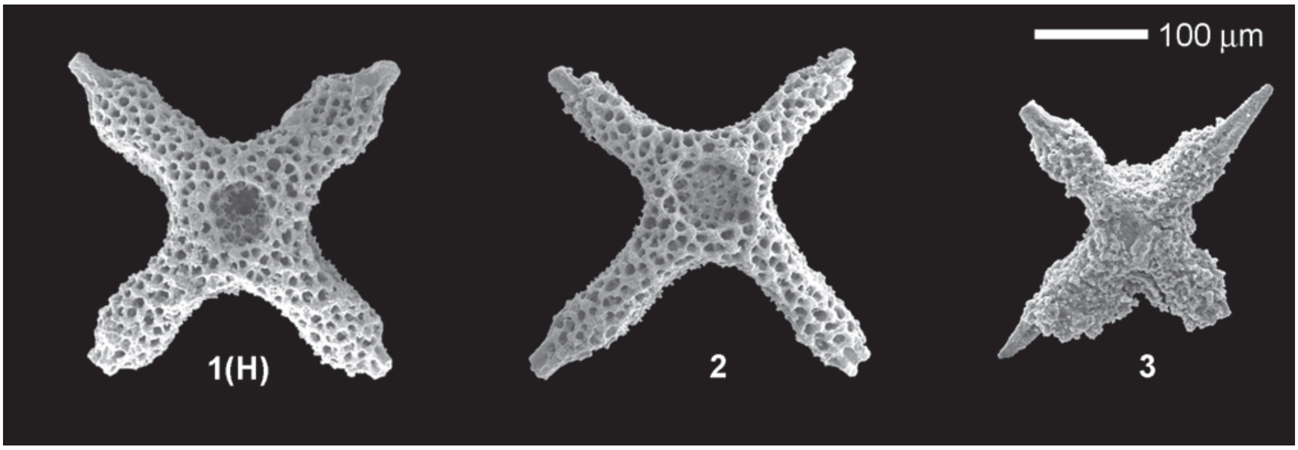


Plate CRU19. ***Crucella cavata intermedicava*** **Carter n. ssp.** Magnification x150. **Fig. 1(H).** QCI, GSC loc. C- 080612, GSC 128888. **Fig. 2.** QCI, GSC loc. C-175311, GSC 128762. **Fig. 3.** OM-00-251, 021518.

Crucella jadeae Carter & Dumitrica n. sp.
Species code: PDC05

Synonymy:
1987b *Pseudocrucella* sp. E – Yeh, p. 30, pl. 2, fig. 18; pl. 3, fig. 14.

Type designation: Holotype, pl. PDC05, fig. 1 (Yeh 1987b, pl. 2, fig. 18); paratype, fig. 2, GSC 128877; Ghost Creek Formation, Queen Charlotte Islands.

Description: Test flat with long and narrow rays; rays increasing very slowly in width distally and terminating in more or less expanded tips. Each ray with a three-bladed, pointed distal spine the length of which is about half the length of ray. Central area flat, small. Surface of rays and central area with small, dense, irregularly arranged pores. Sides of rays vertical to slightly concave.

Remarks: As written by Yeh (1987b) this form differs from *Pseudocrucella magna* Blome (1984b) by having rays with expanded tips and with less massive spines. *Crucella jadeae* is very close to the Sinemurian species *C. kaisunensis* Whalen & Carter but differs in having longer arms and mostly triradiate rather than circular spines.

Measurements (μm):
Based on 6 specimens.

	HT	Max.	Min.	Mean
Length of rays	170-200	390	180	230
Width of rays at base	50	70	50	56
With of rays at tip	70-88	140	68	91

Etymology: The species is named for Kuei-Yu Yeh (Jade) who illustrated the first specimens.

Type locality: OR-536J, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, east-central Oregon; Ghost Creek Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman.

Crucella mijo De Wever 1981b
Species code: CRU13

Synonymy:
1981b *Crucella mijo* n. sp. – De Wever, p. 35, pl. 4, figs. 1, 2.
1982b *Crucella mijo* De Wever – De Wever, p. 253, pl. 28, figs. 1-3.
1996 *Crucella* sp. A – Pujana, p. 136, pl. 1, fig. 14.
2002 *Crucella mijo* De Wever – Suzuki et al., p. 176, fig. 7 C.

Original description: Patulibracchiinae with four wineskin-shaped arms terminating in a spine triradiate in axial-section along its length. Fine spongy network visible, in a relic stage, mainly at base of arms and between them where it is probably more protected. Here and there one or several tiny spines arise radially from this web (Pl. 4, fig. 1). At base of terminal spine on arms, ridges, which separate grooves (corresponding to prolongation of a pore), are carved by secondary grooves. Pores tend to be disposed in an orthogonal network in center, oblique relative to axis of arms, and sometimes slightly aligned on arms. Nodes are often present at intersection of bars on the network.

Original remarks: This species differs from *Crucella messinae* Pessagno (1971, p. 55) by its wineskin-shaped arms and spines triradiate along their length with grooves carved at base. It is distinguished from *C. plana* Pessagno (1971, p. 56) and *C. espartoensis* Pessagno (1971, p. 54) which have different pores, less visible nodes and primary spines rounded in cross-section; from *C. irwini* Pessagno (1971, p. 55) by the shape of the arms. *Stauralastrum euganeum* Squinabol (1903, p. 123) has a more massive shape and does not show aligned pores.

Measurements (μm):
Based on 8 specimens.

	Av.	Min.	Max.	HT
Overall length (2 arms + center, without spines)	366	350	380	380
Maximal width of arm	100	85	116	110
Diagonal of central part	115	85	140	85

Length of terminal spines sometimes reach 115 μm, as on holotype.

Etymology: Arbitrary combination of letters (ICZN, Append. D, V, 26)

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Rennell Junction member of the Fannin Formation; Fernie Formation, NE British Columbia; Sierra Chacaicó Formation, Argentina; Pucara Group, Peru.

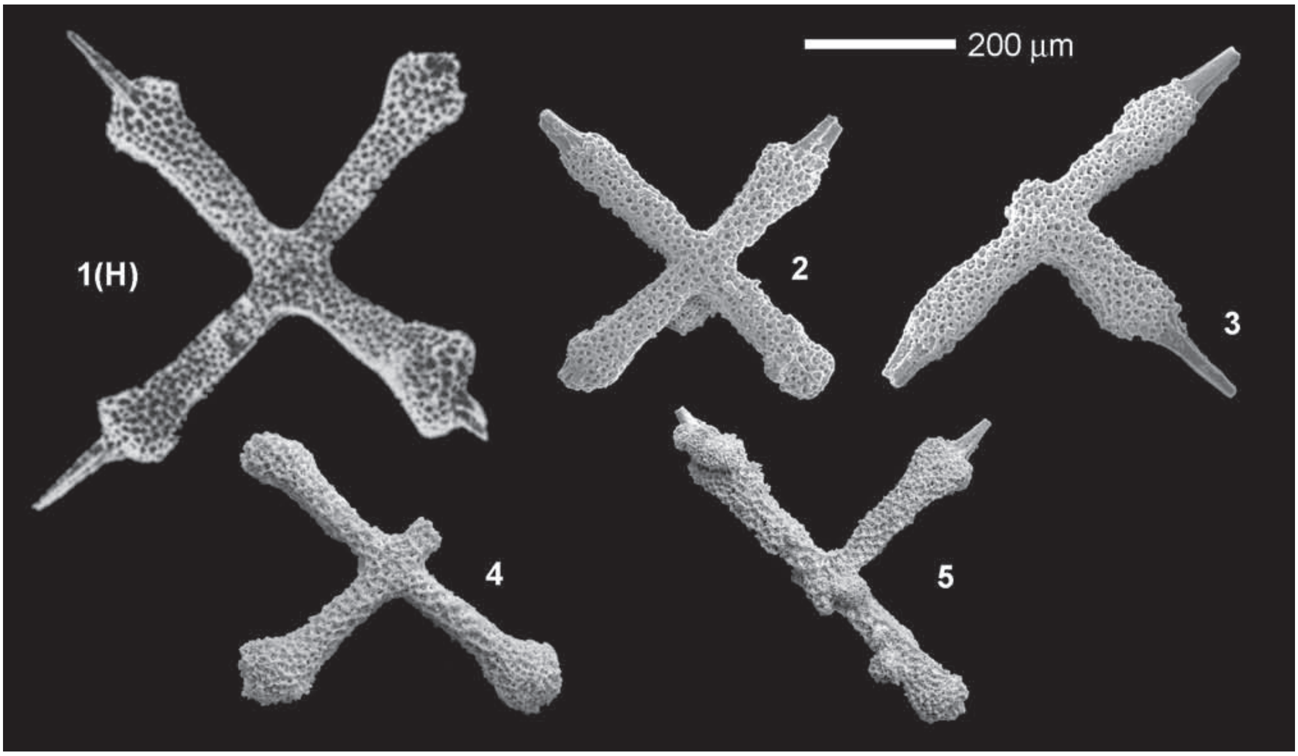


Plate PDC05. ***Crucella jadeae*** **Carter & Dumitrica n. sp.** Magnification x100. **Fig. 1(H).** Yeh 1987b, pl. 2, fig. 18. **Fig. 2.** QCI, GSC loc. C-305388, GSC 128877. **Fig. 3.** QCI, GSC loc. C-305386, GSC 111807. **Fig. 4**. OM, BR524-R04-07. **Fig. 5.** OM, BR523-R03-19.

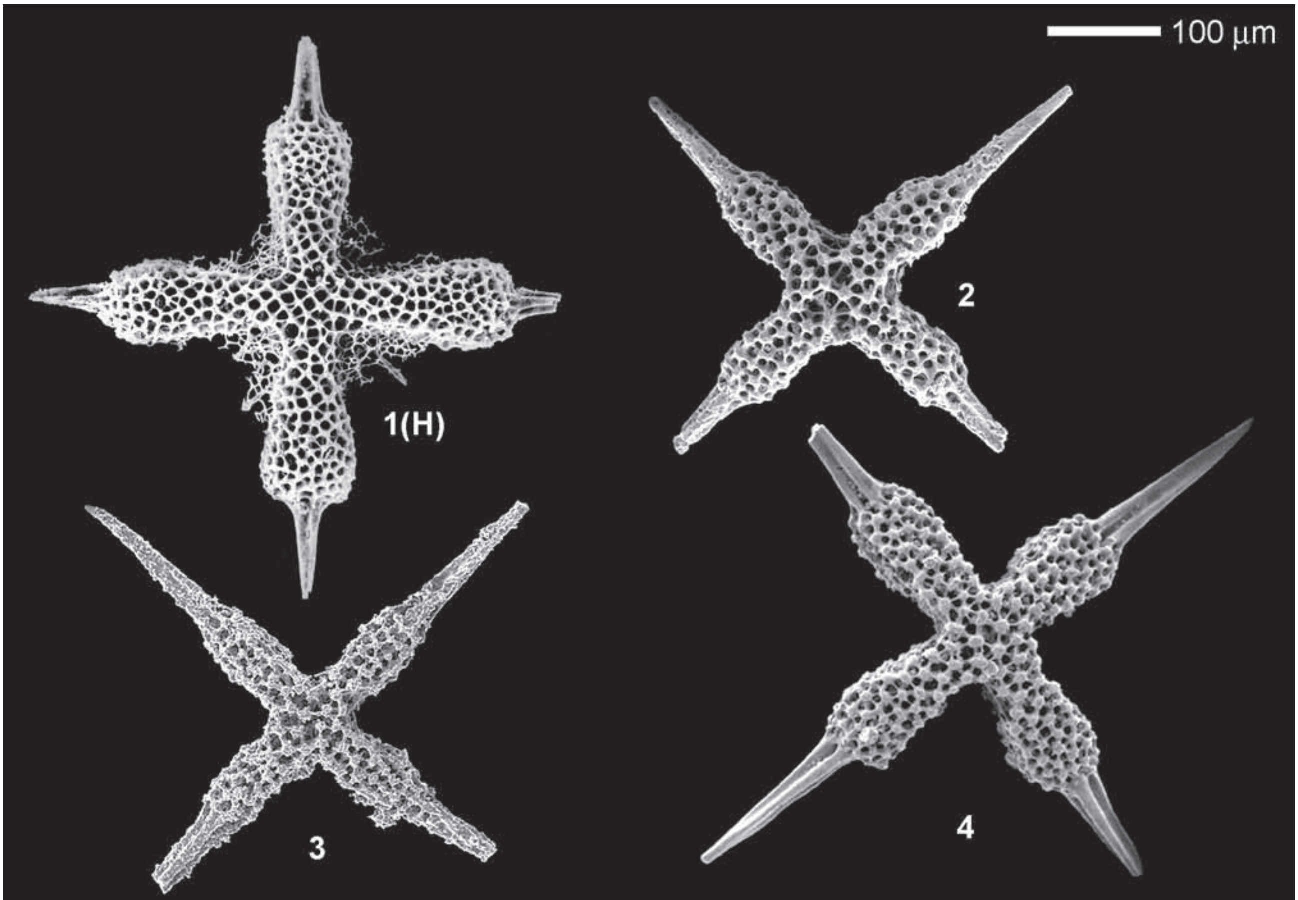


Plate CRU13. ***Crucella mijo*** **De Wever.** Magnification x150. **Fig. 1(H**). De Wever 1981b, pl. 4, fig. 2. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128763. **Fig. 3.** NBC, GSC loc. C-305208, GSC 128764. **Fig. 4.** QCI, GSC loc. C-304566, GSC 128765.

Crucella mirabunda Whalen & Carter 2002

Species code: CRU14

Synonymy:

1987 *Crucella* sp. B - Hattori, pl. 4, fig. 8.
1988 *Pseudocrucella* sp. A – Carter et al., p. 29, pl. 7, figs. 8-9.
2002 *Crucella mirabunda* n. sp. – Whalen & Carter, p. 106, pl. 1, figs. 7, 11; pl. 2, figs. 1, 8.

Original description: Rays with irregularly sized and shaped triangular and tetragonal pore frames with no linear arrangement; pore frames with medium-sized nodes at vertices. Rays subcircular in axial section gradually widening toward distal part of ray. Each ray with one massive spine, triradiate in axial section with broad, rounded longitudinal ridges and narrow longitudinal grooves. Central area broad, flat with no lacuna; pore frames in central area with similar construction and arrangement as rays.

Original remarks: *Crucella mirabunda* n. sp. differs from *C. kaisuensis* Whalen and Carter 1998 by having shorter triradiate spines; it differs from *C. mijo* De Wever 1981b by having shorter, broader rays and more robust spines.

Measurements (μm):
Based on 10 specimens.

Length of ray (Max.)	Length of spine when entire (Max.)	
105	75	HT
120	116	Max.
83	60	Min.
98	88	Mean

Etymology: *Mirabundus, a, um* (Latin, adj.) = full of wonder.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Phantom Creek Formation, Queen Charlotte Islands; Japan.

Crucella spongase De Wever 1981b

Species code: CRU15

Synonymy:

1981 *Crucella* sp. A – Pessagno & Poisson, pl. 2, figs. 6, 8.
1981b *Crucella spongase* n. sp. – De Wever, p. 36, pl. 5, figs. 1-3.
1982b *Crucella spongase* De Wever – De Wever, p. 254, pl. 29, figs. 1-3.

Original description: Patulibracchiinae with four arms orthogonally disposed, each ending in a spine, with a patagium. Arms massive, sometimes bearing very small spines, and covered with a thin spongy network, often residual. Terminal spines triradiate in cross section, but one of them without a 3 part symmetry in cross section. Indeed, one of the basal pores, open in a groove, is much larger than the other two. This large pore suggests a bracchiopyle (Pl. 5, fig. 2).

Arms inflated in center of test, which is flat, and does not show a depressed part (lacuna). Network is looser in center, where pores are triangular, than distally where pores are rectangular. Nodes exist at bar intersections.

Original remarks: This form differs from *Histiastrum valanginica* Aliev (1965) by presence of secondary spines, irregularly arranged pores without alignment, and absence of lacuna.

Measurements (μm):
10 specimens measured.

	HT	Max.	Min.	Mean
Total length of both arms without terminal spines	336	400	297	336
Length of primary spines	59	32	59	47

Etymology: Anagram of E. A. Pessagno Jr. in honor of his pioneer work on Mesozoic Radiolaria.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Dürrnberg Formation, Austria.

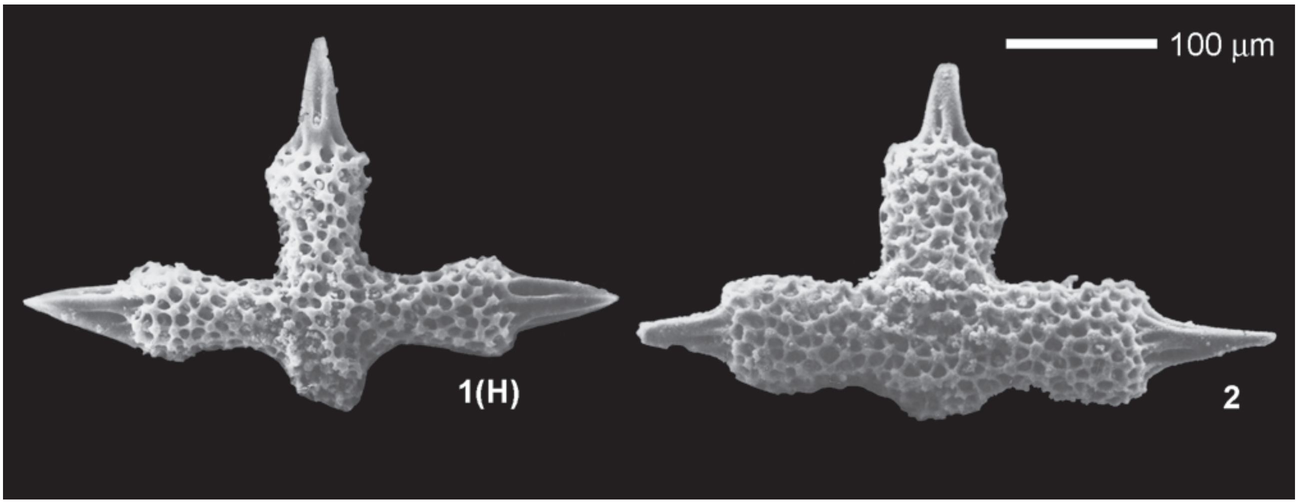


Plate CRU14. ***Crucella mirabunda*** **Whalen & Carter.** Magnification x200. **Fig 1(H).** Whalen & Carter 2002, pl. 1, fig. 7. **Fig. 2.** Whalen & Carter 2002, pl. 2, fig. 1.

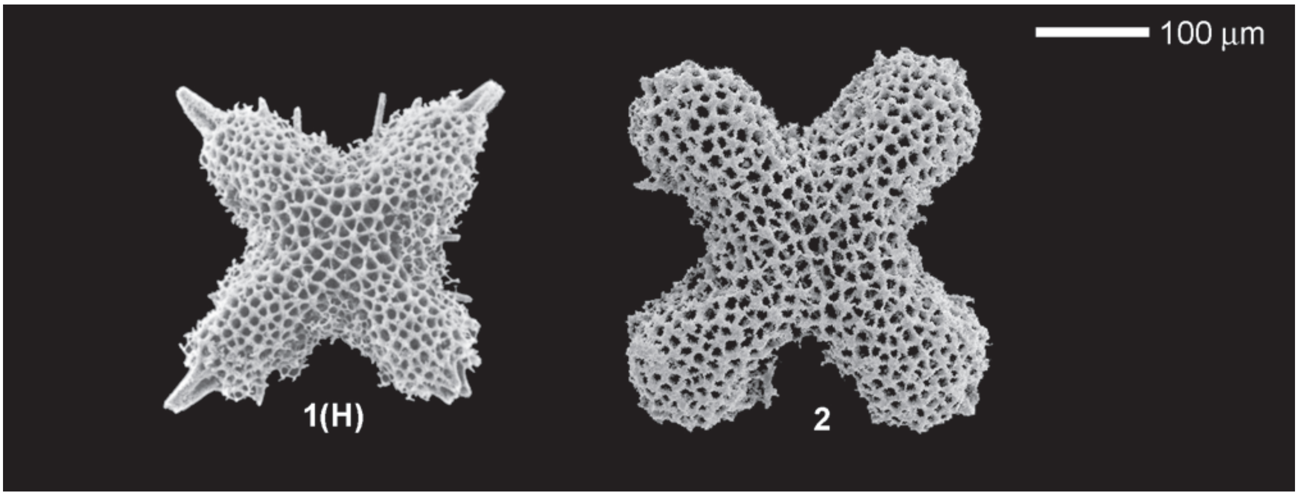


Plate CRU15. ***Crucella spongase*** **De Wever.** Magnification x150. **Fig. 1(H).** De Wever 1981b, pl. 5, fig. 3. **Fig. 2.** AT, BMW-21-24.

Crucella squama (Kozlova) 1971

Species code: CRU16

Synonymy:

1971 *Hagiastrum squama* n. sp. – Kozlova, p. 1175, pl. 1, fig. 10.
1973 *Hagiastrum squama* n. sp. – Kozlova, p. 59, pl. 18, fig. 8.
1981b *Crucella squama* (Kozlova) – De Wever, p. 38, pl. 5, fig. 7.
1982b *Crucella squama* (Kozlova) – De Wever, p. 255, pl. 29, fig. 4.
1988 *Crucella* sp. aff. *C. squama* (Kozlova) – Carter et al., p. 43, pl. 12, figs. 11, 12.
2002 *Crucella squama* (Kozlova) – Whalen & Carter, p. 106, pl. 2, figs. 2, 5.

Original description: Skeleton small, cross-shaped, thick. Four similar, short, triangular arms ending in thick, three-bladed spines. Structure of central part of the disk and arms similar, skeleton consisting of several porous layers that pass in one another. Pores rounded, oval and reniform.

Original remarks: By the outline of skeleton and shape of arms *Hagiastrum squama* Kozlova, sp. nov. is close to *Stauralastrum* (?) sp. Holmes from which it differs only in having less long arms; the comparison with this species is difficult because due to the poor preservation of specimens W. M. Holmes did not describe the structure of skeleton.

Further remarks: *Crucella squama* is very similar to *Crucella beata* (Yeh) but differs from the latter in having three-bladed spines.

Measurements (μm):

	Min.	Max
Length of arms from centre (without spines)	105	120
width of arms at base	75	105
Width of spines at base	-	27
Diameter of pores	6	12

Etymology: *Squama* (Lat.) – scale.

Type locality: Sample Timano-Ural region, Pizhma river, Lower Kimmeridgian Marls.

Occurrence: Timano-Ural region, Russia; Gümüslü Allochthon, Turkey; San Hipólito Formation, Baja California Sur; Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands.

Crucella theokaftensis Baumgartner 1980

Species code: 3131

Synonymy:

1980 *Crucella theokaftensis* n. sp. – Baumgartner, p. 308, pl. 8, figs 19-22; pl. 12, fig. 1.
1982 *Crucella theokaftensis* Baumgartner – Aita, pl. 3, fig. 12.
? 1985 *Crucella theokaftensis* Baumgartner – Nagai, pl. 5, figs. 5, 5a.
1987 *Crucella theokaftensis* Baumgartner – Aita, p. 63, pl. 1, fig. 8; pl. 8, fig. 3.
1987 *Crucella theokaftensis* Baumgartner – Kito, pl. 1, fig. 10.
1989 *Crucella* sp. A – Hattori, pl. 25, fig. G.
1995a *Crucella theokaftensis* Baumgartner – Baumgartner et al., p. 158, pl. 3131, figs. 1-3.
1997 *Crucella theokaftensis* Baumgartner – Hull, p. 20, pl. 4, figs. 6, 12, 14.
2003 *Crucella theokaftensis* Baumgartner – Goričan et al., p. 293, pl. 1, fig. 19.
2004 *Crucella theokaftensis* Baumgartner – Matsuoka, fig. 44.

Original description: Test as with genus, central area inflated subspherical on both sides raised over rays. Rays slender conical tapering into long triradiate spines. Central area with small, irregular pore frames, ray with lengthened pores becoming larger toward the base of the spines, sometimes weakly linearly arranged.

Original remarks: This species is related to *C. messinae* but differs in having an inflated central area with smaller pores and slenderer conical rays. The specimen from the lowest sample of the Argolis Peninsula POB 899 (pl. 8. fig. 19; pl. 12, fig. 1) differs from the topotypic material (POB 986) in having much shorter spines and a smaller test; see measurements.

Measurements (μm):
Based on 7 specimens.

	HT	Av.	Min.	Max.
Length of rays AX	140	119	97	210
Length of rays BX	210	-	-	-
Length of rays CX	200	-	-	-
Length of rays DX	-	-	-	-
Width of rays at base	70	65	50	80
L. longest spine	150	61	50	150

Etymology: Named for the type locality.

Type locality: Locality D of Baumgartner (1980); Argolis Peninsula (Peloponnesus, Greece).

Occurrence: Worldwide.

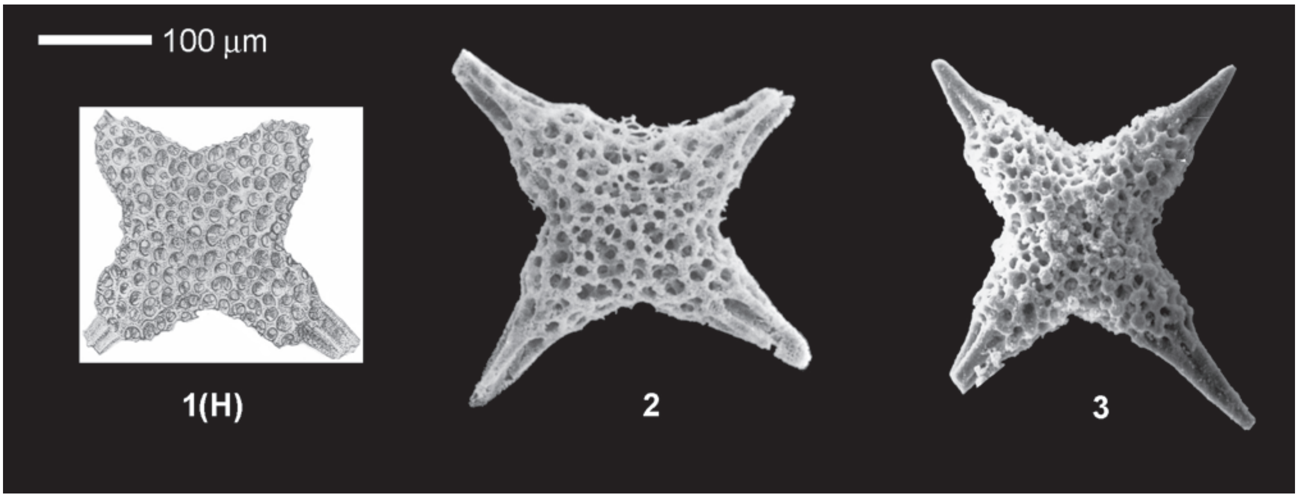


Plate CRU16. *Crucella squama* (Kozlova). Magnification x150. **Fig. 1(H).** Kozlova 1971, pl. 1, fig. 10. **Fig. 2.** De Wever 1981b, pl. 5, fig. 7. **Fig. 3.** Whalen & Carter 2002, pl. 2, fig. 2.

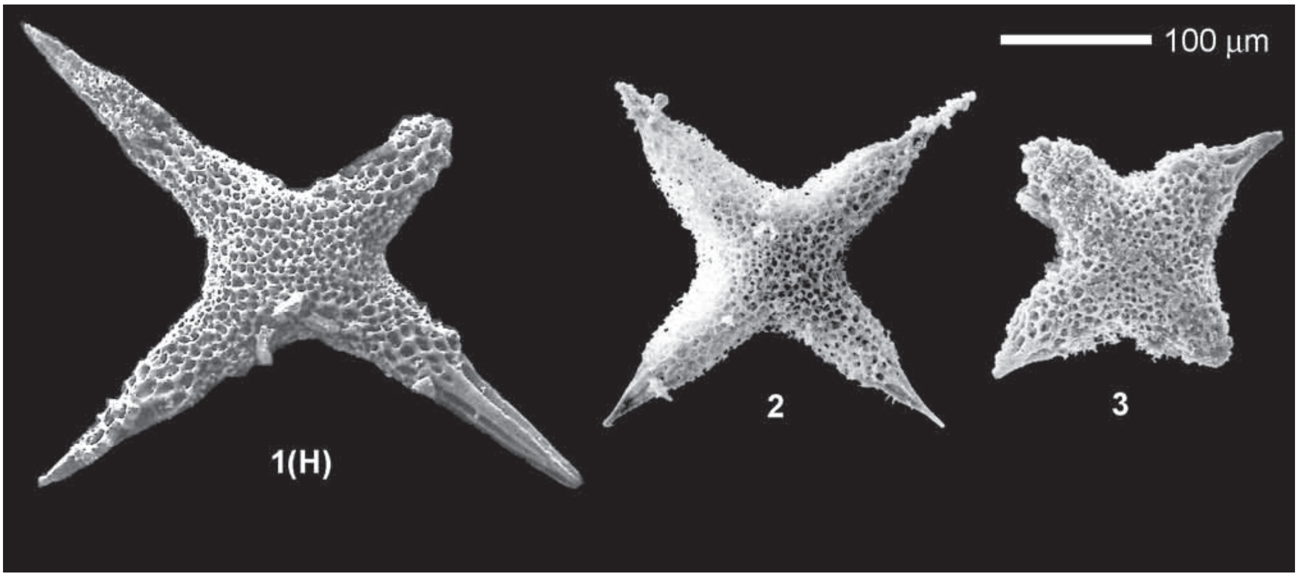


Plate 3131. *Crucella theokaftensis* Baumgartner. Magnification x200. **Fig. 1(H).** Baumgartner 1980, pl. 8, fig. 22. **Fig. 2.** Matsuoka 2004, fig. 44. **Fig. 3.** Goričan et al. 2003, pl. 1, fig. 19.

Genus: *Cyclastrum* Rüst 1898

Type species: *Cyclastrum infundibuliforme* Rüst 1898

Synonymy:
1898 *Cyclastrum* n. gen – Rüst, p. 28.

Original description: Three rays are linked at their distal ends by a band of patagium.

Included species:
CYC01 *Cyclastrum asuncionense* Whalen & Carter 2002
CYC02 *Cyclastrum scammonense* Whalen & Carter 2002
CYC03 *Cyclastrum veracruzense* Whalen & Carter 2002
CYC04 *Cyclastrum* sp. A

Cyclastrum asuncionense Whalen & Carter 2002

Species code: CYC01

Synonymy:
2002 *Cyclastrum asuncionense* n. sp. – Whalen & Carter, p. 110, pl. 4, figs. 8, 9, 14; pl. 17, fig. 1.

Original description: Test subtriangular in outline, margins gently convex between peripheral spines; test thin with rounded edges. Spines medium-sized, slender, triradiate in axial section with rounded, longitudinal ridges, and grooves. Meshwork along triangular margin of test composed of medium sized tetragonal and pentagonal pore frames with no distinctive alignment. Central portion of test depressed, broad, triangular in outline, with three-rayed area defined by smaller, more delicate pore frames than on remainder of test; three-rayed structure raised above central cavity and each ray aligned with peripheral spines.

Original remarks: See remarks under *Cyclastum veracruzense* n. sp. and *Cyclastrum scammonense* n. sp.

Further remarks: The shape of the test, moderately compressed, subtriangular in outline with rounded edges, distinguishes *C. asuncionense* from all other species of *Cyclastrum.*

Measurements (μm):
(n) = number of specimens measured.

Diameter of cortical shell (Max.) (8)	Length of primary spine (Max.) (6)	
236	90	HT
274	90	Max.
225	41	Min.
245	60	Mean

Etymology: This species is named for Punta Asuncion located to the northwest of the type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur.

Cyclastrum scammonense Whalen & Carter 2002

Species code: CYC02

Synonymy:
? 1998 *Orbiculiforma silicatilis* n. sp. – Cordey, p. 93, pl. 21, fig. 7 (not figs. 5, 8).
2002 *Cyclastrum scammonense* n. sp. – Whalen & Carter, p. 111, pl. 4, figs. 3-5, 11-13, 15; pl. 5, figs. 1, 2, 9.

***Original description*:** Test outline a nearly straight-sided equilateral triangle; test very thick with vertical sides. Recessed area sometimes girdles edge of test. Spines medium-sized, triradiate in axial section with broad, rounded longitudinal ridges and narrow longitudinal grooves, becoming circular in axial section distally. Pore frames irregularly shaped, pentagonal, tetragonal and circular showing an indistinct lineation subparallel to margin of test. Central area of test broad, triangular in outline and slightly depressed. Subspherical area, in center of test, with smaller pore frames, connecting with poorly defined rays aligned with peripheral spines.

Original remarks: *Cyclastrum scammonense* n. sp. is distinguished from *C. veracruzense* n. sp. and *C. asuncionense* n. sp. by having a straight-sided test.

Measurements (μm):
(n) = number of specimens measured

Diameter of cortical shell (max.) (17)	Length of primary spine (max.) (14)	
225	71	HT
255	94	Max.
195	45	Min.
222	62	Mean

Etymology: This species is named for Scammon's Lagoon (a haven for migrating gray whales) located to the northeast of the type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Tawi Sadh Member of the Guwayza Formation, Oman.

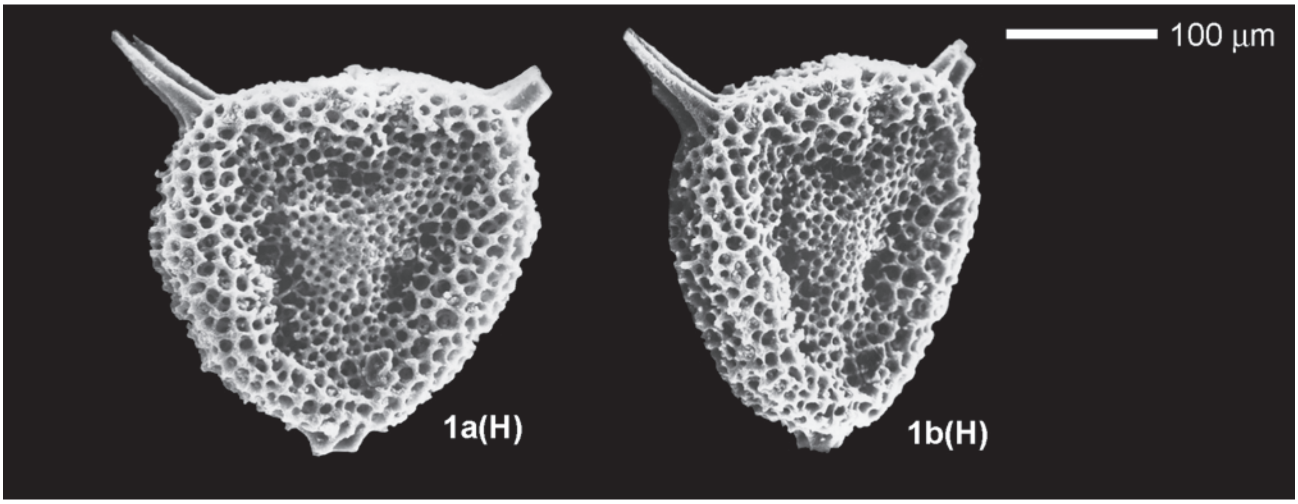


Plate CYC01. ***Cyclastrum asuncionense* Whalen & Carter.** Magnification x200. **Fig. 1(H)a, b.** Whalen & Carter 2002, pl. 4, figs. 8-9.

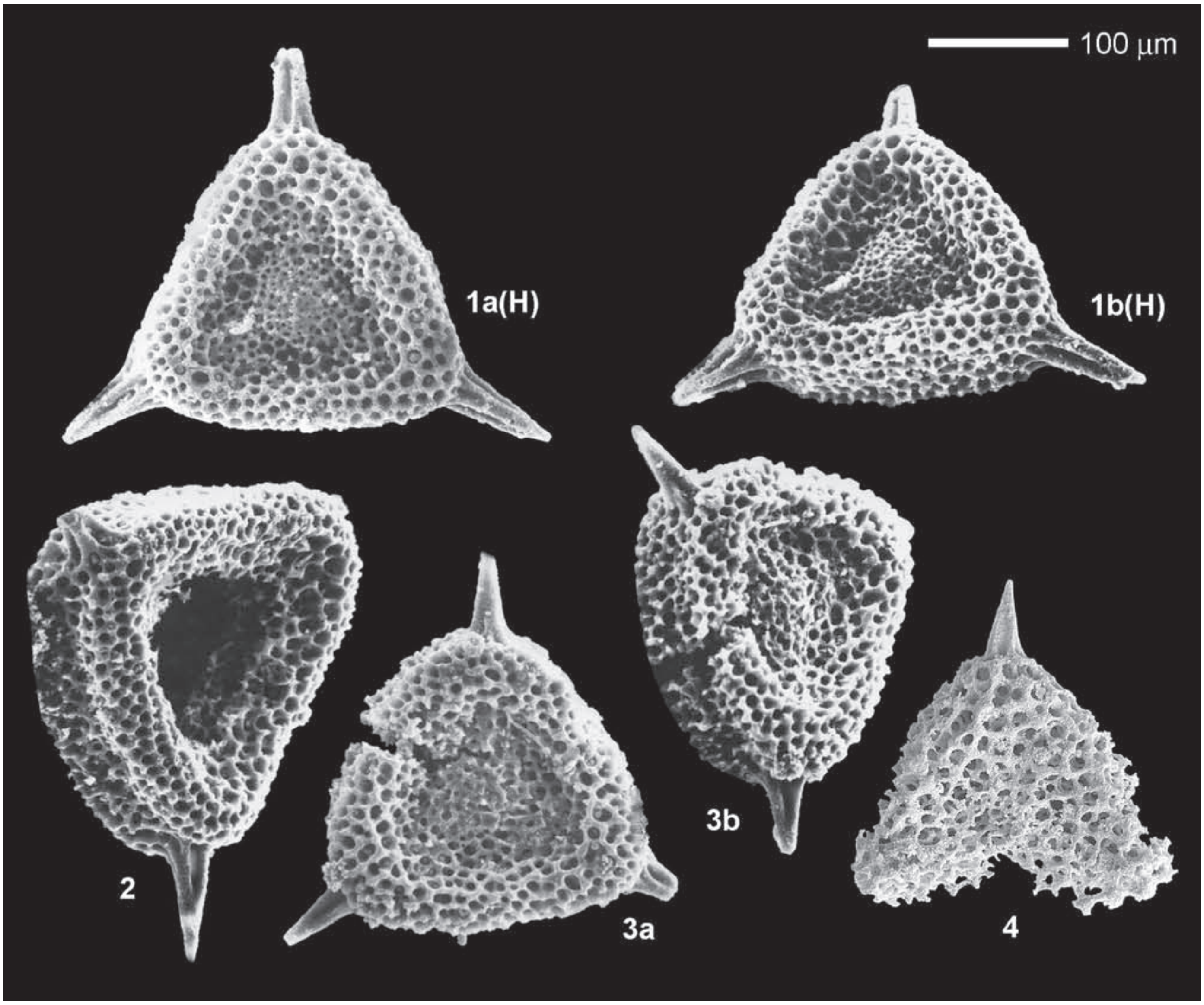


Plate CYC02. ***Cyclastrum scammonense* Whalen & Carter.** Magnification x200. **Fig. 1a,b(H).** Whalen & Carter 2002, pl. 4, figs. 3-4. **Fig. 2.** Whalen & Carter 2002, pl. 5, fig. 2. **Fig. 3a,b.** Whalen & Carter 2002, pl. 4, figs. 5, 12. **Fig. 4.** OM, BR1121, 15928.

Cyclastrum veracruzense Whalen & Carter 2002

Species code: CYC03

Synonymy:

1984 unidentified Radiolaria – Whalen & Pessagno, pl. 1, fig. 14.
2002 *Cyclastrum veracruzense* n. sp. – Whalen & Carter, p. 111, pl. 5, figs. 3, 4, 13; pl. 17, fig. 2.

Original description: Test outline a nearly straight-sided equilateral triangle; on some specimens (including holotype), margins curved gently inward between peripheral spines. Test very thin with gently rounded edges. Spines short, stout, triradiate in axial section with narrow, rounded longitudinal ridges and broad shallow longitudinal grooves. Meshwork along triangular margin of test composed of irregular, medium-sized tetragonal and pentagonal pore frames with no distinctive alignment. Central area of test slightly depressed, broad, triangular in outline, with three-rayed area defined by smaller pore frames with slightly more alignment than on remainder of test; three-rayed structure aligned with peripheral spines.

Original remarks: The shorter, broader peripheral spines and distinctive shape of *Cyclastrum veracruzense* n. sp., distinguish it from *C. asunsionense* n. sp.

Further remarks: The very thin, compressed test and short peripheral spines distinguish *Cyclastrum veracruzense* n. sp. from all other species of *Cyclastrum*.

Measurements (μm):
Based on 6 specimens.

Diameter of cortical shell (max.)	Length of primary spine (max.)	
225	53	HT
225	79	Max.
195	30	Min.
218	59	Mean

Etymology: This species is named for Pico Vera Cruz located to the north of the type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Fannin Formation, Queen Charlotte Islands.

Cyclastrum sp. A

Species code: CYC04

Description: This species is subtriangular in outline and very thick with near vertical margins. Upper and lower surfaces of test with a broad outer rim composed mostly of subrectangular pore frames, and a narrow poorly defined central cavity made up of smaller pore frames. Test has a single spine at each corner of test; spines very small, triradiate at base becoming circular towards tips.

Remarks: This species differs from *Cyclastrum asuncionense* Whalen & Carter in having a much thicker test, a smaller central area and short minuscule spines.

Occurrence: Ghost Creek Formation and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands.

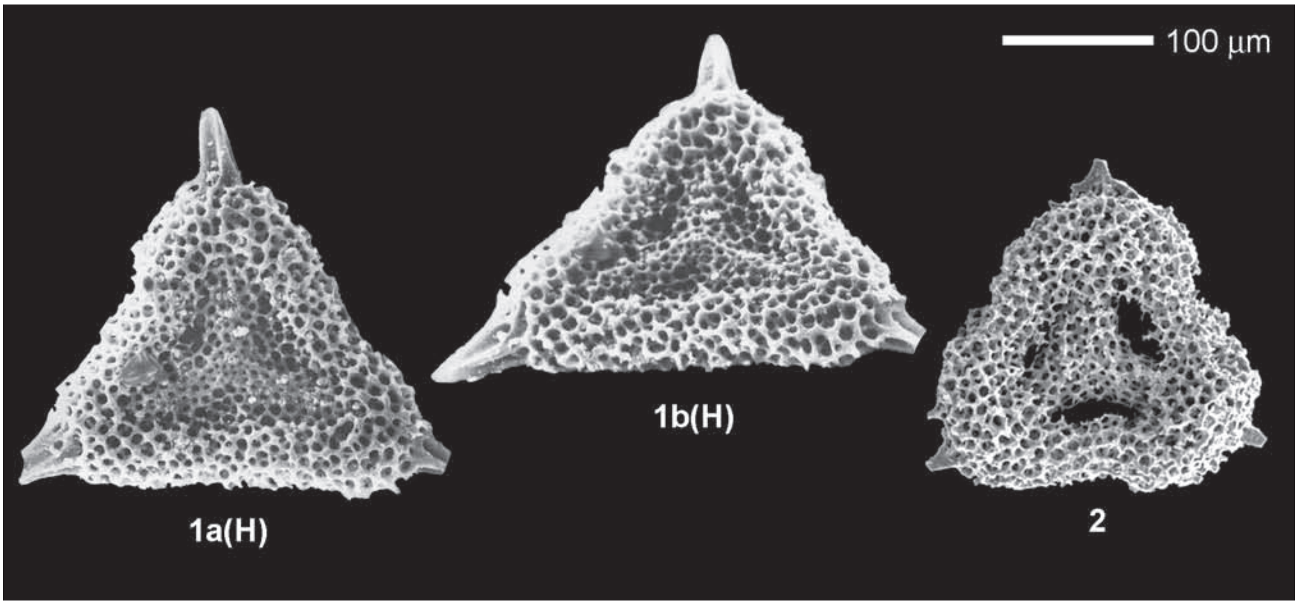


Plate CYC03. ***Cyclastrum veracruzense*** **Whalen & Carter.** Magnification x200. **Fig. 1a,b(H).** Whalen & Carter 2002, pl. 5, figs. 3-4. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128766.

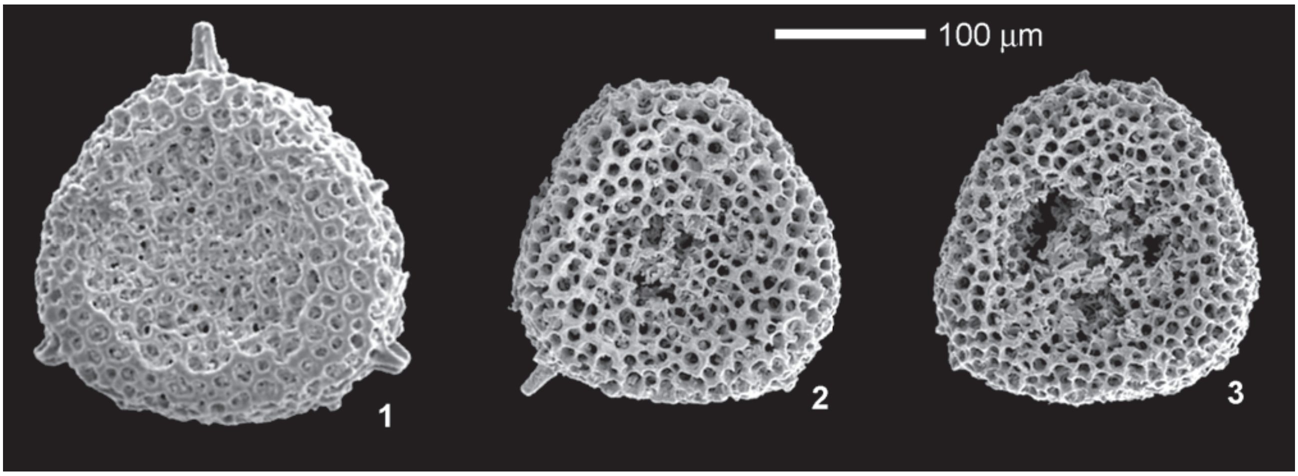


Plate CYC04. ***Cyclastrum*** **sp. A.** Magnification x200. **Fig. 1.** QCI, GSC loc. C-305386, GSC 128767. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128768. **Fig. 3.** QCI, GSC loc. C-304566, GSC 128769.

Genus: *Danubea* Whalen & Carter 1998

Type species: *Danubea howardi* Whalen & Carter 1998

Synonymy:
1998 *Danubea* n. gen. – Whalen & Carter, p. 40.

Original description: Test with two prominent spines in the polar positions. Cortical shell inflated, sub-elliptical in outline with slightly planiform surfaces adjacent to spines; meshwork composed of tetragonal and triangular pore frames with prominent nodes at pore frame vertices; large pores sometimes located on cortical shell at base of spines. Spines triradiate in axial section and tapering distally.

Original remarks: The bipolar spines of *Danubea* n. gen., distinguish it from all other genera of the Subfamily Charlotteinae. *Danubea* n. gen. differs from *Pantanellium* Pessagno by having an inner eccentric spicular network. *Protopsium* Pessagno and Poisson differs from *Danubea* n. gen. by having spongy meshwork.

Etymology: *Danubea* n. gen., is named for the steamer *Danube*, a well known trading ship in the Queen Charlotte Islands in the late 1800s.

Included species:
DAN02 *Danubea* sp. A sensu Whalen & Carter 2002

***Danubea* sp. A** sensu Whalen & Carter 2002

Species code: DAN02

Synonymy:
2002 *Danubea* sp. A – Whalen & Carter, p. 112, pl. 7, figs. 7, 8.

Original remarks: The much smaller cortical shell with smaller pore frames but with more prominent nodes at pore frame vertices and the proportionally longer, more massive polar spines distinguish this species from *D. howardi* Whalen and Carter.

Occurrence: San Hipólito Formation, Baja California Sur; Rennell Junction member of the Fannin Formation, Queen Charlotte Islands.

Genus: *Droltus* Pessagno & Whalen 1982

Type species: *Droltus lyellensis* Pessagno & Whalen, 1982

Synonymy:
1982 *Droltus* n. gen – Pessagno & Whalen, p. 120

Original description: Test conical to cylindrical, lacking strictures at joints. Cephalis with short to long horn. Aperture of final post-abdominal chamber open, not enclosed by latticed dome-shaped cap.

Original remarks: *Droltus* is compared to *Bagotum,* n. gen., under the latter genus.

Further remarks: *Droltus* differs from *Broctus* by lacking a narrow tubular structure on the final postabdominal chamber.

Etymology: *Droltus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 40, p.113).

Included species:
DRO07 *Droltus eurasiaticus* Kozur & Mostler 1990
DRO02 *Droltus hecatensis* Pessagno & Whalen 1982
DRO03 *Droltus laseekensis* Pessagno & Whalen 1982
DRO06 *Droltus lyellensis* Pessagno & Whalen 1982
DRO08 *Droltus sanignacioensis* Whalen & Carter 2002

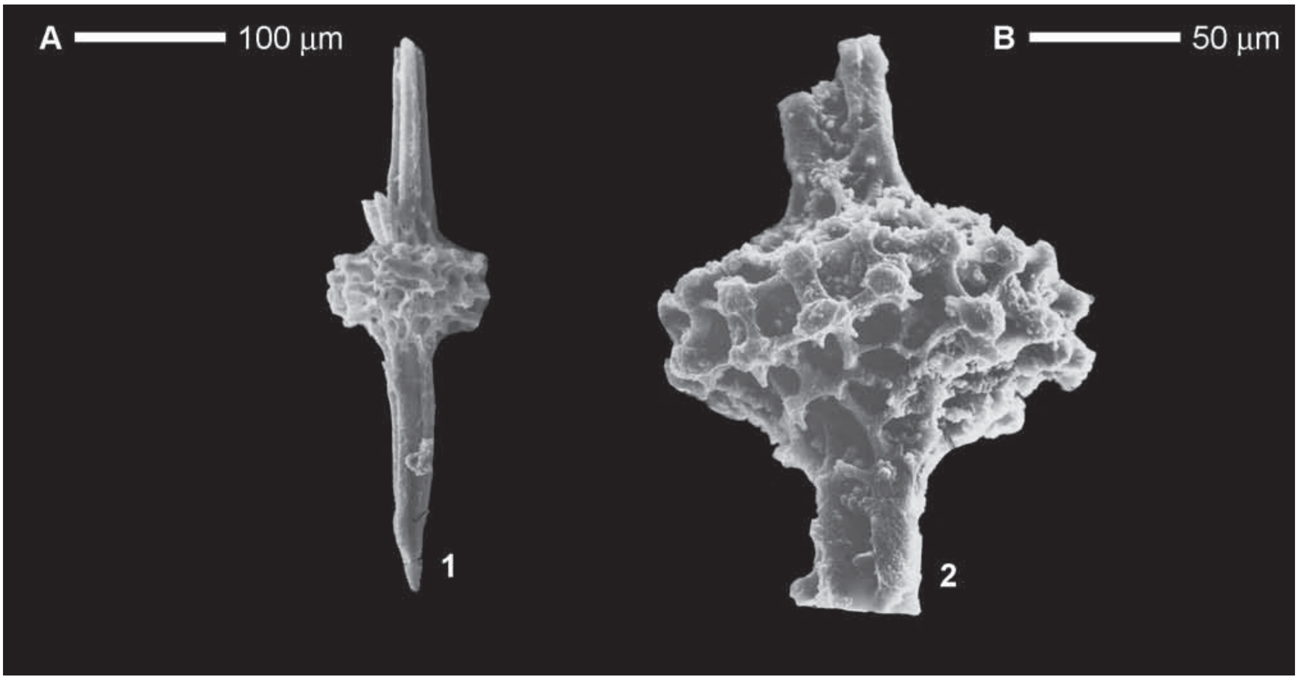


Plate DAN02. ***Danubea*** **sp. A sensu Whalen & Carter.** Magnification Fig. 1 x200, Fig. 2 x400. **Fig. 1.** Whalen & Carter 2002, pl. 7, fig. 7. **Fig. 2.** Whalen & Carter 2002, pl. 7, fig. 8.

Droltus eurasiaticus Kozur & Mostler 1990

Species code: DRO07

Synonymy:

1982 *Parahsuum* (?) sp. A – Yao, pl. 3, fig. 6.
1990 *Droltus eurasiaticus* n. sp. – Kozur & Mostler, p. 223, pl. 17, fig. 3-4.
1998 *Droltus eurasiaticus* Kozur & Mostler – Yeh & Cheng, p. 20, pl. 12, fig. 1.
2002 *Droltus eurasiaticus* Kozur & Mostler – Whalen & Carter, p. 116, pl. 16, figs. 5, 6.

Original description: Test conical, multicyrtid, with 6-7 postabdominal segments lacking strictures at joints. Cephalis rounded conical, imperforate, with prominent apical horn. Cephalis covered by a layer of microgranular silica. Thorax and subsequent chambers trapezoidal in cross section. Pores arranged in vertical lines. In the thorax they are closed by layer of microgranular silica. In the remaining chambers the pores are open and become increasingly larger toward the final postabdominal chamber. Outer latticed layer indistinct, with large pore frames, arranged in vertical lines and with small to distinct nodes at pore frame vertices.

Original remarks: The other *Droltus* species of our material have tricarinate spines.

Measurements (μm):

	Min.	Max.
Length of test	200	214
Maximum width	83	100

Etymology: According to its occurrence in Eurasia.

Type locality: Kirchstein Limestone, Kirchstein, Bavaria, Germany.

Occurrence: Kirchstein Limestone, Germany; Várhegy Limestone, Hungary; San Hipólito Formation, Baja California Sur; Liminangcong Chert, Philippines.

Droltus hecatensis Pessagno & Whalen 1982

Species code: DRO02

Synonymy:

1982 *Droltus hecatensis* n. sp. – Pessagno & Whalen, p. 121; pl. 1, fig. 12, 13, 18, 22; pl. 4, figs. 1, 2, 6, 10; pl. 12, figs. 18-19.
1988 *Droltus* sp. – Sashida, p. 24, pl. 3, figs. 7, 16, 17.
1989 *Droltus hecatensis* Pessagno & Whalen – Hattori, pl. 12, fig. F.
1996 *Droltus hecatensis* s.l. Pessagno & Whalen – Pujana, p. 138, pl. 1, figs. 6, 16, 17.
1996 Bagotidae gen. et sp. indet. – Pujana, p. 138, pl. 1, fig. 10.
1998 *Droltus hecatensis* Pessagno & Whalen – Whalen & Carter, p. 63, pl. 15, fig. 14.
2001 *Droltus hecatensis* Pessagno & Whalen – Gawlick et al., pl. 5, fig. 13.
2002 *Droltus hecatensis* Pessagno & Whalen – Suzuki et al., p. 181, figs. 8 G, L-M, not fig. 8 H.
2002 *Droltus hecatensis* Pessagno & Whalen – Tekin, p. 186, pl. 3, fig. 9.

Original description: Test conical with six or seven postabdominal chambers which are about 5 times as wide as long. Cephalis small, hemispherical, having small horn with subsidiary spine. Cephalis and thorax imperforate. Thorax and subsequent chambers trapezoidal in cross section. Outer latticed layer of abdomen and first several postabdominal chambers with irregularly sized and shaped polygonal (predominantly tetragonal and pentagonal) pore frames; pore frames of last two or three post-abdominal chambers larger, more uniformly sized, predominantly tetragonal (square to rectangular) and aligned in rows.

Original remarks: This species differs from *D. lyellensis*, n. sp., by having a larger, more massive horn with a subsidiary spine, by being more pointed apically, and by having more aligned and more uniformly sized tetragonal pore frames on its final post-abdominal chambers.

Measurements (μm):
Based on 9 specimens.

Length excluding horn	Width (maximum)	
250.0	125.0	HT
260.0	150.0	Max.
225.0	117.5	Min.
243.33	132.2	Mean

Etymology: *D. hecatensis*, n. sp., is named for Hecate Straight east of its type locality.

Type locality: Sample QC 534, Rennell Junction member of the Fannin Formation (Maude Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Sierra Chacaicó Formation, Argentina; Pucara Group, Peru; Dürrnberg Formation, Austria; Hocaköy Radiolarite, Turkey; Musallah Formation and Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

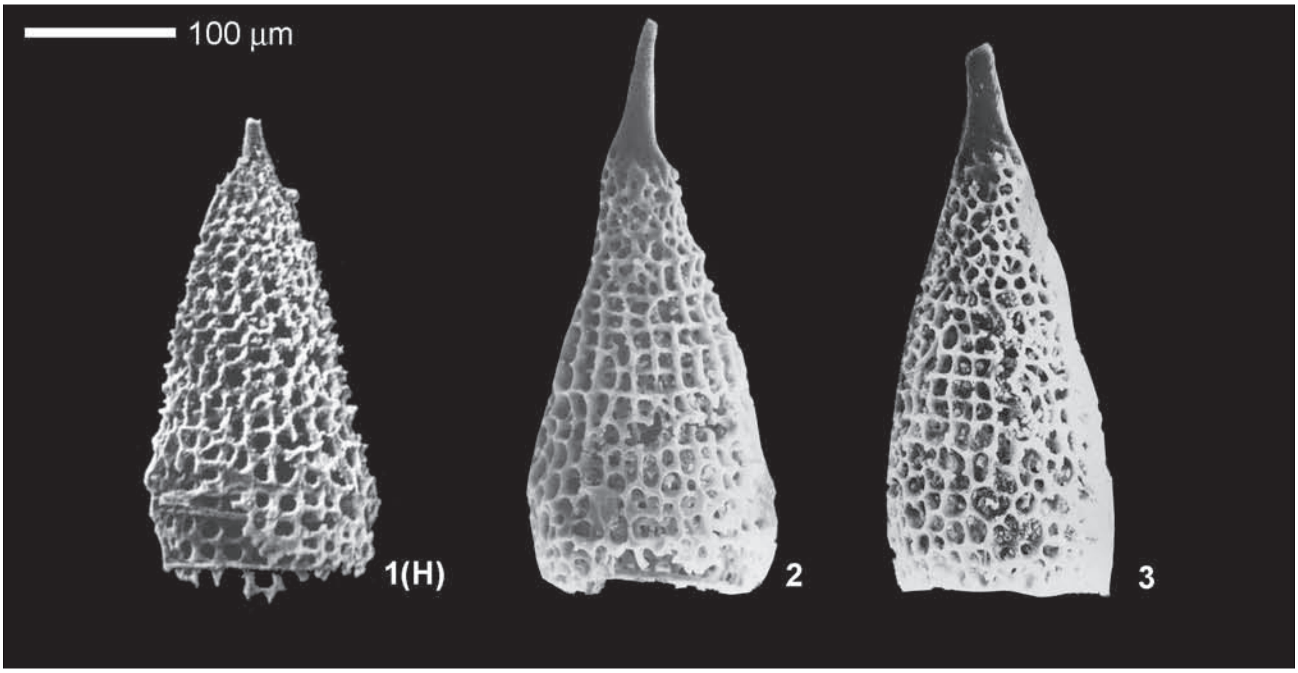


Plate DRO07. *Droltus eurasiaticus* Kozur & Mostler. Magnification x200. **Fig. 1(H).** Kozur & Mostler 1990, pl. 1, fig. 3. **Fig. 2.** Whalen & Carter 2002, pl. 16, fig. 6. **Fig. 3.** Whalen & Carter 2002, pl. 16, fig. 5.

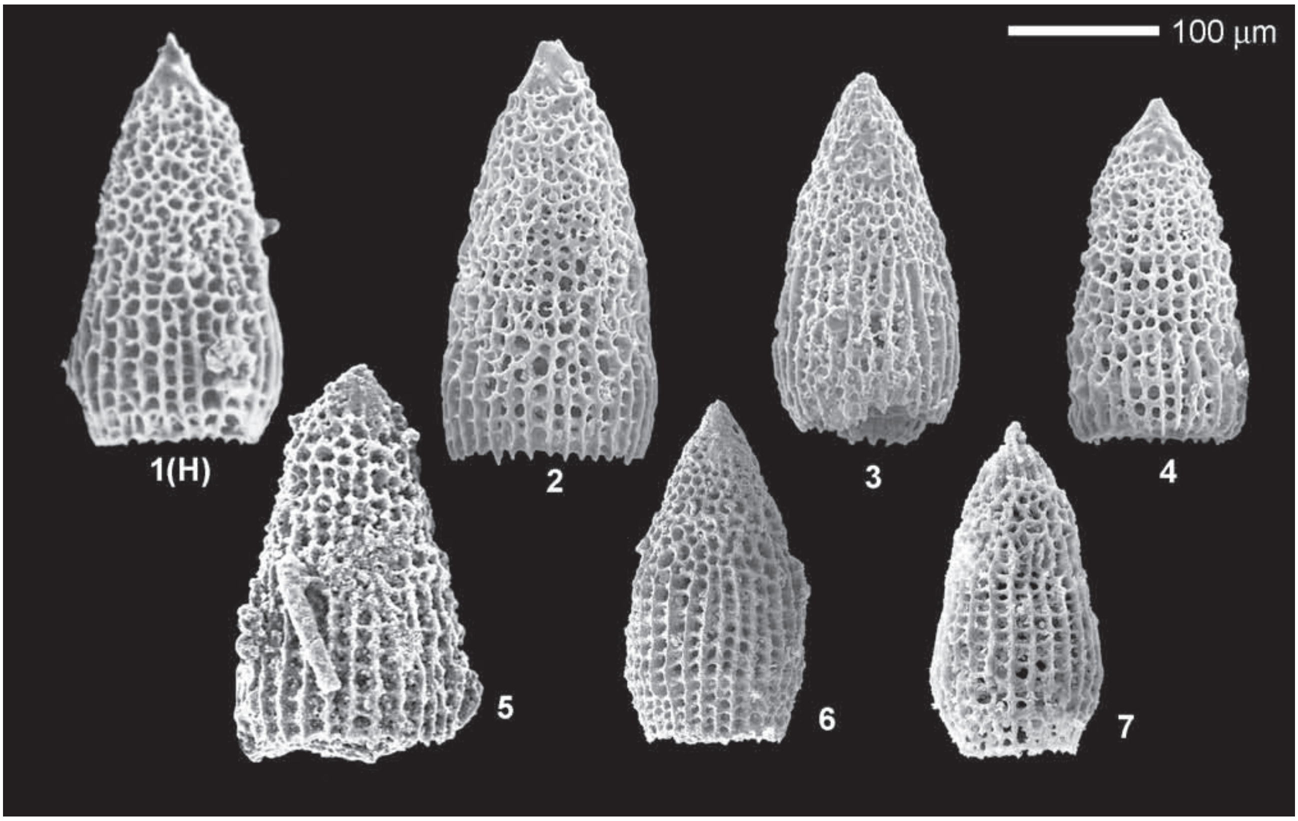


Plate DRO02. *Droltus hecatensis* Pessagno & Whalen. Magnification x200. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 4, fig. 1. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128788. **Fig. 3.** QCI, GSC loc. C-175310, GSC 128789. **Fig. 4.** QCI, GSC loc. C-304567, GSC 128790. **Fig. 5.** OM-00-251, 021431. **Fig. 6.** OM, BR1122-R02-10. **Fig. 7.** JP, MNA-10, MA13212.

Droltus laseekensis Pessagno & Whalen 1982

Species code: DRO03

Synonymy:

1982 *Droltus laseekensis* n. sp. – Pessagno & Whalen, p. 122, pl. 2, fugs. 5, 6, 11, 16; pl. 12, fig. 8, 15.
1998 *Droltus laseekensis* Pessagno & Whalen – Whalen & Carter, p. 63, pl. 15, fig. 8; pl. 26, fig. 4.
2004 *Droltus laseekensis* Pessagno & Whalen – Matsuoka, fig. 199.

Original description: Test as with genus, conical, usually with seven or eight post-abdominal chambers. Abdomen and most post-abdominal chambers rapidly increasing in width; final three post-abdominal chambers gradually increasing in width. Cephalis conical with small horn. Cephalis and thorax sparsely perforate, covered by veneer of microgranular silica; outer latticed layer of abdomen and most post-abdominal chambers with irregularly sized and shaped polygonal (tetragonal and pentagonal) pore frames; pore frames of last two or three post-abdominal chambers slightly larger, more uniformly sized and shaped (rectangular) and aligned in rows.

Original remarks: *D. laseekensis*, n. sp., differs from *D. hecatensis*, n. sp., by having pore frames on its final post-abdominal chambers that are more irregular in shape and disposition.

Measurements (µm):
Based on 10 specimens.

Length excluding horn	Width (maximum)	
257.5	142.5	HT
280.0	142.5	Max.
190.0	95.0	Min.
232.3	122.6	Mean

Etymology: *D. laseekensis*, n. sp., is named for Laseek Bay, north of its type locality.

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Mino Terrane, Japan.

Droltus lyellensis Pessagno & Whalen 1982

Species code: DRO06

Synonymy:

1982 *Droltus lyellensis* n. sp. – Pessagno & Whalen, p. 122, pl. 2, figs. 3, 10; pl. 12, fig. 7.
1998 *Droltus lyellensis* Pessagno & Whalen – Whalen & Carter, p. 63, pl. 16, fig. 9.
2002 *Droltus lyellensis* Pessagno & Whalen – Suzuki et al., p. 182, fig. 8 I.

Original description: Test conical to subcylindrical with five or six post-abdominal chambers over 5 times as wide as long. Cephalis relatively small, hemispherical with asymmetrically oriented short horn. Cephalis and thorax sparsely perforate. Outer latticed layer of abdomen and post-abdominal chambers with somewhat irregular tetragonal, pentagonal, and hexagonal pore frames. Tetragonal pore frames often aligned in rows, tending to be more uniformly sized.

Original remarks: *Droltus lyellensis*, n. sp., is compared to *D. hecatensis* n. sp., under the latter species.

Measurements (µm):
Based on 9 specimens.

Length excluding horn	Width (maximum)	
170.0	87.5	HT
210.0	100.0	Max.
125.0	75.0	Min.
162.0	90.5	Mean

Etymology: This species is named for Lyell Island south of its type locality in the Queen Charlotte Islands.

Type locality: Sample QC 550, Sandilands Formation (Kunga Formation of Pessagno & Whalen, 1982), north shore of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Pucara Group, Peru.

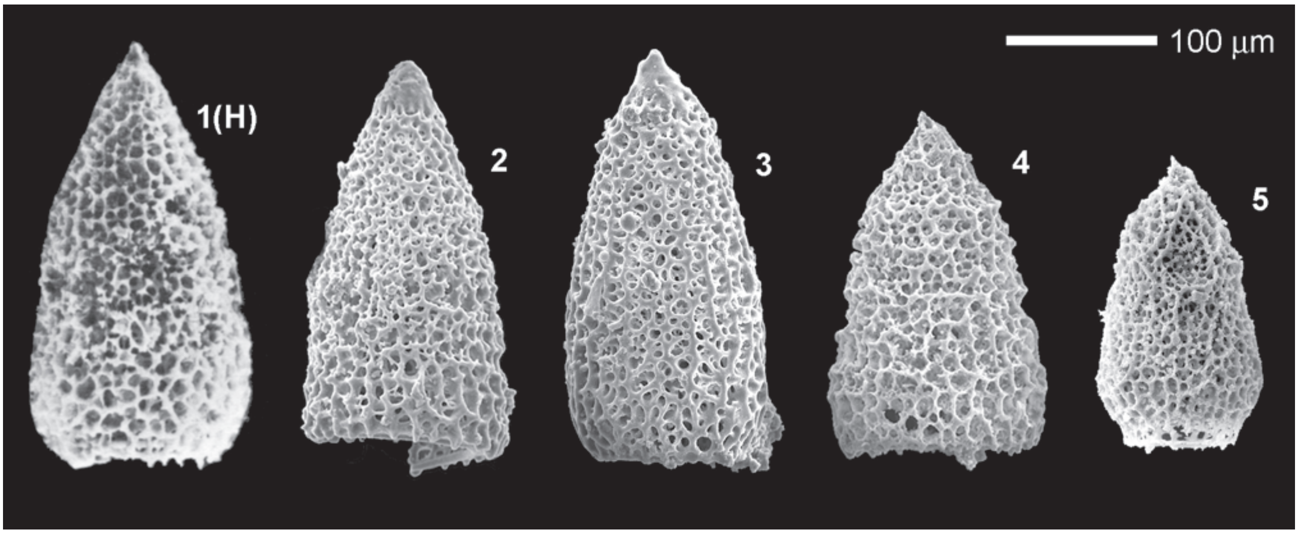


Plate DRO03. *Droltus laseekensis* Pessagno & Whalen. Magnification x200. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 2, fig. 6. **Fig. 2.** QCI, GSC loc. C-305386, GSC 128791. **Fig. 3.** QCI, GSC loc. C-175311, GSC 128792. **Fig. 4.** QCI, GSC loc. C-304566, GSC 128878. **Fig. 5.** Matsuoka 2004, fig. 199.

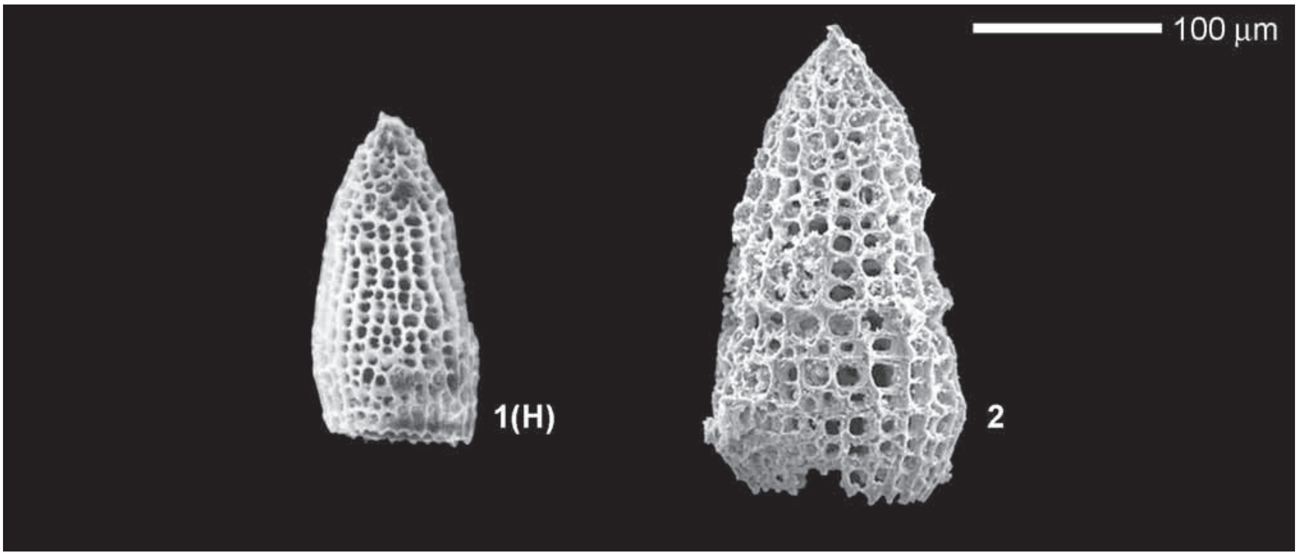


Plate DRO06. *Droltus lyellensis* Pessagno & Whalen. Magnification x250. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 2, fig. 3. **Fig. 2.** QCI, GSC loc. C-175310, GSC 128793.

Droltus sanignacioensis Whalen & Carter 2002
Species code: DRO08

Synonymy:
1984 *Bagotum* sp. – Whalen & Pessagno, pl. 2, figs. 12-14.
1990 *Droltus* (?) sp. – De Wever at al., pl. 4, fig. 6.
1998 *Droltus* sp. – Kashiwagi, pl. 1, fig. 12; pl. 2, figs. 2, 3.
2002 *Droltus sanignacioensis* n. sp. – Whalen & Carter, p. 116, pl. 10, figs. 7, 8, 15.
2003 *Parahsuum* sp. – Kashiwagi & Kurimoto, pl. 3, fig. 5.

Original description: Test conical, with approximately five post-abdominal chambers. Cephalis hemispherical without a horn. Thorax, abdomen and most post-abdominal chambers gradually increasing in width till last post-abdominal chamber which slightly decreases in width. Outer latticed layer on proximal half of test composed of narrow, irregularly shaped pore frames elongated parallel to long axis of test; pore frames of outer latticed layer on distal half of test tetragonal (rectangular) in outline and aligned in rows.

Original remarks: The elongated, irregularly shaped pore frames on the proximal portion of the test distinguish this species from *Droltus lyellensis* Pessagno and Whalen 1982.

Measurements (μm):
(n) = number of specimens measured.

Length (10)	Width (Max.) (11)	
165	90	HT
180	105	Max.
135	90	Min.
158	95	Mean

Etymology: *Droltus sanignacioensis* is named for the town of San Ignacio located to the east of the type area.

Type locality: Sample BPW80-30, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Ghost Creek Formation, Queen Charlotte Islands; Williston Lake, north-east British Columbia; Musallah Formation, Oman; Japan.

Genus: *Ducatus* Whalen & Carter 2002
Type species: *Ducatus hipolitoensis* Whalen & Carter 2002

Synonymy:
2002 *Ducatus* n. gen. – Whalen & Carter, p. 132.

Original description: Test multicyrtid, composed of cephalis, thorax, abdomen, and swollen post-abdominal chamber. Cephalis with horn. Post-abdominal chamber always much larger than cephalis, thorax, and abdomen, terminating in long, gently tapering, closed tubular extension. Post-abdominal chamber with two prominent, porous arms, gently tapering to closed distal tips; arms circular in axial-section, attached at mid-point of spherical portion of post-abdominal chamber, at right angles to long axis of test.

Original remarks: The presence of circumferential porous arms or wings rather than solid spines distinguishes *Ducatus* n. gen., from *Katroma* Pessagno and Poisson 1981, and *Podobursa* Wisniowski 1889, emend. Foreman 1973. *Ducatus* is distinguished from *Podocapsa* Rüst l885, by having only two circumferential wings, rather than three.

Etymology: *Ducatus* is a name formed by an arbitrary combination of letters (ICZN 1985, Appendix D, pt. VI, Recommendation 40, p. 201).

Included species:
DUC01 *Ducatus hipolitoensis* Whalen & Carter 2002

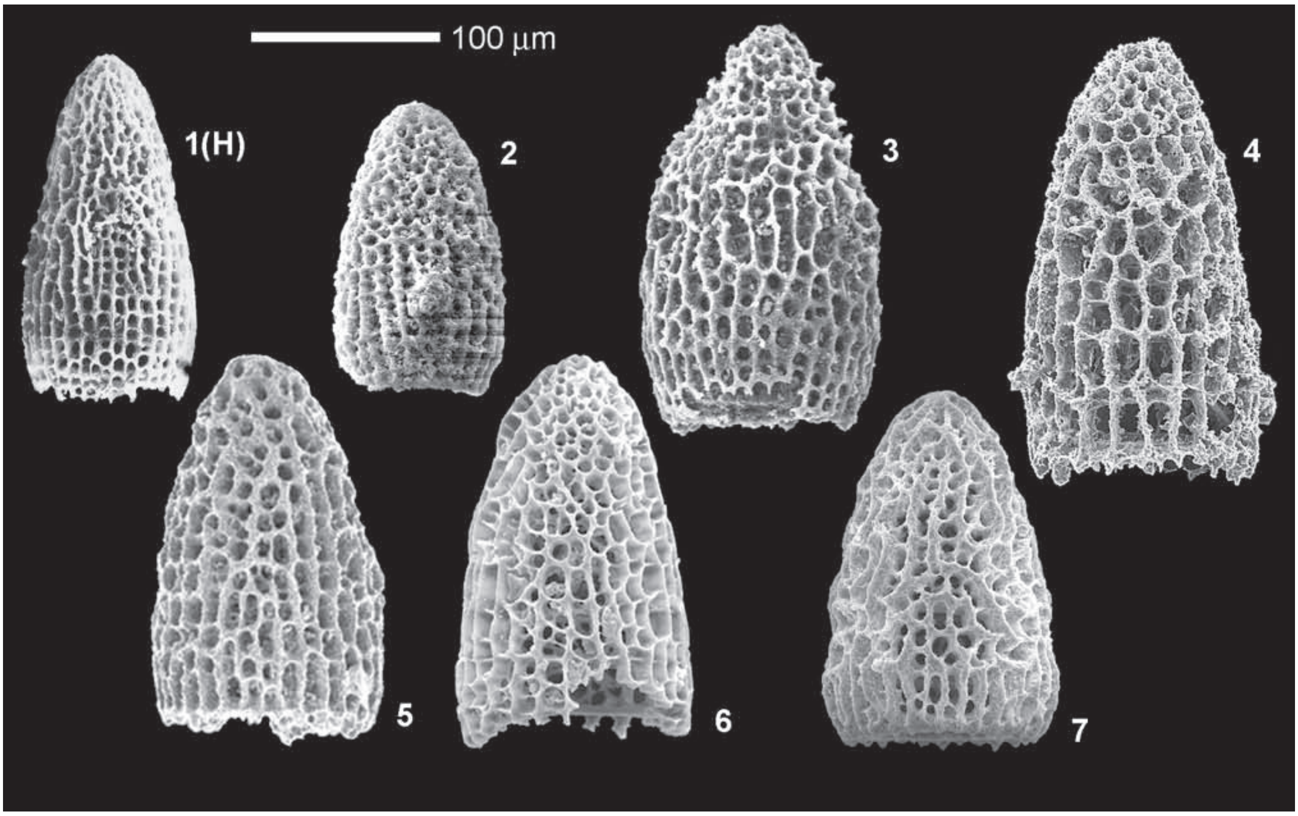


Plate DRO08. *Droltus sanignacioensis* Whalen & Carter. Magnification x250. **Fig. 1(H).** Whalen & Carter 2002, pl. 10, fig. 7. **Fig. 2.** OM-00-252, 021731. **Fig. 3.** OM-00-118, 000629. **Fig. 4.** NBC, GSC loc. C-305208, GSC 128911. **Fig. 5.** QCI, GSC loc. C-305417, GSC 128794. **Fig. 6.** QCI, GSC loc. C-080611, GSC 128795. **Fig. 7.** QCI, GSC loc. C-305417, GSC 128912.

Ducatus hipolitoensis Whalen & Carter 2002
Species code: DUC01

Synonymy:
1984 unidentified Radiolaria – Whalen & Pessagno, pl. 1, fig. 13.
2002 *Ducatus hipolitoensis* n. sp. – Whalen & Carter, p. 132, pl. 13, figs. 3, 5-7, 11-13, 15; pl. 18, figs. 3, 4.

Original description: Test large with cephalis, thorax, abdomen, and post-abdominal chamber. Cephalis large, dome-shaped with horn; cephalis and thorax covered with layer of microgranular silica. Moderately sized single horn, circular in cross-section, tapering distally. Abdomen trapezoidal in outline; noticeable change in slope between chamber wall of thorax and abdomen; abdomen partially covered by layer of microgranular silica. Sub-spherical post-abdominal chamber, large, inflated; hexagonal pore frames larger on medial portion of post-abdominal chamber becoming smaller towards abdomen and terminal tube. Two large porous arms extending at right angles from post abdominal chamber at medial position and 180° apart; arms as long as distal closed tube and covered with pores aligned with long axis of arms.

Original remarks: *Ducatus hipolitoensis* n. sp. is a monospecific genus at this time and is not compared to any other species.

Measurements (μm):
(n) = number of specimens.

Length (9) (excludes horn)	Length of arms (Max.) (10)	
375	143	HT
375	143	Max.
251	79	Min.
300	106	Mean

Etymology: *Ducatus hipolitoensis* n. sp. is named for Punta San Hipólito, type locality of the species.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California.

Genus: ***Dumitricaella*** De Wever 1982a, emend. Dumitrica herein
Type species: *Dumitricaella pauliani* De Wever 1982a

Synonymy:
1982a *Dumitricaella* n. gen. – De Wever, p. 197.

Original description: Form with two segments bearing a strong apical horn, two lateral spines and three feet. Cephalic skeleton consists of actines A, V, D, MB, L_l, L_r, l_l and l_r. At the extremity of V is a large pore (sometimes double) on the cephalic wall. The actines l_l and l_r give rise to two lateral spines; the actines D, L_l and L_r to the three distal feet. Wall of test composed of several layers as for *Jacus* n. gen.

Emended description: Skeleton two-segmented with an initial skeleton consisting of spines A, V, D, L_l, L_r, l_l, l_r originating in a short MB. A spine extended into a strong, three-bladed apical horn. V and l_l and l_r, or only l spines extended outside wall into horizontally directed horns. Wall of cephalis and possibly of thorax two layered. D, L_l and L_r extended into three, three-bladed feet. Cephalis relatively large, more or less separated from thorax by a constriction. Thorax short with a wide aperture and a distinct rim.

Original remarks: *Dumitricaella* differs from *Jacus* by the presence of the two horizontal lateral spines.

Further remarks: The inclusion of *Dumitricaella trispinosa* n. sp. in this genus makes it necessary to emend the genus specifying that the V spine may also be prolonged outside the cephalic wall. In fact, the V spine is easily prolonged outside the cephalis in many genera, whereas the two l spines commonly stop in the cephalic wall. By most its characters *Dumitricaella* seems to be closely related to *Napora* Pessagno from which it differs essentially by the presence of the two secondary lateral spines on the cephalis.

Etymology: Dedicated to P. Dumitrica (Romania) for his excellent, very meticulous work on Triassic radiolarians.

Included species:
JAC05 *Dumitricaella trispinosa* Dumitrica n. sp.

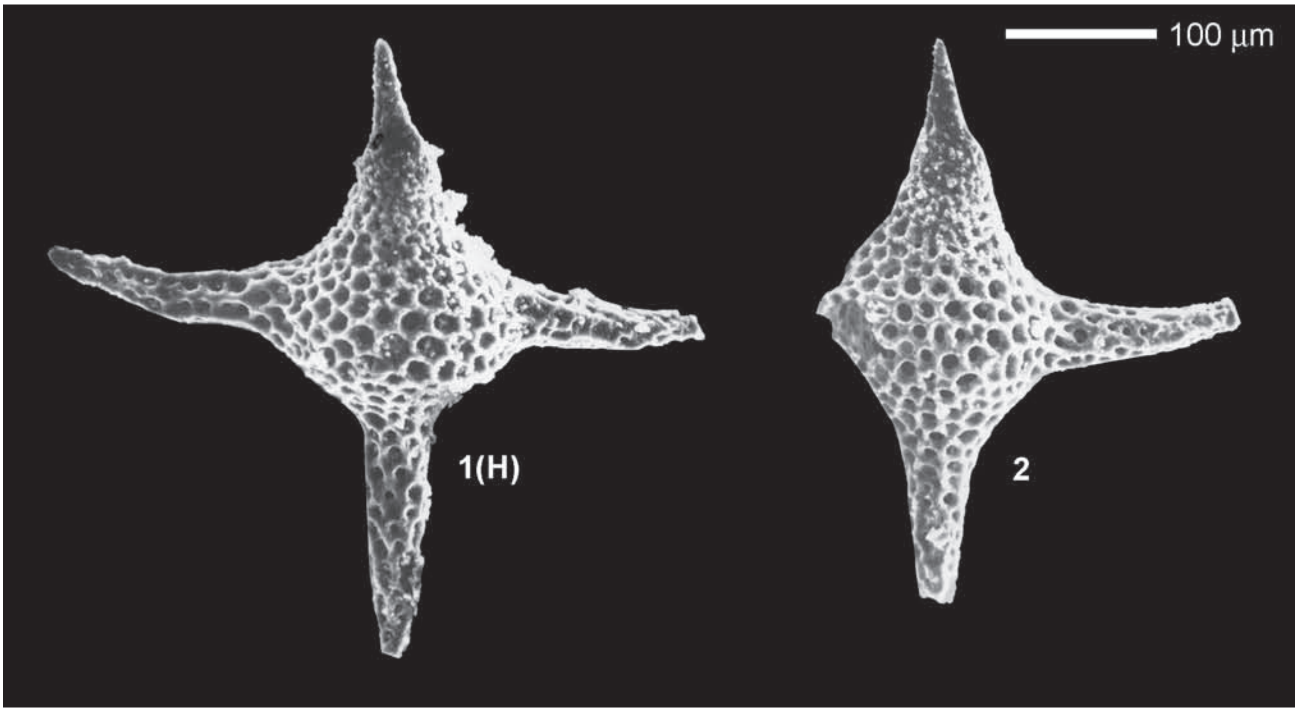


Plate DUC01. ***Ducatus hipolitoensis*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 13, fig. 3. **Fig. 2.** Whalen & Carter 2002, pl. 13, fig. 5.

Dumitricaella trispinosa Dumitrica n. sp.
Species code: JAC05

Synonymy:
1989 *Dumitricaella*? spp. – Hattori, pl. 19, fig. L.

Type designation: Specimen R20-02 (pl. JAC05, fig. 1) from sample BR 485, Tawi Sadh Member of the Guwayza Formation, Oman.

Diagnosis: *Dumitricaella* with three equal V and l spines.

Description: Test small, pyramidal with a thick, pointed, three-bladed apical horn. Blades of horn aligned with spines V and the two l. Cephalis relatively large, perforate, thick-walled with three short, broad, laterally directed, three-bladed spines. Spines sometimes replaced by a lobe-like prolongation of cephalis that becomes trilobate. Pores of cephalis with rounded triangular or quadrangular raised pore frames that can form ridges with different orientations. Collar stricture relatively well marked by a constriction. Thorax slightly longer and broader than cephalis, pyramidal. Dorsal and primary lateral spines prolonged from the base of cephalis in the wall of thorax, their outer blade forming a high rib, and extended into three divergent, curved, pointed feet. Distal end of thorax wide, open and bordered distally by an imperforate peristome. Pores of thorax small, rounded; pore frames aligned to form longitudinal, transversal or oblique ribs.

Remarks: *Dumitricaella trispinosa* n. sp. differs from *D. pauliani* De Wever in having V and l spines equally developed, in having these spines shorter, and a rather well marked collar constriction.

Measurements (μm):
Based on 7 specimens.

	Min.	Max.
Total length of skeleton	160	195
Length of apical horn	45	60
Length of cephalis	26	35
Length of thorax	46	60
Diameter of cephalis with spines or lobes	50	74
Diameter of thorax	72	100

Etymology: From the three spines (V, l_r and l_l) laterally extended from the cephalis.

Type locality: Sample BR 485, Guwayza Formation, Tawi Sadh Member, Jabal Safra, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Oman; Skrile Formation, Slovenia; Japan.

Genus: ***Elodium*** Carter 1988
Type species: *Elodium cameroni* Carter 1988

Synonymy:
1988 *Elodium* Carter – Carter et al., p. 56.
1996 *Elodium* Carter – Yeh & Cheng, p. 118.

Original description: Test conical and large, with well developed horn and numerous closely spaced post-abdominal chambers separated by nodose circumferential ridges. Three rows of longitudinally aligned circular to subcircular pores in polygonal (mostly tetragonal) pore frames, between circumferential ridges. Lateral pore rows flanking ridges slope steeply away from ridges. Post-abdominal chambers constricted between ridges. Pores in constricted area may be irregular to absent on distalmost chambers of test. Cephalis and thorax sparsely perforate to imperforate, covered with outer layer of microgranular silica; this covering may extend onto earliest post-abdominal chambers.

Original remarks: *Elodium* n. gen. possesses three rows of primary (open) pores between circumferential ridges; it differs from *Parvicingula* Pessagno in that these pores are longitudinally aligned rather than offset.

Further remarks: *Elodium* Carter can be distinguished from *Parahsuum* Yao by having prominent circumferential ridges and much less pronounced longitudinal costae.

Etymology: *Elodium* is formed by an arbitrary combination of letters (ICZN, 1985, Appendix D, Pt. VI, Recommendation 40, p. 201).

Included species:
3411 *Elodium cameroni* Carter 1988
PHS08 *Elodium*? *mackenziei* Carter n. sp.
ELD02 *Elodium pessagnoi* Yeh & Cheng 1996
ELD03 *Elodium wilsonense* (Carter) 1988

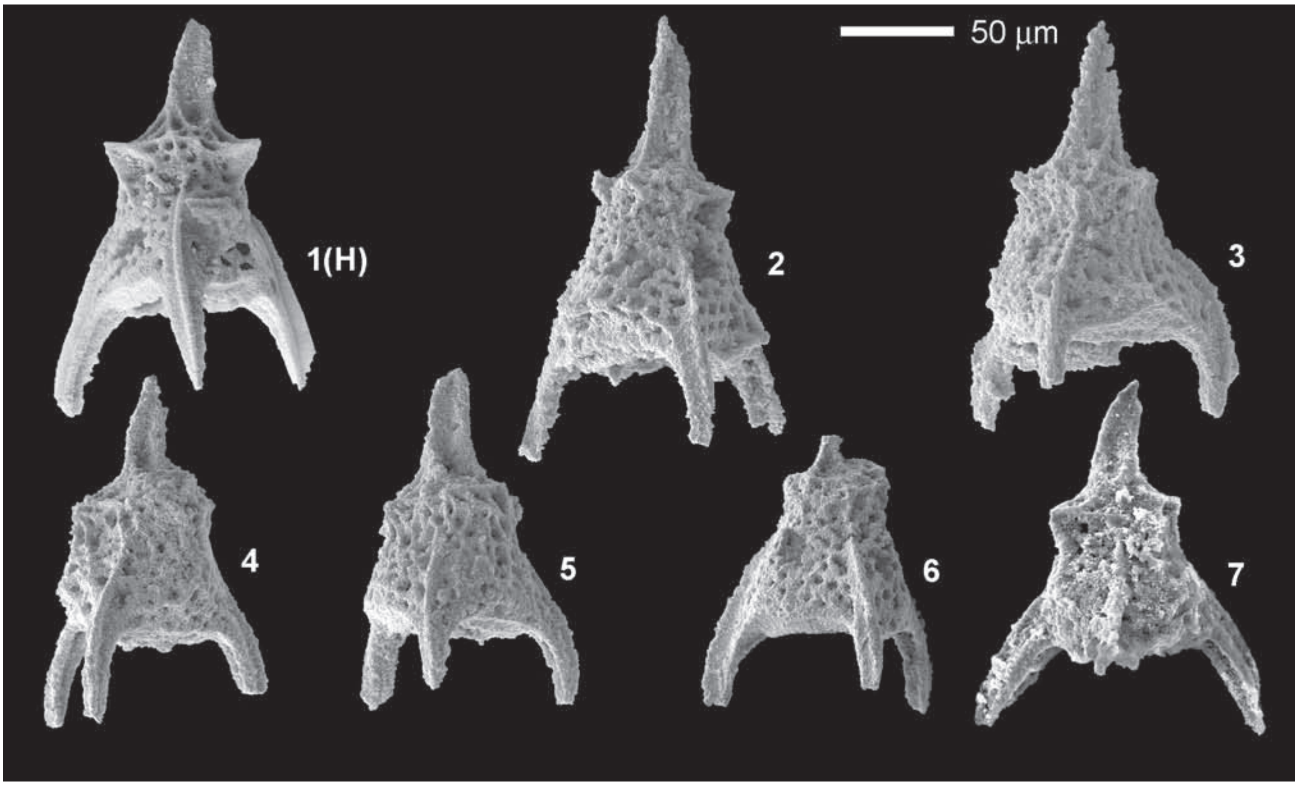


Plate JAC05. ***Dumitricaella trispinosa*** **Dumitrica n. sp.** Magnification x300. **Fig. 1(H)**. OM, BR485-R20-02. **Fig. 2.** OM, BR871-R05-22. **Fig. 3.** BR871-R03-01. **Fig. 4.** BR871-R08-09. **Fig. 5.** OM, BR871-R03-03. **Fig. 6.** OM, BR871-R09-14. **Fig. 7.** SI, MM6.76, 000506.

Elodium cameroni Carter 1988

Species code: 3411

Synonymy:

1988 *Elodium cameroni* n. sp. – Carter et al., p. 56, pl. 13, figs. 1, 2, 6, 9.
1991 *Elodium cameroni* Carter – Tipper et al., pl. 9, fig. 12.
1991 *Elodium cameroni* Carter – Carter & Jakobs, p. 342, pl. 3, fig. 18.
1995a *Elodium cameroni* Carter – Baumgartner et al., p. 194, pl. 3411, figs. 1-2.
1996 *Elodium* sp. aff. *E. pessagnoi* n. sp. – Yeh & Cheng, p. 120, pl. 11, fig. 7 only.
1997 *Elodium* aff. *cameroni* Carter – Yao, pl. 13, fig. 635.
Not 1997 *Elodium cameroni* Carter – Yao, pl. 13, fig. 636.

Original diagnosis: Large conical-cylindrical test with 10 to 14 post-abdominal chambers and a strong asymmetric apical horn. All pores large, primary and circular; three rows on proximal chambers, two rows on distalmost chambers.

Original description: Test large with 10 to 14 strongly constricted post-abdominal chambers separated by nodose circumferential ridges; nodes low and rounded. Cephalis and thorax trapezoidal in external outline, partially perforate, covered by veneer of microgranular silica. Cephalis has strong, asymmetric apical horn. All pores on post-abdominal chambers circular and primary (open); those within constricted areas smaller, disappearing on distalmost chambers. Earliest post-abdominal chambers trapezoidal, increasing gradually in width and height, distal chambers almost cylindrical with slight decrease in height.

Original remarks: *Elodium cameroni* is compared to *E. nadenensis* n. sp., under the latter. *Elodium cameroni* is very abundant, in all middle/upper Toarcian samples.

Original remarks under *Elodium nadenensis* Carter in Carter et al. (1988): Differs from *Elodium cameroni* n. sp. by having a more conical, apically pointed test with a heavier coating of microgranular silica. In addition, the horn is shorter, more symmetrical and circumferential ridges are wider and more rounded. Differs from *Lupherium* (?) sp. B by having more prominent circumferential ridges. Abundant.

Measurements (μm):
Based on 20 specimens.

	HT	Av.	Max.	Min.
Length (excluding horn)	369	352	450	280
Maximum width	161	159	185	147

Etymology: This species is named in honour of B.E.B. Cameron for his important contribution to the Mesozoic stratigraphy and foraminiferal biostratigraphy of the Queen Charlotte Islands, B.C.

Type locality: GSC locality C-080597. Phantom Creek Formation. Yakoun River, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Queen Charlotte Islands, British Columbia; Liminangcong Chert, Philippines; Japan.

Elodium? *mackenziei* Carter n. sp.

Species code PHS08

Synonymy:

? 1982 *Lupherium* sp. A – Pessagno & Whalen, p. 136, pl. 6, fig. 4.
1987b *Lupherium* sp. G – Yeh, p. 68, pl. 23, fig. 5.
1988 *Lupherium* (?) sp. B – Carter et al., p. 54, pl. 5 fig. 11; pl. 13, figs. 5, 10, 12.
? 1990 *Parahsuum simplum* Yao – De Wever at al., pl. 4, fig. 9.
? 2004 *Archaeodictyomitra*? sp. – Hori, pl. 1, fig. 55.
2004 *Lupherium* sp. – Matsuoka, figs. 217, 218.

Type designation: Holotype GSC 80758 (Carter et al. 1988, pl. 13, figs. 5, 10, 12), from GSC loc. C-080583; Phantom Creek Formation (upper Toarcian).

Description: Test elongate, quite pointed apically, usually with ten to twelve post-abdominal chambers. Cephalis conical, possibly including a short apical horn. Remaining chambers in apical half of the test trapezoidal, increasing more in height than width as added; next few chambers cylindrical, final two chambers slightly constricted. Slightly raised circumferential ridges visible between post-abdominal chambers on the distal portion of the test. Costae fine, narrowly spaced throughout length of test. Pores subcircular to subelliptical in shape.

Remarks: *Elodium*? *mackenziei* n. sp. differs from *Elodium nadenense* Carter (1988) in having less prominent circumferential ridges between post abdominal chambers and an absent to poorly developed apical horn. It differs from *E. wilsonense* Carter (1988) in having a more narrowly conical shape and less differentiated apical horn. Genus *Elodium* is queried because the three rows of aligned pores between chambers that characterize the genus are not well developed. *E.*? *mackenziei* n. sp. may be ancestral to all other species of *Elodium* in the upper Toarcian and Aalenian of Queen Charlotte Islands and it may also represent the link between *Parahsuum* and *Elodium*.

Measurements (μm):
Based on 11 specimens.

	HT	Max.	Min.	Mean
Length (excl. horn)	310	343	210	290
Maximum width	118	131	92	120

Etymology: This species is named for J.D. MacKenzie (Geological Survey of Canada) who first mapped central Graham Island in 1913-1914.

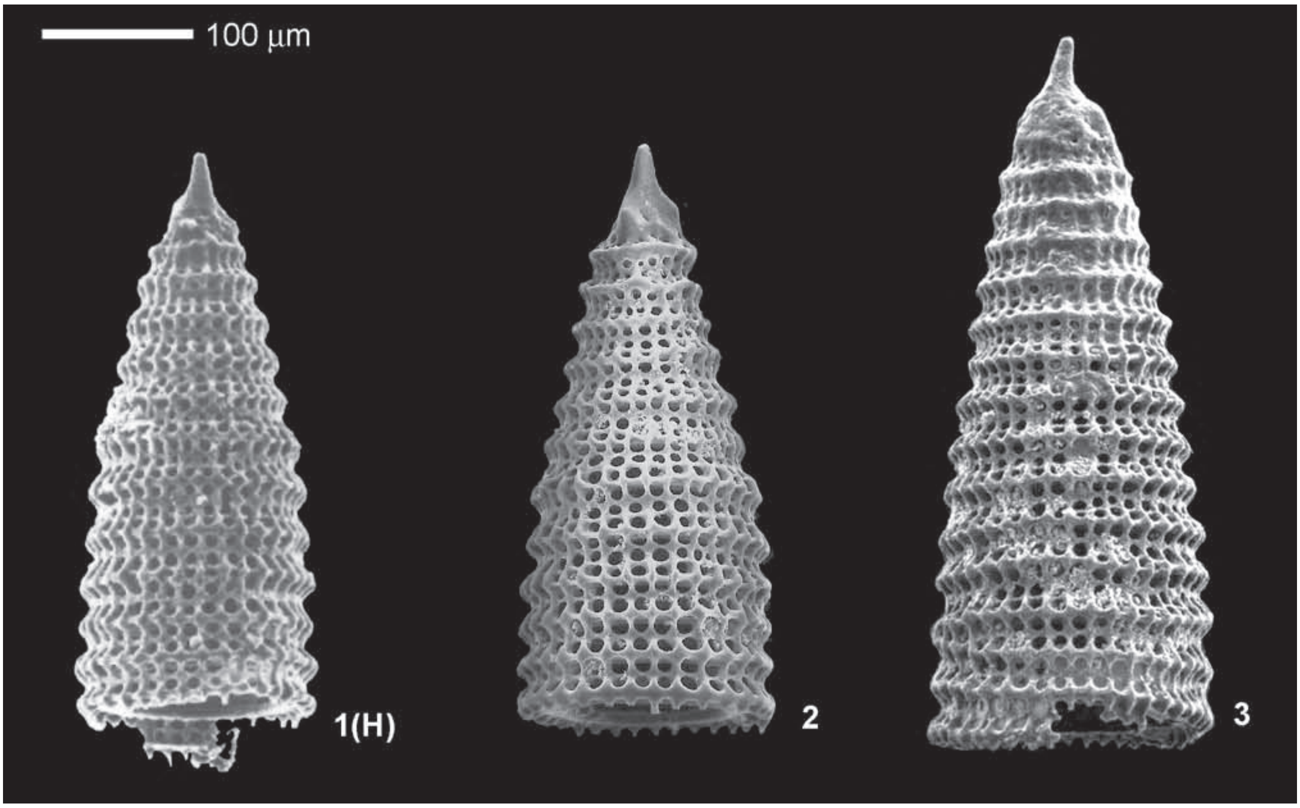


Plate 3411. ***Elodium cameroni*** **Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 13, fig. 2. **Fig. 2.** Carter & Jakobs 1991, pl. 3, fig. 18. **Fig. 3.** Carter et al. 1988, pl. 13, fig. 1.

Type locality: Sample GSC loc. C-080583, Phantom Creek Formation, Yakoun River, Graham Island, approximately 2 km south of Ghost Creek; east side of the river, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin member of the Fannin Formation, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Nicely and Hyde formations, Oregon; Mino Terrane, Japan.

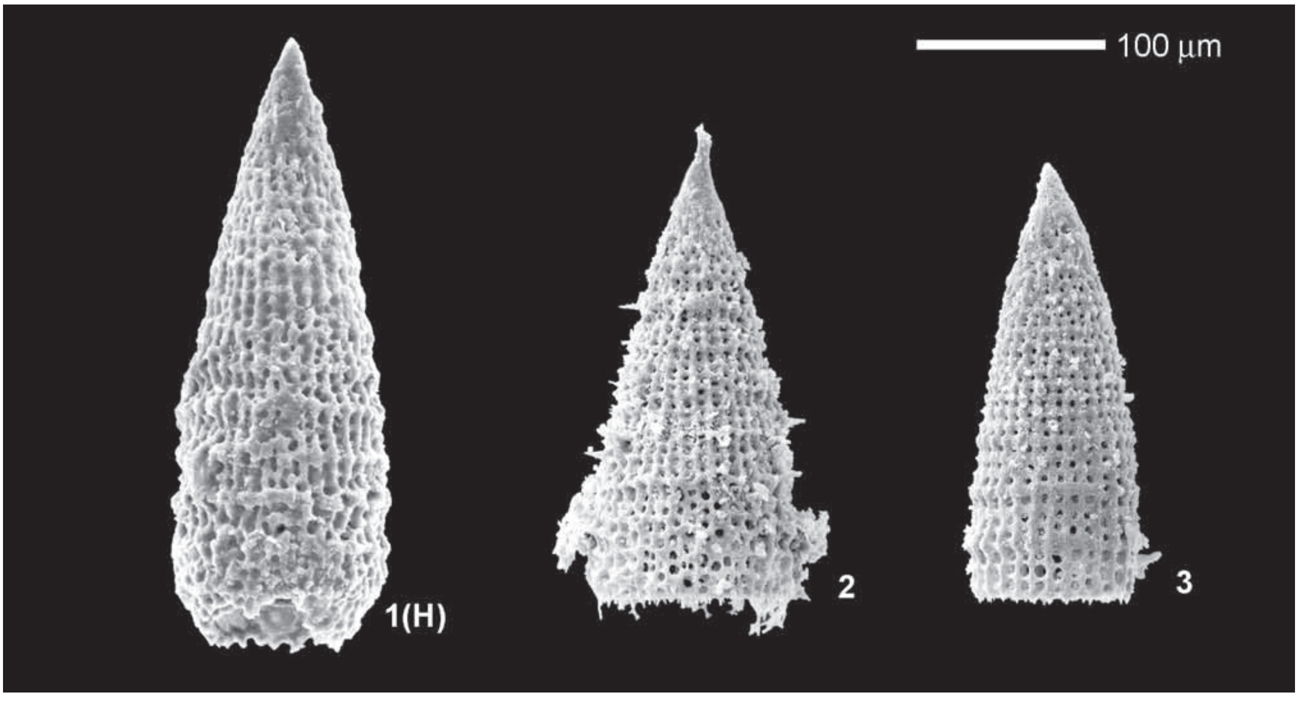


Plate PHS08. ***Elodium*****?** ***mackenziei*** **Carter n. sp.** Magnification x250. **Fig. 1(H).** Carter et al. 1988, pl. 13, fig. 5. **Figs. 2, 3.** Matsuoka 2004, figs. 217, 218.

Elodium pessagnoi Yeh & Cheng 1996

Species code: ELD02

Synonymy:

1982 *Parahsuum*? sp. – Matsuda & Isozaki, pl. 1, figs. 18, 19.
1989 *Parahsuum* (?) sp. aff. *P.* (?) *magnum* Takemura – Hori & Otsuka, p. 182, pl. 3, figs. 13-15.
1990 *Parahsuum* (?) aff. *P. magnum* Takemura – Hori, Fig. 9.37.
1995a *Parahsuum* sp. M - Baumgartner et al., p. 384, pl. 2015, figs. 1, ?2.
1996 *Elodium jurassicum* n. sp. – Yeh & Cheng, p. 118, pl. 11, figs. 1, 2, 6, 12, 13.
1996 *Elodium pessagnoi* n. sp. – Yeh & Cheng, p. 120, pl. 4, figs. 5, 7-8, 10-13; pl. 11, figs. 3, 4, 9, 14.
1996 *Elodium* sp. aff. *E. pessagnoi* n. sp. – Yeh & Cheng, p. 120, pl. 6, fig. 13; pl. 11, figs. 5, 11, 15, not fig. 7.
1996 *Elodium* sp. cf. *E. pessagnoi* n. sp. – Yeh & Cheng, p. 120, pl. 4, fig. 6.
1996 *Elodium* sp. B – Yeh & Cheng, p. 122, pl. 12, figs. 1, 6, 8, 12, not fig. 4.
1996 *Elodium* sp. C – Yeh & Cheng, p. 122, pl. 12, fig. 2, 7, 9, 10.
1996 *Elodium* sp. D – Yeh & Cheng, p. 122, pl. 12, figs. 3, 15.
1996 *Elodium* sp. E – Yeh & Cheng, p. 122, pl. 12, figs. 5, 11.
1997 *Parahsuum* (?) aff. *P. magnum* Takemura – Hori, pl. 1, fig. 7.
2004 *Parahsuum* (?) sp. aff. *magnum* Hori & Otsuka – Ishida et al., pl. 5, fig. 21.

Original description: Test medium in size, conical in shape, multicyrtid with six to seven post-abdominal chambers. Cephalis and thorax moderately broad, hemispherical with massive horn. Horn tapered, circular in axial section. Outer test layer of cephalis and thorax covered with raised irregular pore frames. First postabdominal chamber separated from abdomen and subsequent postabdominal chambers separated from each other by nodose circumferential ridges. Abdomen and postabdominal chambers trapezoidal in shape; each chamber having three rows of tetragonal pore frames. Pore frames longitudinally aligned. Postabdominal chambers increasing very slowly in height and gradually in width as added.

Further remarks: In *Elodium pessagnoi* we include all forms with a long straight apical horn, circular in cross-section. The test is conical or subcylindrical in shape; the apical portion of the test is covered by simple circular pores or possesses an additional layer of raised irregular nodes. *Elodium jurassicum* is herein synonymized with *E. pessagnoi*. It should be noted that holotypes of these two species (and most specimens of informal species) illustrated from Busuanga Island (Yeh & Cheng, 1996) are from a single sample.

Measurements (µm):
Based on 7 specimens.

	Max. test width	Max. test length	Length of horn	No. of postabdom. chambers
HT	148	284	49	6
Mean	145	264	55	5.5
Max.	150	291	74	6
Min.	138	239	41	5

Etymology: This species is named for Prof. E. A. Pessagno, UT-Dallas, U.S.A., in honor of his great contribution to Mesozoic radiolarian studies.

Type locality: Liminangcong Chert near Ocam Ocam village, Busuanga Island, Philippines.

Occurrence: Liminangcong Chert, Philippines; Japan.

Elodium wilsonense (Carter) 1988

Species code: ELD03

Synonymy:

1988 *Crubus wilsonensis* Carter n. sp. – Carter et al., p. 53, pl. 5, fig. 12.
1996 *Elodium* sp. cf. *E. wilsonense* (Carter) – Yeh & Cheng, p. 122, pl. 12, figs. 13, 14.

Original diagnosis: Test large, broadly conical with short horn. Eighteen costae visible laterally; three longitudinally aligned pores per chamber between adjacent costae. Ridges slightly raised with small nodes superimposed on costae.

Original description: Test broadly conical, rounded apically with short cylindrical horn. Cephalis hemispherical, all other chambers trapezoidal in outline. Cephalis imperforate, thorax and abdomen sparsely perforate; all three covered with a layer of microgranular silica. Usually 7 to 9 postabdominal chambers. All but final chamber increase gradually in width and height. Fifteen continuous narrow costae visible laterally, nodose along ridges. Single rows of longitudinally aligned pores (three per chamber, set in square pore frames) alternate with costae.

Original remarks: Differs from *Crubus firmus* Yeh in having three rows of linearly arranged pore frames per chamber, larger pores on initial chambers, a stouter horn, and stronger costae.

Further remarks: *Elodium wilsonense* differs from *E. cameroni* Carter in having fewer postabdominal chambers and much less prominent circumferential ridges. It differs from *E. pessagnoi* Yeh & Cheng in having a more broadly conical shape, two rows of pore frames on early postabdominal chambers and a shorter apical horn.

Measurements (µm):
Based on 10 specimens.

	HT	Av.	Max.	Min.
Length (excluding horn)	334	290	334	210
Maximum width	188	171	190	155

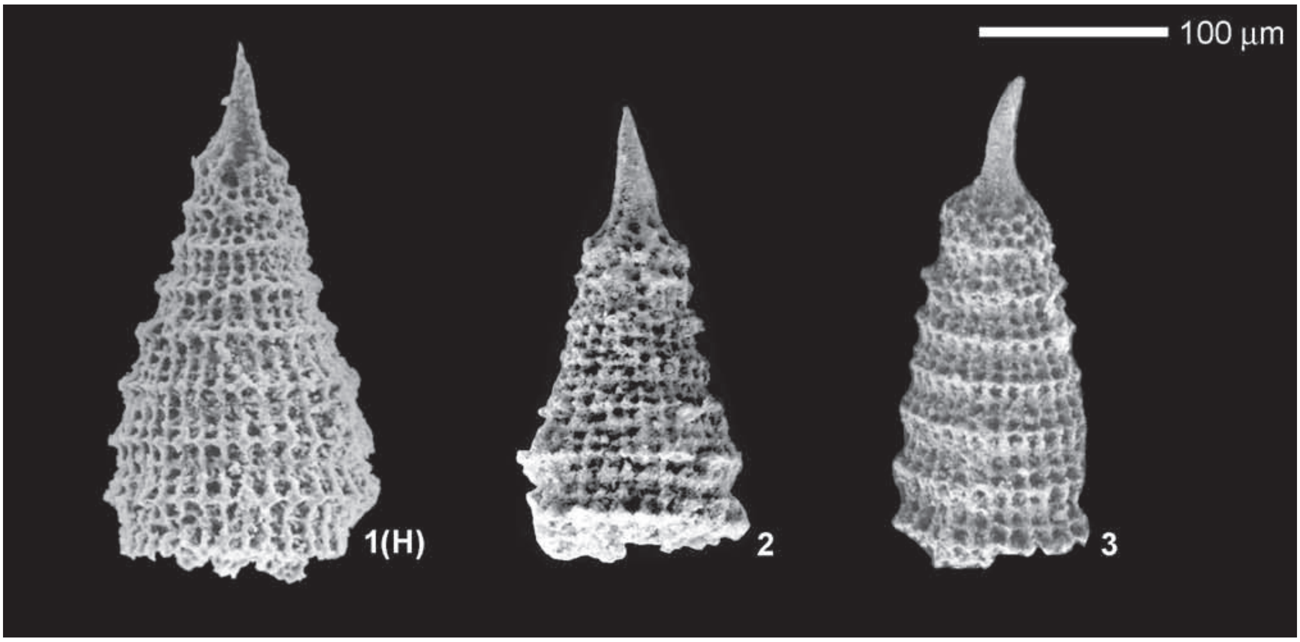


Plate ELD02. ***Elodium pessagnoi*** **Yeh & Cheng.** Magnification x250. **Fig. 1(H).** Yeh & Cheng 1996, pl. 11, fig. 3. **Fig. 2**. JP, NK86050720. **Fig. 3.** Hori 1990, fig. 9-37.

Etymology: Named for Wilson Creek on Graham Island, site of one of the early coal mines.

Type locality: GSC locality C-080579, Whiteaves Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves Formation, Queen Charlotte Islands; Liminangcong Chert, Philippines.

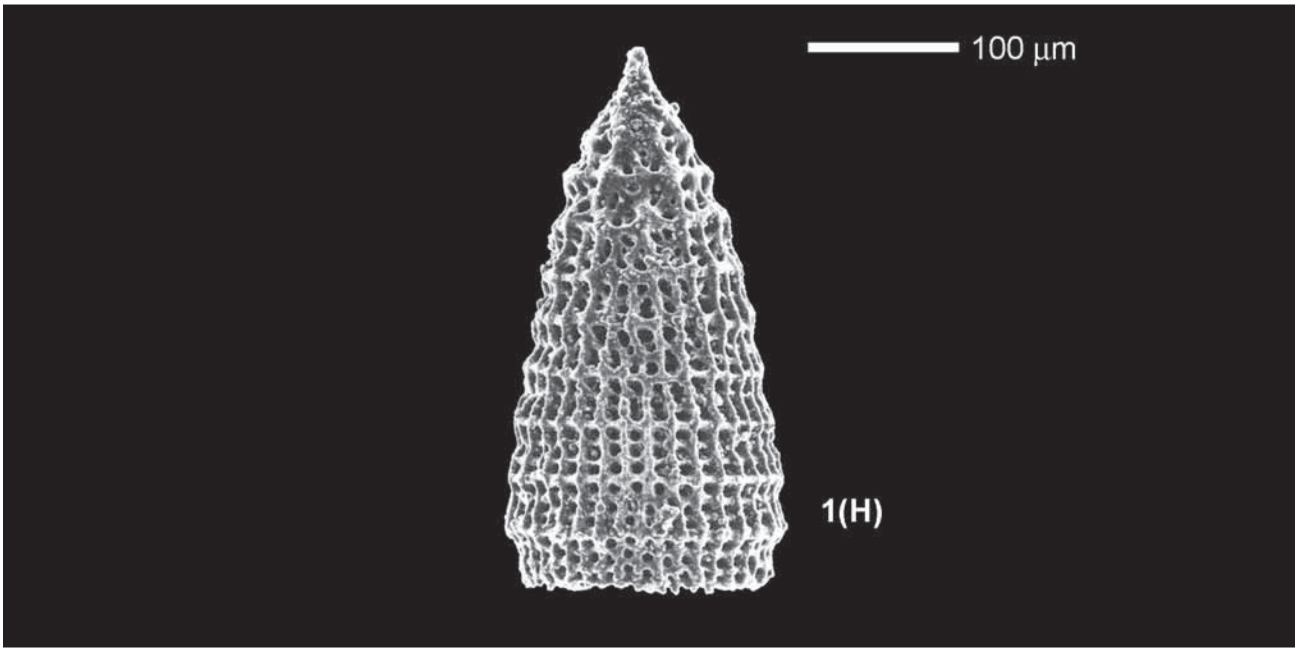


Plate ELD03. ***Elodium wilsonense*** **(Carter).** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 5, fig. 12.

Genus: *Eospongosaturninus* Kozur & Mostler 1990

Type species: *Spongosaturnalis protoformis* Yao 1972

Synonymy:

1990 *Eospongosaturninus* n. gen. – Kozur & Mostler, p. 211.

Original description: Shell large, spongy, consisting of several concentric layers. Microsphere latticed. The shell reaches on the ridge around the base of the peripolar spines. Ring transversally elongated elliptical, narrow to moderately broad, in parts of the ring undifferentiated, in other parts with ridge near the inner side of the ring. Outer margin of ring smooth or with one peripolar spine on the long axis poles. Near the base of the peripolar spines tiny auxiliary spines may be present.

Original remarks: *Eospongosaturninus* n. gen. is the forerunner of *Spongosaturninus* Campbell and Clark, 1944b that has more distinct ridges along the whole inner margin of the ring, a latticed second medullary shell and a rather large third medullary shell (transitional to a cortical shell) covered by a still rather thick spongy layer. *Pseudacanthocircus* n. gen. has an undifferentiated ring and the shell reaches never until the ring. *Spongosaturnalis* Campbell and Clark, 1944b displays more distinct ridges along the whole inner margin of the ring and the shell does not reach the ring. *Eospongosaturninus* n. gen. lies in the transition field between the genera *Pseudacanthocircus* n. gen., *Spongosaturninus* Campbell and Clark, 1944b and *Spongosaturnalis* Campbell and Clark, 1944b. The type species is surely the forerunner of *Spongosaturninus* Campbell and Clark, 1944b. In *Eospongosaturninus? bispinosus* (Yao, 1972) the overreach of the shell on the ring is not so distinct and in several specimens the inner ridge on the ring is indistinct, partly even missing (Yao, 1972, pl. 2, fig. 9). The specimen, figured by Yao (1972, pl. 2, fig. 8) as *Spongosaturnalis bispinosus* belongs to an other species and is probably the first representative of the genus *Spongosaturnalis* Campbell and Clark, 1944b. The genus *Acanthocircus* Squinabol, 1903b has strong outer ridges on the ring or the ridges cover the whole ring. A deep furrow on the lateral outer side of the ring is always present. This genus is only homoeomorphic to the Pseudacanthocircidae n. fam. (and in it to *Eospongosaturninus* n. gen.) and evolved from the parasaturnalinid stock.

Further remarks: In disagreement with Kozur and Mostler (1990) we consider that in spite of its name *Eospongosaturninus* has nothing to do with *Spongosaturninus* and is not »in the transition field between the genera *Pseudacanthocircus* Kozur and Mostler, *Spongosaturninus* Campbell and Clark and *Spongosaturnalis* Campbell and Clark«. In the Middle Jurassic the genus should be restrained to the type species. Its main generic character is the three-bladed ring in the middle part and twisting of the ring, the result being the change of the position of the blades from the middle part to the distal part.

Etymology: Forerunner of *Spongosaturninus* Campbell & Clark 1944.

Included species:

2021 *Eospongosaturninus protoformis* (Yao) 1972

Eospongosaturninus protoformis (Yao) 1972

Species code: 2021

Synonymy:

1972 *Spongosaturnalis protoformis* n. sp. – Yao, p. 27, pl. 1, figs. 2-7; pl. 10, figs. 1-2.

1995a *Acanthocircus protoformis* (Yao) – Baumgartner et al., p. 64, pl. 2021, figs. 1-3.

1996 *Acanthocircus protoformis* (Yao) – Yeh & Cheng, p. 108, pl. 2, fig. 11.

Original description: *Spongosaturnalis* with simple ring, where no spine is developed. Shell approximately spherical, spongy, composed of irregular meshes which become denser centrally. Polar spines short, smooth, not always distinguished when shell extends completely across ring. Polar spines change to sturdy spines inside shell. When shell is not preserved, numerous fragmentary thorns are observed on sturdy spines and rarely on ring where each of polar spines bifurcates. Ring generally bilaterally symmetrical or ovoidal, simple, with ridges on both edges near polar spines. Ridge on outer edge extends across ends of polar spines, and another one on inner edge disappears at polar spines. Both ridges become obsolete on terminal end of ring. No spine on ring.

Original remarks: This species may be similar to *Saturnalis simplex* Squinabol (1914, p. 286-287, pl. 22, fig. 2; Jurassic, Fontanafredda (Euganei), Italy) in the shape of the saturnalin ring, but the generic assignment of *S. simplex* is doubtful because the nature of the shell is not known, namely the shell is not preserved and the fragmentary thorns are not observed on the polar spines. *Spongosaturnalis protoformis* differs from *S. bispinus* (described below) in lacking spine on each terminal end of the ring, and in having ridges on both edges of the ring.

Further remarks: In spite of the similarity to *Saturnalis simplex* Squinabol the species differs from the latter by the character of the blades.

***Measurements* (µm):**
Based on 6 specimens.

	HT	Av.	Min.	Max.
Diameter of ring along polar spines	170	191	170	210
Diameter of ring transversaly	335	362	330	420
Diameter of shell	110	153	110	180
Length of polar spine	20	15	7	20
Breadth of ring	11-21	12-20	9	29

Type locality: Manganese carbonate ore, Mino Belt, river side of the Kiso, east of Unuma, Kagamihara City, Gifu Prefecture, Central Japan.

Occurrence: Inuyama area, Japan; Italy; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines; Snowshoe Formation, Oregon.

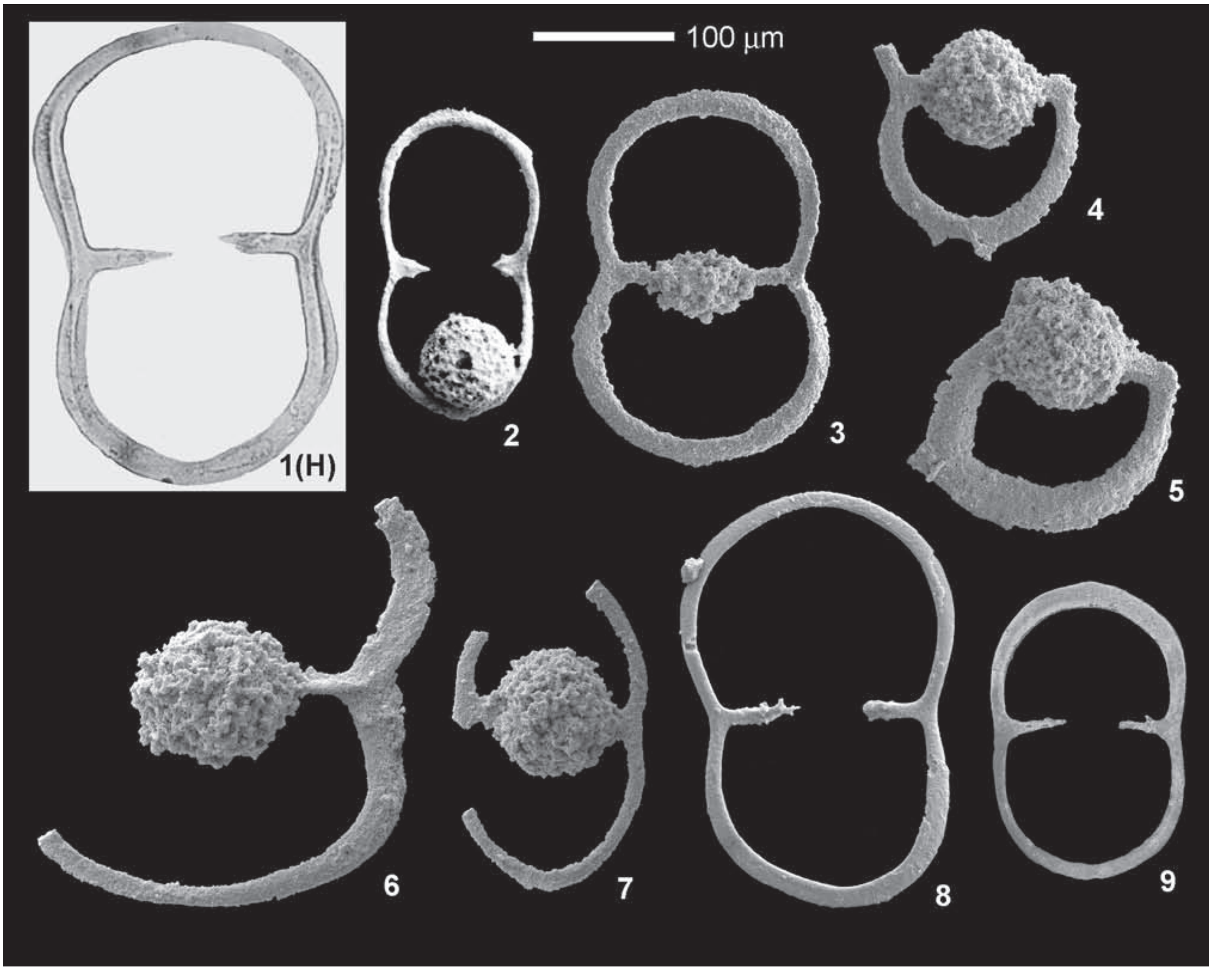


Plate 2021. *Eospongosaturninus protoformis* (Yao). Magnification x200. **Fig. 1(H).** Yao 1972, pl. 1, fig. 2. **Fig. 2.** JP, IYII-17. **Fig. 3.** OM, BR871-R01-08. **Fig. 4.** OM, BR871-R01-11. **Fig. 5.** BR871-R01-05. **Fig. 6.** OM, BR871-R01-12. **Fig. 7.** OM, BR871-R02-12. **Fig. 8.** JP, Nanjo Massif, IH84120462-R05-08. **Fig. 9.** OR555-R07-07.

Genus: *Eucyrtidiellum* Baumgartner 1984

Type species: *Eucyrtidium* (?) *unumaensis* Yao 1979

Synonymy:

1984 *Eucyrtidiellum* n. gen. – Baumgartner, p. 764.
1986 *Monosera* n. gen – Takemura & Nakaseko, p. 1021.
1986 *Eucyrtidiellum* Baumgartner – Takemura, p. 66.
1990 *Eucyrtidiellum* Baumgartner – Nagai & Mizutani, p. 593.

Original description: Test composed of four segments. Cephalis small, spherical, poreless with variably developed straight or slightly oblique apical horn, rare forms with apical and vertical horn. A sutural pore is present at collar stricture or on proximal portion of thorax. Thorax dome-shaped, poreless, with irregular ornamentation consisting of ridges and nodes leaving depressions ("closed pores" of some authors) or with plicae. One or two rows of pores may occur at stricture between thorax and abdomen. Abdomen inflated annular to hemispherical, poreless, except for the distal quarter, where one or two irregular rows of pores may occur. Ornamentation of abdomen varying with species. One row of large pores marks the joint with fourth segment. Fourth segment delicate, mostly cylindrical, covered with circular pores in loose diagonal rows, with a distal poreless constriction.

Original remarks: The Mesozoic species hitherto questionably assigned to *Eucyrtidium* are assigned to this new genus, because they bear no resemblance to the type species *E. acuminatum* (Ehrenberg).

Further remarks: The stratigraphic record and structural features prove that *Eucyrtidiellum* is derived from the genus *Thetis* De Wever, and especially *T. oblonga* De Wever. In fact, the two genera seem to be synonymous: both have four segmented tests where the first three are thicker-walled and the fourth is thin-walled and usually not preserved; a practically imperforate cephalis; and usually an apical horn that is always circular in cross section. What would differentiate *T. oblonga* De Wever, the type species of the genus *Thetis*, from the other species of the genus *Eucyrtidiellum* would be the presence of three thoracic spines representing probably the dorsal and the two primary lateral spines, and the large ventral pore aligned with the ventral spine. However, a ventral pore is present with *Thetis*, or at least the type species. *T. oblonga*? (De Wever, 1982a, pl. 4, fig. 16) seems to show it, and a specimen we illustrate herein from the type sample shows clearly such a pore (see under *T. oblonga*, pl. THT01, fig. 4). The fact that the holotype of *T. oblonga* shows no ventral pore is because it is illustrated in the dorsal position.

Included species:

EUC09 *Eucyrtidiellum disparile* gr. Nagai & Mizutani 1990
EUC10 *Eucyrtidiellum gujoense* (Takemura & Nakaseko) 1986
EUC03 *Eucyrtidiellum gunense* gr. Cordey 1998
EUC06 *Eucyrtidiellum nagaiae* Dumitrica, Goričan & Matsuoka n. sp.
EUC07 *Eucyrtidiellum omanojaponicum* Dumitrica, Goričan & Hori n. sp.
EUC04 *Eucyrtidiellum ramescens* Cordey 1998

Eucyrtidiellum disparile gr. Nagai & Mizutani 1990

Species code: EUC09

Synonymy:

1986 *Eucyrtidiellum* sp. a and sp. a_1 – Nagai, pl. 1, figs. 5, 6.
1986 *Monosera unumaensis* (Yao) – Takemura & Nakaseko, p. 1022, pl. 4, fig. 9.
1987 *Eucyrtidiellum* sp. A – Hattori, pl. 12, figs. 1, 2.
1987 *Eucyrtidiellum* aff. *E. unumaensis* Yao – Hattori, pl. 12, figs. 5, 6.
1988 *Eucyrtidiellum* sp. a – Nagai, pl. 1, figs. 1a-d, 2.
1988 *Eucyrtidiellum* sp. A – Hattori, pl. 8, fig. D.
1988 *Eucyrtidiellum* sp. aff. *E. unumaensis* Yao – Hattori, pl. 8, fig. J.
1989 *Eucyrtidiellum* spp. – Hattori, pl. 7, fig. H.
1989 *Eucyrtidiellum unumaensis* (Yao) - Hattori, pl. 28, Fig. H.
1990 *Eucyrtidiellum disparile* n. sp. – Nagai & Mizutani, p. 594, fig. 3. 6-8a,b,c.
1991 *Eucyrtidiellum* sp. cf. *E. disparile* – Kojima et al., pl. 1, fig. 17.
1993 *Eucyrtidiellum disparile* Nagai & Mizutani – Fujii et al., pl. 1, fig. 13.
1993 *Eucyrtidiellum* sp. a – Fujii et al., pl. 1, fig. 14.
1995 *Eucyrtidiellum disparile* Nagai & Mizutani – Nagai, pl. 4, fig. 3; pl. 5, fig. 8.
1997 *Eucyrtidiellum* aff. *unumaense* (Yao) – Yao, pl. 10, fig. 458.
1998 *Eucyrtidiellum disparile* Nagai & Mizutani – Kashiwagi, pl. 1, fig. 18.
Not 2001 *Eucyrtidiellum disparile* Nagai & Mizutani – Matsuoka et al., pl. 3, fig. 16.
2003 *Eucyrtidiellum disparile* Nagai & Mizutani – Goričan et al., p. 296, pl. 5, figs. 2, 3.
2004 *Eucyrtidiellum disparile* Nagai & Mizutani – Hori, pl. 3, fig. 42; pl. 5, figs. 52-54, not fig. 55; pl. 6, figs. 4-8, pl. 10, fig. 27.
2004 *Eucyrtidiellum* sp. – Ishida et al., pl. 5, fig. 13.
? 2004 *Eucyrtidiellum disparile* Nagai & Mizutani – Matsuoka, fig. 177.
2004 *Eucyrtidiellum disparile* Nagai & Mizutani – Suzuki & Ogane, pl. 8, fig. 2.
2005 *Eucyrtidiellum* aff. *disparile* Nagai & Mizutani – Hori, pl. 8, fig. 20.
2005 *Eucyrtidiellum disparile* Nagai & Mizutani – Hori, pl. 8, fig. 21; pl. 12, figs. 18-20, 49; pl. 13, figs. 24-25.
2005 *Eucyrtidiellum disparile* Nagai & Mizutani – Kashiwagi et al., pl. 6, fig. 11.

Original diagnosis: Abdomen has circular pores regularly arranged along two diagonal lines on its whole surface.

Original description: This species has a test which is composed generally of three segments, cephalis, thorax and abdomen. Cephalis is small, spherical with a medium-sized apical horn. Sutured pores are arranged at a stricture between thorax and abdomen. Thorax truncated-conical with closed pores and irregular hexagonal meshworks on the whole surface. Abdomen is relatively large and inflated-hemispherical, with circular pores regularly arranged along two diagonal lines on its whole surface.

Original remarks: External shell form of *Eucyrtidiellum disparile* is almost identical with that of *E. unumaense*, but differs in having pores on its entire abdomen. Many specimens of *Eucyrtidiellum* have been provisionally described as *Eucyrtidium* (?) sp. or *Eucyrtidiellum* (?) sp., just because of the presence of opened pores in their abdomen.

Further remarks: Although initially we were tempted to separate this species into two subspecies, one with shorter apical horn, the other with longer apical horn, we decided against this because, except for the length of this horn, the test morphology is similar in almost all the other respects. The specimen determined by Matsuoka (2004) as *E. disparile* is questionably included in the synonymy of this species because it lacks pores on the middle part of the abdomen. Accordingly, this specimen is closer to *E. unumaense* (Yao) and looks intermediary between the two species. This would prove that the evolutionary trend giving rise to *E. unumaense* started in the early Toarcian.

Measurements (μm):
Based on 10 specimens.

	Min.	Max.	Av.
Height of apical horn	3	13	8
Height of entire body including cephalis, thorax and abdomen	67	100	79
Height of cephalis	5	19	13
Width of cephalis	8	21	17
Height of thorax	14	23	18
Width of thorax	31	38	35
Height of abdomen	41	66	48
Width of abdomen	48	77	71

Etymology: Derived from Latin adjective *disparilis, -e*, which means unlike or dissimilar.

Type locality: Sample MNHK05, Kamiaso, Mino Terrane, central Japan.

Occurrence: Japan; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman.

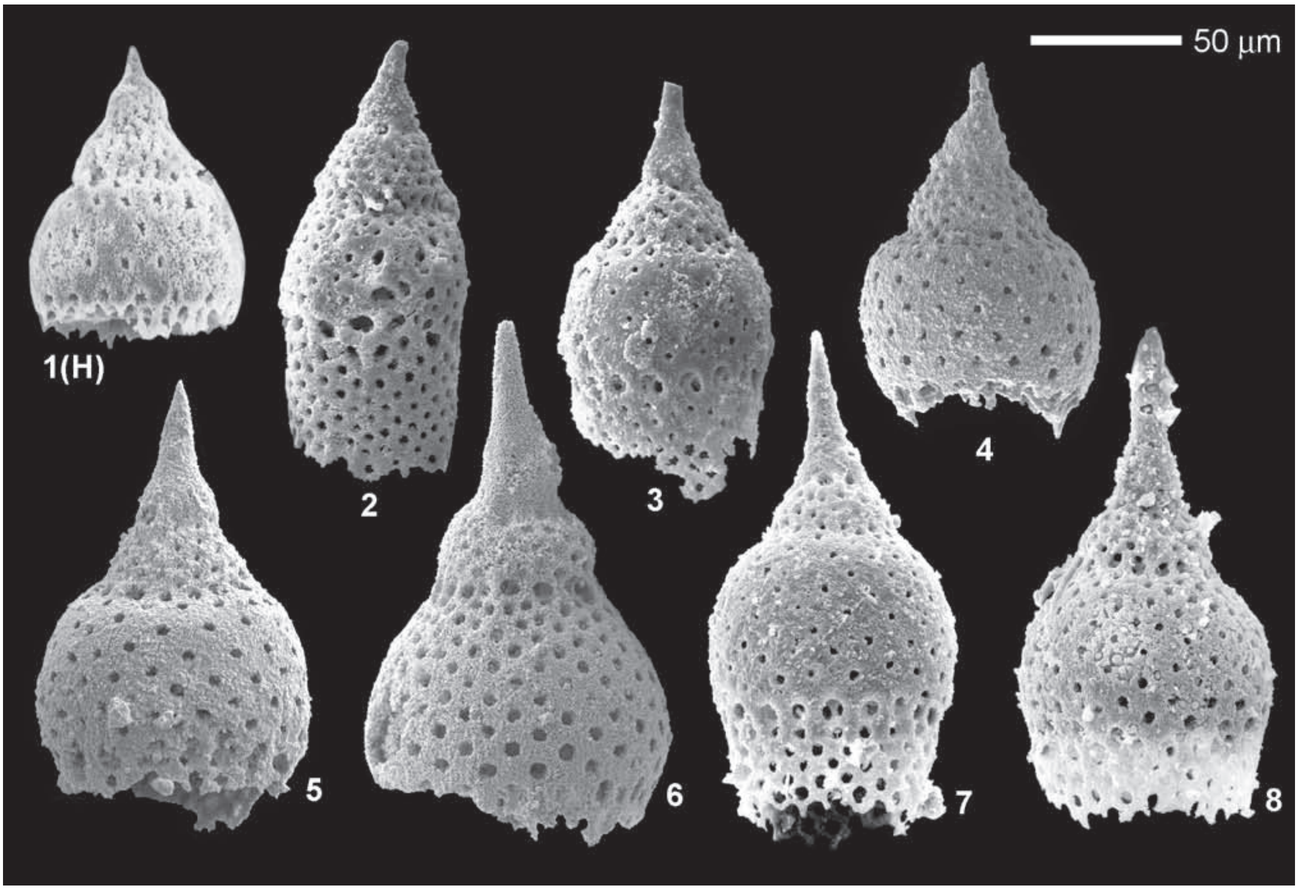


Plate EUC09. *Eucyrtidiellum disparile* gr. Nagai & Mizutani. Magnification x400. **Fig. 1(H).** Nagai & Mizutani 1990, fig. 3-8c. **Fig. 2.** Goričan et al. 2003, pl. 5, fig. 2. **Fig. 3.** Goričan et al. 2003, pl. 5, fig. 3. **Fig. 4.** OM, BR1121-R06-10. **Fig. 5.** OM; BR1121-R06-24. **Fig. 6.** OM, BR706-R13-03. **Fig. 7. JP,** MNA-10, MA13437. **Fig. 8.** JP, MNA-10, MA11896.

Eucyrtidiellum gujoense (Takemura & Nakaseko) 1986

Species code: EUC10

Synonymy:

1986 *Monosera gujoensis* n. sp. – Takemura & Nakaseko, p. 1022, figs. 4.10, 4.11, 5.1-5.3.
1986 *Eucyrtidiellum gujoensis* (Takemura & Nakaseko) – Takemura, p. 67, pl. 12, figs. 13-15.
1986 *Eucyrtidiellum* sp. e – Nagai, p. 14, pl. 1, figs. 3a-c.
1987 *Eucyrtidiellum gujoensis* – Hattori, pl. 12, figs. 14, 15.
1989 *Eucyrtidiellum* sp. aff. *E. gujoensis* Takemura – Hattori & Sakamoto, pl. 10, fig. B.
1988 *Eucyrtidiellum gujoensis* (Takemura & Nakaseko) – Nagai, pl. 2, figs. 5, 9.
1988 *Eucyrtidiellum* sp. f – Nagai, pl. 2, fig. 8.
1989 *Tethys oblonga* De Wever – Hattori, pl. 7, figs. C, D.
1989 *Eucyrtidiellum gujoensis* Takemura & Nakaseko – Nagai, pl. 1, fig. 7; pl. 2, fig. 7a-b; pl. 3, fig. 7; pl. 4, fig. 5.
1995 *Eucyrtidiellum gujoensis* Takemura – Nagai, pl. 5, fig. 9.
1995 *Eucyrtidiellum* sp. f – Nagai, pl. 5, fig. 10.
1997 *Eucyrtidiellum* sp. D0 – Yao, pl. 10, fig. 452.
2001 *Eucyrtidiellum disparile* Nagai & Mizutani – Matsuoka et al., pl. 3, fig. 16.
2002 *Eucyrtidiellum gujoense* (Takemura & Nakaseko) – Hori & Wakita, pl. 3, fig. 4.
2004 *Eucyrtidiellum gujoense* (Takemura & Nakaseko) – Matsuoka, fig. 178.
2004 *Eucyrtidiellum* sp. D0 sensu Yao – Hori, pl. 2, fig. 8.

Original diagnosis: A species of *Monosera* characterized by the existence of pore frames on abdominal surface and by irregular or longitudinal arrangement and dense distribution of abdominal pores.

Original description: Cephalis small, spherical to subspherical, poreless with a strong rod-like apical horn. Thorax truncated conical to subhemispherical with usually irregularly arranged pores or relict pores. Abdomen subspherical with pores on surface. Abdominal pores with pore frames, longitudinally or irregularly distributed in great density. Fourth segment inflated-cylindrical with irregularly distributed pores. Cephalic structure same as genus.

Original remarks: *Monosera gujoensis* n. sp. is distinguished from *M. unumaensis* by the presence of abdominal pore frames and the distribution and density of abdominal pores. *Monosera gujoensis* differs from *Eucyrtidium ptyctum* Riedel and Sanfilippo in the absence of plicae on the surface of the abdomen and in the presence of abdominal pores and pore frames.

Further remarks: Morphologically *E. gujoense* is very close to *Thetis oblonga* De Wever from which it differs in having a shorter, conical apical horn, and lacks spines on the thorax, and shoulders on the upper third of the abdomen.

Measurements (μm):
Based on 15 specimens.

	Min.	Max.
Length of apical horn	10	50
Height of cephalis	15	20
Height of thorax	20	30
Height of abdomen	40	50
Width of cephalis	20	25
Width of thorax	40	50
Width of abdomen	70	90

Etymology: The trivial name, *gujoensis*, is derived from the Gujo County, Gifu Prefecture, Japan.

Type locality: Manganese carbonate ore deposits (sample TKN-105) from the Gujo-hachiman area of the Mino Terrane, Japan.

Occurrence: Japan; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

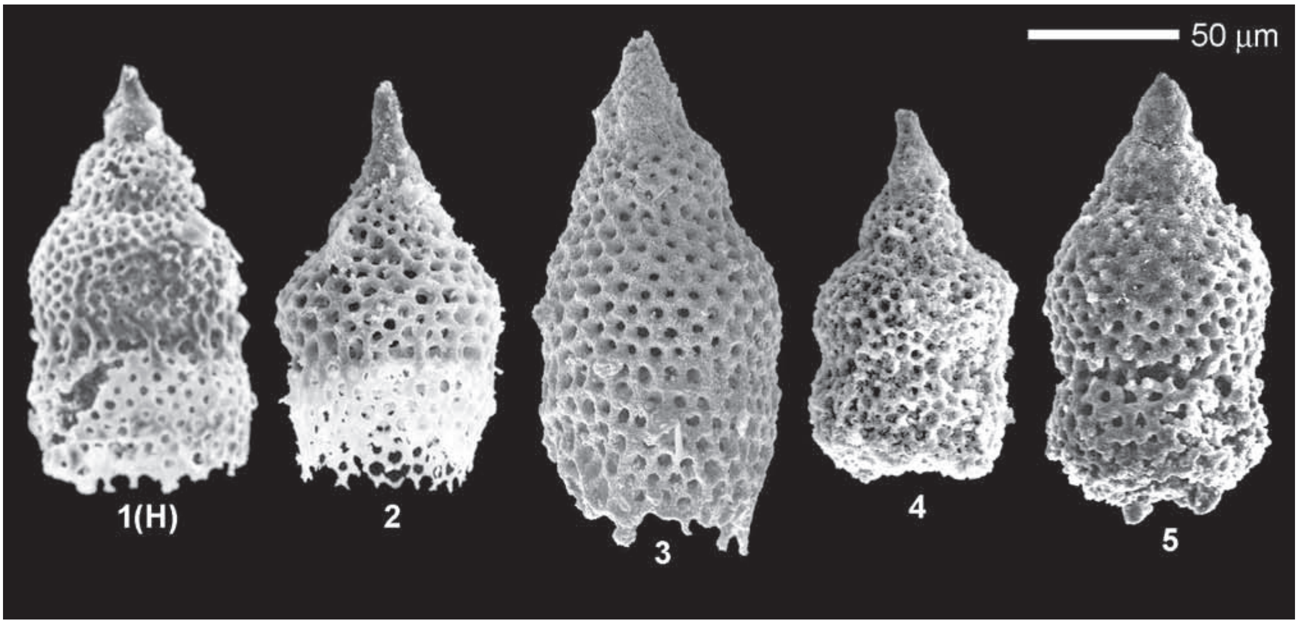


Plate EUC10. *Eucyrtidiellum gujoense* (Takemura & Nakaseko). Magnification x400. **Fig. 1(H).** Takemura & Nakaseko 1986, fig. 4-10. **Fig. 2.** Matsuoka 2004, fig. 178. **Fig. 3.** OM, BR1121-R08-28. **Fig. 4.** OM-00-252, 021905. **Fig. 5.** OM-00-258, 022630.

***Eucyrtidiellum gunense* gr.** Cordey 1998

Species code: EUC03

Synonymy:

1982 *Eucyrtidium* (?) sp. C – Imoto et al., pl. 1. fig. 9.
1984 *Eucyrtidiellum* sp. A – Murchey, pl. 2, fig. 25.
1984 *Eucyrtidiellum* sp. B – Murchey, pl. 2, fig. 26.
1986 *Eucyrtidiellum* sp. C group – Nagai, p. 12, pl. 2, fig. 10, not 11-12.
1987 *Eucyrtidiellum* sp. C – Hattori, pl. 12, fig. 10.
1990 *Eucyrtidiellum* sp. C3 – Nagai, pl. 4, fig. 2, 3.
1992 *Eucyrtidiellum* sp. – Sashida, pl. 1, figs. 19, 20.
1995 *Eucyrtidiellum* sp. C – Nagai, pl. 4, fig. 6.
1997 *Eucyrtidiellum* sp. Q0 – Yao, pl. 10, fig. 453.
1998 *Eucyrtidiellum gunensis* n. sp. – Cordey, p. 109, pl. 25, figs. 8-9.
2004 *Eucyrtidiellum* sp. Q0 sensu Yao – Hori, pl. 2, fig. 7.
2004 *Eucyrtidiellum gunense* Cordey – Matsuoka, fig. 180.
2005 *Eucyrtidiellum* sp. C sensu Nagai – Hori, pl. 8, figs. 16-18, not fig. 19.

Original diagnosis: *Eucyrtidiellum* with a long and massive apical horn.

Original description: Shell with four segments. Cephalis cylindrical and seems incorporated into the proximal part of the long, stout apical horn. Diameter of base of horn same as cephalis; decreasing progressively to the generally sharp tip. Sutural pore observed at base of horn. Thorax small, without pores proximally and smooth or with small costae. Abdomen wide, sphaeroidal, porous and without costae. One row of large pores separates abdomen form fourth segment which is seldom preserved. Fourth segment made of thick pore frames with a loose network.

Original remarks: This form is close to *E. gujoensis* (Takemura and Nakaseko), but differs mainly by having a much stouter and longer apical horn (horn includes cephalis). *E. gujoensis* is known only from the Middle Jurassic while *E. gunense* n. sp. appears during the Lower Jurassic. This new morphotype shows apparent affinities with species attributed to genus *Thetis* De Wever (*Thetis undulata* De Wever, 1982a, p. 196, pl. 5, fig. 8, 9, ?*Thetis oblonga* De Wever, 1982a, p. 196, pl. 4, fig. 15-16); cephalic structure of *Thetis* has not been observed by its author, but this genus possesses three external cephalic spines, which are probably external extensions of inner cephalic spines (De Wever, personal communication, 1987). However, the cephalic structure of *Eucyrtidiellum* does not have these three spines; this implies true phylogenetic differences between *Eucyrtidiellum* and *Thetis* in spite of the common external resemblance of certain species.

Further remarks: Most specimens from Oman and Japan included in this species do not correspond perfectly to the original diagnosis and differ significantly from the holotype, but to a lesser extent from the paratype. The apical horn is shorter and conical in our specimens, and the thorax is larger, well marked by the cortical and lumbar constrictions and is either truncate conical or convex in outline. The thorax is also completely porous whereas the original description mentions that it is poreless proximally. The abdomen is also different: the holotype shows a sphaeroidal abdomen but the abdomen of the paratype is also truncated conical. The original description also mentions a row of large pores separating the abdomen from the postabdominal segment. Our study shows that there are no such pores at the postlumbar boundary, but false pores (when existing) result from some ribs superposed on the test in different directions, most in a longitudinal direction. The fourth segment is wide open and inverted truncate conical, in some specimens (pl. EUC03, figs. 3, 4) it is almost closed distally.

One of the characteristic features of this species, besides those mentioned in the original description or in the paragraph above, is that the abdominal pores are commonly aligned in oblique rows and, consequently, most are rhombically framed. Also the surface of the abdomen may have some oblique ribs representing thickened intervening bars.

E. gunense is very close to *Thetis oblonga* but differs in having the cephalis less marked, and lacking thoracic spines, and in having thick ribs on the entire postabdominal segment or only proximally around the postlumbar stricture.

Etymology: From the name of a local stream Gun.

Type locality: Locality GSC C-300407, Bridge River Complex, Carpenter Lake, British Columbia.

Occurrence: Bridge River Complex, British Columbia; Hyde Formation, Oregon; Franciscan Complex, California; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

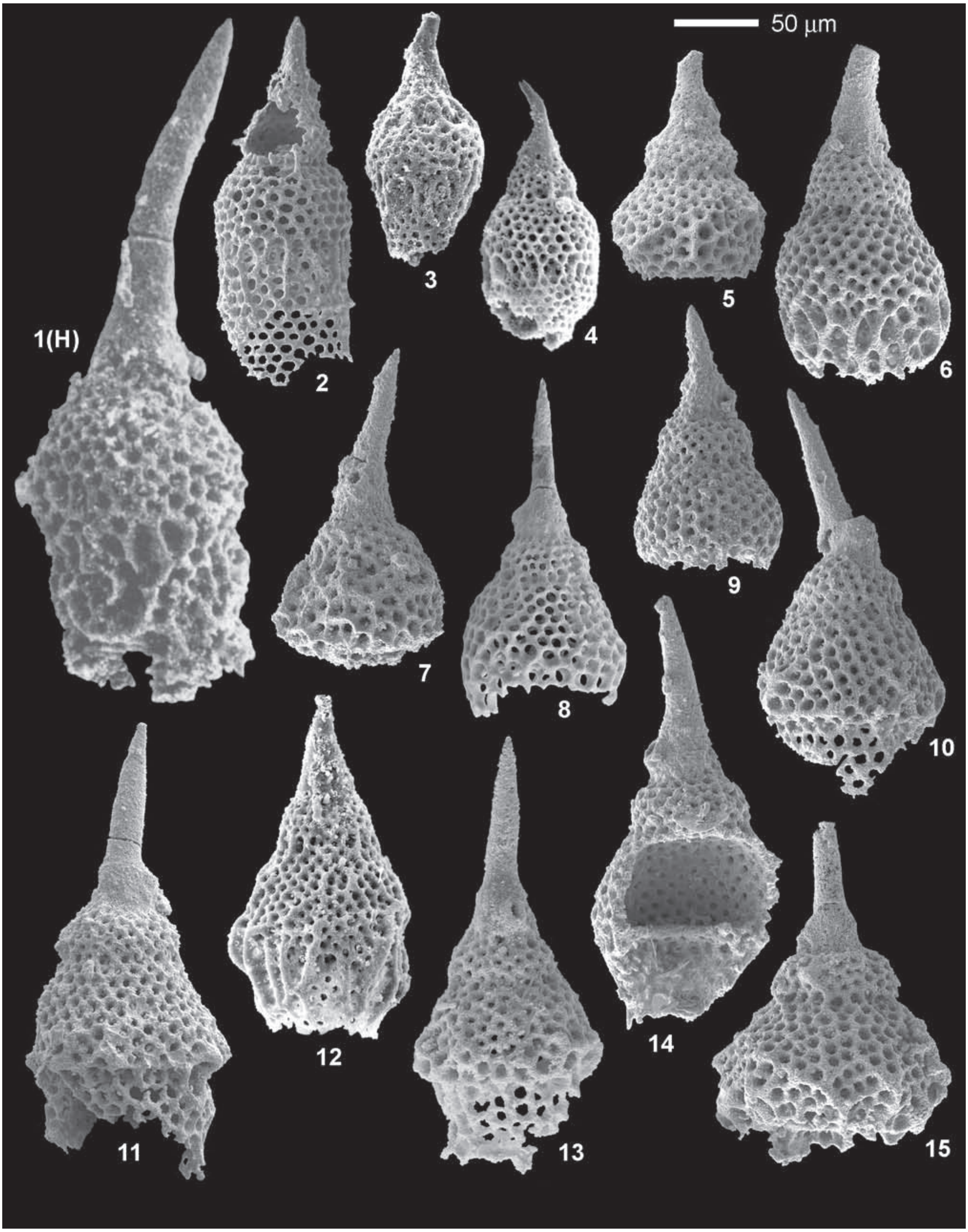


Plate EUC03. *Eucyrtidiellum gunense* gr. Cordey. Magnification x300. **Fig. 1(H).** Cordey 1998, pl. 25, fig. 8. **Fig. 2.** OR600A-R03-01. **Fig. 3.** SI, MM11.76, 010211. **Fig. 4.** OM-99-83, 011312. **Fig. 5.** OM, BR1121-R06-25. **Fig. 6.** OM, BR1121-R08-27. **Fig. 7.** OM, BR1121-R08-03. **Fig. 8.** OM; BR524-R04-19. **Fig. 9.** OM, BR1122-R02-1. **Fig. 10.** OM, BR1122-R02-14. **Fig. 11.** OM; BR1121-R08-21. **Fig. 12.** Matsuoka 2004, fig. 180. **Fig. 13.** OM, BR523-R03-08. **Fig. 14.** OM, BR1121-R08-24. **Fig. 15.** OM, BR1121-R08-06.

Eucyrtidiellum nagaiae Dumitrica, Goričan & Matsuoka n. sp.

Species code: EUC06

Synonymy:

1986 *Eucyrtidiellum* sp. C_2 – Nagai, pl. 2, fig. 12.
1987 *Eucyrtidiellum* sp. C_2 – Hattori, pl. 12, fig. 12.
1989 *Eucyrtidiellum* spp. – Hori & Otsuka, pl. 4, fig. 3, not figs. 1, 2.
1990 *Eucyrtidiellum* sp. C_2 – Nagai, pl. 4, figs. 1a-c.
1995 *Eucyrtidiellum* sp. C_2 – Nagai, pl. 4, figs. 7a-b, 8.
1997 *Eucyrtidiellum* sp. X – Yao, pl. 10, fig. 456.
1997 *Eucyrtidiellum* sp. Y – Yao, pl. 10, fig. 457.
2003 *Eucyrtidiellum* sp. C_2 sensu Nagai – Kashiwagi & Kurimoto, pl. 4, figs. 8, 9.
2004 *Eucyrtidiellum* sp. – Matsuoka, fig. 179.

Type designation: Holotype specimen MA13547 (pl. EUC06, figs. 1a,b) from sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Diagnosis: *Eucyrtidiellum* with stout apical horn and strong longitudinal abdominal costae separated by 2-4 longitudinal rows of pores.

Description: Test composed of three segments. Cephalis smooth, poreless, incorporated into a long, stout, pointed apical horn, circular in cross-section throughout length. Sutural pore situated in the proximal part of the cephalis. Thorax larger, trapezoidal in outline, with a regular meshwork of polygonal pore frames. Abdomen inflated, porous, ornamented with 7-9 strong, continuous vertical costae visible laterally. Pores on abdomen circular; number of pore rows between adjacent costae may vary from two (rarely one) to four on a single specimen.

Remarks: *Eucyrtidiellum nagaiae* n. sp. differs from *E. ramescens* Cordey by having well-individualized costae throughout the abdomen. The wall of the abdomen is otherwise smoother, perforate but the pore frames do not form coalescent thickenings as in *E. ramescens* and the apical horn is shorter. The stout apical horn and the rows of intercostal pores also differentiate this species from *E. ptyctum* (Riedel & Sanfilippo).

Measurements (μm):
Based on 8 specimens.

	HT	Min.	Max.	Mean
Height of cephalis and apical horn	86	37	86	57
Width of cephalis at base	40	20	43	29
Height of thorax	24	20	32	25
Maximum width of thorax	58	40	58	48
Height of abdomen	107	47	114	80
Maximum width of abdomen	112	77	118	95

Etymology: Named for Hiromi Nagai, Nagoya University, to honour her contribution to the knowledge of Mesozoic Radiolaria and especially of *Eucyrtidiellum*.

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Occurrence: Nanjo Massif, Mino Terrane, Japan; Hyde Formation, Oregon; Musallah Formation, Oman.

Eucyrtidiellum omanojaponicum Dumitrica, Goričan & Hori n. sp.

Species code: EUC07

Synonymy:

1990 *Eucyrtidiellum* (?) sp. C group – Hori, fig. 8. 27.
1997 *Eucyrtidiellum* sp. C group of Nagai – Hori, pl. 1, fig. 12.

Type designation: Holotype specimen 15862 (pl. EUC07, fig. 1) from sample BR1122, Tawi Sadh Member of the Guwayza Formation, Wadi Mu'aydin, Oman.

Diagnosis: *Eucyrtidiellum* with numerous thin, longitudinal abdominal costae and a row of pores in each intercostal depression.

Description: Test composed of four segments of which only the first three are completely preserved. Cephalis integrated into the proximal part of the long, stout conical apical horn and visible as a slightly inflated portion at the base of the latter. Diameter of horn at base the same as cephalis, decreasing progressively to the sharp tip. Thorax small, truncate conical with convex sides and numerous small pores disposed irregularly. Abdomen wide, subglobular and porous; pores circular aligned in longitudinal rows, each row separated by thin costae. Fourth segment preserved only as remains.

Remarks: The species is very rare and is described based on 3 specimens only. *E. omanojaponicum* n. sp. resembles *E. nagaiae* n. sp. in having longitudinal abdominal costae, but the costae are weaker and separated by a single row of pores whereas *E. nagaiae* has 2-4 rows of pores in the intercostal intervals.

Measurements (μm):
Based on 3 specimens.

	HT	Min.	Max.
Length of apical horn + cephalis	59	38	84
Length of thorax	27	26	30
Length of abdomen	65	54	86
Diameter of cephalis	24	24	27
Diameter of thorax	55	45	55
Diameter of abdomen	93	83	105

Etymology: From its occurrence in Oman and Japan.

Type locality: Sample BR 1122 from theTawi Sadh Member of the Guwayza Formation, Wadi Mu'aydin, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

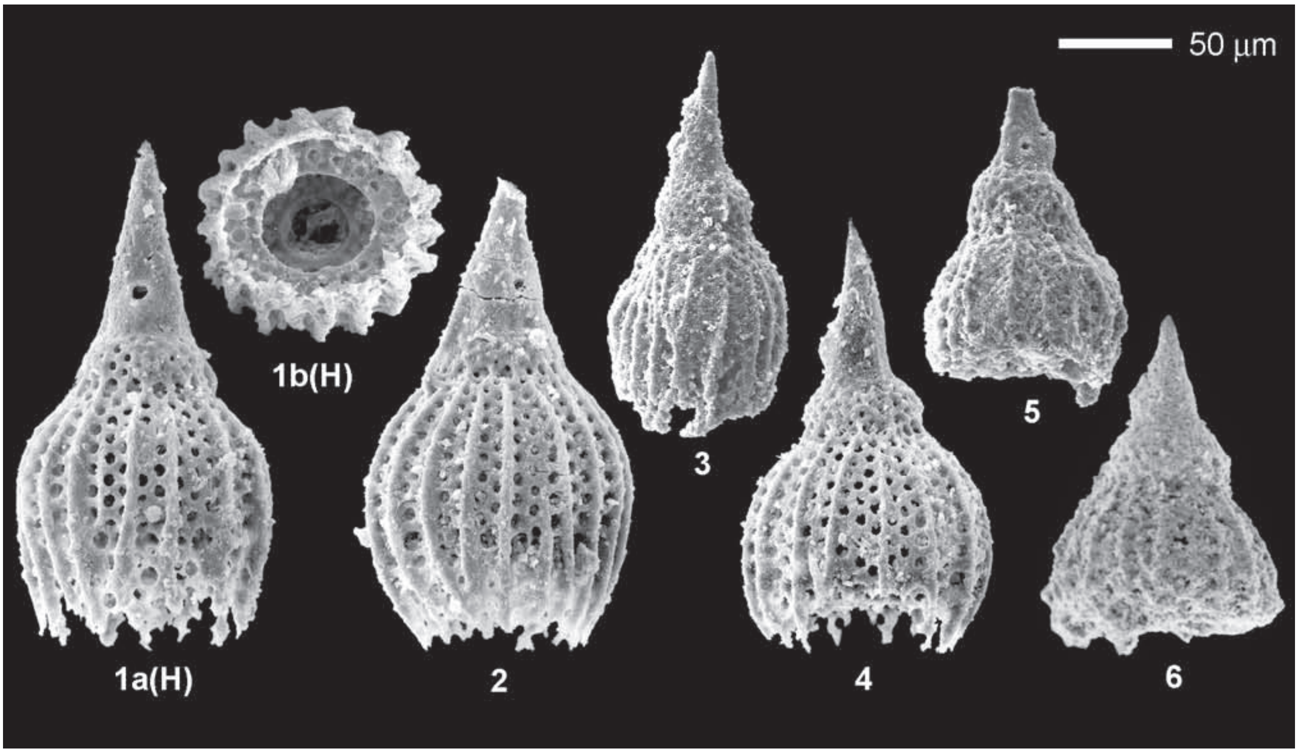


Plate EUC06. ***Eucyrtidiellum nagaiae*** **Dumitrica, Goričan & Matsuoka n. sp.** Magnification x300. **Fig. 1a,b(H).** JP, MNA-10, MA13547, MA13548. **Fig. 2.** JP, MNA-10, MA12501. **Fig. 3.** OM-00-255, 022326. **Fig. 4.** JP, MNA-10, MA12499. **Fig. 5.** OM-00-254, 022126. **Fig. 6.** Hori & Otsuka 1989, pl. 4, fig. 3.

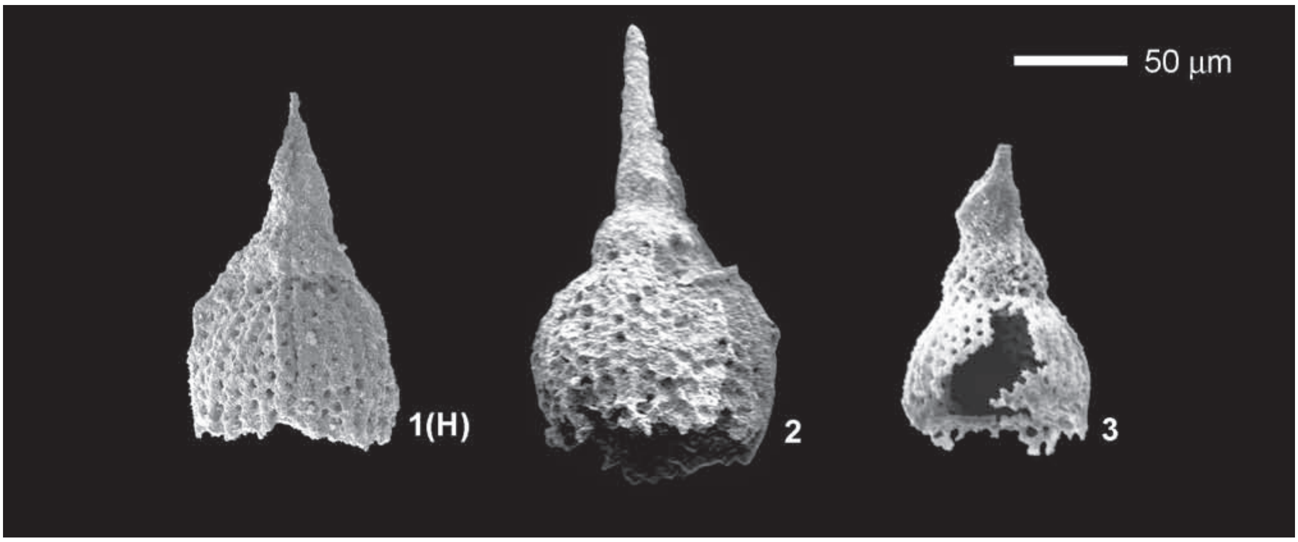


Plate EUC07. ***Eucyrtidiellum omanojaponicum*** **Dumitrica, Goričan & Hori n. sp.** Magnification x300. **Fig. 1(H).** OM, BR1122-R04-04. **Fig. 2.** Hori 1990, fig. 8-27. **Fig. 3.** OM-00-92, 011110.

Eucyrtidiellum ramescens Cordey 1998
Species code: EUC04

Synonymy:
1982 *Eucyrtidium* (?) sp. C – Yao et al., pl. 2, fig. 12.
1982 »*Eucyrtidium*« sp. – Nishizono et al, pl. 2, fig. 13.
1986 *Eucyrtidiellum* sp. C_1 – Nagai, pl. 2, fig. 11.
1987 *Eucyrtidiellum* sp. C_1 – Hattori, pl. 12, fig. 11.
1995 *Eucyrtidiellum* sp. C_1 – Nagai, pl. 4, fig. 5.
1998 *Eucyrtidiellum ramescens* n. sp. – Cordey, p. 110, pl. 25, figs. 7, 11-13.
2004 *Eucyrtidiellum* sp. C_1 sensu Nagai – Hori, pl. 5, fig. 24.
2005 *Eucyrtidiellum* sp. C sensu Nagai – Hori, pl. 8, fig. 19, not figs. 16-18.

Original diagnosis: *Eucyrtidiellum* with a very long apical horn and massive, porous abdominal costae.

Original description: Test composed of four segments. Cephalis cylindrical and appears integrated into the proximal part of the long, stout apical horn. Diameter of horn at base, the same as cephalis, decreasing progressively to the sharp tip. Sutural pore situated in proximal part or near the collar edge. Thorax small, without pores in proximal part and smooth or with small costae. Abdomen wide, sphaeroidal and porous; pores circular without specific alignment. Some pore-frames reinforced near proximal part of abdomen and become thicker distally giving rise to longitudinal costae, sometimes transversally connected. One row of large pores separates abdomen from fourth segment which is seldom preserved. Fourth segment composed of thick pore frames with a loose network.

Original remarks: This form differs from *E. gunensis* n. sp. by the presence of thick abdominal and post-abdominal costae.

Etymology: From Latin *ramus* (branch).

Type locality: Locality GSC C-300407, Bridge River Complex, lake Carpenter, British Columbia.

Occurrence: Bridge River Complex, British Columbia; Musallah Formation, Oman; Japan.

