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THE STATUS OF *NARDOA* (*ANDORA*) A. M. CLARK, 1967  
(ASTEROIDEA: OPHIDIASTERIDAE), WITH THE DESCRIPTION OF  
TWO NEW SUBGENERA AND THREE NEW SPECIES

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SUMMARY

The diagnosis of *Nardoa* (*Andora*) A. M. Clark is expanded and this subgenus of *Nardoa* is elevated to generic rank. Two new subgenera of *Andora* and three new species are described, extending the distribution of the genus from the Arabian Sea to the Mozambique Channel, Heron Island (east coast of Australia) and the Philippine Islands.

INTRODUCTION

Macan (1938) described the species *Nardoa faouzii* from a single specimen collected in shallow-water from off the Arabian coast during the John Murray Expedition (1933-4). The species has not been re-encountered. A. M. Clark (1967) re-examined the holotype and concluded that the regular arrangement of the abactinal plates on the proximal one third of the arms was a character of sufficient weight to distinguish *faouzii* subgenerically from *variolata* (type-species of *Nardoa*; designated by H. L. Clark, 1921) and other species included in the genus *Nardoa* in the same paper. She accordingly defined *Andora* as a subgenus of *Nardoa*.

While preparing a revision of the genus *Nardoa*, I have had the opportunity of examining the holotype of *Nardoa* (*Andora*) *faouzii* Macan as well as undescribed specimens from Mozambique Channel (Western Indian Ocean), the Philippine Islands, and from Heron Island (Queensland coast, Australia). The combination of characters exhibited by these five specimens shows them not only to represent four distinct species (three of them new) but that the species are clearly related within the common supra-specific taxon *Andora*. I believe that the taxon *Andora* is sufficiently distinguishable from other related ophiasterid genera to be elevated to generic level, and that within this taxon two subgeneric taxa should be recognised.

SYSTEMATIC ACCOUNT  
Genus **Andora** A. M. Clark

*Nardoa* (*Andora*) A. M. Clark, 1967, p. 187.

DIAGNOSIS: A genus of ophiasterid with the primary plates distinct; transversely rectangular abactinal plates contiguous and aligned longitudinally and transversely along only 1/3R, distal to which the plates of the carinal and first abactinal-lateral row on each side are of irregular shape and arrangement many being larger than the proximal plates, the plates of the second abactinal-lateral rows can usually be traced to within a short distance of the arm tip, other abactinal-lateral rows of plates extend for a short distance from the base of the arms; number of infero- and superomarginal plates equal or inferomarginal number exceeds superomarginal number by about 50%; marginal plates decrease in size uniformly distally; papulae occur abactinally, intermarginally and actinally (actinal papulae are absent in juvenile specimens, R = 20 mm); granules usually polygonal in cross-section, closely covering all external surfaces; adambulacral plates with 3-5 furrow spines and 3-5 subambulacral spines in two distinct rows, a third row formed by granules is barely distinguishable from the actinal granulation except in the type species of the genus, the furrow and subambulacral spines may be truncate or bevel-tipped; no pedicellariae (on specimens so far examined).

TYPE SPECIES: *Nardoa faouzii* Macan: as designated by A. M. Clark, 1967.

REMARKS: This genus is closest to *Nardoa* from which it may be most readily distinguished by the arrangement of the abactinal plates. Where there is some regular alignment of proximal abactinal plates in *Nardoa* the plates are not contiguous or of the same distinctive shape as those found in *Andora*. The shape and arrangement of the adambulacral armature seems also to be distinctive, at least for three out of the four species. *Andora* is distinguished from *Heteronardoa* and *Certonardoa* also by the distribution of the papulae. Juvenile specimens of *Andora*, lacking papulae actinally, may be distinguished from *Gomophia* by the lack of tuberculate plates and the uniform decrease in size of the marginal plates towards the tip of the arms, there being no alternation of marginal plate sizes and from *Certonardoa* by the restriction of the regularly aligned abactinal plates to the basal portion of the arms.

