PARKERIA SPHAERICA CARTER, 1877 (HYDROZOAN) IN THE VRACONIAN (LOWER CRETACEOUS) OF OROSEI (SARDINIA)

I. DIENI - D. TURNŠEK

Estratto dal
Bollettino della Società Paleontologica Italiana
Vol. 18, n. 2, 1979

S.T.E.M. MUCCHI — MODENA

Bollettino della Società Paleontologica Italiana - Vol. 18, n. 2, 1979, pp. 200-206, 1 pl., text-figs. 1-3.

Parkeria sphaerica Carter, 1877 (Hydrozoan) in the Vraconian (Lower Cretaceous) of Orosei (Sardinia)

Iginio DIENI
Istituto di Geologia e Paleontologia
Università degli Studi di Padova

Dragica TURNŠEK
Inštitut za paleontologijo
Slovenska akademija znanosti in umetnosti, Ljubljana

(manuscript received June 12, 1979,
accepted October 31, 1979)

KEY WORDS — Hydrozoan, Systematics, Vraconian, Sardinia.

ABSTRACT — The occurrence of Parkeria sphaerica *in the Upper Vraconian of Orosei (East-central Sardinia) is recorded. This species, originally described as a large arenaceous foraminifer, has clearly distinguishing features which confirm its inclusion among the epizoic hydrozoans.*

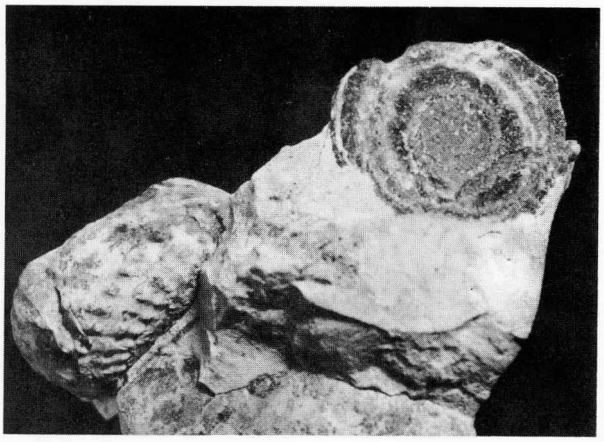
RIASSUNTO — Vengono illustrati gli esemplari di Parkeria sphaerica *rinvenuti nel Vraconiano superiore di Orosei (Sardegna centro-orientale) e si conferma l'appartenenza di questa specie, originariamente descritta come macroforaminifero arenaceo, agli idrozoi epizoici.*

This paper is one of the contributions to a long-term programme of research at the Institute of Geology and Palaeontology of Padua directed toward the illustration of various palaeontological and stratigraphical aspects of the Lower Cretaceous of east-central Sardinia. Monographs of the Upper Valanginian foraminifers (Dieni & Massari 1966), Upper Valanginian-Upper Albian cephalopods of Orosei (Wiedmann & Dieni 1968) and brachiopods of M. Albo, Orosei, Oliena-Urzulei massif (Dieni, Middlemiss & Owen 1975) have been published. Other works, already in an advanced stage of preparation, will continue the systematic description of the Sardinian Cretaceous macrofaunas. Here we illustrate the presence, in the Vraconian of Orosei, of *Parkeria sphaerica* Carter, a species hitherto reported from only a few localities in western Europe and from Mexico, which is characterized by a very restricted stratigraphical range, being limited to the Late Albian and Early Cenomanian.

The genus *Parkeria* has been little studied or noted since the last century and it has sometimes been described as foraminifer and sometimes as hydrozoan; however its treatment in modern comprehensive palaeontological syntheses of either foraminifers or hydrozoans has been eliminated almost entirely because students of the Foraminifera do not regard *Parkeria* as a foraminifer, and because certain students of the Hydrozoa do not consider it as a hydrozoan; for these reasons we will also try to clarify its systematic position.