Genus: ***Farcus*** Pessagno, Whalen & Yeh 1986
Type species: *Farcus graylockensis* Pessagno, Whalen & Yeh 1986

Synonymy:
1986 *Farcus* n. gen. – Pessagno, Whalen & Yeh, p. 23.

Original diagnosis: Test as with family but possessing a single, massive apical horn that is attached to the apical bar. Thorax lacking tubular, velum-like structure distally.

Original description of family Farcidae (Pessagno, Whalen & Yeh 1986, p. 22): Test dicyrtid with single layer of latticed meshwork on both cephalis and thorax. Latticed layer of cephalis and occasionally proximal portion of thorax covered by thin outer layer of microgranular silica. Cephalis large, hemispherical with one horn (e.g., *Farcus* n. gen.), or two horns (e.g., *Rolumbus* n. gen.), which are triradiate in axial section. Cephalic skeletal elements cyrtoid, including vertical bar, primary left lateral bar, primary right lateral bar, median bar, secondary left lateral bar, secondary right lateral bar, and apical bar (dorsal bar absent). Thorax large, inflated, with four (rarely five) feet that are triradiate in axial section. Four feet opposed to two primary lateral and two secondary lateral bars; fifth foot, if present, opposed to vertical bar. Base of thorax hemispherical with centrally-placed circular aperture (mouth) that has an imperforate rim. Thorax with (e.g., *Rolumbus*, n. gen.) or without (e.g., *Farcus*, n. gen.) fragile tubular, velum-like structure extending distally from aperture (mouth) of well-preserved specimens.

Original remarks: *Farcus* n. gen., is compared to *Rolumbus* n. gen., under the latter genus.

Etymology: *Farcus* (masc.) is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 4, p. 113).

Included species:
FAR02 *Farcus asperoensis* Pessagno, Whalen & Yeh 1986
FAR04 *Farcus graylockensis* Pessagno, Whalen & Yeh 1986
FAR03 *Farcus kozuri* Yeh 1987b

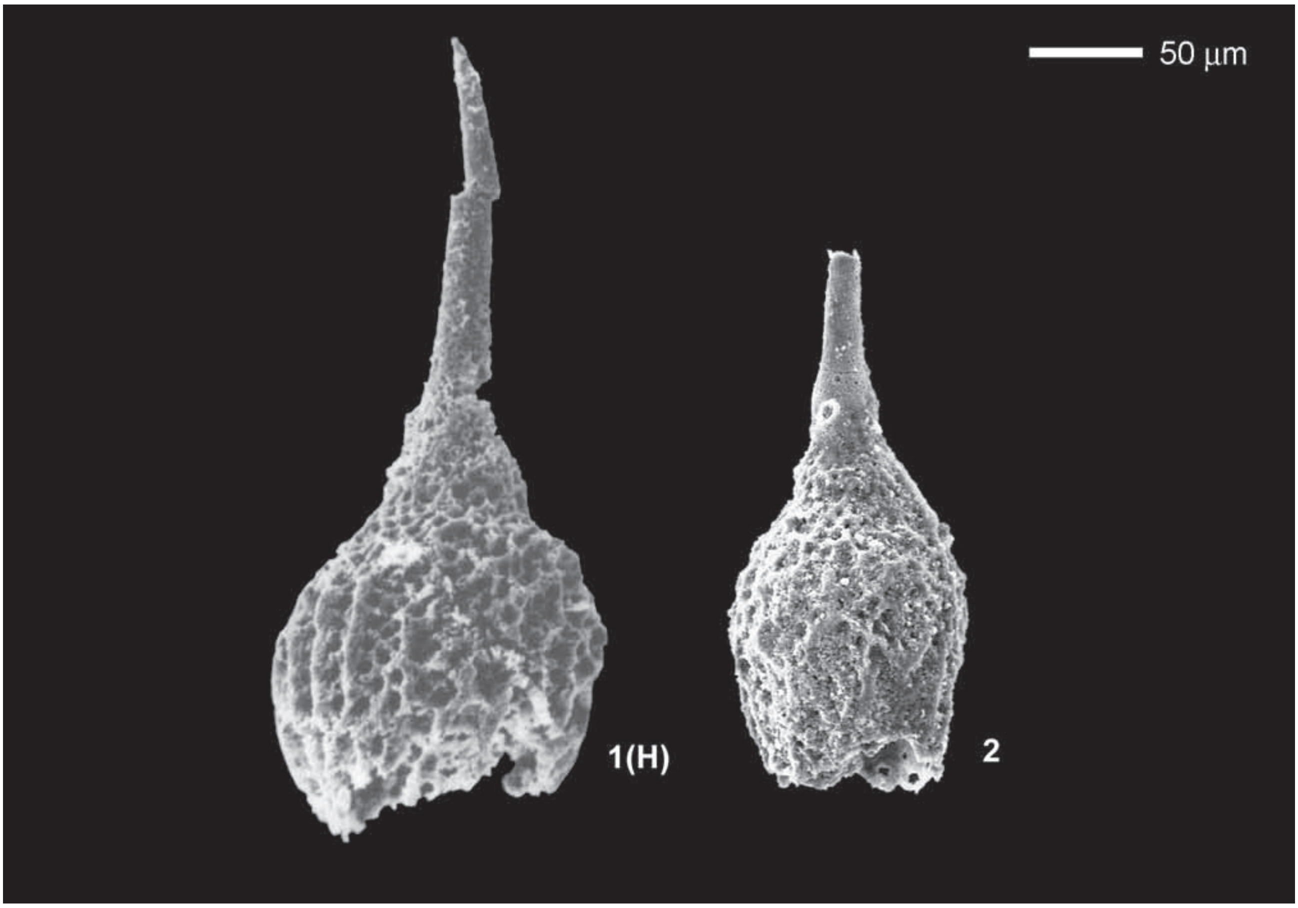


Plate EUC04. ***Eucyrtidiellum ramescens*** **Cordey.** Magnification x300. **Fig. 1(H).** Cordey 1998, pl. 25, fig. 7.
Fig. 2. OM-00-118, 000702.

Farcus asperoensis Pessagno, Whalen & Yeh 1986

Species code: FAR02

Synonymy:

1986 *Farcus asperoensis* n. sp. – Pessagno, Whalen & Yeh, p. 23, pl. 3, figs. 12, 16, 17, 21; pl. 11, fig. 9.

2002 *Farcus asperoensis* Pessagno, Whalen & Yeh – Whalen & Carter, p. 124, pl. 11, figs. 3, 11, 15.

Original diagnosis: Cephalis medium-sized, hemispherical, with single, massive triradiate horn; cephalis commonly covered by layer of microgranular silica. Horn triradiate in axial section with rounded, longitudinal ridges and narrow grooves. Thorax with small, polygonal pore frames, commonly partially covered by a thin layer of microgranular silica. Four feet, medium-sized, triradiate in axial section with narrow, rounded longitudinal ridges and broad grooves. Four feet commonly attached to base of thorax, although on some specimens two of the feet are attached part way up the thorax. Circular mouth surrounded by imperforate rim.

Original remarks: *Farcus asperoensis* n. sp., differs from other species of *Farcus* by the nature of the distinctive imperforate rim surrounding the mouth. An undescribed species of *Farcus* (Pl. 11, fig. 14) from the Hyde Formation of east-central Oregon possesses an elongated thorax and massive horn similar to those of *F. asperoensis*, n. sp.

Measurements (µm):

Numbers of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
length of cephalis	20	22.3 (9)	30 (9)	18 (9)
length of thorax	80	80 (9)	90 (9)	70 (9)
width of thorax at top	48	50.5 (9)	64 (9)	43 (9)
width of thorax at base	50	61.2 (8)	70 (8)	50 (8)
length of horn	48	64.6 (9)	80 (9)	48 (9)
width of horn at base	13	20.4 (9)	25 (9)	13 (9)
length of foot (maximum)	32	61.3 (9)	80 (9)	32 (9)

Etymology: This species is named for Pico Aspero, which is located east of its type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Musallah Formation, Oman.

Farcus graylockensis Pessagno, Whalen & Yeh 1986

Species code: FAR04

Synonymy:

1986 *Farcus graylockensis* n. sp. – Pessagno, Whalen & Yeh, p. 24, pl. 2, figs. 4, 6-8, 12, 15.

1987b *Farcus graylockensis* Pessagno, Whalen & Yeh – Yeh, p. 76, pl. 1, fig. 7.

1996 *Farcus graylockensis* Pessagno, Whalen & Yeh – Pujana, p. 139, pl. 1, fig. 7.

1997 *Farcus graylockensis* Pessagno, Whalen & Yeh – Yao, pl. 8, fig. 395.

1997 *Farcus* aff. *kozuri* Yeh – Yao, pl. 8, fig. 396.

2002 *Farcus graylockensis* Pessagno, Whalen & Yeh – Tekin, p. 189, pl. 4, fig. 2.

Original diagnosis: Single horn wide, massive, triradiate in axial section; horn comprised of three wide, wedge-shaped grooves alternating with three wide, rounded ridges. Thorax with massive, uniformly-sized tetragonal and pentagonal pore frames. Feet moderately long, triradiate in axial section; three longitudinal grooves deep, wider proximally than distally, wedging out distally; three longitudinal ridges rounded, becoming progressively narrower distally.

Original remarks: This species differs from similar forms among the Hilarisiregidae Takemura and Nakaseko, 1982, by possessing a dicyrtid test, and considerably different wall structure (see Pl. 1, figs. 4, 5, 10).

Measurements (µm):

Based on 10 specimens.

	HT	Mean	Max.	Min.
length of cephalis	25	25.7	30	20
length of thorax	100	92.5	100	75
width of thorax at top	62.5	63.7	87.5	50
width of thorax at base	112.5	106.2	120	100
length of horn	70	72.7	87.5	62.5
width of horn at base	25	23.5	25	20
length of foot (maximum)	95	96.5	125	75

Etymology: *Farcus graylockensis* n. sp., is named for Graylock Butte, which is located north of its type locality.

Type locality: OR-536, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Sierra Chacaicó Formation, Argentina; Hocaköy Radiolarite, Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

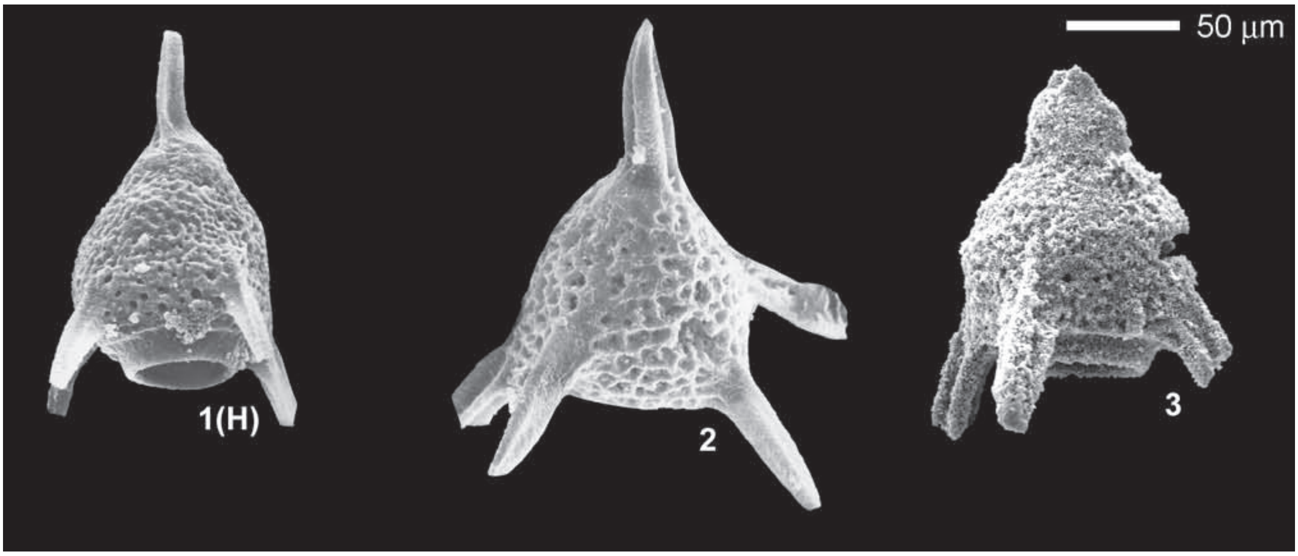


Plate FAR02. ***Farcus asperoensis*** **Pessagno, Whalen & Yeh.** Magnification x300. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 12. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 16. **Fig. 3.** OM-00-251, 021607.

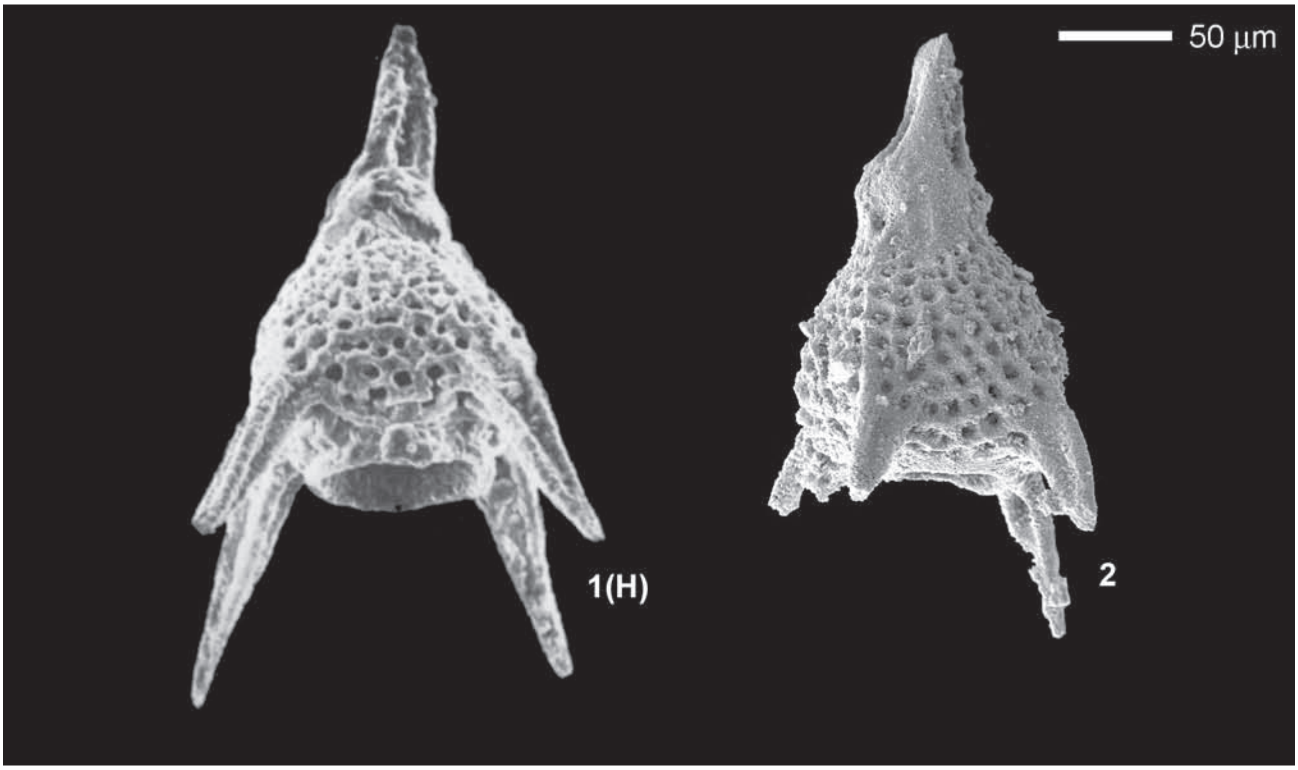


Plate FAR04. ***Farcus graylockensis*** **Pessagno, Whalen & Yeh.** Magnification x300. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 2, fig. 6. **Fig. 2.** OM, BR1122-R01-09.

Farcus kozuri Yeh 1987b

Species code: FAR03

Synonymy:

1986 *Farcus* sp. A – Pessagno, Whalen & Yeh, p. 24, pl. 3, fig. 4.
1986 *Farcus* sp. B – Pessagno, Whalen & Yeh, p. 24, pl. 3, fig. 13.
1987b *Farcus kozuri* n. sp. – Yeh, p. 75, pl. 1, figs. 2, 6, 13.

Original description: Test dicyrtid, cephalis medium in size, hemispherical, imperforate, covered with layer of microgranular silica. Single horn moderately massive, triradiate with three narrow ridges alternating with three wide grooves. Thorax hemispherical, with slightly variable size of massive polygonal pore frames. Distal portion of thorax with three to four prominent transverse ridges, ridges continuous or slightly offset, parallel to each other and merging with those of feet. Feet massive, medium in length, tapering distally, triradiate in axial section with three wide, deep longitudinal grooves alternating with three narrow longitudinal ridges.

Original remarks: *Farcus kozuri*, n. sp., differs from *F. graylockensis* Pessagno, Whalen, and Yeh (1986) by possessing three to four well-developed transverse ridges on the distal portion of thorax.

Measurements (μm):
Based on 10 specimens.

	HT	Mean	Max.	Min.
Length of cephalis	29	29	30	28
Length of thorax	78	84	78	90
width of thorax at top	43	42	43	40
width of thorax (maximum)	114	112	114	108
length of apical horn	78	65	78	36
length of foot (maximum)	100	90	100	78

Etymology: This species is named for Dr. H. Kozur, in honor of his studies on Mesozoic Radiolaria.

Type locality: Sample OR-536J, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Tawi Sadh Member of the Guwayza Formation, Oman.

Genus: *Foremania* Whalen & Carter 1998

Type species: *Foremania sandilandsensis* Whalen & Carter 1998

Synonymy:

1998 *Foremania* n. gen. – Whalen & Carter, p. 79.

Original description: Test elongate, cylindrical with single-layered wall. Cephalis large, dome shaped with irregularly branching horn. Post-abdominal chambers generally rectangular in outline; first few chambers very gradually increasing in size as added; post-abdominal chambers gradually decreasing in width producing an open tube. Regularly shaped pore frames on most post-abdominal chambers; pore frames more regular in shape (tetragonal) and aligned in distinct horizontal and vertical rows on distal portion of test; pore frames smaller on more proximal part of test, larger and more regularly shaped on distal part of test.

Original remarks: The narrow but open tubular extension of the test and the very regularly shaped and aligned pore frames on the distal post-abdominal chambers distinguish *Foremania* n. gen. from *Pseudoeucyrtis* Pessagno. The single-layered wall distinguishes *Foremania* n. gen. from *Canutus* Pessagno and Whalen and *Droltus* Pessagno and Whalen.

Etymology: This genus is named in memory of Helen Foreman a noted scholar of fossil Radiolaria.

Included species:

FRM01 *Foremania sandilandsensis* gr. Whalen & Carter 1998

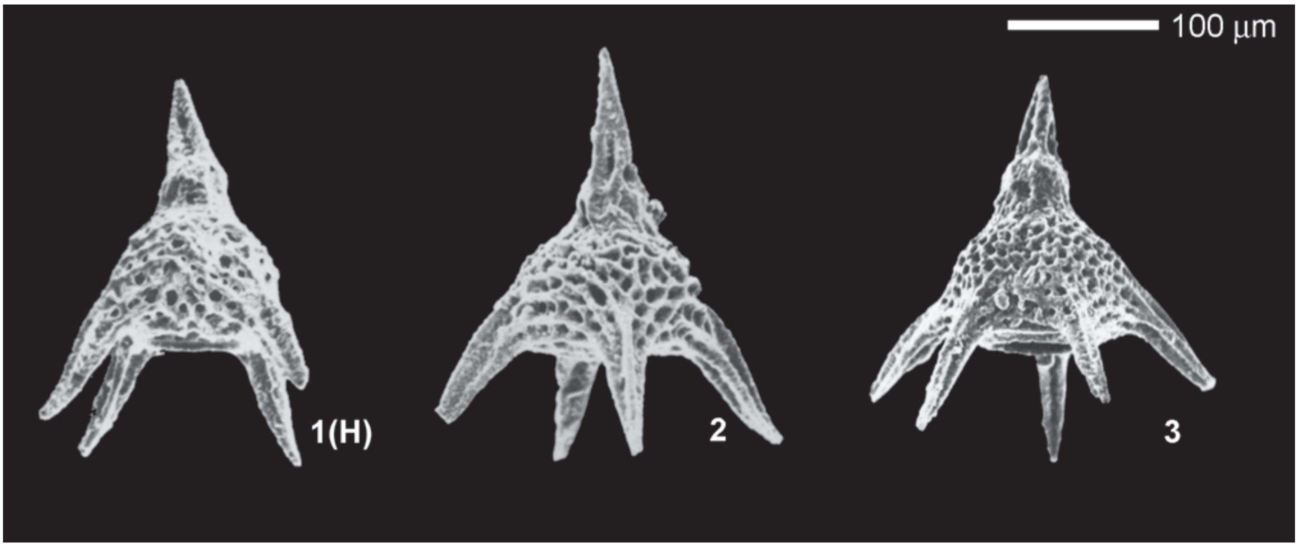


Plate FAR03. *Farcus kozuri* Yeh. Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 1, fig. 6. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 4. **Fig. 3.** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 13.

***Foremania sandilandsensis* gr.** Whalen & Carter 1998
Species code: FRM01

Synonymy:
1982a gen. et sp. indet. 1 – De Wever, p. 220, pl. 13, figs. 13-14.
1982b gen. et sp. indet. 1 – De Wever, p. 354, pl. 56, figs. 10-11.
? 1990 Nassellaria gen. et sp. indet. – De Wever et al., pl. 4, fig. 2.
1990 Gen. sp. indet. 1 in De Wever 1982 – De Wever et al., pl. 4, fig. 3.
1998 *Foremania sandilandsensis* n. sp. – Whalen & Carter, p. 79, pl. 24, figs. 14, 15, 18-21, 24-26.

Original description: Test elongate, cylindrical, commonly with ten postabdominal chambers. Cephalis large, dome-shaped with horn; horn irregularly shaped, branching, usually with two or three prongs varying in size. Cephalis and thorax mostly imperforate, almost completely covered by layer of microgranular silica. Thorax and abdomen trapezoidal in outline. Most postabdominal chambers subrectangular to square in outline, very gradually increasing in width and height as added; last few postabdominal chambers gradually decreasing in width. On well preserved specimens, test terminating in a narrow, open tube. Pore frames on initial chambers of test small and irregularly shaped; pore frames on test gradually increasing in size as added, becoming much more regularly tetragonal and aligned in distinct horizontal and vertical rows on distal part of test; small rounded nodes at vertices of all pore frames.

Original remarks: *Foremania sandilandsensis* is the only species of *Foremania* yet recognized. Since the test is very large and seldom complete, the observed number of postabdominal chambers depends on preservation.

Further remarks: The size of this species is very variable. The length of the specimens illustrated herein varies from 140μm (pl. FRM01, fig 1(H)) to 530μm (pl. FRM01, fig. 8a).

Measurements (μm):
Based on 5 specimens.

Length	Max. width	
140	26	HT
227	103	Max.
140	26	Min.
200	80	Mean

Etymology: This species is named for Sandilands Island, located in Skidegate Inlet, north of South Bay, Queen Charlotte Islands, British Columbia.

Type locality: Sample QC 590A. Kunga Island, north side, Sandilands Formation, Queen Charlotte Islands, British Columbia, Canada.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; Dürrnberg Formation, Austria; Gümüslü Allochthon, Turkey; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman; Japan.

Genus: *Gigi* De Wever 1982a
Type species: *Gigi fustis* De Wever 1982a

Synonymy:
1982a *Gigi* n. gen. – De Wever, p. 194.
1988 *Gigi* De Wever – Hori, p. 558.

Original description: Two-segmented test with a long porous closed tube. Apical horn small, simple or forked. On the cephalis, or at the collar stricture, one (or several ?) spines corresponding to the external prolongation of cephalic spines are present. Cephalic skeleton not in collar plane.

Revised description: By Hori (1988): Test comprising 2 to 3 chambers, cephalis, thorax or abdomen, or both and closed tube, without radial spines. The proximal portion subspherical, having smooth surface and circular pores with a crown-like apical horn and thorn(s). Tube porous and elongated cylindrically, sometimes weakly expanded near the distal end.

Original remarks: This genus differs from *Katroma* by having only two segments, very small cephalic horns (except the apical horn) and smaller pores. It differs from *Podobursa* by the number of segments and the structure of the pores. This genus could be considered as older than *Katroma* (P. Dumitrica, pers. com.).

Further remarks: Contrary to the assumption in the original remarks, our new data show that *Katroma* appears prior to *Gigi*.

Etymology: Name formed by an arbitrary combination of letters (ICZN, art. 40, p. 113).

Included species:
GIG01 *Gigi fustis* De Wever 1982a

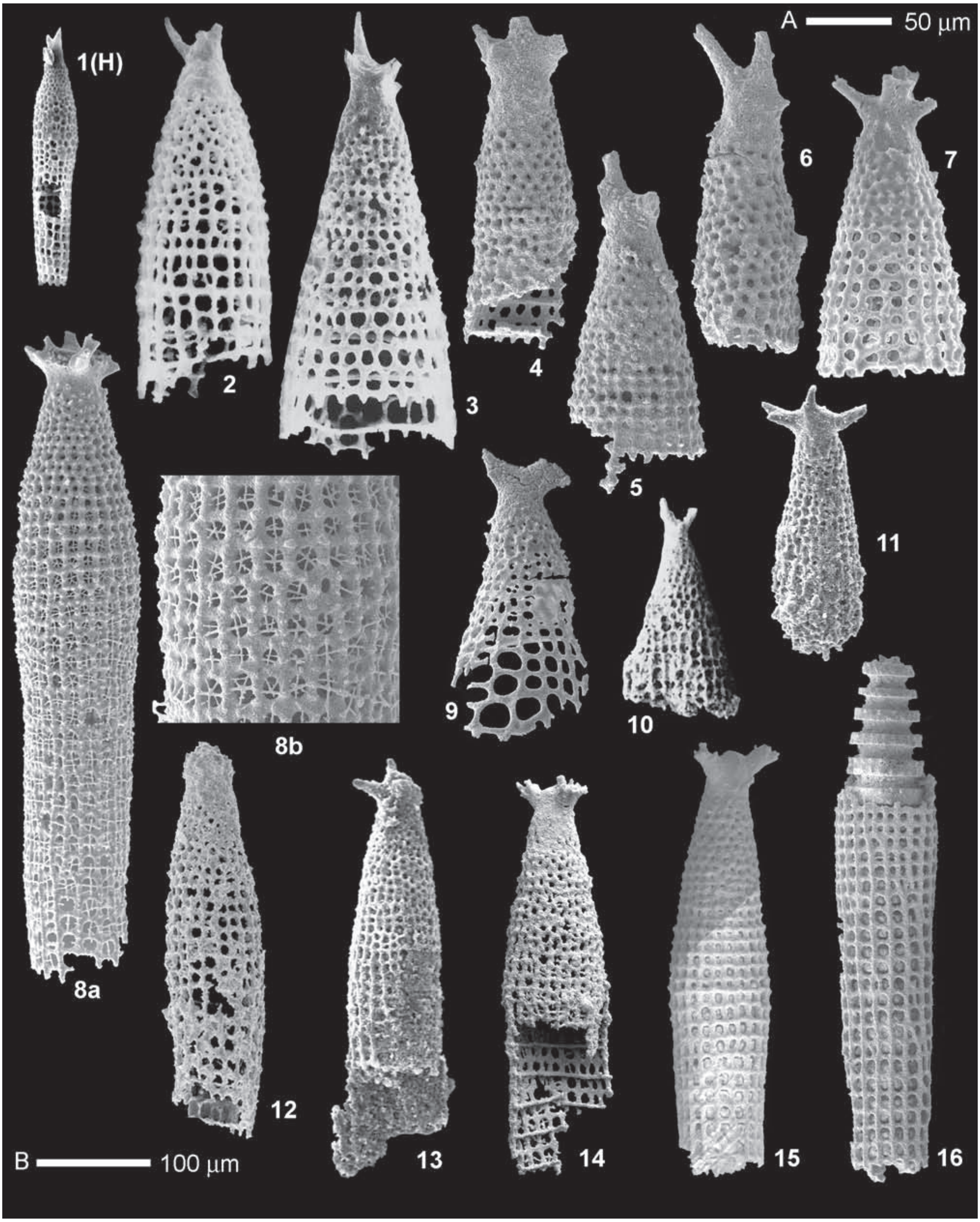


Plate FRM01. ***Foremania sandilandsensis*** **gr. Whalen & Carter.** Magnification Figs. 1-7 x300 (scale bar A), Figs. 8-16 x200 (scale bar B), except Fig. 8b x400. **Fig. 1(H).** Carter et al. 1998, pl. 24, fig. 20. **Fig. 2.** Carter et al. 1998, pl. 24, fig. 19. **Fig. 3.** Carter et al. 1998, pl. 24, fig. 18. **Fig. 4.** OM; BR1121-R10-06. **Fig. 5.** OM, BR1121-R10-11. **Fig. 6.** OM, BR1121-R08-18. **Fig. 7.** QCI, GSC loc. C-305417, GSC 111808. **Fig. 8a,b.** TR, 1662D-R03-12. **Fig. 9.** TR, 1662D-R02-13. **Fig. 10.** JP, IYII8-85. **Fig. 11.** OM-00-252, 022012. **Fig. 12.** AT, BMW21-17. **Fig. 13.** OM-00-118, 000612. **Fig. 14.** OM, BR528-R10-07. **Fig. 15.** OM, BR524-R04-24. **Fig. 16.** OM, BR706-R12-03.

Gigi fustis De Wever 1982a

Species code: GIG01

Synonymy:

1982a *Gigi fustis* n. sp. – De Wever, p. 195, pl. 4, figs. 1-8.
1982b *Gigi fustis* De Wever – De Wever, p. 340, pl. 57, figs. 1-6, 12.
1982 *Gigi fustis* De Wever – De Wever & Origlia-Devos, pl. 1, fig. F.
1988 *Gigi* sp. aff. *G. fustis* De Wever – Hori, p. 559, fig. 9.1, 2.
1988 *Katroma dengqenesis* n. sp. – Li, p. 328, pl. 1, fig. 18, not fig. 9.
1993 *Katroma* sp. – Kashiwagi & Yao, pl. 1, fig. 10.
1993 *Gigi fustis* De Wever – Kashiwagi & Yao, pl. 1, fig. 11.
1994 *Gigi fustis* De Wever – Goričan, p. 70, pl. 16, figs. 11-13.
1995 *Gigi fustis* De Wever – Suzuki, pl. 8, fig. 5.
1997 *Gigi* cf. *G. fustis* De Wever – Hori, pl. 1, fig. 20.
1997 *Gigi* sp. cf. *G. fustis* De Wever – Hori et al., fig. 2.3.
1998 *Gigi fustis* De Wever – Kashiwagi, pl. 2, figs. 13, 14.
2001 *Gigi fustis* De Wever – Kashiwagi, fig. 6.4.
2004 *Gigi fustis* De Wever – Matsuoka, fig. 116.

Original description: Two-segmented test with a long closed tube and a very small clove-shaped apical horn. Horn sometimes simple and not branched when poorly preserved. Cephalis conical, porous. Cephalic skeleton massive, especially at the level of median bar. One spine of the cephalic skeleton (probably V) outgrowing as a small horn. Thorax globular with small pores. Thorax extending in a long tube with widely open proximal pores and smaller distal pores; the latter are aligned along the tube and show a tendency towards helicoidal distribution. Two keels seem to be developed distally.

Original remarks: This species differs from *Katroma neagui, K. bicornus* and *K.* sp. A, *K.* sp. B, by having a simpler outline, smaller horns (apical and lateral), and especially by its two-segmented test.

Measurements (μm):
Based on 14 specimens.

	HT	Max.	Min.	Mean
Total length (including the apical horn)	450	490	360	443
Tube length	320	390	260	315
Tube width	24	33	24	28
Length of cephalis plus thorax	107	170	90	120
Maximum width of thorax	79	110	72	88

Etymology: From the Latin *fustis, -is*, m. = bludgeon, referring to general shape.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Budva Zone, Montenegro; Pindos Zone, Greece; Haliw (Aqil) Formation, Oman; Dengqen area, Tibet; Japan; New Zealand.

Genus: ***Gorgansium*** Pessagno & Blome 1980

Type species: *Gorgansium silviesense* Pessagno & Blome 1980

Synonymy:

1980 *Gorgansium* n. gen. – Pessagno & Blome, p. 234.

Original description: Cortical shell typically elliptical with 3 primary spines of unequal length usually occurring in same plane. Primary spines asymmetrically arranged; 2 spines closer together, often considerably shorter than third spine. Cortical shell usually compressed in plane of 3 primary spines. First medullary shell small, spherical with fragile pore frames.

Original remarks: *Gorgansium,* n. gen. differs from *Betraccium* Pessagno, (Pessagno et al., 1979), in the asymmetrical arrangement and unequal length of its primary spines. Whereas *Betraccium* has symmetrically arranged, more or less equidistant spines of equal length, *Gorgansium* has its 2 shorter spines situated close together.

Etymology: *Gorgansium* is a name formed by an arbitrary combination of letters (ICZN, 1964. Appendix D. Pt. 6. recommendation 40. p.113). The gender of this genus is neuter.

Included species:

GOR02 *Gorgansium gongyloideum* Kishida & Hisada 1985
GOR03 *Gorgansium morganense* Pessagno & Blome 1980

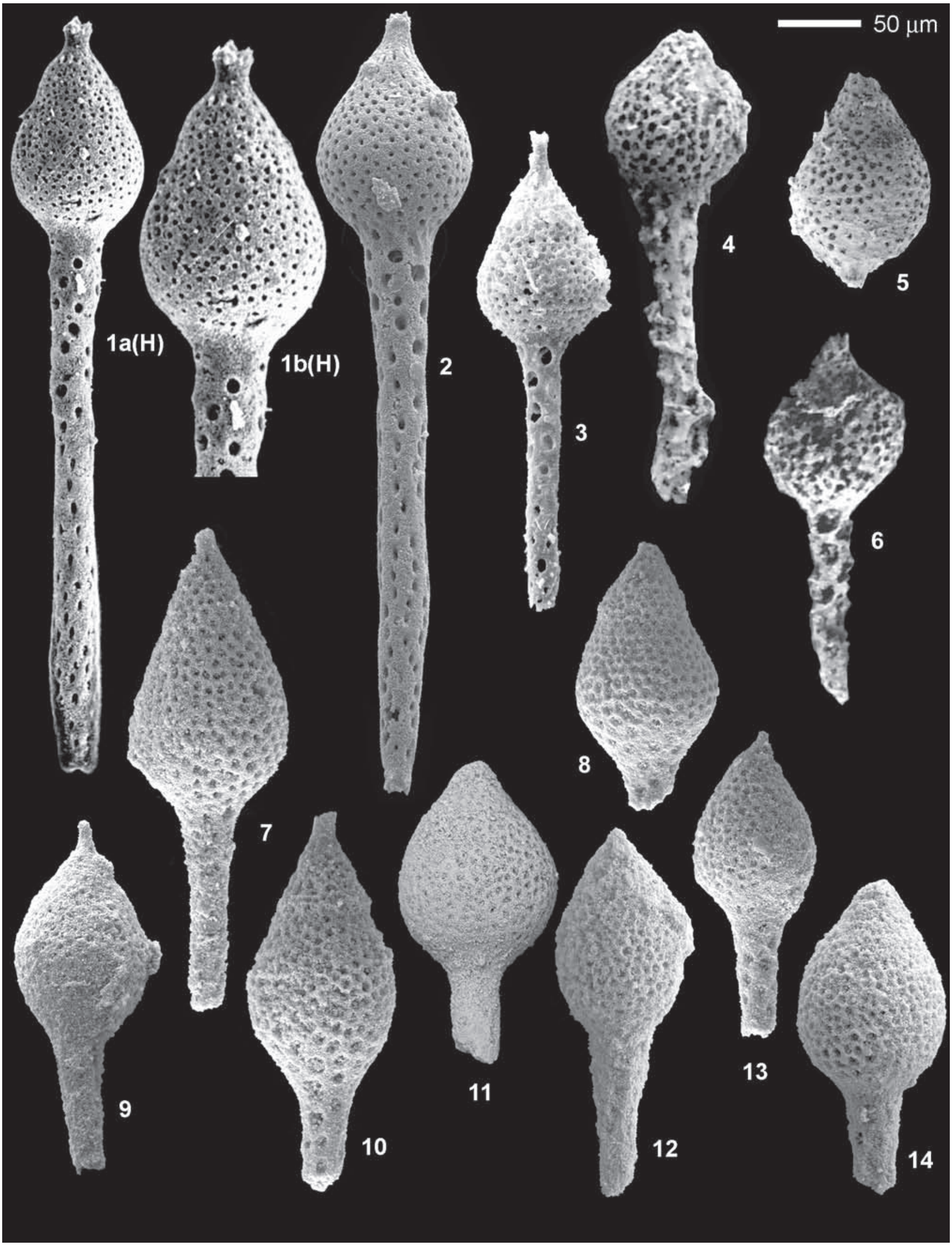


Plate GIG01. ***Gigi fustis*** **De Wever.** Magnification x300, except Fig. 1b(H) x500. **Fig. 1a,b(H)**. De Wever 1982a, pl. 4, figs. 1, 2. **Fig. 2.** TR, 1662D-R02-08. **Fig. 3.** Matsuoka 2004, fig. 116. **Fig. 4.** JP, Nanjo chert, NA-16, RH(1)394. **Fig. 5.** JP, Nanjo chert, NAI-76, RH(1)442. **Fig. 6.** JP, Nanjo chert, NA-11-12, RH(1)391. **Fig. 7.** OM, Haliw-039-R02-05. **Fig. 8.** OM, Haliw-038-R09-23. **Fig. 9.** OM, Haliw-038-R08-08. **Fig. 10.** OM, Haliw-039-R02-06. **Fig. 11.** OM, Haliw-038-R08-19. **Fig. 12.** OM, Haliw-039-R06-20. **Fig. 13.** OM, Haliw-039-R02-08. **Fig. 14.** OM, Haliw-039-R06-28.

Gorgansium gongyloideum Kishida & Hisada 1985

Species code: GOR02

Synonymy:

1982 *Gorgansium* sp. A – Kishida & Sugano, pl. 4, fig. 8.
1984 *Gorgansium* sp. aff. *morganense* Pessagno & Blome – Whalen & Pessagno, pl. 1, figs. 15-16.
1985 *Gorgansium gongyloideum* n. sp. – Kishida & Hisada, p. 116, pl. 1, figs. 21-22.
1986 *Gorgansium gongyloideum* Kishida & Hisada – Kishida & Hisada, Fig. 4.4.
1990 *Gorgansium gongyloideum* Kishida & Hisada – Hori, Fig. 8.6.
1994 *Gorgansium gongyloideum* Kishida & Hisada – Goričan, p. 70, pl. 1, fig. 6.
1998 *Gorgansium gongyloideum* Kishida & Hisada – Yeh & Cheng, p. 12, pl. 1, fig. 1.
2002 *Gorgansium gongyloideum* Kishida & Hisada – Whalen & Carter, p. 105, pl. 6, figs. 3-5, 9-11.
2002 *Gorgansium gongyloideum* Kishida & Hisada – Tekin, p. 179, pl. 1, fig. 4.
2003 *Gorgansium* spp. – Goričan et al., p. 291, pl. 1, fig. 7.

Original diagnosis: Cortical shell spherical, with three three-bladed primary spines. Two spines somewhat shorter than third spine. Third spine as long as diameter of cortical shell.

Original description: Cortical shell spherical, with predominantly hexagonal pore frames lacking well-developed nodes at vertices. Thickness of pore frame bars in Z direction about two times as thick as in Y direction (Text-fig. 5). Seven pore frames visible on test surface along AB, six to seven pore frames visible along CD (Text-fig. 5). Primary spines triradiate in axial section; composed of three narrow grooves alternating with three moderately wide ridges longitudinally. Two primary spines nearly equal in length; third spine somewhat longer. Third spine as long as diameter of cortical shell.

Original remarks: *Gorgansium gongyloideum* n. sp. differs from *Gorgansium crassum* n. sp., in having cortical shell without compression, more numerous pore frames and primary spines with wider ridges.

Measurements (μm):
Based on 5 specimens.
System of measurements shown in Text-fig. 5 of Kishida & Hisada (1985).

AB	CD	AT	EF	GH	
78	81	80	61	59	HT
81	83	88	69	68	Max.
78	81	78	56	57	Min.
79	82	82	62	61	Av.

Etymology: The name is derived from the Latin adjective *gongylis + deus*, meaning spherical.

Type locality: Locality 230 of Kishida & Hisada (1985), Ueno-mura area, Kanto Mountains, Central Japan.

Occurrence: Japan; Fernie Formation, northeastern British Columbia; San Hipólito Formation, Baja California Sur; Skrile Formation, Slovenia; Budva Zone, Montenegro; Hocaköy Radiolarite, Turkey; Liminangcong Chert, Philippines.

Gorgansium morganense Pessagno & Blome 1980

Species code: GOR03

Synonymy:

1980 *Gorgansium morganense* n. sp. – Pessagno & Blome, p. 234, pl. 6, figs. 10, 18, 23.

Original description: Cortical shell circular in outline compressed somewhat in plane of spines and comprised of large pore frames with poorly developed nodes at the vertices. Bars of pore frames of medium thickness along Y; thicker along Z (text-fig. 5). Five to 6 pore frames visible on test surface along AB; 5 pore frames visible along CD (see pl. 8, fig. 16). Two primary spines nearly equal in length; third spine longer. All 3 spines triradiate in axial section, comprised of 3 massive, wide ridges alternating with 3 moderately wide grooves longitudinally; grooves somewhat wider than ridges.

Original remarks: This species differs from *G. silviesense*, n. sp., in having a cortical shell that is circular rather than elliptical in outline and in having much longer primary spines.

Measurements (μm):
Based on 7 specimens.
System of measurement shown in plate 8, figure 16 of Pessagno & Blome (1980).

AB	CD	AT	EF	GH	
94	75	94	69	75	HT
96	81	93	55	65	Av.
106	113	106	75	88	Max.
88	75	81	56	63	Min.

Etymology: *G. morganense* is named for Morgan Mountain near its type locality.

Type locality: Sample OR 536, Nicely Formation, northeast side of Morgan Mountain, Oregon.

Occurrence: Nicely Formation, Oregon; Fannin Formation, Queen Charlotte Islands.

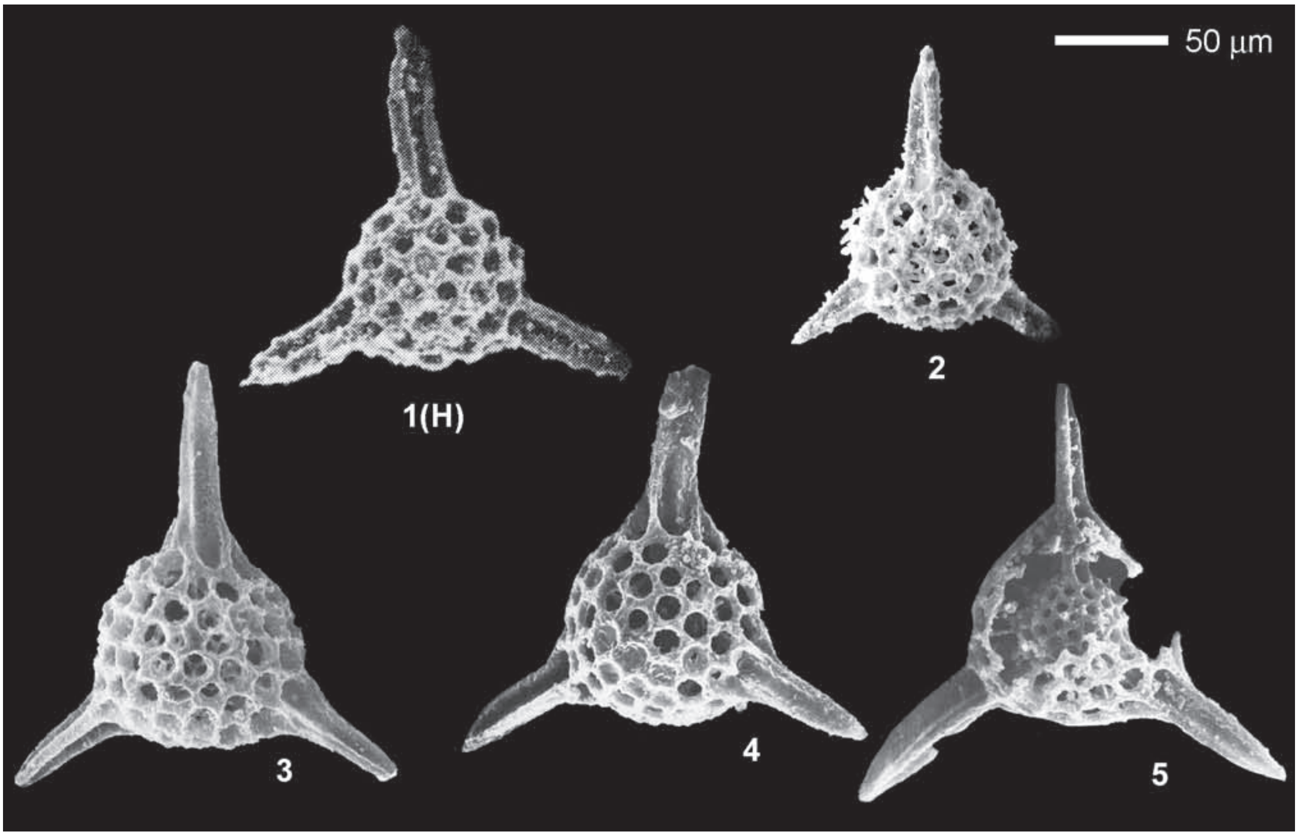


Plate GOR02. ***Gorgansium gongyloideum*** **Kishida & Hisada.** Magnification x300. **Fig. 1(H).** Kishida & Hisada 1985, pl. 1, fig. 21. **Fig. 2.** JP, MNA-10, MA11018. **Fig. 3.** Whalen & Carter 2002, pl. 6, fig. 3. **Fig. 4.** Whalen & Carter 2002, pl. 6, fig. 5. **Fig. 5.** Whalen & Carter 2002, pl. 6, fig. 4.

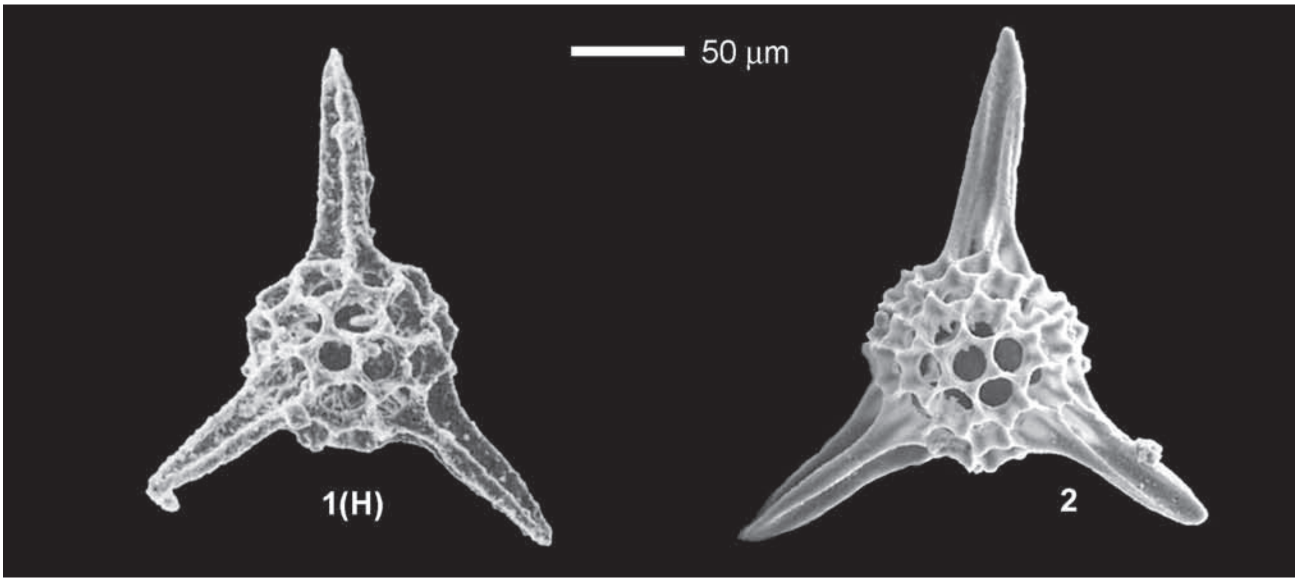


Plate GOR03. ***Gorgansium morganense*** **Pessagno & Blome.** Magnification x300. **Fig. 1(H).** Pessagno & Blome 1980, pl. 6, fig. 10. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128796.

Genus: *Haeckelicyrtium* Kozur & Mostler 1979, emend. Carter 1993

Type species: *Haeckelicyrtium austriacum* Kozur & Mostler 1979

Synonymy:
1979 *Haeckelicyrtium* n. gen. – Kozur & Mostler, p. 98.
1993 *Haeckelicyrtium* Kozur & Mostler – Carter, p. 96.
1997 *Haeckelicyrtium* Kozur & Mostler – Sugiyama, p. 154-155.

Original description: Cephalis imperforate without apical horn. Thorax very wide, cap-shaped, with rough pores, which can be completely closed in the proximal part by an imperforate layer. Abdomen short, very strongly and abruptly flaring into a disc distally. Distal border smooth in the type species, but with short, wide and blunt spines distributed in the disc plane in *Haeckelicyrtium*? *spinosum* n. sp. Aperture wide, circular. Internal spicule as in family.

Emended description: Carter (1993): Includes forms with or without an apical horn. Distal rim of abdomen may be spinose as well as smooth.

Original remarks: *Dreyericyrtium* n. gen. and *Deflandrecyrtium* n. gen. have an apical horn. *Dreyericyrtium* is however considerably more slender, and *Deflandrecyrtium* has a two-segmented conical cephalis as well as laterally and downwardly directed spines at the distal end of the abdomen.

Further remarks: Sugiyama writes that based on evidence from Hori (1992) and from diverse Lower and Middle Jurassic assemblages of Yao (1997), the genus *Haeckelicyrtium* disappears at the end of the Triassic. However, Carter et al. (1998) found *Haeckelicyrtium* sp. A in Hettangian/Sinemurian strata of the Sandilands Formation, Queen Charlotte Islands, Whalen and Carter (2002) found *Haeckelicyrtium* sp. B in Baja California Sur, and abundant *Haeckelicyrtium* (*H. crickmayi* described herein) are present in Pliensbachian formations of Queen Charlotte Islands. Rare specimens of *Haeckelicyrtium* are also known from the Fernie Formation of northeastern British Columbia.

Etymology: Named for E. Haeckel, the famous pioneer of radiolarian research.

Included species:
HCK05 *Haeckelicyrtium crickmayi* Carter n. sp.
HCK04 *Haeckelicyrtium* sp. B sensu Whalen & Carter 2002

Haeckelicyrtium crickmayi Carter n. sp.

Species code: HCK05

Type designation: Holotype GSC 111719 and paratype GSC 111720 from GSC loc. C-304281, Ghost Creek Formation (lowermost Pliensbachian).

Description: Cephalis small and globular, imperforate, without horn. Thorax short, funnel-shaped, with small circular to subcircular pores. Abdomen abruptly flaring to a wide, downwardly directed net-like skirt composed mostly of large subcircular to circular pore frames becoming larger towards periphery. Periphery of skirt most irregular with outer portions of skirt extending as flared perforate arms of variable width. All arms of skirt terminating in one or more short circular spines; narrower arms commonly terminate with bifurcating spines.

Remarks: *Haeckelicyrtium crickmayi* n. sp. differs from *H. karcharos* Carter (1993) in lacking a horn and in possessing long, net-like arms of variable width on the edge of the skirt that terminate in one or more spines. It differs from *Haeckelicyrtium* sp. B of Whalen and Carter (2002) in having a less distinct boundary between the thorax and cephalis and in possessing long, net-like arms on the edge of the skirt.

Measurements (μm):
Based on 9 specimens.

	HT	Max.	Min.	Mean
Diameter of cephalis	52	66	32	51 (7)
Max. diameter of thorax (excl. arms and spines)	464	469	352	429

Etymology: Named for Colin H. Crickmay, who contributed significantly to the knowledge of Late Triassic and Early Jurassic ammonoids of British Columbia

Type locality: Ghost Creek Formation, South side of Maude Island, several hundred metres west of Ells Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Fernie Formation, NE British Columbia.

Haeckelicyrtium sp. B sensu Whalen & Carter 2002

Species code: HCK04

Synonymy:
1998 *Haeckelicyrtium karcharos* Carter – Yeh & Cheng, p. 32, pl. 12, fig. 8.
2002 *Haeckelicyrtium* sp. B – Whalen & Carter, p. 122, pl. 16, fig. 9.

Original remarks: The pore frames of this species are more massive than the pore frames of *Haeckelicyrtium* sp. A of Whalen & Carter 1998.

Occurrence: San Hipólito Formation, Baja California Sur; Liminangcong Chert, Philippines.

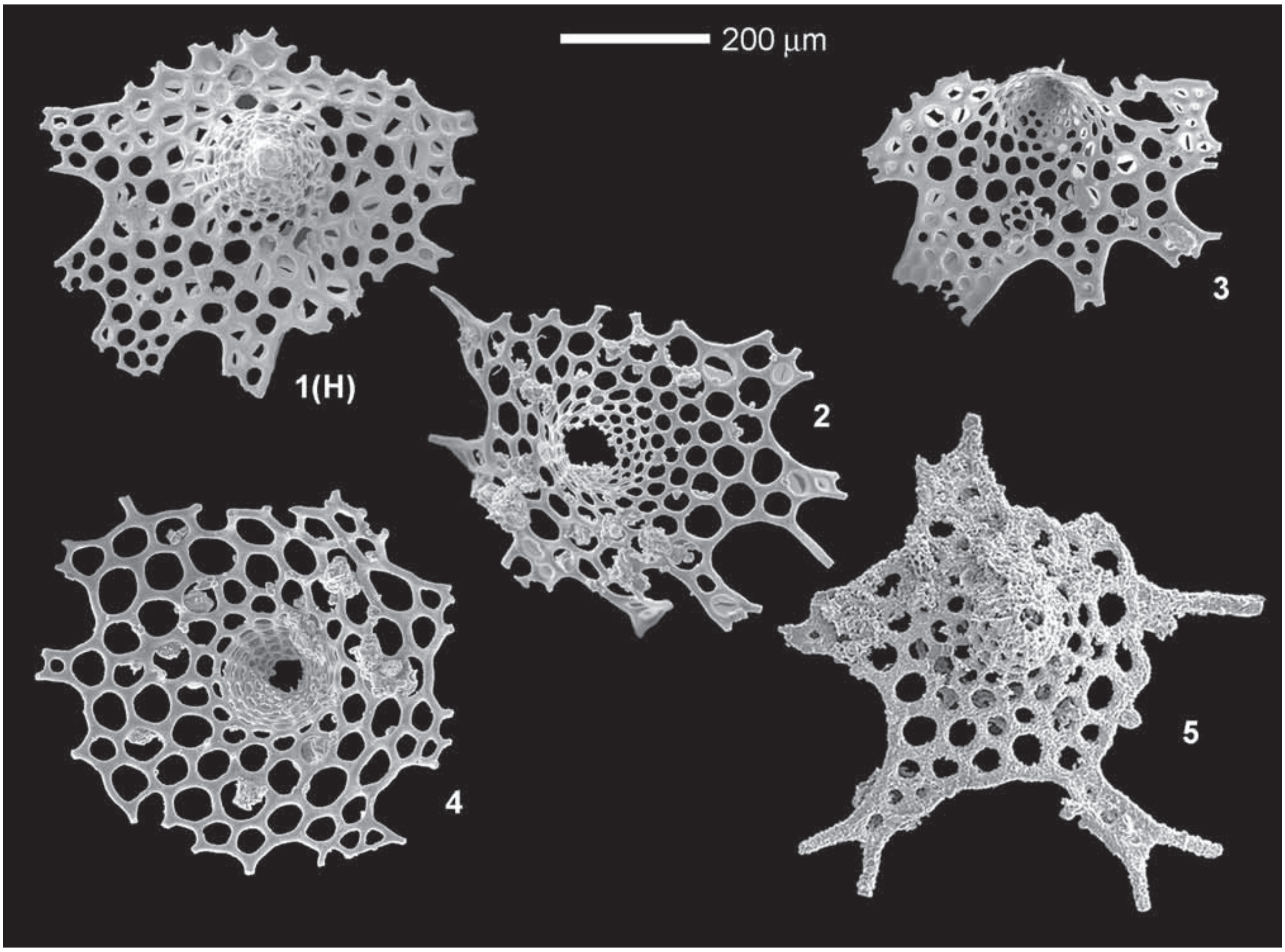


Plate HCK05. ***Haeckelicyrtium crickmayi*** **Carter n. sp.** Magnification x100. **Fig. 1(H).** GSC loc. C-304281, GSC 111719. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128803. **Fig. 3.** QCI, GSC loc. C-304281, GSC 111720. **Fig. 4.** QCI, GSC loc. C-304567, GSC 128913. **Fig. 5.** NBC, GSC loc. C-305208, GSC 128802.

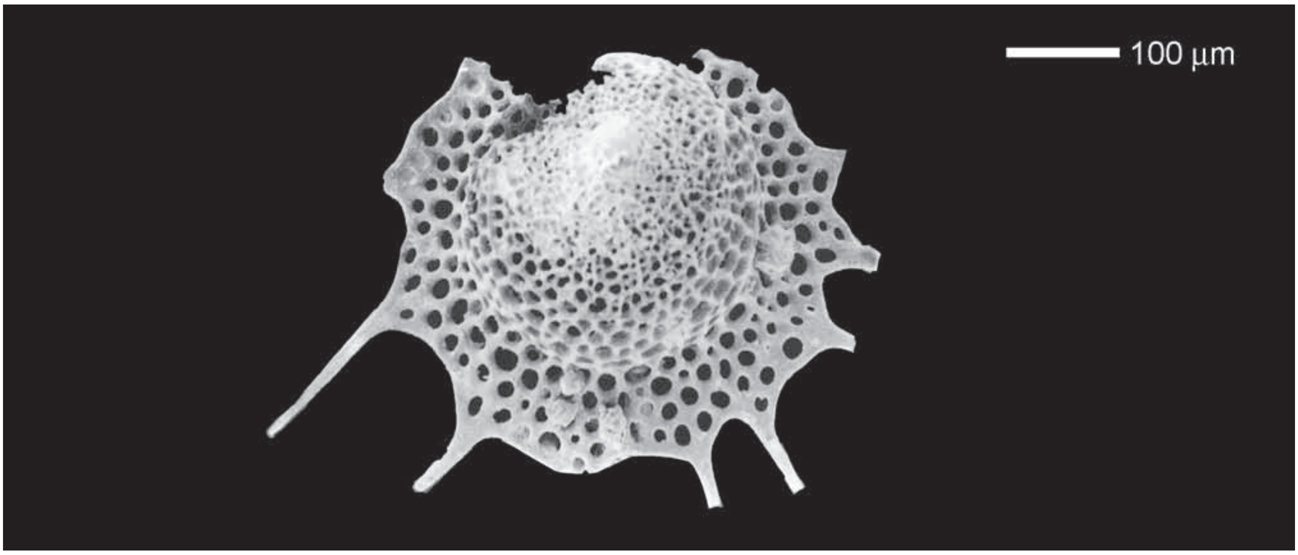


Plate HCK04. ***Haeckelicyrtium*** **sp. B sensu Whalen & Carter.** Magnification x150. **Fig. 1.** Whalen & Carter 2002, pl. 16, fig. 9.

Genus: *Hagiastrum* Haeckel 1881

Type species: *Hagiastrum plenum* Rüst 1885 (subsequent designation by Campbell, 1954)

Synonymy:

1881 *Hagiastrum* n. gen. – Haeckel, p. 460.
1887 *Hagiastrum* Haeckel – Haeckel, p. 542.
1971 *Hagiastrum* Haeckel emend. – Pessagno, p. 52.
1977b *Hagiastrum* Haeckel emend. – Pessagno, p. 72.
1980 *Hagiastrum* Haeckel emend. – Baumgartner, p. 289.

Original description: 3c. Tribe: Euchitonida. Porodiscida with arms, arms chambered situated in the equatorial plane and radiating from the margin of the disk (often with terminal spines on the arms, and often with the arms joined by a patagium or chambered web).
C. With four arms, arranged in the form of a rectangular cross.
CI. With simple arms.
Ia. Without patagium.

Emended description: By Baumgartner (1980): Test as with subfamily, composed of 4 arms approximately at right angles. Rays slender elongate usually with bulbous tips, with or without spines.

Emendation of the subfamily Hagiastrinae Riedel 1971 (Baumgartner, 1980, p. 288): Test as with family, composed of 2 to 4 rays extending from a central area which is simply formed by the convergence of the rays. Cortical rays composed of numerous (8-12) longitudinal external beams, connected by bars regularly in transverse rows forming single rows of circular, rectangular or parallelogram-shaped pores between beams. Cross-section of ray circular or elliptical. Central area of cortical shell usually with smaller, more irregular pore frames, nodes may be developed. Medullary shell centrally placed, about one-third the diameter of cortical shell, leaving a cylindrical cortical space around it. Medullary shell connected by numerous radially arranged subsidiary beams to cortical shell. Medullary shell as with family, rays circular in cross section, composed of several medullary beams comprising 3 (sometimes up to 6) primary canals. Central area of medullary shell with internal vertical beamlets.

Further remarks: By Baumgartner (1980): Included are only those four-rayed forms displaying linear arrangement of beams and pore rows and having an inner structure as in the subfamily. Species with more irregular pore arrangement assigned to this genus by Kozur and Mostler (1978) and Pessagno, Finch and Abbott (1979), should be assigned to the genus *Crucella* Pessagno under the Patulibracchiidae Pessagno, emend.

This volume: Although *Hagiastrum* is the type genus of the family Hagiastridae the cross-section of rays of the type species of *Hagiastrum* is not yet known. In revising the family, Baumgartner (1980) made no remarks on the number of beams and rows of pores because of the difficulty to find a specimen confidently assigned to the type species. Herein we assign to this genus all species answering more or less the emended definition without taking into account the ray structure. However, we note that *Hagiastrum macrum* De Wever (see below) has rays with 3 primary and 9 secondary canals.

Etymology: From the Greek *agion* = holy, and *astron* = starrulet.

Included species:

HAG06 *Hagiastrum macrum* gr. De Wever 1981b
HAG03 *Hagiastrum majusculum* Whalen & Carter 1998
HAG04 *Hagiastrum rudimentum* Whalen & Carter 1998

Hagiastrum macrum gr. De Wever 1981b

Species code: HAG06

Synonymy:

1981b *Hagiastrum macrum* n. sp. – De Wever, p. 29, pl. 1, figs. 7-9.
1982b *Hagiastrum macrum* De Wever – De Wever, p. 232, fig. 75, pl. 20, figs. 7-8; pl. 21, fig. 1.
1987b *Tetratrabs imlayi* n. sp. – Yeh, p. 31, pl. 21, figs. 8, 10, 12.
2004 *Tetraditryma macra* (De Wever) – Matsuoka, fig. 41.

Original diagnosis: *Hagiastrum* with four long and thin rays ornamented with long secondary spines.

Original description: Straight arms, composed of stout longitudinal beams with regularly distributed connecting bars that form quadrangular pores. This network exists only on arms, while pores are randomly arranged in center.

Original remarks: This species is distinguished from other species of *Hagiastrum* by its skeleton-like shape and well-developed secondary spines.

Arm structure is slightly different from other Hagiastrinae. In this subfamily the medullary shell is surrounded by a cortical space, crossed by bars. For *H. macrum*, the large number of bars and their distinctive shape seem to form porous canals that fill the cortical space (pl. 1, fig. 9). This is in agreement with P. O. Baumgartner's observations (1981, pers. comm.) who noticed that the cortical space is more and more restricted in early forms.

Further remarks: Although not mentioned in the original description, the view along one broken ray (De Wever 1981b, pl. 1. fig. 9) shows 3 primary canals surrounded by 9 secondary canals and 9 or more external beams; such structure is similar to that of *Homoeoparonaella elegans* (see Baumgartner, 1980).

Measurements (μm):
Based on 7 specimens.

	HT	Min.	Max.	Mean
Total length (of two rays without terminal spines)	442	430	496	458
Width of rays	40	40	54	44
Length of terminal spines	70	62	70	66

Etymology: From Latin *macer, -a, -crum*, adj. = with little substance, thin, stunted. By analogy with the emaciated shape of this form.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Fernie Formation, NE British Columbia; Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

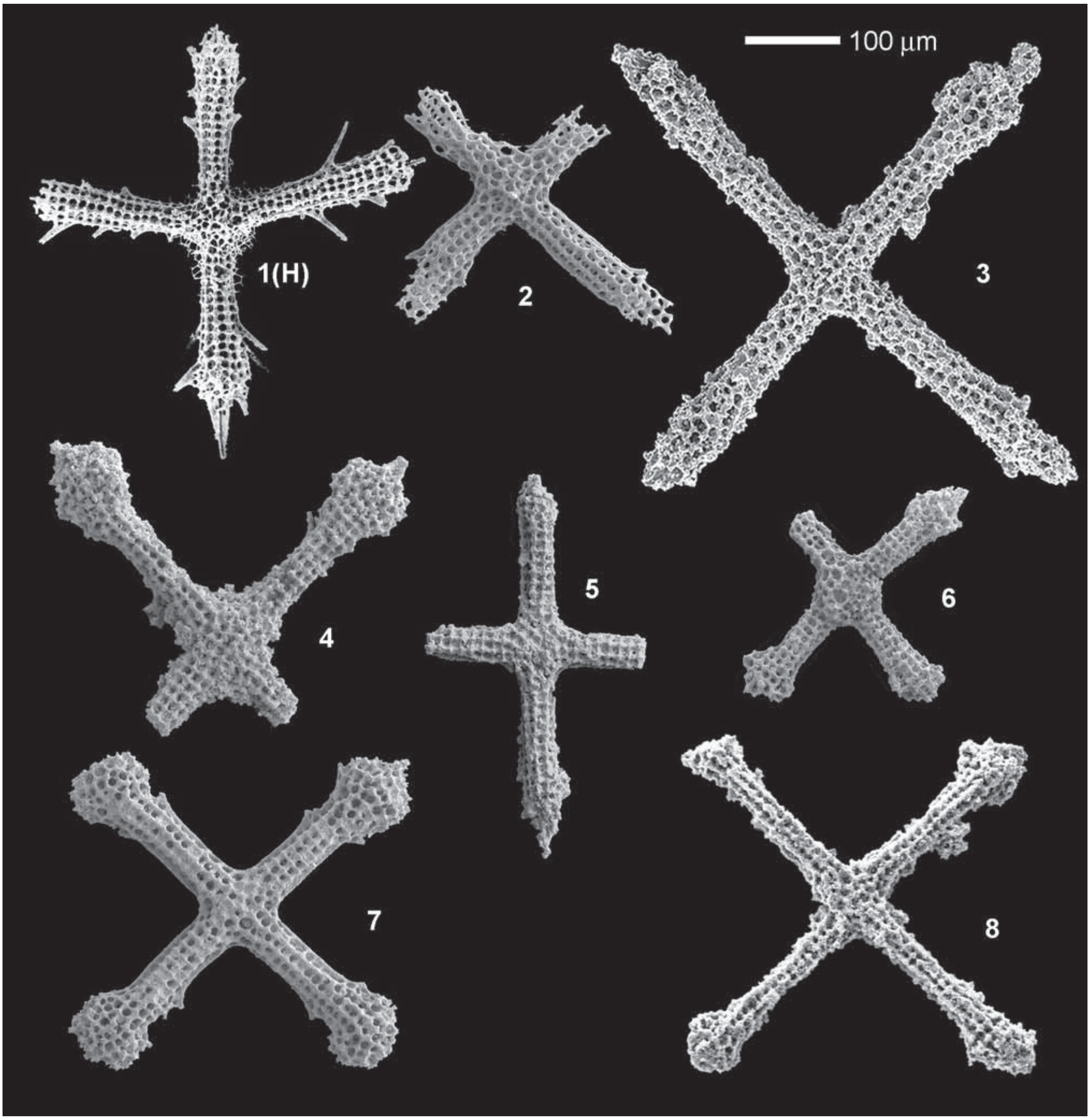


Plate HAG06. *Hagiastrum macrum* gr. De Wever. Magnification 150x. **Fig. 1(H).** TR, De Wever 1981b, pl. 1, fig. 7. **Fig. 2.** TR, 1662D-R07-11. **Fig. 3**. NBC, GSC C-305208, GSC 128807. **Fig. 4.** OM, BR871-R04-04. **Fig. 5.** OM, BR525-R08-10. **Fig. 6.** OM; BR1121-R07-18. **Fig. 7.** OM; BR706-R12-15. **Fig. 8.** OM-00-231, 020405.

Hagiastrum majusculum Whalen & Carter 1998

Species code: HAG03

Synonymy:

1987b *Tetratrabs* sp. E – Yeh, p. 32, pl. 11, fig. 12; pl. 22, fig. 2.
1988 *Hagiastrum* sp. cf. *H. egregium* Rüst – Carter et al., p. 29, pl. 7, figs. 11, 12.
1988 *Hagiastrum* sp. A – Carter et al., p. 29, pl. 2, fig. 2.
1990 *Hagiastrum* sp. – Nagai, pl. 5, fig. 7.
1991 *Hagiastrum* sp. cf. *H. egregium* Rüst – Carter & Jakobs, p. 342, pl. 2, fig. 10.
1996 *Hagiastrum* cf. *H. egregium* Rüst – Tumanda et al., p. 172, fig. 6.6.
1996 *Tetraditryma* sp. A – Yeh & Cheng, p. 97, pl. 1, fig. 5.
1996 *Hagiastrum* sp. A – Yeh & Cheng, p. 96, pl. 1, fig. 12.
1997 *Tetraditryma* sp. F – Yao, pl. 7, fig. 331.
1998 *Hagiastrum* sp. A – Cordey, p. 67, pl. 19, figs. 5, 7, 9-10 only.
1998 *Hagiastrum majusculum* n. sp. – Whalen & Carter, p. 45, pl. 10, figs. 11-12, 14-16.
2002 *Hagiastrum majusculum* Whalen & Carter – Whalen & Carter, p. 103, pl. 8, figs. 3, 11, 13.
2004 *Hagiastrum rudimentum* Whalen & Carter – Matsuoka, fig. 38.

Original description: Test composed of four long, nodose rays with bulbous tips terminating in moderately long triradiate spines. Rays usually composed of eight external nodose longitudinal beams; beams display strong linearity frequently becoming slightly twisted. Beams connected by transverse bars forming single, longitudinal rows of square to tetragonal pore frames; pores circular to subcircular. Nodes at vertices of pore frames elliptical to subrectangular, strongly raised and highly distinctive. Central area small, composed of triangular and rectangular pore frames with large nodes at vertices. Bulbous ray tips composed of square pore frames with weak nodes at vertices. Spines moderate in length, triradiate.

Original remarks: This form is likely derived from *Hagiastrum rudimentum* n. sp. It differs from the latter species in having longer rays with more strongly pronounced linearity, stronger nodes on both rays and central area, and in developing bulbous tips at the ends of the rays.

Further remarks: This species now includes forms with six to eight external beams and a slightly larger, more nodose central area.

Measurements (μm):
Based on 14 specimens.

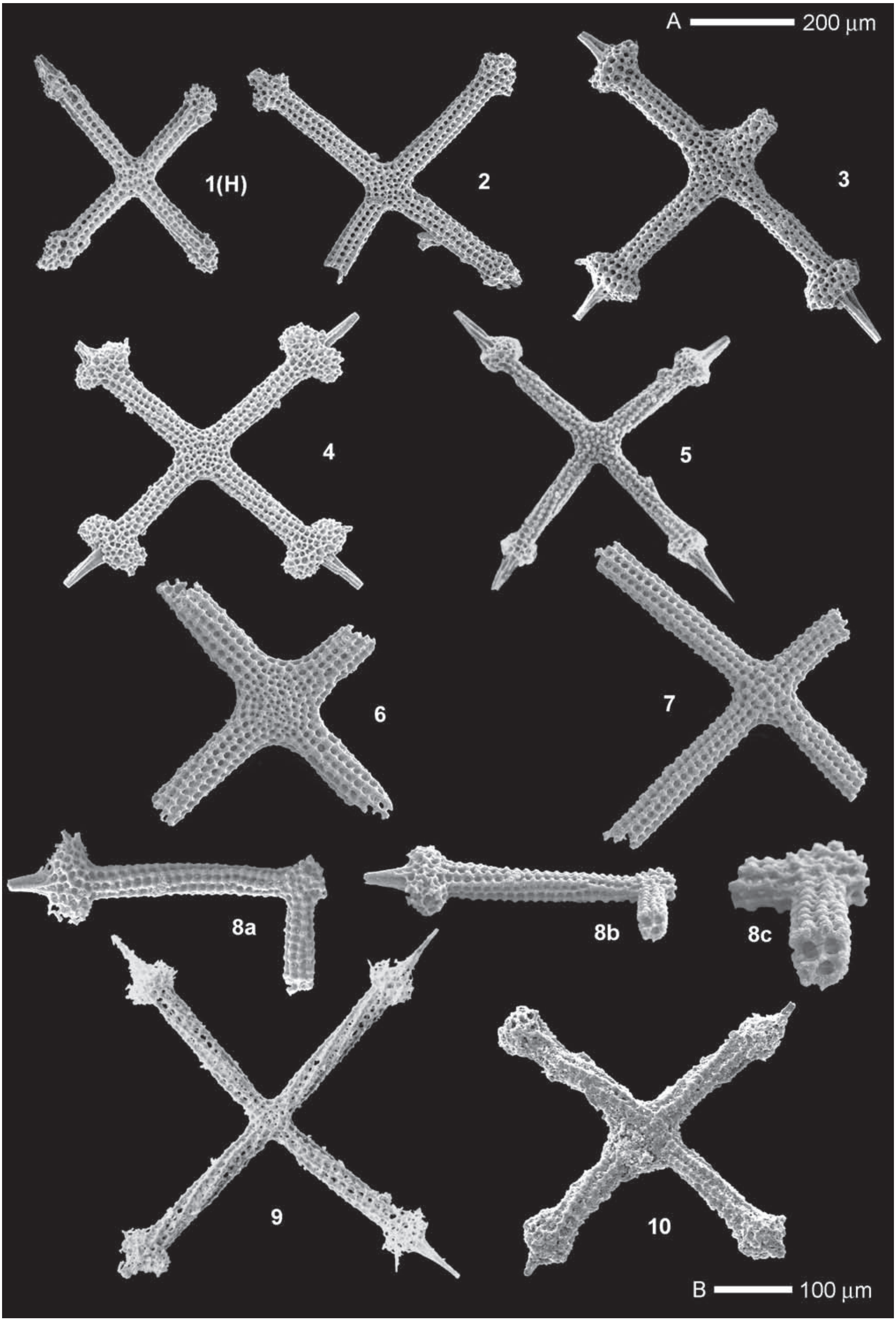
Length of longest ray	Width of widest ray	Width of bulbous tips	Length of longest spine	
249	43	-	-	HT
395	52	99	131	Max.
205	37	74	75	Min.
292	43	85	92	Mean

Etymology: Name from the Latin *majusculus, um* (m.) meaning somewhat larger or greater.

Type locality: Sample 86-OF-KUB-2, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek, Fannin and Phantom Creek formations, Queen Charlotte Islands; Bridge River Complex and Williston Lake, British Columbia; San Hipólito Formation, Baja California Sur; Hyde Formation, Oregon; Japan; Liminangcong Chert, Philippines; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman.

Plate HAG03. *Hagiastrum majusculum* Whalen & Carter. Magnification Figs. 1-5 x100 (scale bar A), Figs. 6-10 x150 (scale bar B), except Fig. 8c x300. **Fig. 1(H).** Carter et al. 1998, pl. 10, fig. 11. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128806. **Fig. 3.** QCI, GSC loc. C-304567, GSC 128804. **Fig. 4.** QCI, GSC loc. C-175306, GSC 128805. **Fig. 5.** Whalen & Carter 2002, pl. 8, fig. 3. **Fig. 6.** OR600A-R01-03. **Fig. 7.** OR600A-R01-07. **Fig. 8a,b,c.** OM, BR682-R10-10. **Fig. 9.** JP, MNA-10, MA10864. **Fig. 10.** SI, MM5.00, 010102.


A 200 µm
1(H)
2
3
4
5
6
7
8a
8b
8c
9
10
B 100 µm

Hagiastrum rudimentum Whalen & Carter 1998
Species code: HAG04

Synonymy:
1987 *Hagiastrum* sp. C – Hattori, pl. 3, fig. 14.
1998 *Hagiastrum* sp. A – Cordey, p. 67, pl. 19, figs. 6, 8 only.
1998 *Hagiastrum rudimentum* n. sp. – Whalen & Carter, p. 46, pl. 10, figs. 2, 7, 8, 18, 19.
2002 *Hagiastrum rudimentum* Whalen & Carter – Suzuki et al., p. 178, figs. 7 H-I.
2002 *Hagiastrum rudimentum* Whalen & Carter – Whalen & Carter, p. 103, pl. 8, fig. 2.

Original description: Test with four long rays, almost cylindrical in cross-section, sometimes broadening slightly near tips. Rays terminating in long triradiate spines having broad ridges and grooves. Rays usually composed of eight external longitudinal beams separated by a single row of pore frames and connected by transverse bars to from a single linear row of pores between two beams. Nodes at vertices of pore frames round and moderately raised. Central area large, composed mostly of triangular and tetragonal pore frames with strongly raised circular nodes at vertices.

Original remarks: This is the earliest species of *Hagiastrum* to appear in our samples. It has a few irregularly arranged pores on the rays but in all other aspects seems to conform to the definition of *Hagiastrum* as emended by Baumgartner (1980). See. *H. majusculum* n. sp. for comparisons.

Measurements (μm):
Based on 10 specimens.

Length of longest ray	Width of widest ray	Length of longest spine	
181	38	43	HT
244	56	146	Max.
161	38	43	Min.
206	46	62	Mean

Etymology: Name from the Latin *rudimentum* meaning first principle, beginning.

Type locality: Sample QC-675, Sandilands Formation, Kunga Island - north side, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; Bridge River Complex, British Columbia; San Hipólito Formation, Baja California Sur; Pucara Group, Peru; Japan.

Genus: *Helvetocapsa* O'Dogherty, Goričan & Dumitrica 2006
Type species: *Tricolocapsa matsuokai* Sashida, in Sashida et al. 1999

Synonymy:
2006 *Helvetocapsa* O'Dogherty, Goričan & Dumitrica n. gen. – O'Dogherty et al., p. 450.

Original diagnosis: Test spindle shaped, multisegmented, composed of three, four, or possibly more segments. Last segment inversely conical with a small constricted aperture at its base. Segmental divisions generally not well pronounced externally, only faint strictures present in some species. Small circular pores on surface arranged in longitudinal rows. Numerous longitudinal plicae are generally well developed on the entire test. One row of pores present between neighbouring plicae.

Original remarks: The genus is similar to *Striatojaponocapsa* Kozur, from which it differs by having an inversely conical last segment with a simple aperture but no appendage or eccentric porous depression. It differs from *Protunuma* Ichikawa and Yao by having only one row of pores between adjacent plicae.

A relatively continuous stratigraphic record can be reconstructed for *Helvetocapsa* n. gen. from previously known occurrences. The genus ranges from the early Toarcian (Matsuoka 1991a, Goričan et al. 2003), through Aalenian and Bajocian (Yao 1997; Sashida et al. 1999) to the Bathonian (Yamamoto et al. 1985; this study). Species of this genus have previously been assigned to different genera, depending on the number of segments. We grouped them together because the available data suggest that the number of pores (one vs. two or more) between adjacent plicae is an important taxonomic character but the number of segments varies through time in the same phylogenetic lineage.

Etymology: Referring to the occurrence in Switzerland.

Included species and subspecies:
TPS03 *Helvetocapsa minoensis* (Matsuoka) 1991
SCP03 *Helvetocapsa nanjoensis* (Matsuoka) 1991
SCP06 *Helvetocapsa plicata* s.l. (Matsuoka) 1991
SCP04 *Helvetocapsa plicata plicata* (Matsuoka) 1991
SCP05 *Helvetocapsa plicata semiplicata* (Matsuoka) 1991

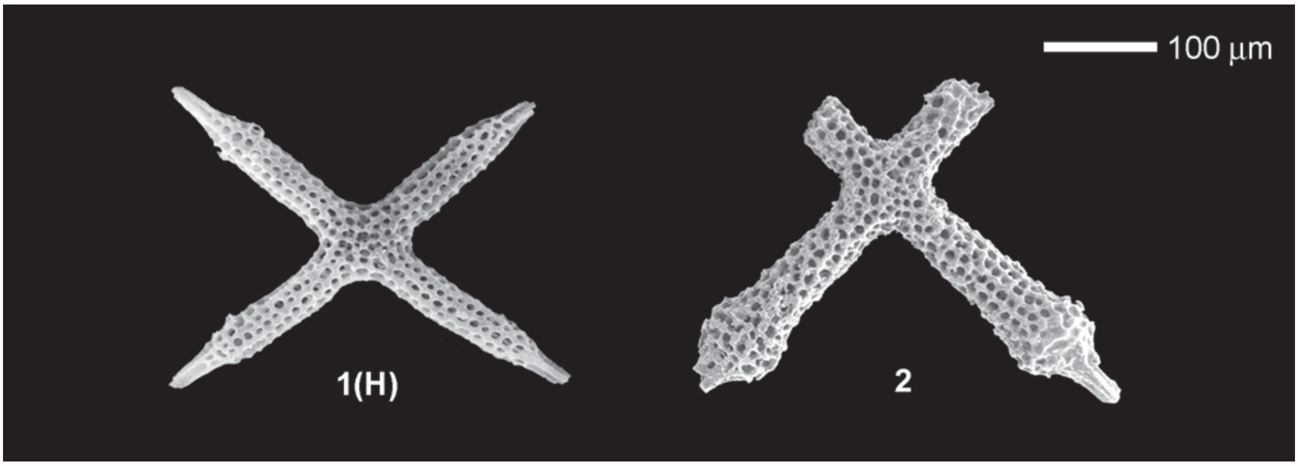


Plate HAG04. *Hagiastrum rudimentum* Whalen & Carter. Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 10, fig. 2. **Fig. 2.** QCI, GSC loc. C-080612, GSC 128808.

Helvetocapsa minoensis (Matsuoka) 1991

Species code: TPS03

Synonymy:

1987 *Tricolocapsa* sp. A – Hattori, pl. 13, fig. 1.
1987 *Tricolocapsa* sp. B – Hattori, pl. 13, fig. 2.
1989 *Tricolocapsa* sp. A – Hattori, pl. 10, fig. A.
1989 *Tricolocapsa* spp. – Hattori, pl. 10, fig. D.
1990 *Tricolocapsa* sp. – Nagai, pl. 4, figs. 5a-b.
1991 *Tricolocapsa minoensis* n. sp. – Matsuoka, p. 723, Fig. 2. 1a-5b.
? 1991 *Tricolocapsa* sp. cf. *T. plicarum* – Kojima et al., pl. 1, fig. 10.
1997 *Tricolocapsa minoensis* Matsuoka – Yao, pl. 9, fig. 422.
2003 *Tricolocapsa minoensis* Matsuoka – Goričan et al., p. 297, pl. 4, figs. 13a-b, 14a-b.
2004 *Tricolocapsa minoensis* Matsuoka – Matsuoka, fig. 81.

Original description: Shell of three segments, drop-like shaped. Cephalis hemispherical, poreless. Thorax truncate conical. Abdomen large, subspherical with constricted aperture. Collar and lumber strictures slightly recognizable or indistinct externally. Outer surface of shell ornamented with continuous longitudinal plicae. Eleven to 15 moderately spaced plicae visible on outer shell. One row of pores present between longitudinal plicae. Pores small to moderate in size, circular and uniform in shape. Aperture moderate in size, circular.

Original remarks: Pores vary in size among specimens, from small (Figures 2-1a,b) to moderate (Figure 2-3).

Tricolocapsa minoensis, n. sp., differs from *T. plicarum* Yao by lacking a dish-like basal appendage, by having more spaced plicae and by its smaller size.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	115	115	93	105	(15)
Maximum width of shell	94	94	72	83	(15)
Diameter of aperture	13	14	12	13	(6)

Etymology: This species is named for the Mino Terrane which includes the type area, Nanjo Massif.

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Japan; Hyde Formation, Oregon; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman.

Helvetocapsa nanjoensis (Matsuoka) 1991

Species code: SCP03

Synonymy:

1991 *Stichocapsa nanjoensis* n. sp. – Matsuoka, p. 733, Fig. 9. 1 – 4b.
1997 *Stichocapsa nanjoensis* Matsuoka – Yao, pl. 9, fig. 440.
2004 *Stichocapsa nanjoensis* Matsuoka – Matsuoka, fig. 88.

Original description: Shell of four segments, spindle-shaped. Cephalis hemispherical, poreless. Thorax truncate conical, abdomen barrel-shaped and fourth segment inverted conical with a constricted, circular aperture. Collar stricture pronounced externally. Other segmental joints indistinct externally. Eight to 10 weakly developed longitudinal plicae run from thorax to the distal end in lateral view. One row of pores arranged between the longitudinal plicae. Pores circular to subcircular, small and uniform in size.

Original remarks: *Stichocapsa nanjoensis*, n. sp. is distinguished from *S. biconica*, n. sp. by its small size, by consisting of four segments rather than five and by having longitudinal plicae. It also differs from *Cyrtocapsa* (?) *kisoensis* Yao by having longitudinal plicae and by lacking an apical horn.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	104	104	90	96	(10)
Maximum width of shell	62	63	54	59	(10)
Diameter of aperture	-	8	7	8	(5)

Etymology: The species is named for the Nanjo Massif, its type locality.

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

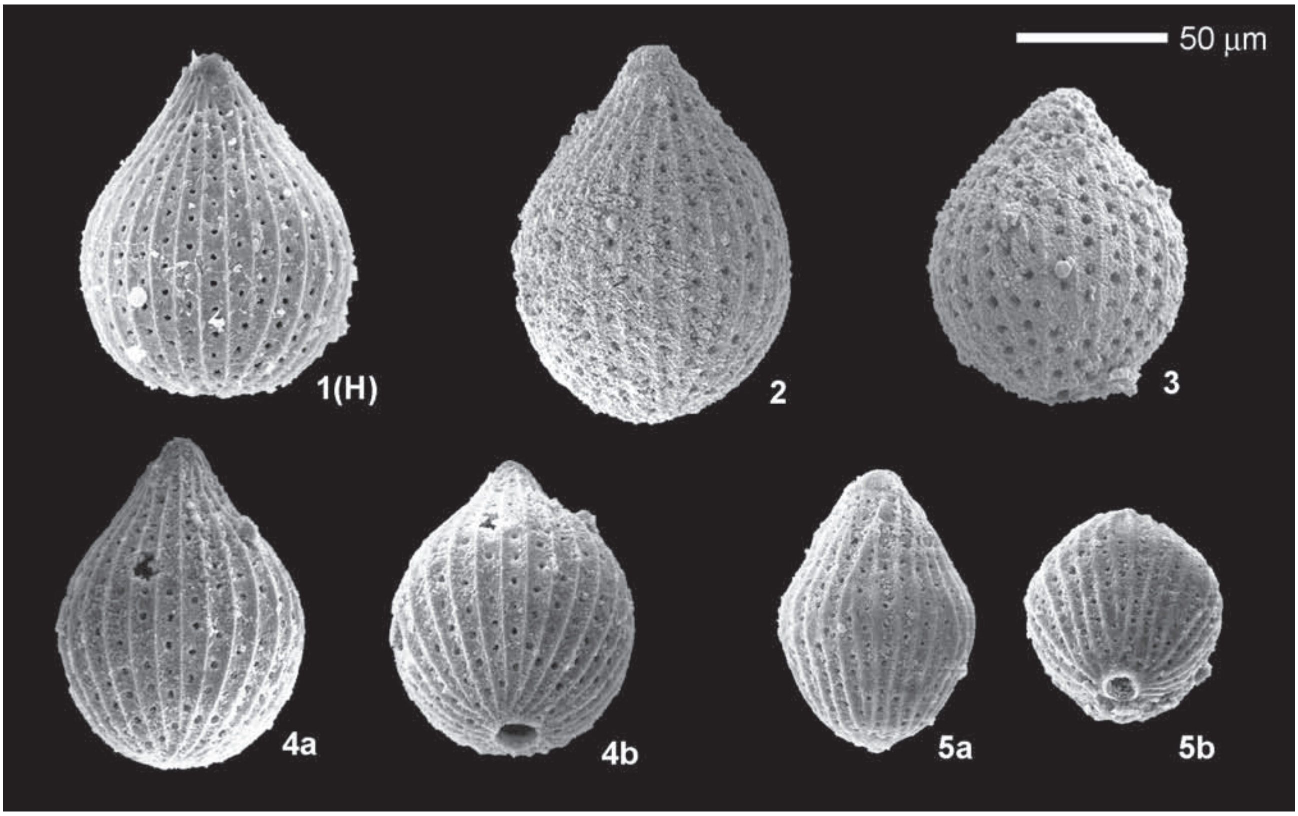


Plate TPS03. *Helvetocapsa minoensis* (Matsuoka). Magnification x400. **Fig. 1(H).** Matsuoka 1991, Fig. 2.1a. **Fig. 2.** OM, BR1122-R02-04. **Fig. 3.** OM, BR1122-R04-16. **Figs. 4a-b, 5a-b.** Goričan et al. 2003, pl. 4, figs. 14a-b, 13a-b.

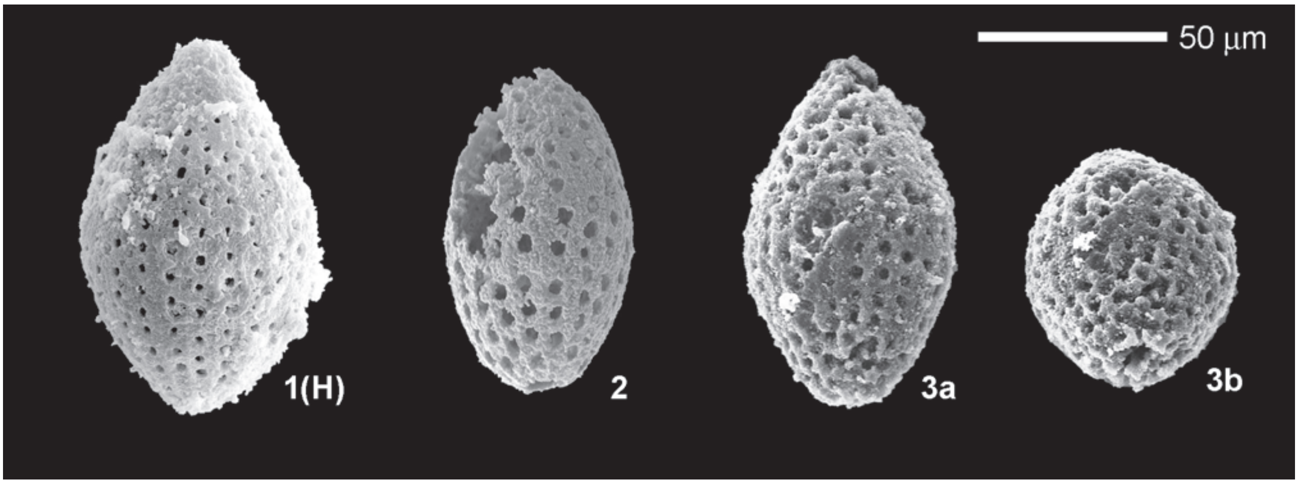


Plate SCP03. *Helvetocapsa nanjoensis* (Matsuoka). Magnification x500. **Fig. 1(H).** Matsuoka 1991, Fig. 9.1. **Fig. 2.** OM, BR1122-R04-15. **Figs. 3a, b.** OM-00-254-022212, 022213.

***Helvetocapsa plicata* s.l.** (Matsuoka) 1991

Species code: SCP06

Synonymy:

1991 *Stichocapsa plicata* n. sp. – Matsuoka, p. 727, Fig. 5-1a-5b: 6-1a-6b.

See also subspecies.

Included subspecies:

SCP04 *Helvetocapsa plicata plicata* (Matsuoka) 1991
SCP05 *Helvetocapsa plicata semiplicata* (Matsuoka) 1991

Original description: Shell of four to six segments, drop-like or spindle shaped. Cephalis hemispherical, poreless. The last segment large, inverted hemispherical or inverted conical with a constricted aperture. Remaining segments including thorax and abdomen truncate conical. Strictures between segments indistinct externally. Fifteen to 22 densely spaced longitudinal plicae visible on outer shell except for cephalis. The longitudinal plicae distinct or partly obscure. One row of pores present between the plicae. Pores uniform, small and circular. Aperture small, circular, occasionally with a short protruding rim.

Original remarks: Two subspecies are included under this species; these are *S. plicata plicata*, n. subsp. and *S. plicata semiplicata*, n. subsp. *S. plicata*, n. sp. differs from *S. convexa* Yao by having longitudinal plicae between which one row of pores is present.

Measurements (µm):
Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	154	170	110	142	(29)
Maximum width of shell	108	124	80	96	(29)
Diameter of aperture	8	8	6	7	(12)

Etymology: This specific name comes from the Latin *plicatus-a-um* (= plicate).

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: See subspecies.

Helvetocapsa plicata plicata (Matsuoka) 1991

Species code: SCP04

Synonymy:

1989 *Tricolocapsa* sp. B. – Hattori, pl. 10, fig. B.
1989 *Tricolocapsa* spp. – Hattori, pl. 10, fig. F.
1989 *Tricolocapsa* sp. D. – Hattori, pl. 29, fig. D.
1989 *Tricolocapsa* sp. – Hattori & Sakamoto, pl. 19, fig. B.
1991 *Stichocapsa plicata plicata* n. subsp. – Matsuoka, p. 729, fig. 5. 1a – 5b.
1997 *Stichocapsa plicata* Matsuoka – Yao, pl. 9, fig. 437.
2003 *Stichocapsa plicata plicata* Matsuoka – Goričan et al., p. 297, pl. 4, fig. 17a-b.
2004 *Stichocapsa plicata plicata* Matsuoka – Matsuoka, fig. 84.

Original description: Shell of four to five segments, drop-like or spindle shaped. Cephalis hemispherical, poreless. The last segment large, inverted hemispherical or inverted conical with a constricted aperture. Remaining segments including thorax and abdomen truncate conical. Strictures between segments indistinct externally. Fifteen to 22 densely spaced longitudinal plicae visible on outer shell. The plicae distinct on whole shell except for cephalis. One row of pores present between plicae. Pores uniform, small and circular. Aperture small, circular, occasionally with a short protruding rim.

Original remarks: Shape varies among specimens; some are drop-like shaped (Figure 5-1a, 3a, 4, 5a, b) and others spindle shaped (Figure 5-2a). *Stichocapsa plicata plicata*, n. subsp. differs from *S. plicata semiplicata*, n. subsp. by having distinct longitudinal plicae that extend from the thorax to the distal end.

Further remarks: In comparison to the type material, some specimens have less numerous plicae and much larger pores with thicker pore frames (pl. SCP04, figs. 6-9). They are included in *Helvetocapsa plicata plicata*, because transitional forms (pl. SCP04, figs. 5a-b) also exist.

Measurements (µm):
Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	154	170	110	142	(20)
Maximum width of shell	108	124	82	102	(20)
Diameter of aperture	8	8	6	7	(9)

Etymology: This subspecies is the nominotypical subspecies of *Stichocapsa plicata*, n. sp.

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Japan; Skrile Formation, Slovenia; Musallah Formation and Tawi Sadh Member of the Guwayza Formation, Oman.

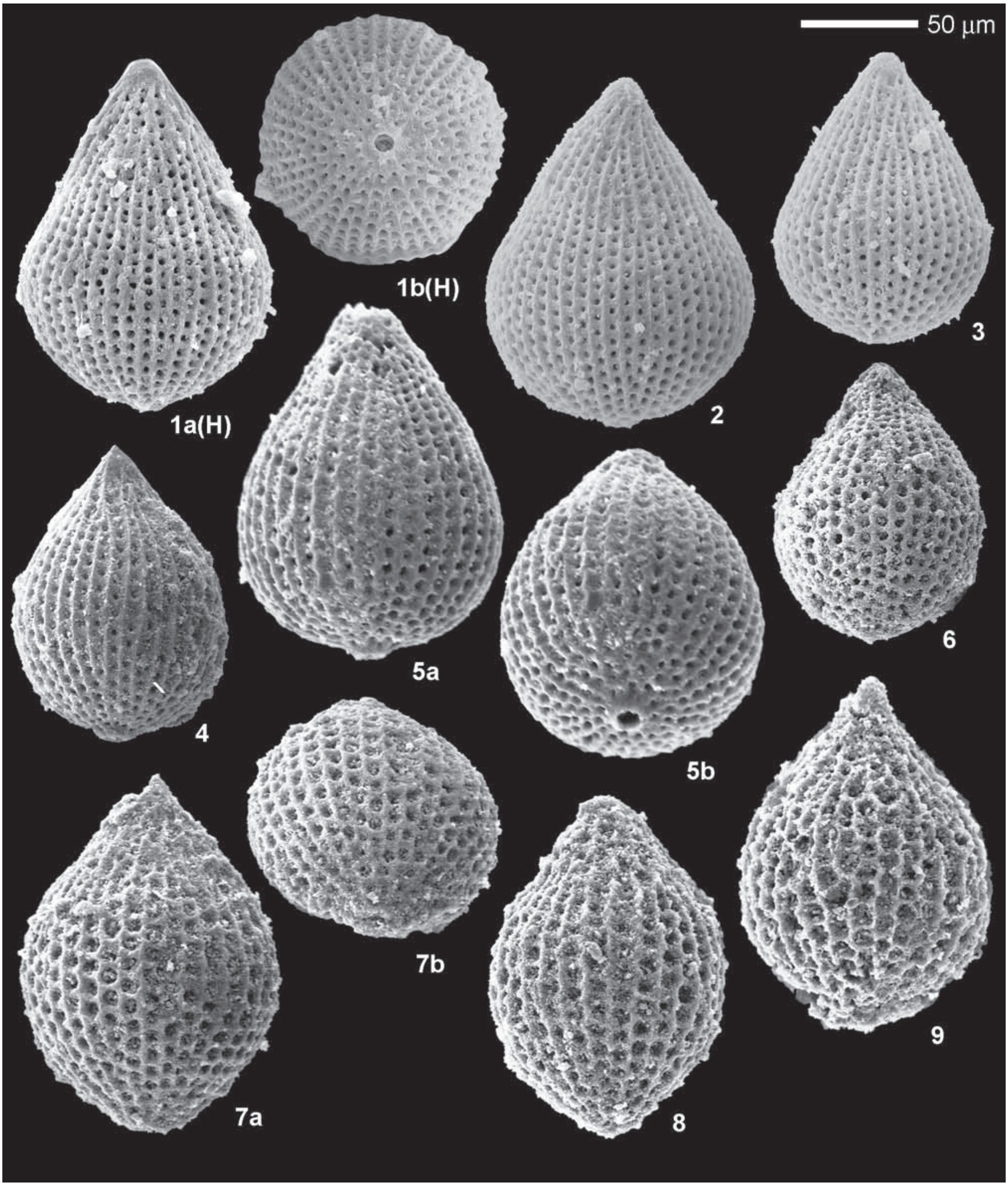


Plate SCP04. ***Helvetocapsa plicata plicata*** **(Matsuoka).** Magnification x400. **Fig. 1(H) a, b.** Matsuoka 1991, Figs. 5.1a-b. **Figs. 2, 3.** Matsuoka 1991, Fig. 5.3a, 4. **Fig. 4.** Goričan et al. 2003, pl. 4, fig. 17a. **Figs. 5a, b.** OM-99-89-011416, 011415. **Fig. 6.** OM-00-263-021330. **Figs. 7a, b.** OM-00-252-022010, 022011. **Fig. 8.** OM-00-251-021609. **Fig. 9.** OM-00-115-023022.

Helvetocapsa plicata semiplicata (Matsuoka) 1991

Species code: SCP05

Synonymy:

1991 *Stichocapsa plicata semiplicata* n. subsp. – Matsuoka, p. 729, Fig. 6. 1a – 6b.

1997 *Stichocapsa semiplicata* Matsuoka – Yao, pl. 9, fig. 438.

2004 *Stichocapsa plicata semiplicata* Matsuoka – Matsuoka, fig. 85.

2005 *Stichocapsa plicata semiplicata* Matsuoka – Kashiwagi et al., pl. 5, fig. 8.

Original description: Shell of five to six segments, drop-like shaped. Cephalis hemispherical, poreless. The last segment large, truncate subspherical with a constricted aperture. Remaining segments including thorax and abdomen truncate conical. Strictures between segments indistinct externally. Fifteen to 22 densely spaced longitudinal plicae visible on outer shell except for cephalis and the middle part of shell. Pores small, circular and arranged longitudinally. One row of pores present between the plicae. Aperture small, circular, occasionally with a short protruding rim.

Original remarks: *Stichocapsa plicata semiplicata*, n. subsp. is compared to *S. plicata plicata*, n. subsp. under the latter subspecies.

Measurements (μm):

Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	139	149	123	142	(9)
Maximum width of shell	95	99	80	94	(9)
Diameter of aperure	7	8	7	7	(3)

Etymology: The subspecific name comes from the Latin *semi* (=half) and *plicatus-a-um* (=plicate).

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

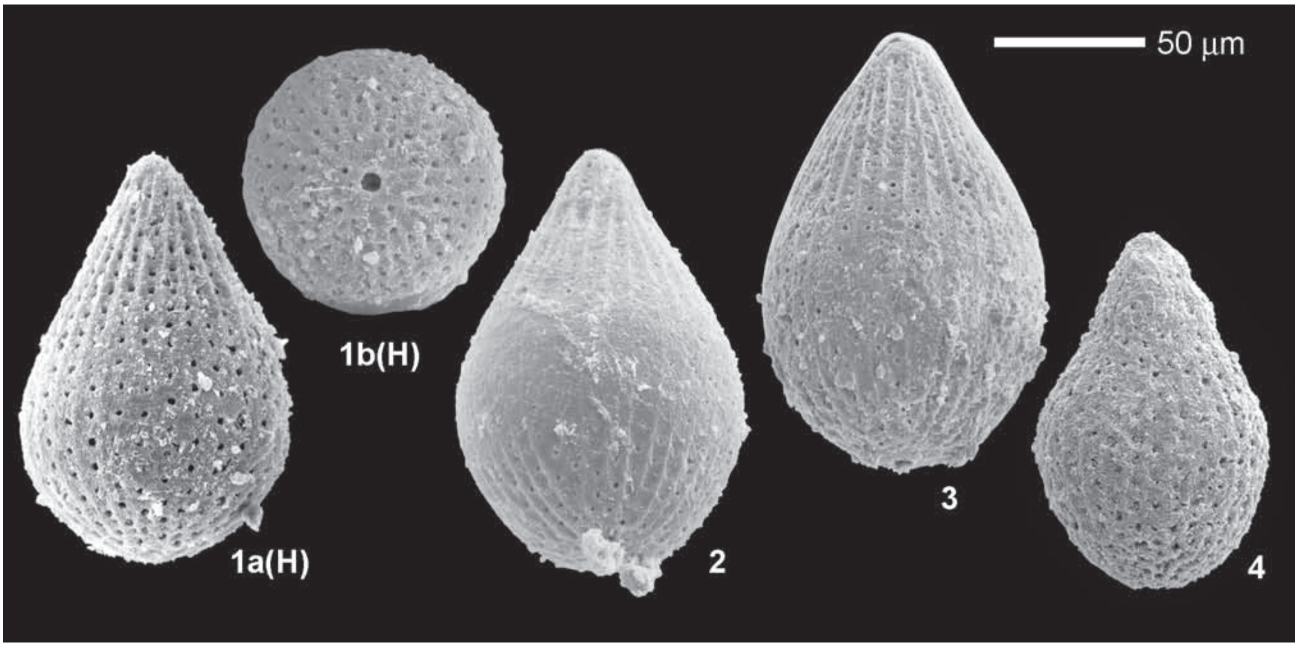


Plate SCP05. ***Helvetocapsa plicata semiplicata*** **(Matsuoka).** Magnification x400. **Fig. 1(H)a, b.** Matsuoka 1991, Fig. 6.1a-b. **Figs. 2, 3.** Matsuoka 1991, Figs. 6.3, 6.5. **Fig. 4.** OM, BR524-R05-16.

Genus: ***Hexasaturnalis*** Kozur & Mostler 1983

Type species: *Spongosaturnalis*? *hexagonus* Yao 1972

Synonymy:

1983 *Hexasaturnalis* n. gen. – Kozur & Mostler, p. 28.
1983 *Yaosaturnalis* n. gen. – Kozur & Mostler, p. 31.

Original description: Ring and outer spines strongly bladed. Outline of ring hexagonal to octagonal or subquadratically rounded. 4-8 very strong outer spines. Two massive polar spines opposite to interspine spaces on the outer margin of the ring. No auxiliary spines. Ring often a little constricted in the polar spine attachment region. Cortical shells spongy, widely separated from the inner margin of the ring. Medullary shell latticed.

Original remarks: By increase of the number of marginal spines the hexagonal to octagonal outline of the ring is transformed to a polygonal to subcircular one. In this manner the genus *Spongosaturnalis* Campbell and Clark, 1944b, evolved in the Cretaceous from *Hexasaturnalis* n. gen. *Praehexasaturnalis* n. gen. from the Norian has the same outline of ring, but the polar spines are still situated opposite to the marginal spines and the narrow ring is still flat to shallow oval in cross section. *Yaosaturnalis* n. gen. has the same outline and structure of ring as *Hexasaturnalis* n. gen., but auxiliary spines are present.

Further remarks: Herein we follow De Wever et al. (2001) who synonymized *Yaosaturnalis* Kozur & Mostler with *Hexasaturnalis* Kozur & Mostler.

Etymology: According to the outline.

Included species:

3502 *Hexasaturnalis hexagonus* (Yao) 1972
SAT11 *Hexasaturnalis octopus* Dumitrica & Hori n. sp.
3089 *Hexasaturnalis tetraspinus* (Yao) 1972

Hexasaturnalis hexagonus (Yao) 1972

Species code: 3502

Synonymy:

1972 *Spongosaturnalis ? hexagonus* n. sp. – Yao, p. 31, pl. 6, figs. 1-3; pl. 11, figs. 3a-c.
1982 *Spongosaturnalis ? hexagonus* Yao – Wakita & Okamura, pl. 5, fig. 2.
1982 *Spongosaturnalis ? hexagonus* Yao – Matsuda & Isozaki, pl. 1, fig. 20.
1982 *Spongosaturnalis ? hexagonus* Yao – Wakita, pl. 4, fig. 11.
1982 *Spongosaturnalis* (?) *tetraspinus* Yao – Kishida & Sugano, pl. 6, fig. 9, not 10.
1982 *Acanthocircus hexagonus* (Yao) – Kido, pl. 3, fig. 10.
Not 1986 *Hexasaturnalis hexagonus* (Yao) – Grill & Kozur, pl. 2, fig. 5.
1987 *Acanthocircus hexagonus* (Yao) – Hattori, pl. 1, fig. 2.
not 1988 *Mesosaturnalis hexagonus* (Yao) – Carter et al., pl. 47, pl. 9, figs. 11-12.
1988 *Acanthocircus hexagonus* (Yao) – Hattori, pl. 1, fig. K.
1989 *Acanthocircus hexagonus* (Yao) – Hattori & Sakamoto, pl. 2, fig. B, not fig. C.
1989 *Acanthocircus hexagonus* (Yao) – Hattori, pl. 18, fig. B, pl. 35, fig. F.
1989 *Mesosaturnalis* sp. cf. *M. hexagonus* (Yao) – Hori & Otsuka, pl. 4, fig. 9.
1990 *Mesosaturnalis hexagonus* (Yao) – Hori, Fig. 9.42.
1991 *Mesosaturnalis hexagonus* (Yao) – Carter & Jakobs, p. 343, pl. 2, fig. 15.
1993 *Acanthocircus hexagonus* Yao – Fujii et al., pl. 1, fig. 3.
1995a *Hexasaturnalis hexagonus* (Yao) – Baumgartner et al., p. 252, pl. 3502, figs. 1-3.
1996 *Mesosaturnalis hexagonus* (Yao) – Tumanda et al., p. 173, fig. 5.19.
1996 *Acanthocircus hexagonus* (Yao) – Yeh & Cheng, p. 106, pl. 2, fig. 9; pl. 7; fig. 4.
1997 *Mesosaturnalis hexagonus* Yao – Hori, pl. 1, figs. 10a-c.
1997 *Hexasaturnalis hexagonus* (Yao) – Yao, pl. 5, fig. 218.
? 1997 *Hexasaturnalis* aff. *hexagonus* (Yao) – Yao, pl. 5, fig. 222.
2002 *Hexasaturnalis hexagonus* (Yao) – Hori & Wakita, pl. 3, fig. 16.
2004 *Hexasaturnalis hexagonus* (Yao) – Hori, pl. 4, fig. 38; pl. 6, fig. 2; pl. 9, fig. 6; pl. 13, fig. 59; pl. 23, fig. 21.
2005 *Hexasaturnalis hexagonus* (Yao) – Hori, pl. 12, fig. 21; pl. 13, fig. 36.

Original description: Spongosaturnalid with subhexagonal ring, and with six strong spines on ring. Shell not preserved, but believed to be wholly spongy because numerous fragmentary thorns, which may be connected with spongy shell, are clearly observed on sturdy spines. Polar spines short, thick, with no ridge. Ring bilaterally symmetrical, subhexagonal, strong, with clear ridge on outer edge. Inner edge of ring curves rather smoothly, while outer edge is subhexagonal, with spine at each vertex. Ring which joins with polar spine bends slightly toward inside. Spines, situated diagonally on ring, strong, somewhat long, of sharp tip, with clear ridges which continue to one on outer edge of ring.

Original remarks: This species differs from *Spongosaturnalis ? septispinus* in the number of the spine, and from *S. ? minoensis* in lacking auxiliary spines on the inner margin of the saturnalin ring. *Spongosaturnalis* ? sp., reported by Foreman (1971, pl.1, fig.4; Cretaceous sediments core, Site 61, west margin of East Mariana Basin, through the Deep Sea Drilling Project), is similar to this species, but the former has slender spines on which there is no ridge.

Measurements (μm):
Based on 6 specimens.

	HT	Av.	Min.	Max.
Diameter of ring longitud.	243	198	156	243
Diameter of ring trans.	278	245	188	282
Diameter of shell	136	104	75	136
Lenght of polar spine	23	19	10	25
Lenght of spine	126	101	62	130
Breadth of ring	36	27	17	39

Type locality: Manganese carbonate ore, Mino Belt, river side of the Kiso, east of Unuma, Kagamihara City, Gifu Prefecture, Central Japan.

Occurrence: Worldwide.

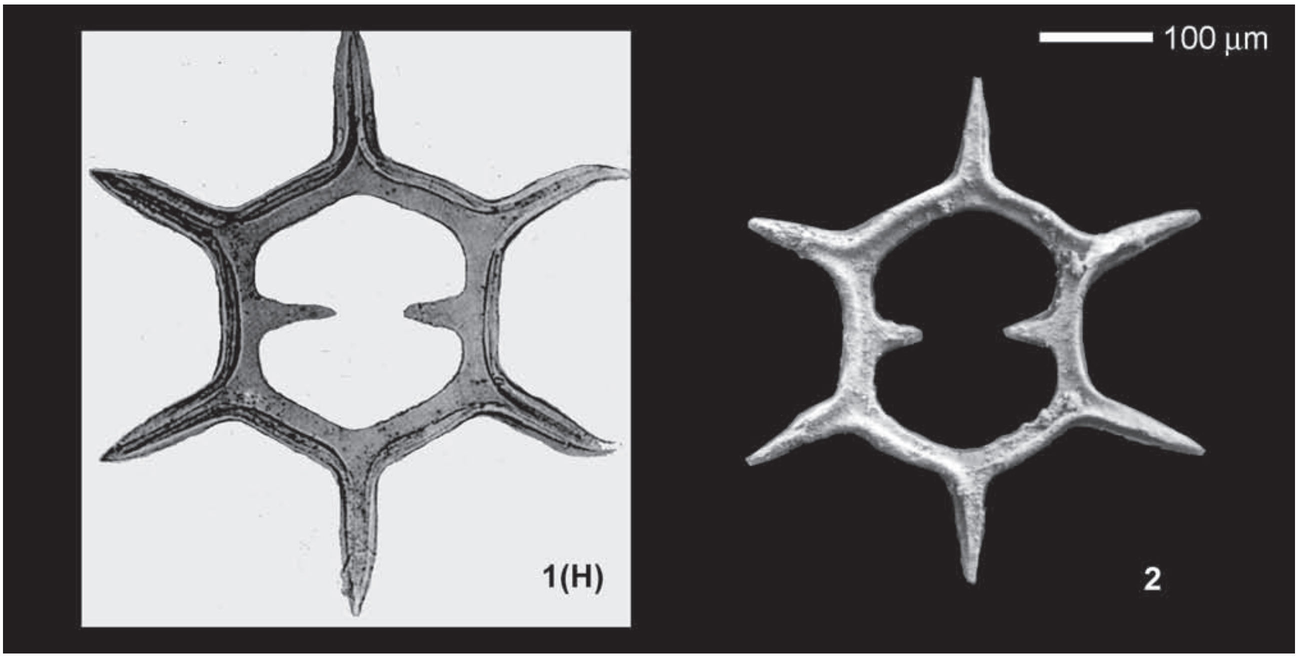


Plate 3502. *Hexasaturnalis hexagonus* (Yao). Magnification x150. **Fig. 1(H).** Yao 1972, pl. 6, fig. 2. **Fig. 2.** Hori 1990, fig. 9-42.

Hexasaturnalis octopus Dumitrica & Hori n. sp.

Species code: SAT11

Synonymy:

1972 *Spongosaturnalis* ? sp. a – Yao, pl. 8, figs. 6, 7.
1997 *Hexasaturnalis* sp. A – Yao, pl. 5, fig. 221.

Type designation: Holotype pl. SAT11, fig. 1, sample BR871, chert of Tawi Sadh Member reworked in the Guwayza Formation, Al Khashbah Mountains, Oman.

Diagnosis: *Hexasaturnalis* with eight-spined ring.

Description: Shell spongy, ellipsoidal when preserved. Ring symmetrical, subcircular or elliptical, rounded on the inner margin, octagonal on outer margin, with a spine at each corner. Inner margin without auxiliary spines. Middle part of ring more or less constricted in the vicinity of contact with polar rays. Outer blades of ring well developed especially at proximal part of ring. Spines usually strong, four-bladed, pointed; peripolar spines longer than distal spines, the latter rarely extremely short. Commonly distal spines closer to each other than to peripolar spines.

Remarks: This new species differs from the other species of the genus *Hexasaturnalis* in the number of spines.

Measurements (μm):
Based on 6 specimens.

	HT	Av.	Min.	Max.
Longitudinal size of ring	213	195	180	213
Transversal size of ring	220	236	220	267
Length of shell	90	-	-	-
Length of polar rays	67+	56	47	73
Length of peripolar spines	47-60	56	40	67
Length of distal spines	27-33	28	20	47
Breadth of ring bar	20	21	17	27

Etymology: From the Greek *octo* - eight and *pous, podos* – foot, referring to the number of spines; noun.

Type locality: Sample BR871, Tawi Sadh Member, Guwayza Formation, Al Khasbah Mountains, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Oman; Japan; Snowshoe Formation, Oregon.

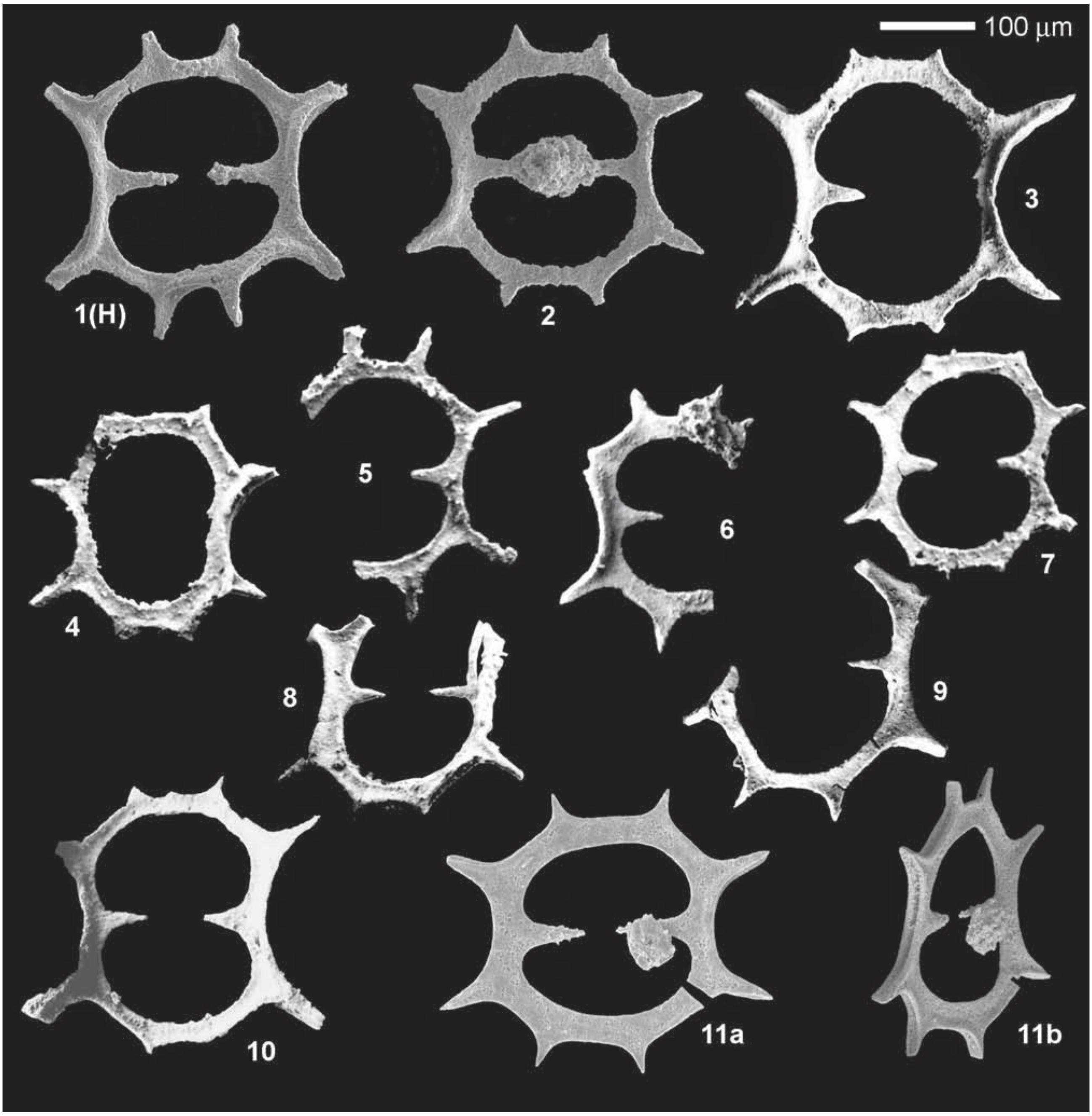


Plate SAT11. ***Hexasaturnalis octopus*** **Dumitrica & Hori n. sp.** Magnification x150. **Fig. 1(H).** OM, BR871-R01-10. **Fig. 2.** OM, BR871-R01-07. **Fig. 3.** JP, IYII10-143. **Fig. 4.** JP, IYII14-41. **Fig. 5.** JP, IYII14-65. **Fig. 6.** JP, IYII14-44. **Fig. 7.** JP, IYII14-43. **Fig. 8.** JP, IYII10-142. **Fig. 9.** JP, IYII10-11. **Fig. 10.** JP, IYII-144. **Fig. 11a,b.** OR555-R07-13.

Hexasaturnalis tetraspinus (Yao) 1972

Species code: 3089

Synonymy:

1972 *Spongosaturnalis* ? *tetraspinus* n. sp. – Yao, p. 29, pl. 4, figs. 1-6; pl. 11, figs. 1-2.
1982 *Spongosaturnalis* ? *tetraspinus* Yao – Wakita, pl. 4, fig. 12.
not 1982 *Spongosaturnalis* ? *tetraspinus* Yao – Kishida & Sugano, pl. 6, figs. 9-10.
? 1984 *Mesosaturnalis squinaboli* – Carayon et al., pl. 1, fig. 2.
? 1986 *Hexasaturnalis hexagonus* (Yao) – Grill & Kozur, pl. 2, fig. 5.
1987 *Mesosaturnalis tetraspinus* (Yao) – Goričan, p. 184, pl. 3, fig. 1.
1988 *Acanthocircus tetraspinus* Yao – Hattori, pl. 2, fig. B.
? 1988 *Mesosaturnalis hexagonus* (Yao) – Carter et al., pl. 47, pl. 9, figs. 11-12.
1989 *Acanthocircus tetraspinus* Yao – Hattori, pl. 35, fig. G.
1990 *Mesosaturnalis tetraspinus* (Yao) – Yao, pl. 3, fig. 24.
1991 *Mesosaturnalis tetraspinus* (Yao) – Carter & Jakobs, p. 343, pl. 2, fig. 16.
1991 *Hexasaturnalis tetraspinus* (Yao) – Tonielli, p. 23, pl. 1, fig. 5.
1995a *Hexasaturnalis tetraspinus* (Yao) – Baumgartner et al., p. 254, pl. 3089, figs. 1-3.
1996 *Acanthocircus tetraspinus* (Yao) – Yeh & Cheng, p. 106, pl. 2, fig. 10.
1997 *Hexasaturnalis tetraspinus* (Yao) – Yao, pl. 5, fig. 219.
? 1997 *Hexasaturnalis* aff. *tetraspinus* (Yao) – Yao, pl. 5, fig. 220.
2004 *Hexasaturnalis tetraspinus* (Yao) – Hori, pl. 4, fig. 39, pl. 11, fig. 43, pl. 13, fig. 60.
2005 *Hexasaturnalis tetraspinus* (Yao) – Hori, pl. 12, fig. 22.

Original description: Spongosaturnalid with four strong spines on proximal part of ring. Shell not preserved, but judged from numerous fragmentary thorns attached to tip of polar spines and on sturdy spines, it is most probably spongy. Polar spines extend and bifurcate to form a subcircular ring with distinct indentation proximally. Ring bilaterally symmetrical, strong, with clear ridge on outer edge. Four spines are present symmetrically on proximal part of ring. Spines strong, slightly curved, with sharp tip, and with clear ridges. In some specimens, short spine is present on terminal end of ring.

Original remarks: This species is distinguished from other species by the strong spines on the proximal part of the ring. There is little variation in the shape of the ring, excluding the presence of a short spine at the terminal end.

Complete specimen with the shell was not found and fragmentary rings are common. Although the generic assignment of this species is slightly doubtful, it may belong to the genus *Spongosaturnalis* because of its morphological feature.

Measurements (μm):
Based on 6 specimens.

	HT	Av.	Min.	Max.
Diameter of ring longit.	360	294	220	360
Diameter of ring; trans.	485	374	220	485
Diameter of shell	105	102	80	120
Length of polar spine	95	63	40	95
Length of spine	90	75	58	100
Breadth of ring	37	30	16	37

Type locality: Inuyama area, central Japan.

Occurrence: Worldwide.

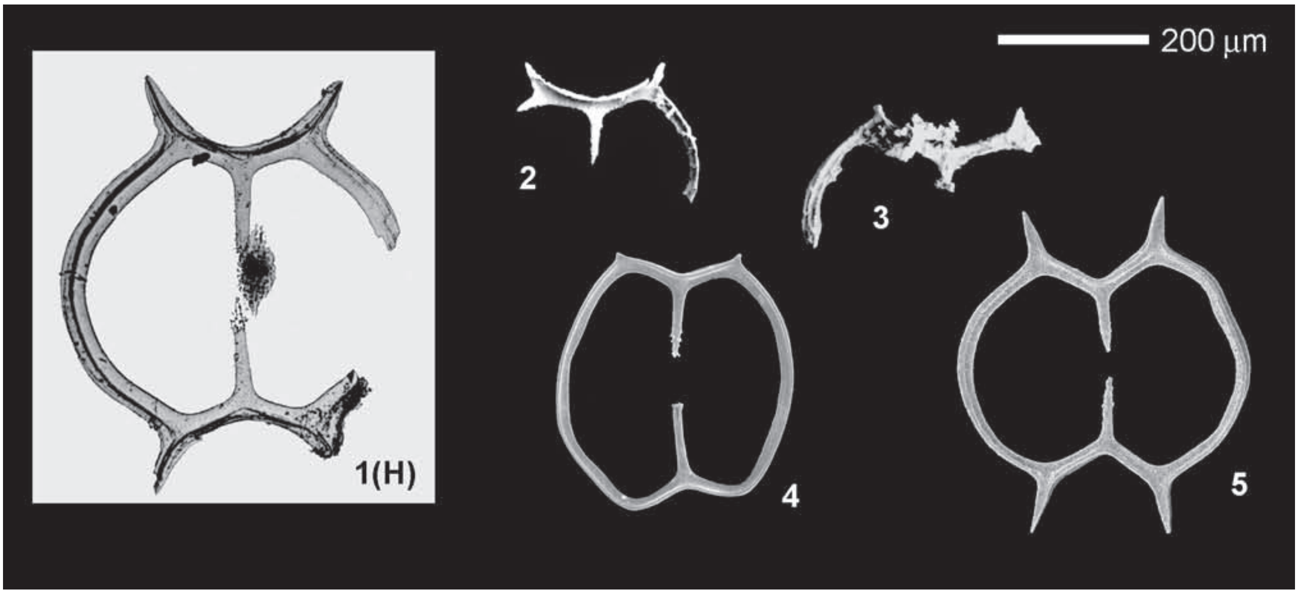


Plate 3089. ***Hexasaturnalis tetraspinus*** **(Yao). Fig. 1(H).** Magnification x100. **Fig. 1(H).** Yao 1972, pl. 4, fig. 6. **Fig. 2.** JP, IYII-14. **Fig. 3.** JP, IYII5-65. **Fig. 4.** OR555-R07-15. **Fig. 5.** OR555-R07-14.

Genus: *Higumastra* Baumgartner 1980

Type species: *Higumastra inflata* Baumgartner 1980

Synonymy:

1980 *Higumastra* n. gen. – Baumgartner, p. 290.

Original description: Test composed of 4 rays at right angles. Cortical rays composed of thin external beams connected by regular bars forming large circular pores in longitudinal rows. Ray tips with central or 2 lateral and central spines. Inner structure in rays and medullary shells always visible in transmitted light observation. Centrally placed shells (1 or 2) are on both sides joined to the cortical shell. Vertical septae lying below the median pore row extend from the innermost medullary shell and divide the inner space of the rays into 2 main canals of semicircular cross section. Vertical septum composed of primary beam and primary lamellae penetrated by large lamellar pores. Vertical septum with 1 or 2 channels below the median pore row on each side. Patagium may be well developed, present as remnants, or absent.

Original remarks: *Higumastra* n. gen. differs from all other four-armed hagiastrids by the easily visible inner structure and in having large pore frames in longitudinal rows with a distinct median pore row.

Etymology: *Higumastra* is an anagram of *Hagiastrum.*

Included species:

HIG01 *Higumastra laxa* Yeh 1987b
HIG04 *Higumastra lupheri* Yeh 1987b
HIG03 *Higumastra transversa* Blome 1984b

Higumastra laxa Yeh 1987b

Species code: HIG01

Synonymy:

1987b *Higumastra laxa* n. sp. – Yeh, p. 25, pl. 8, figs. 13, 18; pl. 29, fig. 20.
1987b *Higumastra splendida* n. sp. – Yeh, p. 26, pl. 8, figs. 2, 4, 11-12, 16, 18, 25-27.
1987b *Higumastra* sp. aff. *H. splendida* n. sp. – Yeh, p. 27, pl. 8, figs. 5, 28.
1987b *Higumastra* sp. A – Yeh, p. 27, pl. 8, figs. 3, 17.
1997 *Higumastra laxa* Yeh – Yao, pl. 7, fig. 317.
? 2003 *Higumastra laxa* Yeh – Goričan et al., p. 293, pl. 1, fig. 18.
2004 *Higumastra laxa* Yeh – Matsuoka, fig. 48.

Original description: Test with large central area and short, wide rays. Rays tapering distally with short, massive triradiate spines. One spine slightly longer than other three. Rays comprised of large tetragonal and pentagonal pore frames with five pores visible laterally at proximal end and three pores visible distally. Central area of cortical shell consisting of concentrically arranged pentagonal and hexagonal pore frames without prominent nodes at vertices. Test with or without patagium.

Original remarks: *Higumastra laxa*, n. sp., differs from *H. splendida*, n. sp., by lacking massive nodes at pore frame vertices and by having wider rays with shorter primary spines.

Remarks: In this work *Higumastra laxa* Yeh and *Higumastra splendida* Yeh are synonymized.

Measurements (µm):
Ten specimens measured.

Length of ray	Width of ray at base	Width of central area	Length of spine	
61	61	122	61	HT
73	73	128	61	Max.
60	58	118	30	Min.
65	65	123	45	Mean

Etymology: *Laxus-a-um* (Latin, adj). = wide.

Type locality: OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Sowshoe Formation, east-central Oregon; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

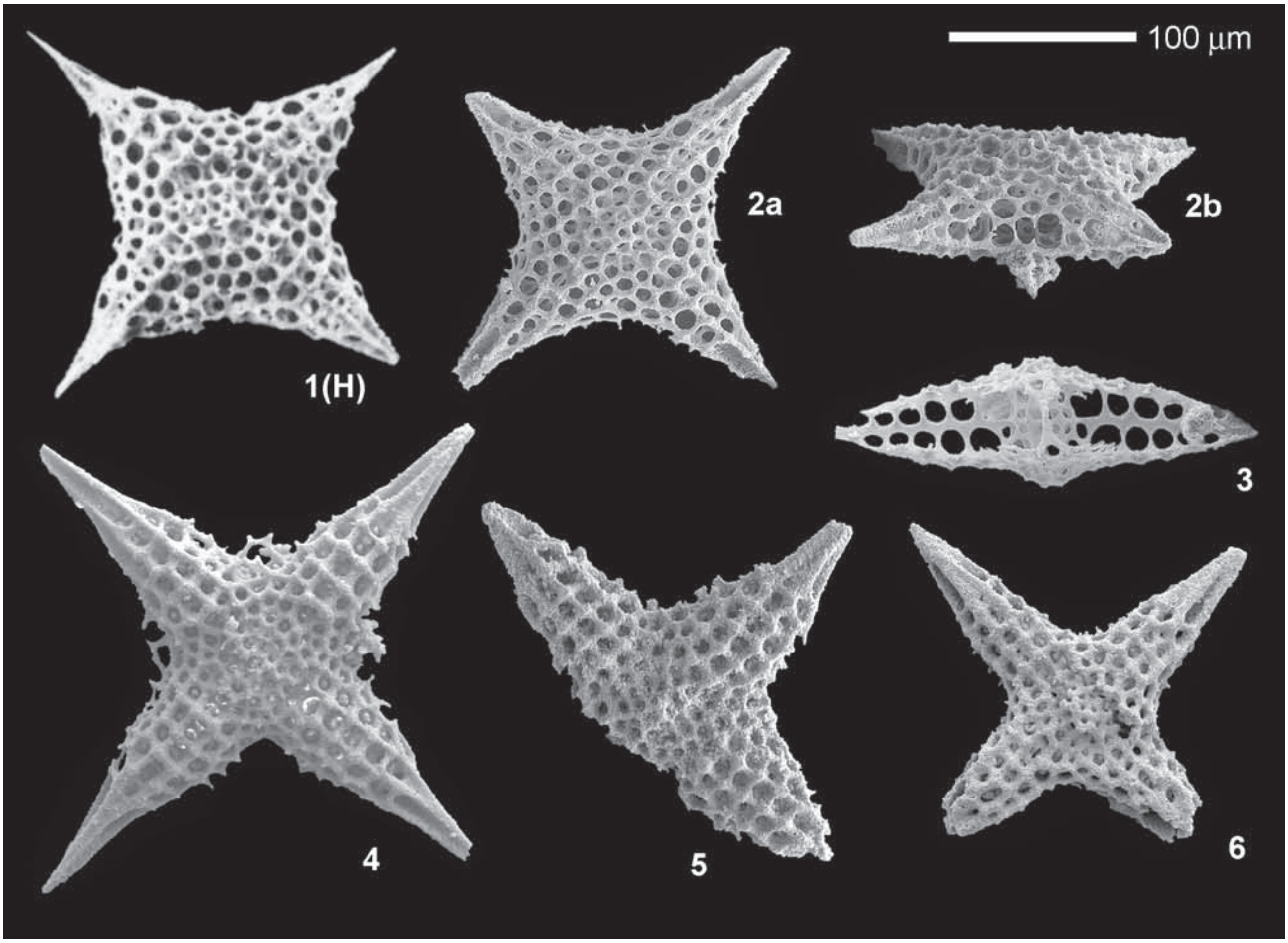


Plate HIG01. *Higumastra laxa* Yeh. Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 8, fig. 13. **Figs. 2a, b.** OR600A, 13151a,b. **Fig. 3.** OR600A, 13126. **Fig. 4.** OM, BR682-R09-21. **Fig. 5.** OM, BR1122-R02-19. **Fig. 6.** OM, BR524-R05-27.

Higumastra lupheri Yeh 1987b

Species code: HIG04

Synonymy:

1987b *Higumastra lupheri* n. sp. – Yeh, p. 25, pl. 8, figs. 8, 24.
1988 *Higumastra* sp. A – Carter et al., p. 29, pl. 10, fig. 6.
2004 *Higumastra lupheri* Yeh – Matsuoka, fig. 48.

Original description: Rays medium in length, wide proximally, slightly tapering distally with long massive triradiate spines, one spine slightly longer than other three. Test comprised of large, nearly uniform size of linearly arranged tetragonal pore frames on rays, small pentagonal and hexagonal concentrically arranged pore frames at central area. Central area medium in size. All pore frames lacking prominent nodes at vertices. Test with or without patagium.

Original remarks: *Higumastra lupheri*, n. sp., differs from *H. oregonensis*, n. sp., by having wider and shorter rays with longer primary spines and by concentrically arranged pore frames on the cortical shell of central area.

Measurements (μm):
Ten specimens measured.

Length of ray	Width of ray at base	Width of central area	Length of spine	
165	110	220	110	HT
170	116	225	118	Max.
150	105	215	105	Min.
160	108	220	110	Mean

Etymology: This species is named for Dr. R. L. Lupher in honor of his early contribution to the geology of east-central Oregon.

Type locality: Sample OR-600A, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Sowshoe Formation, east-central Oregon; Phantom Creek and Graham Island formations, Queen Charlotte Islands; Mino Terrane, Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

Higumastra transversa Blome 1984b

Species code: HIG03

Synonymy:

1984b *Higumastra transversa* n. sp. – Blome, p. 350, pl. 1, figs. 3-5, 8-13, 16-19; pl. 15, fig. 4.
1988 *Crucella* sp. A – Carter et al., p. 43, pl. 15, figs. 9, 12.
1991 *Higumastra* sp. cf. *H. transversa* Blome – Carter & Jakobs, p. 342, pl. 2, fig. 3.

Original description: Test as with genus. Rays usually short, of equal length; rays usually slightly twisted (nodose dorsal surface of ray slightly offset with respect to ventral surface); rays inflated, subrectangular in axial section, usually thickest medially; rays terminating in relatively long central spines, circular in axial section. Meshwork of cortical shell (both rays and central area) consisting of two visible layers of pentagonal and hexagonal pore frames: nodose outer layer composed of three to four rows of nodose pore frames visible on both dorsal and ventral surfaces, pore frames possessing massive, subspherical nodes at the pore frame vertices; outer layer extending linearly from distal end of rays onto middle of central area; inner layer visible on lateral portions of central area, pore frames more regular in size, remnants of subsidiary beams (pillars which connect inner layer to outer layer) sometimes observable at pore frame vertices (see pl. 1, fig. 12). Some specimens exhibit remnants of patagium on lateral surfaces between rays (see pl. 1, fig. 16). Medullary shell as with genus.

Original remarks: *Higumastra transversa* differs from *H. inflata* by having slightly twisting, subrectangular rays, a cortical shell with massive nodes at the pore frame vertices, and longer central spines on the ray tips.

Further remarks: Forms with slightly tapering rays disposed in an X-shaped pattern (i.e. not at 90˚) are also included.

Measurements (μm):
Based on 7 specimens.

Ray length	Ray width	Cortical shell width	Spine length	
100, 105, 106, 112	72, 75, 78, 79	147	87, 90, 112, 118	HT
120	87	168	114	Max.
105	60	133	65	Min.
115	74	147	96	Av.

Etymology: *Transversus-a-um* (latin, adj., f.) = transverse, oblique, in an oblique direction.

Type locality: Sample 80AJM 8A, Shelikof Formation, Puale Bay, southern Alaska.

Occurrence: Shelikof Formation, Alaska; Lonesome Formation, Oregon; Phantom Creek and Graham Island formations, Queen Charlotte Islands.

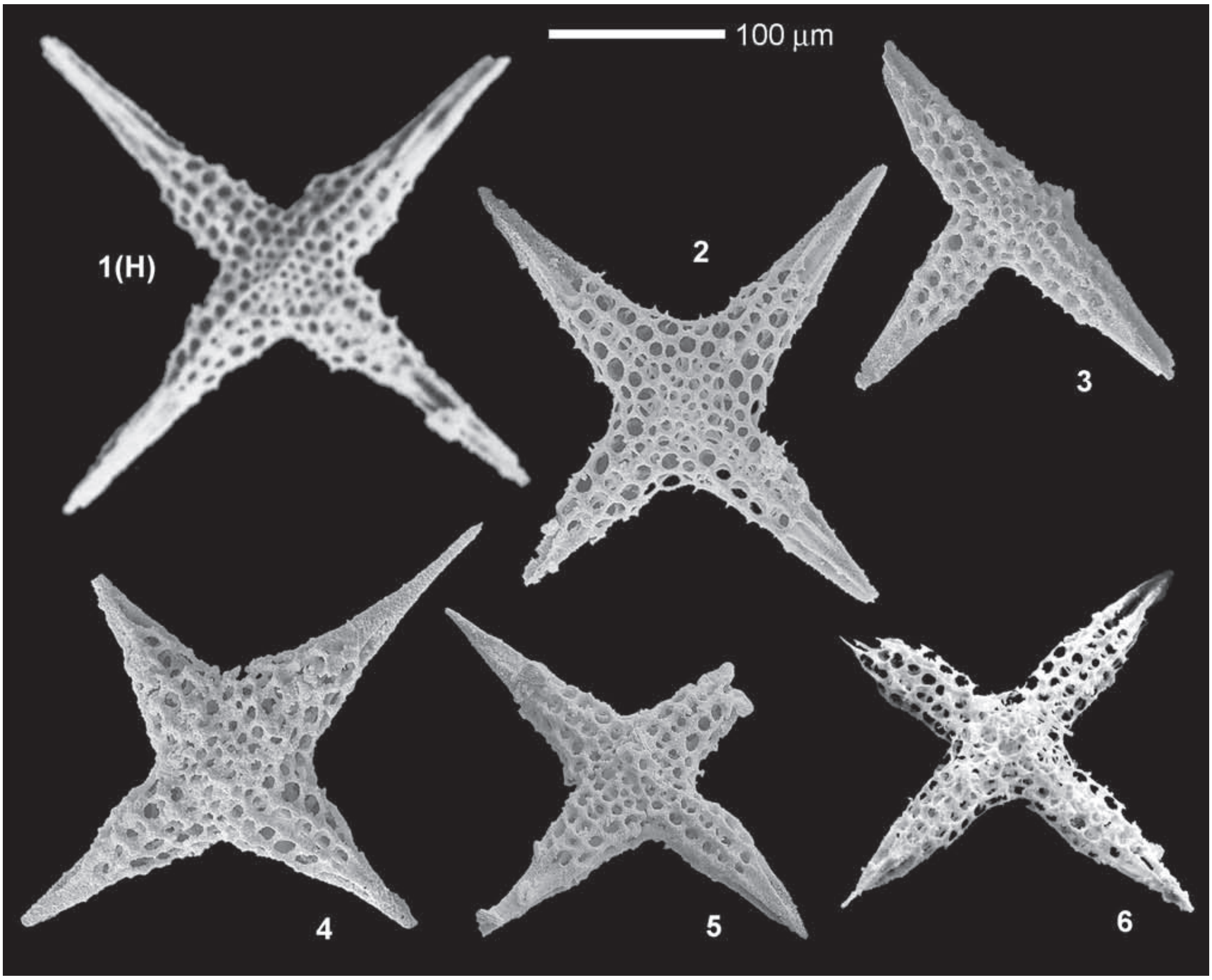


Plate HIG04. ***Higumastra lupheri*** **Yeh.** Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 8, fig. 8. **Fig. 2.** OR600A, 13162. **Fig. 3.** OM, BR1121, 15921. **Fig. 4.** OM, BR706, 15780. **Fig. 5.** OM, BR1121, 15931. **Fig. 6.** JP, MNA-10, MA10707.

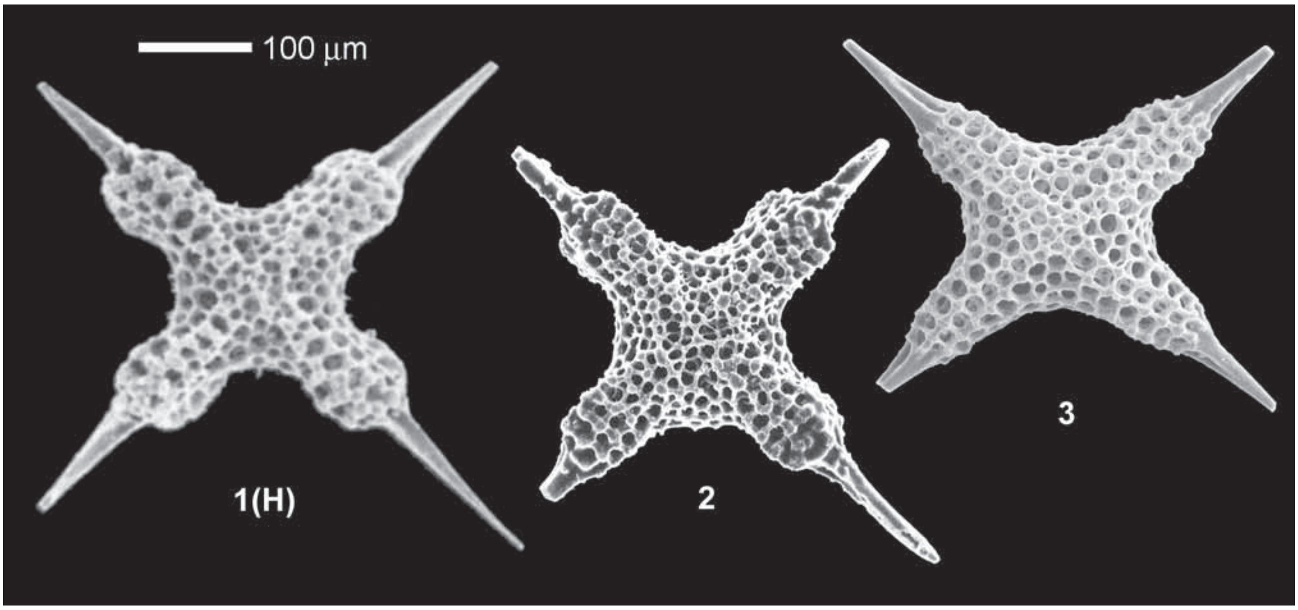


Plate HIG03. ***Higumastra transversa*** **Blome.** Magnification x150. **Fig. 1(H).** Blome 1984b, pl. 3, fig. 3. **Fig. 2.** Carter et al. 1988, pl. 15, fig. 9. **Fig. 3.** Carter & Jakobs 1991, pl. 2, fig. 3.

Genus: *Homoeoparonaella* Baumgartner 1980

Type species: *Paronaella elegans* Pessagno 1977a

Synonymy:

1980 *Homoeoparonaella* n. gen – Baumgartner, p. 288.

Original description: Test as with subfamily, composed of 3 rays with equal to subequal interradial angles lacking a bracchiopyle and a patagium. Cortical rays composed of numerous longitudinal external beams connected by short bars in transverse rows forming small pore frames. Nodes well developed. Ray tips bulbous with or without central spines. Medullary shell composed of centrally placed medullary rays merging in central area. Medullary rays composed of 3 (sometimes 5) primary canals arranged around primary beams. Medullary shell connected by numerous radially arranged subsidiary beams to cortical shell.

Original remarks: *Homoeoparonaella,* n. gen. differs from *Paronaella* Pessagno, 1971 (placed in Patulibracchiidae herein) by its regular linear arrangement of pores and external beams and by its differentiation into cortical and medullary shells. It is distinguished from all other three-armed hagiastrid genera in having numerous external beams and in lacking a bracchiopyle.

Etymology: *Homoeoparonaella* is named for its external homeomorphy with *Paronaella* Pessagno.

Included species:

HOM01 *Homoeoparonaella lowryensis* Whalen & Carter 2002

HOM02 *Homoeoparonaella reciproca* Carter 1988

Homoeoparonaella lowryensis Whalen & Carter 2002

Species code: HOM01

Synonymy:

1998 *Homoeoparonaella* sp. A – Whalen & Carter, p. 46, pl. 13, fig. 13, 17.

2002 *Homoeoparonaella lowryensis* n. sp. – Whalen & Carter, p. 104, pl. 3, figs. 5, 6, 13, 15.

Original description: Elongate slender rays, sub-circular in axial section, all approximately same length. Expanded ray tips with slightly planiform top and bottom surfaces. Meshwork on rays composed of irregularly shaped triangular and tetragonal pore frames with distinct nodes at pore frame vertices; alignment of pore frames parallel to long axis of each ray. Meshwork on expanded ray tips composed of irregularly shaped and distributed rectangular to circular pore frames with slight development of nodes at pore frame vertices. Each ray with one small spine, usually broken.

Original remarks: *Homoeoparonaella hydensis* Yeh 1987 and *H. reciproca* Carter 1988 appear to be distinctly different species from *H. lowryensis* n. sp. because their pore frames are much more regular.

Measurements (µm):

Based on 10 specimens.

Length of ray	
225	HT
225	Max.
173	Min.
193	Mean

Etymology: This species is named for Pico Lowry located to the northeast of the type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Sandilands Formation, Queen Charlotte Islands; Dürrnberg Formation, Austria; Tawi Sadh Member of the Guwayza Formation, Oman.

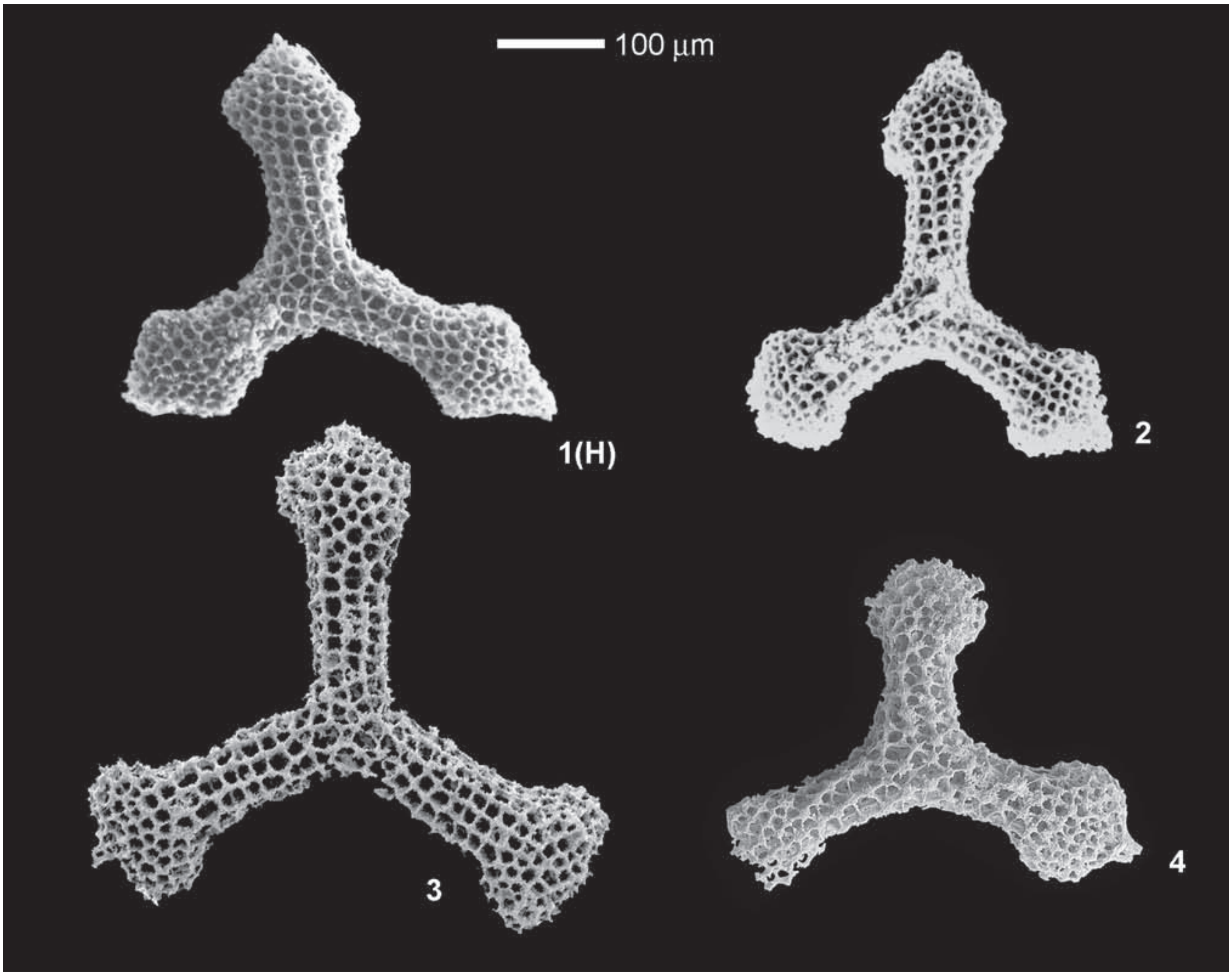


Plate HOM01. ***Homoeoparonaella lowryensis*** **Whalen & Carter**. Magnification x150. **Fig. 1(H).** Whalen & Carter 2002, pl. 3, fig. 5. **Fig. 2.** Whalen & Carter 2002, pl. 3, fig. 6. **Fig. 3.** AT, BMW21-27. **Fig. 4**. OM, BR1121, 15892.

Homoeoparonaella reciproca Carter 1988

Species code: HOM02

Synonymy:

1988 *Homoeoparonaella reciproca* Carter – Carter et al., p. 28, pl. 7, figs. 2-3.

Original diagnosis: Test has three rays of moderate (near equal) length with strongly expanded ray tips terminated by numerous short, fine spines. Pore frames and beams are aligned longitudinally, producing a pattern of single rows of square pore frames that alternate with double rows of triangular pore frames.

Original description: Three-rayed test. Rays of moderate length, interradial angles subequal. Rays composed of 8-10 longitudinal beams with transverse bars oriented both perpendicular and oblique to the beams, forming single rows of square pore frames that alternate with double rows of triangular pore frames. Rays circular in axial section. Pore frames on ray tips are irregularly distributed, polygonal in shape.

Original remarks: Rays are short and stout compared with those of *Homoeoparonaella argolidensis* Baumgartner. *Homoeoparonaella reciproca* differs from *H. hydensis* Yeh in having double rows of triangular pore frames alternating with single rows of square pore frames; *H. hydensis* has only linearly arranged square pore frames and is also much smaller. The alternating pore frame pattern batween beams is diagnostic of *H. reciproca* but observable on well preserved specimens only.

***Measurements* (μm):**

Based on 11 specimens.

		HT	Av.	Max.	Min.
Lengths of rays	AX	185	191	210	150
	BX	202			
	CX	202			
Width of rays		46-49	56	62	46
Width of ray tips		122-133	128	140	95
Length of longest spine		23	29	43	22

Etymology: Latin, *reciprocus* (adj.), alternating. Refers to the alternating pattern of rows of square, and rows of triangular, pore frames between longitudinal beams.

Type locality: GSC locality C-080584, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte Island, British Columbia.

Occurrence: Whiteaves and Phantom Creek formations, Queen Charlotte Island; Japan; Tawi Sadh Member of the Guwayza Formation, Oman.

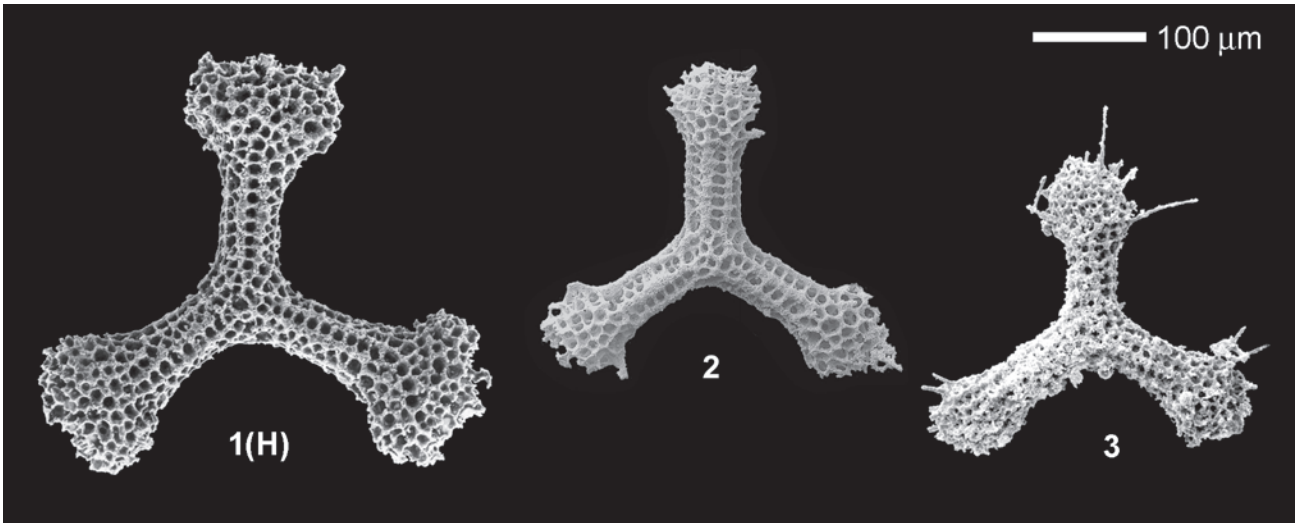


Plate HOM02. *Homoeoparonaella reciproca* Carter. Magnification x150. **Fig. 1(H).** Carter et al. 1988, pl. 7, fig. 2. **Fig. 2.** OM, BR706, 15800. **Fig. 3.** JP, MNA-10, MA11574.

Genus: *Hsuum* Pessagno 1977a

Type species: *Hsuum cuestaense* Pessagno 1977a

Synonymy:

1977a *Hsuum* n. gen – Pessagno, p. 280.
1986 *Hsuum* Pessagno 1977a, emend. – Takemura, p. 49.
1986 *Transhsuum* n. gen – Takemura, p. 51.

Original description: Test multicyrtoid, conical lacking strictures. Cephalis conical, with small horn and sparse irregularly dispersed pores. Thorax trapezoidal with sparse irregularly displaced pores. Abdomen and post-abdominal chambers with massive, continuous to discontinuous, diverging costae; three to six rows of small square pore frames with circular pores between costae. Costae of some species with irregular branches that link adjoining costae and obscure linearly arranged pore frames beneath. Pores of all post-thoracic chambers tending to remain open during ontogeny and to be primary pores.

Original remarks: *Hsuum* n. gen., appears to build its test by secreting costal projections each time a new chamber is formed; linearly arranged square pore frames are then secreted between costal projections. Because it shares the same mode of test building as the Archaeodictyomitridae Pessagno, it is tentatively placed in this family.

Hsuum differs from *Archaeodictyomitra* Pessagno in having several rows of pores between costae and by possessing primary rather than relict pores (cf. Pessagno, 1976).

Further remarks: For purposes of this catalogue we include *Hsuum* Pessagno and *Transhsuum* Takemura together, although we recognize morphological difference.

Etymology: This genus is named for Dr. Kenneth J. Hsu (Swiss Federal Institute of Technology, Zurich, Switzerland) to honor his contributions to the study of the Franciscan complex.

Included species:

HSU01 *Hsuum altile* Hori & Otsuka 1989
HSU02 *Hsuum arenaense* Whalen & Carter 2002
HSU03 *Hsuum busuangaense* Yeh & Cheng 1996
HSU04 *Hsuum exiguum* Yeh & Cheng 1996
HSU05 *Hsuum lucidum* Yeh 1987b
3195 *Hsuum matsuokai* Isozaki & Matsuda 1985
3278 *Hsuum medium* (Takemura) 1986
HSU06 *Hsuum mulleri* Pessagno & Whalen 1982
HSU07 *Hsuum optimum* Carter 1988
HSU08 *Hsuum philippinense* Yeh & Cheng 1996
HSU11 *Hsuum plectocostatum* Carter n. sp.
HSU10 *Hsuum* sp. A sensu Carter 1988

Hsuum altile Hori & Otsuka 1989

Species code: HSU01

Synonymy:

1982 "*Lithostrobus*" sp. b – Kido, pl. 4, figs. 9, 10.
1982 *Hsuum* sp. – Matsuda & Isozaki, pl. 1, figs. 1, 2.
1984 *Hsuum* sp. B – Murchey, pl. 1, fig. 23.
1985 *Hsuum* sp. A – Kishida & Hisada, pl. 4, figs. 11, ?13, 14.
1988 *Hsuum* (?) *matsuokai* Isozaki & Matsuda – Hattori, pl. 13, fig. E.
1989 *Hsuum altile* n. sp. – Hori & Otsuka, p. 180, pl. 1, figs. 1-6.
1990 *Hsuum altile* Hori & Otsuka – Hori, Fig. 9.33.
1996 *Hsuum altile* Hori & Otsuka – Yeh & Cheng, p. 108, pl. 10, figs. 1, 2, 6, 10, 11.
1997 *Hsuum altile* Hori & Otsuka – Hori, pl.1, fig. 2.
2001 *Hsuum altile* Hori & Otsuka – Matsuoka et al., pl. 3, fig. 8.
2004 *Hsuum altile* Hori & Otsuka – Hori, pl. 5, fig. 41; pl. 22, figs. 52-53.
? 2004 *Hsuum altile* Hori & Otsuka – Ishida et al., pl. 5, fig. 15.
2005 *Hsuum altile* Hori & Otsuka – Kashiwagi et al., pl. 6, fig. 1.

Original description: Test multi-segmented, exact number of chambers unknown, possibly less than 8 or 9. Outline of test gourd-shaped with a weak to strong stricture in proximal 1/3 portion. Cephalis hemispherical with an apical horn; horn solid and mostly polygonal in cross-section. The proximal portion of test, above stricture, possessing irregularly arranged pores and circular to polygonal pore frames; surfaces of pore frames smooth to rough, occasionally spiny (Pl. 1, Fig. 1c). The distal portion below stricture inflated and having longitudinally and transversally aligned pores and 14 to 19 longitudinal continuous costae; longitudinal costae mostly long, developed at an interval of 2 or 3 rows of pores, and frequently having branches. Immediately below stricture, some discontinuous costae occasionally observed. In complete specimens, costae disappeared at the distal end of test (Pl. 1, Figs. 3a, b, 5).

Original remarks: *Hsuum altile* sp. nov. is very similar to *Hsuum* (?) *matsuokai* Isozaki and Matsuda, 1985b on its form and costal arrangement. The former, however, differs from the latter by lacking robust massive apical horn which is tetraradiate cruciform in cross section and possessing irregular arranged pores on proximal portion of test. On the basis of morphological resemblances and stratigraphic positions, *H.* sp. α (= the provisional name of *H. altile*) is regarded as the ancestor of *H.* (?) *matsuokai.*

This species also resembles *Hsuum* sp. B of Takemura (1986) and *Hsuum parvulum* Yeh, 1987 but differs in having irregular pore frames on proximal part of test and in being larger and gourd-shaped.

Hsuum sp. aff. *H. mirabundum* of Pessagno and Whalen (1982) and *Hsuum* sp. A of Carter in Carter et al. (1988) are similar to *H. altile*. However, the former two species can be distinguished from the latter by possessing costae on proximal portion of test.

Measurements (μm):
Based on 9 specimens.

	Height	Width	H/W
HT	306+	141	2.2+
Av.	275	145	1.9
Max.	326	165	2.2
Min.	236+	130	1.6+

Etymology: The name is derived from the Latin adjective *altilis*, meaning stout.

Type locality: The Mt. Norikuradake area, Azumi village, Azumi-gun, Nagano Prefecture, central Japan.

Occurrence: Japan; Liminangcong Chert, Philippines; Xialu chert, Tibet; Franciscan Complex, California.

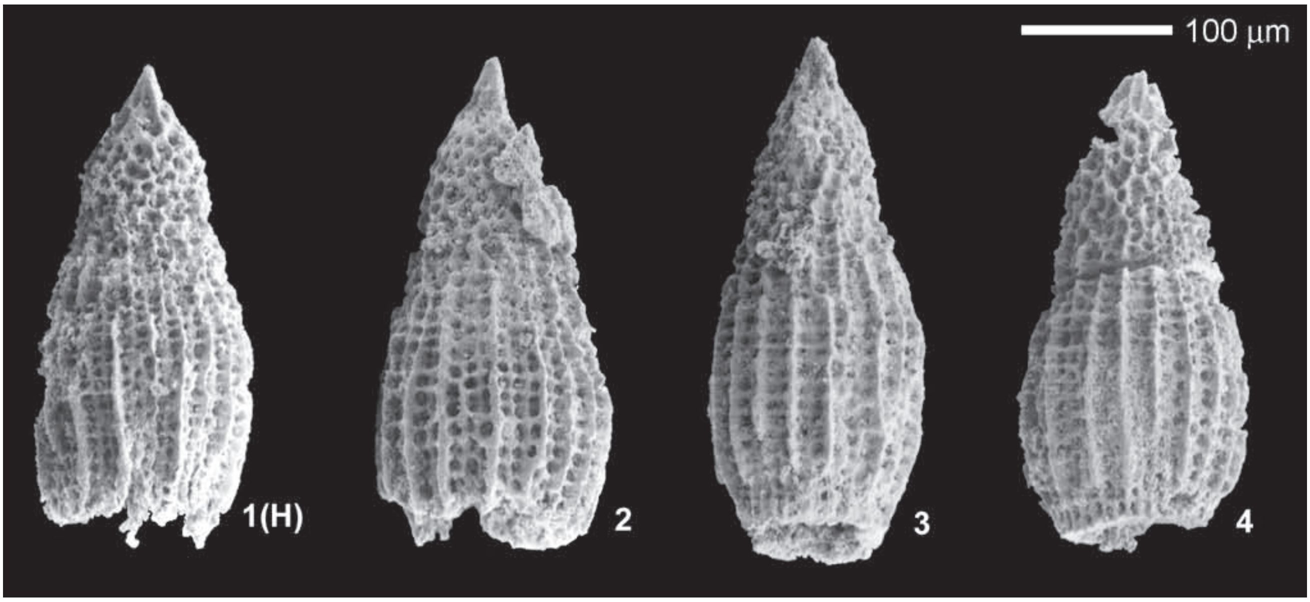


Plate HSU01. *Hsuum altile* Hori & Otsuka. Magnification x200. **Fig. 1(H).** Hori & Otsuka 1989, pl. 1, fig. 1a. **Figs. 2-4.** Hori & Otsuka 1989, pl. 1, figs. 2a, 3a, 5.

Hsuum arenaense Whalen & Carter 2002

Species code: HSU02

Synonymy:

1984 *Hsuum* sp. – Whalen & Pessagno, pl. 4, figs. 1-4.

2002 *Hsuum arenaense* n. sp. – Whalen & Carter, p. 124, pl. 12, figs. 1, 2, 11, 15; pl. 17, figs 10, 11.

Original description: Conical test with approximately seven to eight post-abdominal chambers. Dome-shaped cephalis covered by layer of microgranular silica and terminating in a very small horn. Thorax and post-abdominal chambers mostly trapezoidal in outline (sub-rectangular distally), increasing gradually in width and height as added. Costae, about twice as high as wide, with lateral branches much more irregularly developed in proximal parts of test; costae becoming shorter, narrower with fewer lateral branches and more linearly arranged in distal portions of test. Inner layer consisting of large pore frames, square to rectangular, with round to elliptical pores. Pore frames appear smaller in proximal parts of test due to more extensive development of costae and lateral branches.

