

Massinium, a new genus in the family Phyllophoridae (Echinodermata : Holothuroidea : Dendrochirotida) with description of a new south-west Indian Ocean species *M. maculosum*

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ABSTRACT. Several specimens of a phylloporid holothuroid collected from off the KwaZulu-Natal coast, Republic of South Africa, represent a species new to science. In the structure of the calcareous ring and the absence of tables from the body wall it resembles *Neothyonidium magnum* and *N. arthroprocessum*. In all three species the posterior processes of the calcareous ring are distally joined. Hence, they do not correspond to the diagnosis of *Neothyonidium* as defined by its type species, *N. hawaiiense*, and are now assembled in the new genus *Massinium*. The new species is described as *Massinium maculosum*. The three species are keyed and a distribution map is provided.

KEY WORDS : Holothuroidea, Phyllophoridae, *Massinium* gen. nov., *Massinium maculosum* sp. nov., taxonomy

INTRODUCTION

The genus *Neothyonidium* was erected by DEICHMANN (1938) for phylloporids with 20 tentacles positioned in two well-defined circles and a calcareous ring with long posterior prolongations, formerly classified in *Thyonidium* Düben & Koren, 1844 and *Phyllophorus* Grube, 1840. Unfortunately, DEICHMANN (1938) refrained from giving a complete diagnosis of the genus. Instead, the character of the genus was covered by only two phrases in a key to the Phyllophoridae of the eastern Pacific ['Tentacles arranged in an external circle of five pairs of large tentacles and an inner circle of much smaller tentacles, five deeply divided or five pairs' and 'Calcareous ring tall, tubular with long deeply divided posterior prolongations and long narrow interradians' (DEICHMANN 1938 : 379)]. Only a single species was included by DEICHMANN (1938) : *N. hawaiiense* (Fisher, 1907), the designated type species by monotypy.

HEDING & PANNING (1954) followed DEICHMANN (1938) in recognizing the systematic value of the calcareous ring in the classification of phylloporids. These authors elaborated DEICHMANN's (1938) diagnosis of the genus *Neothyonidium* by adding two-pillared tables as an additional diagnostic character. By doing so, HEDING & PANNING (1954) recognised *Neothyonidium hawaiiense* (Fisher, 1907) as type species of the genus, to which they also assigned *Phyllophorus inflatus* Sluiter, 1901; *P. dear-matus* Dendy & Hindle, 1907; *P. intermedius* Koehler & Vaney, 1908; *P. vultur* Sluiter, 1914; *P. minutus* Ohshima, 1915; *Thyonidium magnum* (Ludwig, 1882) and, with doubt, *P. parvus* (Ludwig, 1881). However, they downgraded *T. alexandri* Fisher, 1907 as a synonym of *N.*

hawaiiense. Unfortunately, the descriptions given by HEDING & PANNING (1954) are in too many cases largely dependent on the accounts of earlier writers. Since then, PAWSON (1965) described *N. armatum* from New Zealand; CHERBONNIER (1988) *N. dissimilis* from Madagascar; ROWE (1989) *N. parvipedum* from north-eastern Tasmania; THANDAR (1989) *N. arthroprocessum* from South Africa and LIAO & PAWSON (2001) *N. spiniferum* from China. In addition, ROWE (in ROWE & GATES 1995) resurrected *T. alexandri* from the synonymy of *N. hawaiiense* as a valid species. A critical review of the genus *Neothyonidium* is beyond the scope of this paper, but it is safe to state that several species assigned to it may not belong to this genus and others may be conspecifics of some well-known species.

THANDAR (1989) emended the diagnosis of the genus *Neothyonidium* to accommodate the southern-African *N. arthroprocessum*, characterised by its peculiar U-shaped deposits in the body wall. At that time he justified this inclusion by stating that the rods of *N. arthroprocessum* may be table derivatives. Later on, additional records of *N. arthroprocessum* revealed that these deposits are derived from minute buttons rather than from tables (THANDAR 1996). On the basis of a new species of a phylloporid holothuroid – here described from the east coast of South Africa – characterised by possessing only rosette-shaped granules and “pseudobuttons” in the body wall, it became clear that the emended diagnosis of *Neothyonidium* (THANDAR 1989; see also 1996) could not be upheld. In fact, both *N. arthroprocessum* and the new species belong to another natural group without body wall tables. Moreover, a careful study of the calcareous ring, internal morphology and ossicle assemblage revealed that

