

## TAXONOMIC NOTES ON SOME CHEILOSTOME BRYOZOA FROM THE PLIOCENE OF THE WESTERN EMILIA REGION (N ITALY)

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Received: June 20, 2006; accepted: January 8, 2007

**Key words:** Bryozoa, Mediterranean Sea, taxonomy, *Cupuladria bugei*, *Cleidochasmidra canakkalense*, *Plesioleidochasma mediterraneum*.

**Abstract.** From a well-preserved fossil assemblage of the mid-Pliocene (Piacenzian) Monte Padova section near Castell'Arquato (northern Italy), three cheilostome bryozoan species are described and figured. The dome-shaped, free-living *Cupuladria bugei* Galopim de Carvalho, described from the Pliocene of the eastern Atlantic, is characterised using SEM photography for the first time, and the present finding is the first from the Mediterranean realm. Similarly, the encrusting unilaminar *Cleidochasmidra canakkalense* Ünsal & d'Hondt, occasionally occurring independently of a substrate, was described from the Recent Mediterranean Sea but hitherto lacked a thorough SEM-based description. It has previously been reported only once from the Pliocene of Italy. *Plesioleidochasma mediterraneum* Chimenz Gusso & Soule, occurring as uni- to plurilaminar encrustations or free of a substrate, was only recently described from the Mediterranean Sea while our finding represents its first fossil occurrence. For the latter two species no information on ancestrula morphology and early colony development was, until now, available from the existing literature.

**Riassunto.** Vengono descritte e figurate tre specie di briozoi cheilostomi contenute in faune del Pliocene medio (Piacenziano) affiorante nella sezione di Monte Padova a Castell'Arquato (PC). Della *Cupuladria bugei* Galopim de Carvalho, specie lunulitiforme istituita su esemplari del Pliocene atlantico della penisola iberica e mai citata in precedenza per il Bacino del Mediterraneo, si propone una dettagliata descrizione ottenuta con un importante apporto di foto al microscopio elettronico (SEM). Per *Cleidochasmidra canakkalense* Ünsal & d'Hondt, specie unilaminata incrostante ma occasionalmente anche a sviluppo libero perché non fissata a substrati, viene proposta una minuziosa descrizione ottenuta anche con osservazioni al microscopio elettronico (SEM). Questa specie che fu istituita su materiale attuale mediterraneo fu citata una sola volta in precedenza per il Pliocene italiano. *Plesioleidochasma mediterraneum* Chimenz Gusso & Soule, trovata come specie incrostante unilaminata od plurilaminata e talvolta anche mancante dei substrati, fu designata solo recentemente da materiale attuale mediterraneo.

Questa nostra segnalazione risulta essere il primo ritrovamento della specie allo stato fossile. Per le ultime due specie vengono date per la prima volta informazioni sull'ancestrula e sui primi zoocci gemmati.

### Introduction

Owing to the excellent state of preservation, with aragonitic fossils and most delicate morphological details preserved, the Plio-Pleistocene bryozoan faunas from the Western Emilia region (Fig. 1) have attracted the attention of palaeontologists since the middle of the 19th century (e.g. Manzoni 1869a,b,c, 1870; Namias 1891; Poluzzi 1975; Pizzaferrri 2004). In the course of our investigations of bryozoan species erected upon specimens coming from this region, we discovered three species which are worth a taxonomic note: *Cupuladria bugei* Galopim de Carvalho, *Cleidochasmidra canakkalense* Ünsal & d'Hondt and *Plesioleidochasma mediterraneum* Chimenz Gusso & Soule. *C. bugei* was originally described from the Pliocene of Portugal (Galopim de Carvalho 1965) and has never been cited to occur in the Mediterranean region. Thus, this species is here reported from Italy for the first time. Although Poluzzi (1975) already found *C. canakkalense* in material from the Piacenza region, he did not specify it and reported this species as *Hippadenella* sp. Four years later, the species was discovered in the Recent Mediterranean Sea and the name formally introduced by Ünsal & d'Hondt (1979). *C. bugei* and *C. canakkalense* have hitherto not been adequately figured and we take this opportunity to describe both species based on scanning

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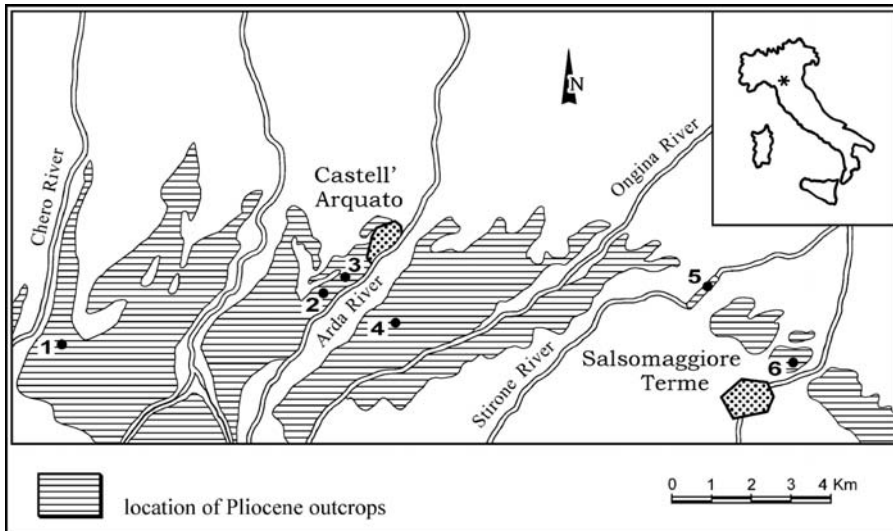


Fig. 1 - Locations of the sampled Pliocene outcrops in the Western Emilia region. 1) Rio Carbonaro section, Chero Valley, Lugagnano Val d'Arda (Piacenza Province); 2) Monte Padova section, Arda Valley, Castell'Arquato (Piacenza Province); 3) Monte Falcone section, Arda Valley, Castell'Arquato (Piacenza Province); 4) Monte Oliveto section, Ongina Valley, Vernasca (Piacenza Province); 5) Stirone River, Salsomaggiore Terme (Parma Province); 6) Campore quarry, Salsomaggiore Terme (Parma Province).

electron microscope (SEM) observations. *P. mediterraneum* is a modern species occurring in the Mediterranean Sea and has only recently been described (Chimenz Gusso & Soule 2003). Our finding thus represents the first fossil record of this species.

