



The genus *Linoporella* Steinmann, 1899 and its type-species *Linoporella capriotica* (Oppenheim, 1889) from the Early Cretaceous of Capri

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ABSTRACT - *Linoporella capriotica* (Oppenheim, 1889), type-species of the genus *Linoporella* Steinmann, 1899, is revised from material of the type locality (Capri island). The relationship between the features now ascertained and the Oppenheim's illustration is discussed.

The original type material, housed in Naples and seemingly in Freiburg or Bonn, having not been found, has to be considered lost. Therefore in the present paper on the ground of the new material a neotype is proposed and a new description is supplied. In particular the occurrence of tertiary laterals (already reported by some authors from the Steinmann's schematic drawing), here ascertained as phloiofhorous and corticated, allow us to emend both the generic and specific diagnoses.

RIASSUNTO - [Il genere *Linoporella* Steinmann, 1899 e la sua specie-tipo *Linoporella capriotica* (Oppenheim, 1899) dal Cretaceo inferiore dell'isola di Capri] - Nel 1889 Gustav Steinmann segnalò, in base a materiale inviatogli da Oppenheim, la presenza di Dasicladali tipo *Diploporella* nei calcari ad *Ellipsactinia* di Capri, fornendone una breve descrizione ed attribuendole al genere *Triploporella* senza assegnarle ad alcuna specie.

Oppenheim, nello stesso anno, nella sua monografia sulla geologia di Capri, descrisse ed illustrò le Dasicladali inviate a Steinmann, attribuendole ad una nuova specie: *Triploporella capriotica*. Nella diagnosi, l'autore concordava con Steinmann sulla presenza di due soli ordini di laterali, l'annulazione del manicotto calcareo e la loro età (Titoniano). Successivamente Steinmann, nel 1899, trasferì la specie dal genere *Triploporella* ad un nuovo genere, *Linoporella*, specificamente istituito.

Nel 1987, durante uno studio sul Mesozoico di Capri, uno degli scriventi ebbe modo di raccogliere, lungo la costa settentrionale dell'isola, un campione particolarmente ricco di dasicladali confrontabili per morfologia, struttura e dimensioni a *Linoporella capriotica*. Il loro studio micropaleontologico dettagliato, reso possibile anche dalla buona fossilizzazione, confermò la presenza di laterali terziari, sfuggiti all'esame degli autori dell'ottocento ma già segnalati, in base ai disegni di Steinmann, da Dieni et al. (1985) che, perciò, ne avevano emendato il genere. Il nuovo materiale evidenziò pure, che i laterali di 3° ordine, contrariamente a quelli di primo e secondo, sono floiofori e corticati. Questi caratteri indussero uno degli scriventi (Barattolo), già nel 1991, a prospettare l'emendamento della specie *capriotica* e conseguentemente del genere *Linoporella*. Tuttavia sarebbe stato opportuno che l'emendamento si basasse anche sull'esame del materiale originale e solo oggi, dopo che le ricerche eseguite per trovarlo sono risultate infruttuose, viene utilizzato soltanto il materiale topotipico raccolto.

Le ricerche di tale materiale hanno interessato le probabili sedi in cui poteva essere conservato. Le collezioni depositate da Oppenheim presso il Museo di Paleontologia di Napoli sono andate probabilmente distrutte nell'ultimo conflitto mondiale, mentre il materiale di Steinmann, probabilmente conservato al Museum für Naturkunde di Freiburg in Gerberau (Germania) o nell'Università della stessa città tedesca dove lo studioso ha lavorato, è risultato irreperibile.

In questo lavoro quindi si propone la designazione di un neotipo per il genere *Linoporella* e l'emendamento della sua diagnosi.

INTRODUCTION

The algae were collected first by Paul Oppenheim in *Ellipsactinia* limestones of Capri. He sent a part of them to Gustav Steinmann for taxonomic identification. Steinmann (1889) pointed out the occurrence of *Diploporella*-like dasyclads giving a brief description and attributing them to the genus *Triploporella*. Although the material was really poor the same year Oppenheim (1889), in his monograph on the geology of Capri, described and illustrated those algae under the name of *Triploporella capriotica*. He agreed with Steinmann in remarking the occurrence of primary and secondary laterals, the clear annulation of the calcareous skeleton, and the age (Late Jurassic, Tithonian).

Later, Steinmann (1899) redescribed and transferred the species from *Triploporella* to a new genus, *Linoporella*, specifically established, having so *Triploporella capriotica* renamed *Linoporella capriotica* (Oppenheim) as type species. Neither Oppenheim nor Steinmann clearly reported the sampling locality of the studied alga (type locality).

At the end of the 80s during a study on the Mesozoic of Capri, one of the authors (Barattolo) collected a sample (BA.43) very rich in a dasycladalean species along the northern coast of Capri, in lowermost Cretaceous beds (Neocomian). This taxon fits rather well the former descriptions and illustrations of *Linoporella capriotica*, although with a certain degree of doubt, because of the presence of tertiary laterals

that could be deduced, but not for sure, only from the single Steinmann's drawing.

However, the closeness between the informations from the two German authors and the present material and, moreover, the occurrence of tertiary laterals and their phloiophorous corticated pattern, allowed Barattolo to prospect at the 5th symposium of I.F.A.A. (Capri, 1991) the emendation of the genus. To this purpose it could have been suitable, if possible, to fund the emendation on the original material. Further unsuccessful research to find it have convinced the authors to propose a neotype based on the present BA.43 material and supply the emendation of both the genus *Linoporella* and its type-species.

SYSTEMATICS

Order DASYCLADALES Pascher 1931

Family TRIPLOPORELLACEAE (Pia, 1920) Berger & Kaever, 1992

Tribe TRIPLOPORELLEAE (Pia, 1920) Bassoulet et al., 1979

Subtribe LINOPORELLEAE Pia, 1927

Genus *Linoporella* Steinmann, 1899 emend.

According to Steinmann's (1899) description *Linoporella capriotica* (Oppenheim) is characterized by a calcareous articulate skeleton, provided with verticillate primary laterals slightly swollen at their ends where they divide into secondary laterals; both primary and secondary laterals are rather thin and elongated. The calcareous skeleton is provided with annulation.

Dieni et al. (1985), on the basis of Steinmann's drawing (see Fig. 3b), affirmed that *Linoporella capriotica* holds also tertiary laterals and supply the following emended diagnosis: "Cylindrical thallus made up of tubular primary branches arranged in whorls, horizontal or more or less oblique to the main axis. Secondary branches bear tufts of short tertiary branches. Calcification normal around primary and secondary branches, rare and weak around the tertiary branches."

The occurrence, in the new material from Capri, of phloiophorous tertiary laterals making a cortex makes more suitable to supply a further emended diagnosis of *Linoporella capriotica* and therefore the genus of which it is the type. The new emended diagnosis of *Linoporella* is the following:

"Cylindrical to slightly club-shaped simple thallus. Primary laterals arranged in close whorls. Short primary laterals and long, thin secondary laterals. Tertiary laterals are phloiophorous in shape and form a cortex. Reproductive organs probably placed within the central stem (endospore-type)."

Suprageneric position - According to Berger & Kaever's (1992) classification *Linoporella* belongs to the Family Triploporellaceae and Tribe Triploporellaeae, in particular to the Subtribe Linoporellinae. The two authors define the Family Triploporellaceae by the following diagnosis "euspondyl arrangement of laterals and cladospore formation of gametangia." Although

endosporous versus cladosporous reproduction is a high taxonomic character, the evidence of one or the other kind of reproduction is lacking in most of fossil taxa, so that an attribution according to this character sounds speculative. On the other hand, the occurrence of thin and delicate laterals, no mean if trichophorous or phloiophorous, often associated with a bulky central stem, is thought a proof of an endosporous reproduction (for a discussion see De Castro, 1997). As a matter of fact, *Linoporella* (Oppenheim) ought to be put apart from this family because of its probable endosporous reproduction. Taking into account the uncertainty mentioned above it seems more advisable to maintain the Berger & Kaever's (1992) classification.

Species referable to the genus - At least the following taxa can be referred to the present genus: *Linoporella gigantea* (Carozzi), *Linoporella elliotti* Praturlon, *Linoporella buseri* Radoicic, *Linoporella svilajaensis* Sokac & Nikler.

Linoporella taurica Pcelincev, although rather similar to Oppenheim's (1889) figuration, does not show tertiary laterals. At the same time, it looks also different from *Linoporella gigantea* (Carozzi) because laterals are nearly orthogonal to the central stem instead of oblique. *Linoporella* (?) *taurica* Pcelincev is considered here as a valid species, but it is assigned to the genus *Linoporella* with doubt.