The specimens described here have been collected in the north-eastern slopes of Cuccuru 'e Flores, in the locality of Sae Ludine, and obtained from a bank (about 0.5 m) of calcareous conglomerate unconformable on an Upper Valanginian-Lower Albian sequence, with lithoclasts often silicified, phosphatized or glauconitized and exceptionally rich in macrofossils. The ammonites demonstrate that this level comprises many palaeontological zones, all belonging to the Upper Albian (Upper Albian *s.s.* and Vraconian) (Wiedmann & Dieni 1968); the conglomerate evidently constitutes a condensed sequence. The specimens of *Parkeria sphaerica* are present only in the highest part of the clastic bank, where, among the ammonites, *Mortoniceras* (*Durnovarites*) *perinflatum* (Spath), *M.* (*D.*) *subquadratum subquadratum* (Spath), *Anisoceras* (*A.*) *saussureanum* (Pictet), *Lechites moreti* Breistroffer, *Mariella* (*M.*) *bergeri* (Brongniart), *M.* (*M.*) *miliaris* (Pictet & Campiche), *Ostlingoceras* (*O.*) *puzosianum* (d'Orbigny) (Text-fig. 1), etc., markers of the *Dispar* Zone, are exclusive, and where, among the microfossils, *Planomalina buxtorfi* (Gandolfi), *Rotalipora appenninica* (Renz), *R. ticinensis*

(Gandolfi), *Favusella washitensis* (Carsey) and *Pithonella ovalis* (Kaufmann) are very abundant. The association of the macro- and microfauna, therefore, indicates an Upper Vraconian age.



Text-fig. 1 - *Parkeria sphaerica* Carter, 1877 (on the right) in association with *Ostlingoceras* (*O.*) *puzosianum* (d'Orbigny, 1842), marker of the *Dispar* Zone. Upper Vraconian of Orosei (Sardinia) - 1.5 x.

Phylum COELENTERATA Frey & Leuckart, 1847
Subphylum CNIDARIA Hatschek, 1888
Class HYDROZOA Owen, 1843
Order STROMATOPOROIDEA Nicholson & Murie, 1878
Superfamily MILLEPORELLICAE Hudson, 1959
Family HETERASTRIDIIDAE Frech, 1890

Genus PARKERIA Carpenter *in* Carpenter & Brady, 1870

(non Gabb, 1881, *Journ. Acad. nat. Sci. Philadelphia,* s. 2, v. 8, n. 4, p. 368).

Type-species: *P. sphaerica* Carter, 1877; SD Kühn 1928 — No nominal species were included by Carpenter at the time he established the genus *Parkeria.* Only subsequently were three species expressly and simultaneously referred to this taxon by Carter (1877), *P. sphaerica, P. nodosa* and *P. compressa;* therefore they are to be treated as the only originally included species [ICZN, 69(a), ii(3)]. Although the characteristics of *P. sphaerica,* and particularly its globular shape,correspond very well to the description given by Carpenter for the specimens at his disposal for the establishment of the genus, it is not possible to deduce from Carter's paper any direct or indirect designation of this species as type of *Parkeria.*

Therefore we consider valid the subsequent designation of « *Parkeria sphaerica* Carp. » as type-species of *Parkeria* proposed by Kühn in 1928.

The systematic position of Parkeria — The genus *Parkeria* was established and described for the first time by Carpenter (*in* Carpenter & Brady 1870) from the Upper Greensand near Cambridge [1] (England); he ascribed it as belonging to the arenaceous Foraminifera. At a later date the structure of this taxon was investigated by Carter (1876, 1877), who came to the conclusion that the skeleton was not arenaceous in its composition, and that the genus was properly referable to the Hydractiniidae. He stated that *Parkeria* had no embryonal chamber like the foraminifers, and that its laminar and concentric structural elements showed resemblance to the hydractinians and even to the stromatoporoids. Carter's views have generally been accepted by subsequent writers, such as Steinmann (1878, p. 18) and Zittel (1879, p. 283).

Nicholson (1888) restudied the original material of *Parkeria* and described all the structures in detail; they are undoubtedly similar to those of the hydrozoans. As a result Nicholson attributed the genus *Parkeria* to the Hydrozoa, placing it as intermediate between the hydrocorallinas and the hydractinians, but with nearer relationships to the latter than to the former.