### Geological Setting

The faunal assemblages containing these three species derive from mid-Pliocene (Piacenzian) sediments cropping out in the Castell'Arquato area (Piacenza Province), the principal region of our investigations (Fig. 1). Additionally, several other sections of Pliocene age, located a few kilometres east and west of Castell'Arquato, yielded similar faunal assemblages and more material for comparison. The sampled strata at Castell'Arquato (Monte Padova section) comprise the First and Second Monte Giogo Biocalcarenites of Raffi et al. (1989), which are both placed within planktic foraminifera zone MP15a (Raffi et al. 1989; Cauquil et al. 1992; Monegatti et al. 2001; Roveri & Taviani 2003), as well as the layers between these two marker horizons. However, in the studied region these beds are not strictly calcarenites but distal representatives of the same turbiditic beds cropping out in the more proximally positioned Monte Giogo section. The sediments comprise un lithified wacke- and floatstones with a silty to clayey matrix, mainly consisting of mica and other terrigenous material, and a variable amount of bioclastic components. Bryozoans are common constituents of these sediments, consisting of a range of free-living (lunulitiform) species as well as encrusting unilaminar (membraniporiform), erect rigid (vinculariiform, adeoniform, reteporiform) and flexible (cellariiform), and nodular (celleporiform) colonies. The accompanying

fauna consists of gastropods and bivalves, which both occur in abundance, echinoid remains, coralline algae and benthic foraminifera (most commonly *Elphidium* spp.). Whole and fragmented mollusc shells most commonly provided substrates for encrusting bryozoans. Bioclastic components range from extremely well preserved to fragmented, abraded and bored, indicating reworking and mixing of lag deposits with fresh material prior to final deposition. The organisms are interpreted to have had their origin in shallow circalittoral environments (e.g. Monegatti et al. 2001).

### Material and methods

Bulk samples were taken from selected beds of the Monte Padova section, spanning the interval between and including the First and Second Monte Giogo Biocalcarenites of Raffi et al. (1989). A list of the other sample locations in the Western Emilia region and respective occurrences of the bryozoan species studied will be provided on request by the senior author.

The whole rock samples were dried, treated with 10% hydrogen peroxide, and washed to remove the fine-grained matrix. Selected specimens for photographic documentation were additionally cleaned in an ultrasonic bath, carefully immersing them for only a few seconds due to their fragile nature. The specimens were mounted on stubs, sputter-coated with gold, and photographed digitally with a LEO 1455VP SEM. The uncoated ancestrulae of *C. canakkalense* and *P. mediterraneum* were photographed with a Zeiss DSM982 Gemini SEM.

Zooidal measurements were made on these micrographs using the image software ImageJ. Each measurement is given in the text as mean plus or minus standard deviation, observed range, and (enclosed in brackets) number of specimens used and total number of measurements made. The measurements are given in microns ( $\mu\text{m}$ ) unless otherwise stated. In *C. bugei*, zoecial characters were measured on the periphery of the colony only in order to exclude from the analysis zoecia of the first generations, in which astogenetic change is reflected in a gradual increase in zooid size.

The documented material of this publication is stored at the Museo Geologico "G. Cortesi" of Castell'Arquato (abbreviated MG). Bryozoan systematics follow the working classification of D.P. Gordon (pers. comm. 2006) who is currently developing the classification

scheme for eventual use in the revised *Treatise of Invertebrate Paleontology*. Measurements of zooecial characters are identified by the following acronyms and abbreviations:

AL: avicularium length	OvW: ovicell width
AW: avicularium width	OW: orifice width
OL: orifice length	VL: vibraculum length
OpL: opesia length	VW: vibraculum width
OpW: opesia width	ZL: zooecium length
OvL: ovicell length	ZW: zooecium width

### Taxonomic account

Suborder **Neocheilostomina** d'Hondt, 1985

Infraorder **Flustrina** Smitt, 1868

Superfamily Calloporoidea Norman, 1903

Family Cupuladriidae Lagaaij, 1952

Genus *Cupuladria* Canu & Bassler, 1919

**Cupuladria bugei** Galopim de Carvalho, 1965

Fig. 2A-F

1965 *Cupuladria bugei* Galopim de Carvalho, p. 155, pl. 1, fig. 1-3; pl. 2, fig. 1-3.

**Material.** MG0921 (6 colonies); numerous additional specimens in the private collections of CP and BB.

### Measurements

ZL 345 ± 34, 291-437 (2, 20)	ZW 329 ± 40, 278-411 (2, 20)
OpL 214 ± 20, 183-259 (2, 20)	OpW 159 ± 23, 124-218 (2, 20)
VL 163 ± 11, 133-186 (2, 20)	VW 138 ± 14, 112-173 (2, 20)
zoarial diameter: up to c. 3.2 mm	zoarial height: up to c. 1.9 mm

**Description.** Zoarium lunulitiform, initially encrusting unilaminar, exceeding and completely enclosing the substrate in later stages and becoming free living; forming a small (max. diameter 3.2 mm) highly conical zoarium in adult stages; peripheral border of basal disc orbicular, indented due to projection of the peripheral zooids. Basal face flat or slightly concave, granular, with deep distinct grooves determining initially irregularly spaced and later radially arranged, rectangular or polygonal sectors. Every sector contains 1-3, relatively large, orbicular to irregularly shaped chambers in the central region, and 3-6 chambers in the peripheral region. During zoarium growth layers of thick, coarsely granular calcification and new chambers are successively produced on basal face of colony; older chambers are

closed by a thin wall, with a central pore remaining open in a pit-like depression connecting the new with the preceding chamber. Basal colony periphery primarily not sculptured except for a small pore deriving from proximal end of each marginal vibraculum and radial sector boundaries which lead to these pores; chambers and tangential sector boundaries develop somewhat proximally towards colony centre. In later ontogeny the sector boundaries in the central basal disk may be masked by secondary calcification.