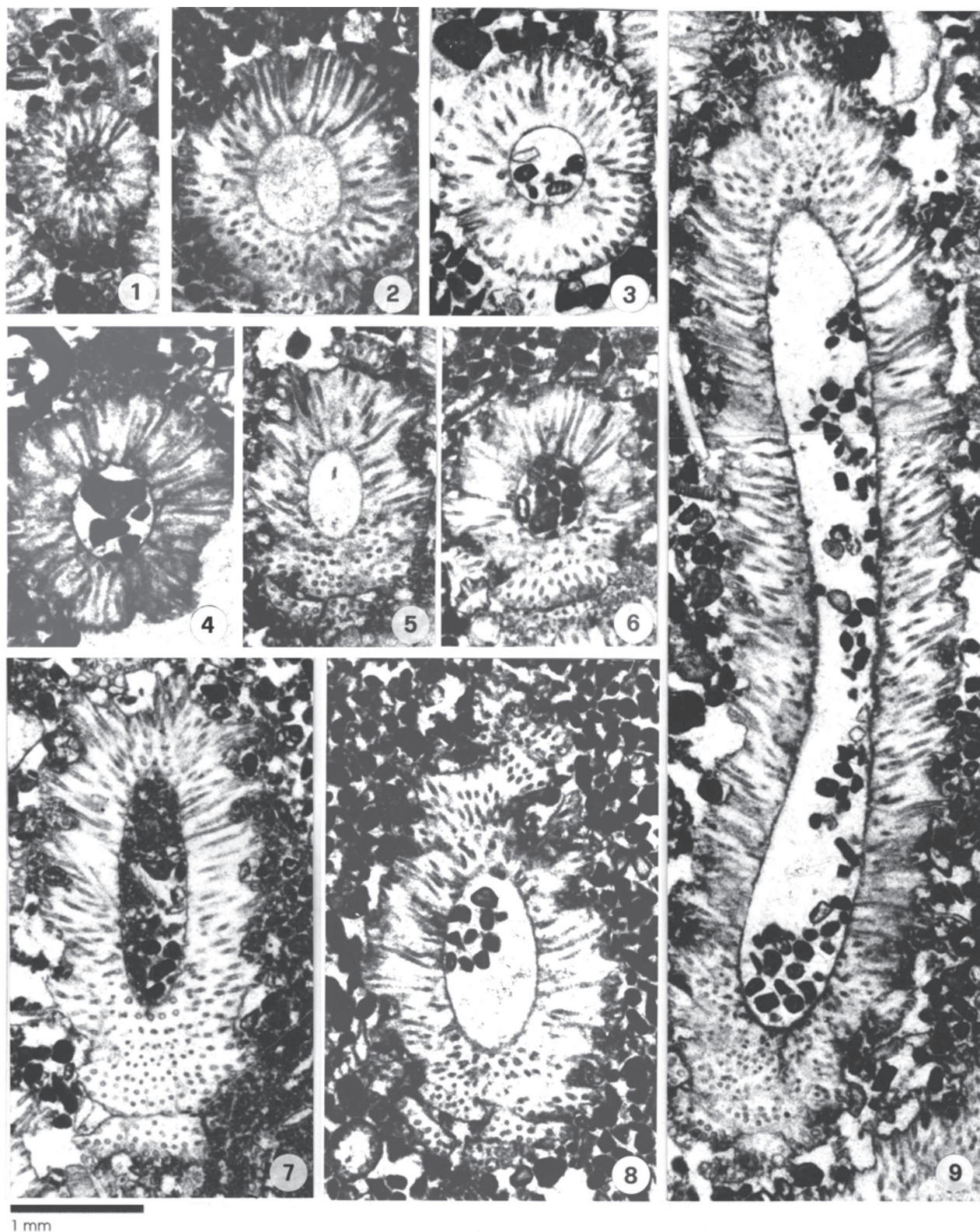
The same is for *Linoporella spissa* Dieni et al. and *Linoporella parva* Dieni et al. that do not show clear evidences of tertiary laterals, and therefore are ascribed to the genus *Linoporella* with uncertainty. As regards the attribution of *Linoporella lucasi* Cros & Lemoine to the genus *Tersella* refer to Barattolo & Bigozzi (1996).

Linoporella capriotica (Oppenheim, 1889) emend.
(Pls. 1-7)

- 1889 *Triploporella capriotica* OPPENHEIM, p. 458, pl. XIX, fig. 7; pl. XX, figs. 11a-c.
- 1899 *Linoporella capriotica* (Oppenheim) - STEINMANN, p. 148, fig. 13.
- 1988 *Linoporella svilajensis* Sokac & Velic. - CHIOCCHINI ET AL., p. 220, pl. II, fig. 6.
- 1991 *Linoporella* sp. - BARATTOLO & D'ANDREA, p. 147, pl. VI; p. 149, pl. VII.
- 1994 *Linoporella capriotica* (Oppenheim). - CHIOCCHINI ET AL., pl. XXXIX, figs. 5-7.

Material - The original material probably consisted of some samples of limestone showing dasyclads skeletons on the etched surfaces. It was collected by Paul Oppenheim 1889 (refer to his p. 758), during a field research on the Capri isle. Having been informed that one year before (March 1888) also Gustav Steinmann was in Capri for geological research, he sent to him some samples bearing *Ellipsactinia* and other fossils among which dasyclads; in fact Steinmann himself (1889, p. 52) affirmed to have obtained some algal-bearing thin sections from one of them.

The original material having been lost (refer below) the study of *Linoporella capriotica* in the present paper

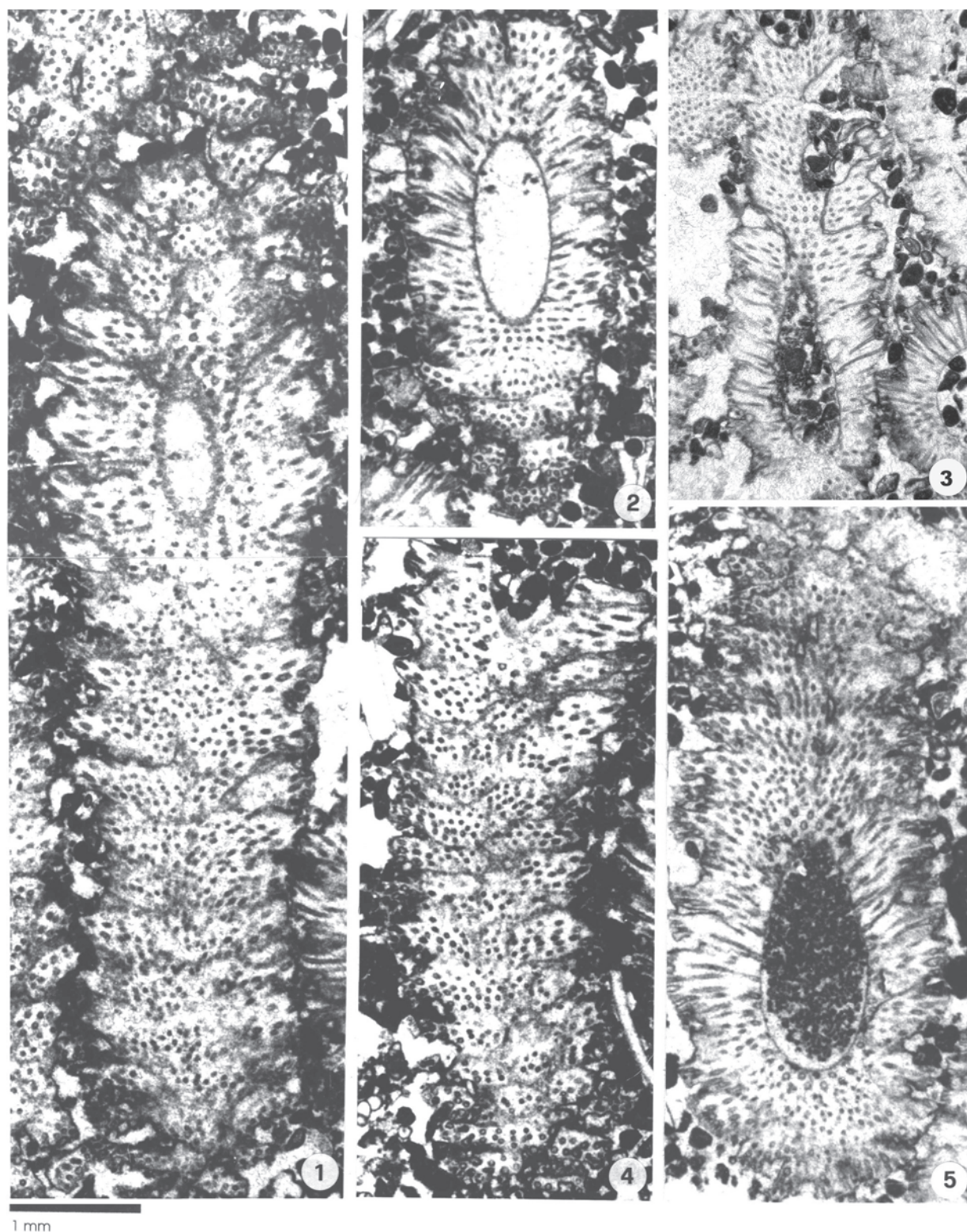


EXPLANATION OF PLATE 1

Figs. 1-9: *Linoporella capriotica* (Oppenheim). Bue marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian). Notice the smooth inner surface and the undulated outer one. The lower part of fig. 7 and 9 shows a fissuration in form of a thin dark line, whereas in fig. 3 (below) fissuration is so important to separate part of the calcareous skeleton.

- 1 - BA.43.26, subtransversal section;
- 2 - BA.43.32, subtransversal section;
- 3 - BA.43.5, subtransversal section;
- 4 - BA.43.4, subtransversal section;
- 5 - BA.43.17, oblique section;

- 6 - BA.43.4, oblique section;
- 7 - BA.43.26, oblique section;
- 8 - BA.43.1, oblique section;
- 9 - BA.43.14, longitudinal-oblique section.



EXPLANATION OF PLATE 2

- Figs. 1-5. *Linoporella capriotica* (Oppenheim). Bue Marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian).
- 1 - BA.43.14, tangential-oblique section;
 - 2 - BA.43.28, oblique section;
 - 3 - BA.43.30, oblique section;
 - 4 - BA.43.14, tangential-oblique section; note the pattern of fissuration in form of mesh;
 - 5 - BA.43.12, oblique section.

Northeastern coast, few meters South of cave locally called *Grotta del Bue Marino*, about four meters above sea level (Fig. 1).

Type-level - The limestones outcropping along the road toward Punta Tragara belong to the upper part of the Capri *Ellipsactinia* Limestone Fm (Barattolo & Pugliese, 1987) and are characterized by the occurrence of *Protopeneroplis ultragranulata* (Gorbachik). The *Linoporella capriotica* limestones at the Bue Marino Cave (site of the sample BA.43) correspond to the uppermost beds of this formation.