In the same year, 1888, Carter established within the Hydrozoa the family Parkeriidae, including in it, apart from *Parkeria,* also the genus *Syringosphaera* Duncan, 1878. In this way he dismissed the family Syringosphaeridae Duncan, 1879. But similarly Frech (1890) dismissed the family Parkeriidae, ascribing *Parkeria* to his new family Heterastridiidae; he based this group on the genus *Heterastridium* Reuss, 1865, which is older than *Parkeria,* excluding the genus *Syringosphaera* from it.

Kühn (1939) recognized the family Heterastridiidae including the genera *Parkeria, Stoliczkaria* Duncan, 1878, *Heterastridium* and *Cycloporidium* Parona, 1909; Alloiteau (1952), too, followed Frech's system and ascribed *Parkeria* to the family Heterastridiidae together with *Heterastridium* and *Stoliczkaria.*

---

[1]) Spath (1943, p. 749) considered this formation to be a « kind of concentrated essence of non-sequence », a phosphatic reworked assemblage, spanning his *Aequatorialis* and *Substuderi* Subzones. Casey (in Edmonds & Dinham 1965, p. 54) concluded that « the phosphatized fauna for which the Cambridge Greensand is famed contains no dateable elements that are not Upper Albian. Though it may well be true that the deposit was finally laid down in Cenomanian times, this assumption is made on non-palaeontological grounds ». Hart (1973), on the other hand, has provided a clear discussion of previous interpretations of the age of this unit, whilst presenting foraminiferal evidence to suggest that the matrix of the Cambridge Greensand is of Early Cenomanian (upper *Carcitanensis* assemblage Zone) age, resting upon Gault Clay of *Auritus* Subzone age. This author was led to the conclusion that the reworked faunas of the Cambridge Greensand thus represent a condensed assemblage spanning the *Aequatorialis, Substuderi* and *Dispar-Perinflatum* Subzones of Spath (1923-1943).

Hill & Wells (1956) mentioned *Parkeria* among the generic names referred to Hydrozoa but belonging to foraminifers. Flügel (1960, 1961) recognized the family Heterastridiidae, although he too was of the opinion that *Parkeria* belonged to Foraminifera. But Chudinova (1962) repeatedly attributed *Parkeria* to the Hydrozoa, family Sphaeractinidae Waagen & Wentzel, 1887, together with the genera *Sphaeractinia* Steinmann, 1878, *Ellipsactinia* Steinmann, 1878 and *Palaeoaplysina* Krotov, 1888.

From these short notes it is clear that the opinions about the systematic position of *Parkeria* have differed considerably.

The possibility of *Parkeria* being a foraminifer rested chiefly on the presence of a « primordial chamber-cone » in the centre of its structure, recorded by Carpenter (1870, p. 736); in fact he described a « nucleus . . composed of a series of chambers . . laid . . in a rectilinear direction . . separated by septa . . which are extremely sinuous, like those of many Ammonites » (op. cit., pp. 727-728). But, as already pointed out by Carter (1877, p. 59) and as shown by the excellent figs. 1 and 2 of Carpenter's Plate LXXIII, the presumed embryonic chamber in the centre of *Parkeria sphaerica* is in fact a foreign body, a minute shell of ammonite on wich the structure of the organism has commenced growth concentrically. Also in cases where there had not apparently been any foreign body, Carter observed that the nucleus presented itself under the form of « minute reticulated tissue-fibre more condensed in some than in other parts » like in the rest of the skeleton, without any morphology resembling the proloculus of the foraminifers. For this reason and for other particularities concerning its composition and microstructure already marked by Carter, and so unnecessary to repeat here, any reference of the genus *Parkeria* to the Foraminiferida has to be excluded.

The study of the specimens from Orosei revealed that *Parkeria* Carpenter is very similar to the hydrozoan genus *Heterastridium* Reuss. Both of them have similar coenostea, tuft-like radial elements enclosing small tubules, and rare concentric laminae. Disposition of short horizontal offsets is similar too, but more common in *Parkeria*. *Heterastridium* differs in having radial zooidal tubes, which in *Parkeria* tend to be arranged horizontally. Dense tubular reticulum brings the genus *Parkeria* close to the representatives of the family Milleporidiidae, which differ in having longer zooidal tubes, more laminae but no bundles. Therefore we attribute *Parkeria* to the family Heterastridiidae which, like Milleporidiidae, belongs to the Stromatoporoidea; the clinogonal microstructure makes it a member of the superfamily Milleporellicae (compare system of Hudson 1960).

