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THE STYLASTERINA OF THE PACIFIC

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In 1857 and 1860, Milne Edwards and Haime listed 9 species of Stylasterina known to occur in the Pacific region, including "*Allopora* (*Stylaster*) *infundibulifera*", a species which later, as *Amphelia infundibulifera* (Lamarck), was to be classified in the Madreporaria (Scleractinia). Moseley (1880), who compiled a list of all the species of the group at that time known, recorded 22 species occurring in the Pacific region. To these Hickson & England (1905) added 14 new species, 4 new formae ("facies"), and 4 records of species up to that time not known from the Pacific; Fisher (1931, 1938) described 14 new species, 4 new subspecies, and 1 new forma; Broch (1932, 1935, 1936, 1942) described 14 new species and 9 new formae. This brings the total of the species and forms known to occur in the Pacific up to 86. To these must be added the corals of the group described by various authors cited at the end of the present paper, which results in 127 Stylasterina of the Pacific regarded as separate species or formae. These are listed below, alphabetically in the different genera, each name followed by one or more numbers in brackets indicating the regions of the Pacific in which the species or formae are known to occur. The limits of the regions are more or less arbitrary, some might have been divided into smaller regions, others might have been combined to larger regions, but the here accepted regions on the whole appear to form a basis for the discussions in the following pages. The regions in which the Pacific area for the present purposes has been divided are:

1, Alaska, Aleutian Islands, Bering Sea; 2, Okhotsk Sea; 3, Japan and adjacent seas; 4, Philippine Islands and Sulu Sea; 5, East Indian Archipelago; 6, New Guinea and Torres Strait; 7, Solomon Islands; 8, New Hebrides; 9, New Caledonia and Loyalty Islands; 10, North East and East Australia; 11, New Zealand, including Kermadec Islands and Chatham

Islands; 12, Pacific coast region of Canada; 13, Pacific coast region of United States; 14, Tropical region of East Pacific, including Galapagos Islands; 15, Chile, including Western Patagonia; 16, Tuamotu Islands; 17, Tahiti, Society Islands; 18, Raratonga, Cook Islands; 19, Samoa, Navigator Islands; 20, Tonga Islands; 21, Fiji Islands; 22, Gilbert Islands (Kingsmill Islands); 23, Marshall Islands; 24, Ponape, Caroline Islands.

The 127 described species and formae, and their occurrence in the here accepted regions of the Pacific, are the following.

Stylaster amphiheloides Kent (5, 6); *bellus* (Dana) (5, 6, 16); *bilobatus* Hicks. & Engl. (5, 6); *cancellatus* Fisher (1); *densicaulis* Moseley (5, 6); *dentatus* Broch (3); *duchassaingi* Pourt. (10), with f. *altus* Hicks. & Engl. (5, 6), f. *dentatus* Hicks. & Engl. (5), f. *irregularis* Hicks. & Engl. (5), f. *minor* Hicks. & Engl. (2, 3, 5, 6), and f. *typica* Broch (4); *elassotomus* Fisher (1); *elegans* Verrill (23); *erubescens* Pourt. (11); *filogranus* Pourt. (9); *flabelliformis* Lmk. (4, 5, 7); *gemmascens* (Esper) (3, 5), with ssp. *alaskanus* Fisher (1); *gracilis* M. E. & H. (3, 4, 6, 10, 11); *incompletus* (Ten.-Wds.) (10); *laevis* Studer (11); *microstriatus* Broch (3); *moora-boolensis* (Hall) (10); *multiplex* Hicks. & Engl. (5); *obliquus* Studer (11); *profundiporus* Broch, with f. *crassicaulis* Broch (3), and f. *typica* Broch (3); *pulcher* Quelch (3); *roseus* (Pallas) (19); *rosso-americanus* Brandt (1); *sanguineus* M. E. & H. (3, 10, 11, 19, 21, 22, 23, 24); *tenuis* Verril (19); *verrucosus* Studer (11); *yabei* Eguchi (3), with ssp. *minor* Eguchi (3); *Stylaster* (sp.?) (4).

