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STUDIES ON POLYZOA (BRYOZOA) FROM THE *ENDEAVOUR* EXPEDITION, 1909-1914

I. A NEW LUNULITIFORM POLYZOAN (ASCOPHORA) FROM SOUTH-EAST AUSTRALIA

II. COLONY FORMATION IN *SELENARIA NITIDA* MAPLESTONE

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Plates 1 and 2. Figure 1 Manuscript received 2nd December, 1964

I. A New Lunulitiform Polyzoan (Ascophora) from South-east Australia

ABSTRACT

A monotypic family is erected in order to accommodate a new lunulitiform ascophoran polyzoan, referred here to *Australiana* n.gen. Family characteristics comprise the cupuliform zoarium with quadrate zooecia radially arranged in single or double rows. The dimorphic orifice is elongate in ordinary zooecia and transversely elliptical in fertile zooecia. A pair of large fenestrae perforate the outer wall of the ectooecium. The basal surface, strongly concave in mature zooecia, is perforated by large foramina, interpreted as kenozooecia, and bears several radicular chambers. Avicularia are not developed. The species is known as a fossil from the lower Muddy Creek (Middle Miocene) beds of Victoria, and from the Recent Peronian faunal province.

INTRODUCTION

The characters of the genus here described, including the remarkably regular arrangement of the zooecia not covered by a mass of secondarily formed avicularia and convexities, as well as the distinctive fenestrate ovicells, clearly distinguish it from other previously described lunulitiform ascophoran genera, and therefore justify its reference (as the type genus) to a new family.

AUSTRALIANIDAE new family

Diagnosis: As for the genus.

Australiana new genus

Type species (here chosen): *Australiana bifenestrata* n.sp. (see below).

Diagnosis: Loosely attached, cupuliform, unilaminar Ascophora with a thin porcellanous frontal wall. Zooecia quadrate, radially arranged in uniserial or biserial rows, extending vertically from the frontal to the basal surface. Orifice dimorphic, the proximal end directed towards the apex of the zoarium, elongate in ordinary zooecia, with two condyles at the proximal third; transversely elliptical in fertile zooecia. Ovicell entozooecial, with a pair of conspicuous frontal pores perforating the outer wall of the ectooecium. Ancestrula membraniporine, apical, giving rise to three first-generation zooecia. Basal surface deeply concave in mature zooecia, with large foramina and scattered radicular chambers. Avicularia wanting.

Remarks: The holotype (plate 1, fig. 5) is chosen from material retrieved by the *Thetis* Expedition (1898) off Bulgo, New South Wales. Additional paratypic material was taken near Gabo Island, Victoria; Bass Strait; and off the New South Wales coast by the *Endeavour* Expedition (1909-14). I have also examined three specimens collected off New South Wales by members of the Australian Museum, also a single specimen from Port Jackson, N.S.W.

The majority of this material was examined some time before 1921 by R. Bretnall, of the Australian Museum staff. He identified this form as a new species of the genus *Lunularia* but his manuscript name was never published, nor is it mentioned in the unpublished and incomplete Bretnall manuscript on the Polyzoa of the *Endeavour* Expedition.

Ecology: Like other lunulitiform as well as some eschariform species, *Australiana bifenestrata* n.sp. favours a " small particle " substrate (Lagaaij 1963: 187). The sea bottom off Gabo Island, Victoria, appears to be an especially suitable environment to judge from the abundant zoaria of *Lunulites*, *Selenaria*, *Conescharellina* as well as the loosely attached eschariform *Lanceopora obliqua* (MacGillivray) and *L. macneilli* (Livingstone), in the *Endeavour* collections of Polyzoa from this area.

It should be noted, however, that the present species is not restricted solely to a firm biotope. The substrate of the type locality (off Bulgo, N.S.W.), for example comprises " mud and abbatoir refuse " (Waite 1899: 22). This tolerance for a soft biotope is doubtless due to the fact that *A. bifenestrata* lives " loosely attached ", anchorage being provided by its chitinous radicles, hence the actual consistency of the substrate is not of the critical importance it is for the encrusting polyzoa.

Australiana bifenestrata* n.sp.

(Text-fig. 1, a-i; plate 1, figs. 1-7)

* with reference to the bifenestrate ovicells

1895 "*? Lunulites angulopora* Tenison-Woods," MacGillivray, p. 46, pl. 8, fig. 1, (not *L. angulopora* Tenison-Woods, 1880, p. 7, pl. 1, fig. 3a-c = *Conescharellina angulopora*).