Synonyms — The genus *Millarella* Carter, 1888 represents a junior synonym of *Parkeria* as its type-species, *M. cantabrigiensis* Carter, 1888, is a subjective synonym of *Parkeria sphaerica* Carter, 1870 (see later).

PARKERIA SPHAERICA Carter, 1877
Pl. 1, figs. 1-2; text-figs. 1-2

1870 *Parkeria* - CARPENTER *in* CARPENTER & BRADY, p. 724, pl. 72, fig. 1; pl. 73, figs. 1-4; pl. 74, figs. 1-5; pl. 75, figs. 1-5; pl. 76, figs. 1-2.
1876 *Parkeria* - CARTER, p. 206.
+1877 *Parkeria sphaerica* - CARTER, p. 61, pl. 8, figs. 13-17.
1877 *Parkeria nodosa* - CARTER, p. 61.
1877 *Parkeria compressa* - CARTER, p. 61.
1878 *Parkeria* - STEINMANN, p. 118.
1884 *Parkeria* - CARTER, p. 353.
1888 *Parkeria sphaerica* - NICHOLSON, p. 2, text-fig. 1: pl. 3, figs. 1-6.
1888 *Millarella cantabrigiensis*, gen. et sp. n. - CARTER, p. 178, pl. 13, figs. 6-8.
1890 *Parkeria sphaerica* - FRECH, p. 93, 2 figs. (after Nicholson 1888).
1909 *Parkeria* sp. - PARONA, *in* PARONA, CREMA & PREVER, p. 162, pl. 16, fig. 22.
1928 *Parkeria sphaerica* Carp. - KÜHN, p. 82.
1939 *Parkeria sphaerica* Carp. - KÜHN, p. 58, fig. 93 (after Nicholson 1888).
1952 *Parkeria sphaerica* Carp. - MOORE, p. 106, fig. 4-6(2) (after Nicholson 1888).

EXPLANATION OF PLATE 1

Parkeria sphaerica Carter, 1877
Upper Vraconian, Orosei (Sardinia)

Fig. 1 - Equatorial cut of coenosteum. At the center a leaching cavity filled with the microfossiliferous matrix. Thin section - 10 x
Fig. 2 - Equatorial-oblique cut of reticulum. At the periphery bundles of radial elements and tubules are visible. Thin section, negative print - 13 x


1


2

1962 *Parkeria sphaerica* Carp. - CHUDINOVA, p. 151, fig. 10 (after Moore 1952).
1963 *Parkeria sphaerica* Carp. - DIENI & MASSARI, p. 579.
1965 *Parkeria sphaerica* Carp. - DIENI & MASSARI, p. 798.
1969 *Parkeria sphaerica* Cart. - BROWN & COOGAN, p. 40.
1973 *Parkeria sphaerica* Carp. (2) - BROWN *in* COOGAN, p. 64, pl. 8, figs. 4-6.
1975 *Parkeria sphaerica* Carp. - DIENI *in* DIENI, MIDDLEMISS & OWEN, p. 172.