Zooecia rhombic, in alternate radiating rows, each with a distal vibraculum, separated by a slightly raised ridge and a narrow groove; granular lateral wall raising distally at about mid-distance of zooecium forming a vestibular arch (sensu Cook 1965: 154) and an irregular zoarial surface; a series of small pores beneath cryptocyst connect zooids to vibracula and neighbouring zooids; additionally, the basal region of vertical walls is perforated by a linear series of relatively large communication pores. Cryptocyst well developed, coarsely granular to tubercular, markedly descending towards the zooid centre and partially occupying the opesia with two lateral, rounded triangular, broad but flat, horizontal denticles, while a third may emerge from the proximal cryptocyst to produce a trifoliate opesia; the proximal denticle is smaller than the lateral pair and is often reduced or absent, in which case the proximal opesia margin is rather straight or convex.

The zoarium develops from a triad of ancestrular autozooids, each with a distal vibraculum; astogenetic change is reflected in a size increase of the zooecia of the next 4 generations. During later ontogeny, up to 12 zooecia of the central zoarial become partially closed by a granular secondary calcification, affecting the cryptocyst and inner vertical walls, leaving open a broad fissure in the centre of the zooecia only; opesia of vibracula associated with these zooecia are not affected by secondary calcification.

An asymmetrical auriform vibraculum is present distolaterally to each zooecium; rostrum short, subtriangular, directed proximally, with an arched, rounded triangular tooth on the convex side of its rim. Vicarious vibracula were not observed.

**Remarks.** Zooecial proliferation in early astogeny in *C. bugei* proceeds as described by Lagaaij (1963: 183, text fig. 10) and Cook (1965: 155, text fig. 1B) for *Cupuladria canariensis* (Busk, 1859), as is typical for the Cupuladriidae, but we also found one small colony in which there are two vibracula associated with a single zooecium of the central zoarial region. These two vibracula are equal in form and dimension and placed distally and proximally to the zooecium. One of the two vibracula is very likely the result of reparative growth after damage of the zooecium in the ancestrular complex. Asexual propagation was, as expected for a

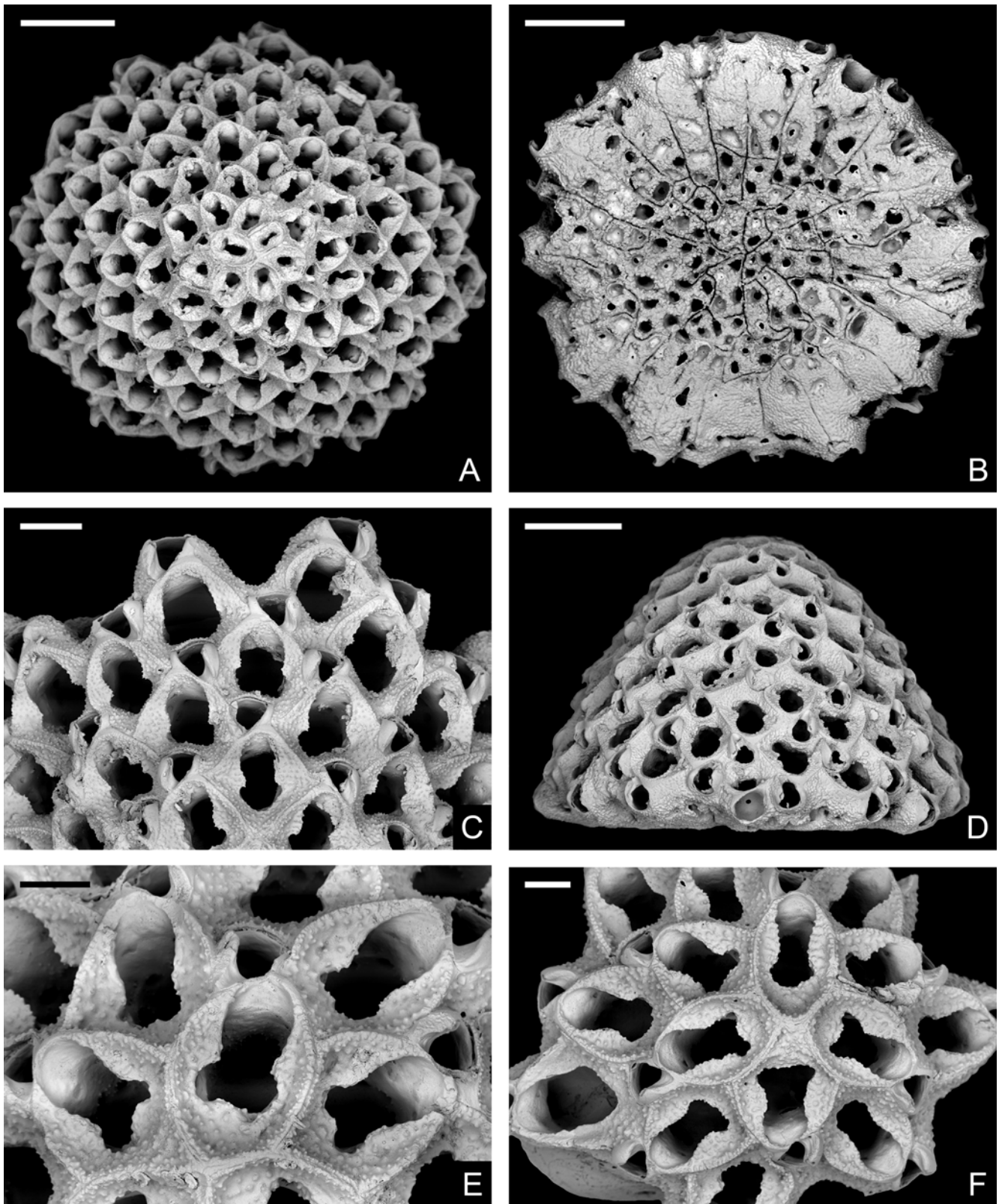


Fig. 2 - *Cupuladria bugei*, MG0921. A) Apical view of adult colony; note partial closure of central zooids. Scale bar 500  $\mu$ m. B) Basal surface of adult colony. Scale bar 500  $\mu$ m. C) Peripheral region of adult colony. Scale bar 200  $\mu$ m. D) Lateral view of adult colony. Scale bar 500  $\mu$ m. E) Close-up of ancestrular region with the first two zooid generations. Scale bar 100  $\mu$ m. F) Ancestrular complex of young colony. Scale bar 100  $\mu$ m.