**Andora** subgen. sensus novo

DIAGNOSIS: A subgenus of *Andora* with the number of inferomarginal and superomarginal plates equal.

TYPE SPECIES: *Nardoa faouzii* Macan; herein designated.

OTHER SPECIES INCLUDED: *Andora* (*Andora*) *bruuni* sp. nov.

**Dorana** subgen. nov.

DIAGNOSIS: A subgenus of *Andora* with the number of inferomarginal plates exceeding the number of superomarginal plates by about 50%.

TYPE SPECIES: *Andora* (*Dorana*) *wilsoni* sp. nov.; herein designated.

OTHER SPECIES INCLUDED: *Andora* (*Dorana*) *popei* sp. nov.

KEY TO THE SUBGENERA AND SPECIES OF *Andora*

1. Superomarginal and inferomarginal plates of similar number;  $R/r = 5.3-6.2$  ..... *Andora* subgen. sensus novo 2.
- Inferomarginal plates exceed superomarginal plates, in number, by 50%;  $R/r = 6.75-7.0$  ..... *Dorana* subgen. nov. 3.
2. Primary plates separated by small plates, primaries up to 2.75 mm diameter; distal abactinal plates circular in outline, up to 2 mm maximum diameter; furrow spines truncate, round-tipped; Arabian Sea ..... *A. (A.) faouzii* (Macan)
- Primary plates contiguous, up to 3.5 mm diameter; distal abactinal plates usually transversely oval or diamond-shaped, up to 3.0 mm maximum diameter; furrow spines with bevelled tip; Mozambique Channel ..... *A. (A.) bruuni* sp. nov.
3. Arrangement of proximal abactinal arm plates not clearly defined; distal plates of two distinct sizes, largest more or less circular up to 2.5 mm maximum diameter; two abactinal-lateral rows; Philippine Islands ..... *A. (D.) wilsoni* sp. nov.
- Arrangement of proximal abactinal arm plates clearly defined; distal plates irregularly shaped but most longitudinally oval, not in two distinct sizes, up to 3.75 mm maximum diameter; three abactinal-lateral rows; Heron Island (eastern coast of Australia) ..... *A. (D.) popei* sp. nov.

**A. (*Andora*) *faouzii*** (Macan)

Fig. 1a-c

*Nardoa faouzii* Macan, 1938, p. 407, pl. I figs 8-9.*N. (Andora) faouzii*. — A. M. Clark, 1967, p. 187.

MATERIAL EXAMINED: 1 specimen (holotype): stn 53, Arabian Sea, 13.5 m, John Murray Expedition, 1933-4; B.M. (N.H.) no. 1937.6.18.306, British Museum (Natural History), London, England.

DESCRIPTION: The holotype has five arms,  $R = 48.5-54$  mm,  $r = 9$  mm,  $R/r = 5.3-6.0$ . Central-dorsal plate oval,  $3.0$  mm  $\times$   $2.5$  mm. Five inner radial plates round to oval, maximum diameter =  $2.75$  mm, spaced from each other and (with the exception of one radial plate) from central-dorsal plate by one or two small plates. Five interradial plates also round to oval, maximum diameter (extending into the interradius) =  $3.0$  mm, each separated from inner radial and outer radial (i.e. first carinal) plates of adjacent radii by one or two small plates. Each interradial contiguous with first plate of first abactinal-lateral row of plates of adjacent arms and a small plate below, which continues second abactinal lateral row of adjacent arms into a continuous series of plates around the interradial arch. One interradial plate carries madreporite. First carinal plate (i.e. outer radial) D-shaped, maximum transverse diameter =  $3.0$  mm. Along abactinal side of each arm a carinal row of 4-5 plates, each plate =  $2$  mm (transverse diameter)  $\times$   $1.75$  mm (longitudinal diameter) (except for the first carinal plate). There are four abactinal-lateral rows. First 4-5 plates of the carinal and abactinal-lateral rows longitudinally and transversely aligned. Distally, second abactinal-lateral row extends to within about  $10$  mm of arm tip, third row extends to about  $2/3R$  and fourth row only to about  $1/2R$ . Carinal and first abactinal-lateral row (on each side of the carinal) irregularly arranged. These plates more or less circular in outline, decreasing evenly in size towards tip of the arms. Maximum diameter of circular plates =  $2$  mm, not larger than plates on proximal part of arm, fig. 1a.

