

ASTEROIDEA

The sea stars of Australia are one of the most notable and attractive groups in her marine fauna. There are 206 species, of which only 17 are extinct; 73 of 83 genera are more or less widely distributed, living still, at all depths around the continental shores and on the reefs and outlying islands. Naturally the great majority of the species occur in the tropical and subtropical seas, but 30 or more are to be found in the cooler waters of the southern coast. The richness of Australia's sea-star fauna is striking in view of the fact that in the whole West Indian region fewer than 20 species are found in shallow water, and fewer than 100 including even the deep-water species. At Broome alone, in shallow water, we took 38 species, and even at Port Jackson on the opposite corner of the continent more than 20 species have been found. The 17 extinct species are all representatives of families which died out long ago, so that there is little indication that the present fauna has any direct relationship with the fossil forms.

Though some of the Australian sea stars are small (under 30 mm. in diameter) and of secretive habits, the great majority are more than 100 mm. across when adult, and live openly on the bottom. Several species exceed 300 mm. in diameter, and 2 or 3 may even exceed half a meter. The coloration is almost always notable in life and many species are very beautiful, but the colors are fugacious and preserved specimens rarely give any indication of their former beauty. Diversity of form is more easily preserved, and ranges from almost circular or definitely pentagonal to long-radiate, with rays 6 or 7 times as long as the diameter of the body. Most species are more or less flat, but in a few cases the height of the body above the mouth may be more than half its own diameter. None of the species are poisonous or disagreeable to handle in any way, and none have yet been shown to be of any economic importance either positively or negatively.

The 206 species represent all 3 of the known orders of sea stars, and these are separated by the following more or less obvious characters:

KEY TO THE ORDERS OF ASTEROIDEA

- A. Marginal plates large and conspicuous, defining outline of body; abactinal skeleton of arms made up of radial, lateral, and marginal series of plates, usually with numerous accessory plates; disk covered with numerous paxilliform, or flat, tessellate plates Phanerozonia
- AA. Marginal plates not conspicuous or defining outline of body; abactinal skeleton of imbricated plates or more or less reticulate:
- Pedicellariae very rare, never pedunculate, forcipiform, or forciform Spinulosa
- Pedicellariae numerous, pedunculate, forcipiform, or forciform Forcipulata

Order PHANEROZONIA

This is a large group of many families, of which more than a dozen are represented in the Australian fauna, but 4 of these are extinct and not closely allied to the remaining groups. The following key indicates how these families may be distinguished, but the grouping is probably arbitrary and perhaps not altogether natural.

KEY TO THE FAMILIES OF PHANEROZONIA

- A. Interbranchial arcs very small with single large axillary marginal or at most a pair:
- B. Single large axillary plate:
- No accessory ray plates of any kind; extinct Hudsonasteridae
- Accessory ray plates present abactinally; extinct Palaeasteridae
- BB. A pair of axillary plates in each interradius; extinct Promopalaeasteridae
- AA. Interbranchial arcs well developed, with several to many plates:
- C. Boundary of animal formed by inferomarginal plates:
- Superomarginal plates present but smaller than inferomarginals; no paxillae; extinct Palasterinidae
- Superomarginals wanting; abactinal plates paxilliform Luidiidae
- CC. Boundary of animal formed by 2 sets of marginal plates, superomarginals generally more prominent:
- D. Tube feet without sucking disks; dorsal surface covered with paxillae; actinal intermediate areas usually small Astropectinidae
- DD. Tube feet with well developed sucking disk:
- E. Abactinal surface covered with paxillae or paxilliform plates:
- F. Marginal plates appreciably alternate, with sharp, conspicuous spines; papulae confined to small area near base of ray Benthoplectinidae
- FF. Marginal plates opposite (at least on basal part of ray); papulae not confined to basal part of ray:
- Disk small, it and upper surface of rays closely covered by paxilliform, tabulate plates; actinal intermediate plates very few Archasteridae
- Disk large, covered by penicillate paxillae; actinal intermediate plates many Radiasteridae
- EE. Abactinal plates neither tabulate nor paxilliform, but flattened or convex, with or without tubercles, spines, or granules:
- G. Disk large, with actinal intermediate areas extensive:
- Marginal plates large and conspicuous; disk covered with polygonal, circular, or stellate plates forming firm pavement; papulae single or few in an area Goniasteridae
- Marginal plates large but not conspicuous; abactinal skeleton stellato-reticulate; numerous papulae in large circumscribed areas Oreasteridae
- Marginal plates small, more or less imbricated; whole body covered by thick, smooth, tough skin Asteropidae
- GG. Disk very small, with greatly reduced actinal intermediate areas:
- Tegumentary developments spinulose; papulae few, isolated, strictly abactinal Metrodiridae
- Tegumentary developments granulose or wanting, skin being very smooth as a rule Ophidiasteridae

Family *HUDSONASTERIDAE

This is a small group, called by Schuchert (1915) the "most primitive known Phanerozonia" and said to be "the primordial stock out of which all asterids progressively developed"; this view, however, is not universally accepted. Of the 2 known genera, only 1 is reported from Australia.

*HUDSONASTER

Stürtz, 1900. Verhandl. Naturhist. Ver. preuss. Rheinland, vol. 56, p. 224.

Genotype: *Palasterina rugosa* Billings, 1857, p. 291.

The discovery of this primitive group in Australia is of exceptional interest. The material was studied by Withers and Keble, to whose excellent account of the Paleozoic sea stars of Victoria the present writer is greatly indebted.

*Hudsonaster australis

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 222; text figs. 1, 3; pl. 10, fig. 6.

This little sea star, less than 20 mm. across, was discovered by Withers and Keble "at the summit of an anticline in a cutting on Yan-Yean—Arthur's Creek road, one-third mile east of Doreen Junction," Victoria. The occurrence is "undoubtedly Silurian," but no more detailed stratigraphical location is attempted. The number of specimens obtained is not stated, but a reference to "other specimens" indicates that there were at least 3. Comparison is made with several American species of *Hudsonaster*, of which *H. narrawayi* (Hudson) seems to be the nearest, but the differences justify the conclusion that the Australian species is distinct.

Family *PALAEASTERIDAE

This family contains but 2 genera, *Palaeaster* and *Australaster*, of which the latter occurs in Australia and is not known as yet from elsewhere. It is said to differ from *Palaeaster* in having a larger disk, longer arms, and more distinct interbrachial arcs, but material is inadequate for a satisfactory diagnosis of either genus. The general facies justifies the recognition of 2 genera and even warrants the suspicion that they are not closely related.

*AUSTRALASTER

Schuchert, 1914. Foss. cat., Anim., pt. 3, p. 12.

Genotype: *Palaeaster (Monaster) giganteus* Etheridge, 1892, p. 74.

Schuchert (1915) includes in this genus 2 species of Australian fossil sea stars which Etheridge placed in *Palaeaster*, giving good figures of both. The descriptions are vague and not easily understood, such phrases as "body elongate" and rays "forming with one another an angle of 60° to 75°" being confusing. In any 5-rayed sea star the angles must average 72°. Apparently, however, the 2 species may be distinguished thus:

Oral plates very large, the twins forming a somewhat cordate plate; adambulacral plates each with a single row of spine-bearing tubercles *giganteus*

Oral plates very small, "pustuliform"; adambulacral plates each with about 3 alternating rows of spine-bearing tubercles *stutchburii*

*Australaster giganteus

Palaeaster (Monaster) giganteus Etheridge, 1892. Mem. Geol. Surv. N. S. Wales, Palaeontol., no. 5, pt. 2, p. 74; pl. 12.

Australaster giganteus Schuchert, 1914. Foss. cat., Anim., pt. 3, p. 12.

Apparently only a single specimen of this notable sea star has been found. $R = 87-90$ mm., $r = 22-25$ mm., $br =$ about 20 mm. at base and nearly as much halfway to tip. This specimen was collected by T. Brown, in the Lower Marine series of the Permocarboneous rocks of Ravensfield Quarry, near Farley, County Northumberland, New South Wales.

*Australaster stutchburii

Palaeaster (Monaster) stutchburii Etheridge, 1892. Mem. Geol. Surv. N. S. Wales, Palaeontol., no. 5, pt. 2, p. 73; pl. 13, fig. 1.

Australaster (?) stutchburii Schuchert, 1915. Bull. 88 U. S. Nat. Mus., p. 73.

A single specimen of this slightly smaller sea star was also found by T. Brown in the Lower Marine series at Ravensfield Quarry. $R = 65-70$ mm., r and br about 15 mm. The nature and condition of the specimen preclude accurate measurements. Schuchert (1915) thinks the systematic position of this sea star is dubious and cannot be satisfactorily determined until more specimens are obtained. It may be a smaller specimen of *giganteus*, or it may not be an *Australaster* at all.

Family *PROMOPALAEASTERIDAE

This family was instituted by Schuchert (1915) to include some 30 fossil sea stars which he grouped in half a dozen genera, only 1 of which occurs in Australia. Spencer (1916) established an additional genus, to which Withers and Keble (1934) assign some small sea stars from the Silurian rocks of Victoria. The 2 Australian genera are distinguishable thus:

Interbrachial areas small, with only 1 pair of inferomarginals *Caractacaster*
Interbrachial areas complex, with more than 1 pair of inferomarginals *Promopalaeaster*

*CARACTACASTER

Spencer, 1916. Brit. Pal. Ast., pt. 2, p. 80.

Genotype: *Palaeaster caractaci* Gregory, 1899, p. 344.

The little Australian sea stars which seem to be associated with this genus are included in a single species.

*Caractacaster yarraensis

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 223; pl. 10, figs. 1, 2.

In the known specimens of this sea star, $R = 8-10$ mm., $r = 3$ mm. or less. They were found in the Yarravian series of Silurian rocks at South Yarra, Victoria, and are admirably described and figured.

***PROMOPALAEASTER**

Schuchert, 1914. Foss. cat., Anim., pt. 3, p. 24.

Genotype: *Palaeaster speciosus* Meek, 1872, p. 277.

This genus is represented in America by 10 or more species, but in Australia only a single small species has been found.

***Promopalaeaster meridionalis**

Palaeaster meridionalis Etheridge, 1891. Rec. Australian Mus., vol. 1, p. 199; pl. 30, figs. 16, 17.

Promopalaeaster meridionalis Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 225; pl. 12, fig. 7.

Withers and Keble (1934) have discussed this little sea star admirably, so far as the material permits. They have also proposed a variety *parvior* based on an individual about half the size of Etheridge's type. As all the available and scanty material comes from the Yarravian series of Silurian rocks near Moonee Ponds or Moonee Ponds Creek, Victoria, the varietal name is of dubious value.

Family ***PALASTERINIDAE**

This family, of half a dozen genera and perhaps 20 species, is well represented in the Silurian rocks of Victoria. Of the apparently 8 species seen by Withers and Keble, 5 are described as new, 1 is referred to as a form long ago named by McCoy, and 2 do not justify naming in view of the condition of the specimens. The half-dozen named species fall equally into 2 genera, which are distinguished thus:

Inferomarginal plates conspicuous, bounding entire outer edge of animal; rays relatively short and wide.....	<i>Petraster</i>
Inferomarginal plates small and often hard to make out; rays relatively long and narrow.....	<i>Palasterina</i>

***PETRASTER**

Billings, 1858. Geol. Surv. Canada, Can. org. remains, dec. 3, p. 79.

Genotype: *Palasterina rigidus* Billings, 1857, p. 291.

Apparently at least 4 species of *Petraster* occur in the Silurian rocks of Victoria, but of 1 the material does not permit a description or warrant a name. The other 3 species may be distinguished thus:

Rays broad and flattened, width at middle about one-half length.....	<i>smythi</i>
Rays longer and narrower, width at middle about one-third length.....	<i>angustior</i>
Intermediate between the above two.....	<i>richi</i>

***Petraster smythi**

McCoy, 1874. Prodr. palaeontol. Victoria, dec. 1, p. 41; pl. 10, figs. 1-1b.

This species has been well figured and discussed by Withers and Keble (1934). It is known as yet only from the Silurian rocks of Victoria.

***Petraster angustior**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 227; pl. 12, figs. 4, 5.

This species is contemporary with the preceding but seems to be distinct. It is as yet known only from the Yarravian series, of the Silurian rocks of South Yarra, Victoria.

***Petraster richi**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 228.

If any less competent authority had named this species, its validity might be questioned, but Withers and Keble's work is so obviously trustworthy, we may rest assured that there are at least 3 species of *Petraster* in the Silurian strata of Victoria. The present one was found "one mile southeast of the Clonbinane Pre-emptive Right, just above the junction of Comet and Sunday creeks." The 4 specimens were collected by T. Rich.

***PALASTERINA**

Salter, 1857. Ann. Mag. Nat. Hist., ser. 2, vol. 20, p. 327.

Genotype: *Uraster primaevus* Forbes, 1848, p. 463.

Although this genus was proposed for certain British Paleozoic sea stars, Withers and Keble (1934) refer to it no fewer than 4 forms from the Silurian rocks of Victoria. Schuchert (1915), after stating that *Uraster primaevus* Forbes is the "genoholotype," takes the extraordinary step of designating *P. bonneyi* Gregory as "for the present" the genoholotype. Obviously a species which was not named for more than 40 years after the genus was established cannot possibly be the genoholotype. Of the 4 Victorian species discussed by Withers and Keble, 1 is left nameless because of inadequate material. The other 3 are distinguished as follows:

KEY TO THE SPECIES OF PALASTERINA

- A. No bosslike protuberances on ambulacral plates:
 Arms long and slender, tapering to a sharp extremity; length about
 6 times greatest width..... *flemingtonensis*
 Arms shorter and wider, tapering little; length about 5 times greatest
 width..... *stachi*
 AA. Conspicuous bosslike protuberances on ambulacral plates; arms rela-
 tively short and wide, length about 4.5-5 times width..... *umbonata*

***Palasterina flemingtonensis**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 231; pl. 11, fig. 3.

This species was based on 4 specimens from the Silurian rocks of "Flemington," near Melbourne, Victoria. They show some diversity in size but are similar in structure. All lack the dorsal side. They are small, with R = 10-20 mm.

**Palasterina stachi*

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 232; pl. 11, figs. 4, 6.

There are 2 specimens of this species, one showing the oral side, the other the dorsal. They have $R = 20-27$ mm. They were discovered in making excavations for foundations for the Herald Building in Melbourne. The strata are Yarravian series, Silurian.

**Palasterina umbonata*

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 233; pl. 10, fig. 4.

This is a stouter species than either of the preceding, but it is no larger, as $R =$ but 20 mm. Only a single specimen is known. This was found "6 feet beneath the surface," in Silurian strata near Plenty Ranges, Victoria.

Family LUIDIIDAE

This widely distributed family has such a characteristic facies, owing to the absence of superomarginal plates and the crowded, regularly arranged dorsal paxillae, that it is easily recognized. More than 50 nominal species have been assigned to it, but Döderlein (1920) in his monograph recognizes only 43 species and 3 subspecies, all of which he includes in the genus *Luidia*, though he groups them in 10 subgenera. They are widely distributed in tropical and subtropical seas, usually in shallow water. Few occur in depths over 200 fms., and fewer still more than 30° from the equator.

LUIDIA

Forbes, 1839. Mem. Wernerian Soc. Nat. Hist., vol. 8, p. 123 (p. 9 of reprint).

Genotype: *Luidia fragilissima* Forbes, 1839, p. 123 (p. 9 of reprint).

The 4 Australian species of *Luidia* are tropical, though one of them extends its range to the southern coast of the continent. Its nearest ally is restricted to the northwestern coast in the vicinity of Broome (so far as we now know). The other 2 species are as yet too little known to permit any definite statement as to their distribution, but one has been found as far south on the eastern coast as Newcastle Bight, New South Wales. The 4 are easily distinguished as follows:

KEY TO THE SPECIES OF LUIDIA

- A. Rays 5; central spinelets of paxillae elongated *forficifera*
 AA. Rays more than 5:
 B. Rays 6, narrow, flat, smooth *hexactis*
 BB. Rays 7, broad, more or less arched; many of central paxillae near tip of arm enlarged:
 Color cream, yellow, or buff blotched with dark green; large adults may be almost wholly dark green dorsally typical *australiae*
 No green; colors cream and chocolate brown forma *brunnea*
 BBB. Rays 8; no enlarged paxillae distally *maculata*

Luidia forficifera

Sladen, 1889. "Challenger" Ast., p. 258; pl. 44, figs. 5, 6.

This sea star was first taken near the western end of Torres Strait, but in recent years it has been taken at several points on the eastern coast of Australia as far south as Newcastle Bight, New South Wales, in 10-40 fms. According to Döderlein (1920), it ranges northwestward to the Persian Gulf and northward to the Gulf of Siam; he thinks *limbata* Sladen is *quinaria* von Martens, and *limbata* Koehler, 1910, is *forficifera* Sladen; on that ground, the range of the present species extends to India and the Persian Gulf. The truth is, not nearly enough material is available as yet to determine whether we are dealing with a single widespread species or with 3 or possibly 4 separate forms. Sladen and Döderlein both were dealing with small specimens ($R = 40-46$ mm.), whereas the New South Wales specimens were nearly or quite twice that size. The Australian specimens so far taken are unicolor, a "bleached ashy white."

Luidia hexactis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 73; pl. 17, fig. 1.

This species is known only from the holotype, having $R = 140$ mm., and the color above, buff blotched and marked with dark greenish gray much as in *maculata*. Taken between Cockatoo and Augustus islands, northwestern Australia.

Luidia australiae

Döderlein, 1920. "Siboga" Ast.: *Luidia*, p. 266.

Apparently the big *Luidias* of southern Australia from Lord Howe Island to Fremantle have become differentiated from those found throughout the East African and East Indian region and northward to Japan. The difference first noted by Döderlein in the paxillae of the distal part of the rays seems to be constant, and the number of rays is apparently fixed at 7. How far to the northward *australiae* extends is still undetermined, for its distinctness from *maculata* was not recognized when my Torres Strait report was published (1921). The largest specimens yet reported are from Lord Howe Island, where individuals with $R = 225-245$ mm.¹ have been taken. Normally the dorsal surface is yellow or buff more or less blotched and marked with dark green. In extreme cases the green predominates, and in the largest known specimen the whole abactinal surface is a dark blackish green, "closer to black than to green." Near Fremantle the *Luidias* taken show no green but are cream color and chocolate brown. This very distinct color variety has been named "forma *brunnea*" (see H. L. Clark, 1938, p. 71). Neither the species nor the variety has been figured.

Luidia maculata

Müller and Troschel, 1842. Syst. Ast., p. 77.

Koehler, 1910a. Abhandl. Senckenb. Naturforsch. Gesellsch., vol. 33, p. 267; pl. 15, fig. 1.

Apparently this East Indian species reaches a larger size than *australiae*, as Koehler (1910a) reports one with $R = 350$ mm. As a rule there are 8 arms,

¹ A specimen from an unknown locality, possibly Lord Howe Island, has $R = 250$ mm.

but specimens with 6, 7, or 9 arms are reported from north of Australia. As yet *maculata* is known in Australian seas only from the vicinity of Broome, which lies almost directly south of the southernmost East Indian islands. The specimen reported from Thursday Island, Torres Strait, by Döderlein (1896a) is probably *australiae*, as are all the specimens listed by me (1909, 1916) from the coasts of Queensland, New South Wales, and South Australia. In coloration the two species are indistinguishable.

Family ASTROPECTINIDAE

Although this family is well represented in Australian waters, nearly all the species belong in the genus *Astropecten*. Döderlein made (1917) a most useful study of this genus, in which he recognized 66 species, 11 subspecies, and 8 varieties. He fails to make clear what distinguishes varieties from subspecies, but apparently his subspecies have, as is usual in zoology, a geographical significance which his varieties lack. His keys, discussion, and figures are of the greatest value to all students of this widespread family. Besides *Astropecten*, the family is represented in Australia by only 2 genera, each with a single deep-water species. The 3 genera may be easily distinguished by means of the following key:

KEY TO THE GENERA OF ASTROPECTINIDAE

- A. Supero- and inferomarginals nearly equally developed, forming more or less vertical lateral faces to ray:
 Inferomarginals touching adambulacrals throughout ray, as actinal intermediate plates are, for the most part, wanting *Astropecten*
 Inferomarginals separated, at least basally, from adambulacrals by actinal intermediate plates *Psilaster*
- AA. Superomarginals much smaller than inferomarginals and confined to abactinal surface *Dipsacaster*

ASTROPECTEN

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 180.

Genotype: *Asterias aranciaca* Linné, 1758, p. 662. Type first designated by Fisher, 1908, but both Gray and Fisher adopt Tiedemann's (1816) extensively emended spelling, *aurantiacus*.

This big cosmopolitan genus has, as already stated, been critically studied and revised by Döderlein (1917). He could not bring himself to break the group up into smaller genera, but he recognized 3 major divisions (Seriventrale Formen, Pluriventrale Formen, and Biventrale Formen). The first includes 7 species comprising the "*schayeri* Gruppe," the second includes 50 or more species, subspecies, and varieties arranged in 10 "Gruppen," and the third consists of 45 or more forms in 5 "Gruppen." These 16 "Gruppen" are of course subgenera, but apparently Döderlein did not consider them sufficiently well defined to warrant giving them names. Ultimately some of them will probably rank as distinct genera.

The 14 species of *Astropecten* now known from Australia are shallow-water sea stars, one or more of which have been taken wherever, on the coasts of the continent, collecting has been done. No species has yet been taken at Lord Howe Island, but dredging in the vicinity will probably yield at least one species. The Australian *Astropectens* include representatives of all 3 of Döderlein's primary

divisions, but the great majority are what he calls "Biventrale Formen." They may be distinguished as follows:

KEY TO THE SPECIES OF ASTROPECTEN

- A. Several series of ventrolateral plates on each side at base of arm:
 Short, stout, conical spine on inner margin of each superomarginal plate in interradial angle, but after third plate it is nearer outer margin; about 15-20 ventrolateral plates in each area *schayeri*
 No spines on basal superomarginal plates; about 30 ventrolateral plates in each area *synotomus*
- AA. Only a single series of ventrolateral plates on each side at base of arm (or, at most, some rudimentary additional plates):
 B. 3 or more ventrolateral plates on each side of arm base:
 At least 3 very large inferomarginal spines forming oblique comb on each plate *pectinatus*
 Not more than 1 conspicuous inferomarginal spine on each plate *problematicus*
- BB. Only 2 ventrolateral plates on each side (occasionally 3, very rarely 4, on one side of a mouth angle):
 C. All superomarginals narrower than long or high (or length and breadth about equal), with conspicuous stout acute spines, except on second (or second to fourth), which plates are somewhat dwarfed *polyacanthus*
- CC. Not as above:
 D. Distal superomarginals with spines:
 E. Most superomarginals with 3 or more spines *triseriatus*
 EE. Superomarginals with 2 or, more commonly, only a single spine:
 At least first superomarginal with a spine on its inner margin *vappa*
 No spine on inner margin of first superomarginals *carcharicus*
- DD. Distal superomarginals without spines:
 F. No superomarginal spines; covering of inferomarginals distinctly squamiform:
 G. Inferomarginals with at least a few distinct acute spines along distal margin *granulatus*
 GG. No acute spines along distal margin of inferomarginals:
 Inferomarginals with only single sharp marginal spine, below which are 1 or 2 enlarged scales *monacanthus*
 Inferomarginals with 2 flat, blunt marginal spines, the lower being smaller; along distal margin of each plate are 2 or 3 similar but smaller, elongated, wide scales *pulcherrimus*
- FF. At least first superomarginal plate with a stout spine on inner margin, or, if this is not evident, covering of inferomarginals is definitely spiniform:
 H. Below the large inferomarginal spine are 2 or 3 subequal spines, distalmost only a little the largest:
 First (and usually second) superomarginal with low, stout spine *velitarius*
 No such spines present *preissi*
- HH. Below large inferomarginal spine is single smaller spine on distal corner of plate *zebra*

Astropecten schayeri

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 60; pl. 1, fig. 1; pl. 7, figs. 1-1c.

This species was based on a single specimen in the Berlin Museum, taken by "Schayer in Tasmania." It has $R = 55$ mm., so is probably adult, but its relation to *pectinatus* Sladen is an open question. A large series of specimens may show that the two are identical. A second specimen of *schayeri*, very similar to the type in size and appearance, is in the Victoria National Museum at Melbourne. It was taken in 1879 at Portland, Victoria.

Astropecten syntomus

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 372; fig. 110.

This species was also based on a single specimen, with $R = 39$ mm., allied to *pectinatus*. It is evidently allied to the preceding species also, but the differences between the 2 type specimens are obvious. It is not unlikely, however, that sufficient material would show that both are individual variants of *pectinatus*. The unique holotype of *syntomus* is from an unknown locality, supposedly South Australian.

Astropecten pectinatus

Sladen, 1883. Jour. Linn. Soc. (Zool.), vol. 17, p. 251.

— 1889. "Challenger" Ast., p. 202; pl. 33, figs. 3, 4; pl. 37, figs. 4-6.

There is still much to be cleared up about the status of this species, and probably only a re-examination of the type material in the British Museum can determine whether it is identical with Döderlein's *schayeri* or not. The relationship to *vappa* (with which I confused it in 1909 and 1916) also needs further study, although it is probable that *pectinatus* is really distinct from that species. At present, Sladen's species is known only from Port Jackson, Bass Strait, Port Phillip, and South Australia. All the specimens are small, with $R = 48$ mm. or less.

Astropecten problematicus

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 163; pl. 6, fig. 7; pl. 15, figs. 4-4b.

This species rests on a single small, dry specimen, with $R = 47$ mm., in the Berlin Museum and supposed to be from Australia. Its validity and its right to a place in the Australian fauna are open to debate, but only more specimens with accurate locality labels can settle the matter.

Astropecten polyacanthus

Müller and Troschel, 1842. Syst. Ast., p. 69.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, pl. 4, figs. 4, 5.

This striking species is widespread in the Indo-Pacific area, ranging from the Red Sea and Zanzibar to the Hawaiian Islands, north to Yokohama, Japan, and south to Port Jackson, New South Wales, and the northern island of New Zealand.

The largest specimen I have found recorded has $R = 134$ mm. (Mauritius); in none of those in the Museum of Comparative Zoölogy does R exceed 105 mm. The color in life is recorded only for specimens from Port Jackson, in which "the paxillar area of the dorsal surface was deep purple, while the oral surface was more or less red-orange with the margins pale yellow; the marginal plates were more or less purplish dorsally but faded out into yellow orally." Museum specimens range from a light brownish yellow to deep dingy, or purplish, brown.

In Australian seas, this conspicuous sea star is apparently confined to the eastern coast as far south as Port Jackson. Although it is listed as from western and northwestern Australia (H. L. Clark, 1921, p. 192), no records from that region seem to have been published. It is, however, known from the Aru Islands.

Astropecten triseriatus

Müller and Troschel, 1843. Arch. f. Naturgesch., vol. 9, no. 1, p. 118.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, pl. 5, fig. 2.

This strikingly spiny species is apparently characteristic of the coast of Western Australia, as it has not yet been taken elsewhere. It is seldom collected (only 3 or 4 specimens are known), probably owing to some peculiarity in its manner of life or in its habitat. It reaches a rather large size ($R = 110$ mm.). The color in life (in the only recorded instance) is "grayish above, the sides of rays and lower surface, cream-color or yellowish."

Astropecten vappa

Müller and Troschel, 1843. Arch. f. Naturgesch., vol. 9, no. 1, p. 119.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 124; pl. 5, fig. 1.

Astropecten hartmeyer Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 156; pl. 5, fig. 8.

A critical examination of all the available material of *vappa* and *hartmeyer* leads to the conclusion that there are no constant, reliable differences between these species, supposed by Döderlein to be so distinct that he makes no comparison of the two. In my earlier report (1938) I followed his lead, chagrined by the fact that I had previously confused *vappa* with *pectinatus*. I gave (p. 67) an account of *vappa*, showing its occurrence on the Queensland coast as well as on the southern coast of Western Australia. But under *hartmeyer*, I listed (p. 62) 2 fine specimens of *vappa* from Augustus Island, which are exactly like specimens of the same size from Queensland, save for the pink tinge in their coloration. It seems clear that *vappa* is a common and widespread Australian species ranging from Augustus Island on the northern coast, westward and southward to Broome, Shark Bay, and Middleton Beach (Albany), eastward to the Great Australian Bight, Tasmania, and the coast of New South Wales, and northward to Lindeman Island, Queensland. Possibly it will be found on the northern coast of the continent between the Barrier Reef and Augustus Island, but it has not yet been reported from that extended coast line.

In life, *vappa* reaches a large size ($R = 125$ mm.), and the fully grown specimens tend to become a uniform dark brown. Specimens with R less than 50 mm. are light yellowish or cream color more or less mottled or marked with patches and blotches of gray; or the upper surface may be gray with margins and oral

surface cream color; the superomarginal spines may be tipped with bright brown-orange. Somewhat larger specimens ($R = 60-70$ mm.) have the upper surface variegated light and dark gray, the lower surface cream white.

Astropecten carcharicus

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 140; pl. 5, figs. 9, 10; pl. 13, figs. 7, 7a.

This species is based on 2 specimens of nearly equal size ($R = 70$ mm.) from Shark Bay, Western Australia. They differ rather markedly in the form of the inferomarginal spines, indicating that the species is variable in this character. Döderlein considers the species closely related to *A. hemprichi* of the Red Sea, Eastern Africa, and Southern Asia. He identifies a very similar *Astropecten* from the southern coast of Formosa as *carcharicus*, but lists it as a subspecies, *formosanus*. Probably all these names refer to a single species, which of course carries the oldest name, *hemprichi*. Much more material is necessary to settle the question.

Astropecten granulatus

Müller and Troschel, 1842. *Syst. Ast.*, p. 75.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 148; pl. 5, fig. 7.

H. L. Clark, 1938. *Mem. Mus. Comp. Zool.*, vol. 55, p. 60; pl. 1, fig. 1 (colored).

Although the type locality for this species is not known, its range is now fairly well established as northern and western Australia from Thursday Island, Torres Strait, to Fremantle, Western Australia. It is the common sea star at Broome, where it lives buried in the sandy mud just below the surface. Large specimens have R over 100 mm. The dorsal surface is deep bluish gray like the sandy mud in which the animal lives, with light brown blotches and markings. The lower surface and marginal spines are pure white.