Allopora bocki (Broch) (22); *boreopacifica* Broch (2, 3), with f. *incrassata* Broch (3), and f. *typica* Broch (3); sp. aff. *boreopacifica* (1); *brochi* Fisher (1); *californica* Verrill (13); *campyleca* Fisher, with ssp. *paragea* Fisher (1), ssp. *trachystoma* Fisher (1), and ssp. *tylota* Fisher (1); *carinata* (Broch) (3); *divergens* (v. Marenz.) (14); *granulosus* (M. E. & H.) (10, 19); *milleri* (Durham) (13); *moseleyana* Fisher (1), with f. *leptostyla* Fisher (1); *moseleyi* Dall (1); *norvegica* (Gunnerus) (12), with ssp. *pacifica* (Broch) (2, 3, 12); *papillosa* Dall (1); *petrograpta* Fisher (1); *polyorchis* Fisher (1); *scabiosa* (Broch) (2, 3); *solida* (Broch) (2); *stejnegeri* Fisher (1); *stellulata* (Stewart) (17); *subviolacea* Kent (3); *venusta* Verrill (12, 13); *verrilli* Dall (1, 13); *Allopora,* species not indicated (16).

Stylantheca porphyra Fisher (13).

Stenohelia minima (Hicks. & Engl.) (5); *profunda* Moseley (11, 14); *tiliata* (Hicks. & Engl.) (5); *umbonata* (Hicks. & Engl.) (5); *virginis* (Lindström) (6).

Crypthelia balia Hicks. & Engl. (5); *gigantea* Fisher (14); *japonica*

(M. E. & H.) (3); *pachypoma* Hicks. & Engl. (5, 14); *platypoma* Hicks. & Engl. (6); *pudica* M. E. & H. (3, 4, 5, 6, 11, 14, 19, 20, 21); *ramosa* Hicks. & Engl. (5); *stenopoma* Hicks. & Engl. (5, 14); *trophostega* Fisher (1).

Conopora major Hicks. & Engl. (5); *tenuis* Moseley (3, 6, 11).

Astya subviridis (Moseley) (4).

Distichopora allnutti Wright (22); *borealis* Fisher (1), with f. *japonica* Broch (3); *brasseyae* Wright (22); *coccinea* Gray (5, 9, 10, 17, 19, 22, 23); *conferta* Quelch (18); *fisheri* Broch (21); *gracilis* Dana (16); *granulosa* Quelch (18); *irregularis* Moseley (4); *livida* Ten.-Wds. (6, 7, 8, 10, 21, 23); *nitida* Verrill (22, 23); *ochracea* Quelch (7); *purpurea* Ltk. (23); *rosea* Kent (10); *serpens* Broch (4); *violacea* (Pallas) (5, 6, 8, 10, 16, 17, 21), with f. *cornuta* Broch (22), and f. *typica* Broch (4, 17, 22, 23); *Distichopora* spec. (10).

Errina antarctica (Gray) (15); *cervicornis* Broch (11); *horrida* Hicks. & Engl. (5); *macrogastra* v. Marenz. (14); *moseleyi* (Ridley) (15); *novaezelandiae* Hickson, with f. *benhami* Hickson (11), f. *cooki* Hickson (11), f. *dendyi* Hickson (11), and f. *ramosa* Hickson (11); *ramosa* Hicks. & Engl. (5); *rubra* Broch (11).

Errinopora nanneca Fisher (1); *pourtalesii* (Dall) (12, 13); *stylifera* (Broch) (2, 3); *zarhyncha* Fisher (1).

Sporadopora dichotoma (Moseley) (10); *marginata* Ten.-Wds. (11); *mortenseni* Broch (11).

Steganopora spinosa Hicks. & Engl. (5).

The data compiled above should not be considered altogether reliable for conclusions concerning the occurrence and the distribution of the Stylasterina in the Pacific area, because quite a number of the published records need confirmation before they may be regarded as established facts.

The genera with a fairly large number of species (*Stylaster, Allopora, Stenohelia, Crypthelia, Distichopora,* and *Errina*) occur in the Pacific, in the Atlantic, and in the Indian Ocean. Species of *Conopora* are known from the Pacific and from the Indian Ocean, a fossil species has been described from Denmark (Nielsen, 1919). *Sporadopora* occurs in the Pacific and in the Atlantic; one species (*Sporadopora providentiae* Hicks. & Engl., 1909) was described from the Indian Ocean; according to Broch (1942) it is a young colony of *Distichopora irregularis* Moseley. The only recent species of *Astya* was obtained in the Pacific; a fossil species of the genus has been described from Denmark (Nielsen, 1919). *Pliobothrus* is with certainty only known from the Atlantic region; *Pliobothrus seriatus* Broch, 1942, from the Indian Ocean, proved to be *Phalangopora regularis* Kirk-

patrick, 1887 (cf. Broch, 1951); according to Broch (1942), *Steganopora spinosa* Hicks. & Engl., 1905, from the East Indies, belongs to the genus *Pliobothrus*. The monotypic genera *Paraërrina* and *Phalangopora* are known from one locality only (Mauritius in the Indian Ocean), *Errinopsis* is restricted to the Antarctic region, *Errinopora* occurs in the North Pacific with one of the species, *E. pourtalesii* (Dall), as far south as California. Finally the monotypic genus *Congregopora* is known as fossil remains only from Denmark (Nielsen, 1919).