Original remarks: The development of very irregularly branching costae on the proximal portions of the test (more developed on some specimens than others) distinguish *Hsuum arenaense* n. sp from *H. mulleri* Pessagno and Whalen 1982, *H. parvulum* Yeh 1987 and from other Lower and Middle Jurassic species of *Hsuum*.

***Measurements* (μm):**

Based on 11 specimens.

Length	Width (Max.)	
240	105	HT
240	128	Max.
195	105	Min.
220	114	Mean

Etymology: This species is named for Isla Arena located to the southeast of its type area.

Type locality: Sample BPW80-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur.

Hsuum busuangaense Yeh & Cheng 1996

Species code: HSU03

Synonymy:

1982 *Hsuum* sp. – Matsuda & Isozaki, pl. 1, fig. 2.

1996 *Hsuum busuangaense* n. sp. – Yeh & Cheng, p. 110, pl. 3, figs. 5, 9, 13.

2004 *Hsuum* aff. *altile* Hori & Otsuka – Hori, pl. 4, fig. 19.

Original description: Test multicyrtid, subspindle-shaped, pointed apically and terminating in a moderately long horn. Cephalis subconical in shape. Cephalis, thorax, and abdomen chambers relatively narrower, outer layer of test wall covered by short, irregularly arranged costae. Post-abdominal chambers inflated, outer layer of test wall covered with long, continuous longitudinal costae. Two or three longitudinal rows of tetragonal pore frames between every two post-abdominal costae. Post-abdominal chambers lacking strictures. Final portion of post-abdominal chambers decreasing in width prominently.

Original remarks: This form is characterized by having a subspindle-shaped inflated test and by having two types of costae structure (short, irregularly arranged costae at apical portion and long, continuous longitudinal costae at distal portion). This form differs from *H. altile* Hori and Otsuka (1989) by having a relatively inflated post-abdominal chambers and by having apical portion with short, irregularly arranged costae rather than with dense polygonal pore frames at the outer layer test wall.

Measurements (μm):

Five specimens measured.

	Max. test width	Max. test length	Length of horn
HT	148	303	37
Mean	153	296	34
Max.	158	308	39
Min.	148	279	27

Etymology: This form is named for its type locality, the Busuanga Island, Philippines.

Type locality: Sample CR91-30B, Liminangcong Chert, Busuanga Island, Philippines.

Occurrence: Liminangcong Chert, Philippines; Japan.

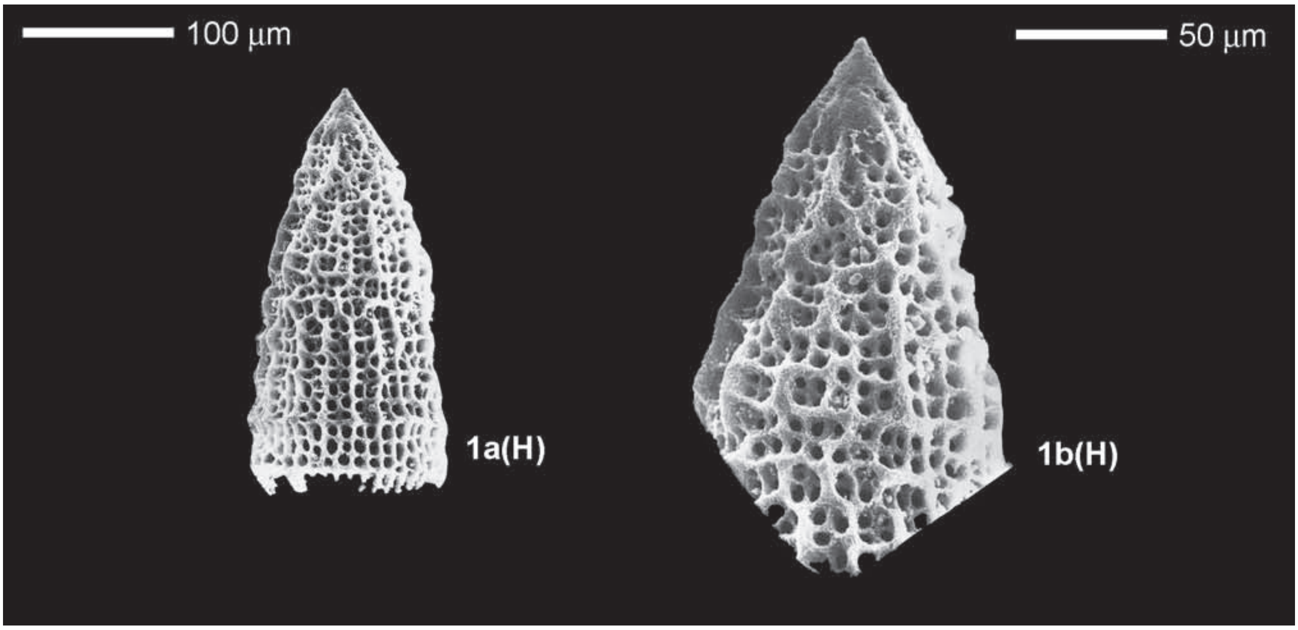


Plate HSU02. *Hsuum arenaense* Whalen & Carter. Magnification Fig. 1a(H) x 200, Fig. 1b(H) x400. **Fig. 1a,b(H).** Whalen & Carter 2002, pl. 12, figs. 1, 11.

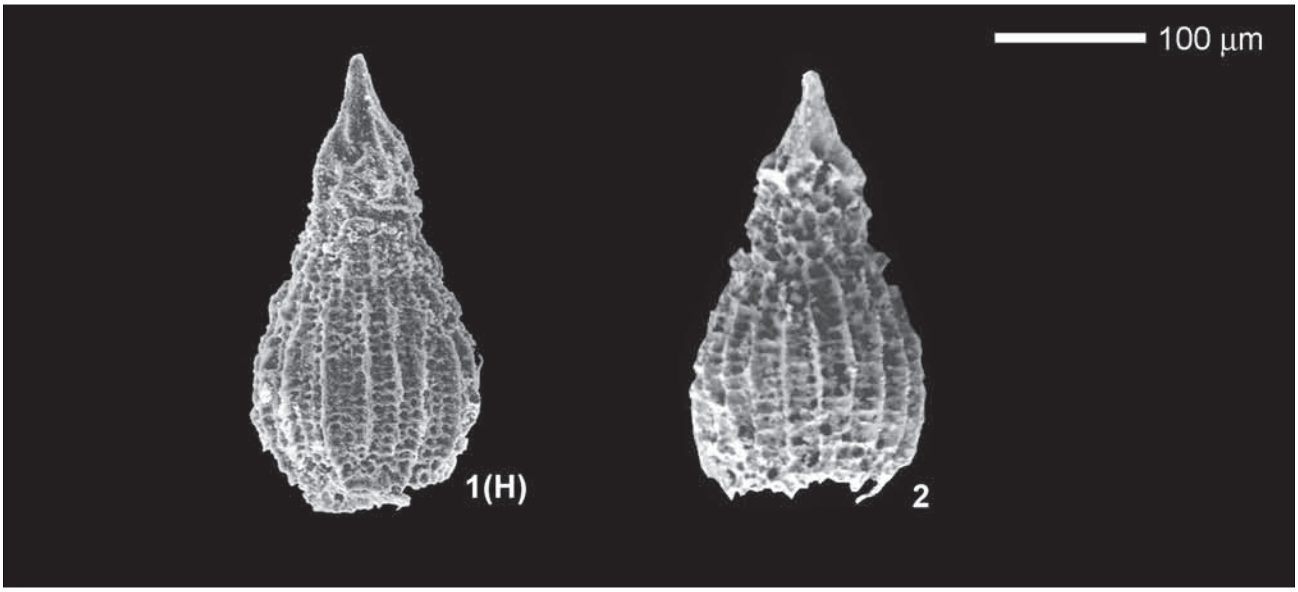


Plate HSU03. *Hsuum busuangaense* Yeh & Cheng. Magnification x200. **Fig. 1(H).** Yeh & Cheng 1996, pl. 3, fig. 5. **Fig. 2.** JP, UFI (22).

Hsuum exiguum Yeh & Cheng 1996

Species code: HSU04

Synonymy:

1989 *Parahsuum* (?) sp. B – Hori & Otsuka, p. 183, pl. 3, figs. 11-12.
1989 *Parahsuum* (?) sp. Y – Hori & Otsuka, p. 182, pl. 3, figs. 6-7.
1990 *Parahsuum* (?) sp. B – Hori, Fig. 9.32.
1997 *Parahsuum* (?) sp. B – Hori, pl. 1, fig. 5.
1996 *Hsuum exiguum* n. sp. – Yeh & Cheng, p. 110, pl. 3, figs. 1, 2, 6, 10; pl. 10, fig. 3.
2004 *Hsuum* sp. – Hori, pl. 3, fig. 30 only; pl. 22, figs. 57-60, 62.
2004 *Hsuum* sp. X sensu Hori & Otsuka – Hori, pl. 4, figs. 20-23.
2004 *Hsuum* sp. Y sensu Hori & Otsuka – Hori, pl. 4, figs. 24-26.
2005 *Hsuum exiguum* Yeh & Cheng – Kashiwagi et al., pl. 6, fig. 2.

Original description: Test relatively short, bell-shaped, cephalis hemispherical in outline, with a moderately long, stout horn. Cephalis and thorax covered by a layer of medium-sized irregular polygonal pore frames. Costae of outer latticed layer short, discontinuous and poorly developed. Post-abdominal chambers slightly increasing in width distally. Final post-abdominal chamber terminated with a rim-like structure.

Original remarks: This form is characterized by its small, short test and by having a stout long horn at cephalis and a rim-like structure at its final post-abdominal chamber.

Measurements (μm):
Five specimens measured.

	Max. test width	Max. test length	Length of horn
HT	124	213	52
Mean	130	216	55
Max.	142	238	43
Min.	124	203	66

Etymology: *Exiguus-a-um* (Latin, adj.) = short

Type locality: Sample CR91-30B, Liminangcong Chert, Busuanga Island, Philippines.

Occurrence: Liminangcong Chert, Philippines; Tawi Sadh Member of the Guwayza Formation, Oman; Japan..

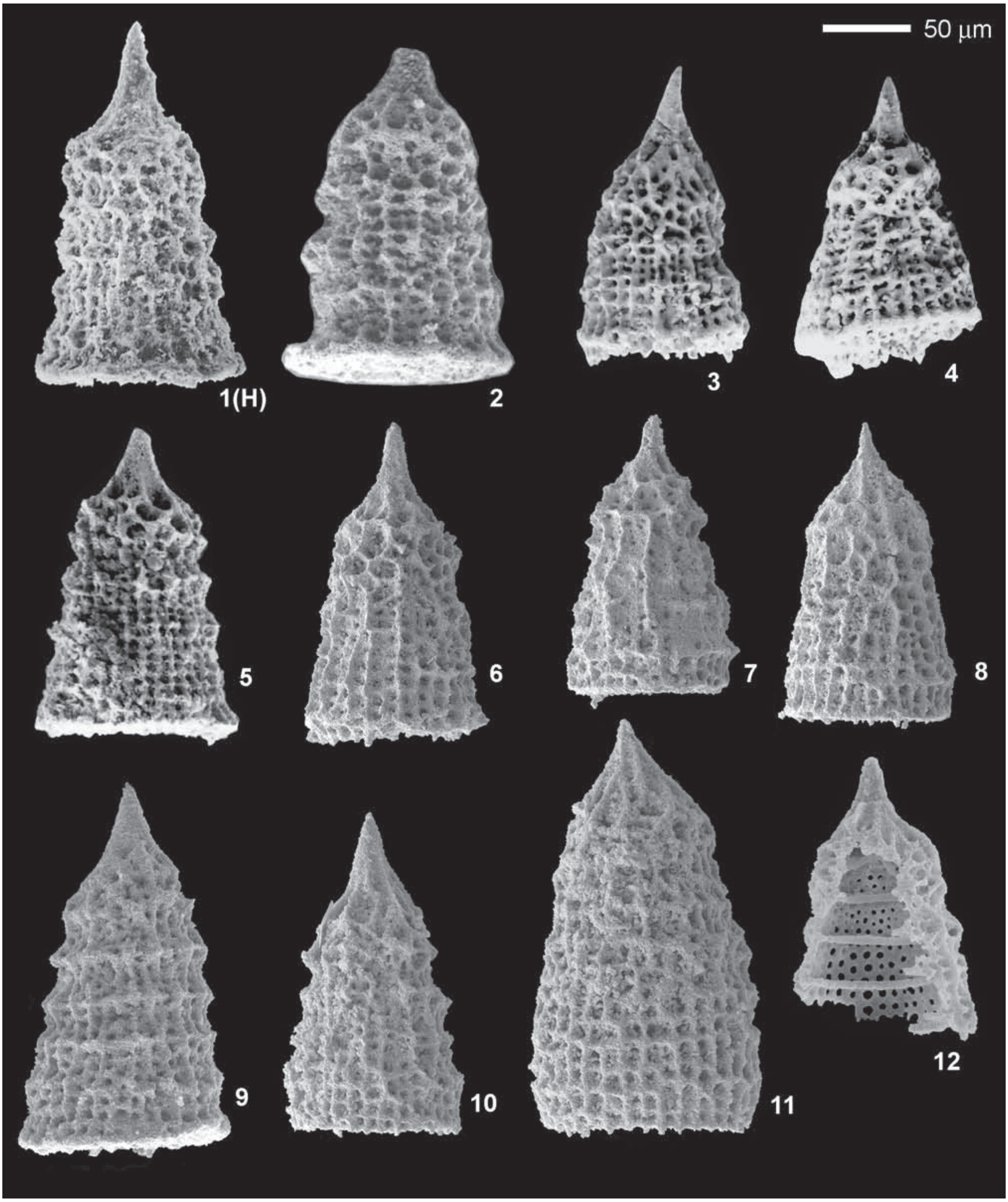


Plate HSU04. ***Hsuum exiguum*** **Yeh & Cheng.** Magnification x300. **Fig. 1(H).** Yeh & Cheng 1996, pl. 3, fig. 1. **Fig. 2.** Hori 1990, fig. 9-32. **Fig. 3.** JP, Nanjo mudstone-1. **Fig. 4.** JP, Nanjo mudstone-2. **Fig. 5.** JP, NKII19-14. **Fig. 6.** OM, BR871-R08-30. **Fig. 7.** OM, BR871-R08-04. **Fig. 8.** OM, BR871-R07-08. **Fig. 9.** OM, BR871-R06-15. **Fig. 10.** OM, BR871-R06-16. **Fig. 11.** OM, BR871-R06-23. **Fig. 12.** OM, BR828-2-R12-03.

Hsuum lucidum Yeh 1987b

Species code: HSU05

Synonymy:

1987b *Hsuum* (?) *lucidum* n. sp. – Yeh, p. 64, pl. 16, figs. 4, 8, 16.
1987b *Hsuum validum* n. sp. – Yeh, p. 66, pl. 3, fig. 26; pl. 5, figs. 17, 22; pl. 17, fig. 12; pl. 28, fig. 1.
1987b *Hsuum* sp. E – Yeh, p. 67, pl. 16, fig. 9; pl. 28, fig. 12.
2003 *Transhsuum lucidum* (Yeh) – Goričan et al., p. 296, pl. 5, figs. 12, 13.
2004 *Hsuum lucidum* Yeh – Matsuoka, fig. 225.

Original description: Test conical, lobate, pointed apically, usually with six to seven post-abdominal chambers. Cephalis small, conical, without rudimentary horn. Cephalis and thorax covered with layer of microgranular silica. Abdomen and post-abdominal chambers rapidly increasing in width, gradually increasing in length as added. Post-abdominal chambers with inner layer of massive tetragonal pore frames with small circular pores; outer layer of mesh work with short, moderately massive costae. Costae mostly occurring on joints of chambers.

Original remarks: *Hsuum* (?) *lucidum*, n. sp., differs from *H. parasolensis* Pessagno and Whalen by lacking a horn on cephalis, and by having a more conical test with less massive costae.

Further remarks: According to Yeh's (1987b) original description *Hsuum validum* differs from *Hsuum lucidum* by having a subconical instead of a conical test. We consider that this difference is not expressed well enough to distinguish two different species, therefore both species are synonymized.

Measurements (μm):
Ten specimens measured.

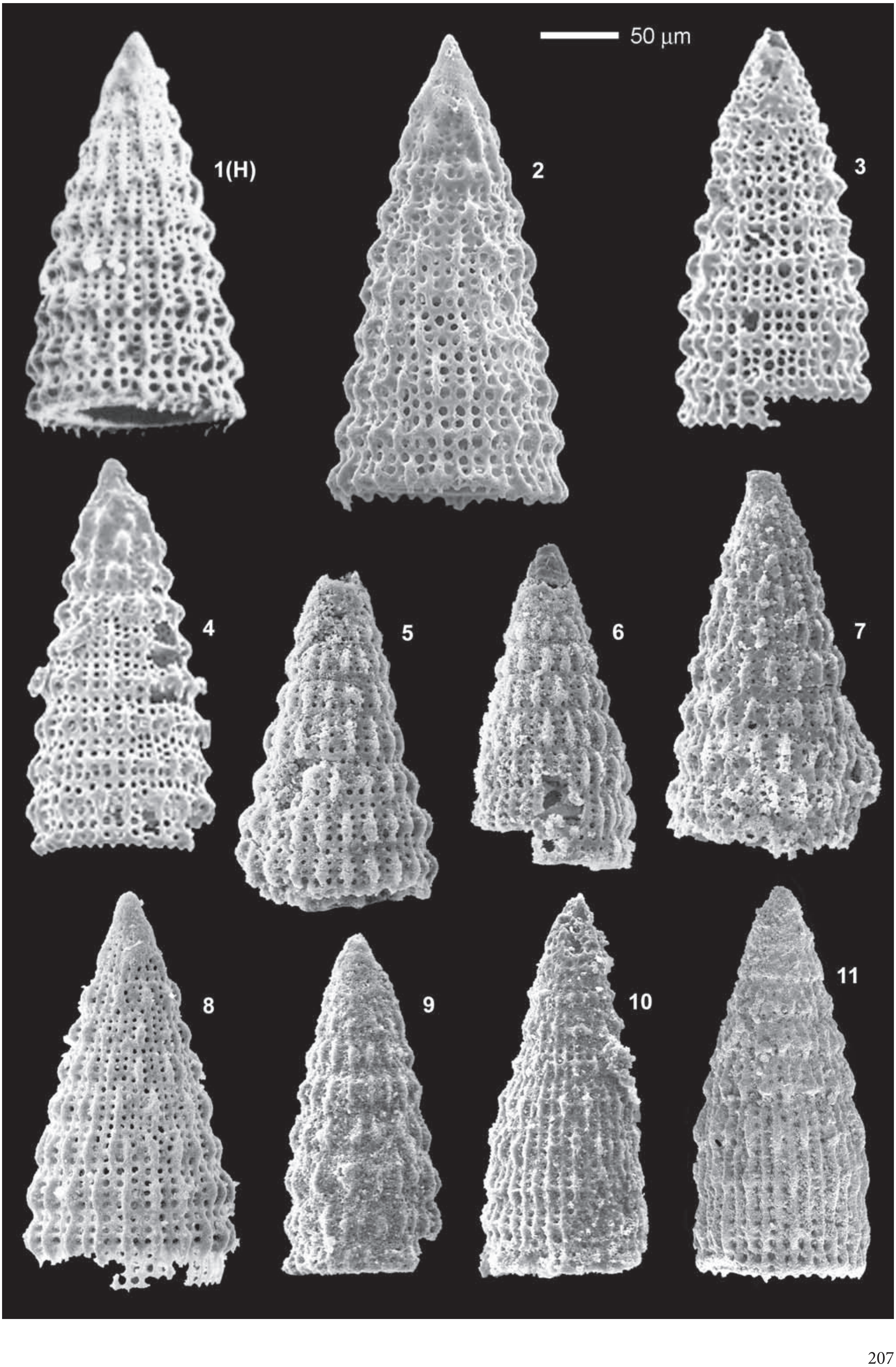
	Length (max.)	Width (max.)
HT	245	153
Mean	253	148
Max.	270	155
Min.	241	140

Etymology: *Lucidus-a-um* (latin, adj.) = bright.

Type locality: Sample OR-600A, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, Oregon; Fannin and Phantom Creek formations, Queen Charlotte Islands; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman; Mino Terrane, Japan.

Plate HSU05. *Hsuum lucidum* Yeh. Magnification x300. **Fig. 1(H).** Yeh, 1987b, pl. 16, fig. 4. **Fig. 2.** QCI, GSC loc. C-304568, GSC 128809. **Fig. 3.** QCI, GSC loc. C-175309, GSC 128810. **Fig. 4.** QCI, GSC loc. C-304568, GSC 111809. **Fig. 5.** SI, MM5.00, 000103. **Figs. 6-7.** Goričan et al. 2003, pl. 5, figs. 12-13. **Fig. 8.** JP, MNA-10, MA13145. **Fig. 9.** OM-00-117, 021128. **Fig. 10.** OM-00-254, 022202. **Fig. 11.** OM, BR1123-R05-06.


50 µm
1(H)
2
3
4
5
6
7
8
9
10
11

Hsuum matsuokai Isozaki & Matsuda 1985

Species code: 3195

Synonymy:

1982 *Hsuum* sp. C – Hattori & Yoshimura, pl. 3, fig. 8.
1982 *Hsuum* sp. B – Kishida & Sugano, pl. 7, figs. 14-16.
1982 Unnamed nassellaria – Wakita & Okamura, pl. 7, fig. 3.
1984 *Hsuum* sp. – Yao, pl. 1, figs. 6-7.
1985 *Hsuum* sp. – Ishida, pl. 1, fig. 3.
1985 *Hsuum* (?) *matsuokai* n. sp. – Isozaki & Matsuda, p. 438, pl. 3, figs. 1-14.
1985 *Hsuum maxwelli* Pessagno – De Wever & Miconnet, pl. 4, fig. 3.
1986 *Hsuum primum* n. sp. – Takemura, p. 50, pl. 5, figs. 17-21.
1986 *Hsuum* sp. – Matsuoka, pl. 2, figs. 1, 3.
1987 *Hsuum* aff. *mclaughlini* Pessagno & Blome – Goričan, p. 183, pl. 2, fig. 11.
1987 *Hsuum primum* Takemura – Hattori, pl. 17, figs. 11-13, not figs. 8-9.
Not 1988 *Hsuum* (?) *matsuokai* Isozaki & Matsuda – Hattori, pl. 13, fig. E.
1988 *Hsuum* (?) *matsuokai* Isozaki & Matsuda – Sashida, p. 19, pl. 4, figs. 16-18.
1989 *Hsuum primum* Takemura – Hattori & Sakamoto, pl. 15, figs. I-J.
1989 *Hsuum* (?) *matsuokai* Isozaki & Matsuda – Hattori & Sakamoto, pl. 16, fig. I.
1990 *Hsuum matsuokai* Isozaki & Matsuda – Hori, Fig. 9.53.
1991 *Hsuum matsuokai* Isozaki & Matsuda – Yao, pl. 2, fig. 18.
1992 *Ogivus falloti* n. sp. – El Kadiri, p. 46, pl. 2, figs. 3-4.
1992 *Hsuum matsuokai* Isozaki & Matsuda – Sashida, pl. 2, fig. 4.
1994 *Hsuum matsuokai* Isozaki & Matsuda – Goričan, p. 73, pl. 19, figs. 9, 11-13.
1995a *Hsuum matsuokai* Isozaki & Matsuda – Baumgartner et al., p. 284, pl. 3195, figs. 1-5(H).
2001 *Hsuum matsuokai* Isozaki & Matsuda – Matsuoka et al., pl. 3, fig. 4.
2004 *Hsuum matsuokai* Isozaki & Matsuda – Hori, pl. 2, fig. 56, pl. 9, fig. 36, pl. 10, fig. 4.
2004 *Hsuum* aff. *matsuokai* Isozaki & Matsuda – Hori, pl. 9, fig. 37, pl. 10, figs. 5-6, 8.
2004 *Hsuum matsuokai* Isozaki & Matsuda – Suzuki & Ogane, pl. 9 fig. 20.
2004 *Hsuum primum* Takemura – Suzuki & Ogane, pl. 9, figs. 22, 23.
2005 *Hsuum matsuokai* Isozaki & Matsuda – Hori, pl. 13, fig. 6.

Original description: Shell of 7 segments, possibly more, long, spindle-shaped; slenderly conical in proximal 3 segments; broad, barrel-shaped in distal half. Cephalis conical with robust apical horn, coated by outer microgranular layer, on which sparse irregularly dispersed pores remain open. Apical horn variously ornamented with thick blades or narrow grooves, having transverse section typically of tetraradiate cruciform with 4 blades at base, almost circular at tip. Internally, 6 collar pores, divided by median bar, D-bar, V-bar, 2 L-bars and 2 l-bars. Post-cephalic segments free from the outer microgranular layer, trapezoidal in longitudinal section; each segment becoming wide distally except for the distal-most one, which is reversely trapezoidal in longitudinal section. Average ratio of height to width of a single segment approximately 1:3 for thorax and abdomen, approximately 1:4 for post-abdominal segments. Wall of segment, thin; its longitudinal section flat in proximal half, slightly convex outward in distal half. Pores circular, uniform in size. Square pore frames aligned longitudinally and transversely; in 2 to 3 longitudinal rows of pores between every neighbouring pairs of costae, in 4 transverse rows for each segment. 16-19 continuous costae developing on post-abdominal segments. Weak irregular transverse bars rarely present, linking adjoining costae. Internal partitions rudimentary, circular in outline with a large centrally placed aperture.

Original remarks: Ornamentation on cephalis varies considerably from specimen to specimen. Generallly, larger specimens tend to have slenderer shell and apical horn of more completely tetraradiate cruciform section (pl. 3, figs. 1-2). Most of the specimens possess 4 rudimentary ornamenting blades around apical horn.

This species is distinguished from other species of the genus *Hsuum* Pessagno by its extraordinarily conspicuous apical horn with various ornamentation and restricted development of thick costae within distal half of the shell. Furthermore, bifurcation of costae or distally widening silhouette of the shell cannot be recognized in *H.* (?) *matsuokai* n. sp. although they are common features among most of the species belonging to *Hsuum* Pessagno.

Pessagno & Whalen (1982) established some new multicyrtoid nassellarian genera of Early to Middle Jurassic age, such as *Droltus* and *Canutus*, which are essentially characterized by linear arrangement of square pore frames. *H.* (?) *matsuokai* n. sp. is not referable to them in wall structure mentioned above. On the other hand, the proximal half of the shell of this species looks rather like that of genus *Parahsuum* Yao, except for its robust apical horn. In these circumstances, this species is here provisionally classified under genus *Hsuum* Pessagno.

Further remarks: By Baumgartner et al. (1995a): This species differs from its ancestor *Hsuum altile* Hori & Otsuka 1989 by having a robust massive apical horn which is tetraradiate cruciform in cross-section.

Measurements (μm):
Based on 13 specimens.

	Height	Width
HT	380	150
Mean	310	140
Max.	410	160
Min.	240	120

Etymology: This species is named for Dr. Matsuoka in honor to his contribution to Jurassic radiolarian biostratigraphy in southwest Japan.

Type locality: Sample 140, Hisuikyo, Kamiaso area, Gifu Prefecture, central Japan.

Occurrence: Worldwide.

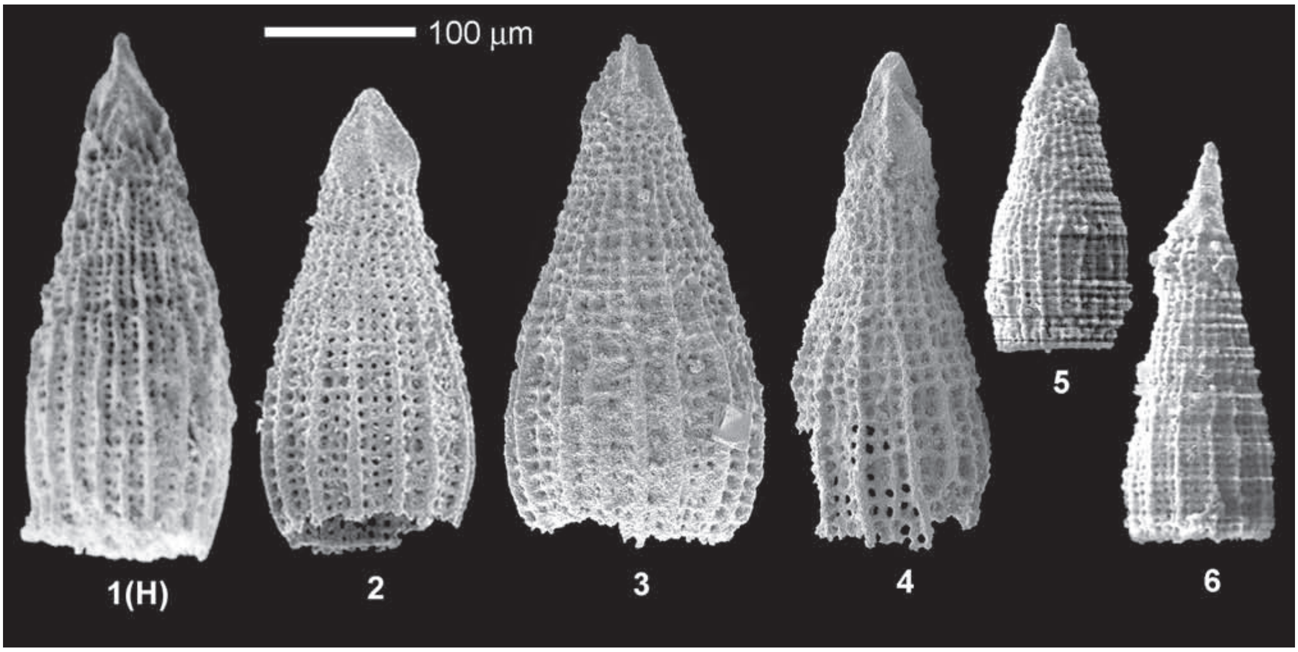


Plate 3195. ***Hsuum matsuokai*** **Isozaki & Matsuda.** Magnification 200x. **Fig. 1(H).** Isozaki & Matsuda 1985, pl. 3, fig. 1. **Fig. 2.** JP, HM1-11, RH623. **Fig. 3.** OM, BR292-4-R10-01. **Fig. 4.** OM, BR292-4-R10-03. **Fig. 5.** OM-99-137, 020710. **Fig. 6.** OM-99-137, 000827.

Hsuum medium (Takemura) 1986

Species code: 3278

Synonymy:

1986 *Transhsuum medium* n. sp. – Takemura, p. 51, pl. 6, figs. 1-2; not pl. 5, figs. 25-26.
1987 *Hsuum* sp. – Hattori, pl. 17, fig. 16.
1990 *Transhsuum medium* Takemura – Hori, fig. 9.43.
1997 *Transhsuum medium* Takemura – Hori, pl. 1, fig. 4.
1995a *Transhsuum medium* Takemura – Baumgartner et al., p. 582, pl. 3278, figs. 1-3.

Original description: Shell conical to cylindrical, with 10 to 15 segments, with strictures at joints of distal segments. Cephalis conical and poreless, with or without conical apical horn. Thorax truncated-conical usually with a single transverse row of small pores. In some specimens some longitudinal ridges covering on the surface of cephalo-thorax. Abdomen and post-abdominal segments cylindrical with small pores, which are usually rectangularly arranged on the inner surface. Each post-abdominal segment bearing four to five transverse rows of pores. Indistinct discontinuous costae, their length is equal to the height of one segment, lying on distal segments. In mature specimens, small spines arising on the shell surface.

Original remarks: The shell structure of the proximal part of *Transhsuum medium* resembles that of the distal part of *Parahsuum cruciferum* (pl. 5, figs. 9, 11). Therefore it suggests that this new species represents the initial stage of the formation of *Transhsuum*-type discontinuous costae and that it is the intermediate form between *Parahsuum*-like form and *Transhsuum*.

Further remarks: Herein we follow Baumgartner et al. (1995a) who assigned forms with a strong apical horn to this species.

Measurements (μm):
Based on 8 specimens.

	Min.	Max.
Length of shell	265	385
Maximum width of shell	100	135

Etymology: The name *medium*, derived from *medius*, means intermediate.

Type locality: Sample TKN-105, Komami, Yamato Village, Gifu Prefecture, central Japan.

Occurrence: Japan; Sogno Formation, Lombardy, Italy.

Hsuum mulleri Pessagno & Whalen 1982

Species code: HSU06

Synonymy:

1982 *Hsuum mulleri* n. sp. – Pessagno & Whalen, p. 133, pl. 5, figs. 6, 8, 9; pl. 12, figs. 16-17.
1982 *Hsuum* sp. D – Pessagno & Whalen, p. 134, pl. 5, fig. 5.

Original description: Test conical, elongate for genus, usually with seven post-abdominal chambers. Cephalis hemispherical with short rudimentary horn; other chambers, except for later post-abdominal chambers, trapezoidal in outline; later post-abdominal chambers subrectangular in outline. Cephalis and thorax imperforate to sparsely perforate; pores buried by layer of microgranular silica. Abdomen and post-abdominal chambers with inner latticed layer of fragile, thin, linearly arranged, square pore frames and outer latticed layer of moderately massive, discontinuous costae which are inserted between rows of pore frames. Costae with few ramifications, more or less equally developed over abdomen and post-abdominal chambers. Post-abdominal chambers increasing slightly in length and more rapidly in width as added; final two or three chambers show little increase in width.

Original remarks: *Hsuum mulleri*, n. sp., differs from *H.* sp. D by having a narrower, more elongate test and less massive, more evenly distributed costae which show few branches laterally.

Measurements (μm):
Based on 6 specimens.

Length excluding horn	Width (max.)	
325.0	137.5	HT
325.0	145.0	Max.
230.0	100.0	Min.
270.8	126.3	Mean

Etymology: This species is named for Dr. Jan E. Muller (Geological Survey of Canada, Vancouver) in honor of his contributions to the geology of British Columbia.

Type locality: Sample QC 534, Fannin Formation (Maude Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Fernie Formation, Williston Lake, northeastern British Columbia.

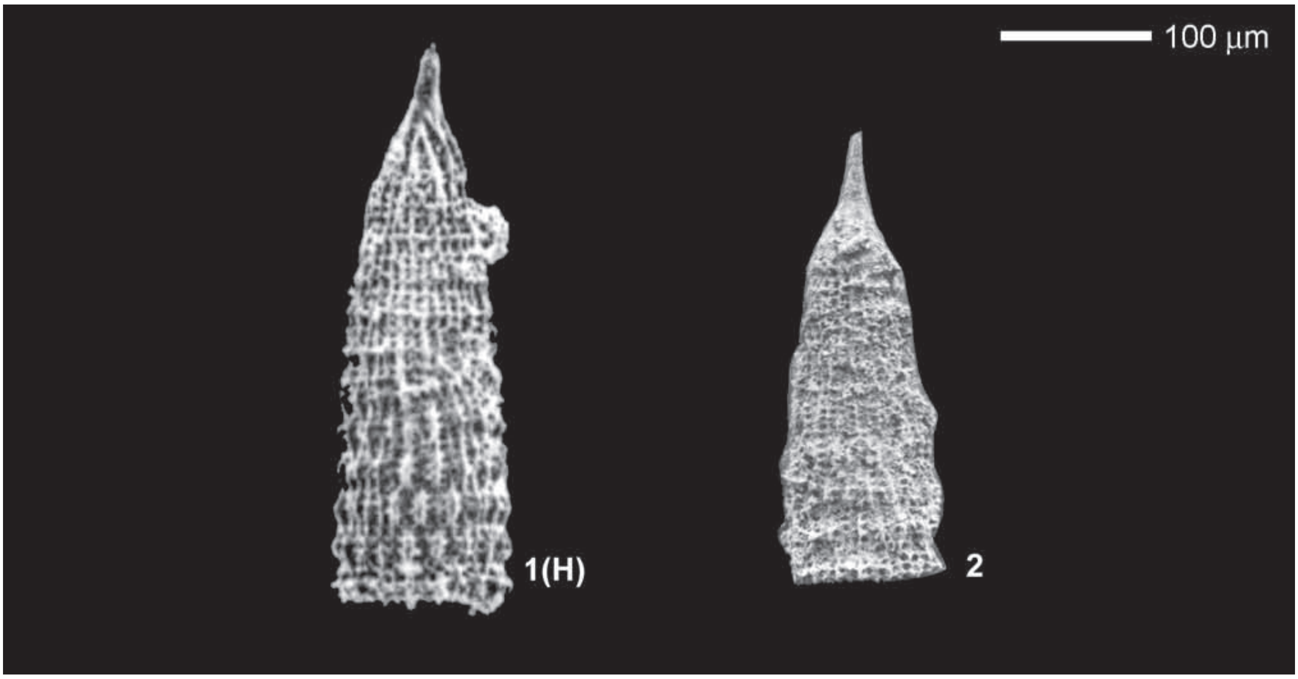


Plate 3278. *Hsuum medium* (Takemura). Magnification 200x. **Fig. 1(H).** Takemura 1986, pl. 6, fig. 1. **Fig. 2.** Hori 1990, fig. 9-43.

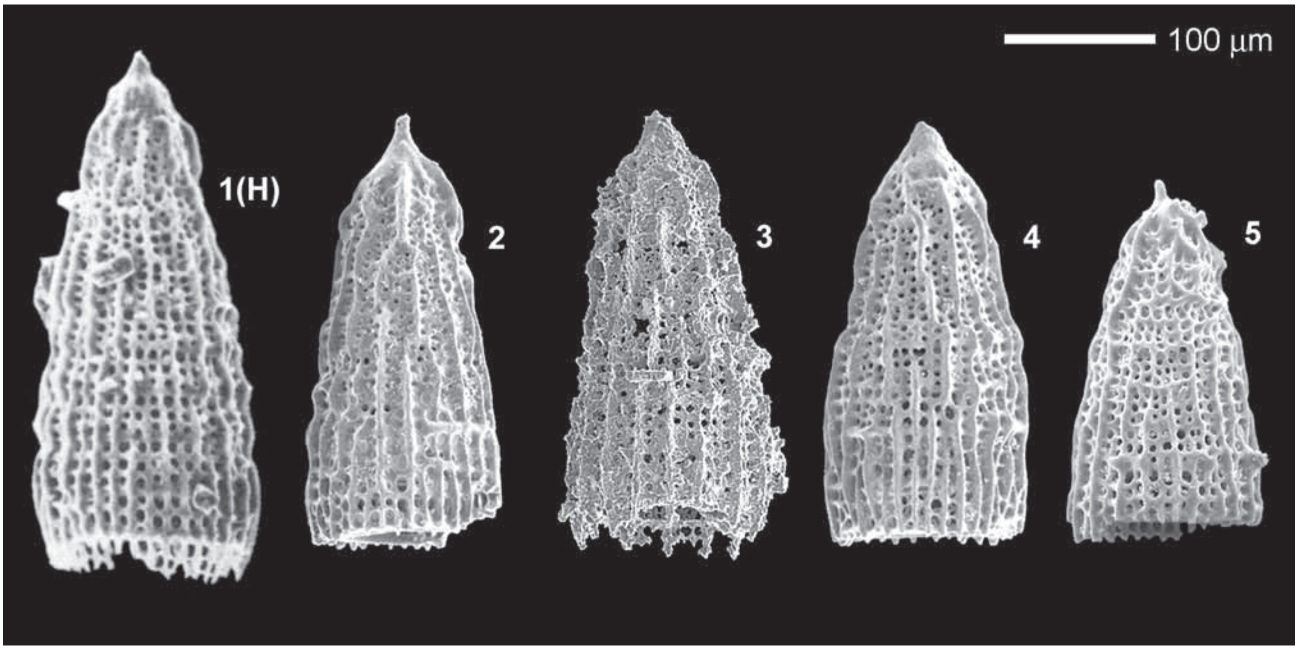


Plate HSU06. *Hsuum mulleri* Pessagno & Whalen. Magnification x200. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 5, fig. 6. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128811. **Fig. 3.** NBC, GSC loc. C-305208, GSC 128812. **Fig. 4.** QCI, GSC loc. C-080611, GSC 128914. **Fig. 5.** QCI, GSC loc. C-080611, GSC 128813.

Hsuum optimum Carter 1988

Species code: HSU07

Synonymy:

1988 *Hsuum optimus* Carter n. sp. – Carter et al., p. 51, pl. 5, fig. 6.

Original diagnosis: Test large, slender conical with short cylindrical horn. Chamber boundaries marked by rows of distinct elongate nodes. Pores small and circular.

Original description: Test large, elongate conical, pointed apically with short, slender, cylindrical horn and as many as 11 postabdominal chambers. Cephalis hemispherical and imperforate; all remaining chambers perforate, trapezoidal in outline. Chamber width increases gradually throughout entire test length; chamber height fairly constant. Test has inner layer of small, linearly arranged, square to rectangular pore frames; pores circular to subcircular. Outer layer consists, in the first three or four chambers, of discontinuous costae. In subsequent chambers, the surface is marked by nonlinear, elongate nodes at chamber joints.

Original remarks: Differs from all other species of *Hsuum* in having elongate nodes (rather than raised costae) superimposed on the longitudinal bars of the inner latticed layer. Differs from *Hsuum* sp. B, in having a more conical shape with more numerous, closely spaced elongate nodes. Extremely abundant.

Further remarks: *Hsuum optimum* differs from *H. philippinense* Yeh & Cheng by having a hemispherical cephalis and a short horn, circular in cross section.

Measurements (μm):

Based on 14 specimens.

	HT	Av.	Max.	Min.
Length excluding horn	346	293	346	210
Maximum width	190	165	190	125

Etymology: Latin, *optimus* (adj.), best.

Type locality: GSC locality C-080579, Whiteaves Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman.

Hsuum philippinense Yeh & Cheng 1996

Species code: HSU08

Synonymy:

1996 *Hsuum philippinense* n. sp. – Yeh & Cheng, p. 112, pl. 3, figs. 3, 4, 8, 12.

1996 *Hsuum* sp. aff. *H. philippinense* n. sp. – Yeh & Cheng, p. 112, pl. 9, figs. 3, 4, 10, 11, 12.

Original description: Test subcylindrical, pointed apically and terminating in a short horn. Cephalis and thorax covered by a layer of microgranular silica, costae present at apical portion, often arranged in radial pattern. Costae of outer latticed layer short, discontinuous, and staggered. Costae quite well-developed, nodose in lateral view. Final post-abdominal chambers slightly decreasing in width as added.

Original remarks: This form is characterized by having a triangular-shaped cephalis with a short pointed horn, and by having short, discontinuous, nodose costae throughout the post-abdominal chambers.

Further remarks: See remarks under *Hsuum optimum* Carter.

Measurements (μm):

Four specimens measured.

	Max. test width	Max. test length	Length of horn
HT	121	271	25
Mean	124	281	28
Max.	132	313	36
Min.	121	259	20

Etymology: This species is named for the country of its type locality, the Philippines.

Type locality: Busuanga Island (CR91-30B), Philippines.

Occurrence: Busuanga Island, Philippines; Japan; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

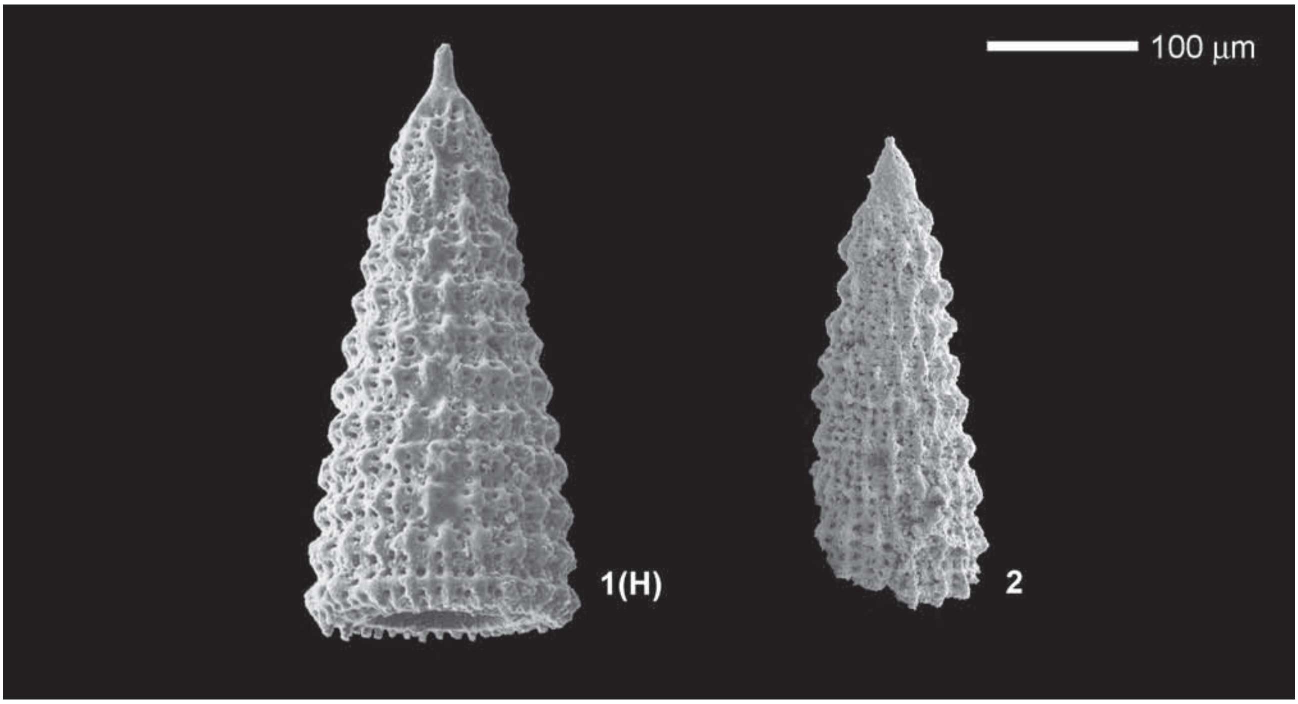


Plate HSU07. ***Hsuum optimum*** **Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 5, fig. 6. **Fig. 2.** OM, BR871-R08-07.

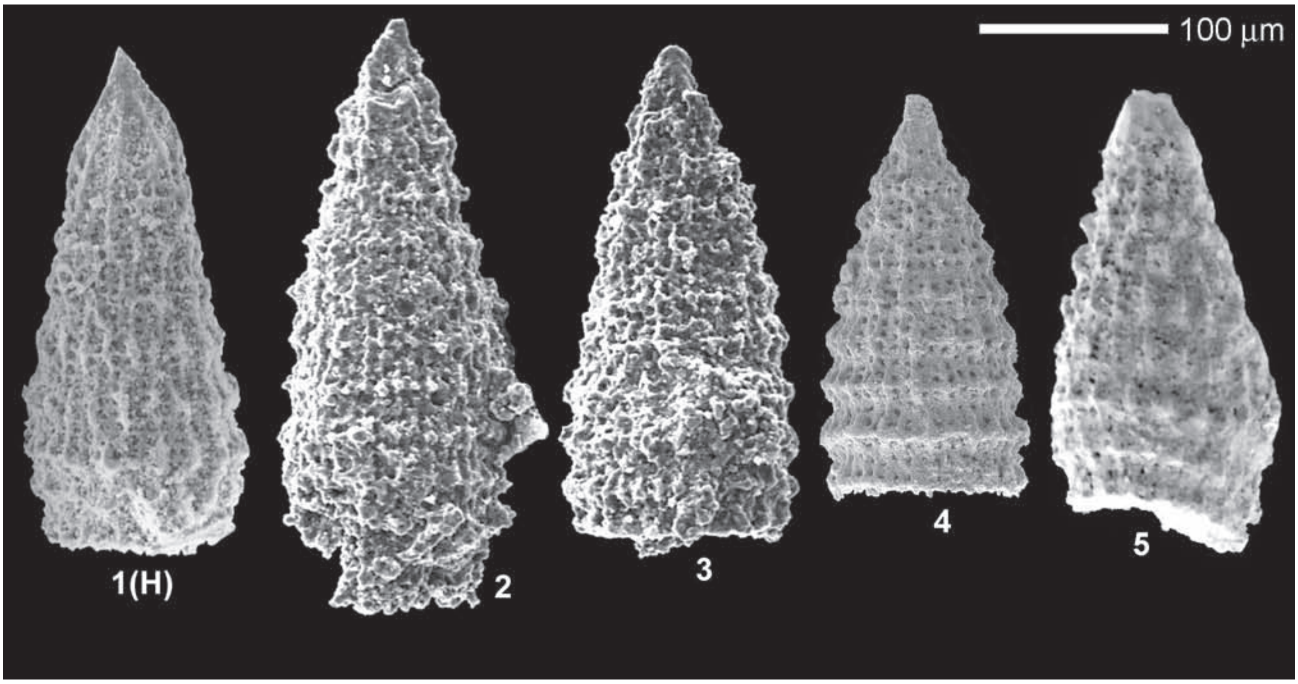


Plate HSU08. ***Hsuum philippinense*** **Yeh & Cheng.** Magnification x250. **Fig. 1(H).** Yeh & Cheng, 1996, pl. 3, fig. 3. **Fig. 2.** OM-00-256, 022423. **Fig. 3.** OM-00-256, 022525. **Fig. 4.** OM, BR871-05. **Fig. 5.** JP, NK9-50.

Hsuum plectocostatum Carter n. sp.

Species code: HSU11

Synonymy:

1988 *Hsuum* sp. B – Carter et al., p. 52, pl. 5, figs. 7, 8.
1989 *Hsuum* (?) sp. Z – Hori & Otsuka, p. 182, pl. 3, fig. 8.
1991 *Hsuum* sp. B – Carter & Jakobs, p. 343, pl. 3, fig. 15.
1996 *Hsuum* sp. cf. *H. philippinense* n. sp. – Yeh & Cheng, p. 114, pl. 9, figs. 5, 13.

Type designation: Holotype GSC 99415 (Carter & Jakobs 1991, pl. 3, fig. 15; late early Aalenian), from GSC loc. C-156399, Phantom Creek Formation.

Description: Test large, conical, pointed apically, with eight or nine post-abdominal chambers and a short, tapering cylindrical horn. Cephalis hemispherical and imperforate with several heavy outer costae penetrating almost on to horn; all remaining chambers trapezoidal, expanding gradually in width as added; final post-abdominal sometimes decreasing in width (see holotype, pl. HSU11, fig. 1). Inner layer of pore frames linearly arranged, square to subrectangular in shape, pores subrounded. Outer layer of test consisting of irregularly twisted costae with small rounded nodes superimposed on circumferential ridges.

Remarks: *Hsuum plectocostatum* n. sp. differs from *Hsuum optimum* Carter in having a more broadly conical shape and the costae, although irregularly fluted/twisted, are more continuous and possess small rounded nodes at ridges. It differs from *H. infirmum* Sashida (1988) in having a much larger test with a lobate outline, and stronger costae.

Measurements (μm):
Based on 13 specimens.

	Max. test width	Max. test length	Length of horn
HT	170	329	15
Mean	150	286	24
Max.	237	416	37
Min.	112.5	229	15

Etymology: From the Latin: *plecto + costatus, -a, -um* referring to twisted costae.

Type locality: Sample GSC loc. C-156399, Phantom Creek Formation Yakoun River, 2.0 km south of Ghost Creek, east side of river; Graham Island; Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Liminangcong Chert, Philippines; Japan.

***Hsuum* sp. A** sensu Carter 1988

Species code: HSU10

Synonymy:

1988 *Hsuum* sp. A – Carter et al., p. 52, pl. 5, fig. 2.

Remarks: The distal post-abdominal chambers of this pyritized form are similar to *Hsuum altile* Hori & Otsuka but initial chambers are quite different: they lack the typical porous structure of *H. altile* and instead have discontinuous costae that appear almost node-like.

Occurrence: Whiteaves Formation, Queen Charlotte Islands.

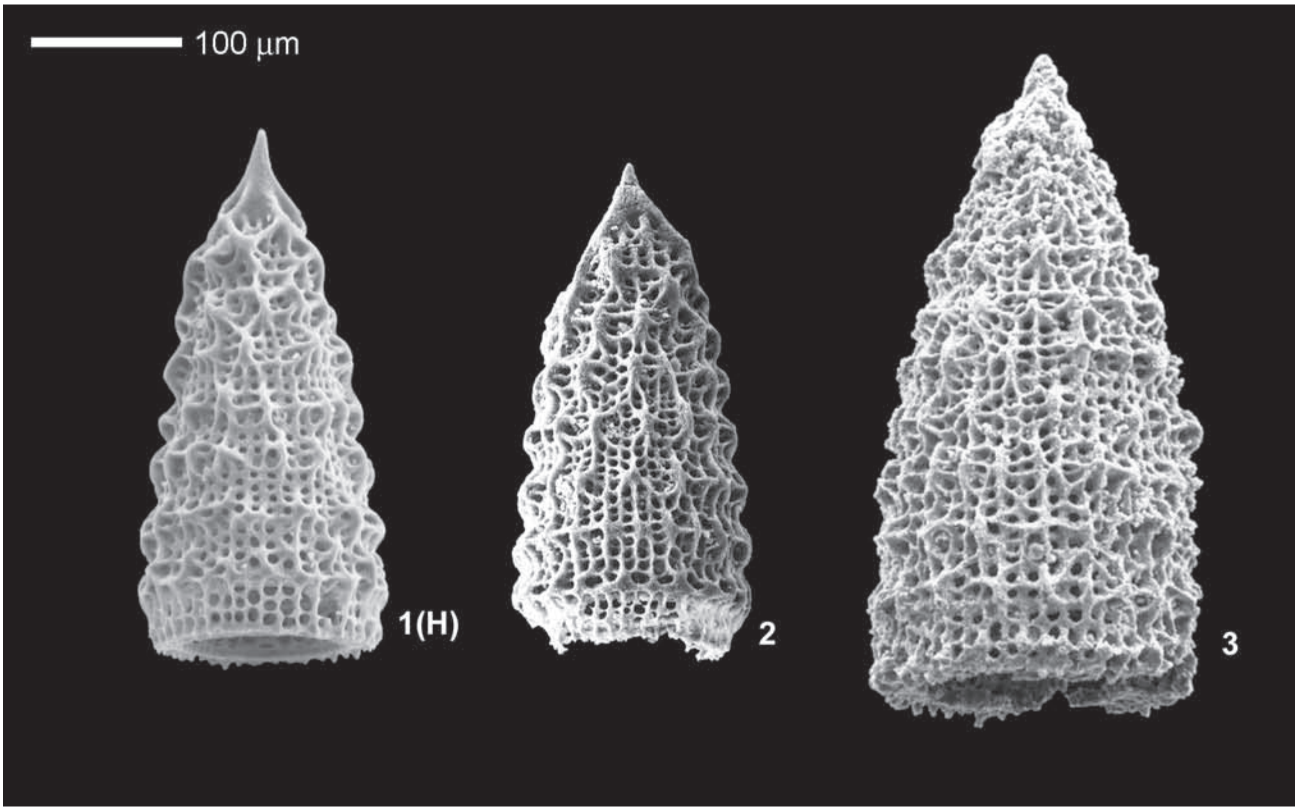


Plate HSU11. ***Hsuum plectocostatum*** **Carter n. sp.** Magnification x200. **Fig. 1(H).** Carter & Jakobs 1991, pl. 3, fig. 15. **Fig. 2.** Carter et al. 1988, pl. 5, fig. 7. **Fig. 3.** Carter et al. 1988, pl. 5, fig. 8.

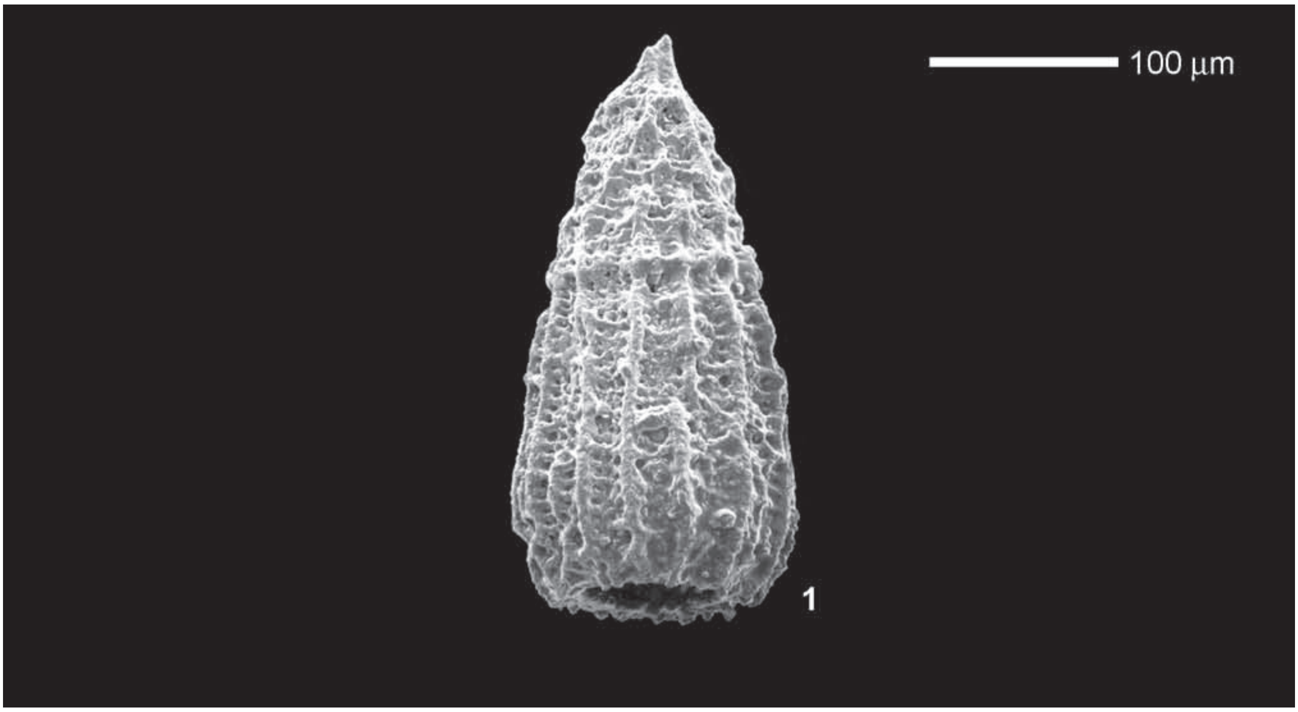


Plate HSU10. ***Hsuum*** **sp. A sensu Carter.** Magnification x250. **Fig. 1.** Carter et al. 1988, pl. 5, fig. 2.

Genus: *Katroma* Pessagno & Poisson 1981, emend. Whalen & Carter 1998

Type species: *Katroma neagui* Pessagno & Poisson 1981

Synonymy:

1981 *Katroma* n. gen. – Pessagno & Poisson, p. 62.
1982a *Katroma* Pessagno & Poisson emend. – De Wever, p. 193.
1988 *Katroma* Pessagno & Poisson – Hori, p. 551.
1998 *Katroma* Pessagno & Poisson, emend. – Whalen & Carter, p. 69.

Original description: Test multicyrtid, comprised of cephalis, thorax, abdomen, and with type species one post-abdominal chamber. Post-abdominal chamber terminating in long, cylindrical, open, tubular extension. Cephalis hemispherical with horn; thorax and abdomen trapezoidal in outline. First post-abdominal chamber subspherical, considerably larger than previous chambers and with variable number of medially arranged circumferential spines.

Original remarks: *Katroma* differs from *Podobursa* Wisniowski by having an open tube on its final post-abdominal chamber.

Further remarks: By Whalen & Carter (1998): The small cephalic spines noted by De Wever (1982a) on specimens of *Katroma* from Turkey were not observed on either the Sinemurian or upper Pliensbachian specimens of *Katroma* from British Columbia or Baja California Sur (Whalen, 1985). Due to the vagaries of preservation, these spines are not considered a diagnostic feature of this genus. Transmitted light photography has revealed that on some species of *Katroma,* the final chamber is the postabdominal chamber, while on others it is the abdominal chamber. The genus *Katroma* is hereby emended to accommodate both conditions. In addition, the terminal tube on some species is closed, while on others it remains open. Since this tube is often broken distally, it is not considered morphologically diagnostic whether it is open or closed.

This volume: Since the open or closed tube is not a diagnostic character, there seems to be no difference between *Katroma* and *Podobursa*, in which case *Katroma* should be considered a junior synonym of *Podobursa*. For the time being, we retain the generic name *Katroma* but restrict it to Early Jurassic species, because a phylogenetic relationship between Early and Middle Jurassic Syringocapsidae is not yet fully understood. It is interesting to note that no *Katroma*, *Syringocapsa* or *Podobursa* have been recorded in a well preserved early-middle Aalenian HK 140 sample from Japan, although they are diverse in older and younger assemblages (see Yao, 1997).

Etymology: The name *Katroma* is formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. IV, Recommendation 40, p.113). Its gender is feminine.

Included species:

KAT07 *Katroma angusta* Yeh 1987b
KAT08 *Katroma aurita* Whalen & Carter 2002
KAT09 *Katroma bicornus* De Wever 1982a
KAT12 *Katroma brevitubus* Dumitrica & Goričan n. sp.
KAT10 *Katroma clara* Yeh 1987b
KAT17 *Katroma elongata* Carter n. sp.
KAT13 *Katroma neagui* Pessagno & Poisson 1981, emend. De Wever 1982a
KAT14 *Katroma ninstintsi* Carter 1988
KAT16 *Katroma*? *sinetubus* Carter n. sp.
KAT18 *Katroma* sp. 4

Katroma angusta Yeh 1987b

Species code: KAT07

Synonymy:

1984 *Katroma* sp. – Whalen & Pessagno, pl. 1, fig. 3.
1987b *Katroma angusta* n. sp. – Yeh, p. 79, pl. 23, fig. 8; pl. 30, fig. 10.
1987b *Katroma inflata* n. sp. – Yeh, p. 81, pl. 9, fig. 11; pl. 10, figs. 12-13, 22.
1998 *Katroma megasphaera* n. sp. – Yeh & Cheng, p. 28, pl. 5, fig. 18; pl. 7, figs. 16, 18, 21, not figs. 9, 20; pl. 9, figs. 15, 16, 25; pl. 10, figs. 6, 11, 19.
2002 *Katroma angusta* Yeh – Whalen & Carter, p. 134, pl. 14, figs. 1-3, 9, 10; pl. 18, figs. 7, 8.
? 2004 *Katroma angusta* Yeh – Hori et al., pl. 6, fig. 4.

Original description: Cephalis small, dome-shaped, with short, well-developed horn. Horn circular in axial section. Thorax and abdomen closely spaced, trapezoidal in outline. First post-abdominal chamber inflated in larger subellipsoidal outline and terminating in a narrow tubular extension. Tubular extension tapering distally. Cephalis, thorax, and abdomen sparsely perforate, covered with layer of microgranular silica. Meshwork of first post-abdominal chamber and tubular extension comprised mainly of pentagonal and hexagonal pore frames. Size of pore frames decreasing apically and distally with largest pore frames at central portion of post-abdominal chamber. Pore frames thin in rims and sides.

Original remarks: *Katroma angusta*, n. sp., differs from *K. inflata*, n. sp., by having a smaller, narrower test with shorter horn.

Measurements (μm):

Ten specimens measured.

	HT	Mean	Max.	Min.
Length of apical horn	37	40	43	37
Length of proximal conical portion	37	52	66	37
Width of conical portion at base	73	72	73	70
Length of inflated segment	146	140	146	132
Width of inflated segment	154	154	161	150

Etymology: *Angustus-a-um* (Latin, adj.) = narrow.

Type locality: Sample OR-589D, Warm Springs member, Snowshoe Formation, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Ghost Creek Formation, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Liminangcong Chert, Philippines; Dürrnberg Formation, Austria.

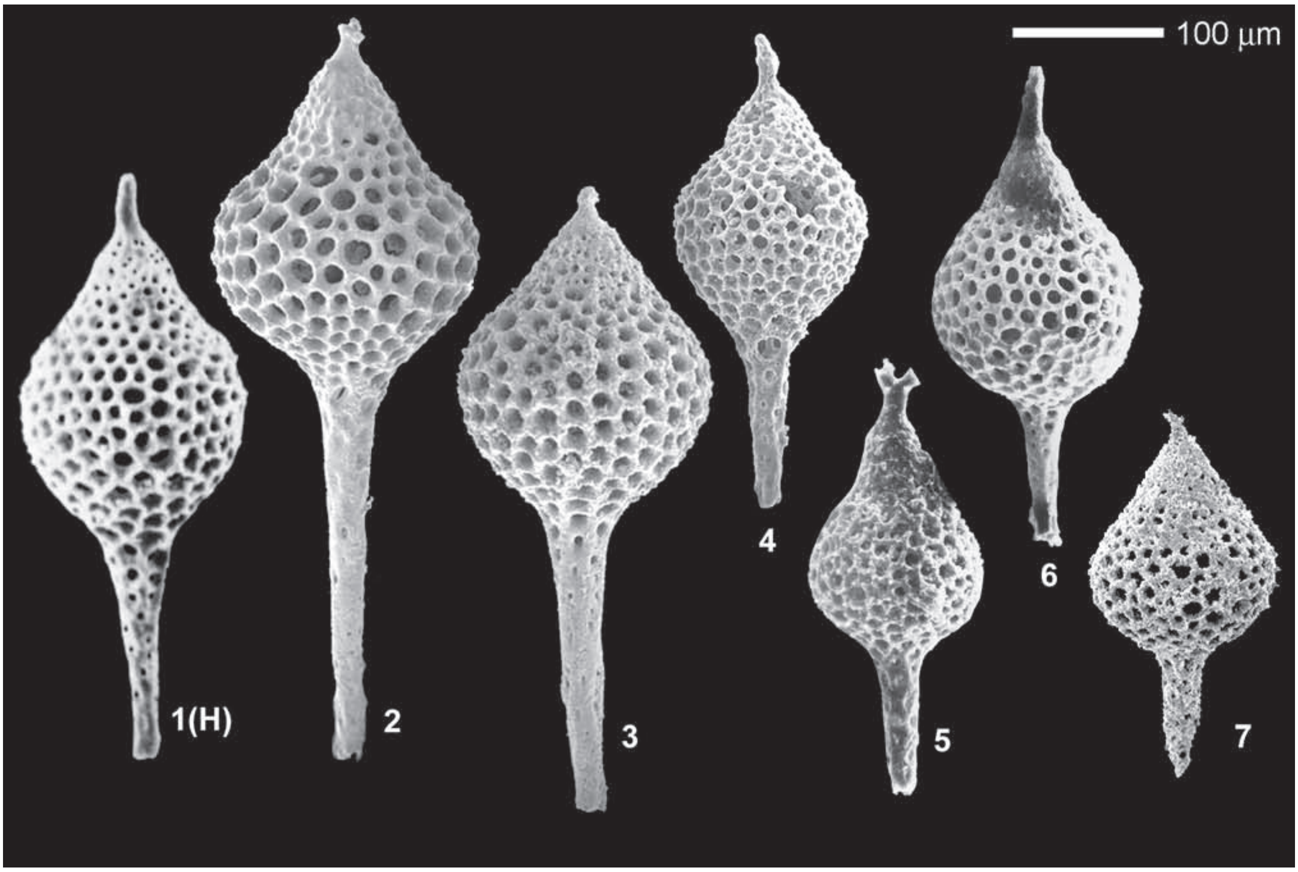


Plate KAT07. ***Katroma angusta*** **Yeh.** Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 23, fig. 8. **Fig. 2.** QCI, GSC loc. C-304281, GSC 128817. **Fig. 3.** QCI, GSC loc. C-080612, GSC 128818. **Fig. 4.** QCI, GSC loc. C-140418, GSC 128819. **Fig. 5.** Whalen & Carter 2002, pl. 14, fig. 2. **Fig. 6.** Whalen & Carter 2002, pl. 14, fig. 1. **Fig. 7.** AT, BMW21-37.

Katroma aurita Whalen & Carter 2002

Species code: KAT08

Synonymy:

1984 *Katroma* spp. – Whalen & Pessagno, pl. 1, figs. 1, 7.
2002 *Katroma aurita* n. sp. – Whalen & Carter, p. 134, pl. 13, figs. 4, 8, 9; pl. 18, figs. 1, 2, 5.

Original description: Test multicyrtid with cephalis, thorax, abdomen and post-abdominal chamber. Small cephalis with massive horn, usually double-pronged. Prongs of horn at an angle of approximately 80° to each other, tapering distally, flattened, with small irregularly spaced spines on margins; horn sometimes more irregular, without clear development of two prongs. Cephalis and thorax hemispherical, perforate but often covered by a thin layer of microgranular silica. Abdomen trapezoidal in outline, perforate, with pores sometimes marked by thin layer of microgranular silica. Large inflated post-abdominal chamber sub-spherical in shape, widest at central point and ending in a closed, tapering cylindrical tube. Meshwork on post-abdominal chamber composed predominantly of pentagonal pore frames, larger medially and decreasing in size towards the abdomen and closed terminal tube. Numerous strong circumferential spines located at widest part of post-abdominal chamber.

Original remarks: *Katroma aurita* n. sp. is distinguished from *K. bicornus* De Wever 1982, by the spines on the double-pronged horn, as well as the more numerous, circumferential spines positioned at right angles to the post-abdominal chamber.

Measurements (μm):
(n) = number of specimens measured

Length (14) (excludes horn)	Width (max.) (15)	
315	135	HT
345	150	Max.
248	105	Min.
290	129	Mean

Etymology: *Auritus, a, um* (Latin, adj.) = long eared lepus.

Type locality: Sample BPW80-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur.

Katroma bicornus De Wever 1982a

Species code: KAT09

Synonymy:

1982a *Katroma bicornus* n. sp. – De Wever, p. 193, pl. 3, figs. 1-4.
1982b *Katroma bicornus* De Wever – De Wever, p. 304, pl. 46, figs. 1-4.
1982 *Syringocapsa* sp. A – Imoto et al., pl. 1, fig. 7.
1982 *Katroma bicornus* De Wever - De Wever & Origlia-Devos, pl. 1, figs. H, I.
1984 *Katroma* aff. *neagui* Pessagno & Poisson – Murchey, pl. 1, fig. 28.
1987b *Katroma bifurca* n. sp. – Yeh, p. 79, pl. 3, figs. 3-4, 24.
1989 *Katroma* sp. B – Hattori, pl. 3, fig. A.
1990 *Katroma* cf. *bicornus* De Wever – Hori, Fig. 8.19.
1996 *Katroma bicornus* De Wever – Tumanda et al., p. 181, Fig. 5.1.
1997 *Katroma* cf. *bicornus* De Wever – Hori, pl. 1, fig. 21.
1997 *Katroma bicornus* De Wever – Yao, pl. 11, fig. 544.
1998 *Katroma bicornus* De Wever – Yeh & Cheng, p. 28, pl. 7, fig. 22.
2004 *Katroma bicornus* De Wever – Matsuoka, fig. 121.

Original description: *Katroma* bearing two stout spines disposed at 120° from one another, on each side of test axis. Porous cephalis in shape of truncated cone. Test bears thin, long spines probably related to cephalic spines. Porous thorax in shape of a truncated cone. There is almost no change in contour between cephalis and thorax. Abdomen inflated, much larger than cephalis and thorax, wider than long. Its median part bears about ten radial spines, rounded in cross-section. Postabdominal tube is subcylindrical, distally closed, with pores sometimes elongated in axial direction. Pores are large all over test with a maximum size on abdomen.

Original remarks: Pores sometimes filled by a thin network as a spider's web. This form differs from *K. neagui* Pessagno and Poisson by its two stout horns, long cephalic spines, larger pores and a wider, distinct abdomen.

Measurements (μm):
Based on 4 specimens.

	Mean	Min.	Max.	HT
Length of horns	65	60	71	60
Length of cephalis	53	50	60	60
Length of thorax	51	45	59	59
Length of abdomen	119	114	125	125
Length of postabdominal tube			200	
Width of cephalis in the middle	43	42	45	42
Width of thorax in the middle	62	50	71	65
Width of abdomen	152	140	165	165

Etymology: From latin *bi-*, two and *cornu, -us*, horn; form with two horns.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Nicely Formation, Oregon; Franciscan Complex, California; Drimos Formation, Greece; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines; Japan.

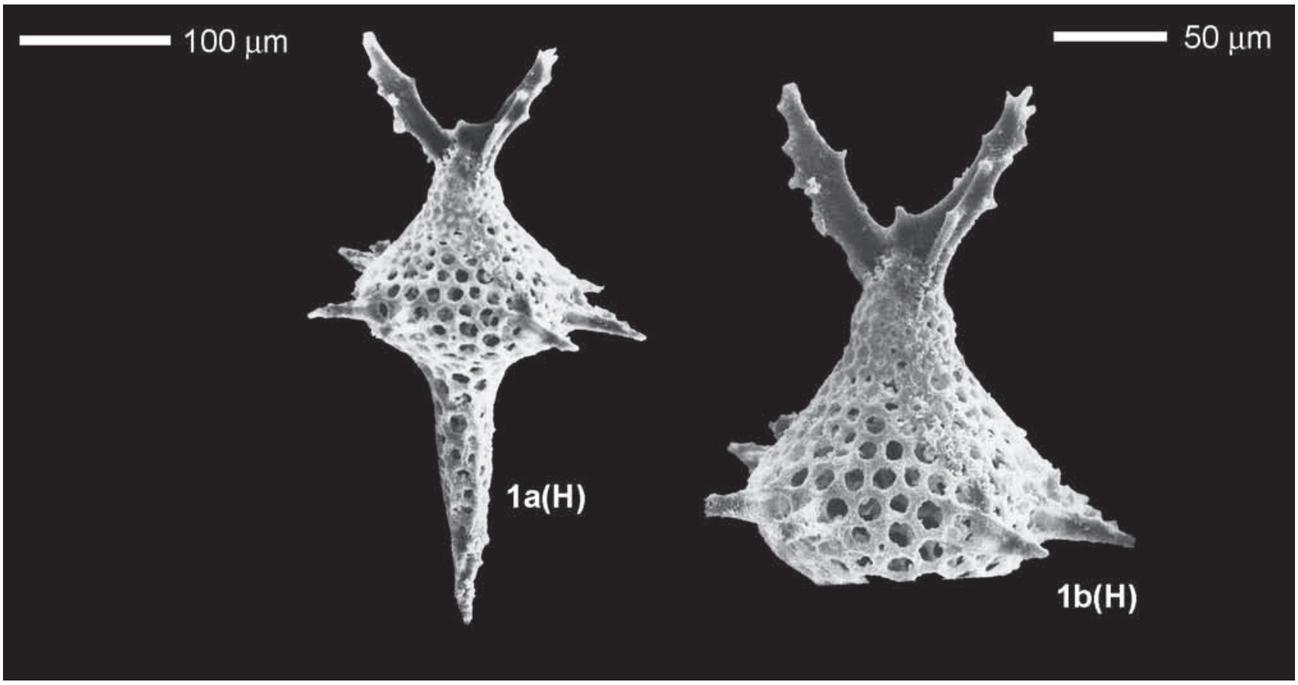


Plate KAT08. ***Katroma aurita*** **Whalen & Carter.** Magnification Fig. 1a(H) x200, Fig. 1b(H) x300. **Fig. 1a(H).** Whalen & Carter 2002, pl. 13, fig. 4. **Fig. 1b(H).** Whalen & Carter 2002, pl. 13, fig. 8.

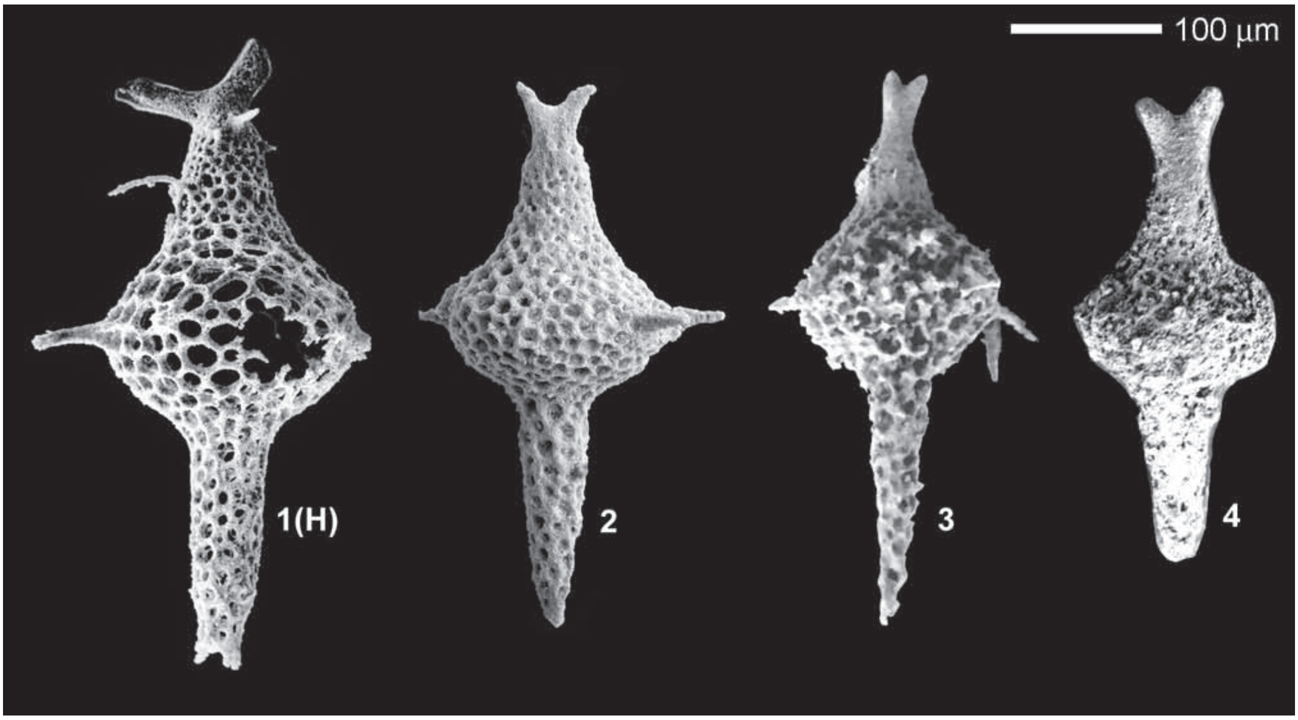


Plate KAT09. ***Katroma bicornus*** **De Wever.** Magnification x200. **Fig. 1(H).** De Wever 1982a, pl. 3, fig. 2. **Fig. 2.** OM, BR474-R17-09. **Fig. 3.** JP, IYII24-15. **Fig. 4.** Hori 1990, Fig. 8.19.

Katroma brevitubus Dumitrica & Goričan n. sp.

Species code: KAT12

Synonymy:

1982 *Syringocapsa* sp. B – Yao, pl. 4, figs. 14-15.
1982 *Syringocapsa* sp. B – Yao et al., pl. 2, fig. 15.
1982 *Syringocapsa* sp. B – Imoto et al., pl. 1, fig. 8.
1990 *Syringocapsa* sp. B – Hori, Fig. 8.11.
1997 *Syringocapsa* sp. B of Yao 1982 – Hori, pl. 1, fig. 18.
1997 *Syringocapsa* sp. D – Yao, pl. 11, fig. 545.
1998 *Katroma megasphaera* n. sp. – Yeh & Cheng, p. 28, pl. 7, figs. 9, 20 only.
1998 *Katroma* sp. B – Yeh & Cheng, p. 30, pl. 9, fig. 23.
2001 *Syringocapsa inflata* (Yeh) – Gawlick et al., pl. 6, fig. 6.
2004 *Syringocapsa* sp. – Hori, pl. 5, fig. 61.

Type designation: Specimen SG 022014 from sample OM-00-252, Musallah Formation, Jabal Buwaydah center east.

Description: Test composed of three segments and a tubular extension. Cephalis and thorax short, broadly conical, collar stricture not well pronounced externally. Apical horn indistinct, short, circular in cross-section. Cephalothorax bears small circular pores. Abdomen inflated, spherical, much larger than cephalothorax, covered with medium-sized hexagonal and pentagonal pore frames. Abdomen without circumferential spines. Tubular extension short, inverted conical, porous. Pores similar in size to those of abdomen. Tubular extension closed; in well-preserved specimens it ends with a short spine, circular in cross-section.

Remarks: *Katroma brevitubus* n. sp. differs from *K. angusta* Yeh by having a much shorter terminal tube. It differs from *Katroma ninstintsi* Carter by having a shorter cephalothorax, more expanded abdomen, and shorter terminal tube.

Measurements (μm):
Based on 11 specimens.

	HT	Min.	Max.	Mean
Length of cephalis and thorax	42	33	55	43
Length of abdomen	145	104	156	125
Length of terminal tube	64	36	79	55
Maximum width of abdomen	159	124	183	141

Etymology: From Latin: *brevis,-e* (short) and *tubus,-i* (tube); noun.

Type locality: Sample OM-00-252 from Musallah Formation, Jabal Buwaydah center east.

Occurrence: Musallah Formation, Haliw (Aqil) Formation and Tawi Sadh Member of the Guwayza Formation, Oman; Dürrnberg Formation, Austria; Liminangcong Chert, Philippines; Japan.

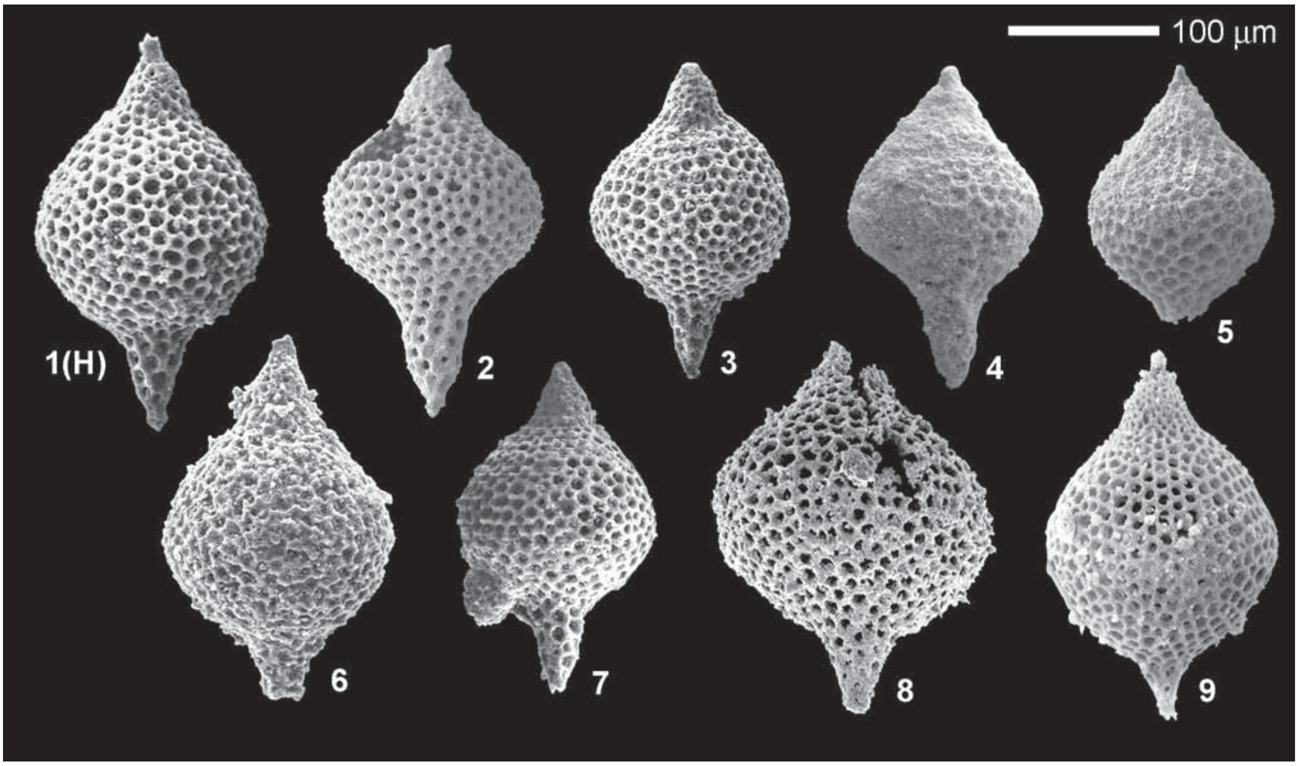


Plate KAT12. ***Katroma brevitubus*** **Dumitrica & Goričan n. sp.** Magnification x200. **Fig. 1(H).** OM-00-252-022014. **Fig. 2.** OM, BR706-R14-02. **Fig. 3.** OM-00-252-021819. **Fig. 4.** OM, Haliw-039-R06-22. **Fig. 5.** OM, Haliw-038-R09-02. **Fig. 6.** OM-00-251-021422. **Fig. 7.** OM-00-252-021814. **Fig. 8.** AT, BMW21-18. **Fig. 9.** JP, MNA-10, MA118883.

Katroma clara Yeh 1987b

Species code: KAT10

Synonymy:

1984 *Katroma* sp. – Whalen & Pessagno, pl. 1, fig. 2.
1987b *Katroma clara* n. sp. – Yeh, p. 80, pl. 3, figs. 6-7.
1987 *Katroma neagui* Pessagno & Poisson, emend. De Wever – Goričan, p. 184, pl. 1, fig. 2.
1988 *Katroma kurusuensis* n. sp. – Hori, p. 553, fig. 6.1a-5.
1989 *Katroma* sp. A – Hattori, pl. 2, fig. K.
1990 *Katroma* sp. N – Hori, fig. 8.20.
1990 *Katroma kurusuensis* Hori – Hori, fig. 8.21.
1997 *Katroma kurusuensis* Hori – Hori, pl. 1, fig. 16.
? 1998 *Katroma* sp. – Cordey, p. 110, pl. 22, figs. 7, 10.
2002 *Katroma clara* Yeh – Whalen & Carter, p. 134, pl. 14, figs. 4, 5, 11, 12, 15; pl. 18, figs. 12, 13.
2004 *Katroma clara* Yeh – Matsuoka, fig. 112.
2004 *Katroma* sp. – Matsuoka, fig. 113.
2005 *Katroma kurusuensis* Hori – Hori, pl. 9, fig. 13.

Original description: Cephalis dome-shaped, with crown-like horn having four to five short branches, each branch circular in cross-section. Thorax and abdomen trapezoidal in outline. Three earlier chambers narrow, long, subcylindrical in shape, sparsely perforate, covered by layer of microgranular silica. First post-abdominal chamber inflated, subspherical in outline, terminating in narrow subcylindrical tubular extension. Test mainly comprised of pentagonal and hexagonal pore frames. Pore frames small on earlier chambers, medium-sized on postabdominal chamber with thick rims and thin sides. One row of ten to twelve short circumferential spines on equatorial surface of first post-abdominal chamber. Tubular extension perforate with small pores in spiral rows of pore frames.

Original remarks: *Katroma clara*, n. sp., differs from *Katroma bifurca*, n. sp., by having a horn with four to five branches rather than with two branches, by having circumferential spines on inflated post-abdominal chamber, and by possessing a test with earlier chamber subcylindrical in shape rather than conical in shape.

Further remarks: By Whalen & Carter (2002): *Katroma clara* Yeh differs from *K. neagui* Pessagno and Poisson 1981, by the more globular shape of the post-abdominal chamber and from all other species of *Katroma* by the distinctive, branching horn.

Measurements (µm):
Ten specimens measured.

	HT	Mean	Max.	Min.
Length of apical horn	22	28	40	22
Length of proximal conical portion	108	109	110	108
Width of conical portion at base	86	83	86	80
Length of inflated segment	162	162	162	150
Width of inflated segment	151	151	200	151

Etymology: *Clarus-a-um* (Latin, adj.) = clear.

Type locality: Sample OR-536J, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; San Hipólito Formation, Baja California Sur; Budva Zone, Montenegro; Gümüslü Allochthon, Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

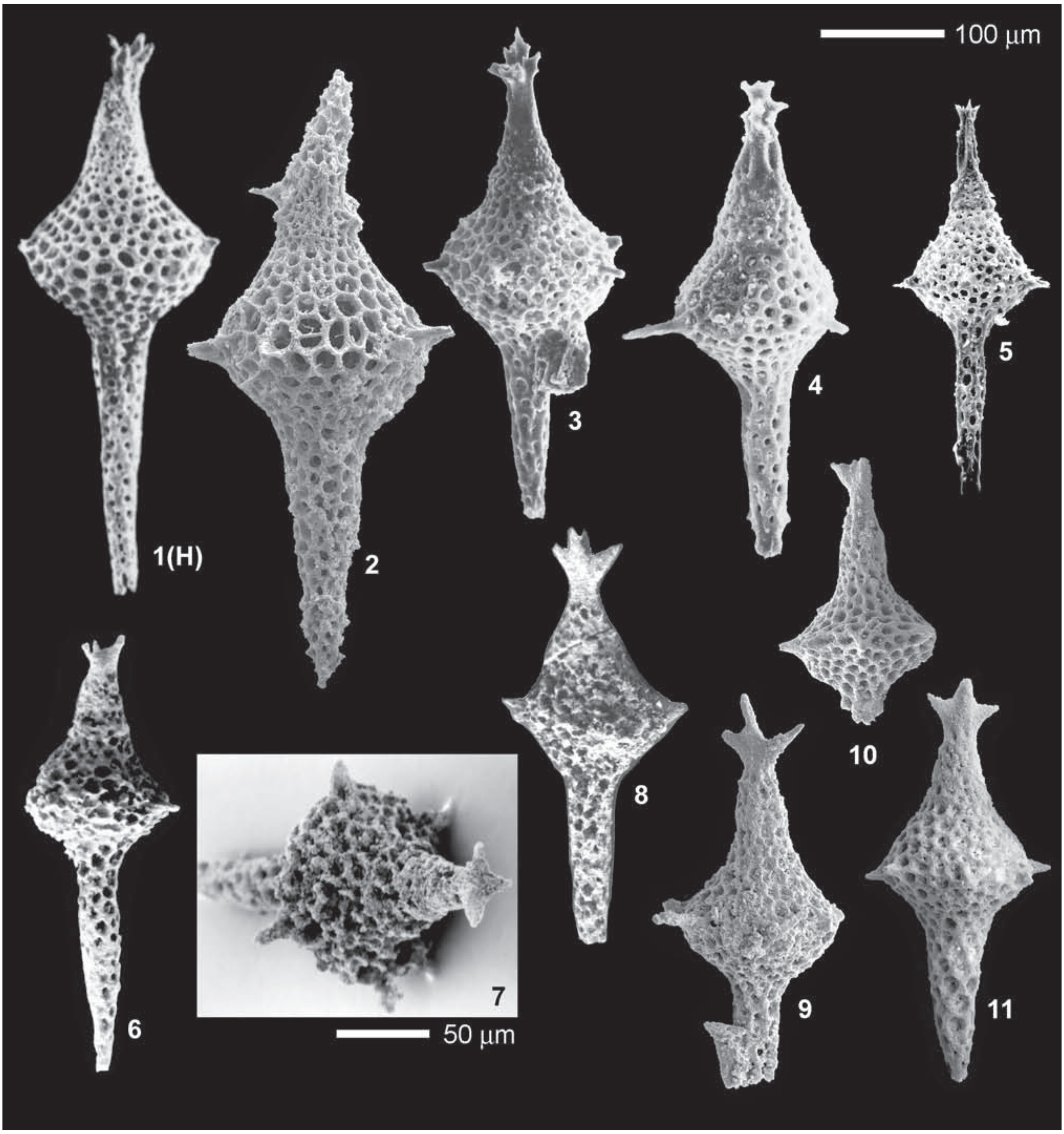


Plate KAT10. ***Katroma clara*** **Yeh.** Magnification x200, except Fig. 7 x300. **Fig. 1(H).** Yeh 1987b, pl. 3, fig. 6. **Fig. 2.** TR, 1662D-R02-01. **Fig. 3.** Whalen & Carter 2002, pl. 14, fig. 4. **Fig. 4.** Whalen & Carter 2002, pl. 14, fig. 5. **Fig. 5.** JP, MNA-10, MA11880. **Fig. 6.** JP, Ku-2-23. **Fig. 7.** Hori 1988, Fig. 6-1b. **Fig. 8.** Hori 1990, Fig. 8-21. **Fig. 9.** OM, BR524-R05-23. **Fig. 10.** OM, BR1121-R07-25. **Fig. 11.** OM, BR477-R19-03.

Katroma elongata Carter n. sp.

Species code: KAT17

Synonymy:

1998 *Katroma* sp. aff. *K. irvingi* n. sp. – Whalen & Carter, p. 70, pl. 19, figs. 11, 19.
1998 *Katroma coliforme* Hori – Yeh & Cheng, p. 28, pl. 7, fig. 6.
2001 *Syringocapsa coliformis* Hori – Gawlick et al., pl. 5, fig. 10; pl. 6, fig. 7.
2001 *Syringocapsa angusta* (Yeh) – Gawlick et al., pl. 5, fig. 11.
2001 *Gigi* aff. *fustis* De Wever – Gawlick et al., pl. 5, fig. 12.

Type designation: Holotype GSC 111721 from GSC loc. C- 080612; Ghost Creek Formation (lower Pliensbachian).

Description: Cephalis small, dome-shaped, with small apical horn, circular in axial section. Thorax, abdomen and first abdominal chamber trapezoidal in outline with small polygonal pore frames. Final post-abdominal chamber marginally inflated, composed of medium-sized polygonal pore frames. No significant break between first and final post-abdominal chambers. Terminal tube narrow, imperforate or with very small pore frames randomly distributed.

Remarks: Whalen & Carter (1998) originally included this species with *Katroma irvingi* Whalen and Carter, a species with widely ranging variation mainly in the size of the final post abdominal chamber. Recent studies of the Pliensbachian fauna, however, indicate that *K. irvingi* s. s. does not range above the Sinemurian, but the successor species, *Katroma elongata* n. sp., does and is abundant through most of the Pliensbachian. For this reason, it has been described as a separate species.

Syringocapsa coliforme Hori (1988) differs from *Katroma elongata* n. sp. in having a more massive apical horn and a narrower abdominal profile.

Measurements (μm):
Based on 9 specimens.

	HT	Max.	Min.	Mean
Length (excl. horn)	376	376	277	329
Maximum width	138	138	84	110

Etymology: Latin (adj.) *elongatus-a-um* = elongate

Type locality: Sample CAA-T-80-7 (GSC loc. C-080612), Ghost Creek Formation, Rennell Junction, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek Formation and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Dürrnberg Formation, Austria; Liminangcong Chert, Philippines.

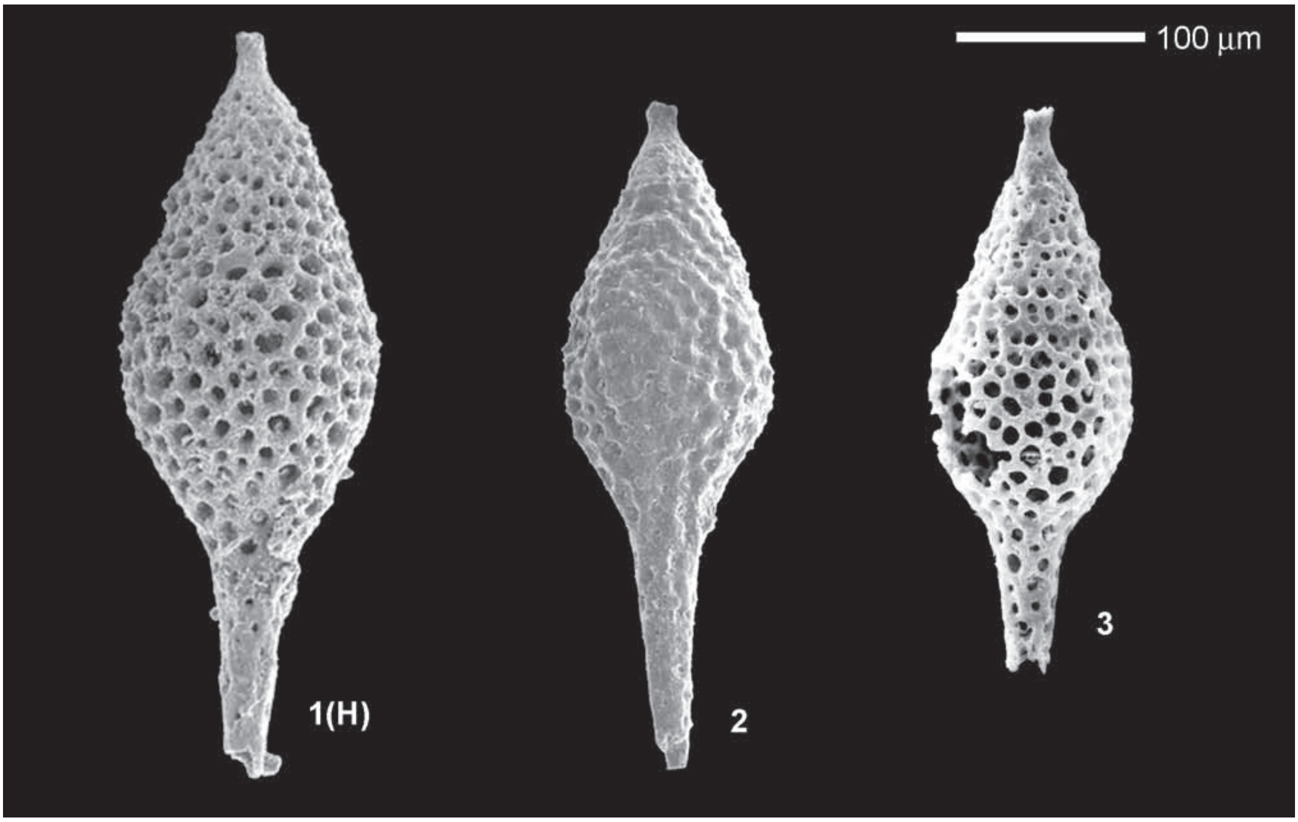


Plate KAT17. ***Katroma elongata*** **Carter n. sp.** Magnification x250. **Fig. 1(H).** QCI, GSC loc. C-080612, GSC 111721. **Fig. 2.** QCI, GSC loc. C-127868, GSC 128814. **Fig. 3.** Carter et al. 1998, pl. 19, fig. 11.

Katroma neagui Pessagno & Poisson 1981, emend. De Wever 1982a

Species code: KAT13

Synonymy:

1981 *Katroma neagui* n. sp. – Pessagno & Poisson, p. 62, pl. 12, figs. 1-5; pl. 15, fig. 3.

1982a *Katroma neagui* Pessagno & Poisson, emend. – De Wever, p. 193, pl. 3, figs. 5-8.

1982b *Katroma neagui* Pessagno & Poisson, emend. De Wever – De Wever, p. 305, pl. 45, figs. 8, 9, 11, 12.

1992 *Katroma neagui* Pessagno & Poisson – Pessagno & Mizutani, pl. 99, figs. 7, 12, 16, 17, 20, 21.

Original description: Test as with genus. Meshwork consisting of massive tetragonal to pentagonal pore frames (predominantly pentagonal); pores becoming larger on tubular extension of first post-abdominal chamber. Cephalis with crown-like horn with four branches; branching components of horn circular in axial section. Row of short spines (approximately 12 in number) occurring circumferentially around medial portion of post-abdominal chamber; spines circular in axial section. Length of tubular extension on first post-abdominal chamber more than half of total length of test.

Original remarks: *Katroma neagui* n. sp., differs from Late Jurassic and Early Cretaceous species of *Podobursa* (e.g., *P. berggreni* Pessagno) by having twelve rather than three circumferentially arranged spines around the medial portion of the final post-abdominal chamber and by having an open, tubular extension on its final post-abdominal chamber.

Further remarks: By De Wever (1982a): The morphological characters described by E. A. Pessagno Jr. and A. Poisson remain valid, except for the following. The apical horn has 3 to 5 branches and not always 4. Cephalis bears at least one very small lateral spine similar to that of *Gigi fustis* n. sp. This species has only 3 segments, not 4; the third one is inflated and continued by a distally closed, and not open, tube.

The occurrence of cephalic spines is paramount for the generic assignment. As a matter of fact, E. A. Pessagno et A. Poisson based the difference between *Katroma* and *Podobursa* on a respectively open and closed abdominal tube; now, fig. 6 clearly shows a closed tube.

Measurements (µm):

Based on 8 specimens.

	HT	Max.	Min.
Width of abdomen	70	70	50
Length of cephalis-abdomen	110	115	65
Length of first post-abdominal chamber	100		50
Width of first post-abdominal chamber	120	120	
Length of tube on post-abdominal chamber	310	310	235

Etymology: This species is named for Dr. Teodor Neagu, University of Bucharest (Romania) in honor of his contributions to Mesozoic stratigraphy and micropaleontology.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey.

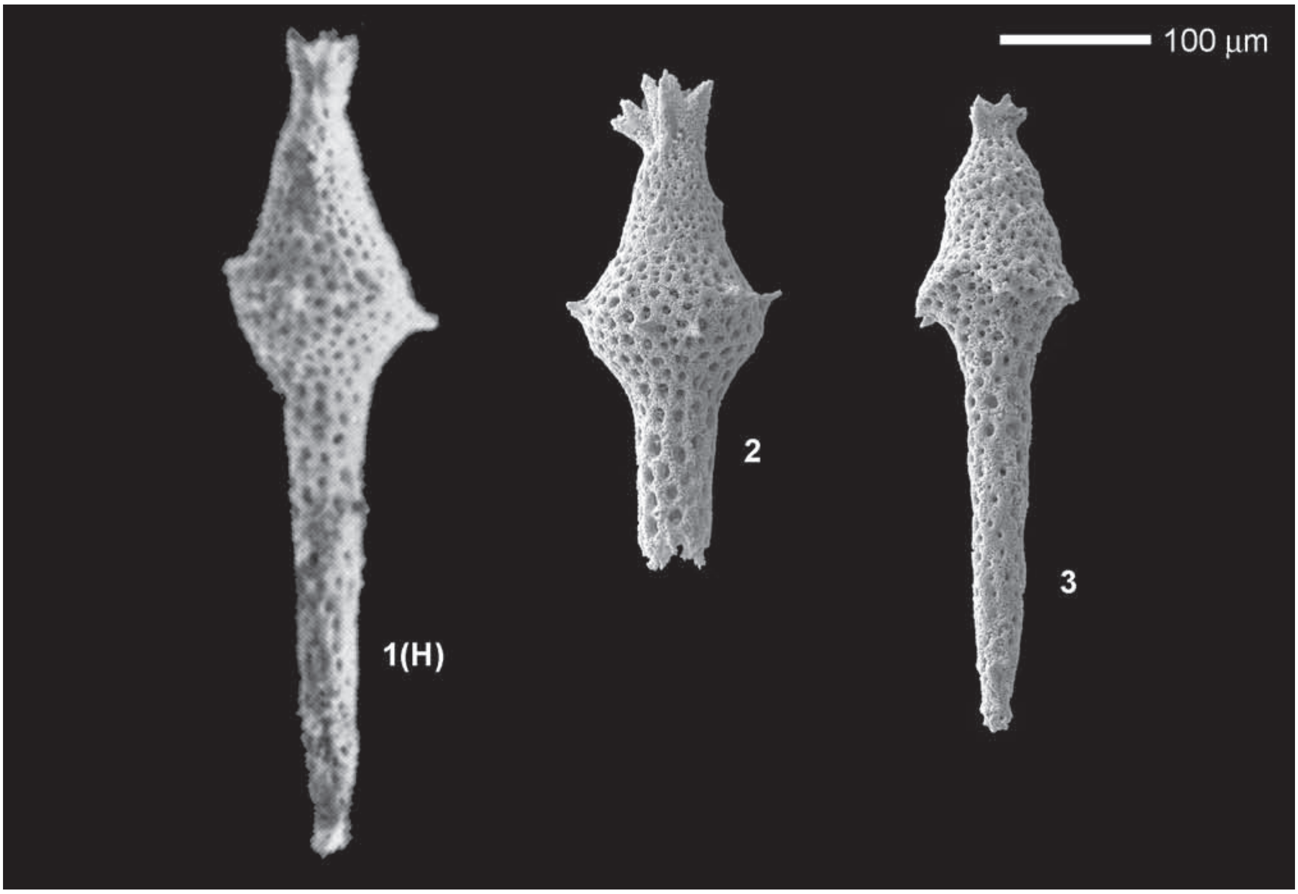


Plate KAT13. *Katroma neagui* Pessagno & Poisson. Magnification x200x. **Fig. 1(H).** Pessagno & Poisson 1981, pl. 12, fig. 1. **Fig. 2.** TR, 1662D-R01-09. **Fig. 3.** TR, 1662D-R02-03.

Katroma ninstintsi Carter 1988

Species code: KAT14

Synonymy:

1985 *Katroma* sp. – Igo et al., pl. 15, fig. 14.
1987b *Katroma* sp. A – Yeh, p. 81, pl. 3, fig.1, pl. 6, figs. 4, 14.
1988 *Katroma ninstintsi* Carter n. sp. – Carter et al., p. 60, pl. 2, figs. 4, 9.
1992 *Katroma* sp. – Pessagno & Mizutani, pl. 99, figs. 6, 10, 11, 15.
1996 *Katroma* sp. A. – Tumanda et al., p. 181, Fig. 4.15.
1998 *Katroma* sp. A – Yeh & Cheng, p. 30, pl. 7, figs. 7, 10.
2001 *Syringocapsa inflata* (Yeh) – Gawlick et al., pl. 5, fig. 9.

Original diagnosis: Tricyrtid test; abdomen expanded and globose with long, open tubular extension. Apical horn small and asymmetrical.

Original description: Tricyrtid test: cephalis small and hemispherical; thorax trapezoidal, expanding more rapidly in height than width; abdomen enlarged and globose, terminating in an open tubular extension. Irregularly shaped pore frames small on initial chambers, becoming larger on expanded portion of abdomen and decreasing in size on tubular extension. Apical horn small and more or less asymmetrical. On some specimens this horn appears to divide in the manner of *Katroma neagui* Pessagno and Poisson (see Pl. 2, fig. 9, this report). Lateral spine (V-spine) present, but very short and usually broken in type material. Very small, radial spines (positioned at maximum extension of abdomen) are more often than not eroded.

Original remarks: A number of forms are tentatively grouped together as *Katroma ninstintsi*; they are thought to represent variants of one species. Collectively they differ in exhibiting a more or less abrupt transition from expanding thorax to inflated abdomen. This change is sometimes quite distinct (see Pl. 2, fig. 9) in other cases not (holotype, Pl. 2, fig. 4).

Katroma ninstintsi normally differs from *K. bicornus* De Wever in having only one very small, asymmetrical apical horn and the radial abdominal spines are much smaller. It differs from *K. neagui* Pessagno and Poisson in having a more expanded abdominal chamber and, whereas the apical horn on some specimens appears to divide, it is much shorter and usually has only two, rather than four, radial branches.

Measurements (μm):
Based on 13 specimens.

	HT	Av.	Max.	Min.
Length of apical horn	15	22.3	61	14
Length of cephalis and thorax	46	85	105	46
Length of abdomen	96	120	150	92
Length of terminal tube	106	144	170	120
Maximum width of abdomen	107	155	200	107

Etymology: Named for Haida Indian Chief Ninstints, of Anthony Island.

Type locality: GSC locality C-080577, Fannin Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Fernie Formation, northeastern British Columbia; Nicely Formation, Oregon; Dürrnberg Formation, Austria; Liminangcong Chert, Philippines; Japan.

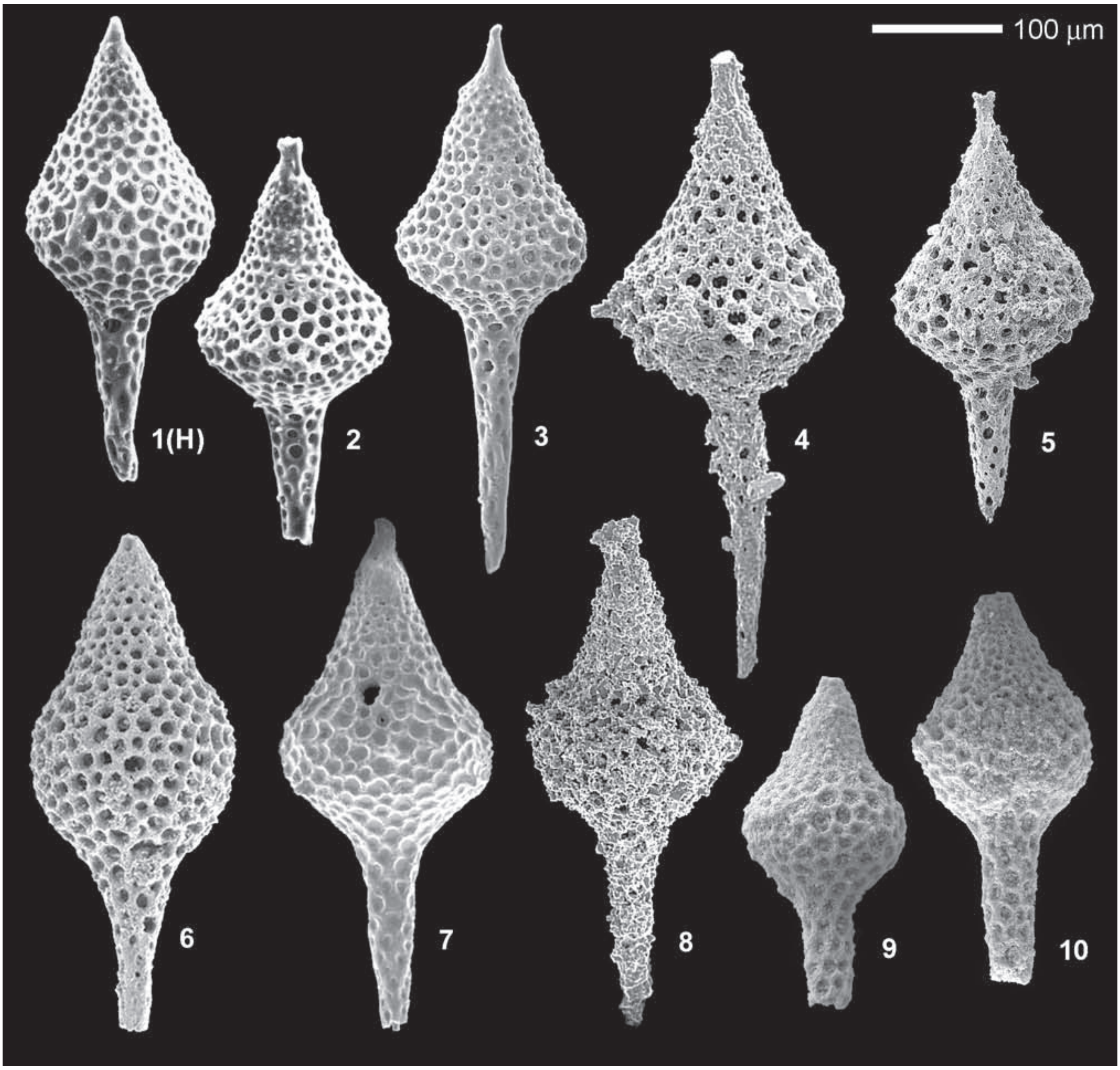


Plate KAT14. *Katroma ninstintsi* Carter. Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 2, fig. 4. **Fig. 2.** Carter et al. 1988, pl. 2, fig. 9. **Fig. 3.** QCI, GSC loc. C-140495, GSC 128820. **Fig. 4.** NBC, GSC loc. C-305208, GSC 128821. **Fig. 5.** NBC, GSC loc. C-305208, GSC 128822. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128823. **Fig. 7.** QCI, GSC loc. C-140495, GSC 128915. **Fig. 8.** NBC, GSC loc. C-305208, GSC 128916. **Fig. 9.** OM, Haliw-039-R07-03. **Fig. 10.** OM, Haliw-039-R03-09.

Katroma*? *sinetubus Carter n. sp.

Species code: KAT16

Type designation: Holotype GSC 111722 and paratype GSC 111723 from GSC loc. C-080611; Ghost Creek Formation (lower Pliensbachian).

Description: Test with three or four chambers and a strong apical and antapical spine. Cephalis small, mostly imperforate with a strong triradiate horn; horn single on holotype (pl. KAT16, fig. 1) but bifurcating on paratype (pl. KAT16, fig. 4). Thorax and abdomen trapezoidal in outline, usually with small polygonal pore frames, but pore frames sometimes larger. Final post-abdominal chamber strongly inflated composed of large pentagonal and hexagonal pore frames; pore frames reduced in size distally. Final post-abdominal chamber terminating in a short triradiate antapical spine; spine with sharp narrow ridges and wide, deep grooves.

Remarks: Genus queried because *Katroma,* as described by Pessagno & Poisson (1981), has an inflated final chamber that terminates in a long open or closed tube. *Katroma*? *sinetubus* n. sp. differs from all other described species of *Katroma* in that the distalmost abdominal chamber terminates in a strong antapical spine rather than a terminal tube.

Measurements (μm):
Based on 7 specimens.

	HT	Max.	Min.	Mean
Length of test (excl. horn and distal spine)	233	233	188	212
Maximum width	171	171	141	157
Length of distal spine	broken	42	22	36 (4)

Etymology: Latin, *sine* + *tubus* = without tube; noun.

Type locality: Sample CAA-79-Ren-Phant, lms 1 (GSC loc. C-080611), Ghost Creek Formation, Rennell Junction section, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek Formation and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands.

***Katroma* sp. 4**

Species code: KAT18

Synonymy:

2002 *Katroma* sp. A – Whalen & Carter, p. 136, pl. 14, fig. 8.

Remarks: This species is very similar to *Katroma clara* Yeh, from which it differs in having thorns along the entire apical horn and in lacking the terminal branching. The horn can be circular (pl. KAT18, fig. 1) or triradiate in cross section (pl. KAT18, figs. 2, 3).

Occurrence: San Hipólito Formation, Baja California Sur; Haliw (Aqil) Formation, Oman.

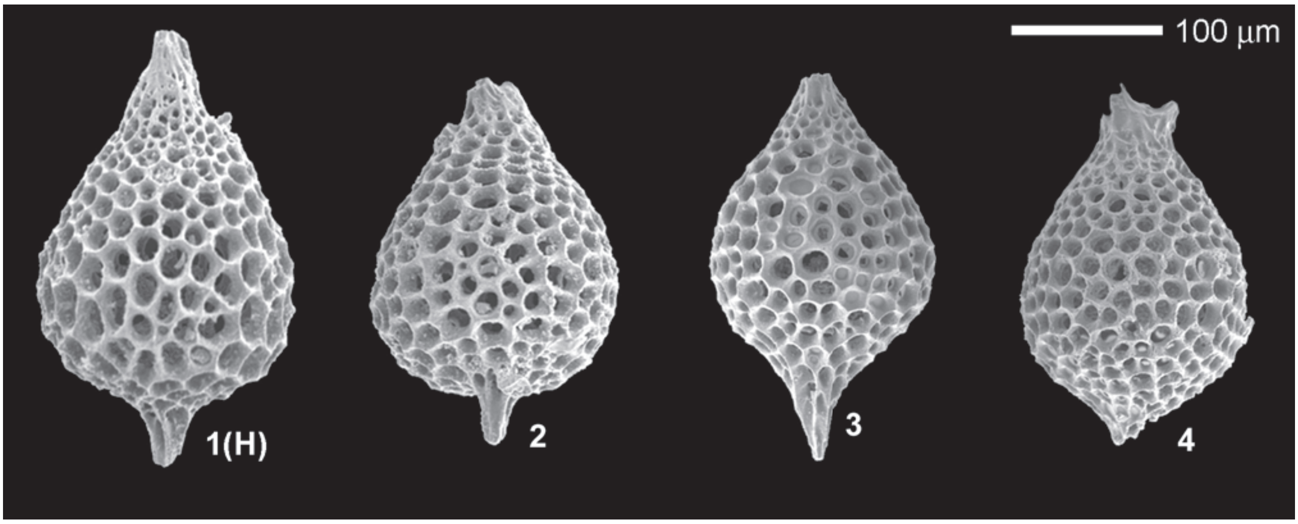


Plate KAT16. ***Katroma*? *sinetubus* Carter n. sp.** Magnification x200. **Fig. 1(H).** QCI, GSC loc. C-080611, GSC 111722. **Fig. 2.** QCI, GSC loc. C-080611, GSC 111723. **Fig. 3.** QCI, GSC loc. C-304281, GSC 128824. **Fig. 4.** QCI, GSC loc. C-304281, GSC 128825.

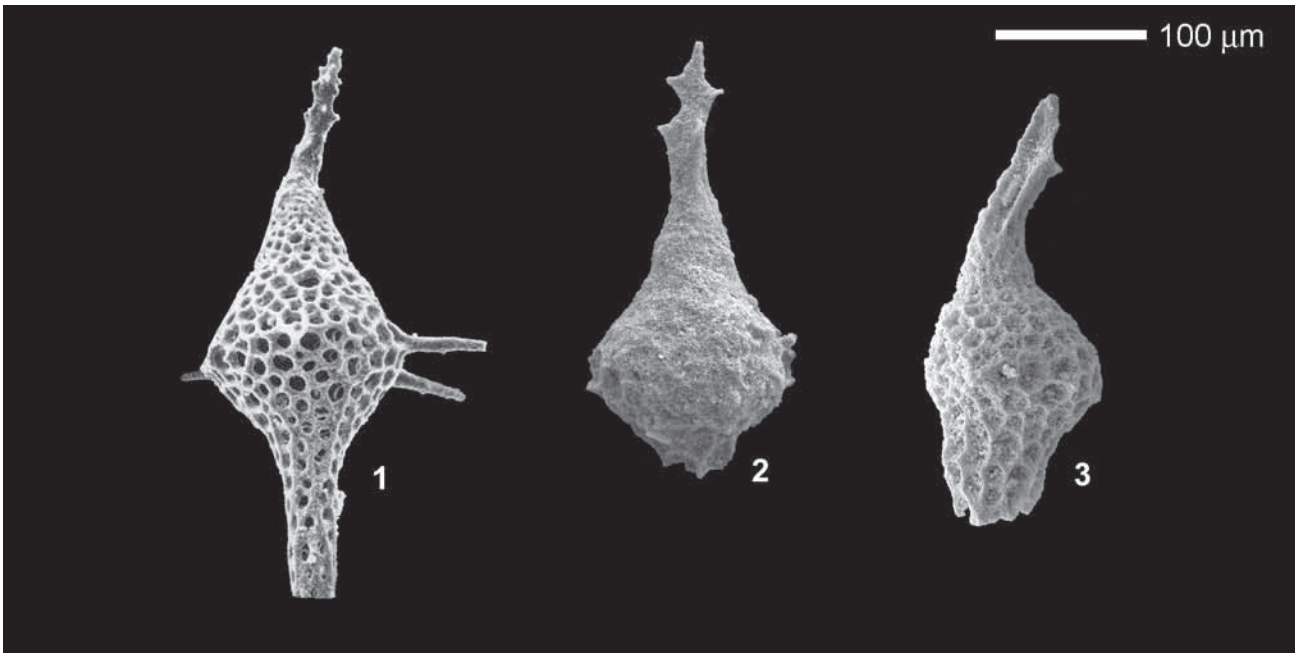


Plate KAT18. ***Katroma* sp. 4.** Magnification x200. **Fig. 1.** BCS, loc. SH-412-14. **Fig. 2.** OM, Haliw-038-R08-18. **Fig. 3.** OM, Haliw-039-R02-10.

Genus: *Lantus* Yeh 1987b

Type species: *Lantus sixi* Yeh 1987b

Synonymy:

1984b *Milax* n. gen. – Blome, p.372.
1987b *Lantus* n. gen. – Yeh, p. 90.
? 1988 *Hemicryptocephalis* n. gen – Li, p. 329.

Original description: Test multicyrtid, conical, with horn, usually with strictures at joints, final post-abdominal chamber closing, with large subspherical, latticed expansion. Cephalis conical or dome-shaped. Cephalis, thorax and abdomen sparsely perforate, covered by layer of microgranular silica. Post-abdominal chambers consisting of single layer of dense, small, tetragonal, pentagonal, or hexagonal pore frames. Pore frames regular to irregular in shape and size.

Original remarks: *Lantus* n. gen., differs from *Pseudoristola* n. gen., by having a test with well-developed horn, strictures at joints, and smaller, less regular polygonal pore frames.

Further remarks: *Lantus* differs from *Minocapsa* Matsuoka in having a conical rather than ovoid shape and more postabdominal chambers. It differs from *Stichocapsa* Haeckel by lacking an aperture.

Milax Blome is synonymized with *Lantus*, because the name *Milax* is occupied for a gastropod genus (Gray 1855).

Hemicryptocephalis Li is questionably synonymized with *Lantus* Yeh, because the description of the former is unclear for the following reasons: (1) Li mentions that a constricted aperture is absent but does not indicate whether the genus is totally closed distally or not, and no illustrations are provided to show this characteristic; (2) the genus supposedly has "two descending spines to form the second post-cephalis cavity" but again this distinguishing feature is not illustrated and it is certainly not present in the genus *Lantus*.

Etymology: *Lantus* is a name formed by an arbitary combination of letters (ICZN, 1985, Appendix D, pt. VI, Recommendation 40, p.201).

Included species:

LAN05 *Lantus intermedius* Carter n. sp.
LAN01 *Lantus obesus* (Yeh) 1987b
LAN04 *Lantus praeobesus* Carter n. sp.
LAN02 *Lantus sixi* Yeh 1987b
LAN03 *Lantus* sp. A sensu Whalen & Carter 2002

Lantus intermedius Carter n. sp.

Species code: LAN05

Synonymy:

1988 *Hemicryptocephalis dengqensis* n. sp. - Li, p. 330, pl. 1, figs. 5, 6; not fig. 4, ? fig. 10.
1989 *Pseudoristola* ? spp. – Hattori, pl. 15, fig. D.
1997 *Parahsuum* sp. NB – Yao, pl. 13, fig. 642.

Type designation: Holotype GSC 111724 from GSC loc. C-304566, Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

Description: Test conical, usually with four or five post-abdominal chambers. Cephalis small, conical, apparently lacking horn. Cephalis imperforate, thorax and abdomen sparsely perforate covered with a layer of microgranular silica. Post-abdominal chambers trapezoidal, variable in width, increasing more in height than width as added, final chamber closed with an ellipsoidal cap. Pore frames on post abdominal chambers polygonal very gradually increasing in size distally. Slightly raised transverse ridges and/or slight alignment of pores on distal chambers observed on some specimens.

Remarks: This species differs from *Lantus praeobesus* n. sp. in being less inflated distally and by sometimes possessing a few very rudimentary circumferential ridges between chambers. *L. intermedius* differs from *L. si*xi Yeh in lacking constrictions between post abdominal chambers. *L. intermedius* appears to be intermediate *between L. praeobesus* which first appears in the earliest Pliensbachian and *L. sixi* Yeh which appears later in the late Pliensbachian and Toarcian.

Measurements (μm):
Based on 12 specimens.

	HT	Max.	Min.	Mean
Max. length	258	340	226	273
Max. width	126	158	116	140

Etymology: From Latin: *intermedius, -a, -um* = intermediate; adjective.

Type locality: Sample 99-CNA-MI-9 (GSC loc. C-304566), Rennell Junction member of the Fannin Formation, Maude Island, west of Ells Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia.

Occurrence: Uppermost Ghost Creek Formation and Fannin Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia; Haliw (Aqil) Formation, Oman; China; Japan.

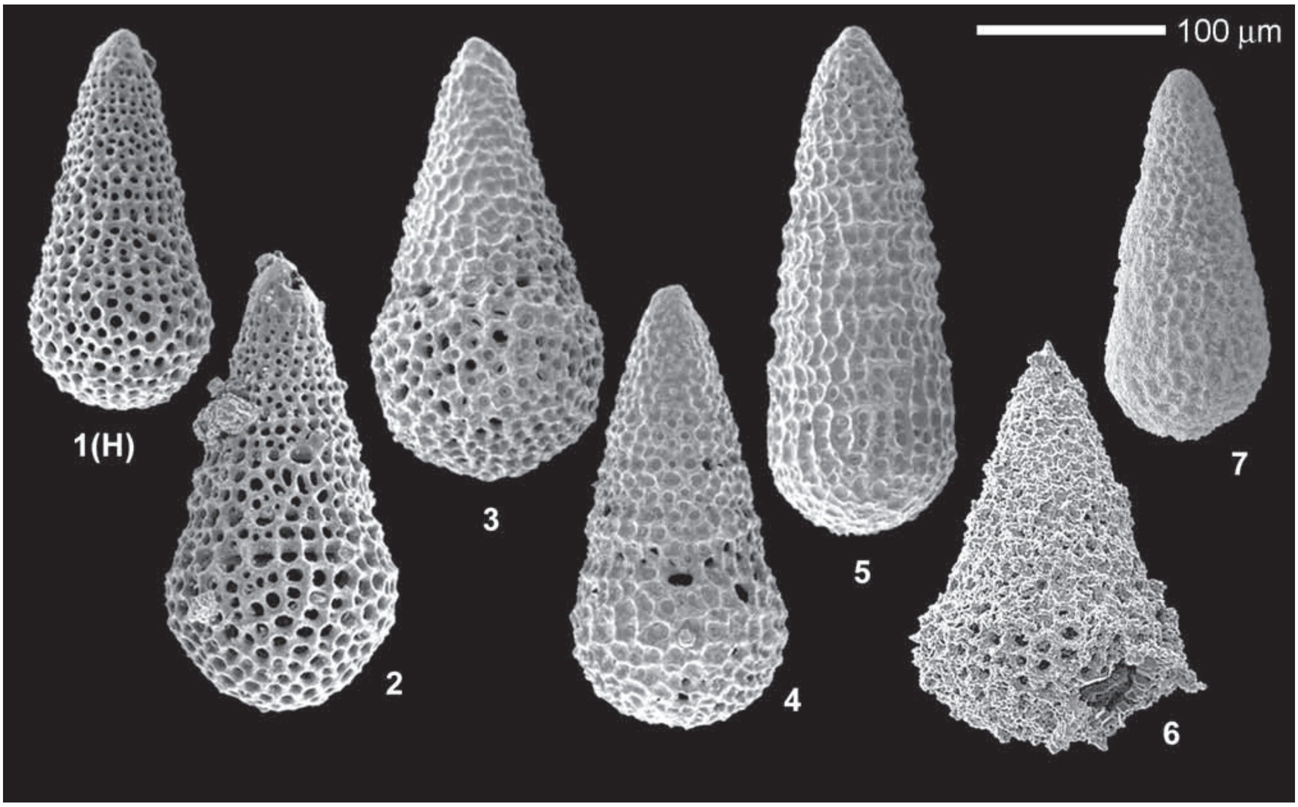


Plate LAN05. ***Lantus intermedius*** **Carter n. sp.** Magnification x200. **Fig. 1(H).** QCI, GSC loc. C-304566, GSC 111724. **Fig. 2.** QCI, GSC loc. C-304567, GSC 128829. **Fig. 3.** QCI, GSC loc. C-140495, GSC 128830. **Fig. 4.** QCI, GSC loc. C-140495, GSC 128831. **Fig. 5.** QCI, GSC loc. C-140495, GSC 128832. **Fig. 6.** NBC, GSC loc. C-305208, GSC 128833. **Fig. 7.** OM, Haliw-038-R09-25.

Lantus obesus (Yeh) 1987b

Species code: LAN01

Synonymy:

1987b *Pseudoristola obesa* n. sp. – Yeh, p. 96, pl. 14, figs. 11-12.
2001 *Stichocapsa obesa* (Yeh) – Gawlick et al., pl. 5, fig. 6.
2003 *Stichocapsa convexa* Yao – Kashiwagi & Kurimoto, pl. 4, figs. 1, 2.
1997 *Pseudoristola obesa* Yeh – Yao, pl. 15, fig. 724.
2005 *Sethocapsa* sp. – Hori, pl. 8, figs. 29-30, 50.

Original description: Test conical, short, with two post-abdominal chambers, without circumferential ridges. Cephalis small, dome-shaped, without horn. Cephalis, thorax, and abdomen closely spaced, sparsely perforate, covered with layer of microgranular silica. Post-abdominal chamber consisting of single layer of pentagonal and hexagonal pore frames. Pore frames increasing in size distally. Bulbous expansion large, subspherical in outline, comprised of nearly two thirds of whole test.

Original remarks: *Pseudoristola obesa* differs from other *Pseudoristola* spp. in this report by having an extremely short test with a very large bulbous spherical final post-abdominal chamber.

Further remarks: Generic name changed to *Lantus* because this species lacks the typical parvicingulid arrangement of pores.

Measurements (μm):
Ten specimens measured.

	Length of proximal conical part (= last segment excluded)	Width at base of conical part	Length of last segment	Width of last segment
HT	114	102	120	156
Mean	111	100	128	162
Max.	114	102	138	171
Min.	107	96	120	156

Etymology: *Obesus-a-um* (Latin, adj.) = fat.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Fannin Formation, Queen Charlotte Islands; Dürrnberg Formation, Austria; Haliw (Aqil) Formation, Musallah Formation and Tawi Sadh Member of the Guwayza Formation, Oman.

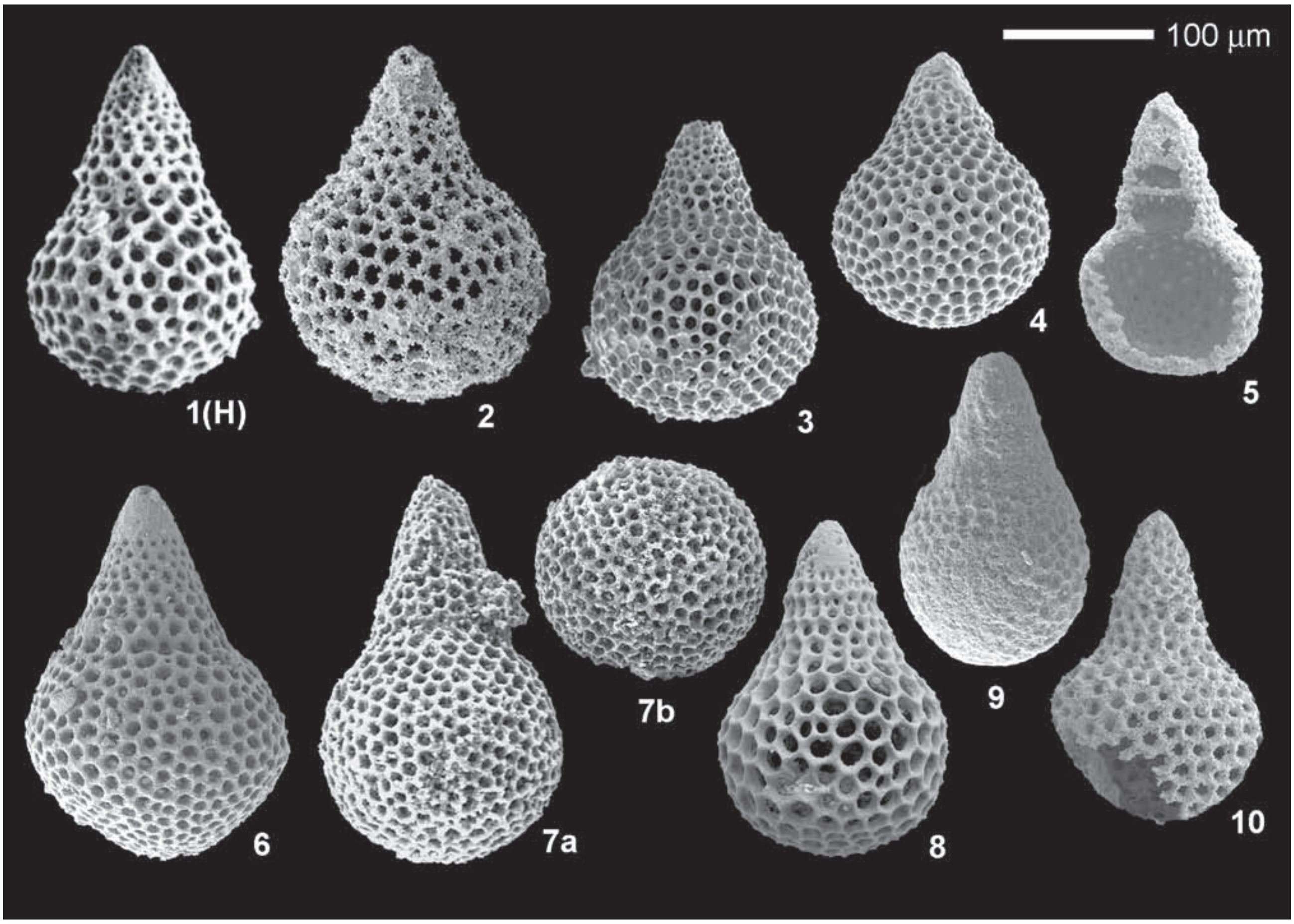


Plate LAN01. *Lantus obesus* (Yeh). Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 14, fig. 12. **Fig. 2**. AT, BMW21-52. **Fig. 3.** QCI, GSC loc. C-304567, GSC 128826. **Fig. 4.** QCI, GSC loc. C305417, GSC 128917. **Fig. 5.** OM, BR1121-R10-12. **Fig. 6.** OM, BR1121-R06-18. **Fig. 7a, b.** OM-00-252-021533, 021534. **Fig. 8.** OM, BR485-R20-06. **Fig. 9.** OM, Haliw-038-R09-03. **Fig. 10.** OM, BR1122-R04-02.

Lantus praeobesus Carter n. sp.

Species code: LAN04

Synonymy:

1988 *Hemicryptocephalis dengqensis* n. sp. – Li, p. 330, pl. 1, figs. ? 4, ? 10; not figs. 5, 6.
1993 *Stichocapsa sp*. – Kashiwagi & Yao, pl. 1, fig. 5.
1998 *Lantus* sp. A – Yeh & Cheng, p. 34, pl. 12, fig. 9.
? 2001 *Stichocapsa* sp. – Kashiwagi, Fig. 6.5.

Type designation: Holotype GSC 111725 from GSC loc. C-304566; Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

Description: Test broadly conical, usually with four to five post-abdominal chambers. Cephalis small, conical, usually without a rudimentary horn. Cephalis imperforate, thorax and abdomen sparsely perforate covered with a layer of microgranular silica. Post-abdominal chambers trapezoidal, rapidly increasing in width as added, final chamber closed with a large ellipsoidal cap. Pore frames on post-abdominal chambers polygonal increasing in size distally.

Remarks: This species differs from *Lantus obesus* (Yeh) 1987 in having a shorter, less inflated final post-abdominal chamber with smaller pore frames, and in lacking a constriction between the final two chambers. *L. praeobesus* n. sp. is the oldest species of *Lantus* included in this catalogue; it first appears in the basal Pliensbachian and is abundant throughout the stage.

Hemicryptocephalis dengquensis Li is questionably synonymized with *L. praeobesus* n. sp. because the description of the former is unclear (see remarks under genus *Lantus*).

Measurements (μm):

Based on 6 specimens.

	HT	Max.	Min.	Mean
Max. length	255	289	203	239
Max. width	145	167	134	152

Etymology: From the Latin, *prae* (prefix) and *obesus* (adj.) = before *obesus*.

Type locality: Sample 99-CNA-MI-9 (GSC loc. C-304566); Rennell Junction member of the Fannin Formation, Maude Island, west of Ells Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek Formation and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia; Haliw (Aqil) Formation, Musallah Formation, and Tawi Sadh Member of the Guwayza Formation, Oman; Japan; Liminangcong Chert, Philippines.

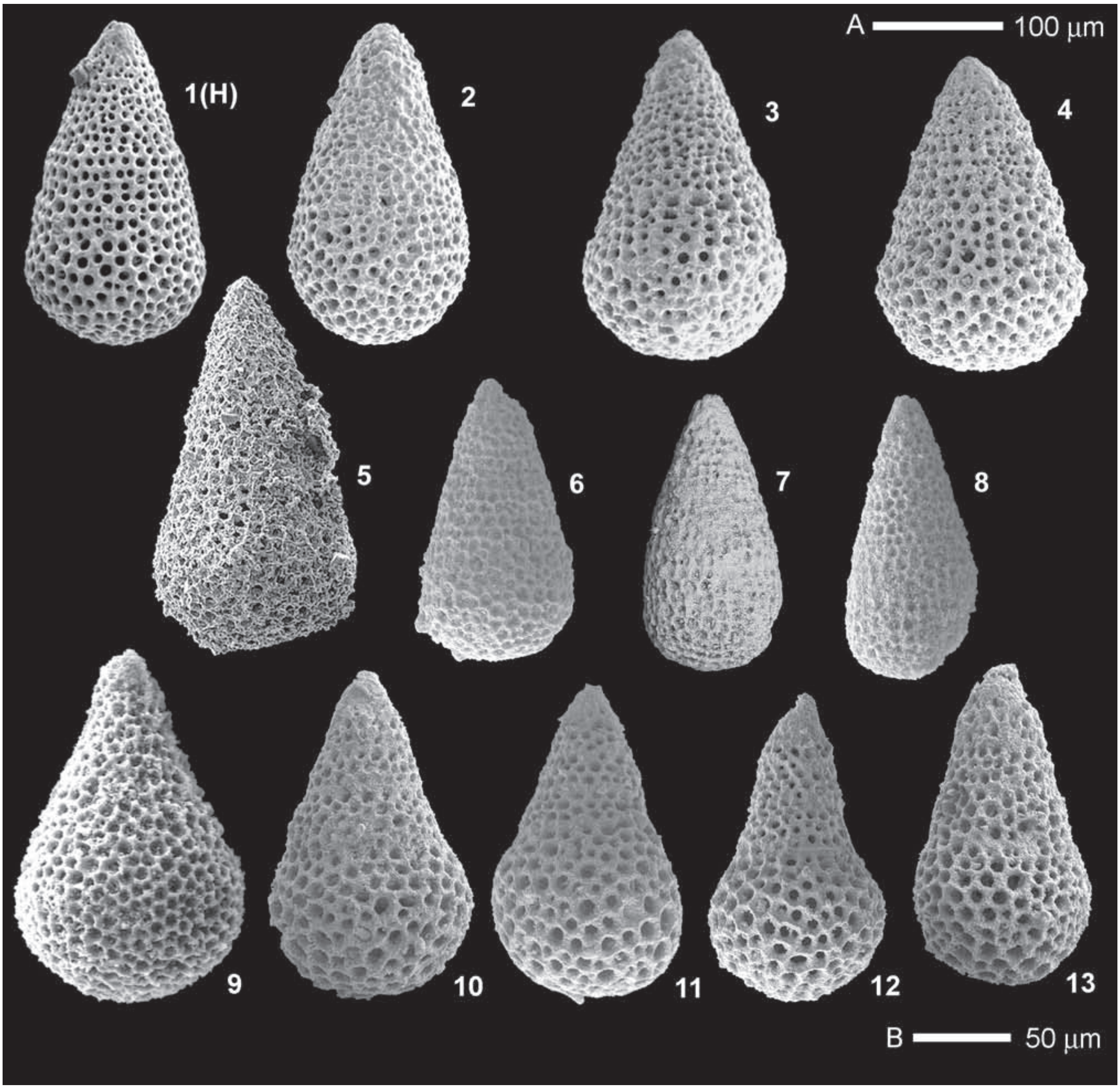


Plate LAN04. *Lantus praeobesus* Carter n. sp. Magnification Figs. 1-8 x200 (scale bar A), Figs. 9-13 x 300 (scale bar B). **Fig. 1(H).** QCI, GSC loc. C-304566, GSC 111725. **Fig. 2.** QCI, GSC loc. C-304281, GSC 128834. **Fig. 3.** QCI, GSC loc. C-304281, GSC 128835. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128836. **Fig. 5.** NBC, GSC loc. C-305208, GSC 128837. **Fig. 6.** OM, Haliw-038-R08-31. **Fig. 7.** OM, Haliw-038-R09-12. **Fig. 8.** OM, Haliw-038-R09-17. **Fig. 9.** OM-00-252-021918. **Fig. 10.** OM, BR1122-R02-11. **Fig. 11.** OM, BR1121-R09-20. **Fig. 12.** OM, BR1121-R08-02. **Fig. 13.** OM, BR1121-R06-15.

Lantus sixi Yeh 1987b

Species code: LAN02

Synonymy:

1987b *Lantus sixi* n. sp. – Yeh, p. 90, pl. 4, fig. 16; pl. 17, figs. 9, 13, 17, 24.
1987b *Lantus* sp. cf. *L. sixi* n. sp. – Yeh, p. 90, pl. 4, fig. 17; pl. 5, fig. 18; pl. 17, fig. 14.
1997 *Lantus sixi* Yeh – Yao, pl. 15, fig. 725.
2004 *Lantus* sp. – Matsuoka, figs. 96, 97.

Original description: Test small, conical in shape, usually four to five post-abdominal chambers. Cephalis small, conical, with short, massive horn. Earlier chambers sparsely perforate, covered by layer of microgranular silica. Post-abdominal chambers having small polygonal pore frames. Pore frames increasing in size distally, irregular on apical portion but tending to be aligned in a regular fashion on final one or two post-abdominal chambers. Final post-abdominal chamber closed by large, latticed, subellipsoidal cap.

Further remarks: Differs from all other species included here in having very slight strictures between post-abdominal chambers. Apical horn not always distinct.

Measurements (μm):
Ten specimens measured.

	HT	Mean	Max.	Min.
Length of apical horn	13	10	13	8
Length of proximal conical part (= last segment excluded)	117	123	130	115
Width at base of conical part	65	75	86	65
Length of last segment	52	58	65	52
Width of last segment	95	102	108	95

Etymology: This species is named for Mr. Walter M. Six, Jr. for his help on this project.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Fannin member of the Fannin Formation, Queen Charlotte Islands; Japan.

***Lantus* sp. A** sensu Whalen & Carter 2002

Species code: LAN03

Synonymy:

2002 *Lantus* sp. A – Whalen & Carter, p. 142, pl. 16, fig. 10.

Original remarks: This species differs from *Lantus sixi* Yeh 1987 in lacking constrictions and by having larger pore frames on distal chambers.

Occurrence: San Hipólito Formation, Baja California Sur; Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman.

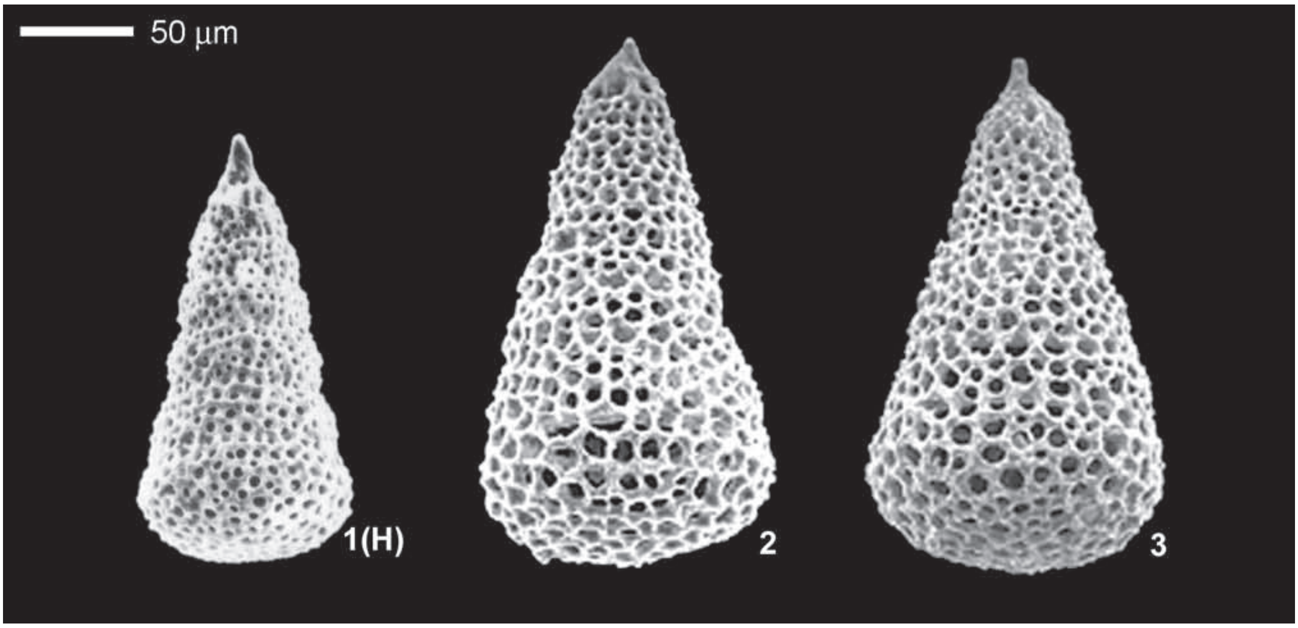


Plate LAN02. ***Lantus sixi*** **Yeh.** Magnification x300. **Fig. 1(H).** Yeh 1987b, pl. 17, fig. 9. **Fig. 2.** QCI, GSC loc. C-304568, GSC 128827. **Fig. 3.** QCI, GSC loc. C-175306, GSC 128828.

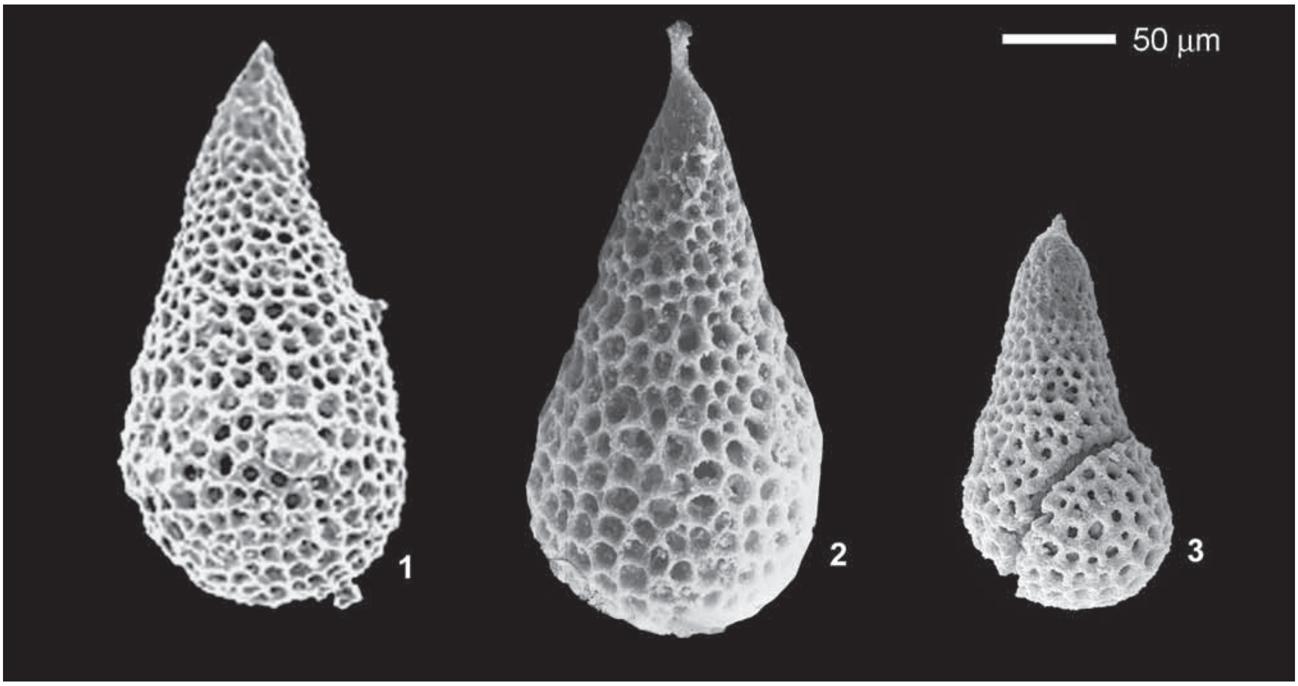


Plate LAN03. ***Lantus*** **sp. A sensu Whalen & Carter.** Magnification x300. **Fig. 1.** QCI, GSC loc. C-304568, GSC 128918. **Fig. 2.** Whalen & Carter 2002, pl. 16, fig. 10. **Fig. 3.** OM, BR523-R01-13.

Genus: ***Laxtorum*** Blome 1984a, emend. Carter 1993

Type species: *Laxtorum hindei* Blome 1984a

Synonymy:
1984a *Laxtorum* n. gen. – Blome, p. 56.
1993 *Laxtorum* Blome emend. – Carter, p. 112.

Original description: Test multicyrtid, consisting of four or more post-abdominal chambers (segments). Cephalis conical, imperforate, with a large, well-developed horn. Thorax trapezoidal in outline, perforate, in some specimens buried by microgranular silica. Abdomen and post-abdominal chambers trapezoidal in outline. Test wall consisting of two layers: inner layer comprised of triangular to pentagonal pore frames that lack nodes; outer layer comprised of triangular to hexagonal pore frames with massive, polygonal nodes at the pore frame vertices, nodes low in relief; pores of both layers of pore frames large, subcircular to polygonal in outline; pore frames of the outer layer generally restricted to the circumferential ridges, with the exception of the final post-abdominal chambers. Post-abdominal chambers commonly increasing more rapidly in width than in height.

Emended definition: Carter (1993): Genus emended to include the following: (1) test may possess up to twelve postabdominal chambers, (2) test may have slender, lateral spines that extend radially from medial and/or distal post-abdominal chambers, and are distributed equally to subequally around perimeter of test, and (3) test may terminate in an open, flaring terminal tube that lacks septal partitions.

Original remarks: *Laxtorum* new genus differs from *Canoptum* Pessagno, 1979, by having a test in which the pores are not buried by an outer layer of accreted microgranular silica.

Etymology: *Laxtorum* is a name formed by an arbitrary combination of letters (ICZN, 1964, p. 113, Appendix D, Pt. IV, Recommendation 40).

Included species:
LAX06 *Laxtorum hemingense* Whalen & Carter 1998

Laxtorum hemingense Whalen & Carter 1998

Species code: LAX06

Synonymy:
1998 *Laxtorum hemingense* n. sp. – Whalen & Carter, p. 80, pl. 25, figs. 6-8, 13-14, 24-25; pl. 27, figs. 5, 6, 16, 20.

Original description: Test conical with approximately eight to nine postabdominal chambers. Cephalis small, steeply dome-shaped with or without a small horn; horn circular in axial section; cephalis imperforate, covered with a thick layer of microgranular silica. Thorax, abdomen and all postabdominal chambers gradually increasing in width as added. Thorax trapezoidal in outline with medium-sized pores mostly obscured by layer of microgranular silica. Mostly tetragonal pore frames on abdomen and postabdominal chambers subaligned in transverse rows. Circumferential ridges composed of thicker, more irregular pore frame bars (zig-zag structure) on proximal parts of test becoming thinner and straighter distally; circumferential ridges with irregular longitudinal extensions superimposed on adjacent pore frames.

Original remarks: *Laxtorum hemingense* n. sp. is distinguished from *Laxtorum* sp. A and *Laxtorum* sp. B by the absence of a prominent horn. It differs from all Rhaetian species of *Laxtorum* in having larger, open, more regularly aligned pore frames and in lacking a terminal tube.

Measurements (μm):
Based on 5 specimens.

Length (excluding horn)	Max. width	
240	105	HT
240	109	Max.
218	98	Min.
229	104	Mean

Etymology: This species is named for Heming Head, located on the east side of Talunkwan Island, northwest of the type locality.

Type locality: Sample QC-549, Sandilands Formation, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

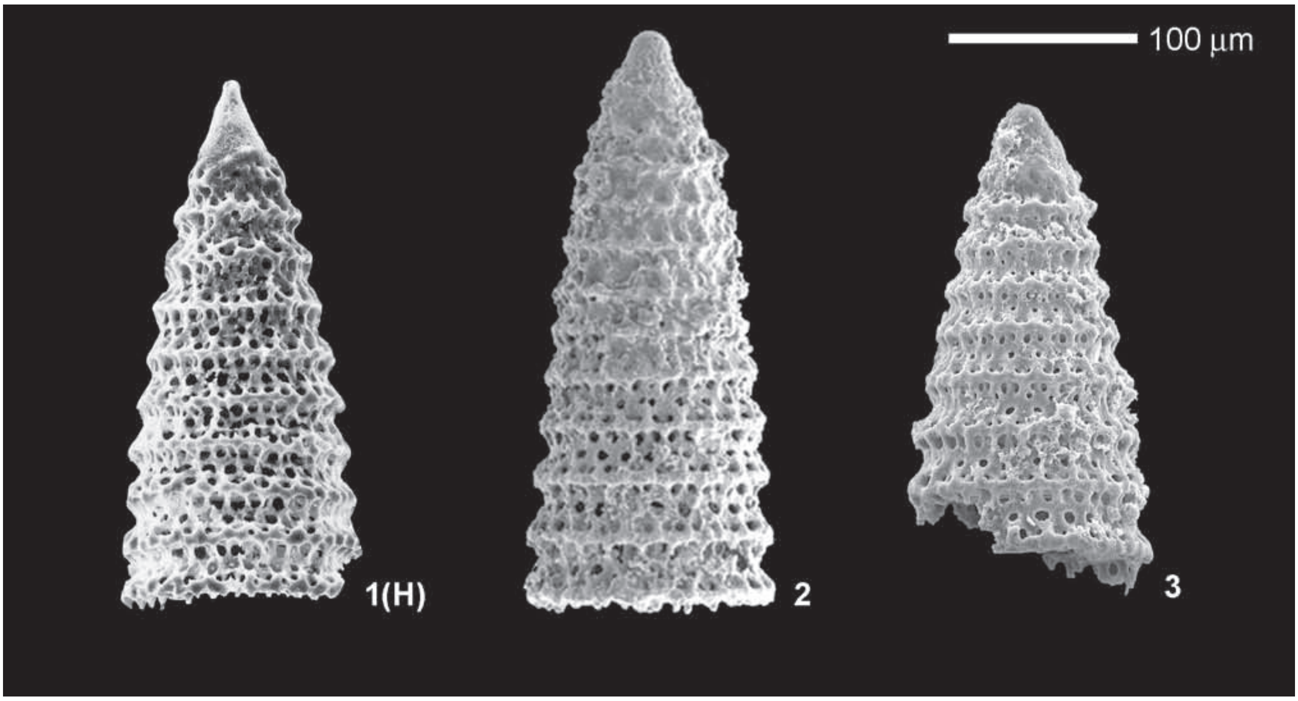


Plate LAX06. ***Laxtorum hemingense*** **Whalen & Carter.** Magnification x250. **Fig. 1(H).** Carter et al. 1998, pl. 25, fig. 6. **Fig. 2.** QCI, GSC loc. C-080612, GSC 128919. **Fig. 3.** QCI, GSC loc. C-175311, GSC 128920.

Genus: *Minocapsa* Matsuoka 1991

Type species: *Minocapsa cylindrica* Matsuoka 1991

Synonymy:

1991 *Minocapsa* n. gen. – Matsuoka, p. 734.

Original description: Closed cyrtid. Shell consisting of four or more segments, pyriform to ovoidal. Cephalis hemispherical without apical horn. Thorax and abdomen truncate conical. Final segment large, hemispherical without aperture. Pores, circular to subcircular and closely spaced.

Original remarks: *Minocapsa*, n. gen. is distinguished from *Stichocapsa* Haeckel by lacking aperture. It also differs from *Zhamoidellum* Dumitrica and *Cryptamphorella* Dumitrica by not being cryptothoracic and by consisting of four or more segments rather than three.

Further remarks: *Minocapsa* differs from *Lantus* Yeh by having fewer segments and the height of the last segment is greater than the remainder of the test. Both genera lack an aperture.

Etymology: The generic name is named for the Mino Terrane which includes the type area, Nanjo Massif.

Included species:

MCP01 *Minocapsa cylindrica* Matsuoka 1991
MCP02 *Minocapsa globosa* Matsuoka 1991
TPS02 *Minocapsa*? *megaglobosa* (Matsuoka) 1991

Minocapsa cylindrica Matsuoka 1991

Species code: MCP01

Synonymy:

1987 *Bagotum* sp. E – Hattori, pl. 15, fig. 4.
1989 *Bagotum* sp. aff. B. *modestum* Pessagno & Whalen – Hattori & Sakamoto, pl. 13, fig. K.
1990 *Stichocapsa* (?) sp. – Nagai, pl. 4, fig. 6.
1991 *Minocapsa cylindrica* n. sp. – Matsuoka, p. 735, figs. 10.1a-5b.
1997 *Minocapsa cylindrica* Matsuoka – Yao, pl. 10, fig. 450.
? 2003 *Stichocapsa* sp. B – Kashiwagi & Kurimoto, pl. 4, fig. 4.
2004 *Minocapsa cylindrica* Matsuoka – Hori, pl. 2, fig. 14.
2004 *Minocapsa cylindrica* Matsuoka – Matsuoka, fig. 91.

Original description: Shell of five segments, ovoidal. Cephalis spherical; thorax and abdomen truncate conical. The proximal three segments form a conical proximal part. The distal two segments form a cylindrical to ovoidal distal part. The last segment hemispherical without aperture. Segmental joints generally indistinct externally; joint between abdomen and fourth segment faintly marked by change in contour from the conical proximal part to the cylindrical to ovoidal distal part. Pores circular to subcircular, rather densely spaced and set in tetragonal to hexagonal pore frames. Pores on the distal part tend to be arranged longitudinally. Pores around distal end slightly larger than those on the rest of the shell; these pores surrounded by circular rims. Small nodes or spines situated at the pore frame vertices.

Original remarks: This species differs from *Minocapsa globosa*, n. sp. by consisting of five segments rather than four, by possessing a more slender distal part and by the pores of the distal part tending to be longitudinally arranged.

Measurements (µm):
Six specimens measured.

	HT	Max.	Min.	Mean
Total height of shell	193	193	165	181
Max. width of shell	120	135	115	125

Etymology: The specific name comes from the Latin *cylindricus-a-um* (=cylindrical).

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan; Musallah Formation, Oman; Skrile Formation, Slovenia; Hyde Formation, Oregon.

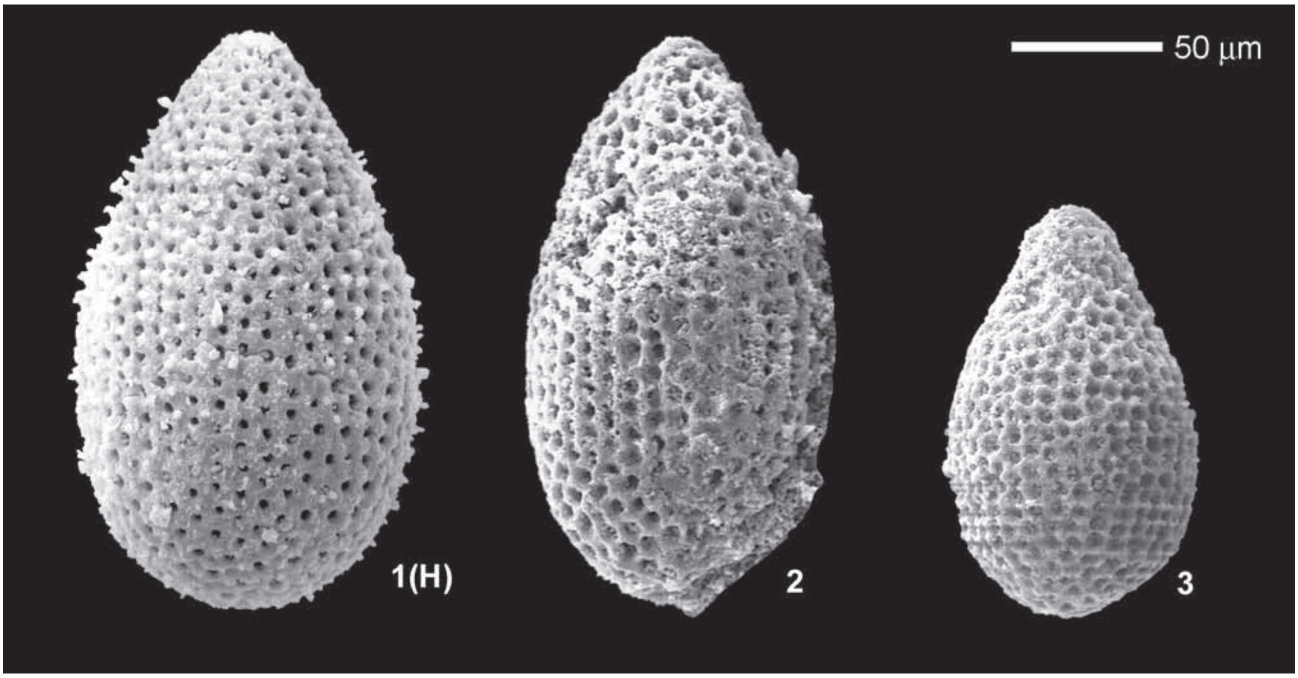


Plate MCP01. ***Minocapsa cylindrica*** **Matsuoka.** Magnification x400. **Fig. 1(H).** Matsuoka 1991, Fig. 10-1a. **Fig. 2.** SI, MM 5.00-010122. **Fig. 3.** OM-00-252-021927.

Minocapsa globosa Matsuoka 1991
Species code: MCP02

Synonymy:
1991 *Minocapsa globosa* n. sp. – Matsuoka, p. 736, figs. 11.1a-4b.
1997 *Minocapsa globosa* Matsuoka – Yao, pl. 10, fig. 451.
2004 *Minocapsa globosa* Matsuoka – Matsuoka, fig. 90.

Original description: Shell of four segments, pyriform. Cephalis spherical; thorax and abdomen truncate conical. The proximal three segments form a conical proximal part. The fourth segment large, subspherical without aperture. Collar and lumber strictures indistinct externally. Joint between abdomen and fourth segment marked by rapid change in contour from the conical proximal part to spherical distal part. Pores circular to subcircular, densely spaced and set in polygonal (largely hexagonal) pore frames. Pores around distal end slightly larger than those on the rest of shell and surrounded by rims. Small nodes situated at the pore frame vertices in some specimens.

Original remarks: This species is compared to *Minocapsa cylindrica*, n. sp. under the latter species.

Measurements (μm):
Six specimens measured.

	HT	Max.	Min.	Mean
Total height of shell	173	185	170	177
Max. width of shell	140	149	135	142

Etymology: The specific name is derived from the Latin *globosus-a-um* (=spherical).

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan.

Minocapsa*? *megaglobosa (Matsuoka) 1991
Species code: TPS02

Synonymy:
1991 *Tricolocapsa* (?) *megaglobosa* n. sp. – Matsuoka, p. 724, figs. 3. 1a-5b.
1997 *Tricolocapsa megaglobosa* Matsuoka – Yao, pl. 9, fig. 423.
2003 *Tricolocapsa* ? *megaglobosa* Matsuoka – Goričan et al., p. 297, pl. 4, fig. 12.
2004 *Tricolocapsa* (?) *megaglobosa* Matsuoka – Matsuoka, fig. 82.

Original description: Shell of three segments with a dish-like basal appendage. Cephalis hemispherical, poreless. Thorax truncate-conical with circular, densely spaced pores. Abdomen large, inflated, barrel-shaped with circular, densely spaced pores larger than those in thorax. Collar stricture distinct externally. Lumber stricture slightly recognizable externally. Joint between abdomen and basal appendage marked by a row of pores slightly larger than those in abdomen. Basal appendage half to a third of abdomen in width, with circular to subcircular densely spaced pores smaller than those in remaining part of shell surface.

Original remarks: This species is questionably assigned to *Tricolocapsa*, because it possesses a dish-like basal appendage. This species is distinguished from *Tricolocapsa* (?) *fusiformis* Yao by having a large, inflated abdomen, densely spaced pores and a distinct collar stricture.

Further remarks: *Tricolocapsa*? *megaglobosa* is herein tentatively assigned to the genus *Minocapsa* Matsuoka because, in common with this genus, it has the following elements: the absence of an aperture, more than three segments, and the presence of an inflated segment. However, according to the generic diagnosis of *Minocapsa*, the last segment is large whereas in this species the last segment is very small and the third segment is the largest. Regardless, even if assignation to *Minocapsa* is questionable, the assignation of this species to *Tricolocapsa* Haeckel is completely wrong because this Cenozoic genus has three segments and a cephalic tube. It is possible that *Minocapsa*? *megaglobosa* has amphipyndacid affinities because the paratype illustrated in transmitted light by Matsuoka (1991, fig. 3.5) seems to show a two-segmented cephalis. The globular, imperforate cephalis of this species also suggests amphipyndacid affinities.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	153	160	120	145	(12)
Maximum width of shell	105	117	88	101	(12)
Width of basal appendage	55	61	47	55	(11)

Etymology: This specific name is derived from the Latin *mega* (=large) and *globosus-a-um* (=spherical).