Astropecten monacanthus

Sladen, 1883. *Jour. Linn. Soc. (Zool.)*, vol. 17, p. 263.

— 1889. "Challenger" Ast., pl. 33, figs. 7, 8.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 150; pl. 14, figs. 5-5b.

Although a very well marked species when dried and examined carefully, this *Astropecten* is much like the preceding and resembles it in color as well as in form. It is smaller, however, with R less than 50 mm.; at least, larger specimens are not yet known. It lives in somewhat deeper water than *granulatus* and hence was not nearly so easy to collect, even at Broome, where both species occur. It has a wider range, however, as it occurs on the East African coast, at the Andaman Islands, on the coast of India, in the China Sea, and in the East Indies, as well as in the Gulf of Carpentaria and on the coast of northwestern Australia.

Astropecten pulcherrimus

H. L. Clark, 1938. *Mem. Mus. Comp. Zool.*, vol. 55, p. 68; pl. 1, fig. 2 (colored).

All that is known of this beautiful sea star from Broome, Western Australia, is recorded in the original account.

Astropecten velitaris

von Martens, 1865. *Arch. f. Naturgesch.*, vol. 31, pt. 1, p. 360.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 159; pl. 6, figs. 5, 15, 16; pl. 15, figs. 3-3a.

This East Indian species occurs not uncommonly on the northwestern coast of Australia. It was found in Mermaid Strait by the "Gazelle" and we found it fairly common in Roebuck Bay, where it reaches, apparently, its maximum size, with $R = 96$ mm. The upper surface is fawn color in life, with 2 irregular cross-bands of a dark shade on distal half of arm; superomarginal plates purple or violet with the superomarginal spines orange, tipped with purple; lower surface and inferomarginal spines white.

Astropecten preissi

Müller and Troschel, 1843. *Arch. f. Naturgesch.*, vol. 9, no. 1, p. 119.

Döderlein, 1917. "Siboga" Ast.: *Astropecten*, p. 161; pl. 5, figs. 4-6.

This is the characteristic sea star of the Fremantle region, but ranges southward and eastward not only to the Albany region, but to Kangaroo Island and St. Vincent Gulf, South Australia. We dredged good series of specimens between Fremantle and Garden Island, with $R = 6-155$ mm. In the largest specimens $R = 71$ and a number of the superomarginals bear small, erect spines. There are, in life, 2 strikingly different color forms, one being yellowish brown or brown-orange, the other, rich violet. These colors are evanescent and disappear in preserved material. Possibly they are secondary sex characters. Döderlein's proposed subspecies *albanicus* is of dubious validity, being based on a variable character which is greatly affected by the manner of preservation.

Astropecten zebra

Sladen, 1883. *Jour. Linn. Soc. (Zool.)*, vol. 17, p. 261.

— 1889. "Challenger" Ast., p. 212; pl. 36, figs. 3, 4.

This is a very dubious species. All the known specimens, taken between India and Thursday Island, Torres Strait, are small (R less than 40 mm.) and apparently immature, except one from Torres Strait figured by Döderlein (1896a, p. 306; pl. 18, figs. 31, 31s). This specimen is so similar to *vappa* of the same size, there can be little doubt that it should be referred to that species; but some of the smaller specimens referred to *zebra* are not so much like *vappa*, and may represent a valid species. The varieties *rosea* Sladen and *sibogae* Döderlein are obviously of dubious value and must be considered unworthy of recognition until mature specimens of *zebra* are adequately characterized. Good series of *Astropectens* from the Aru Islands and New Guinea should enable us to clarify the status of *zebra*.

PSILASTER

Sladen, 1885. "Challenger" Exped. narrative, vol. 1, pt. 2, p. 611.

Genotype: *Astropecten andromeda* Müller and Troschel, 1842, p. 129.

This is a characteristic deep-water genus with a number of species from various regions. In the southern hemisphere, a single species common to Australia and South Africa has been found in water of very moderate depth, 80-245 fms.

Psilaster acuminatus

Sladen, 1889. "Challenger" Ast., p. 225; pl. 40, figs. 1, 2.

This species was first taken at the Cape of Good Hope at an unrecorded depth, by the "Challenger," late in 1873. A few months later it was taken off the eastern coast of New South Wales, in 950 fms., and a few days later off the western coast of New Zealand, in 150 fms. The South African record has been confirmed by the "Pieter Faure," 131-175 fms., and by Mortensen (1933), 143-245 fms. The Australian occurrence was proved by the "Endeavour," 80-200 fms., and the New Zealand by Mortensen (1925), 19-55 fms. Though these specimens show no little diversity in the details of spinulation, it seems to be reasonably sure that *Psilaster acuminatus* occurs in the continental zone of three widely separated land masses of the southern hemisphere. Its bathymetrical range, 19-950 fms., is no less remarkable.

DIPSACASTER

Alcock, 1893. Ann. Mag. Nat. Hist., ser. 6, vol. 11, p. 87.

Genotype: *Dipsacaster sladeni* Alcock, 1893, p. 87.

According to Fisher (1919), the notable sea star taken by the "Endeavour" in the Great Australian Bight and named *Lonchotaster magnificus* by me (1916) is more correctly regarded as a *Dipsacaster*.

Dipsacaster magnificus

Lonchotaster magnificus H. L. Clark, 1916. "Endeavour" rept., p. 30; pl. 6, figs. 1, 2.

Dipsacaster magnificus Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 150.

This fine species is still known only from the single specimen collected by the "Endeavour" in the Great Australian Bight in 80-120 fms. With R = 155 mm., it ranks among the largest of Australian sea stars.

Family BENTHOPECTINIDAE

This family is essentially a deep-water group and has a place here merely because a single Indian Ocean species occurs on the northwestern coast of Australia in less than 200 fms.

CHEIRASTER

Studer, 1883. Sitzungsber. Gesellsch. naturforsch. Freunde, Berlin, p. 130.

Genotype: *Cheiraster gazella* Studer, 1883, p. 130.

This widely distributed genus is represented in Australia solely by its type species, which was first taken by the "Gazelle" in Mermaid Strait, northwestern Australia.

Cheiraster gazellae

Studer, 1883. Sitzungsber. Gesellsch. naturforsch. Freunde, Berlin, p. 130.

— 1884. "Gazelle" Ast., p. 50; pl. 4, figs. 8a, b, c (amended spelling).

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 196; pl. 50; pl. 52, fig. 1.

The specimen on which this species was based had R = 61 mm., but the "Albatross" took scores in the Philippines in 195-256 fms., some of which were double that size. In life the "Gazelle" specimens were white beneath but clear orange above, with the genital bands showing through as red. Excepting the Mermaid Strait specimen, *Cheiraster* has not been taken in Australian waters.

Family ARCHASTERIDAE

This small tropical family, containing but a single genus, is represented on both the eastern and western coasts of Australia. There are 3 known species, and all have been reported from Australia.

ARCHASTER

Müller and Troschel, 1840. Ber. Verhandl. K. preuss. Akad. Wissensch., p. 104.

Genotype: *Archaster typicus* Müller and Troschel, 1840, p. 104.

The 3 species of *Archaster* seem to prefer sandy bottoms in shallow warm water. They are specially characteristic of the eastern Indian Ocean and do not occur in the Red or Arabian seas or on the East African coast or in New Zealand or Japan, but the range does extend to the Ryukyu, Gilbert, and Samoan islands. The following key shows how the species differ:

KEY TO THE SPECIES OF ARCHASTER

- A. Inferomarginal plates with single wide, flat spine at upper end, which is usually more or less appressed to superomarginal plate *typicus*
 AA. Inferomarginal plates with 2 or 3 enlarged flat scales at upper end:
 Paxillae of dorsal surface with short, cylindrical stumps more or less crowded but not making smooth surface *angulatus*
 Paxillae with low, flat, angular granules so crowded as to make a rather smooth pavement *laevis*

Archaster typicus

Müller and Troschel, 1840. Monatsber. K. preuss. Akad. Wissensch., p. 104.

— 1842. Syst. Ast., p. 65; pl. 5, fig. 2.

This is the best known of the Archasters and is very common in many places in the East Indian region. It does not seem to be common in Australian waters, but its range extends southward along the Barrier Reef at least to Lindeman Island, somewhat south of 20° S. lat. It has been reported from Torres Strait, and there is a specimen in the Museum of Comparative Zoölogy from Croker Island, Coburg Peninsula, about 133° E. long. Nevertheless, neither the "Challenger" nor Semon nor I found *Archaster* in the Torres Strait region. The "Alert" took it at Port Denison, but not elsewhere in Australian waters. It would not be unfair to consider it a relatively recent arrival in Australia from the East Indies, for it is abundant in western New Guinea and Amboina. It is the smallest of the 3 species, for specimens with R more than 80 mm. are rare. The color in life is said to be almost indistinguishable from that of the sand upon which the sea stars live. Museum specimens, however, sometimes show a uniformly orange-reddish color.

Archaster angulatus

Müller and Troschel, 1842. Syst. Ast., p. 66.

De Loriol, 1885. Mém. Soc. phys. hist. nat. Genève, vol. 29, no. 4, p. 78; pl. 22, figs. 2-2c.

This is the largest of the Archasters; one in the Museum of Comparative Zoölogy collection has R = 190 mm. It is the common species at Mauritius, but it seems to occur also in the Philippines and the East Indies. It has been reported from Torres Strait, Port Darwin, and Western Australia, but I think the records for Darwin and Torres Strait are misidentifications of *typicus*, and that from Western Australia probably refers to *laevis*. At any rate, the occurrence of *angulatus* in Australia very much needs confirmation.

Archaster laevis

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 75; pl. 17, fig. 2.

This is a characteristic species of Western Australia. As it was taken both in Roebuck Bay and off Fremantle, it may be expected to occur anywhere between those widely separated places in depths of 5-10 fms. It has longer and more slender rays than *typicus*, and R may exceed 120 mm. The lower surface is cream color or whitish, and the upper side is more or less yellow-brown variegated with light fawn gray, bluish gray, or dull light purple.

Family RADIASTERIDAE

This very small family is represented in Australia by a single species taken off southeastern Australia by the "Endeavour," and farther south in much deeper water by the Australasian Antarctic Expedition.

RADIASTER

E. Perrier, 1881. Bull. Mus. Comp. Zoöl., vol. 9, p. 17.

Genotype: *Radiaster elegans* Perrier, 1881, p. 17.

This genus, subsequently called *Mimaster* by Sladen, has been much discussed by Verrill and Fisher, as well as by Perrier and Sladen. Apparently, however, it is now agreed that it is best placed in a family of which it is considered the typical genus. Sladen's name *Mimaster* has been very generally used, but Fisher (1919) shows that *Radiaster* is structurally the same genus and as a name has a year's priority. The Australian species seems to be unquestionably congeneric with Perrier's West Indian genotype.

Radiaster gracilis

H. L. Clark, 1916. "Endeavour" rept., p. 33; pl. 7, figs. 1, 2.

The "Endeavour" took 5 specimens of this notable sea star in the vicinity of Gabo Island, Victoria, in 50-200 fms. Apparently it has been met with but once since then; the Australasian Antarctic Expedition took a specimen in December 1912, south of Maria Island, Tasmania, in 1300 fms. (see Koehler, 1920, p. 242; pl. 49, figs. 4, 18). The largest "Endeavour" specimen had R = 60 mm.; Koehler's specimen was somewhat smaller. The other species of the genus are from the North

Atlantic (Faeroe Channel), 516-555 fms.; South Pacific (off western coast of southern South America), 245-1325 fms.; and among the Molucca Islands, 569-647 fms.—surely a cosmopolitan distribution!

Family GONIASTERIDAE

This large and cosmopolitan family is well represented in Australia by some 19 genera, nearly half of which, if not actually peculiar to the continent, are definitely characteristic of it. They show extraordinary diversity in form and size, but most of them are relatively large and conspicuous. The most brilliantly colored and beautiful sea stars of Australia are with a few exceptions goniasterids. For the most part they live in shallow water (under 20 fms.), and very few occur at any considerable depth (over 100 fms.). The 20 genera may be distinguished as follows:

KEY TO THE GENERA OF GONIASTERIDAE¹

- I. Abactinal surface with paxilliform, tabulate, or markedly convex plates, not flat or covered with membrane:
 - A. Superomarginal plates not contiguous on rays, except sometimes at very tip:
 - B. Abactinal plates medium-sized or small, not conspicuously elevated; papulae single or in groups of 2 or 3:
 - Several series of abactinal plates extend to near tip of ray, one or more reaching terminal plate *Mediaster*
 - Only single series of plates extends to near tip of ray and none reaches terminal plate *Rosaster*
 - BB. Abactinal plates of disk very large, more or less conspicuously elevated; papulae in irregular scattered groups, often of 10 or more:
 - Large abactinal plates markedly convex, covered with coarse granules and often with low-pointed tubercle at center, but without any delimiting series of enlarged spinelets or granules *Nectriaster*
 - Large abactinal plates with big, more or less cylindrical tabulae, crowned with more or less flattened and often enlarged granules, surrounded by a sharply defined circle of short, wide spinelets or coarse, blocklike granules *Nectria*
 - AA. Superomarginal plates contiguous on long, slender rays *Nymphaster*
- II. Abactinal surface with flat or slightly convex, more or less circular, polygonal or stellate plates, smooth, granulose, or spiny:
 - C. Body not covered by a smooth or granular membrane:
 - D. Abactinal plates with upright spines or tubercles of considerable size; each marginal, with one or more rigid spines or tubercles *Calliaster*
 - DD. No considerable spines on rays or marginals, but some disk plates may carry tubercles:
 - E. Superomarginals not contiguous, except possibly a few distal pairs:
 - F. Last marginal in both upper and lower series enlarged; abactinal, marginal, and actinal intermediate plates smooth, bordered by single series of granules *Pentagonaster*

¹ The record of *Goniaster tessellatus* (Lamarck) from "Melbourne, Aust." (H. L. Clark, 1909a, Bull. Mus. Comp. Zoöl., vol. 52, p. 110) is entirely untrustworthy.

- FF. Not as above:
- G. All plates closely granulated and some at least bearing tubercles or spinelets:
- H. No large bivalve pedicellariae on actinal intermediate plates:
- Distal inferomarginals not extending out conspicuously beyond supermarginals; poriferous areas not covered by coarse, flat, polygonal granules *Goniodiscaster*
- Distal inferomarginals projecting conspicuously beyond supermarginals; poriferous areas closely covered with coarse, flat, polygonal granules *Styphlaster*
- HH. Actinal intermediate plates with large bivalve pedicellariae as in *Anthenea* *Pseudogoniodiscaster*
- GG. Abactinal plates smooth, at least centrally *Tosia*
- EE. Supermarginals contiguous on long, slender rays *Iconaster*
- CC. Body covered by membrane obscuring outlines of underlying plates:
- J. Granules on body surface minute, well spaced, or wanting:
- Granules numerous but minute and well spaced *Anthenoides*
- Granules wanting or nearly so, especially actinally *Ogmaster*
- JJ. Granules on body surface very numerous, flat and crowded, forming dense, smooth coating *Stellaster*
- III. Abactinal skeleton stellate-reticulate, overlaid by thick skin, obscuring plate outlines; marginal plates heavy, beset with large granules; actinal plates with coarse granules and huge bivalved pedicellariae:
- K. Dorsal surface and marginal plates closely covered with coat of flat-topped polygonal granules; some (often many) abactinal plates with large, smooth tubercle, which may however be replaced by 3-7 similar but smaller crowded tubercles *Anthaster*
- KK. Not as above:
- L. Supermarginal plates of interbrachial arcs with 1-3 spines on outer margin; many actinal intermediate plates with tuft of spines instead of usual pedicellariae; only 3 adambulacral spines in furrow series *Pseudanthenea*
- LL. Supermarginal plates with granules or tubercles or both, but no spines; no spines on actinal intermediate plates; more than 3 adambulacral spines in furrow series:
- M. Only 2 series of adambulacral spines; outer end of adambulacral plates bare and smooth (except on distal third of arm in some *Pseudoreasters*):
- Some aboral plates, often many, particularly in carinal series, with big hemispherical tubercles, 2-6 mm. in diameter; supermarginal plates more or less vertical with numerous coarse granules, upper end not forming conspicuous part of aboral surface *Pseudoreaster*
- Tubercles on aboral surface much less conspicuous, usually not 2 mm. in diameter; supermarginal plates with upper half bare and smooth, forming marginal border for aboral surface, with few (often only 2 or 3) small tubercles or coarse granules on lower half *Gymnanthenea*
- MM. Adambulacral spines in at least 3 series *Anthenea*

MEDIASTER

Stimpson, 1857. Boston Jour. Nat. Hist., vol. 6, p. 530.

Genotype: *Mediaster aequalis* Stimpson, 1857, p. 530.

This is a widely distributed genus occurring in shallow or moderately deep water, chiefly in the northern hemisphere, but 1 species occurs in South Africa, 1 in New Zealand, and 3 are Australian. These latter may be distinguished thus:

KEY TO THE SPECIES OF MEDIASTER

- A. Paxillae small and very numerous, with few granules (1-7) and marginal series on each, 1 granule often replaced by low, 2-jawed pedicellaria; rays very broad at base, tapering rapidly to nearly cylindrical tip *australiensis*
- AA. Paxillae relatively few, with coarse granules and no pedicellariae; rays not so broad at base, but flat and rather wide near tip:
- Interradial supermarginals narrow (i.e., short), much wider than long; paxillae covered with numerous crowded granules and slender marginal spinelets *boardmani*
- Interradial supermarginals broad, length and breadth nearly equal; paxillae with few coarse, spaced granules and a marginal series of thick, truncate spinelets *praestans*

Mediaster australiensis

H. L. Clark, 1916. "Endeavour" rept., p. 39; pl. 9, figs. 1, 2.

This fine sea star was taken by the "Endeavour" at three stations in Bass Strait and Tasmanian waters in 40-70 fms., but apparently has not been met with since. The attenuate arms and numerous paxillae are very distinctive.

Mediaster boardmani

Pseudarchaster boardmani Livingstone, 1934. Rec. Australian Mus., vol. 19, no. 3, p. 177; pl. 18, figs. 7-11.

This species is based on 4 specimens from off the coast of New South Wales in 75-90 fms., and apparently has not been taken since. Neither in the description nor in the figures of Livingstone is there any indication of the unpaired median tooth at the inner end of the oral plates which is characteristic of *Pseudarchaster*, and consequently it seems best to transfer the species to *Mediaster*; I have, however, never seen a specimen. Livingstone's description, including an account of the color in life, is most valuable.

Mediaster praestans

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 22; pl. 6.

A single specimen, with R scarcely 30 mm., taken off the Queensland coast, on the Great Barrier Reef, near Cairns, is the sole representative of this species yet known. The character of the paxillae distinguishes it from the preceding species. The color in life is not indicated.

ROSASTER

E. Perrier, 1884. Stell. "Travailleur" et "Talisman," p. 386.

Genotype: *Pentagonaster alexandri* Perrier, 1881, p. 22.

Although based on a West Indian sea star, this genus is characteristic of the East Indian area, where half a dozen species occur. One of these enters the northern part of the Australian area.

Rosaster symbolicus

Nymphaster symbolicus Sladen, 1889. "Challenger" Ast., p. 297; pl. 50, figs. 1, 2.
Rosaster symbolicus Fisher, 1913. Proc. U. S. Nat. Mus., vol. 43, p. 630.

As this species was taken by the "Challenger" at her station 188 near the western end of Torres Strait, in 28 fms., it must be included here, though the type locality is in the Philippines and the "Albatross" took it there twice. In the type specimen, R = 85 mm. and the color is given as "yellowish-white."

NECTRIASTER,¹ gen. nov.

Genotype: *Mediaster monacanthus* H. L. Clark, 1916, p. 41.

In the original description of this remarkable sea star, I suggested that it might be made the type of a new genus, intermediate between *Nectria* and *Mediaster*. In 1917, Fisher said he thought it belonged "unquestionably to *Nectria*." In 1925, however, Mortensen expressed his doubt of the wisdom of including *monacanthus* in *Nectria* and thought it better to make it "the type of a new genus between *Mediaster* and *Nectria*." On further study of the available material, Mortensen's opinion seems well justified, for the species does not fit well in either of the related genera. Accordingly, the following diagnosis of the genus is proposed: A group of Goniasteridae having the general character of *Mediaster* and *Nectria* but distinguished from both by the large convex but not tabulate abactinal plates, which lack any delimiting series of spinelets or enlarged granules. The interbranchial septa are markedly calcified and the papulae are in irregularly diffuse groups of from 6 to 18.

Nectriaster monacanthus

Mediaster monacanthus H. L. Clark, 1916. "Endeavour" rept., p. 41; pl. 10, figs. 1, 2.
Nectria monacantha Fisher, 1917. Ann. Mag. Nat. Hist., ser. 8, vol. 20, p. 167.

This very interesting sea star does not seem to have been taken since the "Endeavour" obtained 10 specimens in 47-50 fms., 6 miles east of Cape Hawke, New South Wales. Therefore nothing is yet known as to the color or appearance in life, or the geographical or bathymetrical distribution. It grows to a large size, with R = 100-110 mm., and the rich brown color of dry specimens suggests that the color in life is a deep red.

¹ The name indicates the intermediate position between *Mediaster* and *Nectria*.

NECTRIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 287.

Genotype: *Asterias ocellifera* Lamarck, 1816, vol. 2, p. 553 (by *lap. cal., oculifera*).

This characteristically Australian genus occurs along the southern coast of the continent from New South Wales to Western Australia, but neither the geographical nor the bathymetrical limits of its range are known. No records north of 38° seem to be known from the coast of New South Wales, but on the coast of Western Australia, *Nectria* has been taken between Fremantle and Geraldton, apparently at about 30°. The bathymetrical records are equally hazy, ranging from 30 to 120 fms. Probably, however, it occurs in much less than 30 fms. Mortensen (1925, p. 291) has recorded *Nectria* from New Zealand, a single specimen in the Otago Museum, found at Gisborne, representing an endemic species. Sladen (1889, p. 318) reports a specimen of *Nectria* from Cicia Island, Fiji, but this record needs confirmation, as it is not altogether unlikely that the single individual was brought to Fiji from Australia by a curio-loving sailor or traveler. The 4 Australian species of *Nectria* are easily distinguished by the following characters:

KEY TO THE SPECIES OF NECTRIA

- A. Furrow spines of adambulacral armature 2 to 4, usually 3; no conspicuous pedicellariae on actinal plates near mouth:
- B. Disk large, R = 2.5-3r or br; rays wide at base, tapering rapidly to tip; actinal plates with rounded or somewhat polygonal granules, not usually so crowded but that the series of actinal intermediate plates are easily seen:
- Dorsal tabulae with rounded or polygonal granules, often crowded, marginal ones thick, not flattened *ocellata*
- Dorsal tabulae with flat "granules" of very irregular shape and size, not at all crowded, marginal ones conspicuously flat and scalelike, forming regular, radiating marginal fringe *ocellifera*
- BB. Disk smaller, R = 3.5-4r or br; rays narrower at base, less tapering; actinal surface covered with crowded, coarse prismatic granules, obscuring series of actinal intermediate plates *macrobrachia*
- AA. Furrow spines 5 or 6; conspicuous pedicellariae on first series of actinal intermediate plates proximally; dorsal tabulae covered by large, closely appressed granules of which 1 to 6 at center are much the largest (1-2 mm. across) *multispina*

Nectria ocellata

E. Perrier, 1876. Arch. zool. exp., vol. 5, p. 4.
Sladen, 1889. "Challenger" Ast., pl. 55 (as *N. ocellifera*).

A re-examination of the literature and of all available specimens increases the conviction that Perrier was right in distinguishing the *Nectria* of southeastern Australia from that of the southwestern coast. Sladen's figures show the distinguishing dorsal paxillae admirably. So far as is now known, the range of *ocellata* is from the eastern coast of Tasmania to the western end of the Great Australian Bight in 30-120 fms. It is the largest species of the genus, with R = 120-130 mm. The color in life has been recorded but once; D. L. Serventy says (on label) that the 2 westernmost specimens (120° 22' 15" E.) were "chestnut-orange."

Nectria ocellifera

Asterias ocellifera Lamarck, 1816. Anim. sans vert., vol. 2, p. 553.

Oudart, 1815. Pl. 1.

Nectria oculifera (lap. cal.) Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 287.

Nectria ocellifera Gray, 1866. Syn. sp. starfish, p. 15.

Perrier (1876) discovered and demonstrated that Lamarck's species was not the common *Nectria* of southeastern Australia, but a smaller and less common species of Western Australia. According to Perrier, this sea star is figured by Oudart, 1815, plate 1, but it has not been possible to verify this, as Oudart's plate is not available in Cambridge. Lamarck says that Le Sueur assured him that in life the specimen was "un bon rouge." So far as available specimens show, *ocellifera* does not reach so large a size as *ocellata*, the largest west-coast specimen having $R = 83$ mm. The only known locality for *ocellifera* is the indefinite "between Fremantle and Geraldton, W. A., 60-100 fms." The label also says "color, orange."

Nectria macrobrachia

H. L. Clark, 1923a. Jour. Linn. Soc. (Zool.), vol. 35, p. 236; pl. 13, figs. 5, 6.

This species is known only from 2 specimens taken at Pelsart Island, in Houtman's Abrolhos, Western Australia, at an unrecorded depth. The larger has $R = 60$ mm. There are no notes on the color in life.

Nectria multispina

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 375; figs. IIIA, b.

This species is a little better known than the preceding, but data are lacking for the types. They were taken by Verco in his extensive dredging for mollusks, and hence are almost surely from either Spencer or St. Vincent Gulf, South Australia, at an unrecorded depth. The largest of the 4 specimens has $R = 80-85$ mm. The only other specimen known has $R = 75$ mm. It is "one of many" found in "drift on the sand beach at Middleton Beach," near Albany, Western Australia, "about Christmas, 1929," by E. W. Bennett. When it was collected the color was "orange" below and "red" above. Evidently the ranges of *ocellata* and *multispina* overlap on the southern coast of Western Australia.

NYMPHASTER

Sladen, 1885. "Challenger" Exped. narrative, vol. 1, pt. 2, p. 612 (no species designated).
— 1889. "Challenger" Ast., p. 294.

Genotype: *Nymphaster protentus* Sladen, 1889, p. 303. Type designated by Fisher, 1917, p. 168.

This widespread deep-water genus has been found twice in Australian seas, but it is apparently only on the outer edge of that fauna. The 2 species are evidently much alike, but may be distinguished thus:

Rays long and slender, $R =$ about 4r; superomarginals short and numerous,
30-40, about 10 on each side of disk; numerous pedicellariae *moebii*

Rays shorter and wider, $R =$ about 3r; superomarginals longer, flatter, and fewer, about 20, only 8 on each side of disk; no pedicellariae *pentagonus*

Nymphaster moebii

Pentagonaster (*Dorigona*) *moebii* Studer, 1884. "Gazelle" Ast., p. 35.

Nymphaster moebii Sladen, 1889. "Challenger" Ast., p. 869.

Macan, 1938. John Murray Exped. Ast., p. 375; pl. 4.

Studer's species was discovered by the "Gazelle" in 195 fms. of water off the northwestern coast of Australia. The color in life was clear orange above and white below. According to Macan (1938), the species reaches a large size ($R = 112$ mm.) and is very variable in details of structure. It is common in the Zanzibar area and occurs also in the Gulf of Aden and in the Maldives. The "Siboga" met with *moebii* twice (Döderlein, 1924) in the East Indies, but the "Albatross" did not find it in the Philippines (Fisher, 1919).

Nymphaster pentagonus

H. L. Clark, 1916. "Endeavour" rept., p. 36; pl. 8.

This sea star is still known only from the unique holotype in the Australian Museum, which was taken in 250-450 fms. in the Great Australian Bight, south of the boundary between South and Western Australia. It is extraordinary that the genus should occur there, as it is not elsewhere known south of 20° S. lat. The type has $R =$ about 60 mm. (all the arms are broken) and gives no hint as to the color in life.

CALLIASTER

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 280.

Genotype: *Calliaster childreni* Gray, 1840, p. 280.

The 2 Australian species of this Indo-Pacific genus are so unlike in general appearance that one hesitates to call them congeneric, but as each was based on a single specimen, it seems best to await more material before attempting to discuss their relationship. Moreover, one is the largest *Calliaster* as yet described, and the other is scarcely one-fourth as large. The two may be easily distinguished thus:

Superomarginal plates very large, contiguous for nearly whole length of ray,
each one smooth and bearing only a single huge, pointed spine *erucaradiatus*
Superomarginal plates relatively small, not contiguous, each bearing granules
and a rather conspicuous blunt spine, diminishing distally *spinatus*

Calliaster erucaradiatus

Livingstone, 1936. Rec. Australian Mus., vol. 19, p. 383; pl. 27.

The single specimen on which this species rests was taken "about 11 miles off Crowdy Head, N. S. W., bearing north by west, 50 fms.," by Captain K. Möller of the trawler "Ben Bow," in September 1935. As $R =$ only 34 mm., it probably is not adult, but the general stoutness of the plates indicates maturity. The specimen is no. J5996 in the Australian Museum.

Calliaster spinosus

H. L. Clark, 1916. "Endeavour" rept., p. 44; pl. 11.

The unique holotype of this species, in the Australian Museum, has $R = 140$ mm. and hence is 4 times the size of the preceding. It was taken on the eastern slope of Bass Strait in 80–200 fms. The dry specimen is pale yellowish brown, but nothing is recorded as to the color in life.

PENTAGONASTER

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 280.

Genotype: *Pentagonaster pulchellus* Gray, 1840, p. 280.