Holotype: Australian Museum Cat. No. U. 4022; locality, off Bulgo, New South Wales, south-by-east, 6-8½ miles from shore, 59-63 fathoms. *Thetis* Expedition, Station 47, 16.3.1898.

Diagnosis: As for the genus.

Description: *Zoarium* dome-shaped, loosely attached, attaining a maximum diameter of 5.0 mm and a height of 2.3 mm.

Explanation of Text-Figure 1, a-i, (opposite)

Australiana bifenestrata n.gen. n.sp.

Fig. a: Four ordinary zooecia and a fertile zooecium, with a bifenestrate ovicell.

Fig. b: Longitudinal section through a fertile zooecium, showing the oval brood chamber. A kenozooid lies below, communicating with adjacent zooecia by means of basal septula.

Fig. c: Two distal walls with basal septula, one wall swollen by the impingement of the internal ovicell.

Fig. d: Lateral wall; note the multiporous rosette plate.

Fig. e: Ordinary operculum with occlusor muscles attached.

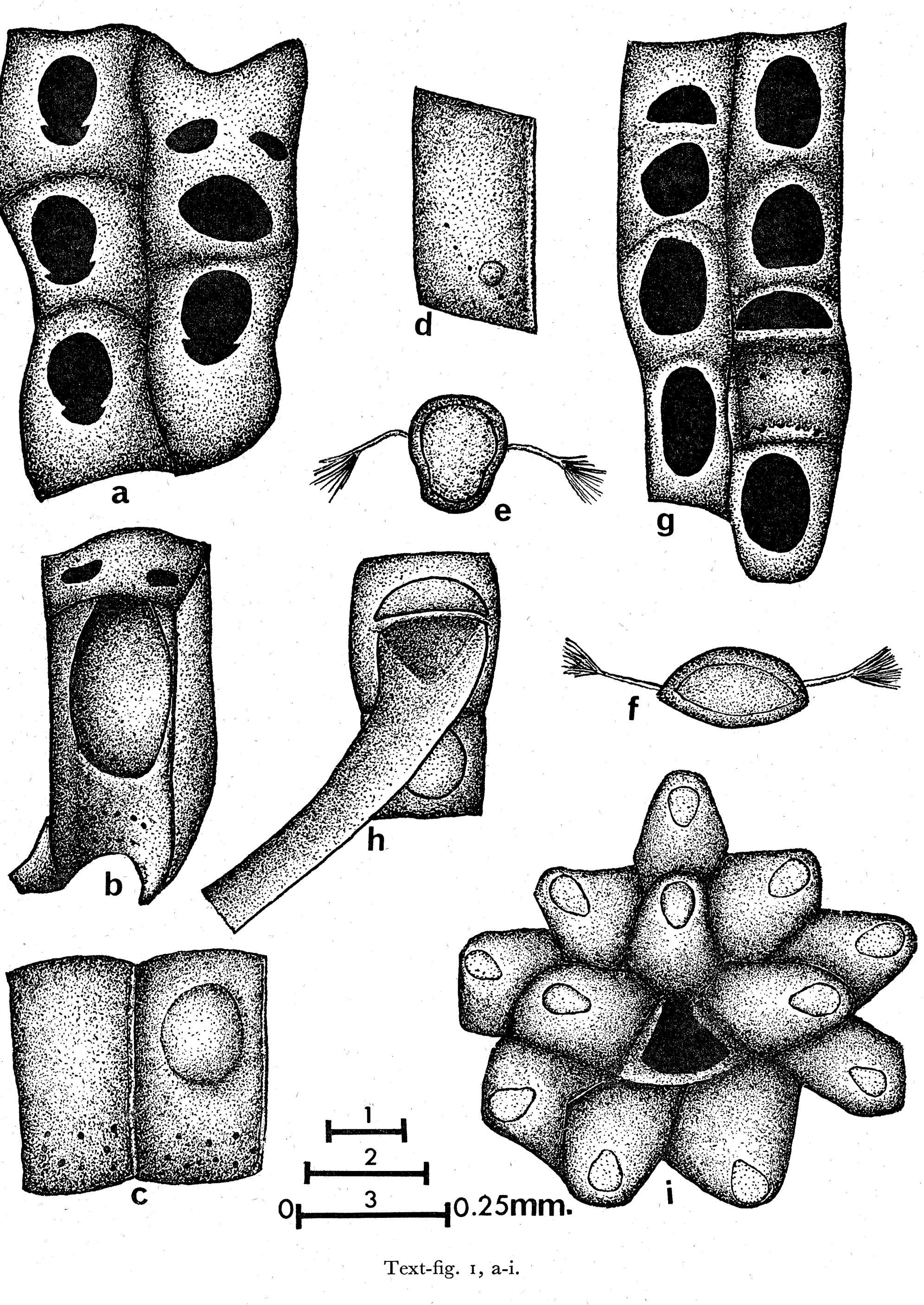
Fig. f: Fertile operculum.