The 26 superomarginal plates are squarish (the fifth measures 2 mm × 2 mm) and decrease in size evenly distally. The 26-27 inferomarginals are of similar dimensions to superomarginal plates, fig. 1c.

Three, with indication of fourth, rows of actinal plates. First row, adjacent to adambulacral plates, extends to within 5-7 mm from arm tip with two plates corresponding to each inferomarginal plate. Second row comprises 4 plates; third row 2-3 plates and fourth a single plate, fig. 1b.

Papulae in groups of up to 8 between abactinal plates, up to 12 between marginal plates and up to 8 between inferomarginal and actinal plates. Granules polygonal in cross section, close fitting, but most abactinal plates rubbed bare. Granules are of mixed size but towards centre of plates many are larger than granules at the periphery (c.6-7/mm: c.10-12/mm respectively). Granules surrounding each papula are of similar size to larger granules on plates.

Adambulacral plates bear 4 (occasionally 5) truncate furrow spines which taper towards but are rounded at tip. Proximal spine largest, but all are of similar length. There are 3 truncate, obliquely aligned subambulacral spines, about 1/2 the length of furrow spines. A row of 4 enlarged granules is present behind the subambulacral spines, fig. 1b.

Oral plates bear 8-9 furrow spines, 5 subambulacral spines, 5 enlarged granules and the rest of the plate is covered with granules.

REMARKS: *A. faouzii* differs from *A. bruuni* n. sp. in the arrangement of the primary plates, numerical distribution of the papulae, shape of the furrow spines and the shape and size of the irregularly arranged abactinal plates. This species is distinguished from *A. popei* and *A. wilsoni* n. spp. by the number of inferomarginal plates as compared with the number of superomarginal plates.

***A. (Andora) bruuni* sp. nov.**

Fig. 1d-f

MATERIAL EXAMINED: 1 specimen (holotype): cruise 8, stn 401C RU93, lat. 19°51'S, long. 36°21'E, 62 m, 4.ix.64, 'Anton Bruun'; U.S.N.M. no. E15901, United States National Museum (Smithsonian Institution), Washington, D.C., U.S.A.

DESCRIPTION: The holotype has five arms,  $R = 54-56.5$  mm.  $r = 9$  mm,  $R/r = 6-6.25$ . Central-dorsal plate oval, 4 mm × 3.25 mm. Five inner radial plates contiguous with each other and of similar shape and size to and contiguous with central-dorsal. Five interradial plates are oval, maximum diameter (extending into the interradius) = 4.0 mm. Each interradial plate contiguous with inner radial plates on adjacent arms, first carinal (outer radial), first abactinal-lateral row of plates on same adjacent arms and a small plate below the interradial which continues second abactinal-lateral rows across interradial arch. One interradial plate carries madreporite. First carinal (i.e. outer radial) D-shaped, maximum transverse diameter = 3.5 mm. Along abactinal side of each arm is a carinal row of 3-4 plates, each plate = 2 mm (transverse diameter) × 1.75 mm (longitudinal diameter) (except for the larger first carinal plate). There are three abactinal-lateral rows. First 3-4 plates of the carinal and abactinal-lateral rows longitudinally and transversely aligned. Distal to this, plates of carinal and first abactinal row on each side of carinal row become irregularly arranged. These latter are mostly larger than the proximal plates but irregular in size up to 3.5 mm maximum diameter, usually transversely oval or diamond-shaped. Plates of second abactinal-lateral rows extends to arm tip but those of third do not extend beyond 1/3R, fig. 1d.