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

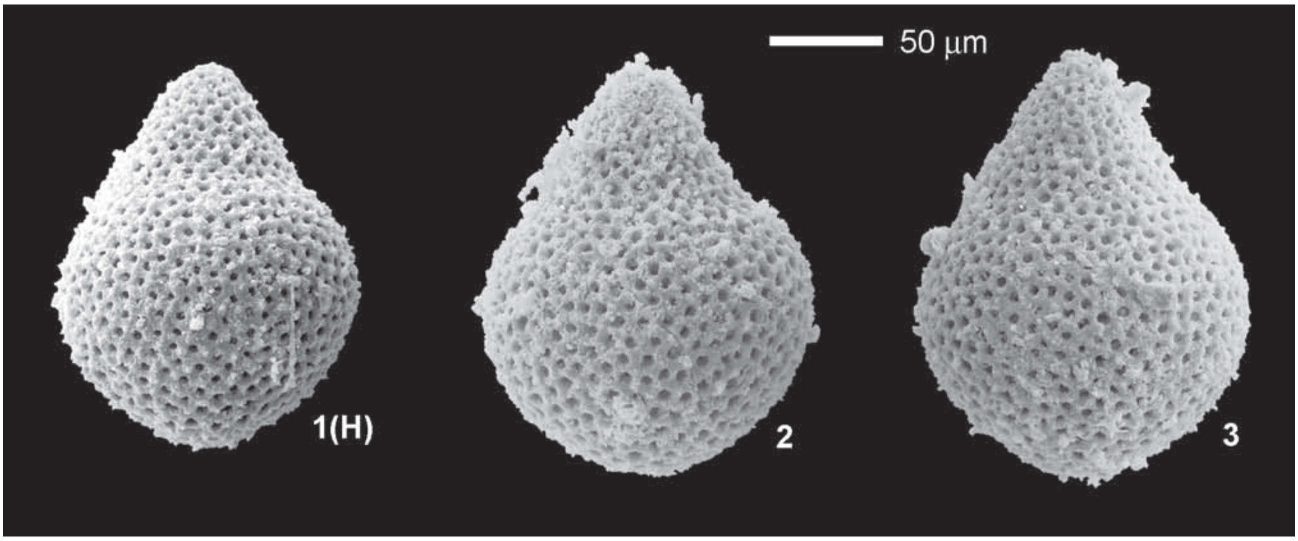


Plate MCP02. ***Minocapsa globosa*** **Matsuoka.** Magnification x300. **Fig. 1(H).** Matsuoka 1991, Fig. 11-1a. **Fig. 2.** Matsuoka 1991, Fig. 11-2. **Fig. 3.** Matsuoka 1991, Fig. 11-3.

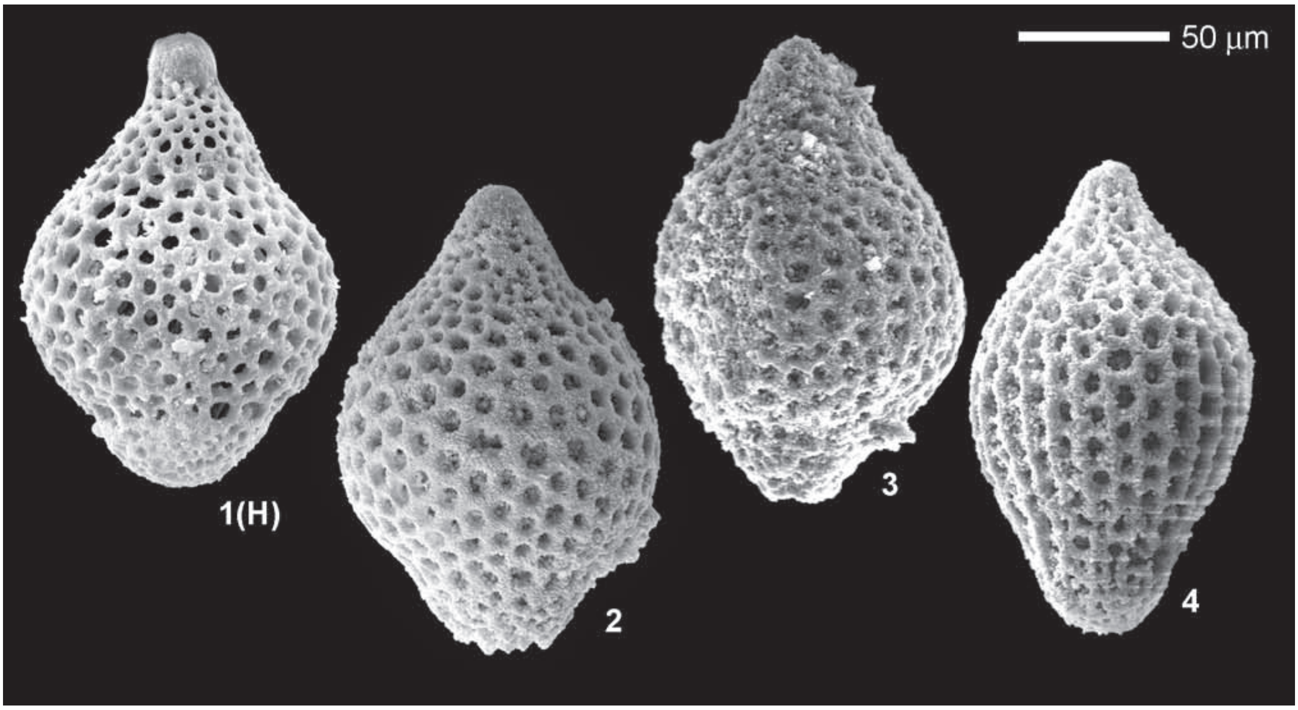


Plate TPS02. ***Minocapsa? megaglobosa*** **(Matsuoka).** Magnification x400. **Fig. 1(H).** Matsuoka 1991, Fig. 3.1a. **Fig. 2.** OM, BR485-R21-15. **Fig. 3.** OM-00-251-021611. **Fig. 4.** OM-00-117-021213.

Genus: *Napora* Pessagno 1977a

Type species: *Napora bukryi* Pessagno 1977a

Synonymy:

1977a *Napora* n. gen – Pessagno, p. 94.
1977b *Ultranapora* n. gen. – Pessagno, p. 38.
1982a *Jacus* n. gen. – De Wever, p. 204.
1986 *Napora* Pessagno emend. – Pessagno et al., p. 34.
1986 *Napora* Pessagno emend. – Takemura, p. 43.
2003 *Napora* Pessagno – Dumitrica & Zügel, p. 57.

Original description: Test dicyrtid with a large conical cephalis and a large subglobular thorax. Cephalis with massive horn bearing longitudinal ridges and grooves and often having subsidiary spines. Thorax with coarse, equal size, polygonal (usually hexagonal) pore frames and circular pores and with a large circular aperture (mouth) at base; three slightly curved feet with longitudinally developed ridges and grooves occurring at base of thorax.

Original remarks: *Napora* n. gen., differs from *Tripilidium* in possessing a dicyrtid test with a well-developed apical horn.

Further remarks: By Dumitrica & Zügel (2003): The study of the initial spicule of the species *Napora modesta* n. sp. in transmitted light showed that the cephalic initial skeleton consists of MB, V, A, two L, two l, D, and the arches VL, Ll, lD, Al. The arch AV is absent, but an arch AD seems to exist because one of the three blades of the apical horn has a dorsal direction. Genus *Jacus* De Wever, 1982 is herein considered a junior synonym of *Napora*. The differences between these two genera concern only the superficial structure of thorax, a character that can be considered of specific level. The absence of the cephalocone, considered by De Wever (1982) an additional distinctive character from *Napora*, has no value because in both genera it is nothing else than the short ventral spine. Moreover, both genera have the apical horn with a verticil of three spines or spinules as extensions of the three blades; exceptions are very rare. This is also a character that differentiates *Napora* and *Jacus* from *Anaticapitula* n. gen.

Etymology: *Napora* is an anagram for C. F. Parona, one of the early students of Jurassic Radiolaria.

Included species:

NAP09 *Napora blechschmidti* Dumitrica n. sp.
NAP08 *Napora bona* Pessagno, Whalen & Yeh 1986
NAP02 *Napora cerromesaensis* Pessagno, Whalen & Yeh 1986
NAP06 *Napora conothorax* Carter & Dumitrica n. sp.
NAP01 *Napora graybayensis* Pessagno, Whalen & Yeh 1986
3410 *Napora nipponica* Takemura 1986
NAP03 *Napora reiferensis* (Pessagno, Whalen & Yeh) 1986
NAP04 *Napora relica* Yeh 1987b
JAC01 *Napora sandspitensis* (Pessagno, Whalen & Yeh) 1986

Napora blechschmidti Dumitrica n. sp.

Species code: NAP09

Type designation: Holotype pl. NAP09, fig. 3, sample BR871-R03-08, all paratypes also from BR871, chert of Tawi Sadh Member reworked in the Guwayza Formation, Al Khashbah Mountains, Oman.

Description: Test high pyramidal with a thick apical horn. Apical horn long, multi-bladed proximally, three-bladed distally, pointed, with a crown of three small thorns between the two portions. Blades of proximal part cover the cephalis that is practically invisible outside. Cephalis indistinct externally, screened by the blades of the apical horn. Thorax pyramidal with convex sides and 2-4 transversal ribs. One rib may be higher making a shoulder on the thorax. Pore frames mostly quadrangular, usually aranged in transverse rows between ribs. One row between each intercostal area. Rows of pores toward cephalis may be more or less disturbed. Feet straight to slightly curved, gently pointed, three-bladed, slightly divergent; external blades rather high along thorax where they make the edges of the pyramid.

Remarks: *Napora blechschmidti* resembles *N. bona* Pessagno, Whalen & Yeh and *N. hasta* Yeh & Cheng but differs especially by having a many-bladed apical horn.

Measurements (μm):
Based on 4 specimens.

	Min.	Max.
Total height of shell with horn and feet	230	260
Height of apical horn and cephalis	100	140
Height of thorax	43	60
Breadth of thorax	100	115
Length of feet	73	97

Etymology: The species is named for Ingo Blechschmidt as a sign of friendship and to honour his contribution to the geology of the Hamrat Duru Basin, Oman.

Type locality: Sample BR871, chert of Tawi Sadh Member reworked in the Guwayza Formation, Al Khashbah Mountains, Oman.

Occurrence: Upper part of the Tawi Sadh Member of the Guwayza Formation, Oman.

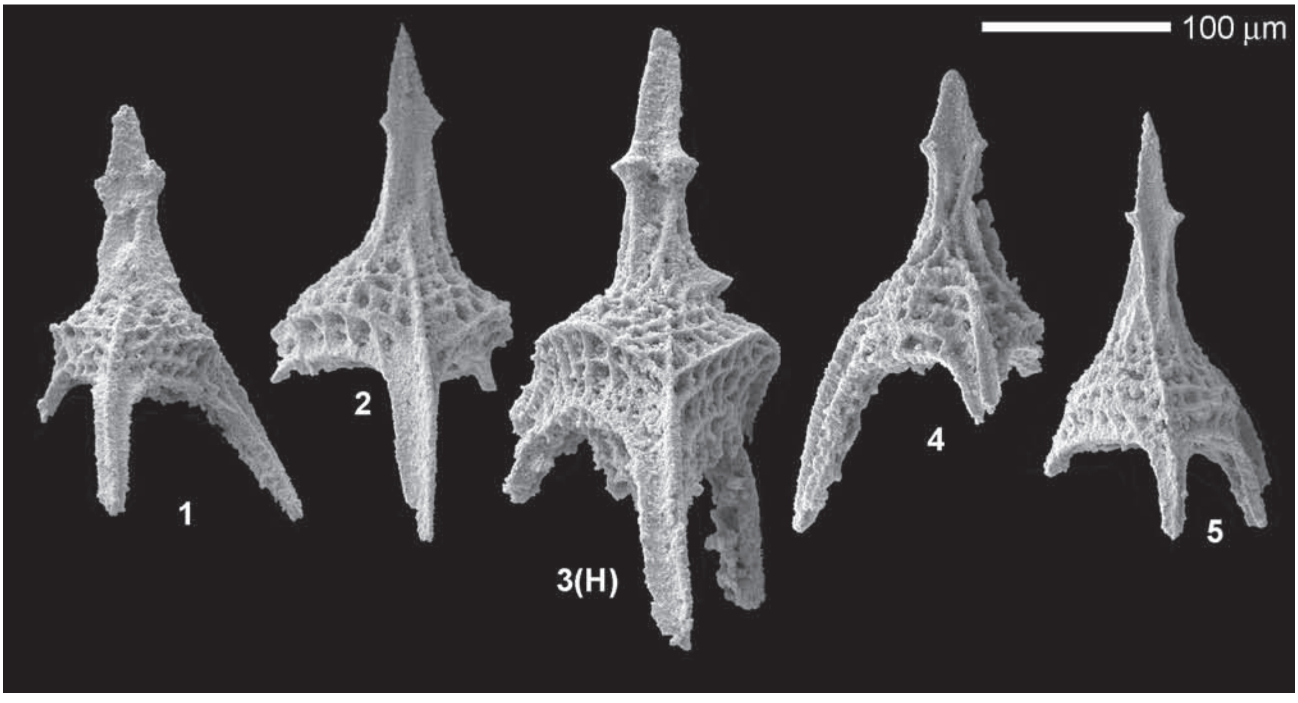


Plate NAP09. ***Napora blechschmidti*** **Dumitrica n. sp.** Magnification x250. **Fig. 1.** OM, BR871-R08-11. **Fig. 2.** OM, BR871-R07-19. **Fig. 3(H).** OM; BR871-R06-10. **Fig. 4.** OM, BR871-R06-10. **Fig. 5.** OM, BR871-R08-14.

Napora bona Pessagno, Whalen & Yeh 1986

Species code: NAP08

Synonymy:

1986 *Napora bona* n. sp. – Pessagno et al., p. 36, pl. 6, figs. 4, 5.
1986 *Napora* sp. A – Pessagno et al., p. 46, pl. 7, fig. 14.
1988 *Napora* sp. aff. *N. cosmica* Pessagno, Whalen & Yeh – Carter et al., p. 58, pl. 14, fig. 2.
1989 *Napora triangularis* Takemura – Hattori, pl. 20, fig. C.
1991 *Napora bona* Pessagno, Whalen & Yeh – Carter & Jakobs, p. 343, pl. 3, fig. 4.
2004 *Napora bona* Pessagno, Whalen & Yeh – Matsuoka, fig. 138.

Original diagnosis: Cephalis large, hemispherical, with well developed large cephalocone and a medium-length horn. Horn triradiate in axial section with three medium-width longitudinal ridges alternating with three somewhat wider longitudinal grooves; ridges wider on proximal two thirds of horn, flaring outwards to give rise to three short spines. Thorax pyramidal with linear, circumferentially-arranged tetragonal pore frames; faces of distal one or two rows of pore frames sloping inwards. Feet incurved, triradiate in axial section with three sharply-bladed longitudinal ridges alternating with three wide longitudinal grooves; ridges high in relief.

Original remarks: *Napora bona* appears closely related to *Napora* sp. A (Pl. 7, Fig. 14). It differs from the latter form by possessing larger, less numerous, and more irregularly shaped thoracic pore frames. Both forms display a row of inwardly-sloping pore frames at the base of the thorax. *N. bona* differs from *N. cosmica*, n. sp., by having a larger cephalis with a well-developed cephalocone; shorter, less curved feet; larger, less numerous, more irregular thoracic pore frames; a shorter, more massive horn; and an inturned row of pore frames at the base of the thorax.

Measurements (μm):
Number of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	20	22.5 (7)	25 (7)	12.5 (7)
Length of thorax	37.5	32.8 (7)	37.5 (7)	25 (7)
Width of thorax at top	37.5	36.4 (7)	37.5 (7)	30 (7)
Width of thorax at base	70	77.1 (7)	95 (7)	62.5 (7)
Length of horn	32.5	45.6 (4)	50 (4)	32.5 (4)
Width of horn at base	20	21.4 (7)	25 (7)	17.5(7)
Length of foot (maximum)	62.5	67.5 (4)	82.5 (4)	50 (4)

Etymology: (Latin) *bonus* = good, useful.

Type locality: Sample OR-580, Warm Springs member, Snowshoe Formation, near bridge over South Fork of John Day River, east-central Oregon.

Occurrence: Warm Springs member of the Snowshoe Formation, Oregon; Phantom Creek Formation, Queen Charlotte Islands; Japan.

Napora cerromesaensis Pessagno, Whalen & Yeh 1986

Species code: NAP02

Synonymy:

1986 *Napora cerromesaensis* n. sp. – Pessagno, Whalen & Yeh, p. 38, pl. 4, figs. 2-4, 10, 15, 16.
2002 *Napora cerromesaensis* Pessagno, Whalen & Yeh – Whalen & Carter, p. 140, pl. 15, fig. 10.
2004 *Napora* sp. cf. *N. cerromesaensis* Pessagno, Whalen & Yeh – Ziabrev et al., Fig. 5-8.

Original diagnosis: Cephalis relatively small, hemispherical, with massive apical horn; cephalis may be partially obscured by a thin layer of microgranular silica. Horn approximately same length as test, triradiate in axial section with narrow, rounded, longitudinal ridges alternating with broad, deep grooves; ridges extended into broad spines midway from base to terminus of horn; narrow ridges of apical horn may extend down over cephalis, although not as pronounced as on horn; horn tapers distally. Thorax subpyramidal in shape with large, irregularly shaped tetragonal and pentagonal pore frames arranged in poorly-defined transverse rows. Massive triradiate feet attached to base of thorax, curved slightly inward. Mouth subtriangular in outline, surrounded by imperforate rim.

Original remarks: *Napora cerromesaensis*, n. sp., is distinguished from *Napora* (?) *graybayensis*, n. sp., by the more regular arrangement of the pore frames and the thin layer of microgranular silica on the cephalis. In addition, *N. cerromesaensis* possesses a more massive horn and feet that are not as curved as those of *N.*(?) *graybayensis*, n. sp.

Further remarks: This species differs from *Napora bona* Pessagno, Whalen & Yeh in that the feet are more massive and less outwardly directed.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	20	16.8 (11)	20 (11)	15 (11)
Length of thorax	80	70.5 (10)	80 (10)	60 (10)
Width of thorax at top	40	38.1 (11)	45 (11)	30 (11)
Width of thorax at base	90	99.5 (11)	110 (11)	90 (11)
Length of horn	70	86.3 (11)	100 (11)	70 (11)
Width of horn at base	20	22.7 (11)	25 (11)	20 (11)
Length of foot (maximum)	80	95.9 (11)	120 (11)	70 (11)

Etymology: The species is named for Cerro Mesa, located to the northeast of its type locality.

Type locality: Sample BPW-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

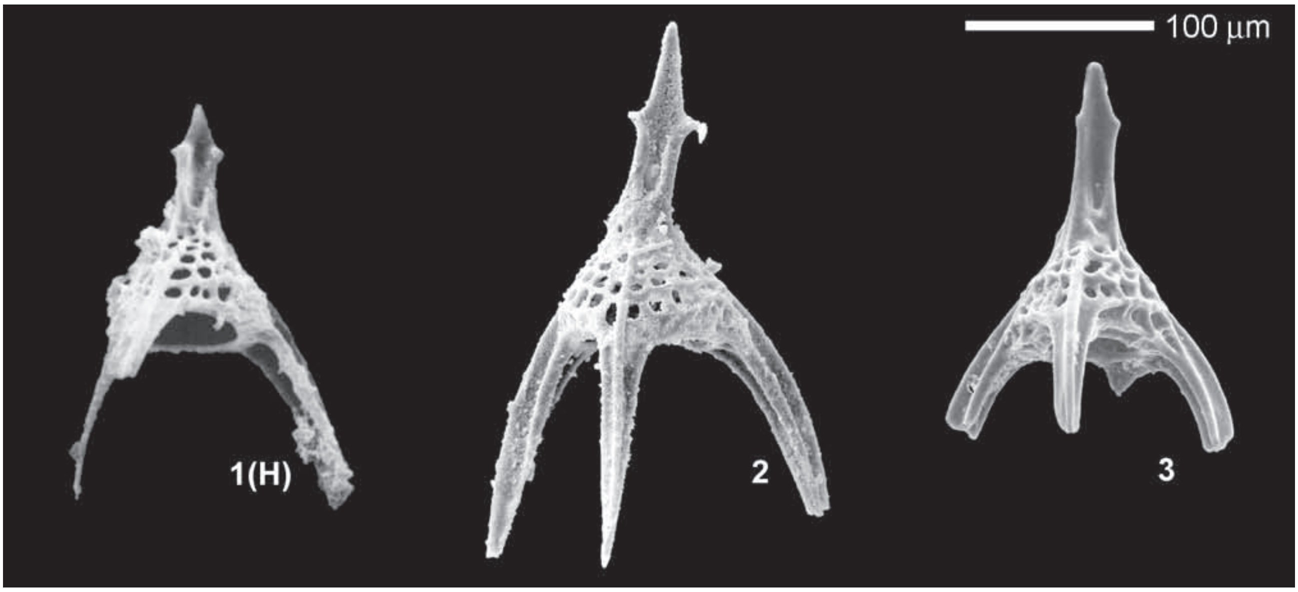


Plate NAP08. ***Napora bona*** **Pessagno, Whalen & Yeh.** Magnification x250. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 6, fig. 4. **Fig. 2.** JP, MNA-10, MA12702. **Fig. 3.** Carter & Jakobs 1991, pl. 3, fig. 4.

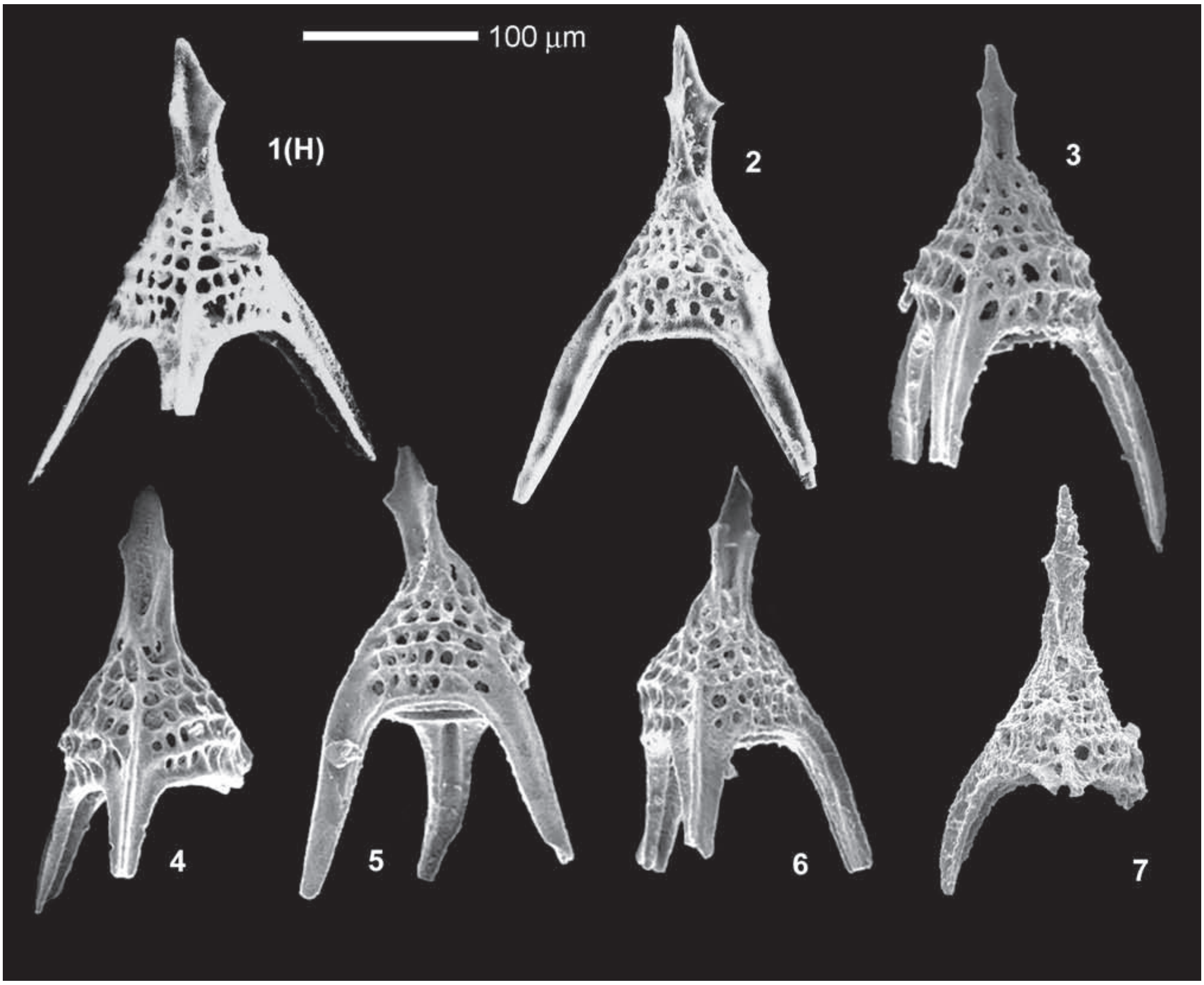


Plate NAP02. ***Napora cerromesaensis*** **Pessagno, Whalen & Yeh.** Magnification x250. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 4, fig. 2. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 4, fig. 3. **Fig. 3.** QCI, GSC loc. C-304567, GSC 128838. **Fig. 4.** QCI, GSC loc. C-304566, GSC 128839. **Fig. 5.** QCI, GSC loc. C-304567, GSC 128840. **Fig. 6.** QCI, GSC loc. C-304567, GSC 128841. **Fig. 7.** NBC, GSC loc. C-305813, GSC 111726.

Occurrence: San Hipólito Formation, Baja California Sur; Nicely Formation, Oregon; Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia; Bainang Terrane, Tibet.

Napora conothorax Carter & Dumitrica n. sp.

Species code: NAP06

Type designation: Holotype pl. NAP06, fig. 1; paratype 1, fig. 2, both from Fernie Formation, Williston Lake, British Columbia; paratype 2, fig. 3, Haliw Formation, Humadiyin, Oman.

Description: Cephalis indistinct externally and imperforate, included at the upper part of thorax. Apical horn three-bladed, relatively thin and short, bearing a verticil of three spinules and terminating in a short conical spine. Vertical spine not visible outside. Thorax and cephalis forming a wide, short cone with longitudinal ridges on the upper part, especially on cephalis, and 3-4 prominent transversal ridges. Ridges interconnected by vertical crests forming rectangular depressions. Pores in single transverse rows between ridges. Feet strongly triradiate and recurved, long, and pointed, with thin ridges and deep grooves. Outer ridge of each foot extends outward from the area of the raised ridge.

Remarks: The apical horn and the feet of this species resemble those of *Napora latissima* Takemura with differing only in that the feet are less divergent and less curved. The paratype from Oman is rather similar to the holotype and paratype from British Columbia but has less pronounced transversal ribs and longitudinal ribs are more visible. Although partly broken, the only preserved foot of this specimen seems to show characters similar to the feet of the holotype and paratype.

Measurements (μm):
Based on 3 specimens.

	HT	Paratype 1	Paratype 2
Length of apical horn	37	-	47
Height of cephalothorax	83	87	90
Diameter of thorax	100	103	100
Length of feet	157	-	-

Etymology: From the conical shape of the thorax; noun.

Type locality: GSC loc. C-305208, Fernie Formation, Williston Lake, northeastern British Columbia.

Occurrence: Fernie Formation, Williston Lake, northeastern British Columbia; Haliw (Aqil) Formation, Oman.

Napora graybayensis Pessagno, Whalen & Yeh 1986

Species code: NAP01

Synonymy:

1986 *Napora* (?) *graybayensis* n. sp. – Pessagno, Whalen & Yeh, p. 39, pl. 2, figs. 1-3, 10, 11, 14; pl. 11, figs. 3, 4.

1998 *Napora*? *graybayensis* Pessagno, Whalen & Yeh – Whalen & Carter, p. 75, pl. 21, fig. 4.

Original diagnosis: Cephalis relatively small, hemispherical, with massive horn; pore frames of cephalis commonly not covered by layer of microgranular silica. Horn triradiate in axial section throughout most of its length, with three narrow, rounded, longitudinal ridges alternating with three broad, shallow grooves; horn tapering sharply distally; length of horn one-half to equal to length of test; small spines commonly located on ridges approximately at midpoint of horn. Thorax subpyramidal in shape with medium- to very large-sized, irregularly-shaped, tetragonal to pentagonal pore frames; pore frames arranged in poorly-defined transverse rows with slight development of transverse ridges separating the rows. Feet of moderate length, curved inward, triradiate in cross-section, consisting of three very narrow, longitudinal ridges alternating with broad shallow grooves. Mouth triangular in outline, bounded by narrow, imperforate rim.

Original remarks: This species of *Napora* is distinguished from others by the irregular shape and distribution of the pore frames. It is questionably assigned to the genus *Napora* because of its peculiar, irregular pore frames, poor definition externally between the cephalis and thorax, and the lack of a microgranular layer proximally.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	10	13.3 (9)	20 (9)	10 (9)
Length of thorax	50	56.6 (9)	75 (9)	45 (9)
Width of thorax at top	30	36.6 (9)	45 (9)	30 (9)
Width of thorax at base	50	69.4 (9)	80 (9)	50 (9)
Length of horn	50	42.2 (7)	60 (7)	30 (7)
Width of horn at base	12.5	14.1 (9)	20 (9)	10 (9)
Length of foot (maximum)	30	65 (8)	80 (8)	45 (8)

Etymology: This species is named for Gray Bay, which is located north of its type locality.

Type locality: Sample QC-675, Sandilands Formation (Kunga Formation of Pessagno, Whalen & Yeh, 1986) Kunga Island - north side, Queen Charlotte Islands, British Columbia, Canada.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

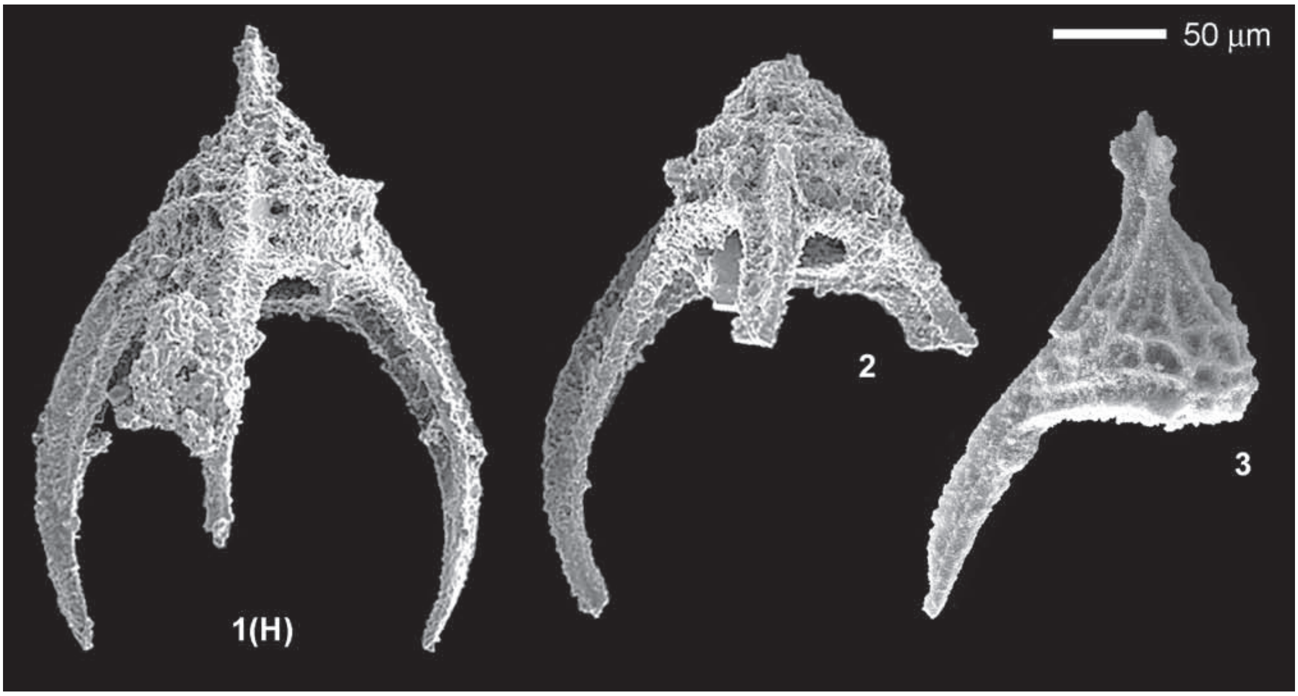


Plate NAP06. ***Napora conothorax*** **Carter & Dumitrica n. sp.** Magnification x300. **Fig. 1.** NBC, GSC loc. C-305208, GSC 128843. **Fig. 2.** NBC, GSC loc. C-305208, GSC 128844. **Fig. 3.** OM, Haliw-038-R08-10.

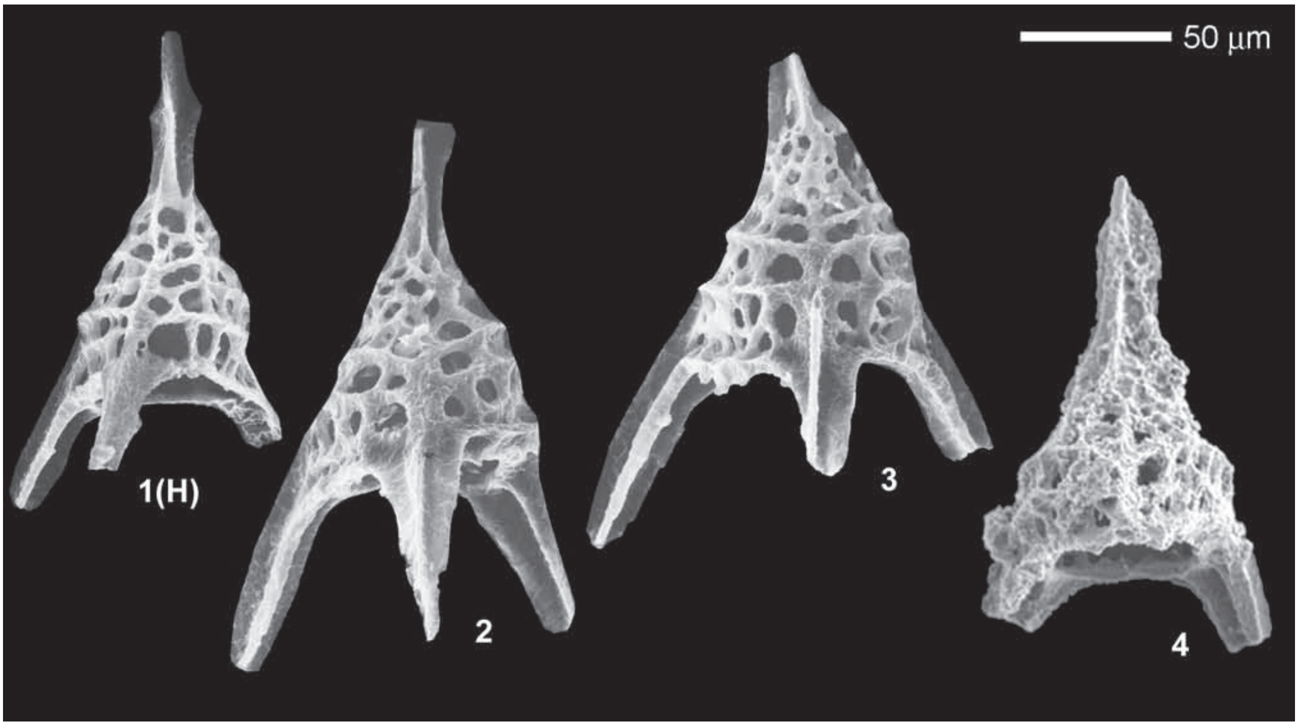


Plate NAP01. ***Napora graybayensis*** **Pessagno, Whalen & Yeh.** Magnification x400. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 2, fig. 1. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 2, fig. 2. **Fig. 3.** Pessagno, Whalen & Yeh 1986, pl. 2, fig. 3. **Fig. 4.** QCI, GSC loc. C-175311, GSC 128842.

Napora nipponica Takemura 1986

Species code: 3410

Synonymy:

1986 *Napora nipponica* n. sp. – Takemura, p. 44, pl. 2, figs. 16-21.
1989 *Napora nipponica* Takemura – Hattori & Sakamoto, pl. 2, fig. M, not fig. L.
1991 *Napora nipponica* Takemura – Carter & Jakobs, p. 343, pl. 3, fig. 1.
1993 *Napora nipponica* Takemura – Pessagno et al., p. 158, pl. 8, fig. 10.
1995a *Napora nipponica* Takemura – Baumgartner et al., p. 330, pl. 3410, figs. 1-2.
1997 *Napora nipponica* Takemura – Yao, pl. 8, fig. 372.

Original description: Cephalis small and subspherical with straight and triradiate apical horn, and with or without cephalocone. Ridges of apical horn may or may not originate at the base of the cephalis. A node located at the position of about half way along each ridge. Thorax subspherical or hemispherical to trigonally pyramidal, with usually transversely arranged circular pores. Three feet triradiate and curved convexly. Aperture subtriangular to circular with remarkable circular or subtriangular apertural ring around it.

Original remarks: Although *Napora nipponica* n. sp. resembles in its shape to *N. bukryi* Pessagno, *N. nipponica* differs from *N. bukryi* in possessing a considerably long apical horn and feet, and a transverse arrangement of thoracic pores. *N. nipponica* is also distinguishable from other species of *Napora* by its shape of apical horn and three feet.

Further remarks: Differs from *Napora bona* Pessagno, Whalen & Yeh by having smaller, more numerous pores on thorax and the feet are more incurved.

Measurements (μm):
Based on 15 specimens.

	Min.	Max.
Length of the shell including horn and feet	200	270
Height of cephalo-thorax	60	85
Maximum width of shell including feet	115	160
Width of thorax	75	110

Etymology: The trivial name is derived from Nippon, Japan in Japanese.

Type locality: Maganese carbonate ore deposit, sample TKN-105. Gujo-Hachiman area, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan; Phantom Creek Formation, Queen Charlotte Islands; Josephine Ophiolite, California.

Napora reiferensis (Pessagno, Whalen & Yeh) 1986

Species code: NAP03

Synonymy:

1986 *Jacus reiferensis* n. sp. – Pessagno, Whalen & Yeh, p. 32, pl. 4, figs. 7-8, 11; pl. 5, figs. 6, 14.
2002 *Napora reiferensis* (Pessagno, Whalen & Yeh) – Whalen & Carter, p. 140, pl. 15, figs. 7, 11.

Original diagnosis: Cephalis medium-sized, hemispherical, commonly covered with a thin layer of microgranular silica; small spine may extend from base of cephalis. Apical horn massive, more than one-half length of test, distally trifurcating. Proximal two-thirds of horn triradiate in axial section with narrow, rounded ridges and broad grooves; distal portion of horn separated into three tapering lobes; lobes elliptical in cross-section, approximately at right angles to long axis of test and in some specimens curving slightly downward; lobes of horn ranging from one-half to equal the length of the triradiate portion of horn. Thorax subpyramidal in outline with small- to medium-sized, slightly nodose, irregularly shaped, elliptical and tetragonal pore frames; pore frames arranged in poorly-defined transverse rows separated by transverse ridges. Massive triradiate feet, attached to base of thorax, curved slightly inward. Subsidiary meshwork (velum?), with very irregularly-shaped and –spaced pore frames and imperforate rim, some attached to base of thorax. Mouth subtriangular in outline.

Original remarks: *Jacus reiferensis*, n. sp., is distinguished from *Jacus coronatus* De Wever, 1982, by the nature of the meshwork on the thorax and velum(?) as well as the structure of the horn.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	20	20.9 (11)	25 (11)	15 (11)
Length of thorax	50	63.1 (11)	80 (11)	50 (11)
Width of thorax at top	45	43.1 (11)	50 (11)	40 (11)
Width of thorax at base	110	100 (11)	120 (11)	90 (11)
Length of horn	65	63.6 (11)	85 (11)	55 (11)
Width of horn at base	25	20.4 (11)	25 (11)	15 (11)
Length of foot (maximum)	100	93.5 (10)	120 (10)	70 (10)

Etymology: This species is named for Pico Reifer, which is located east of its type area.

Type locality: Sample BPW-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur.

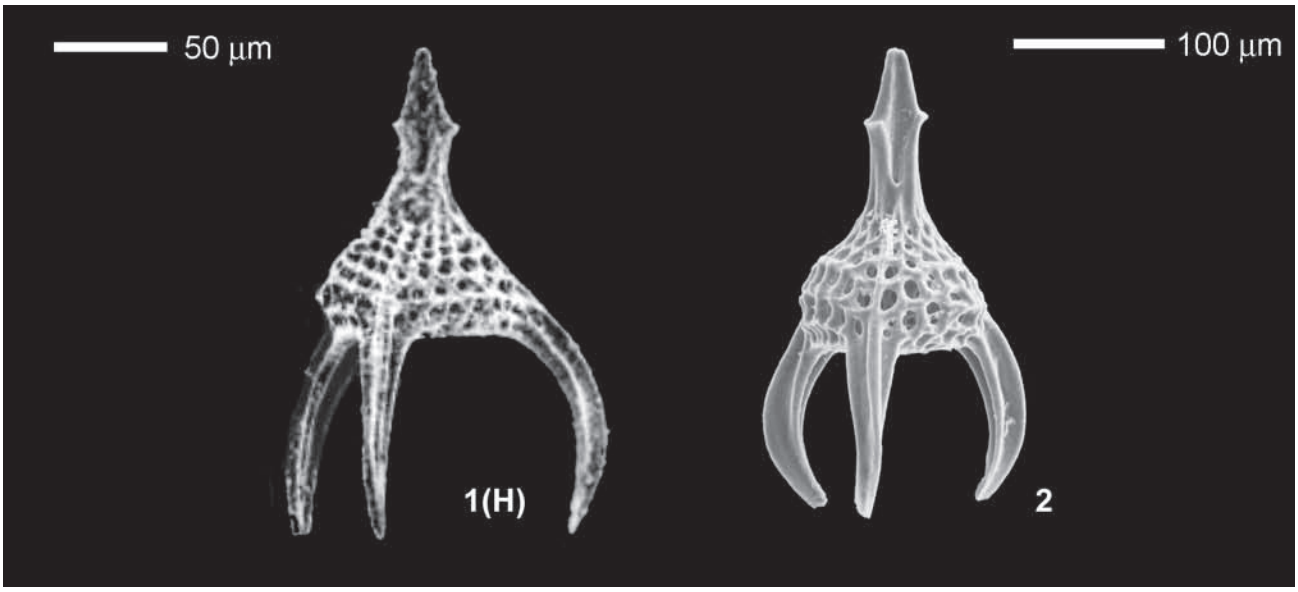


Plate 3410. ***Napora nipponica*** **Takemura.** Magnification Fig. 1(H) x300, Fig. 2. x200. **Fig. 1(H).** Takemura 1986, pl. 2, fig. 20. **Fig. 2.** Carter & Jakobs 1991, pl. 3, fig. 1.

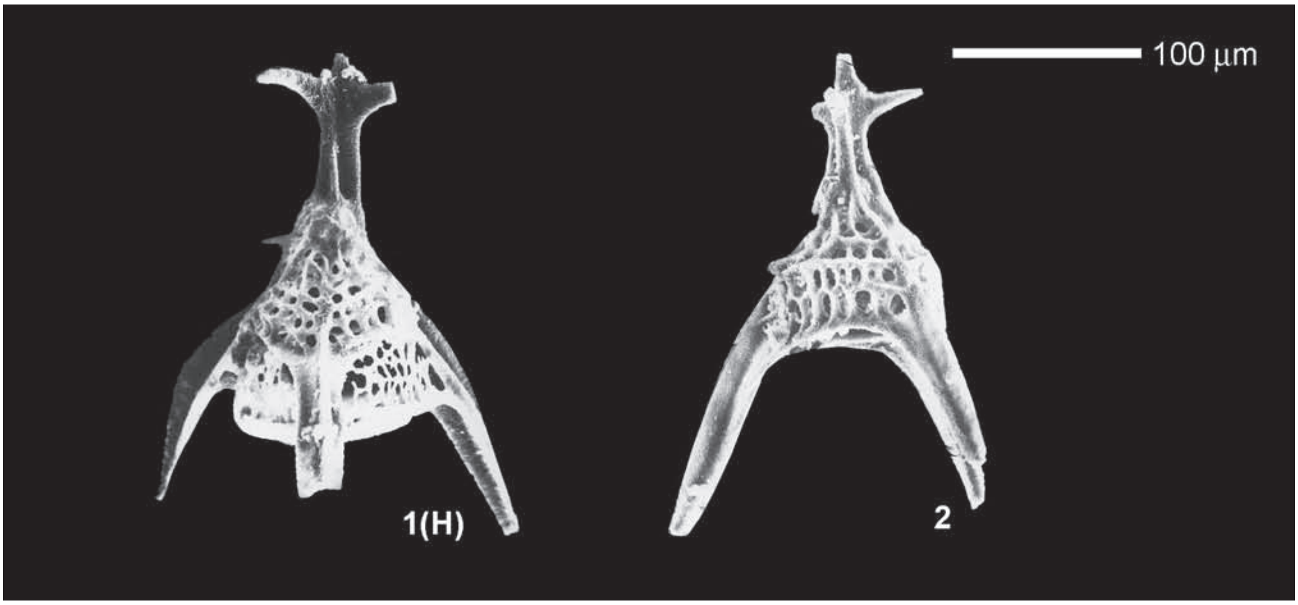


Plate NAP03. ***Napora reiferensis*** **(Pessagno, Whalen & Yeh).** Magnification x 250. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 4, fig. 7. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 5, fig. 6.

Napora relica Yeh 1987b

Species code: NAP04

Synonymy:

1986 *Jacus* (?) species B – Pessagno et al., p. 34, Pl. 5, Fig. 9.
1987b *Napora relica* n. sp. – Yeh, p. 85, Pl. 10, Figs. 4, 17.
1987b *Napora* sp. aff *N. relica* Yeh – Yeh, p. 85, Pl. 24, Figs. 8, 21, 23.
1989 *Napora* sp. A – Hattori, pl. 5, fig. L.
1989 *Napora* sp. B – Hattori, pl. 5, fig. M.
2002 *Napora* sp. B of Hattori – Hori & Wakita, pl. 3, fig. 5.
2003 *Napora relica* Yeh – Goričan et al., p. 296, pl. 4, fig. 4.
2004 *Napora relica* Yeh – Matsuoka, fig. 139.

Original description: Cephalis relatively large, hemispherical, imperforate, covered with layer of microgranular silica. Horn moderately long, triradiate with three narrow ridges alternating with three narrow grooves; each ridge terminating in long pointed spine. Axial part of horn also terminating in short spine and surrounded by long curved spines extending out from ridges. Thorax subhemispherical in outline, with mixture of tetragonal, pentagonal, and hexagonal pore frames arranged in five to six transverse rows; larger pore frames on middle portion of thorax. Aperture large, subcircular in outline. Feet long, tapering distally, triradiate with three narrow ridges alternating with three grooves, grooves wider proximally and narrow distally.

Further remarks: This species is easily recognized by its distinctive horn with three, long, curved pointed spines.

Measurements (μm):
Ten specimens measured.

	HT	Mean	Max.	Min.
Length of cephalis	25	25	27	23
Length of thorax	63	61	63	59
Width of thorax at top	30	30	32	29
Width of thorax at base	94	95	97	93
Length of horn	63	62	65	61
Length of foot (maximum)	113	115	118	110

Etymology: *Relicus-a-um* (Latin, adj.) = outstanding.

Type locality: Sample OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

Napora sandspitensis (Pessagno, Whalen & Yeh) 1986

Species code: JAC01

Synonymy:

1986 *Jacus* (?) *sandspitensis* n. sp. – Pessagno, Whalen & Yeh, p. 33, pl. 2, figs. 5, 9, 13, 16, 17; pl. 11, fig. 13.
1998 *Jacus*(?) *sandspitensis* Pessagno, Whalen & Yeh – Whalen & Carter, p. 75.

Original diagnosis: Cephalis small, hemispherical, with small cephalocone and relatively short horn. Proximal two-thirds of horn triradiate in axial section with three narrow grooves alternating with three rounded ridges of approximately the same width. Grooves often deeply-incised proximally, becoming shallower distally; ridges each bearing short spines before their termination. Distal one-third of horn circular in axial section; lacking ridges and grooves. Thorax with very coarse, nodose polygonal pore frames; distal portion of thorax with mixture of tetragonal and pentagonal pore frames arranged in rows between angled ridges. Feet long, triradiate in axial section with three narrow ridges that alternate with three wide grooves; short spines occur along ridges on proximal half of each foot, suggesting velum attachement. Mouth subcircular in outline, surrounded by an imperforate rim.

Original remarks: This species is questionably assigned to *Jacus* because it possesses a true cephalocone. It is conceivable that the spine extending from the »hole« (cephalopyle?) of De Wever's (1982) specimens of *Jacus* merely represents a remnant of a fragile cephalocone not preserved in his badly-etched material. The presence of a velum in *J.* (?) *sandspitensis* is probably indicated by the short spines that occur on the proximal half of the feet. It should be noted that some specimens of *Napora*, such as *N. praespinifera* (Pessagno, 1977b) and *N. spinifera* (Pessagno, 1977b) display velum-like structure below the thorax and between the proximal halves of the feet; however, we have never observed the basal closure of this velum-like structure. *Jacus* (?) *sandspitensis* differs from *J. coronatus* De Wever, 1982, by possessing a structurally simpler horn lacking a crown-like mass at its tip, and by having considerably longer, slender feet. Both species possess ridges at the base of the thorax, which separate rows of pore frames.

Measurements (μm):
Numbers of specimens measured are in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	25	23.8 (9)	25 (9)	15 (9)
Length of thorax	100	76.1 (9)	100 (9)	55 (9)
Width of thorax at top	50	48.0 (9)	62.5 (9)	40 (9)
Width of thorax at base	112.5	105.5 (9)	125 (9)	95 (9)
Length of horn	55	81.7 (7)	92.5 (7)	50 (7)
Width of horn at base	47.5	35.8 (9)	47.5 (9)	25 (9)
Length of foot (maximum)	170	147.5 (5)	175 (5)	95 (5)

Etymology: This species is named for the town of Sandspit in the Queen Charlotte Islands, British Columbia.

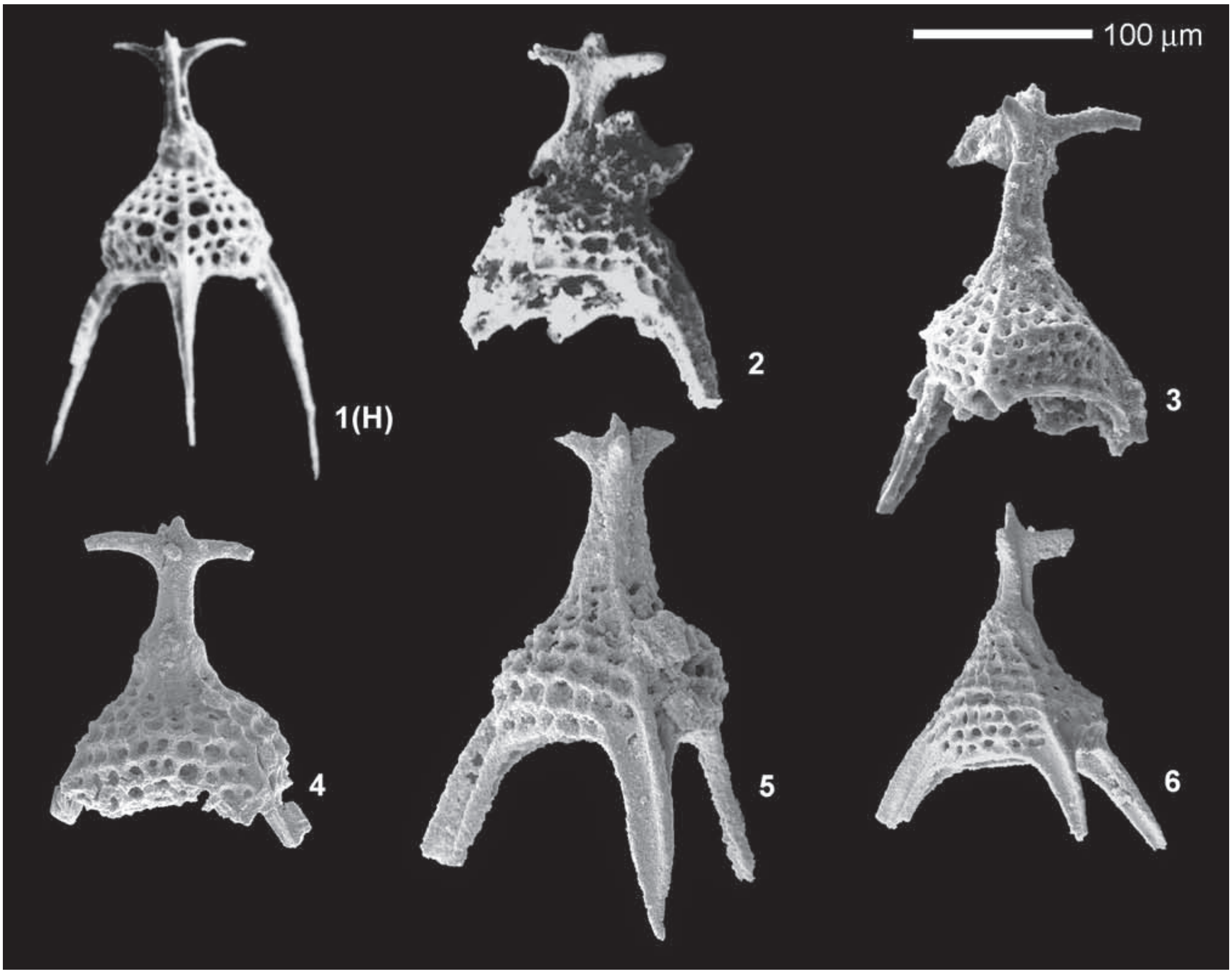


Plate NAP04. ***Napora relica*** **Yeh.** Magnification x250x. **Fig. 1(H).** Yeh 1987b, pl. 10, fig. 4. **Fig. 2.** JP, IYII-20. **Fig. 3.** Goričan et al. 2003, pl. 4, fig. 4. **Fig. 4.** OM, BR1121-R09-06. **Fig. 5.** OM, BR524-R05-24. **Fig. 6.** OM, BR525-R08-01.

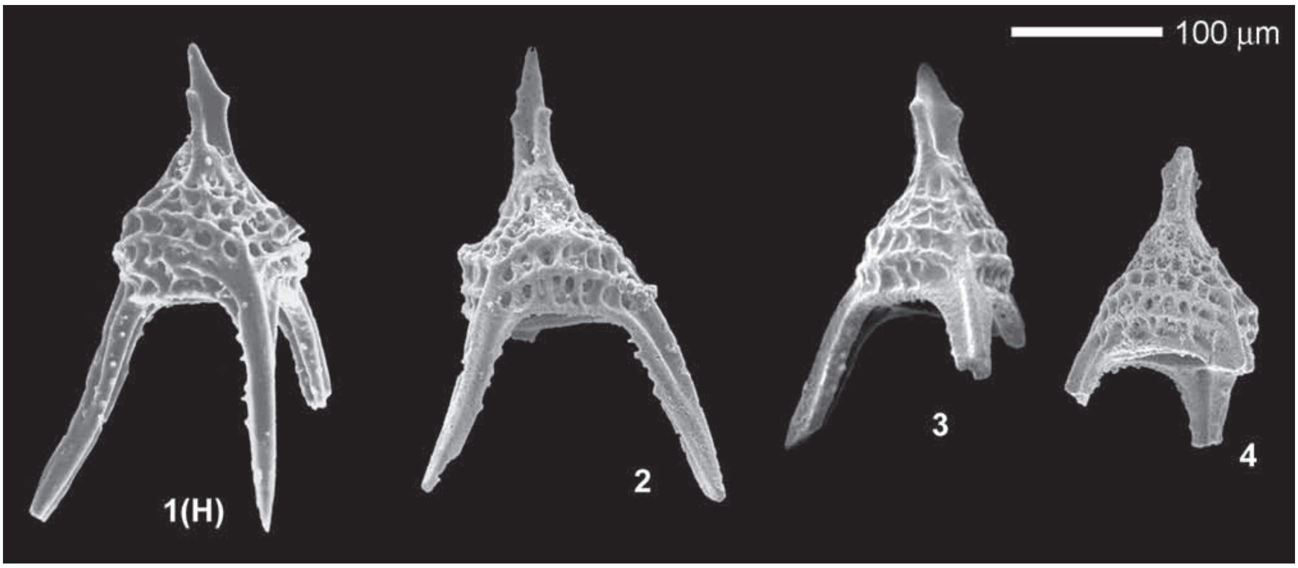


Plate JAC01. ***Napora sandspitensis*** **(Pessagno, Whalen & Yeh).** Magnification x200. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 2, fig. 9. **Fig. 2.** QCI, GSC loc. C-080613, GSC 128845. **Fig. 3.** QCI, GSC loc. C-140495, GSC 128846. **Fig. 4.** QCI, GSC loc. C-175311, GSC 111727.

Type locality: Sample QC-534, Rennell Junction member of the Fannin Formation (Maude Formation in Pessagno et al., 1986), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman.

Genus: *Naropa* Dumitrica n. gen.

Type species: *Naropa vi* Hori, Whalen & Dumitrica n. sp.

Description: Test conical, dicyrtid or eventually tricyrtid, with non-bladed apical and ventral horns and three triradiate feet having two blades on the external side and one on the internal side. Thorax latticed, wide open. Initial spicule unknown but supposed to be similar to that of *Napora*.

Remarks: Superficially this new genus resembles *Napora* and other ultranaporids but differs in having both apical and ventral horns non-bladed and the feet with one blade directed towards the axis of shell and two directed laterally. Unlike this new genus, the apical horn of *Napora* is always three-bladed and commonly has a crown of spinules, the ventral horn is short and bladed, and one blade is always centrifugally directed and represents the prolongation of the dorsal and primary lateral spines of the initial spicule.

Etymology: The name is an anagram of *Napora*, which, in turn, is an anagram of Parona, one of the pioneers of the study of fossil radiolarians. Feminine gender.

Included species:
UTD01 *Naropa vi* Hori, Whalen & Dumitrica n. sp.

Naropa vi Hori, Whalen & Dumitrica n. sp.

Species code: UTD01

Synonymy:
1990 *Dumitricaella* (?) sp. A – Hori, p. 581, fig. 8.24.
2002 Ultranaporid gen. et sp. indet. – Whalen & Carter, p. 140, pl. 16, fig. 14.

Type designation: Holotype specimen pl. UTD01, fig. 1 from sample BPW80-14 Baja California Sur.

Description: Test conical, dicyrtid. Cephalis small, with polygonal pore frames. Apical and ventral horns long, cylindrical and fused at the base; horns disposed in a V shape. Thorax conical with hexagonal pore frames arranged in staggered horizontal rows and, in some specimens, with a circumferential ridge at middle part. Distal opening of thorax triangular, surrounded by a wide imperforate rim. Feet straight, divergent, triradiate, pointed distally. Two outer blades of each foot interconnected with the corresponding blade of neighbouring feet at the base of the preforate part of the thorax.

Remarks: This species is rare but morphologically distinctive. It differs from typical *Napora* in having both apical and ventral horns circular in cross-section. Moreover, the tribladed feet display two outer blades with a wide groove in between.

Measurements (µm):
Number of specimens measured in parentheses.

	HT	Mean	Max.	Min.
Length of cephalis	21	25.3 (23)	33 (23)	20 (23)
Length of thorax	90	79.8 (23)	100 (23)	57 (23)
Maximum width of thorax	80	90.8 (23)	107 (23)	77 (23)
Length of apical horn	64	70.7 (22)	90 (22)	60 (22)
Length of ventral horn	49	35.9 (13)	53 (13)	18 (13)
Maximum length of feet	98	90.8 (23)	107 (23)	77 (23)

Etymology: From the two cephalic horns that outline the V letter; noun.

Type locality: Sample BPW80-14 Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Inuyama, Mino terrane and Kaiji, Kuma, Chichibu terrane, SW Japan.

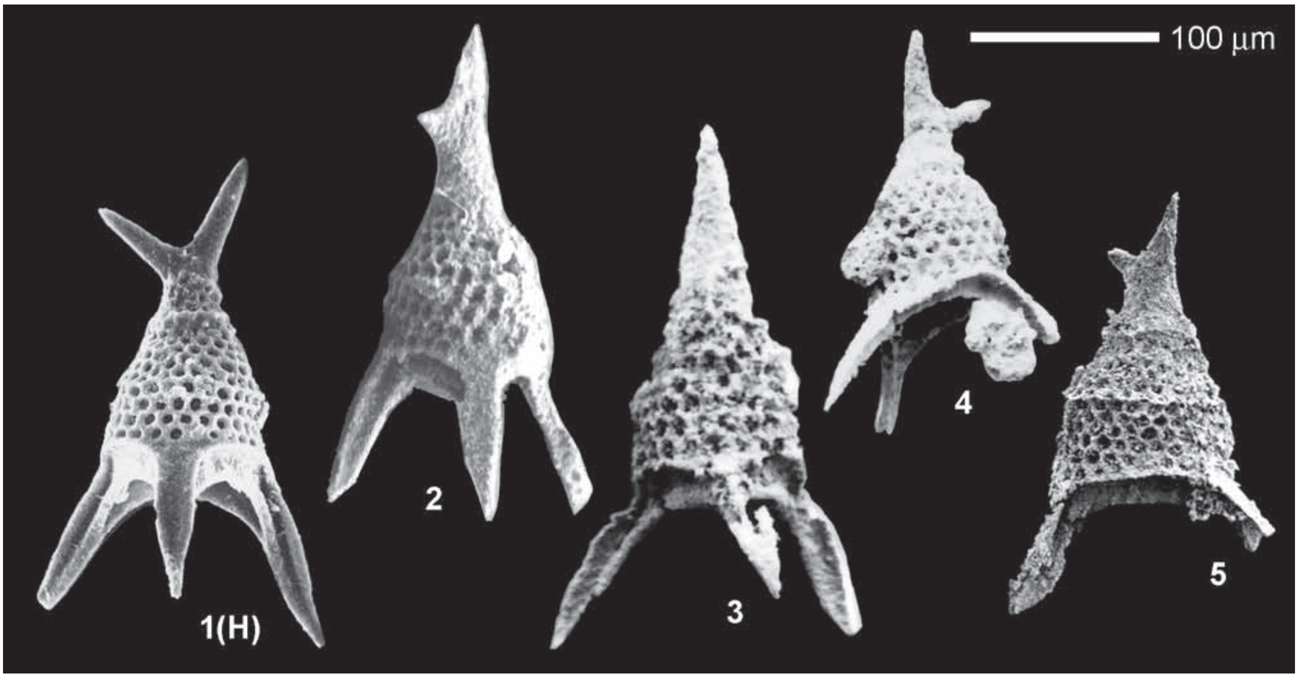


Plate UTD01. ***Naropa vi*** **Hori, Whalen & Dumitrica n. sp.** Magnification x250. **Fig. 1(H).** Whalen & Carter 2002, pl. 16, fig. 14. **Fig. 2.** Hori 1990, fig. 8.24. **Fig. 3.** JP, Ku(b)-5-16, RH(1)1026. **Fig. 4.** JP, UC2-22-1, RH(1)75. **Fig. 5.** JP, KG9-52, RH(1)2803.

Genus: *Noritus* Pessagno & Whalen 1982

Type species: *Noritus lillihornensis* Pessagno & Whalen 1982

Synonymy:

1982 *Noritus* n. gen. – Pessagno & Whalen, p. 123.

Original description: Test conical to subconical. Cephalis with well-developed horn. Pore frames polygonal, regular to irregular, aligned to nonaligned; thickened by the insertion of longitudinal and lateral ridges between pore frames; ridges not inserted between all pore frames. Well-preserved specimens with tubular extension on final post-abdominal chamber; pore frames of tubular extension thinner than those on previous chambers and with rudimentary development of ridges.

Original remarks: *Noritus,* n. gen., differs from *Droltus* n. gen., by possessing a test wall on its post-abdominal chambers with a partially developed outer layer. Whereas the pore frames of *Droltus* are thickened along bars in all directions, those of *Noritus* are not; many pore frames, in fact, may display no thickening at all (cf. pl. 4, figs. 1, 6, 10 and pl. 5, figs. 3, 4, 10, 15, 19). Because of this difference in the mode of test construction, *Noritus* is tentatively placed in the Bagotidae.

Etymology: *Noritus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 40, p. 113).

Included species:

NTS01 *Noritus lillihornensis* Pessagno & Whalen 1982

Noritus lillihornensis Pessagno & Whalen 1982

Species code: NTS01

Synonymy:

1982 *Noritus lillihornensis* n. sp. – Pessagno & Whalen, p. 123, pl. 5, figs. 3, 4, 10, 15, 19; pl. 12, fig. 1.

1992 *Noritus lillihornensis* n. sp. Pessagno & Whalen – Pessagno & Mizutani, pl. 99, figs. 1, 2, 9.

2004 *Noritus* sp. – Matsuoka, fig. 229.

Original description: Test elongate with long massive horn on hemispherical cephalis and with five post-abdominal chambers. Cephalis and thorax with small polygonal pore frames; thorax and subsequent chambers trapezoidal in cross section. Post-abdominal chambers increasing gradually in length and somewhat more rapidly in width as added; final post-abdominal chamber with long, tubular extension which may be 1/3 length of remainder of test. Pore frames tetragonal to pentagonal (predominantly tetragonal). Ridges not developed on all pore frames.

Original remarks: *Noritus lillihornensis,* n. sp., differs from *N.* sp. A by having a much slenderer, more elongate test with a longer, more massive horn. It differs from all species of *Droltus* by the characters cited under the genus.

Measurements (μm):

Based on 10 specimens.

Length excluding horn	Width (max.)	
287.5	100.0	HT
287.5	110.0	Max.
175.0	62.5	Min.
212.7	91.7	Mean

Etymology: This species is named for Lillihorn Island in Skidegate Channel.

Type locality: Sample QC 534, Fannin Formation (Maude Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, Maude Island, Skidegate Inlet, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Japan.

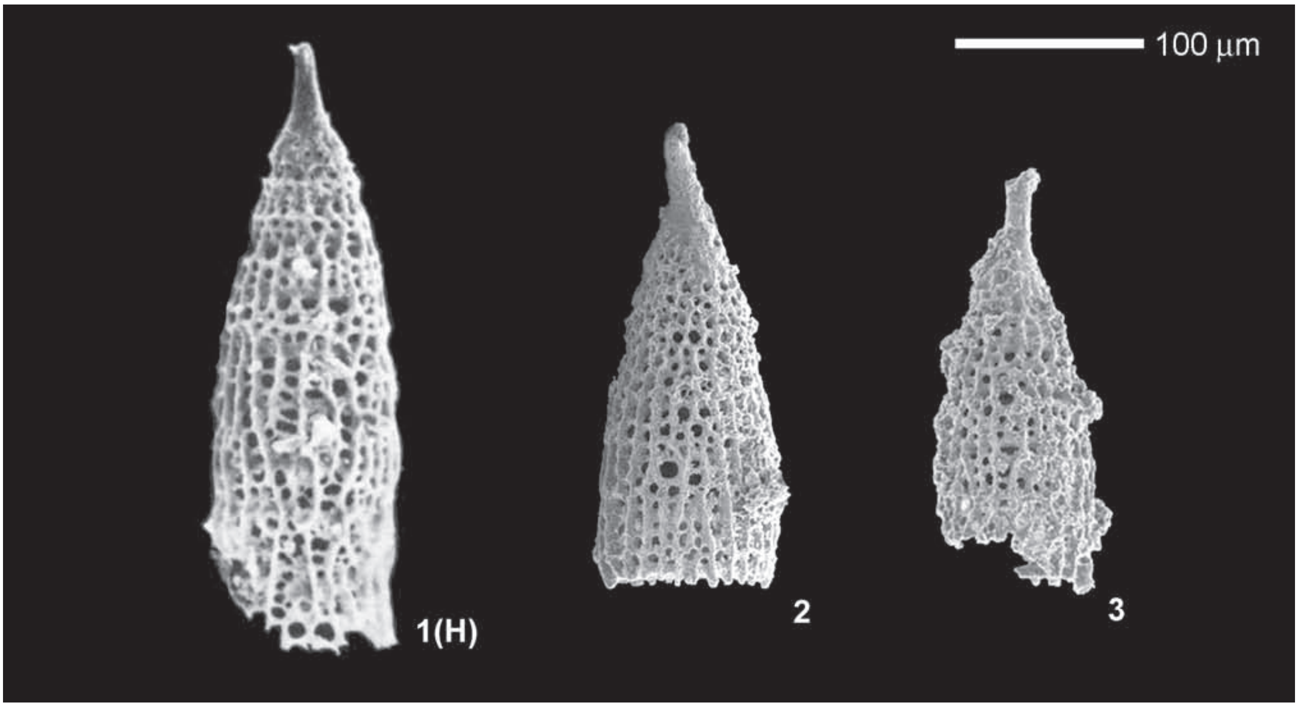


Plate NTS01. *Noritus lillihornensis* Pessagno & Whalen. Magnification x250. **Fig. 1(H)**. Pessagno & Whalen 1982, pl. 5, fig. 3. **Fig. 2.** QCI, GSC loc. C-080612, GSC 128847. **Fig. 3.** QCI, GSC loc. C-080612, GSC 111728.

Genus: ***Orbiculiformella*** Kozur & Mostler 1978

Type species: *Orbiculiforma railensis* Pessagno 1977b

Synonymy:

1978 *Orbiculiformella* n. gen. – Kozur & Mostler, p. 162.

Original description: Circular spongy skeleton. Marginal part clearly inflated, with large pores. Depressed inner part rather thick, with very small pores. Six to twelve main spines extending from test.

Original remarks: According to usual practice in all other radiolarian families, subquadratic forms with four main spines and circular forms with 6-12 main spines will be herein considered as two separate genera. The genus *Orbiculiforma* Pessagno 1973 will be restricted to subquadratic forms with four main spines, the circular forms with 6-12 main spines will be assigned to the new genus *Orbiculiformella*.

Further remarks: The genus should be emended to comprise species with more than six spines, without limiting the higher number. The genus is probably polyphyletic but because of the imperfect preservation of the microsphere and of the absence of studies of the microsphere of all species, we include here all species having the external morphologic diagnostic characters described by the authors of the genus.

Etymology: Arbitrary word formation. This paper: the name is a diminutive of *Orbiculiforma.*

Included species and subspecies:

ORB05 *Orbiculiformella callosa* (Yeh) 1987b
ORB06 *Orbiculiformella incognita* (Blome) 1984b
ORB03 *Orbiculiformella lomgonensis* (Whalen & Carter) 1998
ORB11 *Orbiculiformella mediocircus* Dumitrica n. sp.
ORB02 *Orbiculiformella*? *robusta* (Whalen & Carter) 1998
ORB08 *Orbiculiformella teres* (Hull) 1997
ORB13 *Orbiculiformella*? *trispina* s.l. (Yeh) 1987b
ORB09 *Orbiculiformella*? *trispina trispina* (Yeh) 1987b
ORB10 *Orbiculiformella*? *trispina trispinula* (Carter) 1988

Orbiculiformella callosa (Yeh) 1987b

Species code: ORB05

Synonymy:

1987b *Orbiculiforma callosa* n. sp. – Yeh, p. 41, pl. 2, fig. 25; pl. 5, fig. 19; pl. 11, fig. 11, pl. 22, figs. 10, 12.
1988 *Orbiculiforma kwunaensis* Carter n. sp. – Carter et al., p. 44, pl. 1, figs. 8, 11.
1996 *Orbiculiforma* sp. A – Pujana, p. 135, pl. 1, fig. 12.
1998 *Orbiculiforma callosa* Yeh – Cordey, p. 93, pl. 21, figs. 2, 4, 10.
2002 *Orbiculiformella kwunaensis* Carter – Whalen & Carter, p. 109, pl. 1, fig. 3.
2003 *Orbiculiforma* ? *callosa* Yeh – Goričan et al., p. 295, pl. 3, figs. 1-4.
2004 *Orbiculiformella* sp. – Matsuoka, fig. 53.

Original description: Test thick, circular in outline, with large, deep central cavity. Test consisting of concentric layers of small irregular polygonal pore frames with circular to elliptical pores. Pore frames slightly larger on rims, smaller in central cavity and median band of margin. Margin slightly concaved with several small peripheral spines. Peripheral spines usually thin, short, circular in cross-section. Diameter of central cavity about half the diameter of test.

Original remarks: *Orbiculiforma callosa*, n. sp., differs from *O.* (?) *trispina*, n. sp., by having a test with larger central cavity and by having several small peripheral spines rather than three massive, elongate spines.

Further remarks: *Orbiculiformella kwunaensis* Carter is synonymized with *O. callosa* Yeh because the larger pore frames in central area are now judged to be species variability.

Note that some Pliensbachian specimens (pl. ORB05, fig. 8) can be more than twice as large as the holotype.

Measurements (μm):

Ten specimens measured.

	Diameter of shell	Diameter of central cavity	Length of spines
HT	160	80	
Mean	170	82	38
Max.	187	87	45
Min.	158	75	30

Etymology: *Callosus-a-um* (Latin, adj.) = hard.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Fannin Formation, Queen Charlotte Islands; Bridge River Complex, British Columbia; San Hipólito Formation, Baja California Sur; Sierra Chacaicó Formation, Argentina; Skrile Formation, Slovenia; Dürrnberg Formation, Austria; Gümüslü Allochthon; Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; Mino Terrane, Japan.

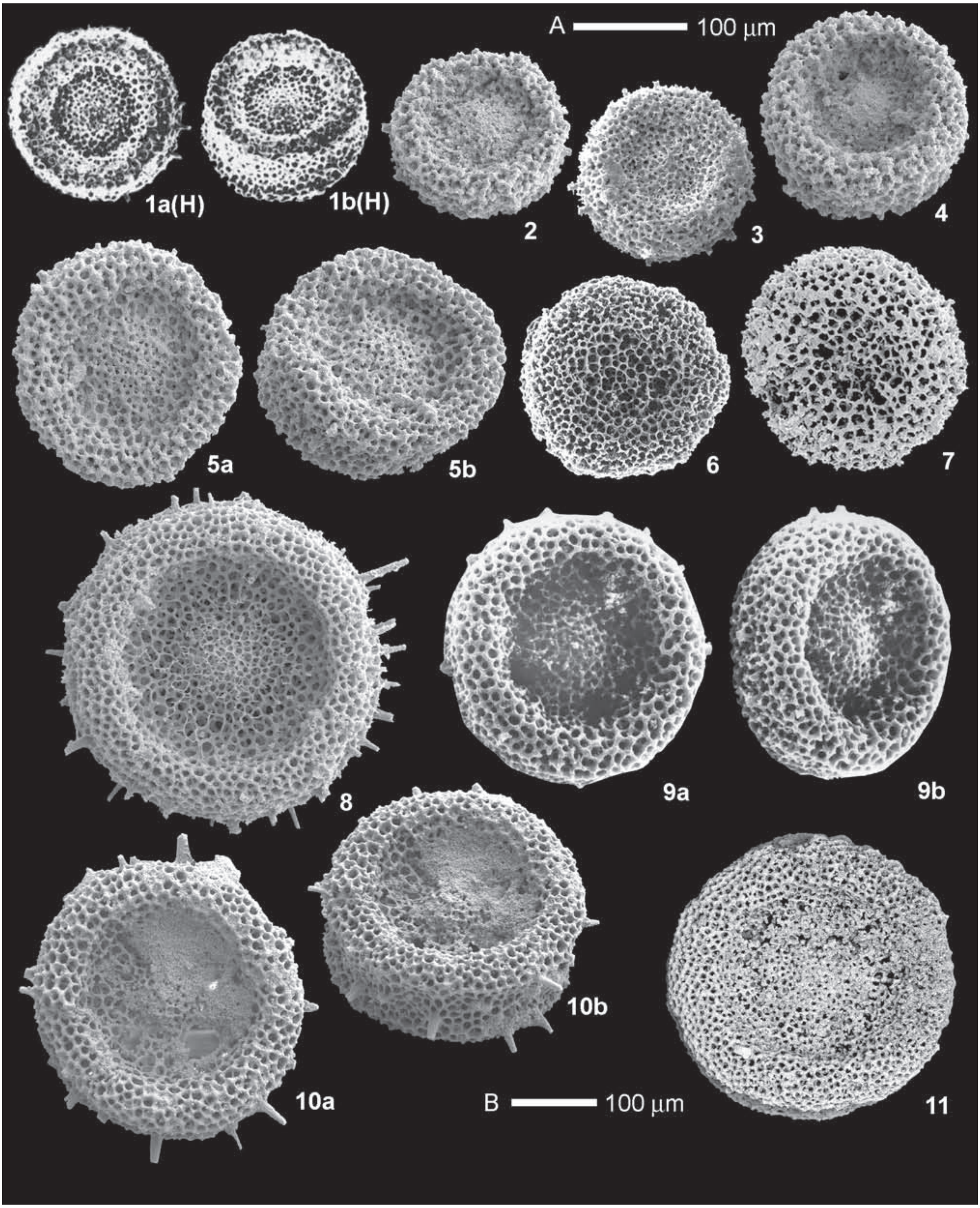


Plate ORB05. *Orbiculiformella callosa* (Yeh). Magnification Figs. 1-5 x200 (scale bar A), Figs. 6-11 x 150 (scale bar B).
Fig. 1a(H). Yeh 1987b, pl. 22, fig. 12. **Fig. 1b(H).** Yeh 1987b, pl. 22, fig. 10. **Fig. 2.** OM, BR871-R02-14.
Fig. 3. Goričan et al. 2003, pl. 3, fig. 1. **Fig. 4.** OM, BR871-R02-13. **Figs. 5a, b.** OM, BR1122-R04-13a, b.
Fig. 6. Carter et al. 1988, pl. 1, fig. 11. **Fig. 7.** AT, BMW21-21. **Fig. 8.** TR, 1662D-R06-16. **Fig. 9a.** BCS, Loc. SH-412-14.
Fig. 9b. Whalen & Carter 2002, pl. 1, fig. 3. **Figs. 10a, b.** OM, BR706-R06-22a, b. **Fig. 11.** OM, BR1121-R07-19.

Orbiculiformella incognita (Blome) 1984b

Species code: ORB06

Synonymy:

1984b *Orbiculiforma* (?) *incognita* n. sp. – Blome, p. 353, pl. 5, figs. 1, 2, 8, 9, 12, 13.

1988 *Spongotrochus* (*Stylospongidium*) sp. aff. *S.* (*S.*) *echinodiscus* Clark and Campbell – Carter et al., p. 46, pl. 10, figs. 7, 10.

2003 *Orbiculiforma* ? *incognita* Blome – Goričan et al., p. 296, pl. 3, figs. 5-7.

Original description: Test thin, circular in outline. Meshwork consisting of irregular, polygonal (tetragonal to hexagonal) pore frames, becoming slightly smaller toward central area; pores circular to elliptical in outline. Central cavity extremely shallow, narrow; width approximately one-third that of test diameter. Sides of test gently rounded. Periphery of test possessing numerous, slender, rodlike peripheral spines; spines circular in axial section.

Original remarks: *Orbiculiforma* (?) *incognita*, n. sp. differs from *O. monticelloensis* Pessagno 1973 as well as other species of *Orbiculiforma* described in this report by having an extremely shallow central area and by having longer, rodlike peripheral spines. This form differs from other taxa belonging to the genus *Orbiculiforma* by not possessing a well-developed central cavity and is therefore questionably assigned to this genus.

Further remarks: We include also forms with upper and lower planar surfaces of the shell and uniformly sized pores. Our specimens have a rather well-pronounced groove running along the test margin, whereas in the type material the test margins are gently rounded.

Measurements (µm):
Based on 6 specimens.

Test diam. (max.)	Spine length	
179	26-36	HT
181	65	Max.
162	22	Min.
172	36	Av.

Etymology: *Incognitus-a-um* (Latin, adj., f.) = unexamined, unknown, unrecognized.

Type locality: Sample 80AJM 8A, Shelikof Formation, Puale Bay, southern Alaska.

Occurrence: Shelikof Formation, southern Alaska; Phantom Creek and Graham Island formations, Queen Charlotte Island, British Columbia; Skrile Formation, Slovenia.

Orbiculiformella lomgonensis (Whalen & Carter) 1998

Species code: ORB03

Synonymy:

1998 *Praeorbiculiformella*? *lomgonensis* n. sp. – Whalen & Carter, p. 58, pl. 9, fig. 8.

Original description: Test large, circular in outline with a straight-sided pariphery; test relatively thick in proportion to diameter. Seven relatively broad grooves radiating from centre of test to margin. Meshwork composed primarily of small, irregularly shaped polygonal pore frames; meshwork generally uniform in size over surface of test.

Original remarks: Although the overall characteristics of *Praeorbiculliformella*? *lomgonensis* n. sp. suggest inclusion with *Praeorbiculliformella* Kozur and Mostler, the unusual radiating grooves have not been observed on any other species of this genus.

Measurements (µm):
Based on 17 specimens.

Maximum diameter of cortical shell	
340	HT
395	Max.
281	Min.
347	Mean

Etymology: This species is named for Lomgon Bay located on the north side of Tasu Sound.

Type locality: Sample 86-CAA-T-2/3, Sandilands Formation, Graham Island, Yakoun River area, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands.

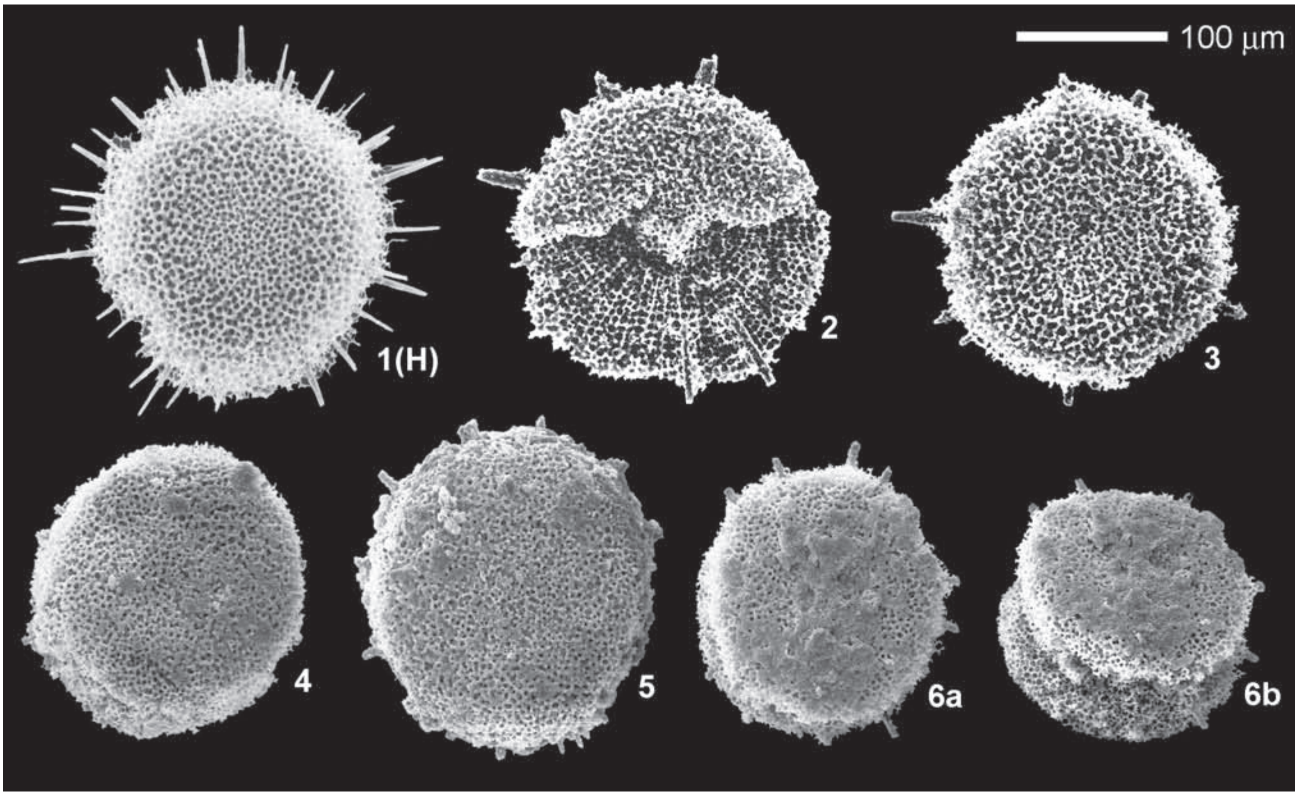


Plate ORB06. *Orbiculiformella incognita* (Blome). Magnification x200. **Fig. 1(H).** Blome 1984b, pl. 5, fig. 1. **Fig. 2.** Carter et al. 1988, pl. 10. fig. 10. **Fig. 3.** Carter et al. 1988, pl. 10, fig. 7. **Fig. 4.** Goričan et al. 2003, pl. 3, fig. 7. **Fig. 5.** SI, MM 21.70-000333. **Figs. 6a, b.** Goričan et al. 2003, pl. 3, figs. 5a, b.

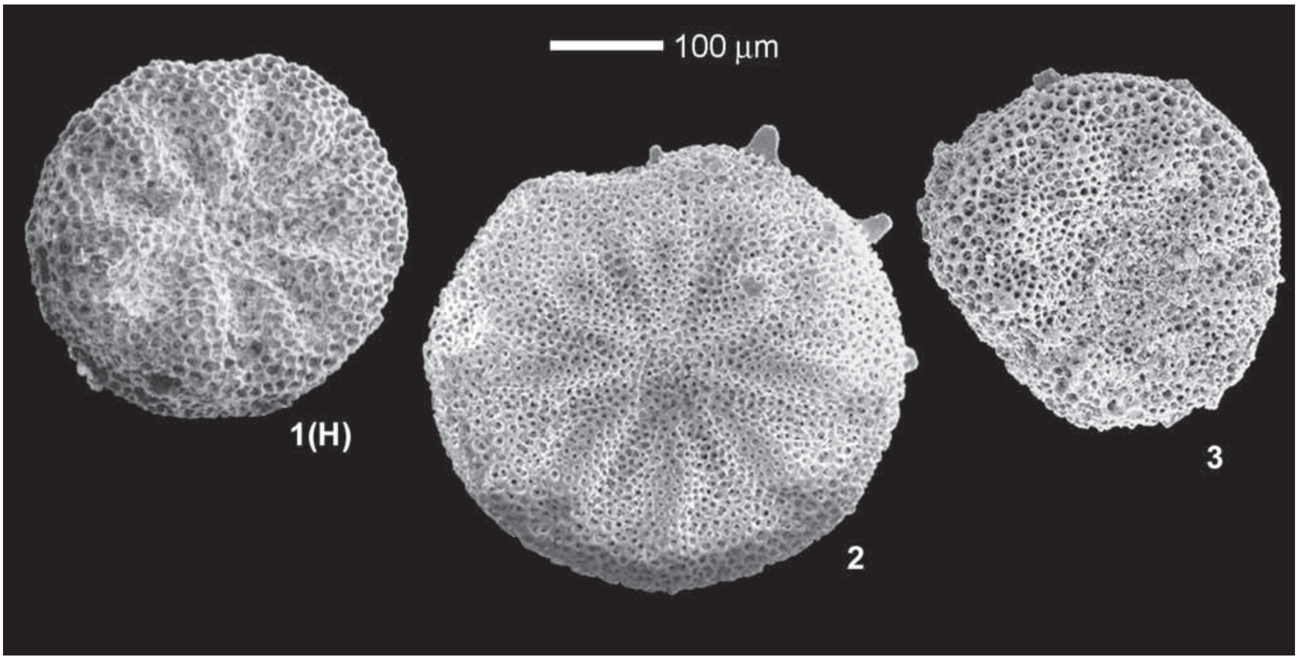


Plate ORB03. *Orbiculiformella lomgonensis* (Whalen & Carter). Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 9, fig. 8. **Fig. 2.** QCI, GSC loc. C-305386, GSC 128848. **Fig. 3.** QCI, GSC loc. C-080612, GSC 128849.

Orbiculiformella mediocircus Dumitrica n. sp.

Species code: ORB11

Type designation: Holotype specimen 1662D-R09-05 from sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Diagnosis: Test spongy, circular with a large central depression, a rounded sloping periphery and a thick spongy circular ridge between the two.

Description: Test spongy, circular with a wide central depression bordered by a thick, high, spongy circular ring which is hemispherical in transverse section. Periphery of disc beyond the ring sloping resulting in a round-angled circular band without solid spines but having fine spinules. Meshwork of test with rounded polygonal meshes which are larger on the thick ring decreasing in size on the periphery.

Remarks: This species is well distinguished from other species of the genus by its larger size and the presence of a thick circular ring between the central depression and sloping periphery.

Measurements (μm):
Based on 4 specimens.

	HT	Min.	Max.
Diameter of central cavity	360	220	360
External diameter of thick ring	490	345	490
Diameter of entire skeleton	605	420	605

Etymology: From the Latin *medius* – in the middle and *circus* – circle; noun.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Taurus Mts., Turkey; Tawi Sadh Member of the Guwayza Formation, Oman.

Orbiculiformella? robusta (Whalen & Carter) 1998

Species code: ORB02

Synonymy:

1998 *Praeorbiculiformella robusta* n. sp. – Whalen & Carter, p. 58, pl. 9, figs. 2, 3, 4, 19.

Original description: Test large, nearly circular in outline with straight-sided periphery, very thin in proportion relative to diameter. Very broad, shallow depression in centre of test usually destroyed. Three strong, principal spines intersect in centre of test; point of intersection surrounded by dense spongy meshwork with small pores; principal spines usually triradiate in axial section and extend from periphery of feet. Subsidiary spine located between each principal peripheral spine; subsidiary spines extend from margins of test only, not penetrating to centre of test. Meshwork primarily composed of small, irregularly shaped pentagonal and tetragonal pore frames; meshwork generally uniform in size over entire test.

Original remarks: The large test and strong spines distinguish *Praeorbiculiformella robusta* n. sp. from *P. yanensis* n. sp.

Measurements (μm):
Based on 13 specimens.

Diameter of cortical shell	Width of central area	Length of longest spine	
325	195	118	HT
354	228	125	Max.
225	195	52	Min.
295	181	92	Mean

Etymology: *Robustus, a, um* (Latin; adj.) = hard and strong like oak.

Type locality: Sample 89-CNA-KUG-1A, Sandilands Formation, north Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

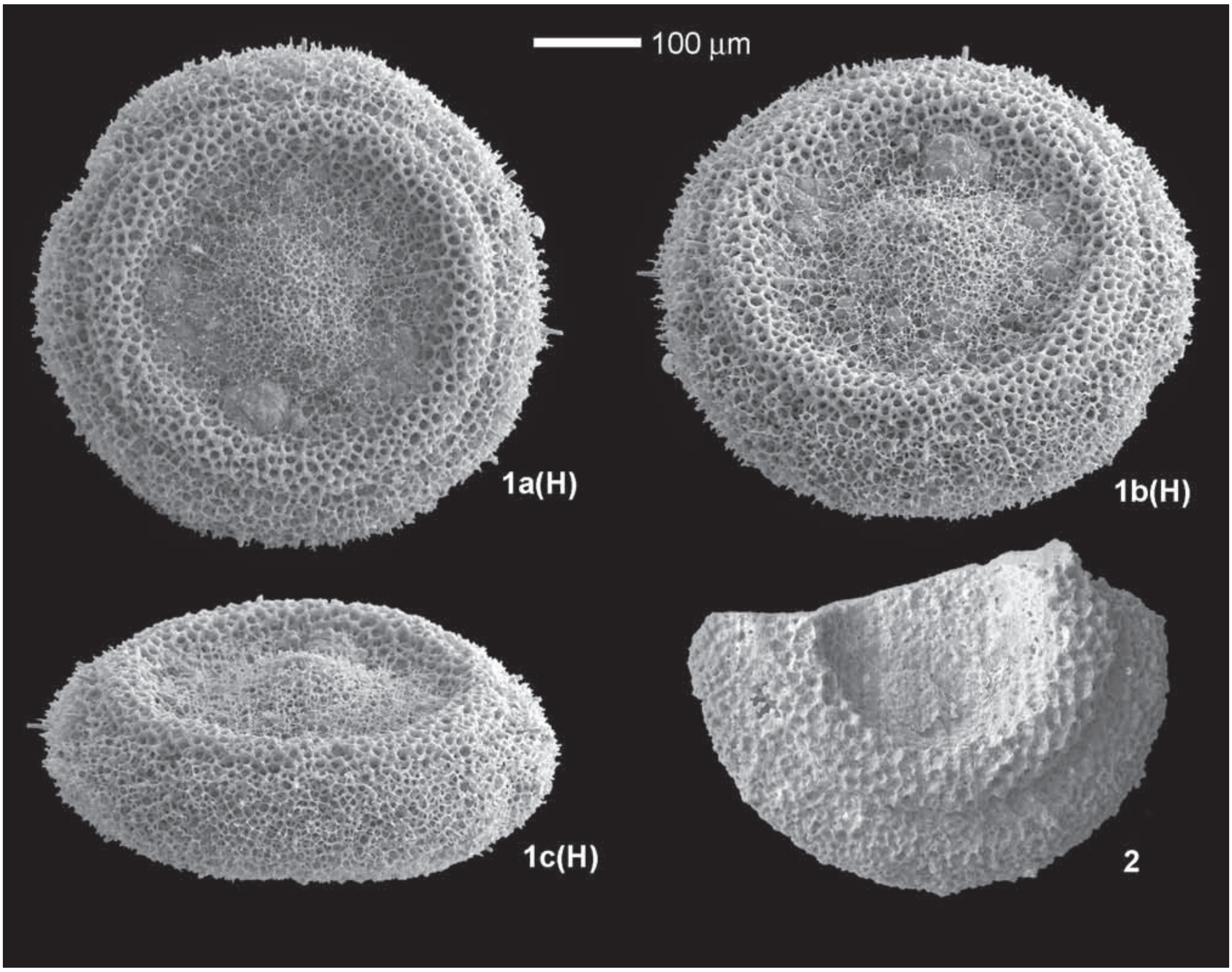


Plate ORB11. ***Orbiculiformella mediocircus*** **Dumitrica n. sp.** Magnification x150. **Figs. 1(H)a-c.** TR, 1662D-R09-05a-c. **Fig. 2.** OM, BR476-R18-01.

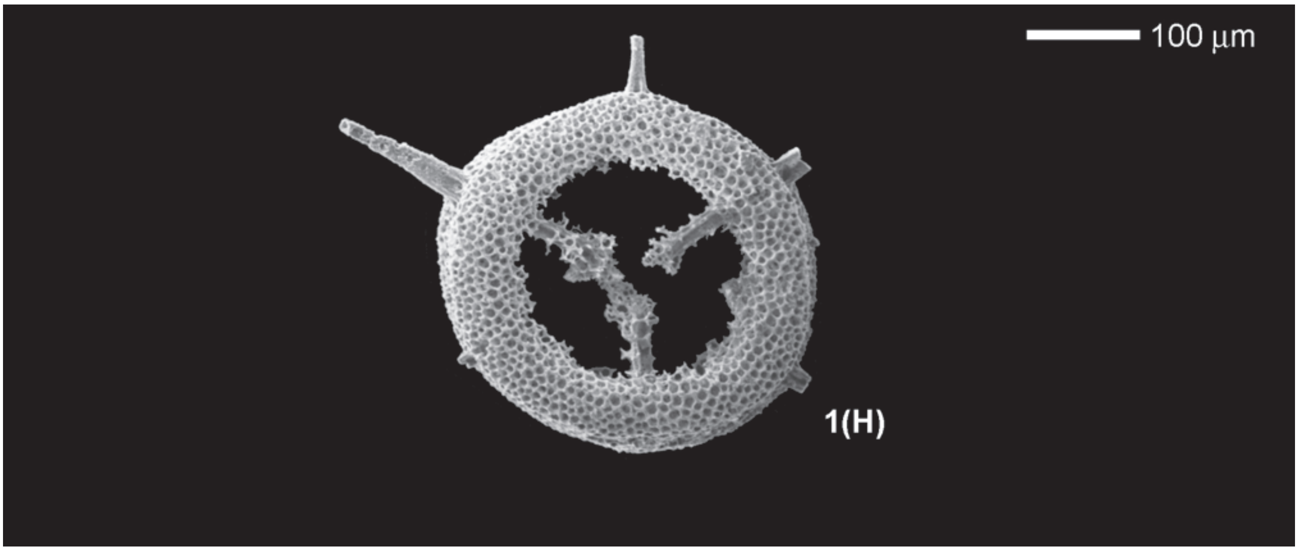


Plate ORB02. ***Orbiculiformella*? *robusta*** **(Whalen & Carter).** Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 9, fig. 2.

Orbiculiformella teres (Hull) 1997

Species code: ORB08

Synonymy:

1997 *Orbiculiforma teres* n. sp. – Hull, p. 16, pl. 1, figs. 10, 11, 15, 19.
1999 *Orbiculiforma* (?) *teres* Hull – Kiessling, p. 41, pl. 8, fig. 6.
2003 *Orbiculiforma*? *teres* Hull – Goričan et al., p. 296, pl. 3, figs. 8-13.

Original description: Test large, relatively thin, subcircular in outline. Central cavity very shallow. Twelve to eighteen short spines along periphery; base of spines usually weakly triradiate, becoming circular in axial section distally. Meshwork fine, composed of tetragonal and pentagonal pore frames.

Original remarks: *Orbiculiforma teres*, n. sp., is distinguished by its large size, very shallow central cavity, and numerous short peripheral spines.

Further remarks: By Goričan et al. (2003): Included are lenticular forms with angled sides of test and numerous peripheral spines. Spines can vary from short and thin to rather thick, sometimes bladed or flattened at the base. Some specimens have a small shallow central depression (Plate III, fig. 11 a, b) whereas others show a perfectly biconvex shell (Plate III, figs. 9, 13). *Orbiculiforma*? *teres* differs from *Orbiculiforma multifora* Pessagno and Poisson (1981) by having a very indistinct or no central depression. De Wever (1981b, p. 46, plate 7, figs. 6-8) illustrated a closely related spongodiscid which, in addition to peripheral spines, possesses two polar spines.

***Measurements* (μm):**
Based on 7 specimens. AA' and BB' represent the diameter of the spongy test in two planes oriented perpendicular to one another.

	HT	Min.	Max.	Mean
AA'	225.0	215.0	252.0	235.4
BB'	75.0	50.0	80.0	68.2

Etymology: *Teres* (Latin, adj.) = smooth, polished.

Type locality: Sample SM-50, Volcanopelagic strata overlying the Coast Range Ophiolite, Stanley Mountain, California Coast ranges.

Occurrence: Volcanopelagic strata at Stanley Mountain, California; Ameghino Formation, Antarctic Peninsula; Skrile Formation, Slovenia.

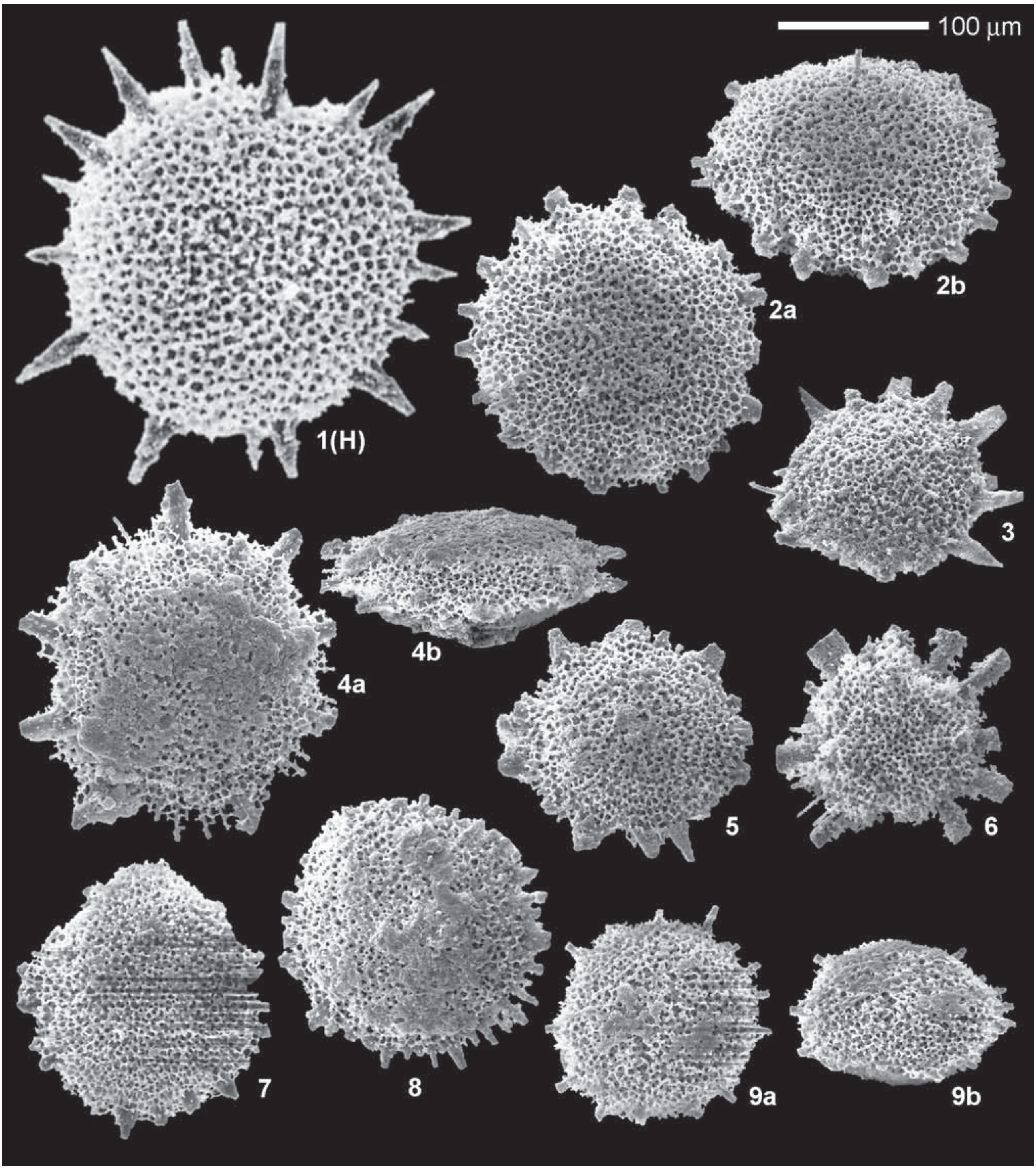


Plate ORB08. ***Orbiculiformella teres*** **(Hull).** Magnification x250. **Fig. 1(H).** Hull 1997, pl. 1, fig. 10. **Figs. 2a, b.** Goričan et al. 2003, pl. 3, figs. 12a, b. **Fig. 3.** Goričan et al. 2003, pl. 3, fig. 9. **Figs. 4a, b.** Goričan et al. 2003, pl. 3, figs. 8a, b. **Fig. 5.** Goričan et al. 2003, pl. 3, fig. 13. **Fig. 6.** Goričan et al. 2003, pl. 3, fig. 10. **Fig. 7.** Goričan et al. 2003, pl. 3, fig. 11b. **Fig. 8.** SI, MM 21.70, 010224. **Figs. 9a, b.** SI, MM 11.76, 000226, 000227.

***Orbiculiformella? trispina* s.l. (Yeh) 1987b**

Species code: ORB13

Synonymy:

1987b *Orbiculiforma* (?) *trispina* n. sp. – Yeh, p. 42, pl. 9, figs. 2, 10 (*O.* (?) *trispinosa* in plate caption).

See also subspecies.

Included subspecies:

ORB09 *Orbiculiformella*? *trispina trispina* (Yeh) 1987b
ORB10 *Orbiculiformella*? *trispina trispinula* (Carter) 1988

***Orbiculiformella? trispina trispina* (Yeh) 1987b**

Species code: ORB09

Synonymy:

1987b *Orbiculiforma* (?) *trispina* n. sp. – Yeh, p. 42, pl. 9, figs. 2, 10 (*O.* (?) *trispinosa* in plate caption).

1998 *Orbiculiforma silicatilis* n. sp. – Cordey, p. 93, pl. 21, figs. 5, ? 8, not fig. 7.

Original description: Test thick, circular in outline, with small, deep central cavity and three periphery spines. Periphery spines elongate, relatively massive, circular in cross-section with most portion circular in cross-section with only proximal end triradiate with three deep grooves alternating with three rounded ridges. Three spines nearly equally spaced. Meshwork of test predominantly of relatively uniform size of small irregular pore frames. Margin of test slightly concaved.

Original remarks: *Orbiculiforma* (?) *trispina*, n. sp., can be easily distinguished from other *Orbiculiforma* spp. in this report by having three long massive periphery spines. It is possible that this form should be assigned to a new genus.

Measurements (μm):

Ten specimens measured.

Diameter of shell	Diameter of central cavity	Length of spines	
158	53	168	HT
170	82	38	Mean
187	88	45	Max.
158	75	30	Min.

Etymology: *Tri* = three, *spina* = spine.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, Oregon; Fannin Formation, Queen Charlotte Islands; Bridge River and Hozameen complexes, British Columbia.

***Orbiculiformella? trispina trispinula* (Carter) 1988**

Species code: ORB10

Synonymy:

1988 *Orbiculiforma trispinula* Carter n. sp. – Carter et al., p. 44, pl. 1, figs. 7, 10.

Original diagnosis: Test discoidal with large central depression and three short radial spines. Meshwork spongy and coarse, pore frames larger in central area.

Original description: Test a circular disc with large central cavity and three radial spines. Surface of test planiform, sides vertical. Central cavity large (approximately half test diameter) and deeply depressed. Pore frames polygonal and concentrically arranged; very small and delicate in the middle of the central area, but immediately surrounding ones are somewhat larger; composed of thin fragile bars. Pore frames on rim-like upper surfaces small, bars are coarser and small nodes occur at vertices of bars. Spines short and circular in section.

Original remarks: This form differs from *Orbiculiforma*(?) *trispina* Yeh by having a larger overall diameter and thickness, a wider central cavity (and narrower rim) and much smaller radial spines.

Further remarks: *Orbiculiformella*? *trispina trispinula* is now considered a subspecies of *Orbiculiformella*? *trispina* (Yeh).

Measurements (μm):

Based on 7 specimens.

	HT	Av.	Max.	Min.
Maximum diameter of test	206	218	230	200
Maximum diameter of central cavity	134	130	155	110
Length of spines	46	43	46	40

Etymology: Latin, *trispinula* (adj.), three small spines.

Type locality: GCS locality C-080577, Fannin Formation, Creek locality, Maude Island.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Fernie Formation, NE British Columbia.

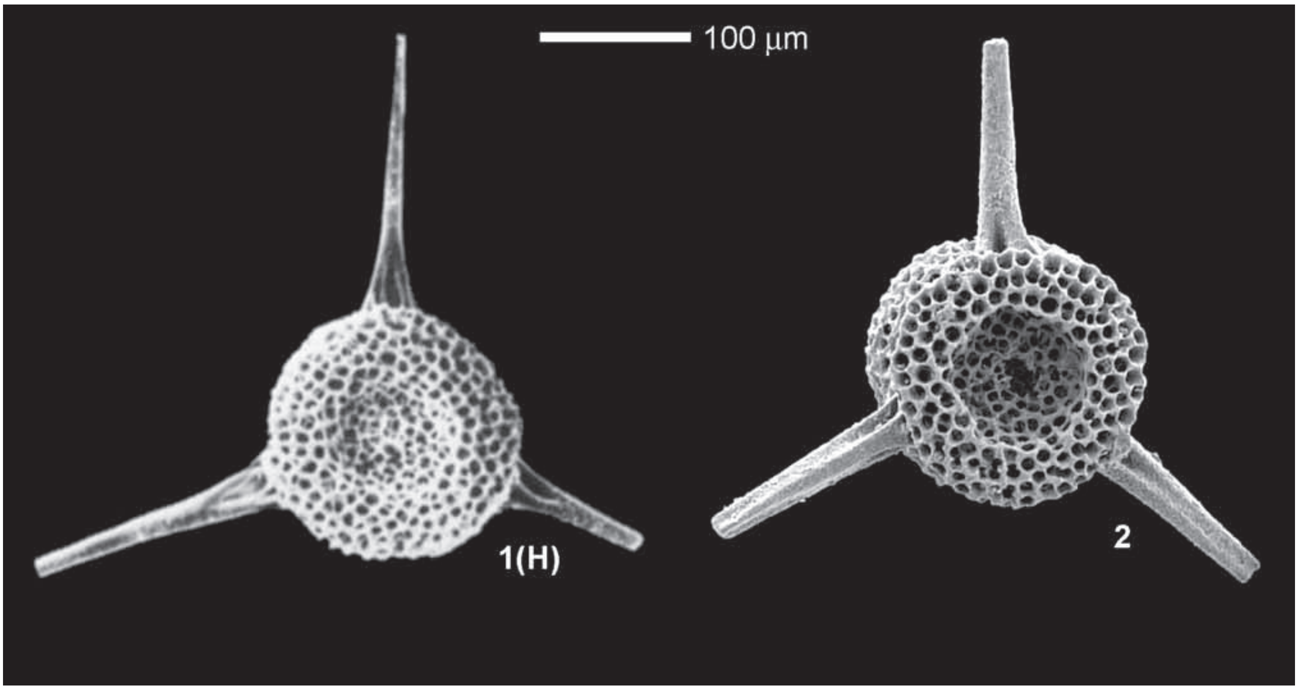


Plate ORB09. ***Orbiculiformella*? *trispina trispina* (Yeh).** Magnification x 200. **Fig. 1(H).** Yeh 1987b, pl. 9, fig. 2. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128851.

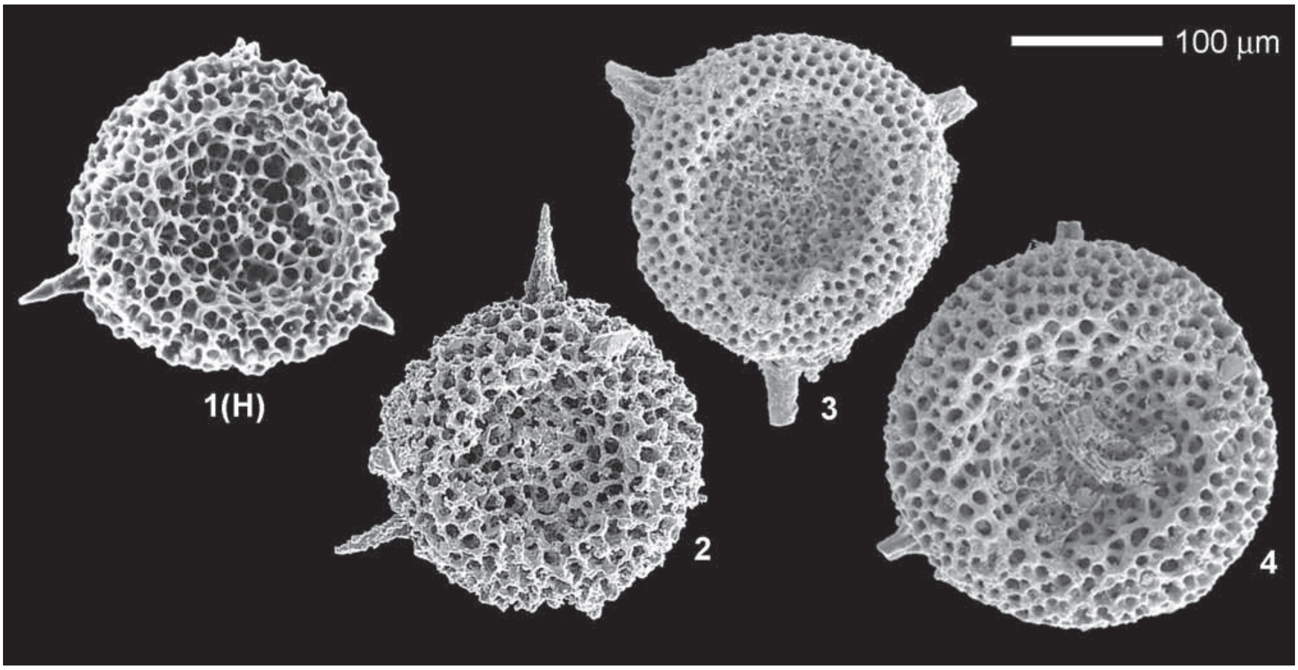


Plate ORB10. ***Orbiculiformella*? *trispina trispinula* (Carter).** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 1, fig. 7. **Fig. 2.** NBC, GSC loc. C-305208, GSC 128852. **Fig. 3.** QCI, GSC loc. C-080612, GSC 128853. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128854 .

Genus: *Palaeosaturnalis* Donofrio & Mostler 1978, emend. Kozur & Mostler 1981

Type species: *Spongosaturnalis triassicus* Kozur & Mostler 1972

Synonymy:

1978 *Palaeosaturnalis* n. gen. – Donofrio & Mostler, p. 33.
1981 *Palaeosaturnalis* Donofrio & Mostler emend. – Kozur & Mostler, p. 55.
1983 *Palaeosaturnalis* Donofrio & Mostler emend. Kozur & Mostler – Kozur & Mostler, p. 19.
1984 *Palaeosaturnalis* Donofrio & Mostler emend. – De Wever, p. 15.

Original diagnosis: Form with a smooth, flat, simple ring of very variable width, bearing spines all around; thorns on the external side missing. In most cases, auxiliary or sustaining bars are developed near polar bars. Cortical and medullary shells as with family.

Emended description: Kozur & Mostler (1981): Forms with a smooth, flattened, simple ring of variable width and a periphery with spines. The two polar spines are always opposite to the spines of outer margin. Sustaining spines of second order absent. Cortical shell mostly spongy, widely separated from the ring. One medullary shell usually present.

Original remarks: The name *Palaeosaturnalis* was chosen because Triassic representatives are all characterized by a ring with a circular cross-section. Unlike Jurassic-Cretaceous representatives, the polar sustaining bars [of the Triassic forms] are, except some specimens, in direct continuation of the peripheral spines (see text-fig. 8). Moreover, the stratigraphically younger forms mostly lack sustaining bars, whereas they are very frequent in Triassic forms.

Further remarks: The genus *Palaeosaturnalis* differs from *Pseudoheliodiscus* in not having auxiliary or/and subsidiary rays (De Wever, 1984, p. 15-16).

Included species:

SAT13 *Palaeosaturnalis* aff. *liassicus* Kozur & Mostler 1990
SAT12 *Palaeosaturnalis subovalis* Kozur & Mostler 1990
SAT14 *Palaeosaturnalis* sp. B sensu Whalen & Carter 2002

Palaeosaturnalis aff. *liassicus* Kozur & Mostler 1990

Species code: SAT13

Synonymy:

aff. 1990 *Palaeosaturnalis liassicus* n. sp. – Kozur & Mostler, p. 192, pl. 1, figs. 2, 3; pl. 12, figs. 1, 3, 4, 6, 8-10; pl. 13, figs. 1, 2, 6, 7.
2002 *Paleosaturnalis* sp. A – Whalen & Carter, p. 108, pl. 5, fig. 5.

Remarks: This species differs from typical *Palaeosaturnalis liassicus* by having fewer peripolar spines.

Occurrence: San Hipólito Formation, Baja California Sur.

Palaeosaturnalis subovalis Kozur & Mostler 1990

Species code: SAT12

Synonymy:

1972 *Spongosaturnalis* ? sp. c – Yao, p. 35, pl. 8, fig. 3.
1987b *Acanthocircus* sp. B – Yeh, p. 49, pl. 5, fig. 13.
1990 *Palaeosaturnalis subovalis* n. sp. – Kozur & Mostler, p. 193, pl. 1, fig. 7; pl. 13, figs. 4, 9.
1991 *Palaeosaturnalis* sp. aff. *P. liassicus* Kozur & Mostler – Yang & Mizutani, p. 65, pl. 2, figs. 4, 11, 13; not pl. 3, figs. 2, 12, 13.
2002 *Palaeosaturnalis lenggriesensis* Kozur & Mostler – Tekin, p. 182, pl. 2, fig. 2.
Not 2002 *Palaeosaturnalis subovalis* Kozur & Mostler – Tekin, p. 182, pl. 2, fig. 5.

Original description: Shell slightly ellipsoidal, spongy, consisting of several concentric layers. Microsphere latticed. Ring suboval to oval, narrow, flat, undifferentiated, with 9-11 slender, relatively short spines. One axial spine as long as the circumaxial spines, the other one is considerably longer and somewhat more slender. A larger smooth segment is present to both sides of the axial spines. Polar spines very robust.

Original remarks: In *Palaeosaturnalis haeckeli* n. sp. the circumaxial spines are more variable in their length. On both sides of the axial spines 1-2 large, widely spaced spines are present. The remaining circumaxial spines are smaller and closely spaced.

Further remarks: The very few specimens we included in this species resemble very well the holotype and especially one paratype (Kozur & Mostler, 1990, pl. 1, fig. 7).

Measurements **(µm):**

	Min.	Max.
Diameter of shell (parallel to polar axis)	76	90
Diameter of shell (perpendicularly to polar axis)	60	77
Diameter of ring (parallel to polar axis)	192	215
Diameter of ring (perpendicularly to polar axis)	190	240

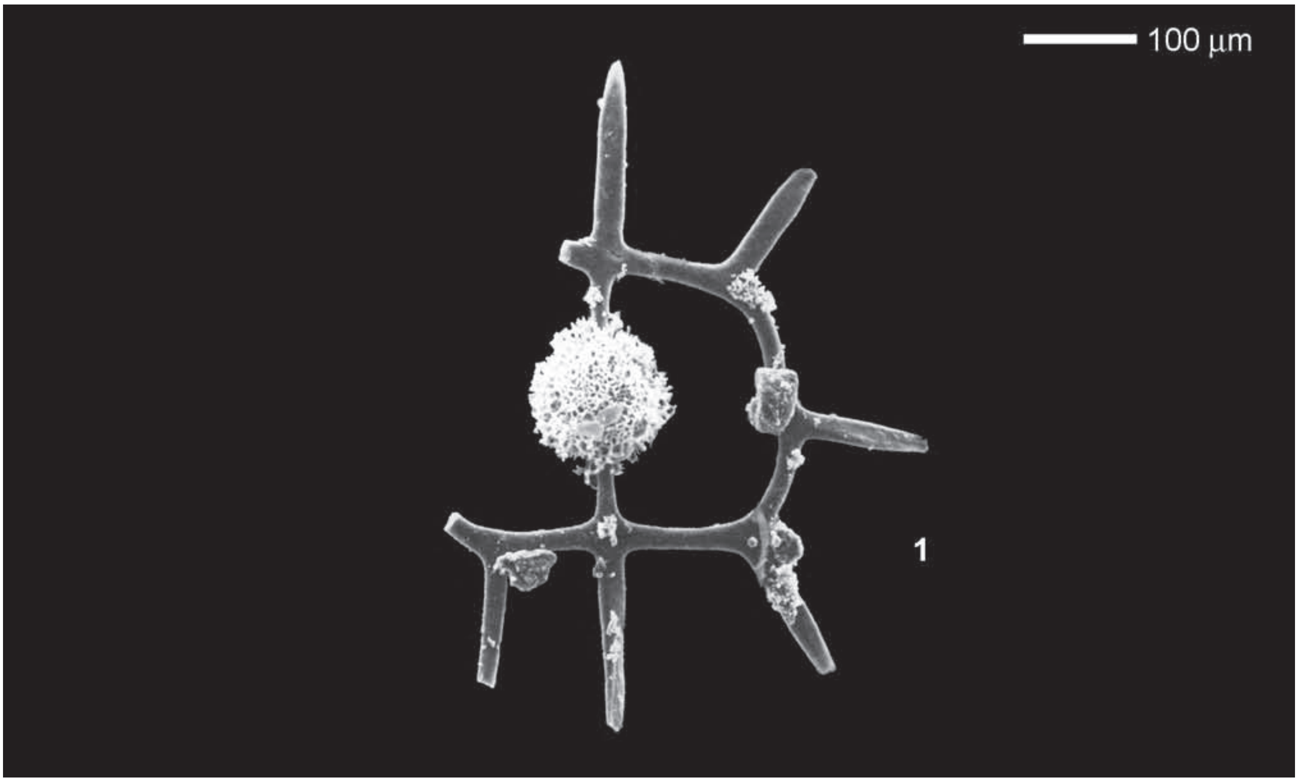


Plate SAT13. ***Palaeosaturnalis*** **aff.** ***liassicus*** **Kozur & Mostler.** Magnification x150. **Fig. 1.** Whalen & Carter 2002, pl. 5, fig. 5.

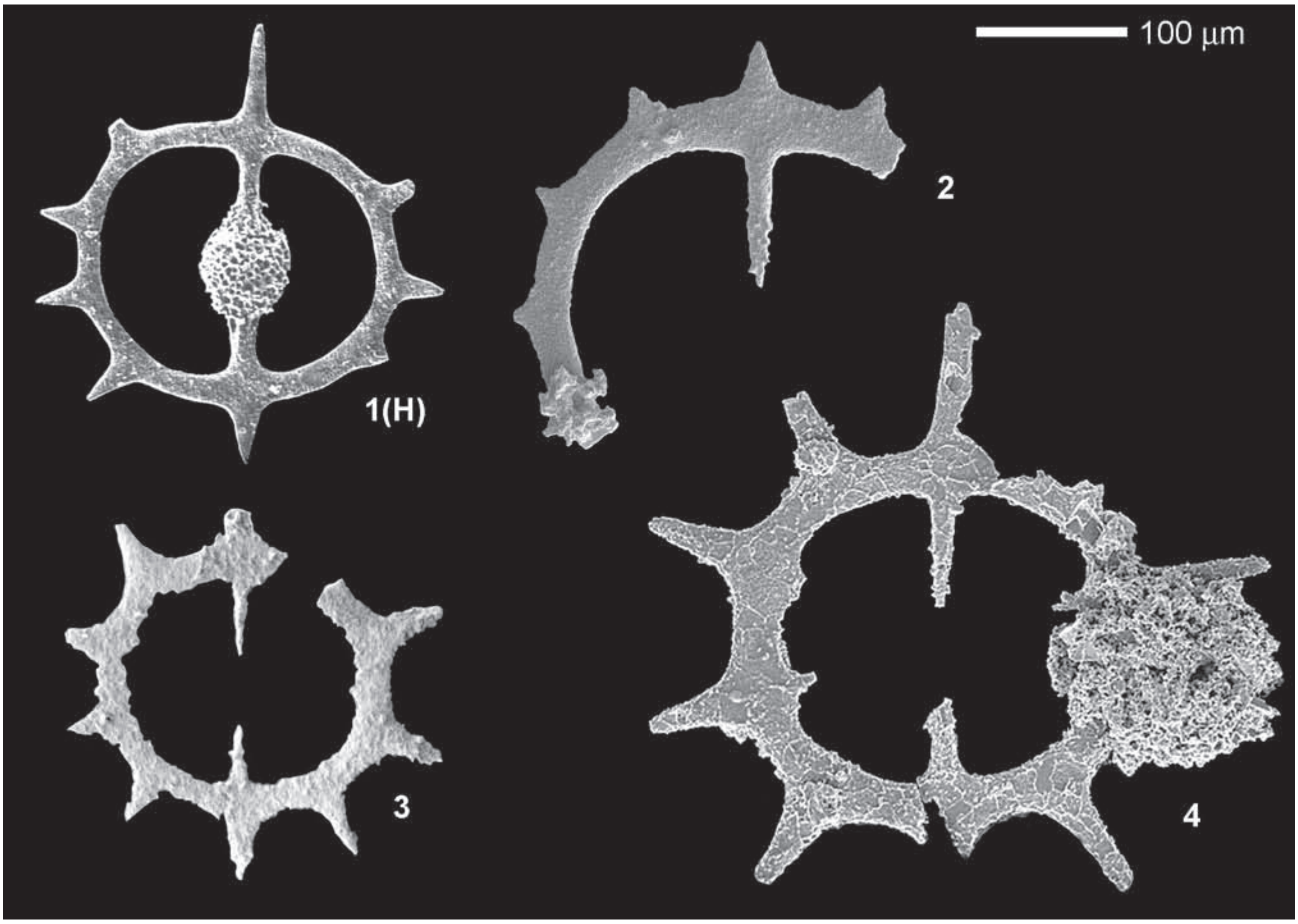


Plate SAT12. ***Palaeosaturnalis subovalis*** **Kozur & Mostler.** Magnification x200. **Fig. 1(H).** Kozur & Mostler 1990, pl. 13, fig. 4. **Fig. 2.** OM, BR706-R13-13. **Fig. 3.** JP, IYII17-63, RH(1)1660. Fig. 4. NBC, GSC loc. C-305208, GSC 111729.

Etymology: According to the suboval ring outline.

Type locality: Sample L1, Kirchstein Limestone at Mt. Kirchstein, 6.5 km WSW of Lenggries/Isar, Bavaria, Germany.

Occurrence: Kirchstein Limestone, Germany; Varhegy Cherty Limestone Formation, Hungary; Hocaköy Radiolarite, Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; Japan; Nadanhada Terrane, China; Nicely Formation, Oregon; Fernie Formation, NE British Columbia.

***Palaeosaturnalis* sp. B** sensu Whalen & Carter 2002

Species code: SAT14

Synonymy:

2002 *Paleosaturnalis* sp. B – Whalen & Carter, p. 108, pl. 5, figs. 6, 10.

Original remarks: This species is distinguished by having bifurcating polar spines.

Occurrence: San Hipólito Formation, Baja California Sur.

Genus: *Pantanellium* Pessagno 1977a

Type species: *Pantanellium riedeli* Pessagno 1977a

Synonymy:

1977a *Pantanellium* n. gen. – Pessagno, p. 78.

Original description: Test divided into ellipsoidal to subspherical cortical shell and spherical first medullary shell, both with massive polygonal pore frames having nodes at vertices. Cortical shell with bipolar primary spines possessing well-developed alternating, longitudinally arranged ridges and grooves. One spine often somewhat shorter than other. Primary spines interconnected and occurring along same axes as primary beams which connect cortical shell to first medullary shell; diameter of two primary beams about half that of primary spines. Secondary radial beams also connecting cortical shell (pl. 6, fig. 6); extending from nodal points of pore frame vertices of both cortical and first medullary shells.

Original remarks: *Pantanellium* n. gen., differs from *Protoxiphotractus* Pessagno in having bipolar spines with longitudinally arranged, alternating grooves and ridges. Many workers, for example Foreman (1973, p. 258), have included species assignable to this genus under *Sphaerostylus* Haeckel. Unfortunately, the single illustration and the description of the type species of *Sphaerostylus* (i.e., *S. zitteli* Rüst) are exceedingly poor and of virtually no use to any worker hoping to make a definitive identification. The resurrection of the name *Sphaerostylus* can serve no purpose. It is suggested, therefore, that the name *Sphaerostylus* be considered a nomen dubium. *Pantanellium* is known to include several species. At present, only the type species and *P. fischeri* (Pessagno) have formal names. One new species is under study from the Upper Triassic and another from the Lower Cretaceous.

Further remarks: Kozur & Mostler (1990, p. 214) argued that *Pantanellium* Pessagno is a younger synonym of *Ellipsoxiphus* Dunikowski 1882 with *Xiphosphaera* (*Ellipsoxiphus*) *suessi* Dunikowski 1882 as type species. In modern radiolarian literature the name *Ellipsoxiphus* has been used for Cenozoic species only. On the other hand, Mesozoic species have been assigned to *Pantanellium* by a great majority of authors and this usage has largely prevailed even since 1990. *Pantanellium* is a thoroughly studied genus with a well-established stratigraphic range from the Late Triassic to the Early Cretaceous (Aptian). In spite of the Principle of Priority we continue to use the generic name *Pantanellium,* because its replacement with *Ellipsoxiphus* would certainly cause confusion (see ICZN 1999, art. 23.2 and Preamble p. XX).

Etymology: This genus takes its name from Dante Pantanelli, one of the early students of Mesozoic Radiolaria.

Included species:

PAN20 *Pantanellium brevispinum* Carter n. sp.
PAN14 *Pantanellium carlense* Whalen & Carter 1998
PAN18 *Pantanellium cumshewaense* Pessagno & Blome 1980
PAN11 *Pantanellium danaense* Pessagno & Blome 1980
PAN19 *Pantanellium inornatum* Pessagno & Poisson 1981
PAN16 *Pantanellium skedansense* Pessagno & Blome 1980

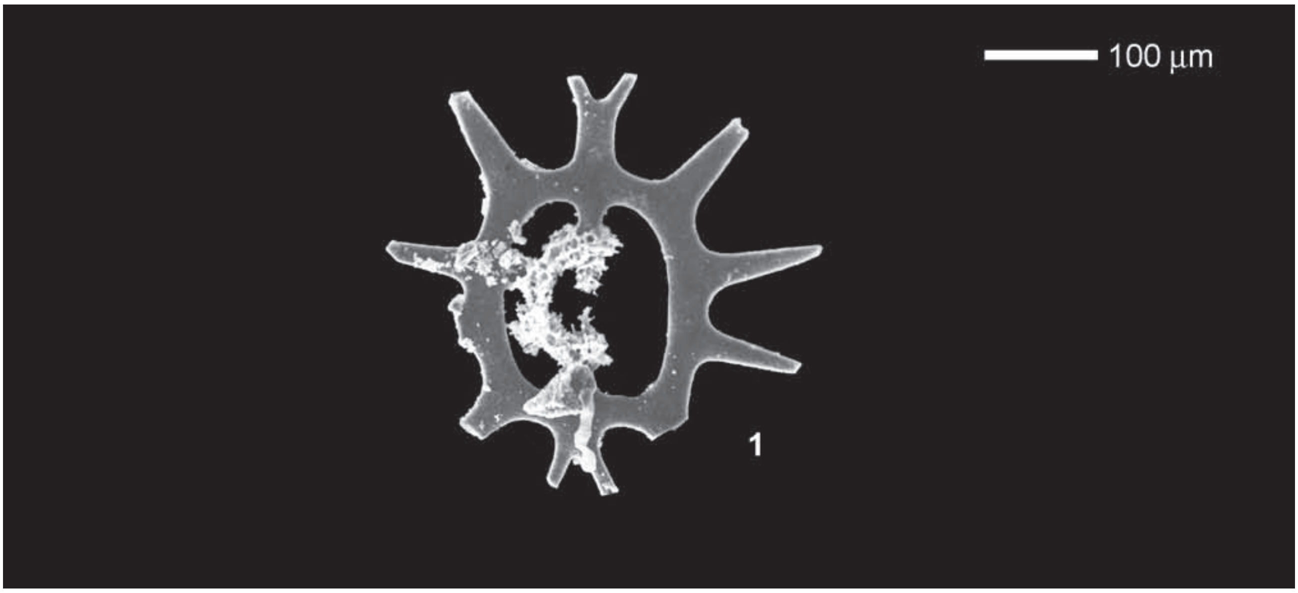


Plate SAT14. *Paleosaturnalis* sp. B sensu Whalen & Carter. Magnification x 150. **Fig. 1.** Whalen & Carter 2002, pl. 5, fig. 6.

Pantanellium brevispinum Carter n. sp.

Species code: PAN20

Synonymy:

1980 *Pantanellium* sp. G – Pessagno & Blome, p. 248, pl. 6, fig. 9.
1997 *Pantanellium* sp. C – Yao, pl. 3, fig. 139.

Type designation: Holotype GSC 111730 from GSC loc. C-080611; Ghost Creek Formation (lower Pliensbachian).

Description: Cortical shell relatively large, spherical to subspherical with medium-sized pores and very low rounded nodes at pore frame vertices. Pore frames pentagonal and hexagonal, thicker in Z direction than in Y direction; five pore frames visible along AA', six visible along BB'. Polar spines very short, less than one-quarter diameter of test; spines strongly tapering, one slightly longer than the other. Spines usually triradiate in axial section with three, narrow ridges and three relatively wide grooves.

Remarks: *Pantanellium brevispinum* n. sp. differs from *P. haidaense* Pessagno & Blome by having much shorter polar spines, and lower nodes at pore frame vertices.

Measurements (μm):

Based on 6 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

	HT	Max.	Min.	Mean
AA'	105	111	94	102
A'S'	37	37	37	43
AS	32	37	32	34
BB'	100	111	93	100
cc'	39	39	23	32
dd'	32	32	23	27

Etymology: From the Latin *brevis + spinus, -a, -um* (with short spines).

Type locality: Sample CAA-79-Ren-Phant, lms 1 (GSC loc. C-080611), Ghost Creek Formation, Rennell Junction section, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Japan.

Pantanellium carlense Whalen & Carter 1998

Species code: PAN14

Synonymy:

1984 *Pantanellium* sp. – Whalen & Pessagno, pl. 1, fig. 17.
1998 *Pantanellium carlense* n. sp. – Whalen & Carter, p. 47, pl. 2, figs. 1, 2, 13, 14, 17, 18.
2002 *Pantanellium carlense* Whalen & Carter – Whalen & Carter, p. 105, pl. 9, figs. 1, 2, 10, 11.

Original description: Cortical shell subspherical in shape, slightly elongated in plane of polar spines, with medium- to large- sized pentagonal and hexagonal pore frames. Bars of pore frames thin along Y, thicker along Z (refer to Fig. 23). All pore frames with irregularly shaped, spinose nodes at vertices. Five pore frames visible along AA'; five to six pore frames visible along BB'. Polar spines triradiate in axial section with narrow, rounded longitudinal ridges and grooves; one polar spine approximately one third shorter than the other; base of shorter polar spine slightly wider at cc' than the base of other spine at dd'. First medullary shell with thin, fragile pentagonal and hexagonal pore frames.

Original remarks: The elongated cortical shell with spiny nodes at pore frame vertices distinguishes *Pantanellium carlense* n. sp. from all other species of *Pantanellium*.

Measurements (μm):

(n) = number of specimens measured. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
(7)	(6)	(6)	(7)	(7)	(7)	
60	120	86	71	34	45	HT
68	120	90	86	45	53	Max.
60	105	79	71	34	38	Min.
65	116	83	79	40	46	Mean

Etymology: This species is named for Mount Carl, located to the north of the type locality.

Type locality: Sample QC-675, southeast side of Kunga Island, Queen Charlotte Islands.

Occurrence: Sandilands Formation, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur.

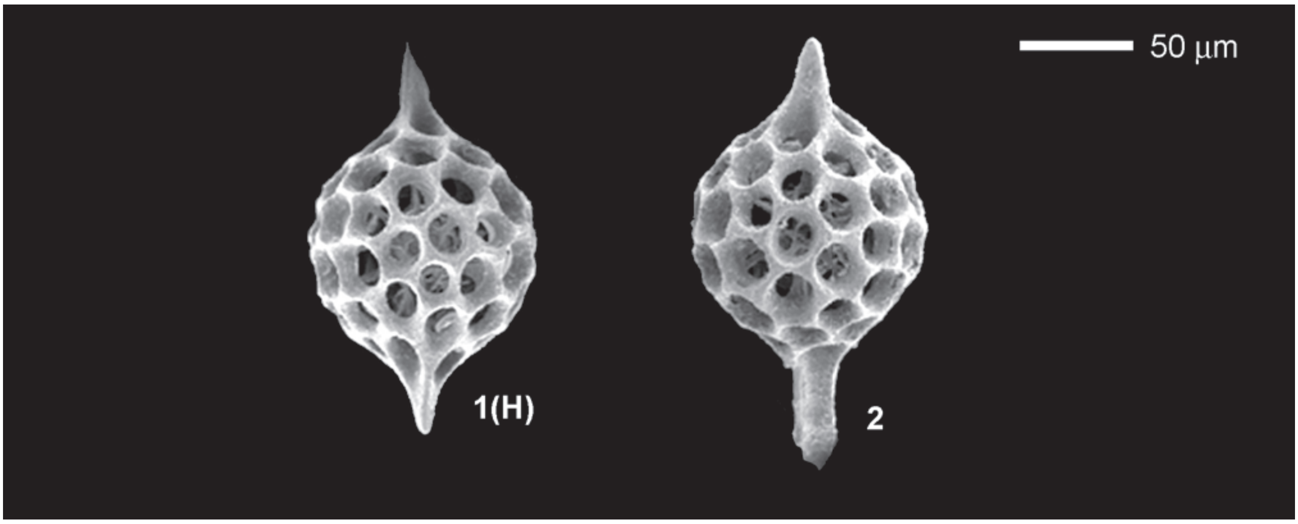


Plate PAN20. ***Pantanellium brevispinum*** **Carter n. sp.** Magnification x300. **Fig. 1(H).** QCI, GSC loc. C-080611, GSC 111730. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128856.

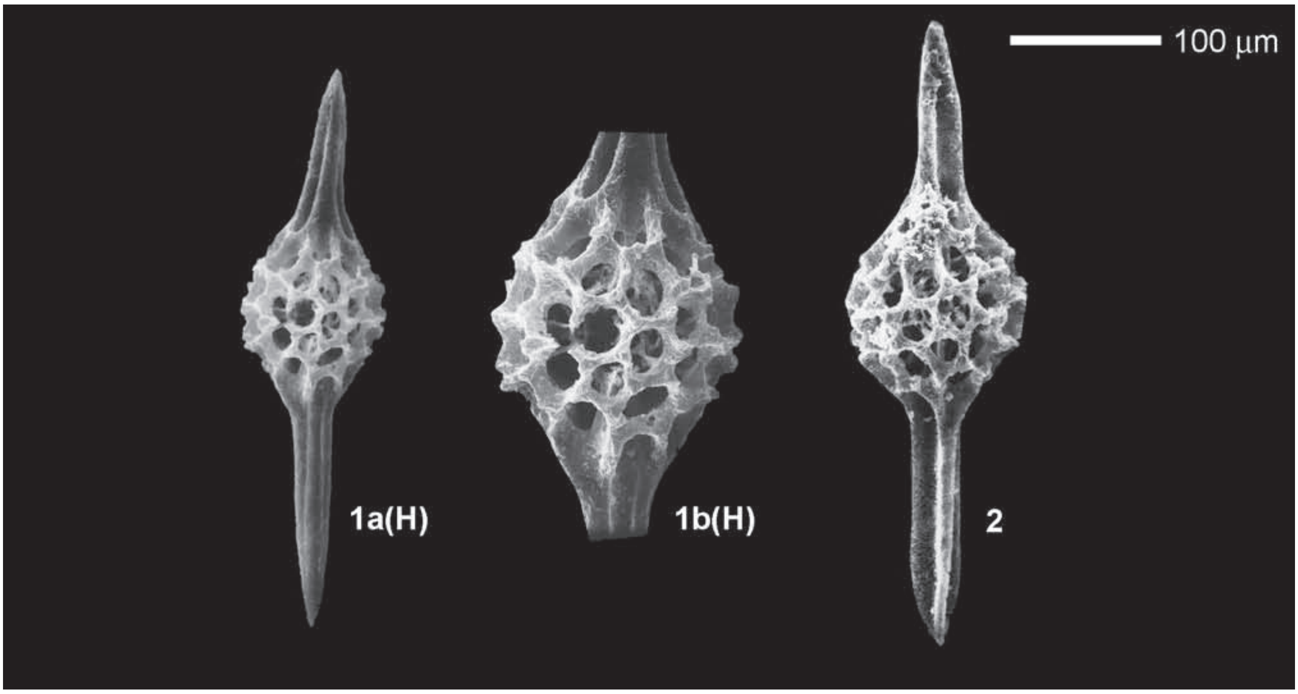


Plate PAN14. ***Pantanellium carlense*** **Whalen & Carter.** Magnification x250, except Fig. 1(H)b x 500. **Fig. 1(H) a, b.** Carter et al. 1998, pl. 2, figs. 1, 17. **Fig. 2.** Whalen & Carter 2002, pl. 9, fig. 2.

Pantanellium cumshewaense Pessagno & Blome 1980

Species code: PAN18

Synonymy:

1980 *Pantanellium cumshewaense* n. sp. – Pessagno & Blome, p. 240, pl. 6, figs. 1, 2, 15, 17, 21, 22.

Original description: Cortical shell subspherical with large, predominantly hexagonal pore frames with poorly developed nodes of low relief at vertices. Bars of pore frames moderately thick; thickness about equal along Y and Z (text-fig. 5). Four to 5 pore frames visible along AA'; 5 pore frames visile along BB'. Polar spines triradiate in axial section; longitudinally comprised of 3 broad grooves alternating with 3 narrow ridges. One polar spine somewhat shorter than other; longer spine somewhat rounded distally, not coming to sharp point; ridges of longer spine disappearing on distal third of spine. First medullary shell with small, fragile pore frames.

Original remarks: *P. cumshewaense*, n. sp., differs from *P. baileyi*, n. sp., in having better defined pore frames which lack spines.

Measurements (µm):

Based on 11 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
110	88	65	95	20	35	HT
101	97	63	97	23	29	Av.
120	115	85	110	35	40	Max.
90	80	40	90	15	20	Min.

Etymology: This species is named for Cumshewa Inlet south of Skidegate Bay in the Queen Charlotte Islands.

Type locality: Sample QC 534, Fannin Formation (Maude Formation in Pessagno & Blome, 1980), Queen Charlotte Islands.

Occurrence: Fannin Formation, Queen Charlotte Islands.

Pantanellium danaense Pessagno & Blome 1980

Species code: PAN11

Synonymy:

1980 *Pantanellium danaense* n. sp. – Pessagno & Blome, p. 241, pl. 4, figs. 9-11, 15.

1990 *Ellipsoxiphus* cf. *danaensis* (Pessagno & Blome) – Kozur & Mostler, p. 215, pl. 14, fig. 13; ? pl. 15, fig. 15.

1998 *Pantanellium danaense* Pessagno & Blome – Whalen & Carter, p. 47, pl. 2, figs. 4, 5.

2004 *Pantanellium danaense* Pessagno & Blome – Hori et al., pl. 5, fig. 4; pl. 6, fig. 16.

Original description: Cortical shell spherical with large (occasional small) pentagonal and hexagonal pore frames; pentagonal pore frames about equal in number to hexagonal pore frames. Bars of pore frames thin along Y; thick along Z (text-fig. 5). All pore frames with spinose nodes at vertices. Six pore frames visible along AA'; 5 pore frames visible along BB'. Polar spines triradiate in axial section, 1 polar spine shorter than the other; shorter spine with 3 moderately wide longitudinal ridges alternating with 3 longitudinal grooves of about the same width. Longer spine with 3 thin longitudinal ridges alternating with 3 wide longitudinal grooves; grooves about 3 times wider than ridges. First medullary shell with thin, fragile, hexagonal and pentagonal pore frames.

Original remarks: *P. danaense*, n. sp., differs from *P. riedeli* Pessagno in having: (1) less massive pore frames; (2) spinose nodes at the pore frame vertices; and (3) less massive, thinner polar spines.

Measurements (µm):

Based on 6 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
85	90	45	100	30	20	HT
80	79	46	93	23	23	Av.
85	90	60	100	30	25	Max.
75	65	40	90	20	20	Min.

Etymology: This species is named for Dana Inlet in its type area.

Type locality: Sample QC 550, Sandilands Formation (Kunga Formation in Pessagno & Blome, 1980), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Kirchstein Limestone, Germany; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

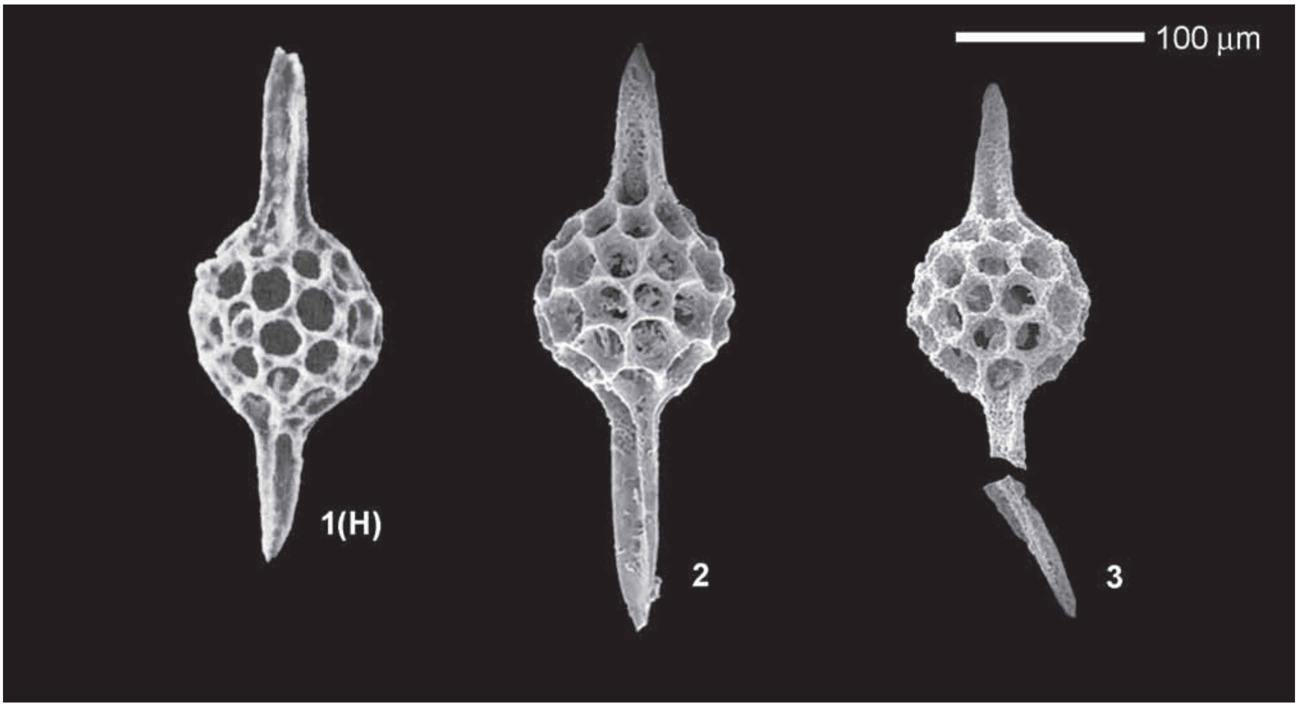


Plate PAN18. ***Pantanellium cumshewaense*** **Pessagno & Blome.** Magnification x250. **Fig. 1(H).** Pessagno & Blome 1980, pl. 6, fig. 1. **Fig. 2.** QCI, GSC loc. C-304566, GSC 128857. **Fig. 3.** QCI, GSC loc. C-305417, GSC 111731.

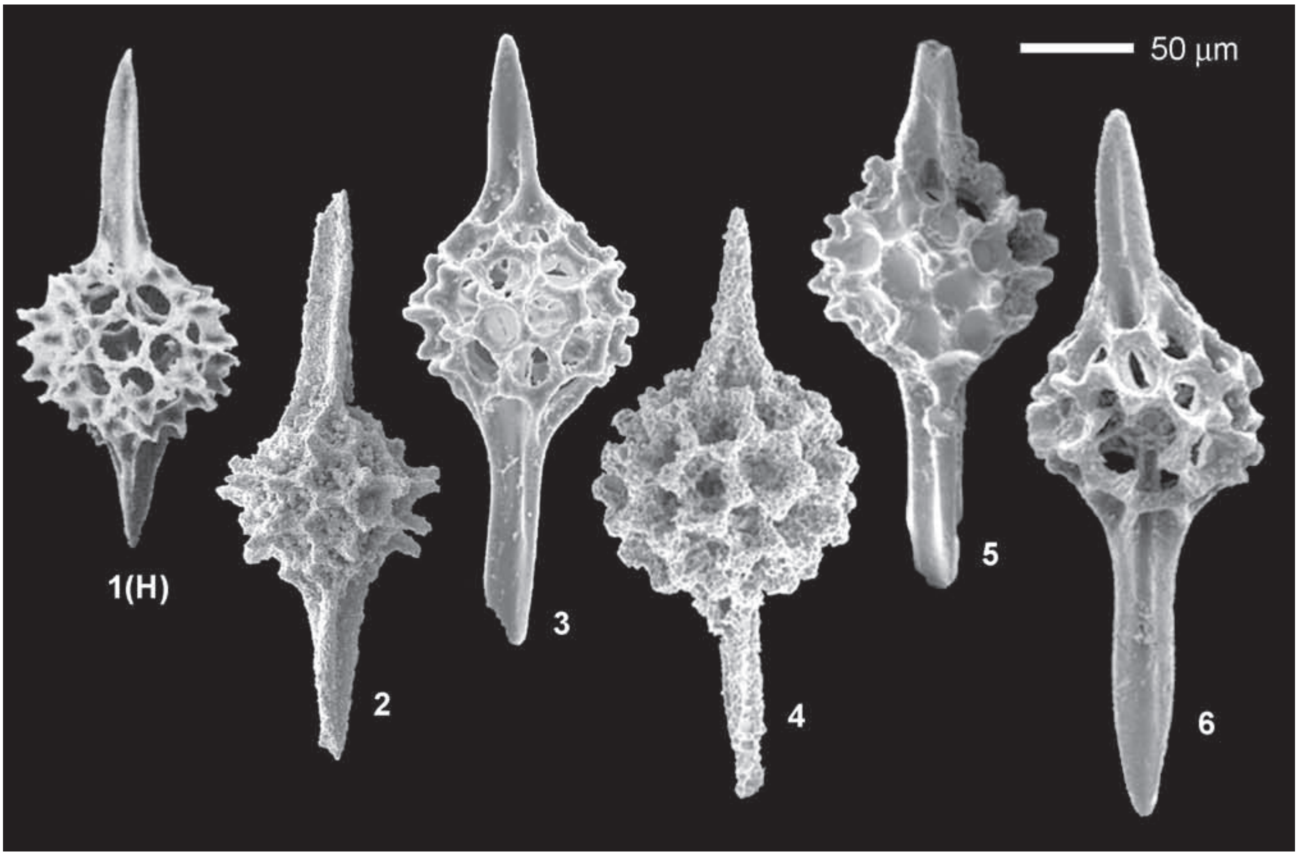


Plate PAN11. ***Pantanellium danaense*** **Pessagno & Blome.** Magnification x300. **Fig. 1**(H). Pessagno & Blome 1980, pl. 4, fig. 9. **Fig. 2.** OM, BR871-R09-01. **Fig. 3.** QCI, GSC loc. C-140495, GSC 128858. **Fig. 4.** QCI, GSC loc. C-305417, GSC 128859. **Fig. 5.** QCI, GSC loc. C-140495, GSC 128860. **Fig. 6.** QCI, GSC loc. C-140495, GSC 111732.

Pantanellium inornatum Pessagno & Poisson 1981

Species code: PAN19

Synonymy:

1981 *Pantanellium inornatum* n. sp. – Pessagno & Poisson, p. 56, pl. 6, figs. 1-9.

1981c *Pantanellium inornatum* Pessagno & Poisson – De Wever, p. 144, pl. 5, fig. 2.

1982b *Pantanellium inornatum* Pessagno & Poisson – De Wever, p. 128, pl. 1, fig. 8, 9.

1982 *Pantanellium inornatum* Pessagno & Poisson – De Wever & Origlia-Devos, pl. 1, fig. N.

1982 *Pantanellium* sp. – Imoto et al., pl. 1, fig. 11.

1988 *Pantanellium* cf. *browni* Pessagno & Blome – Li, pl. 1, fig. 13.

1988 *Pantanellium* aff. *inornatum* Pessagno & Poisson – Li, pl. 1, fig. 14.

1993 *Pantanellium* cf. *kluense* Pessagno & Blome – Kashiwagi & Yao, pl. 1, fig. 13.

1995 *Sphaerostylus inornatum* (Pessagno & Poisson) – Suzuki, pl. 8, fig. 7.

1996 *Pantanellium* sp. A – Pujana, p. 136, pl. 1, fig. 8.

1998 *Pantanellium inornatum* Pessagno & Poisson – Kashiwagi, pl. 2, figs. 16, 17, 21.

1998 *Pantanellium* sp. aff. *P. kungaense* Pessagno & Blome – Yeh & Cheng, p. 13, pl. 1, fig. 4.

1998 *Pantanellium* sp. cf. *P. inornatum* Pessagno & Poisson – Yeh & Cheng, p. 13, pl. 5, fig. 5, not fig. 3.

1998 *Pantanellium skedansense* Pessagno & Blome – Yeh & Cheng, p. 13, pl. 1, fig. 5.

Original description: Cortical shell, thin, spherical with relatively slender triradiate bipolar spines; triradiate bipolar spines with three rounded, narrow ridges alternating with three narrow grooves. Meshwork of cortical shell comprised of equal number of hexagonal and pentagonal pore frames. Pentagonal pore frames slightly smaller than hexagonal pore frames. Meshwork of first medullary shell thick likewise comprised of hexagonal pentagonal pore frames. Secondary radial beams between cortical shell and first medullary shell circular in axial section.

Original remarks: *Pantanellium inornatum* Pessagno, n. sp., differs from *P. riedeli* Pessagno (1977a) (1) by having longer, slender polar spines with narrow ridges separated by narrow grooves; (2) by having smaller, narrower ridges separated by narrow grooves; (3) by having smaller, more numerous pore frames; and (4) by having a thinner walled cortical shell and a thicker walled first medullary shell.

Measurements (μm):

Based on 9 specimens. System of measurements after Pessagno (1973).

A'S	AS	cc'	dd'	AA'	BB'	
110	85	25	20	85	80	HT
110	85	30	25	90	85	Max.
85	55	25	20	85	75	Min.

Etymology: *Inornatus-a-um* (Latin, adj.): unadorned.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Ghost Creek and Fannin formations, Queen Charlotte Islands; Sierra Chacaicó Formation, Argentina; Dürrnberg Formation, Austria; Haliw (Aqil) and Musallah formations, Oman; Dengqen area, Tibet; Liminangcong Chert, Philippines; Japan.

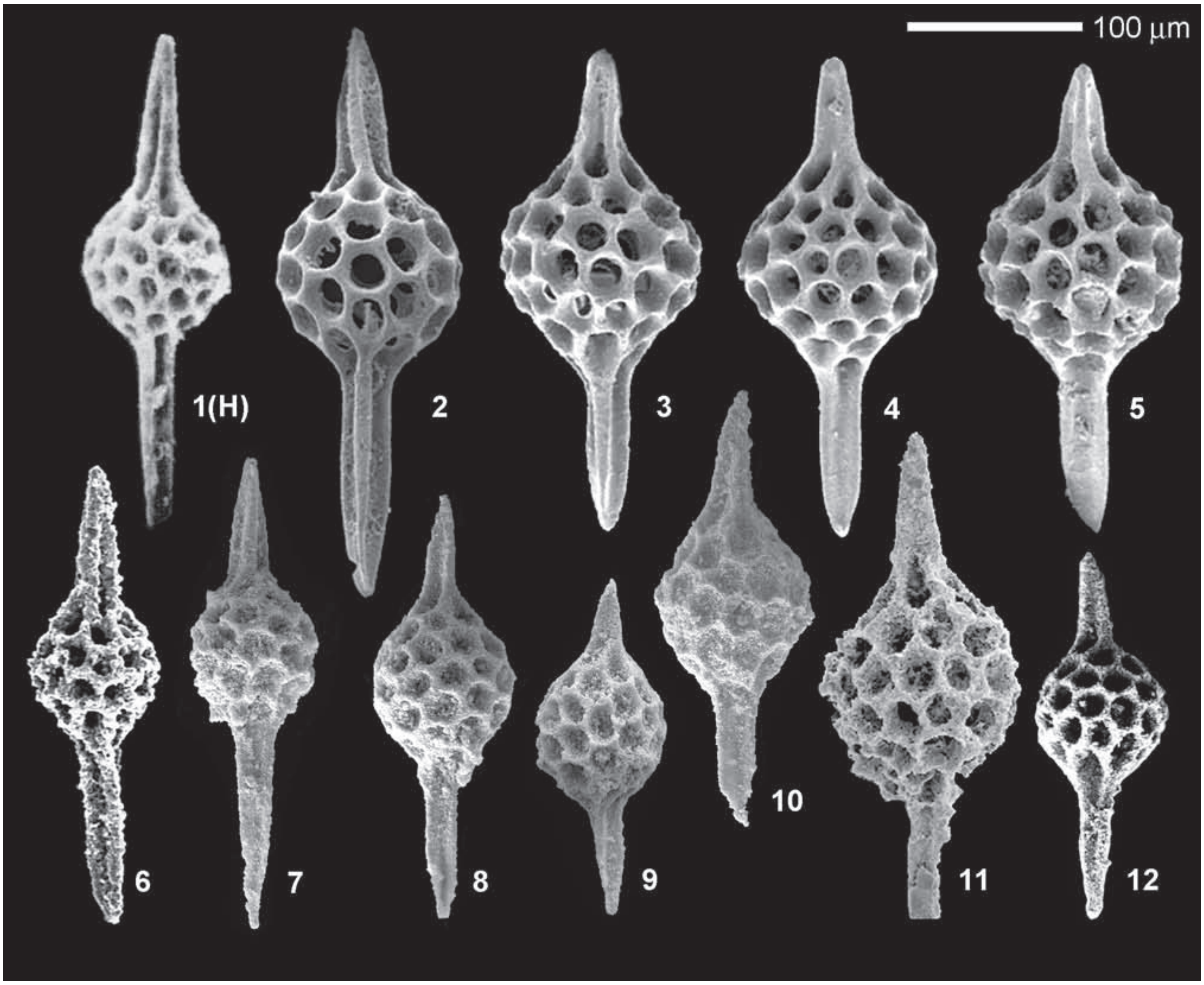


Plate PAN19. ***Pantanellium inornatum*** **Pessagno & Poisson.** Magnification x250. **Fig. 1(H).** Pessagno & Poisson 1981, pl. 6, fig. 1. **Fig. 2.** QCI, GSC loc. C-304566, GSC 111733. **Fig. 3.** QCI, GSC loc. C-080611, GSC 128861. **Fig. 4.** QCI, GSC loc. C-080611, GSC 128862. **Fig. 5.** QCI, GSC loc. C-080611, GSC 128863. **Fig. 6.** OM-00-115-023029. **Fig. 7.** OM, Haliw-039-R03-06. **Fig. 8.** OM, Haliw-039-R06-21. **Fig. 9.** OM, Haliw-039-R02-17. **Fig. 10.** OM, Haliw-038-R08-11. **Fig. 11.** AT, BMW 21-8. **Fig. 12.** JP, Ku(b)-11-24.

Pantanellium skedansense Pessagno & Blome 1980
Species code: PAN16

Synonymy:
1980 *Pantanellium skedansense* n. sp. – Pessagno & Blome, p. 246, pl. 5, figs. 8, 9, 15, 20, 23.
1998 *Pantanellium skedansense* Pessagno & Blome – Whalen & Carter, p. 49, pl. 1, fig. 12.
2002 *Pantanellium skedansense* Pessagno & Blome – Whalen & Carter, p. 105, pl. 6, figs. 7, 8, 13, 14.

Original description: Cortical shell spherical to subspherical with hexagonal and occasional pentagonal pore frames having poorly developed nodes at their vertices. Bars of pore frames thin in both Y and Z directions (text-fig. 5). Five to 6 pore frames visible along AA' and 6 along BB'. Polar spines long, triradiate in axial section, one spine somewhat longer than the other; some specimens with slightly curved spinal tips. Both spines comprised of 3 broad longitudinal grooves alternating with 3 ridges; grooves about 2 times as wide as ridges. Grooves and ridges maintaining about same width throughout.

Original remarks: *Pantanellium skedansense*, n. sp., appears closely related to *P. inornatum* Pessagno and Poisson (in press). It differs from the latter species primarily in possessing longer polar spines with much broader grooves. *Pantanellium skedansense* also closely resembles *P. sanrafaelense*, n. sp., in terms of the distribution and size of its pore frames and the structure of its primary spines; the longer polar spine of both species usually possesses a curved tip as well as wide grooves. *Pantanellium skedansense* differs from *P. sanrafaelense* by lacking prominent, massive nodes at pore frame vertices. It is suggested that *P. skedansense* may be ancestral to *P. sanrafaelense*.

Measurements (μm):
Based on 5 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
80	115	90	75	31	18	HT
72	104	80	68	25	18	Av.
80	115	90	75	31	20	Max.
70	85	70	60	20	15	Min.

Etymology: This species is named for Skedans Point north of Kunga Island.

Genus: *Parahsuum* Yao 1982

Type species: *Parahsuum simplum* Yao 1982

Synonymy:
1982 *Parahsuum* n. gen. – Yao, p. 61.
1982 *Lupherium* n. gen. – Pessagno & Whalen, 1982, p. 135.
1986 *Parahsuum* Yao – Takemura, p. 47.
1987b *Drulanta* n. gen. – Yeh, p. 71.
1987b *Fantus* n. gen. – Yeh, p. 61.
1988 *Parahsuum* Yao – Hori & Yao, p. 49.
1990 *Parahsuum* Yao – Kozur & Mostler, p. 222.

Original description: Shell multisegmented, conical to spindle-shaped lacking well-developed strictures. Cephalis conical to dome-shaped, poreless with or without apical horn. Thorax trapezoidal in outline with sparse irregulary displaced pores. Abdomen and post-abdominal segments with continuous edged costae. Single row of square pore frames with circular, primary pores between costae.

Original remarks: *Parahsuum* differs from *Hsuum* Pessagno (1977a, p. 81) in having single row of pores between costae, from *Archaeodictyomitra* Pessagno (1976, p. 49) in having primary pores, and from *Mita* Pessagno (1977b, p. 44) in having edged costae.

Further remarks: For the distinction between *Parahsuum* Yao and *Canutus* Pessagno & Whalen we follow Kozur & Mostler (1990) who wrote: "Some of the *Canutus* s.l. species, but not the type species *Canutus tipperi* Pessagno and Whalen, 1982, belong also to *Parahsuum* Yao, 1982. Therefore *Canutus* Pessagno and Whalen, 1982 is not synonymous with *Parahsuum* Yao, 1982. *Canutus* can be distinguished from *Parahsuum* by an outer layer that covers parts or all of the inner pore frames with very large rectangular pores. Moreover, typical *Canutus* have a spindle-shaped test. More elongate subconical species of *Canutus* s.l., in which the outer layer is reduced to nodes on the pore frame vertices or directly superimposed on the inner pore frames (no bars of the outer pore frame between the bars of the inner pore frames) as *Canutus giganteus* Pessagno and Whalen, 1982, *C. indomitus* Pessagno and Whalen, 1982 and *C. izeensis* Pessagno and Whalen, 1982 are here placed into *Parahsuum* Yao, 1982."

Etymology: This genus is named according to the similarity of the external shape with *Hsuum* Pessagno.

Included species:
PHS02 *Parahsuum edenshawi* (Carter) 1988
DRO05 *Parahsuum fondrenense* (Whalen & Carter) 1998
PHS09 *Parahsuum formosum* (Yeh) 1987b
2012 *Parahsuum izeense* (Pessagno & Whalen) 1982
PHS03 *Parahsuum longiconicum* Sashida 1988
PHS04 *Parahsuum mostleri* (Yeh) 1987b
PHS05 *Parahsuum ovale* Hori & Yao 1988
PHS01 *Parahsuum simplum* Yao 1982
PHS06 *Parahsuum vizcainoense* Whalen & Carter 2002
PHS07 *Parahsuum*? sp. A sensu Whalen & Carter 2002

Type locality: Sample QC 550, Sandilands Formation (Kunga Formation in Pessagno & Blome, 1980), Queen Charlotte Islands.

Occurrence: Sandilands and Ghost Creek formations, Queen Charlotte Islands; Fernie Formation, Williston Lake, northeastern British Columbia; San Hipólito Formation, Baja California Sur.