Fig. g: Basal surface to show the foramina. The following explanation reads from the distal to proximal margins. Left row—foramen of kenozooid below the ovicell, followed by foramen of fertile zooecium; then two foramina of ordinary zooecia. Right row—two foramina of ordinary zooecia; foramen of radicular chamber, then a foramen of an ordinary zooecium.

Fig. h: Root chamber with radicle.

Fig. i: Apical view of colony to show the arrangement of early formed zooecia. Note the 3-5 sequence of periancestrula zooecia comprising the 1st and 2nd generations respectively. The proximal four zooecia form part of the third-generation.

Figs. a, b, c, d, g are drawn from calcined material. Figs. a, b, c, d, g, h are drawn to scale 2. Figs. e and f drawn to scale 3. Fig. i drawn to scale 1. All figures are from *Endeavour* material taken off Gabo Island, Victoria.



Text-fig. 1, a-i.

Zooecia quadrate, reaching the basal surface of the colony, radially arranged in uni- or biserial rows, forming regular circlets extending in a vertical direction from the apical ancestrula. Interzooecial furrows broad, not distinct. *Orifice* dimorphic, elongate in ordinary zooecia, anter rounded distally, sides converging posteriorly, constricted at the proximal third by two minute condyles, widening into a shallow poster proximally; transversely elliptical in fertile zooecia, condyles not developed. *Opercula* chitinous, finely pitted, and with a complete marginal sclerite, projecting at each margin as two triangular flanges attached by a pair of long occlusor muscles to the lateral walls. Two divaricator muscles originate from each lateral wall passing obliquely towards the frontal surface and inserting into the basal sclerite of the operculum. *Peristome* slightly raised as a salient rim around the distal margin of the orifice, oral spines wanting. *Frontal surface* thin, porcellanous, convex, reduced, traversed at irregular intervals by concentric growth laminae, often bearing scattered pustules. *Ovicells* entozooecial, usually occurring close to the margins of the colony. Outer wall of the ectooecium perforated by two prominent fenestrae covered by chitinous membranes. Inner wall slightly calcified, immersed in the distal region of the zooecial cavity, impinging upon the distal wall to form an oval brood chamber, extending two-thirds the length of the zoarium, delineating a small chamber beneath. *Basal surface* deeply concave, particularly in adult zoaria, with prominent circular or longitudinally elliptical foramina, each foramen covered by a chitinous membrane and surrounded by a low ridge. *Radicular chambers* scattered among the basal foramina, enlarged, quadrate, with a horizontal plate perforated by several small septula, and a semi-elliptical foramen distally; giving rise to long strap-like radicles or capsular chambers. *Zooecial walls* long and narrow, each provided with a zig-zag row of 8-10 septula, or one or two rosette plates within the basal margin. *Ancestrula* membraniporine, frontal wall incomplete, the operculum not completely differentiated from the frontal membrane; generating three zooecia distally. *Avicularia* not developed.

Measurements: The measurements used, and the terminology employed here, are defined in Brown (1952: 33-34).

	Lz = 0.30 — 0.38 mm.	lz = 0.25 — 0.30 mm.
	hr = 0.15 — 0.17 mm.	lr = 0.10 — 0.12 mm.
Ovicelled zooecia	hr = 0.10 mm.	lr = 0.17 mm.

Distribution: (a) Fossil: Muddy Creek (lower beds), (Balcombian, Middle Miocene). National Museum Collection, Victoria.

(b) Recent: Off Gabo Island, Victoria; Bass Strait; Port Jackson, N.S.W.; off the coast of New South Wales.

Other material examined: (All material listed below has paratype status. All catalogue numbers are from the Australian Museum collections).

I. South of Gabo Island, Victoria. 100-200 fathoms. E.6341, E.6342, E.6427, E.6483. Additional material from this locality has been sorted from bulk polyzoan collections, retrieved by the Commonwealth Fisheries Investigation ship *Endeavour* 12.9.1914 (spirit preserved material U. 4021).