There is no more elastic name among sea stars (save *Asterias*) than *Pentagonaster*, first introduced by Linck (1733) for 2 species and used a hundred and fifty years later by Sladen (1889) for 49 species, with one of Linck's species as the type. This action of Sladen is of purely historic interest, since modern zoology does not accept pre-Linnaean names. The first post-Linnaean writer to use the name was Gray (1840), who included only the single species *pulchellus*, but later (1866) with his usual keen systematic sense added 2 congeneric species. E. Perrier (1875), however, with his lack of systematic sense, adopted the name *Pentagonaster* of Linck and included under it 8 of Gray's genera, listing 27 species. Sladen followed his lead, although he rearranged some of the related genera. Verrill (1899) and Fisher (1911) have straightened the matter out, and the use of *Pentagonaster* is now restricted to the New Zealand and Australian sea stars typified by *P. pulchellus* Gray. There has been some doubt as to the number of species known from Australia, since Perrier and Sladen both treat Gray's *Astrogonium inaequale* as a *Pentagonaster* and Sladen records it as from Endeavour River, northern Queensland. It seems improbable that Gray would have failed to call his species a *Pentagonaster* if it were really congeneric with *pulchellus*, and his description does not conform to the generic diagnosis. The species had best be ignored until further material is discovered. Only 2 species therefore are included here, and are to be distinguished thus:

Rays more or less tapering to blunt point; when $R = 35$ mm. or more, there are 5 (or more) superomarginals and 7 (or 6) inferomarginals on each side of each ray	<i>dübeni</i>
Rays expanded at tip, distalmost superomarginal (of which there are 4 or only 3) very large; inferomarginals 5 (or 6)	<i>crassimanus</i>

Pentagonaster dübeni

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 79.
— 1866. Syn. sp. starfish, p. 11; pl. 3, fig. 2.

There seems to be no room for question that this is the common *Pentagonaster* of southeastern Australia. Gray gives "Western Australia" as the place whence his specimen came; but since he gives "China" as the locality for his species *pulchellus*, and we now know it must have come from New Zealand, it is justifiable to believe that the type of *dübeni* came from southeastern, and not western, Australia.

Under a stone in Watson's Bay, Port Jackson, a specimen was found August 25, 1913, which was conspicuous for its lovely coloration; the ground color was a bright vermilion red, but the plates were all outlined in milk white in sharp contrast. There is apparently no published statement concerning the color in life. The largest reported specimen has $R = 67$ mm., with 8 superomarginals on each side of each ray (see H. L. Clark, 1928, p. 380). The limits of the range of this species are not known; it certainly occurs in Port Jackson, New South Wales, and in St. Vincent Gulf, South Australia, but how far north or west it may go we have no information, nor are there any Tasmanian records. Specimens reported from Western Australia (H. L. Clark, 1938, for example) should be referred to the following species.

Pentagonaster crassimanus

Astrogonium crassimanum Möbius, 1859. Neue Seesterne, p. 8; pl. 2, figs. 1, 2.
Pentagonaster abnormalis Gray, 1866. Syn. sp. starfish, p. 11; pl. 8, figs. 1, 2.
Astrogonium crassissimum Gray, 1866. Syn. sp. starfish, p. 11.
Pentagonaster stibarum H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 136; pl. 17.
Pentagonaster dübeni H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 79.

Mortensen (1925) first suggested that *stibarum* was identical with *crassimanus*. The collecting of Western Australian material in 1929 and study of all the now available specimens of *Pentagonaster* proves he is probably correct. The chief debatable point is whether *crassimanus* is really distinct from *dübeni*. It is quite possible that material collected between Fremantle and Albany, Western Australia, would show that the two forms intergrade. Indeed, large series of specimens from any area might show the same thing. But in the absence of such material, it may be well to keep the two forms separate. That Möbius says his specimen was from "Ostindien" cannot be considered an insuperable difficulty, for there is plenty of evidence that in the first half of the nineteenth century, the terms India, China, East Indies, and Australia were very ill defined and vaguely used. No sea star similar to *Pentagonaster* is known from the East Indian region, in spite of all the collecting done in recent years by the "Investigator," "Siboga," and "Albatross." There can be little doubt that Möbius' type was from Australia, and apparently it was from the Swan River region.

One of the best reasons for keeping *crassimanus* distinct from *dübeni* is that the young are so different. In a specimen of *crassimanus* 17–18 mm. across, there are rather more than 40 dorsal plates and 20 relatively very large superomarginals, besides 5 plump terminals. But in a specimen of *dübeni* of the same size, there are more than 100 dorsal plates (many very small) and 40 superomarginals, besides 5 relatively wide terminals. Only 1 example of each species as small as this is available, but it is hard to doubt that they show real specific differences.

So far as color notes are available, the western species, *crassimanus*, tends to be orange rather than red, but it is doubtful how reliable a character this is, for of 4 specimens taken at Point Peron, Western Australia, in October 1929, 1 was vermilion and 1 a deeper red.

The range of *crassimanus* is quite unknown. It seems to be common at Point Peron, Western Australia, in water near low-tide mark, under stones. It is apparently not rare at the Abrolhos Islands in similar situations, but it has also been taken in 40–100 fms. between Fremantle and Geraldton. Presumably it

will be found farther south and possibly north to Shark Bay, but whether it reaches the region of Albany needs demonstrating.

GONIODISCASTER

H. L. Clark, 1909a. Bull. Mus. Comp. Zool., vol. 52, no. 7, p. 110.

Genotype: *Asterias pleyadella* Lamarck, 1816, vol. 2, p. 553.

This is one of the most characteristic genera of the sea stars in the Australian fauna, for although it occurs in the East Indies and Philippines, it is along the tropical coast of Australia that it shows its greatest abundance and diversity. The colors in life are, so far as known, striking, and several species must be ranked among the most beautiful of sea stars. The 8 Australian species may be distinguished as follows:

KEY TO THE SPECIES OF GONIODISCASTER

- A. Primary radial plates each with a stout, pointed tubercle, relatively big:
 Arms relatively wide nearly to rounded tip; $R = 2.5r$ or less *pleyadella*
 Arms tapering evenly to blunt tip; $R = 2.5r$ or more *integer*
- AA. Primary radial plates with no single large tubercle:
 B. Arms relatively long, tapering evenly to tip; $R = 2.5-3.5r$:
 Dorsal surface rough, with many coarse granules and pointed tubercles; R scarcely $3br$ *australiae*
 Dorsal surface more finely granulated; $R = 3.5br$ *coppingeri*
- BB. Arms shorter, relatively wider distally, and blunter; R less than $2.5r$, usually nearer 2 :
 C. Dorsal plates with coarse granules and small, pointed tubercles; small pedicellariae not excessively numerous:
 D. Superomarginals very short and wide, forming much of dorsal surface of ray:
 Aboral surface bluish gray, with marginal plates and coarsest granules and tubercles bright brick red *acanthodes*
 Disk and arm bases clear gray; remainder of arms bright rose red *bicolor*
- DD. Superomarginals about as long as wide, not forming much of dorsal surface of ray *seriatus*
- CC. Dorsal plates without coarse granules and pointed tubercles but with very numerous small pedicellariae *foraminatus*

Goniodiscaster pleyadella

Asterias pleyadella Lamarck, 1816. Anim. sans vert., vol. 2, p. 553.

Goniodiscus pleyadella Döderlein, 1896a. Semon's Ast., in Jena Denkschr., vol. 8, p. 308; pl. 18, figs. 34-34f.

Goniodiscaster pleyadella H. L. Clark, 1909a. Bull. Mus. Comp. Zool., vol. 52, no. 7, p. 110.

This does not seem to be a very common sea star, for on none of my three visits to tropical Australia was a specimen taken, nor did the Great Barrier Reef Expedition find it. The "Alert," however, took specimens in Torres Strait, in 3-5 fms., which Bell (1884) described as a new species, *Pentagonaster validus*. Semon also obtained specimens in Torres Strait, 3 small individuals at Thursday

Island, which Döderlein (1896a) recognized as Lamarck's species. The largest of these Torres Strait specimens had $R = 72$ mm. No notes on the color in life are recorded.

Goniodiscaster integer

Livingstone, 1931a. Rec. Australian Mus., vol. 18, p. 135; pls. 17-19.

This seems to be a typical Barrier Reef species, having been taken at Lindeman Island, in Port Curtis, and near Peel Island, Moreton Bay. The largest individual has $R = 99$ mm., but most of those so far taken are much smaller, the smallest having $R = 18$ mm. Nothing has been recorded as to color.

Goniodiscaster australiae

Tortonese, 1935. Bull. Mus. zool. Univ. Torino, vol. 45, ser. 3, no. 60, p. 3; pl. 1.

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 80; pl. 8, fig. 2 (colored).

This is one of the most beautiful sea stars in the rich marine fauna of north-western Australia, and is by no means rare in the vicinity of Broome in water 5-18 fms. deep. The single dry specimen on which Tortonese based the species was collected by the Italian vessel "Calabria" in "Australia occidentale"; whether this means in the vicinity of Broome is not determinable. All the material of the Museum of Comparative Zoology is from that area. The smallest specimens are not notably different from the adults in color or form, but the largest have the disk more elevated and the arm bases wider. The beautiful diversity in color (deep rose pink, with or without more or less grass green or light gray or blackish) does not seem to be associated with size, though it may be with age or sex.

Goniodiscaster coppingeri

Pentagonaster coppingeri Bell, 1884. "Alert" rept., p. 128.

Goniodiscaster coppingeri H. L. Clark, 1909a. Bull. Mus. Comp. Zool., vol. 52, no. 7, p. 110.

— 1921. Ech. Torres Strait, pl. 23, figs. 1, 2.

This species seems to be confined to the northern end of the Barrier Reef, the northern coast of Queensland, and the eastern coast of the Northern Territory. It occurs as far south as Port Curtis and as far west as Cape Bedwell, Northern Territory, but we did not find it near Darwin. The specimen taken at Cape Bedwell was found in the sand near low-water mark by Melbourne Ward, who kindly presented it to the Museum of Comparative Zoology. It is the largest specimen yet reported, having $R = 93$ mm. and $r = 26$. The color above is much like that of Bell's larger specimen, "slate," not at all red like the specimen from Adolphus Island, nor deep yellow-brown like those from Lindeman Island. The lower surface is light olive brown, very different from any other specimen seen. Information on the color in life is much to be desired.

Goniodiscaster acanthodes

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 84; pl. 5, fig. 2 (colored).

No further information is available concerning this lovely species from Broome.

Goniodiscaster bicolor

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 87; pl. 5, fig. 1 (colored).

No further data are available than those given with the original description. It is greatly to be regretted that the striking colors of life are so fugacious, the original specimens are now only light yellowish brown.

Goniodiscaster seriatus

Goniodiscus seriatus Müller and Troschel, 1843. Arch. f. Naturgesch., vol. 9, no. 1, p. 117.
Goniodiscaster seriatus Döderlein, 1935. "Siboga" Ast.: Oreasteridae, p. 80; pl. 20, fig. 5; pl. 21, figs. 4, 4^a.

This species is the least known of the Australian *Goniodiscaster*s, not having been taken in recent years. The type has $R = 78$ mm., and a paratype, also in Berlin, is only half as large. No other specimens are extant apparently, but Döderlein thinks that the 2 young *Goniodiscaster*s on which Gray (1847) based his *Pentaceros granulatus* probably represented this species. Possibly these specimens are in the British Museum, but Sladen (1889) does not seem to have seen them. They were said to be from Western Australia, whereas the types are recorded as from "Südwest-Australien."

Goniodiscaster foraminatus

Goniodiscus foraminatus Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 415.
Goniodiscaster foraminatus Döderlein, 1935. "Siboga" Ast.: Oreasteridae, p. 79; pl. 20, fig. 6; pl. 21, figs. 5-5b.

This species is based on a series of specimens from Shark Bay, Western Australia, 7-11 fms. They ranged in size from $R = 34$ mm. to $R = 69$ mm. The only other specimen as yet known is no. 9018 in the Western Australian Museum, $R = 35$ mm., taken off Garden Island, near Fremantle, Western Australia. This individual is undoubtedly young, and the specific characters are not very convincingly developed.

STYPHLASTER

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 88.

Genotype: *Styphlaster notabilis* H. L. Clark, 1938, p. 88.

This is a very well marked genus so far as can be determined from a single specimen, but its relationship to *Goniodiscaster* is fairly obvious.

Styphlaster notabilis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 89; pl. 17, figs. 3, 4.

A full account of the unique holotype, which was dredged at Broome, and of the circumstances under which it was taken, was given in the original description of the species.

PSEUDOGONIODISCATER

Livingstone, 1930. Rec. Australian Mus., vol. 18, no. 1, p. 15.

Genotype: *Pseudogoniodiscaster wardi* Livingstone, 1930, p. 16.

This is a very striking genus, actinally like *Anthenea* but abactinally very different. Its relationship with *Goniodiscaster* is not so obvious, but on the whole it is nearer to this genus than to the *Antheneinae*. It is monotypic.

Pseudogoniodiscaster wardi

Livingstone, 1930. Rec. Australian Mus., vol. 18, no. 1, p. 16; pl. 4, figs. 1, 2; pl. 5, figs. 1-3.

It is interesting to know that such novelties as this are still to be found on the Queensland coast. Nothing is known as to the distribution. The unique type, with $R = 77$ mm., was taken by Melbourne Ward, among "weeds," at Rat Island, near Curtis Island, Port Curtis, Queensland. Aborally the color was a dark green, like the "weeds" among which it was found.

TOSIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 281.

Genotype: *Tosia australis* Gray, 1840, p. 281.

This is a typical genus of southern Australia, occurring as far north on the eastern coast as the Capricorn Islets ($23^{\circ} 27'$ S.), but on the western not known to occur north of 30° . It is as yet unknown from New South Wales, although well known from Tasmania. The South African *Tosia tuberculata* is not closely related to the Australian *Tosias*, and is better placed in a separate genus. Livingstone (1932a) has made a careful study of the Australian *Tosias*, recognizing 4 species and a variety. His conclusions are adopted here. The species *grandis* and *rubra* of Gray, and *Astrogonium nobile* and *ornatum* of Müller and Troschel, are probably based on variants of the species *australis* and *aurata*. The following key is adapted from Livingstone:

KEY TO THE SPECIES OF TOSIA

- A. Terminal plate small and inconspicuous:
 - B. Superomarginal plates 6-8 on each side of the more or less pentagonal body:
 - C. Interbrachial arcs rounded, $R = 1.5r$ or less; no actinal pedicellariae:
 - Abactinal and superomarginal plates not markedly convex *australis*
 - Abactinal plates and especially superomarginals more or less convex *australis forma astrologorum*
 - CC. Interbrachial arcs comparatively acute, $R = 1.6-1.9r$; minute actinal pedicellariae *tubercularis*
 - BB. Superomarginal plates 10-16 on each side *aurata*
 - AA. Terminal plate large, as big as or bigger than any superomarginal *queenslandensis*

Tosia australis

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 281.
Livingstone, 1932a. Rec. Australian Mus., vol. 18, no. 7, p. 375; pl. 43, figs. 1, 2, 10-13; pl. 44, fig. 6.

This is the commonest and most wide-ranging member of the genus, having been taken at many places from King Island and Hobart, Tasmania, on the east to Fremantle, Western Australia, on the west. Most specimens are so nearly pentagonal that it is natural to say, in speaking of their size, that the largest specimens are 70-72 mm. across. In life, the color ranges from "deep brown, variegated with fawn color above, cream-color variegated with brown below" to "dark gray variegated with a light bluish gray." Although inert in habit, these curious sea stars are capable of no little activity and may be found climbing wharf piles.

The forma *astrologorum* is an extreme morphological variant which is easily recognized but occurs with the typical form and has not become sufficiently differentiated from it to warrant being given varietal status. It may be found wherever *australis* occurs. For a more detailed discussion of *australis* and forma *astrologorum* see H. L. Clark, 1938, pages 381-384.

Tosia tubercularis

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 81.
Livingstone, 1932a. Rec. Australian Mus., vol. 18, no. 7, p. 378; pl. 44, figs. 1, 2, 7.

This is apparently either a rare or a local species, of which I have never seen a specimen. Livingstone's account indicates its occurrence on the coast of Victoria, but the type locality was "Swan River" (i.e., Western Australia). Gray's figures (1866, pl. 16, figs. 4, 4a) indicate that $R = 30$ mm., whereas Livingstone's specimens were all much smaller, the largest having $R = 23.5$ mm. Probably *tubercularis* is a form of *australis* of the same rank as *astrologorum*.

Tosia aurata

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 80.
Livingstone, 1932a. Rec. Australian Mus., vol. 18, no. 7, p. 377; pl. 43, figs. 3-9; pl. 44, fig. 8.

Though Livingstone's account and figures amply validate this species, which ranges from Hobart to Fremantle, the ratio of R to r shows considerable diversity. Thus, a specimen from Victoria in the Museum of Comparative Zoology has $R = 60$ mm. and $r = 39$, hence $R = 1.5r$; a second Victorian specimen has $R = 63$ mm. and $r =$ only 34, so $R = 1.9r$. Specimens collected in Ralph Bay, Hobart, Tasmania were, in life, variegated brown and fawn color above, grayish fawn color and brown below.

Tosia queenslandensis

Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 243; pl. 5, figs. 1, 2, 7.

The relationship of this sea star is still in doubt, for its geographical isolation (Capricorn and Low Isles, Queensland) and its color in life (crimson) set it apart from all the other *Tosias*, and the color suggests *Pentagonaster dubeni*. The

original specimens (holotype and 2 paratypes) are all small (R only 17 mm. or less) and probably immature. When larger specimens are obtained, it is not impossible that a new genus will be desirable.

ICONASTER

Sladen, 1889. "Challenger" Ast., p. 261.

Genotype: *Astrogonium longimanum* Möbius, 1859, p. 7.

Whether this genus is monotypic or not depends on whether we use Fisher's (1919) name *Glyphodiscus* as a generic or subgeneric name. Bell's (1909) species, *gardineri*, belongs in *Nymphaster*, according to Fisher (1919), but the latter's *Glyphodiscus perierctus* looks so much like *Astroceramus*, it is hard to call it an *Iconaster*. It is not unreasonable, therefore, to consider *longimanus* the only known species of *Iconaster*.

Iconaster longimanus

Astrogonium longimanum Möbius, 1859. Neue Seesterne, p. 7.
Iconaster longimanus Sladen, 1889. "Challenger" Ast., p. 261.
Fisher, 1919. Bull. 100 U. S. Nat. Mus., p. 303; pl. 77, fig. 2; pl. 104, fig. 3.

This is an apparently uncommon but rather widely distributed East Indian sea star, ranging as far south on the Australian coast as Percy Isles, Queensland, and as far west as Broome, Western Australia. The "Siboga" met with it at only three widely separated places, and the "Albatross" took it but once in the Philippines. The largest reported specimen has $R = 110$ mm. The color in life is light orange-brown, with the interradial areas reddish brown; on the upper side of each arm are two parallel cream-white lines.

ANTHENOIDES

E. Perrier, 1881. Bull. Mus. Comp. Zool., vol. 9, p. 23.

Genotype: *Anthenoides peircei* Perrier, 1881, p. 23.

This genus, originally monotypic, now contains no fewer than 9 supposedly distinct species. The genotype is a West Indian sea star, but all its congeners are from the Indo-Pacific region, the range extending from Natal to Hawaii. It is not strange, therefore, that a single small species is found on the northwestern coast of Australia.

Anthenoides dubius

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 91; pl. 17, figs. 5, 6.

There can be little doubt that all the known specimens of this species are immature, and its actual status is therefore still open to question. The largest specimen has R only 18 mm. All were taken near Broome or in Lagrange Bay, Western Australia. The color in life was pale olive gray above, somewhat variegated with a darker shade; terminal plates and a band on distal half of arm, darker; lower surface pure white.

OGMASTER

von Martens, 1865. Arch. f. Naturgesch., vol. 31, pt. 1, p. 359 (as a subgenus of *Goniaster*).
Sladen, 1889. "Challenger" Ast., p. 261.

Genotype: *Goniodiscus capella* Müller and Troschel, 1842, p. 61.

This monotypic genus has been universally recognized as distinct from its nearest relatives, but owing to the scarcity of material its position in the Goniasteridae seems to be still debatable. Neither the "Challenger" nor the "Albatross" met with *Ogmaster* in the East Indian region, but the "Siboga" took 3 very young individuals near Timor and the Kei Islands, and the "Investigator" found it twice in the vicinity of the Andaman Islands. Its occurrence on the coast of Queensland is quite unexpected.

Ogmaster capella

Goniodiscus capella Müller and Troschel, 1842. Syst. Ast., p. 61.

Goniaster (Ogmaster) capella von Martens, 1865. Arch. f. Naturgesch., vol. 31, pt. 1, p. 359.

Dorigona reevesii Gray, 1866. Syn. sp. starfish, p. 7; pl. 7, fig. 3 (*Dongona*, by error).

Ogmaster capella Sladen, 1889. "Challenger" Ast., p. 261.

Koehler, 1910. Indian Mus. Ast., pt. 6, p. 79; pl. 3, fig. 12.

In spite of Gray's statement that this sea star is "common in boxes of insects brought from China and Japan," it is today one of the rarest of sea stars in museums. Goto (1914) says, "The occurrence of this species in Japan is questionable." There are no definite records from China or India, although Döderlein (1935) refers to a single specimen from "China." Leipoldt (1895) reports 3 young specimens from Assab, near the southern end of the Red Sea, but the "Mabahiss" (John Murray Expedition) failed to find *Ogmaster* anywhere. The only Australian record is that of 5 specimens taken by the "Endeavour," northeast of the Capricorn group, off Port Curtis, Queensland, in 50-75 fms. One of these, now in the Museum of Comparative Zoölogy collection, has R = 42 mm. and reveals well the generic characters of a thin, nongranular, naked covering membrane and the total absence of marginal spines. The resemblance to *Anthenoides* is little more evident than to *Stellaster*. The dry specimen is a rather bright yellow-brown, but no information is available as to the color in life.

STELLASTER

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 277.

Genotype: *Stellaster childreni* Gray, 1840, p. 278.

Döderlein's (1935) extended treatment of this fine genus is unsatisfactory, as he designates a half-dozen species and under the sixth lists a dozen named forms. This sixth species he calls *Asterias equestris* Retzius (1820), dividing it into 2 groups, the *childreni* group and the *incei* group. The type of the genus must be in the first group, since he uses Gray's name, *childreni*, for it. The other group includes the commonest Australian *Stellaster*, which he fails to define satisfactorily. He also fails to see that he has redescribed *inspinosus* H. L. Clark under the name *gibbosus*, and he has overlooked *megaloprepes* H. L. Clark—perhaps luckily, as the name is a pure synonym of *princeps* Sladen.

The Australian *Stellasters* do not seem to offer as great difficulties in identification. Besides the 3 well marked species, so striking a feature of the tropical Australian marine fauna, only 1 other need be included here. This is *S. squamulosus* Studer, the type of which Döderlein examined and validates. Perrier's *S. granulatus*, supposed to be from New South Wales, may well be ignored, as Döderlein was unable to identify it from Perrier's description, and only *S. incei* occurs as far south as New South Wales.

KEY TO THE SPECIES OF STELLASTER

- A. Granules around papulae conspicuously swollen and scalelike. *squamulosus*
 AA. Granules around papulae not notably swollen and scalelike:
 B. Many spines on inferomarginal plates; lower surface in life white, with large circular purple area around mouth. *princeps*
 BB. Only 1 inferomarginal spine, or none; lower surface not purple and white:
 Inferomarginal spine usually present; larger plates of disk flat or slightly convex; many abactinal plates carry a bluntly pointed tubercle; abactinal surface in life brown; no red. *incei*
 Inferomarginal spine commonly wanting; larger plates of disk convex or swollen; few, if any, abactinal plates carry tubercles; abactinal surface and many actinal intermediate plates in life deep blood red. *inspinosus*

Stellaster squamulosus

Studer, 1884. "Gazelle" Ast., p. 33; pl. 4, figs. 6a-c.

There is no question that the unique holotype of this species, taken off north-western Australia in 110 fms., is very young. That it is a young *Stellaster princeps* seems to me quite probable. Studer frequently gives the colors in life of his sea stars, but in this case he does not. None of the specimens of *princeps* in our Broome collections are anywhere near small enough to make comparisons with the type of *squamulosus* of any use.

Stellaster princeps

Sladen, 1889. "Challenger" Ast., p. 323; pl. 58, figs. 1-3.

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 98; pl. 4 (colored).

Stellaster megaloprepes H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 141; pl. 18.

This is the largest and most striking in its appearance of all the *Stellasters*, and well deserves the specific name bestowed on it by Sladen. It occurs only on the northern coast of Australia, from Booby Island to Port Hedland, Western Australia. Save for the "Challenger" specimen from Booby Island, it has not been found as yet east of Broome. It reaches a very large size, with R = 150 mm. and the height nearly 40 mm. The coloration (see H. L. Clark, 1938) is correspondingly striking.

Stellaster incei

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 76.

H. L. Clark, 1916. "Endeavour" rept., p. 47; pl. 12.

— 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 94; pl. 2, figs. 1, 2 (colored).

The common *Stellaster* of the Australian coast ranges from northern New South Wales, in 18-74 fms., to Lagrange Bay, Western Australia, 5-18 fms.¹ Very large specimens have $R = 75-90$ mm., and Bell (1884) reports one with $R = 120$ mm. There is very great diversity in the ratio of R to r and to br , for R may be only $2r$ or may exceed $3r$. There is an equal diversity in the matter of tubercles on the dorsal surface. Usually there are tubercles on the radial plates and often on the carinals; in many specimens there are additional tubercles both on disk and on rays; rarely they occur on the superomarginal plates also. In many specimens with $R = 40$ mm. or less, and even in some with $R = 50-60$ mm., tubercles are entirely wanting. On the whole, the absence of tubercles or their presence and number make very untrustworthy specific or varietal characters in this sea star. So far as is known, the brown dorsal side is characteristic of *incei*, and the occurrence of dusky or nearly black actinolateral plates, particularly in the series adjoining the adambulacrals, is a marked specific character even though the number and position of such plates is subject to great diversity.

Stellaster inspinosus

H. L. Clark, 1916. "Endeavour" rept., p. 48; pl. 13.

— 1938. Mem. Mus. Comp. Zool., vol. 55, p. 97; pl. 3 (colored).

Stellaster gibbosus Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 412.

Although museum specimens of this *Stellaster* resemble many representatives of the preceding species, the appearance in life is so different that it would be impossible to confuse the two. Döderlein's types were from Barrow Island and Fremantle, Western Australia, and those of Clark were taken between Fremantle and Geraldton. The striking coloration makes the living specimens easily recognizable, but it is fugacious. In size, *inspinosus* is equal to *incei*.

ANTHASTER

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 27 (30).

Genotype: *Oreaster valvulatus* Müller and Troschel, 1843, p. 115.

This is a monotypic genus confined to the coasts of southern and southwestern Australia, recently rediscovered and redescribed.

Anthaster valvulatus

Oreaster valvulatus Müller and Troschel, 1843. Arch. f. Naturgesch., vol. 9, no. 1, p. 115.

Anthaster valvulatus Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 27 (30); pl. 3.

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 386.

This notable sea star seems to be fairly common on the South Australian coast, having been taken at Kangaroo Island, Althorpe Island, Glenelg, and in St. Vincent Gulf. It has not yet been found on the coast east of Encounter Bay, but westward the range extends to the Western Australian coast in the vicinity of Fremantle. Apparently it does not occur along shore or in very shallow water, for Bennett did

¹The record (H. L. Clark, 1925a) from Long Island, the Abrolhos, Western Australia, undoubtedly refers to the following species, *inspinosus*.

not take it either near Albany or at Bunkers Bay, nor did we find it at Bunbury or at Fremantle. Moreover, the "Endeavour" did not take any specimens in her collecting in the Bight or on the Western Australian coast. The largest reported specimen has $R = 112$ mm., and the smallest has $R = 42$ mm. The color in life is recorded as brick red or violet-red with the lower surface much lighter, salmon red along the ambulacra.

[PSEUDANTHENEAE

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 26.

Genotype: *Anthenea grayi* Perrier, 1876, p. 94.

This genus rests on a single species known from only a single small specimen (78 mm. across), supposed to be in the British Museum. It has not been met with during the past sixty-five years, apparently, and the place where it was collected is unknown. Since, however, Australia is the home of so many *Antheneae* and nearly related forms, it is not unreasonable to suppose that the unique type of *Anthenea grayi* was taken in that region.]

PSEUDOREASTER

Verrill, 1899. Trans. Connecticut Acad., vol. 10, pt. 2, p. 148.

Genotype: *Asterias obtusangula* Lamarck, 1816, vol. 2, p. 556.

This is also a monotypic genus characteristic of the northern coast of Western Australia. It has rather more the aspect, in life, of an *Oreaster* than of an *Anthenea*, as the height of the disk may be as much as $0.40R$. In preserved specimens (particularly if dried) this marked elevation of the disk is commonly lost.

Pseudoreaster obtusangulus

Asterias obtusangula Lamarck, 1816. Anim. sans vert., vol. 2, p. 556.

Pseudoreaster obtusangulus Verrill, 1899. Trans. Connecticut Acad., vol. 10, p. 148.

Anthenea obtusangula Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 48; pl. 4.

Pseudoreaster obtusangulus H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 104; pl. 6 (colored).

Döderlein's (1915) figures are so good and his description so careful, it is odd he did not seem willing to recognize Verrill's genus for this handsome sea star. It is apparently confined to the northern coast of Western Australia between Augustus Island and Port Hedland. The diversity of color in life is notable (see H. L. Clark, 1938, pp. 104-105). Full-grown specimens have $R = 100-115$ mm.

GYMNANTHENEAE

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 105.

Genotype: *Anthenea globigera* Döderlein, 1915, p. (29) 50.

The sea stars of this genus have the oral surface much like that of *Pseudoreaster*, but otherwise are quite distinct. Like that genus, however, *Gymnanthenea* is found only in the seas of Western Australia, where it is represented by 2 species which may be easily distinguished as follows:

- Dorsal tubercles more or less numerous; dorsal pedicellariae few, small, inconspicuous; dorsal surface covered with thin skin *globigera*
 Dorsal tubercles few or none; large pedicellariae conspicuous on aboral plates, especially on adradial series; 2-5 tubercles but no pedicellariae on superomarginal plates; dorsal surface covered with thick, dark skin *laevis*

Gymnanthenea globigera

- Anthenea globigera* Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 50; pl. 8.
Gymnanthenea globigera H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 106; pl. 11, fig. 2 (juv., colored).

This species seems to range from Darwin, Northern Territory, to Turtle Island, northwestern Australia. It is common at and near Broome, but apparently rare at Darwin. The bright orange and red of early youth become variegated with, and often concealed by, duller shades. How far south *globigera* extends its range is still to be determined.