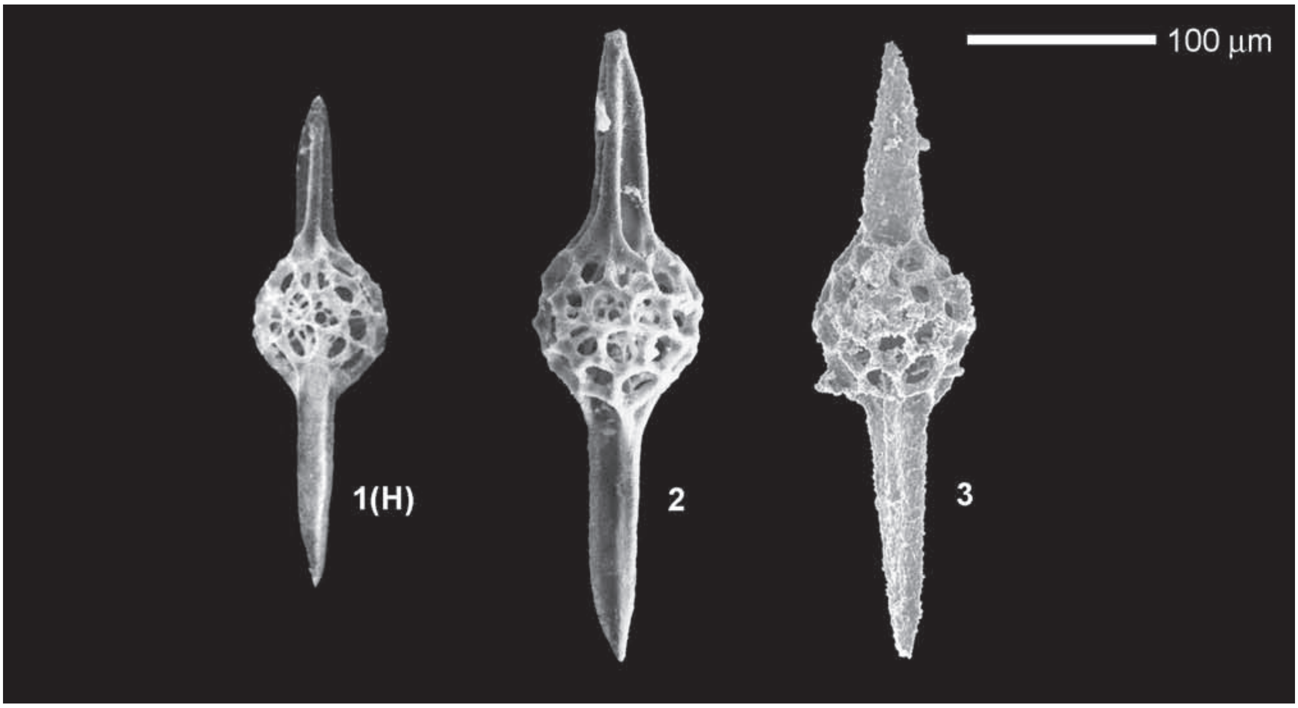


Plate PAN16. *Pantanellium skedansense* Pessagno & Blome. Magnification x250. **Fig. 1(H).** Pessagno & Blome 1980, pl. 5, fig. 8. **Fig. 2.** Whalen & Carter 2002, pl. 6, fig. 7. **Fig. 3.** NBC, GSC loc. C-305813, GSC 111734.

Parahsuum edenshawi (Carter) 1988

Species code: PHS02

Synonymy:

1988 *Drulanta edenshawi* Carter n. sp. – Carter et al., p. 53, pl. 2, fig. 5 only.
1990 *Drulanta* sp. cf. *mostleri* Yeh – De Wever et al., pl. 4, fig. 4.
? 1998 *Parahsuum* sp. – Kashiwagi, pl. 1, fig. 8.
2004 *Parahsuum* sp. – Matsuoka, fig. 210.

Original diagnosis: Test conical, rounded apically without horn. 9 to 12 strong, rounded longitudinal costae visible laterally between single rows of large circular to rectangular pores. Test has a »welded« appearance.

Original description: Test elongate, conical, rounded apically without horn and usually with six or seven post-abdominal chambers. Cephalis hemispherical, all other chambers trapezoidal in outline. All but final one or two chambers increasing gradually in height and width; distal chambers on complete specimens slightly reduced in width. Some tests very slightly constricted at joints. Cephalis and thorax perforate, covered with a smooth layer of microgranular silica. Two rows of thin, circular to rectangular pore frames per chamber; pores circular to subcircular. Continuous costae strong, and rounded; superimposed on test between single longitudinal rows of coarse pores; 9 to 12 costae visible laterally. Test has a »welded« appearance.

Original remarks: *Drulanta edenshawi* has a more variable morphology than *D. mostleri* Yeh. It can have a shorter, stouter test that is very rounded apically as illustrated by the holotype (Pl. 2, fig. 5) as well as a more elongate test illustrated by the paratype (Pl. 2, fig. 6). It is generally larger than *D. mostleri* and has much coarser costae.

Measurements (μm):
Based on 17 specimens.

	HT	Av.	Max.	Min.
Length	296	290	350	210
Maximum width	148	149	170	112

Etymology: Named for Albert Edward Edenshaw, a prominent chief of the Haida Indians whose head village was at Kiusta, later at Kung (both are located on the north coast of Graham Island).

Type locality: GCS locality C-080577, Fannin Formation, Creek locality, Maude Island.

Occurrence: Fannin Formation, Queen Charlotte Islands; Haliw Formation, Tawi Sadh Member of the Guwayza Formation, Musallah Formation, Oman; Japan.

Parahsuum fondrenense (Whalen & Carter) 1998

Species code: DRO05

Synonymy:

1998 *Droltus fondrenensis* n. sp. – Whalen & Carter, p. 63, pl. 15, figs. 9, 18.

Original description: Test conical, finely costate, with approximately four to six postabdominal chambers. Cephalis medium sized, dome-shaped, sparsely perforate, mostly covered by layer of microgranular silica; cephalis with short, delicate horn, circular in axial section. Thorax, abdomen, and postabdominal chambers trapezoidal in outline, increasing gradually in width and height as added. Pore frames of outer latticed layer on abdomen and postabdominal chambers square to rectangular, aligned in distinct transverse and vertical rows, becoming larger as added. First few postabdominal chambers with about 8 costae visible laterally; number of costae increasing to about 12 on final postabdominal chamber.

Original remarks: The much more regularly aligned pore frames of the outer latticed layer, distinguish *Droltus fondrenensis* n. sp. from *D. firmus* n. sp.

Further remarks: This species seems to be closely related to *Parahsuum formosum* (Yeh) from which it differs, because its vertical costae are not continuous throughout the test.

Measurements (μm):
Based on 6 specimens.

Length (excluding horn)	Max. width	
195	105	HT
225	128	Max.
150	94	Min.
191	112	Mean

Etymology: This species is named for Fondren Science Building at the University of Texas at Dallas where much of the systematic research for this paper was carried out.

Type locality: Sample QC-677, Sandilands Formation, Kunga Island, Queen Charlotte Islands.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

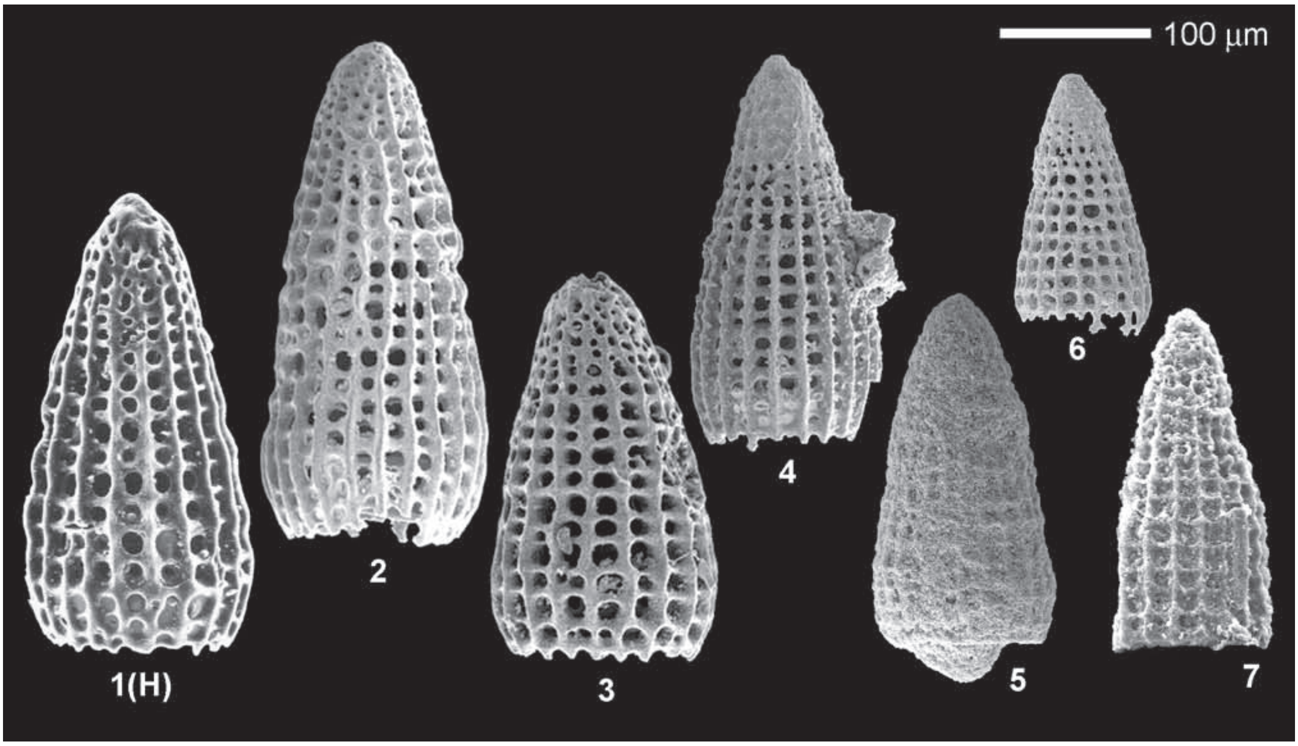


Plate PHS02. *Parahsuum edenshawi* (Carter). Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 2, fig. 5. **Fig. 2.** QCI, GSC loc. C-080611, GSC 128879. **Fig. 3.** QCI, GSC loc. C-304566, GSC 128880. **Fig. 4.** QCI, GSC loc. C-080612, GSC 111735. **Fig. 5.** OM, Haliw-039-R02-13. **Fig. 6.** OM, BR524-R05-15. **Fig. 7.** OM-00-251-021433.

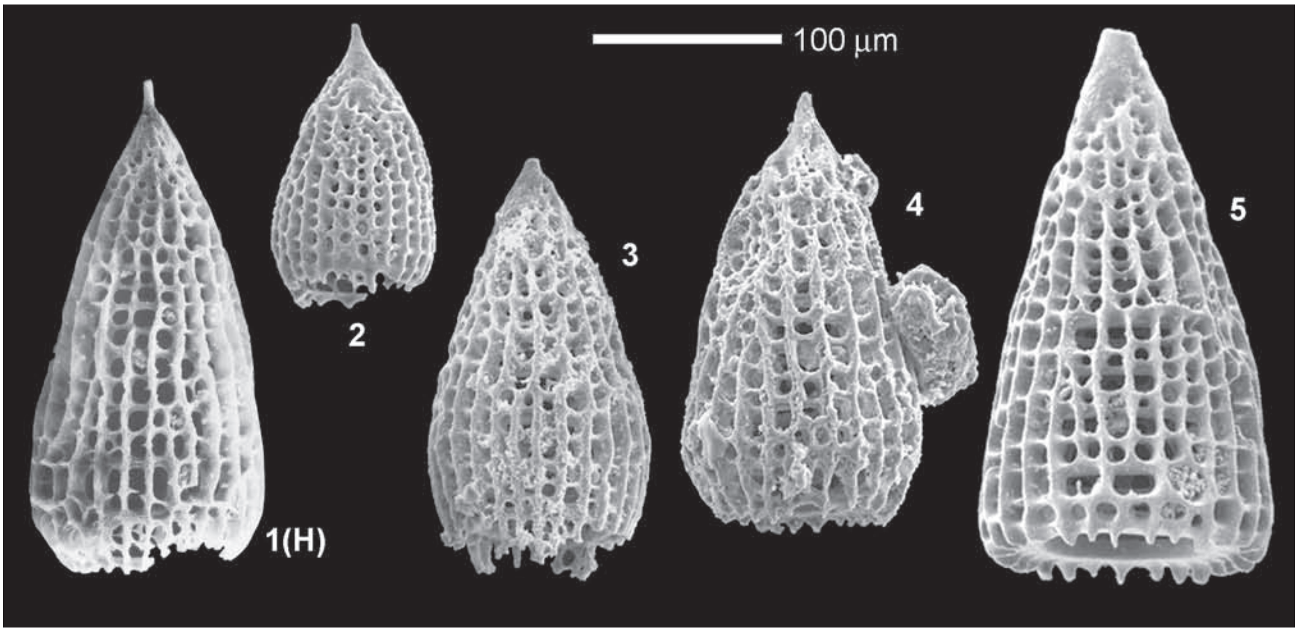


Plate DRO05. *Parahsuum fondrenense* (Whalen & Carter). Magnification x250. **Fig. 1(H).** Carter et al. 1998, pl. 15, fig. 9. **Fig. 2.** QCI, GSC loc. C-304281, GSC 128797. **Fig. 3.** QCI, GSC loc. C-175311, GSC 128798. **Fig. 4.** QCI, GSC loc. C-175310, GSC 128799. **Fig. 5.** QCI, GSC loc. C-080611, GSC 128800.

Parahsuum formosum (Yeh) 1987b

Species code: PHS09

Synonymy:

1987b *Drulanta formosa* n. sp. – Yeh, p. 72, pl. 19, figs. 13-14.
2004 *Droltus* sp. – Matsuoka, fig. 204.

Original description: Test as with genus, costate throughout the test except cephalis and thorax. Costae massive, about ten visible laterally. Cephalis relativelly small, conical. Cephalis and thorax covered with layer of microgranular silica. Meshwork of inner latticed layer consisting of square to rectangular pore frames and increasing in size distally. Chambers increasing in width rapidly and in length gradually as added.

Further remarks: See remarks under *Parahsuum fondrenense* (Whalen & Carter).

Measurements (μm):
Based on ten specimens.

	Max. length	Max. width
HT	200	140
Mean	205	142
Max.	210	146
Min.	194	137

Etymology: *Formosus-a-um* (Latin, adj.) = beautiful.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands; Japan.

Parahsuum izeense (Pessagno & Whalen) 1982

Species code: 2012

Synonymy:

1982 *Canutus izeensis* n. sp. – Pessagno & Whalen, p. 129, pl. 6, figs. 8, 10, 15.
1982 *Canutus giganteus* n. sp. – Pessagno & Whalen, p. 127, pl. 4, figs. 5, 13.
1987b *Broctus izeensis* (Pessagno & Whalen) – Yeh, pl. 4, fig. 29.
? 1987b *Broctus* (?) sp. A – Yeh, p. 54.
1988 *Canutus giganteus* Pessagno & Whalen – Carter et al., p. 50, pl. 3, fig. 1.
1988 *Canutus izeensis* Pessagno & Whalen – Carter et al., p. 51, pl. 3, fig. 2.
1995a *Parahsuum izeense* (Pessagno & Whalen) – Baumgartner et al., p. 378, pl. 2012, figs. 1-2.
1996 *Canutus izeensis* (Pessagno & Whalen) – Pujana, p. 138, pl. 1, fig. 15.
1998 *Canutus izeensis* Pessagno & Whalen – Cordey, p. 104, pl. 25, figs. 5, 10.
2003 *Parahsuum izeense* (Pessagno & Whalen) – Goričan et al., p. 296, pl. 5, figs. 18-19.

Original description: Test short, inflated, spindle-shaped, usually with six post-abdominal chambers. Cephalis hemispherical, knoblike; remaining chambers trapezoidal in cross section; cephalis and thorax usually imperforate. Abdomen and all but last two or three post-abdominal chambers increasing rapidly in width and gradually in length as added; last two or three post-abdominal chambers decreasing somewhat in width. Inner latticed layer of post-abdominal chambers consisting of moderately sized square to rectangular pore frames with nodes at vertices; 15 rows of pore frames visible laterally; three pore frames per row occurring between two longitudinal ridges and joints of chamber. Outer (second) latticed layer consisting of fragile, irregular, polygonal pore frames. Outer latticed layer best developed on earlier post-abdominal chambers.

Original remarks: *Canutus izeensis*, n. sp. differs from *C. tipperi*, n. sp. by having a less inflated test, a hemispherical, knoblike cephalis, and considerably smaller pore frames in the inner layer.

Further remarks: *Parahsuum giganteum* and *P. izeense* are synonymized because they represent a continuum of test shape from slender to broad.

Measurements (μm):
Based on 8 specimens.

Length	Width (max.)	
350.0	200.0	HT
350.0	200.0	Max.
250.0	150.0	Min.
303.1	175.0	Mean

Etymology: This species is named for the village of Izee near its type locality.

Type locality: OR-536, Nicely Formation, southeast side of Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Fannin Formation, Queen Charlotte Islands; Bridge River Complex, British Columbia; Franciscan Complex, California; Sierra Chacaicó Formation, Argentina; Apennines, Italy; Skrile Formation, Slovenia; Musallah Formation, Oman.

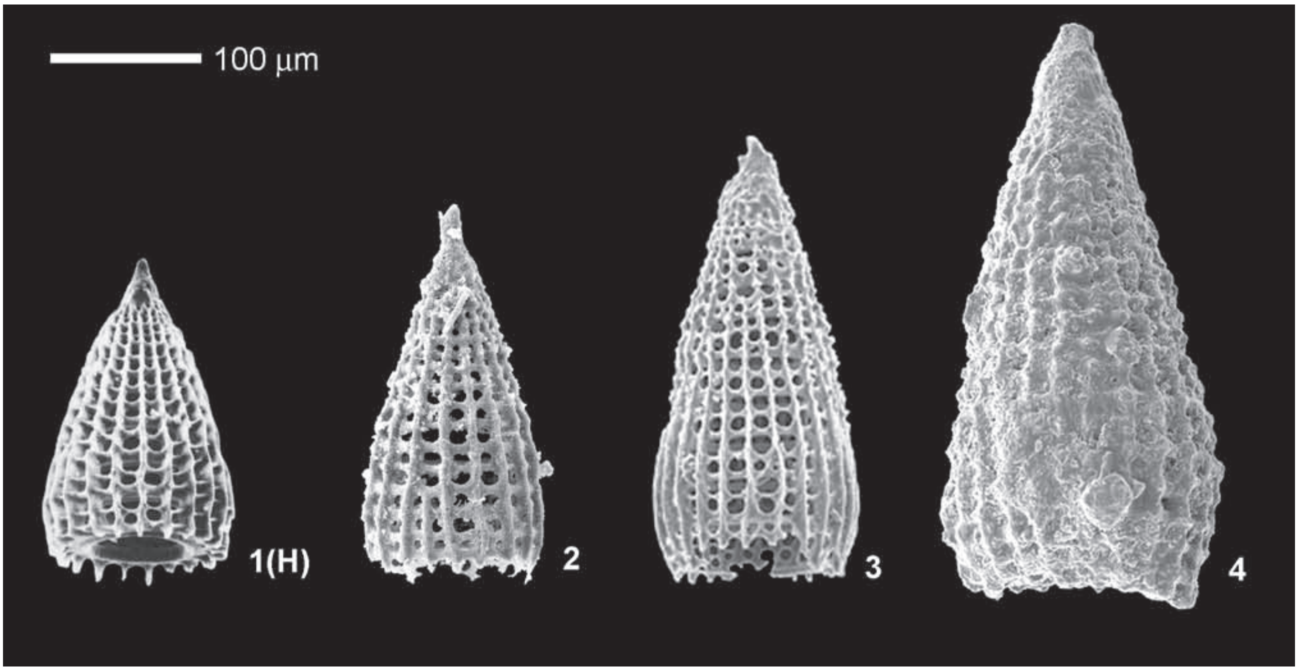


Plate PHS09. ***Parahsuum formosum*** **(Yeh).** Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 19, fig. 13. **Fig. 2.** JP, MNA-10, MA13299. **Fig. 3.** QCI, GSC loc. C-175306, GSC 128881. **Fig. 4.** QCI, GSC loc. C-127898, GSC 111736.

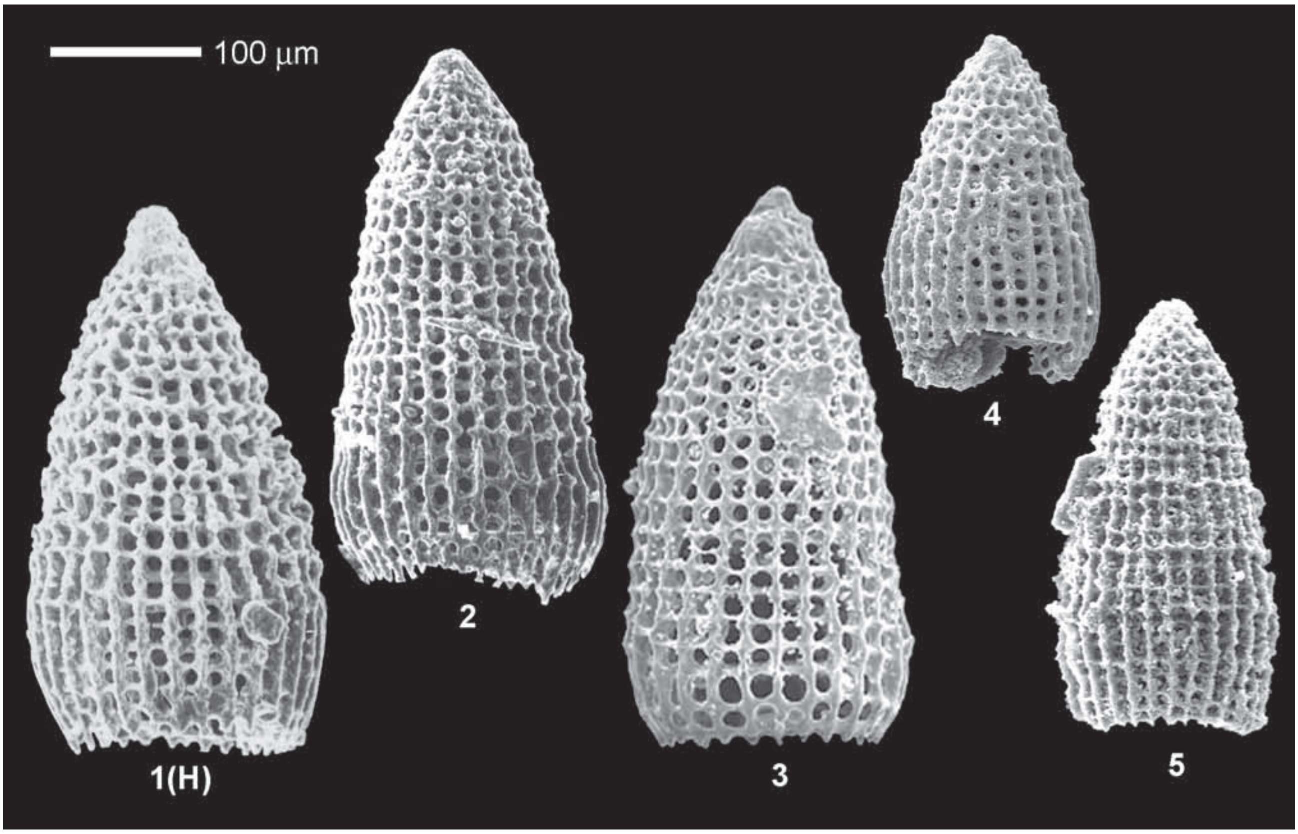


Plate 2012. ***Parahsuum izeense*** **(Pessagno & Whalen).** Magnification x200. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 6, fig. 8. **Fig. 2.** Pessagno & Whalen 1982, pl. 4, fig. 5. **Fig. 3.** QCI, GSC loc. C-080577, GSC 128703. **Fig. 4.** Goričan et al. 2003, pl. 5, fig. 18. **Fig. 5.** OM-00-254-022034.

Parahsuum longiconicum Sashida 1988

Species code: PHS03

Synonymy:

1988 *Parahsuum longiconicum* n. sp. – Sashida, p. 20, pl. 2, figs. 1-4, 16, 17.
1988 *Parahsuum kanyoense* n. sp. – Sashida, p. 21, pl. 1, figs. 14, 15, 20-24;
1990 *Parahsuum* aff. *longiconicum* Sashida – Hori, Fig. 8.14
1996 *Parahsuum longiconicum* Sashida – Tumanda et al., p. 178, Fig. 4.2.
1997 *Parahsuum* sp. aff. *P. longiconicum* Sashida – Hori, pl. 1, fig. 24.
1998 *Parahsuum longiconicum* Sashida – Kashiwagi, pl. 1, fig. 4.
? 2001 *Parahsuum* cf. *longiconicum* Sashida – Kashiwagi, Fig. 6.3.
2003 *Parahsuum longiconicum* Sashida – Goričan et al., p. 296, pl. 5, fig. 16.
2003 *Parahsuum* cf. *longiconicum* Sashida – Kashiwagi & Kurimoto, pl. 3, figs. 7, 10.
2004 *Parahsuum longiconicum* Sashida – Hori, pl. 8, figs. 49-50, 54.
2004 *Parahsuum* sp. – Hori, pl. 8, figs. 51-52, 55-57, ? fig. 59.
2004 *Parahsuum kanyoense* Sashida – Hori, pl. 8, fig. 53.
2004 *Parahsuum longiconicum* Sashida – Ishida et al., pl. 5, figs. 3, 4.

Original diagnosis: *Parahsuum* of cone-shaped test with long conical horn.

Original description: Conical test of medium width with a massive conical horn on hemispherical cephalis. Cephalis usually has wide and deep grooves at the base of conical horn. Thorax and subsequent chambers trapezoidal in outline, increasing gradually in width and length as added except for final post-abdominal chamber. Complete specimens with six to seven post-abdominal chambers. Outer layer comprised continuous edged costae except for apical region. Single row of square pore frames between costae. Weak circumferential ridges present at joint part of the first and second post-abdominal chambers. Ten to eleven costae usually visible on side view of final post-abdominal chamber.

Original remarks: This species closely resembles *Parahsuum kanyoense*, n. sp. in general shell shape. However, the present new species has a longer conical horn and more uniform frame work on the outer surface of shell.

Further remarks: *Parahsuum longiconicum* Sashida differs from *P. formosum* (Yeh) by having linearly arranged costae only on the distal half to two thirds of the test and by having a much stronger horn.

Measurements (μm):
Based on 15 specimens.

Length	Max. width	No. of postabdominal chambers	Length of horn	
230	130	7	50	Max.
205	110	6	25	Min.
220	120	6	40	Mean

Etymology: Latin, *longus* means long and *conica*, conical.

Type locality: Sample TAK-5, Takarazawa Valley, Itsukaichi area, Tokyo Prefecture, central Japan.

Occurrence: Japan; Liminangcong Chert, Philippines; Haliw (Aqil) Formation and Tawi Sadh Member of the Guwayza Formation, Oman; Skrile Formation, Slovenia; Dürrnberg Formation, Austria; Fannin Formation, Queen Charlotte Islands.

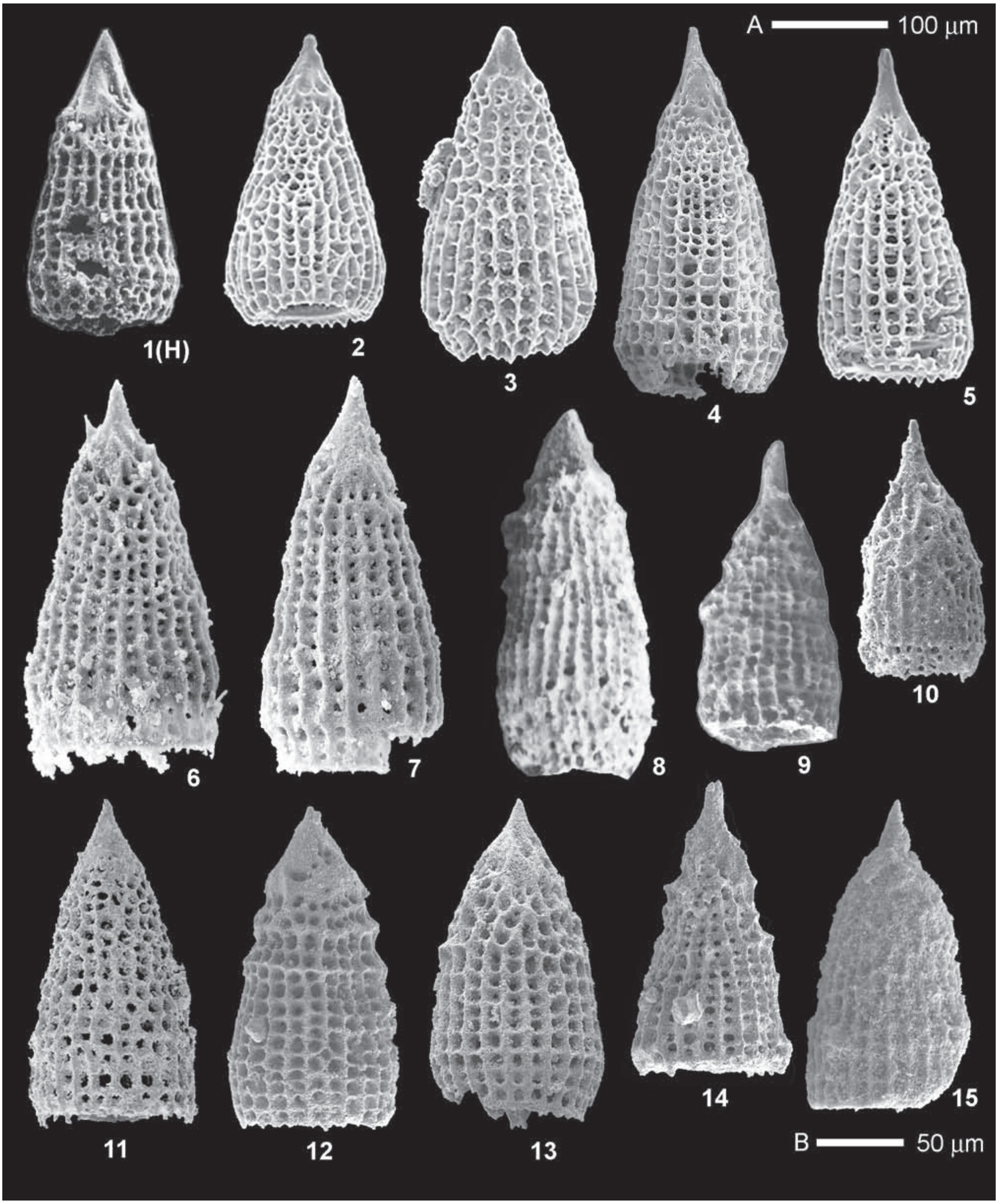


Plate PHS03. ***Parahsuum longiconicum*** **Sashida.** Magnification Figs. 1-5, 9, 11 x200 (scale bar A), Figs. 6-8, 10, 12-15 x300 (scale bar B). **Fig. 1(H).** Sashida 1988, pl. 2, fig. 1. **Fig. 2.** GSC loc. C-304568, GSC 128883. **Fig. 3.** GSC loc. C-304568, GSC 128884. **Fig. 4.** GSC loc. C-080613, GSC 128885. **Fig. 5.** GSC loc. C-304568, GSC 111803. **Fig. 6.** JP, MNA-10, MA12861. **Fig. 7.** JP, MNA-10, MA13012. **Fig. 8.** JP, IYII-11-69. **Fig. 9.** Hori 1990, Fig. 8-14. **Fig. 10.** Goričan et al. 2003, pl. 5, fig. 16. **Fig. 11.** AT, BMW21-55. **Fig. 12.** OM, BR1121-R09-26. **Fig. 13.** OM, BR1122-R02-03. **Fig. 14.** OM, BR1121-R08-01. **Fig. 15.** OM, Haliw-038-R08-32.

Parahsuum mostleri (Yeh) 1987b

Species code: PHS04

Synonymy:

1987b *Drulanta mostleri* n. sp. – Yeh, p. 72, pl. 18, Figs. 3-4, 21.
1987b *Drulanta* sp. cf. *D. mostleri* n. sp. – Yeh, p. 73, pl. 18, fig. 1.
1987b *Drulanta mirifica* n. sp. – Yeh, p. 72, pl. 4, fig. 8; pl. 18, figs. 5, 7-8, 23.
1987b *Drulanta* sp. aff. *D. mirifica* n. sp. – Yeh, p. 72, pl. 3, fig. 17.
1987 *Canutus* aff. *C. hainaensis* – Hattori, pl. 15, fig. 11.
1988 *Drulanta edenshawi* Carter n. sp. – Carter et al., p. 53, pl. 2, fig. 6 only.
1989 *Drulanta* sp. aff. *D. pulchra* Yeh – Hattori, pl. 12, fig. K.
1989 *Drulanta* sp. aff. *D. mirifica* Yeh – Hattori, pl. 12, fig. L.
1997 *Parahsuum mirifica* (Yeh) – Yao, pl. 14, fig. 648.
1998 *Drulanta mirifica* Yeh – Yeh & Cheng, p. 23, pl. 8, fig. 17, pl. 9, fig. 19.
2002 *Parahsuum mostleri* (Yeh) – Whalen & Carter, p. 126, pl. 15, figs. 4, 14.
2003 *Parahsuum mostleri* (Yeh) – Goričan et al., p. 296, pl. 5, fig. 20.

Original description: Cephalis small, conical, usually with seven to nine post-abdominal chambers. Cephalis dome-shaped without horn. Thorax and subsequent chambers trapezoidal in outline. Cephalis and thorax sparsely perforate, covered with layer of microgranular silica. Abdomen and all post-abdominal chambers comprised of ten, longitudinal costae superimposed on each row of pore frames. About nine to ten costae visible laterally. Pore frames medium in size. Chambers increasing gradually in width as added with final post-abdominal chamber remaining in the same width or decreasing slightly in width.

Original remarks: *Drulanta mostleri*, n. sp., differs from *D. mirifica*, n. sp., by having a shorter test with smaller cephalis.

Further remarks: *Drulanta mostleri* and *Drulanta mirifica* are herein assigned to *Parahsuum* and synonymized because they represent variability amongst the population. *P. mostleri* is more elongated and more pointed apically than *P. edenshawi* (Carter).

Measurements (μm):
Ten specimens measured.

Max. length	Max. width	
221	117	HT
218	119	Mean
222	123	Max.
216	115	Min.

Etymology: This species is named after Dr. H. Mostler in honor of his studies on the Mesozoic Radiolaria.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Fannin Formation, Queen Charlotte Islands; San Hipólito Formation, Baja Californian Sur; Skrile Formation, Slovenia; Dürrnberg Formation, Austria; Liminangcong Chert, Philippines; Japan.

Parahsuum ovale Hori & Yao 1988

Species code: PHS05

Synonymy:

1982 *Parahsuum* (?) sp. C – Yao, pl. 4, figs. 9-11.
1982 *Parahsuum* (?) sp. C – Yao et al., pl. 2, fig. 10.
1986 *Parahsuum* (?) sp. C – Hori, fig. 6.3.
1986 *Parahsuum* sp. C – Matsuoka, pl. 1, fig. 2.
1986 *Parahsuum* sp. C – Matsuoka & Yao, pl. 1, fig. 3.
1986 *Parahsuum directiporata* (Rüst) – Sato et al., fig. 17.11.
1986 *Bagotum* sp. A – Sashida et al., fig. 5.18.
1988 *Parahsuum ovale* n. sp. – Hori & Yao, p. 51, pl. 1, figs. 3a-e, 4a-c, 6-8, 9a, b.
1988 *Parahsuum takarazawaense* n. sp. – Sashida, p. 19, pl. 1, figs. 6-13, 18, 19.
1990 *Parahsuum ovale* Hori & Yao – Hori, fig. 8.16.
1990 *Parahsuum ovale* Hori & Yao – Yao, pl. 2, fig. 2.
1992 *Parahsuum takarazawaense* Sashida – Sashida, pl. 1, fig. 7.
1993 *Parahsuum ovale* Hori & Yao – Kashiwagi & Yao, pl. 1, fig. 1.
1994 *Parahsuum ovale* Hori & Yao – Goričan, p. 79, pl. 17, fig. 13.
1997 *Parahsuum ovale* Hori & Yao – Hori, pl. 1, fig. 26.
1997 *Parahsuum ovale* Hori & Yao – Yao, pl. 14, fig. 654.
1998 *Parahsuum ovale* Hori & Yao – Kashiwagi, pl. 1, fig. 3; pl. 2, fig. 20.
2003 *Parahsuum takarazawaense* Sashida – Kashiwagi & Kurimoto, pl. 3, fig. 4.
2004 *Parahsuum ovale* Hori & Otsuka – Hori, pl. 2, figs. 1, 2; ?pl. 2, fig. 25.
2004 *Parahsuum ovale* Hori & Yao – Ziabrev et al., Fig. 5-5.
2005 *Parahsuum ovale* Hori & Otsuka – Hori, pl. 8, fig. 4.

Original description: Shell of 6 or more segments, oval, without stricture. Cephalis poreless apically, flattened conical, without apical horn. Internal cephalic structure quite indistinct. Apical surface of shell smooth, partially with shallow irregular depressions and sparsely arranged pores. Thorax and abdomen with small, circular pores arranged irregularly and with polygonal pore frames. In some specimens, thorax and abdomen with regularly arranged pores and with tetragonal pore frames. Post-abdominal segments with 22-28 continuous longitudinal costae. Each of post-abdominal segments with 2 or 3 transverse rows of pores arranged tetragonally. Edged small nodes occurring at vertices of pore frames.

Original remarks: *Parahsuum ovale* sp. nov. differs from other species of *Parahsuum* in having an oval shell and being fairly flat in apical part. *P. ovale* is possibly co-specific with *Stichocapsa directiporata* Rüst. *S. directiporata* is distinguished from *P. ovale* by having a small number (16-18) of longitudinal costae.

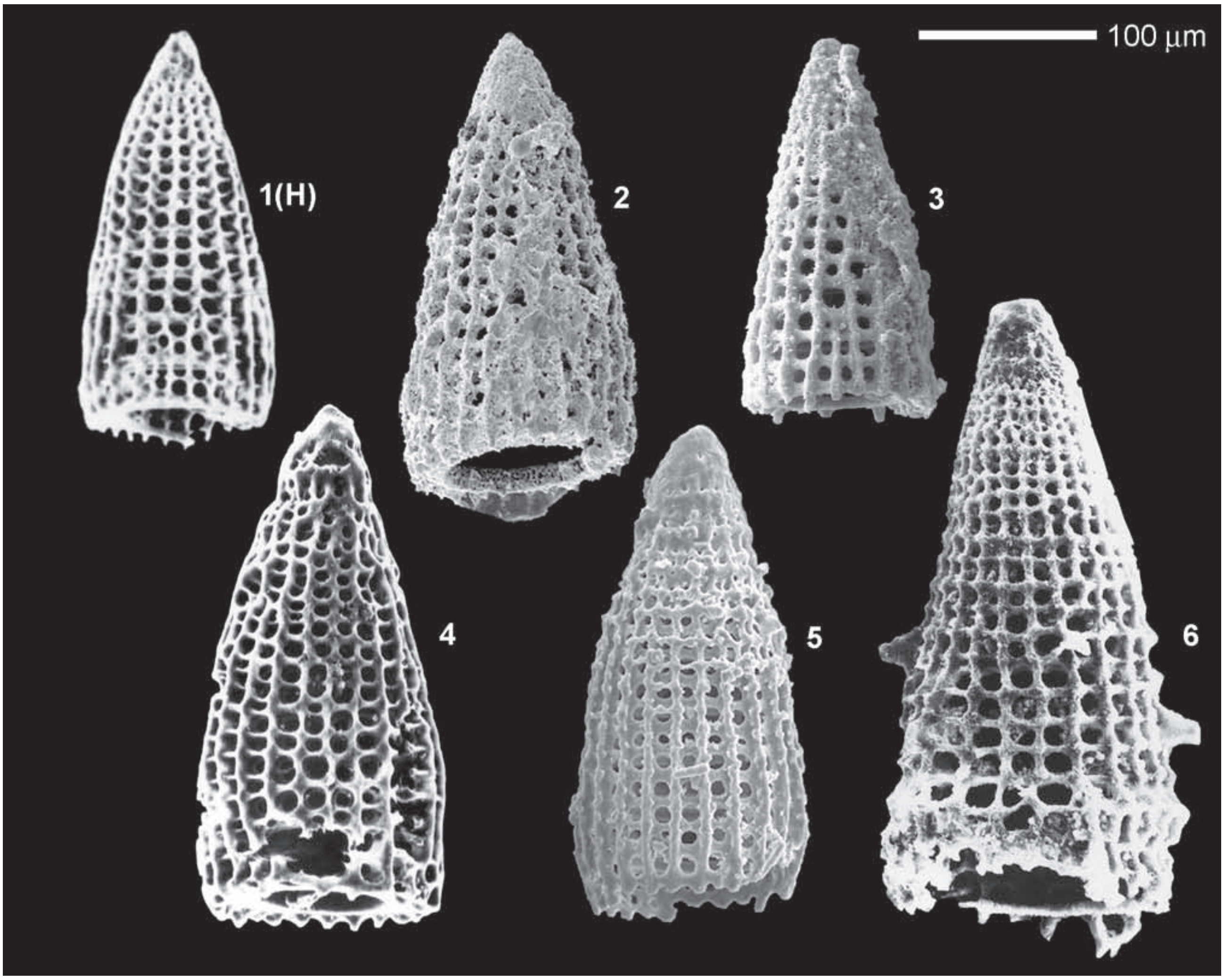


Plate PHS04. *Parahsuum mostleri* (Yeh). Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 18, fig. 3. **Fig. 2.** AT, BMW21-16. **Fig. 3.** Goričan et al. 2003, pl. 5, fig. 20. **Fig. 4.** Carter et al. 1988, pl. 2, fig. 6. **Fig. 5.** QCI, GSC loc. C-305388, GSC 128882. **Fig. 6.** Whalen & Carter 2002, pl. 15, fig. 4.

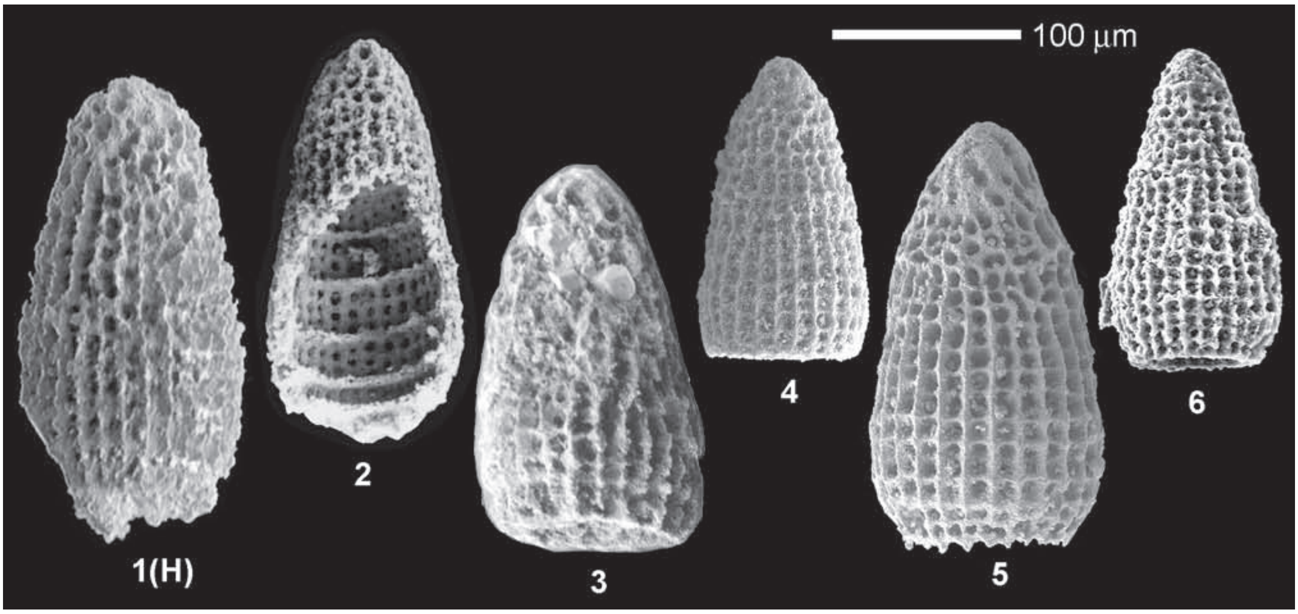


Plate PHS05. *Parahsuum ovale* Hori & Yao. Magnification x250. **Fig. 1(H).** Hori & Yao 1988, pl. 1, fig. 3a. **Fig. 2.** JP, Ku(b)-11. **Fig. 3.** Hori 1990, Fig. 8-16. **Fig. 4.** OM, Haliw-038-R09-19. **Fig. 5.** OM, BR1121-R06-12. **Fig. 6.** OM-00-252-021728.

Measurements (μm):
Based on 13 specimens.

Hight	Width	H/W	
211	120	1.76	HT
225	124	1.82	Av.
246	141	2.05	Max.
211	109	1.50	Min.

Etymology: The name is derived from the Latin adjective *ovalis*, meaning oval (egg-shaped).

Type locality: Sample 38, Inuyama Section, Kiso River, 1.km NE of Unuma, Central Japan.

Occurrence: Japan; Budva Zone, Montenegro; Haliw (Aqil) Formation, Tawi Sadh Member of the Guwayza Formation, Musallah Formation, Oman; Bainang Terrane, Tibet.

Parahsuum simplum Yao 1982

Species code: PHS01

Synonymy:
1982 *Parahsuum simplum* n. sp. – Yao, p. 61, pl. 4, figs. 1-8.
1982 *Parahsuum simplum* Yao – Yao et al., pl. 2, fig. 9.
1982 *Parahsuum simplum* Yao – Imoto et al., pl. 1, figs. 1, 2.
1983 *Parahsuum simplum* Yao – Ishida, pl. 2, figs. 1-2.
1984 *Lupherium*? spp. – Whalen & Pessagno, pl. 4, figs. 8, 10, 11.
1986 *Parahsuum simplum* Yao – Matsuoka & Yao, pl. 1, fig. 2.
1987 *Parahsuum simplum* Yao – Goričan, p. 185, pl. 1, fig. 3.
1988 *Parahsuum simplum* Yao – Hori & Yao, p. 51, pl. 1, figs.1a-d.
1988 *Parahsuum simplum* Yao – Sashida, p. 19, pl. 1, figs. 1-5, 16, 17.
1990 *Parahsuum simplum* Yao – De Wever et al., pl. 4, fig. 1, not fig. 9.
1990 *Parahsuum simplum* Yao – Hori, Fig. 8.15.
1990 *Parahsuum simplum* Yao – Kozur & Mostler, p. 222, pl. 17, fig. 2.
1990 *Parahsuum simplum* Yao – Yao, pl. 2, fig. 1.
1992 *Parahsuum simplum* Yao – Sashida, pl. 1, figs, 1, 2, 5, 6, not figs. 3, 4.
? 1992 *Parahsuum simplum* Yao – Sano et al., pl. 2, fig. A.
1994 *Parahsuum simplum* Yao – Goričan, p. 79, pl. 17, figs. 9, 10, 12.
1996 *Canutus* sp. aff. *C. hainaensis* Pessagno & Whalen – Pujana, p. 138, pl. 1, fig. 5.
1997 *Parahsuum simplum* Yao – Hori, pl. 1, fig. 25.
1997 *Parahsuum simplum* Yao – Sugiyama, p. 184, Fig. 28-8.
1998 *Parahsuum simplum* Yao – Whalen & Carter, 67, pl. 16, ig. 6.
1998 *Parahsuum simplum* Yao – Kashiwagi, pl. 1, figs. 1, 2; pl. 2, fig. 1.
1998 *Parahsuum simplum* Yao – Yeh & Cheng, p. 26, pl. 4, fig. 14.
2002 *Parahsuum simplum* Yao – Whalen & Carter, p. 126, pl. 12, figs. 3, 4, 12, 13; pl. 17, figs. 14, 15.
2002 *Parahsuum* sp. aff. *P. simplum* Yao – Whalen & Carter, p. 126, pl. 12, fig. 5; pl. 17, figs. 12, 13.
2002 *Parahsuum simplum* Yao – Tekin, p. 189, pl. 4, fig. 3.
2003 *Parahsuum simplum* Yao – Kashiwagi & Kurimoto, pl. 3, figs. 1-3.
2004 *Parahsuum simplum* Yao – Hori, pl. 1, fig. 51, pl. 2, fig. 24.
2004 *Parahsuum simplum* Yao – Hori et al., pl. 6, fig. 3.
2004 *Parahsuum simplum* Yao – Ishida et al., pl. 5, figs. 1, 2.
2005 *Parahsuum simplum* Yao – Hori, pl. 8, figs. 1-2.

Original description: Shell of 6 or more segments, elongate, conical, becoming somewhat spindle-shaped in unbroken or mature forms. Cephalis poreless, conical with short apical horn. Internal cephalic structure quite indistinct. Post-thoracic segments with continuous 24-32 costae. Each of post-thoracic segments has 3 or 4 transverse rows of pores arranged tetragonally. In some specimens, weak circumferencial ridges present at joint part of segments.

Original remarks: *Parahsuum simplum* differs from *Parahsuum* (?) sp. A in lacking a long apical horn, and from *Parahsuum* (?) sp. C in having a conical shell.

Further remarks: The considerable range in variation of this species in overall size and width of distal chambers has already been recognized by Hori & Yao (1988).

Measurements (μm):
Based on 27 specimens.

	Min.	Max.	Av.
Height overall	161	293	216
Max. height of segment	28	39	33
Max. width of shell	85	129	104

Etymology: The name is derived from the Latin adjective *simplus*, meaning simple.

Type locality: Sample 38, Inuyama Section, Kiso River, 1 km NE of Unuma, Central Japan.

Occurrence: Worldwide.

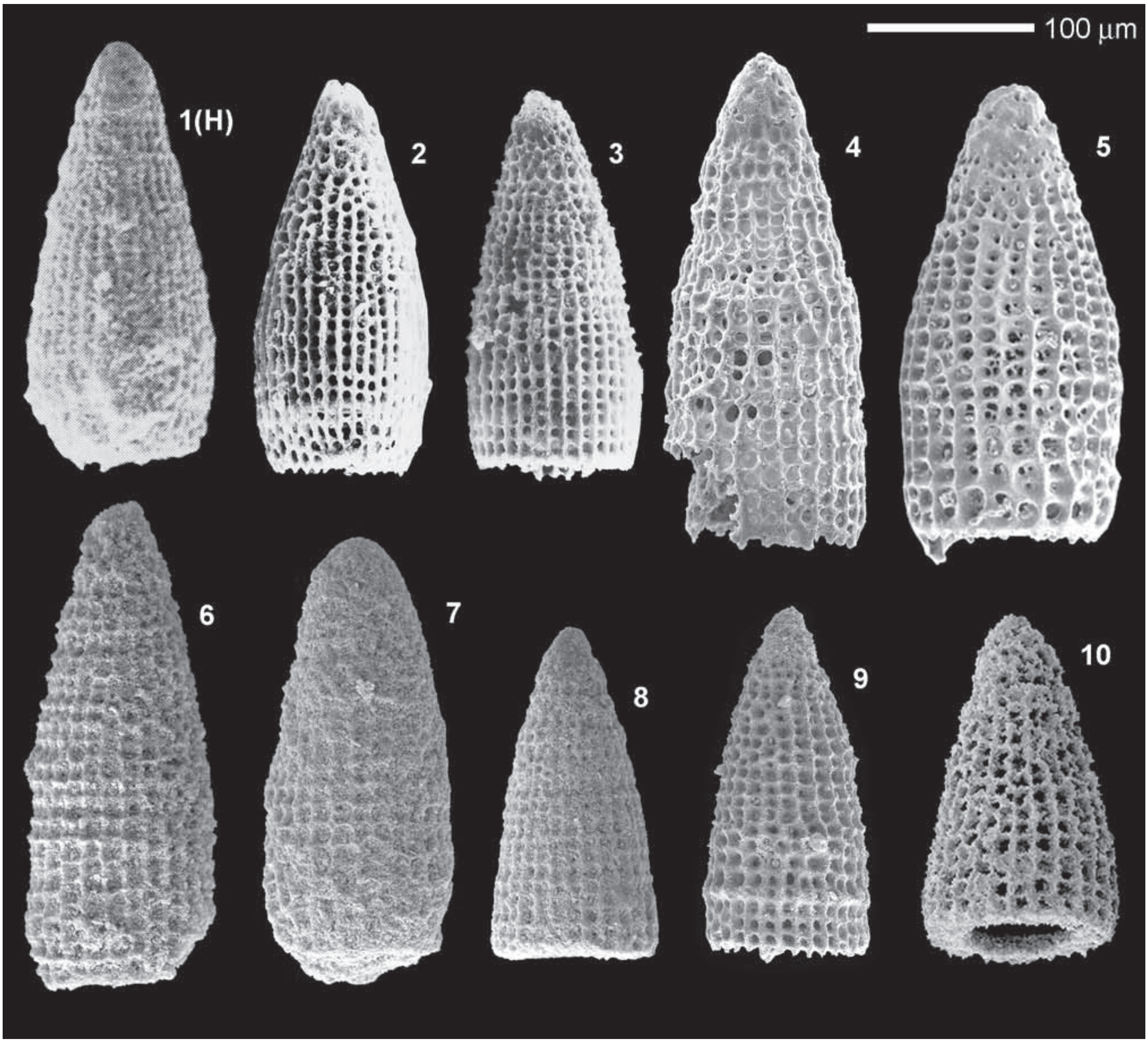


Plate PHS01. ***Parahsuum simplum*** **Yao.** Magnification x250. **Fig. 1(H).** Yao 1982, pl. 4, fig. 1. **Fig. 2-3.** Whalen & Carter 2002, pl. 12, figs. 3-4. **Fig. 4.** QCI, GSC loc. C-080613, GSC 111737. **Fig. 5.** QCI, GSC loc. C-080611 GSC 111738. **Fig. 6.** OM, Haliw-039-R04-05. **Fig. 7.** OM, Haliw-039-R03-18. **Fig. 8.** OM, Haliw-039-R01-02. **Fig. 9.** OM, BR1121-R08-09. **Fig. 10.** AT, BMW21-50.

Parahsuum vizcainoense Whalen & Carter 2002
Species code: PHS06

Synonymy:

1982 *Lupherium* sp. A – Pessagno & Whalen, p. 136, pl. 6, fig. 4.
1984 *Lupherium* sp. – Whalen & Pessagno, pl. 4, figs. 5-7.
1987b *Lupherium* sp. B – Yeh, p. 68, pl. 17, figs. 1, 4.
1987b *Lupherium* sp. C [*Lupherium* (?) sp. E in fig. captions] – Yeh, p. 68, pl. 17, figs. 2, 3, 8.
1998 *Drulanta* sp. cf. *D. mirifica* Yeh – Yeh & Cheng, p. 23, pl. 4, figs. 15, 16.
1998 *Parahsuum* sp. cf. *P. officerense* (Pessagno & Whalen) – Yeh & Cheng, p. 26, pl. 8, fig. 6.
2002 *Parahsuum vizcainoense* n. sp. – Whalen & Carter, p. 126, pl. 12, figs. 6, 10, 14.

Original description: Test elongate, conical to spindle shaped, with six to seven post-abdominal chambers. Large dome-shaped cephalis and thorax with delicate horn, circular in cross section and often broken. Cephalis and usually thorax and abdomen covered by a layer of microgranular silica providing either a complete, smooth coating or incomplete, irregular coating. Thorax, abdomen and most post-abdominal chambers trapezoidal in outline. Post-abdominal chambers gradually increasing in width distally; final few chambers gradually decreasing in width; all post-abdominal chambers gradually increasing in height. Costae fine, closely spaced, not always perfectly aligned or continuous. Pores circular to elliptical in outline.

Original remarks: The more delicate costae and strong horn distinguish this species from *Parahsuum simplum* Yao. In addition it differs from *Parahsuum officerense* (Pessagno and Whalen 1982) in having a shorter test (fewer chambers) and more irregular costae and meshwork. It is possible this new species is the ancestor of *P. officerense* (Pessagno and Whalen).

Measurements (μm):
Based on 8 specimens.

Length (excludes horn)	Width (Max.)	
225	105	HT
285	120	Max.
180	98	Min.
214	109	Mean

Etymology: This species is named for the Vizcaino Peninsula, Baja California Sur.

Type locality: Sample BPW80-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Franciscan Complex, California; Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Liminangcong Chert, Philippines; Japan; Skrile Formation, Slovenia.

***Parahsuum*? sp. A** sensu Whalen & Carter 2002
Species code: PHS07

Synonymy:

? 1998 *Drulanta* sp. A – Yeh & Cheng, p. 23, pl. 8, fig. 11.
2002 *Parahsuum*? sp. A – Whalen & Carter, p. 128, pl. 16, figs. 12, 13, 17.

Original remarks: The chambered test of this species is similar to the genus but it has three, short bladed wing-like extensions on distal post-abdominal chambers.

Occurrence: San Hipólito Formation, Baja California Sur.

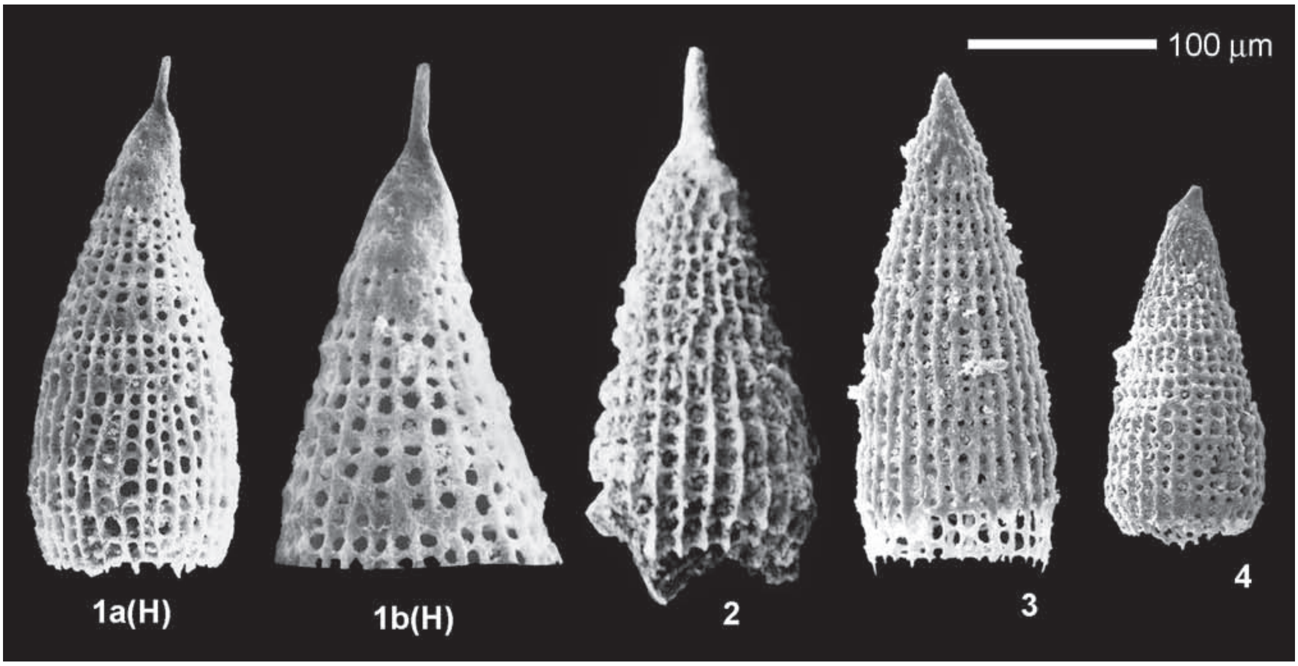


Plate PHS06. *Parahsuum vizcainoense* Whalen & Carter. Magnification x250, except Fig. 1b(H) x400.
Fig. 1(H). Whalen & Carter 2002, pl. 12, figs. 6, 10. **Fig. 2.** JP, IYII-3. **Fig. 3.** JP, MNA-10, MA12853. **Fig. 4.** SI, MM 6.76, 010302.

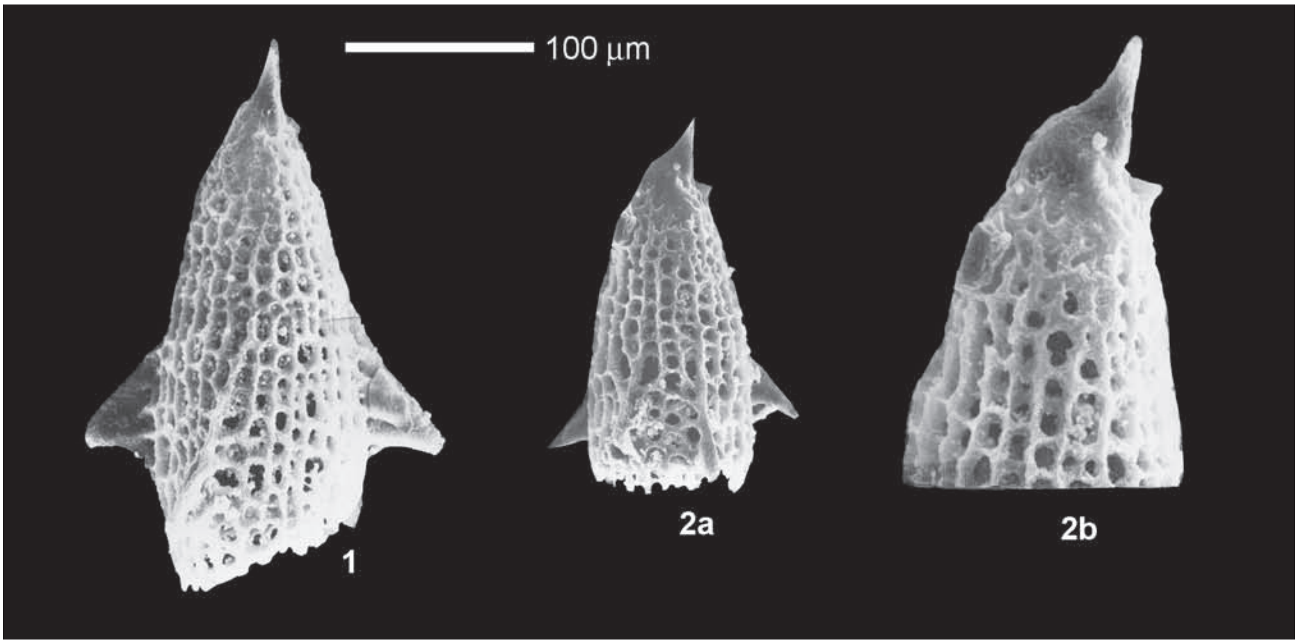


Plate PHS07. *Parahsuum*? sp. A sensu Whalen & Carter. Magnification x250, except Fig. 2b x400. Fig. 1. Whalen & Carter 2002, pl. 16, fig. 12. **Fig. 2.** Whalen & Carter 2002, pl. 16, figs. 13, 17.

Genus: *Parasaturnalis* Kozur & Mostler 1972

Type species: *Spongosaturnalis*? *diplocyclis* Yao 1972

Synonymy:

1972 *Parasaturnalis* n. gen. – Kozur & Mostler, p. 43.

Original description: The double to triple ring encloses a single row of pores and has two polar, or four to five radial rods that connect to a spongy central shell. Moderately long spines occur on the outer rim of the secondary ring.

Original remarks: In *Heliosaturnalis* n. gen. the inner ring is firmly attached to the spongy shell. In *Pseudosaturnalis* the secondary ring shows numerous pores.

Etymology: Composed of the prefix *Para*- and *saturnalis*.

Included species:

2013 *Parasaturnalis diplocyclis* (Yao) 1972
SAT15 *Parasaturnalis yehae* Dumitrica & Hori n. sp.

Parasaturnalis diplocyclis (Yao) 1972

Species code: 2013

Synonymy:

1972 *Spongosaturnalis*? *diplocyclis* n. sp. – Yao, p. 33, pl. 7, figs. 6-10; pl. 8, figs. 1-2.
Not 1981c *Japonisaturnalis diplocyclis* (Yao) – De Wever, p. 141, pl. 1, figs. 5, 7, 8.
Not 1982b *Japonisaturnalis diplocyclis* (Yao) – De Wever, p. 212-213, pl. 13, fig. 9; pl. 14, figs. 1, 2.
1982 *Parasaturnalis* sp. – Wakita, pl. 4, fig. 13.
1987b *Parasaturnalis vigrassi* n. sp. – Yeh, p. 49, pl. 5, fig. 14; pl. 23, fig. 11.
1987b *Parasaturnalis* sp. B – Yeh, p. 50, pl. 9, fig. 8.
1987 *Parasaturnalis diplocyclis* Yao group – Hattori, pl. 1, figs. 7, 8, 9.
1989 *Parasaturnalis diplocyclis* Yao – Hattori, pl. 1, fig. 5; pl. 18, fig. A.
1995a *Parasaturnalis diplocyclis* (Yao) – Baumgartner et al., p. 388, pl. 2013, figs. 1-3.
1996 *Parasaturnalis* sp. A – Yeh and Cheng, p. 108, pl. 2, fig. 6, not pl. 7, fig. 8.
1997 *Parasaturnalis diplocyclis* (Yao) – Yao, pl. 5, fig. 206.
1997 *Parasaturnalis* sp. A – Yao, pl. 5, fig. 207.
2003 *Parasaturnalis* cf. *diplocyclis* (Yao) – Goričan et al., p. 291, pl. 1, fig. 15.
2003 *Spongosaturnalis* (?) *diplocyclis* Yao – Kashiwagi & Kurimoto, pl. 5, figs. 8, 9.
2004 *Parasaturnalis* sp. B sensu Yeh – Hori, pl. 2, fig. 20.
2004 *Parasaturnalis diplocyclis* (Yao) – Hori, pl. 4, fig. 40.
2004 *Parasaturnalis diplocyclis* (Yao) – Matsuoka, fig. 4.

Original description: Spongosaturnalid with double ring, and with second spines on second ring. Shell not preserved, but fragmentary thorns on sturdy spines probably indicate that shell may be spongy. Polar spines a little long or short, somewhat thin, with no ridge. Ring double, first (inner) ring and second (outer) ring, joined by bars (called as first spines), bilaterally symmetrical, circular to subcircular, with smooth surface, and no ridge. First ring curves smoothly, with no auxiliary spine on inner margin. Second ring slightly waves with short wavelength, but in some specimens curves smoothly. Thirteen or more first spines (bars) on first ring, constant in size and shape, joining with second ring. Thirteen or more second spines on second ring, situated respectively at middle point of part joined with first spines, short, thornlike or low protrusive, with rounded or somewhat sharp ends. Spaces enclosed by both rings and first spines, elliptical or subrectangular. One space at end of each polar spine generally larger than others, and in some specimens divided in two parts by transversal bar.

Original remarks: Although only eight specimens, which are represented by fragmentary ring, were found, this species is established because of the morphological feature lacking auxiliary spines. ?*S. catadelos,* having a more complicated ring, is described by Foreman (1968, p. 11-12, pl. 1, figs. la-f; Latest Cretaceous, Moreno formation, California). The ring of ?*S. catadelos* is broad and flat, and perforated by numerous pores arranging in some measure of regularity. It probably indicates that the complicated ring is a combination of the fundamental rings (first ring, second ring etc.) and spines (first spines, second spines etc.). There is considerable variation in the number of spines among specimens.

Measurements (μm)*:*
Based on 6 specimens.

	HT	Av.	Min.	Max.
D. of 1 ring; (polar spines)	203	180	150	203
D. of 1 ring; (transversely)	260	250	190	315
D. of 2 ring; (polar spines)	313	285	230	330
D. of 2 ring; (transversely)	325	302	270	350
Diameter of shell	126	113	100	126
Length of polar spine	23	21	13	30
Length of first spine	18-25	15-25	10	35
Length of sec. spine	23	11	3	25
Breath of 1 ring	15	9	3	15
Breath of 2 ring	8	7	3	13

Type locality: Sample IN-3, manganese carbonate ore, Mino Belt, river side of the Kiso, east of Unuma, Kagamihara City, Gifu Prefecture, central Japan.

Occurrence: Japan; Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Apennines, Italy; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines.

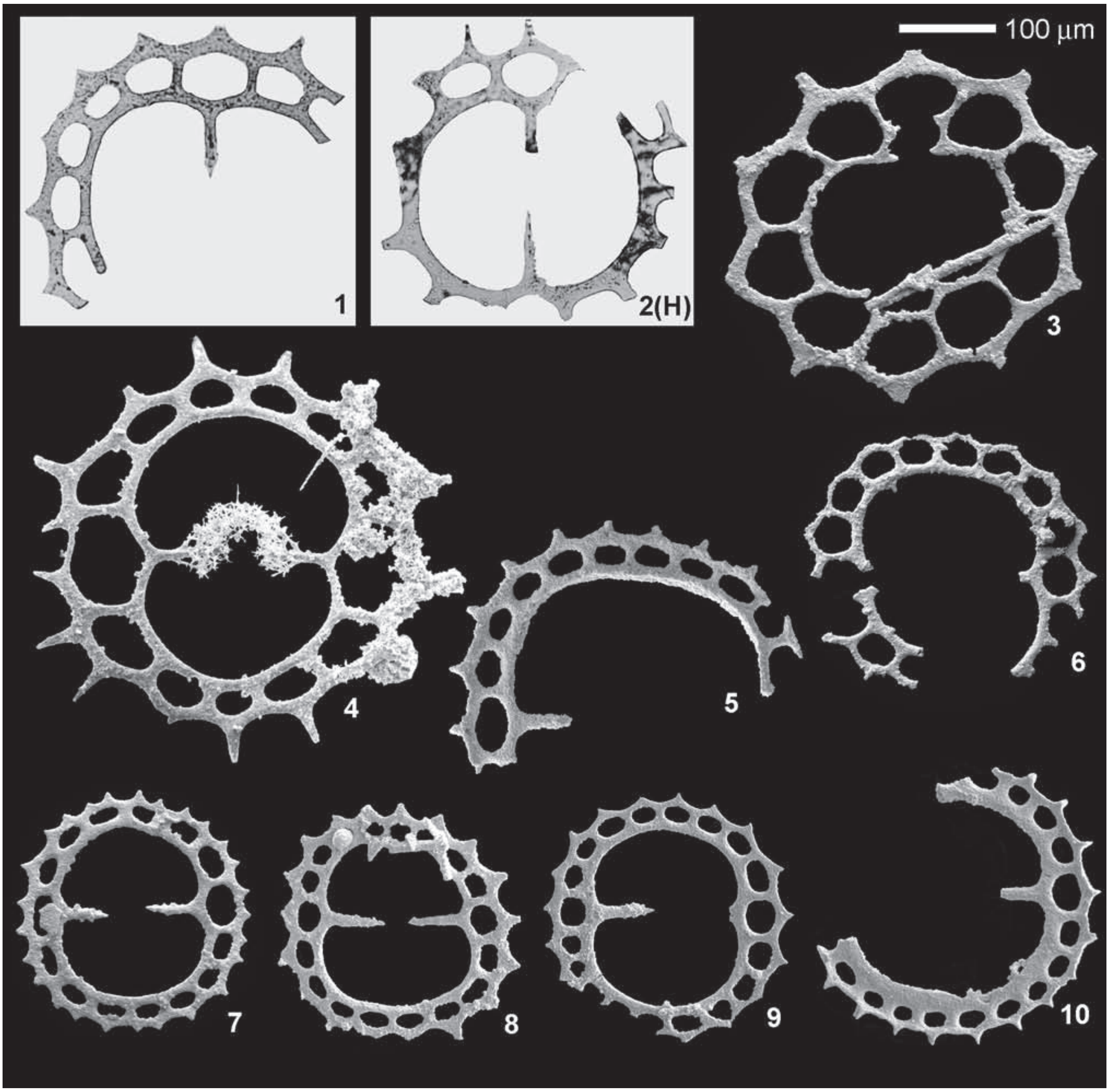


Plate 2013. ***Parasaturnalis diplocyclis*** **(Yao).** Magnification x150. **Fig. 1.** Yao 1972, pl. 8, fig. 1. **Fig. 2(H).** Yao 1972, pl. 8, fig. 2. **Fig. 3.** OM, BR528-R10-16. **Fig. 4.** Matsuoka 2004, fig. 4. **Fig. 5.** OM, BR871-R02-03. **Fig. 6.** OM, BR528-R10-21. **Fig. 7.** OM, BR528-R10-15. **Fig. 8.** BR706-R13-11. **Fig. 9.** OM, BR706-R13-10. **Fig. 10.** OM, BR871-R02-04.

Parasaturnalis yehae Dumitrica & Hori n. sp.

Species code: SAT15

Synonymy:

1981c *Japonisaturnalis diplocyclis* (Yao) – De Wever, p. 141, pl. 1, fig. 5, ? figs. 7, 8.

1982b *Japonisaturnalis diplocyclis* (Yao) – De Wever, p. 212-213, pl. 13, fig. 9; pl. 14, ?figs. 1, 2.

1987b *Parasaturnalis* sp. A – Yeh, p. 49, pl. 3, fig. 16.

1992 *Parasaturnalis* spp. – Pessagno & Mizutani, pl. 99, figs. 10, 15.

1998 *Heliosaturnalis* sp. A – Yeh & Cheng, p. 16, pl. 2, fig. 20; pl. 8, fig. 9; pl. 11, fig. 11.

Type designation: The holotype was illustrated by Yeh (1987b, pl. 3, fig. 16) from the Nicely Formation, Oregon.

Diagnosis: A species of *Parasaturnalis* having the spines of secondary ring aligned with the radial bars connecting the two rings.

Description: Ring double, subcircular to slightly elliptical in outline, thin, smooth. Ring commonly with 12-14 radial bars between the two rings and a similar number of short spines on the secondary ring aligned with the radial bars connecting the two rings. Shell spongy, many-layered, when larger it may be connected to primary ring also by auxiliary and/or subsidiary rays.

Remarks: This new species is clearly different from *Parasaturnalis diplocyclis* (Yao) by the position of the spines on the secondary ring relative to the radial bars connecting the two rings. Whereas in *P. diplocyclis* the bars have an alternate position, in *P. yehae* they are aligned with these bars. The ring of *P. yehae* is comparable to ring of the Carnian species *Heliosaturnalis magnus* Kozur & Mostler.

In the present state of knowledge we include in this species specimens with and without auxiliary or subsidiary rays. The fossil record seems to prove that the latter are stratigraphically younger (late Pliensbachian - Toarcian) (Yeh, 1987b) than the former (Sinemurian - early Pliensbachian) (De Wever, 1981c, 1982b; Yeh & Cheng, 1998) and that the disappearance of these centripetally directed radial bars, is an evolutionary process inherited from the Late Triassic and earliest Jurassic ancestors. If so, these species could be separated into two successive subspecies of evolutionary and stratigraphic value i.e., *Parasaturnalis yehae* ssp. A and *Parasaturnalis yehae yehae*. In the present paper the existance of these two morphotypes is just suggested.

Measurements (µm):

Based on 6 specimens.

	HT	Min.	Max.
Diameter of central shell	-	108	120
Width of primary ring at the end of polar rays	227	239	305
Width of secondary ring	327	365	407
Length of primary ring	289	-	-
Length of secondary ring	360	-	-

Etymology: The species is named after Kuei-Yu Yeh, Tainan National College of the Arts, Tainan, Taiwan, who illustrated several specimens of this species.

Type locality: Sample OR-536J, Nicely Formation, Morgan Mountain, east-central Oregon (Yeh, 1987b).

Occurrence: Nicely Formation, Oregon; Inuyama and Nanjo areas, Japan; Busuanga Island, Philippines; Fernie Formation, northeastern British Columbia; Gümüslü Allochthon, Turkey; Tawi Sadh Member of the Guwayza Formation and Haliw (Aqil) Formation, Oman.

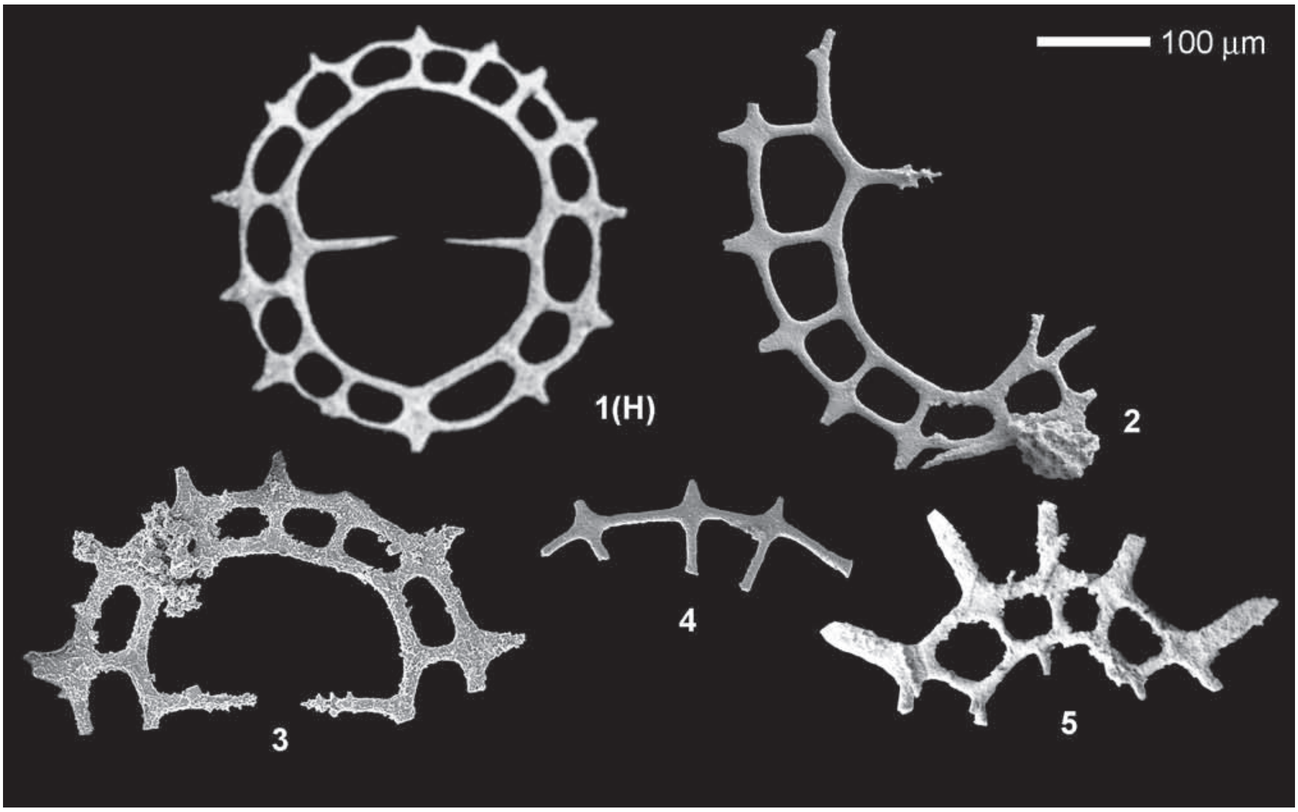


Plate SAT15. ***Parasaturnalis yehae*** **Dumitrica & Hori n. sp.** Magnification x150. **Fig. 1(H).** Yeh 1987b, pl. 3, fig. 16. **Fig. 2.** OM, BR528-R10-17. **Fig. 3.** NBC, GSC loc. C-305208, GSC 111739. **Fig. 4.** OM, BR706-R13-12. **Fig. 5.** JP, Nanjo chert, NAI-132, RH(1)468.

Genus: *Paronaella* Pessagno 1971

Type species: *Paronaella solanoensis* Pessagno 1971

Synonymy:

1971 *Paronaella* n. gen. – Pessagno, p. 46.
1971 *Patulibracchium* n. gen. – Pessagno, p. 26.
1980 *Paronaella* Pessagno emend. – Baumgartner, p. 300.
1981b *Paronaella* Pessagno emend. – De Wever, p. 33.
1987b *Sontonaella* n. gen. – Yeh, p. 44.
1993 *Paronaella* Pessagno emend. Baumgartner – Pessagno et al., p. 121.
1994 *Fluegelium* n. gen. – Steiger & Steiger, p. 457.
1999 *Paronaella* Pessagno, emend. Baumgartner, emend. De Wever – Kiessling, p. 38.

Original description: Test lacks rays with bracchiopyle. Rays always nearly equal in length; expanded or thickened ray tips lacking. Meshwork linear to sublinear; comprised of irregular polygonal pore frames. Pore frames comprised of bars connected to weakly developed nodes.

Original remarks: *Paronaella* n. gen. differs from *Patulibracchium* n. gen. and *Halesium* n. gen. by lacking a bracchiopyle and expanded ray tips and by always having rays which are nearly equal in length.

Further remarks: We include all forms with or without a bracchiopyle and with or without bulbous tips.

Etymology: This genus is named for C. F. Parona, one of the early students of Mesozoic Radiolaria.

Included species and subspecies:

PAR13 *Paronaella corpulenta* De Wever 1981b
PAR22 *Paronaella curticrassa* Carter & Dumitrica n. sp.
PAR24 *Paronaella fera* s.l. (Yeh) 1987b
PAR15 *Paronaella fera fera* (Yeh) 1987b
PAR10 *Paronaella fera jamesi* Whalen & Carter 1998
PAR16 *Paronaella grahamensis* Carter 1988
PAR17 *Paronaella notabilis* Whalen & Carter 2002
2005 *Paronaella skowkonaensis* Carter 1988
PAR19 *Paronaella snowshoensis* (Yeh) 1987b
PAR20 *Paronaella tripla* De Wever 1981b
PAR21 *Paronaella variabilis* Carter 1988

Paronaella corpulenta De Wever 1981b

Species code: PAR13

Synonymy:

1981b *Paronaella corpulenta* n. sp. – De Wever, p. 33, pl. 2, figs. 7-9.
1982b *Paronaella corpulenta* De Wever – De Wever, p. 245, pl. 22, fig. 7; pl. 23, figs. 1-3.
1988 *Paronaella* sp. C – Carter et al., p. 42, pl. 11, fig. 7.
2002 *Paronaella corpulenta* De Wever – Whalen & Carter, p. 107, pl. 2, figs. 6, 12.
2003 *Paronaella* spp. – Goričan et al., p. 295, pl. 2, fig. 4 only.
? 2004 *Paronaella corpulenta* De Wever s.l. – Matsuoka, fig. 32.

Original description: Massive form with three very wide, club-shaped arms terminating in a short, robust triradiate spine.

Arms, almost as wide as long, composed of a spongy network which is embedded within other more delicate spongy material that usually remains only as fragments. This secondary spongy material is responsible for the plump shape of this species. Primary spines at distal ends of arms seem to be deep-set as in a cushion. Some forms possess secondary spines between or on arms; these spines are always thinner than primary spines, although sometimes longer.

Original remarks: This species differs from *Paronaella obesa* (Pessagno) by absence of bracchiopyle, more massive shape, finer less frequent secondary spines and presence of a patagium. Its plump shape, very rounded outline and primary spine (which appears to be deep-set as in a cushion) easily distinguishes this species from others. It differs from *Paronaella tripla* n. sp. by the presence of secondary spines and, mainly by its different network.

Measurements (µm):

Based on 10 specimens.

	HT	Min.	Max.	Av.
Length of ray	185	167	200	177

Length of primary spines is difficult to measure since they arise from the depressed part of a "cushion"; they are generally about 50µm long.

Etymology: From Latin *corpulentus*, *-a, -um*, adj. = corpulent, by analogy with the rotund shape of this species.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Ghost Creek, Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman.

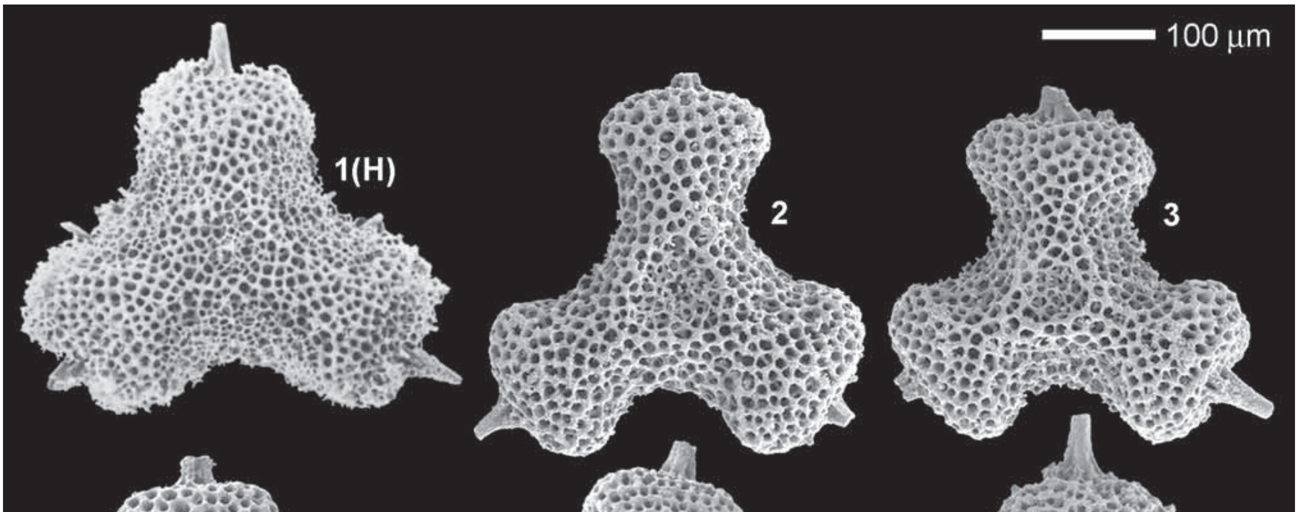


Plate PAR13. ***Paronaella corpulenta*** **De Wever.** Magnification x150. **Fig. 1(H).** De Wever 1981b, pl. 2, fig. 7. **Fig. 2.** QCI, GSC loc. C-175311, GSC 128864. **Fig. 3.** QCI, GSC loc. C-175311, GSC 128865. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128866. **Fig. 5.** QCI, GSC loc. C-080612, GSC 128867. **Fig. 6.** QCI, GSC loc. C-080612, GSC 128868. **Fig. 7.** OM, BR1123-R05-01. **Fig. 8.** OM, BR706-R03-21a. **Fig. 9.** Goričan et al. 2003, pl. 2, fig. 4.

Paronaella curticrassa Carter & Dumitrica n. sp.

Species code: PAR22

Synonymy:

1987b *Sontonella* sp. B – Yeh, p. 47, pl. 11, fig. 10.
1988 *Paronaella* sp. A – Carter et al., p. 42, pl. 4, fig. 10.

Type designation: Holotype, pl. PAR22, fig. 2, Carter et al. 1988, pl. 4, fig. 10 (GSC 80574); paratype, fig. 1, QCI, GSC loc. C-177371, GSC 128875.

Description: Test small with a large slightly raised central area and three short stubby rays widely expanded and club-shaped at tips; each ray with a single short spine. Meshwork of test usually massive on central area and proximal part of arms, pore frames triangular to quadrangular or irregularly polygonal with nodes at vertices; meshwork slightly smaller towards ray tips. Lateral sides of rays vertical. Spines on ray tips triradiate at base then circular in axial section.

Remarks: *Paronaella curticrassa* n. sp. differs from *P. grahamensis* Carter in having a larger central area and shorter rays with more widely expanded ray tips. The holotype appears to be morphologically intermediate between the two other specimens illustrated.

Measurements (μm):
Based on 4 specimens.

	HT	Min.	Max.	Av.
Length of ray from shell centre	135-145	73	160	117
Minimum width of ray	50	36	85	58
Width of expanded tip	120-130	65	170	111

Etymology: From the Latin *curtus* – short and *crassus* – fat, plump; adjective.

Type locality: GSC loc. C-080577, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin Formation, Queen Charlotte Islands; Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Tawi Sadh Member of the Guwayza Formation, Oman.

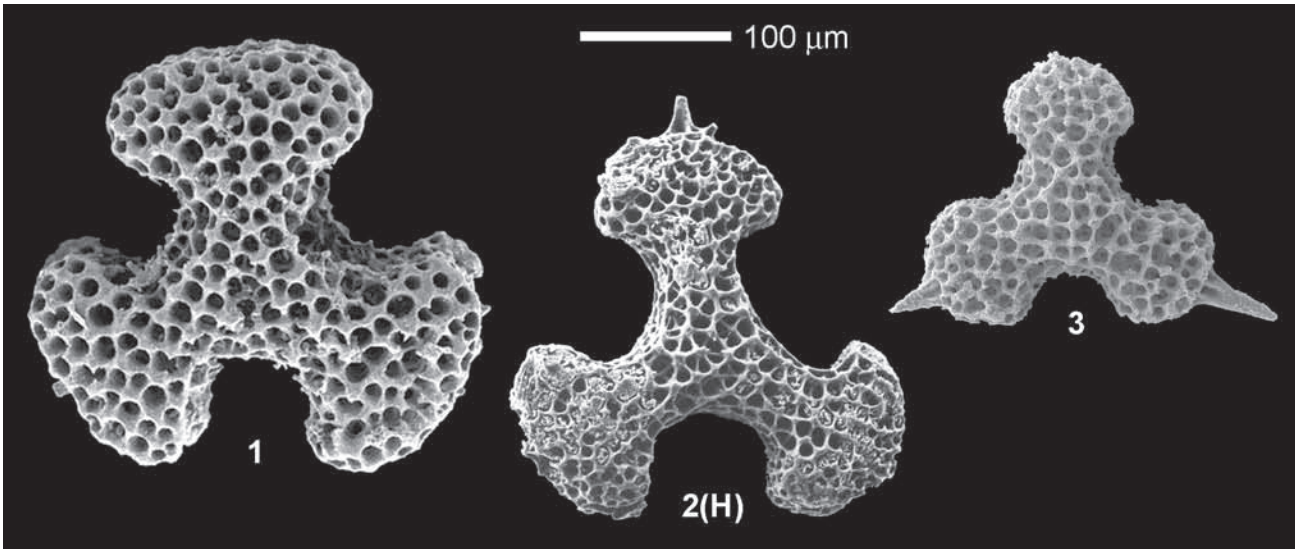


Plate PAR22. ***Paronaella curticrassa*** **Carter & Dumitrica n. sp.** Magnification x200. **Fig. 1.** QCI, GSC loc. C-177371, GSC 128875. **Fig. 2(H).** Carter et al. 1988, pl. 4, fig. 10. **Fig. 3.** OR600A-R03-13.

Paronaella fera **s.l.** (Yeh) 1987b

Species code: PAR24

Synonymy:

1987b *Sontonella fera* n. sp. – Yeh, p. 46, pl. 1, fig. 3; pl. 3, fig. 20.

See also subspecies.

Included subspecies:

PAR15 *Paronaella fera fera* (Yeh) 1987b
PAR10 *Paronaella fera jamesi* Whalen & Carter 1998

Paronaella fera fera (Yeh) 1987b

Species code: PAR15

Synonymy:

1987b *Sontonaella fera* n. sp. – Yeh, p. 46, pl. 1, fig. 3; pl. 3, fig. 20.
1987b *Sontonaella* sp. aff. *S. fera* n. sp. – Yeh, p. 46, pl. 1, fig. 4.

Original description: Rays nearly equal in length and width, with large expanded tips. One tip larger than other two and flanking with two short lateral spines at distal surface. The other two tips with long, massive central spines. All spines circular in cross section. Test mainly with triangular and tetragonal pore frames having prominent nodes at vertices. Pore frames irregularly arranged, medium in size, with smaller pore frames on tips.

Original remarks: *Sontonaella fera* Yeh, n. sp., can be easily distinguished from other *Sontonaella* spp. in this report by having one large tip with two small spines and two smaller tips with extremely long and massive spines.

Measurements (μm):
Ten specimens measured. System of measurement shown in text-figure 7 of Yeh (1987b).

	LA	LB	LC	WR	LT	WT
HT	186	186	186	50	86	143
Mean	177	177	177	56	77	140
Max.	186	186	186	60	86	143
Min.	160	160	160	50	70	135

Etymology: *Ferus-a-um* (Latin, adj.) = wild.

Type locality: Sample OR-536D, Nicely Formation, southeast side of the Morgan Mountain, east-central Oregon.

Occurrence: Nicely Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands and Fernie Formation, Williston Lake, British Columbia; Tawi Sadh Member of the Guwayza Formation.

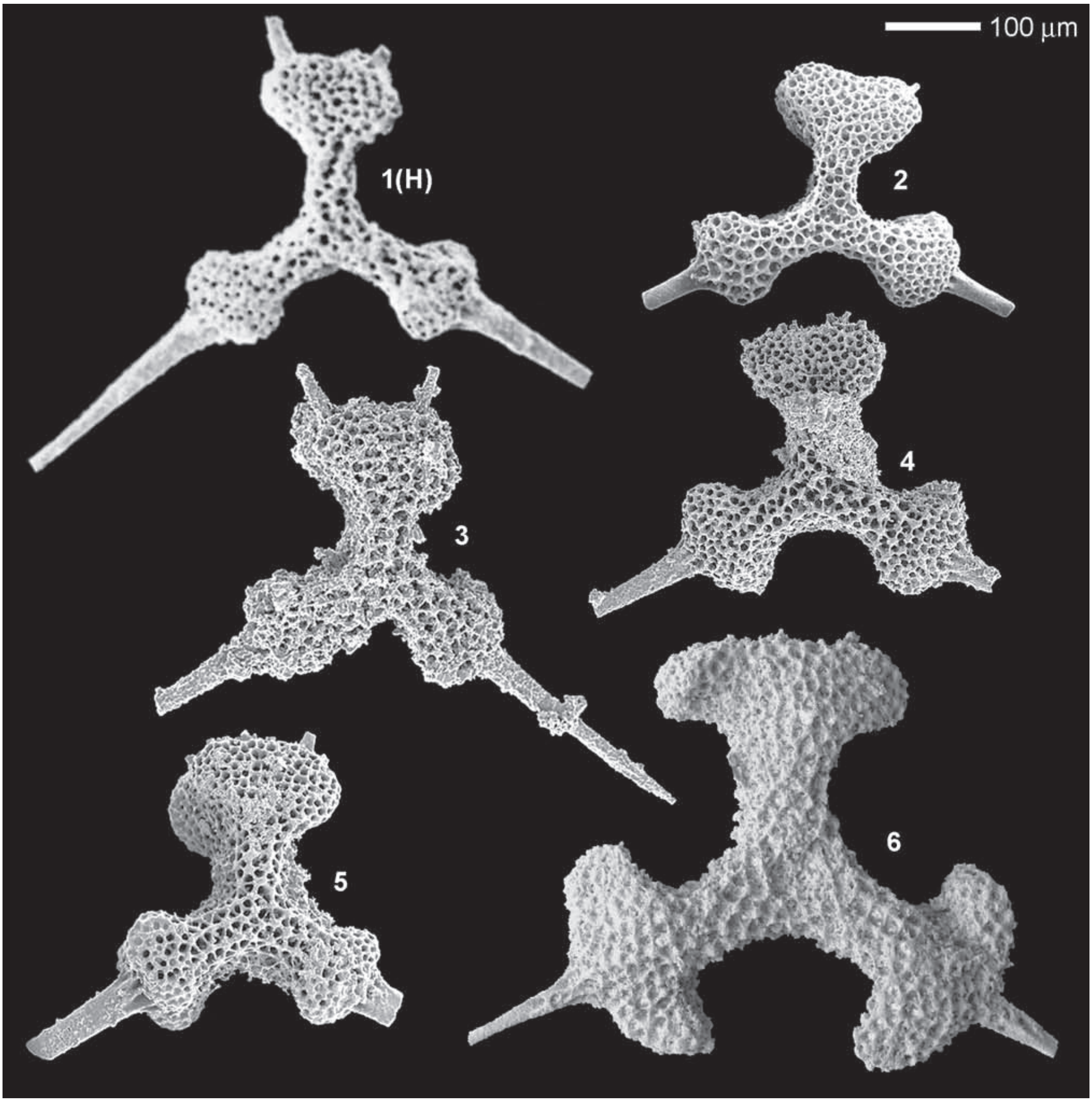


Plate PAR15. ***Paronaella fera fera*** **(Yeh).** Magnification x150. **Fig. 1(H).** Yeh 1987b, pl. 1, fig. 3. **Fig. 2.** QCI, GSC loc. C-304568, GSC 128869. **Fig. 3.** NBC, GSC loc. C-305208, GSC 128870. **Fig. 4.** NBC, GSC loc. C-305208, GSC 128871. **Fig. 5.** QCI, GSC loc. C-080612, GSC 128872. **Fig. 6.** OM, BR528-R10-04.

Paronaella fera jamesi Whalen & Carter 1998

Species code: PAR10

Synonymy:

1998 *Paronaella jamesi* n. sp. – Whalen & Carter, p. 51, pl. 13, figs. 19, 23, not figs. 18, 22, 24.
2002 *Paronaella jamesi* Whalen & Carter – Tekin, p. 181, pl. 1, fig. 11.

Original description: Test with short equally spaced rays; rays approximately equal in length, narrow proximally, gradually expanding in width distally. Ray tips moderately expanded and bulbous. Meshwork composed mostly of strong, triangular and tetragonal pore frames with small nodes at pore frame vertices; slight lineation of pore frames developed externally on proximal portion of rays. Each ray usually with short, circular, flat-bladed to slightly triradiate central spine; some rays with several smaller spines rather than one primary spine.

Original remarks: See remarks under *Paronaella skenaensis* n. sp.

Remarks under *P. skenaensis* Whalen & Carter n. sp. (p. 52): *Paronaella skenaensis* n. sp. differs from *P. jamesi* n. sp. in having much finer meshwork with smaller nodes and more delicate spines.

Further remarks: This species differs from *Paronaella fera fera* (Yeh) because the rays are not rectangular in cross-section and spines are shorter and slightly flat with single central spine on ray tips. Several forms originally assigned to *P. jamesi* Whalen & Carter have now been assigned to *P. grahamensis* Carter.

Measurements (μm):
Based on 8 specimens.

Length of longest ray	Average width of rays at base	Max. width of ray tips	
174	53	121	HT
249	66	184	Max.
146	50	113	Min.
184	59	139	Mean

Etymology: This species is named for James Helwig, Dallas, Texas who assisted with fieldwork and construction of plates.

Type locality: Sample 89-CNA-KUH-8, Sandilands Formation, north side of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Hocaköy Radiolarite, Turkey.

Paronaella grahamensis Carter 1988

Species code: PAR16

Synonymy:

1987 *Paronaella* (?) sp. V – Hattori, pl. 4, fig. 12.
1988 *Paronaella grahamensis* Carter n. sp. – Carter et al., p. 40, pl. 11, figs. 11, 12; not pl. 11, fig. 10.
1998 *Paronaella jamesi* n. sp. – Whalen & Carter, p. 51, pl. 13, figs. 18, 22, 24, not figs. 19, 23.
2002 *Paronaella grahamensis* Carter – Whalen & Carter, p. 107, pl. 2, figs. 3, 4, 9, 11, 13.
2001 *Paronaella grahamensis* Carter – Gawlick et al., pl. 2, fig. 17.
2004 *Paronaella* sp. – Matsuoka, fig. 30.

Original diagnosis: Moderate in size with short rays, expanded tips and slender, almost cylindrical central spine. Rays subrectangular in cross-section.

Original description: Three-rayed patulibracchiid of moderate size with slender central spine. Rays short, approximately equal in length. Tips enlarged and rounded; expansion may occur gradually throughout ray length or more abruptly in distal portion only. Pore frames irregular to sublinearly aligned, uniform in size, mostly tetragonal. Central spines on ray tips are slender, variable in length, circular in section. Rays subrectangular in cross-section.

Original remarks: This abundant form is similar to, but much smaller than, *Paronaella bona* Yeh. Strong central spines are evident on almost all specimens.

Measurements (μm):
Based on 7 specimens.

	HT	Av.	Max.	Min.
Length of longest ray	171	167	200	125
Width of ray	47	60	70	47
Width of ray tip	118	122	140	102
Length of longest spine	65	58	130	35

Etymology: Named for Graham Island; type locality in central portion of island.

Type locality: GSC locality C-080583, Phantom Creek Formation, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Fernie Formation, NE British Columbia; San Hipólito Formation, Baja California Sur; Skrile Formation, Slovenia; Dürrnberg Formation, Austria; Japan.

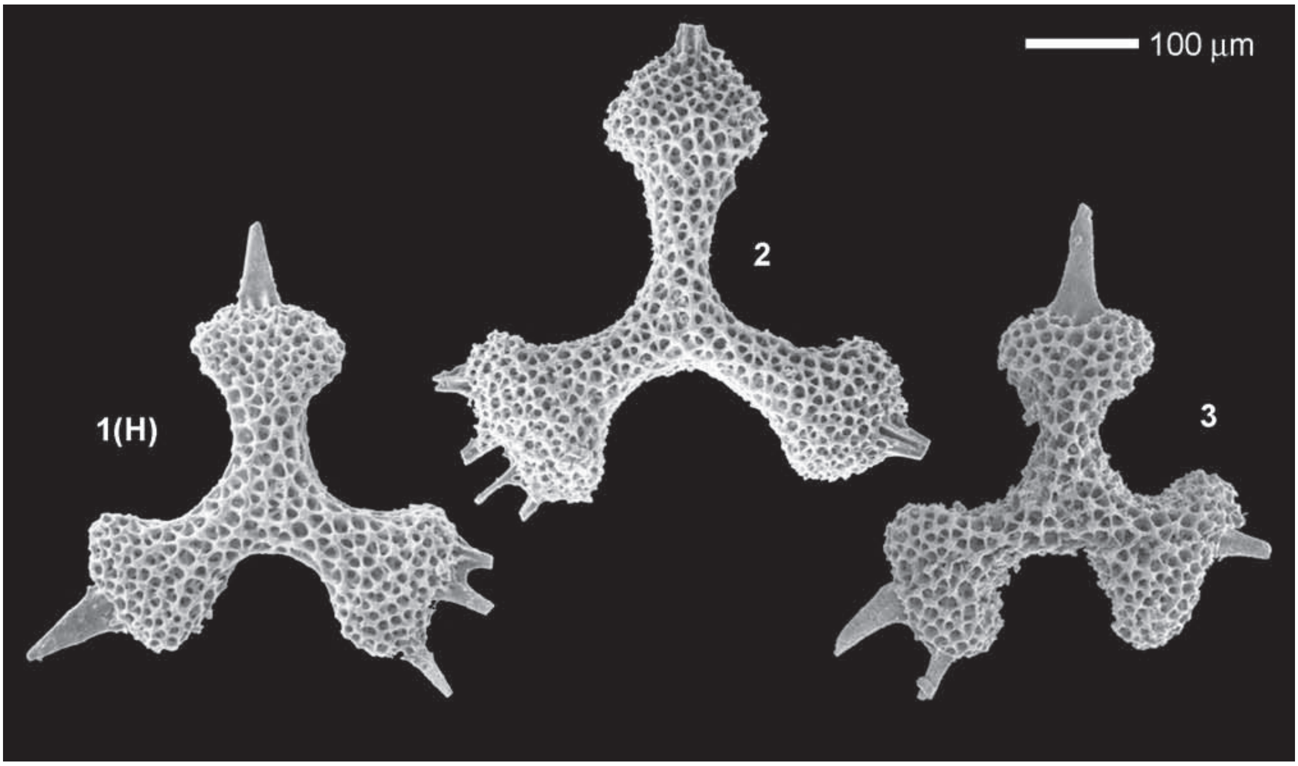


Plate PAR10. ***Paronaella fera jamesi*** **Whalen & Carter.** Magnification x150. **Fig. 1(H).** Carter et al. 1998, pl. 13, fig. 23. **Fig. 2.** Carter et al. 1998, pl. 13, fig. 19. **Fig. 3.** QCI, GSC loc. C-305417, GSC 128873.

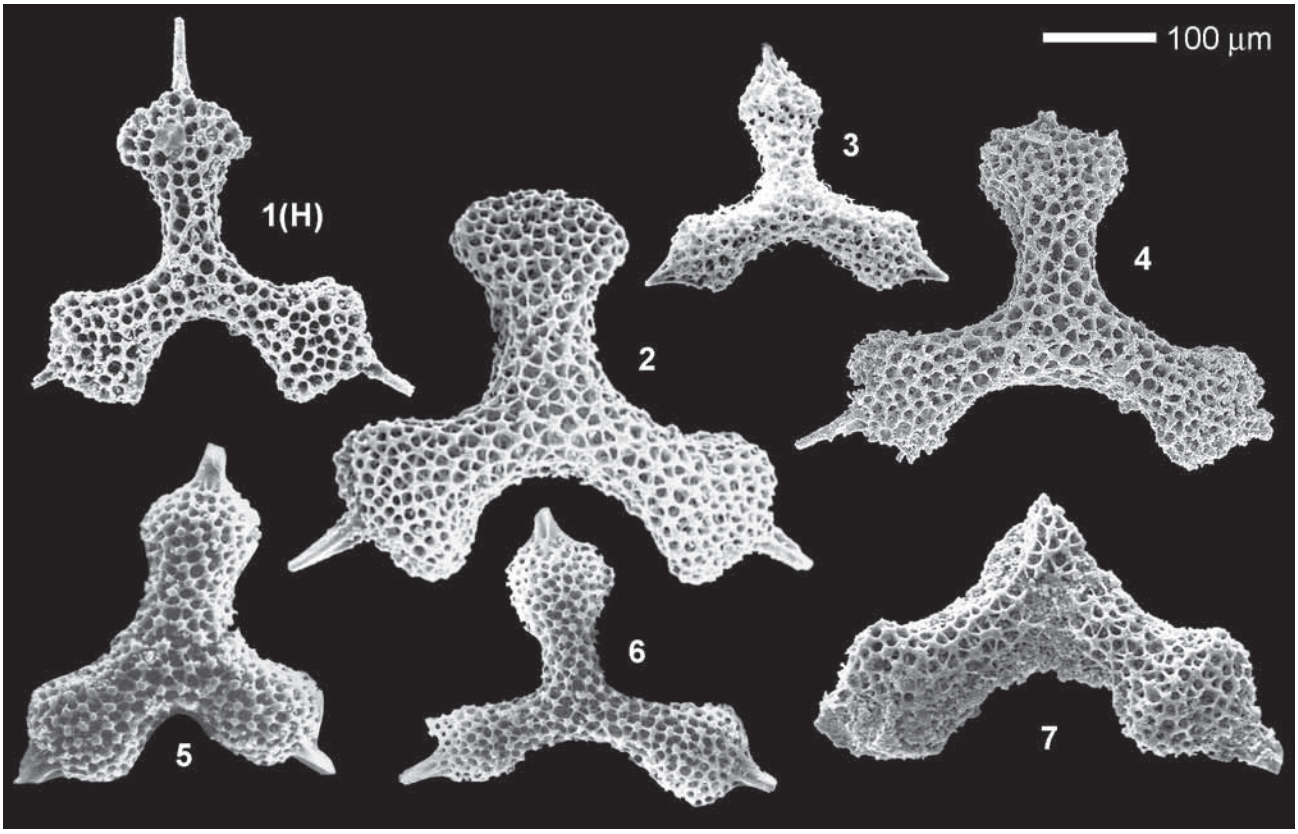


Plate PAR16. ***Paronaella grahamensis*** **Carter.** Magnification x150. **Fig. 1(H).** Carter et al. 1988, pl. 11, fig. 11. **Fig. 2.** QCI, GSC loc. C-304568, GSC 128874. **Fig. 3.** JP, MNA-10, MA10845. **Fig. 4.** NBC, GSC loc. 305208, GSC 111740. **Fig. 5.** Whalen & Carter 2002, pl. 2, fig. 4. **Fig. 6**. Whalen & Carter 2002, pl. 2, fig. 3. **Fig. 7.** SI, MM 5.00, 010106.

Paronaella notabilis Whalen & Carter 2002

Species code: PAR17

Synonymy:

1988 *Paronaella* sp. D – Carter et al., p. 42, pl. 11, fig. 9.
2002 *Paronaella notabilis* n. sp. – Whalen & Carter, p. 107, pl. 2, figs. 7, 10, 14; pl. 3, figs. 1, 8, 11.
2002 *Paronaella notabilis* Whalen & Carter – Tekin, p. 181, pl. 1, figs. 12, 13.

Original description: Test with three stout rays; ray length slightly greater than ray width; distal part of ray somewhat inflated to bulbous. Each ray with small, tapering principal spine, circular in axial section. Small and medium-sized subsidiary spines sometimes present on ray tips. Meshwork composed of irregularly shaped tetragonal and pentagonal pore frames with slight development of nodes at pore frame vertices; no apparent development of pore frame lineation.

Original remarks: The slightly more elongate, less bulbous rays, along with the presence of subsidiary spines on the ray tips, distinguish *Paronaella notabilis* n. sp. from *P. corpulenta* De Wever 1981b.

Measurements (μm):
Based on 11 specimens.

Length of ray	Length of spine	
90	53	HT
105	75	Max.
83	45	Min.
93	55	Mean

Etymology: *Notabilis* (Latin, adj.) = remarkable, striking, noteworthy.

Type locality: Sample BPW80-30, San Hipólito Formation, Vizcaino Peninsula, Baja California Sur, Mexico.

Occurrence: Phantom Creek and Graham Island formations, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Hocaköy Radiolarite, Turkey.

Paronaella skowkonaensis Carter 1988

Species code: 2005

Synonymy:

1987 *Paronaella* sp. O – Hattori, pl. 4, fig. 14.
1988 *Paronaella* sp. F – Hattori, pl. 6, fig. D.
1989 *Homoeoparonaella* sp. – Hattori & Sakamoto, pl. 6, fig. J.
1988 *Paronaella skowkonaensis* Carter n. sp. – Carter et al., p. 40, pl. 11, figs. 4-5.
1989 *Tritrabs* (?) spp. – Hori & Otsuka, pl. 4, fig. 7, not fig. 6.
1989 *Paronaella* (?) sp. – Hori & Otsuka, pl. 4, fig. 8.
1995a *Paronaella skowkonaensis* Carter – Baumgartner et al., p. 398, pl. 2005, figs. 1-2.
2004 *Homoeoparonaella* sp. – Matsuoka, fig. 35.

Original diagnosis: Three-rayed patulibracchiid having long, slender rays with clavate to wedge-shaped tips. Meshwork fine and irregular. Ray tips have numerous short fine spines.

Original description: Test large with three long slender rays expanding at tips. Rays subequal in length at approximately 120°. Tips rounded to wedge-shaped. External pore frames small, sublinearly arranged; tetragonal to pentagonal with weak nodes at vertices. Numerous short, fine spines extend from ray tips of well preserved specimens. Internal meshwork layered and spongy.

Original remarks: This form strongly resembles *Rhopalastrum trixiphus* Rüst 1898, but differs in having several short spines rather than a single central one on each ray tip. It has been assigned to *Paronaella* because of its layered spongy meshwork.

Measurements (μm):
Based on 10 specimens.

	HT	Av.	Min.	Max.
Length of ray AX:	196	197	230	150
Length of ray BX:	188	-	-	-
Length of ray CX:	182	-	-	-
Width of ray:	50	81	70	50
Width of tip:	149	146	205	80

Etymology: Named for Skowkona Mountain, southeast of the type locality.

Type locality: GSC locality C-080584, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte Island, British Columbia.

Occurrence: Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Apennines, Italy; Japan.

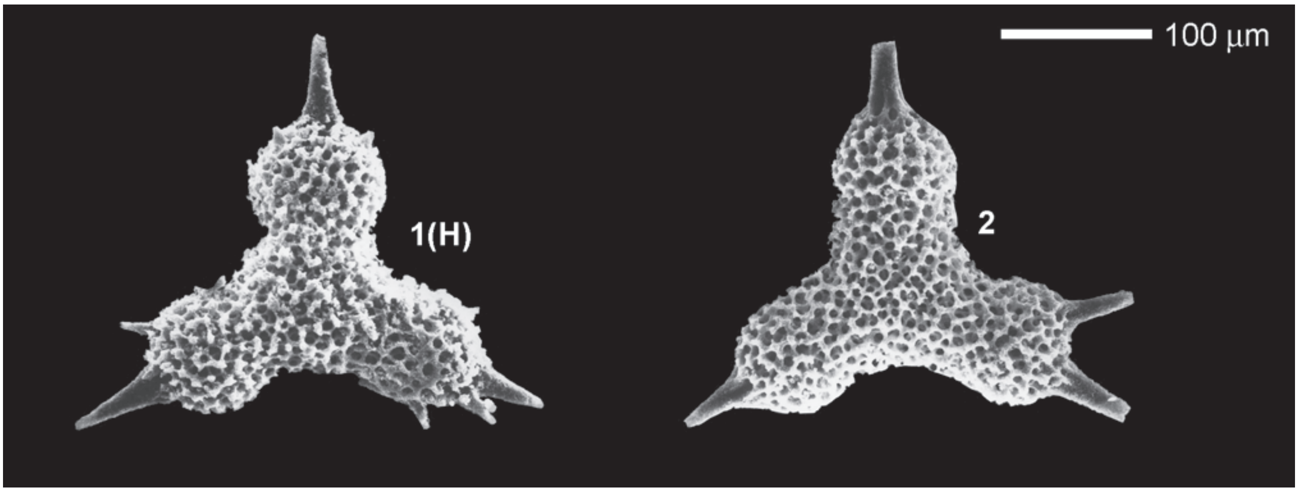


Plate PAR17. ***Paronaella notabilis*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 3, fig. 1. **Fig. 2.** Whalen & Carter 2002, pl. 2, fig. 7.

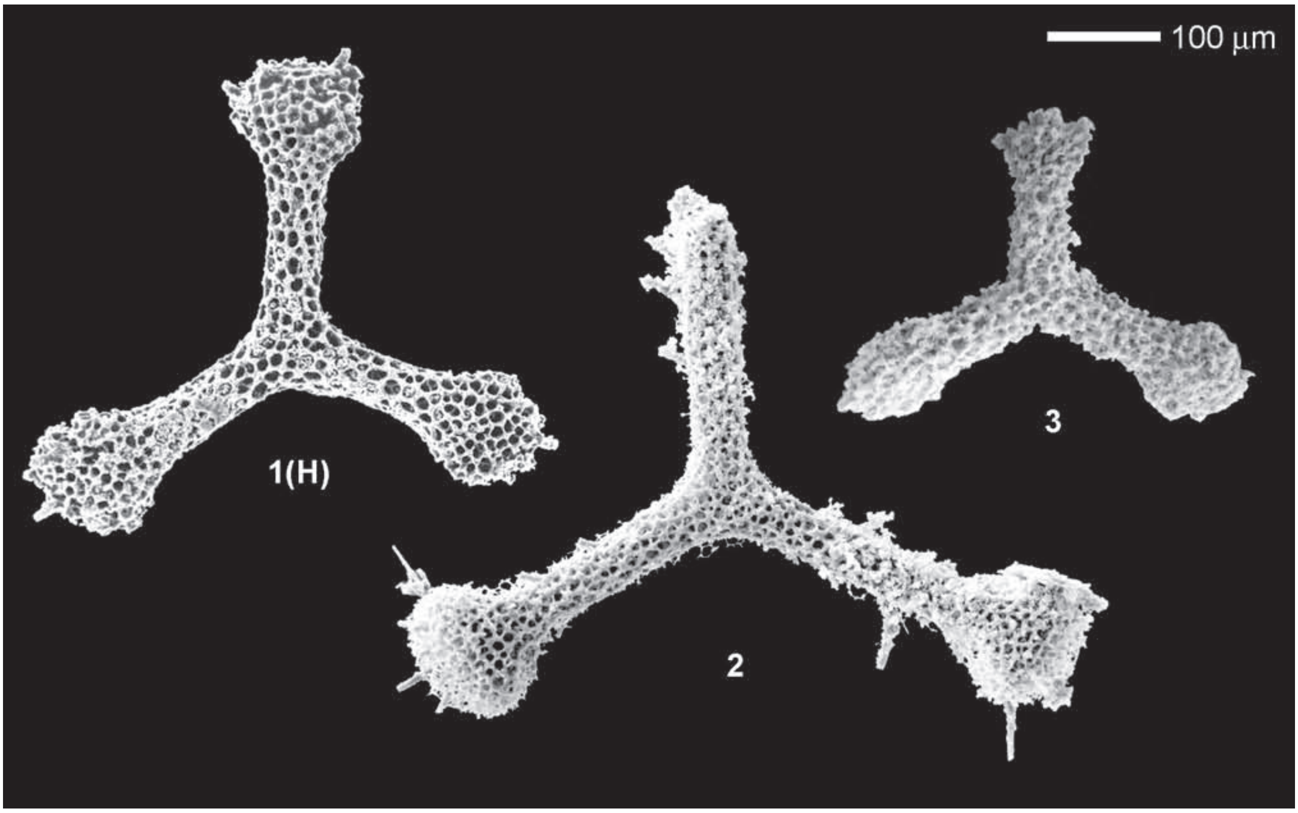


Plate 2005. ***Paronaella skowkonaensis*** **Carter**. Magnification x150. **Fig. 1(H).** Carter et al. 1988, pl. 11, fig. 4. **Fig. 2.** Matsuoka 2004, fig. 35. **Fig. 3.** Hori & Otsuka 1989, pl. 4, fig. 8.

Paronaella snowshoensis (Yeh) 1987b

Species code: PAR19

Synonymy:

1987b *Sontonaella snowshoensis* n. sp. – Yeh, p. 46, pl. 21, fig. 3; pl. 22, figs. 9, 14.

2002 *Paronaella snowshoensis* (Yeh) – Whalen & Carter, p. 107, pl. 3, figs. 2, 9, 12, 14.

Original description: Test large with three rays nearly equal in length. Rays long, moderate in width, subcircular in outline, terminating in large rhombohedral tips with a medium length triradiate spines originating from central portion of tips. Test comprised of nearly uniformly sized sublinearly arranged triangular pore frames on ray shafts and more irregularly arranged polygonal pore frames on tips. Pore frames larger on ray shafts and smaller in central area, all pore frames with nodes at vertices.

Original remarks: *Sontonaella snowshoensis*, n. sp., differs from *S. bona*, n. sp., by having rays consisting chiefly of triangular pore frames rather than tetragonal pore frames, and by having three ray shafts with three large rhombohedral tips rather than with one rhombohedral tip and two ellipsoidal tips.

Measurements (μm):
Ten specimens measured. System of measurement shown in text-figure 7 of Yeh (1987b).

	LA	LB	LC	WR	LT	WT	LSP
HT	315	315	315	63	125	200	150
Mean	320	320	320	70	115	210	152
Max.	355	355	355	80	125	220	155
Min.	300	300	300	63	100	200	150

Etymology: This species is named for the Snowshoe Creek near its type locality.

Type locality: OR-589D, Warm Springs member, Snowshoe Formation, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; San Hipólito Formation, Baja California Sur; Japan.

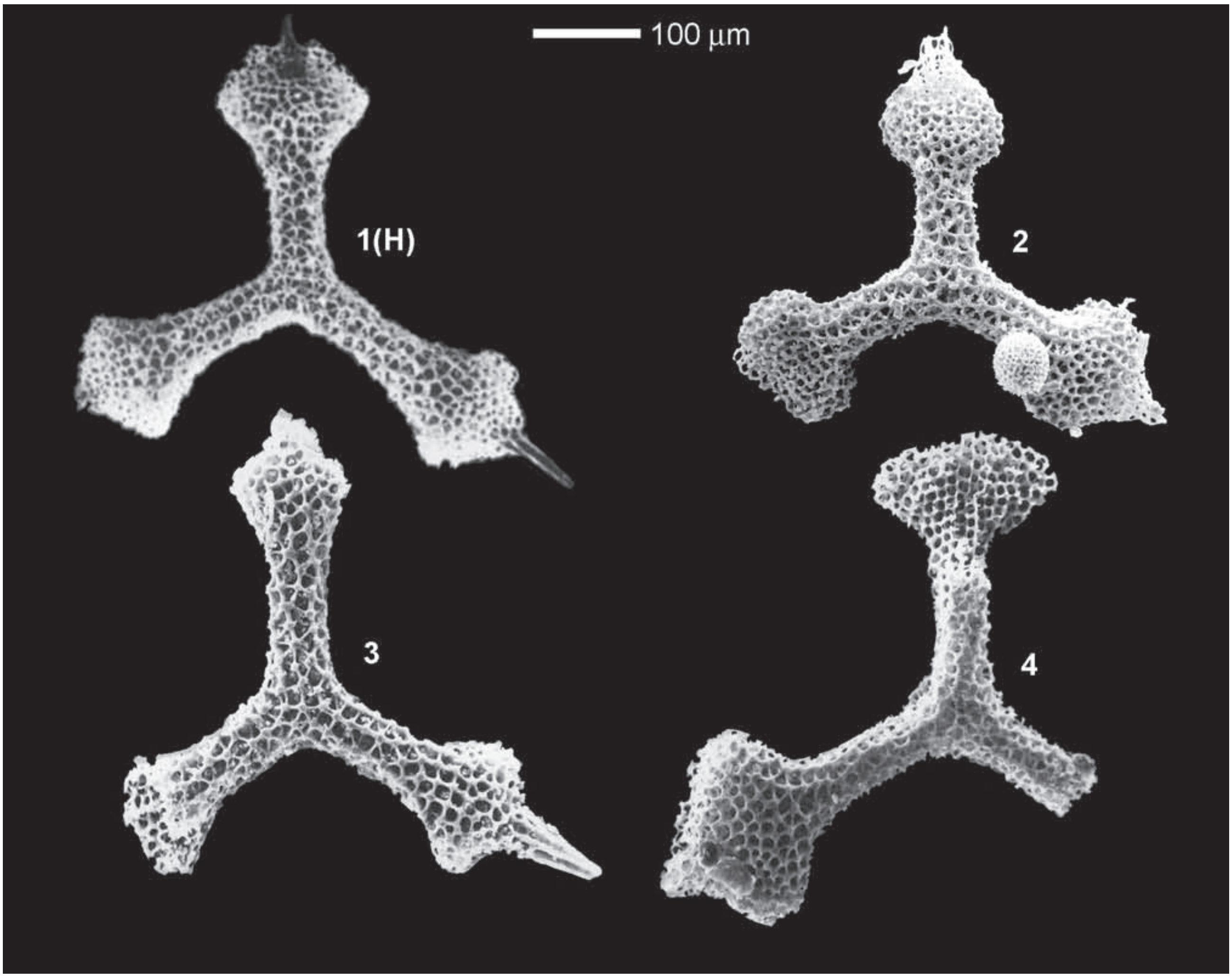


Plate PAR19. ***Paronaella snowshoensis*** **(Yeh).** Magnification x 150. **Fig. 1(H).** Yeh 1987b, pl. 22, fig. 9. **Fig. 2.** JP, MNA-10, MA10797. **Fig. 3.** BCS, Loc. BPW80-30. **Fig. 4.** Whalen & Carter 2002, pl. 3, fig. 2.

Paronaella tripla De Wever 1981b

Species code: PAR20

Synonymy:

1981b *Paronaella tripla* n. sp. – De Wever, p. 34, pl. 3, figs. 5, 6.
1982b *Paronaella tripla* De Wever – De Wever, p. 248, pl. 25, figs. 3-4.
1988 *Paronaella* sp. B – Carter et al., p. 42, pl. 11, fig. 6.

Original description: Form with three massive arms each terminating in a short primary spine. Arms wide at base increasing more in width distally. Five to six longitudinal beams clearly visible on arms, connected to oblique bars framing triangular pores. Nodes, sometimes well developed, present at beam-bar intersections. Fine, loose spongy material visible on well preserved specimens on all test surfaces, especially on general plane of flattening.

Original remarks: This species differs from *Paronaella elegans* by its much more massive shape, wider arms, thinner beams and bars and more abrupt brachial end. It is distinguished from *Paronaella petroleumensis* (Pessagno) 1971 by the absence of a bracchiopyle and its less inflated central part, and from *P. californiensis* (Pessagno) 1971 by the shape of its arms and absence of a bracchiopyle; *Paronaella kotura* Baumgartner (1980) is thinner with slimmer arms.

Measurements (μm):
Based on 6 specimens.

	Mean	Min.	Max.	HT
Length of arm, from center to base of terminal spine	196	157	220	220
Width of arm (before inflated part)	107	100	120	120

Etymology: From latin *triplus, -a, -um*, adj. = triple. This species has three arms, three primary spines, and pores which are triangular most of the time.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Dürrnberg Formation, Austria; Phantom Creek Formation, Queen Charlotte Islands.

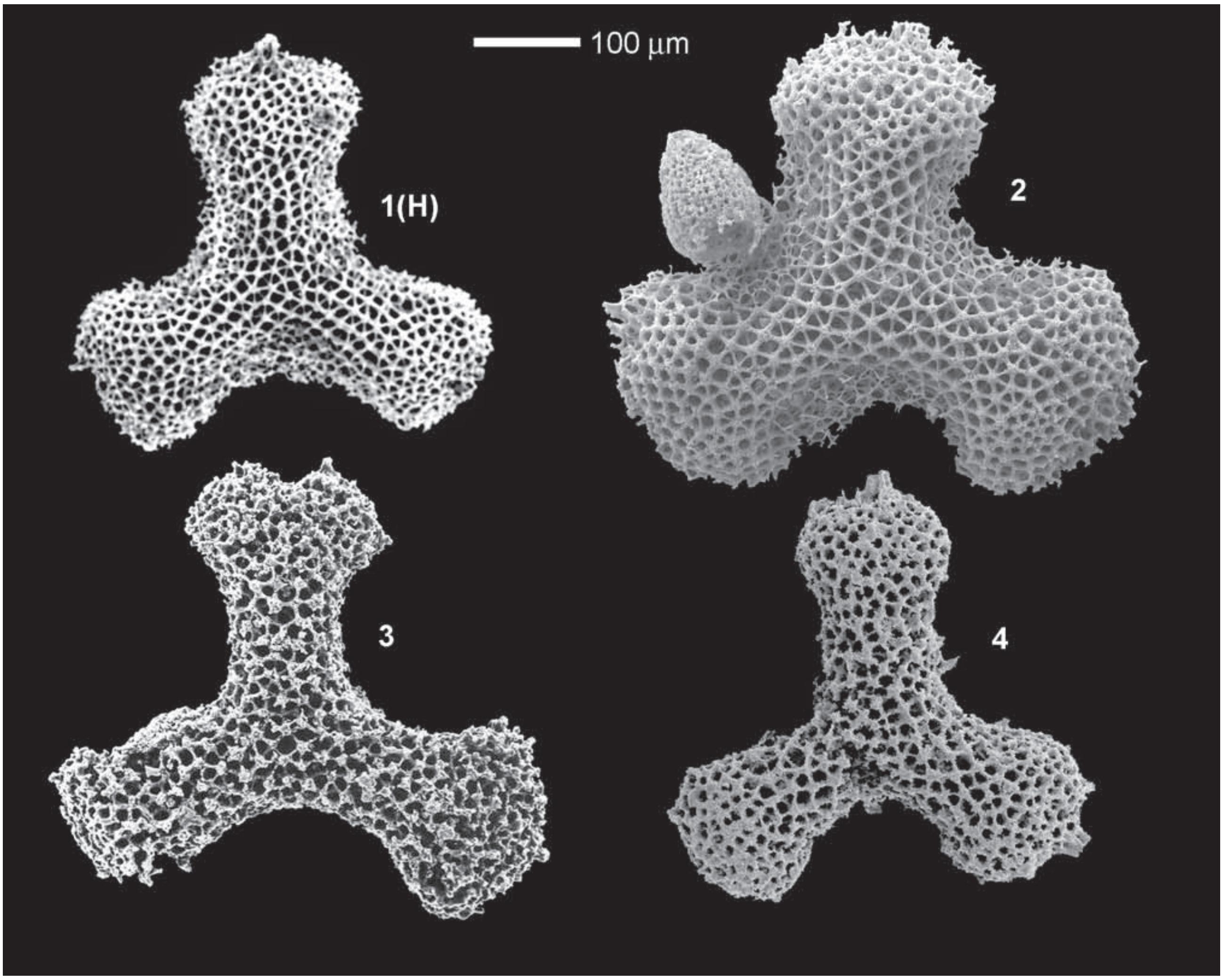


Plate PAR20. ***Paronaella tripla*** **De Wever.** Magnification x150. **Fig. 1(H).** De Wever 1981b, pl. 3, fig. 5. **Fig. 2.** TR, 1662D-R08-05. **Fig. 3.** Carter et al. 1988, pl. 11, fig. 6. **Fig. 4.** AT, BMW21-29.

Paronaella variabilis Carter 1988
Species code: PAR21

Synonymy:
1988 *Paronaella variabilis* Carter n. sp. – Carter et al., p. 41, pl. 11, figs. 1-3.
2002 *Paronaella variabilis* Carter – Whalen & Carter, p. 107, pl. 3, figs. 3, 4, 7, 10.
2004 *Paronaella* sp. cf. *P. bona* (Yeh) – Ziabrev et al., fig. 5-7.

Original diagnosis: Three-rayed patulibracchiid of variable morphology. Rays generally slender with greatly expanded elliptical, wedge or club-shaped tips. Mesh size irregular, coarse to medium, finer on ray tips. Rays terminate in numerous small spines.

Original description: Three-rayed form variable in many respects. Rays moderately slender, expanding to large elliptical, club, or wedge-shaped tips. The largest interradial angle varies continuously from 120º˙to almost 150º (n=81). Pore frames irregularly arranged on most specimens, sublinear on others; always smaller on ray tips. Pore frames triangular and tetragonal, nodes highly developed. Rays cylindrical to subrectangular in cross-section.

n=81	Mean	Standard deviation
Maximum angle	128.41º	5.88
Minimum angle	111.99º	5.93

Original remarks: A variable form extremely abundant in all upper Toarcian samples. Resembles *Paronaella* sp. cf. *P. kotura* figured by Baumgartner (1980, p. 304, Pl. 9, fig. 14), but lacks fine meshwork in central area and has numerous fine spines on ray tips. It differs from *P. kotura* by having highly variable interradial angles, shorter, wider rays with more expanded tips, and by lacking small pores in the central area.

Measurements (μm):
Based on 10 specimens.

	HT	Av.	Max.	Min.
Length of ray AX	196			
BX	188	197	230	150
CX	182			
Width of ray	50	81	70	50
Width of tip	149	146	205	80

Etymology: Latin, *variabilis* (adj.), changeable.

Type locality: GSC locality C-080584, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte Island, British Columbia.

Occurrence: Ghost Creek, Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Haliw (Aquil) Formation, Oman; Bainang Terrane, Tibet.

Genus: ***Perispyridium*** Dumitrica 1978
Type species: *Triloncheʔ ordinaria* Pessagno 1977a

Synonymy:
1978 *Perispyridium* n. gen. – Dumitrica, p. 35.
1987b *Protoperispyridium* n. gen – Yeh, p. 91.

Original description: Flat eptingiids with cephalis small, surrounded in frontal plane by a triangular or subcircular peripheral latticed shell; sagittal ring inserted in the cephalic wall; arches more or less distinct.

Original remarks: *Perispyridium* seems to be the last survivor of the family. It bears the most advanced spumellarian morphology among the eptingiids, the cephalis being able to be easily confused with the microsphere and the peripheral latticed shell with the cortical shell.

Included species:
PSP03 *Perispyridium hippaense* (Carter) 1988
PSP01 *Perispyridium oregonense* (Yeh) 1987b

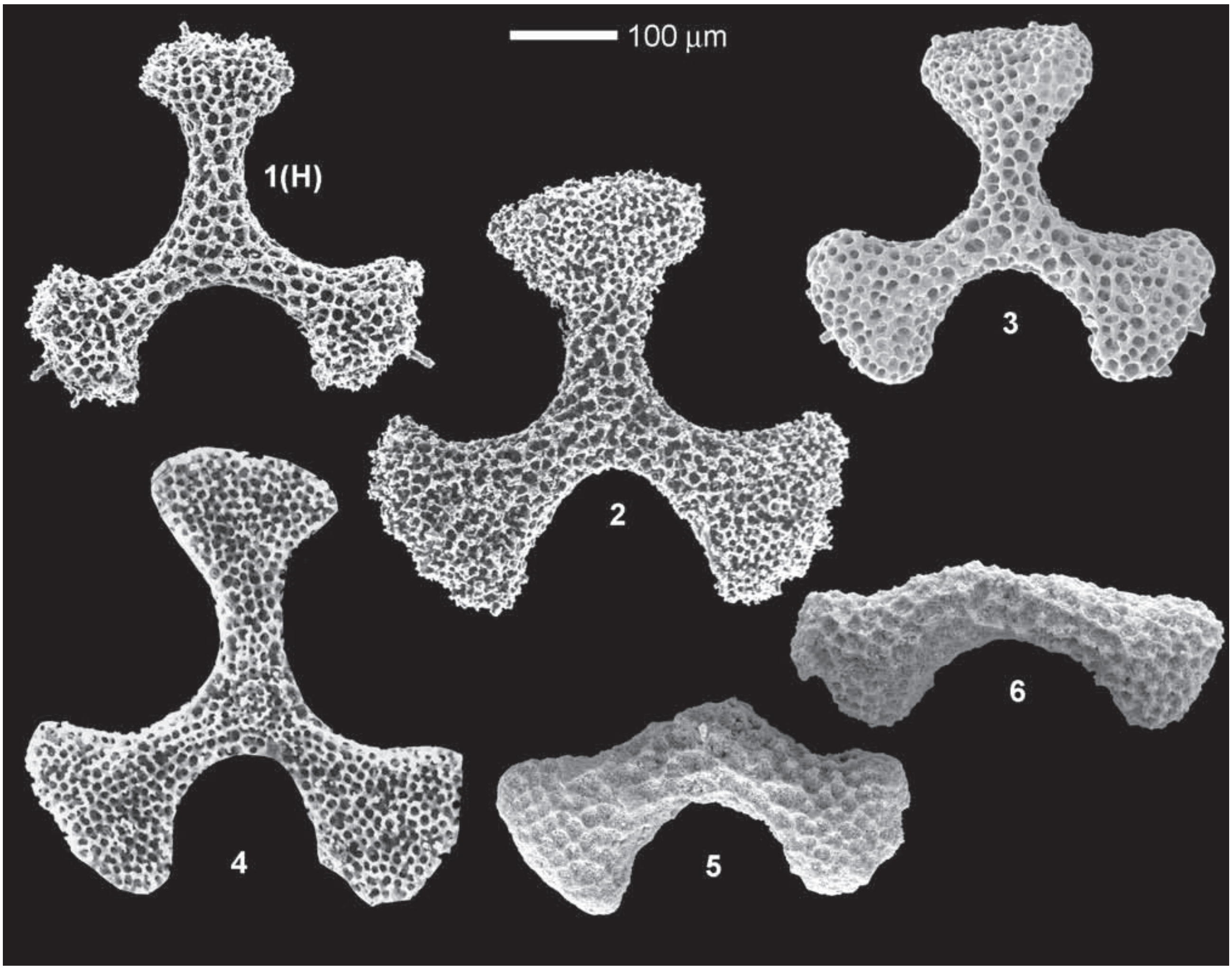


Plate PAR21. ***Paronaella variabilis*** **Carter.** Magnification x 150. **Fig. 1(H).** Carter et al. 1988, pl. 11, fig. 1. **Fig. 2.** Carter et al. 1988, pl. 11, fig. 3. **Fig. 3.** QCI, GSC C-080611, GSC 128876. **Fig. 4.** Whalen & Carter 2002, pl. 3, fig. 3. **Fig. 5.** OM, Haliw-039-R03-10. **Fig. 6.** OM, Haliw-039-R03-11.

Perispyridium hippaense (Carter) 1988

Species code: PSP03

Synonymy:

1987b *Protoperispyridium* sp. A – Yeh, p. 93, pl. 13, figs. 13, 23.
1988 *Protoperispyridium hippaensis* Carter n. sp. – Carter et al., p. 59, pl. 6, figs. 1-2.
2004 *Perisypridium* sp. – Matsuoka, fig. 183.

Original diagnosis: Strongly triangular, thickened peripheral shell with concave sides, heavy nodes and prominent sleeve-like extensions. Three spines are massive and triradiate with crown-like extensions (produced by subsidiary spines on ridge tips).

Original description: Cephalis indistinct, peripheral shell triangular in outline, sides concave; shell thickened at right angles to frontal plane. Apical and two primary lateral spines often not at 120°. Spines massive, triradiate with alternating ridges and grooves. Ridges wide and deep, grooves relatively shallow, merging to a point. Outer tip of each ridge is widened and blunt. The subsidiary spines together produce a crown-like structure.

Original remarks: Differs from *Protoperispyridium* sp. B, in having a thicker shell with concave sides, more massive pore frames and heavier nodes.

Further remarks: *Perispyridium hippaense* differs from *P. oregonense* (Yeh) in having large nodes on the peripheral shell and spines terminating in a crown-like structure.

Measurements (μm):
Based on 10 specimens.

	HT	Av.	Max.	Min.
Width of test (along spine axis)	120	130	150	112
Length of longest spine	93	96	110	82

Etymology: Named for Hippa Island, on the west coast of Graham Island.

Type locality: GSC locality C-080588,Graham Island Formation, Rennell Junction, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves, Phantom Creek, and Graham Island formations, Queen Charlotte Islands; Hyde Formation, Oregon; Japan.

Perispyridium oregonense (Yeh) 1987b

Species code: PSP01

Synonymy:

1987b *Protoperispyridium oregonense* n. sp. – Yeh, p. 91, pl. 13, figs. 14, 16, 18, 20, 22, 24.
1987b *Perispyridium* (?) sp. A – Yeh, p. 91, pl. 3, fig. 8, pl. 24, fig. 4, 13, 22, 24.
1987b *Protoperispyridium* sp. D – Yeh, p. 93, pl. 24, fig. 14.
1989 *Protoperispyridium* sp. cf. *P. oregonense* Yeh – Hattori, pl. 3, fig. J.
1997 *Perispyridium* sp. E0 – Yao, pl. 15, fig. 708.
2003 *Perispyridium* cf. *oregonense* (Yeh) – Goričan et al., p. 296, pl. 4, fig. 1.

Original description: Test convex at right angle to frontal plane. Cephalis large, with irregular large polygonal pore frames forming raised cephalic wall. Sides of peripheral shell concave inwards. Pore frames with thin rims and thick sides. Peripheral shell connected to three spines with truncated, sleeve-like extensions. Apical spines and two primary lateral spines displaced equally, about equal in length, and triradiate with three wide ridges alternating with three wide grooves, grooves about as wide as ridges. Narrow subsidiary grooves occurring on ridges. Peripheral shell consisting of large irregular pore frames with thickest portion on sleeve-like extension and connected to cephalis by two or three butresses which separate one or two small rounded pericephalic pores.

Measurements (μm):
Ten specimens measured. LT = length of test along the axis of apical spine, WT = maximum width of test normal to the axis of apical spine.

	LT (max.)	WT (max.)
HT	123	135
Mean	125	131
Max.	141	135
Min.	123	128

Etymology: This species is named for the state of Oregon.

Type locality: OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands; Skrile Formation, Slovenia; Japan.

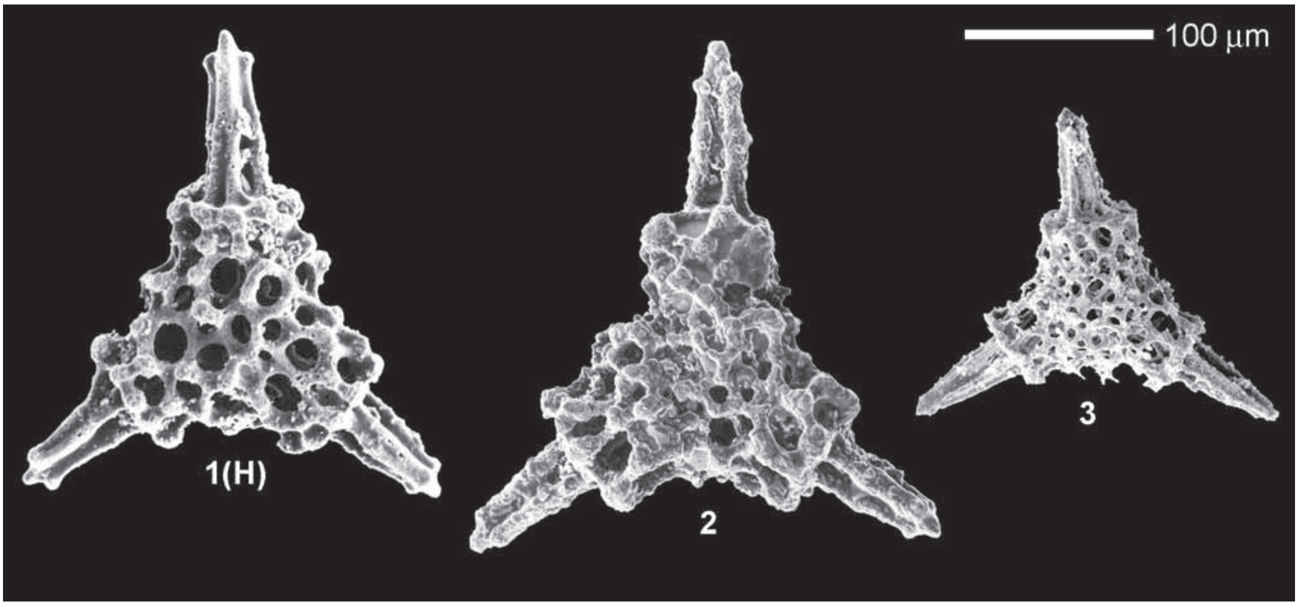


Plate PSP03. *Perispyridium hippaense* (Carter). Magnification x250. **Fig. 1(H).** Carter et al. 1988, pl. 6, fig. 1. **Fig. 2.** Carter et al. 1988, pl. 6, fig. 2. **Fig. 3.** JP, MNA-10, MA11437.

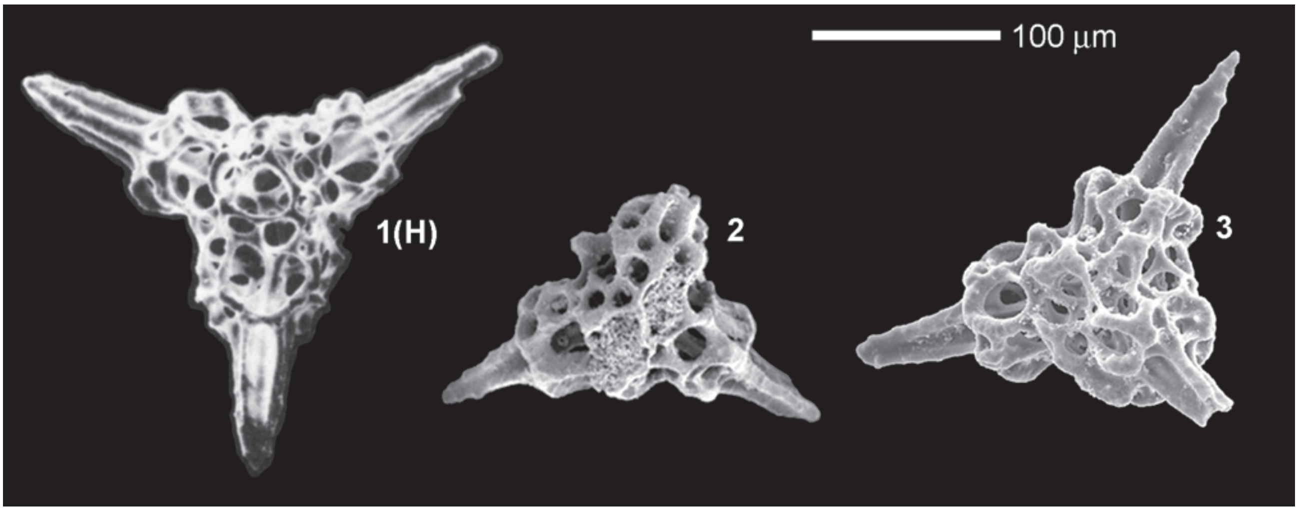


Plate PSP01. *Perispyridium oregonense* (Yeh). Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 13, fig. 14. **Fig. 2.** QCI, GSC loc. C-080611, GSC 111741. **Fig. 3.** QCI, GSC loc. C-175309, GSC 111742.

Genus: *Pleesus* Yeh 1987b

Type species: *Pleesus aptus* Yeh 1987b

Synonymy:

1987b *Pleesus* n. gen. – Yeh, p. 82.

Original description: Test multicyrtid, spindle-shaped (conical when broken), with or without constrictions between joints. Cephalis dome-shaped with horn. Earlier chambers covered with layer of microgranular silica, remaining chambers consisting of single layer of regular to subregular polygonal pore frames. Final post-abdominal chambers slightly inflated and terminating in open, narrow, elongate, tubular extension.

Original remarks: *Pleesus* n. gen., differs from *Katroma* Pessagno and Poisson (1981) by lacking a horn on cephalis, and by having a less inflated final post-abdominal chamber.

Etymology: *Pleesus* is a name formed by an arbitrary combination of letters (ICZN, 1985, Appendix D, pt.Vl, Recommendation 40, p. 201).

Included species:

PLE01 *Pleesus aptus* Yeh 1987b

Pleesus aptus Yeh 1987b

Species code: PLE01

Synonymy:

1987b *Pleesus aptus* n. sp. – Yeh, p. 82, pl. 10, figs. 9, 18, 23; pl. 23, fig. 7.

1996 *Pleesus* sp. – Tumanda et al., p. 181, Fig. 5.9.

1998 *Pleesus* sp. aff. *P. aptus* Yeh – Yeh & Cheng, p. 34, pl. 4, fig. 17.

2004 *Pleesus aptus* Yeh – Matsuoka, fig. 122.

Original description: Test as with genus, elongate, spindle-shaped, with slight constrictions between joints, with as many as nine post-abdominal chambers. Cephalis dome-shaped, medium in size, without horn. Thorax and subsequent chambers trapezoidal in outline, gradually increasing in width as added, with final post-abdominal chamber slightly inflated and terminating in narrow, latticed, tubular extension. Cephalis imperforate, thorax and abdomen sparsely perforate, covered by layer of microgranular silica. Post-abdominal chambers consisting of single layer of subregular tetragonal, pentagonal, and hexagonal pore frames. Pore frames gradually increasing in size distally.

Measurements (µm):

Ten specimens measured.

	Length of conical part	Width of conical part at base	Length of inflated part	Max. width
HT	187	90	75	115
Mean	192	110	73	118
Max.	209	128	75	126
Min.	185	90	71	112

Etymology: *Aptus-a-um* (Latin, adj.) = useful.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Liminangcong Chert, Philippines; Tawi Sadh Member of the Guwayza Formation, Musallah Formation, Oman; Japan.

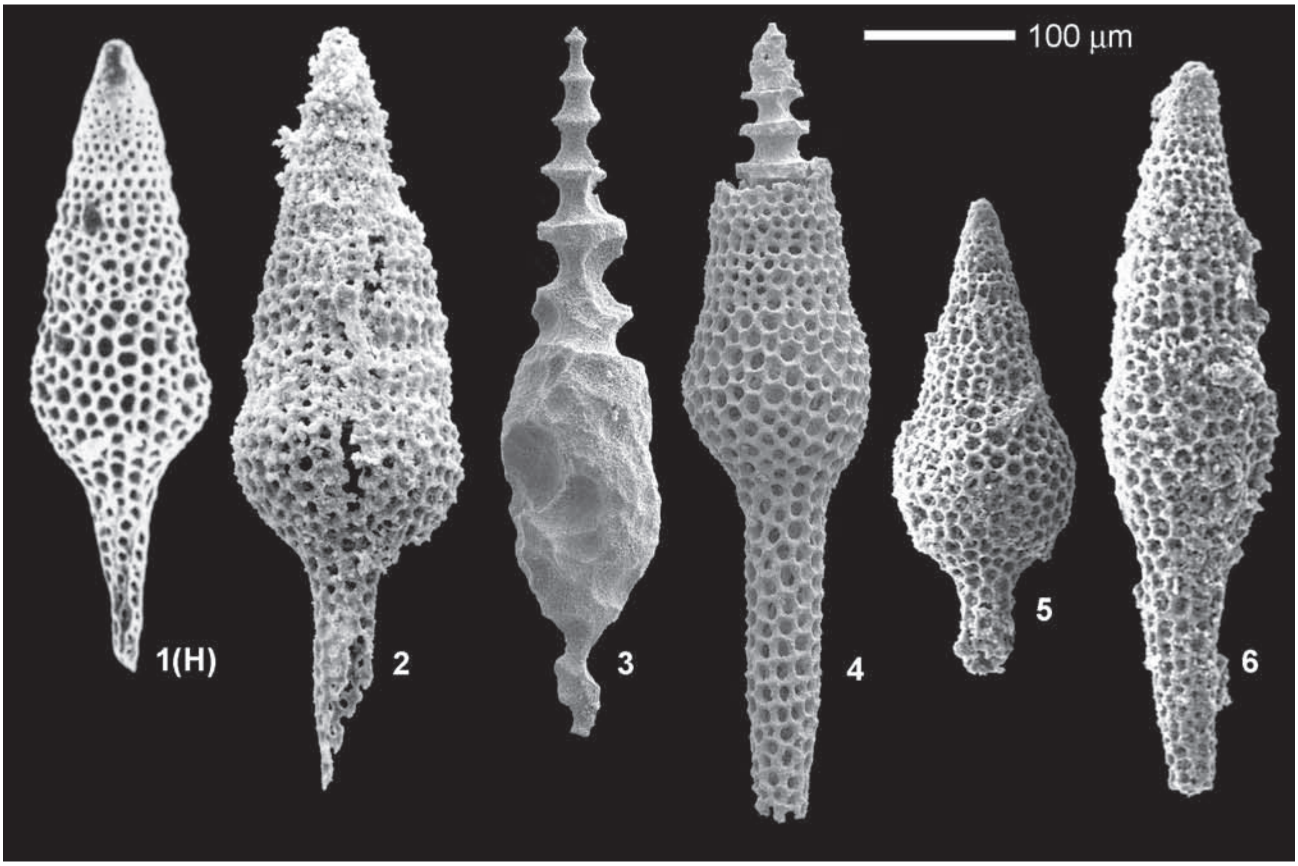


Plate PLE01. ***Pleesus aptus*** **Yeh.** Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 10, fig. 9. **Fig. 2.** Matsuoka 2004, fig. 122. **Fig. 3.** OM, BR706-R12-08. **Fig. 4.** BR706-R12-04. **Fig. 5.** OM-00-252-021817. **Fig. 6.** OM-00-251-021417.

Genus: *Plicaforacapsa* O'Dogherty, Goričan & Dumitrica 2006

Type species: *Stylocapsa catenarum* Matsuoka 1982a

Synonymy:

2006 *Plicaforacapsa* O'Dogherty, Goričan & Dumitrica n. gen. - O'Dogherty et al., p. 443.

Original diagnosis: Test elongated fusiform, composed of two or more segments. Outer surface of shell with longitudinal plicae bearing one row of small circular pores. Cephalis small, hemispherical, last segment inflated with a constricted aperture at the base.

Original remarks: *Plicaforacapsa* differs from other genera in having pores on the longitudinal plicae. At present two species with this ornamentation have been found in the Jurassic: *Stichocapsa elegans* Matsuoka from the Toarcian (Matsuoka 1991a) and *Stylocapsa catenarum* Matsuoka from the middle to late Bathonian (Baumgartner et al., 1995a). A direct phylogenetic relationship between them has not been demonstrated yet.

Etymology: Referring to perforated plicae, feminine gender.

Included species:

SCP02 *Plicaforacapsa*? *elegans* (Matsuoka) 1991

Plicaforacapsa? *elegans* (Matsuoka) 1991

Species code: SCP02

Synonymy:

1991 *Stichocapsa elegans* n. sp. – Matsuoka, p. 731, Fig. 7. 1a – 5b.
2003 *Stichocapsa elegans* Matsuoka – Goričan et al., p. 297, pl. 4, fig. 11.
2004 *Stichocapsa elegans* Matsuoka – Matsuoka, fig. 86.

Original description: Shell of four to five segments, elongate ovoidal. Cephalis hemispherical, poreless. Thorax, abdomen and the fourth segment in the case of five-segmented specimens truncate conical. All segments but the last one form conical proximal part; the last segment large, hemispherical with a strongly constricted aperture. Strictures between segments indistinct externally. Ten to 12 longitudinal plicae observed on the conical proximal portion of shell in lateral view. One row of pores runs on the plicae. The distal portion of shell with smooth, perforated surface. Pores small and circular.

Original remarks: *Stichocapsa elegans*, n. sp. differs from *S. plicata*, n. sp. by its slender form and by possessing perforated longitudinal plicae on the conical proximal portion of the shell.

Measurements (μm):

Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	170	179	152	165	(15)
Max. width of shell	89	105	81	89	(15)
Diameter of aperture	8	8	6	7	(2)

Etymology: The specific name comes from the Latin *elegans* (=elegant).

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman.

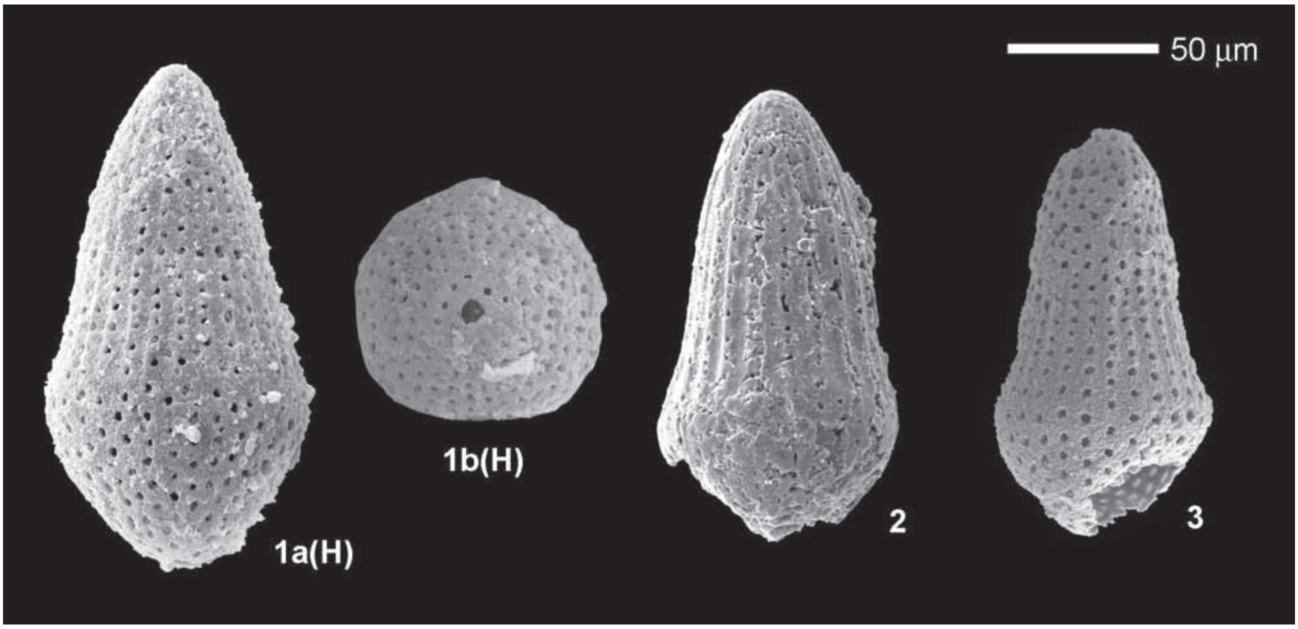


Plate SCP02. *Plicaforacapsa*? *elegans* (Matsuoka). Magnification x400. **Fig. 1(H) a-b.** Matsuoka 1991, fig. 7.1a-b. **Fig. 2.** Goričan et al. 2003, pl. 4, fig. 11. **Fig. 3.** OM, BR1121-R09-17.

Genus: *Podocapsa* Rüst 1885, emend. Foreman 1973

Type species: *Podocapsa guembeli* Rüst 1885 (subsequent designation by Campbell, 1954)

Synonymy:
1885 *Podocapsa* n. gen. – Rüst, p. 304.
1973 *Podocapsa* Rüst emend. – Foreman, p. 267.

Original description: The three following species required the definition of a new genus. A diagnosis would be: *Monocyrtida clausa eradiata, testa subsphaerica, appendicibus tribus vel pluribus ubique clathratis*, and it would have its analogue in the genera Haeckel's dicyrtid genus *Sethrochytris* and Ehrenberg's *Lithochytris*. Of the two latticed extensions the two opposite ones, which could be named basal extensions, are always equal, while the third one, the apical extension, is developed different.

Further remarks: By Foreman (1973): When Campbell (1954, p. D122) subsequently designated *Podocapsa guembeli* Rüst, 1885 as the type species of *Podocapsa*, he did not, in the absence of a type designation by Rüst, indicate which of the two entirely different specimens illustrated by Rüst was to be considered as the lectotype of *P. guembeli*. He did reproduce one of Rüst's illustrations, fig. 5 on pl. 36. However, since he very frequently selected a specimen other than the one or more which were eligible to be the type of the species designated as type species of the genera he treated, this illustration by Campbell is not considered to be a designation. We therefore designate Rüst's specimen (pl. 36, fig. 6) as the lectotype of *Podocapsa guembeli*. Although Rüst considered this specimen to be a monocyrtid with two porous wings and a porous apical extension, it is apparent that the latter is actually the terminal tube of the distalmost segment and that the proximal segments have been broken off. The generic definition of *Podocapsa* is thus emended as follows: Shell of at least three segments, the proximal part small, made up of all but the distalmost segment which is large, globose, and bears three porous wings and a porous terminal tube.

By Baumgartner et al. (1995a): This genus can be distinguished from the genus *Podobursa* by the nature of the laterally directed porous wings as opposed to laterally directed spines on *Podobursa*.

Included species:
POD01 *Podocapsa abreojosensis* Whalen & Carter 2002

Podocapsa abreojosensis Whalen & Carter 2002

Species code: POD01

Synonymy:
1984 unidentified Radiolaria – Whalen & Pessagno, pl. 1, fig. 8.
1998 *Podocapsa* sp. A – Yeh & Cheng, p. 30, pl. 6, figs. 12, 16.
2002 *Podocapsa abreojosensis* n. sp. – Whalen & Carter, p. 136, pl. 14, figs. 6, 7, 13, 14; pl. 18, figs. 10, 11.

Original description: Test composed of cephalis, thorax and abdomen. Cephalis hemispherical, with small horn, small pores masked by a layer of microgranular silica. Thorax trapezoidal in outline with small, irregularly sized and shaped pores covered by layer of microgranular silica. Abdominal chamber spherical, inflated, much larger than first two chambers, terminating in porous, cylindrical terminal extension. Pore frames on abdomen pentagonal, hexagonal, as well as irregular in construction, much larger than on first two segments; abdominal pore frames larger in medial position becoming smaller towards thorax and terminal tube. Three, large, porous arms circumferentially arranged along widest part of abdomen, situated approximately 120° from each other. Both arms and terminal tube gently tapering distally. Arms and terminal tube usually with broken tips but some specimens show closure, particularly on the arms (holotype). Pores on arms and terminal tube slightly smaller than on abdomen, sometimes showing slight trochospiral arrangement.

Original remarks: *Podocapsa abreojosensis* n. sp., is distinguished from *P. amphitreptera* Foreman 1973, by the less globose shape of the cephalis and thorax and longer arms. It is possible *Podocapsa*? *abreojosensis* n. sp., may be a heterochronous homeomorph as it is so disconnected in time from all other species of this genus; for this reason, the genus is queried. However, at this time we are unable to recognize characteristics that would suggest establishing a new genus.

Measurements (µm):
(n) = number of specimens measured

Length (10) (maximum)	Length of arms (11)	
278	135	HT
278	150	Max.
173	60	Min.
213	96	Mean

Etymology: This species is named for Punta Abreojos located to the south of the type area.

Type locality: Sample BPW80-30, San Hipólito Formation, Punta San Hipólito, Vizcaino Peninsula, Baja California, Mexico.

Occurrence: San Hipólito Formation, Baja California Sur; Liminangcong Chert, Philippines; Haliw (Aquil) Formation, Oman.

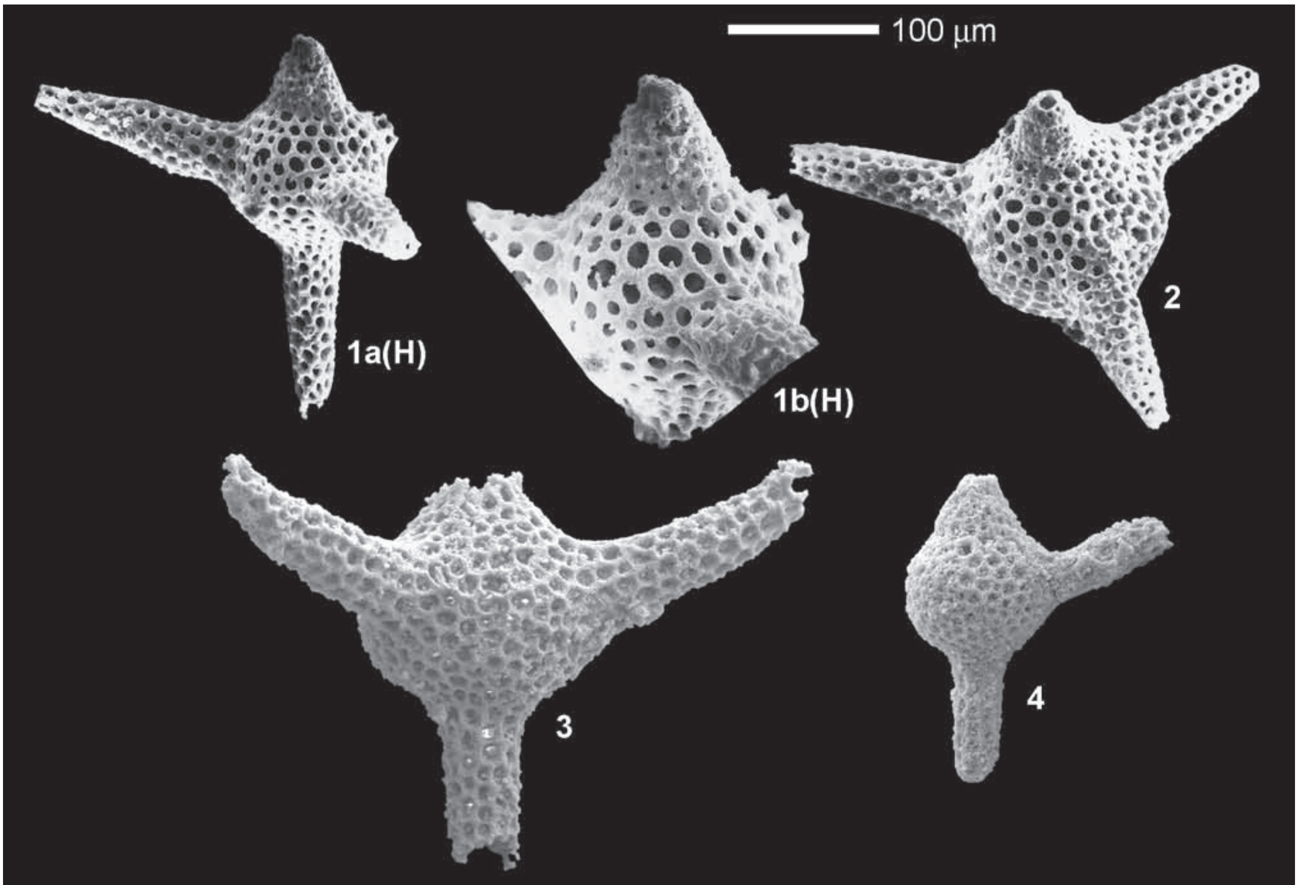


Plate POD01. ***Podocapsa abreojosensis* Whalen & Carter.** Magnification x200 except Fig. 1b(H) x300. **Fig. 1(H).** Whalen & Carter 2002, pl. 14, figs. 6, 13. **Fig. 2.** Whalen & Carter 2002, pl. 14, fig. 7. **Fig. 3.** OM, BR682-R09-13. **Fig. 4.** OM, Haliw-039-R03-04.

Genus: *Praeconocaryomma* Pessagno 1976

Type species: *Praeconocaryomma universa* Pessagno 1976

Synonymy:
1976 *Praeconocaryomma* n. gen. – Pessagno, p. 40.

Original description: Cortical shell invariably with radial spines protruding from mammae. Pore frames differing in size, shape, and distribution between cortical shell and each medullary shell, tending to be proportionately and progressively larger on each medullary shell. Radial beams connecting medullary shells about one-third as thick as those connecting cortical shell to first medullary shell.

Original remarks: *Praeconocaryomma* n. gen., differs from *Conocaryomma* Lipman by invariably having three rather than four or five medullary shells. It differs from *Phaenicosphaera* Haeckel by possessing three medullary shells rather than one.

"Acanthosphaera" magnimamma Rüst and *"Heliosphaera" mammillaria* Rüst from the Kieselkalk of Cittiglio, Italy, appear to be early representatives of *Praeconocaryomma*. These same species are now known from Tithonian strata in the California Coast Ranges. Forms figured by Rüst (1885, pl.28, figs.12-13) from the Koprolithen of Ilsede, northwestern Germany, as *"Carposphaera" circumplicata* Rüst and *"Carposphaera" affinis* Rüst are probably assignable at least to the Praeconocaryommidae. Likewise, *"Conosphaera" sphaeroconus* Rüst (1898, pl. 4, fig. 8) from the Kieselkalk of Cittiglio may be assignable to the Praeconocaryommidae. All three of the last-named species have cortical shells with mammae lacking radial spines; they should probably be assigned to a new genus.