II. 20 miles East of King Island, Bass Strait. E.6362. Collected by C.F.I.S. *Endeavour* 21.6.1909.

III. *Thetis* Expedition, Station 47. Off Bulgo, N.S.W. U.1311.

IV. E.6802. Off Twofold Bay, N.S.W. 30-50 fathoms. C.F.I.S. *Endeavour* 30.9.1914.

V. 2½-4 miles off Botany, N.S.W. 33-56 fathoms. U.985, U.997.

VI. Port Jackson, N.S.W. U.1004. (Comprises a single fragmented specimen, presented by Dr. Porter).

VII. U.1282. *Thetis* Expedition, station not known.

Remarks: The orientation of the polypide (desiccated, owing to the dry preservation of the material) in the tubular exoskeleton of this species conforms with Harmer's (1957: text-fig. 68B) interpretation of polypide orientation within the conescharellinid zooecium. In many instances the thin membranous compensatrix is still retained, forming a large spacious sac that extends almost the full length of the zooecium. Vestiges of the powerful retractor muscles are attached near the base of the proximal walls.

Though the function of the basal foramina is not known, they would appear to be comparable to the cancelli of some Conescharellinidae. The foramina in the present species, however, are not aviculiferous; they have a variety of shapes (text-fig. 1, g), ranging from circular in wide zooecia to elliptical in narrower individuals. Canu and Bassler (1928: 153, 154) interpreted comparable structures in *Mamillopora* as " hydrostatic chambers " in accordance with their hypothesis of a pelagic habitat for that genus. As with the conescharellinid cancelli, I interpret these structures as heterozooecia, or more precisely, kenozooecia, in so far as they lack a polypide or musculature. The chamber beneath the ovicell would also seem to qualify as a kenozooecium, communication with adjacent zooecia being provided by basal septula.

Interspersed among the basal foramina are specialized radicular chambers (approximately eight occurring in a mature colony), which give rise to the long strap-like radicles (text-fig. 1, h). The radicular chambers are recognized by their quadrate outline (plate 1, fig. 6), and considerably larger size compared to the foramina. A salient ridge separates the perforated radicular plate from the transversely semi-elliptical foramen distally. This foramen appears to be comparable to the crescentic slit of the lunoecium in the Conescharellinidae. Unlike lunoecia, however, the present chambers are restricted to the basal area. Their long radicles are inserted into the radicular plate (text-fig. 1, h) and intertwine as an anchoring filament attached to foraminifera or fragmentary polyzoan colonies. The large globular capsules observed on some chambers are probably developing tubes similar to those Silén (1947: 37, 46) recorded in *Conescharellina striata* Silén and *C. japonica* Silén.

The first or primary radicular chamber in a zoarium is always developed on the ancestrula. It differs from the later-formed chambers in that it projects off the basal surface, and has a somewhat rounded outline proximally, rather like the spatulate rostrum of an avicularium. In one fairly young colony, the remains of a chitinous capsule with a fine radicular filament were seen to adhere to the primary chamber. The ancestrula was at first apparently attached directly to a small grain or shell, by means of the capsule, the filamentous thread forming after fixation perhaps when the ancestrula became raised above the substrate.

The sequence of ancestrular budding in this species closely follows that observed by Marcus (1926), and summarized by Harmer (1931: 122) for *Electra pilosa* (Linnaeus) and frequently encountered in other encrusting cheilostomes (Waters 1924: 594). The primary zooecium gives rise to three distal zooecia (text-fig. 1, i) which constitute the first generation. These give rise to the second generation of five zooecia. The developing zoarium is then fan-shaped, but a third generation of thirteen zooecia completely encloses the ancestrula and its early derivatives to form the circular shape of the colony, which then comprises twenty-two zooecia. The zooecia situated proximally to the ancestrula often exhibit some irregularity, and may account for the slight variation in number of zooecia within the third generation between colonies, e.g., 15 in one specimen (plate 1, fig. 4), due to the interpolation of additional zooecia. On attaining the circular form, new zooecia are budded off from the periphery, thereby raising the apical portion of the colony off the substrate.

The shape of the zoarium in *Australiana bifenestrata*, as in other lunulitiform species, varies significantly according to the degree of maturity. Young zoaria are disc-like structures (plate 1, figs. 2, 3), their basal surfaces being only slightly depressed inwards (fig. 6). The mature colony is typified by its broadly conical shape (plate 1, fig. 1), the central area of the basal surface sloping deeply inwards from the peripheral zooecia (fig. 7).