They consist of massive, white, bioclastic packstone-grainstones containing corals, calcareous sponges (ellipsactiniids and chaetetids), *Protopeneroplis*

ultragranulata (Gorbachik), "*Tubiphytes*" *morroneensis* Crescenti, *Mohlerina basiliensis* Mohler, *Nautiloculina bronnimanni* Arnaud-Vanneau & Peybernes, *Andersenolina alpina* (Leupold), *Andersenolina cf. campanella* Arnaud-Vanneau et al., *Andersenolina odukupaniensis* Dessauvage, *Salpingoporella etalloni* Bernier (partially shown in Fig. 2). The assemblage can be referred to the upper Berriasian-Valanginian (Arnaud-Vanneau et al., 1988; Mancinelli & Coccia, 1999).

Discussion - Oppenheim (1889) illustrated by drawings only three specimens. One both in outer and inner frontal view (pl. XX, figs. 11 and 11c respectively, here reproduced in Figs. 3c-d), a second in transversal

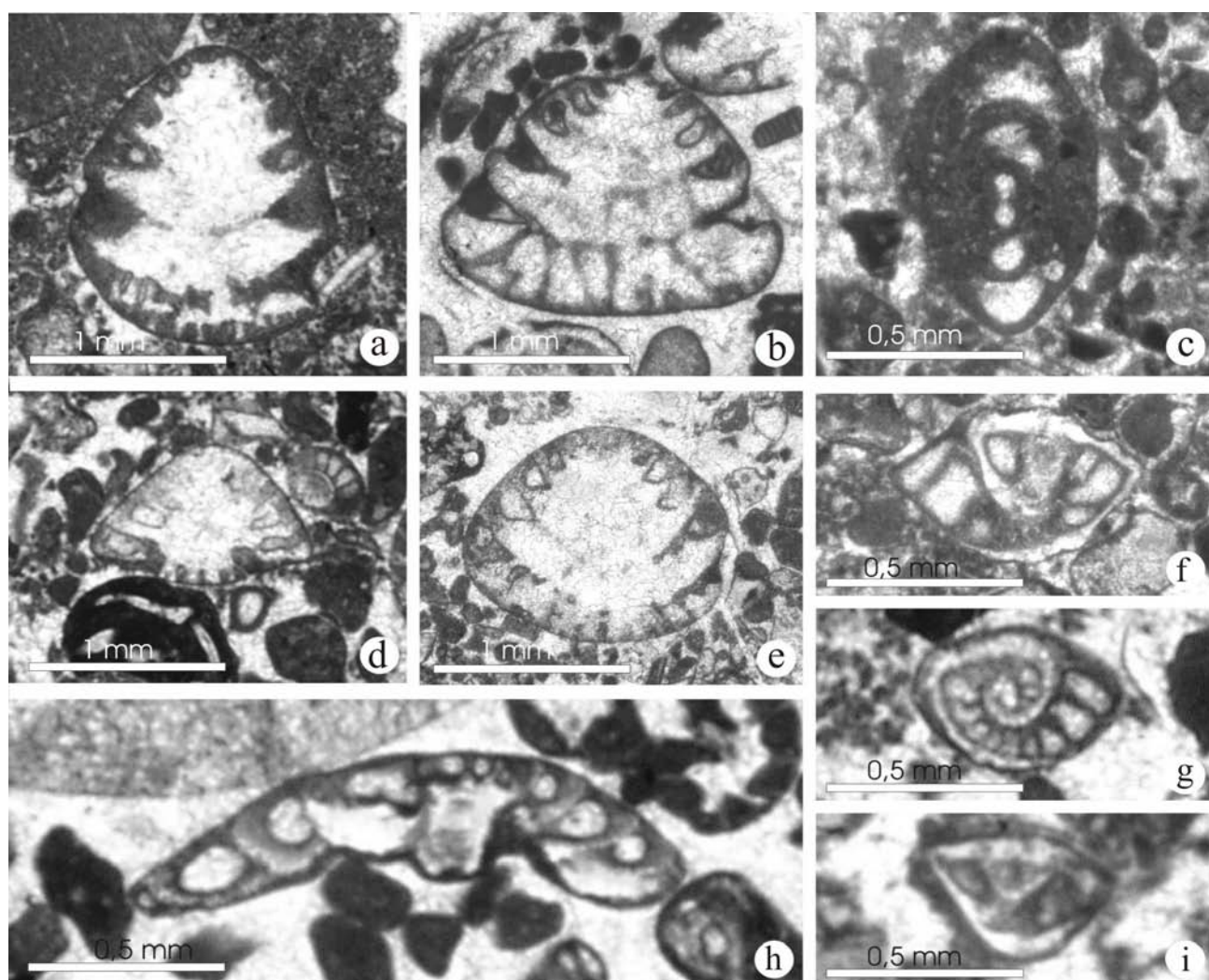
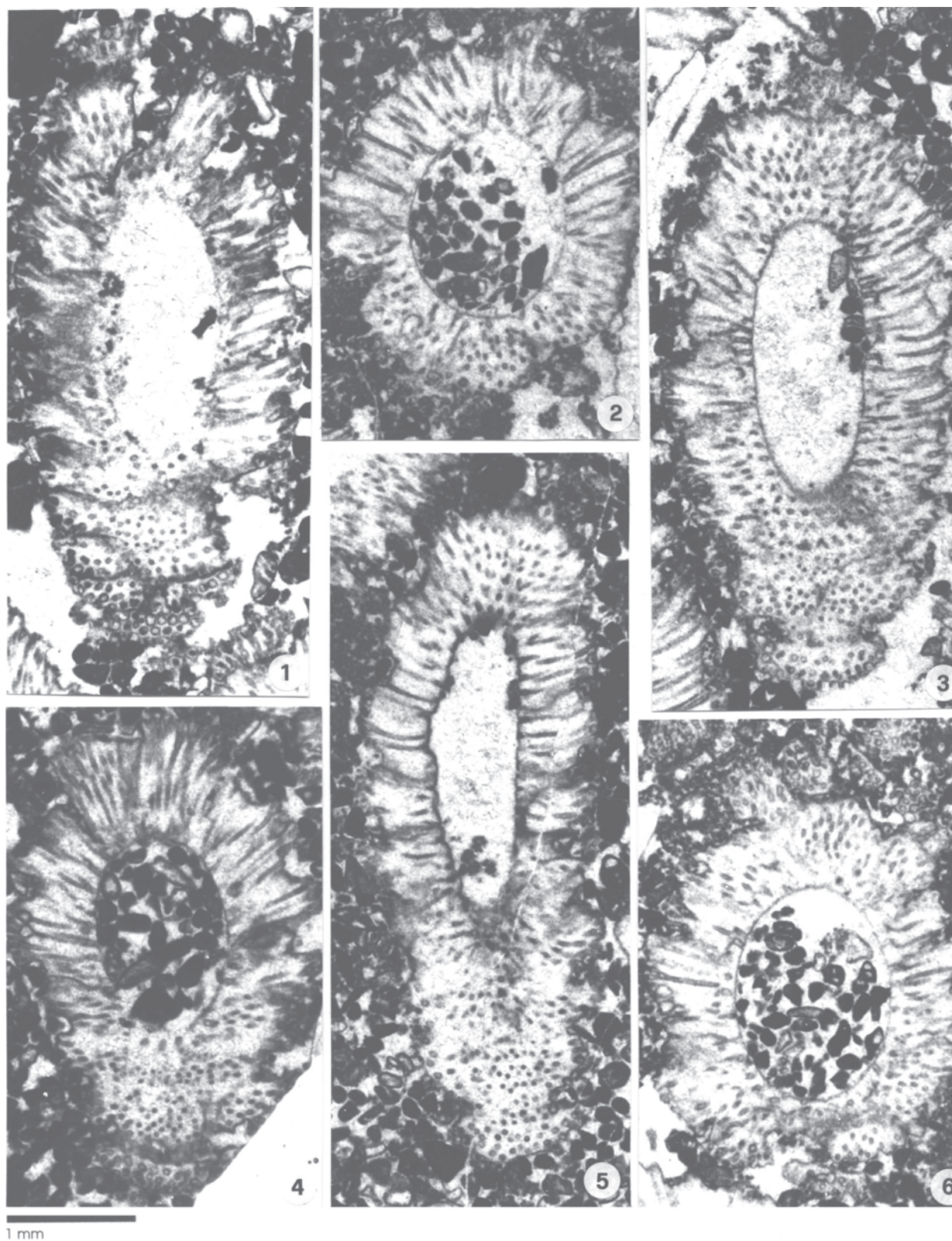


Fig. 2 - Foraminiferal association of *Linoporella capriotica* type-level. Early Cretaceous (upper Berriasian-Hauterivian). Bue Marino Cave (Capri Is., Italy).

- a) *Andersenolina cf. campanella* Arnaud-Vanneau, Boisseau & Darsac, thin section BA. 44;
- b) *Andersenolina alpina* (Leupold), thin section BA. 46;
- c) *Nautiloculina bronnimanni* Arnaud-Vanneau & Peybernes, thin section BA. 43.12;
- d) *Andersenolina odukupaniensis* Dessauvage, thin section BA. 41;
- e) *A. alpina* (Leupold), thin section BA. 43.15;
- f) *Protopeneroplis ultragranulata* (Gorbachik), thin section BA. 43.2;
- g) *P. ultragranulata* (Gorbachik), thin section BA. 41;
- h) *Mohlerina basiliensis* Mohler, thin section BA. 41;
- i) *P. ultragranulata* (Gorbachik), thin section BA. 43.16.



EXPLANATION OF PLATE 3

Figs 1-6 *Linoporella capriotica* (Oppenheim). Bue Marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian).