cupuladriid species with a highly domed and heavily calcified zoarium (see O’Dea [2006] and references therein), not observed in any of the specimens. Reproduction was always sexual (i.e. of ancestrular origin) in *C. bugei*, contrasting with another co-occurring cupuladriid, *Cupuladria cavernosa placentina* Pizzaferrri, 2006, the flat and lightly calcified zoaria of which often showed fragmentation and subsequent colonial budding (e.g. Marcus & Marcus 1962; Håkansson & Thomsen 2001).

The well-developed marginal denticles make *C. bugei* similar in appearance to certain species of the genus *Reussirella* Baluk & Radwanski, 1984 (the ‘Typical’ group sensu Cook & Chimonides 1994). However, the presence of basal sectors with distinct chambers and pores unequivocally justifies a placement in the genus *Cupuladria* and, more precisely, in the *Cupuladria canariensis* complex (sensu Cook & Chimonides 1994). Within this species complex, *C. bugei* most closely resembles the NE Atlantic and Mediterranean *Cupuladria cavernosa* Cadée, 1979 due to a similar morphology of the basal chambers (cf. Cook & Chimonides 1994). Yet *C. bugei* is easily distinguishable from other species of the genus mainly owing to its trifoliate opesia, and, to a lesser extent, to its type of basal disk cover, the disposition of the chambers and pores, and its smaller zooecial dimensions. Furthermore, the colony shape is another conspicuous character in *C. bugei*, which always forms a small, high, conical-cupuliform zoarium. *Cupuladria onubensis* Reguant, 1993 from SW Spain seems very similar to *C. bugei*, mainly owing to the shape of the trifoliate opesia. However, the former has a rather flattened zoarial shape, the colonies have a larger diameter (up to 6 mm) and the zooecia are distinctly larger (see Reguant 1993).

While most specimens of fully-grown colonies found by the senior author in the Pliocene of Bozzoli (Genova Province, N Italy) and of Villavernia (Alessandria Province, N Italy) can also be attributed to *C. bugei*, a few colonies from Bozzoli are not identical to those found in Emilia. These differ in having a deeply concave basal face, and therefore fewer layers of basal chambers, and more regular and lengthened radial sectors. They are very similar to the specimens from Crete described and figured as *Cupuladria canariensis* by Moissette et al. (1993: 92, fig. 4g,h,i). Clearly, more material of this morphotype needs to be screened before any firm conclusions can be drawn concerning its relationship with *C. bugei*.

**Distribution in the Western Emilia region.** Piacenzian (mid-Pliocene): Rio Carbonaro section (Chero Valley at Lugagnano Val d’Arda, Piacenza Province); Campore quarry (at Salsomaggiore Terme, Parma Province; see Raffi & Taviani 1983); Monte Falcone section (1 km NE of the here described Monte Padova section;

see: Poluzzi 1975; Monegatti et al. 1997; Monegatti et al. 2002). Gelasian (Late Pliocene): Stirone River section (at Salsomaggiore Terme, Parma Province; see Iaccarino 1996).

**Stratigraphic distribution.** Eastern Atlantic (Portugal) and Mediterranean Pliocene. If the specimens figured by Moissette et al. (1993) prove to be *C. bugei*, then this species was already present in the Late Miocene Mediterranean Sea.

Infraorder **Ascophora** Levinsen, 1909

“Grade” **Lepraliomorpha** Gordon, 1989

Superfamily Mamilloporoidea Canu & Bassler, 1927

Family Cleidochasmatidae Cheetham & Sandberg, 1964

Genus *Cleidochasmidra* Ünsal & d’Hondt, 1979

**Cleidochasmidra canakkalense** Ünsal & d’Hondt, 1979

Fig. 3A-G

1975 *Hippadenella* sp. - Poluzzi, p. 57, pl. 17, fig. 2.

1979 *Cleidochasmidra canakkalense* subgn. nov., sp. nov. Ünsal & d’Hondt, p. 620, fig. 7-10.

1988 *Lagenipora lepralioides* (Norman) - Poluzzi & Rosso, pl. 2, fig. 8.

1996a *Cleidochasmidra canakkalense* Ünsal & d’Hondt - Rosso, pl. 1, fig. 6.

**Material.** MG0922 (8 colonies); several additional specimens in the private collections of CP and BB.

### Measurements

ZL 430 ± 36, 334-494 (5, 20)	ZW 362 ± 45, 252-462 (5, 20)
OL 135 ± 7, 124-147 (5, 20)	OW 113 ± 8, 93-125 (5, 20)
OvL 163 ± 11, 147-245 (3, 20)	OvW 138 ± 14, 162-239 (3, 20)
AL 162 ± 18, 125-187 (5, 20)	AW 75 ± 10, 60-92 (5, 20)

**Description.** Zoarium encrusting unilaminar, multiserial, sometimes with self-overgrowth, and occasionally occurring independently of a substrate. Zooecia hexagonal, longer than wide, separated by distinct grooves; basal zooecial walls thin but complete in colonies attached to hard substrata; in colonies occurring independent of substrate the central zooecial region may lack calcification or, when basal walls are complete, additional secondary thickening occurs along basal margins. In the latter case, a thickened, broadly V-shaped, distal edge projects from the rhombic lower zooid surface, whereas the proximolateral part is penetrated by one or more pits and/or grooves. Vertical walls deep, with a single large interzooecial pore between each neighbouring zooid.