these two species, together with the tropical west Pacific *N. magnum* (Ludwig, 1882), constitute a well-defined lineage, not corresponding with the diagnosis of *Neothyonidium* as defined by its type species, excellently described by FISHER (1907). This lineage thus constitutes a new genus, here diagnosed as *Massinium*, characterised by the following synapomorphies: a complex calcareous ring with the posterior processes distally linked to each other; four polian vesicles and a body wall that is always devoid of tables. Moreover, in *N. arthroprocessum* and in the new species, the respiratory trees are extremely complex, with a richly-branched subsidiary trunk to each tree. Unfortunately, since we have only anterior fragments of *N. magnum* at our disposal, the detailed structure of its respiratory trees remains poorly described. The new species is here described as *M. maculosum*.

MATERIAL AND METHODS

During recent surveys of the echinoderm fauna of KwaZulu-Natal (Republic of South Africa), several specimens belonging to a species new to science were found. Collecting was done by SCUBA-diving to depths of a maximum of 44 m, but specimens belonging to the new species were found between 17 and 20 m. Specimens were anaesthetized in 5% magnesium chloride for 4 hours, transferred to 100% buffered alcohol for 24 hours, and then to 70% buffered alcohol for permanent storage. They were studied according to conventional methods outlined by workers such as FISHER (1907), DEICHMANN (1948), ROWE & DOTY (1977) and MASSIN (1999), amongst others. Ossicles were removed in household bleach, washed in two changes of distilled water and illustrated with the camera lucida. For scanning electron microscopy, the ossicles were passed through two changes of absolute alcohol and transferred with a fine pipette together with a little alcohol onto a specimen stub to which they normally stick once the alcohol evaporates. They were then sputter-coated with gold for 5 minutes at 30–40 mA and photographed with a Philips SEM 500.

Museum acronyms

MRAC	Muséum Royal de l'Afrique centrale, Tervuren, Belgium
NHM	Natural History Museum, London, United Kingdom
SAM	South African Museum, Cape Town, Republic of South Africa
IRSNB	Institut royal des Sciences naturelles de Belgique, Brussels, Belgium

RESULTS

Family PHYLLOPHORIDAE Oestergren, 1907 Subfamily Semperiellinae Heding & Panning, 1954

Genus *Massinium* gen. nov.

Diagnosis. Dendrochirotid holothuroids with twenty tentacles arranged in two circles of 10 + 10; anus encircled by calcareous teeth; calcareous ring complex, elongated, tubular, with both radial and interradial plates fragmented

into a mosaic of small pieces, prolonged posteriorly with posterior processes distally-linked to adjoining processes of neighbouring plates forming a ribbon-like structure beneath the water-vascular ring; Polian vesicles large, four; ossicles of body wall comprise rods or rosette-shaped deposits, tables always absent; introvert with two-pillared tables and numerous rosettes and/or rods.

Type species *Massinium maculosum* sp. nov.

Etymology. This genus is named after Dr. Claude Massin of the Royal Belgian Institute of Natural Sciences, Section Malacology, in recognition of his excellent contributions to the taxonomy of holothuroids. The gender is neuter.

Key to the genus *Massinium*

1	Body wall ossicles comprise solely rods of variable form, never rosette-like, with minute, often occluded perforations at ends; introvert with two-pillared tables, rods and rosette-shaped bodies <i>M. arthroprocessum</i> (Thandar, 1989)
1'	Body wall ossicles comprise only rosette-like bodies 2
2	Outer tentacles devoid of ossicles; introvert with tables and rosettes; body colour off-white to grey, mottled liberally with dark brown; tentacles with white shaft dashed with brown, tentacle tips spotted with yellow and white <i>M. maculosum</i> sp. nov.
2'	Ossicles of outer ring of tentacles include rosettes; introvert with tables only; body colour yellow to brown, tentacles darker brown <i>M. magnum</i> (Ludwig, 1882)

Massinium maculosum sp. nov.

(Figs 1–5)

Diagnosis. Medium-sized, U-shaped phylloporid with bloated mid-body and relatively short anterior and posterior ends. Anus surrounded by teeth and papillae, variously developed. Ossicles of body wall short, thick, flat, oval to round rosette-shaped rods and "pseudobuttons", often with minute perforations. Introvert ossicles include tables and rosettes. Tentacles of outer ring without ossicles, tentacles of inner ring with rods and rosettes.