It is not astonishing that the larger genera of the Stylasterina have a practically world-wide distribution, for this is not uncommon in a group of animals containing many species living in the deep-sea. A comparison with the distribution of the Scleractinia (Madreporaria), a group of corals that has been more intensely studied than the Stylasterina, shows, however, that here a world-wide distribution of a genus is rather exceptional. Of the recent genera recognized by Vaughan & Wells (1943), 8 have a world-wide distribution (indicated as such); 12 have species in the Pacific, in the Atlantic, and in the Indian Ocean; 13 are represented in the Pacific and in the Atlantic, not in the Indian Ocean; 7 occur in the Atlantic and in the Indian Ocean, not in the Pacific; 34 are restricted to the Atlantic; 96 have a distribution in the Indo-Pacific, often including the Red Sea. In the distribution of the Scleractinia consequently the Indo-Pacific and the Atlantic are distinctly separate areas, the occurrence of a genus in the two areas forms an exception. It may be noted that the genera with world-wide distribution nearly all are found in the deeper waters, *Porites* is the only genus of reef corals of a world-wide distribution in the tropics. As far as species are concerned, the Scleractinia as a rule have a distribution restricted to one of the larger geographical areas, in such a way that the Indo-Pacific represents one larger area in which many species are widely distributed; on the other hand it is highly exceptional that a species occurs in the Atlantic region as well as in the (Indo-) Pacific. On account of these facts it gives rise to grave doubt when in papers dealing with Stylasterina a species originally described from the Atlantic is reported to occur in a locality in the Pacific region (or in the Indian Ocean). In the few instances in which the specimens have been accurately studied they proved to be different, at least subspecifically. This happened to *Stylaster gemmascens* of which the Pacific form now is known as the subspecies *alaskanus*, and to *Allopora norvegica* of which the Pacific form now is known as the subspecies *pacifica*. A similar question arises as far as concerns the species *Stylaster duchassaingi*, originally described from West Indian waters, and later reported from various parts of the Pacific.

Some more details concerning the just mentioned species are found in the here following notes on several of the forms recorded in the list on a previous page. In these notes all the species from the Atlantic region that later were recorded from the Pacific are mentioned, together with the species that originally were described from specimens from the Indian Ocean or from South Africa. The notes moreover contain data on the fossil Stylasterina described from countries bordering the Pacific, and taxonomical changes, chiefly the transfer of certain species from one genus to another, because of evident characters noted in the original descriptions. The placing of species in another genus was especially needed in the group of genera *Stylaster, Allopora, Stenohelia,* and *Stylantheca,* of which the three last named often are regarded as subgenera of *Stylaster* s. l.; they are here kept as genera, because the differences are of the same order as those between *Conopora* and *Astya,* and those between *Paraërrina* and *Errinopora.*

Stylaster amphiheloides Kent. Type specimen from South Africa. Hickson & England (1905) record the species from the East Indies and New Guinea.

Stylaster densicaulis Moseley. Type specimen from off the mouth of the Rio de la Plata. Hickson & England (1905) record the species from the East Indies and New Guinea.

Stylaster duchassaingi Pourtalès (*Stylaster eximius* Kent). Type specimen from the West Indies. Hickson & England (1905) record the species from the East Indies and New Guinea, Ritchie (1911) from off the Australian coast, Broch (1936) from the Okhotsk Sea and the Philippine Islands, Eguchi (1941) from the Japanese seas. Broch (1936) moreover examined a specimen from the West Indies, he described it as forma *atlantica,* and gave the name forma *typica* to specimens from the Philippine Islands, because these showed all the characters of the original material described by Pourtalès (1871).

Stylaster erubescens Pourtalès. Type specimen from the West Indies. Moseley (1879, 1880) adds a query to the record of the species from off the Kermadec Islands.