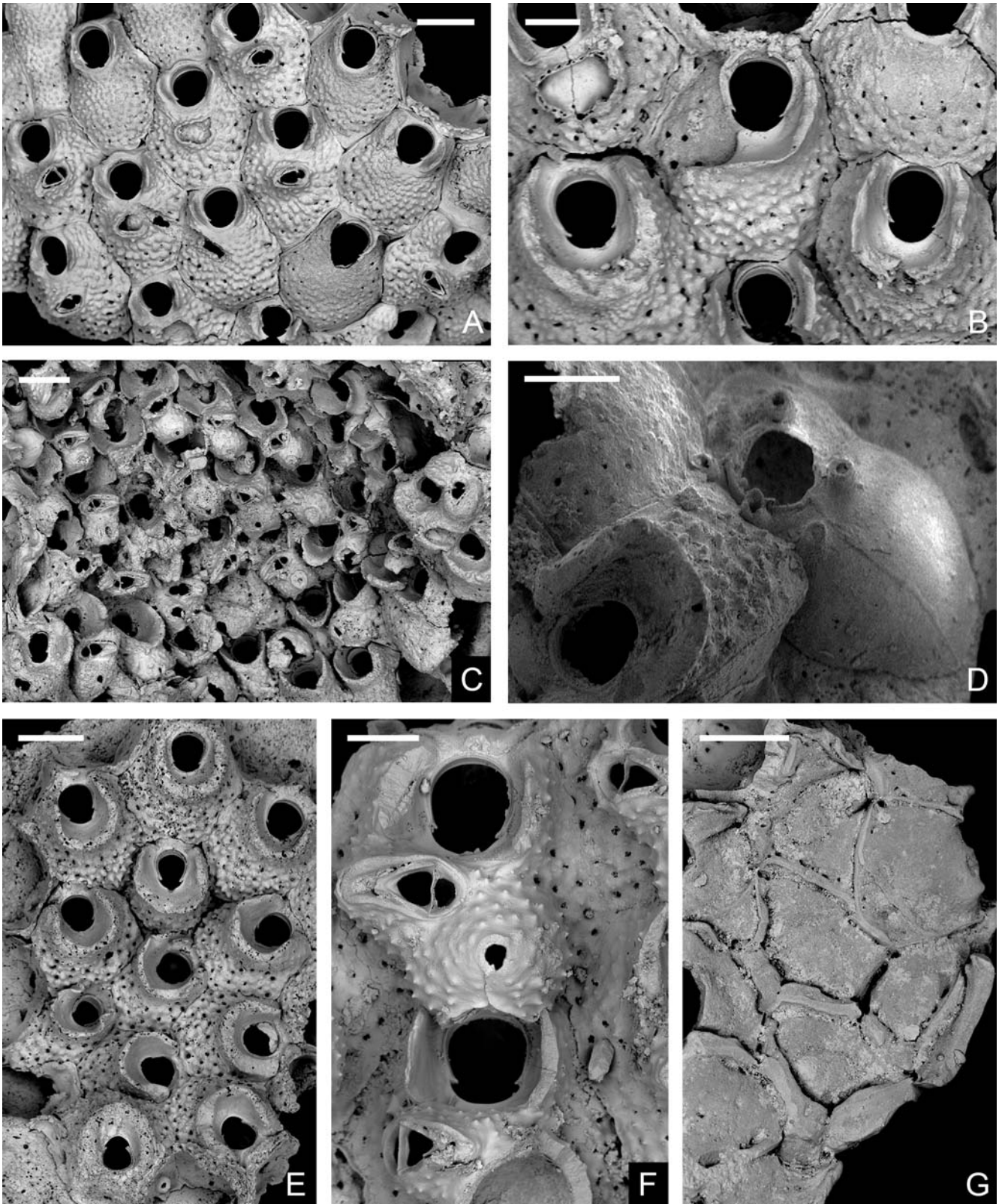


Fig. 3 - *Cleidochasmidra canakkalense*, MG0922. A) Colony occurring free of a substrate; note the presence of flaps lateral to orifice and the occasional occurrence of avicularia [compare with C)]. Scale bar 200  $\mu\text{m}$ . B) Close-up of autozooids; note the loss of information on peristome and surface morphology in the central zooid in which secondary calcification has come off. Scale bar 100  $\mu\text{m}$ . C) Mostly ovicellate zooids encrusting the concave inner side of a bivalve; note the greatly enlarged peristomes and the presence of numerous avicularia [compare with A)]. Scale bar 200  $\mu\text{m}$ . D) Ancestrula. Scale bar 100  $\mu\text{m}$ . E) Young colony. Scale bar 200  $\mu\text{m}$ . F) Close-up of ovicell. Scale bar 100  $\mu\text{m}$ . G) Basal wall of colony occurring free of a substrate. Scale bar 200  $\mu\text{m}$ .



Frontal shield convex, covered by numerous pointed tubercles, and with small, scattered, marginal and occasionally central pores with a toothed margin, sometimes masked by secondary calcification forming a thick cover on the frontal wall. Areolar pores, if present, are not differentiated from other pores. Orifice ovoid, longer than broad, widest at distal third, with pointed and short but conspicuous condyles pointing medio-proximally, situated at proximal third of orifice, formed by an interior orificial lining stretching along the distolateral margin; no lyrula. Although a peristome is not formed in the primary skeleton, during ontogeny and astogeny different peristome morphologies are developed in the course of secondary calcification. Peristome in early astogeny a well-developed, deep, round to oval and widely flaring collar with lateral sinuses at mid-distance, completely encircling the orifice and usually sloping distally; in later astogenetic stages either a similar peristome (lacking the sinuses) is formed, or a pair of tall, more or less straight, lateral flaps develop that level proximally and distally. No spines.

Single, median, suboral, adventitious avicularium present in some zooids, occasionally incorporated into proximal peristome; avicularian chamber slightly swollen and raised above frontal surface; rostrum elongated triangular, directed laterally or rarely proximolaterally, terminating in a blunt tip which is curved in a proximal direction, distal part of rostrum occasionally also bent vertically so that tip points downwards; crossbar thin, complete, without columella, separating a rounded-triangular distal and a semicircular proximal opesia. Distal or proximal part of avicularium incorporated into ovicell of proximal brooding zooids, avicularian chamber may then be slightly displaced laterally and/or inclined to frontal plane.