Etymology. The name *maculosum* refers to the conspicuous colouration of the whitish shaft of the tentacles, mottled with dark brown and yellow.

Name bearing type. Holotype SAM A27882 (specimen with detached calcareous ring)

Type locality. Mabibi, KwaZulu-Natal Republic of South Africa (Fig. 5).

Material examined. Holotype (specimen with detached calcareous ring), RSAKZN/01122, SAM A27882, 13.ii.2001, 20 m, SCUBA-diving, Y. Samyn. Paratype 1 (calcareous ring only), RSAKZN/01121(a), SAM A27883, other data same as holotype. Paratype 2 (calcareous ring only), RSAKZN/99217, SAM A27884, 17.viii.1999, Sodwana Bay (2-Mile Reef), 14 m, SCUBA-diving, Y. Samyn & P. Timm. Paratype 3 (specimen with calcareous ring attached), RSAKZN/01121(b), MRAC 1701, other data same as holotype. Paratype 4 (calcareous ring only), RSAKZN/99139, MRAC 1702, 12.viii.1999, Sodwana Bay (9-Mile Reef), 17 m, SCUBA-diving, Y. Samyn. Paratype 5 (specimen devoid of calcareous ring), RSAKZN/01124, NHM 2003.570, other data same as holotype. Paratype 6 (calcareous ring



Fig. 1. – *Massinium maculosum* sp. nov. as photographed after removal from the substrate at Sodwana Bay, 2-Mile Reef. (Picture by R. Anderson).

only), RSAKZN/01123, NHM 2003.571, other data same as holotype.

Description. Holotype (Fig. 2A). Specimen entire, well-preserved but with ventral surface slightly ruptured and calcareous ring detached. Body form cylindrical, somewhat U-shaped, with the mid-body bloated and with narrower anterior and posterior ends. Length along ventral surface 150 mm, height of mid-body 41 mm, anterior and posterior ends 30 mm and 40 mm in length and 11 mm and 17 mm in diameter respectively. Colour light yellow to off-white, mottled with dark brown, more pronounced at the ends. Body wall thin and smooth in bloated part; thick and wrinkled proximally and distally. Body wall podia papilliform, scattered, more numerous proximally and distally, with dark narrow rings encircling reduced suckers. Tentacles 20, in two circles of 10+10, well branched, outer tentacles with whitish stalks spotted with dark brown, branches black proximally and white at tips, inner tentacles much shorter, also with whitish stalks and uniformly black branches. Largest tentacle about 30 mm long. Anus encircled by five groups of papillae, with 4-7 papillae per group. Single papilla of one group heavily calcified, appearing as a tooth covering most of the anal opening; another tooth underdeveloped, not covering anus.

Calcareous ring (see that of paratype 4 : Fig. 4H) 42 mm in length, distinctly tubular with radial and interradial plates fused for three-quarters of their length, both radial and interradial plates broken into a mosaic; radial plates anteriorly bifid, with depressions for attachment of retractor muscles; anterior of interradial plates pointed. Posterior processes of radial plates short, broad, bifurcating and uniting with adjacent processes of neighbouring plates to form a ribbon-like structure encircled by the water vascular ring. Polian vesicles four (one per interradius except the mid-dorsal), up to 25 mm long. Stone canal single, slightly shorter than polian vesicles, free, terminating in an ovoid, well-calcified madreporic body. Gonad (testis) in two tufts,

well-developed, white, branched, mostly dichotomously. Respiratory trees remarkably well-developed, reaching anterior end of body, with heavily branched subsidiary trunks extending both to the level of the calcareous ring and beneath the cloaca; exact origin and ramifications of the subsidiary branches could not be determined without further damage to the holotype.