Gymnanthenea laevis

- H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 108; pl. 19, figs. 4, 5.

Nothing is known of this species save what has been gleaned from the unique holotype, taken at the "Wallaby Group" of the Abrolhos Islands, Western Australia, in "shore collecting," by W. J. Dakin. It has R = 70 mm. and may therefore be considered adult.

ANTHENEAE

- Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 279.

Genotype: *Anthenea chinensis* Gray, 1840, p. 279 = *Asterias pentagonula* Lamarck, 1816, vol. 2, p. 554.

This notable genus of large sea stars is characteristic of tropical Australia but occurs also in the East Indies and on the coasts of India and China. Of the 19 apparently valid species, 15 occur on the Australian coast; on the east, one species extends its range as far south as Tasmania, and on the west, another occurs down to Fremantle. Between Darwin and Cape Leveque, Western Australia, no Antheneas have yet been taken, probably because very little collecting has been done along that coast. On the Queensland coast, notably around Port Curtis, and on the Western Australian coast at Broome, Antheneas are common and diversified. Adult specimens of the 15 Australian species may be separated by the following key, but individuals with R less than 40 mm., and senescent adults, will give difficulty.

KEY TO THE SPECIES OF ANTHENEAE¹

- A. Arms relatively long, R = 2r more or less, narrowed distally and commonly more or less pointed, bluntly:
 B. Pedicellariae extraordinarily abundant on oral surface, many small; each inferomarginal with 6-15 or more *polygnatha*

¹ Condensed from the more elaborate key in H. L. Clark, 1938, Mem. Mus. Comp. Zool., vol. 55, pp. 110-112.

- BB. Pedicellariae not excessively abundant on oral surface, rarely more than 3 or 4 on an inferomarginal plate:
 C. Disk elevated, covered with smooth, thin skin with few pedicellariae or small spinelets; interradial superomarginals low and wide, with few (1-8) granules *obesa*
 CC. Not as above:
 D. Superomarginal plates in interbrachial arc more or less horizontal, forming conspicuous part of aboral surface:
 E. Aboral surface with numerous bluntly pointed tubercles, forming 5-9 distinct longitudinal series on each ray; inferomarginal plates closely covered with small granules and only a single small pedicellaria or often none *elegans*
 EE. Aboral surface diverse; inferomarginals with coarse granules, at least at outer end, and usually 2 or more large pedicellariae:
 Aboral tubercles numerous and coarse; upper half of superomarginals bare on each side, with a few coarse granules, often in a narrow, or even a single, vertical series *crassa*
 Aboral tubercles few, scattered, relatively insignificant; superomarginals rather uniformly covered with granules, though they may be fewer and coarser at upper end *aspera*
 DD. Superomarginal plates in interbrachial arc more or less vertical or so small they form inconspicuous part of aboral surface:
 F. Pedicellariae very large both aborally (jaws up to 1.7 mm. wide) and orally (jaws up to 4 mm.), and correspondingly conspicuous *crudelis*
 FF. Pedicellariae numerous and not exceptionally large:
 G. Disk more or less conspicuously elevated, reticulate nature of its skeleton often distinctly evident in large specimens; superomarginal plates well covered with granules clear to upper margin *acuta*
 GG. Disk usually not much elevated or reticulated; upper end of superomarginals more or less bare:
 Superomarginals low, wide, with tubercles only on lower half; aboral tubercles low and more or less flattened *australiae*
 Superomarginals high, narrow, with a large granule near top and below it a swollen pair or trio, and lower half of plate covered with smaller though often coarse granules; aboral tubercles high, not flattened *conjungens*
 AA. Arms short and rounded at tip, form often quite pentagonal; R = 1.6-1.8r:
 H. Enlarged aboral plates near arm tips, each with several (2-8) large granules or small tubercles:
 I. Whole aboral surface covered with big pointed tubercles, 9-13 series on each ray *acanthodes*
 II. Aboral surface with relatively blunt or capitate small tubercles:
 J. Aboral tubercles numerous, small, in about 9 parallel series on each ray *godeffroyi*

- JJ. Aboral tubercles fewer, larger, in not more than 5 series on each ray:
 Dorsal surface with few small spinelets but many pedicellariae *sibogae*
 Dorsal surface with many more or less capitate spines and few pedicellariae *mertoni*
- HH. Enlarged aboral plates near arm tips, each with 1 granule or tubercle (rarely 2):
 Tubercles of abactinal surface and of superomarginals few and coarse *tuberculosa*
 Tubercles of abactinal surface and of superomarginals small, more like large granules *viguieri*

These species are now presented in alphabetical order, for convenience of reference.

Anthenea acanthodes

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 124; pl. 18, fig. 2.

The status of this *Anthenea* rests on the unique holotype in the Australian Museum, from Port Curtis, Queensland. It has $R = 97$ mm. and hence is undoubtedly adult.

Anthenea acuta

Goniodiscus acutus Perrier, 1869. Ann. sci. nat., ser. 5, vol. 12, p. 280.

Anthenea acuta Perrier, 1876. Arch. zool. exp., vol. 5, p. 91.

Anthenea australiae var. *sidneyensis* Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 53; pl. 9, fig. 4.

Long known as the common *Anthenea* of New South Wales, this species ranges to Tasmania on the south and to Fraser Island, Queensland on the north. Whitelegge (1889) reports its occurrence at Port Jackson, in 6-15 fms.; he also lists a species *flavescens* as occurring in 0-5 fms. He remarks that "there is some confusion in reference to our single species of *Anthenea*." He does not lessen the confusion by listing it as two distinct species. The "Endeavour" dredged *acuta* in many places in 25-40 fms. The largest specimens had $R = 115-120$ mm., vertical diameter of high disk 40-50 mm. Nothing has been recorded as to the color in life.

Anthenea aspera

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 35; pl. 4, figs. 1, 2.

Two dry specimens from "Australia" served as the basis for this species, but specimens in the Australian Museum show that it is a native of the Queensland coast, where it attains a size of $R = 125$ mm. Occurrence at Port Curtis seems to be beyond question, but a specimen from Port Denison is less certainly *aspera*. According to a note with one of the Port Curtis specimens, the color in life was "irregular mottling of brown and sage green; actinal surface yellow."

Anthenea australiae

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 52; pl. 9, figs. 1-3.

The type locality for this species is given as Fremantle, and many specimens are said to be from there; also 1 small one from Shark Bay. It occurs at the Abrolhos

Islands and also at Broome. It reaches a size of $R = 85-93$ mm., but there is no record of the color in life. For further notes on the distribution of this *Anthenea*, see H. L. Clark, 1938, page 119.

Anthenea conjungens

Döderlein, 1935. "Siboga" Ast.: Oreasteridae, p. 107; pl. 27, figs. 3, 3a.

Based on a single specimen from Australia in the Hamburg Museum, this proves to be one of the commonest sea stars at Broome, Western Australia, and is, so far as we yet know, confined to the northwestern coast of the continent. It grows to a large size, with $R = 125$ mm., and the color in life shows great diversity.

Anthenea crassa

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 124; pl. 18, fig. 1.

This seems to be the common *Anthenea* at Port Curtis, Queensland, where it apparently replaces *acuta*, of the coasts farther south. It reaches a fairly large size, as R may = 115 mm., and the arms are relatively long, $R = 2.1-2.5r$. How far *crassa* ranges north and south of Port Curtis remains to be determined.

Anthenea crudelis

Anthenea australiae var. *crudelis* Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 53; pl. 10, figs. 1, 2.

Anthenea crudelis H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 114.

The unique holotype of this species, in the Berlin Museum, is from an unknown locality, but there is some reason for thinking it came from Australia, so it seems wise to give its distinguishing characters in the key to the genus.

Anthenea elegans

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 126; pl. 18, fig. 4.

This is a common species at Broome, and is of nearly the same size as *conjungens*. Adult specimens are readily distinguished, but individuals with R less than 50 mm. are easily confused. The colors in life and the limits of the range of *elegans* are still to be discovered and recorded.

Anthenea godeffroyi

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 45; pl. 11.

This species rests on a single specimen in the Museum Godeffroy. When described, it was supposed to be from Samoa, but further consideration led Döderlein to believe it was from Australia.

Anthenea mertoni

Koehler, 1910a. Abhandl. Senckenb. Naturforsch. Gesellsch., vol. 33, p. 268; pl. 16, figs. 1, 2.
 H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 121; pl. 7 (colored).

Originally known from only a single specimen taken at the Aru Islands, this well marked species is now known to occur on the coast of the Northern Territory of Australia and in the Gulf of Carpentaria. Large specimens have $R = 85-95$ mm. A large adult from Darwin had (in life) the upper surface gray with large, irregular blackish-brown blotches, and the oral surface light reddish buff. We did not find *mertoni* west of Darwin.

Anthenea obesa

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 127; pl. 19, fig. 1.

Nothing more is known of this apparently well marked species. The 2 known specimens were taken by the "Endeavour" off Geraldton, Western Australia, in 29 fms. The color in life was recorded as scarlet or crimson.

Anthenea polygnatha

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 128; pl. 18, fig. 3; pl. 19, figs. 2, 3.

The apparent dimorphism of this *Anthenea* is one of its striking features and deserves further investigation. Should it prove to be sexual, it would be a most interesting novelty among sea stars. The species is as yet known only from the Lacepede Islands and the vicinity of Broome. It grows to a large size, $R = 125-130$ mm., and is either purple-violet or orange in color, but difference in form does not seem to be associated with any constant difference in color.

Anthenea sibogae

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 47; pl. 10, fig. 5.

The status of this species is dubious, as it was described from a single large specimen ($R = 102$ mm.) and its relation to *tuberculosa* Gray, *mertoni* Koehler, and *viguieri* Döderlein is still a confusing problem. Material of all these species is scanty and so scattered that direct comparison between the types is impracticable. It is hard to believe that the specimen figured from life from Thursday Island (H. L. Clark, 1921, pl. 6, fig. 1) and the one, also figured in its living colors, from Darwin (H. L. Clark, 1938, pl. 7, figs. 1, 2) are the same species. It is at present impossible to determine how many valid species of this short-armed, flattened, more or less pentagonal type occur on the tropical Australian coast, east of Cambridge Gulf.

Anthenea tuberculosa

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 77.

— 1866. Syn. sp. starfish, p. 9; pl. 4, figs. 1, 1a.

This species is based on a single specimen from Port Essington, but no *Anthenea* was found on my visit to that isolated spot in 1932. Without additional living material, I can throw no light on the validity and connections of this species. The record of McNeill and Livingstone (1926) probably refers to the preceding species, but the specimen was not full grown and its specific characters may be incompletely developed. Livingstone's (1932) specimens, taken by the Great Barrier Reef Expedition, are all much too young to be of any service in defining the species.

Anthenea viguieri

Döderlein, 1915. Jahrb. Nassau. Ver. Naturk. Wiesbaden, vol. 68, p. 34; pl. 5, figs. 2, 3.

This species, described from one individual from an unknown locality, is allowed a place in the Australian fauna on the strength of a specimen from Restoration Island, Queensland, now in the Museum of Comparative Zoology. But the identity of this specimen with Döderlein's type is not beyond debate.

Family OREASTERIDAE

This interesting family of large, littoral, tropical sea stars, almost wholly confined to the Indo-Pacific region, seems to need critical revision, as the limits accepted and used by Döderlein are much wider than those used by Fisher. In my judgment, the family is better defined and is a more natural group if recognized in Fisher's sense, and I am therefore following him here in the use of the name Oreasteridae. On the other hand, Döderlein's segregation of several groups of Oreasters, in the old sense of that generic name, seems proper and useful, and two of them are used here for some of the Australian members of the family. The genus *Asterodiscus* is regarded by Döderlein as a goniasterid, but it is, in my opinion, more naturally associated with the Oreasters. The 5 genera of this family which are found on the Australian coasts may be distinguished as follows:

KEY TO THE GENERA OF OREASTERIDAE

- A. Arms well developed, as distinct from disk; r much less than two-thirds R :
 - B. Arms rather abruptly narrowed distally, tips without pair of swollen, smooth, hemispherical plates:
 - Distal actinal and inferomarginal plates closely covered by pavement of unequal, polygonal platelets, flat and smooth; no obvious reticulation of abactinal skeleton. *Protoreaster*
 - Distal actinal and inferomarginal plates covered by unequal, irregular, rounded granules; abactinal skeleton more or less markedly reticulate *Pentaceraster*
 - BB. Arms more or less triangular, not narrowed at tip, where there is conspicuous pair of swollen, smooth hemispherical plates. *Asterodiscus*
- AA. Form nearly pentagonal or even circular; r more than two-thirds R :
 - Upper surface with irregularly arranged, more or less circular but often ill defined papular areas; actinal surface not tessellated, covered with more or less irregular granules and spinelets. *Culcita*
 - Upper surface with regularly arranged, triangular papular areas; actinal surface regularly tessellated, with no spinelets or granules. *Halityle*

PROTOREASTER

Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 420.

Genotype: *Asterias nodosa* Linné, 1758, p. 661.

This is a small but well defined group of 3 or 4 species, occurring in the Indian Ocean and northeastward to the Ryukyu Islands and southeastward to Queensland. The 2 Australian species may be distinguished thus:

Papular areas more or less confluent; big dorsal tubercles often pointed and bare	<i>nodosus</i>
Papular areas small and conspicuously distinct; dorsal tubercles rounded and not bare	<i>nodulosus</i>

Protoreaster nodosus

Asterias nodosa Linné, 1758. Syst. Nat., ed. 10, p. 661.

Protoreaster nodosus Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 420.

Oreaster nodosus H. L. Clark, 1921. Ech. Torres Strait, p. 31; pl. 24, fig. 1; pl. 25, figs. 1, 2.

This is a conspicuous East Indian sea star whose range extends to Torres Strait and the northern end of the Barrier Reef, and even as far south as Port Denison on the Queensland coast. In life, Torres Strait specimens are brilliantly colored red and blue, with considerable individual diversity as to shade and extent of each color. Whether this striking coloration is characteristic of the species throughout its range is not known, but Livingstone (1932) says that around Port Denison the predominating colors, according to E. H. Rainford, are crimson and white, and Barbour's notes on specimens collected at Amboina and New Guinea (see H. L. Clark, 1908a) indicate that although red is usual, blue is lacking in specimens from north of Torres Strait. Full-grown specimens have $R = 175-200$ mm., but most of those in museums are considerably smaller.

Protoreaster nodulosus

Pentaceros nodulosus Perrier, 1876. Arch. zool. exp., vol. 5, p. 53.

Protoreaster nodulosus Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 420.

— 1936. "Siboga" Ast.: Oreasterinae, p. 323; pl. 22, figs. 1-5.

This is the common oreasterid of Australia's northwestern coast, having been taken at various points between Shark Bay and Augustus Island. In Roebuck Bay and southwestward it is particularly common and a striking feature of the shallow-water fauna. The absence of red in the coloration is a conspicuous difference between it and the preceding species. It is also somewhat smaller than *nodosus*, R not often exceeding 160 mm. A more detailed account of form and color will be found in H. L. Clark, 1938.

PENTACERASTER

Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 424.

Genotype: *Asterias mamillata* Audouin, 1826, p. 209.

This is another group segregated by Döderlein from *Oreaster sens. lat.*, and, like *Protoreaster*, it is represented in tropical Australia by 2 species, one of which is common on the Queensland coast; the other, apparently rare in Torres Strait, ranges southward on the Queensland coast to the vicinity of Port Curtis, and westward to the Lacepede Islands, Western Australia—perhaps farther, as is suggested by a specimen from an unknown locality in the Perth Museum. The 2 species are easily distinguished thus:

R = rather less than $2.5r$ usually, arms not abruptly narrowed distally; disk large but high (height one-sixth or more of maximum diameter of whole animal), not regularly reticulated; with more or less numerous

conical tubercles, 5 conspicuously big (one at beginning of each carinal series); interbranchial sides of disk concave	<i>australis</i>
$R = 2.5r$ or more, rather abruptly narrowed distally; disk large, low (height not more than one-seventh or one-eighth of maximum diameter), markedly reticulated, with no conspicuously big tubercles, and more or less straight sides in interbranchial arcs	<i>gracilis</i>

Pentaceraster australis

Oreaster australis Lütken, 1871. Vidensk. Medd., vol. 23, pp. 252, 263.

Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 247; pl. 6, figs. 1-6; pl. 7, figs. 1-4; pl. 8, figs. 5, 6; pl. 10, figs. 1-4.

Pentaceraster australis Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 433.

This is the common oreasterid of the Queensland coast, ranging from south of Double Island Point to Lizard Island (Eagle Islet) in the far north. The exact limits of its range are not as yet known. Livingstone's (1932) account of his observations on the specimens from Eagle Islet is a most important and admirable piece of work. Döderlein's (1936) revision of the Oreasterinae is equally valuable, but leaves me unconvinced that *australis* is identical with *regulus* Müller and Troschel. The latter species is far too little known to justify such a conclusion. Hence it is better to retain the name *australis* for the Australian species. Livingstone's photographs of *australis* reveal a diversity of form and tuberculation which demands a still more detailed study of a far larger series of specimens. In large adults, $R = 150$ mm. and more. No accurate data on the color in life are available.

Pentaceraster gracilis

Oreaster gracilis Lütken, 1871. Vidensk. Medd., vol. 23, p. 260.

Pentaceraster gracilis Döderlein, 1916. Zool. Jahrb., Abt. syst., vol. 40, p. 427.

— 1936. "Siboga" Ast.: Oreasterinae, p. 357; pl. 31, figs. 1, 2.

This is one of the rarest of the Oreasteridae and is still very imperfectly known. The few specimens in museums are from tropical Australia: several are known from Torres Strait; 1 from southwest of Lady Elliott Island, Queensland; 1 from North Island, Sir Edward Pellew group, Gulf of Carpentaria; 1 from the Lacepede Islands, Western Australia; and 1 is in the Perth Museum from "Western Australia." Bell's record from Saya de Malha, Indian Ocean, may be ignored, as his records from Port Denison and Port Molle almost certainly refer to the preceding species; Döderlein, however, reports 4 specimens in the Hamburg Museum from Port Denison, so it is possible Bell had an "Alert" specimen from that place. Koehler (1910a) gives excellent figures and a very detailed description of a young oreasterid (*Pentaceros rouxi*) which both Döderlein and I consider a young *gracilis*. It was taken at the Aru Islands, and this is the northernmost record for this species. The largest reported specimen is that taken by the "Challenger" near Booby Island, Torres Strait, which Sladen described under the name *Pentaceros callimorphus*. In this individual R measured 278 mm., but no other specimen is recorded with R over 235 mm. An interesting account of the coloration in life is recorded by McNeill and Livingstone (1926), based on the large specimen ($R = 175$ mm.) taken by W. E. J. Paradiçe at North Island, Gulf of Carpentaria. Paradiçe's notes show that white and olive green predominate, with tubercles orange and yellow.

ASTERODISCUS

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 75.

Genotype: *Asterodiscus elegans* Gray, 1847, p. 75.

Although Döderlein became convinced that this genus was goniasterid and removed it from the Oreasteridae, its relationship to the latter family seems to me more probable, and I follow Fisher (1919) in retaining it therein. The single Australian species is conspicuously different, however, from its allies in those seas and is easily distinguished from its East Indian congeners by the great size of the abactinal tubercles.

Asterodiscus truncatus

Coleman, 1911. Mem. Australian Mus., vol. 4, p. 699.

Apparently this sea star occurs along the southern coast of Australia from off Botany Bay, New South Wales, to the western end of the Great Australian Bight, in 47-200 fms. Nothing is recorded as to the color or appearance in life. The largest specimens as yet taken have $R = 150-165$ mm.

CULCITA

L. Agassiz, 1835a. Mém. Soc. sci. nat. Neuchâtel, vol. 1, p. 192.

Genotype: *Asterias discoidea* Lamarck, 1816, vol. 2, p. 554 = *Asterias schmideliana* Retzius, 1805, p. 11.

Specific lines in this genus are hard to draw, but apparently only a single species occurs in Australia. It shows no little individual diversity, but on the whole keeps its specific characters reasonably clear.

Culcita novaeguineae

Müller and Troschel, 1842. Syst. Ast., p. 38.

Döderlein, 1896a. Semon's Ast., in Jena Denkschr., vol. 8, p. 310; pl. 19, figs. 1-4.

H. L. Clark, 1921. Ech. Torres Strait, p. 32; pl. 5, fig. 1 (colored).

This remarkable pentagonal sea star seems to occur only on the most tropical coasts of Australia, ranging from the Low Isles, near the northern end of the Barrier Reef, westward through Torres Strait to Augustus and Champagne islands, on the northern coast of Western Australia. Young individuals (under 80 mm. in diameter) are so flat and otherwise unlike the adults that they have been described under three other generic names. Adults become so swollen and cushion-like that they tend to lose their sea-star traits aborally. They reach a large size, with a horizontal diameter of 200 mm. and a vertical one of 80 mm.. For a full account of form, color, habits, etc., see H. L. Clark, 1921. For a discussion of possible varietal forms see Livingstone, 1932b, but the desirability of recognizing these varieties by name is dubious. The range of the species appears to be from Mauritius to Samoa, and northward to southernmost Japan. The exact limits of its range to the south are as yet unknown, but Livingstone (1932) records it as being "as common as any other asteroid at Low Isles," except *Linckia laevigata*. He gives no clues to the size of his specimens.

HALITYLE

Fisher, 1913a. Proc. U. S. Nat. Mus., vol. 46, p. 211.

Genotype: *Halityle regularis* Fisher, 1913a, p. 211.

It seems quite certain that *Culcitaster* H. L. Clark, 1914, is not generically different from *Halityle*, though at first sight the body form seems quite unlike. Since only a single specimen of the Australian species is known, and only 3 of that from the Philippines, further discussion of their relationship had best await more material.

Halityle anamesus

Culcitaster anamesus H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 145; pl. 19.

The unique holotype of this species is in the Western Australian Museum at Perth, but lacks all data as to its origin, though "it is said to have been taken on the coast of West Australia." As $R = 185$ mm. and $r = 110$ mm., in its present dry state, it must have been at least 16 inches across when living. There is no hint as to the color in life.

Family ASTEROPIDAE

This small family consists of but 3 or 4 genera occurring in the southern hemisphere, 2 of which are Australian, though not confined to that continent. It is rather close to the Poraniidae, a family chiefly found in the northern hemisphere, which is somewhat more nearly allied to the Asterinidae. The 2 Australian genera may be distinguished as follows:

Marginal and some abactinal plates with large spines *Asterope*
No large abactinal spines *Petricia*

ASTEROPE

Müller and Troschel, 1840. Ber. Verhandl. K. preuss. Akad. Wissensch., Apr., p. 104.

Genotype: *Asterias carinifera* Lamarck, 1816, vol. 2, p. 556.

This well marked genus is widely distributed in the Indo-Pacific region, with one species ranging from Mozambique, Zanzibar, and the Red Sea on the west to the Hawaiian and Society islands on the east, and a second occurring in the Galápagos Islands and on the Mexican coast.

Asterope carinifera

Asterias carinifera Lamarck, 1816. Anim. sans vert., vol. 2, p. 556.

Asterope carinifera Müller and Troschel, 1840. Ber. Verhandl. K. preuss. Akad. Wissensch., p. 104.

H. L. Clark, 1921. Ech. Torres Strait, p. 33; pl. 5, fig. 2 (colored).

Gymnasteria carinifera von Martens, 1866. Arch. f. Naturgesch., vol. 32, pt. 1, p. 74.

Goto, 1914. Monog. Japan. Ast., p. 610; pl. 18, figs. 270, 271.

This widely distributed sea star seems to have but a limited occurrence in Australia, as it has been found as yet only at the northern end of the Barrier Reef from

the Low Isles to Mer. Fully grown individuals have $R = 65-70$ mm. Specimens from the Low Isles are recorded as "of a very dark chocolate hue," whereas those found at Mer were more olive green and drab. For details see H. L. Clark, 1921, page 33. The absence of *Asterope* from Torres Strait and the coast farther west is quite remarkable.

PETRICIA

Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 81.

Genotype: *Petricia punctata* Gray, 1847, p. 81 = *Asterias vernicina* Lamarck, 1816, vol. 2, p. 554.

This is a definitely Australasian genus, confined to the Kermadec Islands and the southern side of the Australian continent, where it occurs in shallow water along shore. There are seemingly 2 Australian species, but it is not certain that they do not intergrade. They are apparently to be distinguished by the following characters:

Rays narrow distally, with granules, spinelets, or tubercles on marginal plates; skin smooth and shiny in dried specimens *vernicina*
 Rays broad and rounded at tip, with no tubercles, spinelets, or even granules on distal marginal plates; skin thick and dull *obesa*

Petricia vernicina

Asterias vernicina Lamarck, 1816. Anim. sans vert., vol. 2, p. 554.

Petricia vernicina Fisher, 1908a. Zool. Anz., vol. 33, p. 357.

Petricia punctata Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 80.

— 1866. Syn. sp. starfish, p. 16; pl. 6, figs. 1, 1a.

This species is said by Whitelegge (1889) to be common under stones in Chowder Bay and at Watson's Bay in Port Jackson. A large series of specimens in the South Australian Museum suggests that it is not rare in Spencer and St. Vincent gulfs, and Stach (1938) reports it as common at Reevesby Island, Spencer Gulf. Adult specimens have $R = 50-58$ mm., and Stach (*loc. cit.*) reports the color in life as "brilliant brick-red." He gives photographs (pl. 18), one-half natural size, of 2 specimens, which supplement admirably the drawings reproduced by Gray (1866). The diversity in the number and arrangement of the big, isolated, sunken, bivalve pedicellariae is very great (see H. L. Clark, 1928, p. 388), and no reliance can be placed on them for specific characters.

Petricia obesa

H. L. Clark, 1923. Jour. Linn. Soc. (Zool.), vol. 35, p. 241; pl. 13, figs. 1, 2.

— 1938. Mem. Mus. Comp. Zool., vol. 55, p. 142; pl. 10, fig. 1 (colored).

This beautiful sea star was first taken at Pelsart Island, Abrolhos group, Western Australia, but has since been found on the mainland coast near Point Peron and farther south at Bunkers Bay. The largest specimen has $R = 75$ mm. The color in life is such a brilliant scarlet that *obesa* is one of the most striking of Australian sea stars. Whether it is really isolated on the west coast and specifically distinct from *vernicina* remains to be shown.

Family METRODIRIDAE

This is an isolated group, the correct status and relationships of which it is very difficult to determine. It is based on a single monotypic genus. Formerly associated with the Echinasteridae, it is now considered more nearly allied to the Asteropidae, chiefly because of the character of the dorsal plates. The single genus is easily recognized by the small disk, long, slender, terete arms, isolated papulae, and small but numerous, rather stout spinelets.

METRODIRA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 282.

Genotype: *Metrodira subulata* Gray, 1840, p. 282.

This genus, though a hundred years old, is still known only from a single species, which has a definitely East Indian distribution and has been frequently described, figured, and discussed.

Metrodira subulata

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 282.

Koehler, 1910. Indian Mus. Ast., p. 172; pl. 4, figs. 1, 2; pl. 18, fig. 9.

— 1910a. Abhandl. Senckenb. Naturforsch. Gesellsch., vol. 33, p. 284; pl. 15, figs. 3-5.

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 187; pl. 11, fig. 3 (colored).

This odd sea star seems to be widely distributed from Ceylon and the Andaman Islands eastward to the Philippines and southward to Lindeman Island, Queensland, but it has been taken in some numbers only at Broome on the northwestern coast of Australia; a single specimen from Carnarvon reveals that the range extends to that northwestern corner of the continent. The largest reported specimen, having $R = 82$ mm., is from Lindeman Island. The great majority of known specimens are much smaller, with $R = 50$ mm. or less. The handsome blue, white, and rust coloration in life is very fugitive. There is much diversity in the relative length and thickness of the arms and the size of the disk, as $R = 5.5-9$ br; as a rule $R = 6-7r$ and $7-8br$.

Family OPHIDIASTERIDAE

This is a large tropicopolitan family of sea stars occurring on all the coasts of Australia, commonly in shallow water, and particularly associated with corals and rock slabs on the tropical reefs. The small disk and long, often cylindrical or subcylindrical arms are characteristic features. The colors in life are often bright; red, blue, purple, and variegated forms are frequent. The 11 genera occurring in Australia may be distinguished as follows, but a more extended key accompanying a revision of the whole family was published in H. L. Clark, 1921, pages 36-94.

KEY TO THE GENERA OF OPHIDIASTERIDAE

- A. Abactinal plates of ray not in regular longitudinal series:
 - B. Adambulacral armature spiniform:
 - C. Papulae on actinal surface as well as on abactinal:

- D. Papulae isolated, not in groups:
 Size moderate or small, usually much less than 100 mm. across alternate rays; seldom more than 2 series of actinal papulae *Fromia*
 Much larger, often more than 100 mm. across; 3-6 series of actinal papulae *Austrofromia*
- DD. Papulae in groups; rays more or less terete *Nardoa*
- CC. No papulae on actinal surface *Neoferdina*
- BB. Adambulacral armature granuliform:
 Papulae in groups; skeletal plates covered with granules *Linckia*
 Papulae usually single or in groups of 2-4; skeletal plates swollen and bare, separated by granules *Bunaster*
- AA. Abactinal plates in regular longitudinal series; obscured in some senescent Ophidiasters:
 E. Body wall rigid, with well developed skeleton:
 F. Whole test covered with thick, smooth skin *Leiaster*
 FF. Whole test more or less covered with granules or little tubercles:
 G. Papular areas present on actinal surface, at least 1 series below inferomarginals:
 Papular areas in 8 series; rays cylindrical *Ophidiaster*
 Papular areas in 10 series; rays often somewhat trigonal at base *Hacelia*
 GG. Papular areas wanting on actinal surface, in only 6 series abactinally *Tamaria*
- EE. Body wall thick and leathery without rigid abactinal skeleton *Pseudophidiaster*

FROMIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 286.

Genotype: *Asterias milleporella* Lamarck, 1816, vol. 2, p. 564.

This genus of more than a dozen species is typically Indo-Pacific in its distribution, ranging from the Red Sea and Madagascar to Hawaii and Samoa. None is of large size, R rarely exceeding 50 mm. These sea stars live under slabs of rock or coral, or among coral fragments. Only 3 species occur in Australia. Two of these are from the Queensland coast in very shallow water, but neither has been found in Torres Strait or on the northern coast. One of the 2, however, has been found at the Abrolhos Islands, Western Australia, where half a dozen specimens of the third species were also taken.