- 1 - BA.43.26, oblique section;
- 2 - BA.43.12, oblique section;
- 3 - BA.43.28, oblique section;
- 4 - BA.43.4, oblique section;
- 5 - BA.43.6, oblique section;
- 6 - BA.43.12, oblique section; note that the lower part exhibits large circular pores corresponding to tertiary laterals next to the cortical layer.

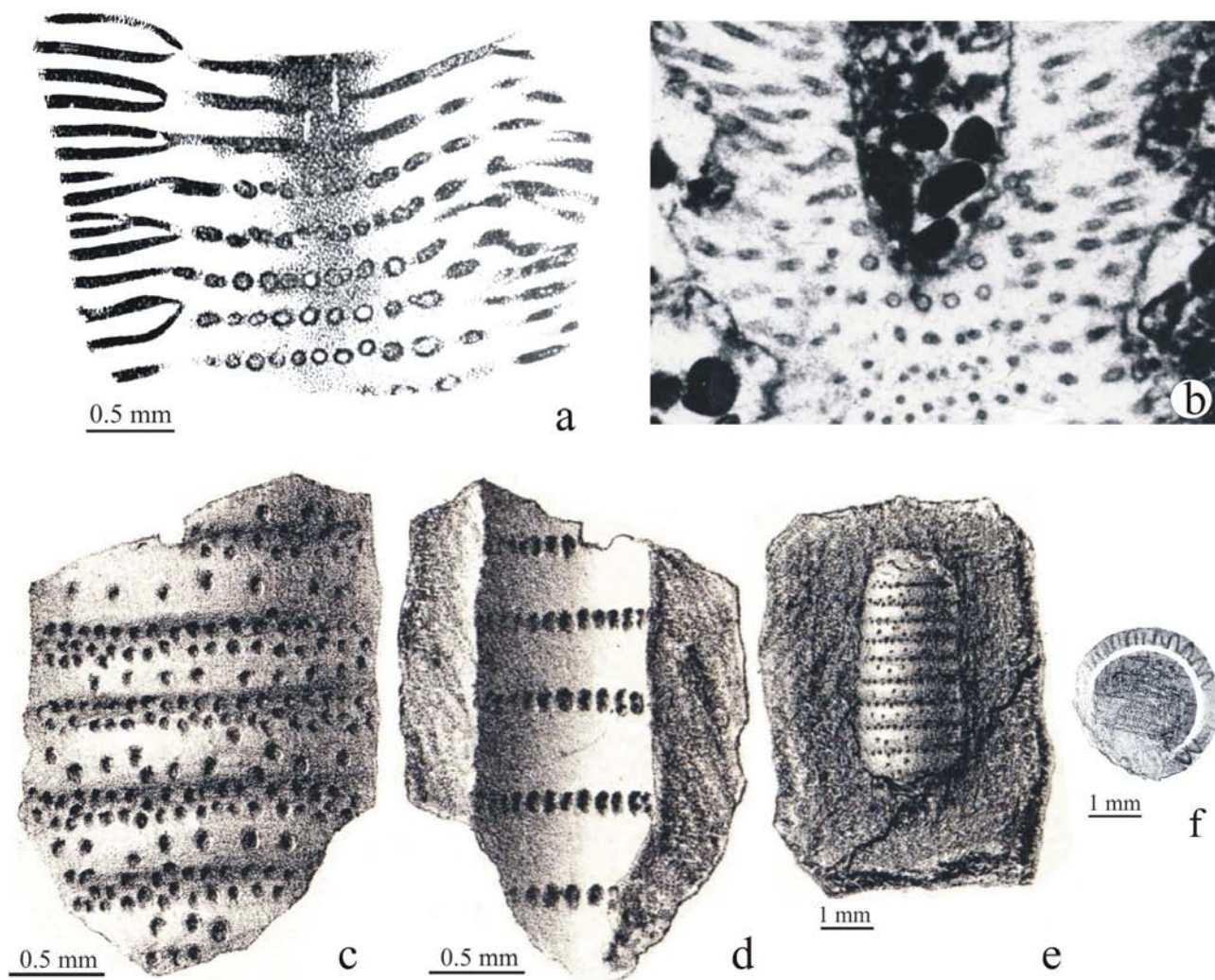


Fig. 3 - *Linoporella capriotica* (Oppenheim). a) original illustration from Steinman (1899). b) detail of Pl. 1, fig. 7, oblique section, thin section BA. 43.26, (x 3). c-f) original illustrations from Oppenheim (1889).

view (pl. XX, fig. 11b, here reproduced in Fig. 3f) and a third from an etched surface (pl. XX, fig. 11a and pl. XIX, fig. 7, here reproduced in Fig. 3e). No specimen has been indicated by Oppenheim (1889) as holotype. Anyway, all the specimens figured by Oppenheim ought to be accepted as isotype.

The specimens of Figs. 3c-d show on the whole an articulated skeleton, rather spaced whorls of primary

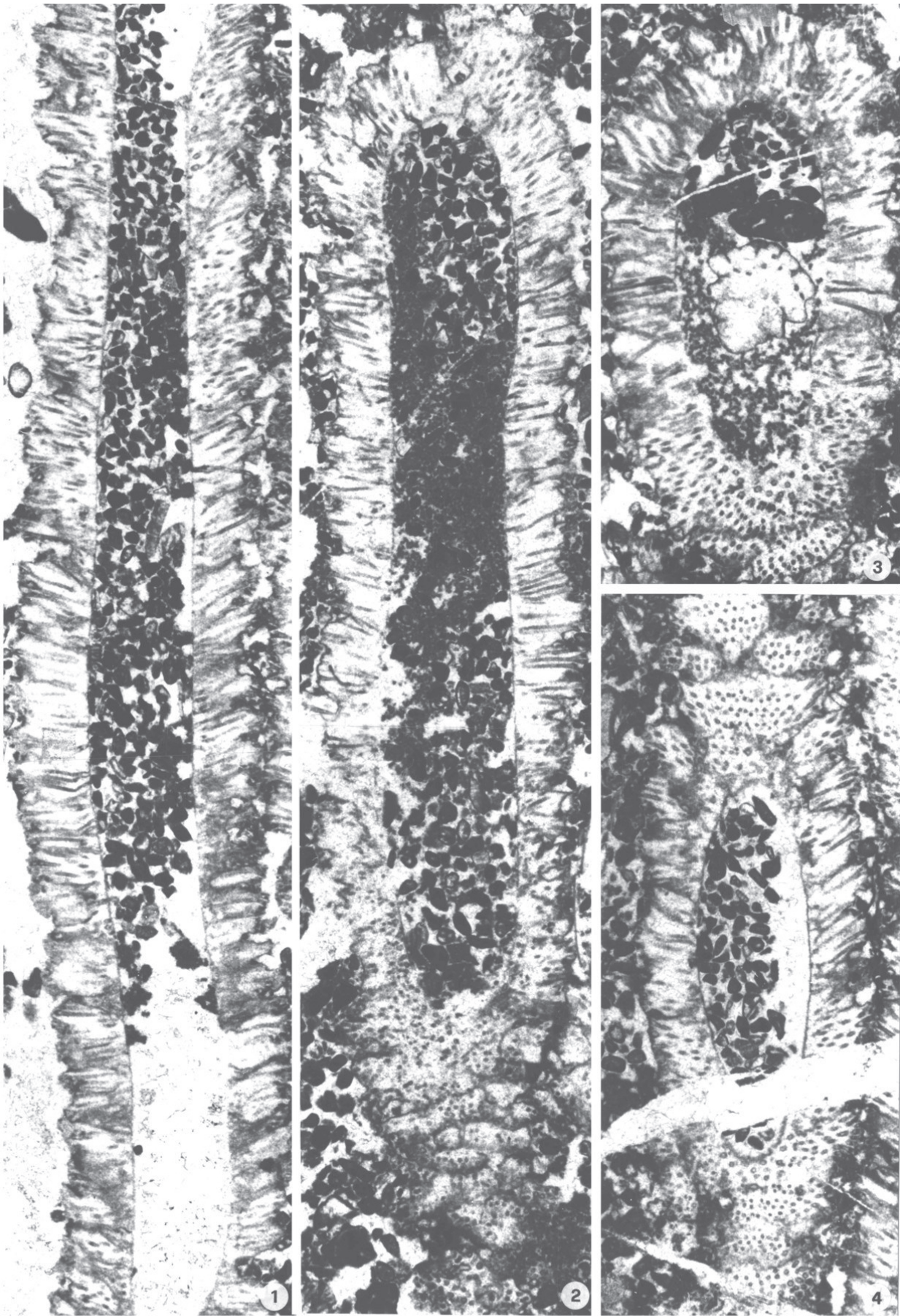
laterals of unknown shape and more numerous pores, thus testifying a ramification, at the outer surface of the calcareous skeleton, specially in the grooves. The Fig. 3e is strictly comparable to the previous specimen (Fig. 3c) and shows the articulated outer surface of the skeleton.

Steinmann (1899, fig. 13) illustrated one specimen in oblique-tangential section (here reproduced in Fig.

EXPLANATION OF PLATE 4

Figs. 1-4. *Linoporella capriotica* (Oppenheim). Bue marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian). Figs. 2 and 3 show a rounded upper part with laterals set upwards. This fact can be explained with cuts next to the top of the thallus (apex), otherwise it could be an effect of a calcareous skeleton curved upward.

- 1 - BA.43.21, axial section;
- 2 - BA.43.3, longitudinal section; the section probably shows the top of the thallus;
- 3 - BA.43.27, oblique section;
- 4 - BA.43.3, oblique section;



1 mm

3a). The Steinmann's specimen (Fig. 3a) looks bigger than Oppenheim's (Figs. 3c-d), but with closer whorls. It is much more indicative than the Oppenheim drawings, and has been traditionally used to deduce generic and specific characters of the alga. It shows

an undulated outer surface only on the right side. The uniform arrangements of outer laterals hardly agree with the Oppenheim's drawing (Fig. 3c) which shows a distribution of outer pores restricted mainly to the furrows.