Included species:
PRY05 *Praeconocaryomma bajaensis* Whalen n. sp.
PRY01 *Praeconocaryomma decora* gr. Yeh 1987b
PRY02 *Praeconocaryomma immodica* Pessagno & Poisson 1981
PRY03 *Praeconocaryomma parvimamma* Pessagno & Poisson 1981
PRY07 *Praeconocaryomma sarahae* Carter n. sp.
PRY04 *Praeconocaryomma whiteavesi* Carter 1988
PRY06 *Praeconocaryomma*? *yakounensis* Carter n. sp.

Praeconocaryomma bajaensis Whalen n. sp.

Species code: PRY05

Synonymy:
1989 *Praeconocaryomma* spp. – Hattori, pl. 9, fig. M.
1996 *Praeconosphaera sphaeroconus* (Rüst) Yang – Pujana, p. 136, pl. 1, fig. 21.
1997 *Praeconocaryomma* sp. A – Yao, pl. 1, fig. 32.
2002 *Praeconocaryomma* sp. A – Whalen & Carter, p. 108, pl. 8, fig. 8.
2003 *Praeconocaryomma* spp. – Goričan et al., p. 291, pl. 1, fig. 14 only.

Type designation: Holotype USNM 401912 (pl. PRY05, fig. 1) from sample BPW80-30. Paratype, GSC 111744 from GSC loc. C-140418 (pl. PRY05, fig. 2).

Description: Test spherical with large, closely spaced porous mammae that comprise a large part of the total surface area. Surfaces of mammae rounded, penetrated by many small circular pores centered around a small rod-like spine. Pores in intermammary area generally small, very irregular in shape. Outermost medullary shell with variably-sized pentagonal pore frames. Thin triradiate beams connect medullary shell with mammae on cortical shell.

Remarks: This form is similar to *Praeconocaryomma whiteavesi* Carter but differs in having less numerous but much larger mammae and correspondingly smaller intermammary areas with smaller pores.

Measurements (μm):
Based on 6 specimens

	HT	Max.	Min.	Mean
Diameter of cortical shell	224	308	207	247
Diameter of mammae	32	53	25	37
Height of mammae	20	31	14	21

Etymology: Named for Baja California Sur, Mexico.

Type locality: Loc. BPW80-30, sandstone member, San Hipólito Formation, Punta San Hipólito, Vizcaino Peninsula, Baja California Sur, Mexico. Paratype from Louise Island, Queen Charlotte Islands.

Occurrence: San Hipólito Formation, Baja California Sur; Ghost Creek and Fannin formations, Queen Charlotte Islands; Sierra Chacaicó Formation, Argentina; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

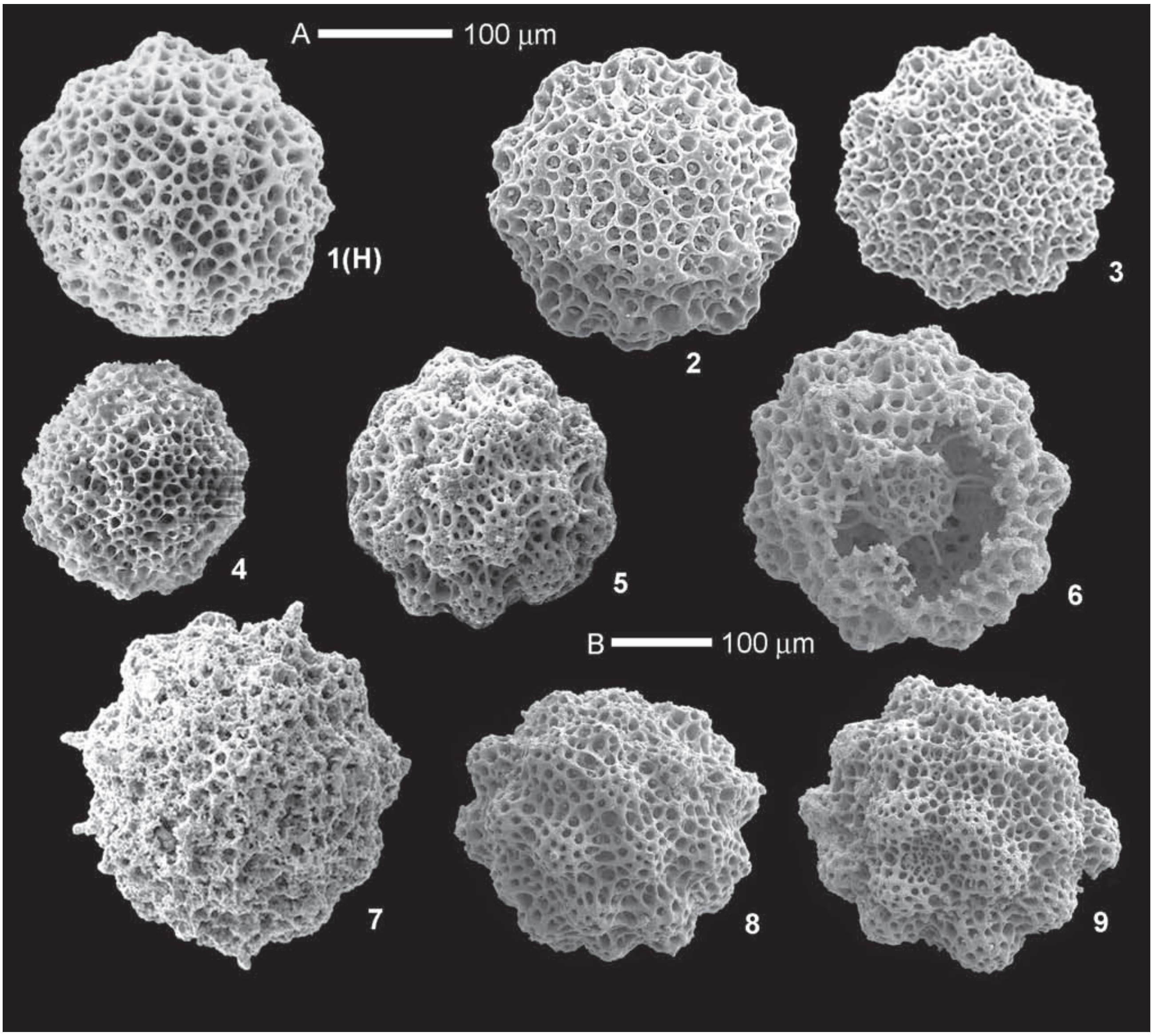


Plate PRY05. *Praeconocaryomma bajaensis* Whalen n. sp. Magnification Figs. 1-4, 6 x200 (scale bar A), figs. 5, 7-9 x150 (scale bar B). **Fig. 1(H).** Whalen & Carter 2002, pl. 8, fig. 8. **Fig. 2.** QCI, GSC loc. C-140418, GSC 111744. **Fig. 3.** QCI, GSC loc. C-304566, GSC 111745. **Fig. 4.** Goričan et al. 2003, pl. 1, fig. 14. **Fig. 5.** SI, MM 5.00, 010114. **Fig. 6.** OM, BR1121-R06-02. **Fig. 7.** QCI, GSC loc. C-305417, GSC 111746. **Fig. 8.** OM, BR1121-R06-06. **Fig. 9.** OM, BR1121-R07-24.

***Praeconocaryomma decora* gr.** Yeh 1987b

Species code: PRY01

Synonymy:

1987b *Praeconocaryomma decora* n. sp. – Yeh, p. 39, pl. 6, fig. 15; pl. 20, figs. 1-2, 9, 16, 19.
1987b *Praeconocaryomma* sp. A – Yeh, p. 40, pl. 2, figs. 17, 22; pl. 20, fig. 4.
1990 *Praeconocaryomma decora* Yeh – Nagai, pl. 6, fig. 6.
1998 *Praeconocaryomma decora* Yeh – Yeh & Cheng, p. 15, pl. 11, figs. 1, 5.
2002 *Praeconocaryomma* sp. A Yeh – Whalen & Carter, p. 108, pl. 8, fig. 5.
2003 *Praeconocaryomma* spp. – Goričan et al., p. 291, pl. 1, fig. 10 only.

Original description: Cortical shell with closely spaced mammae. Mammae uniform in size, moderately large, high in relief, distal surface rounded, hexagonal or subcircular in outline, with long primary spine originating from center of each mamma. Primary spines slender, circular in axial section. Each mamma with five to seven short rays connecting directly to adjacent mammae or linking with rays from surrounding mammae. Rays single, bifurcate, or trifurcate. Mammary pore frames poorly developed, with thin bars connecting massive rays and formnig small subtriangles beneath mammae. Intermammary pore frames large, regular in size, mostly triangular and tetragonal in outline.

Original remarks: *Praeconocaryomma decora*, n. sp., is very similar to *P. immodica* Pessagno & Poisson (1981) by having a cortical shell with large rounded, closely spaced mammae and by having primary spines circular in axial section. These two species can be distinguished by different patterns of intermammary pore frames.

Measurements (µm):
Ten specimens measured.

	Diameter of cortical shell	Diameter of medullary shell	Length of spines
HT	180		48
Mean	180	90	70
Max.	184	95	92
Min.	174	87	45

Etymology: *Decorus-a-um* (latin, adj.) = graceful.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; San Hipólito Formation, Baja California Sur; Skrile Formation, Slovenia; Liminangcong Chert, Philippines; Tawi Sadh Member of the Guwayza Formation, Oman.

Praeconocaryomma immodica Pessagno & Poisson 1981

Species code: PRY02

Synonymy:

1977a P*raeconocaryomma magnimamma* (Rüst) – Pessagno, p. 77, pl. 5, figs. 14-16; pl. 6, fig. 1.
1981 *Praeconocaryomma immodic*a n. sp. – Pessagno & Poisson, p. 57, pl. 7, figs. 2-9.
1984 *Praeconocaryomma immodica* Pessagno & Poisson – Pessagno et al., p. 24, pl. 1, figs. 22-24.
1987 *Praeconocaryomma* aff. *P. immodica* Pessagno & Poisson – Hattori, pl. 21, fig. 1.
1988 *Praeconocaryomma immodica* Pessagno & Poisson – Carter et al., p. 31, pl. 1, fig. 1.
1996 *Praeconocaryomma immodica* Pessagno & Poisson – Tumanda et al., p. 173, Fig. 4.7.
1996 *Praeconocaryomma immodica* Pessagno & Poisson – Yeh & Cheng, p. 100, pl. 2, fig. 12.
1998 *Praeconocaryomma immodica* Pessagno & Poisson – Cordey, p. 89, pl. 22, figs. 1, 2.
1998 *Praeconocaryomma immodica* Pessagno & Poisson – Yeh & Cheng, p. 15, pl. 1, fig. 11, 14; pl. 11, fig. 15.
2004 *Praeconocaryomma immodica* Pessagno & Poisson – Hori, pl. 5, fig. 9.
2004 *Praeconocaryomma immodica* Pessagno & Poisson – Ziabrev et al., Fig. 5-6.
2005 *Praeconocaryomma immodica* Pessagno & Poisson – Hori, pl. 8, fig. 53.

Original description: Cortical shell with prominent mammae which tend to be exceedingly high in relief. Distal surfaces (tops) of mammae imperforate, somewhat flattened, pentagonal in outline; mammae with radially arranged primary spines that are circular in axial section. Each face of pentagonal mammae with large pores; pores separated by stout rays which project into intermammary areas; individual rays bifurcate or trifurcate linking up with rays of adjoining mammae and forming triangular intermammary pore frames. Massive nodes present at point of bifurcation or trifurcation. Well preserved specimens with thinner rays projecting from bottom side of rays at nodal points forming subsidiary triangular pore frames. Primary radial beams (circular in axial section) continuous with radial beams connecting cortical shell with first medullary shell and first medullary shell with second medullary shell. First medullary shell with triangular meshwork comprised of equilateral triangular pore frames; second medullary shell with polygonal pore frames.

Original remarks: *P. immodica*, n. sp., differs from *P. media*, n. sp., (1) by having mammae which are pentagonal rather than hexagonal in ouline and which are considerably higher in relief; (2) by having mammae which are more closely spaced; and (3) by having more complex intermammary areas. *P. media* has triangular mammary pore frames closed by a bar at their base; however, the mammary pore frames of *P. immodica* lack the basal bar and are open basally.

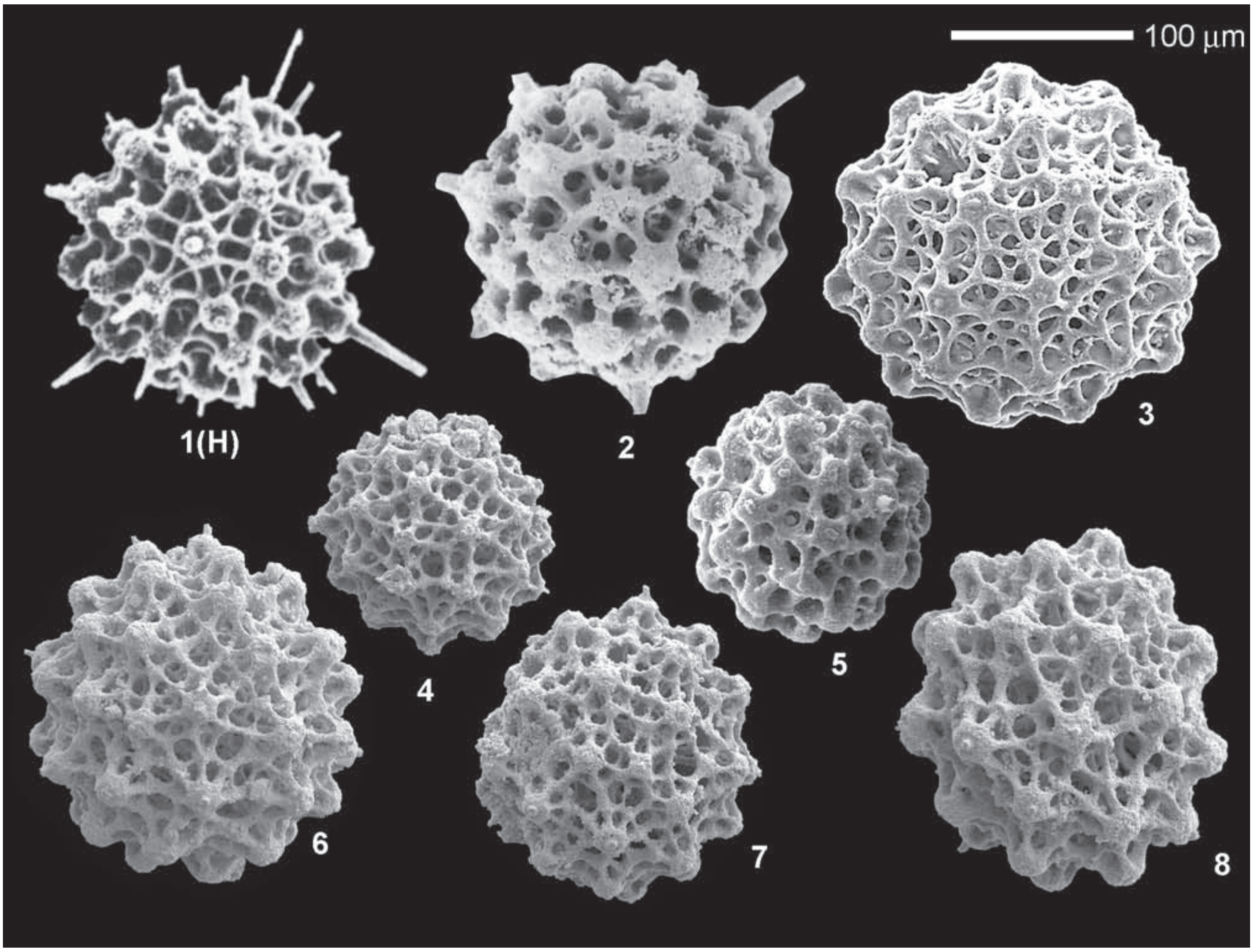


Plate PRY01. ***Praeconocaryomma decora*** **gr. Yeh.** Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 19, fig. 2. **Fig. 2.** Whalen & Carter 2002, pl. 8, fig. 5. **Fig. 3.** QCI, GSC loc. C-304568, GSC 111804. **Fig. 4.** OM, BR1121-R09-13. **Fig. 5.** Goričan et al. 2003, pl. 1, fig. 10. **Fig. 6.** OM, BR1121-R06-01. **Fig. 7.** OM, BR1121-R08-29. **Fig. 8.** OM, BR1121-R06-03.

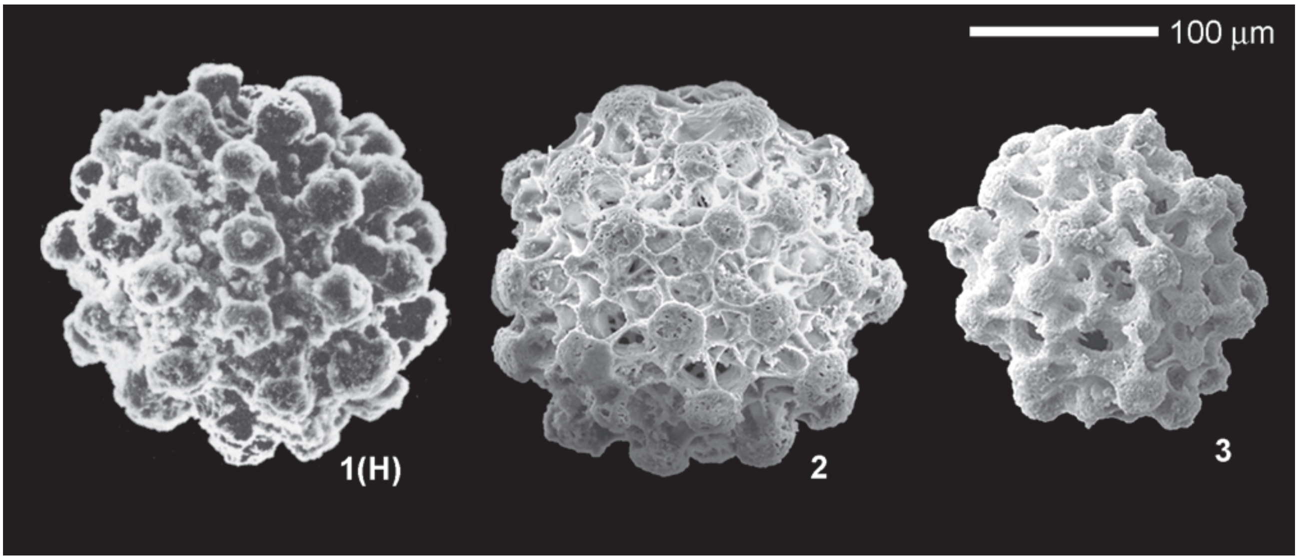


Plate PRY02. ***Praeconocaryomma immodica*** **Pessagno & Poisson.** Magnification x250. **Fig. 1(H).** Pessagno & Poisson 1981, pl. 7, fig. 2. **Fig. 2.** QCI, GSC loc. C-080613, GSC 111743. **Fig. 3.** OM, BR1121-15929.

This species seems to be the most advanced form in the *P. parvimamma*, n. sp., lineage group. At present it is not possible to link it directly to earlier and simpler forms such as *P. media*. It would, however, appear that the basal bar of the *P. media* mammary pore frames has been lost in the course of the evolution of this lineage.

Measurements (µm):
Based on 10 specimens.

	Diameter of cortical shell	Height of mammae
HT	206	44
Max.	225	44
Min.	193	25

Etymology: *Immodicus-a-um* (Latin, adj.): immoderate, excessive.

Type locality: Sample BK 605, red radiolarian chert in mélange, Franciscan Complex, California.

Occurrence: Franciscan Complex, California; Fannin, Whiteaves and Phantom Creek formations, Queen Charlotte Islands; Bridge River Complex, British Columbia; Liminangcong Chert, Philippines; Japan; Bainang Terrane, Tibet; Tawi Sadh Member of the Guwayza Formation, Oman.

Praeconocaryomma parvimamma Pessagno & Poisson 1981

Species code: PRY03

Synonymy:

1981 *Praeconocaryomma parvimamma* n. sp. – Pessagno & Poisson, p. 58, pl. 8, figs. 5-8, pl. 9, fig. 2.

1998 *Praeconocaryomma parvimamma* Pessagno & Poisson – Cordey, p. 89, pl. 22, figs. 3, 6.

Original description: Cortical shell with mammae having radially arranged relatively long primary spines originating from the center of their flat distal (top) surfaces. Primary spines relatively long, circular in cross-section. Distal flattened surfaces of mammae hexagonal in outline; six sides of each mamma with massive triangular mammary pore frames at their base; mammary pore frames with massive nodes at their base only; pore frames and sides of mammae sloping gently outward. Six rays originating from position of nodes at base of mammary pore frames, aligned with legs of each mammary pore frame and interconnecting with rays of adjoining mammae. Large subelliptical pores occurring between rays. Cortical shell and two medullary shells connected by radial beams which are circular in axial section. First medullary shell with triangular pore frames having nodes at their vertices; second medullary shell with polygonal (pentagonal?) pore frames.

Original remarks: *P. parvimamma*, n. sp., differs from *P. media*, n. sp., (1) by having much smaller, less inclined mammary pore frames and (2) by having mammae which are smaller with flattened distal (top) surfaces.

P. parvimamma appears to be the earliest and simplest form of a lineage group (termed the *P. parvimamma* lineage group here) which includes at least four morphotypes. The data at hand indicate the the *P. parvimamma* lineage group makes its first appearance in the Lower Pliensbachian (?Upper Sinemurian) and its final appearance in the Lower Tithonian. During the period from Early Pliensbachian to Early Tithonian times this lineage tends to change through an increase in the width and height of mammae and by developing more complex structure in the intermammary areas. All members of this group display a first medullary shell with equilateral triangular pore frames.

It should be noted that the form figured by Pessagno (1977) as *P. magnimamma* (Rüst) is assigned to *P. immodica*, n. sp., herein. Rüst's (1898, Pl. IV, fig. 1) illustration of *A. magnimamma* shows a form with mammae and intermammary areas perforated by numerous small pores. Pessagno originally assumed that the small pores were a figment of Rüst's imagination and that the extremely large mammae with long smooth (circular in axial section) primary spines were the distinguishing feature of *P. magnimamma*. Unfortunately, however, a form quite similar to Rüst's form occurs in Pliensbachian cherts from the Franciscan Complex. This form is referred to *P.* sp. aff. *P. magnimamma* (Rüst) herein.

Measurements (µm):
Based on 9 specimens.

	HT	Min.	Max.
Diameter of cortical shell	235	200	260
Height of mammae	20	12	20

Etymology: *Parvus-a-um* (Latin, adj.): small + *mamma* (*-ae*, F.) = breast.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Franciscan Complex, California; Bridge River Complex, British Columbia; Tawi Sadh Member of the Guwayza Formation, Oman.

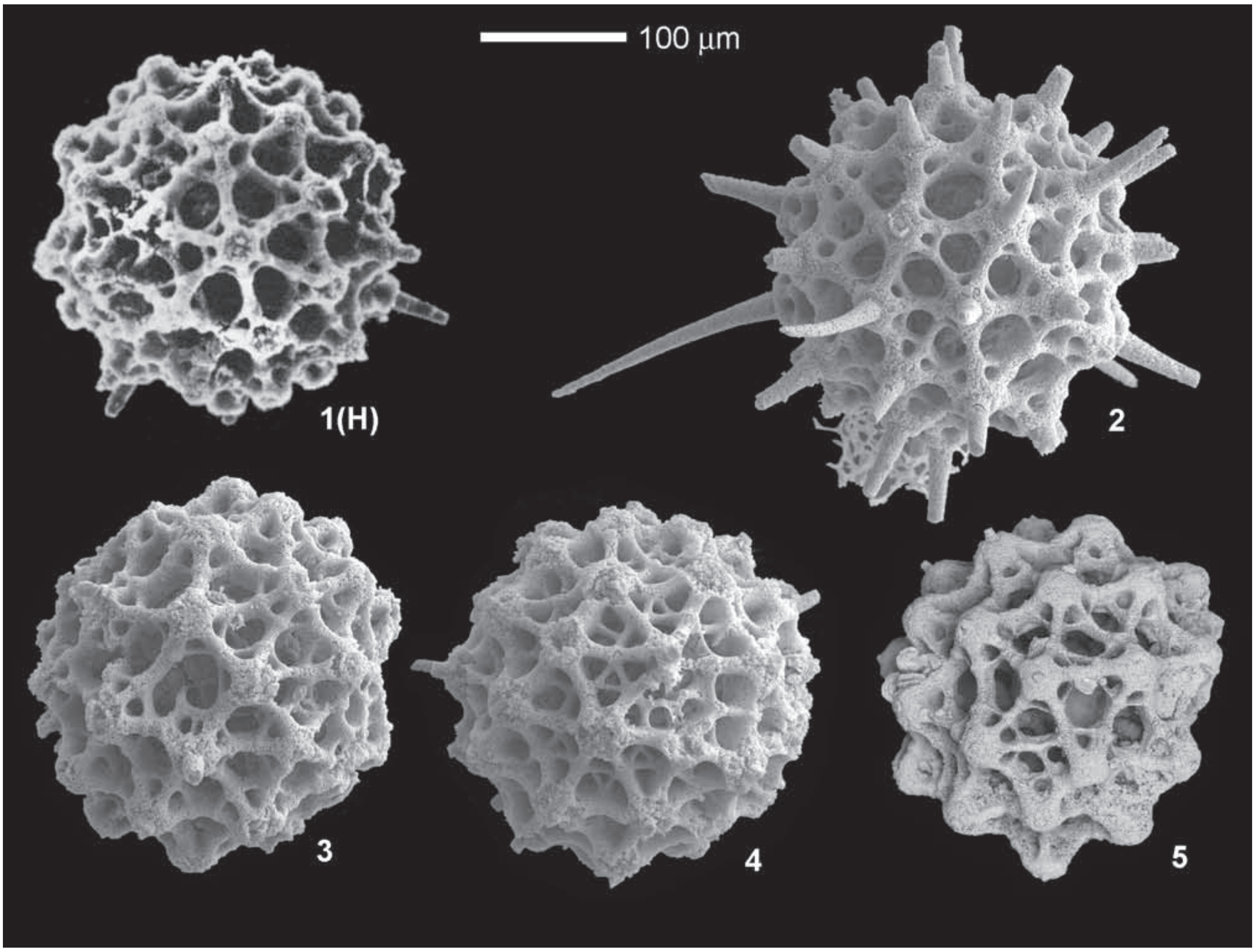


Plate PRY03. *Praeconocaryomma parvimamma* Pessagno & Poisson. Magnification x200. **Fig. 1(H).** Pessagno & Poisson 1981, pl. 8, fig. 5. **Fig. 2.** TR, 1662D-R04-09. **Fig. 3.** TR, 1662D-R04-02. **Fig. 4.** TR, 1662D-R04-07. **Fig. 5.** OM, BR1121-R07-20.

Praeconocaryomma sarahae Carter n. sp.

Species code: PRY07

Synonymy:

? 1987 *Praeconocaryomma* sp. B – Hattori, pl. 20, fig. 18.

? 1997 *Praeconocaryomma* ? sp. D0 – Yao, pl. 1, fig. 36.

2001 *Praeconocaryomma media* Pessagno & Poisson – Gawlick et al., pl. 6, fig. 2.

2002 *Praeconocaryomma media* Pessagno & Poisson – Suzuki et al., p. 172, fig. 4-A.

2002 *Praeconocaryomma parvimamma* Pessagno & Poisson – Suzuki et al., p. 172, fig. 4-B.

Type designation: Holotype GSC 111747 from GSC loc. C-304568 (pl. PRY07 fig. 1), Rennell Junction member of the Fannin Formation (upper lower Pliensbachian). Paratype GSC 111751 from GSC loc. C-305417 (pl. PRY07, fig. 5), Sandilands Formation (basal Pliensbachian).

Description: Multi-layered cortical shell with mammae, some having remnants of short, circular primary spines. Distal surfaces of mammae low to moderately raised with relatively flat surfaces; usually hexagonal (occasionally pentagonal or septagonal) in shape. Each mamma usually surrounded by six massive triangular mammary pore frames whose outer vertices link with other mammae forming an interlocking meshwork. Inner layer(s) of shell with triangular pore frames that apparently are connected to the inner surface of external mammae directly or are connected by some type of pillar-like structures. Inner layer of pore frames slightly rotated, but usually aligned. Size of pore frames gradually decreasing towards center of test. Central structure of test unknown.

It is interesting to note that the outer shell structure of *P. sarahae* n. sp. closely parallels that of the genus *Pseudopantanellium* Yeh, and species *P. floridum* Yeh. Both species are approximately the same age which suggests the possibility that some type of horizontal gene transfer (Dumitrica & Guex, 2003) may have been operational during this time.

Remarks: *Praeconocaryomma sarahae* n. sp. differs from *P. parvimamma* Pessagno & Poisson in lacking the six small pores that surround the base of each mamma. Pessagno & Poisson (1991) suggest that *P. parvimamma* is probably the earliest and simplest form of the genus *Praeconocaryomma*. *P. sarahae* n. sp. is even simpler morphologically and may be the older of the two.

Measurements (μm):

Based on 6 specimens.

	HT	Max.	Min.	Mean
Diameter of cortical shell	207	232	197	210
Height of mammae	10	11	7	10

Etymology: Named for Sarah K. Carter, a mammal biologist and ecologist for her help with the author's research and her constant support.

Type locality: Sample 99-CNA-MI-11 (GSC loc. C-304568), Rennell Juction member of the Fannin Formation, Maude Island, Skidegate Inlet, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands and Ghost Creek formations and Rennell Junction member of the Fannin Formation, Queen Charlotte Islands; Pucara Group, Peru; Dürrnberg Formation, Austria.

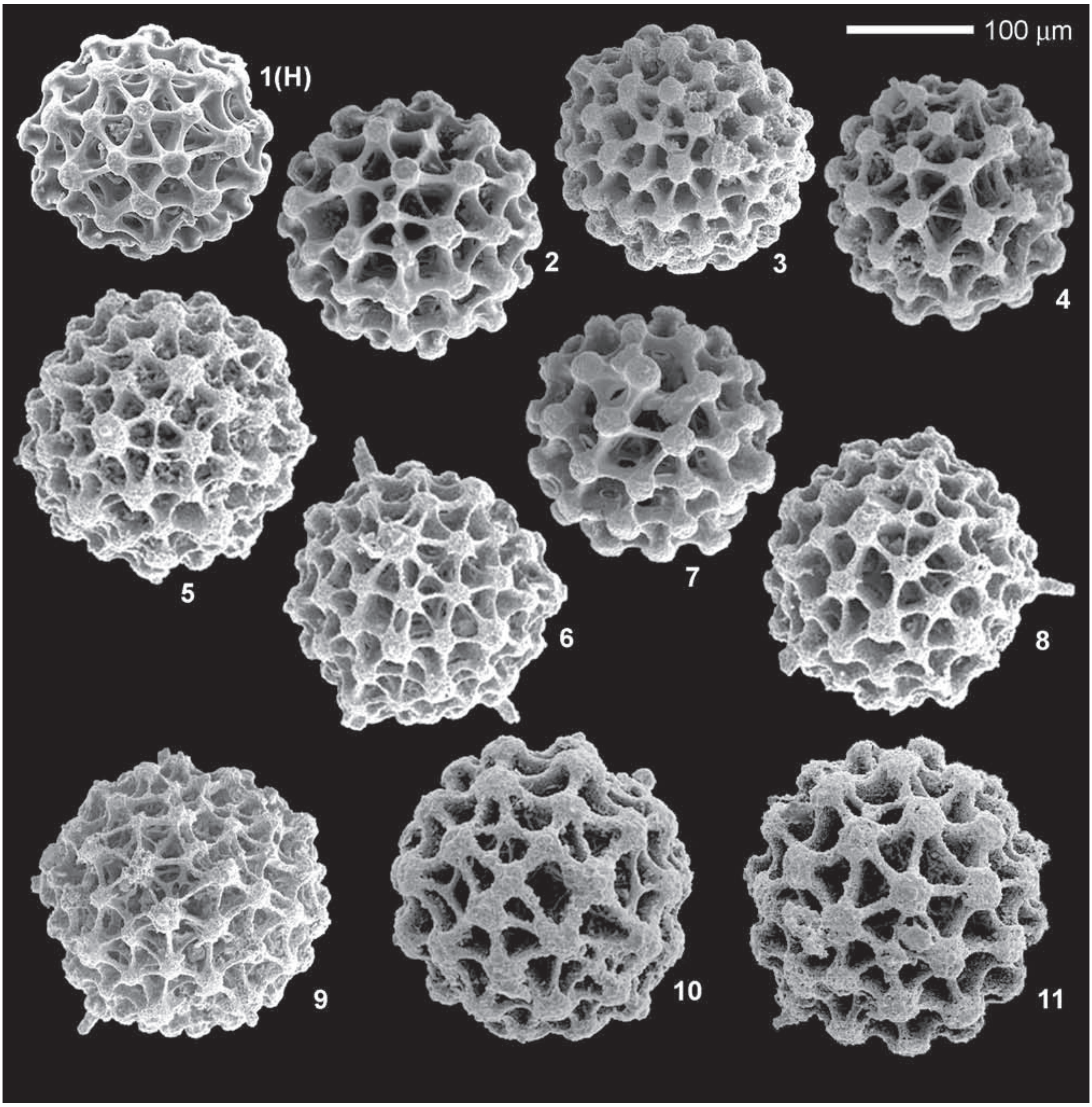


Plate PRY07. ***Praeconocaryomma sarahae*** **Carter n. sp.** Magnification x200. **Fig. 1(H).** GSC loc. C-304568, GSC 111747. **Fig. 2.** QCI, GSC loc. C-140495, GSC 111748. **Fig. 3.** QCI, GSC loc. C-080612, GSC 111749. **Fig. 4.** QCI, GSC loc. C-140495, GSC 111750. **Fig. 5.** QCI, GSC loc. C-305417, GSC 111751. **Fig. 6.** QCI, GSC loc. C-305417, GSC 111752. **Fig. 7.** QCI, GSC loc. C-305417, GSC 111753. **Fig. 8.** QCI, GSC loc. C-305417, GSC 111754. **Fig. 9.** QCI, GSC loc. C-305417, GSC 111755. **Fig. 10.** AT, BMW21-01. **Fig. 11.** AT, BMW21-07.

Praeconocaryomma whiteavesi Carter 1988
Species code: PRY04

Synonymy:

1981 *Praeconocaryomma* sp. aff. *P. magnimamma* (Rüst) – Pessagno & Poisson, p. 59, pl. 9, figs. 3-5.
1987b *Praeconocaryomma* sp. C – Yeh, p. 40, pl. 2, fig. 28; pl. 20, fig. 5.
1988 *Praeconocaryomma whiteavesi* Carter n. sp. – Carter et al., p. 31, pl. 1, figs. 3, 6.
1989 *Praeconocaryomma whiteavesi* Carter – Hattori, pl. 18, fig. F.
1989 *Praeconocaryomma* spp. – Hattori, pl. 19, fig. B.
1998 *Praeconocaryomma whiteavesi* Carter – Cordey, p. 90, pl. 22, fig. 8.
Not 1998 *Praeconocaryomma whiteavesi* Carter – Yeh & Cheng, p. 15, pl. 1, figs. 9, 12.
1998 *Praeconocaryomma* sp. A – Yeh & Cheng, p. 15, pl. 1, fig. 10.
2005 *Praeconocaryomma* sp. aff. *P. magnimamma* (Rüst) sensu Pessagno & Poisson – Kashiwagi et al., pl. 6, fig. 12.

Original diagnosis: Spherical test with small, closely spaced porous mammae. Pores in intermammary areas normally much larger; elliptical and subtriangular in shape.

Original description: Test spherical with small, closely spaced, porous mammae. Surfaces of mammae penetrated by a number of small circular pores centred around a small spine, which is circular in section. Pores in intermammary area irregularly sized; larger pores subtriangular in shape, smaller pores more elliptical. Occasional nodes arise near centres of intermammary areas where a number of pores converge. First medullary shell has pentagonal pore frames of varying size with weakly developed nodes at bar vertices. Sturdy triradiate beams connect medullary shell with mammae on cortical shell.

Original remarks: This form is somewhat similar to *Praeconocaryomma* sp. aff. *P. magnimamma* (Rüst) illustrated by Pessagno and Poisson (1981, p. 59, pl. 9, figs. 3-5). It differs by having smaller mammae and correspondingly larger intermammary areas with larger pores. These differences become even more apparent when this form is compared with *P. magnimamma* (Rüst) 1898 and *P.* sp. aff. *P. magnimamma* figured by Feary and Pessagno (1980, figs. 3, 4), and are considered significant enough to warrant designating this form a new species.

Further remarks: *Praeconocaryomma* sp. aff. *P. magnimamma* (Rüst) figured by Pessagno and Poisson (see above) is now considered variability of *P. whiteavesi*.

Measurements (μm):
Based on 7 specimens.

	HT	Av.	Max.	Min.
Diameter of cortical shell	196	189	200	180
Height of mammae	15	14	20	11

Etymology: Named in honour of J. F. Whiteaves, who studied the early paleontological collection from Maude Island.

Type locality: GCS locality C-080577, Fannin member of the Fannin Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin Formation, Queen Charlotte Islands and Bridge River Complex, British Columbia; Warm Springs member of the Snowshoe Formation, Oregon; Gümüslü Allochthon, Turkey; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman; Liminangcong Chert, Philippines; Japan.

Praeconocaryomma? yakounensis Carter n. sp.
Species code: PRY06

Type designation: Holotype GSC 111794 (pl. PRY06, fig. 1), and paratype GSC 111795 (pl. PRY06, fig. 2) from GSC loc. C-140441; Sandilands Formation (upper Sinemurian).

Description: Large multi-layered cortical shell with prominent mammae. Distal surfaces of mammae small to medium in size, low to moderately raised, pentagonal to hexagonal in shape, with slightly rounded surfaces. Each mamma surrounded by six strong triangular pore frames whose vertices link with other mammae. Inner layer(s) of shell comprised of smaller irregular to subtriangular pore frames connected to the outer triangular pore frames forming a slightly depressed interconnecting meshwork. Short peripheral spines visible on some specimens. Central structure of test unknown.

Remarks: *Praeconocaryomma? yakounensis* n. sp. differs from *P. sarahae* n. sp. in possessing a larger test. Furthermore, the inner layer of pore frames connects to the outer triangular pore frames forming an interlocking meshwork rather than telescoping inward as in *P. sarahae* n. sp. In Queen Charlotte Islands, this is the oldest form (late Sinemurian) that can even questionably be assigned to the genus *Praeconocaryomma* Pessagno.

Measurements (μm):
Based on 5 specimens.

	HT	Max.	Min.	Mean
Diameter of cortical shell	279	302	279	292
Height of mammae	21	21	15.6	17.5

Etymology: Named for the type locality on the western bank of the Yakoun River, central Graham Island.

Type locality: Sample CAA-86-T-2/3 (GSC loc. C-140441), Sandilands Formation, Yakoun River area, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands, British Columbia.

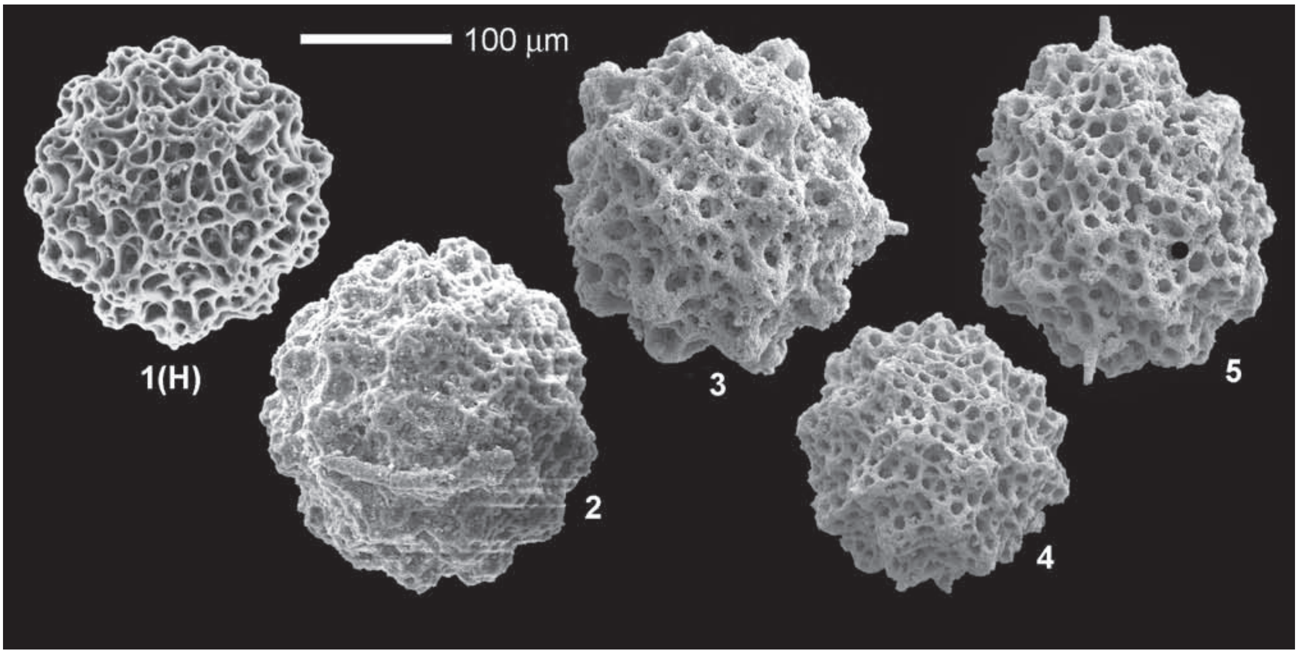


Plate PRY04. ***Praeconocaryomma whiteavesi*** **Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 1, fig. 3. **Fig. 2.** OM-00-251, 021521. **Fig. 3.** OM, BR1121-R06-04. **Fig. 4.** OM, BR1121-R10-07. **Fig. 5.** OM, BR1121-R08-16.

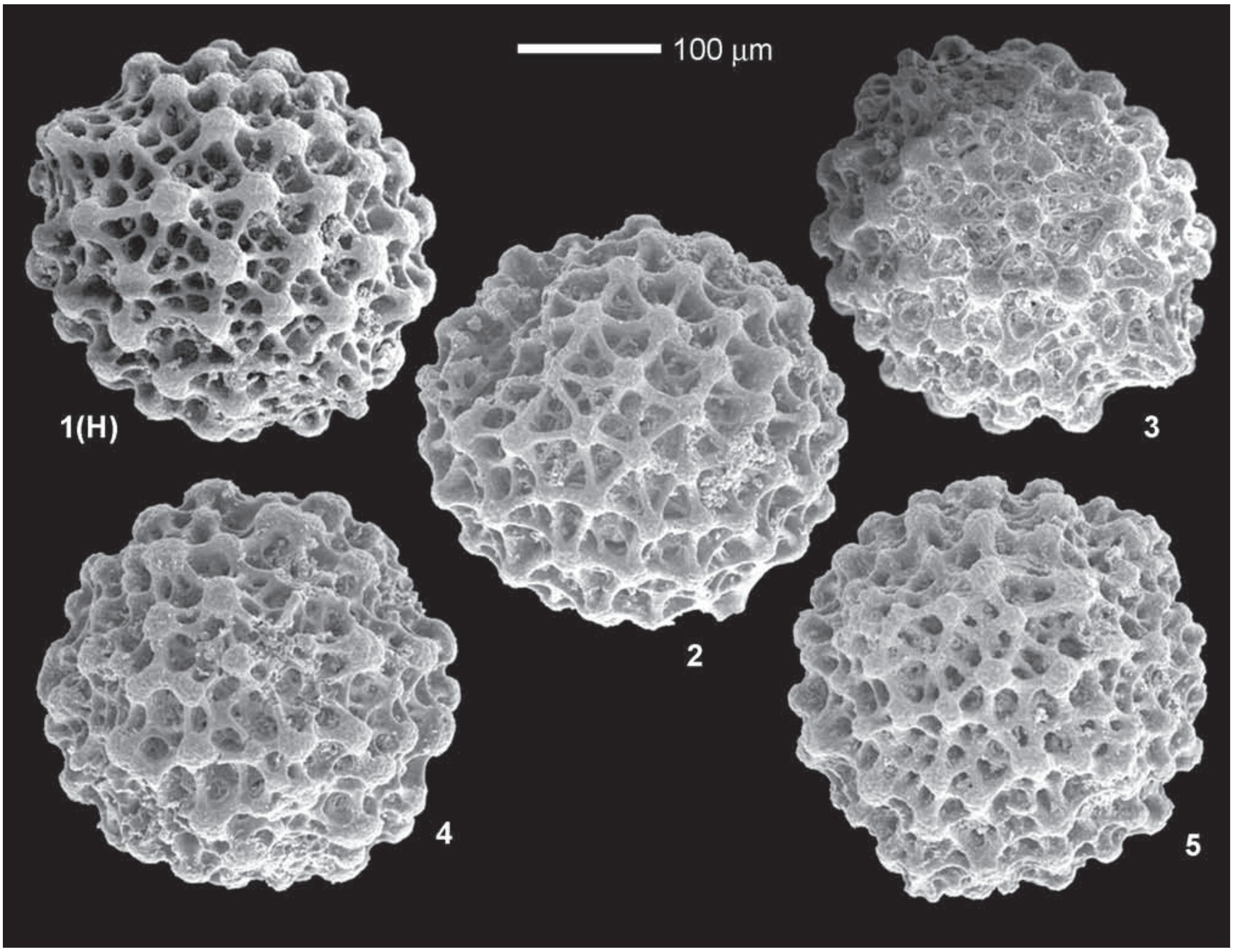


Plate PRY06. ***Praeconocaryomma*? *yakounensis*** **Carter n. sp.** Magnification x200. **Fig. 1(H).** GSC loc. C-140441, GSC 111794. **Fig. 2.** QCI, GSC loc. C-140441, GSC 111795. **Fig. 3.** QCI, GSC loc. C-140441, GSC 111796. **Fig. 4.** QCI, GSC loc. C-140441, GSC 111797. **Fig. 5.** QCI, GSC loc. C-140441, GSC 111798.

Genus: ***Praehexasaturnalis*** Kozur & Mostler 1983, emend. Kozur & Mostler 1990

Type species: *Palaeosaturnalis tenuispinosus* Donofrio & Mostler 1978

Synonymy:

1983 *Praehexasaturnalis* n. gen. – Kozur & Mostler, p. 30.

1990 *Praehexasaturnalis* Kozur & Mostler, emend. – Kozur & Mostler, p. 194.

Original diagnosis: Ring narrow but not differentiated yet. Its cross section is flat. Outline of ring hexagonal to octagonal. 8-6 very strong marginal spines. 2 polar spines opposite to marginal spines. No auxiliary spines. Cortical shells spongy. Medullary shells latticed.

Emended description: By Kozur & Mostler (1990): Spongy shell globular, consisting of several concentric layers. Microsphere latticed. Ring mostly narrow, rarely moderately broad, in most primitive forms with 8 spines and with rounded octagonal outline to rounded hexagonal outline, later invariably with rounded hexagonal to hexagonal outline and 6 spines, occasionally with 1-2 further, mostly distinctly smaller spines. Most primitive forms only with polar spines, higher evolved forms additionally with 2-12 auxiliary spines.

Original remarks: In the ring outline this new genus is quite identical with *Hexasaturnalis* n.gen. but the ring is still flat to shallow oval in cross section and has no ridges. Moreover, the polar spines are situated opposite to the marginal spines. *Palaeosaturnalis* Donofrio and Mostler, 1978, is distinguished by its circular outline. Moreover, in most species the ring is broader. *Praehexasaturnalis* n.gen. is a perfect transitional form between *Palaeosaturnalis* Donofrio and Mostler, 1978, and *Hexasaturnalis* n.gen. As for the first time in this genus the typical ring outline of the Hexasaturnalinae n.subfam. appears, it is already placed in this subfamily.

Further remarks: By Kozur & Mostler (1990): Kozur and Mostler (1983) assumed that *Praehexasaturnalis* Kozur and Mostler, 1983 represents the forerunner of *Hexasaturnalis* Kozur and Mostler, 1983, because the striking hexagonal ring outline is in both genera the same and *Hexasaturnalis* began later than *Praehexasaturnalis.* As already pointed out under the remarks to the Saturnaliacea Deflandre, 1953 and Parasaturnalidae Kozur and Mostler, 1972, *Praehexasaturnalis* is a dead-ending sidebranch of the Parasaturnalidae, in which the same hexagonal ring outline as in primitive Acanthocircinae Pessagno, 1977b emend. (*Hexasaturnalis* Kozur and Mostler, 1983, *Yaosaturnalis* Kozur and Mostler, 1983) evolved, but the other characteristics of the Acanthocircinae (peripolar spines, ridges on the outer margin of the ring) never evolved. Within the genus *Praehexasaturnalis* for the first time the development of taxa with auxiliary spines from taxa without auxiliary spines have been observed. Both morphologically and phylogenetically near related forms, connected by transitional forms, are here united into *Praehexasaturnalis* that is therefore here used in a broader sense as by Kozur and Mostler (1983). The forms with auxiliary spines continued seemingly until the Upper Cretaceous without larger morphological changes. These Upper Cretaceous forms have the highest number of auxiliary spines (about 12). However, the inner structure of the shell of these Upper Cretaceous forms is unknown. Therefore they can be only tentatively assigned to *Praehexasaturnalis.*

Etymology: According to the supposed phylogenetic line *Praehexasaturnalis* n. gen. – *Hexasaturnalis* n. gen.

Included species:

SAT01 *Praehexasaturnalis tetraradiatus* Kozur & Mostler 1990

Praehexasaturnalis tetraradiatus Kozur & Mostler 1990

Species code: SAT01

Synonymy:

1984 *Pseudoheliodiscus* (?) spp. – Whalen & Pessagno, pl. 3, fig. 12, 13.

1990 *Praehexasaturnalis tetraradiatus* n. sp. – Kozur & Mostler, p. 195, pl. 6, figs. 8, 9, 11, 12.

1994 *Praehexasaturnalis tetraradiatus* Kozur & Mostler – Carter, pl. 1, fig. 19.

1998 *Praehexasaturnalis tetraradiatus* Kozur & Mostler – Whalen & Carter, p. 54, pl. 14, figs. 1, 2, 5, 6, 9, 10.

2002 *Praehexasaturnalis tetraradiatus* Kozur & Mostler – Whalen & Carter, p. 108, pl. 5, figs. 7, 11, 12.

2002 *Praehexasaturnalis tetraradiatus* Kozur & Mostler – Tekin, p. 184, pl. 2, fig. 10.

Original description: Shell large, globular, spongy, consisting of several concentric layers. Microsphere latticed. Shell surface with delicate, short, needle-like spines. Ring narrow, flat, undifferentiated, ouline hexagonal. 6 very large, slender spines in the 6 corners of the ring. Axial spines a little larger and more robust than the 4 circumaxial spines. Polar spines robust. Two auxiliary spines cross-like arranged with the polar spines, mostly short, elongated triangular.

Original remarks: The phylomorphogenetic development within the genus *Praehexasaturnalis* Kozur & Mostler, 1983 emend. is now well known. The oldest forms (Lower to Middle Norian) have 8 needle-like spines, all of about the same length (the axial spines may be somewhat larger than the circumaxial spines, like in the stratigraphically younger forms). The main stock (with narrow ring) of these oldest *Praehexasaturnalis* is represented by *Praehexasaturnalis burnensis* (Blome, 1984a), synonym, see under the genus. The outline of this species is still variable (roundish octagonal, roundish suboval, subquadratic).

The next younger form is *Praehexasaturnalis elegans* (Kozur & Mostler, 1972) from the Middle and Upper Norian. In this species the 2 spines perpendicularly to the polar spines are already distinctly shorter than the remaining spines, the outline of the ring is rounded hexagonal to rounded subquadratic.

In the Upper Norian (? to Rhaetian) *Praehexasaturnalis tennuispinosus* (Donofrio & Mostler, 1978) occurs, in which the 2 spines perpendicular to the polar spines are not more present. The ring outline is hexagonal.

In the (highest Upper Norian?) Rhaetian and Hettangian *Praehexasaturnalis tetraradiatus* n. sp. occur, that coincides morphologically with *P. tenuispinosus*, but has 2 auxiliary spines additional to the polar spines. These 4 inner spines are cross-like arranged.

In the Hettangian *P. kirchsteinensis* evolved then remained morphologically unchanged, but displays 5-10 auxiliary spines.

Maybe Upper Cretaceous forms with the same morphological character, but with peripolar spines, are the last representatives of this line that yields important guide forms for the Norian to Hettangian time-interval. 5 distinct zones can be discriminated within this interval by evaluation of the phylomorphogenetic development within the genus *Praehexasaturnalis*: *P. burnensis* without *P. elegans* (Lower Norian), *P. elegans* without *P. tenuispinosus* (Middle Norian), *P. tenuispinosus* without *P. tetraradiatus* (Upper Norian, higher Upper Norian radiolarian faunas not yet well investigated) *P. tetraradiatus* without *P. kirchsteinensis* (?uppermost Norian, Rhaetian), *P. tetraradiatus* and *P. kirchsteinensis* (Hettangian).

Taxonomically this development is interesting, because taxa with auxiliary spines evolved from taxa without auxiliary spines. Moreover, in *P. tetraradiatus* the 2 polar spines and the 2 auxiliary spines are cross-like arranged, like in the genus *Stauracanthocircus* Kozur & Mostler, 1983 emend. This is surely a homoeomorphy (see under this genus).

Measurements (μm):

	Min.	Max.
Diamater of shell	110	120
Diameter of ring (in polar axis)	144	170
Diamater of ring (perpendicular to polar axis)	144	170
Width of ring	13	21
Length of spines	90	125

Etymology: According to the 4 rays at the inner margin of the ring (2 polar spines, 2 auxiliary spines).

Type locality: Kirchstein Limestone, 6.5 km WSW of Lenggries/Isar, Bavaria, Germany.

Occurrence: Kirchstein Limestone, Bavaria; Csövár Limestone and Várhegy Cherty Limestone formations, Hungary; Sandilands Formation, Queen Charlotte Islands; San Hipólito Formation, Baja California Sur; Hocaköy Radiolarite, Turkey.

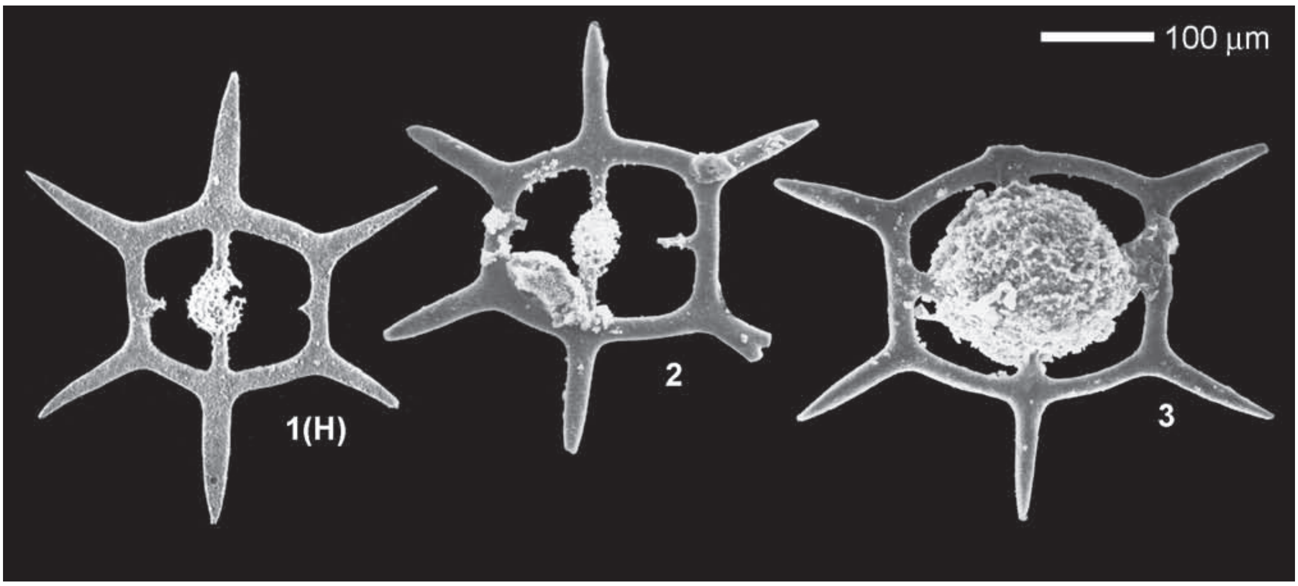


Plate SAT01. *Praehexasaturnalis tetraradiatus* Kozur & Mostler. Magnification x150. **Fig. 1(H).** Kozur & Mostler 1990, pl. 6, fig. 11. **Fig. 2.** Whalen & Carter 2002, pl. 5, fig. 7. **Fig. 3.** Whalen & Carter 2002, pl. 5, fig. 11.

Genus: *Praeparvicingula* Pessagno, Blome & Hull 1993

Type species: *Parvicingula profunda* Pessagno & Whalen 1982

Synonymy:

1993 *Praeparvicingula* Pessagno, Blome & Hull n. gen. – Pessagno et al., p. 144.

1993 *Praecaneta* Pessagno, Blome & Hull n. gen. – Pessagno et al., p. 142.

Original description: Test conical to subcylindrical (never spindle-shaped) with horn. Final postabdominal chamber(s) either increasing in width or maintaining same width. Final chamber lacking narrow terminal tube as with *Parvicingula* s. s.

Original remarks: *Praeparvicingula* was originally referred to by Pessagno et al. (1987a, 1987b, 1989) as *Parvicingula* s. l. *Praeparvicingula* differs from *Parvicingula* s. s. by lacking a narrow tube on the final postabdominal chamber. Moreover, the final postabdominal chamber/chambers of *Praeparvicingula* continue to increase in width, either rapidly or slowly, as added.

Further remarks: In this catalogue we include *Praecaneta* with *Praeparvicingula*, because on many morphotypes the »H-linked« circumferential ridges are not clearly distinctive.

Etymology: From the Latin *prae* prefix = before, and *Parvicingula* Pessagno.

Included species:

PVG01 *Praeparvicingula aculeata* (Carter) 1988
PVG02 *Praeparvicingula elementaria* (Carter) 1988
PVG03 *Praeparvicingula gigantocornis* (Kishida & Hisada) 1985
PVG04 *Praeparvicingula nanoconica* (Hori & Otsuka) 1989
TVS01 *Praeparvicingula*? *spinifera* (Takemura) 1986
PCA02 *Praeparvicingula tlellensis* Carter n. sp.

Praeparvicingula aculeata (Carter)1988

Species code: PVG01

Synonymy:

1982 *Parvicingula* sp. A – Wakita, pl. 1, fig. 7.

1988 *Parvicingula aculeata* Carter n. sp. – Carter et al., p. 54, pl. 18, figs. 1, 2, 7.

1988a *Parvicingula* sp. aff. *P. schoolhousensis* Pessagno &Whalen – Hattori, pl. 10, fig. M.

1997 *Parvicingula dhimenaensis dhimenaensis* Baumgartner – Yao, pl. 13, fig. 625.

Original diagnosis: Test subcylindrical with 10 or more post-bdominal chambers and very short, slender horn. Test has rows of pointed nodes in place of circumferential ridges between abdomen and first few post-abdominal chambers.

Original description: Test elongate, subcylindrical with 10 or more post-abdominal chambers when well preserved. Cephalis small, conical with very short, slender horn (not visible on all specimens). Thorax, abdomen and first few post-abdominal chambers trapezoidal, remaining chambers subrectangular in outline. Cephalis and thorax sparsely perforate. Post-abdominal chambers have three lateral rows of symmetrical (predominantly pentagonal) pore frames between ridges. Pore frames in rows flanking circumferential ridges slope steeply away from ridges. Those in central row depressed, smaller and staggered; pores elliptical. Test has rows of sharp pointed nodes, rather than discrete circumferential ridges, between abdomen and first three or four post-abdominal chambers. More distal ridges are narrow with small rounded nodes.

Original remarks: Differs from all other species of *Parvicingula* by having a very short, almost non-existent, horn and sharp pointed nodes separating the abdomen and first few post-abdominal chambers.

Praeparvicingula elementaria (Carter) 1988

Species code: PVG02

Synonymy:

1988 *Eucyrtidium elementarius* Carter n. sp. – Carter et al., p. 60, pl. 17, fig. 13.

1988 *Parvicingula* sp. B – Carter at al., p. 56, pl. 18, figs. 3, 4.

2001 *Eucyrtidium* ex gr. *elementarius* Carter – Vishnevskaya, p. 162, pl. 60, fig. 9; pl. 69, figs. 6, 8.

2001 *Laxtorum* ? *jurassicum* Isozaki & Matsuda – Vishnevskaya, p. 166, pl. 69, fig. 4 only.

Original diagnosis: Ovate, smooth multicyrtid with thick-walled test (at least two layers), and medium-sized symmetrical horn.

Original description: Test ovate, usually with six to eight post-abdominal chambers, and a medium-sized symmetrical horn. Boundaries between initial chambers indistinct; distal chambers separated by slightly thickened ridges and/or lateral rows of small, poorly developed nodes. All chambers separated internally by planiform partitions with circular apertures. Apical chambers increase rapidly in width; intermediate chambers are cylindrical; final chamber always slightly constricted. Height of all chambers appears to be constant. Test walls thick, composed of at least two (and likely more) layers of pores set in hexagonal pore frames.

Measurements (µm):

Based on 7 specimens.

	HT	Av.	Max.	Min.
Length (excluding horn)	321	308	346	260
Maximum width	126	116	130	109

Etymology: Latin, *aculeatus* (adj.), prickly.

Type locality: GSC locality C-080595, Graham Island Formation, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Graham Island Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

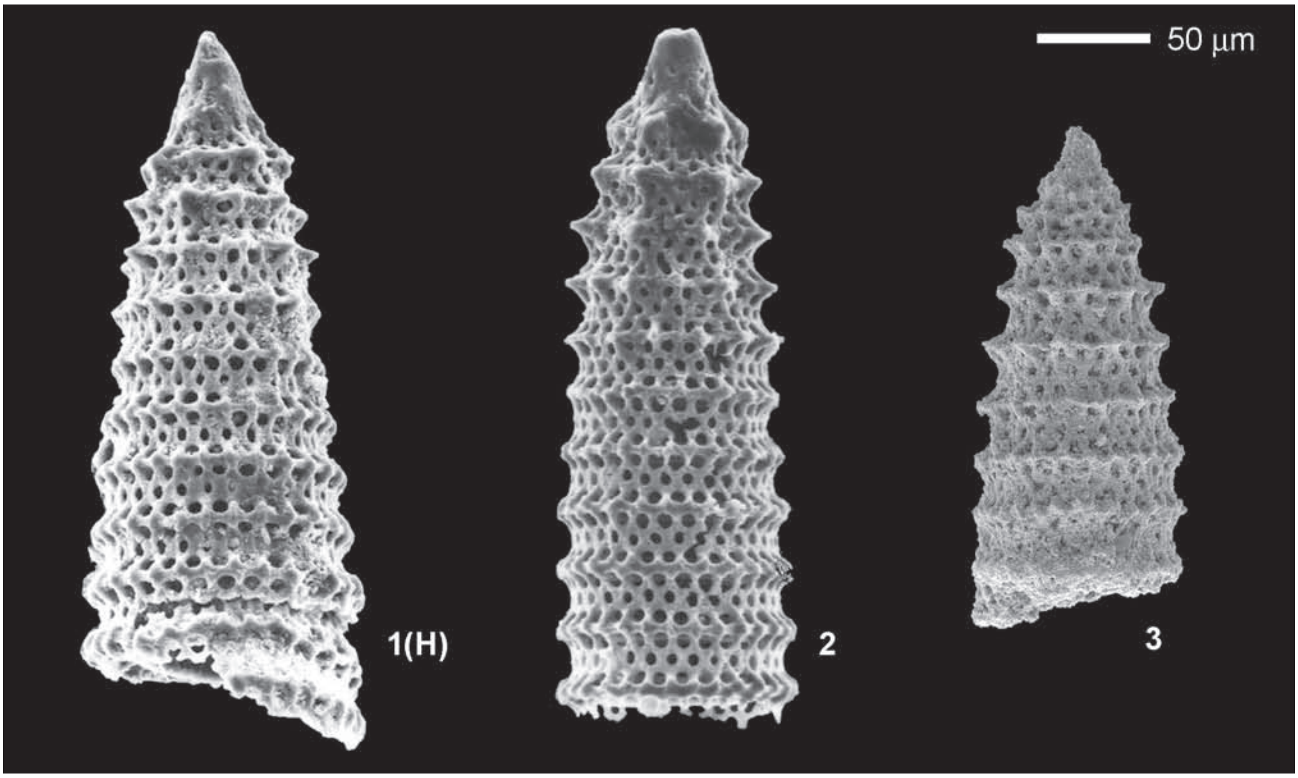


Plate PVG01. *Praeparvicingula aculeata* (Carter). Magnification x300. **Fig. 1(H).** Carter et al. 1988, pl. 18, fig. 1. **Fig. 2.** Carter et al. 1988, pl. 18, fig. 2. **Fig. 3**. OM, BR871-R07-27.

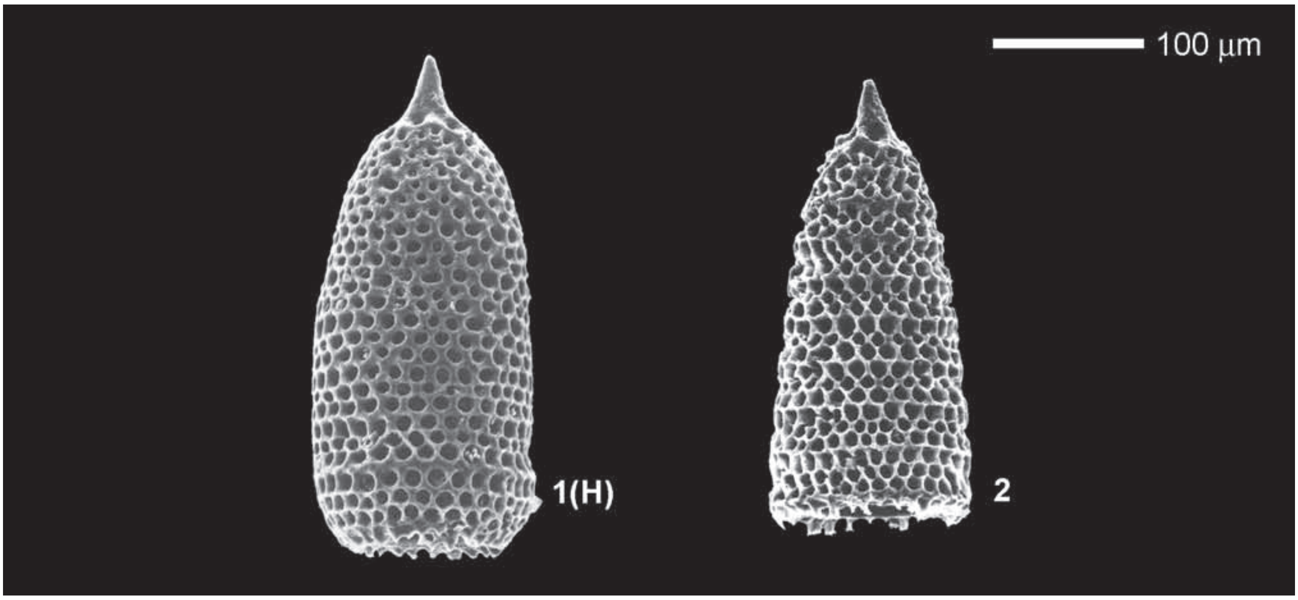


Plate PVG02. *Praeparvicingula elementaria* (Carter). Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 17, fig. 13. **Fig. 2.** Carter et al. 1988, pl. 18, fig. 4.

Pores circular on outer layer; small on proximal chambers, becoming larger and more uniform in size on distal chambers.

Original remarks: This form bears no resemblance to any known species of *Eucyrtidium*. Specimens (not illustrated) of middle Toarcian age are very similar (possibly ancestral ?) to this species but differ in having a greater number of postabdominal chambers and coarser meshwork with smaller, more irregularly arranged pore frames.

Further remarks: This species is now assigned to *Praeparvicingula* because we consider *Eucyrtidium elementarius* and *Parvicingula* sp. B of Carter (in Carter et al. 1988) conspecific and *Parvicingula* sp. B has slight ridges.

Measurements (μm):
Based on 17 specimens.

	HT	Av.	Max.	Min.
Maximum length (excluding horn)	244	287	350	230
Maximum width	144	153	170	135
Length of horn	38	28	40	20

Etymology: Latin, *elementarius* (adj.), pertaining to rudiments of first principles.

Type locality: Locality GSC C-080595, Graham Island Formation, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves, Phantom Creek and Graham Island formations, Queen Charlotte Islands; Koryak, Far East Russia.

Praeparvicingula gigantocornis (Kishida & Hisada) 1985

Species code: PVG03

Synonymy:

1982 *Parvicingula*? sp. A – Kishida & Sugano, pl. 7, fig. 8.
? 1982 *Parvicingula* sp. – Matsuda & Isozaki, pl. 1, figs. 14, 17.
1982 *Parvicingula* sp. – Kido, pl. 4, figs. 11, 12.
1985 *Parvicingula gigantocornis* n. sp. – Kishida & Hisada, p. 118, pl. 4, figs. 1-5.
1988 *Parvicingula gigantocornis* Kishida & Hisada – Sashida, p. 22, pl. 2, figs. 5, 10-12, 20, 21; pl. 3, figs. 4, 5.
1988 *Parvicingula* sp. aff. *P. media* Pessagno &Whalen – Carter et al., p. 55, pl. 18, figs. 9, 11.
1990 *Parvicingula* cf. *gigantocornis* Kishida & Hisada – Hori, Fig. 9.31.
1991 *Parvicingula* sp. B – Carter & Jakobs, p. 343, pl. 3, fig. 20.
1992 *Parvicingula* aff. *gigantocornis* Kishida & Hisada – Sashida, pl. 2, fig. 7.
1993 *Parvicingula* sp. – Fujii et al., pl. 1, fig. 2.
2001 *Praeparvicingula gigantocornis* (Kishida & Hisada) – Kashiwagi, Fig. 6.6.
2003 *Parvicingula gigantocornis* Kishida & Hisada – Kashiwagi & Kurimoto, pl. 3, fig. 21.
2004 *Parvicingula gigantocornis* Kishida & Hisada – Hori, pl. 13, figs. 49-52.
2004 *Parvicingula gigantocornis* Kishida & Hisada – Ishida et al., pl. 5, fig. 14.

Original diagnosis: Test multicyrtid, with long, massive horn. Each circumferentail ridge widely spaced, separated by two or sometimes three rows of small circular pores.

Original description: Test conical, with six to eight preserved chambers, terminating in long, thick, massive apical horn. Cephalis small, hemispherical; subsequent chambers trapezoidal in outline. Cephalis and thorax sparsely pored. Each circumferential ridge widely spaced, separated by two or sometimes three rows of small circular pores; center row of pores poorly developed. Abdomen and post-abdominal chambers increasing gradually in height and increasing rapidly in width as added.

Original remarks: *Parvicingula gigantocornis*, n. sp., appears to be closely related to such species as *Parvicingula matura*, *P. grantensis*, *P. vera* and others described by Pessagno & Whalen (1982) from Middle Jurassic strata in North America. However, *P. gigantocornis* differs from these species, in having smaller pores and poorly developed center row of pores. It is likely that *P. gigantocornis* is a more primitive species of the genus *Parvicingula*.

Measurements (μm):
Based on 7 specimens.

Length	Width	
128	88	HT
160	128	Max.
120	80	Min.
138	90	Av.

Etymology: The name is derived from the Latin noun *gigantocornis*, meaning giant horn.

Type locality: Locality 253, black bedded chert, Ueno-mura area, Kanto Mountains, Central Japan.

Occurrence: Kanto Mountains, Japan; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman; Phantom Creek and Graham Island formations, Queen Charlotte Islands.

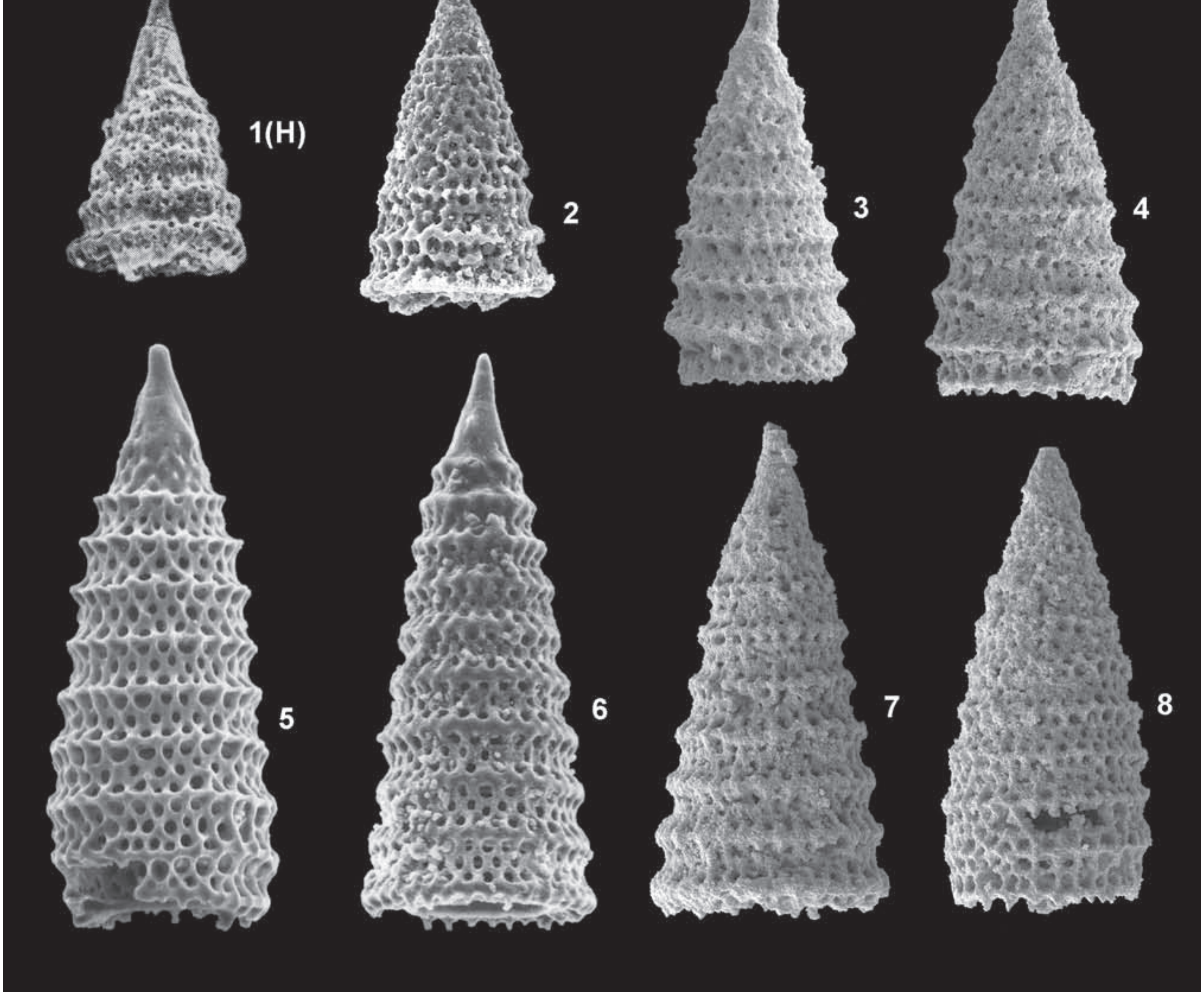


Plate PVG03. ***Praeparvicingula gigantocornis*** **(Kishida & Hisada).** Magnification x300. **Fig. 1(H).** Kishida & Hisada 1985, pl. 4, fig. 1. **Fig. 2.** OM-00-256-022434. **Fig. 3.** OM, BR871-R07-06. **Fig. 4.** BR871-R09-02. **Fig. 5.** Carter & Jakobs 1991, pl. 3, fig. 20. **Fig. 6**. Carter et al. 1988, pl. 18, fig. 11. **Fig. 7.** OM, BR871-R06-20. **Fig. 8.** OM, BR871-R06-21.

Praeparvicingula nanoconica (Hori & Otsuka) 1989

Species code: PVG04

Synonymy:

1982 *Parvicingula* sp. – Matsuda & Isozaki, pl. 1, figs. 13, 16, 17.
1984 *Parvicingula* sp. A – Murchey, pl. 1, fig. 22.
1989 *Parvicingula nanoconica* n. sp. – Hori & Otsuka, p. 183, pl. 2, figs. 1-6.
1990 *Parvicingula nanoconica* Hori & Otsuka – Hori, Fig. 9.40.
1993 *Parvicingula gigantocornis* Kishida & Hisada – Fujii et al., pl. 1, fig. 1.
1996 *Praeparvicingula nanoconica* (Hori & Otsuka) – Yeh & Cheng, p. 116, pl. 6, fig. 5; pl. 9, figs. 1, 2, 7.
1997 *Parvicingula* sp. D2 – Yao, pl. 13, fig. 624.
1999 *Praeparvicingula nanoconica* (Hori & Otsuka) – Hori, pl. 1, fig. 9.
2004 *Parvicingula nanoconica* Hori & Otsuka – Hori, pl. 3, ig. 32, pl. 4, figs. 8-12; pl. 23. figs. 8, 9.
2004 *Parvicingula* sp. – Hori, pl. 23, fig. 14.
2005 *Parvicingula nanoconica* Hori & Otsuka – Hori, pl. 12, fig. 42.
2005 *Parvicingula nanoconica* Hori & Otsuka – Kashiwagi et al., pl. 6, fig. 5.

Original description: Test consisting of 5 to 7 chambers, possibly more, conical with developed circumferential ridges. Cephalis hemispherical with long apical horn; horn, solid, elongated cone. Thorax and subsequent chambers, truncated cone, increasing in width except distalmost chamber. Surface of cephalis having irregularly arranged pores. Meshwork of outer layer clearly, hexagonal symmetrically constructed by 3 rows of pore frames between two circumferential ridges; in some species, 4 rows of pore frames are served on distal part. Pores above and below adjoining circumferential ridges lined up in radius distance lag. Pore frames slope steeply away from ridges and formed wavy or nodose structure of circumferential ridges. In some specimens, proximal portion of test possessing nodose or spiny circumferential ridges.

Original remarks: *Parvicingula nanoconica* sp. nov. is apparently similar to *P. gigantocornis* Kishida & Hisada, 1985 but the former is distinguished from the latter by having clearly meshwork of outer layer and rather longer test. The present authors doubted whether this form was one of poor preserved specimens of *P. gigantocornis* at the first. Resulting from comparison between the two from siliceous mudstones, this form was considered the different species from *P. gigantocornis*. Both species, *P. nanoconica* and *P. gigantocornis*, differ from all other species of *Parvicingula* by possessing a very small test and a long horn. *P. nanoconica* also morphologically resembles *P. vera* Pessagno and Whalen, 1982 and *P. profunda* Pessagno and Whalen, 1982. The latter two species are distinguished from the former in these following features additionally by lacking of a small test and a very long horn; by having more weakly developed circumferential ridges and by possessing chamber comprised of a central row of smaller pores than that of other two rows respectively. Almost all pores in each chamber of *P. nanoconica* are about equal in size.

Measurements (μm):
Based on 17 specimens.

	Height	Width	H/W	Length of apical horn
HT	198+	98	2.0+	55+
Av.	184	103	1.8	55
Max.	233	134	2.4+	64
Min.	161+	80	1.3+	37

Etymology: The name is derived from the Latin adjective nano-conicus, meaning small coned.

Type locality: The Mt. Norikuradake area, Azumi village, Azumi-gun, Nagano Prefecture, central Japan.

Occurrence: Japan; Franciscan Complex, California; Musallah Formation, Oman; Liminangcong Chert, Philippines.

Praeparvicingula? spinifera (Takemura) 1986

Species code: TVS01

Synonymy:

1986 *Triversus spinifer* n. sp. – Takemura, p. 63, pl. 10, figs. 21-23; pl. 11, figs. 1-2.
1987 *Ristola* sp. E – Hattori, pl. 19, fig. 6.
1989 *Ristola* spp. – Hattori, pl. 14, fig. H.
1997 *Parvicingula* aff. *spinifer* (Takemura) – Yao, pl. 13, fig. 609.
2003 *Parvicingula spinifer* (Takemura) – Goričan et al., p. 297, pl. 5, fig. 5.
2004 *Triversus spinifer* Takemura – Matsuoka, fig. 239.

Original description: Conical to spindle-shaped shell of seven to nine segments with many spines or nodes on its surface. Cephalis small, spherical and poreless, with or without an apical horn. Thorax truncated-conical, poreless or with sparsely distributed small pores. Abdomen truncated-conical, with irregularly or transversely distributed small pores. Post-abdominal segments truncated-conical proximally, cylindrical in subsequent segments and deflated in distal segments, with circular pores arranged hexagonally and in transverse three rows. Spines conical or triradiate, situated at joints of the segments.

Original remarks: *Triversus spinifer* n. sp. is distinguished from *T. japonicus* in possessing many spines or nodes on its surface.

Further remarks: *Triversus* is not a valid name because this name had been used a few years previously for a nematod (Sher, 1974). This species is questionably assigned to *Praeparvicingula* because of its *Amphipyndax*-like cephalic skeletal structure as shown by Takemura (1986).

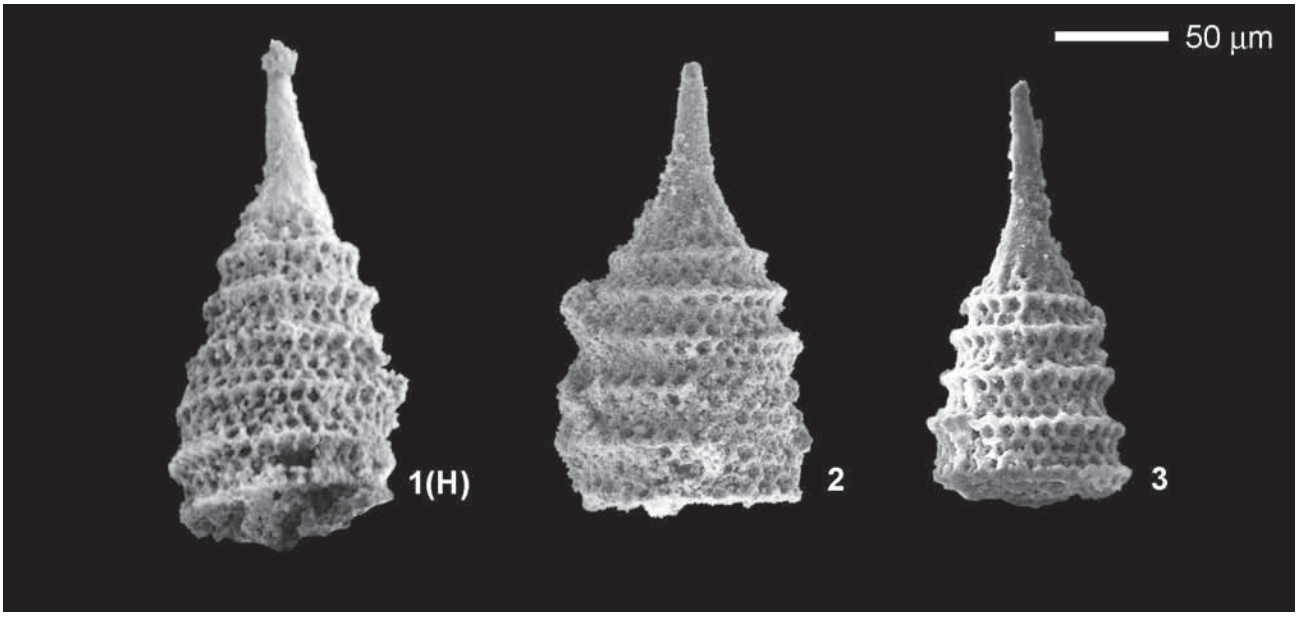


Plate PVG04. *Praeparvicingula nanoconica* (Hori & Otsuka). Magnification x300. **Fig. 1(H).** Hori & Otsuka 1989, pl. 2, fig. 1a. **Fig. 2.** Hori & Otsuka 1989, pl. 2, fig. 5. **Fig. 3.** OM-99-137-000816.

Measurements (µm):
Based on 10 specimens.

	Min.	Max.
Length of shell	135	210
Max. width of shell including spines	80	110

Etymology: The name, *spinifer*, means thorny.

Type locality: Sample TKN-105, manganese carbonate ore, Gujo-Hachiman area, Mino terrane, central Japan.

Occurrence: Japan; Tawi Sadh Member of the Guwayza Formation, Oman; Skrile Formation, Slovenia.

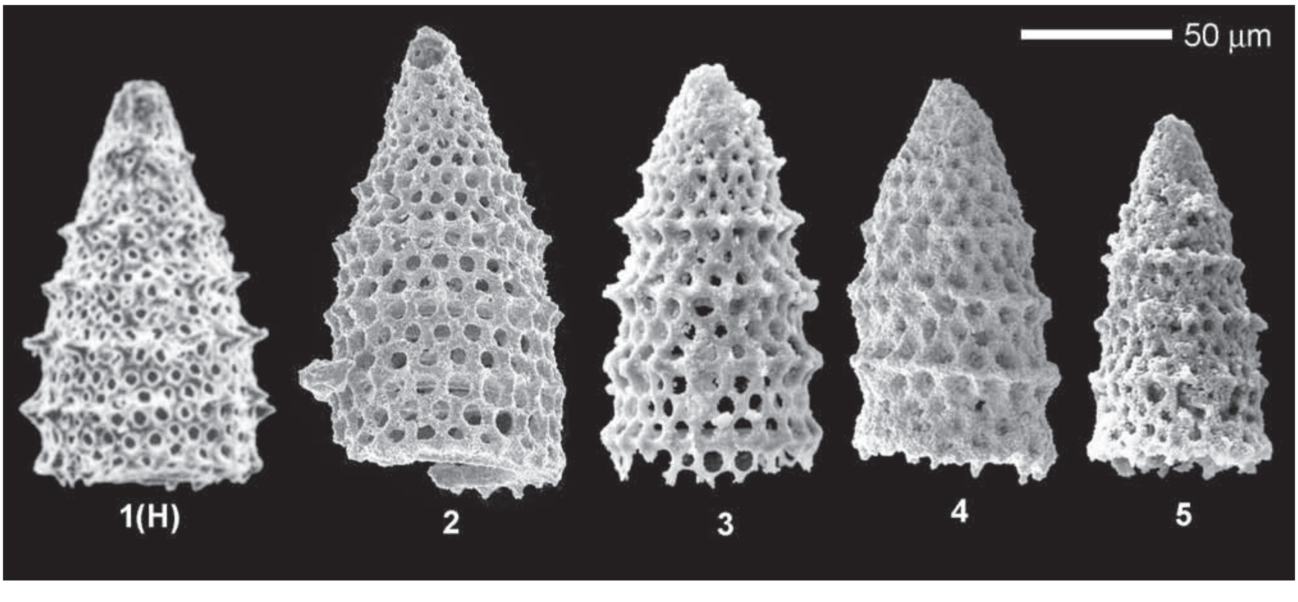


Plate TVS01. *Praeparvicingula*? *spinifera* (Takemura). Magnification x400. **Fig. 1(H).** Takemura 1986, pl. 10, fig. 21. **Fig. 2.** JP, HM1-22, RH627. **Fig. 3.** JP, MNA-10, MA12396. **Fig. 4.** OM, BR871-R09-15. **Fig. 5.** Goričan et al. 2003, pl. 5, fig. 5.

Praeparvicingula tlellensis Carter n. sp.

Species code: PCA02

Synonymy:

1984 *Ristola* sp. B – Murchey, pl. 1, fig. 10.
1987 *Ristola* sp. D – Hattori, pl. 19, fig. 5.
1987 *Ristola* sp. N – Hattori, pl. 19, fig. 9.
1987b *Pseudoristola* sp. B – Yeh, p. 97, pl. 14, fig. 21.
1988 *Parvicingula sp*. E – Carter et al., p. 56, pl. 5, fig. 13.
1989 *Ristola* spp. – Hattori, pl. 14, fig. I.
1990 *Pseudoristola* sp. B of Yeh – Nagai, pl. 2, fig. 9.
1997 *Parvicingula* sp. B – Yao, pl. 13, fig. 607.
2003 *Parvicingula* aff. *decora* (Pessagno & Whalen) – Goričan et al., p. 297, pl. 5, figs. 6-9.

Type designation: Holotype GSC 80699 (Carter in Carter et al. 1988, pl. 15, figs. 1-2) from GSC loc. C-080586; Phantom Creek Formation (Aalenian).

Description: Test conical, almost rounded apically with a very rudimentary horn. Cephalis hemispherical, imperforate; thorax slightly trapezoidal, sparsely perforate. Abdomen and five to seven post- abdominal chambers slightly widening distally as added; all with three rows of hexagonal pore frames. Outer rows of pore frames staggered with respect to central row; circumferential ridges separating chambers smooth, nodes low and rounded.

Remarks: *Praeparvicingula tlellensis* n. sp. differs from *P. decora* (Pessagno & Whalen) in having a more gradually conical outline, in lacking H-linked circumferential ridges, and in having much smaller nodes on ridges. *P. tlellensis* n. sp. differs from *Parvicingula* (?) *spinata* (Vinassa) in having a more rounded cephalis, smaller pores on post-abdominal chambers, and rounded rather than sharp circumferential ridges.

Measurements (μm):
Based on 10 specimens.

	HT	Max.	Min.	Mean
Length (excl. horn)	192	234	184	210
Maximum width	100	109	90	100

Etymology: Named for the Tlell River northeast of the type locality, name of Haida origin meaning place-of-big-surf and alternately, land-of-berries.

Type locality: Sample GSC loc. C-080586, Phantom Creek Formation, waterfall locality on the east side of Branch Road 59, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves, Phantom Creek and Graham Island formations, Queen Charlotte Islands; Hyde Formation, Oregon; Franciscan Complex, California; Skrile Formation, Slovenia; Japan.

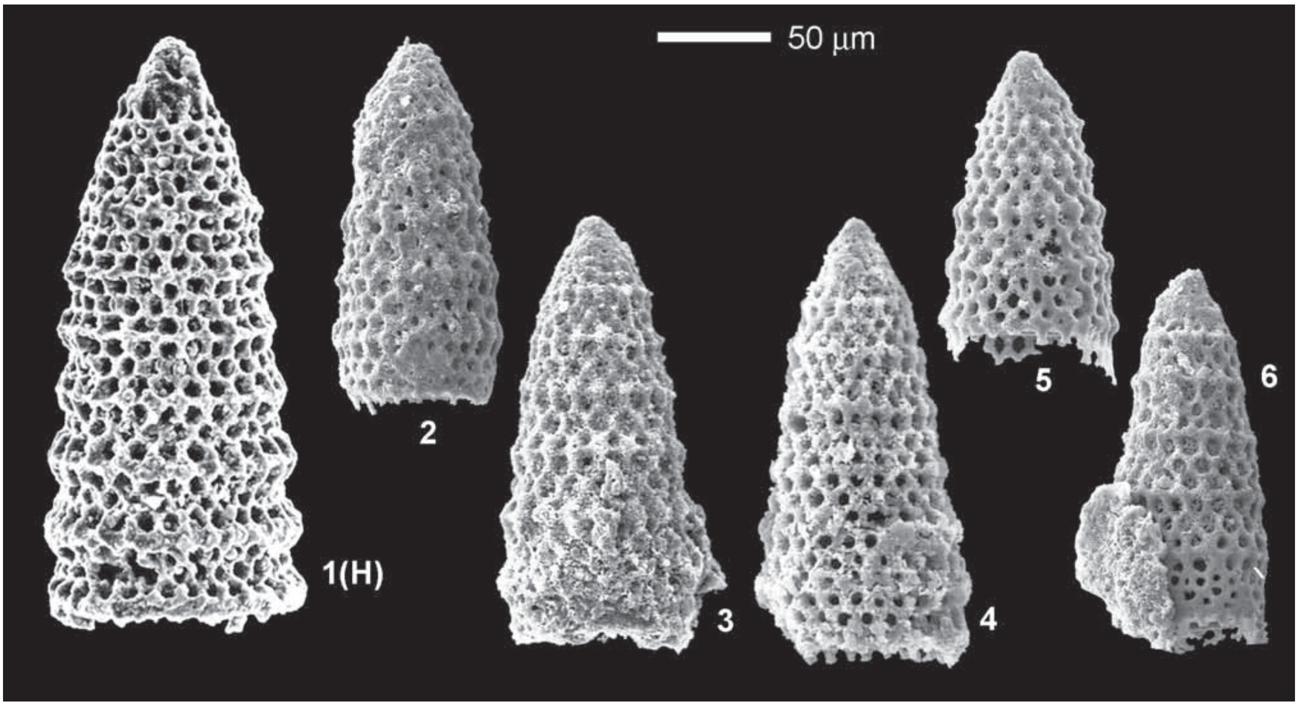


Plate PCA02. *Praeparvicingula tlellensis* Carter n. sp. Magnification x300. **Fig. 1(H).** Carter et al. 1988, pl. 5, fig. 13. **Figs. 2-5.** Goričan et al. 2003, pl. 5, figs. 6-9. **Fig. 6.** SI, MM 21.70, 010221.

Genus: ***Protopsium*** Pessagno & Poisson 1981

Type species: *Protopsium ehrenbergi* Pessagno & Poisson 1981

Synonymy:

1981 *Protopsium* n. gen. – Pessagno & Poisson, p. 53.

Original description: Primary test ellipsoidal (sometimes somewhat flattened) with two polar spines. Patagium-like mass of irregularly shaped and distributed pore frames occurring in one plane. Secondary spines of variable size radiating out from primary test into patagium-like mass seemingly offering support for the irregular meshwork. Polar spines with or without alternating grooves and ridges, occasionally bifurcating.

Original remarks: *Protopsium* n. gen., differs from *Archaeospongoprunum* Pessagno (1973): (1) by possessing a patagium-like mass supported by secondary spines; (2) by having polar spines which may or may not have alternating ridges and grooves and which sometimes bifurcate; and (3) by sometimes displaying a somewhat compressed test. *Protopsium* like *Archaeospongoprunum* possesses meshwork arranged in concentric layers.

Etymology: *Protopsium* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. IV, Recommendation 40, p. 113).

Included species:

PTP01 *Protopsium gesponsa* De Wever 1981c

Protopsium gesponsa De Wever 1981c

Species code: PTP01

Synonymy:

1981c *Protopsium gesponsa* n. sp. – De Wever, p. 145, pl. 5, fig. 9-11.
1981c *Protopsium* sp. aff. P. *gesponsa* – De Wever, p. 148, pl. 5, fig. 19.
1981 *Protopsium* sp. A – Pessagno and Poisson, p. 54, pl. 4, figs. 1, 4.
1981 *Protopsium* sp. C – Pessagno and Poisson, p. 54, pl. 4, figs. 3, 5-8.
1982b *Protopsium gesponsa* De Wever – De Wever, p. 185, pl. 10, figs. 11-13; pl. 15, figs. 3-6.
2003 *Protopsium gesponsa* De Wever – Goričan et al., p. 295, pl. 2, figs. 11, 12.
2004 *Protopsium gesponsa* De Wever – Matsuoka, fig. 15.

Original description: *Protopsium* with an ovoid shell bearing two stout spines triradiate in cross-section over half their length. Spines frequently asymmetric, conical in general shape.

Original remarks: This species differs from *P. ispartaensis* by its less massive spines, triradiate in cross-section over half their length, and a shell with a finer network often prolongated by long spurs subparallel to spines (pl. 5, fig. 9).

This form is distinguished from *P. ehrenbergi* by its very elongate central shell and conical spines that are partially rounded in cross-section. It differs from *P. libidonosum* and *P. posinos* by the presence of two spines rather than three or more.

Measurements (μm):

Based on 4 specimens.

	HT	Av.	Min.	Max.
Length of central shell	130	123	110	130
Width of shell	82	90	82	100

Spines can reach 110 μm in length.

Etymology: Anagram of E. A. Pessagno Jr. who illustrated this form.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Mino Terrane, Japan.

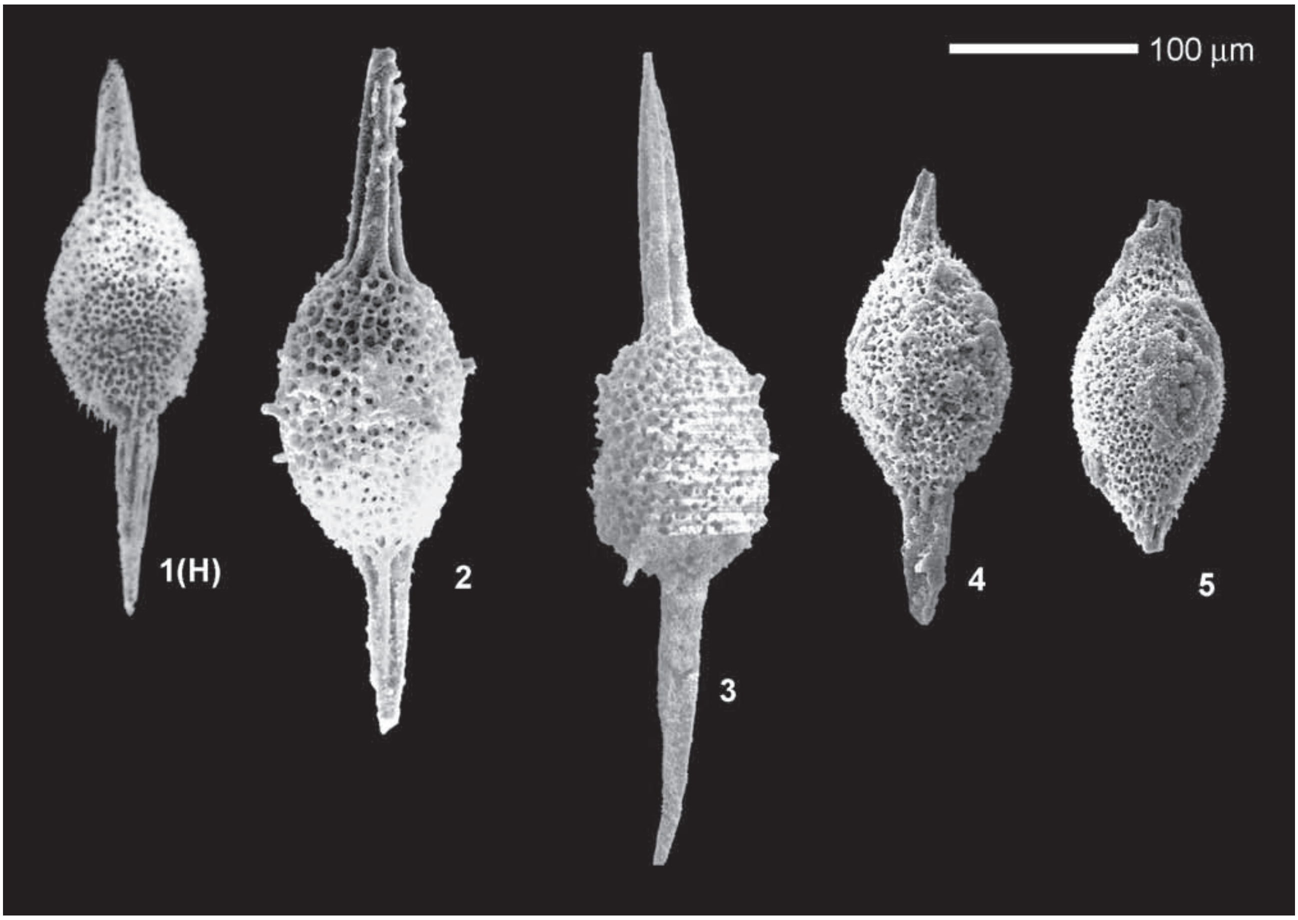


Plate PTP01. ***Protopsium gesponsa* De Wever.** Magnification x250. **Fig. 1(H).** De Wever 1981c, pl. 5, fig. 11. **Fig. 2.** Matsuoka 2004, fig. 15. **Fig. 3.** OM, BR706-R05-20. **Figs. 4, 5.** Goričan et al. 2003, pl. 2, figs. 11-12.

Genus: *Protunuma* Ichikawa & Yao 1976

Type species: *Protunuma fusiformis* Ichikawa & Yao 1976

Synonymy:

1976 *Protunuma* n. gen. – Ichikawa & Yao, p. 114.

Original description: Spindle shaped, multisegmented form with inversely subconical last segment which has a small aperture at its base. No indentation at surface junction of segments. Numerous small circular pores on surface aligned in longitudinal rows and in diagonal aspect. Numerous longitudinal plicae on surface generally running continuously through segments. Apical horn not present or, if present, insignificant.

Original remarks: This genus differs from *Unuma* in the last segment, which has no basal appendage with large pores but has a constricted, small, terminal aperture. At present, no spiny form like *Unuma* (*Spinunuma*) has been observed in the genus *Protunuma*.

Included species:

PRU01 *Protunuma paulsmithi* Carter 1988

Protunuma paulsmithi Carter 1988

Species code: PRU01

Synonymy:

1988 *Protounuma paulsmithi* Carter n. sp. – Carter et al., p. 54, pl. 6, figs. 9, 12.

1991 *Protounuma paulsmithi* Carter – Carter & Jakobs, p. 344, pl. 3, fig. 17.

Original diagnosis: Spindle-shaped, inflated, lacking horn. Base partially constricted; aperture half of maximum diameter of test. Test surface has ten to fourteen longitudinal plicae, with two to three longitudinal rows of circular pores between flanking plicae.

Original description: Test spindle-shaped, multisegmented, final chamber partially constricted at base, aperture half of maxmum diameter of test. Apical horn lacking on all specimens examined. Cephalis small and imperforate. All chambers, except for the final one or two, increase rapidly in width; final chamber(s) slightly constricted. Ten to fourteen longitudinal plicae superimposed on surface of test; plicae mostly continuous from thorax to aperture. Two to three longitudinal rows of circular pores between adjacent plicae. Pores usually arranged diagonally, but sometimes horizontally. Pore size increases very slightly from apex to base.

Original remarks: This species is larger than *Protunuma fusiformis* Ichikawa & Yao, has a larger aperture, fewer plicae and larger pores; but like *P. fusiformis* it too is quite variable, having both short broad forms and more elongate 'slender' ones. Differs from *P. costata* (Heitzer) in having a larger terminal aperture, fewer rows of pores between adjacent plicae, and these pores are larger.

Further remarks: *Protunuma paulsmithi* differs from typical Middle and Late Jurassic *Protunuma* species in having a widely open instead of a strongly constricted aperture. This species, however, lacks a perforate basal appendage, characteristic of *Unuma* Ichikawa & Yao. *Protunuma paulsmithi* seems to be the oldest representative of the genus.

Measurements (μm):

Based on 19 specimens.

	HT	Av.	Max.	Min.
Maximum length	216	179	216	130
Maximum width	121	107	121	98

Etymology: Named in honour of Dr. P. L. Smith, of the University of British Columbia, for his contributions to the study of Jurassic ammonite biostratigraphy.

Type locality: GSC locality C-080579, Whiteaves Formation, Creek locality, Maude Island, Queen Charlotte Islands, British Columbia.

Occurrence: Whiteaves and Phantom Creek formations, Queen Charlotte Islands.

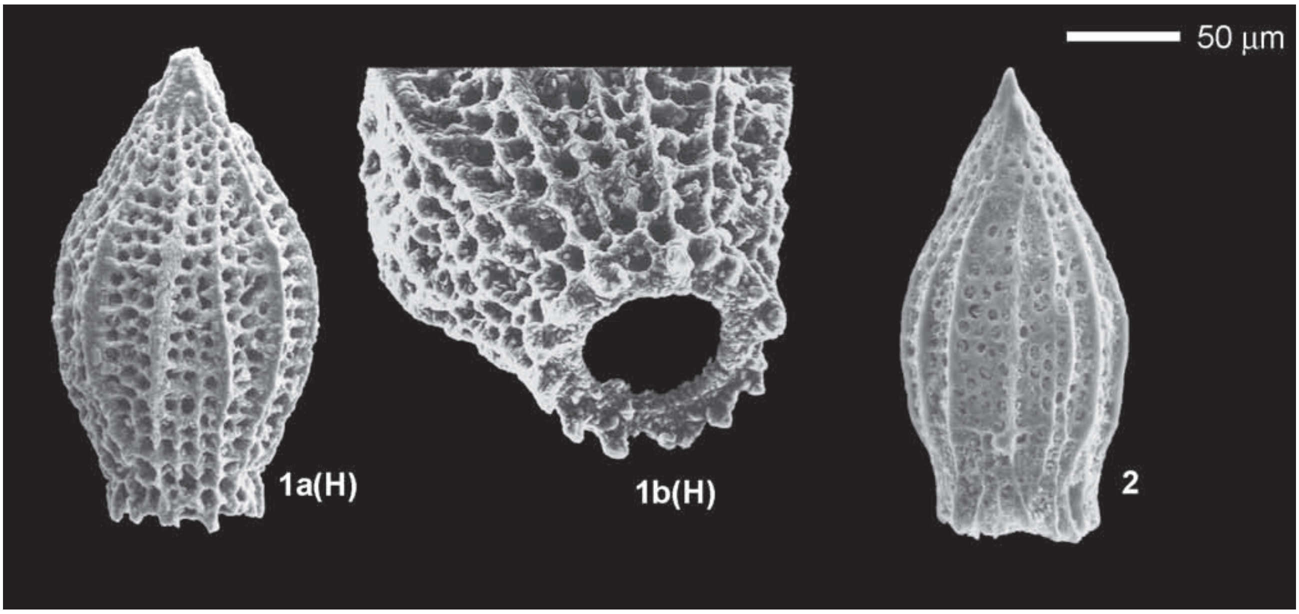


Plate PRU01. ***Protunuma paulsmithi*** **Carter.** Magnification x300, except Fig. 1b(H) x500. **Fig. 1(H)a, b.** Carter et al. 1988, pl. 6, figs. 9, 12. **Fig. 2.** Carter & Jakobs 1991, pl. 3, fig. 17.

Genus: *Pseudocrucella* Baumgartner 1980

Type species: *Crucella sanfilippoae* Pessagno 1977a

Synonymy:

1980 *Pseudocrucella* n. gen. – Baumgartner, p. 291.
1982b *Pseudocrucella* Baumgartner – De Wever, p. 239.
1984b *Pseudocrucella* Baumgartner – Blome, p. 351.
1995a *Pseudocrucella* Baumgartner – Baumgartner et al., p. 442.

Original description: Test as with subfamily composed of 4 rays at right angles, usually with tapering tips and long triradiate central spines. Cortical shell composed of 2 lateral and 1 to 3, sometimes merging, median external beams on each side connected by transverse bars with more or less developed nodes at intersections. Pores circular, rectangular or parallelogram-shaped in 2 or more partly continuous rows. Central area with irregular meshwork, nodose with smaller pores, or with a depression exposing the medullary shell. Lateral sides exposing the medullary rays with 2 or 3 paired or alternating rows of circular or rectangular pores. Cross section of rays rectangular or square. The discoidal medullary shell is on one side axially attached to the cortical shell. On the other side it is surrounded by cortical space. Primary canals are large, with a vertical axis of symmetry, surrounded by small, less regularly distributed canals which connect with the cortical space (see text-fig. 4K).

Original remarks: *Pseudocrucella* n. gen. differs from other four-rayed hagiastrids by its inner structure, by a rectangular cross section of rays and less regularly arranged pore rows on top and bottom sides. The described internal structure has been reconfirmed in topotypes of *P. sanfilippoae* from Point Sal (NSF 907, Pessagno collection) (pl. 8, figs. 23-24).

Included species:

PDC03 *Pseudocrucella ornata* De Wever 1981b
3126 *Pseudocrucella sanfilippoae* (Pessagno) 1977a
PDC04 *Pseudocrucella* sp. C sensu Carter 1988

Pseudocrucella ornata De Wever 1981b

Species code: PDC03

Synonymy:

1981b *Pseudocrucella* (?) *ornata* n. sp. – De Wever, p. 32, pl. 2, figs. 1-6.
1982b *Pseudocrucella* (?) *ornata* De Wever – De Wever, p. 240, pl. 22, figs. 1-6.
1987b *Pseudocrucella jurassica* n. sp. – Yeh, p. 29, pl. 2, figs. 5, 19.
1988 *Pseudocrucella* sp. A – Carter et al., p. 29, pl. 7, figs. 8-9.
1991 *Pseudocrucella* sp. A, n. sp. – Carter & Jakobs, p. 344, pl. 2, fig. 13.

Original description: Form with four orthogonal arms and patagium (sometimes poorly developed or preserved). Subcylindrical arms ending in spines, triradiate in cross-section at base and distally rounded. In cross-section, arms show three primary canals that are subtriangular in shape, surrounding the primary beam (pl. 2, fig. 6). Three small secondary canals prolongate the primary blades. This structure resembles that described by P. O. Baumgartner (1980, text-fig. 4, C) for *Tetratrabs gratiosa*. Arms, on surface, show three (or four) longitudinal beams, connected by transverse bars, aligned from one beam to the other thus delimiting all orthogonal network. Well-developed node present where beam and bar intersect. Central part of shell inflated with few nodes on most specimens.

Original remarks: This species differs from "*Pseudocrucella* sp. C" cited by Baumgartner (1980, pl. 8, fig. 11) by its more regularly arranged pores, more massive nodes and the presence of a patagium.

Histiastrum elizabethae Rüst (1898, p. 30) has more spindle-shaped, slim arms that do not have aligned pores on their central part. Spines extend from arms without abrupt change in outline. And finally, one does not know the inner structure.

Histiastrum valanginica Aliev (1965, p. 33) has a central lacuna while *P.* (?) *ornata* n. sp. has an inflated center.

This species is tentatively assigned to *Pseudocrucella* because it does seem to have all the criteria of the genus. It has the proper external architecture, but the primary and secondary canals with their respective proportions evoke the Tritrabinae structure.

Measurements (µm):
Based on 8 specimens.

	Av.	Min.	Max.	HT
Total length (of two rays without spines)	217	220	310	264
Length of spines of rays	55	54	57	54
Width of rays	52	40	62	55

Etymology: From Latin *ornatus, -a, -um* (adj.) = adorned, decorated.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Nicely Formation, Oregon; Phantom Creek Formation, Queen Charlotte Islands, British Columbia.

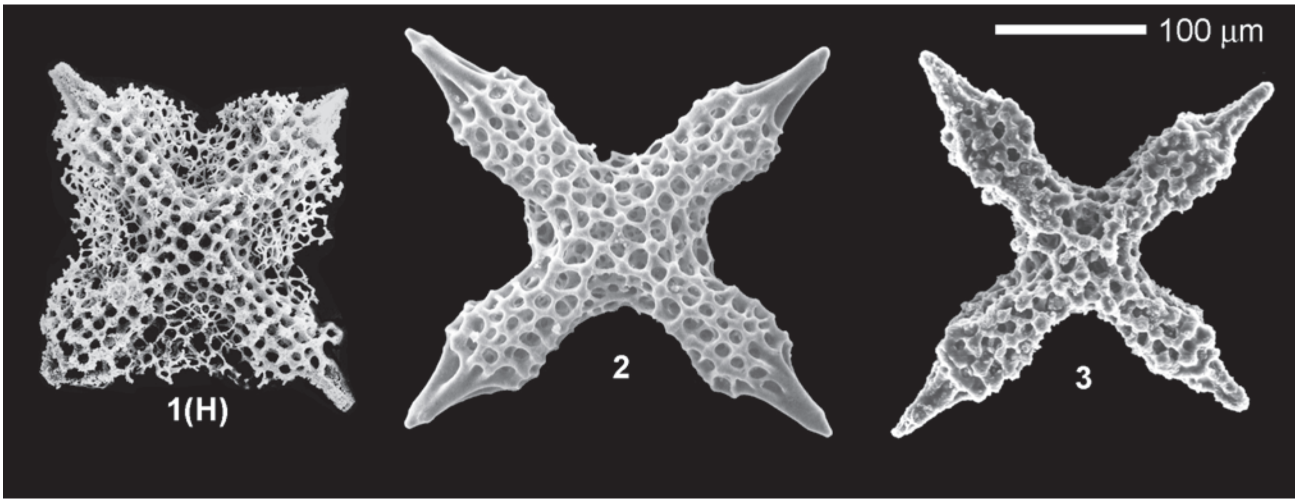


Plate PDC03. *Pseudocrucella ornata* De Wever. Magnification x200. **Fig. 1(H).** De Wever 1981b, pl. 2, fig. 1. **Fig. 2.** Carter & Jakobs 1991, pl. 2, fig. 13. **Fig. 3.** Carter et al. 1988, pl. 7, fig. 8.

Pseudocrucella sanfilippoae (Pessagno) 1977a

Species code: 3126

Synonymy:

1977a *Crucella sanfilippoae* n. sp. – Pessagno, p. 72, pl. 2, figs. 15-16.
1982 *Crucella sanfilippoae* Pessagno – Aita, pl. 3, fig. 9.
1980 *Pseudocrucella sanfilippoae* (Pessagno) – Baumgartner, p. 291, pl. 8, figs. 1, 23-24.
1981 *Pseudocrucella sanfilippoae* (Pessagno) – Kocher, p. 88, pl. 16, fig. 1.
1984 *Pseudocrucella sanfilippoae* (Pessagno) – Baumgartner, p. 781, pl. 7, fig. 17.
1988 *Pseudocrucella sanfilippoae* (Pessagno) – Carter et al., p. 29, pl. 7, figs. 1, 4.
1989 *Pseudocrucella* (?) sp. A – Hori & Otsuka, pl. 4, fig. 5.
1995a *Pseudocrucella sanfilippoae* (Pessagno) – Baumgartner et al., p. 444, pl. 3126, figs. 1-3.

Original description: Meshwork with linearly arranged square pore frames having massive nodes at their corners. Spines triradiate in axial section proximally and circular in axial section distally.

Original remarks: *Crucella sanfilippoae* n.sp. differs from *C. messinae* by virtue of its linearly arranged square pore frames and the structure of its spines.

***Measurements* (µm):**

Based on 10 specimens.

	Min.	Max.
Length of ray	100	170
Width of ray	50	60
Length of spines	55	120

Etymology: This species is named for Annika Sanfilippo (Scripps Institution of Oceanography) in honor of her contributions to the study of Jurassic Radiolaria

Type locality: Sample NSF 907, Point Sal, Santa Barbara County, California.

Occurrence: Worldwide.

***Pseudocrucella* sp. C** sensu Carter 1988

Species code: PDC04

Synonymy:

1988 *Pseudocrucella* sp. C – Carter et al. p. 30, pl. 7, fig. 7.
2003 *Pseudocrucella* sp. C sensu Carter – Goričan et al., p. 293, pl. 1, fig. 20.

Remarks: This species is characterized by long slender rays and a rather irregular arrangement of pores. In Carter et al. (1988) it was considered identical with *Pseudocrucella* sp. C of Baumgartner (1980, p. 292, pl. 8, figs. 10, 11) but it differs from the latter by having rounded and not vertical sides of rays.

Occurrence: Whiteaves and Phantom Creek formations, Queen Charlotte Islands, British Columbia; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation and Musallah Formation, Oman.

→

Plate PDC04. *Pseudocrucella* sp. C sensu Carter. Magnification x250. **Fig. 1.** Carter et al. 1988, pl. 7, fig. 7. **Fig. 2.** OM, BR825-3-R09-07. **Fig. 3.** OM-00-114, 023132. **Fig. 4.** Goričan et al. 2003, pl. 1, fig. 20. **Fig. 5.** SI, MM 6.76, 010330. **Fig. 6.** SI, MM 6.76, 000518.

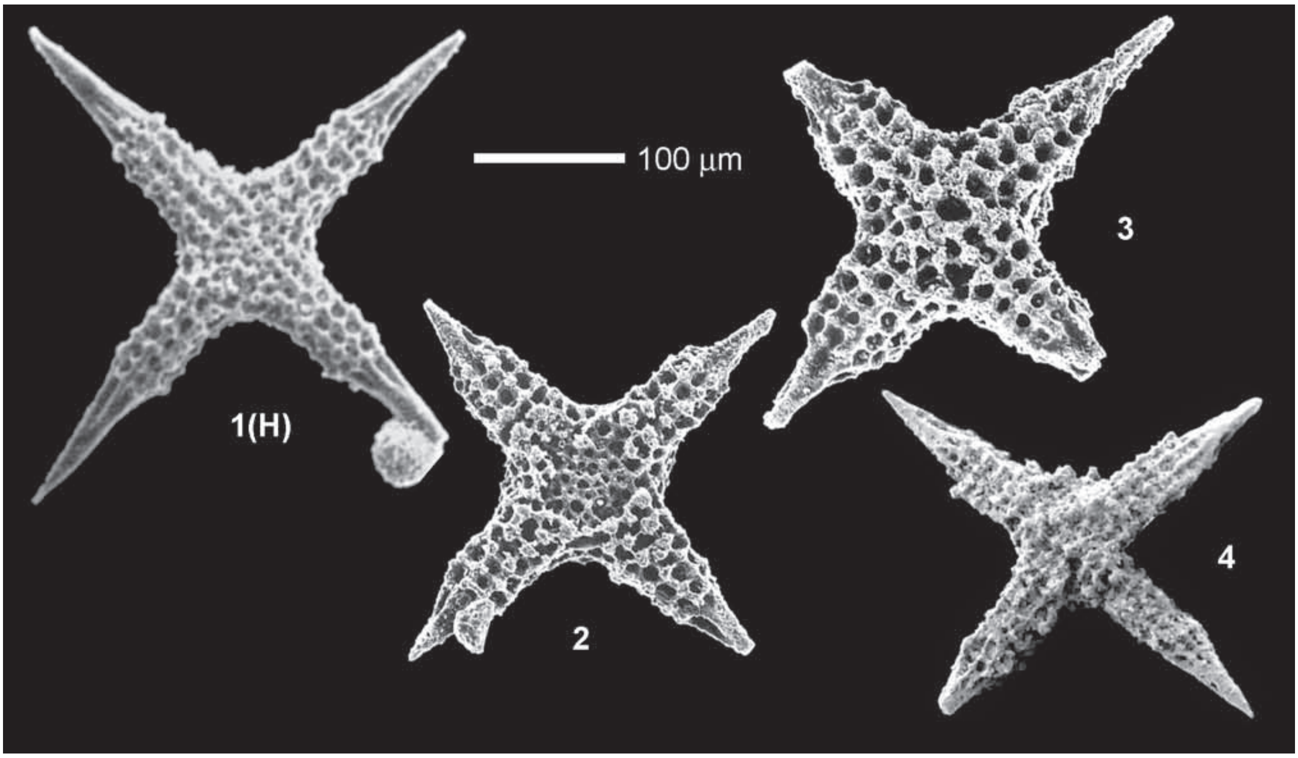
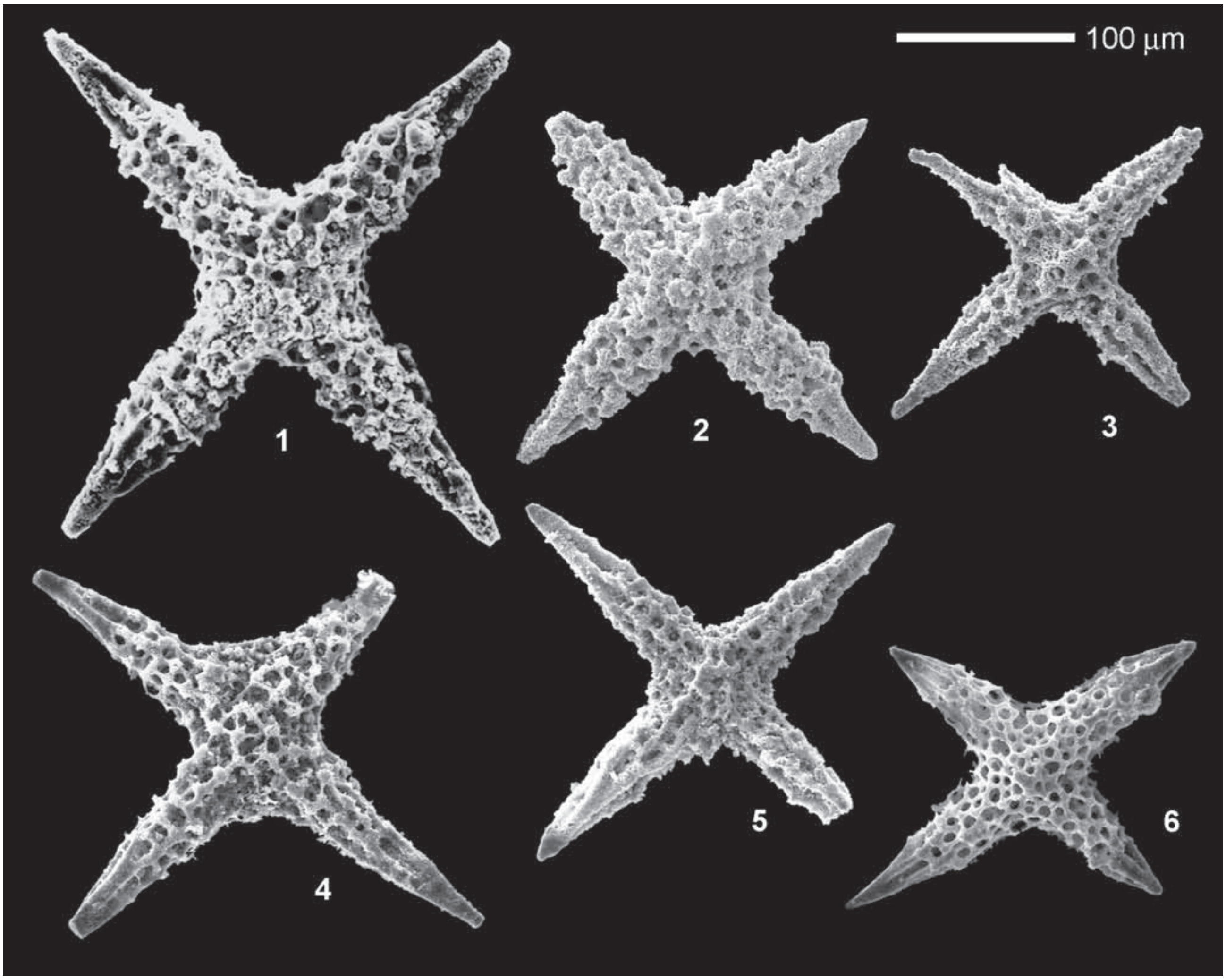


Plate 3126. *Pseudocrucella sanfilippoae* (Pessagno). Magnification x200. **Fig. 1(H).** Pessagno 1977a, pl. 2, fig. 15. **Fig. 2.** Carter et al. 1988, pl. 7, fig. 1. **Fig. 3.** Carter et al. 1988, pl. 7, fig. 4. **Fig. 4.** JP, NK9-62.



Genus: *Pseudoeucyrtis* Pessagno 1977b

Type species: *Eucyrtis* (?) *zhamoidai* Foreman 1973

Synonymy:

1977b *Pseudoeucyrtis* n. gen. – Pessagno, p. 58.
1990 *Pseudoeucyrtis* Pessagno – Yang & Wang, p. 213.
1994 *Pseudoeucyrtis* Pessagno – O'Dogherty, p. 179.
1997 *Pseudoeucyrtis* Pessagno – Hull, p. 158.

Original description: Test elongate, spindle shaped, multisegmented termination in a closed (?) tube. Cephalis imperforate with short, often massive horn. Remaining chambers coarsely perforate with polygonal pore frames; pore frames often spinose. Post-cephalic chambers (exclusive of terminal tube) increasing gradually in height, but somewhat more rapidly in width to middle of test where they begin to decrease in width. Test devoid of strictures.

Original remarks: *Pseudoeucyrtis* n. gen. differs from *Eucyrtis* Haeckel (type species = *E. conoidea* Rüst, 1885; see Foreman, 1973, p. 264) by lacking strictures, by having a more coarsely and densely perforate test, and by being spindle shaped.

Further remarks: Some species may possess weakly developed strictures. Some species lack apical horn (e.g., *Pseudoeucyrtis safraensis* Dumitrica & Goričan n. sp.).

Included species:

PSE02 *Pseudoeucyrtis angusta* Whalen & Carter 1998
PSE04 *Pseudoeucyrtis busuangaensis* (Yeh & Cheng) 1998
PSE03 *Pseudoeucyrtis safraensis* Dumitrica & Goričan n. sp.

Pseudoeucyrtis angusta Whalen & Carter 1998

Species code: PSE02

Synonymy:

1998 *Pseudoeucyrtis angusta* n. sp. – Whalen & Carter, p. 73, pl. 18, figs. 9-12, 16.
? 1998 *Pseudoeucyrtis angusta* Whalen & Carter – Yeh & Cheng, p. 31, pl. 9, figs. 3, 11.
Not 2002 *Pseudoeucyrtis angusta* Whalen & Carter – Whalen & Carter, p. 138, pl. 16, fig. 3.
Not 2004 *Pseudoeucyrtis angusta* Whalen & Carter – Matsuoka, fig. 123.

Original description: Test multicyrtid, cylindrical, with narrow terminal tube. Cephalis very small, hemispherical with short horn; horn circular in axial section, sometimes slightly bifurcate; cephalis with small, polygonal pore frames usually covered by layer of microgranular silica. Thorax and abdomen roughly trapezoidal in outline with small irregularly shaped pore frames usually covered by a layer of microgranular silica. Seven to ten postabdominal chambers, rectangular, with medium-sized, irregularly shaped pore frames; chambers very gradually increasing in size to central widest part of test, then gradually decreasing in width; chambers in central part of test just slightly wider than first and last postabdominal chambers; strictures usually weakly developed between postabdominal chambers in central part of test. Terminal tube usually open, with numerous circular pores.

Original remarks: *Pseudoeucyrtis angusta* n. sp. differs from *P.* sp. A by possessing weakly developed strictures. The very narrow elongate test of *P. angusta* n. sp. distinguishes it from *Protokatroma aquila* n. sp.

Measurements (µm):
Based on 5 specimens.

	Length (excluding horn)	Max. width
HT	592	99
Max.	592	99
Min.	526	86
Mean	551	92

Etymology: *Angustus, a, um* (Latin; adj.) = narrow, tight.

Type locality: Sample 89-CNA-KUD-16, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

Pseudoeucyrtis busuangaensis (Yeh & Cheng) 1998

Species code: PSE04

Synonymy:

1998 *Protokatroma busuangaensis* n. sp. – Yeh & Cheng, p. 30, pl. 7, figs. 2, 3; pl. 9, figs. 4, 5, 24.
1998 *Protokatroma* sp. aff. *P. aquila* Whalen & Carter – Yeh & Cheng, p. 30, pl. 7, fig. 1; pl. 9, figs. 6, 7.
1998 *Protokatroma* sp. B. – Yeh & Cheng, p. 31, pl. 10, figs. 2, 3.
2004 *Pseudoeucyrtis* sp. – Hori, pl. 2, figs. 49-51.

Original description: Test slender, slightly swollen at median portion, with short tubular horn. Final post-abdominal chamber terminating with moderately long cylindrical closed tubular extension which gently decreases in width towards its distal end.

Original remarks: This form is characterized by having a slender test which is slightly inflated at its median portion.

Further remarks: The specimens from the Haliw Formation of Oman (pl. PSE04, figs. 2-7) resemble the holotype

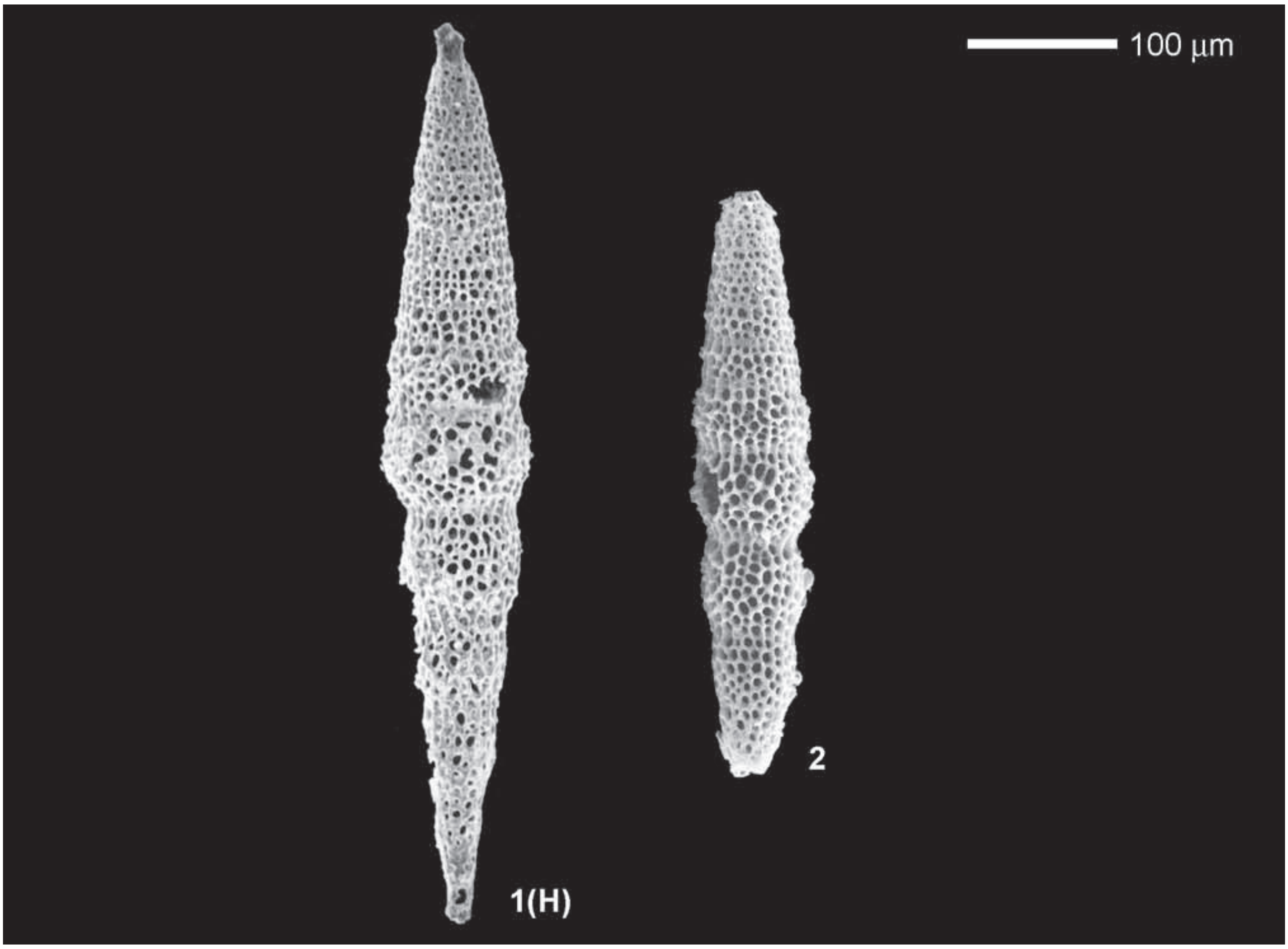


Plate PSE02. ***Pseudoeucyrtis angusta*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 18, fig. 10. **Fig. 2.** Carter et al. 1998, pl. 18, fig. 9.

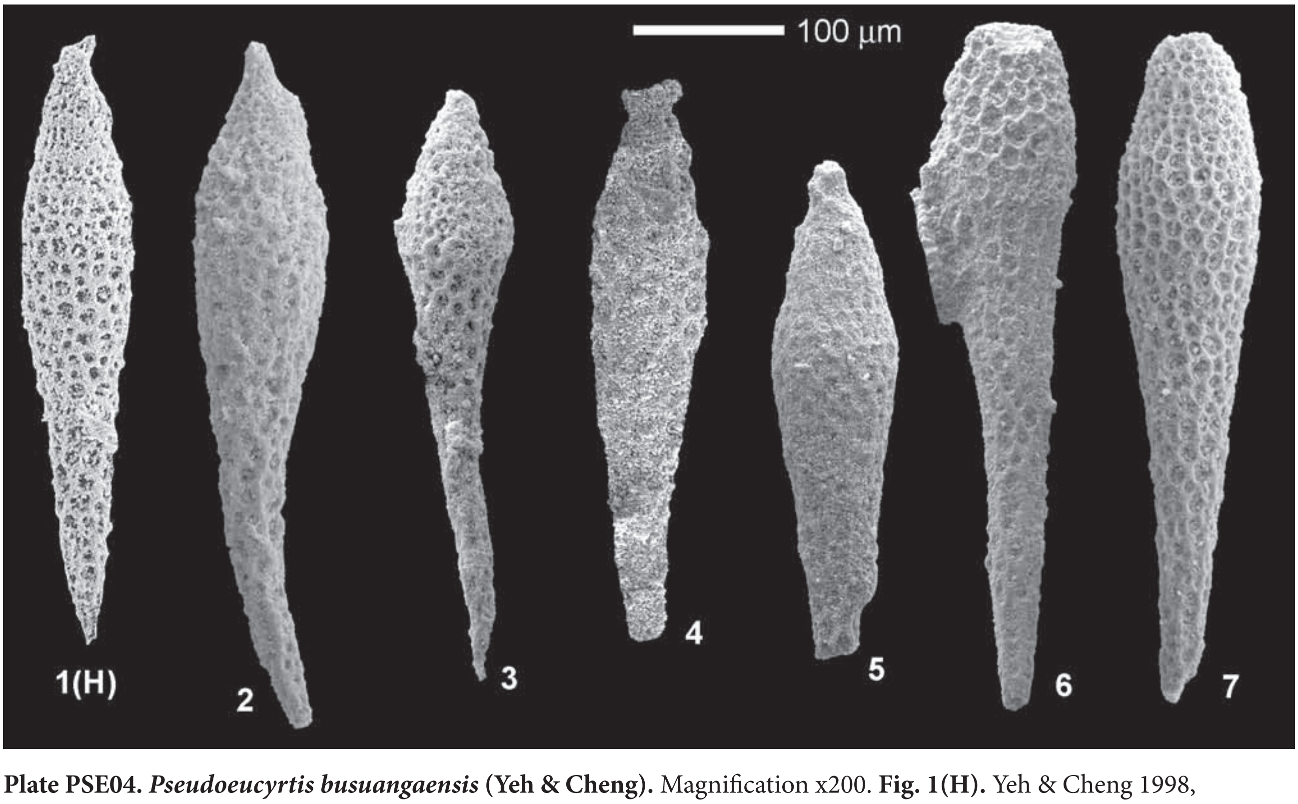


Plate PSE04. ***Pseudoeucyrtis busuangaensis*** **(Yeh & Cheng).** Magnification x200. **Fig. 1(H).** Yeh & Cheng 1998, pl. 9. fig. 4. **Fig. 2.** OM, Haliw-039-R01-05a. **Fig. 3.** OM, Haliw-039-R02-07. **Fig. 4.** OM, Haliw-039-R01-07. **Fig. 5.** OM, Haliw-039-R01-06. **Fig. 6.** OM, Haliw-038-R08-23. **Fig. 7.** OM, Haliw-039-R01-05.

but differ only in being more inflated and the maximum diameter is in the proximal third of shell rather than in the middle.

Measurements (µm):
Based on 7 specimens.

	Length (excluding horn)	Width (maximum)
HT	380	74
Max.	397	77
Min.	380	66
Mean	387	72

Etymology: This form is named after its type locality, Busuanga Island, Philippines.

Type locality: Sample CR91-49E, Liminangcong Chert, a reddish bedded chert sequence exposed at a road side of the Coron Highway, about 400 m to the west of milestone KM35.

Occurrence: Liminangcong Chert, Busuanga Island, Philippines; Haliw (Aqil) Formation, Oman; Japan.

Pseudoeucyrtis safraensis Dumitrica & Goričan n. sp.

Species code: PSE03

Type designation: Holotype specimen R20-04 from sample BR 485, Tawi Sadh Member, Guwayza Formation, Jabal Safra; paratype specimen 021416, sample OM-00-251, Musallah Formation, Al Aridh Group, Jabal Buwaydah, Oman.

Description: Test multicyrtid, spindle-shaped, elongate. Cephalis small, hemispherical; lacking apical horn. Following five to seven segments roughly trapezoidal in outline, increasing slowly in width as added; segments with polygonal pore frames arranged diagonally. Remainder of test slowly decreasing in width, mostly comprising a long tube; pore frames of tube larger, mostly rectangular, arranged linearly. Intersegmental constrictions indistinct, usually weakly developed on proximal part but always lacking on the terminal portion with linearly arranged pores.

Remarks: *Pseudoeucyrtis safraensis* n. sp. differs from *P. angusta* Whalen & Carter 1998 and *P. busuangaensis* Yeh & Cheng 1998 in having linearly arranged pores. In *P. safraensis* the linear pore arrangement characterizes at least one third of the test. *P. safraensis* is similar to *Foremania sandilandsensis* Whalen & Carter 1998 in the alignment of pores, but differs in being proportionally narrower, distally more constricted, and in lacking a large, branched apical horn. Also, the pores of *F. sandilandensis* are arranged in both longitudinal and transversal rows (square pattern), whereas in *P. safraensis* they are arranged in longitudinal rows only.

Measurements (µm):
Based on 5 specimens.

	Length	Max. width
HT	670	81
Max.	670	100
Min.	408	81
Mean	--	90

Etymology: Named after type locality.

Type locality: Sample BR 485, Tawi Sadh Member, Guwayza Formation, Jabal Safra, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Sabt and Musallah formations, Oman.

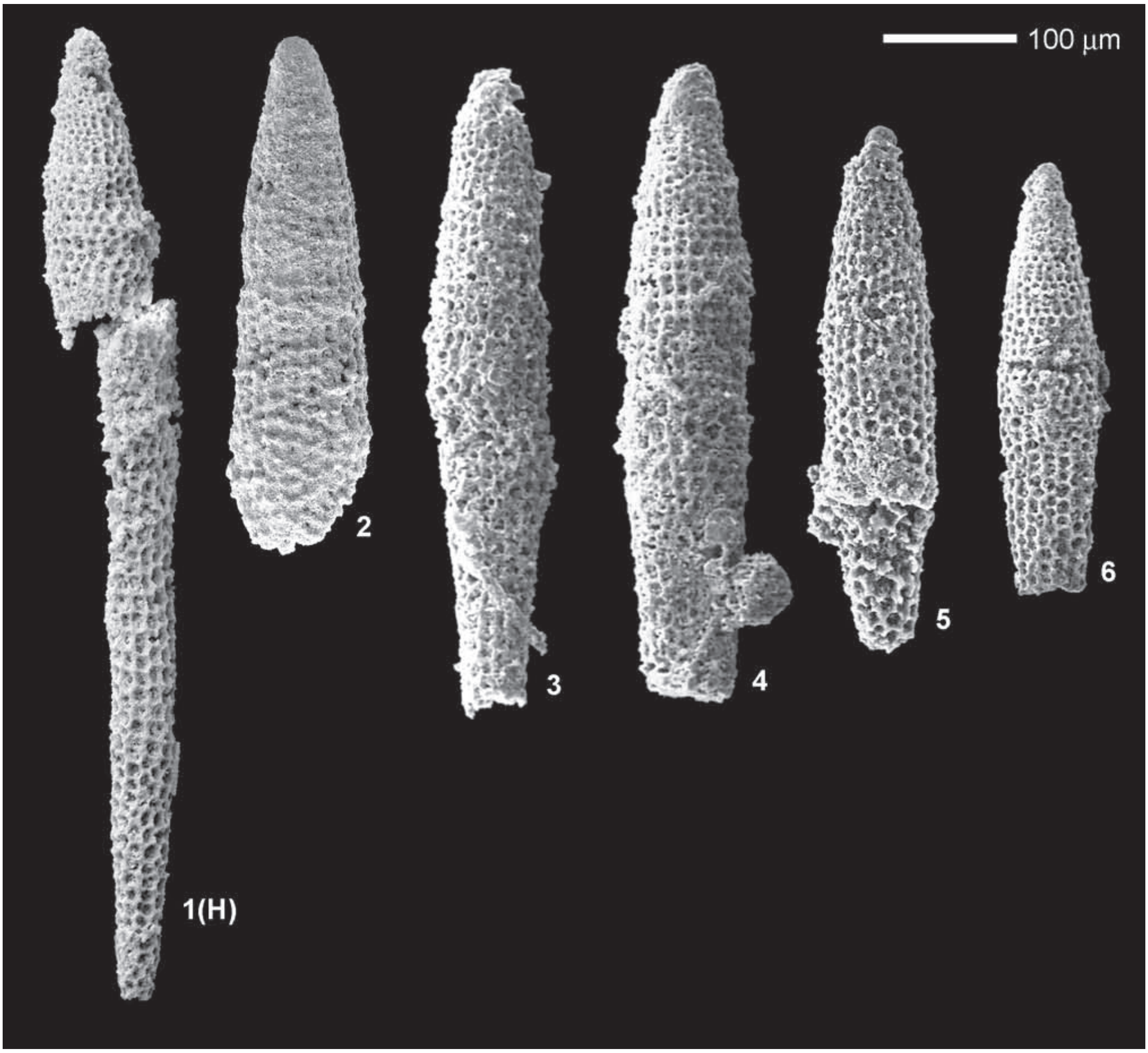


Plate PSE03. ***Pseudoeucyrtis safraensis*** **Dumitrica & Goričan n. sp.** Magnification x200. **Fig. 1(H).** OM, BR485-R20-04. **Fig. 2.** OM, BR706-R12-18. **Fig. 3.** OM-01-21, 010830. **Fig. 4.** OM-01-21, 010829. **Fig. 5.** OM-00-251, 021416. **Fig. 6.** OM-00-252, 021822.

Genus: *Pseudogodia* Tekin 1999, emend. Carter herein

Type species: *Pseudogodia sonmezi* Tekin 1999

Synonymy:
1999 *Pseudogodia* n. gen. – Tekin, p. 120.

Original description: Test thick, roughly hexagonal in outline composing of big nodes. Each side of the test slightly convex. Rim of the test mainly includes big nodes (six to seven) in different size mainly situated in every corner but sometimes irregular. Nodes separating from each other and from central nodes by shallow depressions. Central nodes have same feature those of nodes situated at the side of the test. Meshwork consisting of irregular polygonal (mainly trigonal and hexagonal) pore frames and mainly circular pores in different size. Test possesses two peripheral spines tapering distally and circular in cross section, usually one of them robust and ticker than the other could be the polar spine.

Emended description: Test disc-shaped, thick, subhexagonal in outline. Planar surfaces of test slightly convex, composed of large raised central area surrounded by one or more rings of large irregularly-sized tubercules. Tubercules separated from each other and from central area by shallow depressions. Meshwork of tubercules consisting of irregular polygonal (mainly trigonal and hexagonal) pore frames with irregular circular pores. Test with two or more peripheral spines.

Original remarks: This genus could be distinguished from the genus *Orbiculiforma* Pessagno by having polygonal outline instead of circular, strong nodes both at rim and center of the test. It differs also from Cretaceous genus *Godia* Wu by possessing polygonal outline instead of circular and whole test of former composing mainly large nodes, latter has small pores on the surface of the test.

Emended remarks: This genus is distinguished from *Godia* Wu in possessing a polygonal outline. By its polygonal outline it also differs from *Orbiculiforma* Pessagno, which is now restricted to subquadratic forms with four main spines (see original remarks under *Orbiculiformella* Kozur & Mostler). *Pseudogodia* further differs from *Godia* Wu and *Orbiculiformella* Kozur & Mostler in possessing a large central area and large raised tubercules around the periphery.

Etymology: For the similarity to Cretaceous genus *Godia* Wu.

Included species:
ORB12 *Pseudogodia deweveri* Carter n. sp.

Pseudogodia deweveri Carter n. sp.

Species code: ORB12

Synonymy:
1981c G. sp. indet. – De Wever, p. 150, pl. 5, figs. 28, 29.

Type designation: Holotype GSC 111756 from GSC loc. C 3045686 and paratype GSC 128855 from GSC loc. C-080613; Rennell Junction member of the Fannin Formation (upper lower Pliensbachian).

Description: Test disc-shaped, large and thick, subcircular to slightly scalloped in outline with short spines radiating from the periphery in different planes. Upper and lower surfaces of test with well defined raised central area, width greater than one-half diameter of test. Central area with numerous large, slight- to moderately-raised tubercules (Holotype, pl. ORB12, fig. 1). Outer rim of test covered with fine spongy pore frames; pore frames in central part of central area sometimes larger and well defined (Paratype, pl. ORB12, fig. 2), but pore frames on tubercules always much smaller. Peripheral spines short, irregularly spaced, variable in width, circular in axial section.

Remarks: This distinctive species was first recognized in the Pliensbachian of Turkey (De Wever, 1981c) and mentioned as having a pseudoaulophacid outline similar to *Pseudoaulophacus lenticulatus* Pessagno, a central thickening, and peripheral spines.

There are pronounced similarities between *Pseudogodia deweveri* n. sp. and *Orbiculiformella lomgonensis* Whalen & Carter 1998, both similar in age. The former possesses large porous tubercules on the raised central area, whereas the latter has a depressed central area and raised tubercules around the periphery of the test. Until more is known, *O. lomgonensis* is still included with the genus *Orbiculiformella*.

Measurements (μm):
Based on 8 specimens.

	HT	Max.	Min.	Mean
Diameter of cortical shell	363	363	281	322
Diameter of central area	199	206	160	184

Etymology: Named for Patrick De Wever, Muséum National d'Histoire Naturelle, Paris, to honour his pioneering contribution to the knowledge of Pliensbachian radiolarians and for his helpful guidance in the author's early studies of the late Early Jurassic of Queen Charlotte Islands.

Type locality: Sample 99-CNA-MI-11 (GSC loc. C-304568), Rennell Junction member of the Fannin Formation, Maude Island, east of Ells Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin Formation, Queen Charlotte Islands; Gümüslü Allochthon, Turkey.

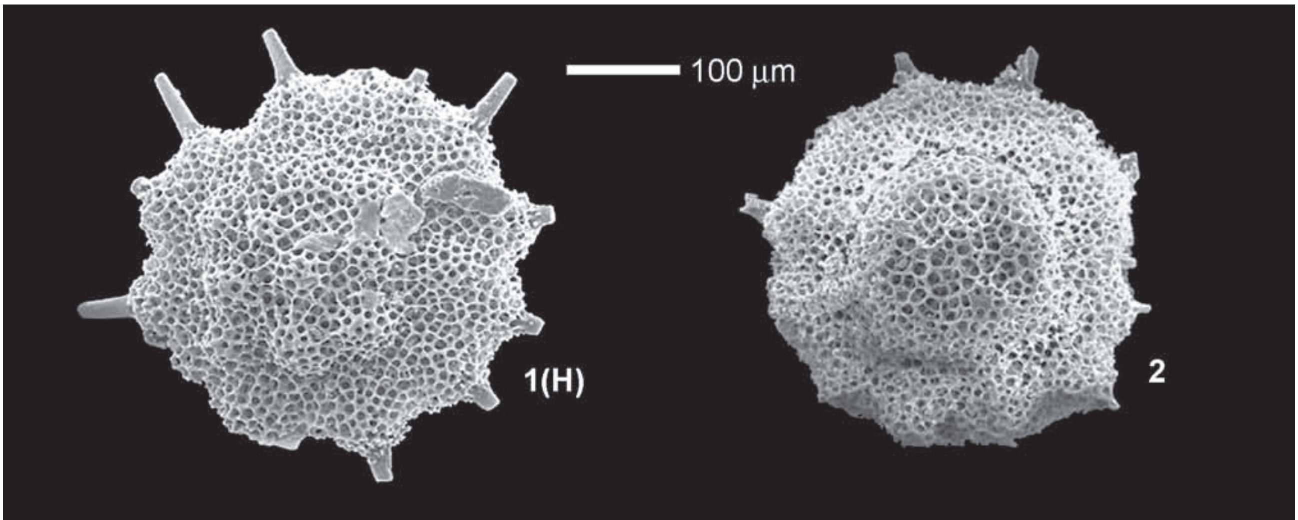


Plate ORB12. *Pseudogodia deweveri* Carter n. sp. Magnification x150. **Fig. 1(H).** QCI, GSC loc. C-304566, GSC 111756. **Fig. 2.** QCI, GSC loc. C-080613, GSC 128855.

Genus: *Pseudoheliodiscus* Kozur & Mostler 1972, emend. De Wever 1984

Type species: *Pseudoheliodiscus riedeli* Kozur & Mostler 1972

Synonymy:

1972 *Pseudoheliodiscus* n. gen. – Kozur & Mostler, p. 24.
1979 *Pseudoheliodiscus* Kozur & Mostler, emend. Pessagno – Pessagno et al., p. 169.
1984 *Pseudoheliodiscus* Kozur & Mostler emend. – De Wever, p. 15.
1990 *Pseudoheliodiscus* Kozur & Mostler, emend. Pessagno – Kozur & Mostler, p. 189.

Original diagnosis: Shell spongy to delicately latticed, with two prominent needle-shaped polar spines on the inner side. Usually with one or two medullary shells which are not always present. Shell connected directly with a girdle bearing very long radial spines.

Emended diagnosis: De Wever (1984): Palaeosaturnalinae with simple ring, with auxiliary and/or subsidiary rays.

Original remarks: This genus is transitional between *Heliodiscus* Haeckel 1862, where the spines are not fused to a ring, and Saturnalinae, where the ring is clearly detached from the shell.

Further remarks: We use here the emendation of the genus by De Wever (1984) that takes into account the presence or absence of polar spines. For Pessagno (in Pessagno et al., 1979) and Kozur & Mostler (1990) this character has no value.

Etymology: By similarity with *Heliodiscus* Haeckel, 1862.

Included species:

SAT16 *Pseudoheliodiscus* aff. *alpinus* Kozur & Mostler 1990 sensu Whalen & Carter 2002
SAT07 *Pseudoheliodiscus yaoi* gr. Pessagno 1981

Pseudoheliodiscus aff. *alpinus* Kozur & Mostler 1990 sensu Whalen & Carter 2002

Species code: SAT16

Synonymy:

1984 *Pseudoheliodiscus* (?) spp. – Whalen & Pessagno, pl. 3, fig. 8, 9.
aff. 1990 *Pseudoheliodiscus alpinus* n. sp. – Kozur & Mostler, p. 189, pl. 5, fig. 1, 3, 5-9, 11, 12.
2002 *Pseudoheliodiscus* sp. aff. *P. alpinus* Kozur & Mostler – Whalen & Carter, p. 108, pl. 5, figs. 8, 14.

Original remarks: This species differs from *P. alpinus* Kozur & Mostler by having fewer rays between the polar spines that are shorter and less robust.

Occurrence: San Hipólito Formation, Baja California Sur.

Pseudoheliodiscus yaoi gr. Pessagno 1981

Species code: SAT07

Synonymy:

1981 *Pseudoheliodiscus yaoi* Pessagno n. sp. [*Pseudoheliodiscus yaoi* Pessagno & Poisson n. sp. in fig. captions] – Pessagno & Poisson, p. 55, pl. 4, fig. 9; pl. 5, figs. 1, 4, 7-9; pl. 13, fig. 2.
1981c *Pseudoheliodiscus yaoi* Pessagno – De Wever, p. 144, pl. 5, fig. 1.
1981c *Pseudoheliodiscus yaoi* Pessagno ? – De Wever, p. 144, pl. 4, figs. 8-10.
1982b *Pseudoheliodiscus yaoi* Pessagno – De Wever, p. 224, pl. 20, fig. 6.
1982b *Pseudoheliodiscus yaoi* Pessagno ? – De Wever, p. 225, pl. 20, figs. 1-3.
1982 *Pseudoheliodiscus yaoi* Pessagno – De Wever & Origlia-Devos, pl. 1, fig. T.

Original description: Test with extremely broad, flat ring having thirteen to fourteen peripheral spines and about twelve auxiliary spines. Central spongy cortical shell occupying most of ring on most specimens; cortical shell comprised of concentric layers of irregular polygonal (triangular, tetragonal, pentagonal) pore frames.

Original remarks: *Pseudoheliodiscus yaoi*, n. sp., differs from *P. riedeli* Kozur & Mostler (1972) by having a much broader ring with shorter peripheral spines. It differs from *P. finchi* Pessagno (1979) by having a somewhat wider ring and thirteen to fourteen as opposed to ten or eleven peripheral spines.

Measurements (μm):

Based on 8 specimens.

	HT	Max.	Min.
Diameter of spongy cortical shell	140	150	135
Diameter of test including cortical shell and ring, excluding peripheral spines on ring	230	260	230
Width of ring, exclusive of peripheral spines	30	45	30

Etymology: This species is named for Dr. Akira Yao (Osaka City University) in honor of his contributions to the study of Parasaturnalidae.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Ghost Creek Formation, Queen Charlotte Islands; Drimos Formation, Greece; Tawi Sadh Member fo the Guwayza Formation, Oman.

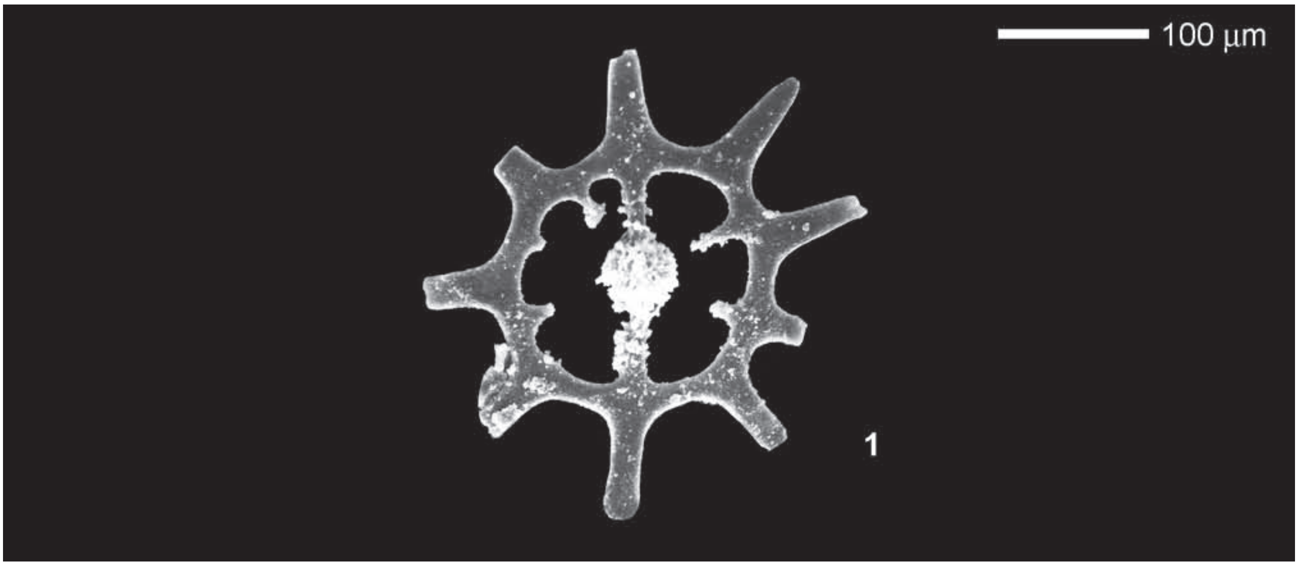


Plate SAT16. *Pseudoheliodiscus* aff. *alpinus* Kozur & Mostler sensu Whalen & Carter. Magnification x200.
Fig. 1. Whalen & Carter 2002, pl. 5, fig. 8.

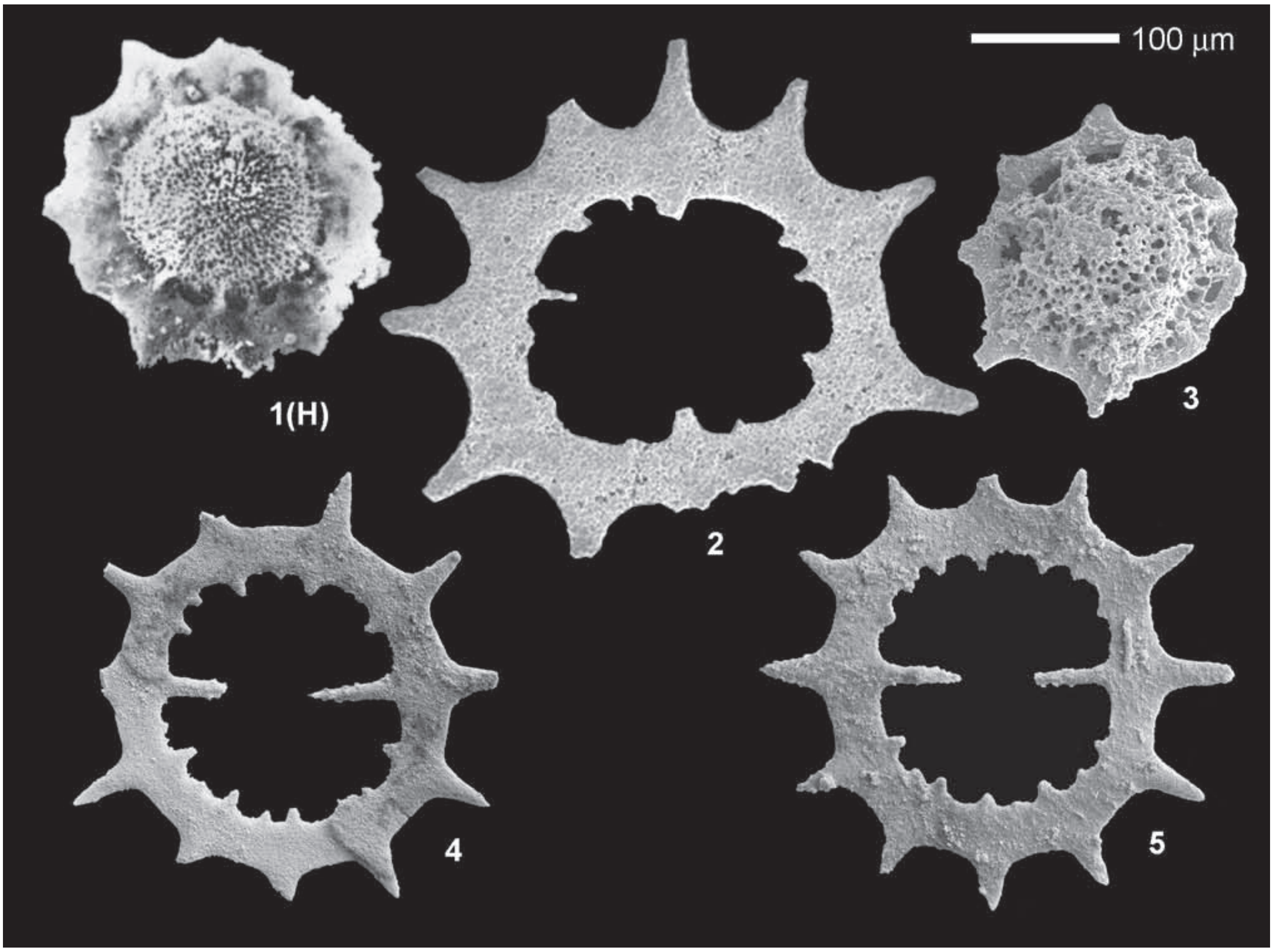


Plate SAT07. *Pseudoheliodiscus yaoi* gr. Pessagno. Magnification x200. **Fig. 1(H).** Pessagno & Poisson1981, pl. 4, fig. 9.
Fig. 2. QCI, GSC loc. C-305417, GSC 111757. **Fig. 3.** QCI, GSC loc. C-080612, GSC 111758.
Fig. 4. OM, BR485-R20-13. **Fig. 5.** OM, BR485-R20-16.

Genus: *Pseudopantanellium* Yeh 1987b

Type species: *Pseudopantanellium floridum* Yeh 1987b

Synonymy:

1987b *Pseudopantanellium* n. gen. – Yeh, p. 50.

Original description: Test spherical to ellipsoidal with two triradiate polar spines. Meshwork of test comprised of numerous concentric subspherical rings of pentagonal and hexagonal pore frames anchoring to pillar-like structure at pore frame vertices. Size of pore frames decreasing gradually toward center of spherical test.

Original remarks: *Pseudopantanellium* n. gen., has superficial resemblance to *Pantanellium* Pessagno (1977b). However, *Pseudopantanellium* can be distinguished from *Pantanellium* by having a series of concentric layers of pentagonal or hexagonal pore frames rather than consisting only of a cortical shell and a medullary shell.

Etymology: From the Latin *pseudo* = false, and *Pantanellium.*

Included species:

PPN01 *Pseudopantanellium floridum* Yeh 1987b

Pseudopantanellium floridum Yeh 1987b

Species code: PPN01

Synonymy:

1987b *Pseudopantanellium floridum* n. sp. – Yeh, p. 50, pl. 10, figs. 3, 21; pl. 20, fig. 10.
1987b *Pseudopantanellium* sp. A – Yeh, p. 51, pl. 2, figs. 7, 13, 24.
1987b *Pseudopantanellium* sp. B – Yeh, p. 51, pl. 2, fig. 14.
1987b *Pseudopantanellium* sp. C – Yeh, p. 51, pl. 10, fig. 1, 15.
1987b *Pseudopantanellium* sp. D – Yeh, p. 51, pl. 10, fig. 2; pl. 23, figs. 4, 15.
1987 Gn. Sp. indet. – Hattori, pl. 22, fig. 17.
1996 *Pseudopantanellium* sp. A – Pujana, p. 137, pl. 1, fig. 2.

Original description: Test as with genus, large, spherical in shape, polar spines relatively thin, medium in length, triradiate with three ridges alternating with three narrow grooves, extremely narrow subsidiary grooves occurring on ridges. Concentric rings of meshwork usually of large pentagonal and hexagonal pore frames anchoring to pillar-like structure at vertices. Pore frames of outermost layer large, with prominent thin in [sic] rims and moderately thick in [sic] sides, with prominent nodes at vertices. Five to six pore frames visible.

Original remarks: *Pseudopantanellium floridum* n. sp., can be distinguished from other *Pseudopantanellium* spp. in this report by having a large spherical test with very symmetrical pore frames.

Measurements (μm):
Ten specimens measured.

	Maximum diameter of test	Maximum width of spine	Maximum length of polar spines
HT	200	30	150
Mean	175	25	156
Max.	200	30	165
Min.	143	17	145

Etymology: From the Latin *floridus* = flowery.

Type locality: Sample OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands; Sierra Chacaicó Formation, Argentina; Japan.

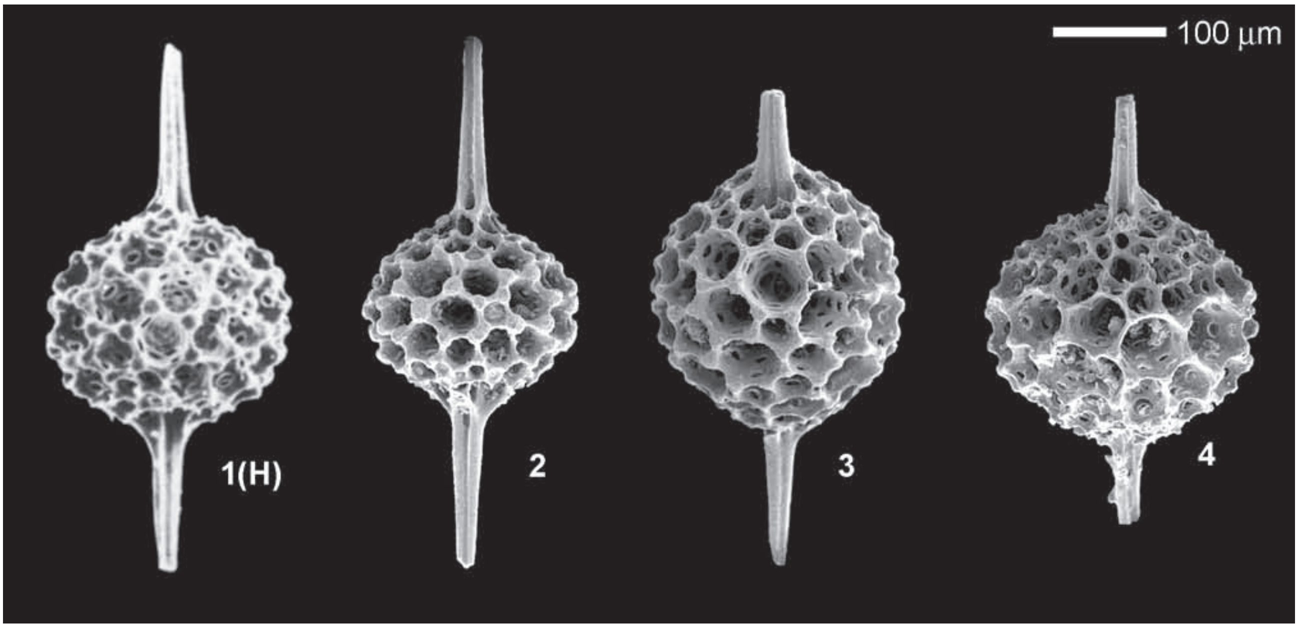


Plate PPN01. *Pseudopantanellium floridum* Yeh. Magnification x150. **Fig. 1(H).** Yeh 1987b, pl. 10, fig. 3. **Fig. 2.** QCI, GSC loc. C-140495, GSC 111759. **Fig. 3.** QCI, GSC loc. C-140495, GSC 111760. **Fig. 4.** QCI, GSC loc. C-304566, GSC 111761.