KEY TO THE SPECIES OF FROMIA

- A. Rays short and wide, R = 2.5-3.8r and 2.5-3.3br:
 Disk and rays flat; rays often more than 5 and madreporites often 2 or 3; furrow spinelets 3 or 4 *milleporella*
 Disk and rays convex; rays 5; madreporite single; only 2 furrow spinelets *andamanensis*
- AA. Rays 5, long and narrow; R = 3.5-5.5r and 4-5br *elegans*

Fromia milleporella

Asterias milleporella Lamarck, 1816. Anim. sans vert., vol. 2, p. 564.

Fromia milleporella Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 286.

de Loriol, 1885. Mém. Soc. phys. hist. nat. Genève, vol. 29, no. 4, p. 44; pl. 16, figs. 2-4

H. L. Clark, 1921. Ech. Torres Strait, p. 40; pl. 7, figs. 4, 5 (colored).

This pretty little sea star seems to extend its range southward along the Barrier Reef to Low Isles and to Coates Reef, outer Great Barrier Reef, between 17° and 19° S., but it is not known from the mainland coast, nor from Torres Strait. Northward it reaches the Ryukyu Islands, Japan, and westward it is known from the Red Sea, Mauritius, and Madagascar. To the east it reaches Fiji and Samoa at least, and a specimen in the Museum of Comparative Zoology is said to be from the Low Archipelago, collected by the U. S. Exploring Expedition. As is well known, too much reliance must not be placed on this label. The specimen may be from Samoa. No *Fromias* are known from Hawaii or the Society Islands. The bright red color is very fugacious, and preserved specimens range from dull brown to white. In life, these little sea stars, rarely over 60 mm. across, live on the under surface of rock fragments in shallow water.

Fromia andamanensis

Koehler, 1909. Indian Mus. deep sea Ast., p. 105; pl. 7, figs. 5, 6.

H. L. Clark, 1923a. Jour. Linn. Soc. (Zool.), vol. 35, p. 239.

The status of this species is very dubious. Originally described from a single small specimen (R = 27-29 mm.) taken at the Andaman Islands, supposedly at 238-290 fms., it has since been reported only from Houtman's Abrolhos Islands, Western Australia, where half a dozen specimens were taken by W. J. Dakin in very shallow water, in 1913 or 1915. Owing to lack of material for comparison, the identification of these specimens needs verification. In fact, the specific limits in *Fromia* are most unsatisfactory, since only 1 of the 15 species which have been assigned to the genus is known from as many as a dozen specimens, and of most, not more than 2 or 3 specimens are known. The probability that the type of *andamanensis* is from shallow water, and that the depth to which it is assigned by Koehler (and presumably by the label with it) is due to a mistake, is very great. The largest of the Australian specimens has R = 54 mm., and hence is practically double the size of the unique holotype of the species. Notes on the color in life would be a great help in determining relationships.

Fromia elegans

H. L. Clark, 1921. Ech. Torres Strait, p. 43; pl. 7, fig. 3 (colored); pl. 29, figs. 5, 6.

This is an endemic species so far as is yet known, and since it has been found at three widely separated points, it is probably pretty well distributed on the tropical coasts of Australia. It has not been found elsewhere, for although Domantay and Roxas (1938) record it from the Philippines, it is evident both from the figures given and from their description of the color in life that their specimens are different from the Australian species. The Murray Islands at the northern end of the Barrier Reef are the type locality, and the next record was from the Abrolhos Islands, Western Australia, where Dakin collected 2 specimens which seem to be identical with Murray Islands material (see H. L. Clark, 1923a). In 1924, W. E. J. Paradise took 2 *Fromias* on Coates Reef, outer Great Barrier Reef, Queensland, between 17° and 19° S., which cannot be distinguished from the type specimens. And yet diligent collecting in 1929 and 1932 failed to find a single *Fromia* of any species between Torres Strait and Fremantle, Western Australia, although

no little collecting was done in areas where local conditions seem very suitable. Evidently these sea stars require very definitely balanced environmental conditions.

AUSTROFROMIA

H. L. Clark, 1921. Ech. Torres Strait, p. 48.

Genotype: *Fromia polypora* H. L. Clark, 1916, p. 51.

This is a south temperate genus with a single species in South African waters and one in those of southern Australia. It is possible that there is more than one Australian species, but material is still much too scanty to make it feasible to determine whether the Tasmanian form differs constantly from the West Australian.

Austrofromia polypora

H. L. Clark, 1916. "Endeavour" rept., p. 51; pl. 14, figs. 1, 2.

Large specimens of this species have R = 95-112 mm. with the minor radius about one-fifth as much. The width of the arms is from one-fifth to one-fourth of their length. The color of living specimens has never been recorded, but some alcoholic specimens are reddish buff, suggesting that in life the color is some shade of red. Only 7 specimens have as yet been taken, but these show that the species ranges from Tasmania to Rottneest Island, Western Australia. It is possible that more than one species is represented in this series.

NARDOA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 286.

Genotype: *Asterias variolatus* Lamarck, 1816, vol. 2, p. 565.

The Nardoas are notable sea stars of graceful form and often of large size. About a dozen species are known, of which half occur in the tropical waters of northeastern Australia. None are known from Torres Strait or west thereof except *tuberculata*, whose right to a place in the Australian fauna is dubious. The other 5 species are all found at the Murray Islands, where they form a conspicuous feature of the echinoderm fauna (see H. L. Clark, 1921, pp. 49-55). The Australian Nardoas may be distinguished thus:

KEY TO THE SPECIES OF NARDOA

- A. No abactinal or marginal plates noticeably tuberculiform:
 B. Superomarginal plates not alternately large and small:
 C. Abactinal plates on distal part of ray not markedly and rather abruptly different from those on basal part *pauciforis*
 CC. Abactinal plates on distal part of ray markedly and somewhat abruptly smaller and more crowded than basally:
 Many large abactinal plates 2.5 mm. in diameter or more; ground color light brown *novaecaledoniae*
 Few or no large abactinal plates; ground color deep, rich brown *mollis*
 BB. Superomarginal plates more or less regularly alternating, large and small *rosea*

AA. Some and often many abactinal plates swollen and more or less conspicuously tuberculiform:

- Tubercles small, 2 mm. or less in diameter *tuberculata*
 Tubercles very large, often 2.5-4 mm. in diameter *mamillifera*

Nardoa pauciforis

Linckia pauciforis von Martens, 1866. Arch. f. Naturgesch., vol. 32, pt. 1, p. 69.

Nardoa pauciforis Sladen, 1889. "Challenger" Ast., p. 412.

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 381; pl. 108, fig. 3.

Nardoa finschi de Loriol, 1891. Mém. Soc. phys. hist. nat. Genève, suppt. vol., no. 8, p. 28; pl. 2 (11), figs. 4-4g.

This species, in which R may be as much as 140 mm., is fairly common at the northern end of the Barrier Reef from Seaforth Island, about 50 miles north of Mackay, to Mer and Erub at the entrance to Torres Strait. It is also known from Flores, Amboina, New Britain, and the Philippines (Cebu). The color in life is more or less bright buff or fawn color.

Nardoa novaecaledoniae

Scytaster novaecaledoniae Perrier, 1875. Arch. zool. exp., vol. 4, p. 426 (p. 162 of reprint).

Nardoa novaecaledoniae Sladen, 1889. "Challenger" Ast., p. 412.

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 380; pl. 108, fig. 2.

This species has the same distribution (from Green Island, Queensland, to New Caledonia and the Philippines) as the preceding, which it resembles in size and color. The difference in the distal abactinal plates seems to be constant, and dissection shows it is not associated with sex.

Nardoa mollis

de Loriol, 1891. Mém. Soc. phys. hist. nat. Genève, suppt. vol., no. 8, p. 26; pl. 3 (12), figs. 4-4f.

This is a less common species than the 2 preceding, and has as yet been taken only at Mer; New Britain; Port Galera Bay, Mindoro, Philippine Islands; the Sulu Archipelago; and Andaman Islands. It reaches almost as large a size as its congeners, but the color is much darker, a deep olive brown associated with a velvety texture quite different from that of the allied species.

Nardoa rosea

H. L. Clark, 1921. Ech. Torres Strait, p. 53; pl. 10, fig. 1 (colored); pl. 29, figs. 1, 2.

As this beautiful sea star is known only from the northern end of the Barrier Reef, it must be regarded as the most definitely endemic species of Australian Nardoas, but it is by no means common, as only half a dozen specimens are known. One of these is from Heron Island in the Capricorn group, one from Eagle Islet, and the remainder from Mer. It is somewhat smaller than the species already listed, as R = 78 mm. or less. The roseate color so striking in life is unfortunately evanescent, and no trace of it remains in preserved specimens.

Nardoa tuberculata

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 287.
 Koehler, 1910. Indian Mus. Ast., p. 160; pl. 17, figs. 1, 2.

This is a widely distributed East Indian *Nardoa* of large size (R = 130 mm.) and distinctive appearance, but it is very doubtful whether it occurs in Australian waters. It is included here on the basis of Bell's (1894) record "from North-western Australia, 9-38 fms." Though it is not at all impossible that it should occur in that region, *Nardoa* is not otherwise known from west of Torres Strait, south of Timor.

Nardoa mamillifera

Livingstone, 1930. Rec. Australian Mus., vol. 18, p. 20; pl. 7, figs. 1-5.

This well marked species is based on a unique specimen, with only 3 rays, in which R = 63 mm. Obviously the absence of 2 rays is accidental, probably the result of an attack by a fish. The color in life is unknown. This extraordinary sea star was taken in 1907 at Mer, where six years later the Carnegie Institution's party during a stay of five weeks took 4 other species of *Nardoa*, but failed to find a second specimen of *mamillifera*. Apparently it is most nearly allied to *N. tumulosa* Fisher from the Philippines, but Livingstone makes no reference to that species in his account of *mamillifera*.

NEOFERDINA

Livingstone, 1931. Australian Zoologist, vol. 6, p. 307.

Genotype: *Ferdina cumingii* Gray, 1840, p. 283.

Livingstone's clear differentiation of the two quite distinct types of sea stars confused in Gray's genus *Ferdina* justifies his establishment of this genus, in which he includes half a dozen species. It is probable, however, that abundant material will reduce this number at least one-half. Only a single species has yet been reported from Australia, but the few known specimens show so much diversity that it seems probable more than one species is involved.

Neoferdina ocellata

Ferdina ocellata H. L. Clark, 1921. Ech. Torres Strait, p. 60; pl. 6, fig. 5 (colored); pl. 31, figs. 1, 2.

Livingstone, 1930. Rec. Australian Mus., vol. 18, p. 18; pl. 6, figs. 1, 2.

Neoferdina ocellata Livingstone, 1931. Australian Zoologist, vol. 6, p. 307.

This beautiful and unusual sea star is known as yet from only 3 specimens. Of these, the 2 from Mer seem to be unquestionably conspecific, but the one from Northwest Islet, described and figured by Livingstone, is superficially very different. Until further material is obtained, however, it is best to use a single name for the trio. No *Neoferdinas* have been taken in Torres Strait or west thereof.

LINCKIA

Nardo, 1834. Oken's Isis, vol. 7, p. 717.

Genotype: *Linckia typus* Nardo, 1834, p. 717 = *Asterias laevigata* Linné, 1758, p. 662.

This tropicopolitan genus, to which no fewer than 45 nominal species have been referred, is widespread on the tropical coasts of Australia, but of the 3 species, only 1 is locally common, and 1 is known from but 2 specimens taken at a single place. The 45 nominal species are now considered to represent not more than 8 or 10 valid forms, a fact which shows how great are the growth changes and the individual diversity in the genus. The 3 Australian species, however, are easily recognized and may be distinguished by the following characters:

KEY TO THE SPECIES OF LINCKIA

- A. Adambulacral furrow spines separated by vertical series of several granules *laevigata*
 AA. Furrow spines not separated by granules:
 No abactinal plates conspicuously enlarged and swollen *guildingii*
 Numerous abactinal plates enlarged and swollen *tyloplax*

Linckia laevigata

Asterias laevigata Linné, 1758. Syst. Nat., ed. 10, p. 662.

Linckia laevigata Nardo, 1834. Oken's Isis, p. 717.

H. L. Clark, 1921. Ech. Torres Strait, p. 64; pl. 9, figs. 1, 2 (colored); pl. 26, fig. 1.

Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 254; pl. 3, fig. 1; pl. 4, figs. 2, 5.

This sea star is notable among all its kin for its conspicuous blue color when adult, and its habit, then, of lying exposed to the tropical sun without shelter. A full account of its habits and reactions is given in H. L. Clark, 1921. It is abundant at Mer, but does not occur in, or west of, Torres Strait. Its Australian range reaches as far south as the Palm Islands (19° S.), and wherever conditions are favorable it is abundant. It is widespread in the Indo-Pacific region, but owing to its confusion with other species hitherto, the exact limits of its range are still uncertain. It reaches a large size, R sometimes 200 mm., but most adults are not much more than half that.

Linckia guildingii

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 285.

A. Agassiz, 1877. Mem. Mus. Comp. Zoöl., vol. 5, p. 105; pl. 14, figs. 1-6.

Linckia ehrenbergii de Loriol, 1885. Mém. Soc. phys. hist. nat. Genève, vol. 29, no. 4, p. 31; pl. 10, figs. 1-7a.

This large, inert, and ungraceful sea star is notable for its tropicopolitan distribution and for its peculiarly unreliable coloration. In the West Indies small specimens are dull purplish red often mottled indefinitely with gray, and thus are inconspicuous among corals and coral fragments. As they get bigger they become more unicolor, and when adult (R = 150-215 mm.) they are often found out on sandy bottoms, a uniform yellow-brown. This is also often the color in the Indo-

Pacific area and in Australia, but both in the West Indies and in the Pacific, the uniform color may not be brown, but violet or even (in Australia) bright blue. So far, no structural characters have been discovered associated with these color vagaries, and their cause and purpose is unknown. Here is a problem of fascinating interest for a physicochemical-experimentally minded zoologist to attack.

In Australia, *guildingii* has been found at Lord Howe Island, at Masthead Island, Queensland, at Yonge and Ribbon reefs (farther north on the Great Barrier, where it is reported as "very common"), and at Broome, Western Australia, where half a dozen specimens of widely different colors have been taken. But nowhere does it seem to multiply and become a conspicuous feature of the shallow-water fauna as *laevigata* does.

Linckia tyloplax

H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 147; pl. 20.

This curious species is more of a deep-water form than either of the preceding, for it is known, as yet, only from 80-120 fms. off the coast of Western Australia, between Geraldton and Perth. The color is very dark, and the numerous swollen abactinal plates give it a very un-*Linckia*-like appearance. It reaches a large size, 1 of the 2 specimens having $R = 150$ mm.

BUNASTER

Döderlein, 1896a. Semon's Ast., in Jena Denkschr., vol. 8, p. 317.

Genotype: *Bunaster ritteri* Döderlein, 1896a, p. 317.

The members of this genus are among the smallest species in the family and are as yet little known. Of the 4 species, 3 are known from only a single specimen each. One of these is from the Philippine Islands and one from Amboina. The 2 Australian species may be distinguished as follows:

Rays with single series of abactinal plates between superomarginals *uniserialis*
Rays with 3 series of abactinal plates on basal half *variegatus*

Bunaster uniserialis

H. L. Clark, 1921. Ech. Torres Strait, p. 69; pl. 7, fig. 2 (colored); pl. 36, figs. 5-7.

The unique holotype of this pretty little sea star was taken from a cranny in coral in 5-6 feet of water on the southwestern reef at Mer, Murray Islands, Torres Strait. It had $R =$ only 11 mm., so it probably is not more than half grown. The color in life was prettily variegated with maroon, brown, and bluish white. The dried specimen is variegated with brown of different shades and buffy white. The supposedly distinctive character, a single series of abactinal plates on the rays, may be associated with youthfulness.

Bunaster variegatus

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 134; pl. 22, fig. 1.

Of this species 17 specimens are known, of which the largest, presumably adult, have $R = 23$ mm. As in the other species, the color is variegated, with brown,

diverse reddish shades, and white predominating; the colors are for the most part lost in alcoholic material. Apparently *variegatus* is an endemic species of southwestern Australia, as it has not been taken on the mainland coast north of Rottneest Island. It was found, however, by Dakin at the Abrolhos Islands, at both Pelsart and Wooded islands. E. W. Bennett found 2 specimens at Bunkers Bay, near the southwestern corner of the continent. Although 11 of the known specimens are from Rottneest Island, all were taken after our visit October 18-19, 1929, when we did not find a single specimen.

LEIASTER

Peters, 1852. Monatsber. K. preuss. Akad. Wissensch. Berlin, p. 177.

Genotype: *Leiaster coriaceus* Peters, 1852, p. 177.

Although 8 species of *Leiaster* have been described, none is known from sufficient material to give an adequate understanding of its distinctive characters. Apparently these sea stars live so closely associated with corals that they are difficult to find and even when found are very hard to collect. Robert Baxter, who gave us the specimen brought from Lord Howe Island in 1932, said that it took him half an hour to dig it out of the coral rock. It is very doubtful whether more than a single species occurs in Australia. The few specimens known are from the two widely separated islands, Mer and Lord Howe. Apparently the only distinguishing character is the color, and on this character alone they may for the present be maintained.

Color variegated, orange-yellow and bright red, with or without magenta *leachii*
Color uniformly crimson *speciosus*

Leiaster leachii

Ophidiaster leachii Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 284.

Leiaster leachii de Loriol, 1885. Mém. Soc. phys. hist. nat. Genève, vol. 29, no. 4, p. 40;

pl. 14, figs. 1-2c.

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 136; pl. 9 (colored).

Although de Loriol's colored figure indicates a uniformly red sea star, his description refers to orange and two quite different shades of red, which would seem to indicate a variegated coloration in his Mauritius specimens similar to that of those taken at Lord Howe Island. No *Leiasters* are yet recorded from the Australian mainland, and the geographical distribution of *leachii* is very imperfectly known. It is at least odd that the Lord Howe species should be the one best known from Mauritius and East Africa. It reaches a very large size, $R = 250-275$ mm.

Leiaster speciosus

von Martens, 1866. Arch. f. Naturgesch., vol. 32, pt. 1, p. 70.

H. L. Clark, 1921. Ech. Torres Strait, p. 74; pl. 11 (colored); pl. 27, figs. 1, 2.

Judging wholly from the appearance in life of the *Leiaster* collected at Mer in 1913 and of the one Baxter gave me at Lord Howe Island in 1932, it is hard to believe they can be the same species. But in preserved specimens, the differences

are insignificant. Until far more material is available, however, it may be best to continue using the name *speciosus* for the short-armed ($R = 7br$ in life), unicolorous crimson individuals, and *leachii* for the long-armed ($R = 14br$ in life), parti-colored ones. Flores, Mindoro in the Philippines, and Macclesfield Bank are the only other known localities for *speciosus* unless we accept Sladen's record from Kandavu in Fiji. According to Domantay and Roxas (1938), the Leiasters from Mindoro are "gorgeously brilliant red," and even when dried, $R =$ about 8br. Their largest specimen had $R = 250$ mm.

OPHIDIASTER

L. Agassiz, 1835a. Mém. Soc. sci. nat. Neuchâtel, vol. 1, p. 191.

Genotype: *Asterias ophidiana* Lamarck, 1815, vol. 2, p. 567.

This is the largest and most widely distributed genus in the family, with at least 20 valid species, of which 7 are reported from Australia, all from the eastern tropical coast. No *Ophidiaster* has been found west of Torres Strait or of Bass Strait. The smaller species are not clearly distinguishable, and the line between *Ophidiaster* and *Tamaria* is by no means sharply drawn in nature. Adult Australian *Ophidiasters*, however, may be distinguished by the following key. In life the species are more or less distinctively colored, but in preserved material these characters have generally vanished. Of 3 of the species, the holotype alone is known, and of the other 4, only 1 (*confertus*) has as yet been collected in adequate numbers.

KEY TO THE SPECIES OF OPHIDIASTER

- A. Adambulacral spines in close contact, no granules separating them:
 B. No abactinal plates conical with bare tips:
 C. No spinelets or conspicuously enlarged granules abactinally even at tip of rays..... *lioderma*
 CC. Spinelets or enlarged granules present abactinally near distal end of rays:
 Rays stout, $R = 4-4.5br$; distal spinelets rather inconspicuous; actinal papular areas well developed..... *granifer*
 Rays slender, $R = 5-7br$; distal spinelets well marked; actinal papular areas only on basal part of rays or wanting in small specimens..... *armatus*
 BB. Many abactinal plates conical with bare tips..... *watsoni*
 AA. Adambulacral spines separated more or less markedly by granules:
 D. Adambulacral spines in pairs, pairs separated by granules..... *propinquus*
 DD. Adambulacral spines not clearly in pairs and separated by granules:
 Papulae numerous in conspicuous large groups (10-20 in each); pedicellariae numerous..... *confertus*
 Papulae 3-8 in each rather ill defined area; pedicellariae few or wanting..... *squamus*

Ophidiaster lioderma

H. L. Clark, 1921. Ech. Torres Strait, p. 80; pl. 27, figs. 3, 4.

This fine species is still known only from the holotype, which in life had $R = 115$ mm. and a dull light brownish-red coloration. It was found near extreme low-water mark on the southwestern reef at Mer, Murray Islands.

Ophidiaster granifer

Lütken, 1871. Vidensk. Medd., vol. 23, p. 276.

H. L. Clark, 1921. Ech. Torres Strait, p. 81; pl. 7, fig. 1 (colored); pl. 29, figs. 3, 4.

Ranging from Port Galera, Mindoro, and Port Palapag, Samar, Philippine Islands, eastward to the Carolines and to the Tonga Islands, and south to Green Island, Queensland, this small *Ophidiaster* ($R =$ only 30-32 mm.) has a characteristic facies. The colors are gray and brownish red. It is fairly common at Mer and was also found at Erub (Darnley Island).

Ophidiaster armatus

Koehler, 1910a. Abhandl. Senckenb. Naturforsch. Gesellsch., vol. 33, p. 277; pl. 15, fig. 8; pl. 17, fig. 6.

This species is still too imperfectly known (only half a dozen specimens) to make a discussion of its relationships profitable. The largest known specimen ($R = 66$ mm.) is from Lindeman Island, Queensland, and Koehler's types are from the Aru Islands. Specimens recorded from the Caroline and Andaman islands are apparently wrongly identified. The color in life has not been recorded, but preserved specimens range from brown, with papular areas much darker than the convex plates which separate them, to deep yellowish violet with 2 or 3 irregular yellowish annulations on the distal third of the arm.

Ophidiaster watsoni

Livingstone, 1936. Rec. Australian Mus., vol. 19, no. 6, p. 386; pl. 28, figs. 1, 3, 5, 7.

This interesting species is known only from the holotype, which has $R = 50$ mm. It was taken at Bushy Island, off Mackay, Queensland, on the edge of the coral reef at low tide. That it is an *Ophidiaster* seems doubtful, nor does the relationship to *armatus* seem at all obvious. Further material is essential.

Ophidiaster propinquus

Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 255; pl. 12, figs. 5, 11, 16, 18.

This is another species known only from the holotype. It was taken on Ribbon Reef, Great Barrier Reef, northeast of Cape Flattery, Queensland. It is a small form with R only 26.5 mm., and has several important diagnostic characters. Aside from the arrangement of the adambulacral spines in separated pairs, the double series of subambulacral spines or tubercles and the rather uniform granulation of the abactinal plates are good recognition marks.

Ophidiaster confertus

H. L. Clark, 1916. "Endeavour" rept., p. 53; pl. 15, figs. 1, 2.
 — 1938. Mem. Mus. Comp. Zool., vol. 55, p. 138; pl. 10, figs. 2, 3 (colored).

This is the one Australian *Ophidiaster* of which sufficient material has been collected to warrant confidence in its specific characters. It is one of the common

echinoderms of Lord Howe Island, and Livingstone (1930) reports it from three stations on the coast of New South Wales. He also records a specimen from North-West Islet, Capricorn group, Queensland, and a specimen from Heron Island, in the same group, is in the Museum of Comparative Zoölogy, the gift of Melbourne Ward. Full-grown specimens have $R = 155-160$ mm. The usual habitat is among coral heads and rock fragments with little attempt at concealment. The color in life is deep tawny yellow or orange-brown; extremes are yellow-orange and, on the other hand, almost a red-brown. The oral side along the ambulacral grooves shows the brightest tint.

Ophidiaster squameus

Fisher, 1906. Bull. U. S. Fish Comm. no. 23, p. 1079; pl. 31, figs. 6-6b; pl. 37, fig. 4.
H. L. Clark, 1921. Ech. Torres Strait, p. 83; pl. 8, fig. 2 (colored).

This species seems to be widely distributed in the Pacific region, as it is reported from the Philippines, Hawaii, the Paumotus, and the Murray Islands. The type locality is in Hawaii, but the type specimens were very small, the larger having R only 19 mm. Specimens with $R = 35-45$ mm. from off Waikiki Beach in $4\frac{1}{2}$ fms. are now in the Museum of Comparative Zoölogy. The only specimen from the Paumotus is very small ($R = 23$ mm.), but the identification is seemingly correct. The Murray Island specimens are apparently adults of the Hawaiian species; they are the only ones known from Australia. The record for the Philippines (Domantay and Roxas, 1938) rests on a single specimen with $R = 37$ mm. found under a rock at Gabino Point, Port Galera, Mindoro. It differs markedly in coloration from all the other known specimens, for whereas the latter were red (vermillion to crimson, in different cases, and more or less variegated), the Port Galera specimen was "reddish-purple, mottled with dull violet and grayish-brown"; the madreporite was "deep orange," and the actinal side was "reddish-purple mottled with brown," with orange on the "adambulacral and ambulacral spines." The figures given certainly look like *squameus*, but obviously more material is necessary.

HACELIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 284 (as subgenus).

Genotype: *Ophidiaster attenuatus* Gray, 1840, p. 284.

Only 4 species are assigned to this genus, but they are widely distributed, with 1 in the Mediterranean and eastern Atlantic, 1 in the West Indies, 1 in the East Indies, 1 in tropical Australia. The Australian species seems to be most like the European, but the latter is the only one of which adequate material has been collected.

Hacelia helicosticha

Ophidiaster helicostichus Sladen, 1889. "Challenger" Ast., p. 405; pl. 69, figs. 5-7.
Hacelia helicosticha H. L. Clark, 1909a. Bull. Mus. Comp. Zoöl., vol. 52, no. 7, p. 111.

Originally taken near Booby Island, Torres Strait, this fine sea star was later collected by the "Alert" in Prince of Wales Channel and in the Arafura Sea. It has been reported also from Holothuria Bank, much farther west, and a large

specimen in the Australian Museum, with $R = 150-155$ mm., is from "north-western Australia." The bathymetrical range is 6-36 fms. Bell's (1884) record of a specimen with $R = 213$ mm. is obviously an error, as the measurement of the lesser radius is out of proportion. If his other measurements are correctly given, R in the biggest specimen would be about 165 mm., making it much the largest specimen known. Nothing is recorded as to the color in life.

TAMARIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 283.

Genotype: *Tamaria fusca* Gray, 1840, p. 283.

This is the most perplexing group of sea stars occurring in the Australian region, for the absence of adequate adult material of the type species and the extraordinary growth changes that occur in at least one of the others have led to much confusion. Livingstone (1930, 1932, 1932a) has given much attention to the group and has published many admirable figures, but since he has given no "key" to the species and no comparative tabulation of their characters, I am unable to make out what distinctive features his 18 figures of *fusca* reveal which set that species apart from *ornata* and young *megaloplax*. He is, moreover, skeptical as to the validity of the genus *Tamaria* because young *Ophidiaster*s often pass through a *Tamaria*-like stage, and large (probably senescent) *Tamarias* are quite *Ophidiaster*-like. It may be that the line between the two genera is arbitrary and unnatural, but in the species, such as *tumescens* and *megaloplax*, which can be defined from adequate adult material, the generic limits of *Tamaria* seem fully justified. To prevent further confusion, I am accepting both *fusca* and *ornata* as valid species. The only specimens available to me are very youthful ones identified by Livingstone, but although they are obviously not conspecific, I do not think either shows reliable specific characters. My key to the Australian species of *Tamaria* must be presented in the following negative form:

KEY TO THE SPECIES OF TAMARIA

- A. Abactinal plates conspicuously tumid, covered with a rather smooth coat of coarse granules; papular areas large with many (10-20) papulae; inferomarginal spines may or may not be present *tumescens*
- AA. Not as above:
- B. Granulation very coarse; papular areas small, deep-sunken, with very few papulae; large central pointed tubercles or spinelets present on many marginal plates, especially near tip of arm *ornata*
- BB. Not as above:
- Granulation irregular, with central granules on each plate large, often becoming conspicuous pointed tubercles or spines, most frequent and evident in half-grown specimens but becoming resorbed in adults; papular areas large, with 10-20 papulae *megaloplax*
- Not as above *fusca*

Tamaria tumescens

Ophidiaster tumescens Koehler, 1910a. Abhandl. Senckenb. Naturforsch. Gesellsch., vol. 33, p. 277; pl. 16, figs. 3, 4.
Tamaria propetumescens Livingstone, 1932a. Rec. Australian Mus., vol. 18, p. 369; pl. 42.

Tamaria tumescens H. L. Clark, 1921. Ech. Torres Strait, p. 94.
 ——— 1938. Mem. Mus. Comp. Zool., vol. 55, p. 141.

This fine *Tamaria* was first described from the Aru Islands in 10 fms. and later was reported from Parry Shoal, west of Melville Island, northern Australia. In 1932, it was found to be fairly common near Broome, and its lovely old-rose color was first revealed. It grows to a large size (R = 98 mm.) and shows much diversity in the arrangement of the aboral plates.

Tamaria ornata

Ophidiaster ornatus Koehler, 1910. Indian Mus. Ast., p. 151; pl. 18, figs. 3, 4.
Tamaria ornata Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 260; pl. 12, fig. 2.

As the only known specimens of this *Tamaria* are very young, its validity as a species is dubious. Its right to a place in the Australian fauna is based on the fact that a small specimen with R = 22 mm. is in the Museum of Comparative Zoölogy from Holothuria Bank in the Timor Sea.