Ovicell dependent, prominent, hyperstomial, ovoidal, longer than wide, vertically elongated, surface as zooidal frontal wall, imperforate; a longitudinal median suture in proximal face of ovicell leads to a subcircular opening on the apex; ovicell aperture semicircular, not closed by zooidal operculum.

Ancestrula oval, longer than wide (380 x 230  $\mu\text{m}$ ), with an extensive, convex, very lightly calcified gymnocyst, slightly constricted just proximal to reduced, faintly oval, distal opesia (87 x 77  $\mu\text{m}$ ) encircled by a prominent rim; a more or less median suture leading from the proximal edge of gymnocyst towards proximal opesia margin; basal wall absent, etching of substrate visible. Six thick hollow spines placed irregularly around opesia. First generation zooids smaller but with adult morphology; no spines.

**Remarks.** The genus *Cleidochasmidra* was originally introduced as a subgenus of *Cleidochasma* Harmer, 1957 (now considered a junior synonym of *Characodoma* Maplestone, 1900) by Ünsal & d'Hondt (1979).

However, orifice characteristics and especially the distinct mode of ovicell formation distinguish this taxon from all other genera in the Cleidochasmatidae and justify raising *Cleidochasmidra* to generic level (Soule et al. 1991). Furthermore, to meet the demands of articles 11.2 and 32.5.2 of the ICZN (1999) the diacritical character in the species name *C. çanakkalense* is here changed to the Latin character *C. canakkalense*.

The present species description differs slightly from the original account given by Ünsal & d'Hondt (1979) concerning the porous frontal wall. While distinct areolar pores are lacking in both fossil and Recent representatives of *C. canakkalense*, as mentioned in the original description, Ünsal & d'Hondt stated that the frontal wall is imperforate. This is clearly not the case in our fossil material. However, since these pores are difficult to observe using optical instruments only (SEM photos were not provided in the original description), and may also be disguised by secondary calcification, we believe this feature is also present in Recent *C. canakkalense*.

The ancestrula is here described and figured for the first time (Fig. 3D). It is rarely preserved due to its fragile nature and may become (partly) overgrown by adult zooids during later astogeny. Despite its characteristic morphology, however, a systematic comparison with ancestrulae of other taxa of the family Cleidochasmatidae is hindered by the near-absence of information on early colony development in species belonging to this family.

Intraspecific variability of peristome development in *C. canakkalense* is clearly evident in the available material. Whereas colonies that occur independently of a substrate show the presence of lateral flaps only (Fig. 3A), it appears that the formation of a widely flared rim is restricted to colonies that encrust hard substrates. Particularly large and deep peristomes are furthermore developed in parts of colonies that grew on concave surfaces, such as the inner sides of disarticulated bivalve shells (Fig. 3C). Here, also the avicularia were more numerous and larger than in zoaria growing on even surfaces or independently of a substrate. It therefore seems that the development of the peristome and also of avicularia are induced by certain environmental conditions, as previously suggested for other species by Harmelin (1988), Harmelin & d'Hondt (1992) and Rosso (2004). The cause(s) for this marked variability needs to be assessed in Recent representatives. However, *C. canakkalense* is a rare species today and has, since its discovery in the eastern Mediterranean in 1979, been reported only from off Sicily in the Ionian Sea (Poluzzi & Rosso 1988; Rosso & Sanfilippo 1992; Rosso 1996a,b), as well as the northern Tyrrhenian Sea and the Strait of Sicily (A. Rosso pers. comm. 2005).

In colonies occurring free of a substrate the irregular topography of the thickened basal walls, which contain not only deep pits and grooves but also projections of the vertical walls (Fig. 3G), is a peculiar feature. Growth on ephemeral or particulate substrates, or uplift of the zoarial margin from the encrusted surface may be responsible for this characteristic; basal kenozooids, however, which may function as rhizoids for anchorage in soft sediment, were not observed.

When secondary calcification is abraded, corroded or dissolved, which is the case in many fossil assemblages, any information on the presence and structure of the peristome and nodular frontal calcification is lost (see central zooid in Fig. 3B). This notion has to be taken into account when comparing these or Recent specimens with other potential fossil representatives (see also Discussion in *P. mediterraneum* below). The reasons for the loss of the frontal layer of secondary calcification may be manifold, depending on taphonomic processes and/or mineralogical composition of the outer surface of the frontal wall, as well as on differences between the ultrastructure of primary skeleton and secondary calcification. Cheilostome bryozoan skeletons show a wide range of mineralogies (wholly calcitic, low- to high-Mg calcite, wholly aragonitic, or bi-mineralic, differing even within colonies) and ultrastructures (primary skeleton vs. secondary layer[s]) (e.g. Cheetham et al. 1969; Rucker & Carver 1969; Taverner-Smith & Williams 1972; Smith et al. 2006). Whereas physical abrasion during post-mortem transport especially affects all (but primarily prominent) superficial structures alike (but see Smith & Nelson 2003: 4), loss of secondary calcification due to corrosion or dissolution may be more subtle and structure-specific. During diagenesis superficial aragonitic layers are especially subject to dissolution and skeletons composed of high-Mg calcite are prone to neomorphism. But also the decay of dispersed organic matter, which is often present in secondary layers (Taverner-Smith & Williams 1972), may possibly weaken the cohesion between the distinct and ultrastructurally different layers of primary skeleton and secondary calcification (Cheetham et al. 1969), even in sediments in which aragonite is preserved.

#### Distribution in the Western Emilia region.

Late Zanclean (Early Pliocene): Monte Oliveto section (Ongina Valley at Vernasca, Piacenza Province; see Cauquil et al. 1992; Monegatti et al. 2001); Moja quarry (at Monticelli near Quattro Castella, Reggio Emilia Province).