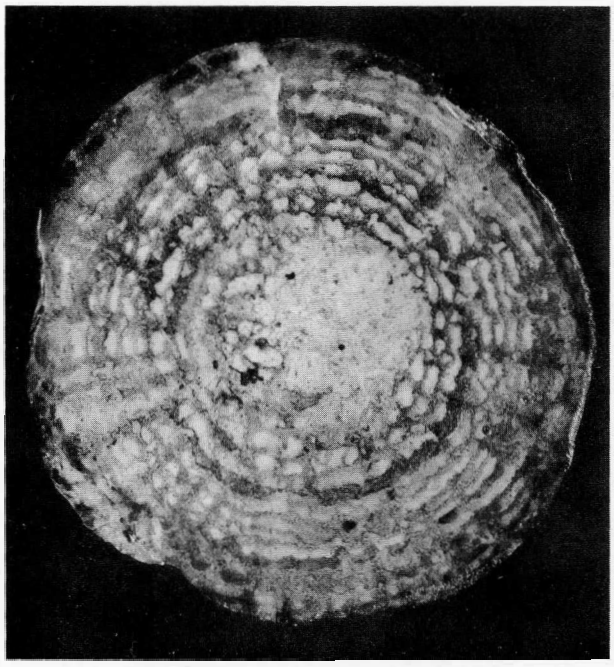
Description — Coenosteum is spherical with concentric framework marked by a characteristic onion-like peeling (Text-figs. 1 and 2); its surface in unworn specimens exhibits rounded or elongated elevations separated by intervening depressions, or it may, in other instances, present an alveolar aspect. Roughly fractured specimens or equatorially oriented thin slides reveal that vertical skeletal elements grow radially from the central part to the periphery; in some intervals they are condensed into bundles which run without interruption through the whole coenosteum. Between these bundles there are short pillars arranged laterally at several levels; they look like concentric layers here and there limited by longer or shorter laminae. Apart from these laminae there are some offsets proceeding from the pillars. The whole of this skeleton encloses tubes and a number of tubules and interspaces of different shape and size.

State of preservation and dimensions — All the specimens and particularly their outer parts are more or less phosphatized, glauconitized and silicified, usually in a selective way with respect to the original concentric framework. The inner part of the sectioned specimens has been affected by early leaching and subsequently filled with biomicrite corresponding to the surrounding matrix (Text-fig. 2; tav. 1, fig. 1); for this reason it is impossible to observe the early stages of growth of the species.

The diameter of coenosteum of the specimens of Orosei ranges from 14 to 24 mm; therefore the Sardinian material falls well within the limits of dimensional variation of the species inferred from the specimens described by Carpenter (1870), Carter (1877), Nicholson (1888) and Brown (*in* Coogan 1973), who give diameter values extending from about 10 to 50 mm. The dimensions of the skeletal elements and tubes within the coenosteum are very irregular and cannot be precisely measured.

The author of the specific name — Apart from the cases in which the attribution is imprejudiced, such as Nicholson (1888) and Frech (1890), almost all the authors indicate Carpenter as responsable for the name *sphaerica.* But at the moment of the establishment of the genus he did not use any specific Latin name to define the specimens at his disposal, although it is undoubtable from the context of his very detailed description (« globular Calcareous bodies » at p. 724; « sphere » at pp. 725, 728, etc.) and from the very good accompanying figures, that Carpenter was dealing with this taxon. Thus, even if it is clear that the genus *Parkeria* must be attributed to Carpenter, the species *sphaerica* is to be ascribed to Carter 1877, the first author to use a name satisfying the rules of nomenclature.

(2) Carter in the explanation of pl. 8, figs. 4-6.



Text-fig. 2 - *Parkeria sphaerica* Carter, 1877. Upper Vraconian, Orosei (Sardinia).
Equatorial section of coenosteum showing radiating pillars and concentric laminae. At the center early leaching cavity filled with the microfossiliferous matrix. Polished surface - 5,5 x

Synonyms — Besides *P. sphaerica,* Carter nominated two other species in 1877, giving a very summary description: *P. nodosa,* characterized by « a bossed form in which the surface projects into a number of large, circular, convex eminences » and by a « wavy disposition of its laminae », and *P. compressa,* with a « circular compressed » form, « that is biconvex or lenticular ». Also these two taxa were collected in the Cambridge Greensand. We are of the opinion that *nodosa* and *compressa* represent only particular morphological varieties of *P. sphaerica,* of which therefore they must be considered synonymous.