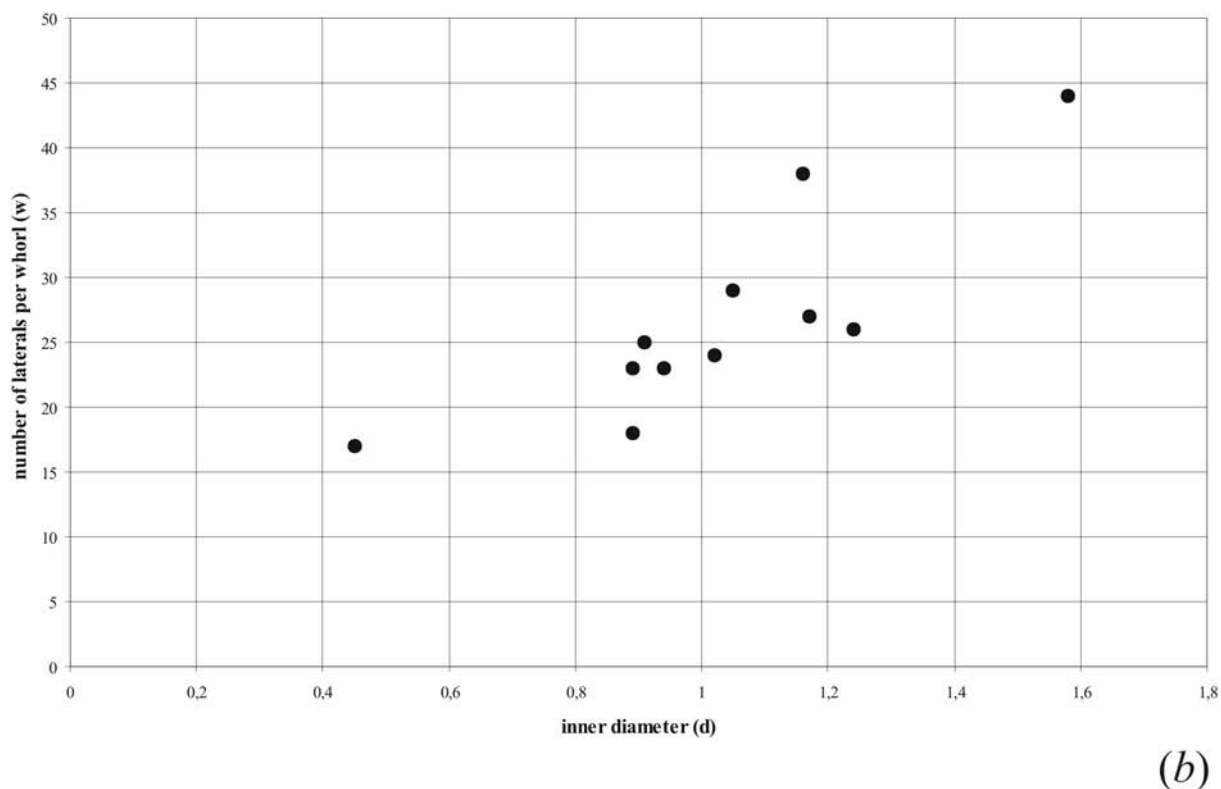
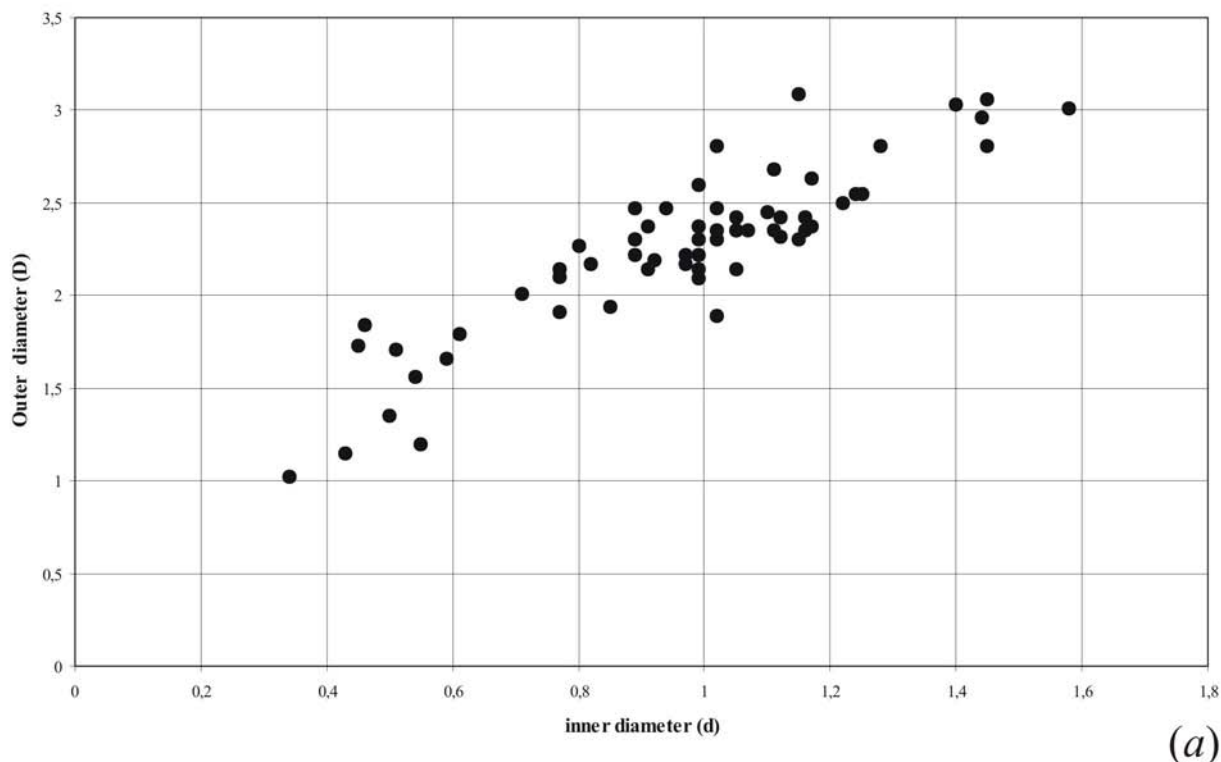
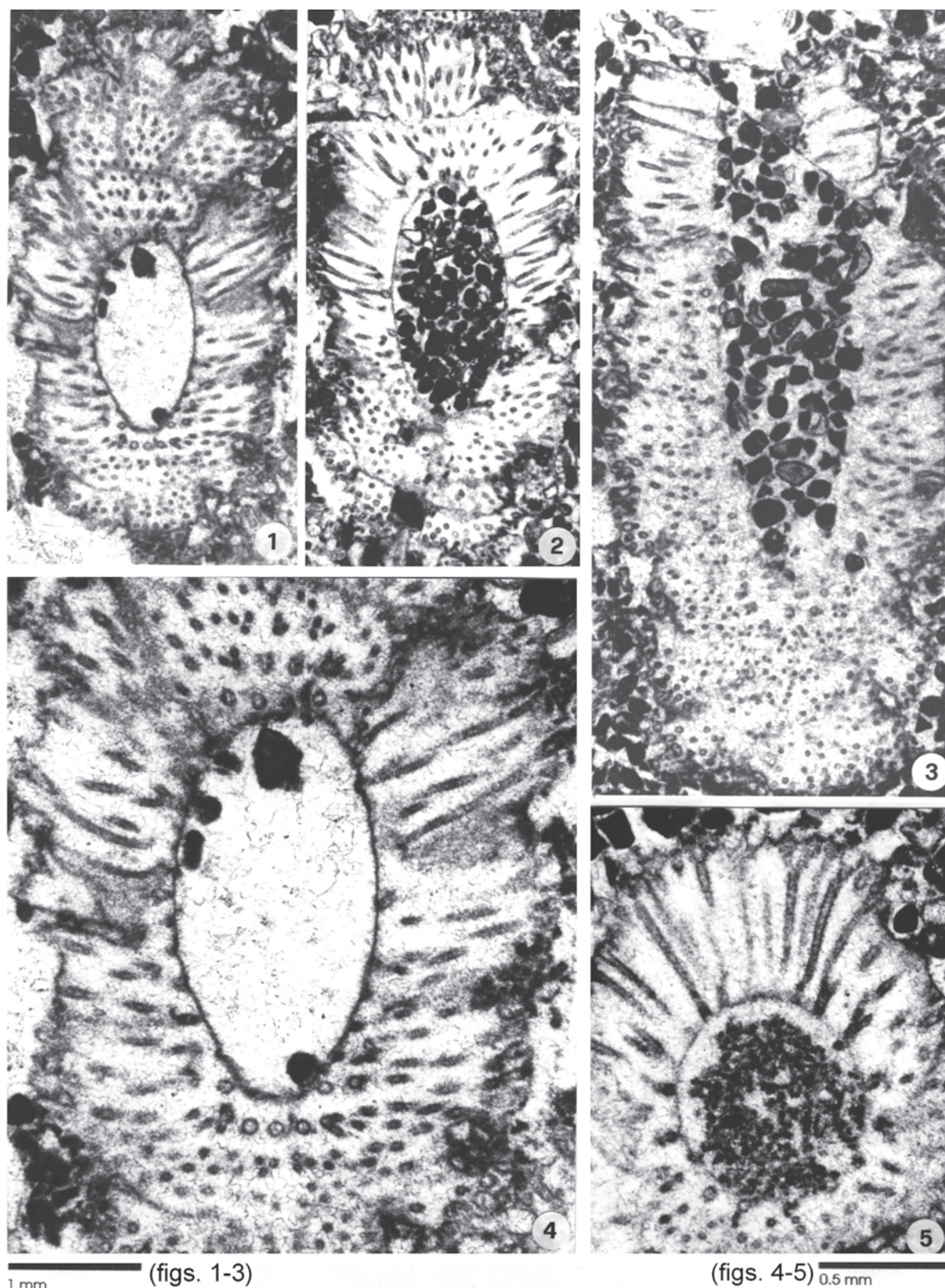


Fig. 4 - *Linoporella capriotica* (Oppenheim). Outer diameter of the calcareous skeleton (D) and number of pores for whorl (w) against the inner diameter (d) of the calcareous skeleton, are illustrated in (a) and (b) respectively.