Ossicles of the dorsal and ventral body wall similar – comprising small, thick, flat, elongated to roundish bodies in the form of rods, rosettes and “pseudobuttons”, the latter evidently derived from rosettes (Fig. 2B, C, 3A-C). Elongate ventral deposits 27-40 μm long (mean 34.5 μm) and 13-24 μm wide (mean 19.5 μm). Roundish ventral deposits 24-42 μm long (mean 28.6 μm) and 18-41 μm wide (mean 25.8 μm). Elongate dorsal deposits 27-45 μm long (mean 35 μm) and 14-27 μm broad (mean 17.8 μm). Roundish dorsal deposits fewer, 23-25 μm long (mean 24.7 μm) and 19-23 μm wide (mean 22 μm). Rosettes of dorsal body wall more abundant and more complex. Some ossicles large and bone-shaped, dorsally 26-51 μm long (mean 39 μm) and 6-14 μm wide (mean 8.3 μm); ventrally 37-49 μm long (mean 45 μm) and 6-11 μm wide (mean 8.6 μm). “Pseudobuttons” oval, irregular, multilocular, more dominant ventrally, holes minute, larger in ventral body wall (Fig. 3D, E). Ventral podial deposits in the form of tables, plates, rods and rosettes similar to those of body wall (Fig. 2F). Tables with smooth ovoid discs, 50-75 μm long, perforated by four large central holes and a variable number of irregularly-positioned peripheral ones. Spires of moderate height, comprising two pillars united by a single cross bar or cross bar absent, pillars diverging distally to terminate in two spiny tips. Rods straight, smooth, elongate, with terminal perforations and/or processes. Some rods irregular with medial processes or formed into plate-like deposits with several perforations in the middle and/or the tips. End-plates present with numerous holes, not varying in size peripherally (Fig. 4G). Dorsal podia without tables; other deposits similar to those of ventral podia. Introvert podia with tables and rods (Fig. 4B). Anal podia with tables and rosettes (Fig. 4E, F). Large tentacles (from outer ring) without deposits. Small tentacles (from inner ring) comprise tables at their roots, similar to those of introvert, rosettes and slender rods at their tips; rods straight or slightly curved with wrinkled apices (Fig. 4C, D). Introvert deposits comprise tables and rosettes (Figs 2D, E; 3F, G). Tables with large subcircular to oval discs with smooth margins and perforated by four large central holes and usually a single circle of smaller holes, the latter 3-12 in number. Table discs 69-135 μm long (mean 100 μm) and 55-104 μm wide (mean 79 μm); spire 30-53 μm high (mean 45 μm), with a single cross bar and 2-6 terminal teeth. Occasionally pillars reduced to knobs on surface of disc. Rosettes similar to those of body wall, 23-53 μm long (mean 37 μm).

Paratype 1. Represented by calcareous ring and tentacles only. Introvert bordered by numerous podia arranged in rows in the radii. Tentacles as in holotype, longest 24 mm. Polian vesicles four, of unequal length, longest 29 mm. Stone canal free, slightly twisted proximally. Madreporite poorly calcified, slightly wider than stone canal.