Tamaria megaloplax

Linckia megaloplax Bell, 1884. "Alert" rept., p. 126.
Tamaria megaloplax Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 259; pl. 9, figs. 1-3; pl. 12, figs. 8, 12, 14.
 ——— 1932a. Rec. Australian Mus., vol. 18, p. 369; pl. 40.
Ophidiaster tuberifer Sladen, 1889. "Challenger" Ast., p. 404; pl. 55, figs. 1-4.
Tamaria tuberifera H. L. Clark, 1921. Ech. Torres Strait, p. 90; pl. 8, fig. 1 (colored).
 ——— 1938. Mem. Mus. Comp. Zool., vol. 55, p. 139.

Livingstone has given much attention to the problems involved in Bell's confusion of 2 or more species in his original description of this sea star. It was well described and figured by Sladen under a different name, but Bell's has priority. The range of the species extends from the northern part of the Barrier Reef (off Snake Reef, 13½ fms.), Queensland, to Broome, and Livingstone includes also the Andaman Islands and Philippines (Sulu Archipelago, *vide* Fisher, 1919). Full-grown specimens have R = 90-100 mm. and lack entirely the spinelets so evident in half-grown individuals, an extraordinary growth change. The color in life is an attractive combination of shades of brown and gray. Further material is necessary for understanding the diversity involved in the growth changes.

Tamaria fusca

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 283.
 Livingstone, 1932. Sci. rept. Great Barrier Reef Exped., vol. 4, no. 8, p. 257; pl. 9, figs. 4-7; pl. 11, figs. 1-4, 7, 8; pl. 12, figs. 1, 4, 6, 7, 10, 15, 17, 19.

The only specimen of this species at hand is one with R = 12 mm. from off Direction Island, Queensland, taken by the Great Barrier Reef Expedition and identified by Livingstone. It is of course very young and its specific characters are uncertain. It has more pedicellariae and a finer coating of granules than any other *Tamaria* I have seen. It is very different from the adult *fusca* (R = 50 mm.)

figured by Livingstone in 1930 (pl. 8, figs. 2, 5). The distribution of *fusca* as given by Livingstone in 1932 is "Philippine Islands, Celebes and coast of North Queensland."

PSEUDOPHIDIASTER

H. L. Clark, 1916. "Endeavour" rept., p. 54.

Genotype: *Pseudophidiaster rhysus* H. L. Clark, 1916, p. 54.

This odd ophidiasterid seems to be quite set apart from the rest of the family by its characteristic modification for a deep-water life.

Pseudophidiaster rhysus

H. L. Clark, 1916. "Endeavour" rept., p. 55; pl. 16, figs. 1, 2.

The few known specimens of this endemic Australian sea star were taken along the southern coast of the continent between Oyster Bay, Tasmania, and the Great Australian Bight in 60-200 fms. In size they range from R = 58 to R = 150 mm. The color in life is reported to be dark purple; dry specimens are dingy gray or brown.

Order SPINULOSA

This order is not so large as the preceding and is not nearly so conspicuous a feature of the Australian marine fauna. Of the 9 families represented, 3 are now extinct and occur only as fossils, and 3 of the remainder have but one representative each. The extinct forms are very different from any of the living sea stars and throw little light on the history of the present fauna. The 9 families are to be distinguished as follows:

KEY TO THE FAMILIES OF SPINULOSA

- A. Inferomarginal plates wanting or, if present basally, in contact with adambulacrals, hence no actinolateral plates; all extinct:
- B. Rays short and wide with single series of superomarginal plates; lower surface covered by huge adambulacrals and opposite ambulacrals Monasteriidae
- BB. Not as above:
- Interbranchial areas practically wanting; no inferomarginals; rays long and tapering; abactinal surface covered with numerous small plates Urasterellidae
- Interbranchial areas more or less well developed; inferomarginals developed proximally but only in contact with adambulacrals Schuchertiidae
- AA. Inferomarginal plates present, more or less separated from adambulacrals by well developed actinolateral plates; chiefly Recent:
- C. Mouth plates small; ambulacral furrows narrow:
- D. Abactinal skeleton formed of closely imbricating plates, usually bearing spines or spinelets; actinal skeleton formed of imbricating plates, bearing a tuft or fan of spinelets or 1 or 2 small spines Asteriniidae

- DD. Abactinal skeleton formed of plates in longitudinal and transverse series forming a more or less open meshwork;
- E. No pedicellariae; abactinal skeleton reticulated, with spines, spinelets, or groups of spinules; interbrachial septa rudimentary or wanting Echinasteridae
- EE. 2-jawed pedicellariae present; disk large; interbrachial septa well developed:
- Rays and madreporites numerous; skeleton open-reticulated, armed with large, isolated spines Acanthasteridae
- Rays 5; madreporite single; abactinal plates regularly arranged, bearing small, isolated spines Valvasteridae
- CC. Mouth plates large, plowshare shape; ambulacral furrows wide; adambulacral armature pectinate:
- No supradorsal membrane, or segmental pores or papillae; interbrachial septa calcified Solasteridae
- Supradorsal membrane complete; segmental pores and papillae present; interbrachial septa not calcified Pterasteridae

Family *MONASTERIDAE

This family was instituted by Schuchert (1915) for a single genus containing a remarkable sea star occurring in the Permocarboneous rocks of New South Wales. It is an isolated form, and, though included in the Spinulosa, has very little resemblance to any of the other sea stars included in the order; the real relationships have yet to be worked out.

*MONASTER

Etheridge, 1892. Mem. Geol. Surv. N. S. Wales, Palaeontol., no. 5, pt. 2, p. 71.

Genotype: *Palaeaster clarkei* de Koninck, 1877, p. 166.

Etheridge proposed this group as a subgenus, but Schuchert (1915), after careful study and discussion, raised it to full generic rank, as it has no close relationship with *Palaeaster*. Only a single species is known.

**Monaster clarkei*

Palaeaster clarkei de Koninck, 1877. Foss. Pal. Nouv.-Galles du Sud, pt. 3, p. 166; pl. 7, figs. 6, 6a.

Palaeaster (Monaster) clarkei Etheridge, 1892. Mem. Geol. Surv. N. S. Wales, Palaeontol., no. 5, pt. 2, p. 71; pl. 14, figs. 1, 2; pl. 15, fig. 4.

Only 4 specimens of this remarkable sea star have as yet been found, 1 in the Upper Marine series, and 3 in the Lower Marine series of the Permocarboneous rocks of County Northumberland, New South Wales. As Paleozoic sea stars go, it is a large species, R = 50-65 mm. The great width of the rays in proportion to the length is one of the most striking features.

Family *URASTERELLIDAE

This family was believed by Schuchert (1915) to contain but a single genus, to which he assigned a dozen species from North America, Europe, and Australia.

Withers and Keble (1934), however, consider the Australian species are best placed in 2 genera, which may be distinguished thus:

- All the rows of adradials exactly similar *Salteraster*
 Rows of adradials not exactly alike *Urasterella*

*SALTERASTER

Stürtz, 1893. Verhandl. Naturhist. Ver. preuss. Rheinland, vol. 50, pp. 43, 60.

Genotype: *Palaeaster asperrimus* Salter, 1857, p. 325.

Schuchert (1915) was doubtful about the validity of this genus, but Withers and Keble (1934) after careful study of Victorian specimens consider it worthy of recognition. They distinguish 2 Australian species thus:

- Rays elongate, tapering, with median radial series of plates and 3 series of adradials on each side *selwyni*
 Rays short, not tapering, with only 2 series of plates on dorsal side above inferomarginals *biradialis*

**Salteraster selwyni*

Urasterella selwyni McCoy, 1874. Prodr. palaeontol. Victoria, dec. 1, p. 42; pl. 10, figs. 2, 3.
Salteraster selwyni Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 235; pl. 11, figs. 1, 2.

This little sea star, with R only 13 mm., is known only from the Silurian rocks of the range on the eastern side of Commonage Reserve, Kilmore, Victoria.

**Salteraster biradialis*

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 237; text figs. 9, 10; pl. 11, fig. 5.

Of this tiny sea star only 2 specimens were found, 1 with R about 12 mm., the other with R only about 7 mm. They were taken "from the same open reddish sandstone bed on the eastern side of Commonage Reserve, Kilmore, Victoria" as *S. selwyni*.

*URASTERELLA

McCoy, 1851. Brit. Pal. foss., p. 59.

Genotype: *Uraster ruthveni* Forbes, 1848, p. 463.

McCoy's account gives no distinctive features of the genus, but he proposes it for 2 species, *ruthveni* and *hirudo*. As the latter is very possibly the young of *ruthveni*, the first-named and better-known species should be regarded as the genotype. Of the dozen species listed by Schuchert, only 1 occurs in Australia, and that is now included in the preceding genus. But a new species of *Urasterella* was described in 1934 from Victoria, and thus the genus remains in the Australian fauna.

***Urasterella creswelli**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 234; pl. 12, fig. 6.

Based on a single specimen, with R only 10 mm., this little sea star is possibly a *Salteraster*, but the high quality of the work of its authors warrants accepting their judgment as to its generic position. It was found in the "mudstone quarries" in the Yeringian (Silurian) strata of Lilydale, Victoria, associated with an abundant fauna of marine invertebrates.

Family ***SCHUCHERTIIDAE**

This family, including but a single genus, is regarded by Schuchert (1915) as "the most primitive and ancient of all large-disked or pentagonal sea-stars devoid of marginals." He stated that it was known only from North America, but Spencer (1922) records it from Great Britain, and Withers and Keble (1934) have added it to the Australian fauna.

***SCHUCHERTIA**

Gregory, 1899. Geol. Mag., n. s., dec. 4, vol. 6, p. 351.

Genotype: *Palasterina stellata* Billings, 1857, p. 290.

Two good-sized fossils which are apparently congeneric but are certainly not conspecific justify including this North American and British genus in the Australian fauna. The 2 forms are easily separated as follows:

Disk large, its diameter greater than length of free arms *macrata*
 Disk rather small, its diameter much less than length of free arms *junori*

***Schuchertia macrata**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 239; pl. 12, fig. 3.

A poorly preserved fossil from Hoffman Brick Pit, Brunswick, Victoria, is the holotype and only known specimen of this sea star. It has R = 40 mm., r = 15. The rock in which it was found is a "bluish mudstone," in Silurian strata "100 feet below the surface."

***Schuchertia junori**

Withers and Keble, 1934. Proc. Roy. Soc. Victoria, vol. 46, p. 238; pl. 10, fig. 3.

This species is also based on a single specimen in the National Museum at Melbourne, but it is finely preserved, though the apical side is wanting. It has R = 35 mm., r = 9. It was found "in hard greenish sandstone" in "Collins Quarry, Kinglake West," Victoria, the facies of which is "distinctly upper Silurian."

Family **ASTERINIDAE**

This widely distributed family is very well represented in Australia, and on rocky shores and reefs these sea stars are an interesting part of the fauna, especially in the tropics. Most of the species are secretive and are found clinging closely to the under side of rock fragments or concealed in crevices, but a few occur on sandy

bottoms, and one of the largest species lives concealed just beneath the surface on bottoms of pure sand. Many species are brightly colored, but in some the specific coloration is excessively diversified and inconstant. Most of the species are small, with R less than 50 mm. There is great diversity of form, however, some being flattened with r nearly equal to R, while at the other extreme are species with slender, more or less nearly cylindrical rays and R = 5-6r. The 9 genera occurring in Australia are distinguished from one another chiefly by body form and proportions, by the character of the abactinal plates, and by the spinulation.

KEY TO THE GENERA OF ASTERINIDAE

- A. Form not excessively flattened, v.d. = 0.15 h.d. or more; papulae widely distributed over abactinal surface:
 B. Disk large; rays and body more or less flattened, with r tending to be $\frac{1}{2}$ R or more:
 C. Abactinal skeleton rigid, no plates carrying long spines:
 D. Actinal spinulation not sacculate; no patch of uncalcified membrane in actinal intermediate areas near mouth:
 E. Abactinal plates not obviously divided into 2 areas; no regular, crowded, transverse series of small rounded plates along sides of rays:
 Abactinal plates of papular areas all of one kind, not crescentic or notched for papulae, wholly or partly spinulose *Asterina*
 Abactinal plates of papular areas of 2 or more kinds, the larger crescentic or notched for papulae *Patiriella*
 EE. Abactinal plates divided into 2 areas: one, on disk and along radial crests, of crescentic plates; the other, comprising rest of upper surface, covered by regular, crowded transverse series of small, rounded plates *Paranepanthia*
 DD. Actinal spinulation sacculate; patch of uncalcified membrane in each actinal intermediate area near mouth *Disasterina*
 CC. Abactinal skeleton not rigid, many plates not in close contact with their fellows; on distal part of arm they carry long, slender spines *Manasterina*
 BB. Disk small; rays more or less elongate and tending to be cylindrical or at least arched dorsally, or markedly trigonal:
 F. Rays not trigonal and keeled:
 Abactinal plates, at least larger ones, definitely crescentic; papulae evident *Nepanthia*
 Abactinal plates not crescentic, crowded, often swollen; papulae inconspicuous or invisible *Parasterina*
 FF. Rays trigonal and keeled *Tegulaster*
 AA. Form excessively flattened, v.d. less than 0.10 h.d.; papulae confined to narrow radial bands *Anseropoda*

ASTERINA

Nardo, 1834. Oken's Isis, vol. 7, p. 716.

Genotype: *Asterina minuta* Nardo, 1834, p. 716 = *Asterias gibbosa* Pennant, 1777, p. 62.

The sea stars composing this genus are mostly small, pentagonal forms living on the lower surface of rocks and coral fragments. A few species have 6 or more

rays and, at least in youth, reproduce by fission. They show great diversity in color, but within each species the general tint is fairly constant. They are most abundant in the tropics, but are to be found on all the coasts of Australia and particularly at Lord Howe Island, where 4 species were taken.

KEY TO THE SPECIES OF ASTERINA

- A. Rays 5 only:
 B. Form more or less pentagonal, though sides may be concave; $r = \frac{2}{3} R$ or more:
 C. Actinal intermediate plates with single short, blunt spine or none *atyphoida*
 CC. Actinal intermediate plates with 2 or more spinelets:
 D. Spinelets of actinal plates 2 or 3, long and slender, exceeding width of plate *perplexa*
 DD. Spinelets of actinal plates short, often minute:
 E. Abactinal plates practically bare; actinal plates with minute spinules in central group of 2-4:
 Interradial margins markedly concave; papulae large, in about a dozen longitudinal series on basal half of each ray; colors in life gray, orange, and white *nuda*
 Interradial margins nearly straight or even convex; papulae small, in about 8 series; colors in life white and dull blue *inopinata*
 EE. Abactinal plates with minute spinelets in crescentic series; actinal plates with distinct "fans" of 4-6 slender spinules; color in life orange or orange-yellow *lutea*
 BB. Form more or less stellate; $r =$ about $\frac{1}{2} R$ or less:
 F. Abactinal plates bare; actinal plates with 1-3 minute spinelets *alba*
 FF. Abactinal plates with numerous spinelets:
 G. Abactinal plates with straight or curved compressed ridges, densely crowned with very minute spinules *scobinata*
 GG. Not as above:
 H. Abactinal spinelets blunt, scarcely twice as long as thick, forming granular coat *crassispina*
 HH. Abactinal spines slender and acute, often minute:
 Some, usually many, abactinal plates along radial areas irregularly and conspicuously enlarged as bases for clusters of enlarged spinules *coronata*
 No such swollen plates *burtonii*
 AA. Rays 6, 7, or 8:
 Abactinal spinelets low, blunt; 1 or 2 minute acute spinelets on actinal intermediate plates *heteractis*
 Abactinal spinelets minute, acute; 3 or more minute, short spinelets on each actinal plate *anomala*

Asterina atyphoida

H. L. Clark, 1916. "Endeavour" rept., p. 57; pl. 17, figs. 1, 2.

This is the *Asterina* characteristic of the southern coasts of Australia, as it has been taken as yet only in the vicinity of Kangaroo Island and in Spencer and St. Vincent gulfs. It is a small species, the largest yet taken being only 22 mm. across. Nothing is recorded as to the color in life. The close resemblance to the Panamic *Asterina modesta* is noteworthy.

Asterina perplexa

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 155; pl. 22, fig. 4.

A single specimen of this *Asterina* was taken at Ned's Beach, Lord Howe Island, April 6, 1932, and no other specimen is as yet known. It has $R = 14$ mm. and is now pale brown; in life it was "white but with indefinite orange-yellow areas aborally; orally, pure-white."

Asterina nuda

H. L. Clark, 1921. Ech. Torres Strait, p. 98; pl. 23, figs. 3, 4.

This species also was described from a single specimen, from the other end of the Barrier Reef, found on the under side of a rock fragment at Weier, Murray Islands, September 30, 1913. It was about 33 mm. in diameter and the color was notably different from that of any other *Asterina* found at the Murray Islands. The upper surface was deep pearl gray, lightest in interradial, darkest on crest of rays; plates at tip of ray distinctly purple; marginal plates orange-brown; area around anus bright orange; madreporite white; lower surface faintly mottled brown, orange, and white; tube feet whitish. The dry specimen is dull brownish yellow. Livingstone (1933) reports 2 specimens in the Australian Museum from the "type locality" (presumably meaning the Murray Islands), but he gives no information about them.

Asterina inopinata

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 3; pl. 5, figs. 1-8, 14.

This is one of the most attractive species of *Asterina* yet known, the flattened, nearly circular form and the very unusual coloration combining to give it a fine appearance. The color in life is white more or less clouded and blotched with blue; the younger the specimen, the less the blue. The shade of blue varies in different individuals, from dusky to a definite dark blue. In alcohol, the white becomes cream color and the blue a dusky green. Dried specimens lose all distinctive coloring. The largest specimen yet reported has $R = 20$ mm. Livingstone has recorded interesting growth changes, very young individuals having interradial slits (lunules) as in *Tremaster*, which are gradually obliterated as the individual grows. The significance of this extraordinary fact is a complete mystery. *Tremaster* is known as yet only from moderately deep water in the western North Atlantic, whereas *inopinata* is found only on the southeastern corner of the Australian continent, from the Tuggerah "lakes," New South Wales, to Tasmania, in very shallow water.

Asterina lutea

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 153; pl. 12, fig. 2 (colored).

This is one of the characteristic sea stars of the Broome region, but we did not find it west of Roebuck Bay. Bardwell obtained a specimen far to the east, however, at either Augustus or the Champagne islands. Its bright color makes it fairly easy to discover on overturned rock fragments. The very young are white, becoming more and more bright orange as they mature, but some individuals be-

come only a dull yellow or a grayish orange. Full-grown specimens are 40–45 mm. across, with the sides nearly straight but sometimes concave, sometimes convex. Non-pentamerous variants are rare, but 1 tetramerous and 1 hexamerous specimen were taken.

Asterina alba

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 150; pl. 22, fig. 7.

So far as is yet known, this species is endemic at Lord Howe Island, but it will probably be found on the Barrier Reef and possibly on the mainland coast. It is so small ($R = 7-9$ mm.) and secretive that it is easily overlooked, yet the color is not at all protective. It is more or less pure white, but the largest individuals show, under a lens, traces of orange-yellow and a few scattered dusky or purple patches on the aboral surface. It occurs often with the usually non-pentamerous species *anomala*, but its consistent pentamerous symmetry is evidenced by the occurrence of only 1 hexamerous individual, which shows no evidence of autotomy.

Asterina scobinata

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 1; pl. 5, figs. 9–12, 15.

This species was based on 3 pentamerous individuals, with $R = 11-13$ mm., from Tasmania. Five additional specimens from Tasmania were taken in 1929, and 4 are now in the Museum of Comparative Zoölogy. In them, $R = 7-15$ mm. They show considerable diversity in body form, but it is probable that this is largely due to varied methods of killing and preservation. The color in life of 2 of these was deep brown above, cream color below, in sharp contrast. If this coloration is constant, it is distinctive. The types had 5 pairs of small noncalcified spots in the actinal interradial areas, and these can be made out with more or less difficulty in the other specimens, but are of diverse size and position.

Asterina crassispina

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 390; fig. 112.

Only a single specimen of this *Asterina* is known. It is in the South Australian Museum, dry, and not in very good condition, but shows the distinctive characters well. In it, $R = 20$ mm. and $r = 11$. It is supposed to be from the coast of the Northern Territory, but whether from the northeastern or northwestern side there is no clue.

Asterina coronata

von Martens, 1866. Arch. f. Naturgesch., vol. 32, pt. 1, p. 73.

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, pp. 411–416; pl. 115, figs. 1–3; pl. 116, figs. 1, 2.

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 145; pl. 12, fig. 1 (colored).

This is the distinctive and characteristic sea star of Darwin and vicinity, but it has not yet been taken either in Queensland or in Western Australia. It is known from various stations in the East Indian region north to southern Japan and east to the Caroline Islands. Fisher (1919) has made a careful study of the

diversities shown and recognizes 3 subspecies besides von Martens' original *coronata*. The name *fascicularis* belongs to the North Australian form. It is a rather handsome green and red star with $R = 30-33$ mm. The references given above supply all details.

Asterina burtonii

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 289.

H. L. Clark, 1921. Ech. Torres Strait, p. 96; pl. 6, fig. 2 (colored).

Asterina cepheus Müller and Troschel, 1842. Syst. Ast., p. 41.

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 411; pl. 115, fig. 4.

As I said in 1921, the abandoning of Gray's name seems to me unjustified, despite my dislike for attaching human proper names to plants and animals. There is, I believe, no doubt as to the sea star which Gray called *Asterina burtonii*. It is widespread in the Indo-Pacific region from Mozambique to the Paumotu, but does not seem to have been found common anywhere. Full-grown specimens may be 40 mm. across, but most museum specimens are less than that. Little is recorded as to the color in life. Australian specimens were orange-vermilion when small ($R = 10-12$ mm.), but big ones were greenish gray. They have been taken at the Murray Islands, Torres Strait, at Roebuck Bay and Shark Bay, Western Australia, and at Long and Wooded islands, Houtman's Abrolhos.

Asterina heteractis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 152; pl. 22, fig. 5.

As all the known material of this species came from Lord Howe Island, it must be considered endemic there, but as it is small and secretive and not easily seen and collected, it may well be found in the Barrier Reef region if not on the coast of New South Wales. There are 4 specimens, but only 1, the holotype, with $R = 7$ mm., can be considered even approximately adult. It has 7 similar rays, and the color in life was salmon pink above and whitish below. The other specimens show that reproduction occurs by autotomy, for 1 has 6 rays, with 3 on one side twice as large as the opposite 3, and the other 2 have but 3 arms each. These 3 specimens were light orange or whitish in life.

Asterina anomala

H. L. Clark, 1921. Ech. Torres Strait, p. 95; pl. 7, fig. 8 (colored); pl. 23, fig. 5; pl. 26, figs. 2, 3.

In addition to the account given in 1921, all that is further known of this odd little sea star is given in H. L. Clark, 1938, pages 143–144. Intensive collecting at Mer and at Lord Howe revealed this species at each end of Australia's eastern reef region. It is of course probable that it will be found in many suitable spots between these extremes. The species is very small, with $R = 10-12.5$ mm. in the largest individuals. The number of rays ranges up to 8, with 5 the least common—only about 1 in 75 is pentamerous. More than half the known specimens have 7 rays. Conditions at Lord Howe seem to suit this little sea star well, as it is found there by the hundred. It was found just once west of Torres Strait, 2 small specimens being collected at Cape Leveque, Western Australia. These had

the characteristic green and red coloration of the Barrier Reef specimens, with the red predominant. A careful study of the asexual reproduction of this species would be rewarding.

PATIRIELLA

Verrill, 1913. Amer. Jour. Sci., ser. 4, vol. 35, pp. 480, 483.

Genotype: *Asterina (Asteriscus) regularis* Verrill, 1867, p. 250.

This genus is characteristic of the southern hemisphere and is well represented in Australia by 7 species, at least 3 of which are among the commonest of Australian sea stars. They occur among and under rocks in very shallow water, even above low-water mark in some favored areas. Excepting *exigua*, they do not occur in the tropics, but only on the more southern coasts of the continent. The species are distinguished as follows, but it should be noted that 2 species are known from only a single specimen each, 1 is known from 1 indubitable and 3 more dubious examples, and a fourth supposed species is not certainly distinct from *gunnii*.

KEY TO THE SPECIES OF PATIRIELLA

- A. Rays normally more than 5; no suboral spine on oral plates:
 B. Rays 7-9, normally 8; actinal intermediate plates usually with single spine *calcar*
 BB. Rays 5-7, normally 6; actinal intermediate plates usually with 2 spines:
 Colors in life diversified; spines of actinal plates more or less cylindrical and bluntly pointed *gunnii*
 Unicolor, usually more or less purple; tube feet orange; spines of actinal plates very short, flat, and truncate *brevispina*
 AA. Rays normally 5; 1 or more suboral spines on oral plates:
 C. Only a single suboral spine:
 Form stellate; only a single spine on actinal intermediate plates except sometimes near disk margin *mimica*
 Form pentagonal; 2 spines on distal actinal intermediate plates; color in life, black *nigra*
 CC. 2 or more suboral spines, though there may be but 1 on some plates:
 Rather large, R = 27 mm.; markedly stellate; innermost oral spine flat, very wide, notched at tip *inornata*
 Small, R rarely exceeds 15 mm.; more or less pentagonal; innermost oral spine not peculiar *exigua*

Patiriella calcar

Asterias calcar Lamarck, 1816. Anim. sans vert., vol. 2, p. 557.

Asterina calcar Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 290.

McCoy, 1890. Prodr. zool. Victoria, dec. 20, p. 371; pl. 200, figs. 1-1d (1, 1a, 1d colored).

Patiriella calcar Verrill, 1913. Amer. Jour. Sci., ser. 4, vol. 35, p. 484.

McCoy (1890) calls this the commonest sea star on the coast of Victoria. It is also common at favored places on the coasts of New South Wales, at least as far north as Coffs Harbour; all around the island of Tasmania; and on the South Australian coast at least to Spencer Gulf. There are no published records from farther west. It occurs in shallow water along shore, even above low-water mark.

The number of rays is usually 8, but 7- and 9-rayed specimens are not very rare. The adults are commonly 60-80 mm. in diameter, occasionally 100 mm. or a little more. The coloration is more or less diversified and often notably handsome. Green is common as a tinge, if not as a ground color, and orange and brown are very generally evident; white blotches or markings may occur.

Patiriella gunnii

Asterina gunnii Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 289.

McCoy, 1890. Prodr. zool. Victoria, dec. 20, p. 372; pl. 200, figs. 2-2c (2, 2a colored).

Patiriella gunnii Verrill, 1913. Amer. Jour. Sci., ser. 4, vol. 35, p. 484.

Like the preceding, this is an endemic species of the southern coast of Australia, but it has a far wider range, as it is common on the southwestern corner of the continent and ranges as far north as Dongarra on the western coast. On the east coast, the farthest north recorded is at Long Reef, Collaroy, New South Wales. I have seen no specimens or records from Tasmania. Like *calcar*, it lives in very shallow water, near low-tide mark. The number of rays ranges from 5 to 8. Of 539 specimens, practically 90 per cent had 6 rays, 6.5 per cent had 7, 2.5 per cent had 8, and rather more than 1 per cent had but 5. Adults are usually about 100 mm. across, but may be as much as 140 mm. The outline is normally hexamerous with $R = 1.16r$, but rarely it is circular, with $r = R$; on the other hand, individuals occur with $R = 1.25-1.50r$. The vertical diameter varies greatly with the method used and care taken in killing and preservation; v.d. = 0.06-0.40 h.d. in museum specimens. The coloration is as varied as in *calcar*, but is perhaps on the average darker and duller, with little or no white or pale yellow. McCoy (1890) says the color is "generally purple above," though his colored figure does not show it. Apparently he had been impressed by specimens of the following species, *brevispina*.

Patiriella brevispina

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 166; pl. 22, figs. 2, 3.

This unicolor sea star is characteristic of the southwestern corner of Australia. The color in life is "deep purple or brownish-crimson or more nearly brown (but with surprisingly little difference), with deep orange tube-feet." It is somewhat smaller than *gunnii*, the largest specimen as yet seen being 90 mm. across. The actinal spines are remarkably small, flat, and truncate. Aside from a large specimen taken at Port Willunga, South Australia, this species is known only from Koombana Bay, Bunbury; Bunkers Bay; and Ellenbrook Bay, Western Australia. But, as was noted above under *gunnii*, McCoy had apparently found specimens of *brevispina* on the coast of Victoria and considered them purple *gunnii*.

Patiriella mimica

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 16; pl. 1, figs. 6, 7; pl. 2, figs. 8, 10, 11.

The unique holotype of this species, having $R = 24$ mm., was dredged in 16-19 fms. off Newcastle Bight, New South Wales. Its color in life was not noted, nor

is it very evident how it is to be distinguished from the New Zealand species *regularis*, which has been shown by both Farquhar and Mortensen to be anything but regular.

Patiriella nigra

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 167; pl. 21, figs. 3, 4.

This extraordinary black sea star has been found as yet only at Lord Howe Island. The holotype has $R = 27-28$ mm., but a specimen in the Australian Museum has $R = 35$ mm. Further collecting of *Patiriellas* of the *regularis* type at Lord Howe Island is essential for determining the true status of *nigra*.

Patiriella inornata

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 17; pl. 1, figs. 2, 4; pl. 2, figs. 1, 4, 7.

This species is based on a single 5-rayed specimen, with $R = 27$ mm., from "Western Australia." If the character of the oral spines as shown in this individual is constant, it is a good recognition mark, but obviously more material is essential.

Patiriella exigua

Asterias exigua Lamarck, 1816. Anim. sans vert., vol. 2, p. 554.

Asterina exigua Perrier, 1876. Arch. zool. exp., vol. 5, p. 222 (p. 302 of reprint).

Koehler, 1910. Indian Mus. Ast., p. 129; pl. 9, figs. 6, 7.

H. L. Clark, 1921. Ech. Torres Strait, p. 97; pl. 7, figs. 6, 7 (colored).

Patiriella exigua Verrill, 1913. Amer. Jour. Sci., ser. 4, vol. 35, p. 484.

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 163.