The structure of the zoarium in *A. bifenestrata* is essentially adapted to a loosely attached mode of life on the sea bottom, anchored by means of the basal radicles. A similar method of attachment is exhibited by *Actisecos pulcher* Harmer (1957: 859).

Zoarial shape in *Australiana bifenestrata* is superficially close to some conescharellinid species, but the Australianidae differ from the Conescharellinidae in several fundamental aspects. These include:—

(a) structure of the zoarium; unilaminar in *Australiana*, with a deeply concave basal surface, whereas in *Conescharellina* the zoarium consists of a solid cone, the interior is filled with a mass of old cancelli, extending to the central area of its base.

(b) orientation of the orifice; this is directed away from the ancestrula in Australianidae, but directed *towards* the ancestrula in the Conescharellinidae, contrary to the arrangement in all other Ascophora.

(c) avicularia; wanting in *Australiana* but proliferated over both the frontal and basal surfaces of the conescharellinid colony.

(d) ovicells; immersed and bifenestrate in the Australianidae (text-fig. 1, b) whereas the brood chambers are hyperstomial and imperforate in the Conescharellinidae.

(e) rootlet chambers; these are confined to the basal surface in *Australiana* while the lunoecia are developed on the frontal surface of the conescharellinid zoarium. The manner in which the latter is oriented with reference to the sea bottom remains in doubt.

Certain features of the Mamilloporidae are close to those of the Australianidae. In *Mamillopora cupula* Smitt, for example, the zoarium is cupuliform, with a concave basal surface. The orifices are also broadly similar, those of ordinary and fertile zooecia being dimorphic, the former with opercular condyles as in *A. bifenestrata*. Nevertheless, such resemblances are outweighed by marked differences, especially the frontal and basal avicularia in *Anoteropora*, a typical member of the Mamilloporidae. Although the ovicells in *Mamillopora cupula* Smitt are immersed (Canu and Bassler 1928: plate 26, fig. 9) they are large, rounded, imperforate chambers as in *Anoteropora magnicapitata* Canu and Bassler. Another difference is the zoarial habit, which is free in both those genera, radicular chambers being wanting.

Some resemblances between the Australianidae and the Actisecidae of Harmer (1957) are evident. The basal surface of *Actisecos pulcher* Harmer has numerous foramina which resemble those of *Australiana bifenestrata*. Rootlet pores with fine filaments " to which minute Foraminifera are attached " (Harmer 1957: 859) also occur on the basal surface of Harmer's species. The long tubular peristomes and the globular, finely perforated globular ovicells of the Actisecidae, however, preclude any relationship between the two families.

Australiana bifenestrata is unquestionably the species MacGillivray (1895: 46) doubtfully attributed to *Lunulites angulopora* Tenison-Woods (= *Conescharellina angulopora*). MacGillivray misoriented his material, which is of a fragmentary nature, interpreting the zooecia as basal avicularia, and the radicular chambers as zooecia. The locality of his material was not given. Waters (1921: 423) commented on MacGillivray's specimens thus: " MacGillivray gives this with a ? as fossil, but it really seems as if both his description and figure have got into the wrong place, at least I cannot understand them ".

Mr. Edmund Gill, Curator of Fossils in the National Museum, Victoria, has examined the specimen in question and he states (*in litt*): " it is labelled 'Muddy Creek'. Presumably it comes from the Miocene 'lower beds' as Polyzoa are rare in the upper beds, and it would be so stated if the specimen came from these ". Gill also confirms, from foraminiferal samples he collected in 1961, that these 'Muddy Creek' beds are of Balcombian, Middle Miocene, age.

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EXPLANATION OF PLATE 1

Fig. 1: Mature zoarium. Paratype x 26. Lateral view. A peripheral ovicelled zooecium is indicated. A.M. Cat. No. U.1311. *Thetis* Station 47.

Fig. 2: Juvenile zoarium. Paratype x 26. Lateral view. Sorted from bulk material collected by the *Endeavour* Expedition, off Gabo Island, Victoria.