Piacenzian (mid-Pliocene): Campore quarry (at Salsomaggiore Terme, Parma Province; see Raffi & Taviani 1983); Monte Falcone section (1 km NE of the here described Monte Padova section; see Poluzzi 1975). Gelasian (Late Pliocene): Stirone River section

(at Salsomaggiore Terme, Parma Province; see Iaccarino 1996).

**Stratigraphic distribution.** Pliocene to Recent in the Mediterranean basins. Probably endemic to the Mediterranean realm.

**Ecology.** *C. canakkalense* was found alive at 60-70 m depth in the Aegean Sea by Ünsal & d'Hondt (1979) and at c. 50-95 m in the Noto Gulf (Sicily) by Rosso (1996a,b; pers. comm. 2006). Dead specimens were recorded from both shallower environments and greater depths (40-130 m, A. Rosso pers. comm. 2006). Most species of the family Cleidochasmatidae are today restricted to tropical and subtropical environments.

In the Pliocene of Western Emilia, the encrusting specimens have been found in circalittoral sediments, whereas the specimens occurring free of substrates may have lived as epibionts or on soft particulate bottoms in deeper waters of the circalittoral or upper epibathyal (such as at Moja and Campore quarries; personal observation CP).

Superfamily Celleporoidea Johnston, 1838

Family Phidoloporidae Gabb & Horn, 1862

Genus *Plesiocleidochasma* Soule, Soule & Chaney, 1991

***Plesiocleidochasma mediterraneum*** Chimenz Gusso & Soule, 2003

Fig. 4A-D

1969 *Cleidochasma* sp. - Harmelin, p.1202, fig. 3:6-7.

1995 *Schedocleidochasma porcellaniforme* Soule, Soule & Chaney - Nicoletti et al., p. 398.

2003 *Plesiocleidochasma mediterraneum* Chimenz Gusso & Soule, p. 72, fig. 2A-F.

**Material.** MG0923 (3 colonies); several additional specimens in the private collections of CP and BB.

#### Measurements

ZL 375 ± 53, 316-495 (3, 20)	ZW 361 ± 43, 297-474 (3, 20)
OL 141 ± 8, 121-155 (3, 20)	OW 104 ± 7, 85-113 (3, 20)
OvL 191 ± 18, 174-229 (2, 7)	OvW 213 ± 14, 194-238 (2, 7)
AL 84 ± 7, 71-92 (3, 14)	AW 54 ± 5, 46-64 (3, 14)

**Description.** Colony encrusting, unilaminar or occasionally plurilaminar, multiseriate. Zooecia ovoid or hexagonal in radiating linear series, arrangement more irregular in frontally budded layers; zooecia initially separated by deep grooves soon filled by thick secondary calcification during ontogeny, primary zooid boundaries are then disguised. Frontal shield moder-