This little sea star ranges along the whole eastern coast of Australia from Hobart, Tasmania, to Erub (or Darnley Island), Torres Strait, but it has not been found west of Spencer Gulf on the southern coast or anywhere on the western or northern coasts of the continent, save for 1 specimen in the South Australian Museum labeled "North Australia." The occurrence throughout the western Indo-Pacific area from South Africa to the Philippines and southeastward to the New Hebrides would lead one to expect it on the coast of northwestern Australia, but not one individual did we find either in 1929 or in 1932. It is a gregarious species and occurs in great numbers in favored localities, as at Erub and Lord Howe Island. At Erub conditions seem to be particularly favorable, and *exigua* reaches its maximum size here, 35 mm. in diameter. For discussions of its habits and diversity, see H. L. Clark, 1921 and 1938.

PARANEPANTHIA

Fisher, 1917. Ann. Mag. Nat. Hist., ser. 8, vol. 20, p. 172.

Genotype: *Nepanthia platydisca* Fisher, 1913a, p. 218.

This is a well marked genus of half a dozen species, of which 3 occur in the temperate waters of southern Australia, and the others in the tropical seas of the Andaman Islands, the Philippines, and Celebes. Fisher's name replaces Verrill's

Asterinopsis, a name given to a somewhat heterogeneous group with Lamarck's *penicillaris* designated as the type, and Mortensen (1933, p. 258) has pointed out that this name is invalid. Its revival by Cotton and Godfrey (1942) is unnecessary and regrettable.

KEY TO THE SPECIES OF PARANEPANTHIA

- A. Interbranchial arcs rather deep and more or less acute; plates of disk and radial areas different from those of interradial and sides of rays:
 Large, R up to 70 mm.; actinal plates along rays very numerous and in distinctly separated transverse series; color dull *grandis*
 Small, R less than 12 mm.; actinal plates along ray not very numerous, arranged in 2 or 3 longitudinal series; color in life rose red, more or less variegated with cream color *rosea*
- AA. Interbranchial arcs shallow and more or less rounded; plates of disk and radial areas not conspicuously different from those of interradial and sides of rays *praetermissa*

Paranepanthia grandis

Nepanthia grandis H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 393; fig. 113.

Paranepanthia grandis H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 159.

This is an endemic and characteristic sea star of southern and southwestern Australia, apparently not rare on the coast of Victoria, judging from specimens in the National Museum at Melbourne, and in St. Vincent and Spencer gulfs, South Australia, but reaching a maximum size on the coast of Western Australia, where it has been found at Bunkers Bay and even at Point Peron. The specimen taken at the latter place is of maximum size, with R about 70 mm. in life. Owing to the dull coloration and the close adhesion to the lower surface of rock fragments, even so large a sea star may easily escape observation. The color in life is dull fawn color or some shade of yellowish brown or grayish brown.

Paranepanthia rosea

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 161; pl. 22, fig. 8.

Common at Rottneest Island, and occurring also at Point Peron, this pretty little sea star seems to be an endemic species of Western Australia. Its rose and cream coloration attracts attention in spite of the small size (less than 20 mm. across). It lives appressed to the lower surface of rock fragments and may be easily overlooked if there is much animal or plant growth thereon. Hexamerous individuals are by no means rare.

Paranepanthia praetermissa

Asterinopsis praetermissa Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 14; pl. 3, figs. 1, 2; pl. 4, figs. 2, 3.

Paranepanthia praetermissa H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 161.

Across the continent from the preceding, this sea star represents the genus on the coast of New South Wales, where 7 specimens have been taken and listed from

Port Jackson, besides the holotype from Little Bay. It is much larger than *rosea*, adults having $R = 32-36$ mm., but it is not known to approach *grandis* in maximum size. No notes on the color in life are recorded, but apparently it is somewhat lighter and more yellowish than that of *grandis*. The spinulation is noticeably different from that of the larger species, but the difference is difficult to show in a photograph and almost impossible to describe. The tufts of spinules are better spaced and the spinules are fewer, shorter, and more flaring than in *grandis*, but such a statement tends to exaggerate the difference. See the published figures, noting especially the interradial areas of the upper surface.

DISASTERINA

E. Perrier, 1875. Arch. zool. exp., vol. 4, pp. 292, 302 (no adequate diagnosis and no species mentioned).

— 1876. Arch. zool. exp., vol. 5, p. 209 (no diagnosis, but 1 species described).

Genotype: *Disasterina abnormalis* Perrier, 1876, p. 209.

Livingstone (1933) did an admirable piece of work in clarifying this genus and in demonstrating that my *Habroporina* (1921, p. 34) is a synonym of Perrier's quite inadequately diagnosed genus. I had not noticed *Disasterina*, being of the opinion that my Murray Islands specimens belonged in the Poraniidae. Livingstone has now shown that my specimens from Mer are identical with Perrier's from New Caledonia. Moreover, he has shown that another of my species (*Asterina leptalacantha*) also belongs in Perrier's genus, and he has added a third species from Port Curtis, Queensland. A single specimen of a little sea star from Broome seems to warrant including *Disasterina* in the fauna of that happy hunting ground of the marine zoologist, but it is apparently distinct from the Barrier Reef species. The 4 Australian forms may be distinguished thus:

KEY TO THE SPECIES OF DISASTERINA

A. Rays not short and broad, $R = 2r$ or more:

B. Abactinal surface covered by bare, thick skin, more or less obscuring underlying plates even when dry *abnormalis*

BB. Abactinal surface more or less bare but not skin-covered:

Abactinal plates near center of disk with small spinelets; ambulacral armature, 4-6 (usually 5) spinelets; oral plates with 7-9 marginal spines *leptalacantha*

No abactinal spinelets except low down in interradial; ambulacral spinelets 3 or 4; oral spinelets 4 *spinulifera*

AA. Rays short and broad; $R = 1.7r$; no abactinal spinelets save a few granule-like ones near anus and madreporite *praesignis*

Disasterina abnormalis

Perrier, 1876. Arch. zool. exp., vol. 5, p. 209.

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 7; pl. 4, figs. 6, 7; pl. 5, fig. 13.

Habroporina pulchella H. L. Clark, 1921. Ech. Torres Strait, p. 34; pl. 4, fig. 2 (colored); pl. 24, figs. 2, 3; pl. 26, figs. 4, 5.

This little but attractive sea star is as yet known only from New Caledonia and the northern end of the Barrier Reef. The Australian records are from Murray

Islands, Torres Strait, and from Michaelmas Cay, off Cairns, Queensland. The few individuals so far collected do not exceed $R = 25$ mm. The color in life is green and white with a distinct spot of blue at the tip of each arm. Dried or alcoholic specimens are commonly "museum color." The few *abnormalis* that have been taken were found on the lower surface of broken slabs or fragments of rock or coral in very shallow water.

Disasterina leptalacantha

Asterina leptalacantha H. L. Clark, 1916. "Endeavour" rept., p. 57; pl. 18, figs. 3, 4.
Disasterina leptacantha (lap. cal.) Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 8; pl. 3, figs. 5, 6; pl. 4, figs. 1, 4.

This species is of about the same size as the preceding, but seems to be of somewhat stouter build. Nothing is recorded of its color in life. It has been taken as yet only at the Capricorn group of islets on the Barrier Reef, under rocks or coral fragments, in pools at low tide.

Disasterina spinulifera

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 156; pl. 22, fig. 6.

The holotype and only known specimen of this species was taken at Broome, Western Australia, in June 1932. It was so small ($R = 7-8$ mm.) and its coloration so inconspicuous that its capture was not even noted in the field books. Its occurrence on the northwestern coast is of great interest, as all the other Australian *Disasterinas* come from the Barrier Reef region. Its general appearance is strikingly different from that of its congeners, but how much of this difference is due to its youth and the method of preservation, one cannot say.

Disasterina praesignis

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 10; pl. 1, figs. 5, 8; pl. 2, fig. 5.

This species also is known from only a single specimen, but the strikingly different facies sets it apart from the other members of the genus. The holotype has $R = 14$ mm., and the rays are so short and wide that the resemblance to a true *Asterina* is rather marked. It was taken in North Channel, off Curtis Island, Port Curtis, Queensland, in 3-4 fms., on a somewhat muddy bottom having patches of dead and living coral.

MANASTERINA

H. L. Clark, 1938. Mem. Mus. Comp. Zoöl., vol. 55, p. 157.

Genotype: *Manasterina longispina* H. L. Clark, 1938, p. 157.

It is unfortunate to create a monotypic genus, but it is doubly unfortunate when the type species is known from but a single specimen. Such is the case here, but the characters of the extraordinary sea star concerned do not admit of any other course. It is apparently not very nearly related to *Disasterina* or any other of the Asterinidae.

Manasterina longispina

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 157; pl. 21, figs. 1, 2.

The unique holotype of this sea star was collected at Rottneest Island, Western Australia, in 1934 by Beresford E. Bardwell, who very generously sent it to the Museum of Comparative Zoölogy. He reports that in life it was "about 3½ inches across," very soft and fleshy, reddish pink above and pale lemon yellow below. It was living attached to a flat sandstone rock on pure sand bottom. In its dry condition it is scarcely half as large, with R = only 24 mm., an unusual shrinkage but in keeping with its soft and fleshy appearance in life.

NEPANTHIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 287.

Genotype: *Nepanthia maculata* Gray, 1840, p. 287.

Although Perrier (1876) recognized the validity of this group, he considered it only a subgenus of *Asterina*, to which he added 2 species which he found in the British Museum. Sladen (1889) restored *Nepanthia* to its full generic rank, and it has not been questioned since. The genus is common on the tropical coasts of Australia, and is further known from the Philippine Islands and the coast of Indo-China. The half-dozen Australian species may be distinguished as follows:

KEY TO THE SPECIES OF NEPANTHIA

- A. Arms short, R = 3-4r:
 B. Rays 6 or 7 (rarely 5 or 8), short and thick in adults; madreporites 2-8; autotomy very general; adambulacral armature with about 5 furrow spines..... *belcheri*
 BB. Rays 5, rarely 6 or 7; madreporite usually single, 2 or 3 in multi-radiate individuals; autotomous only when young; furrow spines more than 5:
 C. Aboral plates densely clothed with minute spinelets almost like velvet; innermost oral spine not notable:
 Aboral skeleton with short, wide, crescentic plates, not arranged in very regular longitudinal series except near tip of arms; adambulacral and oral armature of numerous very slender, acute spines..... *brevis*
 Aboral skeleton with fewer, longer, narrower, more crescentic plates in very regular series; adambulacral armature of fewer, coarse, blunt spines..... *variabilis*
 CC. Aboral plates with fewer, coarser spinelets, not at all velvety; innermost oral spine conspicuously large, flattened and acute..... *magnispina*
 AA. Arms long, R = 5-6r:
 Small supplemental plate proximal to each papula;¹ furrow spines 8-10; R a little more than 6r..... *maculata*
 No conspicuous supplemental plates proximal to papulae; furrow spines 5 or 6; R rather less than 6r..... *tenuis*

¹ Fisher (1919) says this little plate is wanting in all the Philippine specimens.

Nepanthia belcheri

Asterina (Nepanthia) belcheri Perrier, 1876. Arch. zool. exp., vol. 5, p. 240 (p. 320 of reprint).

Henricia heteractis H. L. Clark, 1909. Mem. Australian Mus., vol. 4, p. 530; pl. 49, figs. 1, 2.

Nepanthia polyplax Döderlein, 1926. K. svenska Vetensk.-Akad. Handl., ser. 3, vol. 2, no. 6, p. 20; pl. 4, figs. 2, 2a.

Nepanthia belcheri H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 169.

A full account of this interesting species is given in H. L. Clark, 1938. It is one of the commonest and most characteristic sea stars of Lord Howe, but has not yet been found in sufficient numbers on the mainland coast of Australia to enable us to know what the limits of its range there are. Livingstone (1932) records skeptically a "*Nepanthia* (? *brevis*) Perrier" from Low Isles, but as it had 6 arms and 5 madreporites it would be better to refer it to *belcheri*. Döderlein's type of *polyplax* was from Rockhampton, so the occurrence of *belcheri* as far north as Low Isles is not improbable. There are several records from Port Jackson, but none from farther south. Full-grown specimens have R = 30-35 mm., but most of the specimens taken at Lord Howe were considerably smaller than that. The color in life is an inconspicuous dull green, indistinctly speckled orally with reddish, but the colors are very fugacious.

Nepanthia brevis

Asterina (Nepanthia) brevis Perrier, 1876. Arch. zool. exp., vol. 5, p. 241 (p. 321 of reprint).

Nepanthia brevis Sladen, 1889. "Challenger" Ast., p. 387; pl. 63, figs. 3-5.

H. L. Clark, 1921. Ech. Torres Strait, p. 95; pl. 6, figs. 3, 4 (colored).

This is one of the characteristic sea stars of Torres Strait, but its range extends southward to Port Curtis, overlapping that of *belcheri*, and westward to Darwin. Studer's record from northwestern Australia probably is based on specimens of *variabilis*, as none of the *Nepanthias* which we took west of Darwin are *brevis*. The colors of the upper side are dull, grayish olive, whitish, and black; orally, white with blue lines, speckled with light brown and orange. But the colors are completely fugacious and museum specimens give no hint of their variety. The largest specimens of *brevis* have R up to 55 mm., but few individuals reach that size, most having R = 30-45 mm. The habitat is the under side of rock fragments in very shallow water, near low-tide mark.

Nepanthia variabilis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 176; pl. 10, figs. 4, 5 (colored); pl. 20, figs. 4, 5.

A very striking and characteristic sea star of the Broome region, this fine *Nepanthia* reveals an astonishing diversity of color, though the adambulacral and oral spines are commonly deep green, sometimes appearing almost black. It reaches a considerable size, with R = 60 mm. and more. Very young individuals are hexamerous, but about 95 per cent of adults are pentamerous. Further details

are given in H. L. Clark, 1938. As yet *variabilis* is known only from Roebuck and Lagrange bays, Western Australia, and along the intervening coast.

Nepanthia magnispina

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 174; pl. 20, figs. 1, 2.

This species rests wholly on a unique specimen from Augustus (or Champagne) Island, northern Western Australia, collected by Beresford E. Bardwell. Though the supposed specific characters may prove to be elusive, the holotype is obviously different from any of the other *Nepanthias* taken on the northwestern coast.

Nepanthia maculata

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 287.

Sladen, 1889. "Challenger" Ast., p. 388; pl. 64, figs. 1-4.

Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 422; pl. 113, figs. 3, 4.

This species is included in this account because the fine specimen, with $R = 66$ mm., from which Sladen's figures were made was taken at "Challenger" station 188, which is in shallow water (28 fms.) at the extreme western end of Torres Strait. Perhaps this is just outside the arbitrary limits I have set for the Australian region, but the genus is so typically Australian, it seems proper to include *maculata* here.

Nepanthia tenuis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 175; pl. 20, fig. 3.

Only 3 specimens of this well marked species were taken by us at Broome, all in 1932. The largest has $R = 64$ mm., the other 2 are much smaller. No other specimens have as yet been reported, but the species is probably not restricted to the Roebuck Bay region. It resembles the genotype more closely than does any other Australian *Nepanthia*.

PARASTERINA

Fisher, 1908. Smithsonian Misc. Coll., vol. 52, p. 90.

Genotype: *Patiria? crassa* Gray, 1847, p. 83.

Fisher (1941) points out that the character which was supposed to distinguish *Parasterina* from its allies does not exist and that the genus is so near *Nepanthia* it may well be discarded. It seems to me, however, that the 3 Western Australian species, *crassa*, *troughtoni*, and *occidentalis*, form a homogeneous group, easily distinguished from *Nepanthia* by the rather conspicuous difference in the character of the abactinal surface. A fourth species, *Patiria ocellifera*, is listed by Gray from an unknown locality, and Sladen (1889) refers it to Western Australia, on the testimony of Tenison-Woods. But I am inclined to think there is confusion here with *Nectria ocellifera*, which Gray (1866) puts just before *Nepanthia*. Certainly I know of no good reason for including *Patiria ocellifera* in a list of Australian sea stars. The 3 species here included in *Parasterina* are distinguished thus:

KEY TO THE SPECIES OF PARASTERINA

- Swollen plates of abactinal surface low hemispherical, densely covered with very slender and numerous spinules, well spaced, with small plates and numerous large papulae among them..... *crassa*
 Most abactinal plates somewhat raised but rather flat-topped, covered with low granule-like spinelets; small plates and papulae rather numerous..... *troughtoni*
 Abactinal plates elevated, transversely elongated, densely covered with granule-like spinelets, forming a more or less smooth coat without small plates, and with few large, somewhat hidden papulae..... *occidentalis*

Parasterina crassa

Patiria? crassa Gray, 1847. Proc. Zool. Soc. London, pt. 15, p. 83.

Parasterina crassa Fisher, 1908. Smithsonian Misc. Coll., vol. 52, p. 90.

Nepanthia crassa Fisher, 1941. Proc. U. S. Nat. Mus., vol. 90, p. 453; pl. 70, fig. 2.

Apparently fairly common on the Western Australian coast between Geraldton and Rockingham, this species has been a source of much confusion from the days of Gray until now. Fisher's recent (1941) notes and figures leave no room for further misunderstanding. It is not a conspicuous sea star, as it lives among or under rock fragments in tide pools or below low-water mark. The color in life is reddish brown so far as we have any record. Large specimens have $R = 60-64$ mm., r and br about one-fourth as much.

Parasterina trougtoni

Livingstone, 1934. Rec. Australian Mus., vol. 19, no. 3, p. 179; pl. 18, figs. 1-6.

Little is known of this species, for it was described from a single small specimen ($R = 16$ mm.) from Albany, King Georges Sound, Western Australia, where it was taken in shore collecting. A specimen of the same size is in the Museum of Comparative Zoology, and one twice as large is in the Western Australian Museum at Perth. These 2 specimens are from an unknown locality on the Western Australian coast. Nothing is known as to the color in life.

Parasterina occidentalis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 180; pl. 21, fig. 5.

This well marked species has been found as yet only near Fremantle, but it is apparently not very uncommon there, for at least five local stations have yielded specimens. Full-grown ones have $R = 65$ mm., r and br about one-fifth as much. The color in life is reported to be brick red.

TEGULASTER

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 11.

Genotype: *Tegulaster emburyi* Livingstone, 1933, p. 12.

This genus was erected to include *Disasterina ceylonica* Döderlein and a closely related sea star found on the Great Barrier Reef. Livingstone stresses the trigonal

character of the arms, but this is not very obvious in the figures given, which are strikingly suggestive of *Asterina coronata*. That sea star, however, does not have bare abactinal plates.

Tegulaster emburyi

Livingstone, 1933. Rec. Australian Mus., vol. 19, no. 1, p. 11; pl. 1, figs. 1, 3; pl. 2, figs. 2, 3, 6, 9.

This interesting sea star was described from a single specimen collected at Norwest Island, Capricorn group, Queensland, where it was "living under a dead coral boulder." It is small, R = only 19 mm. The color in life is said to be "very gaudy," being a combination of orange and magenta, both light and dark, on a deep cream-colored ground.

ANSEROPODA

Nardo, 1834. Oken's Isis, vol. 7, p. 716.

Genotype: *Asterias membranacea* Retzius, 1783, p. 238.

This very remarkable group of sea stars presents the most extreme reduction in vertical diameter to be found in the whole echinoderm phylum. The genus occurs in European but not in American seas. Several species are known in the East Indian region, and of these the following occurs in Australia, not only on the northwestern coast, but also in Queensland waters.

Anseropoda rosacea

Asterias rosaceus Lamarck, 1816. Anim. sans vert., vol. 2, p. 558.

Anseropoda rosacea Fisher, 1906. Bull. U. S. Fish Comm. no. 23, p. 1089.

H. L. Clark, 1916. "Endeavour" rept., p. 59; figs. 5, 6.

Palmipes rosaceus Koehler, 1910. Indian Mus. Ast., p. 127; pl. 20.

This extraordinary sea star has been so well figured by Koehler that detailed description is unnecessary. It grows to a large size, as much as 240 mm. across. It is excessively flat in life, but in drying it may become elevated or even considerably arched centrally. It lives apparently just below the surface of the sand in shallow water, but not near low-tide mark. The color in life is gray above and creamy white beneath, with black speckling above, and more or less rust color along the ambulacra. It is widely distributed in the northern and northeastern Indian Ocean, and the range extends to southern Queensland (25 miles southeast of Double Island Point, 33 fms.) and to northern Western Australia at Broome and Port Hedland. For a discussion of the number of rays and other details see H. L. Clark, 1938, page 182.

Family ECHINASTERIDAE

This cosmopolitan family is represented in Australia by 3 genera. One of these is a monotypic endemic and another is a tropical genus containing many species, of which several endemic forms are a conspicuous feature of the sea-star fauna of South and Western Australia. The third genus is the highly differentiated and perplexing *Henricia*, widespread in both the northern and southern hemispheres,

the despair of any orderly-minded systematist. These genera are quite unlike in general appearance and are easily distinguished as follows:

KEY TO THE GENERA OF ECHINASTERIDAE

- A. Adambulacral spines and spinelets disposed in transverse series on each plate; abactinal plates forming meshwork of small, ill defined papular areas:
 Abactinal plates covered with thick skin and bearing isolated or clustered spines, often of considerable size *Echinaster*
 Abactinal plates with numerous minute spines, often granuliform *Henricia*
 AA. Adambulacral spines arranged in 2 longitudinal series; abactinal plates forming very coarse network, with meshes 5-10 mm. across *Plectaster*

ECHINASTER

Müller and Troschel, 1840. Ber. Verhandl. K. preuss. Akad. Wissensch., Apr., p. 102.

Genotype: *Asterias seposita* Lamarck, 1816, vol. 2, p. 562 = *Asterias sagena* Retzius, 1805, p. 21.

This is a large group of some 25 nominal species of world-wide distribution in tropical and warm-temperate seas. Fisher thinks it may well be broken into 2 genera according to the distribution of the papulae, those with intermarginal and actinal papulae being segregated under the name *Othilia* Gray. This is not, however, an easy line of division to follow, as large specimens of *sagenus* have papulae in the intermarginal area and below it on the proximal part of the rays. It is possible that the division between *Othilia* and *Echinaster* is a natural one and should be maintained; but for the present, it seems best to let the Australian species remain under the name with which they were described. They are a rather striking group of relatively large sea stars with considerable diversity of appearance. They may be distinguished as follows:

KEY TO THE SPECIES OF ECHINASTER

- A. Abactinal spines large, coarse, and well spaced, or in elevated groups:
 B. Abactinal spines acute or blunt, low or high, but not chisel-shaped or clavate:
 C. Abactinal spines not grouped in elevated clusters:
 Abactinal plates do not form conspicuous reticulum; abactinal spines high, acute, rather uniformly scattered *acanthodes*
 Abactinal plates form coarse reticulum with large meshes; abactinal spines low and blunt *arcystatus*
 CC. Abactinal spines in elevated groups of 5-12 or more, well spaced *glomeratus*
 BB. Abactinal spines numerous, rather uniformly scattered, low and stout, with chisel-shaped or clavate tips *superbus*
 AA. Abactinal spines small, numerous, blunt or pointed, rather uniformly scattered:
 Small (R = 75-125 mm.), 5-7 rays, autotomous; rays rather slender, covered with numerous small, blunt spinelets; subambulacral and actinal spinelets tend to form series parallel to adambulacral; color rust red speckled with blackish, or whole upper surface blackish, but with no trace of purple *luzonicus*

Large (R = 150-190 mm.), 5 rays, not autotomous; rays stouter with less numerous spinelets; bare area on actinal surface of rays just outside adambulacral spines, not occupied by series of subambulacral and actinal spines parallel to furrow; color deep buff spotted or blotched with purple, or unicolor either purple or bright red *varicolor*

Echinaster acanthodes

H. L. Clark, 1916. "Endeavour" rept., p. 61; pl. 19, figs. 1, 2.

This is a rather small sea star with slender rays for an *Echinaster*, and finds its nearest relative in *E. stereosomus* Fisher from the Philippine Islands. It is, however, much more spiniferous, and its conspicuous subambulacral spines are distinctive. It has as yet been taken only near the southern coasts of Queensland, off Fraser Island in 32 fms., and 25 miles southeast of Double Island Point in 33 fms. The largest specimen has R = 70 mm. Nothing is recorded as to the color in life.

Echinaster arcystatus

H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 148; pl. 21.

This is another well marked species of which too few (only half a dozen) specimens are known. They were taken between Fremantle and Geraldton, and at Bunkers Bay, Western Australia—one at each place—and in South Australian waters; of 4 specimens there taken, only 1 has a definite label, "between Backstairs Passage and the Pages, 25 fms." The Fremantle specimen is said to have been "purple" in life; the dry specimens are deep red or reddish brown or brown. The largest specimen has R = 172 mm., and the arms taper markedly so that R = 11br at the middle of the arm but only 7br at base. In the holotype R = about 5.5br at base and 7br near middle. In the Bunkers Bay specimen R = about 4.5br, the arms being conspicuously short and stout. No doubt some of this great discrepancy in proportions is due to differences in the killing and preserving of the specimens.

Echinaster glomeratus

H. L. Clark, 1916. "Endeavour" rept., p. 62; pls. 22, 23.

So far as is yet known, this is an endemic South Australian sea star, all known specimens being from near Kangaroo Island or from the Verco collections in St. Vincent and Spencer gulfs. It is a smaller species than the preceding, the largest individual of the 8 known having R = 97 mm. Nothing is recorded as to the color in life, the yellow-brown of the dried specimens giving no clues. A specimen in the South Australian Museum has the arms so short and nearly cylindrical and the groups of spinelets so large and numerous, it has been designated by a varietal name, *extremus* (see H. L. Clark, 1928, p. 396), but it probably intergrades with the typical form. The suggestion by Cotton and Godfrey (1942) that *glomeratus* might be placed in *Henricia* indicates a lack of acquaintance with that genus.

Echinaster superbus

H. L. Clark, 1916. "Endeavour" rept., p. 64; pls. 24, 25.

If ever a specific name was happily chosen, this notable sea star bears it, for not only is it the most beautiful of Australian sea stars in coloration, but its large size and extraordinary spinulation justify enthusiasm in any reference to it. It is greatly to be regretted that the only specimen we obtained during our two visits to Broome was taken when we were in Pender Bay, far from town, and Mrs. Clark was not available to make a colored figure. My notes are quite inadequate to set forth the striking green, white, and rose coloring. Only 4 specimens are as yet known, 2 in the museum at Perth, 1 in Sydney (the holotype), and 1 in the Museum of Comparative Zoölogy, the largest of all (R = 145 mm., over 150 mm. in life). All are from Broome or the immediate vicinity; though one in the Perth museum has no locality label, there is no reason to doubt it is from the vicinity of Broome. The extraordinary spinulation sets *superbus* quite apart from the other members of the genus. The Pender Bay specimen was brought up by a diver who said he found it "on top of a rock." Possibly the normal habitat is among rocks and corals where it cannot be reached with a dredge.

Echinaster luzonicus

Othilia luzonica Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 282.

Echinaster luzonicus Müller and Troschel, 1842. Syst. Ast., p. 23.

H. L. Clark, 1921. Ech. Torres Strait, p. 98; pl. 10, figs. 2-4 (2, 3 colored).

Echinaster eridanella Müller and Troschel, 1842. Syst. Ast., p. 24.

H. L. Clark, 1916. "Endeavour" rept., p. 62; pl. 20, figs. 1, 2; pl. 21, fig. 2 (fig. 1 of pl. 21 is *Echinaster purpureus* Gray, a poorly preserved specimen).

Othilia purpurea Fisher, 1919. Bull. 100 U. S. Nat. Mus., vol. 3, p. 432; pl. 122, fig. 1; pl. 132, figs. 7, 7a, b (NON *Othilia purpurea* Gray, 1840, p. 282, the closely allied species of the western Indian Ocean).

The close resemblance between the *Echinasters* of the western Indian Ocean and those of the East Indian region, combined with the very poor and often unidentifiable condition of dried specimens, has led to much confusion. The question was discussed in H. L. Clark, 1921, pages 98-100, and the conclusion was reached that the name *purpureus* might well be retained for the western *Echinaster*, Gray's name *luzonicus* being restricted to the species of the East Indian region and northeastern Australia. This decision accounts for the presence of Fisher's *purpurea* in the synonymy given above. Müller and Troschel's *fallax* and Perrier's *vestitus* are apparently identical with *purpureus* and are not found in the Australian fauna, though I listed Perrier's species in 1914 from Port Hedland, Western Australia. The specimen so named was undoubtedly a small adult of the following species (*varicolor*).

At the northeastern corner of Australia and southward along the Queensland coast to the Low Isles, to Bowen, and even to "25 miles southeast of Double Island Point, 33 fms.," *luzonicus* is more or less common in shallow water along shore. Most specimens have R less than 100 mm., but big adults may reach 125. The color is fundamentally "rusty red," but this is commonly speckled with blackish, and adult specimens tend to become dark, even a dull black, at least aborally; there is no tendency toward violet or purple. Although common in Torres Strait, *luzonicus*

has not been found on the Australian coast west of there, but it ranges northward to the Philippines. Livingstone (1932) records some interesting data concerning the occurrence of this *Echinaster* at the Low Isles.

Echinaster varicolor

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 184; pl. 11, fig. 1 (colored).
Echinaster vestitus H. L. Clark, 1914. Rec. W. Australian Mus., vol. 1, p. 150 (non Perrier, 1869, p. 254).

The remarkable diversity of color shown by this big *Echinaster* is very perplexing and suggests what an interesting bit of research it would be to fertilize a few hundred eggs, carry them through their development to maturity, and see whether all three color forms would appear as the offspring of one female. The spotted form is undoubtedly the most common, but the uniformly violet individuals were not very rare, and several examples of the bright red form were taken. Yet when dried, all lost their bright tints and became brown of some shade with no correlation between the color in life and the shade of brown. The largest specimen has R = 190 mm.; in life it probably exceeded 200. The species seems to be very local and does not occur along shore; all the specimens were obtained by dredging or by a diver in 5-10 fms. The specimen of *Echinaster* from Port Hedland which I reported in 1914 as *vestitus* Perrier is undoubtedly a small adult *varicolor*.

HENRICIA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 184.

Genotype: *Henricia oculata* Gray, 1840, p. 184 = *Asterias sanguinolenta* O. F. Müller, 1776, p. 234.