The 25-26 superomarginal plates are higher than wide, viewed laterally (3 mm × 2.5 mm; fifth plate), but decrease in size regularly distally. The 26-27 inferomarginal plates are slightly smaller than the superomarginals and squarish (2.0 mm × 2.0 mm; fifth plate), fig. 1e-f.

Three rows of actinal plates. First row extends to within 5 mm of arm tip. The plates are of two sizes. Proximally for first 12 inferomarginals plates there are 18 actinal plates, with 2 actinal plates under several of the inferomarginals. Beyond that there are 2 actinal plates for each inferomarginal plate. The actinal plates are irregular in shape but usually becoming squarish distally. Second row comprises 4 plates and the third row 2-3 plates, fig. 1e.

Papulae in groups of up to 10 between abactinal plates, up to 7 between marginal plates and up to 4 between inferomarginal plates and actinal plates. Granules are similar in all respects to those of the previously described species.

Adambulacral plates bear 4, occasionally 5, bevel-tipped furrow spines of which the first spine is largest but all are of similar length; 3-4 truncate or prismatic subambulacral spines, which are about 1/2 length of furrow spines and behind these 4-5 granules only slightly larger than remaining granules covering rest of adambulacral plates, not markedly so, fig. 1e.

Oral plates bear 8-9 furrow spines, 4-5 subambulacral spines, 7-8 enlarged granules and rest of the plate with 3-4 sided granules which are more elongate than those on rest of actinal surface.

REMARKS: *A. bruuni* differs from *A. faouzii* in the more compact arrangement of and size of the primary plates, the shape and size of the abactinal plates on the arms, the numerical distribution of the papulae and the shape of the furrow spines. This species is distinguished from *A. popei* and *A. wilsoni* n. spp. by the arrangement of the marginal plates.

**A. (*Dorana*) *wilsoni* sp. nov.**

Fig. 2a-e

MATERIAL EXAMINED: 1 specimen (holotype); Doc Can Is., Sulu Archipelago, Philippines, 18.3 m, 20.11.64, B. R. Wilson; W.A.M. no. 1054-74, Western Australian Museum, Perth, Western Australia.

1 specimen (juvenile): Pearl Bank, Zal Is., Sulu Archipelago, Philippines, 18.3 m, 21.11.64, B. R. Wilson; W.A.M. no 1757-74, as above.

DESCRIPTION: The holotype has five arms, one of which is damaged, R = 47 mm - 54 mm, r = 8 mm, R/r = 6.1-6.75. Central-dorsal plate oval, slightly lobed, 2.6 mm × 2 mm. Five inner radial plates round to oval, maximum diameter = 2.1 mm. These plates are separated from each other by small plates but are just contiguous with central-dorsal plate. Five interradial plates larger, oval and lobed, maximum diameter (extending into the interradius) = 3.2 mm. These plates are generally separated from inner and outer (first carinal plate) radials by small plates but are contiguous with first plate of first abactinal-lateral row. Outer radial or first carinal plate D-shaped maximum transverse diameter = 2.5 mm. Along abactinal side of each arm a carinal row of 3-4 plates, each plate = 2 mm (transverse diameter) × 1.5 mm (longitudinal diameter) (except for the first carinal plate). There are only two abactinal-lateral rows of which the first extends regularly with the carinal row for 3-4 plates, after which, together with the carinal row the plates become irregularly arranged. Second lateral row extends for about 2/3R. The distal arm plates are

of two sizes with larger, more or less circular plates (up to 2.5 mm diameter) being mixed with small angular plates (up to 1 mm diameter). Plates decrease in size regularly distally. Larger plates stand out because of their slightly convex surface against smaller, flat plates, fig. 2a.