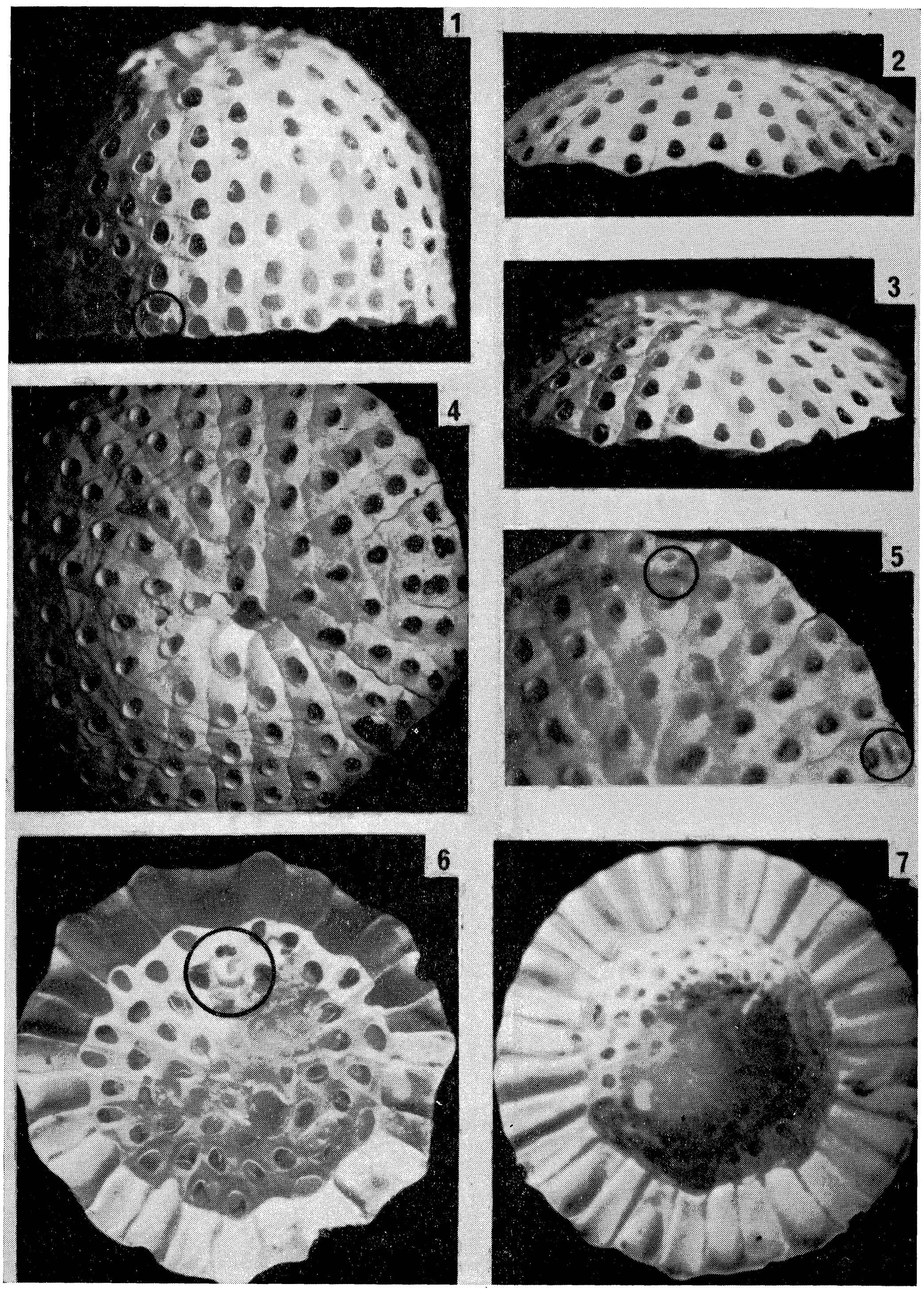
Fig. 3: Same zoarium as fig. 2, but from a distal-lateral aspect.

Fig. 4: Apical view of zoarium at an intermediate growth stage x 26. *Thetis* Station 47.

Fig. 5: View of the growing margin. Holotype x 28. Ovicelled zooecia encircled. A.M. Cat. No. U.4022. *Thetis* Station 47.

Fig. 6: Basal aspect of an immature zoarium. x 26. The central area is only slightly depressed. Note the foramina. A radicular chamber is indicated. The basal septula on the distal walls of the peripheral zooecia are visible in one or two instances. *Thetis* Station 47.

Fig. 7: Basal surface of mature zooecia. x 26. The medial concavity has become greatly immersed. Focused to show the foramina. *Thetis* Station 47.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