It is probably no exaggeration to say that this is the most perplexing genus of sea stars, because it is so widely distributed in the cooler waters of both northern and southern hemispheres and shows an extraordinary lack of constancy in elementary species characters such as body form and proportions, and type of spinulation. The species are fewer and individuals apparently less numerous in the southern than in the northern seas, but even the southern species are ill defined and difficult to delimit. The genus, however, is seldom taken in Australian waters, the only specimens as yet reported being those dredged by the "Endeavour" during her fisheries investigations. These were all referred to the following species.

Henricia hyadesi

Cribrella hyadesi Perrier, 1891. Miss. Sci. Cap Horn, vol. 6, pt. 3, p. K100; pl. 9, figs. 1a-d.
Henricia hyadesi Fisher, 1911. Bull. 76 U. S. Nat. Mus., pt. 1, p. 293.
 H. L. Clark, 1916. "Endeavour" rept., p. 60.

In his important discussion of the *Henricias* taken by the "Discovery," Fisher (1940, pp. 162-169) treats *hyadesi* as identical with *obesa* Sladen. He also reports (p. 166) his observations on 3 of the *Henricias* taken by the "Endeavour." He considers 2 of them forms of *Cribrella sufflata* Sladen (taken by the "Challenger" near the Kermadec Islands); the one from the Great Australian Bight he says is "of the *compacta* group," this also a "Challenger" species taken in deep water west of New Zealand. After a re-examination of the "Endeavour" specimens, now

in the Museum of Comparative Zoölogy, and comparison with two *Henricias* from off eastern Patagonia, supposed to be *hyadesi*, and a cotype of *H. compacta* var. *aucklandiae* Mortensen, I am still unable to reach a definite conclusion. Meanwhile it seems best to let the "Endeavour" specimens remain listed under the name *hyadesi*, but with the added statement that the Great Australian Bight material probably represents a different species from the one taken farther east in Bass Strait and off eastern Tasmania. All the "Endeavour" *Henricias* were taken in comparatively deep water (50-200 fms.). The largest has R = 80 mm.

PLECTASTER

Sladen, 1889. "Challenger" Ast., p. 535.

Genotype: *Echinaster decanus* Müller and Troschel, 1843, p. 114.

This is, in striking contrast with the preceding genus, a sharply defined, monotypic, endemic group confined to the southern side of the Australian continent.

Plectaster decanus

Echinaster decanus Müller and Troschel, 1843. Arch. f. Naturgesch., vol. 9, no. 1, p. 114.
Plectaster decanus Sladen, 1889. "Challenger" Ast., p. 535.
 H. L. Clark, 1916. "Endeavour" rept., p. 66; pl. 26, figs. 1, 2.

This is one of the most typically Australian of all the remarkable sea stars in the fauna. It ranges from Port Jackson southward and westward to the Bight in shallow or moderately deep water (90 fms.), but does not seem to be common anywhere. In large specimens, R = 100-110 mm. The colors in life are striking, for the skeletal network, abactinally, is red and the big papular areas are purple.

Family SOLASTERIDAE

A group of sea stars of conspicuous appearance, frequently with more than 5 and often with more than 10 rays, this family is more common in northern than in tropical or southern seas. Only 2 genera occur in Australia. One was taken by the "Challenger" at the western end of Torres Strait, and the other by the "Endeavour" in her fisheries investigations off southeastern Australia. The two are easily distinguished thus:

Actinal intermediate plates few and inconspicuous *Crossaster*
 Actinal intermediate plates, each with curved comb of spines, extend to tip of ray *Rhipidaster*

CROSSASTER

Müller and Troschel, 1840. Ber. Verhandl. K. preuss. Akad. Wissensch., Apr., p. 103.

Genotype: *Asterias papposa* Linné, 1767, p. 1098.

A northern genus of rather more than half a dozen species, *Crossaster* was found by the "Challenger" in South Africa, by the "Albatross" in the Philippines, and by the "Endeavour" near the southeastern corner of Australia. The Australian species is quite distinct from the others, particularly in the multiplicity of ambulacral and oral spines.

Crossaster multispinus

H. L. Clark, 1916. "Endeavour" rept., p. 66; pl. 18, figs. 5, 6.

Nothing further has been recorded of this sea star since the original description. It was taken off southeastern Victoria in 50-100 fms. and also off Bruni Island, Tasmania, 150-230 fms. The 4 known specimens are small (R = 40 mm.) and may not be mature. Nothing is known of the color in life, but in the preserved material, the 3 Tasmanian specimens are lighter than the fourth.

RHIPIDASTER

Sladen, 1889. "Challenger" Ast., p. 447.

Genotype: *Rhipidaster vannipes* Sladen, 1889, p. 448.

A monotypic genus is this, resting on a single species, which in turn rests on a single specimen.

Rhipidaster vannipes

Sladen, 1889. "Challenger" Ast., p. 448; pl. 69, figs. 1-4.

The unique holotype of this interesting sea star was taken at "Challenger" station 188 at the western end of Torres Strait, just within the Australian limits adopted for this report, in 28 fms. It has 8 rays, 85-88 mm. long, and the color in alcohol is light yellowish brown.

Family ACANTHASTERIDAE

This is a monogeneric family which Fisher considers a relict of an old and at one time more extensive group. These remarkable asteroids are, however, distinct from any others now living, the large size, the multiplicity of rays and madreporites, and the big, articulated spines setting them quite apart. At least 4 species seem to be known, but only 1 occurs in Australia and it is by no means common.

ACANTHASTER

Gervais, 1841. Dict. sci. nat., suppt. 1, pt. 2, p. 470.

Genotype: *Acanthaster echinus* Gervais, 1841, p. 474 = *Asterias planci* Linné, 1758, p. 823.

This extraordinary genus barely enters the Australian region, but a few specimens have been taken at the northern end of the Barrier Reef. They all seem to represent the type species.

Acanthaster planci

Asterias planci Linné, 1758. Syst. Nat., ed. 10, p. 823.

Acanthaster planci Verrill, 1914. Shallow water starfishes, N. Pacific coast, p. 364.

Acanthaster echinites Döderlein, 1896a. Semon's Ast., in Jena Denkschr., vol. 8, p. 320; pl. 21, figs. 2-7.

This extraordinary sea star, with 13-16 rays and exceeding 400 mm. in diameter when full grown, just enters the Australian region at the northern end of the Barrier Reef, having been taken at Warrior Reef, at the Murray Islands, and at the Low Isles. In my Torres Strait report (1921, p. 101) I have given an account of this curious animal as it appears in life. Apparently it may be found anywhere from Zanzibar to Hawaii.

Family VALVASTERIDAE

Originally proposed as a subfamily, this monogeneric group has been elevated to family rank by Fisher, as in the case of *Acanthaster*. *Valvaster* has such an unusual combination of characters that Koehler has also approved of recognizing the family.

VALVASTER

E. Perrier, 1875. Arch. zool. exp., vol. 4, p. 376 (p. 112 of reprint).

Genotype: *Asterias striata* Lamarck, 1816, vol. 2, p. 564.

The discovery of a *Valvaster* at Mer, Murray Islands, in 1913 added a second species to the genus, originally monotypic, and revealed it as a member of the Australian fauna. Owing to their secretive habits and a habitat difficult of access, very few specimens of *Valvaster* have ever been taken, but there seems no reason to doubt that the unique Australian specimen is a different species from the genotype.

Valvaster spinifera

H. L. Clark, 1921. Ech. Torres Strait, p. 102; pl. 6, fig. 6 (colored); pl. 36, figs. 8, 9.

All that is known of this beautiful sea star is recorded in the reference given above. It appears to be quite distinct from Lamarck's species, but neither is yet sufficiently known to make any conclusion regarding them perfectly trustworthy. This *Valvaster* is at least a worthy rival of *Echinaster superbus* as Australia's most beautiful sea star.

Family PTERASTERIDAE

This remarkable family of several genera and many species is widely distributed all over the world, usually in deep water, rarely less than 100 fms. Only 2 genera have yet been found in Australia, and these are represented each by but a single species. The 2 genera are to be distinguished as follows:

Muscle bands of supradorsal membrane not conspicuous or regularly reticulated,	
but meandering or crisscrossing, usually very inconspicuous.....	<i>Pteraster</i>
Muscle bands conspicuous, regularly reticulated.....	<i>Retaster</i>

PTERASTER

Müller and Troschel, 1842. Syst. Ast., p. 128.

Genotype: *Asterias militaris* O. F. Müller, 1776, p. 234.

This large, widely distributed genus, with some 30 species, is poorly represented in Australia, where a single specimen of a single species is the only example yet

found. This is quite different from its nearest congeners and represents a well marked, possibly endemic species.

Pteraster tetracanthus

H. L. Clark, 1916. "Endeavour" rept., p. 67; pl. 18, figs. 1, 2.

The unique holotype, with $R = 30$ mm., is the only *Pteraster* yet taken in Australia, and, as has been suggested, is very possibly endemic, since it has distinctive specific characters. It was taken in 90-150 fms. southeast of Cape Everard, Victoria.

RETASTER

E. Perrier, 1878. Nouv. arch., ser. 2, vol. 1, p. 56.

Genotype: *Pteraster cribrosus* von Martens, 1867, p. 109.

As was pointed out in H. L. Clark, 1923, page 298, if we are to retain the genus *Retaster*, we must accept *cribrosus* as the type. Perrier's inclusion of *capensis* with *cribrosus* in his proposed genus was a mistake probably due to accepting Gray's misleading diagnosis. The *Pteraster* from "The Cape" is not a *Retaster* according with Perrier's brief definition. Fisher's (1919) designation of *capensis* as the type of *Retaster* is probably due to observance of the "first named" principle, but if insisted on makes *Retaster* simply a synonym of *Pteraster*. It seems best therefore to use the second species given by Perrier, namely *cribrosus* von Martens.

Retaster insignis

Sladen, 1882. Jour. Linn. Soc. (Zool.), vol. 16, p. 200.

— 1889. "Challenger" Ast., p. 482; pl. 76, figs. 3, 4.

In life, this *Retaster* is one of the most extraordinary sea stars on the Australian coast. The characteristic reticulated character of the dorsal side, the brilliant red color, and the thick coat of transparent, colorless jelly in which the animal is enshrouded (at least on the abactinal surface) combine to make the living animal an oddly beautiful object. The smallest specimen seen has $R = 14$ mm., and the largest has R almost exactly 6 times as much ($= 83$ mm.). The small specimen is from Lindeman Island, Queensland, the big one from Shark Bay, Western Australia. Livingstone (1932) gives the southern limit of the range on the east coast as "probably Port Jackson," but the "Challenger" did not take it there, and Whitelegge (1889) gives it only with a question mark "*fide* Bell." As the "Endeavour" did not take any specimens, it is doubtful whether this *Retaster* belongs in the New South Wales fauna. On the west coast, Shark Bay is assuredly as far south as *Retaster* may be expected. To the northward the range extends to the Philippines.

Order FORCIPULATA

This order contains perhaps as many species as the preceding, but they are not nearly so strikingly differentiated. Only 3 families occur in the Australian fauna, and they are represented by relatively few species. The contrast in this respect between North America and Australia is striking. The families occurring in Australia are easily separated thus:

KEY TO THE FAMILIES OF FORCIPULATA

- A. Deep-water forms with small, circular disk and slender, often deciduous arms, distinctly set off from it; adambulacral ossicles not compressed *Brisingiidae*
- AA. Disk not circular or distinctly set off from slender arms; adambulacral ossicles compressed:
- Only straight pedicellariae present; deep-water species with small disk and 5 slender, tapering rays *Zoroasteridae*
- Both straight and crossed pedicellariae present; often shallow-water forms and often with more than 5 rays *Asteriidae*

Family BRISINGIDAE

Though this is a widespread family with many genera, it is represented in Australia by a single species, and that known only from 2 specimens taken by the "Endeavour."

ODINIA

E. Perrier, 1885. Ann. sci. nat., ser. 6, vol. 19, no. 8, p. 9.

Genotype: *Odinia semicoronata* Perrier, 1885, p. 9.¹

This is a widely distributed genus occurring in deep water in the Atlantic, Pacific, and Indian oceans. Apparently it does not occur in the Antarctic deeps, but the "Endeavour" found the following species south of Australia.

Odinia australis

H. L. Clark, 1916. "Endeavour" rept., p. 75; pl. 27, figs. 1, 2.

This well marked species, the first *Odinia* taken in the southern hemisphere, was found southeast of Cape Everard, Victoria, in 200 fms. No other *Odinia* is known from so moderate a depth. The disk is about 25 mm. across, the 14 arms are only 100 mm. long. There is no record of the color in life.

Family ZOROASTERIDAE

This family is widespread in deep water, but apparently not found in the Antarctic. One species, however, another of the "Endeavour"'s prizes, has been found in the deep water south of Australia, far from any of its near relatives.

ZOROASTER

Wyville-Thomson, 1873. Depths of the sea, p. 154.

Genotype: *Zoroaster fulgens* Wyv.-Thomson, 1873, p. 154.

There are 10 or more species of *Zoroaster* in the Indo-Pacific region, yet none of them has been found near Australia. The following was found, however, on

¹ This species is listed by Perrier as *Brisinga semicoronata* in his preliminary paper (1885a, p. 442), but the name is little better than a *nomen nudum* and was not really valid until his description was published in the Ann. sci. nat.

the southern side of the continent by the "Endeavour," in the deepest water in which she took any echinoderms.

Zoroaster macracantha

H. L. Clark, 1916. "Endeavour" rept., p. 68; pl. 28, figs. 1, 2.

Three specimens of this interesting sea star were taken in the Great Australian Bight in 250-450 fms. The largest specimen has $R = 160$ mm., $r =$ only 14 mm. The nearest relative of this *Zoroaster* is apparently the Hawaiian species *Z. spinulosus* Fisher, but there are differences which warrant keeping the two separate at least until more material is available.

Family ASTERIIDAE

This large and widely distributed family, so conspicuous a feature of the sea-star fauna of the northern hemisphere, is rather poorly represented in Australia, save for the single genus *Uniophora*, which is endemic there. Nevertheless 8 genera are distributed along the southern coasts of the continent, and 2 of these are quite common. The following key will show the characters on which the 8 genera are based and how they differ. It is known that another genus, *Coronaster* or something allied thereto, occurs on the southern coast of the continent, for there is a small, 6-rayed sea star, obviously immature, in the South Australian Museum and supposedly from St. Vincent or Spencer Gulf, which cannot be referred to any of the genera now known from Australia (see H. L. Clark, 1928, p. 398).

KEY TO THE GENERA OF ASTERIIDAE

- A. Tube feet biserial; skeleton an open network with very small spines; crossed pedicellariae never in circlets about them nor present on adambulacral spines *Pedicellaster*
- AA. Tube feet quadriserial, at least basally:
- B. Adambulacral spines without pedicellariae; rays 5 or more; abactinal and marginal spines prominent, spaced, styliform or acicular, wreathed with pedicellariae; one series of actinal plates:
- C. Only the outer of the two inferomarginal spines (on each plate) carries cluster of pedicellariae; 7-12 rays:
- Adambulacral plates diplacanthid *Astrostole*
- Adambulacral plates monacanthid *Coscinasterias*
- CC. Both inferomarginal spines with pedicellariae; adambulacral plates diplacanthid; rays 5 *Australiaster*
- BB. Adambulacral spines carry pedicellariae singly or in clusters; abactinal spines short, more or less blunt, tubercular or variously granuliform; actinal areas broad, generally with 2 or more series of plates:
- D. Abactinal plates small, in network; not forming obvious longitudinal series *Smilasterias*
- DD. Abactinal plates in rather definite longitudinal series:
- E. Actinal plates in single series, dominated by their inferomarginals, which form ventrolateral margin to ray *Allostichaster*

- EE. Actinal plates in 2 or more series forming actinolateral areas along ray:
- Large unguiculate, straight pedicellariae; actinostome sunken; adoral carina long *Cosmasterias*
- No large, unguiculate pedicellariae; actinostome not sunken; adoral carina short *Uniophora*

PEDICELLASTER

Sars, 1861. Oversigt af Norges Echinodermer, p. 77.

Genotype: *Pedicellaster typicus* M. Sars, 1861, p. 77.

Most of the known species of *Pedicellaster* are found in moderate depths in the Atlantic, but 2 occur in the Antarctic and at least 2 in the Pacific Ocean. The occurrence of the following species in Australian seas was hardly to be expected.

Pedicellaster reticulatus

H. L. Clark, 1916. "Endeavour" rept., p. 69; pl. 27, figs. 3, 4.

A single individual of this sea star was taken by the "Endeavour" east of Maria Island, Tasmania, in 78 fms. It has 6 rays, the longest 30 mm. long. It is unlike the Atlantic *Pedicellasters* but bears considerable resemblance to Ludwig's species *improvisus* from the Galápagos Islands.

ASTROSTOLE

Fisher, 1923. Ann. Mag. Nat. Hist., ser. 9, vol. 12, p. 255.

Genotype: *Margaraster* (?) *scaber* Hutton, 1872, p. 5.

This is a group confined to and characteristic of the southern Pacific, and its right to a place in the Australian fauna is due to the occurrence of an endemic species at Lord Howe Island.

Astrostole insularis

H. L. Clark, 1938. Mem. Mus. Comp. Zool., vol. 55, p. 191; pl. 8, fig. 1 (colored).

This handsome sea star is apparently not rare at Lord Howe Island, where it is found under and among coral fragments near low-water mark. The largest specimen has $R = 70-110$ mm. The color in life is unusual, as blue predominates, and blue is a rare color among echinoderms. Although it has not yet been reported from the Australian coast, it is possible that specimens have been taken and confused with the following species, which it resembles superficially.

COSCINASTERIAS

Verrill, 1867. Trans. Connecticut Acad., vol. 1, p. 248.

Genotype: *Coscinasterias muricata* Verrill, 1867, p. 249 = *Asterias calamaria* Gray, 1840, p. 179.

Fisher (1928) divides this genus into 2 subgenera, including the species from the southern hemisphere in *Coscinasterias s. s.* and placing the 2 related forms of

the northern hemisphere in a subgenus, *Stolasterias*. The latter may well be accepted as a genus itself. Whether *muricata* Verrill is a complete synonym of Gray's *calamaria* may still be debatable, but Mortensen, who has collected at both Mauritius and New Zealand, so regards it, and my own observations in Australia have led to the same conclusion.

Coscinasterias calamaria

Asterias calamaria Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 179.

Coscinasterias calamaria Perrier, 1894. Stell. "Travailleur" et "Talisman," p. 106.

Coscinasterias gemmifera (Perrier) H. L. Clark, 1916. "Endeavour" rept., p. 74; pls. 31, 32.

This is undoubtedly the commonest littoral sea star of the southern coasts of Australia, ranging from Lord Howe Island on the east to Rottneest on the west. The number of rays ranges from 7 to 11, full-grown adults usually having 11. The coloration is diversified and variable, but blue is a not uncommon shade, though greenish, grayish, and brown shades predominate as a rule. For further discussion see H. L. Clark, 1938, pages 189-190.

AUSTRALIASTER

Fisher, 1923. Ann. Mag. Nat. Hist., ser. 9, vol. 12, p. 253.

Genotype: *Coscinasterias dubia* H. L. Clark, 1909, p. 532.

The establishment of a monotypic genus as a resting place for this endemic sea star is a satisfactory solution of that matter, but just what its relationships are remains a problem, for it is certainly not very closely allied to any other Australian form, nor is it very near to any of the other genera in the subfamily *Coscinasterinae*.

Australiaster dubia

Coscinasterias dubia H. L. Clark, 1909. "Thetis" rept., p. 532; pl. 49, figs. 3, 4; pl. 50.

Australiaster dubia Fisher, 1923. Ann. Mag. Nat. Hist., ser. 9, vol. 12, p. 253.

Both the "Thetis" and the "Endeavour" found this endemic sea star fairly common in 20-70 fms. off the southeastern corner of the continent and near Tasmania. The "Endeavour" also took it in 200 fms. south of Gabo Island and at least once on "the southern coast of South Australia," but it is notable that Verco did not find it during his extensive dredging in St. Vincent and Spencer gulfs. It is a well marked species which cannot be confused with any other Australian sea star. It reaches a considerable size ($R = 138$ mm.), but nothing is recorded as to color or general appearance in life.

SMILASTERIAS

Sladen, 1889. "Challenger" Ast., p. 562 (as subgenus).

Genotype: *Asterias (Smilasterias) scalprifera* Sladen, 1889, p. 562.

The granting of generic rank to this group by Fisher seems quite justifiable, though the material of the Australian species is so scanty and poor that it is not certain whether it represents one species or more. Nor does this procedure give

assurance that these little sea stars from the southern coast of Australia are really congeneric with the material collected by the "Challenger" in subantarctic seas, on which Sladen based his subgenus.

Smilasterias irregularis

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 402; figs. 116a, b.

The holotype of this species, said to be from Spencer or St. Vincent Gulf, is in the South Australian Museum. It has but 3 rays, of which 1 is very small; the largest is 49 mm. long. A second specimen, symmetrically pentamerous with $R = 25$ mm., taken at Western Port, Victoria, is in the National Museum at Melbourne. As these 2 specimens have not been compared side by side, it is quite possible that they are not conspecific. In the Museum of Comparative Zoölogy there are 17 small sea stars, in very poor condition, taken at Western Port and in Port Phillip by J. Gabriel in 1915. The larger of these are apparently identical with the National Museum specimen, but whether they are identical with the one at Adelaide is very doubtful.

ALLOSTICHAETER

Verrill, 1914. Shallow water starfishes, N. Pacific coast, p. 363.

Genotype: *Asteracanthion polyplax* Müller and Troschel, 1844, p. 178.

This is a group of 5 species occurring in the waters around southern South America, New Zealand, and Australia, but not yet found in South Africa. The 2 species found in Australia may be easily distinguished thus:

Rays 6-9, usually 8; seldom symmetrical owing to continually repeated autotomy	<i>polyplax</i>
Rays 5, symmetrical; autotomy rare or wanting	<i>regularis</i>

Allostichaster polyplax

Asteracanthion polyplax Müller and Troschel, 1844. Arch. f. Naturgesch., vol. 10, no. 1, p. 178.

Allostichaster polyplax Verrill, 1914. Shallow water starfishes, N. Pacific coast, p. 363.

Koehler, 1920. Australasian Antarctic Exped.: Ech. Ast., p. 85; pl. 18, figs. 7-11.

This is one of the most common and characteristic of southern Australian sea stars, ranging as it does from Long Reef, Colloroy, New South Wales, to Rottneest Island, Western Australia. It also occurs in New Zealand and Tasmania, but oddly enough has not yet been found at Lord Howe Island. Very probably the water there is too warm. Full-grown, symmetrical specimens of *polyplax* are rare, for autotomy seems to continue long after maturity is reached. With $R = 35-38$ mm. maximum size seems to be attained. In its habits, this little sea star is secretive and sluggish, living in crevices or in dead shells, or on the under side of rocks. Its colors show considerable diversity; brown, greenish, cream color, orange, and red occur in many shades and arrangements, but are never bright and are very fugacious.

Allostichaster regularis

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 400; figs. 115a, b.

In its pentamerous symmetry and regularity, this species is in striking contrast with the preceding, but otherwise the differences are not conspicuous. The largest specimen has $R = 30$ mm. No information is available as to color or habits. All the known specimens are from St. Vincent and Spencer gulfs, South Australia.

COSMASTERIAS

Sladen, 1889. "Challenger" Ast., p. 562 (as subgenus).

Genotype: *Asteracanthion sulcifer* Perrier, 1869, p. 235.

This is another group of southern-hemisphere sea stars to which Verrill properly gave generic rank. A single species occurs in Australian seas, having been discovered by the "Endeavour."

Cosmasterias dyscrita

H. L. Clark, 1916. "Endeavour" rept., p. 71; pl. 29, figs. 1, 2.

A single specimen with $R = 67$ mm. is the only evidence that *Cosmasterias* is an Australian genus. It was taken by the "Endeavour" south of Gabo Island, Victoria, in 200 fms. Nothing was recorded as to its appearance in life.

UNIOPHORA

Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 288.

Genotype: *Uniophora globifera* Gray, 1840, p. 288 = *Asterias granifera* Lamarck, 1816, vol. 2, p. 560.

This is perhaps the most distinctively endemic genus of Australian sea stars, remarkable for the degree of speciation that has been attained in a relatively restricted habitat, for at least 5 and possibly 6 species occur in the waters of South Australia, centering in Spencer and St. Vincent gulfs. Moreover, the genus does not occur north of Port Jackson on the east coast and Fremantle on the west. No fewer than 9 species seem to be recognizable and distinguishable as follows:

KEY TO THE SPECIES OF UNIOPHORA

- A. Large, straight pedicellariae rare or wanting except on inner end of oral plates:
- B. Dorsal spines conspicuously capitate, globose, or fungiform:
Dorsal, lateral, and actinal spines fungiform, the dorsal crowded. *fungifera*
Spines more or less globose or capitate *granifera*
- BB. Dorsal spines of divers forms, often capitate, but not conspicuously so and never fungiform:
- C. Spines more or less numerous on dorsal surface as well as on marginal and actinal plates:
- D. Carinal series of plates and spines conspicuous and well defined:

E. Carinal series more or less zigzag, at least distally; dorso-lateral plates generally with spines:

F. Carinal series conspicuously zigzag, except near disk, its spines capitate, particularly the large ones; carinal and dorsolateral spines marking a double series of large polygonal areas. *sinusoida*

FF. Carinal series zigzag only distally, or if zigzag proximally its spines not capitate; no double series of large polygonal areas on dorsal side of rays, but 2 series of small areas on each side of carinals:
Arms relatively short and stout; most dorsal spines small and capitate *obesa*

Arms longer, tapering; dorsal spines numerous, long, not capitate *multispina*

EE. Carinal series nearly or quite straight; not more than 1 spine to a plate; dorsolateral spines practically wanting *uniserialis*

DD. Carinal series inconspicuous and incomplete; spines of inferomarginal and actinal plates flattened, with tips chisel-shaped, or deeply channeled on upper side or even divided into 2 or 3 short branches. *dyscrita*

CC. Spines relatively few, wanting dorsally and on marginals except near tip of ray; more or less numerous but often nearly wanting on actinal plates *gymnonota*

AA. Large, straight pedicellariae numerous both in ambulacral furrow and external to adambulacral spines. *nuda*

Uniophora fungifera

Asterias fungifera Perrier, 1875. Arch. zool. exp., vol. 4, p. 338 (p. 74 of reprint).

Uniophora fungifera Fisher, 1926. Ann. Mag. Nat. Hist., ser. 9, vol. 18, p. 198 (not figured).

This remarkable sea star undoubtedly came from "Nouvelle Hollande" as its label says, but it has not been met with in recent years.

Uniophora granifera

Asterias granifera Lamarck, 1816. Anim. sans vert., vol. 2, p. 560.

Uniophora globifera Gray, 1840. Ann. Mag. Nat. Hist., vol. 6, p. 288.

Uniophora granifera Bell, 1881. Proc. Zool. Soc. London, p. 497.

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 403; figs. 117a, b.

Nothing is recorded as to the distribution of this species, or its habits or appearance in life, save for the single record from Port Jackson which I reported in 1938 (p. 196). This individual was bright, deep carmine red, shaded on depressed areas with dusky. Aside from Port Jackson, no definite localities are known for this species, but it apparently occurs on the South Australian coast. The largest specimen noted has $R = 55$ mm.

Uniophora sinusoida

Asterias sinusoida Perrier, 1875. Arch. zool. exp., vol. 4, p. 338 (p. 74 of reprint).

Uniophora sinusoida Fisher, 1923. Ann. Mag. Nat. Hist., ser. 9, vol. 12, p. 597.

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 411; figs. 121a, b.

The only specimens I have seen of this species are from Spencer or St. Vincent Gulf, South Australia. The largest has $R = 75$ mm. The original specimen was said to be from Hobart, Tasmania. Stach (1938) reports 2 specimens (the larger with $R = 85$ mm.) from the Posidonia bank off Lusby Island, Spencer Gulf, where, he says, the species is fairly common.

Uniophora obesa

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 409; figs. 120a, b.

There is nothing to add to the original account of this species. The types were from Kangaroo Island, South Australia, and had $R = 62$ mm. Some specimens in poor condition were larger, the largest with $R = 100$ mm.

Uniophora multispina

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 407; figs. 119a, b.

The original material, $R = 52-82$ mm., was all from the vicinity of Adelaide or at least St. Vincent Gulf. Stach (1938) reports 14 small *Uniophoras* from the Posidonia bank, Lusby Island, Spencer Gulf, of which he refers 4 to this species. The other 10 he considers representatives of the following species, which he treats as a subspecies of *multispina*. I do not see from either his remarks or his figures any evidence that he had any specimen of *uniserialis*. All his specimens seem to have been *multispina*, small specimens of which would of course have fewer and more regularly arranged dorsal spines than the adults. But young *uniserialis* would have very few dorsal spines indeed.

Uniophora uniserialis

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 413; figs. 122a, b.

There were only 3 specimens in the original lot, the largest having $R = 65$ mm. No further information about this species has come to light. Stach's (1938) report of specimens from Lusby Island, Spencer Gulf, is apparently due to a misunderstanding of the characteristic spines.

Uniophora dyscrita

H. L. Clark, 1923a. Jour. Linn. Soc. (Zool.), vol. 35, p. 244.

The holotype is still unique in spite of much collecting near the spot where it was taken—Garden Island, Fremantle. It has $R = 55$ mm. but is probably not full grown. Unfortunately it has never been figured.

Uniophora gymnonota

H. L. Clark, 1928. Rec. S. Australian Mus., vol. 3, p. 405; figs. 118a, b.

No further information is available concerning this species. It reaches a fairly large size ($R = 75-88$ mm.) and seems to be rather common in the vicinity of St. Vincent Gulf.

Uniophora nuda

Asterias nuda Perrier, 1875. Arch. zool. exp., vol. 4, p. 335 (p. 71 of reprint).
Uniophora nuda Fisher, 1926. Ann. Mag. Nat. Hist., ser. 9, vol. 18, p. 198.

The holotype of this species, from Port Lincoln, South Australia, is still unique. Fisher has examined it and places it in *Uniophora*. It has not been figured.