The 22 superomarginal plates are squarish or slightly wider than high (viewed laterally) and are lobed on intermarginal edge (2.5 mm × 2.5 mm; fifth plate). The 31 inferomarginal plates also squarish (1.5 mm × 1.25 mm; seventh plate) with 1.5 plates aligned under each superomarginal, figs 2b-c.

Two actinal rows of plates. First extends to within 5 mm of arm tip, the plates being squarish and aligned two under each inferomarginal. Second row comprises 2-3 plates, fig. 2b.

Papulae in groups of up to 8 between abactinal plates, up to 7 between marginal plates and up to 4 between inferomarginal and actinal plates. Granules are similar to those in preceding species.

Adambulacral plates bear 4-5 bevel-tipped furrow spines, of which first is largest but all are of similar length. There are 3-4 subambulacral spines similarly bevel-tipped, about 1/2 length of furrow spines and closely adpressed against them. The 4-5 granules immediately adjacent to subambulacral spines are barely perceptibly larger than other granules covering the rest of adambulacral plate, fig. 2b.

Oral plates bear 8-9 furrow spines, 5 subambulacral spines and rest of the plate covered with granules similar to those on rest of actinal surface.

The juvenile has five arms,  $R = 19-20$  mm,  $r = 4$  mm,  $R/r = 4.75-5.0$ . Primary interradial plates = 1 mm maximum diameter, interradials have long interradial diameter = 1.5 mm, outer radials (first carinals) have transverse diameter = 1.4 mm. Larger, circular distal abactinal plates = up to 1 mm diameter and stand out above smaller, flat plates between. There are two rows of abactinal-lateral plates but the second row cannot be traced beyond first 3-4 plates, fig. 2d.

There are 15 superomarginal and 22-23 inferomarginal plates. Two rows of actinal plates, but second row represented by only one plate. Furrow and subambulacral spines are as in holotype but 1 or 2 rows of 4-5 granules immediately adjacent to subambulacral spines are larger than rest on the plate, fig. 2e.

REMARKS: This species is distinguished from *A. popei* n. sp. by its size,  $R/r$  ratio, shape, size and arrangement of the distal abactinal plates, and lobed primary and marginal plates. From *A. faouzii* (Macan) and *A. bruuni* n. sp. it is immediately distinguished by the arrangement of the marginal plates.

***A. (Dorana) popei* sp. nov.**

Fig. 2f-h

MATERIAL EXAMINED: 1 specimen (holotype): Heron Island, Queensland, Australia, 32.4 m, collector unknown (this specimen was brought to my attention by my predecessor, Miss E. C. Pope, who was unable to furnish any further data); A. M. no. J.9653, The Australian Museum, Sydney, New South Wales, Australia.

DESCRIPTION: The holotype has five arms,  $R = 71.5-84$  mm,  $r = 11$  mm,  $R/r = 6.5-7.6$ . Central-dorsal plate oval, 2.5 mm × 2.25 mm. Five inner radial plates round, maximum diameter = 2.25 mm. Each is separated from its adjacent neighbour by small plates. Two radials are contiguous with central-dorsal plate. A ring of 15 small plates more or less

encloses plates described above. Five larger, rounded interradial plates, maximum diameter = 3.25 mm, one of which carries the madreporite. These plates are separated from the outer radial (first carinal) plates by a small plate on each side. Interradials in contact with first plate of the first abactinal-lateral row on adjacent arms. A small plate below interradial continues second abactinal-lateral row around the interradial arch. First carinal plate (the outer radial) D-shaped = 3.2 mm (transverse diameter) × 1.75 mm (longitudinal diameter). Along abactinal side of each arm is a carinal row of 3-5 plates, each plate = 3 mm (transverse diameter) × 1.75 mm (longitudinal diameter) (except for the first carinal plate). There are three abactinal-lateral rows. First 3-5 plates of carinal and abactinal-lateral rows regularly transversely and longitudinally aligned. Beyond 5th plate, plates of the carinal and first abactinal-lateral rows are larger than proximal plates and not in regular order. These plates are slightly lobed, irregular in shape but more generally longitudinally oval with maximum diameter up to 3.5 mm. The size of these plates decreases regularly towards tip of arms. Plates of second abactinal-lateral row may be restricted in order to basal 5-6 plates or may be recognisable along length of arms. Third abactinal-lateral row does not extend beyond the proximal half of arms, fig. 2f.