Genus: *Pseudopoulpus* Takemura 1986

Type species: *Pseudopoulpus yamatoensis* Takemura 1986

Synonymy:

1986 *Pseudopoulpus* n. gen. – Takemura, p. 39.
1987b *Pseudopoulpus* Takemura emend. – Yeh, p. 86.
2003 *Pseudopoulpus* Takemura – Dumitrica & Zügel, p. 32.

Original description: Shell of one segment, cephalis with apical horn and three feet. Cephalis subspherical, large and perforated by many irregularly or hexagonally arranged pores. Cephalis subdivided usually slightly into two parts by longitudinal grooves on cephalic surface, which accords with arches Al. Apical horn, which is a prolongation of A, usually triradiate and thinner than the three feet. Three feet, prolongations of two L and D, triradiate and strong. MB, A, V, D, two L and two l as cephalic skeletal elements and two arches Al existing. VL, Ll, and lD at collar portion. Arch AV not existing. V not on the same plane defined by MB and two L.

Original remarks: *Pseudopoulpus,* n. gen. differs from the genera *Saitoum* Pessagno and *Poulpus* De Wever, which belong to the subfamily Poulpinae De Wever, in lack of arch AV, which is the sagittal ring. Although *Pseudopoulpus,* n. gen. has a thick and latticed cephalic shell, this new genus is tentatively assigned to the family Plagoniidae Haeckel, emend. Riedel in the present paper; because of its tripod skeleton and considerably large cephalis. Cephalic skeletal structures of Cenozoic Plagoniids, however, have not yet been clarified sufficiently.

Etymology: The genus name, is derived from "pseudo" and the genus name *Poulpus* De Wever.

Included species:

2007 *Pseudopoulpus acutipodium* Takemura 1986
POU01 *Pseudopoulpus* sp. A sensu Whalen & Carter 2002

Pseudopoulpus acutipodium Takemura 1986

Species code: 2007

Synonymy:

1986 *Pseudopoulpus acutipodium* n. sp. – Takemura, p. 40, pl. 1, figs. 5-8.
1987b *Pseudopoulpus pessagnoi* n. sp. – Yeh, p. 89, pl. 12, figs. 7-9, 12, 13, 22, 26.
1987b *Pseudopoulpus* sp. A – Yeh, p. 89, pl. 26, fig. 18.
1987b *Pseudopoulpus* sp. B – Yeh, p. 89, pl. 26, fig. 14.
1987b *Pseudopoulpus* sp. D – Yeh, p. 90, pl. 12, fig. 1.
1991 *Pseudopoulpus acutipodium* Takemura – Carter & Jakobs, p. 344, pl. 3, fig. 10.
2004 *Pseudopoulpus acutipodium* Takemura – Matsuoka, fig. 162.

Original description: Cephalis large and subspherical, with irregularly or hexagonally arranged usually circular pores and pore frames. Apical horn thin, short and triradiate proximally. Three feet strong, straight, triradiate and sharply pointed.

Original remarks: *P. acutipodium* n. sp. is distinguished from *P. yamatoensis* by its sharply pointed feet.

Measurements (μm):
Based on 5 specimens.

	Min.	Max.
Length of shell including horn and feet	175	240
Height of cephalis	85	100
Maximum width of shell including feet	180	215
Width of cephalis	95	120

Etymology: *Acutipodium*, means sharpened foot.

Type locality: Sample TKN-105, Gujo-Hachiman area in the Mino terrane, central Japan.

Occurrence: Mino Terrane, Japan; Phantom Creek Formation, Queen Charlotte Islands; Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon.

***Pseudopoulpus* sp. A** sensu Whalen & Carter 2002

Species code: POU01

Synonymy:

1984 unidentified Radiolaria – Whalen & Pessagno, pl. 1, fig. 4.
2002 *Pseudopoulpus* sp. A – Whalen & Carter, p. 130, pl. 13, figs. 1, 2, 14.

Original remarks: This species is similar to *Pseudopoulpus pessagnoi* Yeh 1987, but differs in having a more massive apical horn.

Further remarks: *Pseudopoulpus pessagnoi* Yeh is now assigned to *Pseudopoulpus acutipodium* Takemura.

Occurrence: San Hipólito Formation, Baja California Sur.

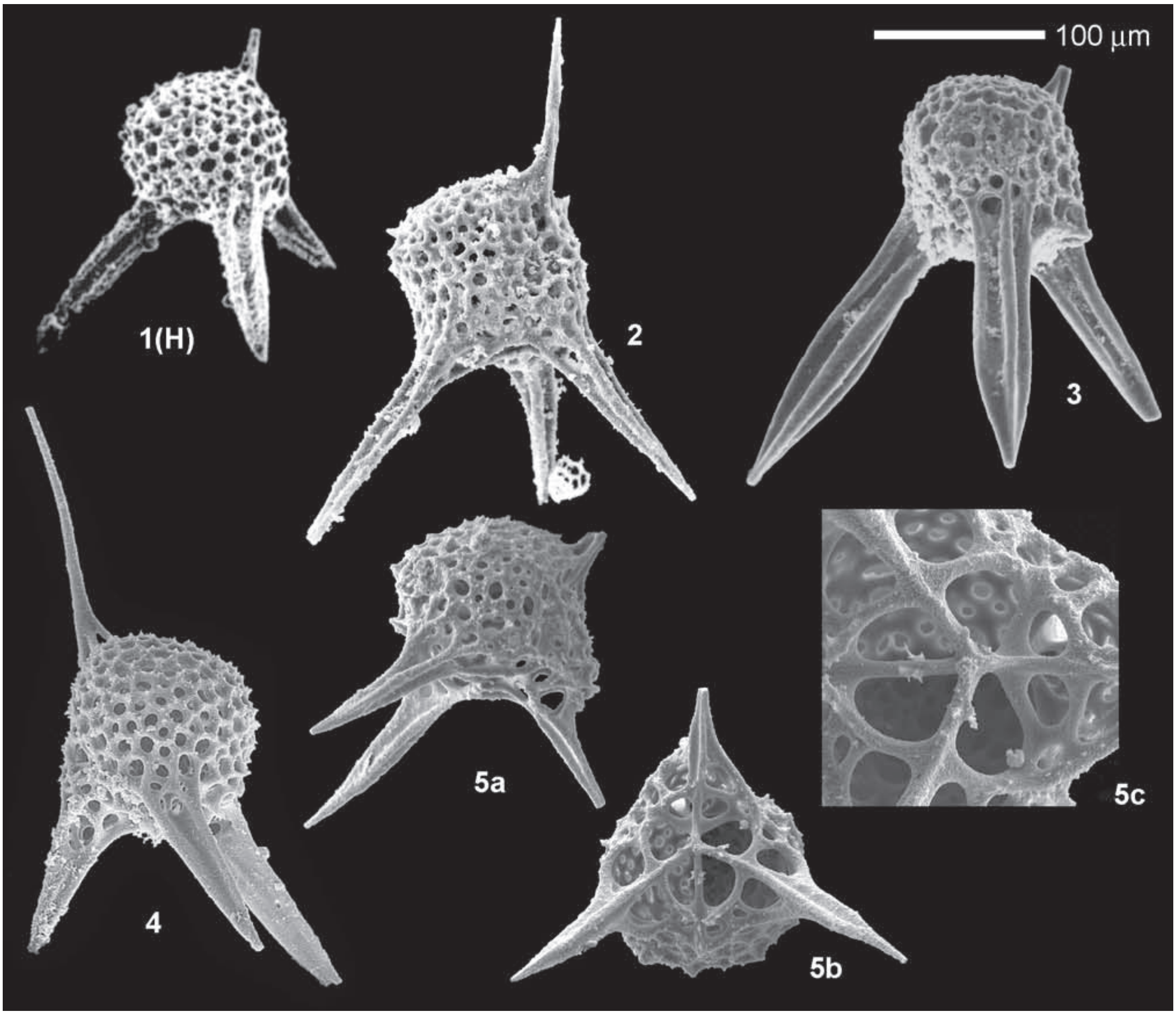


Plate 2007. *Pseudopoulpus acutipodium* Takemura. Magnification x250, except Fig. 5c x500. **Fig. 1(H).** Takemura 1986, pl. 1, fig. 5. **Fig. 2.** Matsuoka 2004, fig. 162. **Fig. 3.** Carter & Jakobs 1991, pl. 3, fig. 10. **Fig. 4.** OR600A, 13165. **Figs. 5a-c.** OR600A-R03-08a-c.

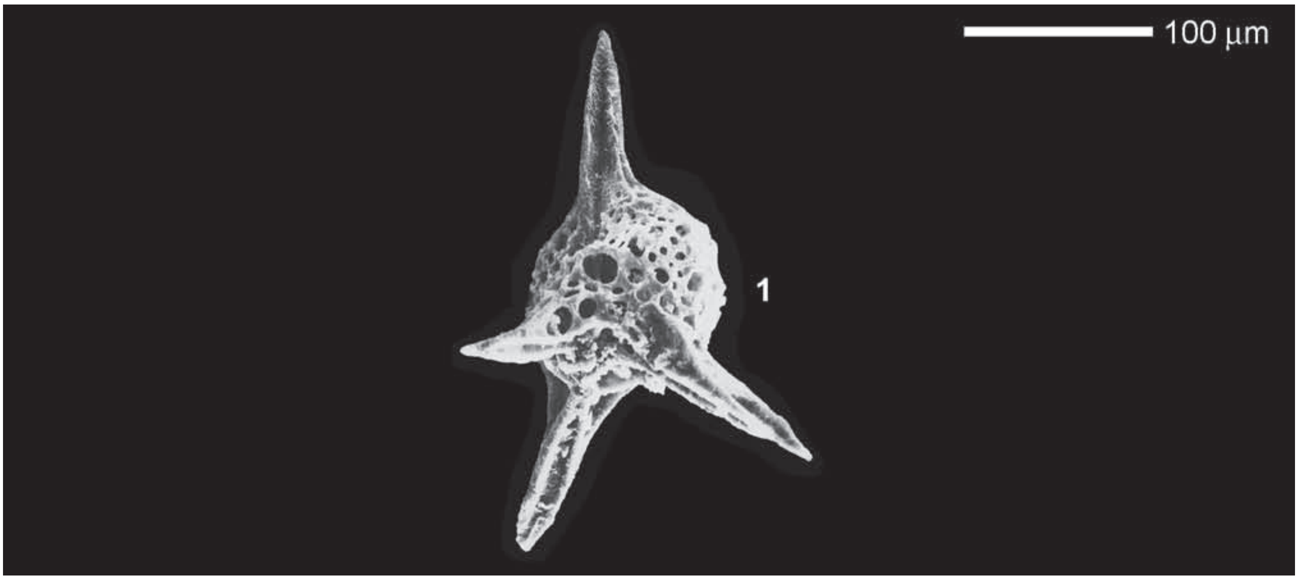


Plate POU01. *Pseudopoulpus* sp. A sensu Whalen & Carter. Magnification x250. **Fig. 1.** Whalen & Carter 2002, pl. 13, fig. 2.

Genus: *Pseudoristola* Yeh 1987b

Type species: *Pseudoristola faceta* Yeh 1987b

Synonymy:
1987b *Pseudoristola* n. gen. – Yeh, p. 95.

Original description: Test multicyrtid, conical to subconical, with two to six post-abdominal chambers. Cephalis conical to dome-shaped without horn. Thorax and subsequent chambers trapezoidal in outline. Earlier chambers covered with layer of microgranular silica, remaining chambers consisting of single layer of regular to subregular pentagonal and hexagonal pore frames. Each post-abdominal chamber with two to three transverse rows of pore frames. Pore frames slightly variable in size, usually with largest pores along partitions. Test with or without poorly developed circumferential ridges. Final post-abdominal chamber closing and with latticed bulbous expansion.

Original remarks: *Pseudoristola* n. gen., differs from *Ristola* Pessagno and Whalen (1982) by having a test with pore frames more irregular in shape, by lacking well-developed circumferential ridges on post-abdominal chambers, and by having its final post-abdominal chamber closing with a large latticed bulbous expansion rather than terminating in an open tubular extension.

Further remarks: See original remarks under *Lantus* Yeh.

Etymology: From the Latin *pseudo* = false, and *Ristola.*

Included species:
PRL01 *Pseudoristola megaglobosa* Yeh 1987b

Pseudoristola megaglobosa Yeh 1987b

Species code: PRL01

Synonymy:
1987b *Pseudoristola megaglobosa* n. sp. – Yeh, p. 96, pl. 14, fig. 13; pl. 23, figs. 17, 22.
1987b *Pseudoristola* sp. cf. *P. megaglobosa* n. sp. – Yeh, p. 96, pl. 14, fig. 15.
2004 *Pseudoristola megaglobosa* Yeh – Matsuoka, fig. 93.

Original description: Test conical, without horn, with five to six post-abdominal chambers. Cephalis conical, remaining chambers trapezoidal in outline and gradually increasing in width as added. Earlier chambers closely spaced, sparsely perforate, covered with layer of microgranular silica. Post-abdominal chamber consisting of two to three rows of polygonal pore frames in each chamber. Final post-abdominal chamber terminating in large subspherical expansion. Pore frames subregular, slightly variable in size, with largest pore frames on bulbous expansion. Test without prominent circumferential ridges, with H-linked pattern along joints.

Measurements (µm):
Ten specimens measured.

	HT	Mean	Max.	Min.
Length of proximal conical part (= last segment excluded)	166	180	198	165
Width at base of conical part	105	107	110	105
Length of last segment	133	145	160	132
Width of last segment	177	190	220	177

Etymology: *Megaglobosa*: *mega* (=large) + *globosa-a-um* (=spherical).

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation and Warm Springs member of the Snowshoe Formation, Oregon; Ghost Creek and Fannin formations, Queen Charlotte Islands; Musallah Formation, Oman; Japan.

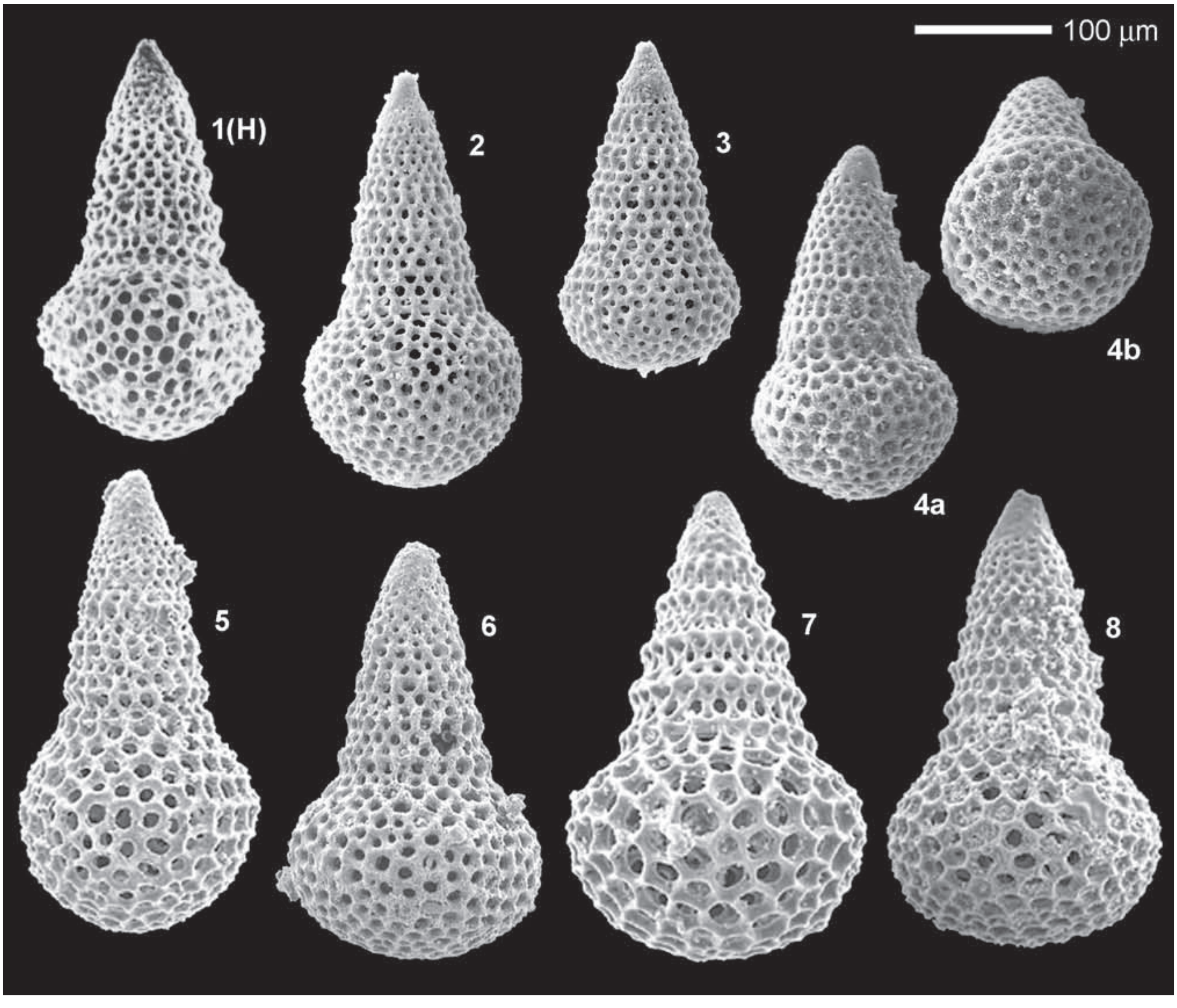


Plate PRL01. *Pseudoristola megaglobosa* Yeh. Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 23, fig. 22. **Fig. 2.** Matsuoka 2004, fig. 93. **Fig. 3.** JP**,** MNA-10, MA13457. **Fig. 4a, b.** OM-00-118, 000618, 000619. **Fig. 5.** QCI, GSC loc. C-304566, GSC 111762. **Fig. 6.** QCI, GSC loc. C-080611, GSC 111763. **Fig. 7.** QCI, GSC loc. C-175309, GSC 111764. **Fig. 8.** QCI, GSC loc. C-080613. GSC 111765.

Genus: *Religa* Whalen & Carter 2002

Type species: *Religa globosa* Whalen & Carter 2002

Synonymy:

2002 *Religa* n. gen – Whalen & Carter, p. 142.

Original description: Test multicyrtid with cephalis, thorax, abdomen and usually two post-abdominal chambers. Cephalis with strong horn. Final post-abdominal chamber spherical, very inflated, significantly larger than other chambers, with circumferentially arranged, solid spines at widest part.

Original remarks: The absence of a tubular extension on the terminal chamber distinguishes this genus from *Podobursa* Wisniowski 1889; emend. Foreman 1973, from *Podocapsa* Rüst, 1885; emend. Foreman 1973, and from *Katroma* Pessagno and Poisson 1981; emend. De Wever 1982, while the presence of strong spines circumferentially arranged along the widest part of the final post-abdominal chamber distinguishes it from *Sethocapsa* Haeckel 1881. The very inflated nature of the final chamber of *Religa* distinguishes it from *Lantus* Yeh 1987b. *Arcanicapsa* Takemura 1986 is distinguished from *Religa* n. gen. by having an inflated abdominal chamber and irregularly distributed spines.

Etymology: The genus *Religa* is named from an arbitrary combination of letters (ICZN, 1985, Appendix. D, pt. VI, Recommendation 40, p. 201).

Included species:

REG01 *Religa globosa* Whalen & Carter 2002
REG02 *Religa* sp. A

Religa globosa Whalen & Carter 2002

Species code: REG01

Synonymy:

1998 *Katroma* sp. aff. *K. pinquitudo* Whalen & Carter – Yeh & Cheng, p. 29, pl. 9, fig. 20.
2002 *Religa globosa* n. sp. – Whalen & Carter, p. 144, pl. 15, figs. 2, 3, 8, 9; pl. 18, figs. 14, 15.
2004 *Religa globosa* Whalen & Carter – Matsuoka, fig. 103.

Original description: Test with small, dome-shaped cephalis with small pores masked by a thin layer of micrognanular silica. Cephalis with strong horn, subcircular in axial-section with two short branches irregular in length and shape. Dome-shaped thorax much larger than cephalis, covered by a thin layer of microgranular silica. Abdomen and first post-abdominal chamber trapezoidal in outline; abdominal and post-abdominal pores more exposed, surrounded by raised areas of microgranular silica; thorax, abdomen and first post-abdominal chamber sometimes defined by transversely-aligned discontinuous ridges produced by buildup of microgranular silica. Post-abdominal chamber spherical, inflated, much larger than other chambers, closed distally. Pores on globular post-abdominal chamber larger medially becoming smaller towards first post-abdominal chamber and distal part of test. Circumferential spines usually at widest part of post-abdominal chamber but sometimes in a more distal position; spines triradiate in axial section at base becoming circular in axial section distally.

Original remarks: *Religa globosa* n. sp. is an abundant and distinctive species in the upper Sinemurian and Pliensbachian and as yet, has no comparatives.

Measurements (μm):
Based on 12 specimens

	Length (excludes horn)	Width (max.)
HT	195	143
Max.	195	150
Min.	154	120
Mean	174	132

Etymology: *Globosus, a, um* (Latin: adj.) = globular, spherical. This species is named for the globular shape of its post-abdominal chamber.

Type locality: Sample BPW80-30, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Ghost Creek and Fannin formations, Queen Charlotte Islands; Liminangcong Chert, Philippines; Japan.

Religa sp. A

Species code: REG02

Remarks: This species has a much smaller apical horn than *Religa globosa* Whalen and Carter and lacks circumferential spines.

Occurrence: Ghost Creek Formation, Queen Charlotte Islands; Skrile Formation, Slovenia.

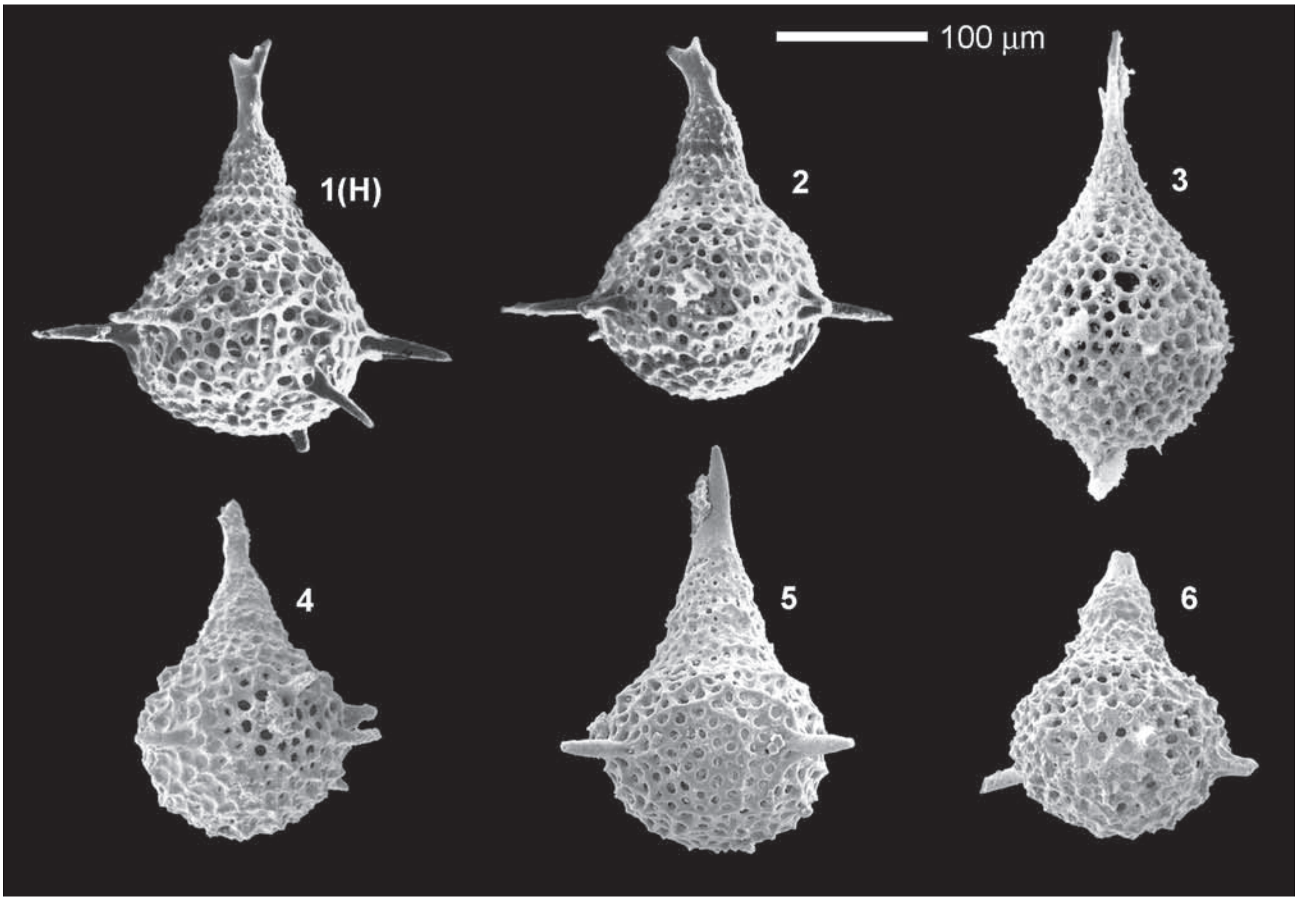


Plate REG01. ***Religa globosa*** **Whalen & Carter.** Magnification x200. **Fig. 1(H).** Whalen & Carter 2002, pl. 15, fig. 2. **Fig. 2.** Whalen & Carter 2002, pl. 15, fig. 3. **Fig. 3.** Matsuoka 2004, fig. 103. **Fig. 4.** QCI, GSC loc. C-304281, GSC 111766. **Fig. 5.** QCI, GSC loc. C-080610, GSC 111767. **Fig. 6.** QCI, GSC loc. C-304281, GSC 111768.

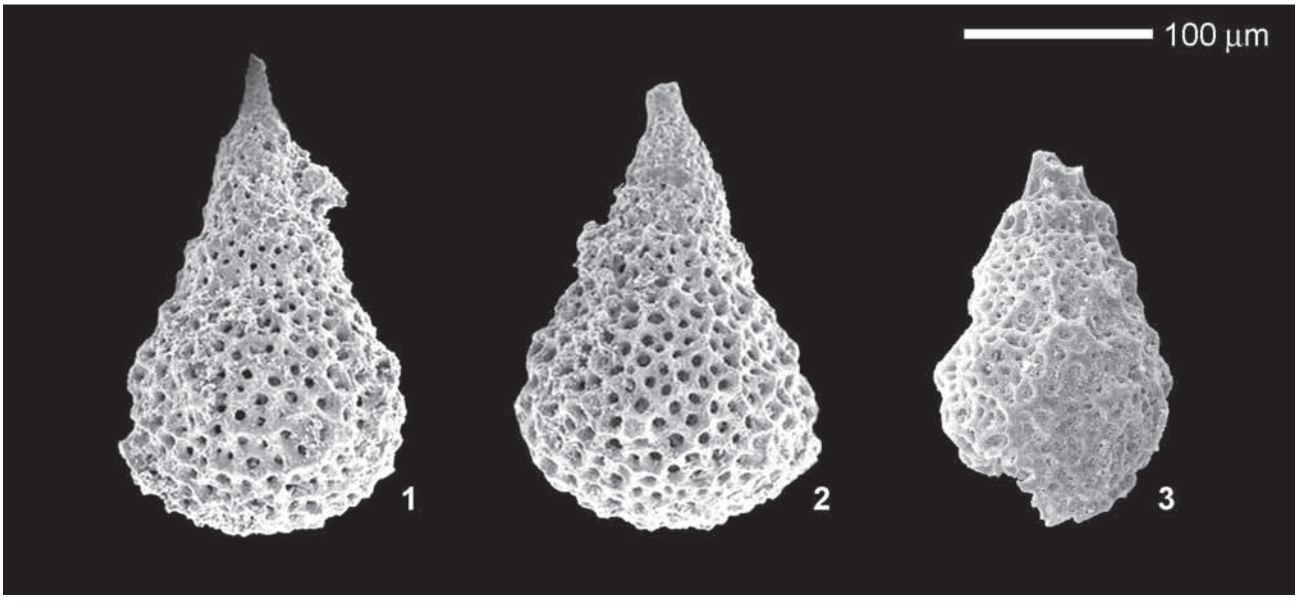


Plate REG02. ***Religa*** **sp. A.** Magnification x250. **Fig. 1.** QCI, GSC loc. C-080612, GSC 111769. **Fig. 2.** QCI, GSC loc. C-080612, GSC 111770. **Fig. 3.** SI, MM 5.00, 992106.

Genus: ***Rolumbus*** Pessagno, Whalen & Yeh 1986

Type species: *Rolumbus mirus* Pessagno, Whalen & Yeh 1986

Synonymy:

1986 *Rolumbus* n. gen. – Pessagno, Whalen & Yeh, p. 26.

Original diagnosis: Test as with family but possessing two massive horns: a vertical horn attached to the vertical bar and an apical horn attached to the apical bar. Tubular, velum-like structure extending from base of thorax on well-preserved specimens (Pl. 1, fig. 2).

Description of family Farcidae Pessagno, Whalen & Yeh 1986 (p. 22): Test dicyrtid with single layer of latticed meshwork on both cephalis and thorax. Latticed layer of cephalis and occasionally proximal portion of thorax covered by thin outer layer of microgranular silica. Cephalis large, hemispherical with one horn (e.g., *Farcus* n. gen.), or two horns (e.g., *Rolumbus* n. gen.), which are triradiate in axial section. Cephalic skeletal elements cyrtoid, including vertical bar, primary left lateral bar, primary right lateral bar, median bar, secondary left lateral bar, secondary right lateral bar, and apical bar (dorsal bar absent). Thorax large, inflated, with four (rarely five) feet that are triradiate in axial section. Four feet opposed to two primary lateral and two secondary lateral bars; fifth foot, if present, opposed to vertical bar. Base of thorax hemispherical with centrally-placed circular aperture (mouth) that has an imperforate rim. Thorax with (e.g., *Rolumbus* n. gen.) or without (e.g., *Farcus* n. gen.) fragile tubular, velum-like structure extending distally from aperture (mouth) of well-preserved specimens.

Original remarks: *Rolumbus* n. gen., differs from *Hilarisirex* Takemura and Nakaseko, 1982, by being dicyrtid rather than tricyrtid, by having only a single layer of latticed meshwork, and by lacking A-frames. It differs from *Farcus* n. gen., by having two rather than one horn and by having a tubular, velum-like structure extending from the base of the thorax (see *Rolumbus* sp. Pl. 1, Fig. 2).

Etymology: *Rolumbus* (masc.) is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. VI, Recommendation 4, p.113).

Included species:

RBS01 *Rolumbus gastili* Pessagno, Whalen & Yeh 1986
RBS02 *Rolumbus halseyensis* Pessagno, Whalen & Yeh 1986

Rolumbus gastili Pessagno, Whalen & Yeh 1986

Species code: RBS01

Synonymy:

1986 *Rolumbus gastili* n. sp. – Pessagno, Whalen & Yeh, p. 26, pl. 4, figs. 1, 5, 6, 9, 12-14..
2002 *Rolumbus gastili* Pessagno, Whalen & Yeh – Whalen & Carter, p. 124, pl. 11, figs. 4, 9, 13, 16, 17.

Original diagnosis: Cephalis large, dome-shaped with an irregular layer of microgranular silica; pore frames may be exposed at base of cephalis. Horns straight; apical horn longer than vertical horn; horns triradiate in axial section with narrow, rounded, longitudinal ridges and narrow grooves; discontinuous, narrow ridges may lie between three main ridges, extending part way up horn. Thorax with very irregularly-sized and -shaped tetragonal and pentagonal pore frames; pore frames arranged in poorly-defined transverse rows separated by ridges. Four feet of medium length, triradiate in axial section with narrow, rounded ridges and broad grooves. Mouth circular in outline. Tubular, velum-like structure may be preserved at base of thorax.

Original remarks: The moderately-developed transverse ridges of *Rolumbus gastili*, n. sp., distinguish it from *Rolumbus halseyensis*, n. sp.

Measurements (μm):

Numbers of specimens measured are in parentheses, X = broken.

	HT	Mean	Max.	Min.
Length of cephalis	30	25.3 (9)	30 (9)	20 (9)
Length of thorax	85	76.8 (8)	90 (8)	65 (8)
Width of thorax at top	55	49.8 (9)	58 (9)	40 (9)
Width of thorax at base	100	97.3 (9)	110 (9)	75 (9)
Length of apical horn	90	88.3 (9)	108 (9)	60 (9)
Length of vertical horn	20X	52.6 (3)	60 (3)	48 (3)
Distance between horn tips	150	126.6 (3)	140 (3)	120 (3)
Length of foot (maximum)	80	69.2 (7)	80 (7)	50 (7)

Etymology: This species is named for R. Gordon Gastil (San Diego State University, San Diego, CA) in honor of his immense contribution to our understanding of the geology of Baja California.

Type locality: Sample BPW-30, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Tawi Sadh Member of the Guwayza Formation, Oman.

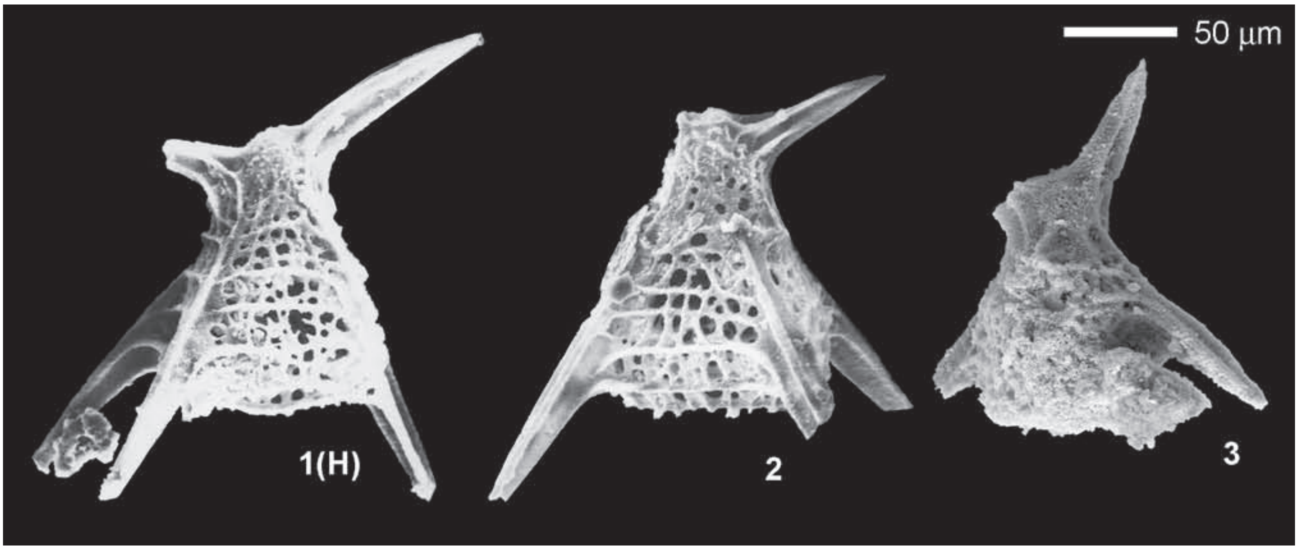


Plate RBS01. ***Rolumbus gastili*** **Pessagno, Whalen & Yeh.** Magnification x300. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 4, fig. 5. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 4, fig. 1. **Fig. 3.** OM, BR485-R20-07.

Rolumbus halseyensis Pessagno, Whalen & Yeh 1986

Species code: RBS02

Synonymy:

1986 *Rolumbus halseyensis* n. sp. – Pessagno, Whalen & Yeh, p. 28, pl. 3, figs. 1, 6, 18, 19.

2002 *Rolumbus halseyensis* Pessagno, Whalen & Yeh – Whalen & Carter, p. 124, pl. 11, figs. 5, 8, 12, 14.

Original diagnosis: Cephalis large, hemispherical, with layer of microgranular silica and small nodes. Horns straight to slightly curved downward, apical horn much larger than vertical horn; horns triradiate in axial section with narrow, rounded, longitudinal ridges and broad grooves; small pores may be open at base of horns. Thorax with small tetragonal and pentagonal pore frames, commonly obscured by layer of microgranular silica?; pore frames arranged in poorly-defined transverse rows separated by transverse ridges. Four feet of moderate length, triradiate in axial section with narrow, rounded ridges and broad grooves. Mouth circular in outline. Tubular velum-like structure commonly extending from base of thorax.

Original remarks: This species is compared to *Rolumbus gastili*, n. sp., under the latter species.

Measurements (μm):

Numbers of specimens measured are in parentheses, X = broken.

	HT	Mean	Max.	Min.
Length of cephalis	35	27.1 (6)	35 (6)	15 (6)
Length of thorax	55	59.6 (6)	80 (6)	50 (6)
Width of thorax at top	60	49.8 (6)	55 (6)	44 (6)
Width of thorax at base	90	75.8 (6)	90 (6)	55 (6)
Length of apical horn	82	79 (4)	100 (4)	54 (4)
Length of vertical horn	44	43.6 (5)	58 (5)	28 (5)
Distance between horn tips	155	131.2 (4)	152 (4)	98 (4)
Length of foot (maximum)	50X	55 (4)	90 (4)	30X (4)

Etymology: This species is named for Monte Halsey, which is located southeast of its type area.

Type locality: Sample SH-412-14, San Hipólito Formation, Baja California Sur.

Occurrence: San Hipólito Formation, Baja California Sur; Fannin Formation, Queen Charlotte Islands.

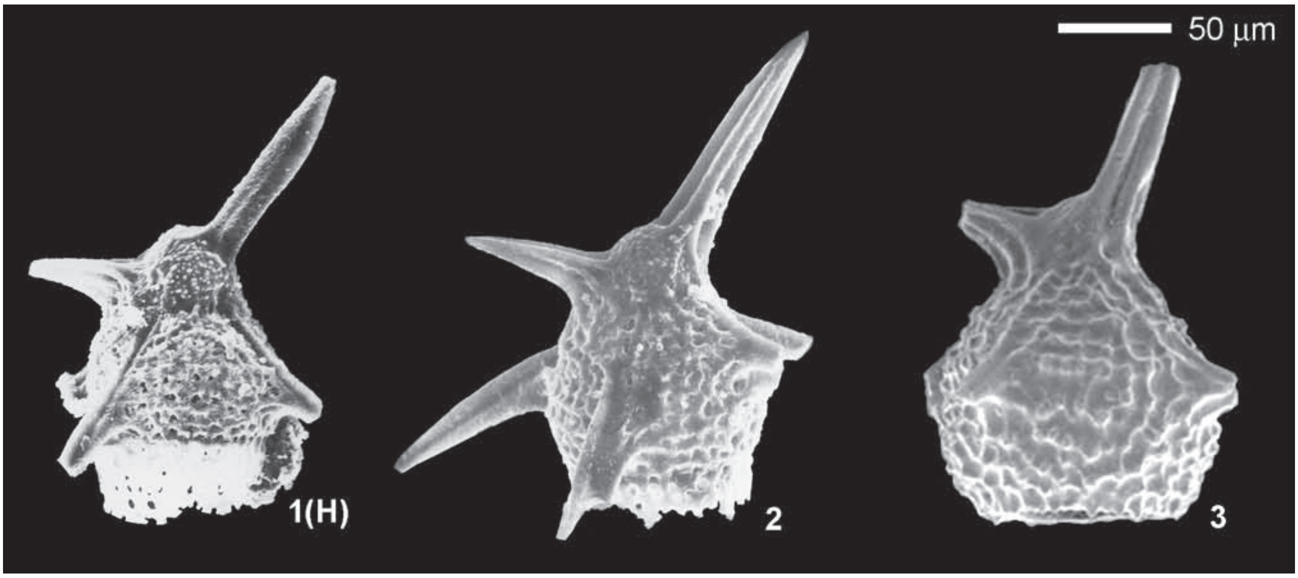


Plate RBS02. ***Rolumbus halseyensis*** **Pessagno, Whalen & Yeh.** Magnification x300. **Fig. 1(H).** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 1. **Fig. 2.** Pessagno, Whalen & Yeh 1986, pl. 3, fig. 6. **Fig. 3.** QCI, GSC loc. C-140495, GSC 111771.

Genus: *Spongosaturninus* Campbell & Clark 1944

Type species: *Spongosaturninus ellipticus* Campbell & Clark 1944

Synonymy:

1944 *Spongosaturninus* n. gen. – Campbell & Clark, 497.
1990 *Spongosaturninus* Campbell & Clark – Kozur & Mostler, p. 210.

Original description: Spongostylinae with 3 concentric shells, outer shell spongy, inner a double lattice shell, and having 2 equal polar spines, distal ends of which are connected by an elliptical ring.

Revised description: By Kozur & Mostler (1990): The shell consists of a tiny latticed microsphere, a second latticed medullary shell and a rather large third latticed medullary shell (or cortical shell) covered by a thick layer of spongy meshwork that reaches along the peripolar spines on the ring or even beyond the ring. Ring transversally strongly elongated elliptical, with distinct ridge on the inner margin of the ring. Cross-section of the ring therefore triangular with broad base inside. The ring has mostly 1-3 spines in each polar region of the long axis, but may be additionally spined around the whole outer ring margin.

Original remarks: Possibly this new genus was derived from *Saturninus* by the development of a spongy, instead of latticed cortical shell, from *Saturnalis* by the addition of a spongy shell to the 2 concentric shells, or from our other new genus, *Spongosaturnalis,* by the addition of inner shells to the spongy shell.

Further remarks: By Kozur & Mostler (1990): *Spongosaturninus* Campbell and Clark, 1944 is a transitional group to the Saturnalidae Deflandre, 1953. The third medullary shell is so large that it can be also regarded as cortical shell (see Dumitrica, 1985). However, the spongy layer on this shell is always thicker than the distance between the second and third (medullary) shells. In *Saturnalis* Haeckel, 1881 disappeared this thick outer spongy layer. By this the outer latticed medullary shell was transformed into a latticed cortical shell.

Included species:

SAT18 *Spongosaturninus bispinus* (Yao) 1972

Spongosaturninus bispinus (Yao) 1972

Species code: SAT18

Synonymy:

1972 *Spongosaturnalis bispinus* n. sp. – Yao, p. 28, pl. 2, figs. 1-9.
1996 *Acanthocircus bispinus* (Yao) – Yeh & Cheng, p. 106, pl. 2, figs. 4, 5; pl. 7, fig. 3.
1997 *Acanthocircus bispinus* (Yao) – Yao, pl. 5, fig. 210.
2004 *Spongosaturninus bispinus* (Yao) – Matsuoka, fig. 8.

Original diagnosis: *Spongosaturnalis* with fundamentally one sharp spine at each opposite narrow end of ring.

Original description: Shell spherical, loosely spongy, composed of irregular meshes. Ring narrow, subovoidal, with one spine (in some specimens three spines) at each opposite narrow end. Spines short or in some specimens long, smooth, with sharp tip. Ring generally smooth, in some specimens with weak ridges on both edges near narrow ends. Ridge on outer edge disappears at spines and not on them, and ridge on inner edge becomes obsolete near proximal part of ring. Polar spines short, smooth, their extensions into shell change to conical sturdy spines with fragmentary thorns joining to spongy shell.

Original remarks: This species differs from *S. protoformis* in having two (or more) spines on the ring, and in lacking the clear ridge on the ring. *S. bispinus* appears to be simlar to *Saturnalis minimus* Squinabol (1914, p. 287-288, pl. 22, fig. 1, and pl. 23, figs. 6a-b; Jurassic, Cittiglio (Laveno), and Middle Cretaceous, Novale (Vicentino), Italy) and *Spongosaturninus parvulus* Campbell and Clark (1944b, p. 9, pl. 3, figs. 1, 3 and 5; Late Cretaceous, Middle California) in the shape of the saturnalin ring, but differs from them in having a completely spongy shell.

There is a considerable variation in length of spines and presence of ridges among specimens. According to Foreman (1968), the ridge on the saturnalin ring is an important element in specific classification of Saturnalin radiolaria. In this species, however, importance of the ridge is not quite definitive.

Measurements (μm):
Based on 6 specimens.

	HT	Min.	Max.	Mean
D. of ring along polar spines	158	115	210	160
D. of ring transversely	337	212	348	302
D. of shell	(86)	80	185	102
L. of polar spine	23	10	25	17.6
L. of spine	30	18	85	36.7
B. of ring	8-22	8-11	13-21	

Type locality: Sample IN 11, Kiso River, Inuyama area, central Japan.

Occurrence: Mino Belt, Japan; Liminangcong Chert, Busuanga Island, Philippines; Tawi Sadh Member of the Guwayza Formation, Oman.

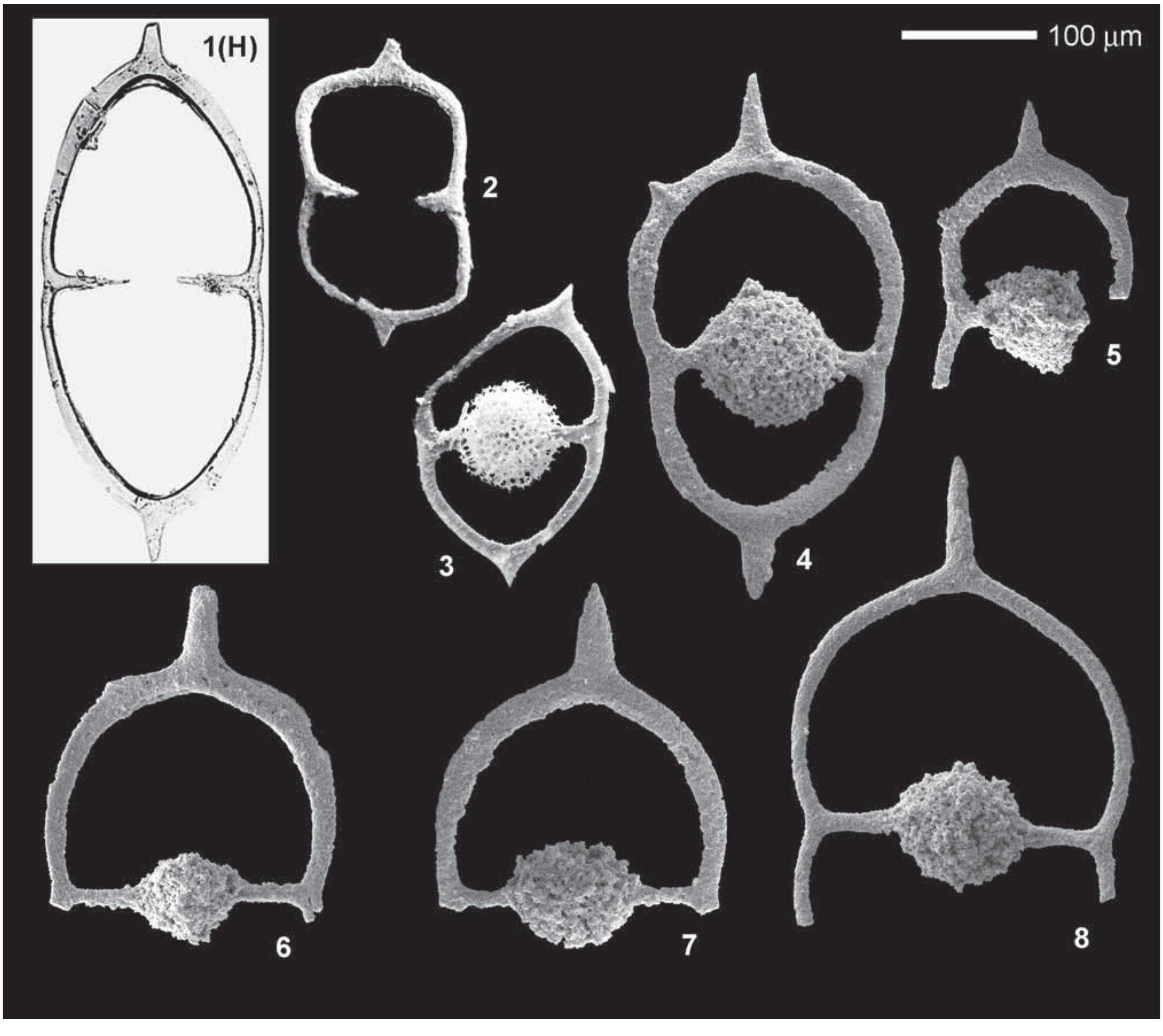


Plate SAT18. ***Spongosaturninus bispinus*** **(Yao).** Magnification x200. **Fig. 1(H).** Yao 1972, pl. 2, fig. 1. **Fig. 2.** JP, IYII-52. **Fig. 3.** Matsuoka 2004, fig. 8. **Fig. 4.** OM, BR871-R01-03. **Fig. 5.** OM, BR871-R01-06. **Fig. 6**. OM, BR871-R01-09. **Fig. 7.** OM, BR871-R02-01. **Fig. 8.** OM, BR871-R01-04.

Genus: *Stauromesosaturnalis* Kozur & Mostler 1990

Type species: *Stauromesosaturnalis schizospinosus* Kozur & Mostler 1990

Synonymy:

1990 *Stauromesosaturnalis* n. gen. – Kozur & Mostler, p. 201.

Original diagnosis: Shell spherical or subspherical with rounded subquadratic equatorial outline, spongy, consisting of several concentric layers and a tiny latticed microsphere. Ring narrow, flat, undifferentiated, with subelliptical to rounded quadratic outline and numerous, relatively short peripheral spines. 2 peripolar and 2 auxiliary spines (also opposite to interspine spaces) are cross-like arranged. In early forms the peripolar spines are somewhat broader than the auxiliary spines. In highly evolved forms all 4 spines have the same size. At least opposite to the peripolar spines, in higher evolved forms opposite to all 4 inner spines the ring is concavely incised.

Original remarks: *Stauracanthocircus* Kozur and Mostler, 1983 emend. has polar spines. *Praemesosaturnalis* Kozur and Mostler, 1983 has several small auxiliary spines, not cross-like arranged with the peripolar spines. This genus is probably the forerunner of *Stauromesosaturnalis* n. gen. However, also a direct derivation from *Stauracanthocircus* Kozur and Mostler, 1983 emend. by transformation of the polar spines into peripolar spines cannot be excluded.

Japonisaturnalis Kozur and Mostler, 1972 has evolved from *Stauromesosaturnalis* species with bifurcated peripheral spines. If the terminal branches of adjacent spines grow together, a second ring evolved, separated from the primary ring by a pore ring. The first true *Japonisaturnalis* Kozur and Mostler, 1972 is known from the Pliensbachian.

Etymology: According to the peripolar spines (as in *Mesosaturnalis* Kozur and Mostler, 1983), cross-like arranged with 2 auxiliary spines.

Included species:

SAT19 *Stauromesosaturnalis deweveri* Kozur & Mostler 1990

Stauromesosaturnalis deweveri Kozur & Mostler 1990

Species code: SAT19

Synonymy:

1981c *Pseudoheliodiscus* ? sp. aff. *P. concordis* – De Wever, p. 142, pl. 2, fig. 4.

1984 *Pseudoheliodiscus*(?) sp. – Whalen & Pessagno, pl. 3, figs. 10, 11.

1990 *Stauromesosaturnalis deweveri* n. sp. – Kozur & Mostler, p. 202.

1997 *Kozurastrum* sp. A – Yao, pl. 5, fig. 205.

2002 *Stauracanthocircus sanrafaelensis* n. sp. – Whalen & Carter, p. 108, pl. 6, figs. 1, 2; pl. 17, fig. 3.

2004 *Stauromesosaturnalis deweveri* Kozur & Mostler – Matsuoka, fig. 11.

Original diagnosis: Shell globular, spongy. Ring narrow, flat, undifferentiated, outline rounded subquadratic, opposite to the 4 first order spines concavely incised. 21 short, triangular peripheral spines. 4 first order inner spines of equal size in cross-like arrangement, all opposite to interspine spaces. Peripolar and auxiliary spines cannot be separated.

Original remarks: See under *Stauromesosaturnalis schizospinosus* n. gen. n. sp.

Original remarks under *S. schizospinosus*: *Stauromesosaturnalis schizospinosus* n. gen. n. sp. is the forerunner of the Pliensbachian *Japonisaturnalis* n. sp. A (= *Japonisaturnalis japonicus* sensu De Wever, 1981c, pl. 1, fig. 6). By fusion of the terminal branches of adjacent peripheral spines a second ring evolved that encloses together with the primary ring and the primary peripheral spines of the pore ring. The Pliensbachian *Stauromesosaturnalis deweveri* n. sp. displays terminally unbranched spines, the ring is concavely incised opposite to all 4 first order spines that have all the same size.

Measurements (μm):

Holotype from De Wever (1981c), other values from Whalen & Carter (2002), (n) = number of specimens measured.

	Diameter of ring (max.) (6)	Width of ring (max.) (7)	Length of peripheral spine (max.) (7)
HT	250 and 260	15-18	14-25
Max.	300	23	15
Min.	255	15	4
Mean	269	17	10

Etymology: In honor of Dr. P. De Wever, Paris, who figured this species for the first time.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; San Hipólito Formation, Baja California Sur; MinoTerrane, Japan.

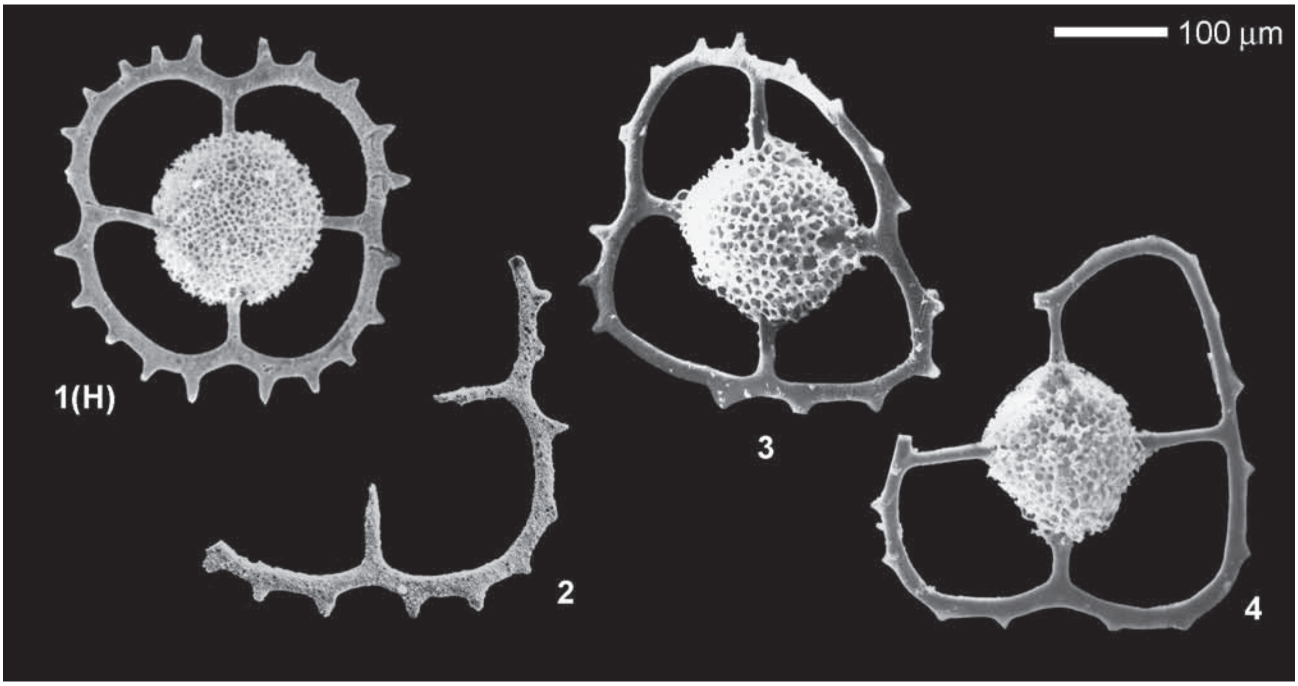


Plate SAT19. *Stauromesosaturnalis deweveri* Kozur & Mostler. Magnification x150. **Fig. 1(H).** De Wever 1981c, pl. 2, fig. 4. **Fig. 2.** OM, BR485-R21-02. **Fig. 3.** Whalen & Carter 2002, pl. 6, fig. 2. **Fig. 4.** Whalen & Carter 2002, pl. 6, fig. 1.

Genus: *Stichocapsa* Haeckel 1881
Type species: *Stichocapsa jaspidea* Rüst 1885

Synonymy:
1881 *Stichocapsa* n. gen. – Haeckel, p. 439.

Original description:
5d-Tribe: Stichocapsida
Closed, eradiate Stichocyrtida.
A. Obtuse (with cephalis smooth, not spiny).

Further remarks: This genus, as used in modern radiolarian literature, is polyphyletic. Although it was originally defined as having a distally closed test, most species still assigned to *Stichocapsa* have a constricted last segment with an aperture.

Etymology: Greek *Stichocapsa*, jointed capsule.

Included species:
SCP01 *Stichocapsa biconica* Matsuoka 1991

Stichocapsa biconica Matsuoka 1991
Species code: SCP01

Synonymy:
1991 *Stichocapsa biconica* n. sp. – Matsuoka, p. 733, Fig. 8. 1a – 5b.
1997 *Stichocapsa biconica* Matsuoka – Yao, pl. 9, fig. 439.
2004 *Stichocapsa biconica* Matsuoka – Matsuoka, fig. 87.

Original description: Shell of five segments, spindle shaped. Cephalis hemispherical, poreless, occasionally with rough surface. Thorax and abdomen truncate conical. Fourth segment barrel-shaped. The last segment inverted conical with a constricted aperture. Collar stricture rather distinct. Strictures between segments, except for the collar one, indistinct. Pores small to moderate and circular to subcircular. Aperture moderate in size, circular.

Original remarks: This species differs from *Cyrtocapsa* (?) *kisoensis* Yao by consisting of five segments rather than four and by lacking an apical horn.

Genus: *Tetraditryma* Baumgartner 1980
Type species: *Tetraditryma pseudoplena* Baumgartner 1980

Synonymy:
1980 *Tetraditryma* n. gen. – Baumgartner, p. 296.
1993 *Saldorfus* Pessagno, Blome & Hull n. gen. – Pessagno et al., p. 126.

Original description: Test as with subfamily, composed of 4 rays of equal length. Cortical shell composed of 2 strong lateral and 1 weak median external beams, connected by short, thin bars branching at right angles to beams, forming 2 rows of paired circular pores. Lateral sides concave, with 3 to 4 alternating horizontal rows of uniform circular to rhombic pores. Centrally placed discoidal medullary shell connected by subsidiary beams to cortical shell. Medullary rays composed of 3 primary canals lie on each top or bottom side of the medullary shell; they connect with the cortical space and are confined by rows of subsidiary beams linking medullary and external beams. Ray tips inflated or tapered.

Original remarks: *Tetraditryma* differs from *Pseudocrucella* n. gen. and all other four-rayed hagiastrids by the paired rows of pores on top and bottom surfaces and by the horizontal symmetry axis of the arrangement of primary canals. The cortical wall of some species in this genus seems to be a relict of an additional lateral external beam on each side which can be observed on early forms of this subfamily.

Etymology: Greek: *tetra*, four-, *di*-, two-, *tryma* (feminine), hole - 4 rays with 2 rows of pores.

Included species:
3407 *Tetraditryma* cf. *praeplena* Baumgartner sensu Carter & Jakobs 1991

Tetraditryma cf. *praeplena* Baumgartner sensu Carter & Jakobs 1991
Species code: 3407

Synonymy:
1991 *Tetraditryma* cf. *praeplena* Baumgartner – Carter & Jakobs, p. 344, pl. 2, fig. 1.
1995a *Tetraditryma* sp. cf. *T. praeplena* Baumgartner – Baumgartner et al., p. 558, pl. 3407, fig. 1.
1997 *Tetraditryma* cf. *praeplena* Baumgartner – Yao, pl. 7, fig. 328.

Original remarks: Lacks slender triradiate lateral spines that extend from the ray tips at a 60-70° angle to the ray axis, but otherwise is very similar to *P. praeplena* and may be its immediate ancestor.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands; Japan.

Measurements (μm):

Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	153	153	110	130	(15)
Maximum width of shell	77	77	57	68	(15)
Diameter of aperture	9	9	9	9	(2)

Etymology: The specific name is derived from the Latin *bi* (=two) and *conicus-a-um* (=conical).

Type locality: MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, Japan.

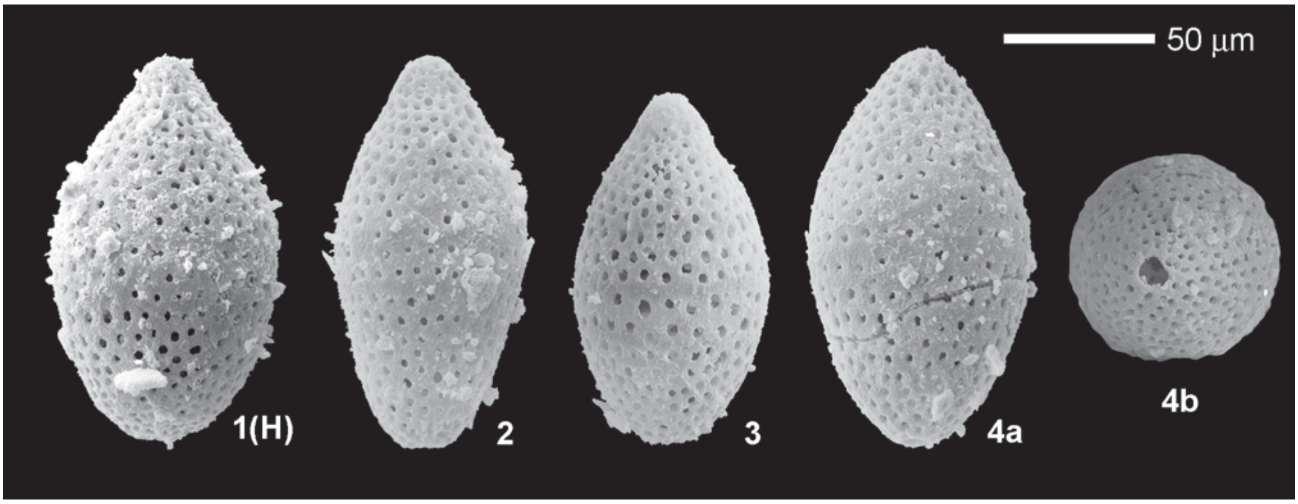


Plate SCP01. *Stichocapsa biconica* Matsuoka. Magnification x400. **Fig. 1(H).** Matsuoka 1991, Fig. 8.1a. **Figs. 2-3.** Matsuoka 1991, Fig. 8.3-4. **Figs. 4a, b.** Matsuoka 1991, Fig. 8.2a-b.

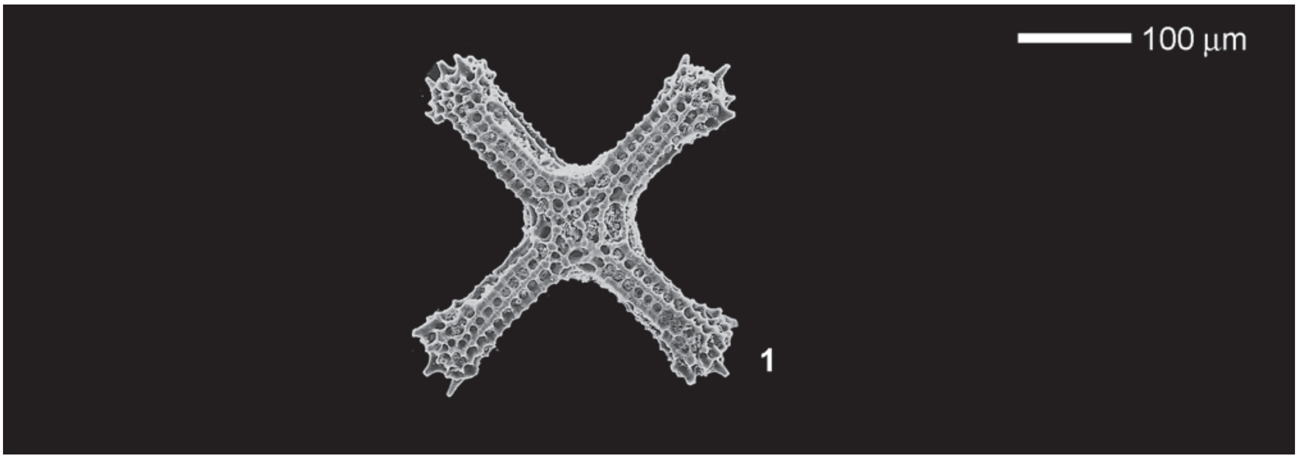


Plate 3407. *Tetraditryma* cf. *praeplena* Baumgartner sensu Carter & Jakobs. Magnification x150. **Fig. 1.** Carter & Jakobs 1991, pl. 2, fig. 1.

Genus: ***Thetis*** De Wever 1982a, emend. Dumitrica herein

Type species: *Thetis oblonga* De Wever 1982a

Synonymy:

1982 a *Thetis* n. gen. – De Wever, p. 195.
? 1984 *Eucyrtidiellum* n. gen. – Baumgartner, p. 764.
? 1986 *Monosera* n. gen. – Takemura & Nakaseko, p. 1021.
? 1986 *Eucyrtidiellum* Baumgartner – Takemura, p. 66.
? 1990 *Eucyrtidiellum* Baumgartner – Nagai & Mizutani, p. 593.

Original description: Multicyrtid with a stout apical horn and three thoracic spines. Last segment is prolonged by a velum.

Emended description: Test composed of four segments: the first three are strong and rapidly increase in size as added, the fourth is usually cylindrical, thinner-walled, open or closed. Cephalis small, poreless with a conical or cylindrical (never bladed), apical horn and ventral pore in the prolongation of ventral spine. Initial spicule with MB and apical, dorsal, and ventral spines. Secondary lateral spines absent. On outer test wall, L and D expressed as thin spines descending along thorax. Thorax porous; abdomen much larger, porous. First postabdominal segment cylindrical, thinner-walled, straight or undulate in outline; wide open or tending to close distally.

Original remarks: This genus differs from *Ectonocorys* by its hemispherical cephalis.

Further remarks: The original definition of this genus is so imprecise that it can be applied to many nassellarian genera. In the emended definition, the genus includes only two of the three species originally (De Wever, 1982a) included: *T. oblonga* De Wever and *T. undulata* De Wever. *T.* (?) *stolata* De Wever undoubtedly belongs to another genus because it has a three-bladed apical horn (a characteristic never found in either *Thetis* or *Eucyrtidiellum*), robust bladed spines L and D, and a dicyrtid test. Such characteristics indicate a closer affinity to *Jacus*? *anatiformis* De Wever and the genus *Anaticapitula* Dumitrica & Zügel.

The genus *Thetis* was not defined as having a ventral pore on cephalis but this feature is present on the type species (see further remarks under this species), and De Wever (1982a) mentioned it with *T. undulata*.

Thetis is structurally very close to *Eucyrtidiellum* Baumgartner. The only characteristic that could differentiate these two genera is the presence of the L and D spines on thorax. Unfortunately we do not know the initial spicule of the genus *Thetis*: it could be similar to *Eucyrtidiellum* (see Takemura, 1986) i.e., with L expressed only as short thorns, or it could have very thin L bars that tend to disappear. The latter possibility is supported by the presence of the spines L and D outside test wall. Regardless, the two genera are so close that *Eucyrtidiellum* could be a junior synonym of the genus *Thetis*, or a subgenus.

Etymology: Dedicated to *Thetis*, goddess of the sea, granddaughter of *Tethys* and mother of *Achilles*.

Included species:

THT01 *Thetis oblonga* De Wever 1982a

Thetis oblonga De Wever 1982a

Species code: THT01

Synonymy:

1982a *Thetis oblonga* n. sp. – De Wever, p. 195, pl. 4, figs. 10-14.
1982a *Thetis oblonga* ? n. sp. – De Wever, p. 196, pl. 4, figs. 15-16.
1982b *Thetis oblonga* De Wever – De Wever, p. 312, pl. 42, figs. 1-5.
1982b ? *Thetis oblonga* De Wever – De Wever, p. 313, pl. 42, figs. 7, 8.
? 1982 *Thetis oblonga* De Wever – De Wever & Origlia-Devos, pl. 1, fig. A.
2002 *Thetis oblonga* De Wever – Whalen & Carter, p. 138, pl. 16, fig. 4.

Original description: Three-segmented form with a subcylindrical velum. Cephalis usually imperforate. Cephalis, thorax, and abdomen with a relatively thick wall; external surface frequently covered with lumps that may represent an external silica layer. Apical horn long, circular in cross section. From the collar section, or the upper thorax, three spines are developed that are extensions of A, L_l and L_r spines and are linked to the thorax and/or the abdomen by small bars. The three spines are sub-parallel to the test outline; being fragile, they are often broken. Pores distributed in approximately transversal rows.

The velum prolonging abdomen has a thin wall that corresponds to the internal layer of the abdominal wall. It is cylindrical or has a slight distal constriction.

Original remarks: This species differs from *Ectonocorys spinosa* Yao (1979, p. 44, pl. 11, figs. 10-17) by having a circular apical horn, a smaller cephalis, more slender thoracic spines closer to the test, and by the absence of abdominal spines. It differs from *Ectonocorys* (?) *furcillata* n. sp. by lacking a forked apical horn and having spines on thorax. It differs from *Thetis undulata* n. sp. by having only three segments and by the outline of the distal part.

Further remarks: The original description is incomplete concerning both cephalis and abdomen. The description does not mention, for instance, the presence of a ventral pore on the cephalis that is aligned with the ventral spine. This pore with a protruding rim exists and is visible on the right side of the cephalis on the paratype illustrated in De Wever, 1982a, pl. 4, fig. 13 and pl. 4, fig. 16 (pl. THT01, figs. 2, 3 in this catalogue), directed towards the reader. An additional topotype specimen, illustrated from the same position as the former (pl. THT01, fig. 4), clearly shows this pore. The three thoracic spines representing external prolongations of spines D, L_r, L_l of the initial spicule are not always all present. The shape of the abdomen is very characteristic in this species; it is truncated conical in the proximal third and cylindrical with straight or concave sides on the remaining part; the boundary between the two parts forms a rather characteristic shoulder.

Measurements (μm):
Based on 10 specimens.

	HT	Min.	Max.	Mean
Length of apical horn	56	40	64	50
Width of cephalis	21	16	26	20
Width of thorax	37	25	38	34
Width of abdomen	53	40	64	53
Length of cephalis+thorax +abdomen (without apical horn)	56	50	78	60
Total length (including apical horn and velum)	144	135	182	157

Etymology: From the Latin *oblongus*, *-a, -um*, adj., oblong.

Type locality: Sample 1662D, Gümüslü Allochthon, Taurus Mts., Turkey.

Occurrence: Gümüslü Allochthon, Turkey; San Hipólito Formation, Baja California Sur.

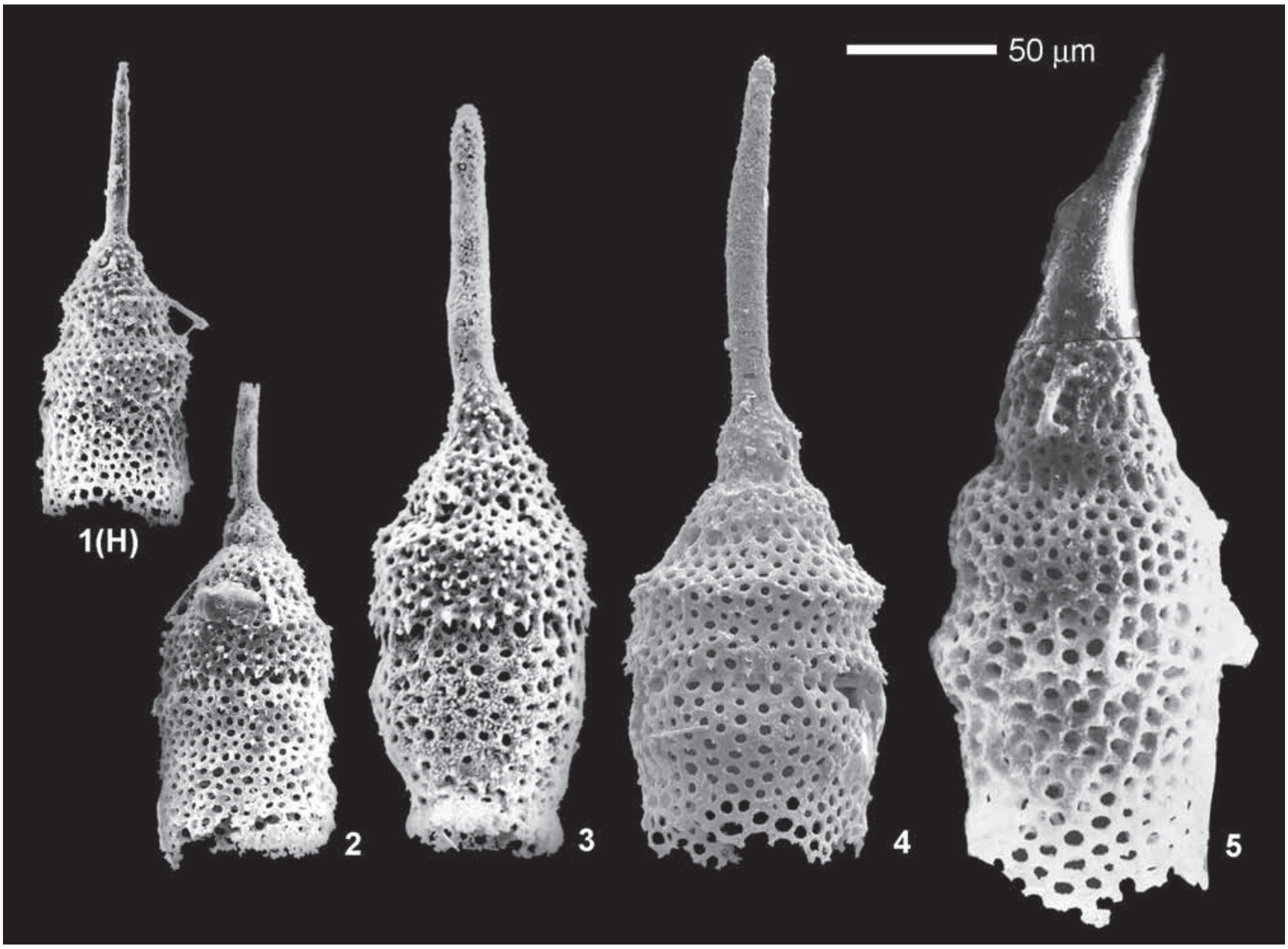


Plate THT01. *Thetis oblonga* De Wever. Magnification x400. **Fig. 1(H).** De Wever 1982a, pl. 4, fig. 10.
Figs. 2, 3. De Wever 1982a, pl. 4, figs. 13, 16. **Fig. 4.** TR, 1662D-R02-06. **Fig. 5.** Whalen & Carter 2002, pl. 16, fig. 4.

Genus: *Thurstonia* Whalen & Carter 1998

Type species: *Thurstonia minutaglobus* Whalen & Carter 1998

Synonymy:

1998 *Thurstonia* n. gen. – Whalen & Carter, p. 42.

Original description: Test with spherical shell and six prominent tapering spines; two spines bipolar, at right angles to four equally spaced spines, in radial plane. Cortical shell with triangular and tetragonal pore frames with rounded nodes at pore frame vertices; large pores sometimes apparent at base of spines. Spines circular or triradiate in axial section.

Original remarks: The internal structure of *Thurstonia* n. gen. is not completely understood but because of the suggestion of an internal spicular network (see Pl. 8, Fig. 13), we tentatively assign this genus to the Subfamily Charlottinae. *Thurstonia* n. gen., is distinguished from all the included genera of the Subfamily Charlotteinae by having six prominent spines, four of which are in the same plane.

Etymology: *Thurstonia* n. gen. is named for the "Nellie G. Thurston", a schooner owned by the Pacific Fish and Cold Storage Company and a regular visitor to the fishing grounds of the Queen Charlotte Islands in the early 1900s.

Included species:

THU01 *Thurstonia gibsoni* Whalen & Carter 1998
THU04 *Thurstonia timberensis* Whalen & Carter 1998

Thurstonia gibsoni Whalen & Carter 1998

Species code: THU01

Synonymy:

1998 *Thurstonia gibsoni* n. sp. – Whalen & Carter, p. 42, pl. 6, figs. 1, 2.
2002 *Thurstonia* sp. aff. *T. timberensis* Whalen & Carter – Tekin, p. 188, pl. 3, fig. 20.
2004 *Thurstonia gibsoni* Whalen & Carter – Hori et al., pl. 5, fig. 6.

Original description: Test with small, spherical cortical shell and six narrow spines. Cortical shell composed of small, irregularly shaped and distributed triangular and tetragonal pore frames with prominent rounded nodes at pore frame vertices. Spines approximately equal in length, circular in axial section with length of each spine slightly less than diameter of cortical shell.

Original remarks: The small cortical shell and very delicate spines (circular in axial section) of *Thurstonia gibsoni* n. sp. distinguish it from *T. timberensis* n. sp.

Measurements (μm):
Based on 15 specimens.

Maximum diameter of cortical shell	Length of longest spine	
135	85	HT
135	131	Max.
96	66	Min.
115	80	Mean

Etymology: This species is named in honor of Gibson (Gib) Carter, Vernonia, Oregon, who assisted the authors in many aspects of this research.

Type locality: Sample 89-CNA-SKUD-27, Sandilands Formation, southeast side of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Hocaköy Radiolarite, Turkey; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

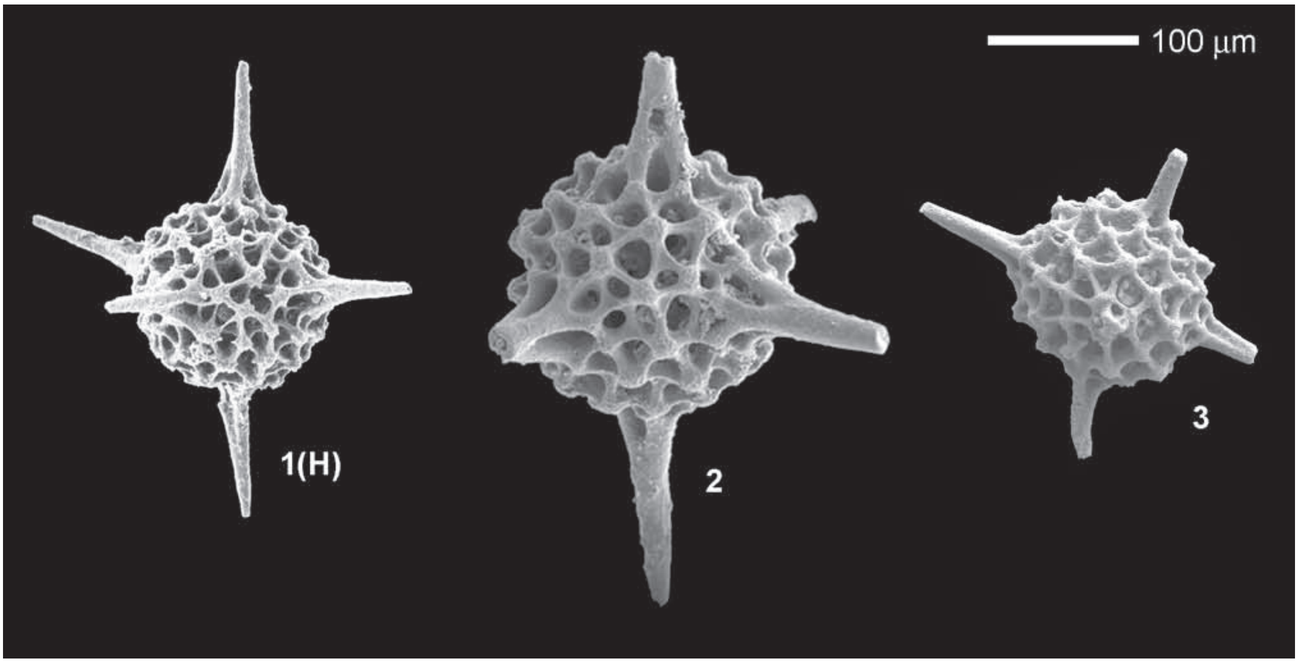


Plate THU01. *Thurstonia gibsoni* Whalen & Carter. Magnification x200. **Fig. 1(H).** Carter et al. 1998, pl. 6, fig. 1. **Fig. 2.** QCI, GSC loc. C-080611, GSC 111772. Fig. 3. OM, BR682-R10-20.

Thurstonia timberensis Whalen & Carter 1998

Species code: THU04

Synonymy:

1989 Genus 4 spp. – Hattori, pl. 17, figs. B, C.
1990 *Beturiella* ? sp. – Nagai, pl. 6, figs. 1, 2.
1998 *Thurstonia timberensis* n. sp. – Whalen & Carter, p. 43, pl. 6, figs. 3, 4, 5, 10.
1998 *Thurstonia* sp. B – Yeh & Cheng, p. 11, pl. 8, fig. 8.

Original description: Test with medium-sized spherical cortical shell with six strongly tapering spines. Cortical shell composed of small- to medium-sized, irregularly shaped and distributed triangular and tetragonal pore frames with prominent, rounded nodes at pore frame vertices; pore frame bars very thin in Y direction and very thick in Z direction; very large pores present at contact of spine with cortical shell. All spines approximately equal in length, usually longer than diameter of cortical shell. Spines triradiate in axial section proximally with narrow, rounded longitudinal ridges and broad, rounded, tapering longitudinal grooves; spines becoming circular in axial section distally.

Original remarks: The broad, strongly tapering spines and smaller, more delicate pore frames of *Thurstonia timberensis* n. sp. distinguish it from *Thurstonia minutaglobus* n. sp.

Measurements (µm):
Based on 11 specimens.

Maximum diameter of cortical shell	Length of longest spine	
169	156	HT
169	188	Max.
131	122	Min.
152	151	Mean

Etymology: This species is named for Timber Road, the road leading to Beth Carter's ranch in Vernonia, Oregon where much of the biostratigraphic work for this paper was completed.

Type locality: Sample 87-CNA-KUD-14, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands, Ghost Creek and Fannin formations, Queen Charlotte Islands; Fernie Formation, Williston Lake, NE British Columbia; Hyde Formation, Oregon; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines; Japan.

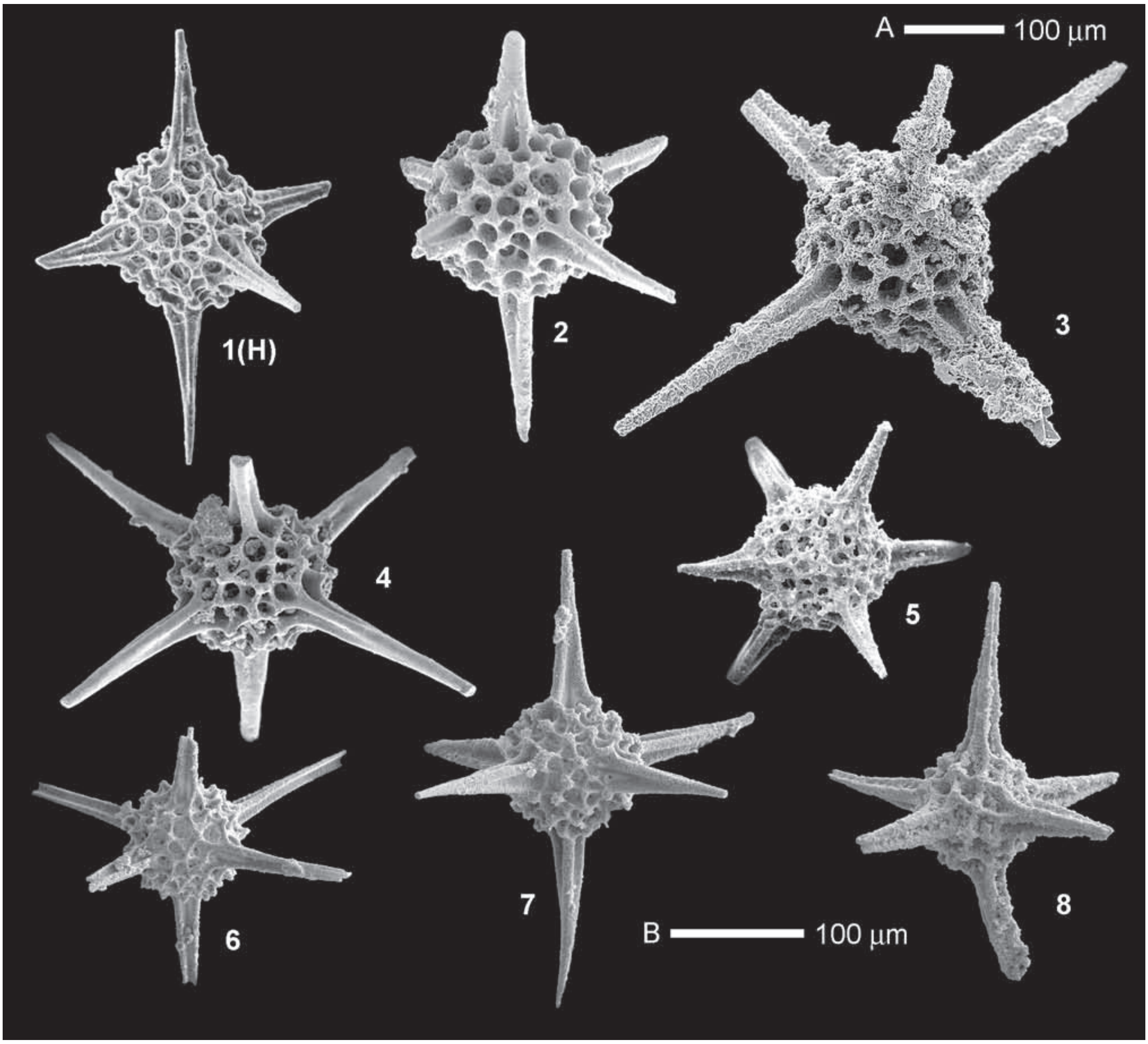


Plate THU04. ***Thurstonia timberensis*** **Whalen & Carter.** Magnification Figs. 1-4 x150 (scale bar A) Figs. 5-8 x200 (scale bar B). **Fig. 1(H).** Carter et al. 1998, pl. 6, fig. 3. **Fig. 2.** QCI, GSC loc. C-304281, GSC 111773. **Fig. 3**. NBC, GSC loc. C-305208, GSC 111810. **Fig. 4.** QCI, GSC loc. C-304566, GSC 111774. **Fig. 5.** JP, MNA-10, MA11342.
Fig. 6. OR600A-R02-02. **Fig. 7.** OR600A-R03-02. **Fig. 8.** BR871-R02-17.

Genus: *Trexus* Whalen & Carter 1998

Type species: *Trexus dodgensis* Whalen & Carter 1998

Synonymy:
1998 *Trexus* n. gen. – Whalen & Carter, p. 81.

Original description: Robust, inflated, dome-shaped multicyrtid, with small horn. Test lacks strictures. Thick multilayered wall: inner layer composed of large, fragile, irregularly polygonal pore frames; outer layers more massive, composed of irregularly sized and shaped polygonal pore frames; outer layers connected by irregularly sized and shaped pillars; small nodes at pore frame vertices on outer latticed layer.

Original remarks: *Trexus* n. gen. differs from *Canutus* Pessagno and Whalen by possessing irregularly polygonal pore frames rather than square to rectangular, linearly arranged pore frames on both the inner and outer layers (see Pl. 24, fig. 22).

Canutus? *beehivensis* and *C.*? *ingrahamensis* described by Carter from the Rhaetian part of the Sandilands Formation in Queen Charlotte Islands, are herein reassigned to the genus *Trexus* Whalen and Carter n. gen.

Etymology: *Trexus* n. gen. is a name formed by an arbitrary combination of letters (ICZN, 1985, Appendix D, pt. VI, Recommendation 40, p. 201).

Included species:
TRX01 *Trexus dodgensis* Whalen & Carter 1998

Trexus dodgensis Whalen & Carter 1998

Species code: TRX01

Synonymy:
1998 *Trexus dodgensis* n. sp. – Whalen & Carter, p. 82, pl. 24, figs. 11, 12, 16, 22, 23.
2001 *Trexus dodgensis* Whalen & Carter – Gawlick et al., pl. 2, fig. 26; pl. 6, fig. 5.
2002 *Trexus dodgensis* Whalen & Carter – Suzuki et al., p. 184, fig. 9 D.
2004 *Canutus* sp. – Matsuoka, fig. 213.

Original description: Test large, dome-shaped, inflated with three to four postabdominal chambers. Cephalis small, hemispherical to dome-shaped, with short horn. Thorax and abdomen trapezoidal in outline. Postabdominal chambers subrectangular in outline, increasing very gradually in width, more rapidly in height as added. Outer latticed layer consisting of irregularly sized and shaped polygonal pore frames (mostly pentagonal and hexagonal) with small nodes at pore frame vertices. Inner latticed layer composed of delicate, polygonal pore frames.

Original remarks: The irregularly sized and shaped pore frames of the outer layers of *T. dodgensis* n. sp. distinguish it from all other Jurassic multicyrtid Nassellariina with multiwalled construction. *T. dodgensis* n. sp. differs from *T. beehivensis* (Carter) and *T. ingrahamensis* (Carter) by having a more dome-shaped test and it lacks a terminal tube.

Measurements (μm):
Based on 7 specimens.

Length (excluding horn)	Maximum width	
150	120	HT
173	143	Max.
150	120	Min.
155	132	Mean

Etymology: This species is named for Dodge Point, Queen Charlotte Islands, British Columbia, located to the southeast of the type locality.

Genus: *Triactoma* Rüst 1885

Type species: *Triactoma tithonianum* RÜST 1885 (subsequent designation by Campbell, 1954).

Synonymy:
1885 *Triactoma* n. gen. – Rüst, p. 289.
1989 *Tripocyclia* Haeckel, emend. Pessagno & Yang – Pessagno et al., p. 212.

Original description: Spherical latticed test with three long, slender spines arranged in one plane. 10 rows of round pores, 10 per row. Not frequent. (Haeckel, 1881, p. 457) Spined Phacodiscida, with marginal spines situated in the equatorial plane of the lens; with three equidistant spines with the medullary shell single, and without a spiny zone.

Further remarks: Herein we follow Baumgartner et al. (1995a) who considered *Tripocyclia* Haeckel (as emended by Pessagno & Yang) to be a synonym of *Triactoma*.

Included species:
3409 *Triactoma jakobsae* Carter 1995
TCA01 *Triactoma rosespitensis* (Carter) 1988

Type locality: Sample QC-574, Sandilands Formation, north side of Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Pucara Group, Peru; Dürrnberg Formation, Austria; Japan.

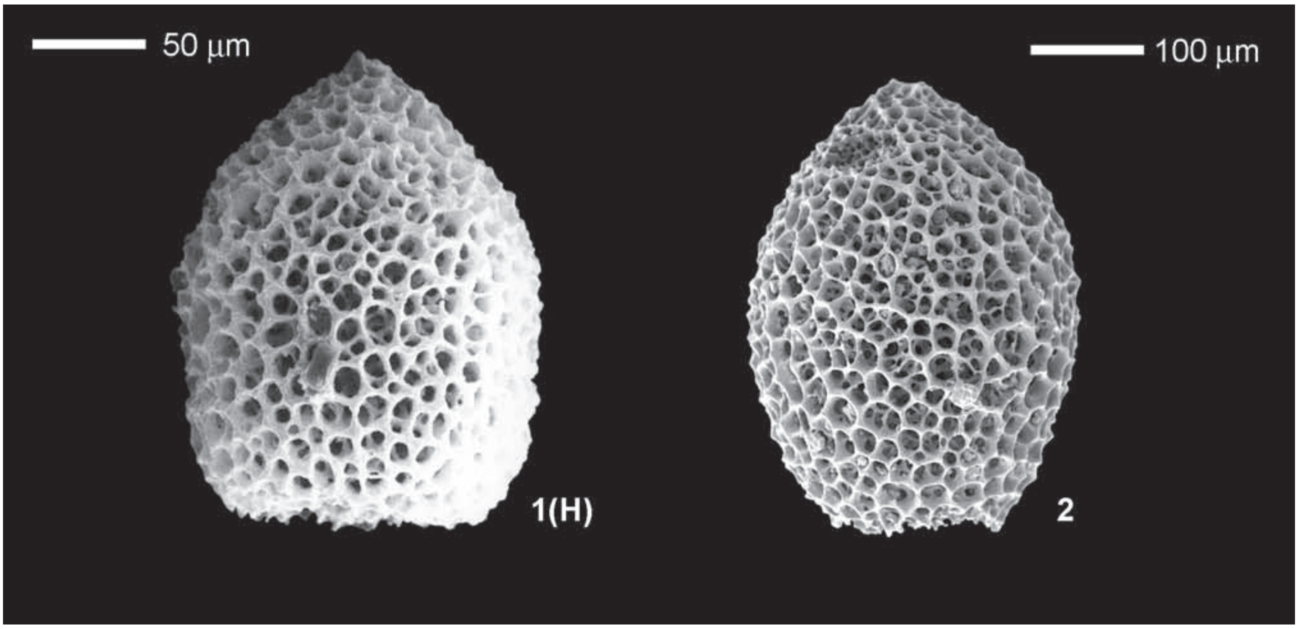


Plate TRX01. *Trexus dodgensis* Whalen & Carter. Magnification Fig. 1 x300, Fig. 2. x150. **Fig. 1(H).** Carter et al. 1998, pl. 24, fig. 16. **Fig. 2.** QCI, GSC loc. C-304567, 111790.

Triactoma jakobsae Carter 1995
Species code: 3409

Synonymy:
1988 *Tripocyclia* sp. B – Carter et al., p. 27, pl. 10, figs. 2-3.
1989 *Triactoma* sp. – Hattori & Sakamoto, pl. 7, figs. J, K.
1989 *Tripocyclia* ? sp. – Hattori, pl. 45, fig. L.
1989 *Tripocyclia* sp. A – Pessagno & Yang, p. 229, pl. 2, fig. 10.
1995a *Triactoma jakobsae* Carter n. sp. – Baumgartner et al., p. 588, pl. 3409, figs. 1-3.
1996 *Tripocyclia yaoi* n. sp. – Yeh & Cheng, p. 102, pl. 2, fig. 3, pl. 5, figs. 1, 2, 4, 5, 11.
1996 *Tripocyclia* sp. aff. T. *yaoi* n. sp. – Yeh & Cheng, p. 102, pl. 5, figs. 7, 8, 10.
1997 *Triactoma jakobsae* Carter – Yao, pl. 1, fig. 25.
2004 *Triactoma jakobsae* Carter – Suzuki & Ogane, pl. 4, fig 1.

Original description: Cortical shell spherical to subspherical. Outer latticed layer thick, composed of small, mostly hexagonal pore frames with small, rather sharp nodes at vertices of pore frames. Spines short to moderate in length but length never exceeds diameter of cortical shell. Spines robust, triradiate, composed of longitudinal ridges and grooves. Ridges rounded with small to medium-sized tear drop-shaped subsidiary grooves tapering towards distal part of spine. Longitudinal grooves narrow and deep, tapering distally but open to spine tips. Spine tips bluntly terminating with the three longitudinal ridges turned outward to form crown-like structures. On well preserved specimens a short, robust, central spine extends beyond ridge terminations. Cortical buttresses weakly developed.

Original remarks: *Triactoma jacobsae* n.sp. is larger than *Tripocyclia wickiupensis* Pessagno & Yang in all respects and further differs from that species in having a spherical to subspherical cortical shell composed of larger pore frames, and in having spine tips with better developed triradiate structures.

Further remarks: Forms with less massive spines (see synonymy) are now included in *Triactoma jakobsae* Carter.

Measurements (μm):
Based on 13 specimens.

	HT	Av.	Max.	Min.
Diameter of cortical shell	155	154	169	150
Length secondary spines	127	120	135	99
Width of spine base	59	53	60	43

Etymology: Named for Dr. Giselle K. Jakobs for her contribution to the biostratigraphy of the Toarcian and Aalenian of Western North America.

Type locality: GSC locality C-176579- Section 12, Phantom Creek Formation, Yakoun River, central Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands; Warm Springs member of the Snowshoe Formation, Oregon; Liminangcong Chert, Philippines; Japan.

Triactoma rosespitensis (Carter) 1988
Species code: TCA01

Synonymy:
1987b *Tripocyclia* sp. A – Yeh, p. 52, pl. 3, fig. 9; pl. 26, fig. 8.
1988 *Tripocyclia rosespitense* Carter n. sp. – Carter et al., p. 27, pl. 10, fig. 1.
? 1990 *Tripocyclia* sp. – Hori, Fig. 9.41.
1996 *Tripocyclia* sp. cf. *T. yaoi* n. sp. – Yeh & Cheng, p. 102, pl. 5, figs. 3, 6, 9, 12.
2002 *Triactoma rosespitensis* (Carter) – Whalen & Carter, p. 112, pl. 8, fig. 9.

Original diagnosis: Test small, with uniform, mostly hexagonal, pore frames and three slender tribladed spines.

Original description: Test small, spherical, and slightly flattened in plane of spines. Three triradiate spines are slender with alternating ridges and grooves. Ridges narrow and rounded; grooves about twice width of ridges. Terminal portion of spines normally pointed, but occasionally ridges widen at tip to produce a crown-like extension. Pore frames small, most are hexagonal, a few pentagonal.

Original remarks: This species is similar in pore frame size and shape, and spine structure to *Tripocyclia trigonium* (Rüst), (Rüst, 1885, p. 23, Pl. 30(5), fig. 3; Parona, 1890, p. 155, Pl. 2, fig. 15; and Pessagno, 1977a, p. 80, Pl. 7, figs. 6, 7), but differs in having a distinctly spherical rather than subtriangular test shape.

Measurements (μm):
Based on 7 specimens.

	HT	Av.	Max.	Min.
Diameter of test	141	143	150	140
Length of longest spine (on 4 complete specimens)	136	126	148	110

Etymology: Named for Rose Spit, on the northeastern tip of Graham Island.

Type locality: GSC locality C-080597, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands, British Columbia; Nicely Formation and Warm Springs member of the Snowshoe Formation, Oregon; San Hipólito Formation, Baja California Sur; Liminangcong Chert, Philippines; Japan.

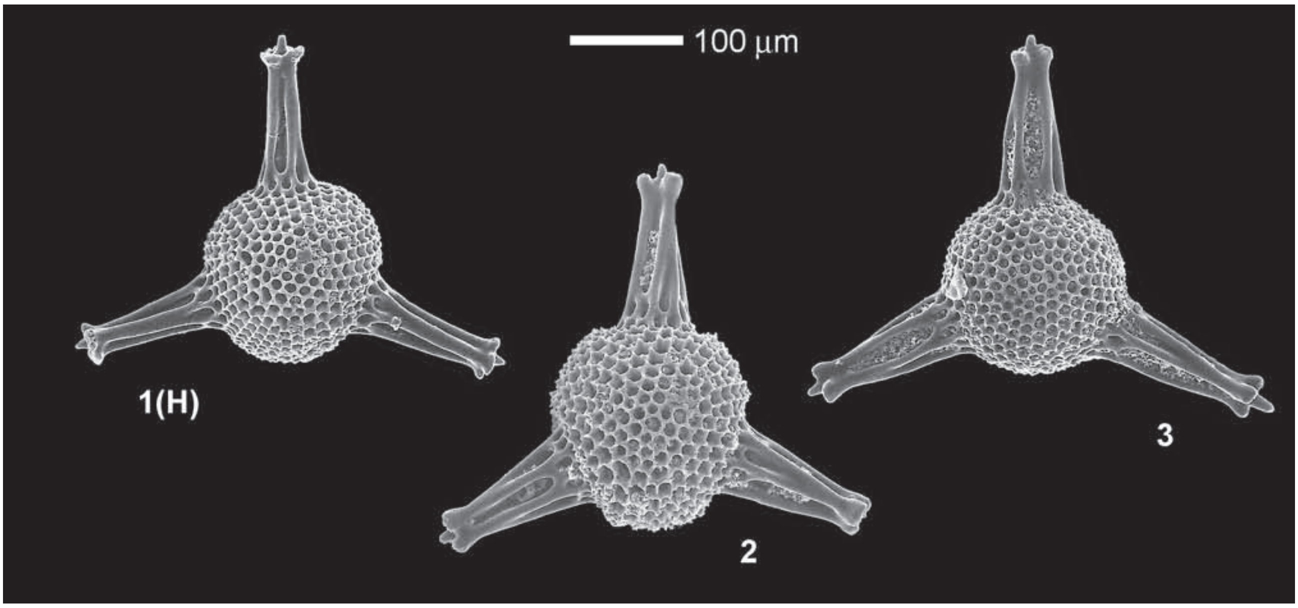


Plate 3409. *Triactoma jakobsae* Carter. Magnification x150. **Fig. 1(H).** Baumgartner et al. 1995a. pl. 3409, fig. 1. **Fig. 2.** Baumgartner et al. 1995a. pl. 3409, fig. 3. **Fig. 3**. Baumgartner et al. 1995a. pl. 3409, fig. 2.

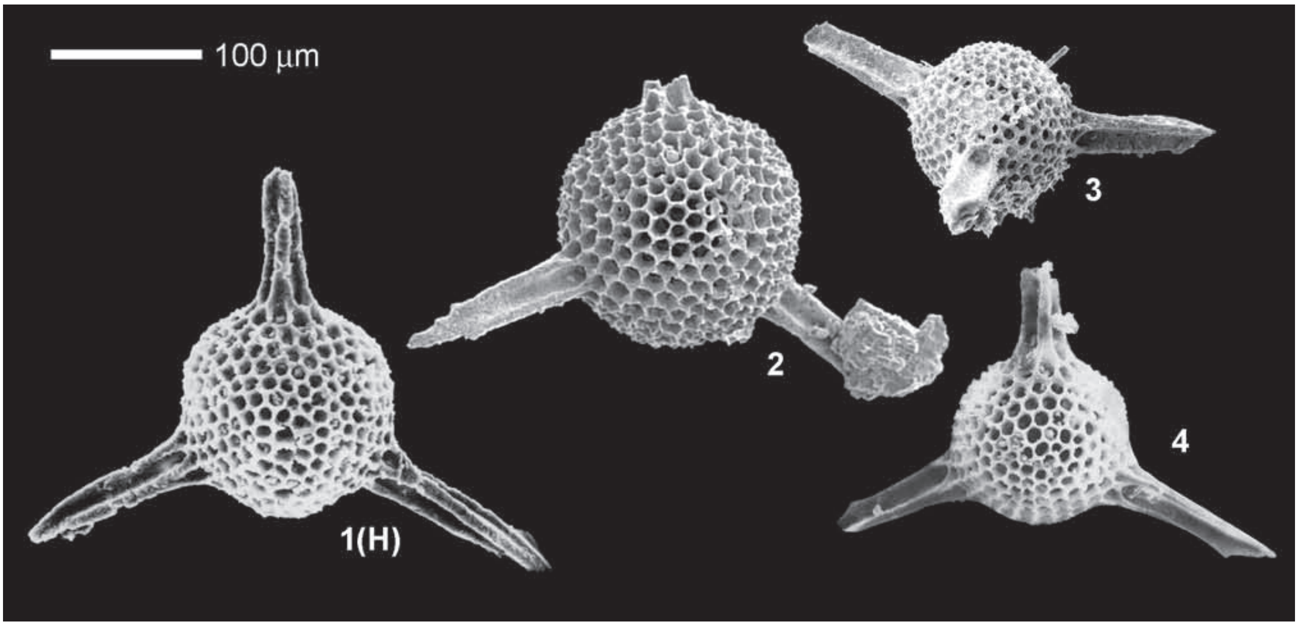


Plate TCA01. *Triactoma rosespitensis* (Carter). Magnification x200. **Fig. 1(H).** Carter et al. 1988, pl. 10, fig. 1. **Fig. 2.** QCI, GSC loc. C-304567, GSC 11181.**Fig. 3.** Matsuoka 2004, fig. 73. **Fig. 4.** Whalen & Carter 2002, pl. 8, fig. 9.

Genus: *Trillus* Pessagno & Blome 1980

Type species: *Trillus siedersi* Pessagno & Blome 1980

Synonymy:
1980 *Trillus* n. gen – Pessagno & Blome, p. 248.

Original description: Cortical shell with well developed raised median band comprised of pore frames which are greatly thickened in Z direction (text-fig. 5). Pore frames of raised median band lacking massive secondary spines.

Original remarks: *Trillus* n.gen. differs from *Zartus* n.gen. in possessing a raised median band without large, massive secondary spines. It differs from *Pantanellium* Pessagno in possessing a well-developed median band. The phylogenetic relationship of *Trillus* to other genera of Pantanellinae is discussed elsewhere in this report.

Etymology: *Trillus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. 6, recommendation 40, p. 113).

Included species:
TRL01 *Trillus elkhornensis* Pessagno & Blome 1980
TRL02 *Trillus seidersi* Pessagno & Blome 1980

Trillus elkhornensis Pessagno & Blome 1980

Species code: TRL01

Synonymy:
1980 *Trillus elkhornensis* n. sp. – Pessagno & Blome, p. 249, pl. 6, figs. 11, 12, 16, 20, 25; pl. 9, fig. 11.
1982 *Trillus elkhornensis* Pessagno & Blome – Nishizono et al., pl. 1, fig. 10.
1987b *Trillus elkhornensis* Pessagno & Blome – Yeh, p. 37, pl. 5, fig. 5.
1987b *Trillus* sp. aff. *T. elkhornensis* Pessagno & Blome – Yeh, p. 37, pl. 5, fig. 7.
1987b *Trillus* sp. A – Yeh, p. 37, pl. 5, figs. 5, 25.
1989 *Trillus elkhornensis* Pessagno & Blome – Hattori & Sakamoto, pl. 4, fig. B.
1989 *Trillus* sp. C – Hattori & Sakamoto, pl. 4, fig. G.
1989 *Trillus* sp. I – Hattori & Sakamoto, pl. 4, fig. N.
1989 *Trillus elkhornensis* Pessagno & Blome – Hattori, pl. 8, figs. E, F.
1989 *Trillus elkhornensis* Pessagno & Blome – Hori & Otsuka, pl. 4, fig. 15.
1990 *Trillus elkhornensis* Pessagno & Blome – De Wever et al., pl. 3, fig. 12.
1990 *Trillus elkhornensis* Pessagno & Blome – Hori, Fig. 8.30.
1992 *Trillus elkhornensis* Pessagno & Blome – Sashida, pl. 2, figs. 21, 22.
1993 *Trillus* sp. – Fujii et al., pl. 1, fig. 6.
1996 *Trillus elkhornensis* Pessagno & Blome – Yeh & Cheng, p. 98, pl. 8, fig. 2.
1996 *Trillus* sp. cf. *T. elkhornensis* Pessagno & Blome – Yeh & Cheng, p. 98, pl. 6, figs. 8, 12.
1996 *Trillus* sp. B – Yeh & Cheng, p. 98, pl. 8, fig. 1.
1996 *Trillus elkhornensis* Pessagno & Blome – Pujana, p. 137, pl. 1, fig. 1.
1997 *Trillus elkhornensis* Pessagno & Blome – Hori, pl. 1, fig. 14.
1997 *Trillus elkhornensis* Pessagno & Blome – Yao, pl. 3, fig. 147.
2003 *Trillus elkhornensis* Pessagno & Blome – Goričan et al., p. 291, pl. 1, fig. 2.
2003 *Trillus elkhornensis* Pessagno & Blome – Kashiwagi & Kurimoto, pl. 4, figs. 10, 12, not fig. 11.
2004 *Trillus elkhornensis* Pessagno & Blome – Hori, pl. 4, fig. 41, pl. 13, fig. 55; pl. 23, ? fig. 25.
2004 *Trillus elkhornensis* Pessagno & Blome – Matsuoka, fig. 16.
2005 *Trillus elkhornensis* Pessagno & Blome – Kashiwagi et al., pl. 6, fig. 8.

Original description: Cortical shell subspherical with well-developed median band; pore frames pentagonal and hexagonal, about equal in number, with poorly developed nodes of low relief at vertices. Bars of pore frames of equal thickness along Y and Z (text-fig. 5). Five to 6 pore frames visible along AA'; 6 along BB'. Both polar spines triradiate in axial section, shorter spine about 3/4 length of longer spine; spines comprised of massive, rather wide ridges alternating longitudinally with somewhat wider grooves.

Original remarks: *Trillus elkhornensis*, n. sp., is compared with *T. seidersi*, n. sp., under the latter species.

Measurements (μm):
Based on 9 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
113	125	94	100	25	31	HT
99	113	88	97	29	28	Av.
113	125	94	106	31	31	Max.
88	88	81	88	25	25	Min.

Etymology: *T. elkhornensis* is named for Elkhorn Creek near its type locality.

Type locality: Sample OR 536, Nicely Formation, northeast side of Morgan Mountain, eastern Oregon.

Occurrence: Worldwide.

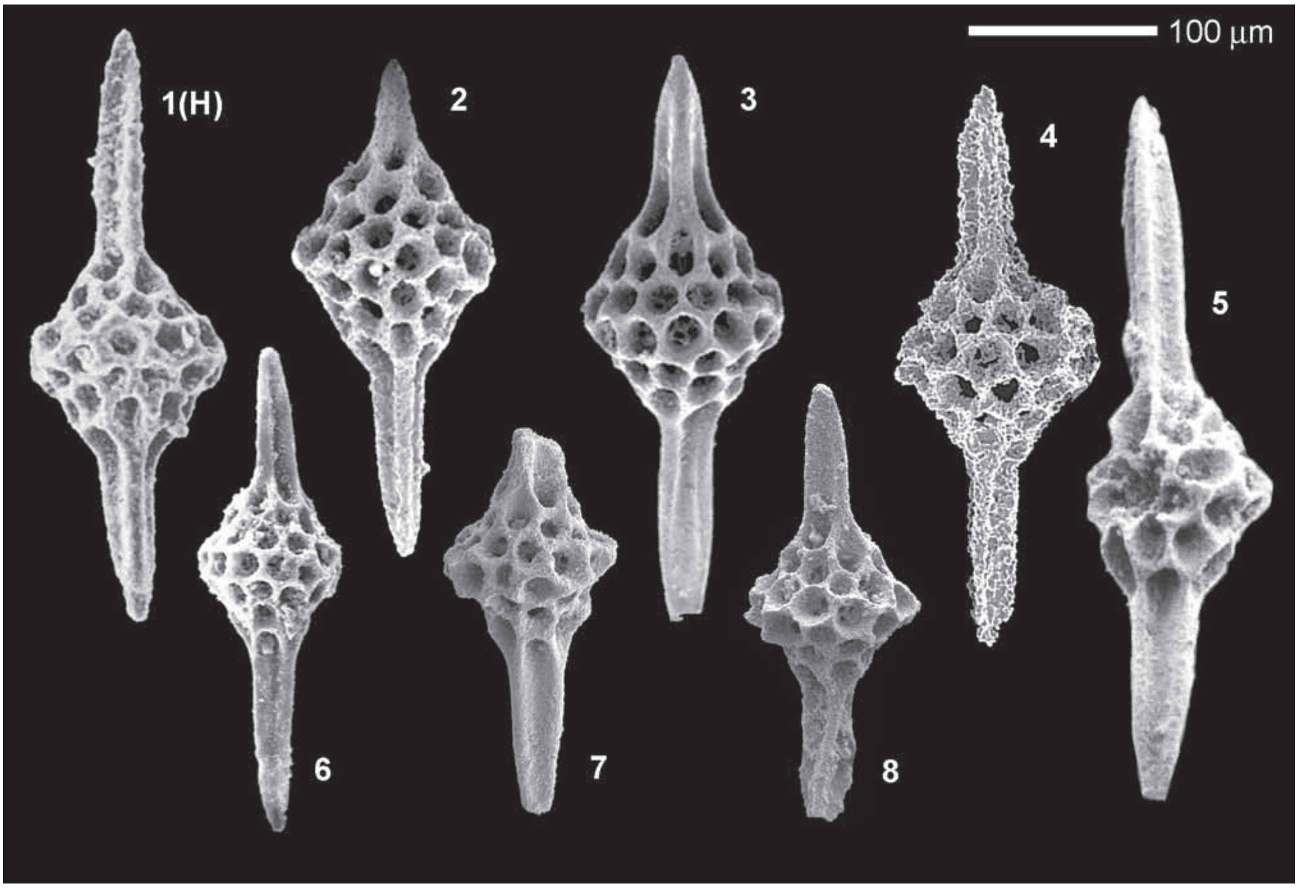


Plate TRL01. *Trillus elkhornensis* Pessagno & Blome. Magnification x250. **Fig. 1(H).** Pessagno & Blome 1980, pl. 6, fig. 12. **Fig. 2.** GSC loc. C-080611, GSC 111775. **Fig. 3.** GSC loc. C-080611, GSC 111776. **Fig. 4.** NBC, GSC loc. C-305208, GSC 111777. **Fig. 5.** Hori 1990, Fig. 8.30. **Fig. 6.** Goričan et al. 2003, pl. 1, fig. 2. **Fig. 7.** OM, BR706-R14-05. **Fig. 8.** OM, BR1121-R09-08.

Trillus seidersi Pessagno & Blome 1980
Species code: TRL02

Synonymy:
1980 *Trillus seidersi* n. sp. – Pessagno & Blome, p. 249, pl. 9, figs. 2-4, 9, 19.
1987b *Trillus* sp. cf. *T. seidersi* – Yeh, p. 37, pl. 7, figs, 10, 11, 16, 25.
1988 *Trillus* sp. cf. *T. seidersi* Pessagno & Blome – Carter et al., p. 38, pl. 16, fig. 1.
1989 *Trillus* sp. aff. *T. elkhornensis* – Hattori, pl. 8, fig. H.
1996 *Trillus* sp. A – Yeh & Cheng, p. 98, pl. 2, figs. 1, 2.
1997 *Trillus* sp. D – Yao, pl. 3, fig. 146.

Original description: Cortical shell small, subspherical with about equal number of pentagonal and hexagonal pore frames which lack nodes at vertices. Surface of test sloping steeply from median band toward polar spines. Bars of pore frames of medium thickness along Y and 2 to 3 times thicker along Z; tending to be thicker along Z in area of median band. Five pore frames visible along AA' and BB'. Polar spines quite long, triradiate in axial section; one spine somewhat longer than the other and usually showing curvature of its tip. Both polar spines having 3 very broad longitudinal grooves alternating with 3 relatively narrow ridges. Ridges and grooves maintaining same width for most of their length.

Original remarks: *Trillus seidersi*, n. sp., differs from *Trillus elkhornensis*, n. sp., in having larger and fewer pore frames and polar spines with much wider grooves. Both species have long polar spines. It is conceivable that *T. elkhornensis* gave rise to *T. seidersi* through a reduction in the number of pore frames and an increase in the width of the grooves on its polar spines.

Further remarks: Forms referred to *Trillus* cf. *seidersi* in Carter et al. (1988) are herein considered *T. seidersi* s.s.

Measurements (μm):
Based on 9 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
90	130	90	90	25	25	HT
81	122	89	85	24	26	Av.
90	140	100	92	30	42	Max.
60	105	80	80	20	20	Min.

Etymology: This species is named for Dr. Victor M. Seiders in honor of his significant contribution to the study of California Coast Ranges.

Type locality: Sample OR 513, Snowshoe Formation, along Izee-John Day Road, eastern Oregon.

Occurrence: Snowshoe Formation, Oregon; Rennell Junction member of the Fannin Formation and Graham Island Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman; Liminangcong Chert, Philippines; Japan.

Genus: *Tripocyclia* Haeckel 1881, emend. Kiessling 1999
Type species: *Tripocyclia trigonum* Rüst, subsequent designation by Campbell (1954)

Synonymy:
1881 *Tripocyclia* n. gen. – Haeckel, p. 458.
1999 *Tripocyclia* Haeckel 1881, emend. – Kiessling, p. 39.

Original description:
2b. Spiny Coccodiscida with marginal spines lying in equatorial plane and radiating from the margin of the lens-shaped test (without chambered rays).
B. With three equidistant spines.

Emended description: By Kiessling (1999): Spongy lenticular disc, triangular in axial view. Three strong triradiate primary spines, symmetrically arranged, but sometimes of slightly different size. Spines originating from a pseudoaulophacid microsphere as thin cylindrical beams, triradiate development only on the surface or slightly inside the test. Spongy meshwork internally arranged in indistinct concentric layers. Externally the disc commonly shows very small pores. Secondary spines rarely present, very small. No tholi and no distinct nodes developed.

Remarks: By Kiessling (1999): The emendation of this genus is based on material from the Southern Alps (Italy and Switzerland), where common specimens of the type species were found in Bathonian to Kimmeridgian sediments (Kiessling 1995b). Well-preserved specimens of *Tripocyclia trigonum* were also figured by De Wever et al. (1986, pl. 16, figs. 17-19). The forms fit very well to the original description, figure and measurements of *Tripocyclia trigonum* provided by Rüst (1885), but are definitely not synonymous with *Tripocyclia trigonum* as described by Pessagno (1977a). *T. trigonum* also shows no similarity with the species described under *Tripocyclia* by Pessagno and Yang in Pessagno et al. (1989), Yang (1993), and Hull (1997). All those species are *Xiphostylidae*, whereas *Tripocyclia* has to be assigned to the Pseudoaulophacidae. Thus the emendation of *Tripocyclia* by Pessagno & Yang (1989) cannot be considered valid. Much of the taxonomic confusion about *Tripocyclia* stems from the poor original description of the genus (Haeckel 1881) and the type species (Rüst 1885). Although the subsequent assignment of *T. trigonum* as the type species of *Tripocyclia* by Campbell (1954) may have altered the original concept of Haeckel (1881) it has to be accepted according to the IRZN (1985).

Tripocyclia differs from *Tripodictya* Haeckel by lacking concentric chambered rings internally. The differences to *Spongotripus* Haeckel are less clear. The emended definition of *Tripocyclia* actually fits better to the original definition of *Spongotripus* than to that of *Tripocyclia*. However, the subsequent designation of *Spongotripus regularis* Haeckel

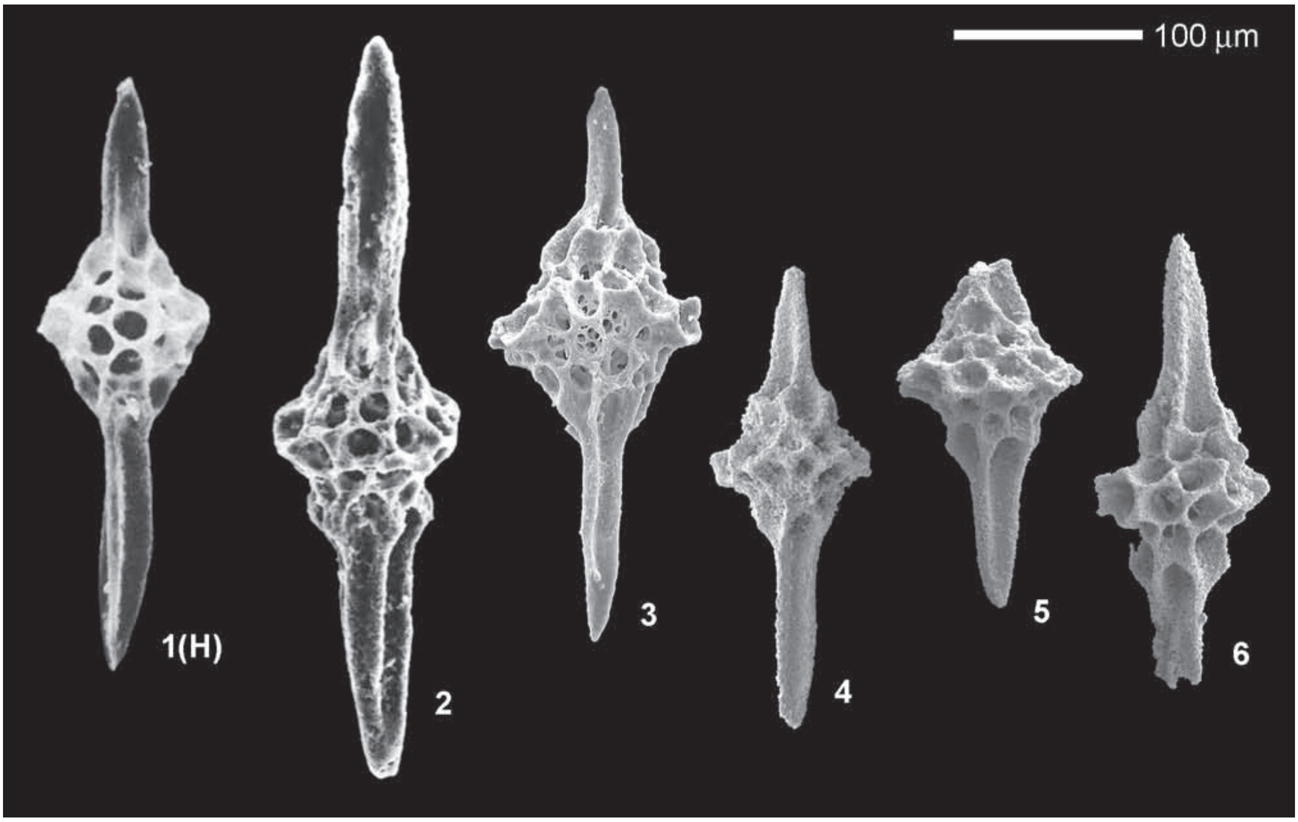


Plate TRL02. *Trillus seidersi* Pessagno & Blome. Magnification x250. **Fig. 1(H).** Pessagno & Blome 1980, pl. 9, fig. 2. **Fig. 2.** Carter et al. 1988, pl. 16, fig. 1. **Fig 3.** QCI, GSC loc. C-304 566, GSC 111778. **Fig. 4.** OM, BR871-R07-07. **Fig. 5.** OM, BR706-R06-26. **Fig. 6.** OM, BR1121-R09-22.

as the type species of *Spongotripus* (Campbell 1954) is not considered valid, since this species was not figured by Haeckel (1887) and hence represents a nomen dubium. A possibility to define a valid type species could be *Spongechinus neumayri* Dunikowski which was originally included into the type-series by Haeckel (1887). However, this species cannot serve as type species, owing to its spherical test. *Spongotripus pauper* Rüst is amongst the first species of this genus that was sufficiently described and figured and fits to the original definition of the genus and should be assigned as type species. This species differs externally from *Tripocyclia* by its test being flat rather than lenticular and its much shorter spines. More work needs to be done on the status of both *Tripocyclia* and *Spongotripus* to clarify the taxonomic problems.

Further remarks: We have strong doubts that the microsphere of this genus is of pseudoaulophacid structure as mentioned in the emended description. Sections to microsphere made by one of us (PD) in several species assignable to *Tripocyclia* Haeckel as emended by Kiessling, species coming from the very well preserved fauna of the Bajocian sample IN7 of Yao (1997), show a central microsphere similar to that of *Paronaella* rather than to the Pseudoaulophacidae (see Dumitrica & Zügel (2002) and Dumitrica (1997) for the morphology of the two types of microsphere).

Regarding the type species of the genus *Spongotripus* Haeckel, we must use the species designated by Campbell (1954) and not *Spongotripus pauper* Rüst 1888 as re-designated by Kiessling (1999) because the redesignation of a type species is against the ICZN, art. 61. The reason Kiessling designated another type species for *Spongotripus* is because he considered that the designation of *S. regularis* by Campbell is not valid since this species was not illustrated by Haeckel. However, the ICZN art. 69A only specifies that "In designating a type-species for a genus, a zoologist should give preference to a species that is adequately figured". There is no mention that the zoologist must designate an illustrated species. In fact neither *Spongotripus regularis* as type species nor *S. pauper* solve the taxonomical problems of Mesozoic species with spongy disk-shaped test and three three-bladed equatorial spines. *Spongotripus* comprises probably only Cenozoic Spongodiscidae because its description was based on Cenozoic material and because its type species has conical rather than three-bladed spines, whereas Jurassic and Cretaceous species have bladed spines and may belong to differing genera of several families such as: Angulobracchiidae, Pseudoaulophacidae, Tritrabidae, etc. Moreover, *Spongotripus pauper* as illustrated by Rüst (1888) does not seem to be an equatorial section because it shows no regular structure in the center and the three spines do not reach the central part, thus giving no information on the family group to which it may belong. In summary, Mesozoic species answering the original generic diagnosis of *Spongotripus* should always be questionably assigned to this genus.

Included species:
SPT01 *Tripocyclia*? *tortuosa* Dumitrica, Goričan & Whalen n. sp.

Tripocyclia*? *tortuosa Dumitrica, Goričan & Whalen n. sp.

Species code: SPT01

Synonymy:
1990 *Triactoma* (?) sp. – Nagai, pl. 5, fig. 1.
1997 *Spongotripus* sp. B0 – Yao, pl. 5, fig. 235.
2003 *Spongotripus* sp. B0 sensu Yao – Goričan et al., p. 296, pl. 2, fig. 6.

Type designation: Holotype specimen BR523-R02-04 (pl. SPT01, fig. 1), paratypes specimens BR524-R04-10 and BR 825-3-R09-06 (pl. SPT01, figs. 2, 4) from the Guwayza Formation, Tawi Sadh Member, Jabal Safra, Oman.

Description: Cortical shell subspherical with three triradiate spines at approximately 120° to each other. Meshwork of cortical shell delicate, composed of thin bars forming a dense spongy pattern arranged in concentric layers. Superficial layer of mature specimens with small but distinct nodes. Spines long, dextrally torsioned, with pointed tip; degree of torsion and length of torsioned portion variable.

Remarks: *Tripocyclia*? *tortuosa* n. sp. differs from other related species by having torsioned spines. From *Spongotripus incomptus* Carter 1988 it further differs by having much longer spines and a less dense and triangular test. In the structure of the nodose shell surface, *Tripocyclia*? *tortuosa* n. sp. is the most similar to *Alievium*? *juskatlaensis* Carter 1988 but the latter species has straight spines. Our specimens are not well enough preserved to make equatorial sections in order to know the structure of the microsphere, but specimens with a superficially similar test and very slightly torsioned spines from the Bajocian of Japan (sample IN 7 of Yao, 1997) show in their center a microsphere similar to that of *Paronaella*.

Measurements (μm):
Based on 5 specimens.

	HT	Min.	Max.
Diameter of shell	83	83	113
Preserved length of spines	95	-	100

Etymology: From Latin: *tortuosus, -a, -um* = tortuous, referring to torsioned spines.

Type locality: Sample BR523, Guwayza Formation, Tawi Sadh Member, Jabal Safra, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation, Oman; Skrile Formation, Slovenia; Japan; San Hipólito Formation, Baja California Sur; Hyde Formation, Oregon.

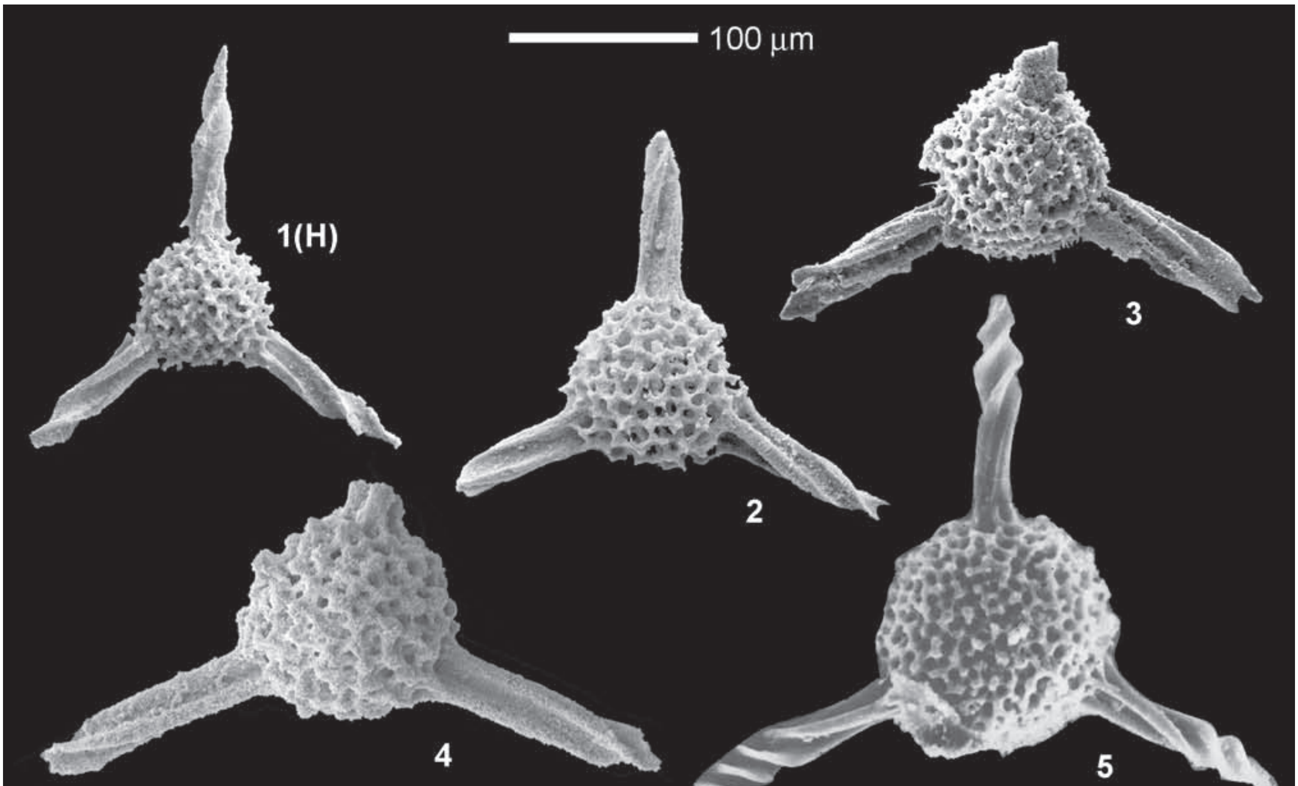


Plate SPT01. ***Tripocyclia*****?** ***tortuosa*** **Dumitrica, Goričan & Whalen n. sp.** Magnification x250. **Fig. 1(H).** OM, BR523-R02-04. **Fig. 2.** OM, BR524-R04-10. **Fig. 3.** Goričan et al. 2003, pl. 2, fig. 6. **Fig. 4.** OM, BR825-3-R09-06. **Fig. 5.** BCS, SH-412-14.

Genus: *Turanta* Pessagno & Blome 1982, emend. Takemura 1986

Type species: *Turanta capsensis* Pessagno & Blome 1982

Synonymy:

1982 *Turanta* n. gen. – Pessagno & Blome, p. 296.

1986 *Turanta* Pessagno & Blome emend. – Takemura, p. 64.

Original description: Test dicyrtid. Cephalic wall incompletely formed, mostly open, partially lacking sides and roof, but possessing well-developed cyrtoid collar plate (pl. 3, figs. 2-3, 11-12); collar plate usually visible externally. Prominently curved to slightly curved horn attached to apical bar; base of horn covering collar plate on dorsal side (in position of dorsal bar) (pl. 3, figs. 2, 11; 3, 12). Thorax with two feet connected with and in line with vertical and dorsal bars (pl. 4, fig. 17). Horns and feet varying in length and curvature with species, typically triradiate in axial section with alternating ridges and grooves. Horn and feet usually in same plane; distance between horn and vertical foot always differing from distance between horn and dorsal foot. Thorax subspherical, often somewhat compressed at right angles to the plane of the horn and feet; flattened area occurring between horn and vertical foot; thorax lacking mouth and with symmetrical pentagonal and hexagonal pore frames.

Original remarks: *Turanta*, n.gen., differs from all other Mesozoic dicyrtid Nassellariina by virtue of the partially formed, naked nature of its cephalis. It may well be that the missing cephalic walls were extremely thin and fragile in character and were not capable of being fossilized; they are for the most part missing on all specimens of *Turanta* observed during this study.

The spumellarian-like test of *Turanta* at first suggests a kinship to *Tripocyclia* Rüst. However, the two genera can be easily distinguished externally by the asymmetrical placement of the horn and feet of *Turanta* as well as the flattened area between the horn and vertical foot.

Emended diagnosis: By Takemura (1986): Shell of one segment, cephalis, large, subspherical and latticed, with three usually triradiate spines, which are prolongations of A, V, and D. Three spines located in a same plane, which is perpendicular to the collar plate. Dorsal spine usually curved slightly to the side of the apical spine. Cephalic pores large and circular, regularly or irregularly distributed. Cephalic skeletal elements, MB, V, D, two L and two l at the base of the cephalis, and A inside the cephalis.

Further remarks: By Takemura (1986): Pessagno & Blome (1982) described *Turanta* as dicyrtid Nassellaria, of which cephalis was naked. However, *Turanta* possesses all the cephalic skeletal elements and specially A, originated at the point where MB, D and two l join, prolonging into an apical spine (pl. 11, 17-18), penetrating inside the shell which is described as "thorax" by Pessagno & Blome (1982). This fact clearly indicates that the large subspherical latticed shell of *Turanta* is the cephalis. Therefore, the horn described by Pessagno & Blome (1982) is the dorsal spine and the two feet are the apical and vertical spines.

Etymology: *Turanta* (f.) is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. VI, Recommendation 40, p. 113).

Included species:

3247 *Turanta morinae* gr. Pessagno & Blome 1982

Turanta morinae gr. Pessagno & Blome 1982

Species code: 3247

Synonymy:

1982 *Turanta morinae* n. sp. – Pessagno & Blome, p. 300, pl. 1, figs. 3-4, 8, 11, 16.

1982 *Turanta officerensis* n. sp. – Pessagno & Blome, p. 301, pl. 2, figs. 2-3, pl. 8, fig. 1.

1988 *Turanta morinae* Pessagno & Blome – Carter et al., p. 62, pl. 14, fig. 8.

1991 *Turanta* sp. A, n. sp. – Carter & Jakobs, p. 344, pl. 3, fig. 13.

1995a *Turanta morinae* gr. Pessagno & Blome – Baumgartner et al., p. 616, pl. 3247, figs. 1-3.

1996 *Turanta* sp. A – Yeh & Cheng, p. 122, pl. 8, fig. 10.

1997 *Turanta morinae* gr. Pessagno & Blome – Yao, pl. 8, fig. 356.

Original description: Cephalis as with genus. Thorax subspherical with equal number of pentagonal and hexagonal pore frames having weakly developed nodes at vertices; hexagonal pore frames somewhat larger than pentagonal pore frames. Horn and feet relatively long, triradiate in axial section with grooves and ridges of equal width; grooves and ridges gradually decreasing in width distally. Proximal 1/2 of horn curved; distal 1/2 straight. Feet straight, widely separated, nearly at right angles to horn.

Original remarks: *Turanta morinae*, n. sp., differs from *Turanta silviensis* n. sp. by having a longer horn, longer feet and fewer pore frames. Furthermore, whereas *T. morinae* tends to have about the same number of hexagonal and pentagonal pore frames, *T. silviensis* has predominantly hexagonal pore frames.

Measurements (μm):

Based on 8 specimens.

	HT	Mean	Min.	Max.
Length of thorax	162.5	154.68	125	175
Width of thorax	137.5	146.25	125	175
Length of foot	150+	164.58	100	225
Length of horn	150	122.5	87.5	150

Etymology: This species is named for Karen E. Morin in honor of her recent contributions to the study of Upper Cretaceous Radiolaria.

Type locality: Sample OR-580, Warm Springs member, Snowshoe Formation, near bridge over South Fork of John Day River, east-central Oregon.

Occurrence: Snowshoe Formation, Oregon; Phantom Creek Formation, Queen Charlotte Islands; Sogno Formation, Italy; Liminangcong Chert, Philippines; Japan.

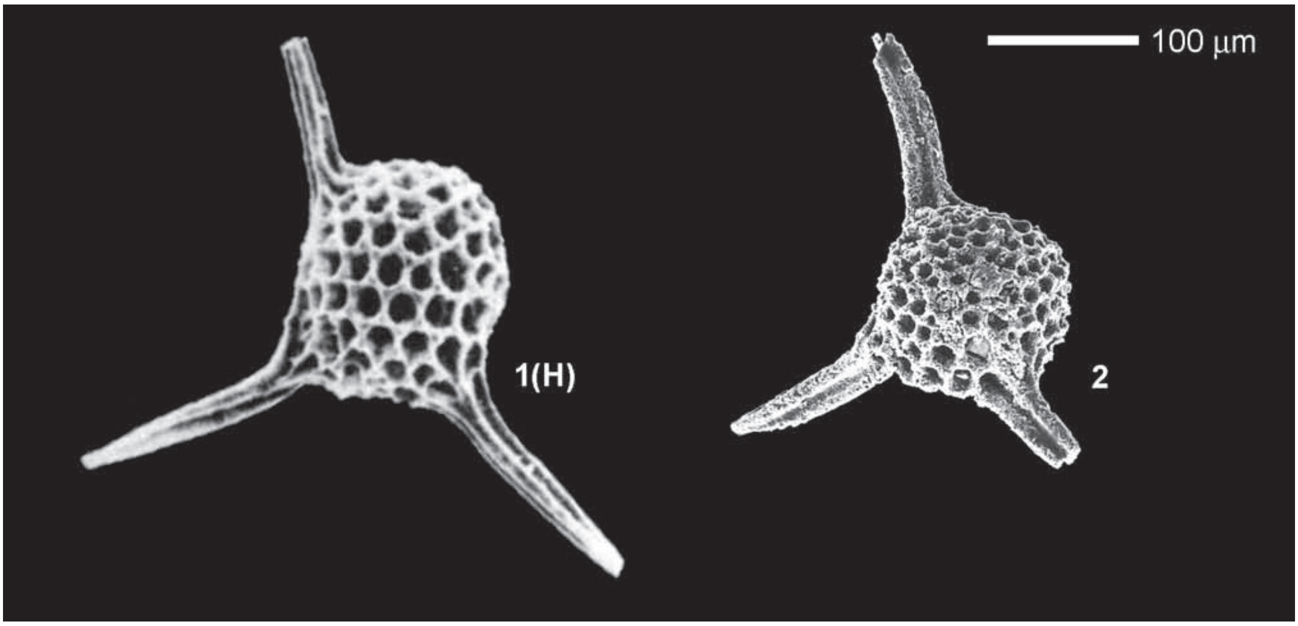


Plate 3247. *Turanta morinae* Pessagno & Blome. Magnification x200. **Fig. 1(H).** Pessagno & Blome 1982, pl. 1, fig. 3. **Fig. 2** Carter et al. 1988, pl. 14, fig. 8.

Genus: *Tympaneides* Carter 1988

Type species: *Tympaneides charlottensis* Carter 1988

Synonymy:

1988 *Tympaneides* Carter n. gen. – Carter et al., p. 37.

Original description: Test is a flattened sphere (drum-shaped) with four spines extending from sides to form a cross in one plane. Top and bottom surfaces planiform, sides vertical to slightly concave. Latticed cortical shell composed of two layers of pore frames on planar surfaces and a single layer on the sides. Nodes on outer layer interconnected by fragile bars to form triangular or tetragonal pore frames.

Original remarks: *Tympaneides* n. gen. is assigned to the Staurolonchidae Haeckel because of its shape, mode of shell construction and spine structure. It differs from *Emiluvia* Foreman in having a test that is circular and drum-shaped rather than rectangular, and from *Staurolonche* Haeckel in having a double-, rather than a single-layered cortical shell.

Etymology: From the Greek *tympanon* = drum.

Included species:

3408 *Tympaneides charlottensis* Carter 1988

Tympaneides charlottensis Carter 1988

Species code: 3408

Synonymy:

1988 *Tympaneides charlottensis* Carter n. sp. – Carter et al., p. 37, pl. 9, figs. 4, 5.

1989 *Tympaneides* sp. cf. *T. charlottensis* Carter – Hori & Otsuka, pl. 4, fig. 10.

1991 *Tympaneides charlottensis* Carter – Carter & Jakobs, p. 344, pl. 2, fig. 2.

1991 *Tympaneides charlottensis* Carter – Tipper et al., pl. 9, fig. 10.

1995a *Tympaneides charlottensis* Carter – Baumgartner et al., p. 618, pl. 3408, figs. 1,2.

1998 *Tympaneides charlottensis* Carter – Cordey, p. 95, pl. 20, fig. 12.

Original diagnosis: Test circular, drum-shaped. Meshwork on planar surfaces very fine, pore frames triangular, nodes minute. Equatorial spines long, slender and triradiate.

Original description: Test circular (drum-shaped) with four long spines extending from sides of test at 90° to one another. Outer layer of cortical shell covered with very small triangular pore frames composed of thin bars with fine nodes at their vertices. Spines long (one to three times test diameter), slender and of uniform width. Spines with alternating ridges and grooves. Ridges rounded and approximately twice as wide as grooves, which are narrow and deep.

Original remarks: This species is very abundant in middle to upper Toarcian samples.

Measurements (μm):

Based on 14 specimens.

	HT	Av.	Max.	Min.
Diameter of test	129	118	150	80
Length of longest spine	162	170	238	123

Etymology: This species is named for Queen Charlotte (wife of George III of England) after whom the Queen Charlotte Islands were named.

Type locality: GSC locality C-080583, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte Islands, British Columbia.

Occurrence: Phantom Creek Formation, Queen Charlotte Islands; Fernie Formation, Williston Lake; Bridge River Complex, British Columbia; Japan.

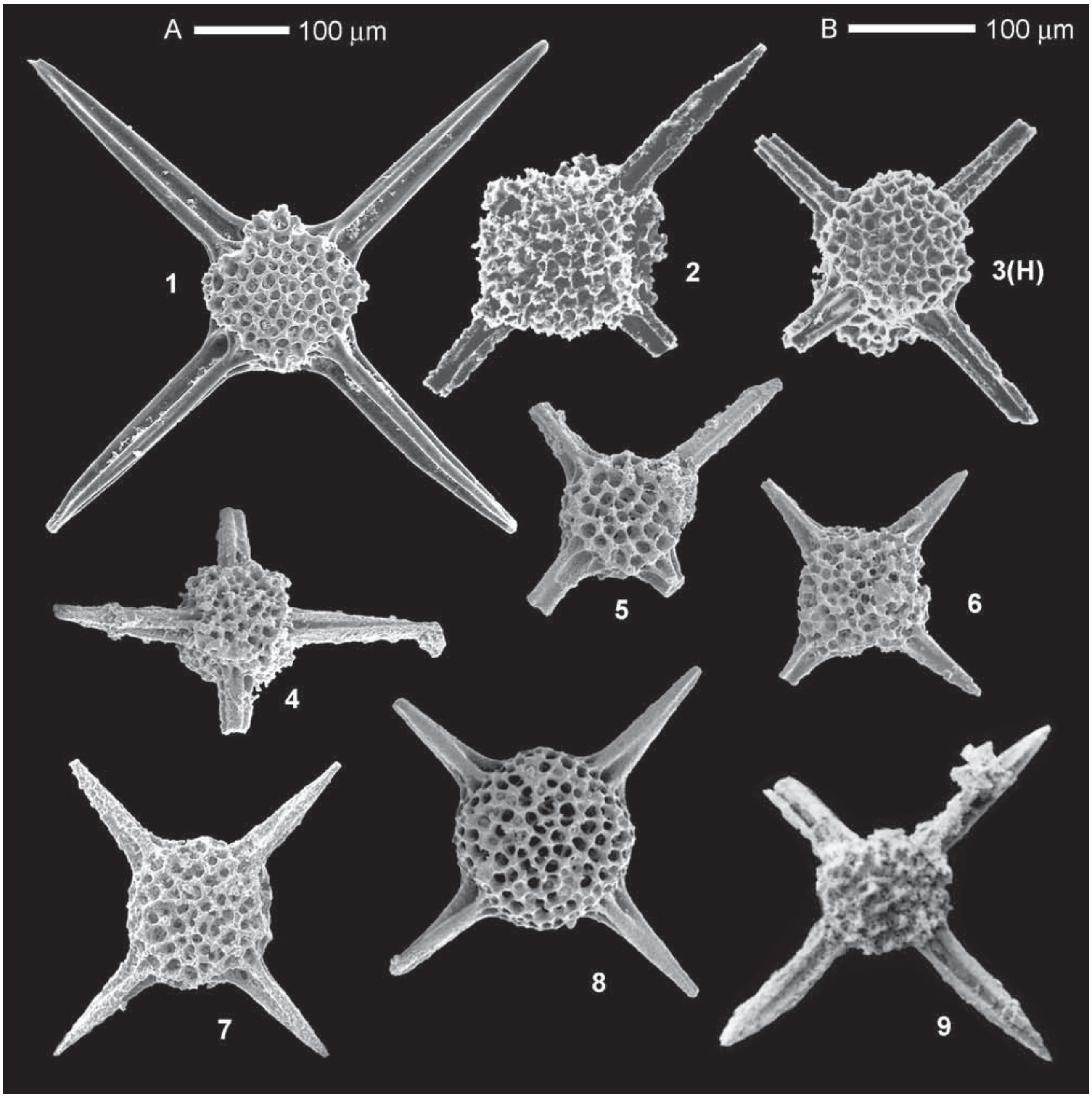


Plate 3408. ***Tympaneides charlottensis*** **Carter.** Magnification Fig. 1 x150 (scale bar A), Figs. 2-9 x200 (scale bar B). **Fig. 1.** Carter & Jakobs 1991, pl. 2, fig. 2. **Fig. 2.** Carter et al. 1988, pl. 9, fig. 5. **Fig. 3(H).** Carter et al. 1988, pl. 9, fig. 4. **Fig. 4.** QCI, GSC loc. C-080612, GSC 128705. **Fig. 5.** QCI, GSC loc. C-304281, GSC 111779. **Fig. 6.** QCI, GSC loc. C-304281, GSC 111780. **Fig. 7.** NBC, GSC loc. C-205813, GSC 111781. **Fig. 8.** QCI, GSC loc. C-080611, GSC 111782. **Fig. 9.** Hori & Otsuka 1989, pl. 4, fig. 10.

Genus: *Udalia* Whalen & Carter 1998

Type species: *Udalia dennisoni* Whalen & Carter 1998

Synonymy:

1998 *Udalia* n. gen. – Whalen & Carter, 1998, p. 59.

Original description: Test square or rectangular in outline, usually quite thick with four prominent spines in the same plane, one at each corner. Upper and lower surfaces of test planiform, sides vertical. Test composed of multiple layers of fine meshwork; meshwork of cortical shell with numerous, irregularly shaped (mostly triangular and tetragonal) pore frames with small nodes at pore frame vertices. Pore frames of inner layers much thinner and lack nodes. Inner structure unknown as center of test hollow in all specimens observed. Spines circular or triradiate, tapering distally.

Original remarks: *Udalia* n. gen. differs from *Sophia* n. gen. by lacking an entactiniid-like inner structure, having a thinner shell, more pore frames, and much smaller nodes at pore frame vertices. We note that *Udalia* n. gen. has ferresiid-like meshwork. It is possible this genus could be assigned to the Ferresiidae Carter if that family were revised to include forms with four spines in the cruciform position. Comparison with *Emiluvia* Foreman is difficult because of the absence of information on the inner structure of *Udalia* n. gen.

Etymology: This genus named for the "Udal", a mission ship built in Sandspit, Queen Charlotte Islands in the early 1900s.

Included species:

UDA05 *Udalia plana* Whalen & Carter 1998

Udalia plana Whalen & Carter 1998

Species code: UDA05

Synonymy:

1998 *Udalia plana* n. sp. – Whalen & Carter, p. 60, pl. 5, figs. 7, 8, 12, 13; pl. 7, figs. 13, 14, 15, 18.

2002 *Udalia plana* Whalen & Carter – Suzuki et al., p. 178, fig. 7 J.

2002 *Udalia plana* Whalen & Carter – Whalen & Carter, p. 112, pl. 7, figs. 9-10.

2002 *Udalia plana* Whalen & Carter – Tekin, p. 185, pl. 3, fig. 3.

Original description: Cortical shell diamond-shaped in outline, very thick, with planiform upper and lower surfaces and vertical sides. Meshwork composed of irregularly shaped triangular and tetragonal pore frames with large, rounded nodes at pore frame vertices; pore frame bars thinner in Y direction than in Z direction (refer to Pl. 4, fig. 11 for measurement system). Test with four long spines, all equal in length and width and tapering distally; spines triradiate in axial section with narrow, rounded longitudinal ridges and grooves.

Original remarks: See remarks under *Udalia parvacapsa* n. sp.

Remarks under *Udalia parvacapsa* n. sp.: *Udalia parvacapsa* n. sp. differs from *U. plana* n. sp. in having a smaller test and much longer spines.

Measurements (μm):

(n) = number of specimens measured.

Maximum diameter of cortical shell (7)	Maximum length of primary spines (6)	
113	131	HT
143	131	Max.
105	79	Min.
122	93	Mean

Etymology: *Planus, a, um* (latin; adj.) = even, level, flat.

Type locality: Sample QC-676, Sandilands Formation, Kunga Island, Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands; Fernie Formation, NE British Columbia; San Hipólito Formation, Baja California Sur; Pucara Group, Peru; Hocaköy Radiolarite, Turkey.

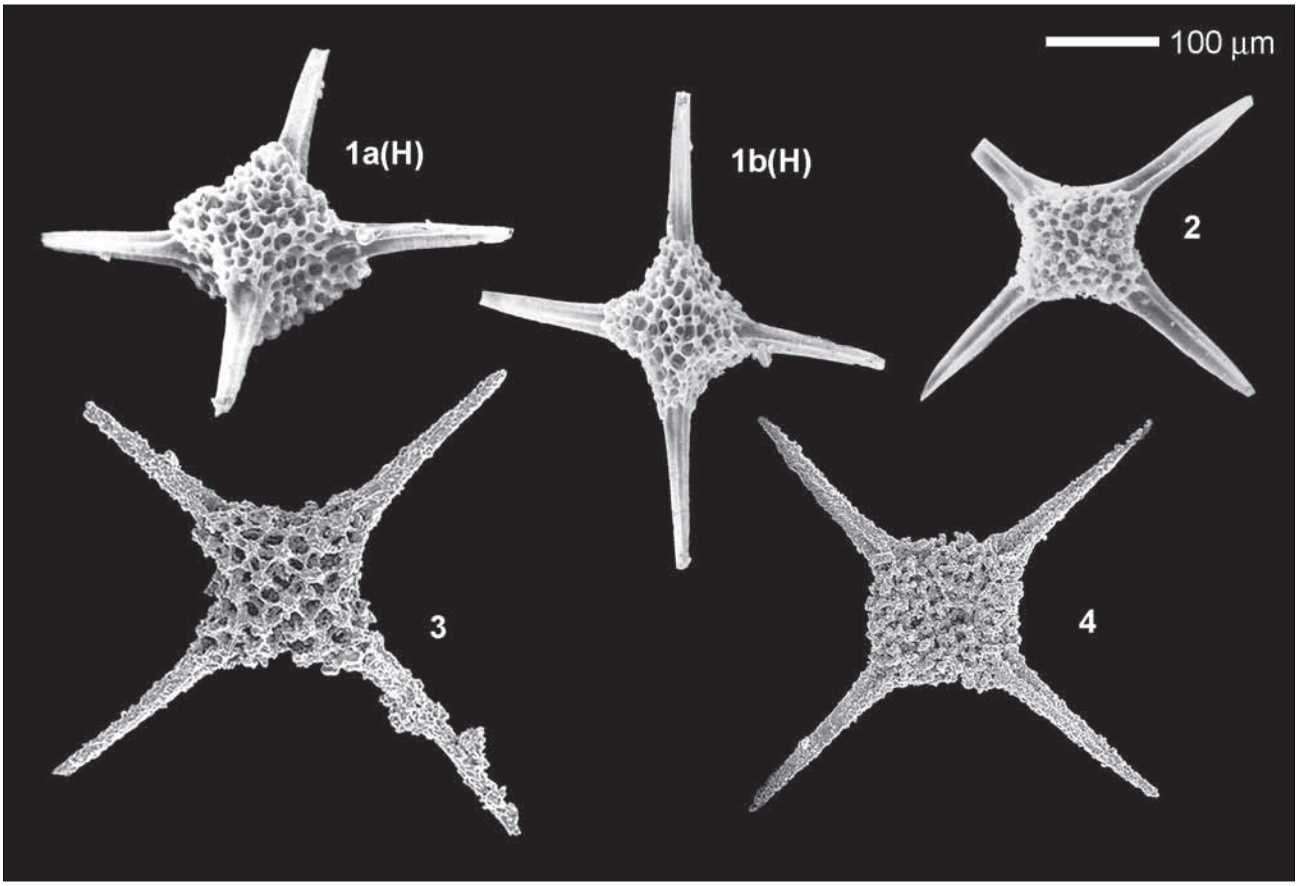


Plate UDA05. *Udalia plana* Whalen & Carter. Magnification x150. **Fig. 1(H)a-b.** Carter et al. 1998, pl. 5, figs. 8, 7. **Fig. 2.** Whalen & Carter 2002, pl. 7, fig. 10. **Fig. 3.** NBC, GSC loc. C-305208, GSC 111783. **Fig. 4.** NBC, GSC loc. C-305208, GSC 111784.

Genus: *Unuma* Ichikawa & Yao 1976

Type species: *Unuma* (*Unuma*) *typicus* Ichikawa & Yao 1976

Synonymy:

1976 *Unuma* n. gen. – Ichikawa & Yao, p. 111.
1976 *Unuma* sensu stricto – Ichikawa & Yao, p. 112.
1976 *Spinunuma* n. subgen. – Ichikawa & Yao, p. 112.
1986 *Unuma* Ichikawa & Yao – Takemura, p. 58.

Original description: Spindle-shaped multisegmented form with inversely subconical basal appendage which has pores much larger than those of the preceding main segments. Junction of segments not externally expressed as an indentation. Numerous small circular pores on the surface, aligned in longitudinal and diagonal rows. Numerous longitudinal plicae on the surface generally running continuously through segments. Apical horn may be minute or large; radial spines and basal spine may or may not be present.

Original remarks: A spindle-shaped form with small pores, the absence of an externally expressed stricture, the presence of large pores on the inversely subconical basal appendage and of longitudinal plicae are stable diagnostic features of the genus *Unuma*.

The last segment is represented by the distal part of the main spindle-shaped shell with small pores. The basal portion with large pores may be considered as a lid-like appendage of the last segment rather than as the last segment itself.

Two subgenera, *Unuma* (*Unuma*) and *Unuma* (*Spinunuma*), are distinguished on the basis of the presence or absence of a distinct apical horn, radial spines, and basal spine. The morphological difference between the type species of these subgenera may appear to be significantly great at first glance, but there exist some forms transitional with respect to the degree of development of radial spines, so that a separation at subgeneric level is applied here.

Etymology: From the locality of the type specimens of the type species. *Unuma* (regarded as masculine).

Included species:

UNM01 *Unuma unicus* (Yeh) 1987b

Unuma unicus (Yeh) 1987b

Species code: UNM01

Synonymy:

1987b *Hsuum* (?) *unicum* n. sp. – Yeh, p. 66, pl. 17, figs. 15-16, 21.
1997 *Unuma unicum* (Yeh) – Yao, pl. 10, fig. 476.
2004 *Hsuum* (?) *unicum* Yeh – Matsuoka, fig. 190.

Original description: Test very small, spindle-shaped, with four to five post-abdominal chambers. Cephalis dome-shaped without horn. Test comprised of inner latticed layer of tetragonal pore frames with circular to elliptical pores; outer layer with long massive costae usually extending continuously throughout test. One to three rows of pore frames between two adjacent costae. Seven to eight costae visible laterally. Final post-abdominal chamber terminating in latticed, hemispherical cap.

Original remarks: This form is questionably assigned to *Hsuum* Pessagno because it consists of a latticed, hemispherical closing cap at final post-abdominal chamber and also because it lacks a horn.

Further remarks: This species is herein assigned to *Unuma* Ichikawa & Yao, because the complete specimens (including the holotype) have a perforate basal appendage. *Unuma unicus* seems to be the oldest representative of the genus.

Measurements (μm):
Ten specimens measured.

	Total length	Max. width
HT	160	120
Mean	153	118
Max.	160	120
Min.	147	115

Etymology: *Unicus-a-um* (Latin, adj.) = unique.

Type locality: OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Hyde Formation, Oregon; Japan.

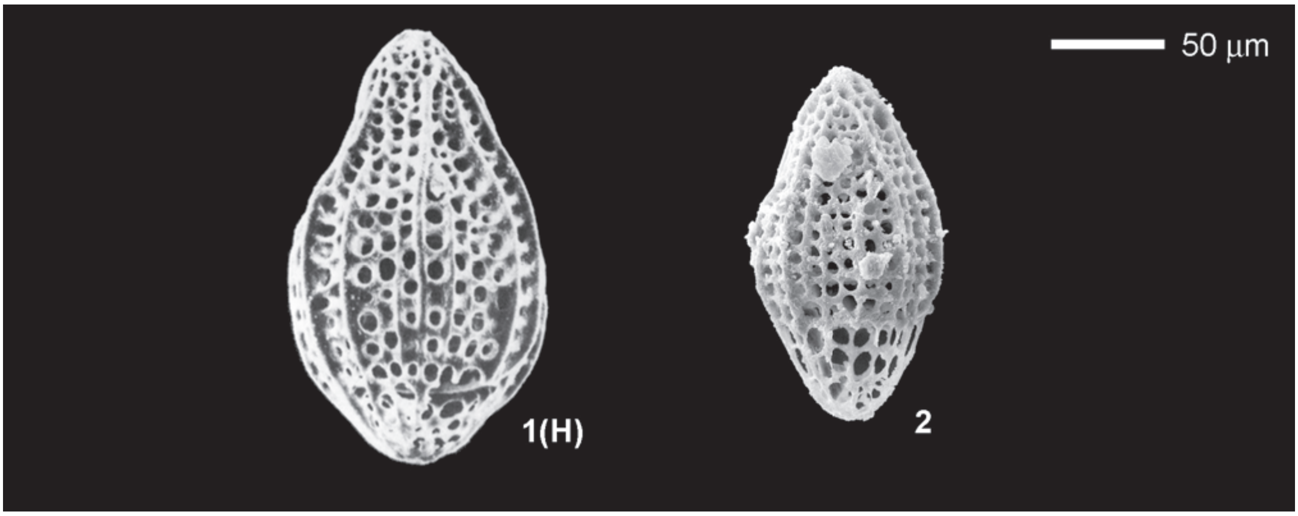


Plate UNM01. ***Unuma unicus*** **(Yeh).** Magnification x300. **Fig. 1(H).** Yeh 1987b, pl. 17, fig. 21.
Fig. 2. Matsuoka 2004, fig. 190.

Genus: *Williriedellum* Dumitrica 1970

Type species: *Williriedellum crystallinum* Dumitrica 1970

Synonymy:

1970 *Williriedellum* n. gen. – Dumitrica, p. 69.

Original diagnosis: Cryptothoracic tricyrtids with large inflated abdomen having a constricted aperture and a complex sutural pore; cephalis free, poreless, with four collar pores, with or without a short apical horn; thorax porous, campanulate, small, without descending spines and partly depressed into abdomen.

Original remarks: *Williriedellum* is morphologically rather similar to *Zhamoidellum* n. gen. *Cryptamphorella* n.gen. and *Hemicryptocapsa* Tan. It differs from the first two ones particularly in having a constricted aperture, which constitutes the first external distinctive character. From the last one, with which it seems to be closely related by their constricted aperture, it differs in lacking the three descending thoracic spines and in the complex structure of its sutural pore.

Etymology: This genus is dedicated to William R. Riedel (Scripps Institution of Oceanography) as a homage for his sustained and indefatigable work in the study of Radiolaria. Neuter gender.

Included species:

TPS01 *Williriedellum*? *ferum* (Matsuoka) 1991

Williriedellum? *ferum* (Matsuoka) 1991

Species code: TPS01

Synonymy:

1991 *Tricolocapsa* (?) *fera* n. sp. – Matsuoka, p. 726, Fig. 4. 1a-3b.

2004 T*ricolocapsa*(?) *fera* Matsuoka – Matsuoka, fig. 83.

Original description: Shell of three segments, pyriform. Cephalis hemispherical, poreless with a small apical horn. Thorax truncate conical or cylindrical with small pores. Abdomen large, subspherical with a constricted aperture. Collar stricture slightly recognizable externally. Lumber stricture pronounced. Pores moderate in size, circular to subcircular, densely spaced and set in polygonal (largely hexagonal) pore frames. Abdomen possessing small pointed spines situated at the pore frame vertices. Aperture moderate in size, circular with a short protruding rim.

Original remarks: This species is questionably assigned to *Tricolocapsa* because it possesses a small apical horn. However, it is uncertain whether the presence of an apical horn is an important criterion for classification at generic level of three-segmented nassellaria. The horn seems to be an extension of apical spine. *Tricolocapsa* (?) *fera*, n. sp., is similar to *T. tetragona* Matsuoka and *T*. sp. cf. *T. ruesti* Tan Sin Hok (in Yao, 1979) in general outline but differs from both by having an apical horn and by densely spaced pores on the abdomen.

Further remarks: In the present state of knowledge there is no Mesozoic genus to which this species can be confidently assigned. Since assignation to *Tricolocapsa* cannot be sustained any longer we assign it provisionally to *Williriedellum* because of the general shape, the number of segments and the presence of an aperture. However, the cephalis is divided into two chambers by an oblique septum as in the Amphipyndacidae and particularly in the Cretaceous genus *Squinabollum* Dumitrica. *Squinabollum* is similar in the general shape of shell, it has an apical horn, but lacks an aperture.

Measurements (μm):

Numbers of specimens measured are in parentheses.

	HT	Max.	Min.	Mean	
Total height of shell	139	146	125	133	(6)
Max. width of shell	100	125	96	107	(6)
Diameter of aperture	11	14	8	11	(5)

Etymology: This specific name is derived from the Latin *ferus-a-um* (= wild).

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, central Japan.

Occurrence: Mino Terrane, central Japan.

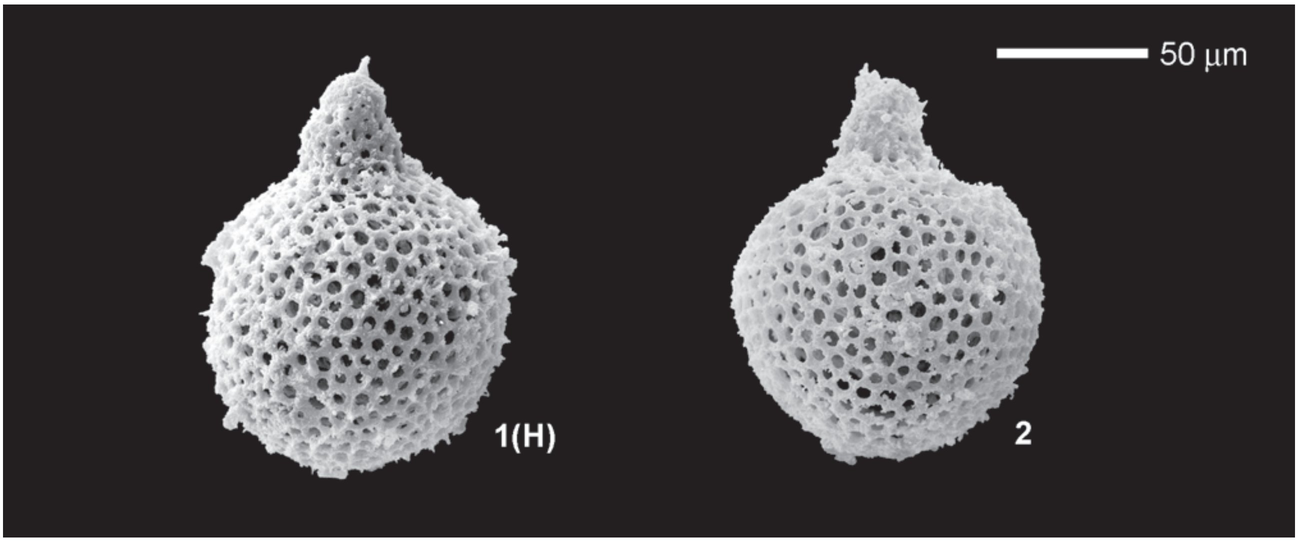


Plate TPS01. *Williriedellum*? *ferum* (Matsuoka). Magnification x400. **Fig. 1(H).** Matsuoka 1991, Fig. 4.1a.
Fig. 2. Matsuoka 1991, Fig. 4.2a.