EXPLANATION OF PLATE 5

Figs 1-5. *Linoporella capriotica* (Oppenheim). Bue marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian).

- 1 - BA.43.24, neotype, oblique section;
- 2 - BA.43.19, oblique section;
- 3 - BA.43.8, oblique section;
- 4 - Detail of fig. 1; note the primary laterals and the tufts of three secondary laterals cut transversally;
- 5 - BA.43.12, detail of an oblique section; in the upper part the tufts of phloiophorous tertiary laterals come strictly in contact outwards (cortex).

<i>Linoporella capriotica</i> (Oppenheim)												
<i>Thin section</i>	<i>specimen</i>	<i>D</i>	<i>d</i>	<i>p</i>	<i>l</i>	<i>w</i>	<i>h</i>	<i>p'</i>	<i>l'</i>	<i>w'</i>	<i>p''</i>	<i>l''</i>
BA 43.21	1	2,27	0,8	0,05	0,1		0,06	0,03				
BA 43.21	2	2,09	0,99	0,04				0,03			0,04	
BA 43.21	3	1,91	0,77	0,04				0,05				
BA 43.21	4	2,01	0,71					0,05				
BA 43.21	5	1,73	0,45	0,04	0,1	17		0,03	0,34		0,05	0,09
BA 43.21	6	1,02	0,34	0,03				0,03				
BA 43.21	7	2,14	0,77					0,04				
BA 43.21	8	2,42	1,05	0,05	0,12			0,03				
BA 43.21	9	2,3	0,89	0,05	0,08			0,03			0,04	0,1
BA 43.21	10	2,22	0,97	0,06	0,2			0,03	0,51			
BA 43.21	11	2,3	0,99					0,05				
BA 43.21	12	1,79	0,61					0,03				
BA 43.21	13	1,84	0,46					0,04				
BA 43.21	14	2,68	1,11	0,04	0,1			0,03	0,47		0,04	0,13
BA 43.21	15	2,14	1,05	0,04	0,13		0,07	0,05	0,48		0,04	0,13
BA 43.21	16	2,35	1,02					0,04			0,06	0,16
BA 43.21	17	1,56	0,54									
BA 43.21	18	2,63	1,17					0,04				
BA 43.21	19	3,03	1,4	0,04	0,14			0,03	0,45		0,04	0,2
BA 43.21	20	1,35	0,5	0,04	0,1			0,04	0,30		0,05	0,11
BA 43.21	21	1,94	0,85	0,05	0,1			0,05	0,42			0,12
BA 43.21	22	2,14	0,99	0,05	0,1			0,04	0,36		0,05	0,12
BA 43.21	23	2,45	1,1	0,05	0,11			0,04	0,43		0,05	0,15
BA 43.21	24	2,3	0,89	0,04				0,04	0,46		0,04	0,11
BA 43.21	25	2,6	0,99	0,06	0,14			0,04	0,40		0,07	0,17
BA 43.21	26	2,47	0,89	0,05	0,1	18		0,03			0,04	
BA 43.21	27	2,35	1,11	0,06				0,05				0,18
BA 43.21	28	2,17	0,82	0,05	0,12			0,03	0,42			0,15
BA 43.21	29	2,1	0,77	0,06	0,15			0,04	0,40			0,13
BA 43.21	30	2,19	0,92	0,05	0,14			0,04	0,37			
BA 43.21	31	2,47	0,94	0,05	0,12	23	0,07	0,04	0,54		0,04	0,13
BA 43.21	32	2,47	1,02	0,06	0,1	24		0,04	0,56	3	0,05	0,17
BA 43.21	33	2,22	0,89	0,05	0,1	23	0,08	0,03	0,45		0,04	0,12
BA 43.21	34	2,81	1,02	0,05	0,13		0,07	0,04	0,52		0,05	0,16
BA 43.21	35	2,42	1,16	0,06	0,11	38	0,07	0,04	0,45		0,04	0,13
BA 43.21	36	2,81	1,45					0,05				
BA 43.21	37	3,01	1,58	0,07	0,12	44	0,1	0,04	0,53		0,06	0,12
BA 43.21	38	2,14	0,91		0,13	25		0,04	0,33		0,04	
BA 43.21	39	2,5	1,22		0,15			0,04	0,43		0,04	0,12
BA 43.21	40	2,37	0,91		0,13			0,05	0,43		0,04	0,12
BA 43.21	41	2,22	0,99	0,07	0,16			0,04	0,35			0,12
BA 43.21	42	2,17	0,97						0,37			
BA 43.21	43	2,3	1,02		0,14				0,40			0,1
BA 43.21	44	2,55	1,24		0,15	26		0,04	0,45		0,04	0,13
BA 43.21	45	2,42	1,12									
BA 43.21	46	2,55	1,25					0,05			0,06	
BA 43.21	47	3,06	1,45	0,05	0,1		0,09	0,04	0,48		0,05	0,13
BA 43.21	48	2,81	1,28									
BA 43.21	49	1,2	0,55									
BA 43.21	50	2,35	1,16		0,15				0,46			0,13
BA 43.21	51	1,89	1,02					0,04				
BA 43.21	52	2,37	1,17	0,05	0,11	27	0,06	0,04	0,43		0,05	0,12
BA 43.21	53	1,66	0,59	0,05	0,09			0,04	0,42		0,04	0,12
BA 43.21	54	1,71	0,51	0,06	0,15			0,04	0,40			0,09
BA 43.21	55	1,15	0,43									
BA 43.21	56	2,32	1,12					0,05			0,05	0,15
BA 43.21	57	3,09	1,15					0,04				
BA 43.21	58	2,96	1,44	0,04	0,08			0,05	0,57		0,06	0,12
BA 43.21	59	2,35	1,05	0,04	0,12	29		0,04	0,43		0,05	0,1
BA 43.21	60	2,3	1,15		0,13			0,04	0,45			
BA 43.21	61	2,37	0,99	0,07	0,23			0,04	0,38			0,09
BA 43.21	62	2,35	1,07									
BA 43.21	63	2,35	1,05	0,07	0,19			0,05	0,54		0,05	0,2
<i>Total</i>		63	63	37	39	11	9	54	37	1	31	37
<i>Min</i>		1,02	0,34	0,03	0,08	17	0,06	0,03	0,3	3	0,04	0,09
<i>Max</i>		3,09	1,58	0,07	0,23	44	0,1	0,05	0,57	3	0,07	0,2
<i>Average</i>		2,26	0,965	0,0508	0,126	26,7	0,0744	0,0398	0,437		0,0471	0,131
<i>St. deviation</i>		0,43980	0,26917	0,01010	0,03184	8,00114	0,01333	0,00687	0,06530		0,00824	0,02816

Tab. 1 - Most significant biometrical values of *Linoporella capriotica* (Oppenheim, 1889) from sample BA.43. All dimensional values are in millimetres. (*D* = outer diameter of the calcareous skeleton, *d* = inner diameter of the calcareous skeleton, *p* = width of the primary lateral, *l*₁ = length of the primary lateral, *w* = number of primaries in a whorl, *h* = height between whorls, *p'* = width of the secondary lateral, *l*₂ = length of the secondary lateral, *w'* = number of secondaries per primary lateral, *p''* = width of the tertiary lateral, *l*₃ = length of the tertiary lateral).

Finally, the specimen in transversal view (Fig. 3f) shows a calcareous skeleton comparatively thinner than the others. This view appears to be incomplete, too, because it do not show the pore beginnings. Moreover, the drawn outward-convergence of the pores is questionable. Such characters might be enough to put apart the drawing.

As regards the alga of our sample BA.43 (see for example Fig. 3b) it looks more like the Steinmann's specimen (Fig. 3a) than the Oppenheim ones from the morphological and dimensional point of view. However, some parameters, such as the distance between whorls (h), length of primary (l) and secondary (l') laterals, appear to be lower (see Tab. 2). Unfortunately, all the reserves on the more or less agreement of the Steinmann and Oppenheim drawings between themselves and with our sections cannot be solved and a comparative study is impossible because both Oppenheim's and Steinmann's material has to be considered lost (see depository). Thus the definition of a neotype is necessary. On the other hand, the alga from our sample BA.43 looks reasonably comparable to the most indicative original illustration of the alga (Fig. 3a). Therefore we propose as neotype the specimen in oblique section figured in the Pl. 5, fig. 1 (thin section BA.43.24).

Depository - Paul Oppenheim left the material at the Geological Museum of the University of Naples (Oppenheim, 1889, captions of pls. XIX and XX). In 1932 all paleontological collections of this museum were transferred to constitute the newly-founded Museum of Paleontology of the same University, presently Centro Musei delle Scienze Naturali (Section of Paleontology), University of Naples Federico II. All researches made by one of the authors (Barattolo) in the last decade to find the algal material in the Museum

were unsuccessful. Therefore it ought to be considered lost (an amount of the collections was destroyed during the Second World War).