There are 26 superomarginal plates, first two higher than wide (viewed laterally) but rest squarish and decrease in size regularly distally. Fourth superomarginal = 3.5 mm × 3.5 mm. There are 36 inferomarginals similar in shape to superomarginals but smaller, 6th = 2.75 mm × 2.5 mm. First 7 plates more or less underlie first 6-7 superomarginal plates but after that there are 1 or 2 inferomarginals per superomarginal, fig. 2g-h.

Two rows of actinal intermediate plates, first extending to within 10 mm of arm tip and second comprising 2-4 plates. Plates of first row wider than long (2.5 mm × 1 mm) with 2 underlying each inferomarginal. The plates decrease regularly in size distally for about 1/2R but beyond that there is a tendency for the plates to alternate in two sizes. Where arm regeneration has occurred, superomarginals, inferomarginals and actinal-intermediate plates have become misaligned so that superomarginal plates are aligned from inferomarginal line, the inferomarginals from actinal line and actinals form a new line, fig. 2g.

Papulae in groups of twelve abactinally, marginally and actinally. Granules similar in all respects to those described for other species included in this paper.

Adambulacral plates bear 4, occasionally 3, bevel-tipped furrow spines, 3-4 similarly bevel-tipped subambulacral spines which are about half length of furrow spines and closely adpressed to them and 4-5 granules immediately adjacent to subambulacral spines are barely perceptible larger than other granules which cover rest of surface of plates, fig. 2g.

Oral plates bear 8-9 furrow spines, 5 subambulacral spines and rest of surface of plates is covered by angular granules of which 7-10 adjacent to subambulacral spines are slightly the largest.

REMARKS: *A. (D.) popei* is most closely related to *A. (D.) wilsoni* n. sp. from which it can be distinguished most readily by its size, R/r ratio, arrangement of the abactinal plates and numerical distribution of the papulae. *A. (D.) popei* is immediately separated from *A. (A.) faouzii* (Macan) and *A. (A.) bruuni* n. sp. by the arrangement of the marginal plates.

## DISCUSSION

In his excellent revision of the family Ophidiasteridae, H. L. Clark (1921) laid great stress on the importance of the arrangement of the skeletal plates and the distribution of the papulae in recognising the supra-specific taxa. Using his key, *Andora* can be most closely related to *Nardoa*. The recognition of the subgeneric groups is based on the coincidental occurrence of two distinct species with equal numbers of inferomarginal and superomarginal plates in the Indian Ocean and two distinct species with substantially more inferomarginal than superomarginal plates in the Pacific Ocean. Since all the other features, although specific, are similar in the four species, the species are retained under the mantle of a common generic taxon. The species so far encountered extend to depths of 13.5 m (Arabian Sea) and 62 m (Mozambique Channel) in the Indian Ocean and to 18.3 m (Philippines) and 32.4 m (Heron Island) in the Pacific. The genus can thus be considered to inhabit relatively shallow water. Ecological data available indicates that the species prefer hard substrates since Macan (1938) records that off the Arabian Coast the slopes are steep and rocky and Wilson records the larger specimen from the Philippines as being collected from rocky/*Lithothamnion* bottom (holotype of *wilsoni*) and the smaller one from a sandy/*Lithothamnion* bottom (juvenile of *wilsoni*). Of the related genera, *Nardoa* is commonly collected intertidally or at the most to a few meters, *Certonardoa* is collected from similar depths and *Heteronardoa* from deeper water.