Genus: ***Wrangellium*** Pessagno & Whalen 1982, emend. Yeh 1987a

Type species: *Wrangellium thurstonense* Pessagno & Whalen 1982

Synonymy:

1982 *Wrangellium* n. gen. – Pessagno & Whalen, p. 126.
1987a *Wrangellium* Pessagno & Whalen, emend. – Yeh, p. 67.

Original description: Test conical, multicyrtid, large, lobulate in outline with numerous closely spaced post-abdominal chambers separated by nodose circumferential ridges with H-linked structure. Longitudinally aligned, paired circular to elliptical primary pores situated in symmetrical, polygonal (mostly tetragonal) pore frames sloping steeply to either side of circumferential ridges; ridges continuous with platform-like septal partitions possessing large, circular apertures. Post-abdominal chambers with medially situated constrictions in areas between ridges. Single transverse row of large polygonal pore frames situated in constrictions between ridges, often completely obscured by veneer of micro-granular silica (pl. 3, fig. 10). Cephalis and thorax imperforate, covered by veneer of microgranular silica. Cephalis lacking horn. Test terminating in a large (approximately 1/3 length of test) flaring, tubular structure with large irregular pores and longitudinal ridges (pl. 3, fig. 18); tubular structure lacking septal partitions.

Original remarks: *Wrangellium* n. gen., differs from *Canoptum* Pessagno by having large primary pores on its circumferential ridges which remain open during ontogeny and by having a single row of large symmetrical pore frames in the constrictions between ridges. It is likely that *Wrangellium* was derived from a *Canoptum* stock with H-linked circumferential ridges.

Emended definition: By Yeh (1987a): As with that of Pessagno & Whalen (1982, p. 126), but including forms with three pores aligned perpendicular to each circumferential ridge, and also including forms with spine on the cephalis.

Etymology: *Wrangellium* is named for the Mesozoic terrane of Wrangellia (Jones, Silberling and Hillhouse, 1977).

Included species:

WNG03 *Wrangellium oregonense* Yeh 1987a
WNG01 *Wrangellium thurstonense* Pessagno & Whalen 1982
WNG04 *Wrangellium* sp. A sensu Pessagno & Whalen 1982

Wrangellium oregonense Yeh 1987a

Species code: WNG03

Synonymy:

1987a *Wrangellium oregonense* n. sp. – Yeh, p. 69, pl. 2, figs. 1-8, 14-15, 19-20.
1987b *Wrangellium oregonense* Yeh – Yeh, p. 58, pl. 15, figs. 5-7, 14, 18-19, 24; pl. 27, figs. 3, 22.
1987b *Crubus* sp. B – Yeh, p. 71, pl. 23, fig. 6.
1988 *Wrangellium oregonense* Yeh – Carter et al., p. 50, pl. 6, figs. 8, 11.

Original description: Test conical, lobate, with as many as eight post-abdominal chambers. Cephalis conical, moderately large, with small delicate horn when well-preserved. Thorax and subsequent chambers rapidly increasing in width and gradually increasing in length as added. Cephalis, thorax, and abdomen imperforate, covered with thick layer of microgranular silica and separated from each other by one row of small elliptical pores. Each post-abominal chamber with central row of pore frames covered with microgranular silica, flanking rows of pore frames remaining open. Pores rapidly increasing in size distally. About eight to ten pores visible laterally in each row.

Original remarks: *Wrangellium oregonense*, n. sp., differs from *W. izeense*, n. sp., by having a smaller, more conical cephalis with small spine, by having a test more conical in shape, and by possessing larger, paired pores aligned perpendicular to the ridges.

Measurements (μm):

Ten specimens measured.

	Max. length	Max. width
HT	258	123
Mean	274	123
Max.	288	135
Min.	258	118

Etymology: This species is named for the state of Oregon.

Type locality: Sample OR-600A, Hyde Formation along Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Snowshoe Formation, Oregon; Fannin and Whiteaves formations, Queen Charlotte Islands.

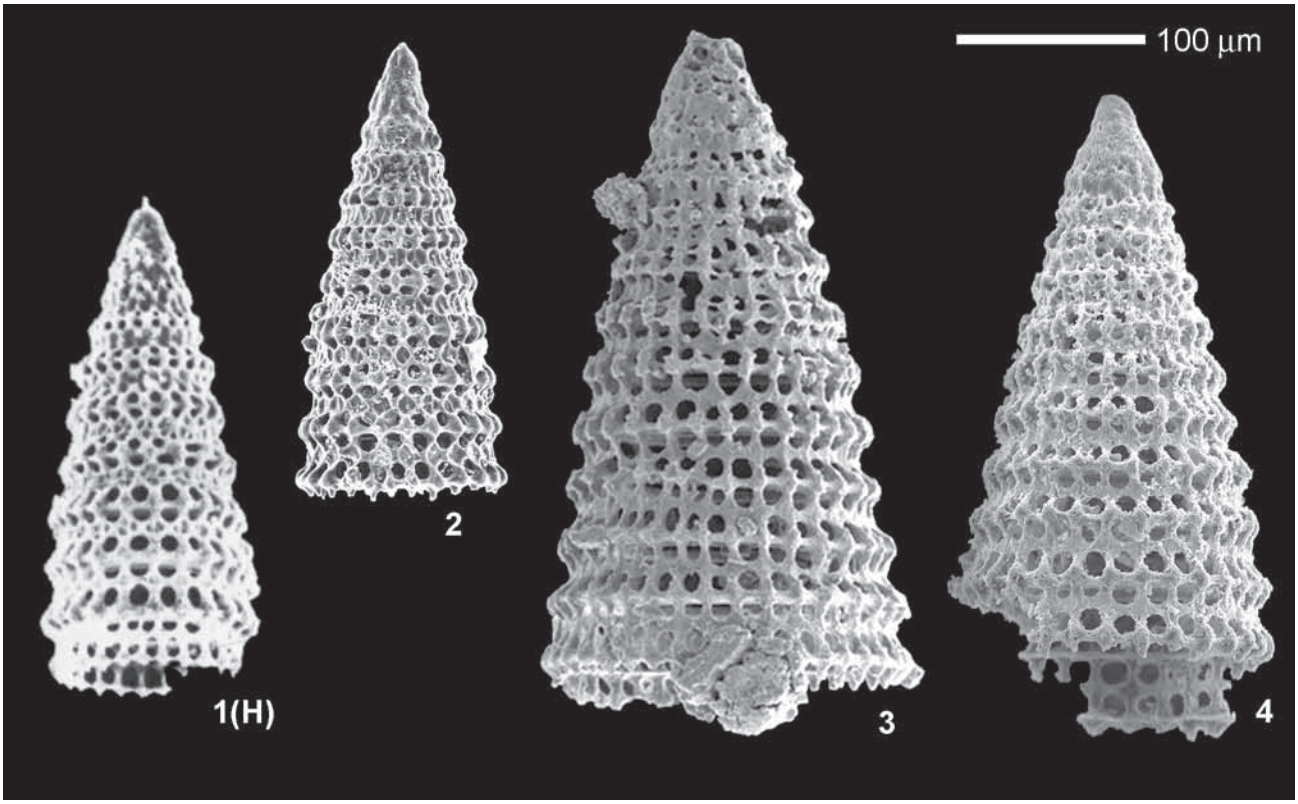


Plate WNG03. ***Wrangellium oregonense*** **Yeh.** Magnification x250. **Fig. 1(H).** Yeh 1987b, pl. 15, fig. 5. **Fig. 2.** Carter et al. 1988, pl. 6, fig. 8. **Fig. 3.** QCI, GSC loc. C-304566, GSC 111785. **Fig. 4.** QCI, GSC loc. C-080613, GSC 111786.

Wrangellium thurstonense Pessagno & Whalen 1982
Species code: WNG01

Synonymy:
1982 *Wrangellium thurstonense* n. sp. – Pessagno & Whalen, p. 126, pl. 2, figs. 7, 13; pl. 3, figs. 1, 3, 10, 18; pl. 12, fig. 13.
1998 *Wrangellium thurstonense* Pessagno & Whalen – Whalen & Carter, p. 65, pl. 17, figs. 5, 6; pl. 26, fig. 7.

Original description: Test with as many as 13 post-abdominal chambers with rare spines attached to circumferential ridges (many more spines probably broken off). Majority of large primary pores circular, set in square pore frames along circumferential ridges. When visible, pores within constrictions large, circular. Cephalis and thorax conical, imperforate, completely covered by microgranular silica. Proximal post-abdominal chambers very gradually increasing in width with distal post-abdominal chambers remaining the same width. Flaring, tubular structure rapidly increasing in width, about 50% wider than test at its termination. Irregularly sized pores randomly distributed over tubular structure with two sharp ridges extending along its length.

Original remarks: *Wrangellium thurstonense*, n. sp. differs from *Wrangellium* sp. A by having much less pronounced circumferential ridges. In addition, *Wrangellium* sp. A possesses larger pores within the constrictions between ridges.

Measurements (μm):
Based on 7 specimens.

Length	Width (max.)	
325.0	100.0	HT
382.0	160.0	Max.
245.0	100.0	Min.
303.1	112.4	Mean

Etymology: This species is named for Turston Harbor, northwest of its type locality.

Type locality: Sample QC 590A, Sandilands Formation (Kunga Formation in Pessagno & Whalen, 1982), Queen Charlotte Islands, British Columbia.

Occurrence: Sandilands Formation, Queen Charlotte Islands.

***Wrangellium* sp. A** sensu Pessagno & Whalen 1982
Species code: WNG04

Synonymy:
1982 *Wrangellium* sp. A – Pessagno & Whalen, p. 126, pl. 3, figs. 2, 8, 9.

Remarks: Differs from *Wrangellium thurstonense* Pessagno & Whalen 1982 in having fewer postabdominal chambers and a more lobate outline. It further differs from *W. izeense* Yeh 1987a in having a conical rather than rounded cephalis and two rows of pores rather than three per chamber.

Occurrence: Franciscan Complex, California; Sandilands and Ghost Creek formations, Queen Charlotte Islands.

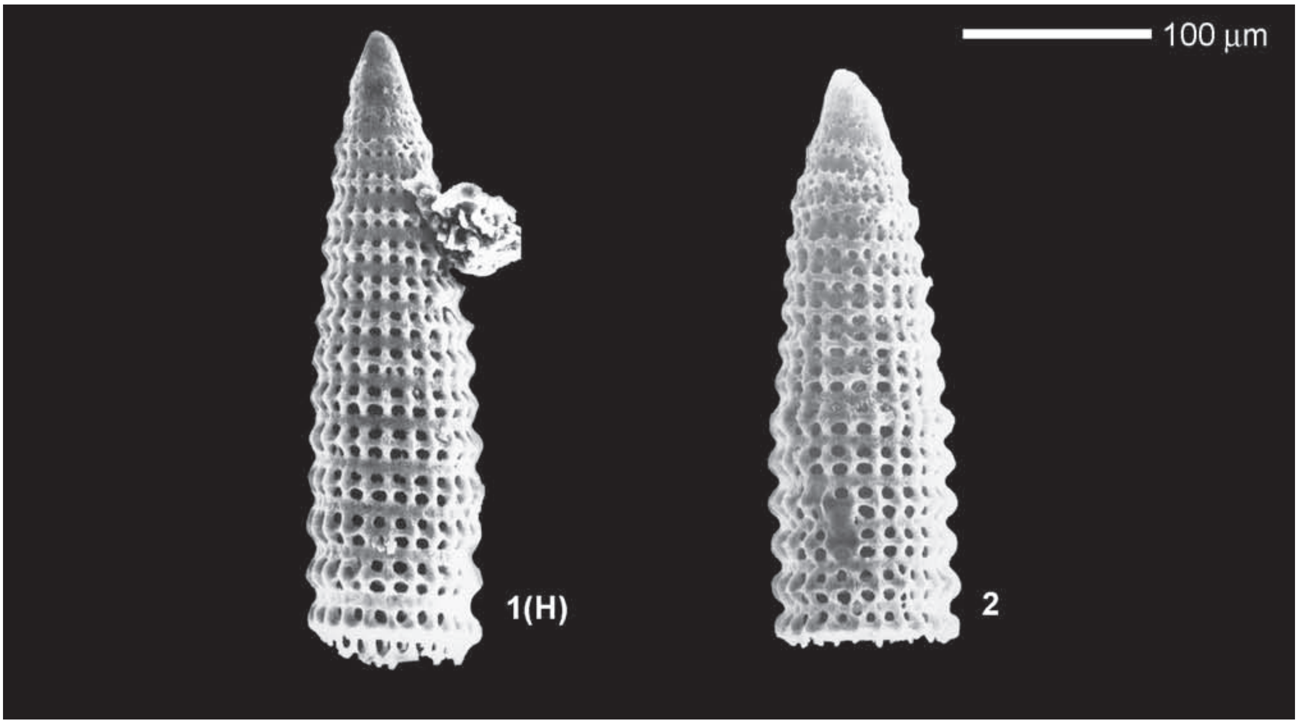


Plate WNG01. ***Wrangellium thurstonense* Pessagno & Whalen.** Magnification x250. **Fig. 1(H).** Pessagno & Whalen 1982, pl. 2, fig. 7. **Fig. 2.** Carter et al. 1998, pl. 17, fig. 5.

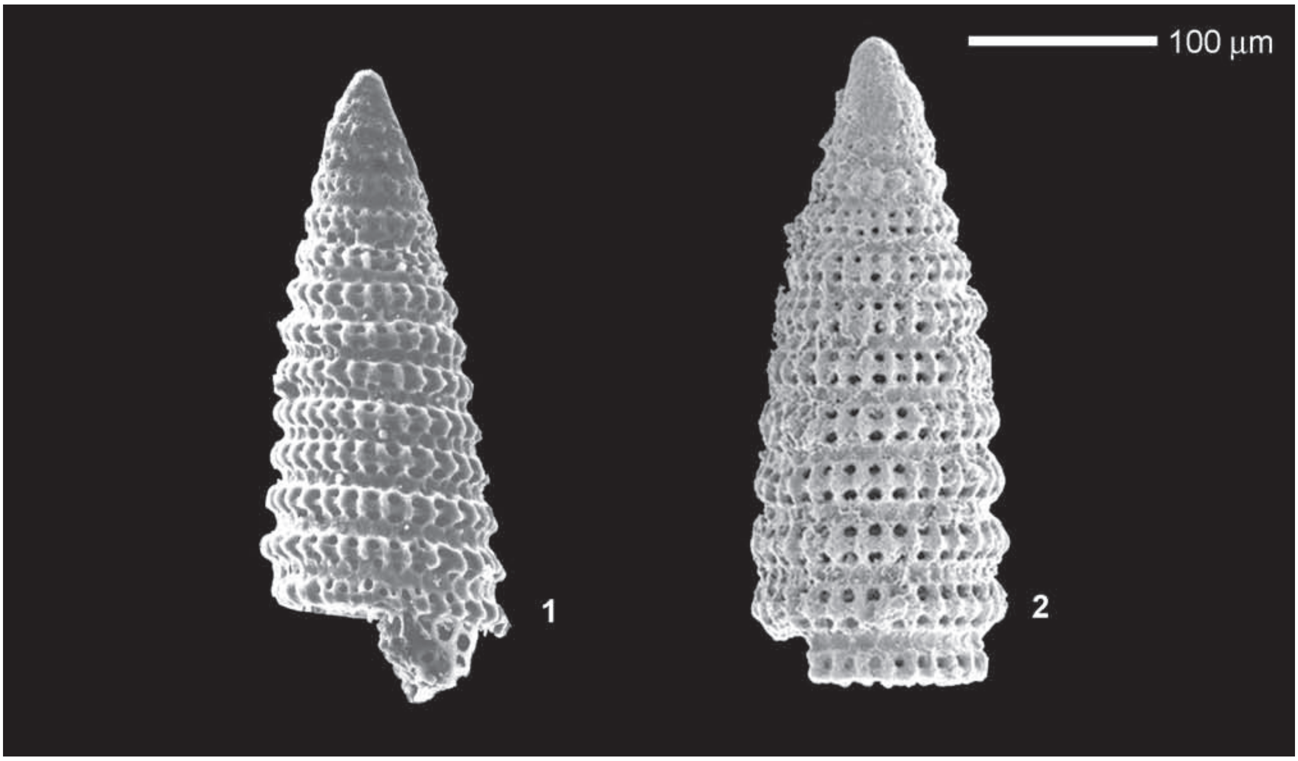


Plate WNG04. ***Wrangellium* sp. A sensu Pessagno & Whalen.** Magnification x250. **Fig. 1.** Pessagno & Whalen 1982, pl. 3, fig. 2. **Fig. 2.** QCI, GSC loc. C-080612, GSC 111787.

Genus: *Xiphostylus* Haeckel 1881, emend. Pessagno & Yang 1989

Type species: *Xiphostylus attenuatus* Rüst 1885 (subsequent designation by Campbell, 1954)

Synonymy:

1881 *Xiphostylus* n. gen. – Haeckel, p. 449.

1989 *Xiphostylus* Haeckel emend. Pessagno & Yang – Pessagno et al., p. 232.

Emended description: By Pessagno & Yang in Pessagno et al. (1989): Test with subspherical to ellipsoidal cortical shell with opposed secondary spines. Secondary spines subequal in length, predominantly triradiate in axial section with three longitudinal grooves alternating with three longitudinal ridges. Shorter spine often more massive and wider than longer spine. Spines attached to latticed cortical shell by means of latticed protrusions of cortical shell referred to herein as cortical buttresses (pl. 1, figs. 3-4). Outer latticed layer of cortical shell usually not as thick as that of *Tripocyclia* Hackel or *Triactoma* Rüst (cf. pl. 1, figs. 2, 5-6, 8, 10-11, 13).

Emended remarks: By Pessagno & Yang in Pessagno et al. (1989): *Xiphostylus* Haeckel differs from *Triactoma* Rüst by possessing two opposed secondary spines with cortical buttresses, and a less spherical cortical shell.

Included species:

XTL02 *Xiphostylus duvalensis* Carter n. sp.

XTL01 *Xiphostylus simplus* Yeh 1987b

Xiphostylus duvalensis Carter n. sp.

Species code: XTL02

Type designation: Holotype GSC 111788 from GSC loc. C-080610; Fannin member of the Fannin Formation (upper Pliensbachian).

Description: Cortical shell large, spherical in outline, with two polar spines approximately equal in length. Shell comprised of small pentagonal and hexagonal pore frames with thin rims and deep walls; small pointed nodes at pore frame vertices. Spines relatively short (less than diameter of shell), and fairly constant in width. Spines triradiate with wide rounded ridges and narrow grooves; ridges terminate with small thorns, raised at right angles to axis of spine. Spine tips circular in axial section.

Remarks: *Xiphostylus duvalensis* n. sp. differs from *X. simplus* Yeh in having spines whose ridges terminate in small thorns.

Measurements (μm):
Based on 2 specimens.

	HT	2nd spec.
Diameter of cortical shell	136	107
Length of longer polar spine	93	97
Length of shorter polar spine	82	83

Etymology: Species named for Duval Rocks, west of type locality on north shore of Cumshewa Inlet, Queen Charlotte Islands.

Type locality: Sample CAA-85-SP-27, lms. 2 (GSC loc. C-080610), Fannin member of the Fannin Formation, north shore Cumshewa Inlet, Moresby Island, Queen Charlotte Islands, British Columbia.

Occurrence: Fannin member of the Fannin Formation, Queen Charlotte Islands; Tawi Sadh Member of the Guwayza Formation, Oman.

Xiphostylus simplus Yeh 1987b

Species code: XTL01

Synonymy:

1987b *Xiphostylus simplus* n. sp. – Yeh, p. 52, pl. 10, fig. 7; pl. 22, fig. 4.

1987b *Xiphostylus* sp. A – Yeh, p. 53, pl. 3, fig. 15; pl. 10, fig. 10.

1987b *Xiphostylus* sp. B – Yeh, p. 53, pl. 26, figs. 7, 11.

1987 *Xiphosphaera* spp. – Hattori, pl. 22, figs. 9-14, not fig. 15.

1989 *Xiphostylus* sp. – Hattori & Sakamoto, pl. 1, fig. K.

1989 *Xiphostylus* spp. – Hattori, pl. 4, fig. B, C, D.

1990 *Xiphostylus* sp. – Nagai, pl. 5, fig. 5.

1997 *Xiphostylus simplus* Yeh – Yao, pl. 1, fig. 15.

1997 *Xiphostylus* sp. P2 – Yao, pl. 1, fig. 16.

2003 *Xiphostylus* spp. – Goričan et al., p. 291, pl. 1, fig. 1.

Original description: Test large, subspherical in outline, with two polar spines unequal in length. One spine long and massive, triradiate with three rounded ridges alternating with three wide grooves; ridges and grooves displaying slight torsion. One polar spine extremely short and pointed in nature. Test comprised of regularly sized pentagonal and hexagonal pore frames. Pore frames thin in rims and thick in sides with numerous laminations superimposed on each pore frame (plate 22, figure 4).

Original remarks: This form is characterized by having a large spherical test with one extremely short polar spine and one long, massive polar spine.

Further remarks: Included are specimens with simple polar spines regardless of their length.

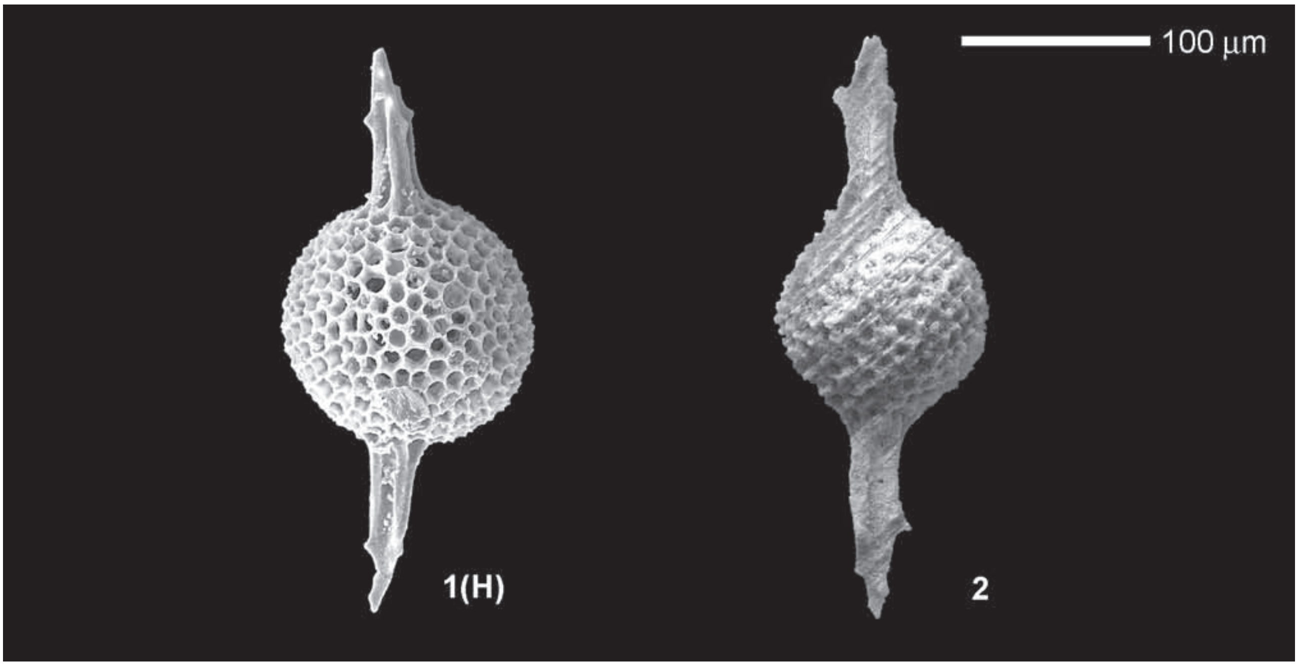


Plate XTL02. *Xiphostylus duvalensis* Carter n. sp. Magnification x250. **Fig. 1(H).** QCI, GSC loc. C-080610, GSC 111788. **Fig. 2.** OM, BR473-R16-02.

Measurements (µm):

Ten specimens measured.

	Diameter of test	Length of longer polar spine	Length of shorter polar spine
HT	110	110	25
Mean	111	108	27
Max.	115	110	30
Min.	108	102	23

Etymology: *Simplus-a-um* (Latin, adj.) = simple.

Type locality: Sample OR-600M, Hyde Formation at Izee-Paulina road, east-central Oregon.

Occurrence: Nicely and Hyde formations, and Warm Springs member of the Sowshoe Formation, Oregon; Skrile Formation, Slovenia; Tawi Sadh Member of the Guwayza Formation, Oman; Japan.

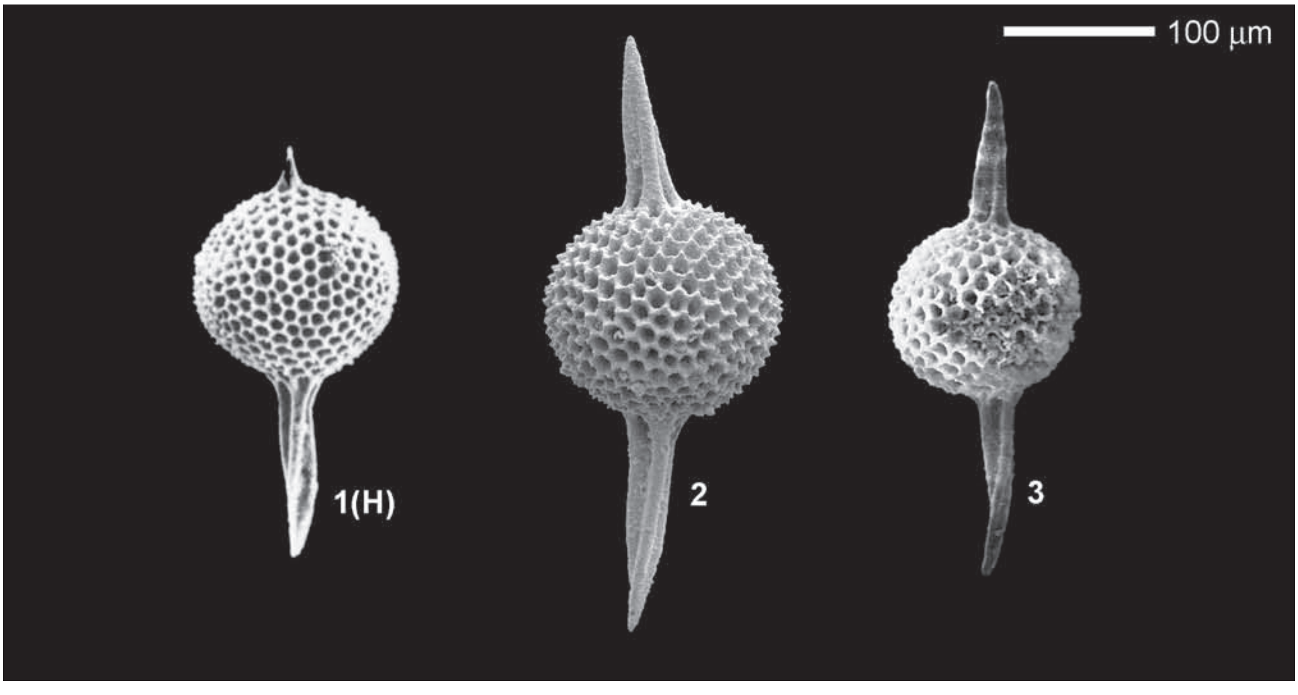


Plate XTL01. *Xiphostylus simplus* Yeh. Magnification x200. **Fig. 1(H).** Yeh 1987b, pl. 10, fig. 7. **Fig. 2.** OM, BR706-R13-01. **Fig. 3.** Goričan et al. 2003, pl. 1, fig. 1.

Genus: *Zartus* Pessagno & Blome 1980

Type species: *Zartus jonesi* Pessagno & Blome 1980

Synonymy:

1980 *Zartus* n. gen. – Pessagno & Blome, p. 249.

Original description: Cortical shell spherical to ellipsoidal with well developed raised median band. Pore frames on median band thicker in Z direction (text-fig. 5) than those of remainder of test. Raised median band with short, broad, often massive, triradiate secondary spines; secondary spines centered on pore frame vertices with ridges of spines extending onto 3 bars of adjacent pore frames. Test with 2 polar spines of different length; polar spines usually triradiate but sometimes partially circular in axial section. First medullary shell with thin, fragile pore frames.

Original remarks: The triradiate secondary spines of *Zartus* n. gen. are centered on the pore frame vertices along the center of the median band. Their ridges extend distally onto the bars of 3 adjacent pore frames (pl. 7, figs. 6, 12). The pore frames of *Zartus*, which are normally quite thick in the Z direction (text-fig. 5), are even thicker in the Z direction along the median band. Such an increase in thickness along the median band may offer stouter support for the massive secondary spines. *Zartus* n. gen. differs from *Pantanellium* Pessagno in possessing a well-developed, raised median band with triradiate secondary spines. The phylogenetic relationship of *Zartus* to other genera of the Pantanellinae is discussed elsewhere in this report.

Etymology: *Zartus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. IV, Recommendation 40, p. 113).

Included species:

ZRT01 *Zartus mostleri* Pessago & Blome 1980

ZRT03 *Zartus stellatus* Goričan & Matsuoka n. sp.

Zartus mostleri Pessagno & Blome 1980

Species code: ZRT01

Synonymy:

1980 *Zartus mostleri* n. sp. – Pessagno & Blome, p. 252, pl. 6, figs. 3-5, 13.
1989 *Zartus* sp. A – Hattori, pl. 9, fig. G.
1989 *Zartus* sp. B – Hattori, pl. 9, fig. H.
1989 *Zartus* sp. C – Hattori, pl. 9, fig. I.
1989 *Zartus* spp. – Hattori, pl. 9, fig. K.
1997 *Zartus* sp. B0 – Yao, pl. 4, fig. 153.
1997 *Zartus dicksoni* Pessagno & Blome – Yao, pl. 4, fig. 154.
2003 *Zartus* aff. *mostleri* Pessagno & Blome – Goričan et al., p. 291, pl. 1, figs. 4-6.

Original description: Cortical shell ellipsoidal with large, hexagonal to pentagonal pore frames with spinose nodes at vertices. Bars of pore frames thin in Y direction; thick in Z direction (text-fig. 5). Four to 5 pore frames visible along AA'; 5 along BB'. Median band weakly developed, having 4 wide, long (16 x 25µm on holotype) relatively massive triradiate secondary spines. Polar spines triradiate in axial section; shorter spine with 3 massive, wide ridges alternating with 3 moderately narrow grooves; grooves about equal in width to ridges. Shorter polar spine about 2/3 length of longer polar spine. Longer polar spine with 3 wide grooves alternating with 3 relatively narrow ridges. First medullary shell with fragile hexagonal and pentagonal pore frames.

Original remarks: *Zartus mostleri* n. sp., differs from *Z. jurassicus*, n. sp., in having much longer polar spines and a much narrower median band. It appears to have been the first species of *Zartus* to appear and may have arisen from *Pantanellium danaense*, n. sp., ancestor.

Further remarks: In this species we also include forms with many short triradiate secondary spines, extending from most of the pore-frame vertices on the median band (pl. ZRT01, figs. 3, 4). These forms differ from *Zartus mostleri* s. s. by having more numerous (more than four) and shorter secondary spines.

Measurements (µm):

Based on 6 specimens. System of measurement shown in text-figure 5 of Pessagno & Blome (1980).

AA'	A'S'	AS	BB'	cc'	dd'	
95	125	115	100	35	25	HT
98	117	83	101	30	28	Av.
110	125	115	115	35	40	Max.
90	100	65	90	25	25	Min.

Etymology: This species is named for Dr. Helfried Mostler in honor of his pioneering contribution to the study of Triassic Radiolaria.

Type locality: Sample QC 534, Fannin Formation (Maude Formation in Pessagno Blome, 1980), Queen Charlotte Islands.

Occurrence: Ghost Creek and Fannin formations, Queen Charlotte Islands; Skrile Formation, Slovenia; Japan.

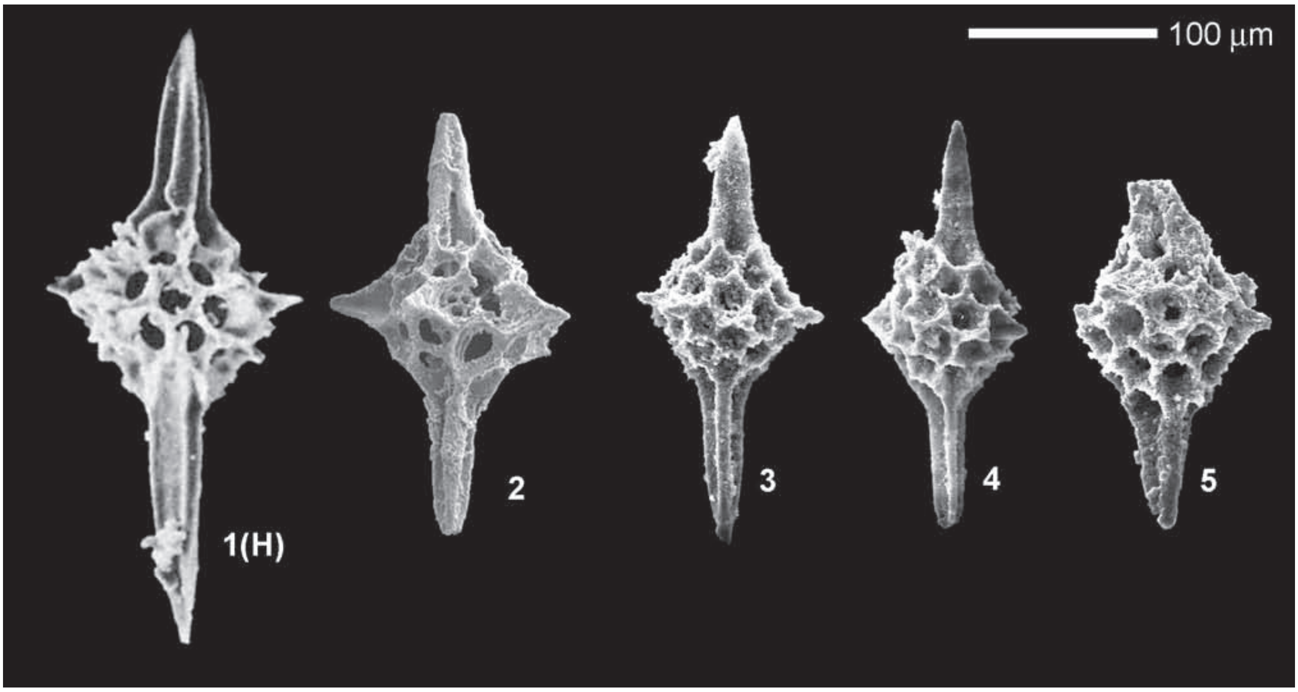


Plate ZRT01. *Zartus mostleri* Pessagno & Blome. Magnification x250. **Fig. 1(H).** Pessagno & Blome 1980, pl. 6, fig. 3. **Fig. 2.** QCI, GSC loc. C-080612, GSC 111789. **Fig. 3.** Goričan et al. 2003, pl. 1, fig. 4. **Fig. 4.** SI, MM 6.76, 000407. **Fig. 5.** Goričan et al. 2003, pl. 1, fig. 6.

Zartus stellatus Goričan & Matsuoka n. sp.

Species code: ZRT03

Synonymy:

? 1989 *Zartus* spp. – Hattori, pl. 9, fig. L.
1997 *Zartus* sp. A0 – Yao, pl. 4, fig. 152.
2003 *Zartus* sp. A0 sensu Yao – Goričan et al., p. 291, pl. 1, fig. 3.
2004 *Zartus* (?) sp. – Matsuoka, fig. 17.

Type designation: Holotype specimen MA 11322 from sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Description: Cortical shell subspherical with relatively small hexagonal and pentagonal pore frames. Five to six pore frames visible along AA'. Median band bears several (more than four, usually seven) long massive triradiate secondary spines, pyramidal in shape. Polar spines long and robust, approximately equal in length; width constant through most of the length, then decreasing more rapidly towards spine tips. Polar spines triradiate with three rounded ridges alternating with three deep grooves.

Remarks: *Zartus stellatus* n. sp. differs from all other *Zartus* species by having larger polar spines and numerous long secondary spines on median band.

Measurements (μm):
Based on 5 specimens.

	HT	Min.	Max.	Mean
Width of shell along BB'	76	75	90	80
Length of polar spines	128, 145	72	145	108
Width of polar spines at base	40, 34	30	40	35
Maximum length of secondary spines	46	26	46	36

Etymology: *Stellatus-a-um* (Latin, adj.) = stellate, arranged like a star, radiating.

Type locality: Sample MNA-10, Nanjo Massif, Mino Terrane, Japan.

Occurrence: Mino Terrane, Japan; Skrile Formation, Slovenia.

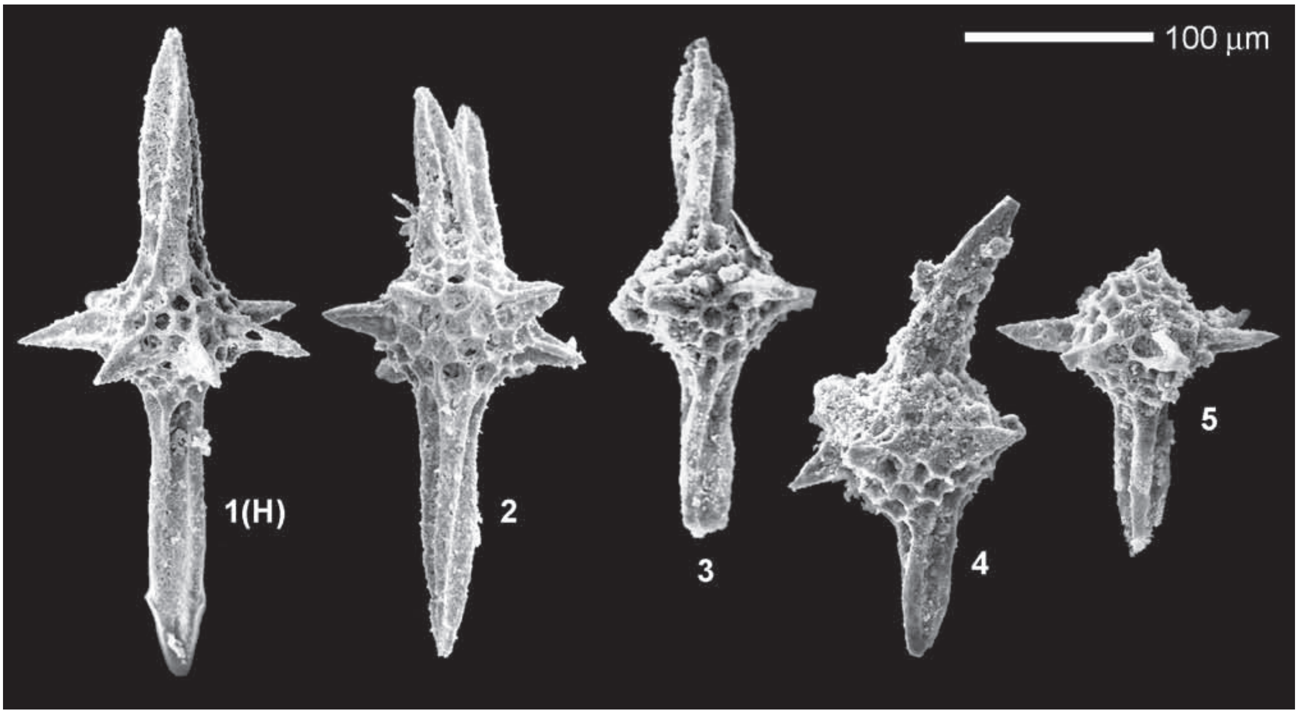


Plate ZRT03. ***Zartus stellatus*** **Goričan & Matsuoka n. sp.** Magnification x250. **Fig. 1(H).** Matsuoka 2004, fig. 17. **Fig. 2.** JP, MNA-10, MA11505. **Fig. 3.** Goričan et al. 2003, pl. 1, fig. 3. **Fig. 4.** SI, MM 6.76, 000525. **Fig. 5.** SI, MM 6.76, 000406.

Genus: ***Zhamoidellum*** Dumitrica 1970

Type species: *Zhamoidellum ventricosum* Dumitrica 1970

Synonymy:
1970 *Zhamoidellum* n. gen. – Dumitrica, p. 79.
1992 *Complexapora* n. gen. – Kiessling & Zeiss, p. 190.

Original description: Cryptothoracic tricyrtids with large inflated abdomen without aperture or sutural pore. Cephalis poreless, with four collar pores, with or without a short apical horn; thorax campanulate, porous, partly depressed into the abdominal cavity, its opening without descending spines.

Original remarks: This new genus is very similar to *Cryptamphorella* n. gen. from which it differs, firstly, by the porous structure of its thorax and, secondly, by having no sutural pore. In fact, *Cryptamphorella* sometimes does not possess a sutural pore. The members of this genus are very frequent in the Upper Jurassic. We described herein only two better preserved species.

Further remarks: It is possible that this genus is a junior synonym of *Trisyringium* Vinassa, 1901 (type species *Trisyringium capellinii* Vinassa) from which it only differs in lacking spines on the abdominal segment. *Complexapora* Kiessling & Zeiss 1992 (type species *Complexapora tirolica* Kiessling) should be considered a junior synomym of *Zhamoidellum*. The latter genus was originally considered to differ from *Zhamoidellum* only in having a sutural pore; however, this pore is only a depression of the abdominal wall. Such a depression is present but very weakly developed in the type species.

Etymology: The genus is dedicated to Dr. A. I. Zhamoida as a homage to his activity for disentangling the biostratigraphy of the Mesozoic radiolaritic series. Neuter gender.

Included species:
COM01 *Zhamoidellum yehae* Dumitrica n. sp.

Zhamoidellum yehae Dumitrica n. sp.

Species code: COM01

Synonymy:
1988 *Dicolocapsa* aff. *verbeeki* Tan – Li, pl. 1, fig. 23.
1998 *Complexapora* sp. A – Yeh & Cheng, p. 33, pl. 4, fig. 13; pl. 9, fig. 18, 22.
2005 *Tricolocapsa* sp. – Kashiwagi et al., pl. 6, fig. 18.

Type designation: Holotype specimen BR1121-R06-22 from sample BR 1121, Guwayza Formation, Tawi Sadh Member, Wadi Mu'aydin, Oman.

Diagnosis: A small species of *Zhamoidellum* with cephalothorax half or more depressed in the cavity of a spherical abdomen.

Description: Cephalothorax with apically rounded, imperforate cephalis and with thorax depressed in the abdominal cavity. Abdomen spherical with numerous small pores of various size and irregular arrangement. Pore frames circular or polygonal, usually hexagonal, with or without tiny thorns at vertices. Sutural pore represented by a small, irregular depression in the vicinity of cephalothorax.

Remarks: *Zhamoidellum yehae* n. sp. differs from *Z. ventricosum* Dumitrica in being smaller, in having a spherical abdomen and a small sutural depression.

Measurements (μm): Based on 6 specimens. Diameter of abdomen 123-132 (holotype 132). The two specimens illustrated by Yeh & Cheng (1998) are larger; the diameter of their abdomen is 157 and 182 respectively.

Etymology: The species is named for Kuei-Yu Yeh, Taiwan, honoring her contribution to the knowledge of Mesozoic Radiolaria.

Type locality: Sample BR1121, Tawi Sadh Member, Guwayza Formation, Wadi Mu'aydin, Oman.

Occurrence: Tawi Sadh Member of the Guwayza Formation and Haliw (Aqil) Formation, Oman; Liminangcong Chert, Philippines; Dengqen area, Tibet; Japan; Ghost Creek Formation, Queen Charlotte Islands.

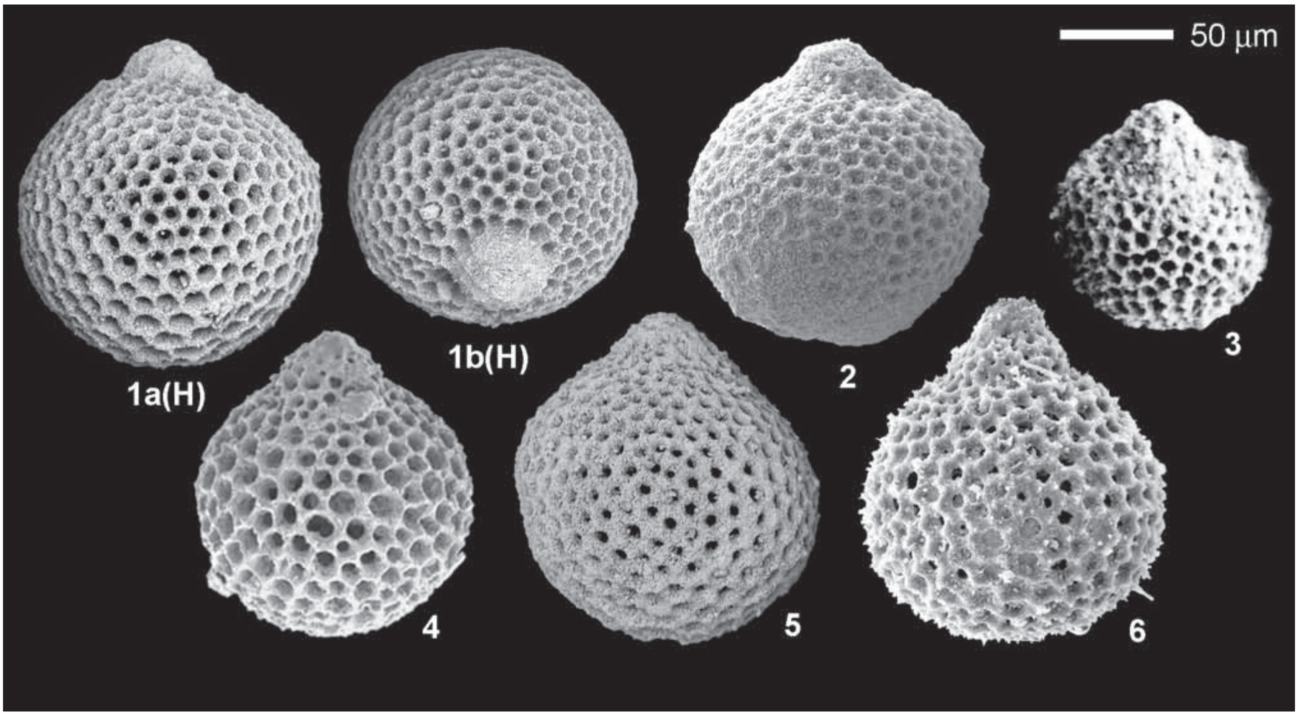


Plate COM01. ***Zhamoidellum yehae*** **Dumitrica n. sp**. Magnification x300. **Fig. 1(H)a-b.** OM, BR1121-R06-22a, b. **Fig. 2.** OM, Haliw-038-R08-20. **Fig. 3.** JP, Ku(b)-11-77. **Fig. 4**. QCI, GSC loc. C-304281, GSC 128751. **Fig. 5.** OM, BR1121-R05-05b. **Fig. 6.** JP, MNA-10, MA12277.

3. DESCRIPTION OF LOCALITIES

Locality data are provided only for specimens that are illustrated in the catalogue. The exact location, a short description of lithology and the overall stratigraphic range of the studied successions are given. Stratigraphically important co-occurring fossils are also indicated. The number preceding each area corresponds to the locality number on the world map (Fig. 1.2, p. 11). Stratigraphic ranges of all studied formations are summarized in Fig. 3.1, p. 416.

1. NORTHEASTERN BRITISH COLUMBIA

Williston Lake

NTS 94B/3 Mt. Brewster; Peach Reach, UTM 497385N, 6215650W. Fernie Formation at Black Bear Ridge.

GSC loc. C-305208. Parts of a calcareous concretion collected in thinly laminated black, siliceous shales and siltstones from the lower part of the formation at Pardonet Creek, by R. Hall (University of Alberta, Calgary). Faunas present include a "bedding plane exposure of crinoids, which I assume to be *Seirocrinus* …." and a few "scrappy ammonite impressions" (R.H. Hall, pers. comm. 2000). Radiolarians are probably equivalent to faunas from the Whiteavesi Ammonite Zone in Queen Charlotte Islands (ESC).

NTS 94B/3 Mt. Brewster. UTM 497670N, 6215500W. 4 km northeast of Nabesche River. Fernie Formation. Sample collected 3.5 m west (?upsection) from crinoid bed at Black Bear Ridge section.

GSC loc. C-305813 (01-OF-BBR 6A), Pliensbachian. Sample collected by R. Hall.

2. QUEEN CHARLOTTE ISLANDS

Sinemurian

Graham Island, Yakoun River area

NTS 103 F/8 Graham Island. UTM 681500m E; 5921800m N (53° 24' 57.3" N; 132° 16' 8.3" W). Sandilands Formation, Kunga Group. Sample collected by B.E.B. Cameron in transit along west side of Yakoun River, south of junction with Ghost Creek, central Graham Island. Eroded riverside sequence of sandstone, siltstone and shale with rare limestone concretions. Ammonites collected in association with limestone sample are upper Sinemurian and belong to the Harbledownense Assemblage of Pálfy (1991) (H.W. Tipper, personal communication, 1994).

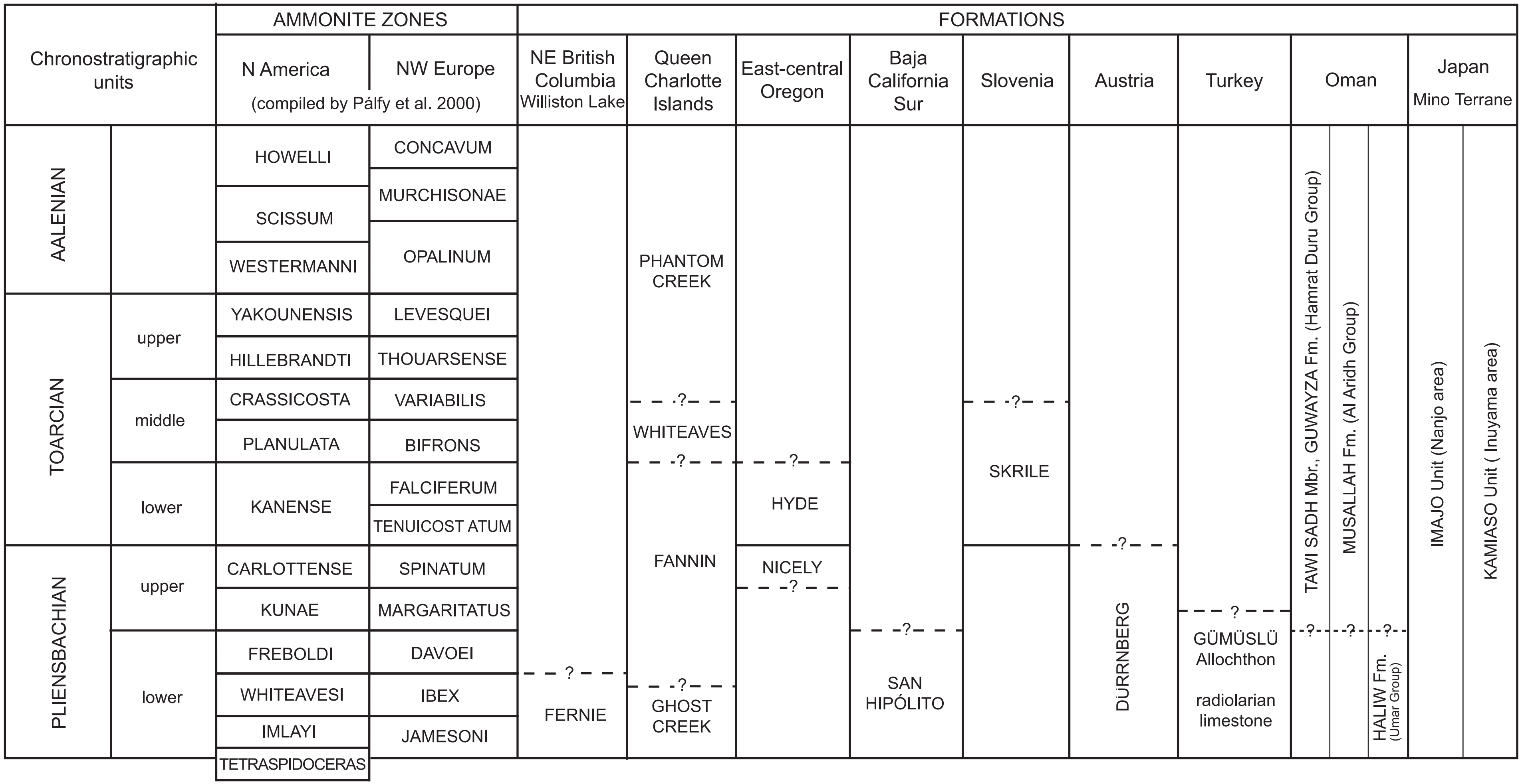


Fig. 3.1. Stratigraphy of included sites.

CAA- 86-T-2/3 GSC loc. C-140441. Carbonate concretion collected 76 m above base. Upper Sinemurian. Sample collected by B.E.B. Cameron.

Pliensbachian

Pliensbachian locality data from Queen Charlotte Islands (excluding Section 4 from Carter et al., 1988) are from an unpublished report to the Geological Survey of Canada by E. S. Carter (March 2002). Nearly all radiolarian samples co-occur with ammonites identified by H.W. Tipper (Geological Survey of Canada, deceased 2005) who also provided the ammonite zonal assignment.

Kunga Island

NTS 103 b/13 & 103 B/14 Louise Island. Lat. 52° 45' 53"N, Long. 131° 33' 08"W. Sandilands Formation, Kunga Group. Stratigraphic sequence along the southeast shore of Kunga Island. Note: the Sandilands Formation extends upward to the lowermost Pliensbachian at this locality whereas in nearly all others it extends only to the upper Sinemurian. Sequence composed mainly of interbedded siltstone and shale with minor sandstone, limy lenses and concretions.

GSC loc. C-305417. Limestone concretion collected 10.94 m above base of section. Tetraspidoceras Ammonite Assemblage, basal Pliensbachian.

Central Graham Island

NTS 103 F/8, Yakoun Lake. Lat. 53° 22' 30"N, Long. 132° 16' 00"W. Rennell Junction member of the Fannin Formation, Maude Group. Quarry above Rennell Junction, Rd. 19. Section consists of thick sandstone beds alternating with sequences of limy concretions and lenses in siltstone and fine sandstone.

GSC loc. C-177371. Limestone sample; base of Whiteavesi Zone, upper lower Pliensbachian.

Cumshewa Inlet, Moresby Island

NTS 103 G/4 Cumshewa Inlet. Lat. 53° 02' 53"N, Long. 131° 56' 05"W. Basal two-thirds of section composed of shale with very minor limestone concretions (Ghost Creek Formation); upper part composed of limy concretions and lenses in siltstone and minor shale (Rennell Junction member of Fannin Formation); uppermost beds more sandy with fewer concretionary lenses.

GSC loc. C-080610. Fannin Formation; spot sample collected in upper part of section by B.E.B. Cameron in 1986. ?Kunae Zone; upper Pliensbachian.

GSC loc. C-140413. Rennell Junction member of the Fannin formation. Collected 54 m below top of Fannin Formation. Whiteavesi Zone, upper lower Pliensbachian.

Louise Island

NTS 103 G/4 Cumshewa Inlet. Lat. 53° 02' 06"N, Long. 131° 52' 47"W. Fannin Formation. North shore of Louise Island approximately 2 km northeast along shore from Beattie Anchorage. Upper Pliensbachian stratigraphic sequence consists of sandstone alternating with limy concretions and lenses in siltstone and fine sandstone.

GSC loc. C-140418). Limy concretionary lens. ?Kunae/Carlottense Zones, upper Pliensbachian.

Maude Island, below ammonite type section

NTS 103 F/1 Skidegate Channel. Lat. 53° 11' 06"N, Long. 132° 04'02"W. Sandilands Formation, Kunga Group. Shoreline exposure ~ 0.5 km west of type section. Sequence composed mainly of siltstone and shale with minor sandstone and limy lenses.

GSC loc. C-304428. Sample from discontinuous limestone bed 6 cm thick. ?Tetraspidoceras Ammonite Assemblage; uppermost Sinemurian/basal Pliensbachian (J. Pálfy, pers. comm. 2001).

Maude Island, Tipper Creek

NTS 103 F/1 Skidegate Channel. Lat. 53° 11.82'N, Long. 132° 3.63'W. Fannin Formation, Maude Group. Tipper Creek flows onto beach approximately 100 m west of Fannin Bay (southwest coast of Maude Island) about midway through the type section of the Ghost Creek and Fannin formations (Cameron & Tipper, 1985). Stratigraphic sequence composed of interbedded medium grey sandstone, dark grey siltstone with rare shale and sandy limestone.

GSC loc. C-080577. Limestone sample collected 54.3 m stratigraphically below top of Fannin Formation. Carlottense Zone, upper Pliensbachian (see section 4, Bulletin 386, Carter et al., 1988).

Maude Island, west of Ells Bay

NTS 103 F/1 Skidegate Channel. Lat. 53° 11' 57"N, Long. 132° 2' 56"W. West side of Ells Bay. Type section of the Maude Formation of Sutherland Brown (1968). Total section extends over 112 m stratigraphically. The lower Ghost Creek Formation (46 m) is thick dark grey shale with rare limestone concretions and lenses; the overlying Rennell Junction member of the Fannin Formation (~37m) is comprised mainly of limy concretions and lenses interbedded in dark grey siltstone, minor shale and sandstone. Note: the upper beds of the Fannin Formation (~30 m) are much more sandy and contain only rare limy concretionary beds. The upper part of the Rennell Junction member yields the best preserved and most abundant radiolarian faunas in the entire sequence.

GSC loc. C-305386. Ghost Creek Formation, collected 1.0 m above base of section. Imlayi Ammonite Zone, lower Pliensbachian.

GSC loc. C-305388. Ghost Creek Formation, collected 3.0 m above base of section. Imlayi Ammonite Zone, lower Pliensbachian.

GSC loc. C-175310. Rennell Junction member of the Fannin Formation, collected 62 m above base of section. Whiteavesi Ammonite Zone, upper lower Pliensbachian.

GSC loc. C-304565. Rennell Junction member of the Fannin Formation, collected 68.9 m above base of section. Whiteavesi Ammonite Zone, upper lower Pliensbachian.

GSC loc. C-304566. Rennell Junction member of the

Fannin Formation, collected 70.7 m above base of section. Whiteavesi Ammonite Zone, upper lower Pliensbachian.

GSC loc. C-304567. Rennell Junction member of the Fannin Formation, collected 71.8 m above base of section. Whiteavesi Ammonite Zone, upper lower Pliensbachian.

GSC loc. C-304568. Rennell Junction member of the Fannin Formation, collected 75.4 m above base of section. Whiteavesi/Freboldi Ammonite Zones, upper lower Pliensbachian.

GSC loc. C-175306. Fannin Formation, collected 85 m above base of section. Basal Kunae Ammonite Zone; upper Pliensbachian.

Graham Island, Ghost Creek

NTS 103 F/8, Yakoun Lake. Lat. 53° 25' 46"N, Long. 132° 17' 16"W. Fannin Formation; Quarry on road north of Ghost Creek.

GSC loc. C-175309. Limy concretion in sandy beds of the Fannin Formation collected for radiolarians in 1990, by H.W. Tipper. Kunae Ammonite Zone, upper Pliensbachian.

Rennell Junction, Graham Island

NTS 103 F/8, Yakoun Lake. Lat. 53° 24' 26"N, Long. 132° 18' 13"W. High waterfall section east of 'Queen Charlotte Main', 0.25 km north of junction of 'Queen Charlotte Main' with road to Rennell Sound. Lower half of sequence mainly shale with rare limy concretions and lenses (Ghost Creek Formation); upper part of the sequence comprised of interbedded siltstone, sandstone, limestone and shale with rare concretionary lenses. This locality was collected in 1979-82 soon after the area was logged. It is now totally overgrown with a tall, dense forest and is, for all but the most doggedly-determined, totally inaccessible.

GSC loc. C-175311. Ghost Creek Formation. Collected 0.9 m above base of section. Imlayi Ammonite Zone, basal Pliensbachian.

GSC loc. C-080612. Ghost Creek Formation. Collected 2.8 m above base of section. Imlayi Ammonite Zone, lowermost Pliensbachian.

GSC loc. C-127868. Ghost Creek Formation. Collected ~6 m above base of section. Imlayi Ammonite Zone, lower Pliensbachian.

GSC loc. C-127867. Ghost Creek Formation. Collected ~6 m above base of section. Imlayi Ammonite Zone, lower Pliensbachian.

GSC loc. C-080611. Ghost Creek Formation. Collected 58.1 m above base of section. Whiteavesi Ammonite Zone, lower Pliensbachian.

GSC loc. C-080613. Rennell Junction member of the Fannin Formation. Collected 94.2 m above base of section. Freboldi Ammonite Zone, upper lower Pliensbachian.

GSC loc. C-140495. Rennell Junction member of the Fannin Formation. Collected 110 m above base of section. Basal Freboldi Ammonite Zone, upper lower Pliensbachian.

Toarcian, Aalenian and Bajocian localities

For further information see Appendix 1 in Carter et al. (1988).

Skidegate Inlet, Maude Island, south side

NTS 103 F/1, Skidegate Channel. Lat. 53° 11.94'N, Long. 132° 3.25'W. Whiteaves Formation, Maude Group. Creek flows onto beach just east of Fannin Bay, above a prominent sandstone with nodular coquinoid beds containing ammonites, bivalves, brachiopods and nautiloids (see Section 6 in Carter et al., 1988). Sequence comprised of pale grey-green weathering shale with limestone nodules and septarian nodules.

GSC loc. C-080579. Dark grey limestone nodule collected in creek bed 20.5 m stratigraphically below top of Whiteaves Formation. Occurs with *Phymatoceras* sp.; middle Toarcian.

Central Graham Island
Yakoun River

NTS 103 F/8, Yakoun Lake. Phantom Creek Formation, Maude Group. Yakoun River, Graham Island, approximately 2 km south of Ghost Creek; east side of river (see Section 12 in Carter et al., 1988). Grey-green weathering shale overlain by pale brown sandstone with minor shale interbeds and common buff-weathering sandy limestone lenses.

GSC loc. C-080583 and GSC loc. C-080584. Lat. 53° 25.19'N, Long. 132° 16.64'W. Light grey to brownish-grey sandy limestone collected 10.5 m and 14.5 m respectively, above top of Whiteaves Formation. Samples occur with ammonites and belemnites of late middle or early late Toarcian age.

GSC loc. C-080597. Lat. 53° 25.22'N, Long. 132° 15.73'W. Light grey limestone sample collected by H.W. Tipper, 1.8 km south of Ghost Creek. Occurs with late Toarcian ammonites.

GSC loc. C-156399. Lat. 53° 25' 20"N, Long. 132° 15' 45"W. Sample from large ellipsoidal buff-weathering carbonate concretion (60 cm diameter) collected 5 m above base of belemnite sandstone member of Phantom Creek Formation. Associated ammonites include *Erycitoides howelli* (White) which occurs 1.0 m above sample, and *Bredia* sp., which occur both 0.7 m below and 4.3 m above sample. Sample is probably early late Aalenian in age. For further information see Carter & Jakobs (1991).

Branch Road 59

NTS 103 F/8, Yakoun Lake. Lat. 53° 23.19'N, Long. 132° 16.23'W. Phantom Creek Formation, Maude Group. Small waterfall locality on east side of Branch Road 59, 0.5 km from 'Queen Charlotte Main' about 0.75 km north of junction with road to Rennell Sound (see section 13 in Carter et al., 1988). Exposed is upper part of Phantom Creek Formation and base of Graham Island Formation. Lowest beds are grey-green weathering shale and siltstone, equivalent to shales on Maude Island, Yakoun River and above the waterfall at Rennell Junction. Irregularly bedded, porly sorted sandstone overlies the shale and above the sandstone is a thick sequence of interbedded shale and tuff (Graham Island Formation).

GSC loc. C-080586. Medium dark grey sandy pelletal limestone talus sample. 'Hammatoceratid' ammonites below sample location; *Tmetoceras* sp. above; Aalenian.

Branch Road 57

NTS 103 F/8, Yakoun Lake. Branch Road 57, Graham Island. Graham Island Formation, Yakoun Group. Branch road 57 intersects 'Queen Charlotte Main' approximately 2 km north of its junction with the Rennell Sound Road (see section 14 in Carter et al., 1988). Base of section in fault contact with Phantom Creek Formation. Exposed are dark grey shale and siltstone with rare sandy layers and thin beds of buff weathering concretionary limestone.

GSC loc.C-080592. Lat. 53° 23.64'N, Long. 132° 16.21'W. Brownish grey limestone sample collected in shale 34 m stratigraphically above base of Graham Island Formation. Occurs with early Bajocian ammonites.

GSC loc. C-080593. Lat. 53° 23.63'N, Long. 132° 16.1'W. Greenish grey limestone sample, collected in shale 57 m stratigraphically above base of Graham Island Formation. Occurs with early Bajocian ammonites.

GSC loc. C-080595. Lat. 53° 23.63'N, Long. 132° 16.07'W. Greenish brown limestone sample collected in shale 63 m stratigraphically above base of Graham Island Formation. Occurs with early Bajocian ammonites.

3. EAST-CENTRAL OREGON

Hyde Formation

OR-600A. Massive, medium grey, volcaniclastic sandstone (volcanic wacke) with occasional thin interbeds of tuffaceous mudstone and siltstone. Well preserved silicified Radiolaria occurring in small, dark grey, micritic limestone nodules about 7.5 cm in diameter. State highway 63 (Izee-Paulina road) along South Fork of John Day River just west of bridge over river. 61 m above base. Early Toarcian. Data from Yeh (1987b). Material illustrated herein studied by P. Dumitrica. Residue gift from K.-Y. Yeh.

Snowshoe Formation

OR 555. Warm Springs member of the Snowshoe Formation. Reddish-brown weathering, dark-gray, fissile shales with dark-grey, micritic limestone nodules and lenticular masses of silty limestone. Limestone nodules commonly bear well-preserved silicified Radiolaria. Sample collected 70 m above contact with the underlying Hyde Formation. National Forest road 16020 near Duncan Hollow, 2.88 km west of intersection with State Highway 63 (Izee-Paulina road). Probably lowermost Bajocian (*discites* Standard Zone) or uppermost Aalenian (*concavum* Standard Zone). Data from Pessagno et al. (1986). Material illustrated herein studied by P. Dumitrica. Residue gift from E.A. Pessagno.

4. BAJA CALIFORNIA SUR

Punta San Hipólito, Vizcaíno Peninsula

Lower third of sandstone member of the San Hipólito Formation, type section, Pliensbachian (probably early Pliensbachian). No age-diagnostic fossils, other than radiolarians are associated. Samples collected by P.A. Whalen in 1980 and 1982. Detailed description and radiolarian inventory in Whalen & Carter (2002).

SH-412-14. Thin to medium-bedded, poorly sorted, olive grey to light greenish brown, tuffaceous sandstone interbedded with silty and cherty tuffs and silty, tuffaceous, light grey limestone. Sample from a light grey micritic calcareous concretion containing abundant well-preserved silicified Radiolaria. Sample collected approximately 250 m above base of sandstone member. Sample from Dr. David Barnes, Western Michigan University.

BPW80-14. Lithology same as for SH-412-14 (above). Sample from a light grey micritic calcareous concretion containing abundant well-preserved silicified Radiolaria. Sample collected 261 m above base of sandstone member.

BPW80-15A. Lithology same as SH-412-14 (above). Sample from a light grey slightly silty micritic limestone bed 12-15 cm thick, containing well-preserved silicified Radiolaria. Sample collected 270 m above base of sandstone member.

BPW80-15B. Lithology same as for SH-412-14 (above). Sample from a light grey, slightly silty, micritic limestone bed 15 cm thick. Sample collected 270 m above base of sandstone member.

BPW80-26. Lithology same as for SH-412-14 (above). Sample from a light grey slightly silty micritic calcareous concretion 45 cm in diameter, with rare moderately well-preserved silicified Radiolaria. Sample collected 282 m above base of sandstone member.

BPW80-16. Lithology same as for SH-412-14 (above). Sample from a calcareous cannonball concretion 30 cm in diameter, with abundant well-preserved silicified Radiolaria. Sample collected 283 m above base of sandstone member.

BPW80-27. Lithology same as for SH-412-14 (above). Sample from a light greyish-tan, slightly silty micritic calcareous concretion 60 cm long and 18 cm thick, with moderately well-preserved silicified Radiolaria. Sample collected 293 m above base of sandstone member.

BPW80-28. Lithology same as for SH-412-14 (above). Sample from a tan micritic limestone bed 6.3 cm thick containing well-preserved silicified Radiolaria. Sample collected 303 m above base of sandstone member.

BPW80-29. Lithology same as for SH-412-14 (above). Sample from a light grey micritic limestone bed 10 cm thick containing moderately well-preserved silicified Radiolaria. Sample collected approximately 345 m above base of sandstone member.

BPW80-30. Lithology same as for SH-412-14 (above). Sample from a medium grey slightly silty micritic limestone bed 5 cm thick containing abundant well-preserved silicified Radiolaria. Sample collected 345 m above base of sandstone member.

5. SLOVENIA

Mt. Mangart, Julian Alps

The section is exposed near the Slovenian–Italian border (N 46^{0}26'80", E 13^{0}39'18", alt. 2164 m). The succession is 28 m thick and consists of organic and manganese rich calcareous shales with interbedded dark grey siliceous radiolarian-bearing limestone (Skrile Formation of Šmuc, 2005). No age-diagnostic fossils other than radiolarians are associated. Detailed description and radiolarian inventory given in Goričan et al. (2003). The lower part of the succession (samples MM 5.00, MM 6.76 and MM 11.76) is assigned to the early Toarcian, the upper part (samples MM 21.70 and MM 27.20) may range to the middle Toarcian.

MM 5.00. Dark grey siliceous limestone, 3.60 m above the base of the Skrile Formation.

MM 6.76. Dark grey siliceous limestone.

MM 11.76. Dark grey siliceous limestone.

MM 21.70. Dark grey siliceous limestone.

MM 27.20. Siliceous limestone 2 m below the top of the Skrile Formation.

6. AUSTRIA

Teltschengraben, Northern Calcareous Alps

Located in Teltschengraben, east of Bad Mitterndorf. Dürrnberg Formation (Gawlick et al., 2001). Grey marl and marly limestone, partly siliceous bedded limestone. Liassic continuation of the Zlambach Formation but much more cherty.

BMW-21. Siliceous limestone with radiolarians and sponge spicules. Slide in Bathonian-Callovian radiolaritic matrix (Hallstatt Mélange). Sample collected by H.-J. Gawlick, studied by L. O'Dogherty.

7. TURKEY

Gümüslü Allochthon, Domüz Dag massif

Located 1 km NW of the Gümüslü village at 1400 m altitude. Alternation of light grey radiolarian-bearing limestone and marl. The overlying limestone (Ammonitico rosso facies) contains late Pliensbachian ammonites of the Margaritatus Zone. Detailed locality description and stratigraphic column given in De Wever (1982b, p. 93).

1662D. Light grey bedded limestone. Sample collected by A. Poisson. Radiolarians previously described by Pessagno & Poisson (1981) and De Wever (1981b, c; 1982a, b). Sample restudied for this catalogue by P. De Wever and P. Dumitrica.

8. OMAN

Hamrat Duru Group

In the Hamrat Duru Group of the Hawasina Nappes the late Pliensbachian to early Bajocian radiolarian assemblages occur in the Tawi Sadh Member of the Guwayza Formation (Blechschmidt et al., 2004). This member underlies the Oolitic Limestone Member of the same formation and corresponds to the upper member of the Matbat Formation of Béchennec (1987) and BRGM group (1984-1993). The Tawi Sadh Member is lithologically variable but generally consists of softer rocks than the underlying and overlying units. For the most part it consists of greenish to dark grey shale, grey-green bedded chert up to 10 cm thick and interbedded shale and, in some sections and especially in the upper part, a mixed carbonate/siliciclastic sequence consisting of pelletal calcarenite with a variable content of sand-sized quartz and limestone lithoclasts, sandstones and some chert levels. The member may be very thick, up to 150 m, or thinner. Its lower boundary may be tectonic or may lay normally over the Al Ayn Formation, but its contact with the overlying Oolitic Limestone Member is gradual. The member is late Pliensbachian to early-middle Bajocian in age on the basis of radiolarians, which are practically the only fossils, other than sponge spicules that occur.

The Tawi Sadh Member was sampled in several sections, those most important for the purpose of this catalogue are described below. The samples were collected and studied by P. Dumitrica.

Section 1 – Wadi Mu'aydin

UTM 569514/2538712 (Blechschmidt et al., 2004, fig. 8). Several samples have been collected from this section but only the following ones contained determinable radiolarians.

BR1120. Grey chert at the base of the section (upper Pliensbachian?-lower Toarcian).

BR1121. Grey chert ~4 m above the base of the section.

BR1122. Grey chert 7-8 m above base.

BR1123. Grey chert 11-12 m above base.

BR1128. Grey chert 32 m above base.

BR1129. Grey chert 34 m above base.

BR1130. Grey chert 44 m above base.

BR1131. Grey chert 46 m above base (upper Aalenian-lower Bajocian).

OM-00-92. Approximately equivalent to BR1123 (studied by Š. Goričan).

Section 2 (composite section) – Jabal Safra

UTM 582215/2513436 and UTM 586090/2512975. Three sections were sampled in this area, two on the northern side of the Jabal Safra ridge (sections 2A, 2B) and one on the southern side (section 2C). The fourth section (2D) from the northern side of Jabal Safra yielded only one sample (BR706). Together these sections offer the most complete radiolarian sequence of the upper Pliensbachian to lower Bajocian interval.

On the northern side of the Jabal Safra ridge the Tawi Sadh Member is not complete, the upper part presumably comprising Aalenian and Bajocian strata is missing. The missing part is exposed on the southern side of the ridge.

The two sections from the northern side of Jabal Safra (UTM 582215/2513436) are two neighbouring parallel sections that complement each other and partly overlap. One section begins at the contact with the underlying Al Ayn Formation (BR469) and ends 32 m above (BR488) where the upper part of the succession is covered by scree from the overlying Oolitic Limestone Member of the Guwayza Formation. The other section (samples BR523 to BR533) continues the succession of the first section for another 28.5 m. A portion of the lower part is probably overlapped on a portion of the upper part of the first section. The contact of this section with the overlying member is covered by a scree of oolitic limestone, but fragments of chert scattered among the scree allow the determination of the radiolarian assemblage from beneath the contact. Both sections consists of a monotonous succession of green shale and grey-green, yellow weathering chert.

The section 2C from the southern side of the Jabal Safra ridge (UTM 586090/2512975) (samples BR824 to BR828) differs from those exposed on the northern side. It consists of a succession of light grey or yellowish platy limestones with some more or less silicified levels and red radiolarites towards the top.

Section 2A - Jabal Safra, northern side

Lower part of the Tawi Sadh Member of the Guwayza Formation.

BR469. 1.5-3.0 m above base, green claystone and several beds of silicified claystone and a bank of calcarenite at the middle of the interval (Pliensbachian).

BR470. 3-4.5 m above base, intercalations of green claystone and weakly silicified claystone.

BR471. 4.5-6 m above base, intercalations of more or less silicified green claystone.

BR472. 6-7.5 m above base, intercalations of more or less silicified green claystone.

BR473. 7.5-9 m above base, green claystone and more or less silicified chert.

BR474. 9-10.5 m above base, green claystone and more or less silicified chert.

BR475. 10.5-12 m above base, more or less silicified green claystone.

BR476. 12-13.5 m above base, more or less silicified green claystone.

BR477. 13.5-15 m above base, green chert and claystone.

BR478. 15-16.5 m above base, green chert and claystone.

BR479. 16.5-18 m above base, green chert and claystone.

BR480. 18-19.5 m above base, green chert and claystone.

BR481. 19.5-21 m above base, green chert and claystone.

BR482. 21-22.5 m above base, grey or green chert and claystone.

BR483. 22.5-24 m above base, green chert and claystone.

BR484. 24-25.5 m above base, green chert.

BR485. 25.5-27 m above base, green chert.

BR486. 27-28.5 m above base, green chert.

BR487. 28.5-30 m above base, green chert and claystone.

BR488. 30-32 m above base, green chert and claystone (Pliensbachian).

Section 2B - Jabal Safra, northern side

Tawi Sadh Member of the Guwayza Formation.

BR523. 3-4.5 m above base, green chert and claystone (Pliensbachian).

BR524. 4.5-6 m above base, green chert and claystone.

BR525. 6-7.5 m above base, green chert and claystone.

BR526. 7.5-9 m above base, grey chert and grey marl.

BR527. 9-10.5 m above base, green chert and grey marl.

BR528. 10.5-12 m above base, grey chert and marl.

BR529. 12-13.5 m above base, grey chert and marl.

BR530. 13.5-15 m above base, grey chert, marl and 50 cm of oolitic limestone.

BR531. 15-16.5 m above base, grey chert, marl and 20 cm of calcarenite (upper Pliensbachian?-lower Toarcian).

BR532. 22 m above base, grey chert float.

BR533. 28.5 m above base, yellow brown chert float.

OM-99-83 and OM-99-89. Approximately equivalent to the interval between BR529 and BR531 (studied by Š. Goričan).

Section 2C - Jabal Safra, southern side

BR824. cca 60 m above base of Tawi Sadh Member, red chert (upper Toarcian-lower Aalenian).

BR825/3. cca 63 m above base of Tawi Sadh Member, red chert.

BR825. cca 74 m above base of Tawi Sadh Member, red chert.

BR826. cca 88 m above base of Tawi Sadh Member, red chert (Bajocian).

Section 2D - Jabal Safra, northern side

BR706. 72-76 m above base of section, which is located about 1 km east of section 2B. The section begins in the Al Ayn Formation and continues in the Tawi Sadh Member of the Guwayza Formation. Sample BR706 is from the base of the Tawi Sadh Member (upper Pliensbachian-?lower Toarcian).

BR682. Jabal Safra, coordinates not taken. Tawi Sadh Member of the Guwayza Formation, lower Toarcian.

Section 3 - Al Sawad

UTM 578108/2544420. The section is well exposed on the right side of the Wadi Muti upstream of the village of Al Sawad. The succession of the Tawi Sadh Member consists of three lithologic units. Radiolarians occur only in the lower unit, measuring about 80 m and characterized by a succession of dark green, more or less silicified shale with green radiolarian chert and intercalations of yellowish-brown lithoclastic limestone. Radiolarians are frequent at several levels but moderately preserved.

BR560. Base of section (Aalenian).

BR586. Approximately 60 m above base of section.

BR587. 2.5-3 m above BR586.

BR590. 9 m above BR587.

BR591. 11-12 m above BR587 (Aalenian-?lower Bajocian).

Section 4 - Wadi Saal

UTM 489029/2524022 and UTM 49001/2523209. In the Wadi Saal, in the western part of the Hamrat Duru Range, the Tawi Sadh Member is not well exposed mostly due to tectonic complications, partly to its softer rocks. It is represented by white, light grey or green chert and shale and yellowish-brown lithoclastic or oolitic limestone. Radiolarians, although visible in the chert, were generally not sufficiently preserved to be extracted. Only the following three samples from three levels of the succession contained a determinable fauna.

BR117. cca 7-8 m above base, white chert and silicified limestone (upper Pliensbachian?-lower Toarcian).

BR131. cca 15 m above base, white chert and silicified limestone.

BR137. 55 m above base, with a level of chert in a succession of yellowish-brown lithoclastic limestone (Aalenian).

Section 5 - Al Khashbah Mt.

UTM 609565/2504490.

BR871 is a yellowish-brown chert reworked in the Oolitic Limestone Member of the Guwayza Formation (Aalenian).

Section 6 - FB 007

Sabt, east of Ibra (N 22°28'20", E 59°04'14"). Sabt Formation according to Béchennec et al. (1993). The 60 m thick Pliensbachian-Toarcian succession is composed predominantly of green shale and siliceous mudstone with rare intercalations of radiolarian sandstone; chert beds occur toward the top. This succession is overlain by calcareous turbidites.

OM-01-21. Light green chert, collected 2.5 m below calcareous turbidites.

Al Aridh Group

The studied samples are from the lower part of the Musallah Formation as defined by Béchennec (1987). The oldest age previously obtained in the Musallah Formation was late Callovian-early Kimmeridgian (Béchennec et al., 1993). Current radiolarian dating reveals that the base of the formation is as old as Pliensbachian. The Pliensbachian to upper Toarcian-lower Aalenian succession treated in this catalogue consists of varicoloured bedded radiolarian chert interstratified locally with resedimented limestones. No age-diagnostic fossils other than radiolarians are associated.

Sections measured by F. Béchennec and C. Robin, radiolarian samples collected and studied by Š. Goričan.

Section 1 – FB 2841

Near Al Aridh north of Ibri (N 23°21'50", E 56°36'19"). Lower part of the Musallah Formation.

OM-99-131. Light reddish argillaceous chert, 1 m above the outcropping base (lowermost part of the Musallah Formation not exposed).

OM-99-133. Light greenish yellow argillaceous chert, 6.5 m above OM-99-131.

OM-99-137. (Bajocian). Red nodular argillaceous chert, 23 m above OM-99-133.

Section 2 – FB 2895

Jabal Buwaydah East (N 22º52'06.2", E 57º05'40.9"). Lower part of the Musallah Formation.

OM-00-251. Light reddish chert, 25.5 m above the contact with medium-grained calcareous turbidites.

OM-00-252. Light reddish chert, 3 m above OM-00-251.

OM-00-254. Beige argillaceous chert, 8 m above OM-00-252.

OM-00-255. White chert, 2.5 m above OM-00-254.

OM-00-256. Light yellow chert, 12.5 m above OM-00-255, 0.5 m below a succession of coarse limestone breccias.

OM-00-258 (upper Aalenian-lower Bajocian). Red nodular argillaceous chert, approximately 30 m above OM-00-256.

Section 3 – FB 156

Jabal Buwaydah Center East (N 22°55'20", E 57°05'35"). Lower part of the Musallah Formation, a 7 m thick chert level intercalated between resedimented oolitic limestone below and limestone breccia above.

OM-00-117. Yellow argillaceous chert near the top of the chert level.

OM-00-118. Light red argillaceous chert, approximate lateral equivalent of sample OM-00-117.

Section 4 – FB 124

Jabal Buwaydah East (N 22°51'36", E 57°07'43"). Lower part of the Musallah Formation.

OM-00-263. Red chert within a 1 m thick chert level intercalated between two limestone breccia beds.

Section 5 – FB 298

Jabal Buwaydah Center West (N 22º59'9", E 57º01'8"). Lower part of the Musallah Formation, 7 m thick chert succession bounded by a tectonic contact below and limestone breccias above.

OM-00-115. Vivid red chert, base of chert succession.

OM-00-114. Yellow chert with red spots, 6 m above sample OM-00-115.

Umar Group

Humadiyin

UTM 2247563N/5747425E, Haliw (Aqil) Formation. According to Béchennec (1987), the Umar Group is the uppermost structural unit of the Hawasina Nappes and comprises two formations: the Sinni Formation, composed mainly of Triassic volcanic rocks and the Aqil Formation, composed predominantly of Middle Triassic to Cretaceous siliceous pelagic deposits, calcirudite and/or megabreccias of reworked carbonates. The latter formation was initially separated by Glennie et al. (1974) as the Haliw Formation from the same area as the Aqil Formation and, consequently, has priority over the latter. The upper Norian to Lower Jurassic is represented here by red chert and is now under study.

O38 and O39. For the moment the only information on the Early Jurassic radiolarians from the Haliw Formation comes from these two lower Pliensbachian samples, collected from floated fragments under megabreccias that cover the chert sections near the locality Humadiyin, on the north side of the road Nizwa-Sinew. Radiolarian samples collected by L. Krystyn and studied by P. Dumitrica.

9. JAPAN

Mino Terrane - Inuyama area

Lower Jurassic (Hettangian-Toarcian), Lat. 35° 25±2'N; long. 136° 58±2'E. The Kamiaso Unit (Wakita, 1988), Mino Terrane, SW Japan, is one of the Jurassic accretionary complexes comprised of bedded cherts and clastic sedimentary rocks. A late Bathonian – early Callovian ammonite, *Choffatia* sp., was reported from the clastic rocks (Sato, 1974; Sato & Westermann, 1985). Triassic-Lower Jurassic radiolarian and upper Lower Triassic and Middle–Upper Triassic conodont fossils were obtained from bedded chert sequences in this area and biostratigraphic studies were summarized (e.g. Hori, 1988; 1990; Matsuda & Isozaki, 1991; Sugiyama, 1997).

Samples for this study were collected by R. S. Hori (Katsuyama (UF), Iwayakannon (IY), Kurusu (KU), UC sections) and R.S. Hori and M. Takeuchi (KA log = Pliensbachian – Toarcian part of UF section and IW log = those of IY section). See Hori (1990) for section locations in the Inuyama area. All samples were obtained from bedded chert sequences.

The outcrops of these sections are located on the right bank of the Kisogawa River (UF, IY and UC sections) and the left bank (KU section). Four chert sequences of the Kamiaso Unit are exposed along the Kisogawa River, namely CH-1, CH-2, CH-3 and CH-4 in structurally ascending order (Yao et al., 1980).

The sedimentation rate of Lower Jurassic chert sequences from the Inuyama area is ca. 1m/m.y. = 0.1cm/kyr (Hori et al., 1993).

Katsuyama (UF) Section (Hori, 1990)
This section is located on the CH-3 chert-sheet near the Katsuyama road junction, Gifu prefecture, SW Japan. Detailed sample locations of the outcrop and vertical distributions of representative taxa are shown in Hori (1992). Between UFI19 and UFI21, the Toarcian Oceanic Anoxic Event (OAE) was recorded lithologically and geochemically (Hori, 1993).

The UF section consists of ca. 32 m thick chert sequence which is one of the most complete sections of Upper Triassic to Lower Jurassic strata in the Inuyama are. The outcrop extends down to the Middle and upper Lower Triassic (Matsuoka et al., 1994). Hori (1992) and Carter & Hori (2005) reported detailed radiolarian and conodont biostratigraphy at the Triassic/Jurassic boundary of this section. The basal horizon (0 cm) is located at UFI3, which is the dusty red chert bed (T/J boundary event level) =Kb1 (01) of Hori (1992) and Carter & Hori (2005).

UFI6. 560 cm above top of dusty red chert bed, red bedded chert.
UFI7. 720 cm above top of dusty red chert bed, red bedded chert.
UFI8. 860 cm above top of dusty red chert bed, red bedded chert.
UFI9. 960 cm above top of dusty red chert bed, red bedded chert.
UFI10. 1070 cm above top of dusty red chert bed, red bedded chert.
UFI11. 1170 cm above top of dusty red chert bed, red bedded chert.
UFI12. 1280 cm above top of dusty red chert bed, red bedded chert.
UFI13. 1410 cm above top of dusty red chert bed, red bedded chert.
UFI14. 1840 cm above top of dusty red chert bed, green bedded chert.
UFI15. 1990 cm above top of dusty red chert bed, green bedded chert
UFI16. 2050 cm above top of dusty red chert bed, grey bedded chert.
UFI17. 2170 cm above top of dusty red chert bed, grey bedded chert.
UFI18. 2240 cm above top of dusty red chert bed, grey bedded chert.
UFI19. 2460 cm above top of dusty red chert bed, grey bedded chert; just below the OAE.
UFI20. 2540 cm above top of dusty red chert bed; high peak of Toarcian OAE. (70 cm below the base of white massive chert bed). No radiolarian data.
UFI21. 2720 cm above top of dusty red chert bed, green and red bedded chert; above the OAE.
UFI22. 2860 cm above top of dusty red chert bed, green bedded chert.
UFI23. 3160 cm above top of dusty red chert bed, green bedded chert.
UFI24. 3220 cm above top of dusty red chert bed, green bedded chert.

Kb log of UF section (Hori, 1992)
This log is located around the Triassic/Jurassic boundary of the UF section. Original data and sample locations were published in Hori (1992). Kb01 is the same level as Kb1 in Carter & Hori (2005). The base of this Kb log is located at the Kb01 which is the purple red (or dusty red) chert bed characterized by the extinction level of conodont *Misikella posthernsteini*.

Kb07. 281 cm above the Kb01 bed.
Kb09. 368 cm above the Kb01 bed.
Kb10. 419 cm above the Kb01 bed.
Kb11. 493 cm above the Kb01 bed.
Kb12. 543 cm above the Kb01 bed.
Kb13. 575 cm above the Kb01 bed.
Kb14. 679 cm above the Kb01 bed.
Kb15. 724 cm above the Kb01 bed and 70 cm below the UFI10 of the UF section.

KA log of UF section (Takeuchi, 2001)
The KA log is the upper Pliensbachian - Toarcian part of the UF section, focusing on the interval of the Toarcian OAE. The base of this section is a white massive chert bed 2790 cm above the top of the dusty red chert bed (Kb01) of the UF section. The sketch map of this white massive chert was shown in Fig. 3 of Hori (1992), the lithological column of this section was illustrated in Takeuchi (2001).
KA:-170. 504 cm below base of white massive chert bed.
KA:-150. 470 cm below base of white massive chert bed.
KA:-121. 393 cm below base of white massive chert bed.
KA:-95. 311 cm below base of white massive chert bed; pre OAE level.
KA:-5. 20 cm below base of white massive chert bed; in OAE level.
KA:+22. 127 cm above base of white massive chert bed; post black chert (OAE) level.
KA:+25. 131 cm above base of white massive chert bed.
KA:+40. 157 cm above base of white massive chert bed.
KA:+55. 187 cm above base of white massive chert bed.
KA:+60. 202 cm above base of white massive chert bed.
KA:+68. 214 cm above base of white massive chert bed.

Iwayakannon (IY) Section (Hori, 1988)
The sketch map and sample locations of this section are shown in Hori (1988). This section consists of ca. 25 m bedded chert sequence located on the CH-4 chert-sheet of Yao et al. (1980). Detail sample locations and outline of vertical distributions of representative taxa are shown in Hori (1988). The top of this section is in contact with Middle Jurassic green mudstone containing the *Unuma echinatus* assemblage. The Toarcian OAE level is correlated with a thick shale bed just below IYII 14.
IYIII1. 1940 cm below top of section.
IYII24. 1880cm below top of section.
IYII23. 1810 cm below top of section.
IYII22. 1630 cm below top of section.
IYII21. 1490 cm below top of section.
IYII18. 1140 cm below top of section.
IYII17. 960 cm below top of section.
IYI7. 810 cm below top of section.
IYII14. 580 cm below top of section.
IYI6. 510 cm below top of section.
IYII13. 490 cm below top of section.
IYII12. 440 cm below top of section.
IYII11. 380 cm below top of section.
IYII10. 310 cm below top of section.
IYII9. 200 cm below top of section.
IYI4. 180 cm below top of section.
IYII8. 120 cm below top of section.
IYII7. 90 cm below top of section.
IYII6. 80 cm below top of section.
IYII5. 65 cm below top of section.
IYII4. 40 cm below top of section.
IYII3. 20 cm below top of section.
IYII2. At the top of the section.

IW log of IY section (Takeuchi, 2001)
The standard level of this section is located at the base of a thick green shale bed just below IYII 14 (6 m below the top of the IY section). The lithological column of this section is illustrated in Takeuchi (2001).
IW:-2. 5 cm below base of thick green shale bed.
IW:+7. 22 cm above base of thick green shale bed.
IW:+18. 45 cm above base of thick green shale bed.
IW:+24. 57 cm above base of thick green shale bed.
IW:+37. 97 cm above base of thick green shale bed.
IW:+51. 125 cm above base of thick green shale bed.
IW:+57. 137 cm above base of thick green shale bed.

Kurusu (KU) Section (Hori, 1988)
The KU section was first described by Hori (1988). This section is located on the left bank of the Kisogawa River, Inuyama City, Aichi Prefecture. It is one of the most complete sequences of Triassic/Jurassic boundary bedded cherts in the Inuyama area. The cherts are ca. 35 m thick without remarkable lithological change such as boundary clay.
KU(b)14. 2261 cm below KU (a)1, green chert.
KU(b)13. 2126 cm below KU (a)1, greenish grey chert.
KU(b)12. 1950 cm below KU(a)1, greenish grey chert.
KU(b)11. 1820 cm below KU(a)1, greenish grey chert.
KU(b)5. 1519 cm below KU(a)1, black chert.
KU(b) 4. 751 cm below KU(a)1, grey chert.
KU(b)3. 670 cm below KU(a)1, black chert.
KU(b)1. 420 cm below KU(a)1, black chert.
KU(a)7. 310 cm below KU(a)1, green chert; thick shale bed intercalated which corresponds to Toarcian OAE level.
KU(a)5. 260 cm below KU(a)1, grey chert.
KU(a)4. 220 cm below KU(a)1, greenish grey chert.
KU(a)3. 140 cm below KU(a)1, green chert.
KU(a)2. 70 cm below KU(a)1, green chert.
KU(a)1. Top 0 cm grey chert.

UC Section (Hori, 1986; also data provided by Hori, 1990, 1993)
This section consists of 11 m of bedded chert that extends from the upper Sinemurian to Aalenian. Black cherts including FeS_2 minerals occur in the upper part of the section (ca. 520 cm level), which suggest the Toarcian OAE (Hori, 1993). Lithological and preliminary radiolarian data are shown in Hori (1986, 1990).
UC1. 0 cm, greenish red chert (Pliensbachian chert).
UC2. 27 cm above UC1, greenish red chert.
UC3. 86 cm above UC1, greenish red chert.
UC4. 118 cm above UC1, red chert.
UC5. 138 cm above UC1, red chert.
UC6. 164 cm above UC1, greenish red chert.
UC7. 205 cm above UC1, greenish red chert.
UC8. 227 cm above UC1, greenish grey chert.
UC9. 280 cm above UC1, grey chert.
UC10. 341 cm above UC1, grey chert.
UC11. 373 cm above UC1, grey chert.
UC12. 423 cm above UC1, grey chert.
UC13. 472 cm above UC1, grey chert.
UC14. 515 cm above UC1, grey chert; just below the beginning of black chert of the Toarcian OAE.

UC15. 714 cm above UC1, greenish black chert; Toarcian OAE.
UC16. 755 cm above UC1, greenish black chert; Toarcian OAE.
UC17. 842 cm above UC1, greenish black chert; Toarcian OAE.

Mino Terrane - Nanjo area

This area is located in the northwestern part of the Mino Terrane (Lat. 35˚, 42±1'N; Long.136˚, 17±1E). Lithological data by Hori (1990 MSc thesis). Samples collected by R. S. Hori.

Mélange rocks belonging to the Lower Jurassic accretionary complex in the Mino Terrane are exposed in this area. A chert sample (85072502B) obtained from the same locality as Ito & Matsuda (1980) is from one of the tectonic blocks and the mudstone sample is from the matrix of the mélange.
85072502B. Green chert block in Jurassic sedimentary complex.
850725044. Mudstone, mélange matrix of Jurassic complex.

Nanjo Massif - Imajo unit
MNA-10. Manganese band in a siliceous mudstone layer. This band contains manganese carbonate spherules ranging from 0.5 to 2.0 mm in diameter. Radiolarian fauna diverse and well preserved. One of the best-preserved radiolarian-bearing samples of Toarcian age. Radiolarians studied by A. Matsuoka (1991, 2004, this catalogue).
IH84120461 and IH84120462. Two samples given by I. Hattori to P. Dumitrica. According to Hattori (1989) the samples are from rhodochrosite concretions in red shale outcropping in the Nanjo Massif, Sugentan-Minami locality (Hattori, 1989, fig. 3). Radiolarians from this locality have been illustrated by Hattori (l. cit.) in plates 18-34 and the list of species occurring in the two samples (61 and 62) are in Hattori (1989, Table 2). The assemblage proves an Aalenian age.

Mino Terrane - Mt. Norikuradake area

Yukawa Complex by Otsuka (1988), northeastern part of the Mino Terrane (Lat. 36˚, 8±1'N; Long. 137˚, 27±1'E), SW Japan. Samples collected by R. S. Hori. Pliensbachian-Toarcian bedded cherts and Toarcian-Aalenian siliceous shale occur in this area. Lithological data and Toarcian radiolarian fauna documented by Hori & Otsuka (1989). Descriptions of sample locations shown in Hori (1988, 1990) and Hori & Otsuka (1989).

Norikuradake (NK) section (Hori & Otsuka, 1989)
Lat. 36˚ 7'36"N; Long. 137˚ 27' 30"E.
NKI7. +0 m chert bed.
NKI8. +8.04 m above the NKI7 chert, chert bed.
NKI9. +17.1 m above the NKI7 chert, chert bed.
NKI10. +24 m above the NKI7 chert, chert bed. A minor fault developed this level.
NKI11. – 21.3 m below the top of NKI17 chert bed, just above the fault, chert bed.
NKI12. –13.2 m below the top of NKI17 chert bed.
NKII2. –9.64 m below the top of NKI17 chert bed.
NKII3. –7.07 m below the top of NKI17 chert bed.
NKII4. –3.93 m below the top of NKI17 chert bed.
NKII5. – 2.68 m below the top of NKI17 chert bed.
NKI17. +0 m just below the red shale.
NKII7. -2 +0.43 m above the NKI17, red siliceous shale.
NKII8. +1 m above the NKI17, red siliceous shale.
NKII9. +1.7 m above the NKI17, red chert.
NKII10. +2.31 m above the NKI17, red siliceous shale.
NKI20. + 2.68 m above the NKI17, red siliceous shale.

Mino Terrane - Middle Jurassic

Inuyama area
Radiolarians studied by A. Matsuoka.
MIN-1. Inuyama area, Aichi Prefecture. The locality is on the left bank of the Kisogawa River. The sample is a manganese carbonate band included in a siliceous mudstone layer south of the CH-2 chert-sheet of Yao et al. (1980). It contains 93 nassellarian species (Matsuoka, 1992) and is assignable to the *Tricolocapsa plicarum* Zone or JR 4 of Matsuoka (1995).
MIN-10. Inuyama area, Aichi Prefecture. Same locality as MIN-1. The sample is assignable to the *Laxtorum* (?) *jurassicum* Zone or JR 3 of Matsuoka (1995).

Kamiaso (Hisuikyo) area
Lat. 35˚, 32'52"N; Long.137˚, 7'47"E. Triassic and Jurassic radiolarian bedded cherts and Middle Jurassic siliceous mudstones well exposed along the Hida River, which formed Hisukyo Gorge in the Kamiaso area, Gifu Prefecture of SW Japan.

Matsuda & Isozaki (1982), and Isozaki & Matsuda (1985) documented Lower Jurassic radiolarian fossils from this area. In particular, a black chert bed containing manganese carbonate spherules from the Hisuikyo Gorge contains well-preserved radiolarian fossils described by Isozaki and Matsuda (1985); this is the type locality of the *Hsuum hisuikyoense* Assemblage. Sample mentioned in this study (only for systematic part) collected by R. S. Hori from the black chert horizon of Isozaki & Matsuda (1985).

Gujo-Hachiman area
Lat. 35˚, 49.8'N; Long.136˚, 52'55"E. Radiolarian fossils from this area were described by Takemura (1986), and Yao (1997).

Samples in the systematic part of this study collected by R. S. Hori from the same area as Takemura (1986). Extremely well preserved radiolarian fossils from manganese carbonate nodules in black shale (e.g. Wakita, 1982, 1984). The radiolarian faunas are correlated with UAZ 3 of Baumgartner et al. (1995b) (late Aalenian?) as discussed by Yao (1997).

MKM-1 (studied by A. Matsuoka). The locality is the same as that of Takemura (1986). The sample contains 64 nassellarian species (Matsuoka, 1992) and is assignable to the *Laxtorum* (?) *jurassicum* Zone or JR 3 of Matsuoka (1995).

Chichibu Terrane

Kuma area

The Kuma area is located in western Kyushu, southwest Japan. The biostratigraphy of Mesozoic radiolarians has been documented mainly by Nishizono et al. (1982), Nishizono & Murata (1983), Sato & Nishizono (1983) and Nishizono (1996).

Samples mentioned in this study (only for systematic descriptions) were collected by R. S. Hori. Precise sample numbers and radiolarian data were shown in Hori (1990). Kaiji (KG) and Kajiki-1 (=Kajiki: KS in Hori, 1990) sections were investigated by Matsuoka & Yao (1986), Hori (1990), and Matsuoka (1995). The KG section ranges from the *Parahsuum simplum* subzone I to subzone IV (Sinemurian to Pliensbachian) and the KS section corresponds to the *Mesosaturnalis hexagonus* Assemblage Zone to the *Hsuum hisuikyoense* Assemblage Zone (Toarcian to Aalenian) (Hori, 1990).

KG-9. Chert. Top of *Parahsuum simplum* subzone II.

4. LISTING OF SPECIES

4.1. Alphabetical listing by genus

2001 *Acaeniotylopsis ghostensis* (Carter) 1988
4066 *Acaeniotylopsis triacanthus* Kito & De Wever 1994
JAC02 *Anaticapitula anatiformis* (De Wever) 1982a
JAC04 *Anaticapitula omanensis* Dumitrica n. sp.
ADM01 *Archaeodictyomitra munda* (Yeh) 1987b
ADM02 *Archaeodictyomitra* sp. A
ADM03 *Archaeodictyomitra* sp. B
3149 *Archaeohagiastrum longipes* Baumgartner 1995
3271 *Archaeohagiastrum munitum* Baumgartner 1984
HAG01 *Archaeohagiastrum oregonense* (Yeh) 1987b
HAG02 *Archaeohagiastrum pobi* Whalen & Carter 1998
ASP01 *Archaeospongoprunum coyotense* Whalen & Carter 2002
ATT01 *Archaeotritrabs hattorii* Dumitrica n. sp.
ARS03 *Ares armatus* De Wever 1982a
ARS07 *Ares avirostrum* Dumitrica & Matsuoka n. sp.
ARS06 *Ares cuniculiformis* Dumitrica & Whalen n. sp.
4061 *Ares cylindricus* s.l. (Takemura) 1986
3001 *Ares cylindricus cylindricus* (Takemura) 1986
4032 *Ares cylindricus flexuosus* (Takemura) 1986
ARS04 *Ares mexicoensis* Whalen & Carter 2002
ARS01 *Ares moresbyensis* Whalen & Carter 1998
ARS02 *Ares sutherlandi* Whalen & Carter 1998
ARS08 *Ares takemurai* Dumitrica & Matsuoka n. sp.
4008 *Ares* sp. A sensu Baumgartner et al. 1995a
ATA02 *Atalanta emmela* Cordey & Carter 1996
BAG01 *Bagotum erraticum* Pessagno & Whalen 1982
BAG03 *Bagotum funiculum* Whalen & Carter 2002
BAG02 *Bagotum helmetense* Pessagno & Whalen 1982
BAG04 *Bagotum kimbroughi* Whalen & Carter 2002
BAG05 *Bagotum maudense* Pessagno & Whalen 1982
BAG06 *Bagotum modestum* Pessagno & Whalen 1982
BAG07 *Bagotum pseudoerraticum* Kishida & Hisada 1985
ORB04 *Beatricea? argescens* (Cordey) 1998
PDC01 *Beatricea? baroni* Cordey 1998
SPI03 *Beatricea christovalensis* Whalen & Carter 1998
ORB07 *Beatricea sanpabloensis* (Whalen & Carter) 2002
CRU18 *Beatricea*? sp. A
3222 *Bernoullius delnortensis* Pessagno, Blome & Hull 1993
BER01 *Bernoullius saccideon* (Carter) 1988
BPD13 *Bipedis calvabovis* De Wever 1982a
BPD05 *Bipedis diadema* Whalen & Carter 1998
BPD14 *Bipedis fannini* Carter 1988

BPD15 *Bipedis japonicus* Hori n. sp.
BPD16 *Bipedis yaoi* Hori n. sp.
BIS04 *Bistarkum mangartense* Goričan, Šmuc & Baumgartner 2003
BIS02 *Bistarkum phantomense* (Carter) 1988
BIS01 *Bistarkum rigidium* Yeh 1987b
BIS03 *Bistarkum saginatum* Yeh 1987b
BRO02 *Broctus kuensis* Pessagno & Whalen 1982
BRO03 *Broctus ruesti* Yeh 1987b
BRO01 *Broctus selwynensis* Pessagno & Whalen 1982
CAN12 *Canoptum anulatum* Pessagno & Poisson 1981
CAN13 *Canoptum artum* Yeh 1987b
CAN08 *Canoptum columbiaense* Whalen & Carter 1998
CAN09 *Canoptum dixoni* Pessagno & Whalen 1982
CAN11 *Canoptum margaritaense* Whalen & Carter 1998
CAN14 *Canoptum rugosum* Pessagno & Poisson 1981
CTS06 *Canutus baumgartneri* Yeh 1987b
CTS08 *Canutus diegoi* Whalen & Carter 2002
CTS09 *Canutus hainaensis* Pessagno & Whalen 1982
CTS10 *Canutus nitidus* Yeh 1987b
CTS15 *Canutus rennellensis* Carter n. sp.
CTS03 *Canutus rockfishensis* Pessagno & Whalen 1982
CTS12 *Canutus tipperi* gr. Pessagno & Whalen 1982
CTS16 *Canutus* sp. O
SUM03 *Carterwhalenia minai* (Whalen & Carter) 2002
CHA02 *Charlottea amurensis* Whalen & Carter 1998
CHA09 *Charlottea hotaoensis* Carter n. sp.
CHA10 *Charlottea penderi* Carter n. sp.
CHA03 *Charlottea proprietatis* Whalen & Carter 1998
CHA05 *Charlottea triquetra* Whalen & Carter 1998
CHA07 *Charlottea* sp. A sensu Whalen & Carter 2002
CHA08 *Charlottea* sp. B
CHA11 *Charlottea* sp. C
XNM01 *Charlottea*? sp. Y
4033 *Citriduma hexaptera* (Conti & Marcucci) 1991
CIT05 *Citriduma radiotuba* De Wever 1982a
CRB01 *Crubus chengi* Yeh 1987b
CRU21 *Crucella angulosa* s.l. Carter 1988
CRU11 *Crucella angulosa angulosa* Carter 1988
CRU12 *Crucella angulosa longibrachiata* Carter n. ssp.
PDC02 *Crucella beata* (Yeh) 1987b
CRU22 *Crucella cavata* s.l. Whalen & Carter 1998
CRU10 *Crucella cavata cavata* Whalen & Carter 1998
CRU20 *Crucella cavata giganticava* Carter n. ssp.
CRU19 *Crucella cavata intermedicava* Carter n. ssp.
PDC05 *Crucella jadeae* Carter & Dumitrica n. sp.
CRU13 *Crucella mijo* De Wever 1981b
CRU14 *Crucella mirabunda* Whalen & Carter 2002
CRU15 *Crucella spongase* De Wever 1981b
CRU16 *Crucella squama* (Kozlova) 1971
3131 *Crucella theokaftensis* Baumgartner 1980
CYC01 *Cyclastrum asuncionense* Whalen & Carter 2002
CYC02 *Cyclastrum scammonense* Whalen & Carter 2002
CYC03 *Cyclastrum veracruzense* Whalen & Carter 2002
CYC04 *Cyclastrum* sp. A
DAN02 *Danubea* sp. A sensu Whalen & Carter 2002
DRO07 *Droltus eurasiaticus* Kozur & Mostler 1990
DRO02 *Droltus hecatensis* Pessagno & Whalen 1982
DRO03 *Droltus laseekensis* Pessagno & Whalen 1982
DRO06 *Droltus lyellensis* Pessagno & Whalen 1982
DRO08 *Droltus sanignacioensis* Whalen & Carter 2002
DUC01 *Ducatus hipolitoensis* Whalen & Carter 2002
JAC05 *Dumitricaella trispinosa* Dumitrica n. sp.
3411 *Elodium cameroni* Carter 1988
PHS08 *Elodium*? *mackenziei* Carter n. sp.
ELD02 *Elodium pessagnoi* Yeh & Cheng 1996
ELD03 *Elodium wilsonense* (Carter) 1988
2021 *Eospongosaturninus protoformis* (Yao) 1972
EUC09 *Eucyrtidiellum disparile* gr. Nagai & Mizutani 1990
EUC10 *Eucyrtidiellum gujoense* (Takemura & Nakaseko) 1986
EUC03 *Eucyrtidiellum gunense* gr. Cordey 1998
EUC06 *Eucyrtidiellum nagaiae* Dumitrica, Goričan & Matsuoka n. sp.
EUC07 *Eucyrtidiellum omanojaponicum* Dumitrica, Goričan & Hori n. sp.
EUC04 *Eucyrtidiellum ramescens* Cordey 1998
FAR02 *Farcus asperoensis* Pessagno, Whalen & Yeh 1986
FAR04 *Farcus graylockensis* Pessagno, Whalen & Yeh 1986
FAR03 *Farcus kozuri* Yeh 1987b
FRM01 *Foremania sandilandsensis* gr. Whalen & Carter 1998
GIG01 *Gigi fustis* De Wever 1982a
GOR02 *Gorgansium gongyloideum* Kishida & Hisada 1985
GOR03 *Gorgansium morganense* Pessagno & Blome 1980
HCK05 *Haeckelicyrtium crickmayi* Carter n. sp.
HCK04 *Haeckelicyrtium* sp. B sensu Whalen & Carter 2002
HAG06 *Hagiastrum macrum* gr. De Wever 1981b
HAG03 *Hagiastrum majusculum* Whalen & Carter 1998
HAG04 *Hagiastrum rudimentum* Whalen & Carter 1998
TPS03 *Helvetocapsa minoensis* (Matsuoka) 1991
SCP03 *Helvetocapsa nanjoensis* (Matsuoka) 1991
SCP06 *Helvetocapsa plicata* s.l. (Matsuoka) 1991
SCP04 *Helvetocapsa plicata plicata* (Matsuoka) 1991
SCP05 *Helvetocapsa plicata semiplicata* (Matsuoka) 1991
3502 *Hexasaturnalis hexagonus* (Yao) 1972
SAT11 *Hexasaturnalis octopus* Dumitrica & Hori n. sp.
3089 *Hexasaturnalis tetraspinus* (Yao) 1972
HIG01 *Higumastra laxa* Yeh 1987b
HIG04 *Higumastra lupheri* Yeh 1987b
HIG03 *Higumastra transversa* Blome 1984b
HOM01 *Homoeoparonaella lowryensis* Whalen & Carter 2002
HOM02 *Homoeoparonaella reciproca* Carter 1988
HSU01 *Hsuum altile* Hori & Otsuka 1989
HSU02 *Hsuum arenaense* Whalen & Carter 2002
HSU03 *Hsuum busuangaense* Yeh & Cheng 1996
HSU04 *Hsuum exiguum* Yeh & Cheng 1996
HSU05 *Hsuum lucidum* Yeh 1987b
3195 *Hsuum matsuokai* Isozaki & Matsuda 1985
3278 *Hsuum medium* (Takemura) 1986
HSU06 *Hsuum mulleri* Pessagno & Whalen 1982

HSU07 *Hsuum optimum* Carter 1988
HSU08 *Hsuum philippinense* Yeh & Cheng 1996
HSU11 *Hsuum plectocostatum* Carter n. sp.
HSU10 *Hsuum* sp. A sensu Carter 1988
KAT07 *Katroma angusta* Yeh 1987b
KAT08 *Katroma aurita* Whalen & Carter 2002
KAT09 *Katroma bicornus* De Wever 1982a
KAT12 *Katroma brevitubus* Dumitrica & Goričan n. sp.
KAT10 *Katroma clara* Yeh 1987b
KAT17 *Katroma elongata* Carter n. sp.
KAT13 *Katroma neagui* Pessagno & Poisson 1981, emend. De Wever 1982a
KAT14 *Katroma ninstintsi* Carter 1988
KAT16 *Katroma*? *sinetubus* Carter n. sp.
KAT18 *Katroma* sp. 4
LAN05 *Lantus intermedius* Carter n. sp.
LAN01 *Lantus obesus* (Yeh) 1987b
LAN04 *Lantus praeobesus* Carter n. sp.
LAN02 *Lantus sixi* Yeh 1987b
LAN03 *Lantus* sp. A sensu Whalen & Carter 2002
LAX06 *Laxtorum hemingense* Whalen & Carter 1998
MCP01 *Minocapsa cylindrica* Matsuoka 1991
MCP02 *Minocapsa globosa* Matsuoka 1991
TPS02 *Minocapsa*? *megaglobosa* (Matsuoka) 1991
NAP09 *Napora blechschmidti* Dumitrica n. sp.
NAP08 *Napora bona* Pessagno, Whalen & Yeh 1986
NAP02 *Napora cerromesaensis* Pessagno, Whalen & Yeh 1986
NAP06 *Napora conothorax* Carter & Dumitrica n. sp.
NAP01 *Napora graybayensis* Pessagno, Whalen & Yeh 1986
3410 *Napora nipponica* Takemura 1986
NAP03 *Napora reiferensis* (Pessagno, Whalen & Yeh) 1986
NAP04 *Napora relica* Yeh 1987b
JAC01 *Napora sandspitensis* (Pessagno, Whalen & Yeh) 1986
UTD01 *Naropa vi* Hori, Whalen & Dumitrica n. sp.
NTS01 *Noritus lillihornensis* Pessagno & Whalen 1982
ORB05 *Orbiculiformella callosa* (Yeh) 1987b
ORB06 *Orbiculiformella incognita* (Blome) 1984b
ORB03 *Orbiculiformella lomgonensis* (Whalen & Carter) 1998
ORB11 *Orbiculiformella mediocircus* Dumitrica n. sp.
ORB02 *Orbiculiformella*? *robusta* (Whalen & Carter) 1998
ORB08 *Orbiculiformella teres* (Hull) 1997
ORB13 *Orbiculiformella*? *trispina* s.l. (Yeh) 1987b
ORB09 *Orbiculiformella*? *trispina trispina* (Yeh) 1987b
ORB10 *Orbiculiformella*? *trispina trispinula* (Carter) 1988
SAT13 *Palaeosaturnalis* aff. *liassicus* Kozur & Mostler 1990
SAT12 *Palaeosaturnalis subovalis* Kozur & Mostler 1990
SAT14 *Palaeosaturnalis* sp. B sensu Whalen & Carter 2002
PAN20 *Pantanellium brevispinum* Carter n. sp.
PAN14 *Pantanellium carlense* Whalen & Carter 1998
PAN18 *Pantanellium cumshewaense* Pessagno & Blome 1980
PAN11 *Pantanellium danaense* Pessagno & Blome 1980
PAN19 *Pantanellium inornatum* Pessagno & Poisson 1981
PAN16 *Pantanellium skedansense* Pessagno & Blome 1980
PHS02 *Parahsuum edenshawi* (Carter) 1988
DRO05 *Parahsuum fondrenense* (Whalen & Carter) 1998
PHS09 *Parahsuum formosum* (Yeh) 1987b
2012 *Parahsuum izeense* (Pessagno & Whalen) 1982
PHS03 *Parahsuum longiconicum* Sashida 1988
PHS04 *Parahsuum mostleri* (Yeh) 1987b
PHS05 *Parahsuum ovale* Hori & Yao 1988
PHS01 *Parahsuum simplum* Yao 1982
PHS06 *Parahsuum vizcainoense* Whalen & Carter 2002
PHS07 *Parahsuum*? sp. A sensu Whalen & Carter 2002
2013 *Parasaturnalis diplocyclis* (Yao) 1972
SAT15 *Parasaturnalis yehae* Dumitrica & Hori n. sp.
PAR13 *Paronaella corpulenta* De Wever 1981b
PAR22 *Paronaella curticrassa* Carter & Dumitrica n. sp.
PAR24 *Paronaella fera* s.l. (Yeh) 1987b
PAR15 *Paronaella fera fera* (Yeh) 1987b
PAR10 *Paronaella fera jamesi* Whalen & Carter 1998
PAR16 *Paronaella grahamensis* Carter 1988
PAR17 *Paronaella notabilis* Whalen & Carter 2002
2005 *Paronaella skowkonaensis* Carter 1988
PAR19 *Paronaella snowshoensis* (Yeh) 1987b
PAR20 *Paronaella tripla* De Wever 1981b
PAR21 *Paronaella variabilis* Carter 1988
PSP03 *Perispyridium hippaense* (Carter) 1988
PSP01 *Perispyridium oregonense* (Yeh) 1987b
PLE01 *Pleesus aptus* Yeh 1987b
SCP02 *Plicaforacapsa*? *elegans* (Matsuoka) 1991
POD01 *Podocapsa abreojosensis* Whalen & Carter 2002
PRY05 *Praeconocaryomma bajaensis* Whalen n. sp.
PRY01 *Praeconocaryomma decora* gr. Yeh 1987b
PRY02 *Praeconocaryomma immodica* Pessagno & Poisson 1981
PRY03 *Praeconocaryomma parvimamma* Pessagno & Poisson 1981
PRY07 *Praeconocaryomma sarahae* Carter n. sp.
PRY04 *Praeconocaryomma whiteavesi* Carter 1988
PRY06 *Praeconocaryomma*? *yakounensis* Carter n. sp.
SAT01 *Praehexasaturnalis tetraradiatus* Kozur & Mostler 1990
PVG01 *Praeparvicingula aculeata* (Carter)1988
PVG02 *Praeparvicingula elementaria* (Carter) 1988
PVG03 *Praeparvicingula gigantocornis* (Kishida & Hisada) 1985
PVG04 *Praeparvicingula nanoconica* (Hori & Otsuka) 1989
TVS01 *Praeparvicingula*? *spinifera* (Takemura) 1986
PCA02 *Praeparvicingula tlellensis* Carter n. sp.
PTP01 *Protopsium gesponsa* De Wever 1981c
PRU01 *Protunuma paulsmithi* Carter 1988
PDC03 *Pseudocrucella ornata* De Wever 1981b
3126 *Pseudocrucella sanfilippoae* (Pessagno) 1977a
PDC04 *Pseudocrucella* sp. C sensu Carter 1988
PSE02 *Pseudoeucyrtis angusta* Whalen & Carter 1998
PSE04 *Pseudoeucyrtis busuangaensis* (Yeh & Cheng) 1998

PSE03 *Pseudoeucyrtis safraensis* Dumitrica & Goričan n. sp.
ORB12 *Pseudogodia deweveri* Carter n. sp.
SAT16 *Pseudoheliodiscus* aff. *alpinus* Kozur & Mostler 1990 sensu Whalen & Carter 2002
SAT07 *Pseudoheliodiscus yaoi* gr. Pessagno 1981
PPN01 *Pseudopantanellium floridum* Yeh 1987b
2007 *Pseudopoulpus acutipodium* Takemura 1986
POU01 *Pseudopoulpus* sp. A sensu Whalen & Carter 2002
PRL01 *Pseudoristola megaglobosa* Yeh 1987b
REG01 *Religa globosa* Whalen & Carter 2002
REG02 *Religa* sp. A
RBS01 *Rolumbus gastili* Pessagno, Whalen & Yeh 1986
RBS02 *Rolumbus halseyensis* Pessagno, Whalen & Yeh 1986
SAT18 *Spongosaturninus bispinus* (Yao) 1972
SAT19 *Stauromesosaturnalis deweveri* Kozur & Mostler 1990
SCP01 *Stichocapsa biconica* Matsuoka 1991
3407 *Tetraditryma* cf. *praeplena* Baumgartner sensu Carter & Jakobs 1991
THT01 *Thetis oblonga* De Wever 1982a
THU01 *Thurstonia gibsoni* Whalen & Carter 1998
THU04 *Thurstonia timberensis* Whalen & Carter 1998
TRX01 *Trexus dodgensis* Whalen & Carter 1998
3409 *Triactoma jakobsae* Carter 1995
TCA01 *Triactoma rosespitensis* (Carter) 1988
TRL01 *Trillus elkhornensis* Pessagno & Blome 1980
TRL02 *Trillus seidersi* Pessagno & Blome 1980
SPT01 *Tripocyclia*? *tortuosa* Dumitrica, Goričan & Whalen n. sp.
3247 *Turanta morinae* gr. Pessagno & Blome 1982
3408 *Tympaneides charlottensis* Carter 1988
UDA05 *Udalia plana* Whalen & Carter 1998
UNM01 *Unuma unicus* (Yeh) 1987b
TPS01 *Williriedellum*? *ferum* (Matsuoka) 1991
WNG03 *Wrangellium oregonense* Yeh 1987a
WNG01 *Wrangellium thurstonense* Pessagno & Whalen 1982
WNG04 *Wrangellium* sp. A sensu Pessagno & Whalen 1982
XTL02 *Xiphostylus duvalensis* Carter n. sp.
XTL01 *Xiphostylus simplus* Yeh 1987b
ZRT01 *Zartus mostleri* Pessago & Blome 1980
ZRT03 *Zartus stellatus* Goričan & Matsuoka n. sp.
COM01 *Zhamoidellum yehae* Dumitrica n. sp.

4.2. Alphabetical listing by species

abreojosensis	POD01	*Podocapsa abreojosensis* Whalen & Carter 2002
aculeata	PVG01	*Praeparvicingula aculeata* (Carter)1988
acutipodium	2007	*Pseudopoulpus acutipodium* Takemura 1986
alpinus	SAT16	*Pseudoheliodiscus* aff. *alpinus* Kozur & Mostler 1990 sensu Whalen & Carter 2002
altile	HSU01	*Hsuum altile* Hori & Otsuka 1989
amurensis	CHA02	*Charlottea amurensis* Whalen & Carter 1998
anatiformis	JAC02	*Anaticapitula anatiformis* (De Wever) 1982a
angulosa	CRU21	*Crucella angulosa* s.l. Carter 1988
angulosa	CRU11	*Crucella angulosa angulosa* Carter 1988
angusta	KAT07	*Katroma angusta* Yeh 1987b
angusta	PSE02	*Pseudoeucyrtis angusta* Whalen & Carter 1998
anulatum	CAN12	*Canoptum anulatum* Pessagno & Poisson 1981
aptus	PLE01	*Pleesus aptus* Yeh 1987b
arenaense	HSU02	*Hsuum arenaense* Whalen & Carter 2002
argescens	ORB04	*Beatricea*? *argescens* (Cordey) 1998
armatus	ARS03	*Ares armatus* De Wever 1982a
artum	CAN13	*Canoptum artum* Yeh 1987b
asperoensis	FAR02	*Farcus asperoensis* Pessagno, Whalen & Yeh 1986
asuncionense	CYC01	*Cyclastrum asuncionense* Whalen & Carter 2002
aurita	KAT08	*Katroma aurita* Whalen & Carter 2002
avirostrum	ARS07	*Ares avirostrum* Dumitrica & Matsuoka n. sp.
bajaensis	PRY05	*Praeconocaryomma bajaensis* Whalen n. sp.
baroni	PDC01	*Beatricea*? *baroni* Cordey 1998
baumgartneri	CTS06	*Canutus baumgartneri* Yeh 1987b
beata	PDC02	*Crucella beata* (Yeh) 1987b
biconica	SCP01	*Stichocapsa biconica* Matsuoka 1991
bicornus	KAT09	*Katroma bicornus* De Wever 1982a
bispinus	SAT18	*Spongosaturninus bispinus* (Yao) 1972
blechschmidti	NAP09	*Napora blechschmidti* Dumitrica n. sp.
bona	NAP08	*Napora bona* Pessagno, Whalen & Yeh 1986
brevispinum	PAN20	*Pantanellium brevispinum* Carter n. sp.
brevitubus	KAT12	*Katroma brevitubus* Dumitrica & Goričan n. sp.
busuangaense	HSU03	*Hsuum busuangaense* Yeh & Cheng 1996
busuangaensis	PSE04	*Pseudoeucyrtis busuangaensis* (Yeh & Cheng) 1998
callosa	ORB05	*Orbiculiformella callosa* (Yeh) 1987b
calvabovis	BPD13	*Bipedis calvabovis* De Wever 1982a
cameroni	3411	*Elodium cameroni* Carter 1988
carlense	PAN14	*Pantanellium carlense* Whalen & Carter 1998
cavata	CRU22	*Crucella cavata* s.l. Whalen & Carter 1998
cavata	CRU10	*Crucella cavata cavata* Whalen & Carter 1998
cerromesaensis	NAP02	*Napora cerromesaensis* Pessagno, Whalen & Yeh 1986
charlottensis	3408	*Tympaneides charlottensis* Carter 1988
chengi	CRB01	*Crubus chengi* Yeh 1987b
christovalensis	SPI03	*Beatricea christovalensis* Whalen & Carter 1998
clara	KAT10	*Katroma clara* Yeh 1987b
columbiaense	CAN08	*Canoptum columbiaense* Whalen & Carter 1998
conothorax	NAP06	*Napora conothorax* Carter & Dumitrica n. sp.
corpulenta	PAR13	*Paronaella corpulenta* De Wever 1981b
coyotense	ASP01	*Archaeospongoprunum coyotense* Whalen & Carter 2002
crickmayi	HCK05	*Haeckelicyrtium crickmayi* Carter n. sp.
cumshewaense	PAN18	*Pantanellium cumshewaense* Pessagno & Blome 1980
cuniculiformis	ARS06	*Ares cuniculiformis* Dumitrica & Whalen n. sp.
curticrassa	PAR22	*Paronaella curticrassa* Carter & Dumitrica n. sp.
cylindrica	MCP01	*Minocapsa cylindrica* Matsuoka 1991
cylindricus	4061	*Ares cylindricus* s.l. (Takemura) 1986
cylindricus	3001	*Ares cylindricus cylindricus* (Takemura) 1986

danaense	PAN11	*Pantanellium danaense* Pessagno & Blome 1980
decora	PRY01	*Praeconocaryomma decora* gr. Yeh 1987b
delnortensis	3222	*Bernoullius delnortensis* Pessagno, Blome & Hull 1993
deweveri	ORB12	*Pseudogodia deweveri* Carter n. sp.
deweveri	SAT19	*Stauromesosaturnalis deweveri* Kozur & Mostler 1990
diadema	BPD05	*Bipedis diadema* Whalen & Carter 1998
diegoi	CTS08	*Canutus diegoi* Whalen & Carter 2002
diplocyclis	2013	*Parasaturnalis diplocyclis* (Yao) 1972
disparile	EUC09	*Eucyrtidiellum disparile* gr. Nagai & Mizutani 1990
dixoni	CAN09	*Canoptum dixoni* Pessagno & Whalen 1982
dodgensis	TRX01	*Trexus dodgensis* Whalen & Carter 1998
duvalensis	XTL02	*Xiphostylus duvalensis* Carter n. sp.
edenshawi	PHS02	*Parahsuum edenshawi* (Carter) 1988
elegans	SCP02	*Plicaforacapsa? elegans* (Matsuoka) 1991
elementaria	PVG02	*Praeparvicingula elementaria* (Carter) 1988
elkhornensis	TRL01	*Trillus elkhornensis* Pessagno & Blome 1980
elongata	KAT17	*Katroma elongata* Carter n. sp.
emmela	ATA02	*Atalanta emmela* Cordey & Carter 1996
erraticum	BAG01	*Bagotum erraticum* Pessagno & Whalen 1982
eurasiaticus	DRO07	*Droltus eurasiaticus* Kozur & Mostler 1990
exiguum	HSU04	*Hsuum exiguum* Yeh & Cheng 1996
fannini	BPD14	*Bipedis fannini* Carter 1988
fera	PAR24	*Paronaella fera* s.l. (Yeh) 1987b
fera	PAR15	*Paronaella fera fera* (Yeh) 1987b
ferum	TPS01	*Williriedellum? ferum* (Matsuoka) 1991
flexuosus	4032	*Ares cylindricus flexuosus* (Takemura) 1986
floridum	PPN01	*Pseudopantanellium floridum* Yeh 1987b
fondrenense	DRO05	*Parahsuum fondrenense* (Whalen & Carter) 1998
formosum	PHS09	*Parahsuum formosum* (Yeh) 1987b
funiculum	BAG03	*Bagotum funiculum* Whalen & Carter 2002
fustis	GIG01	*Gigi fustis* De Wever 1982a
gastili	RBS01	*Rolumbus gastili* Pessagno, Whalen & Yeh 1986
gesponsa	PTP01	*Protopsium gesponsa* De Wever 1981c
ghostensis	2001	*Acaeniotylopsis ghostensis* (Carter) 1988
gibsoni	THU01	*Thurstonia gibsoni* Whalen & Carter 1998
giganticava	CRU20	*Crucella cavata giganticava* Carter n. ssp.
gigantocornis	PVG03	*Praeparvicingula gigantocornis* (Kishida & Hisada) 1985
globosa	MCP02	*Minocapsa globosa* Matsuoka 1991
globosa	REG01	*Religa globosa* Whalen & Carter 2002
gongyloideum	GOR02	*Gorgansium gongyloideum* Kishida & Hisada 1985
grahamensis	PAR16	*Paronaella grahamensis* Carter 1988
graybayensis	NAP01	*Napora graybayensis* Pessagno, Whalen & Yeh 1986
graylockensis	FAR04	*Farcus graylockensis* Pessagno, Whalen & Yeh 1986
gujoense	EUC10	*Eucyrtidiellum gujoense* (Takemura & Nakaseko) 1986
gunense	EUC03	*Eucyrtidiellum gunense* gr. Cordey 1998
hainaensis	CTS09	*Canutus hainaensis* Pessagno & Whalen 1982
halseyensis	RBS02	*Rolumbus halseyensis* Pessagno, Whalen & Yeh 1986
hattorii	ATT01	*Archaeotritrabs hattorii* Dumitrica n. sp.
hecatensis	DRO02	*Droltus hecatensis* Pessagno & Whalen 1982
helmetense	BAG02	*Bagotum helmetense* Pessagno & Whalen 1982
hemingense	LAX06	*Laxtorum hemingense* Whalen & Carter 1998
hexagonus	3502	*Hexasaturnalis hexagonus* (Yao) 1972
hexaptera	4033	*Citriduma hexaptera* (Conti & Marcucci) 1991
hipolitoensis	DUC01	*Ducatus hipolitoensis* Whalen & Carter 2002
hippaense	PSP03	*Perispyridium hippaense* (Carter) 1988
hotaoensis	CHA09	*Charlottea hotaoensis* Carter n. sp.
immodica	PRY02	*Praeconocaryomma immodica* Pessagno & Poisson 1981
incognita	ORB06	*Orbiculiformella incognita* (Blome) 1984b
inornatum	PAN19	*Pantanellium inornatum* Pessagno & Poisson 1981

intermedicava	CRU19	*Crucella cavata intermedicava* Carter n. ssp.
intermedius	LAN05	*Lantus intermedius* Carter n. sp.
izeense	2012	*Parahsuum izeense* (Pessagno & Whalen) 1982
jadeae	PDC05	*Crucella jadeae* Carter & Dumitrica n. sp.
jakobsae	3409	*Triactoma jakobsae* Carter 1995
jamesi	PAR10	*Paronaella fera jamesi* Whalen & Carter 1998
japonicus	BPD15	*Bipedis japonicus* Hori n. sp.
kimbroughi	BAG04	*Bagotum kimbroughi* Whalen & Carter 2002
kozuri	FAR03	*Farcus kozuri* Yeh 1987b
kuensis	BRO02	*Broctus kuensis* Pessagno & Whalen 1982
laseekensis	DRO03	*Droltus laseekensis* Pessagno & Whalen 1982
laxa	HIG01	*Higumastra laxa* Yeh 1987b
liassicus	SAT13	*Palaeosaturnalis* aff. *liassicus* Kozur & Mostler 1990
lillihornensis	NTS01	*Noritus lillihornensis* Pessagno & Whalen 1982
lomgonensis	ORB03	*Orbiculiformella lomgonensis* (Whalen & Carter) 1998
longibrachiata	CRU12	*Crucella angulosa longibrachiata* Carter n. ssp.
longiconicum	PHS03	*Parahsuum longiconicum* Sashida 1988
longipes	3149	*Archaeohagiastrum longipes* Baumgartner 1995
lowryensis	HOM01	*Homoeoparonaella lowryensis* Whalen & Carter 2002
lucidum	HSU05	*Hsuum lucidum* Yeh 1987b
lupheri	HIG04	*Higumastra lupheri* Yeh 1987b
lyellensis	DRO06	*Droltus lyellensis* Pessagno & Whalen 1982
mackenziei	PHS08	*Elodium*? *mackenziei* Carter n. sp.
macrum	HAG06	*Hagiastrum macrum* gr. De Wever 1981b
majusculum	HAG03	*Hagiastrum majusculum* Whalen & Carter 1998
mangartense	BIS04	*Bistarkum mangartense* Goričan, Šmuc & Baumgartner 2003
margaritaense	CAN11	*Canoptum margaritaense* Whalen & Carter 1998
matsuokai	3195	*Hsuum matsuokai* Isozaki & Matsuda 1985
maudense	BAG05	*Bagotum maudense* Pessagno & Whalen 1982
mediocircus	ORB11	*Orbiculiformella mediocircus* Dumitrica n. sp.
medium	3278	*Hsuum medium* (Takemura) 1986
megaglobosa	TPS02	*Minocapsa*? *megaglobosa* (Matsuoka) 1991
megaglobosa	PRL01	*Pseudoristola megaglobosa* Yeh 1987b
mexicoensis	ARS04	*Ares mexicoensis* Whalen & Carter 2002
mijo	CRU13	*Crucella mijo* De Wever 1981b
minai	SUM03	*Carterwhalenia minai* (Whalen & Carter) 2002
minoensis	TPS03	*Helvetocapsa minoensis* (Matsuoka) 1991
mirabunda	CRU14	*Crucella mirabunda* Whalen & Carter 2002
modestum	BAG06	*Bagotum modestum* Pessagno & Whalen 1982
moresbyensis	ARS01	*Ares moresbyensis* Whalen & Carter 1998
morganense	GOR03	*Gorgansium morganense* Pessagno & Blome 1980
morinae	3247	*Turanta morinae* gr. Pessagno & Blome 1982
mostleri	PHS04	*Parahsuum mostleri* (Yeh) 1987b
mostleri	ZRT01	*Zartus mostleri* Pessago & Blome 1980
mulleri	HSU06	*Hsuum mulleri* Pessagno & Whalen 1982
munda	ADM01	*Archaeodictyomitra munda* (Yeh) 1987b
munitum	3271	*Archaeohagiastrum munitum* Baumgartner 1984
nagaiae	EUC06	*Eucyrtidiellum nagaiae* Dumitrica, Goričan & Matsuoka n. sp.
nanjoensis	SCP03	*Helvetocapsa nanjoensis* (Matsuoka) 1991
nanoconica	PVG04	*Praeparvicingula nanoconica* (Hori & Otsuka) 1989
neagui	KAT13	*Katroma neagui* Pessagno & Poisson 1981 emend. De Wever 1982a
ninstintsi	KAT14	*Katroma ninstintsi* Carter 1988
nipponica	3410	*Napora nipponica* Takemura 1986
nitidus	CTS10	*Canutus nitidus* Yeh 1987b
notabilis	PAR17	*Paronaella notabilis* Whalen & Carter 2002
obesus	LAN01	*Lantus obesus* (Yeh) 1987b
oblonga	THT01	*Thetis oblonga* De Wever 1982a
octopus	SAT11	*Hexasaturnalis octopus* Dumitrica & Hori n. sp.
omanensis	JAC04	*Anaticapitula omanensis* Dumitrica n. sp.

omanojaponicum	EUC07	*Eucyrtidiellum omanojaponicum* Dumitrica, Goričan & Hori n. sp.
optimum	HSU07	*Hsuum optimum* Carter 1988
oregonense	HAG01	*Archaeohagiastrum oregonense* (Yeh) 1987b
oregonense	PSP01	*Perispyridium oregonense* (Yeh) 1987b
oregonense	WNG03	*Wrangellium oregonense* Yeh 1987a
ornata	PDC03	*Pseudocrucella ornata* De Wever 1981b
ovale	PHS05	*Parahsuum ovale* Hori & Yao 1988
parvimamma	PRY03	*Praeconocaryomma parvimamma* Pessagno & Poisson 1981
paulsmithi	PRU01	*Protunuma paulsmithi* Carter 1988
penderi	CHA10	*Charlottea penderi* Carter n. sp.
pessagnoi	ELD02	*Elodium pessagnoi* Yeh & Cheng 1996
phantomense	BIS02	*Bistarkum phantomense* (Carter) 1988
philippinense	HSU08	*Hsuum philippinense* Yeh & Cheng 1996
plana	UDA05	*Udalia plana* Whalen & Carter 1998
plectocostatum	HSU11	*Hsuum plectocostatum* Carter n. sp.
plicata	SCP06	*Helvetocapsa plicata* s.l. (Matsuoka) 1991
plicata	SCP04	*Helvetocapsa plicata plicata* (Matsuoka) 1991
pobi	HAG02	*Archaeohagiastrum pobi* Whalen & Carter 1998
praeobesus	LAN04	*Lantus praeobesus* Carter n. sp.
praeplena	3407	*Tetraditryma* cf. *praeplena* Baumgartner sensu Carter & Jakobs 1991
proprietatis	CHA03	*Charlottea proprietatis* Whalen & Carter 1998
protoformis	2021	*Eospongosaturninus protoformis* (Yao) 1972
pseudoerraticum	BAG07	*Bagotum pseudoerraticum* Kishida & Hisada 1985
radiotuba	CIT05	*Citriduma radiotuba* De Wever 1982a
ramescens	EUC04	*Eucyrtidiellum ramescens* Cordey 1998
reciproca	HOM02	*Homoeoparonaella reciproca* Carter 1988
reiferensis	NAP03	*Napora reiferensis* (Pessagno, Whalen & Yeh) 1986
relica	NAP04	*Napora relica* Yeh 1987b
rennellensis	CTS15	*Canutus rennellensis* Carter n. sp.
rigidium	BIS01	*Bistarkum rigidium* Yeh 1987b
robusta	ORB02	*Orbiculiformella? robusta* (Whalen & Carter) 1998
rockfishensis	CTS03	*Canutus rockfishensis* Pessagno & Whalen 1982
rosespitensis	TCA01	*Triactoma rosespitensis* (Carter) 1988
rudimentum	HAG04	*Hagiastrum rudimentum* Whalen & Carter 1998
ruesti	BRO03	*Broctus ruesti* Yeh 1987b
rugosum	CAN14	*Canoptum rugosum* Pessagno & Poisson 1981
saccideon	BER01	*Bernoullius saccideon* (Carter) 1988
safraensis	PSE03	*Pseudoeucyrtis safraensis* Dumitrica & Goričan n. sp.
saginatum	BIS03	*Bistarkum saginatum* Yeh 1987b
sandilandsensis	FRM01	*Foremania sandilandsensis* gr. Whalen & Carter 1998
sandspitensis	JAC01	*Napora sandspitensis* (Pessagno, Whalen & Yeh) 1986
sanfilippoae	3126	*Pseudocrucella sanfilippoae* (Pessagno) 1977a
sanignacioensis	DRO08	*Droltus sanignacioensis* Whalen & Carter 2002
sanpabloensis	ORB07	*Beatricea sanpabloensis* (Whalen & Carter) 2002
sarahae	PRY07	*Praeconocaryomma sarahae* Carter n. sp.
scammonense	CYC02	*Cyclastrum scammonense* Whalen & Carter 2002
seidersi	TRL02	*Trillus seidersi* Pessagno & Blome 1980
selwynensis	BRO01	*Broctus selwynensis* Pessagno & Whalen 1982
semiplicata	SCP05	*Helvetocapsa plicata semiplicata* (Matsuoka) 1991
simplum	PHS01	*Parahsuum simplum* Yao 1982
simplus	XTL01	*Xiphostylus simplus* Yeh 1987b
sinetubus	KAT16	*Katroma? sinetubus* Carter n. sp.
sixi	LAN02	*Lantus sixi* Yeh 1987b
skedansense	PAN16	*Pantanellium skedansense* Pessagno & Blome 1980
skowkonaensis	2005	*Paronaella skowkonaensis* Carter 1988
snowshoensis	PAR19	*Paronaella snowshoensis* (Yeh) 1987b
spinifera	TVS01	*Praeparvicingula? spinifera* (Takemura) 1986
spongase	CRU15	*Crucella spongase* De Wever 1981b
squama	CRU16	*Crucella squama* (Kozlova) 1971

stellatus	ZRT03	*Zartus stellatus* Goričan & Matsuoka n. sp.
subovalis	SAT12	*Palaeosaturnalis subovalis* Kozur & Mostler 1990
sutherlandi	ARS02	*Ares sutherlandi* Whalen & Carter 1998
takemurai	ARS08	*Ares takemurai* Dumitrica & Matsuoka n. sp.
teres	ORB08	*Orbiculiformella teres* (Hull) 1997
tetraradiatus	SAT01	*Praehexasaturnalis tetraradiatus* Kozur & Mostler 1990
tetraspinus	3089	*Hexasaturnalis tetraspinus* (Yao) 1972
theokaftensis	3131	*Crucella theokaftensis* Baumgartner 1980
thurstonense	WNG01	*Wrangellium thurstonense* Pessagno & Whalen 1982
timberensis	THU04	*Thurstonia timberensis* Whalen & Carter 1998
tipperi	CTS12	*Canutus tipperi* gr. Pessagno & Whalen 1982
tlellensis	PCA02	*Praeparvicingula tlellensis* Carter n. sp.
tortuosa	SPT01	*Tripocyclia*? *tortuosa* Dumitrica, Goričan & Whalen n. sp.
transversa	HIG03	*Higumastra transversa* Blome 1984b
triacanthus	4066	*Acaeniotylopsis triacanthus* Kito & De Wever 1994
tripla	PAR20	*Paronaella tripla* De Wever 1981b
triquetra	CHA05	*Charlottea triquetra* Whalen & Carter 1998
trispina	ORB13	*Orbiculiformella*? *trispina* s.l. (Yeh) 1987b
trispina	ORB09	*Orbiculiformella*? *trispina trispina* (Yeh) 1987b
trispinosa	JAC05	*Dumitricaella trispinosa* Dumitrica n. sp.
trispinula	ORB10	*Orbiculiformella*? *trispina trispinula* (Carter) 1988
unicus	UNM01	*Unuma unicus* (Yeh) 1987b
variabilis	PAR21	*Paronaella variabilis* Carter 1988
veracruzense	CYC03	*Cyclastrum veracruzense* Whalen & Carter 2002
vi	UTD01	*Naropa vi* Hori, Whalen & Dumitrica n. sp.
vizcainoense	PHS06	*Parahsuum vizcainoense* Whalen & Carter 2002
whiteavesi	PRY04	*Praeconocaryomma whiteavesi* Carter 1988
wilsonense	ELD03	*Elodium wilsonense* (Carter) 1988
yakounensis	PRY06	*Praeconocaryomma*? *yakounensis* Carter n. sp.
yaoi	BPD16	*Bipedis yaoi* Hori n. sp.
yaoi	SAT07	*Pseudoheliodiscus yaoi* gr. Pessagno 1981
yehae	SAT15	*Parasaturnalis yehae* Dumitrica & Hori n. sp.
yehae	COM01	*Zhamoidellum yehae* Dumitrica n. sp.
sp. A	ADM02	*Archaeodictyomitra* sp. A
sp. A	4008	*Ares* sp. A sensu Baumgartner et al. 1995a
sp. A	CRU18	*Beatricea*? sp. A
sp. A	CHA07	*Charlottea* sp. A sensu Whalen & Carter 2002
sp. A	CYC04	*Cyclastrum* sp. A
sp. A	DAN02	*Danubea* sp. A sensu Whalen & Carter 2002
sp. A	HSU10	*Hsuum* sp. A sensu Carter 1988
sp. A	LAN03	*Lantus* sp. A sensu Whalen & Carter 2002
sp. A	PHS07	*Parahsuum*? sp. A sensu Whalen & Carter 2002
sp. A	POU01	*Pseudopoulpus* sp. A sensu Whalen & Carter 2002
sp. A	REG02	*Religa* sp. A
sp. A	WNG04	*Wrangellium* sp. A sensu Pessagno & Whalen 1982
sp. B	ADM03	*Archaeodictyomitra* sp. B
sp. B	CHA08	*Charlottea* sp. B
sp. B	HCK04	*Haeckelicyrtium* sp. B sensu Whalen & Carter 2002
sp. B	SAT14	*Palaeosaturnalis* sp. B sensu Whalen & Carter 2002
sp. C	CHA11	*Charlottea* sp. C
sp. C	PDC04	*Pseudocrucella* sp. C sensu Carter 1988
sp. O	CTS16	*Canutus* sp. O
sp. Y	XNM01	*Charlottea*? sp. Y
sp. 4	KAT18	*Katroma* sp. 4

4.3. Listing in ascending order of species/subspecies codes

2001 *Acaeniotylopsis ghostensis* (Carter) 1988
2005 *Paronaella skowkonaensis* Carter 1988
2007 *Pseudopoulpus acutipodium* Takemura 1986
2012 *Parahsuum izeense* (Pessagno & Whalen) 1982
2013 *Parasaturnalis diplocyclis* (Yao) 1972
2021 *Eospongosaturninus protoformis* (Yao) 1972
3001 *Ares cylindricus cylindricus* (Takemura) 1986
3089 *Hexasaturnalis tetraspinus* (Yao) 1972
3126 *Pseudocrucella sanfilippoae* (Pessagno) 1977a
3131 *Crucella theokaftensis* Baumgartner 1980
3149 *Archaeohagiastrum longipes* Baumgartner 1995
3195 *Hsuum matsuokai* Isozaki & Matsuda 1985
3222 *Bernoullius delnortensis* Pessagno, Blome & Hull 1993
3247 *Turanta morinae* gr. Pessagno & Blome 1982
3271 *Archaeohagiastrum munitum* Baumgartner 1984
3278 *Hsuum medium* (Takemura) 1986
3407 *Tetraditryma* cf. *praeplena* Baumgartner sensu Carter & Jakobs 1991
3408 *Tympaneides charlottensis* Carter 1988
3409 *Triactoma jakobsae* Carter 1995
3410 *Napora nipponica* Takemura 1986
3411 *Elodium cameroni* Carter 1988
3502 *Hexasaturnalis hexagonus* (Yao) 1972
4008 *Ares* sp. A sensu Baumgartner et al. 1995a
4032 *Ares cylindricus flexuosus* (Takemura) 1986
4033 *Citriduma hexaptera* (Conti & Marcucci) 1991
4061 *Ares cylindricus* s.l. (Takemura) 1986
4066 *Acaeniotylopsis triacanthus* Kito & De Wever 1994
ADM01 *Archaeodictyomitra munda* (Yeh) 1987b
ADM02 *Archaeodictyomitra* sp. A
ADM03 *Archaeodictyomitra* sp. B
ARS01 *Ares moresbyensis* Whalen & Carter 1998
ARS02 *Ares sutherlandi* Whalen & Carter 1998
ARS03 *Ares armatus* De Wever 1982a
ARS04 *Ares mexicoensis* Whalen & Carter 2002
ARS06 *Ares cuniculiformis* Dumitrica & Whalen n. sp.
ARS07 *Ares avirostrum* Dumitrica & Matsuoka n. sp.
ARS08 *Ares takemurai* Dumitrica & Matsuoka n. sp.
ASP01 *Archaeospongoprunum coyotense* Whalen & Carter 2002
ATA02 *Atalanta emmela* Cordey & Carter 1996
ATT01 *Archaeotritrabs hattorii* Dumitrica n. sp.
BAG01 *Bagotum erraticum* Pessagno & Whalen 1982
BAG02 *Bagotum helmetense* Pessagno & Whalen 1982
BAG03 *Bagotum funiculum* Whalen & Carter 2002
BAG04 *Bagotum kimbroughi* Whalen & Carter 2002
BAG05 *Bagotum maudense* Pessagno & Whalen 1982
BAG06 *Bagotum modestum* Pessagno & Whalen 1982
BAG07 *Bagotum pseudoerraticum* Kishida & Hisada 1985
BER01 *Bernoullius saccideon* (Carter) 1988
BIS01 *Bistarkum rigidium* Yeh 1987b
BIS02 *Bistarkum phantomense* (Carter) 1988
BIS03 *Bistarkum saginatum* Yeh 1987b
BIS04 *Bistarkum mangartense* Goričan, Šmuc & Baumgartner 2003
BPD05 *Bipedis diadema* Whalen & Carter 1998
BPD13 *Bipedis calvabovis* De Wever 1982a
BPD14 *Bipedis fannini* Carter 1988
BPD15 *Bipedis japonicus* Hori n. sp.
BPD16 *Bipedis yaoi* Hori n. sp.
BRO01 *Broctus selwynensis* Pessagno & Whalen 1982
BRO02 *Broctus kuensis* Pessagno & Whalen 1982
BRO03 *Broctus ruesti* Yeh 1987b
CAN08 *Canoptum columbiaense* Whalen & Carter 1998
CAN09 *Canoptum dixoni* Pessagno & Whalen 1982
CAN11 *Canoptum margaritaense* Whalen & Carter 1998
CAN12 *Canoptum anulatum* Pessagno & Poisson 1981
CAN13 *Canoptum artum* Yeh 1987b
CAN14 *Canoptum rugosum* Pessagno & Poisson 1981
CHA02 *Charlottea amurensis* Whalen & Carter 1998
CHA03 *Charlottea proprietatis* Whalen & Carter 1998
CHA05 *Charlottea triquetra* Whalen & Carter 1998
CHA07 *Charlottea* sp. A sensu Whalen & Carter 2002
CHA08 *Charlottea* sp. B
CHA09 *Charlottea hotaoensis* Carter n. sp.
CHA10 *Charlottea penderi* Carter n. sp.
CHA11 *Charlottea* sp. C
CIT05 *Citriduma radiotuba* De Wever 1982a
COM01 *Zhamoidellum yehae* Dumitrica n. sp.
CRB01 *Crubus chengi* Yeh 1987b
CRU10 *Crucella cavata cavata* Whalen & Carter 1998
CRU11 *Crucella angulosa angulosa* Carter 1988
CRU12 *Crucella angulosa longibrachiata* Carter n. ssp.
CRU13 *Crucella mijo* De Wever 1981b
CRU14 *Crucella mirabunda* Whalen & Carter 2002
CRU15 *Crucella spongase* De Wever 1981b
CRU16 *Crucella squama* (Kozlova) 1971
CRU18 *Beatricea*? sp. A
CRU19 *Crucella cavata intermedicava* Carter n. ssp.
CRU20 *Crucella cavata giganticava* Carter n. ssp.
CRU21 *Crucella angulosa* s.l. Carter 1988
CRU22 *Crucella cavata* s.l. Whalen & Carter 1998
CTS03 *Canutus rockfishensis* Pessagno & Whalen 1982
CTS06 *Canutus baumgartneri* Yeh 1987b
CTS08 *Canutus diegoi* Whalen & Carter 2002
CTS09 *Canutus hainaensis* Pessagno & Whalen 1982
CTS10 *Canutus nitidus* Yeh 1987b
CTS12 *Canutus tipperi* gr. Pessagno & Whalen 1982
CTS15 *Canutus rennellensis* Carter n. sp.
CTS16 *Canutus* sp. O
CYC01 *Cyclastrum asuncionense* Whalen & Carter 2002
CYC02 *Cyclastrum scammonense* Whalen & Carter 2002
CYC03 *Cyclastrum veracruzense* Whalen & Carter 2002
CYC04 *Cyclastrum* sp. A
DAN02 *Danubea* sp. A sensu Whalen & Carter 2002
DRO02 *Droltus hecatensis* Pessagno & Whalen 1982
DRO03 *Droltus laseekensis* Pessagno & Whalen 1982
DRO05 *Parahsuum fondrenense* (Whalen & Carter) 1998
DRO06 *Droltus lyellensis* Pessagno & Whalen 1982

DRO07 *Droltus eurasiaticus* Kozur & Mostler 1990
DRO08 *Droltus sanignacioensis* Whalen & Carter 2002
DUC01 *Ducatus hipolitoensis* Whalen & Carter 2002
ELD02 *Elodium pessagnoi* Yeh & Cheng 1996
ELD03 *Elodium wilsonense* (Carter) 1988
EUC03 *Eucyrtidiellum gunense* gr. Cordey 1998
EUC04 *Eucyrtidiellum ramescens* Cordey 1998
EUC06 *Eucyrtidiellum nagaiae* Dumitrica, Goričan & Matsuoka n. sp.
EUC07 *Eucyrtidiellum omanojaponicum* Dumitrica, Goričan & Hori n. sp.
EUC09 *Eucyrtidiellum disparile* gr. Nagai & Mizutani 1990
EUC10 *Eucyrtidiellum gujoense* (Takemura & Nakaseko) 1986
FAR02 *Farcus asperoensis* Pessagno, Whalen & Yeh 1986
FAR03 *Farcus kozuri* Yeh 1987b
FAR04 *Farcus graylockensis* Pessagno, Whalen & Yeh 1986
FRM01 *Foremania sandilandsensis* gr. Whalen & Carter 1998
GIG01 *Gigi fustis* De Wever 1982a
GOR02 *Gorgansium gongyloideum* Kishida & Hisada 1985
GOR03 *Gorgansium morganense* Pessagno & Blome 1980
HAG01 *Archaeohagiastrum oregonense* (Yeh) 1987b
HAG02 *Archaeohagiastrum pobi* Whalen & Carter 1998
HAG03 *Hagiastrum majusculum* Whalen & Carter 1998
HAG04 *Hagiastrum rudimentum* Whalen & Carter 1998
HAG06 *Hagiastrum macrum* gr. De Wever 1981b
HCK04 *Haeckelicyrtium* sp. B sensu Whalen & Carter 2002
HCK05 *Haeckelicyrtium crickmayi* Carter n. sp.
HIG01 *Higumastra laxa* Yeh 1987b
HIG03 *Higumastra transversa* Blome 1984b
HIG04 *Higumastra lupheri* Yeh 1987b
HOM01 *Homoeoparonaella lowryensis* Whalen & Carter 2002
HOM02 *Homoeoparonaella reciproca* Carter 1988
HSU01 *Hsuum altile* Hori & Otsuka 1989
HSU02 *Hsuum arenaense* Whalen & Carter 2002
HSU03 *Hsuum busuangaense* Yeh & Cheng 1996
HSU04 *Hsuum exiguum* Yeh & Cheng 1996
HSU05 *Hsuum lucidum* Yeh 1987b
HSU06 *Hsuum mulleri* Pessagno & Whalen 1982
HSU07 *Hsuum optimum* Carter 1988
HSU08 *Hsuum philippinense* Yeh & Cheng 1996
HSU10 *Hsuum* sp. A sensu Carter 1988
HSU11 *Hsuum plectocostatum* Carter n. sp.
JAC01 *Napora sandspitensis* (Pessagno, Whalen & Yeh) 1986
JAC02 *Anaticapitula anatiformis* (De Wever) 1982a
JAC04 *Anaticapitula omanensis* Dumitrica n. sp.
JAC05 *Dumitricaella trispinosa* Dumitrica n. sp.
KAT07 *Katroma angusta* Yeh 1987b
KAT08 *Katroma aurita* Whalen & Carter 2002
KAT09 *Katroma bicornus* De Wever 1982a
KAT10 *Katroma clara* Yeh 1987b
KAT12 *Katroma brevitubus* Dumitrica & Goričan n. sp.
KAT13 *Katroma neagui* Pessagno & Poisson 1981 emend. De Wever 1982a
KAT14 *Katroma ninstintsi* Carter 1988
KAT16 *Katroma*? *sinetubus* Carter n. sp.
KAT17 *Katroma elongata* Carter n. sp.
KAT18 *Katroma* sp. 4
LAN01 *Lantus obesus* (Yeh) 1987b
LAN02 *Lantus sixi* Yeh 1987b
LAN03 *Lantus* sp. A sensu Whalen & Carter 2002
LAN04 *Lantus praeobesus* Carter n. sp.
LAN05 *Lantus intermedius* Carter n. sp.
LAX06 *Laxtorum hemingense* Whalen & Carter 1998
MCP01 *Minocapsa cylindrica* Matsuoka 1991
MCP02 *Minocapsa globosa* Matsuoka 1991
NAP01 *Napora graybayensis* Pessagno, Whalen & Yeh 1986
NAP02 *Napora cerromesaensis* Pessagno, Whalen & Yeh 1986
NAP03 *Napora reiferensis* (Pessagno, Whalen & Yeh) 1986
NAP04 *Napora relica* Yeh 1987b
NAP06 *Napora conothorax* Carter & Dumitrica n. sp.
NAP08 *Napora bona* Pessagno, Whalen & Yeh 1986
NAP09 *Napora blechschmidti* Dumitrica n. sp.
NTS01 *Noritus lillihornensis* Pessagno & Whalen 1982
ORB02 *Orbiculiformella*? *robusta* (Whalen & Carter) 1998
ORB03 *Orbiculiformella lomgonensis* (Whalen & Carter) 1998
ORB04 *Beatricea*? *argescens* (Cordey) 1998
ORB05 *Orbiculiformella callosa* (Yeh) 1987b
ORB06 *Orbiculiformella incognita* (Blome) 1984b
ORB07 *Beatricea sanpabloensis* (Whalen & Carter) 2002
ORB08 *Orbiculiformella teres* (Hull) 1997
ORB09 *Orbiculiformella*? *trispina trispina* (Yeh) 1987b
ORB10 *Orbiculiformella*? *trispina trispinula* (Carter) 1988
ORB11 *Orbiculiformella mediocircus* Dumitrica n. sp.
ORB12 *Pseudogodia deweveri* Carter n. sp.
ORB13 *Orbiculiformella*? *trispina* s.l. (Yeh) 1987b
PAN11 *Pantanellium danaense* Pessagno & Blome 1980
PAN14 *Pantanellium carlense* Whalen & Carter 1998
PAN16 *Pantanellium skedansense* Pessagno & Blome 1980
PAN18 *Pantanellium cumshewaense* Pessagno & Blome 1980
PAN19 *Pantanellium inornatum* Pessagno & Poisson 1981
PAN20 *Pantanellium brevispinum* Carter n. sp.
PAR10 *Paronaella fera jamesi* Whalen & Carter 1998
PAR13 *Paronaella corpulenta* De Wever 1981b
PAR15 *Paronaella fera fera* (Yeh) 1987b
PAR16 *Paronaella grahamensis* Carter 1988
PAR17 *Paronaella notabilis* Whalen & Carter 2002
PAR19 *Paronaella snowshoensis* (Yeh) 1987b
PAR20 *Paronaella tripla* De Wever 1981b
PAR21 *Paronaella variabilis* Carter 1988
PAR22 *Paronaella curticrassa* Carter & Dumitrica n. sp.

PAR24 *Paronaella fera* s.l. (Yeh) 1987b
PCA02 *Praeparvicingula tlellensis* Carter n. sp.
PDC01 *Beatricea*? *baroni* Cordey 1998
PDC02 *Crucella beata* (Yeh) 1987b
PDC03 *Pseudocrucella ornata* De Wever 1981b
PDC04 *Pseudocrucella* sp. C sensu Carter 1988
PDC05 *Crucella jadeae* Carter & Dumitrica n. sp.
PHS01 *Parahsuum simplum* Yao 1982
PHS02 *Parahsuum edenshawi* (Carter) 1988
PHS03 *Parahsuum longiconicum* Sashida 1988
PHS04 *Parahsuum mostleri* (Yeh) 1987b
PHS05 *Parahsuum ovale* Hori & Yao 1988
PHS06 *Parahsuum vizcainoense* Whalen & Carter 2002
PHS07 *Parahsuum*? sp. A sensu Whalen & Carter 2002
PHS08 *Elodium*? *mackenziei* Carter n. sp.
PHS09 *Parahsuum formosum* (Yeh) 1987b
PLE01 *Pleesus aptus* Yeh 1987b
POD01 *Podocapsa abreojosensis* Whalen & Carter 2002
POU01 *Pseudopoulpus* sp. A sensu Whalen & Carter 2002
PPN01 *Pseudopantanellium floridum* Yeh 1987b
PRL01 *Pseudoristola megaglobosa* Yeh 1987b
PRU01 *Protunuma paulsmithi* Carter 1988
PRY01 *Praeconocaryomma decora* gr. Yeh 1987b
PRY02 *Praeconocaryomma immodica* Pessagno & Poisson 1981
PRY03 *Praeconocaryomma parvimamma* Pessagno & Poisson 1981
PRY04 *Praeconocaryomma whiteavesi* Carter 1988
PRY05 *Praeconocaryomma bajaensis* Whalen n. sp.
PRY06 *Praeconocaryomma*? *yakounensis* Carter n. sp.
PRY07 *Praeconocaryomma sarahae* Carter n. sp.
PSE02 *Pseudoeucyrtis angusta* Whalen & Carter 1998
PSE03 *Pseudoeucyrtis safraensis* Dumitrica & Goričan n. sp.
PSE04 *Pseudoeucyrtis busuangaensis* (Yeh & Cheng) 1998
PSP01 *Perispyridium oregonense* (Yeh) 1987b
PSP03 *Perispyridium hippaense* (Carter) 1988
PTP01 *Protopsium gesponsa* De Wever 1981c
PVG01 *Praeparvicingula aculeata* (Carter)1988
PVG02 *Praeparvicingula elementaria* (Carter) 1988
PVG03 *Praeparvicingula gigantocornis* (Kishida & Hisada) 1985
PVG04 *Praeparvicingula nanoconica* (Hori & Otsuka) 1989
RBS01 *Rolumbus gastili* Pessagno, Whalen & Yeh 1986
RBS02 *Rolumbus halseyensis* Pessagno, Whalen & Yeh 1986
REG01 *Religa globosa* Whalen & Carter 2002
REG02 *Religa* sp. A
SAT01 *Praehexasaturnalis tetraradiatus* Kozur & Mostler 1990
SAT07 *Pseudoheliodiscus yaoi* gr. Pessagno 1981
SAT11 *Hexasaturnalis octopus* Dumitrica & Hori n. sp.
SAT12 *Palaeosaturnalis subovalis* Kozur & Mostler 1990
SAT13 *Palaeosaturnalis* aff. *liassicus* Kozur & Mostler 1990
SAT14 *Palaeosaturnalis* sp. B sensu Whalen & Carter 2002
SAT15 *Parasaturnalis yehae* Dumitrica & Hori n. sp.
SAT16 *Pseudoheliodiscus* aff. *alpinus* Kozur & Mostler 1990 sensu Whalen & Carter 2002
SAT18 *Spongosaturninus bispinus* (Yao) 1972
SAT19 *Stauromesosaturnalis deweveri* Kozur & Mostler 1990
SCP01 *Stichocapsa biconica* Matsuoka 1991
SCP02 *Plicaforacapsa*? *elegans* (Matsuoka) 1991
SCP03 *Helvetocapsa nanjoensis* (Matsuoka) 1991
SCP04 *Helvetocapsa plicata plicata* (Matsuoka) 1991
SCP05 *Helvetocapsa plicata semiplicata* (Matsuoka) 1991
SCP06 *Helvetocapsa plicata* s.l. (Matsuoka) 1991
SPI03 *Beatricea christovalensis* Whalen & Carter 1998
SPT01 *Tripocyclia*? *tortuosa* Dumitrica, Goričan & Whalen n. sp.
SUM03 *Carterwhalenia minai* (Whalen & Carter) 2002
TCA01 *Triactoma rosespitensis* (Carter) 1988
THT01 *Thetis oblonga* De Wever 1982a
THU01 *Thurstonia gibsoni* Whalen & Carter 1998
THU04 *Thurstonia timberensis* Whalen & Carter 1998
TPS01 *Williriedellum*? *ferum* (Matsuoka) 1991
TPS02 *Minocapsa*? *megaglobosa* (Matsuoka) 1991
TPS03 *Helvetocapsa minoensis* (Matsuoka) 1991
TRL01 *Trillus elkhornensis* Pessagno & Blome 1980
TRL02 *Trillus seidersi* Pessagno & Blome 1980
TRX01 *Trexus dodgensis* Whalen & Carter 1998
TVS01 *Praeparvicingula*? *spinifera* (Takemura) 1986
UDA05 *Udalia plana* Whalen & Carter 1998
UNM01 *Unuma unicus* (Yeh) 1987b
UTD01 *Naropa vi* Hori, Whalen & Dumitrica n. sp.
WNG01 *Wrangellium thurstonense* Pessagno & Whalen 1982
WNG03 *Wrangellium oregonense* Yeh 1987a
WNG04 *Wrangellium* sp. A sensu Pessagno & Whalen 1982
XNM01 *Charlottea*? sp. Y
XTL01 *Xiphostylus simplus* Yeh 1987b
XTL02 *Xiphostylus duvalensis* Carter n. sp.
ZRT01 *Zartus mostleri* Pessago & Blome 1980
ZRT03 *Zartus stellatus* Goričan & Matsuoka n. sp.

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