Steinmann's material seemingly should have been stored in Freiburg in Gerberau (Germany), perhaps at the Museum für Naturkunde or in the Geological Institute of the University, where once Gustav Steinmann taught (years 1886-1906: Pfannenstiel, 1957). Unfortunately this material is not present here (Dr. Ursula Leppig, pers. comm., November 2003).

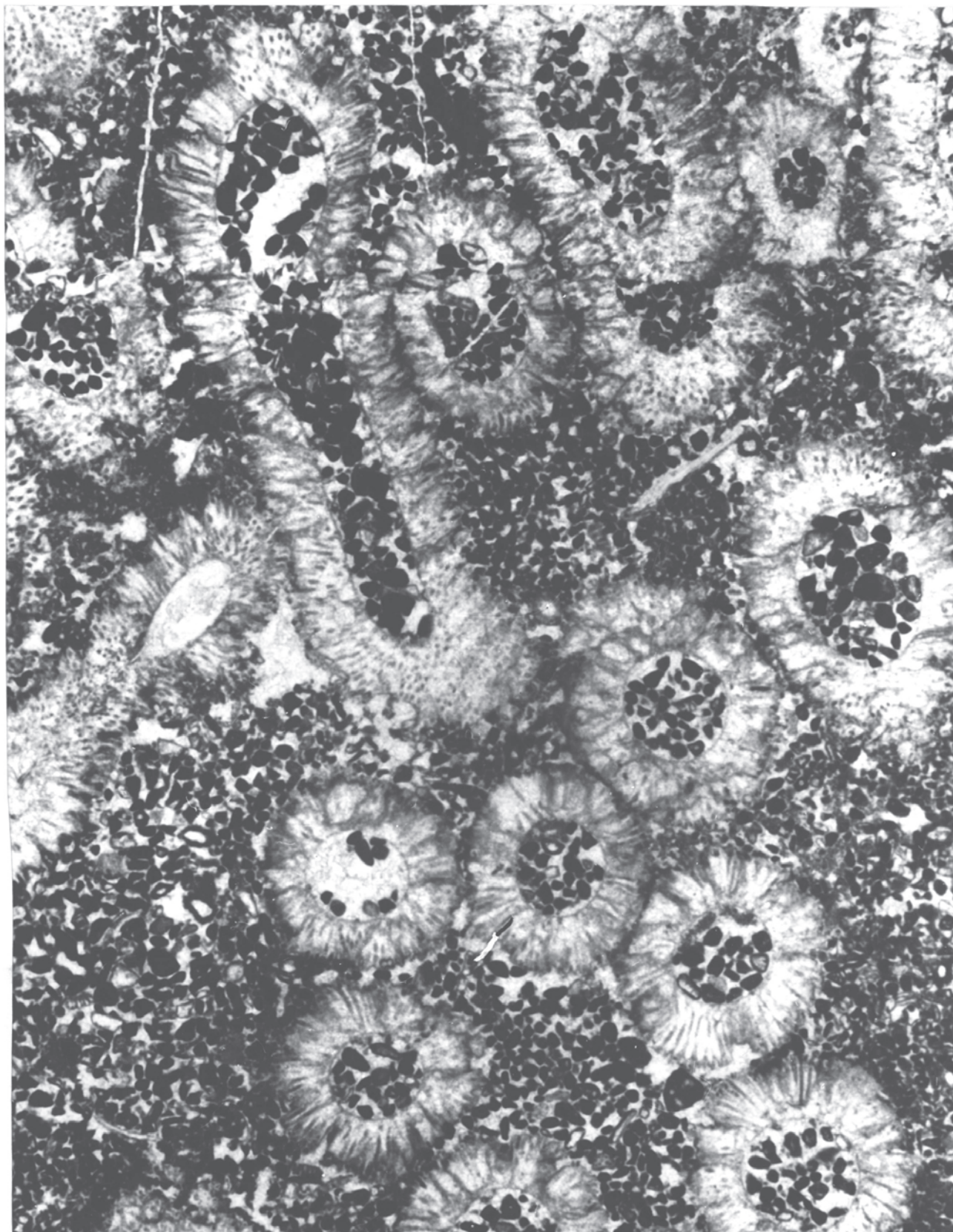
An attempt has been made also in Bonn, where Steinmann taught after 1906, but *Linoporella capriotica* is missing also in the collections of the Paleontological Museum, Institut für Paläontologie, Bonn University (Dr. P. Martin Sander, pers. comm., December 2003).

The sample BA.43 and the neotype (thin section BA.43.24) are housed at the Dipartimento di Scienze della Terra, University of Naples Federico II (Barattolo collection).

Emended diagnosis - *Linoporella capriotica* from sample BA.43 shows also phloiophorous tertiary laterals of modest length; so that the following emended diagnosis is proposed: cylindrical to slightly club-shaped simple thallus. Primary laterals arranged in close whorls, they are rather short and thin, slightly widening outwards. Thin, elongated secondary laterals, slightly widened at their distal ends, in number of two-five per primary lateral. The tertiary laterals are rather short, phloiophorous, and forming a cortex; they are most likely in tufts of two-three per secondary lateral. The calcareous skeleton is strong, roughly cylindrical and more or less articulated, it surrounds the central stem and the laterals. Most significant biometrical values are reported in Tab. 1. Tab. 2 compares the biometrical values reported by Oppenheim (1889), Steinmann (1899) and our material (sample BA.43).

	Oppenheim	Steinmann	BA.43		Oppenheim	Steinmann	BA.43
D	1,5	4,0	1,0-3,1 <i>2,26 0,4398</i> (63).	p'		0,07	0,03-0,05 <i>0,040 0,00687</i> (54)
d		1,0	0,34 -1,6 <i>0,96 0,2692</i> (63)	l'		0,8	0,30-0,57 <i>0,44 0,06530</i> (38)
p		0,1	0,03-0,07 <i>0,051 0,01010</i> (37)	w'			2-5 (20)
l		0,6	0,08-0,23 <i>0,13 0,03184</i> (40)	p''			0,04-0,07 <i>0,047 0,00824</i> (31)
w			17-44 (11) <i>26,7 8,00</i>	l''			0,09-0,20 <i>0,131 0,02816</i> (36)
h		0,23	0,06-0,10 <i>0,074 0,01333</i> (9)	w''			2-3

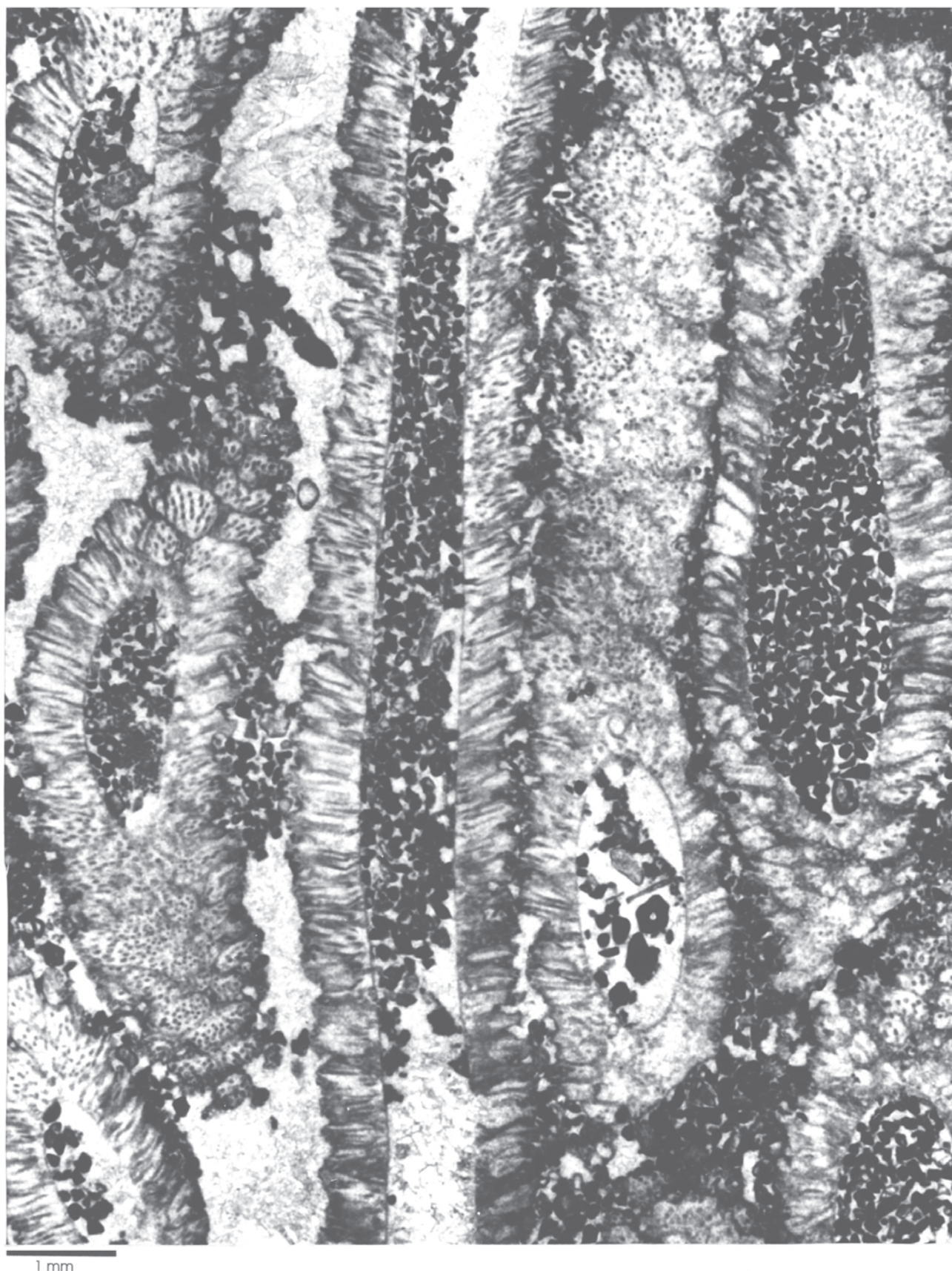
Tab. 2 - Comparison among the most significant biometrical values of *Linoporella capriotica* (Oppenheim) from Oppenheim (1889), Steinmann (1899) and from sample BA.43. The ranges of variability are in bold, average values and standard deviations are in italics; number of measurements has been indicated between brackets. All dimensional values are given in millimetres. (symbols as in Tab. 1, plus w'' = number of tertiaries per secondary lateral).