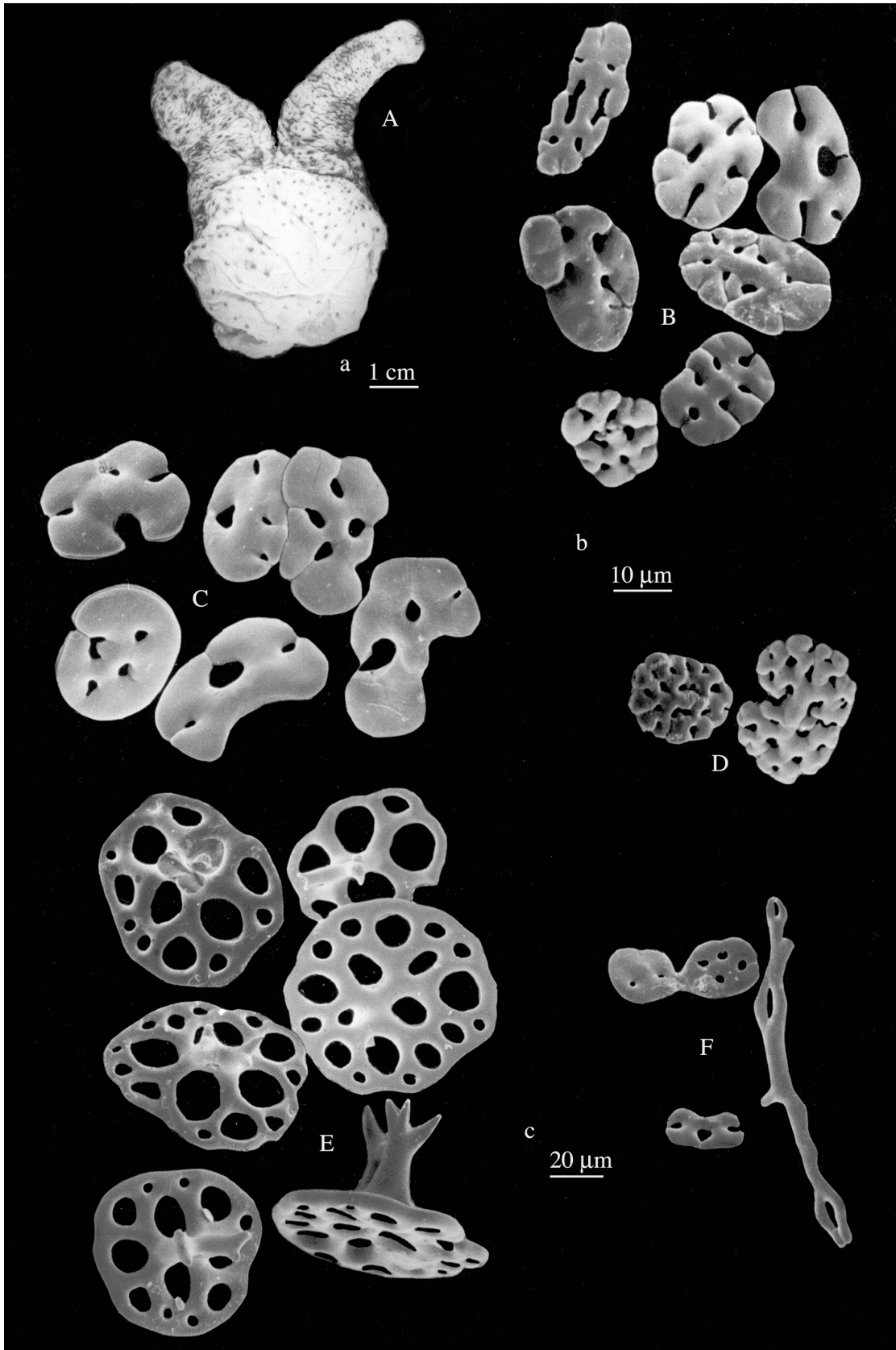


Fig. 2. – *Massinium maculosum* sp. nov. A, entire; B, rosette-shaped ossicles from mid-dorsal body wall; C, rosette-shaped ossicles from mid-ventral body wall; D, rosettes from the introvert; E, tables from the introvert; F, podial deposits.