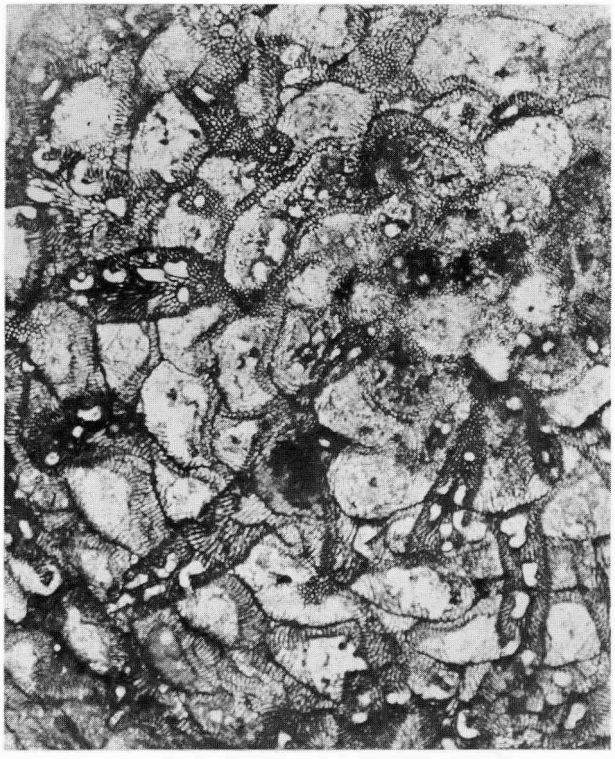
Still using material from the Cambridge Greensand, Carter established in 1888 the genus *Milla-*

rella, so similar in general form (« subspherical with a small irregular cup-like shallow excavation . . . at one end » corresponding to « the place where the organism was originally attached to some submarine object », op. cit., p. 178) to *Parkeria,* with which it was associated, as to « be easily mistaken » for it, but sufficiently differentiated « by the total absence of all distinct tubuliferous structure both externally and internally, together with the quantity of foraminiferal detritus in its composition ». But we are of the opinion that its type-species (by monotypy), *M. cantabrigiensis* Carter, 1887, represents a junior synonym of *Parkeria sphaerica,* that is we believe that the structural particularities accurately listed by Carter can be explained by means of the obliteration of the original characters of *Parkeria* caused by the replacement of the skeleton by phosphate, glauconite, etc. and by means of the filling up of leaching cavities with the surrounding microfossiliferous sediment. Our opinion is indirectly confirmed by Carter himself, who in the foot-note on p. 180 describes a specimen of *Millarella* « which forms the nucleus or support upon which a Parkerian structure has been built ». In conclusion we are convinced that the type-material of *Millarella cantabrigiensis* consists of nothing but specimens of *Parkeria sphaerica* in which there is an interference between nearly unmodified parts with others deeply involved with secondary, post-depositional processes.

In 1909 Parona nominated the species *Provalei* on the basis of three specimens of *Parkeria* collected in the locality of Fossato Cerasetti, NW of M. Ocre (Abruzzo, Central Italy), within a layer of marls with orbitolinas, at that time ascribed to the Cenomanian but now considered no younger than Aptian (Cherchi, De Castro & Schroeder, 1978). We had the opportunity to examine the type-material, held in the Museum of the Geological Institute of Turin; as already pointed out by Parona, this species can be distinguished from *P. sphaerica,* not only by its more or less compressed shape, but by the different, irregular arrangement of the radial elements and the better developed, but not concentric laminae (Text-fig. 3).

P. sphaerica and *P. provalei* constitute therefore the only species of the genus *Parkeria* known until now.

Life habit — Although the state of preservation of the Sardinian material does not allow us any actual confirmation, it is possible to conclude on the basis of the descriptions given by some authors, and above all by Carter (1877), Nicholson (1888) and Brown & Coogan (1969), that *Parkeria sphaerica* has a common habit of encrusting the shell of selected molluscan taxa, in particular small specimens of ammonoid or nautiloid tests, which often have been found at the center of its skeleton.



Text-fig. 3 - *Parkeria provalei* Parona, 1909 - Syntype - 10 x. Aptian of Fosso Cerasetti, Monte d'Ocre (Abruzzo, Central Italy).
Tangential section of coenosteum showing irregularly arranged radial elements and well developed, but not concentric laminae.

Occurrence — Stratigraphic data from the known occurrences of *Parkeria sphaerica* indicate that it is restricted to beds of Late Albian s.l. (Vraconian) and Early Cenomanian age. In fact this species has been hitherto recorded from the Cambridge Greensand of England (see foot-note page 201), from El Abra Limestone of Mexico, whose fauna is assigned by Cooper (1973, p. 56) to the Early Cenomanian, and from the Upper Vraconian conglomerate of Orosei.