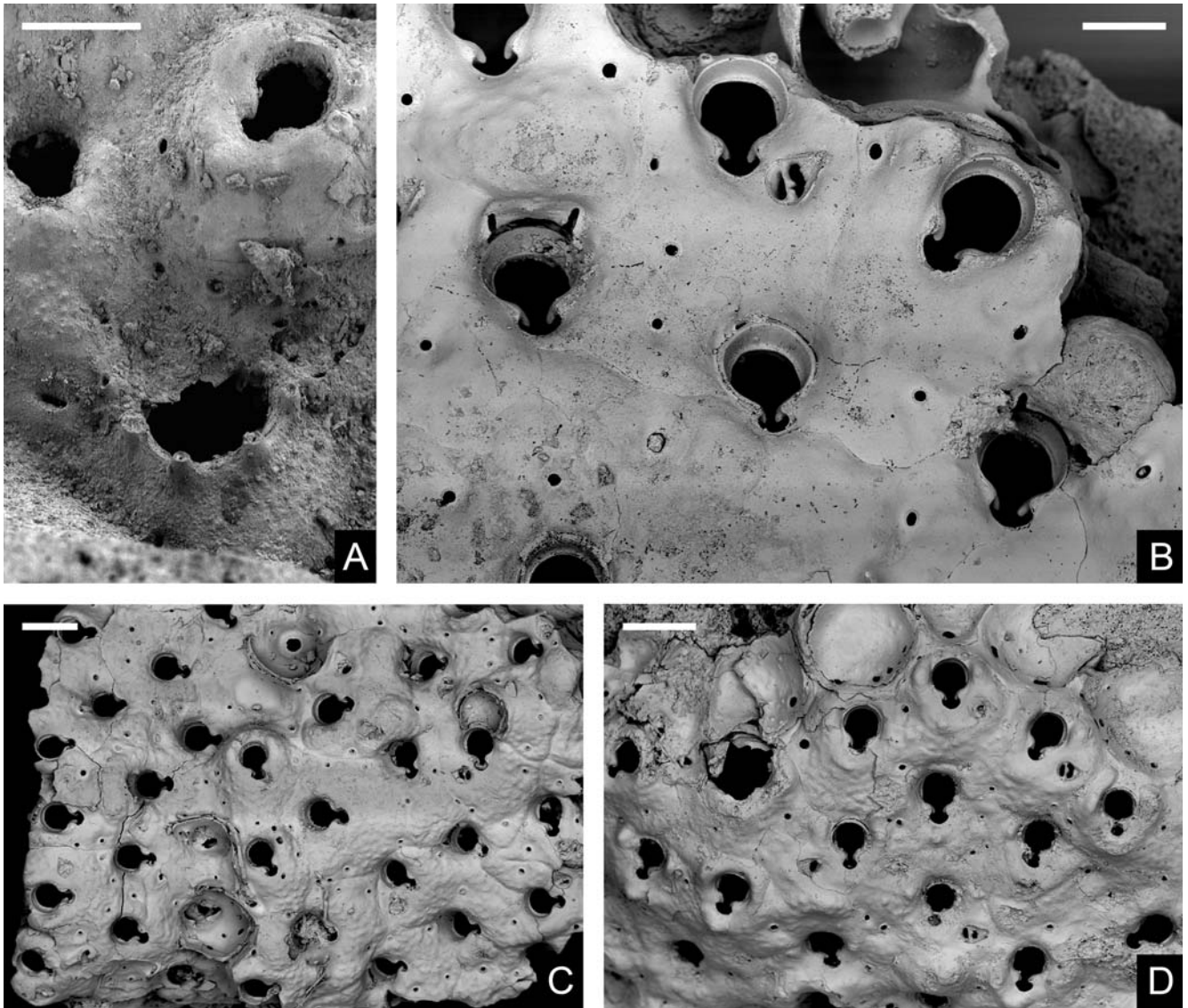


Fig. 4 - *Plesiocheilochasma mediterraneum*, MG0923. A) Ancestrula, distally covered by secondary calcification. Scale bar 100  $\mu$ m. B) Autozooids and ovicellate zooids (top left, lower right); note difference in surface morphology between ovicells with and without secondary calcification. Scale bar 100  $\mu$ m. C) Autozooids and ovicellate zooids in a plurilaminar, frontally budding colony. Scale bar 200  $\mu$ m. D) Autozooids with marked suboral umbos at the colony margin. Scale bar 200  $\mu$ m.

ately convex, imperforate, covered by smooth and glossy secondary calcification, surface wrinkled or coarsely grained in older colonies, occasionally with a blunt, median, suboral umbo and/or a pair of elongated umbos lateral to orifice; two to four round pores near lateral and proximal zooid margin, becoming more pronounced in later ontogeny due to a slightly elevated rim. Vertical walls with one interzoecial pore per adjacent zoecium. Dorsal wall usually complete, but occasionally incomplete in its centre in colonies that occur independent of substratum. Orifice longer than wide, cleithriate, anter large and round, set off from the smaller round or elliptical poster by strong condyles produced by a smooth inner lining, directed proximally and downwards; two spines on distolateral peristomial rim in primary skeleton which are soon lost and covered by secondary calcification during ontogeny.

Single avicularium occasionally present, situated lateral or proximolateral to sinus, originating from a marginal pore; rostrum short and broadly triangular, directed laterally or distolaterally, proximal opesia semi-circular, crossbar complete with a thick, rounded, median columella. In one case the ancestrula regenerated as, or was later replaced by, a vicarious avicularium similar in morphology to an adventitious one.

Ovicell dependent, prominent or perhaps slightly immersed, hyperstomial, little wider than long and flattened frontally, imperforate, with vitreous wall in early ontogeny, not closed by the operculum. A pair of proximolateral fissures delimits a simple labellum with a concave proximal edge. Due to extensive secondary calcification fissures may be closed and the ovicell becomes completely covered, projecting only slightly above zoarial surface in later ontogeny.

Ancestrula oval, longer than wide (280 x 210 µm), convex gymnocyst well developed proximally with steep lateral walls, surface rugose; opesia oval, occupying about half of ancestrula length; nine thick spines regularly placed around opesia on an elevated rim. Peri-ancestrular zooids with adult morphology but smaller and with four spines.

**Remarks.** Our species description differs from the original description by Chimenz Gusso & Soule (2003) in that in the fossil material the central pore in the proximal ovicell margin was not observed and the incisions delimiting the labellum are occasionally occluded during ontogeny. While these features were as such not described in Recent material, they may be related to colony age or, possibly, variation in hypercalcification depending on environmental conditions, e.g. water temperature. The ancestrula, which may be covered by secondary calcification during colony growth, is here described and figured for the first time (Fig. 4A).

Abrasion or corrosion of secondary calcification in fossil material will give the zooecia a different appearance (see Fig. 4B) and will therefore hamper a substantiated comparison between taxa and a comprehensive species description in many fossil assemblages. For example, without the secondary calcification cover, the ovicell and orifice in *P. mediterraneum* are nearly identical to those in the fossil *Schedocleidochasma incisa* (Reuss, 1874) (formerly referred to *Buffonellodes incisa*), as described and figured by Berning (2006). When information on the frontal surface is lost only the difference in avicularian morphology provides positive evidence for keeping these taxa apart. Besides, the close morphological proximity of these and other species suggests that the genus definitions of *Plesioleidochasma* and *Schedocleidochasma* Soule, Soule & Chaney, 1991 may need to be revised.

Furthermore, *P. mediterraneum* could perhaps correspond to *Lepralia minutissima* Seguenza, 1880 (p. 82, pl. 8, fig. 13). If this hypothetical attribution can be demonstrated, then Seguenza's species would be the senior synonym.

**Distribution in the Western Emilia region.** Piacenzian (mid-Pliocene): Campore quarry (at Salsomaggiore Terme, Parma Province; see Raffi & Taviani 1983). Gelasian (Late Pliocene): Stirone River section (at Salsomaggiore Terme, Parma Province; see Iaccarino 1996).

**Stratigraphic distribution.** Pliocene to Recent in the Mediterranean basins and perhaps endemic to this region. If it can be shown that *Plesioleidochasma mediterraneum* is conspecific with *Lepralia minutissima* Seguenza, 1880 then this species was already present in the Late Miocene (Tortonian).

**Ecology.** In the Recent Mediterranean Sea this species was reported encrusting coralline algae and roots of the seagrass *Posidonia oceanica* at depths of 16 m and 28 m respectively by Chimenz Gusso & Soule (2003), and from 10 m in Sicily Strait and down to 65 m in the Gulf of Noto (A. Rosso pers. comm. 2006). The Pliocene specimens encrust coralline algae, bivalves and occasionally occur independently of a substrate, which may indicate either the presence of seagrass with a later redeposition of the bryozoan fragments at greater depths, or growth of this species on other ephemeral substrates in a circalittoral environment.

*Acknowledgements.* We thank Jens Hartmann and Stefan Müllegger for SEM photography, Bianca Reitberger for technical support, and Giampietro Braga for providing us with bibliographic material. Pierre Moissette and Paul D. Taylor are thanked for critically reviewing our manuscript, while Antonietta Rosso made valuable comments on an earlier draft. BB gratefully acknowledges funding by the Deutsche Forschungsgemeinschaft (Be 1272/13 to Christian Betzler) during the early stages of this project. Current funding is provided by the Austrian FWF (P18189 to Werner Piller).

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