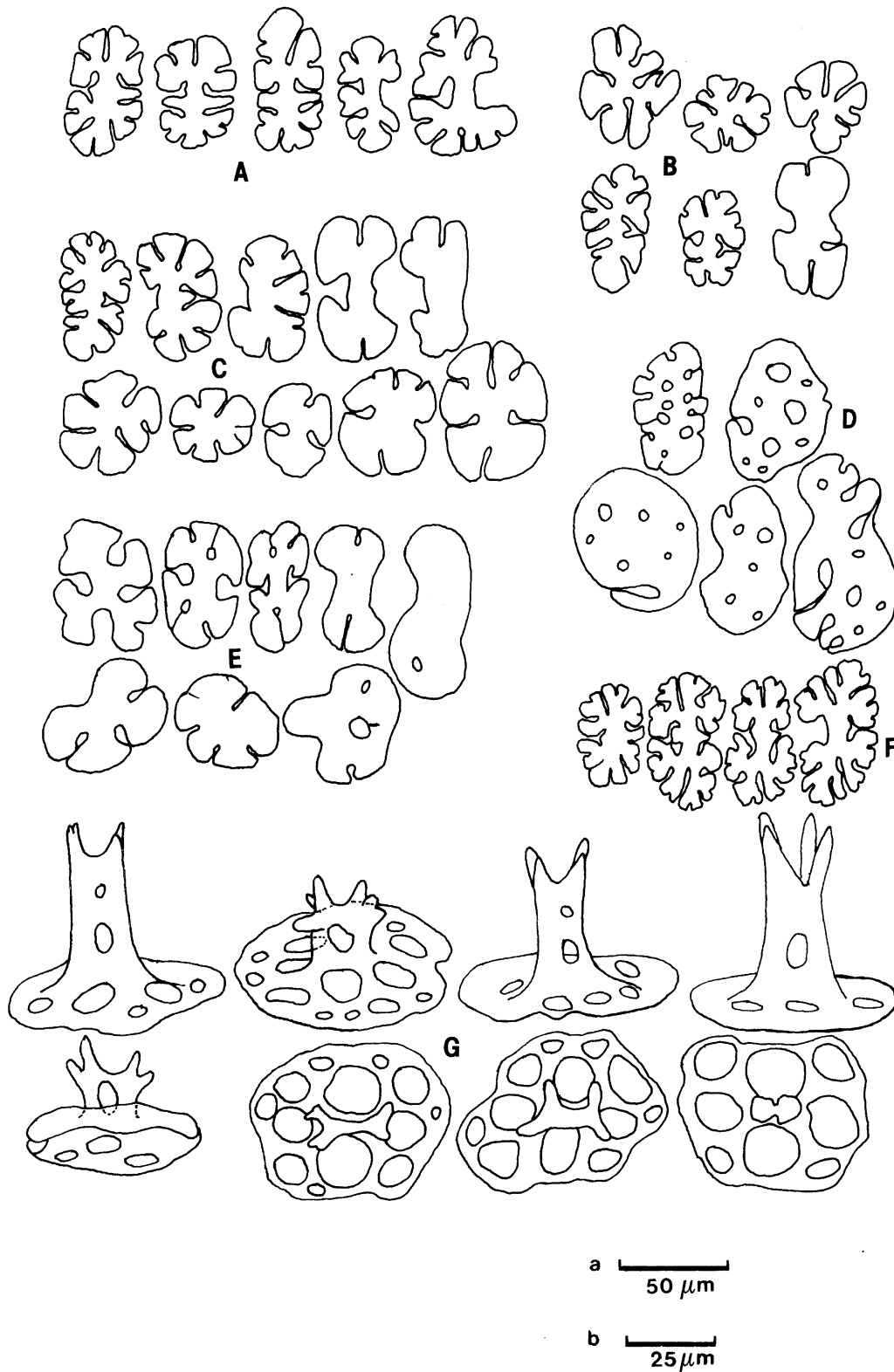


Fig. 3. – *Massinium maculosum* sp. nov. Ossicles. A, rosette-shaped deposits from antero-dorsal body wall; B, rosette shaped plates from antero-ventral body wall; C, rosette-shaped deposits from mid-dorsal body wall; D, pseudobuttons from dorsal body wall; E, pseudobuttons from ventral body wall; F, Rosettes from introvert; G, tables from introvert. (A-F - scale b; G - scale a)