Stylaster filogranus Pourtalès. Type specimen from the West Indies. England (1926) records specimens from Lifu, Loyalty Islands.

Stylaster gemmascens (Esper). In the older literature the East Indies are noted as the only locality (Esper, 1794; Dana, 1848; Milne Edwards & Haime, 1857), in all probability this is due to an error in the original data of Esper. Hickson & England (1905) identified specimens from the East Indies as *S. gemmascens,* it is improbable that this identification is

correct. In modern literature the occurrence of *S. gemmascens* is restricted to the North Atlantic (Broch, 1914b); in the North Pacific (Alaskan region) a separate subspecies, *S. gemmascens alaskanus,* occurs (Fisher, 1938). Eguchi (1941) records *Stylaster* cf. *gemmascens* from Japanese waters.

Stylaster incompletus (Tenison-Woods). Described as *Allopora incompleta.* The characters indicate that the specimens possibly belong to the species identified by Hickson & England (1905), Ritchie (1911), and Broch (1936) as *Stylaster duchassaingi* Pourt. (*S. eximius* Kent).

Stylaster mooraboolensis (Hall). Described from the Eocene and Miocene of Victoria (Australia) by Hall (1893, 1898) as *Deontopora mooraboolensis.* The species has all the characters of a *Stylaster* similar to *S. duchassaingi* Pourt. (cf. Boschma, 1951a).

Stylaster obliquus Studer. Hickson & England (1905) classify this species in the group that is here regarded as a separate genus, *Stenohelia.* The original description (Studer, 1877), however, does not directly warrant this conclusion.

Stylaster roseus (Pallas). Originally described after specimens from the West Indies. Krämer (1897) records the species from Samoa; it is highly improbable that the identification is correct.

Stylaster rosso-americanus Brandt. Not a valid species, the name is a nomen nudum only.

Stylaster sanguineus M. E. & H. Mentioned by Kent (1893, p. 203) as *Allopora sanguinea,* "usually accredited with an Australian, Barrier district, habitat."

Stylaster (sp. ?). Mentioned by Moseley (1879, 1880) as obtained off Meangis Island (near the Philippine Islands).

Allopora boreopacifica f. *typica* Broch was reported from the Sea of Japan and from Alaska (Broch, 1936). Fisher (1938) showed that the Alaskan specimens belong to *Allopora campyleca paragea* Fisher; accordingly the Alaskan record for *A. boreopacifica* f. *typica* was omitted from the list.

Allopora milleri (Durham). Described as *Stylaster milleri* from the Lower Oligocene of Washington.

Allopora moseleyi Dall. According to Fisher (1938) the name is a synonym of *A. verrilli* Dall.

Allopora norvegica (Gunnerus). Type specimen from off the Norwegian coast. The species was mentioned for the Canadian waters by Hickson (1915) and by Clemens (1933), for the Okhotsk Sea by Broch (1935). The form occurring in the Pacific was described as *A. norvegica* forma *pacifica* by Broch (1936); Fisher (1938) uses the trinomial *Allopora norvegica*

pacifica (Broch). According to Fisher, Broch's specimens of the forma *pacifica* from the Strait of Georgia (Canada) belong to *Allopora verrilli* Dall.

Allopora stellulata (Stewart). Described as *Stylaster stellulatus.*

Allopora subviolacea Kent. Type specimen from unknown locality. Later the name was used by Broch (1914a) for specimens from West Africa, and by Broch (1936) for specimens from South Africa. Eguchi (1941) identified specimens from Japanese waters as *Allopora* cf. *subviolacea.*

Allopora, species not indicated. Agassiz (1903) states that in the lagoon of Makemo, Tuamotu Islands, *Allopora* is quite common in from 12 to 13 fathoms, and records a specimen of eight inches in length; probably the coral was a species of *Stylaster.*

Stylantheca porphyra Fisher, 1931. Described under this name, in a later paper (Fisher, 1938) named *Allopora porphyra* (Fisher). The structure conforms with many species of *Allopora,* but the nearly constant occurrence of several gonozooids in one cyclosystem may be considered a character of generic value.

Stenohelia minima (Hicks. & Engl.). Described as *Stylaster minimus.*

Stenohelia profunda Moseley. The localities recorded by Moseley (1879, 1880) are the West Indies and off the Kermadec Islands; the figured specimens are from the West Indies. The specimens described as *S. profunda* by Marenzeller (1904) belong to a different species. Hutton (1904) records *Allopora profunda* from the New Zealand region, obviously *Stenohelia profunda* is meant. When *Allopora* and *Stenohelia* are considered subgenera of *Stylaster, Stenohelia profunda* becomes a homonym of *Allopora profunda*; then the name *S. profunda* must be replaced by *S. challengeri* Boschma, 1951a.