According to Brown (in Cooper, op. cit., p. 64) this taxon is also present in rocks of Central Asia; evidently the author deduced this datum from the paper of Carter 1888, who states on pages 172 and 182 that the spheroidal fossils from north-east Kashmir commonly called « Karakoram stones » must undoubtedly be ascribed for the most part to *Parkeria.* However we don't agree with this assignment; the « Karakoram stones », which are of Upper Trias-

sic age, seem more properly referable to the genera *Heterastridium* Reuss, 1865 and *Stoliczkaria* Duncan, 1879.

ACKNOWLEDGMENTS

The research was financially supported by the Italian Consiglio Nazionale delle Ricerche, programme n. 76.00253.05.

The authors are indebted to F. A. Middlemiss (Department of Geology, Queen Mary College, London) for the bibliographic supply, to P. Clari (Institute of Geology, University, Turin) for the loan of Parona's types and to C. Brogiato (Institute of Geology, University, Padua) for the photographs.

BIBLIOGRAPHY

ALLOITEAU, J., 1952, Classe des Hydrozoaires. *In* Piveteau, J. (Edit.), Traité de Paléontologie, I: pp. 376-684, Paris.

BROWN, N.K. jr & COOGAN A.H., 1969, The Hydrozoan Genus *Parkeria* Carpenter, 1869, and its occurrence in the Cretaceous of Mexico: Geol. Soc. Amer., Abstr. 1968, p. 40, Boulder.

CARPENTER, W.B. & BRADY, H.B., 1870, Description of *Parkeria* and *Loftusia,* two gigantic types of arenaceous Foraminifera: Royal Soc. London, Philos. Trans., v. 159, pp. 721-754, 9 pls., 3 text-figs., London.

CARTER, H. J., 1876, Note on *Parkeria. In* On the Polytremata (Foraminifera), especially with reference to their mythical Lybrid nature: Ann. & Mag. Nat. Hist., s. 4, v. 17, pp. 206-210, 1 pl., London.

—, 1877, On the close Relationship of *Hydractinia, Parkeria* and *Stromatopora;* with Descriptions of new Species of the former, both Recent and Fossil: Ann. & Mag. Nat. Hist., s. 4, v. 19, pp. 44-76, 1 pl., London.

—, 1884, Note on the assumed relationship of *Parkeria* to *Stromatopora,* and on a microscopic section of *Stromatopora mamillata* Fr. Schmidt: Ann. & Mag. Nat. Hist., s. 5, v. 13, pp. 353-356, London.

—, 1888, On two new Genera allied to *Loftusia,* from the Karakoram Pass and the Cambridge Greensand respectively: Ann. & Mag. Nat. Hist., s. 6, v. 1, pp. 172-184, 1 pl., London.

CHERCHI, A., DE CASTRO, P. & SCHROEDER, R., 1978, Sulla età dei livelli a Orbitolinidi della Campania e delle Murge Baresi (Italia meridionale): Boll. Soc. Natural. Napoli, v. 87, 24 pp., 3 pls., 1 text-fig., Napoli.

CHUDINOVA, I. I., 1962, Klass Hydrozoa. Gydroidnie polypi. *In* Orlov, Y. A. (Edit.). Osnovy paleontologii. 2: Gubki, arkheociati, kishechnopolostnie, chervi: pp. 146-156, 17 text-figs., Moskva.

COOGAN, A.H., 1973, Nuevos rudistas del Albiano y Cenomaniano de Mexico y del Sur de Texas: Rev. Inst. Mexic. Petróleo, v. 5 (2), pp. 51-83, 9 pls., 8 text-figs., Mexico.

DEHORNE, Y., 1920, Les Stromatoporoïdés des terrains secondaires: Mém. Carte Géol. France, 170 pp., 17 pls., 33 text-figs., Paris.

DIENI, I. & MASSARI, F., 1963, Il Cretaceo dei dintorni di Orosei (Sardegna): Acc. Naz. Lincei, Rend. Cl. Sci. fis. mat. nat., s. 7, v. 35, pp. 575-580, Roma.