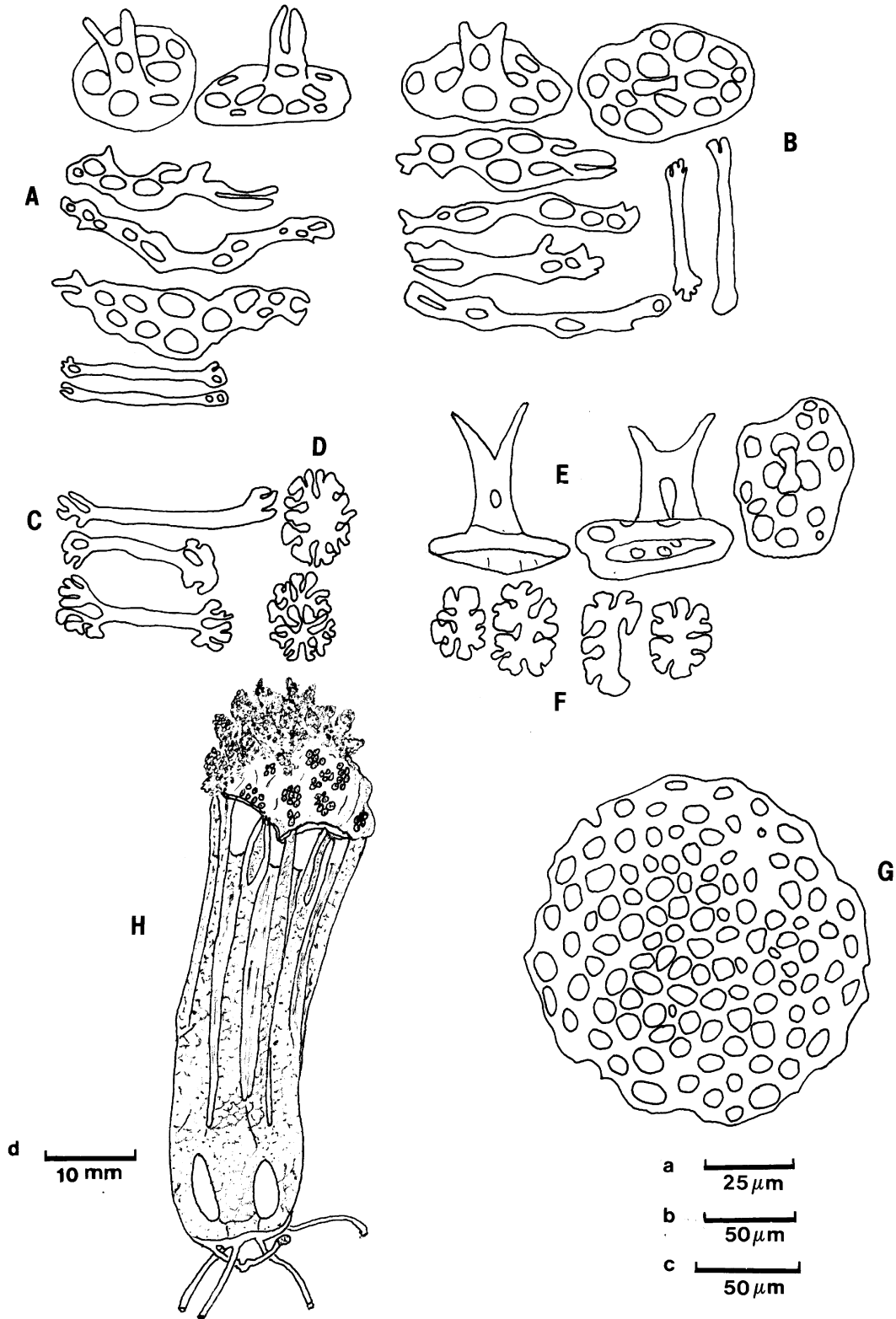


Fig. 4. – *Massinium maculosum* sp. nov. Calcareous ring and ossicles. A, introvert deposits; B, introvert podial deposits; C, rods of tentacle of inner ring; D, rosettes of tentacle of inner ring; E, tables from anal podia; F, rosettes from anal region; G, end-plate from pedicel; H, calcareous ring of paratype 4 showing tentacles, four polian vesicles and a single stone canal. (A, B & E – scale c; C, D & F – scale a; G – scale b & H – scale d)

Paratype 2. Represented by calcareous ring, tentacles and anterior fragment of body wall. Polian vesicles four, two branched proximally and one terminally, giving the impression that there are more than four polian vesicles. Stone canal typical but very much coiled proximally. Madreporite as in holotype. Body wall ossicles typical. Ossicles absent from large tentacles. Small tentacles include rods, rosettes and tables, table discs subcircular to oval with four large central perforations and numerous smaller perforations, up to 20, in one or two circles. Spire high, consisting of two pillars and one or two cross-bars, terminating in four teeth. Rosettes similar to those of body wall. Rods straight or curved, with one to two terminal perforations.

Paratype 3. Same form and colouration as holotype, with eviscerated calcareous ring still attached to main body. Length along ventral surface 130 mm, height of mid-body 32 mm, anterior and posterior ends 20 mm and 9 mm respectively. Anus encircled by four calcareous teeth of which one is best developed, each bordered by three to four papillae. Calcareous ring as in holotype, fragmented. Polian vesicles four, elongate, up to 37 mm, tubular. Stone canal free, slightly twisted proximally, madreporite hardly distinguishable from stone canal. Tentacles as in holotype, number difficult to determine as inner circle is obscured within oral cavity. Length of larger tentacles variable, up to 20 mm. Ossicles of ventral and dorsal body wall similar to holotype, 33-59 μm long (mean 46 μm); introvert tables with discs 104-137 μm long (mean 114 μm).

Paratype 4 (Fig. 4H). Represented by the calcareous ring and tentacles as illustrated. Calcareous ring 50 mm in length, best preserved of all type material.

Paratype 5. Specimen small without calcareous ring. Colour as in holotype but dark speckling more pronounced, obscuring the lighter areas of the skin. Length along ventral surface 75 mm, height of mid-body 21 mm, anterior and posterior ends 15 mm and 9 mm respectively. Five equally-sized anal teeth, each bordered by four papillae. Body wall ossicles similar to holotype, 31-60 μm long (mean 40 μm).