1 mm

EXPLANATION OF PLATE 6

Microfacies of *Linoporella capriotica* (Oppenheim). Bue marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian). Thin section BA.43.21.



1 mm

EXPLANATION OF PLATE 7

Microfacies of *Linoporella capriotica* (Oppenheim). Bue marino Cave (Capri Is., Italy). Early Cretaceous (upper Berriasian-Valanginian). Thin section BA.43.21.

General features of the calcareous skeleton - The calcareous skeleton is cylindrical, but a more or less marked undulation may occur at the outer surface. In longitudinal section this outer ornamentation appears rather irregular and uneven. The distance between two swellings is 0.3-0.65 mm. The furrow is 0.12-0.24 mm height and attains in ratio 0.20-0.50 the whole thickness of the calcareous skeleton. The inner skeleton-surface is smooth. This one, added to the fact that primary pores are very narrow at the inner surface, witnesses that calcification was adjoining to the central stem. Calcification encrusts outwards laterals at different levels according to the undulation. In detail laterals are enveloped up to the distal swollen end of tertiaries in the ridges (swellings), whereas calcification is restricted to the distal end of secondary laterals to even less in the furrows (constrictions).

In addition to undulation also a clear fissuration occurs. Thus the calcareous skeleton in its middle and outer parts is even more fragmented (Pl. 1, fig. 8; Pl. 2, fig. 2). In tangential sections fissuration gives rise to a mesh of irregular to roughly quadrangular skeleton-elements (Pl. 2, fig. 4) decreasing in size outwards (Pl. 2, figs. 1-3). Fissuration is absent or at least not so evident in specimens from other localities (e.g. Barattolo & D'Andrea, 1991).

The outer diameter (D) is 1.0-3.1 mm, the inner diameter (d) is 0.34-1.6 mm, the thickness of the calcareous skeleton is 0.45-0.86 mm. The inner and outer diameter are directly correlated (Fig. 4a).

Primary laterals - They are arranged in close whorl ($h = 0.06-0.10$ mm). Laterals of two subsequent whorls are usually set in alternate position (Pl. 1, fig. 7; Pl. 2, figs. 2, 5; Pl. 3, fig. 3). Rarely they exhibit a less regular pattern up to an occasional rough arrangement in continuity (Pl. 2, fig. 1)

Number of laterals per whorls increases directly to the size of the thallus; it is 17-44 (Figs. 4A-b). Primary laterals incline of about $75^{\circ}-80^{\circ}$ as to the main axis. Each lateral shows a short peduncle in its inner end which joins to the most important outer part, cylindrical to slightly phloiophorous.

Secondary laterals - They are subcylindrical, 0.30-0.57 mm long (l_2) and 0.03-0.05 mm thin (p'), slightly flaring outwards. A tuft of 3-5 laterals can be seen at the distal end of primary laterals. Secondary laterals show approximately the same inclination of primaries, but those of the same tuft slightly diverge. All secondary laterals gently bend downward in their outer part so that their distal end may be more or less orthogonal to the central-stem axis.

Tertiary laterals - The distal part of the secondary laterals divides in tertiary laterals (Pl. 1, figs. 2, 7, 9). In spite of the abundant material it has been difficult to deduce the number of tertiary per tuft. It is probably of two or three. Tertiary laterals are phloiophorous, moderately thin and elongated. In their external part they flare gradually out, then they came laterally in contact in their distal end (Pl. 5, fig. 5). Tertiary laterals in their middle part are 0.04-0.07 mm in diameter (p'')

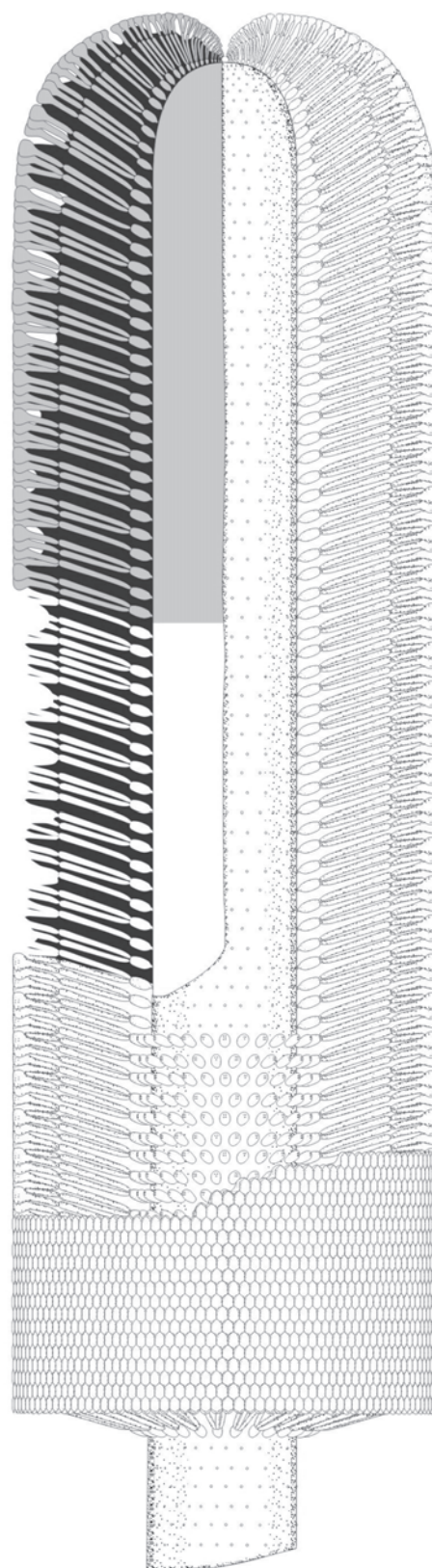


Fig. 5 - *Linoporella capriotica* (Oppenheim). Reconstruction of the thallus in longitudinal view. *Left side*: stem, primary, secondary, tertiary laterals and calcification (black) in axial section. *Right side*: longitudinal view of the thallus without calcification; the central stem shows the junctions of primary laterals; in the lower part a perspective view of the laterals and the cortex is drawn. (x 27).

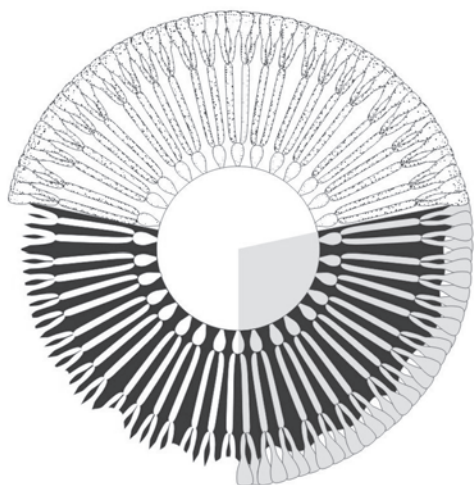


Fig. 6 - *Linoporella capriotica* (Oppenheim). Reconstruction in transversal view. Lower-right: transversal section at whorl level showing primary, secondary, tertiary laterals and calcification (black). Lower-left: only calcification (black). Upper: primary, secondary, tertiary laterals without calcification. (x 27).

and 0.09-0.20 mm long (l_3). The vertical width at the swollen distal end (p''_{vd}) is 0.07-0.10 mm.

Reproductive organs - No trace of reproductive organ has been observed within the central stem, the laterals and even inside the calcareous skeleton. The modest size of laterals of whatever order makes to suppose reproduction was located within the central stem (endosporous type).

Reconstruction of the thallus - To infer a reconstruction of the thallus, a discussion on unfossilized parts is needed: i.e. the top and the bottom of the thallus and the uncalcified ends of the tertiary laterals.

There are strong evidences (laterals strictly close each other and distally swollen) that tertiary laterals formed a cortex distally; it has been supposed a pattern of roughly-hexagonal meshes.

By analogy with cylindrical to slightly club-shaped dasycladaleans with phloiophorous or akrophorous laterals (e.g. *Neomeris* and *Dasycladus*), the top of the thallus was probably formed by laterals decreasing in size and inclination upwards and closed like a bud at the apex. No significant change in inclination has been usually observed along the calcareous skeleton, but the upper end of some longitudinal (e.g. Pl. 4, fig. 2) and oblique sections shows laterals bending more and more upward, this may confirm the presence of a calcified apex. As it happens to extant dasycladaleans, the lower part of the siphon was probably formed by a stalk-like segment attached to the substratum, without laterals. According to the calcified parts and taking into account what can be inferred for those uncalcified ones, a reconstruction in longitudinal (Fig. 5) and transversal (Fig. 6) view is proposed.

Paleoecology - Some paleoecological information on *Linoporella capriotica* (Oppenheim) can be deduced by the sedimentological features of the stratigraphic sequences. The species most likely populated protected micro-habitats within shelf-margin to outer lagoon environments. The algal remains can be found as bioclastic component of coarse calcareous sands. Exceptionally it is also found in life position to form small mats of dense-packed gregarious thalli immersed in a fine-grained sand (sample BA.43, see Pls. 6-7), like in the extant *Dasycladus vermicularis*.

Stratigraphic and geographic distribution - *Linoporella capriotica* (Oppenheim) is recorded from the earliest Cretaceous (Neocomian) of Central and Southern Italy.

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