—, —, 1965, Le Crétacé inférieur d'Orosei (Sardaigne) et ses analogies avec celui du Sud-Est de la France: Mém. B.R.G.M., v. 34, pp. 795-799, Paris.

—, MIDDLEMISS, F.A. & OWEN, E.F., 1975, The Lower Cretaceous Brachiopods of east-central Sardinia: Boll. Soc. Paleont. Ital., v. 12, pp. 166-216, 7 pls., 18 text-figs., Modena.

DUNCAN, P.M., 1879, Karakoram Stones, or *Syringosphaeridae*: Sci. Res. 2nd Yarkand Mission. pp. 1-17, 3 pls., Calcutta.

EDMONDS, E.A. & DINHAM, C.H., 1965, Geology of the Country around Huntingdon and Biggleswade: Mem. Geol. Surv. G.B., 90 pp., 5 text-figs., 4 pls., London.

FLÜGEL, E., 1960, *Heterastridium conglobatum conglobatum* Reuss, an Upper Triassic hydrozoan from the Petra-Tou-Roumiou of Pendakomo, Cyprus: Journ. Paleont., v. 34, pp. 127-132, 1 pl., Tulsa.

—, 1961, Gattungliste der fossilen Hydrozoen: N. Jb. Geol. Palaeont. Abh., v. 113, pp. 68-94, Stuttgart.

FRECH, F., 1890, Die Korallenfauna der Trias. Die Korallen der juvavischen Triasprovinz (Zlambachschichten, Hallstätter Kalke, Rhaet): Palaeontogr., v. 37, pp. 1-116, 21 pls., 69 text-figs., Stuttgart.

HART, M.B., 1973, Foraminiferal evidence for the age of the Cambridge Greensand: Proc. Geol. Ass., v. 84, pp. 65-82, 5 text-figs., London.

HILL, D. & WELLS, J.W., 1956, Hydroida and Spongiomorphida. *In* Moore, R.C. (Edit.). Treatise on Invertebrate Paleontology, part F (Coelenterata): pp. 81-89, 10 text-figs., Geol. Soc. Amer. & Univ. Kansas Press, Lawrence.

HUDSON, R.G.S., 1960, The Tethyan Jurassic Stromatoporoids *Stromatoporina, Dehornella,* and *Astroporina*: Palaeont., v. 2, pp. 180-199, 5 pls., London.

KÜHN, O., 1928, Hydrozoa. *In* Diener, C. (Edit.). Fossilium Catalogus, I: v. 36, 114 pp., Junk ed., Berlin.

—, 1939, Hydrozoa. *In* Schindewolf, O.H. (Edit.). Handbuch der Paläozoologie: v. 2A(5), pp. 1-68, 96 text-figs., Berlin.

MOORE, R.C., 1952, Coelenterates. *In* Moore, R.C., Lalicker, C.G & Fischer, A.G., Invertebrate fossils. First edit.: pp. 99-155, 30 text-figs., McGraw-Hill, N. York.

NICHOLSON, H.A., 1888, On the Structure and Affinities of the Genus *Parkeria,* Carp.: Ann. & Mag. Nat. Hist., s. 6, v. 1, pp. 1-12, 1 pl., London.

PARONA, C. F., CREMA, C. & PREVER, P. L., 1909, La fauna coralligena del Cretaceo dei Monti d'Ocre nell'Abruzzo aquilano: Mem. Descr. Carta Geol. Ital., v.5(1), 242 pp., 28 pls., 59 text-figs., Roma.

SPATH, L.F., 1923-1943, A monograph of the Ammonoidea of the Gault: Palaeont. Soc. London, 787 pp., 72 pls., London.

STACHE, G., 1873, Neue Petrefactenfunde aus Istrien: Verhandl. K.K. geol. Reichsanst., 1873, n. 8, pp. 147-149, Wien.

STEINMANN, G., 1878, Ueber fossile Hydrozoen aus der Familie der Coryniden: Palaeontogr., v. 25, pp. 101-124, 3 pls., Stuttgart.

—, 1907, Einfürung in die Paläontologie: 542 pp., 902 text-figs., Leipzig.

ZITTEL, K.A., 1879, Handbuch der Palaeontologie. I: 765 pp., 58 text-figs., Leipzig.