Paratype 6. Represented only by calcareous ring and a fragmented part of the body wall. Four polian vesicles, single free stone canal, proximally coiled. Madreporite ovoid, slightly wider than stone canal.

Ecology. This species lives buried deeply in sand, under boulders and coral debris exposing its tentacle crown only when feeding. Upon slightest disturbance, even shading, the tentacle crown and the introvert are swiftly retracted into the body leaving no trace of the animal. Individuals were observed to be actively feeding during daytime (recorded observations : 11h00-13h45; no observations were made at night). The species appears to be more common at Mabibi where, during 108 dive-minutes, six individuals were spotted whereas at Sodwana, only two individuals were spotted during the same period of time at the 9-Mile Reef and just one at the 2-Mile Reef, in more than nine hours of underwater observations. Depth range 14-21 meters.

Geographical distribution. For now only known from northern KwaZulu-Natal (Republic of South Africa) (Fig.5).

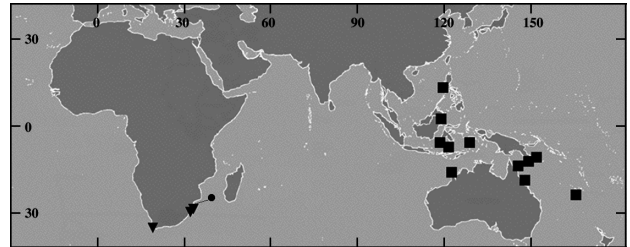


Fig. 5. – Distribution of the currently known *Massinium* spp. : *Massinium arthroprocessum* (Thandar, 1989) is represented by triangles; *M. maculosum* sp. nov. by a circle; *M. magnum* (Ludwig, 1882) by squares.

DISCUSSION

Massinium maculosum is very similar to *Massinium magnum* (Ludwig, 1882), differing in colouration of the tentacles, the absence of ossicles from the tentacles of the outer ring and the form of the body wall deposits. The original description of *M. magnum* was based only on the introvert and the calcareous ring. Only SLUITER (1901), DOMANTAY (1933) and CHERBONNIER (1980) claim to have studied complete specimens of this species. However, CHERBONNIER (1980), who also examined LUDWIG'S (1882) type, is of the opinion that both Sluiter's and Domantay's specimens may not be the true *M. magnum* as there are significant differences in the form of the introvert tables – those of the holotype are according to him 'absolument identiques' [sic] to his specimens in having multilocular discs with one or more series of peripheral holes in contrast to Sluiter's and Domantay's specimens, which have fewer peripheral perforations, restricted in an incomplete or a single series. SLUITER (1901) unfortunately failed to describe the colour of his specimens; DOMANTAY (1933), on the other hand, described the colouration of his specimens accurately. The latter author noted that the tentacles are deep chocolate brown in life and almost black in contracted condition; the introvert is brown and the body wall is almost white. We have examined the introvert in specimens of *M. magnum* described by MASSIN (1999) from Sulawesi (Indonesia) and also in two undescribed specimens collected by Massin from Papua New Guinea. As stated by MASSIN (1999) the introvert of his Sulawesi specimens contains only tables. We here corroborate MASSIN'S (1999) observations and further state that this is also true for his Papua specimens. However, the introvert tables of the Sulawesi specimen have tall spires and few peripheral holes, many of which alternate with the large central holes; whereas those of the Papua specimens have moderate to low spires and more peripheral holes. It is therefore certain that *M. magnum* is either a highly variable species or a species-complex. This is corroborated by colour illustrations of *M. magnum* given by FÉRAL & CHERBONNIER (1986) from New Caledonia, GOSLINER *et al.* (1996) from Papua New Guinea and MASSIN (1999) from Sulawesi. Hence a redescription of *M. magnum*,

based on all the available material, is urgent and will be the subject of our next investigation.

In his revision of the southern African phylloporids, THANDAR (1990) listed only *M. arthroprocessum* in the subfamily Semperiellinae. The new species now increases to two the number of species in this subfamily occurring in southern Africa.

Massinium is distributed throughout the tropical and subtropical Indo-West Pacific Ocean: *M. magnum* is known from the tropical West Pacific, whereas *M. arthroprocessum* and *M. maculosum* for now are restricted to the subtropical West Indian Ocean. The distribution is mapped in fig. 5.

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