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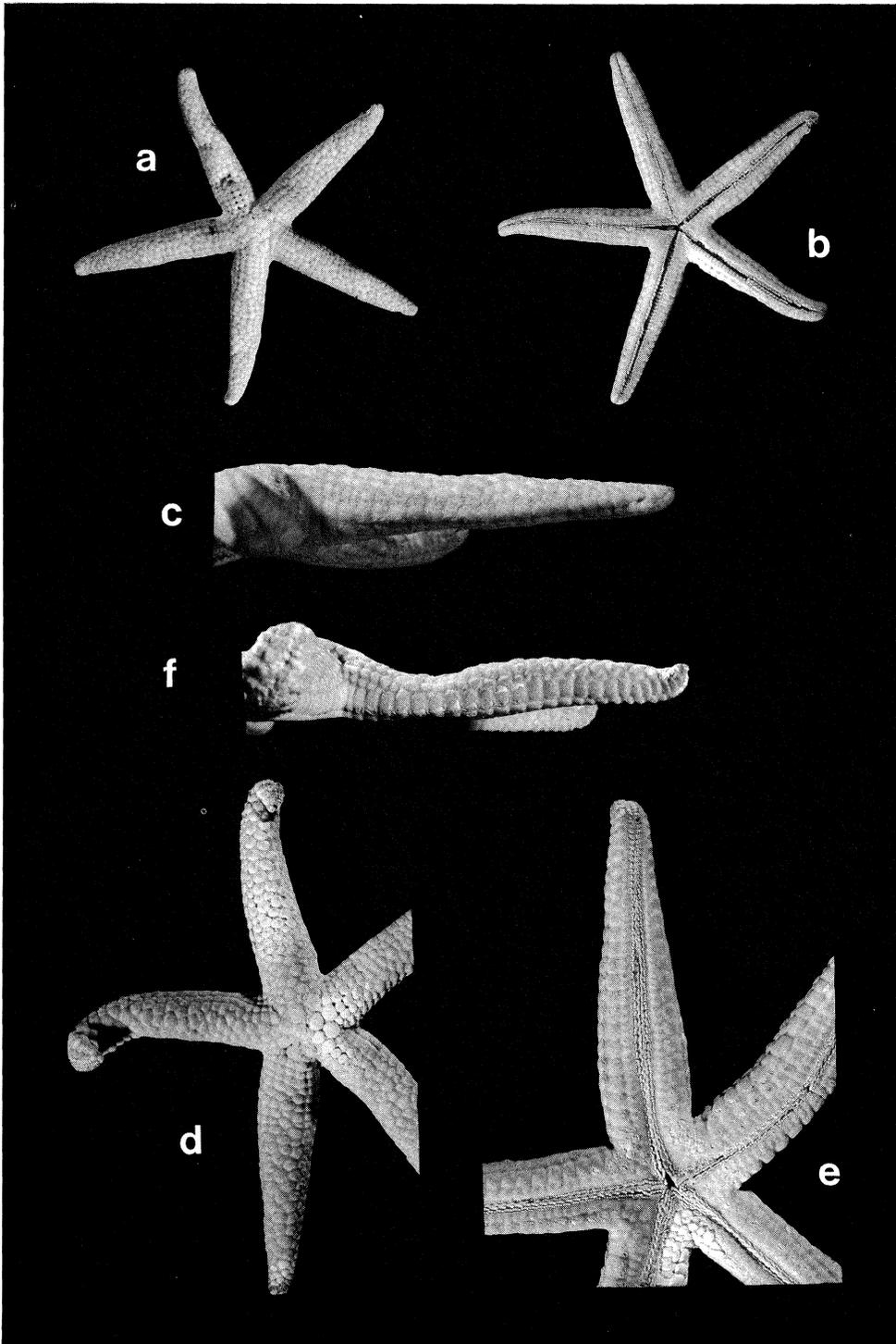


FIGURE 1.— A-C. *Andora (Andora) faouzii* (Macan), holotype, a. abactinal, b. actinal, c. lateral views, R = 48.5 — 54mm. D-F. *A. (A.) bruuni* sp. nov., holotype, d. abactinal, e. actinal, f. lateral views, R = 54 — 56.5mm.

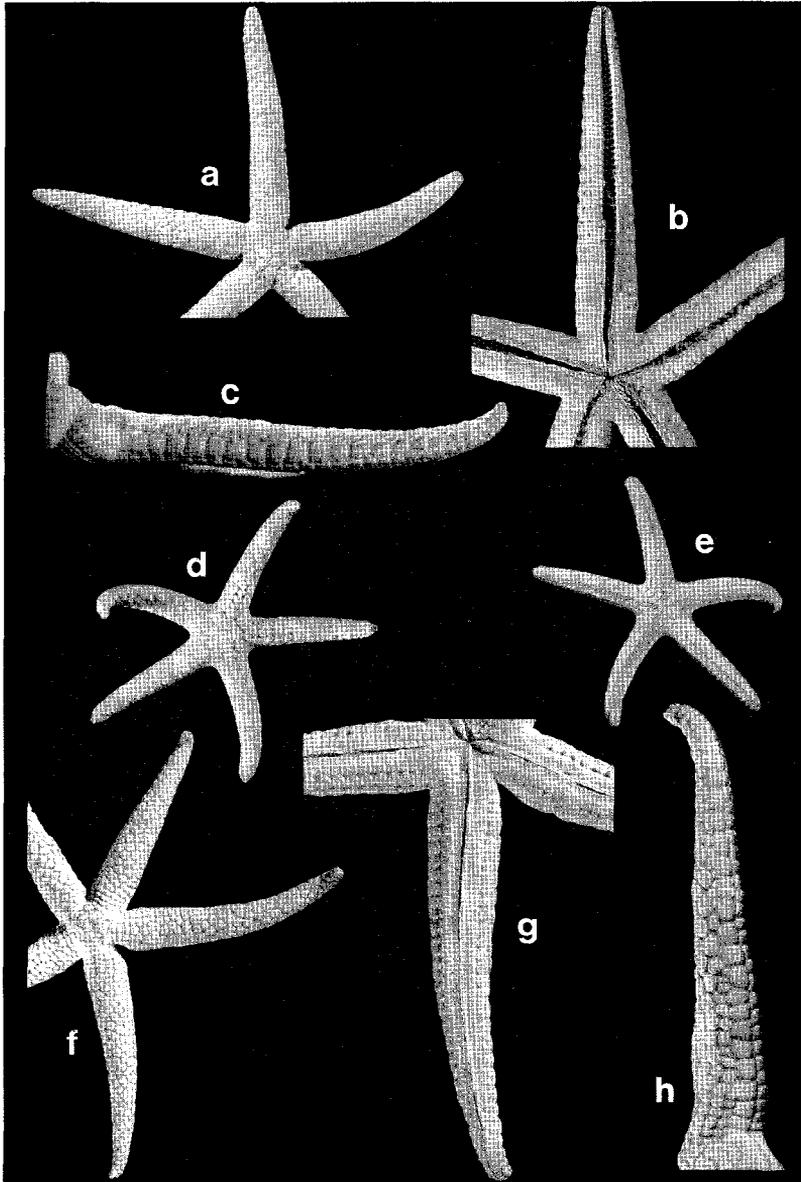


FIGURE 2. — A-C. *Andora (Dorana) wilsoni* sp. nov., holotype, a. abactinal, b. actinal, c. lateral views, R = 47 — 54mm. D-E. *A. (D.) wilsoni* sp. nov., juvenile, d. abactinal, e. actinal views, R = 19 — 20mm. F-H. *A. (D.) popei* sp. nov., holotype, f. abactinal, g. actinal, h. lateral views, R = 71.5 — 84.