Stenohelia tiliata (Hicks. & Engl.) and *Stenohelia umbonata* (Hicks. & Engl.). Described as *Stylaster tiliatus* and *Stylaster umbonatus.*

Stenohelia virginis (Lindström). Described from the West Indies as *Cryptohelia virginis,* tentatively placed in *Stylaster* by Moseley (1879). Hickson & England (1905) record the species from New Guinean waters. Broch (1936) places *S. virginis* (Lindström) in the synonymy of *Stenohelia complanata* (Pourt.), adding the record by Hickson & England with a query.

Crypthelia pudica M. E. & H. The Challenger Expedition obtained material of *Crypthelia* from the Atlantic and from the Pacific, in the text (Moseley, 1879, 1880) referred to as *C. pudica* M. E. & H. Moseley (1880, p. 71) states: "The specimens, the anatomy of which is here described, were dredged off the mouth of the La Plata." Hickson & England (1905) remark that Moseley's specimens are different from the real *C. pudica,* for the former they introduce the name *C. moseleyi.* The name *C. affinis* Moseley,

occurring on one of the plates in Moseley's publication, has priority against *C. moseleyi* (cf. Boschma, 1951a). On account of the above quotation the name *C. affinis* may for the present be restricted for the Atlantic specimens obtained by the Challenger; for the Pacific specimens the identification as *C. pudica* may be provisionally considered correct.

Distichopora allnutti Wright. Probably a synonym of *D. brasseyae* Wright (cf. Boschma, 1951b).

Distichopora coccinea Gray and *D. nitida* Verrill are regarded by Fisher (1938) as colour variations of *D. violacea*; also Broch (1942) places the two names in the synonymy of *D. violacea*.

Distichopora milesii Quelch. The locality of this species was noted as "South Sea Islands" (Quelch, 1884), a too vague record to place the species with an indication of the region of occurrence in the above list.

Distichopora purpurea Ltk. The species was mentioned by Schmeltz (1875); the paper in which the original description of the species (by Lütken?) appeared is unknown to the present author.

Distichopora rosea Kent is, according to Fisher (1938), the same species as *D. gracilis* Dana.

Distichopora violacea forma *cornuta* Broch is probably the same species as *D. coccinea* Gray.

Distichopora spec. From the Miocene of Victoria (Australia), described by Hall (1898), who compared the fossils with recent specimens of *D. coccinea* Gray; the fossil specimens had larger pores than the recent.

Sporadopora dichotoma Moseley. Type specimen from off the mouth of the Rio de la Plata. Hall (1898) records the species from the Miocene of Victoria (Australia).

Sporadopora marginata Ten.-Wds. Described from the Upper Eocene of the Chatham Islands (New Zealand region). The species differs from the only other known at that time, *S. dichotoma* Moseley, by having pores with a raised margin.

Steganopora spinosa Hicks. & Engl. According to Broch (1942) the species belongs to the genus *Pliobothrus*.

As a general note here to be added it must be remarked that not all the species enumerated in the list really deserve this rank. A detailed examination of the described species undoubtedly will result in placing a fairly large number in the synonymy of previously described species. Up till the present time very little has been done to establish the true nature of a great number of insufficiently known forms described as species. Sometimes conclusions of the kind as here meant are made, perhaps not always with sufficient reason. When, e. g., *Distichopora coccinea* Gray is regarded as a synonym

of *D. violacea* (Pallas), as argued by Fisher (1938) and Broch (1942), no account is taken of the peculiar form of growth of *D. coccinea* with its warty incipient side branches on the flat surface of the larger stems and branches, a peculiarity never observed in specimens of *D. violacea* of the typical form of growth.

When the data concerning the distribution of the 127 species and formae of the list on previous pages are tabulated they give an idea of our present knowledge of the occurrence of corals of the group in various parts of the Pacific region (cf. table). Here the 24 regions are those previously mentioned, though noted more concisely.

	Stylaster	*Allopora*	*Stenohelia*	*Stylantheca*	*Crypthelia*	*Conopora*	*Astya*	*Distichopora*	*Errina*	*Errinopora*	*Sporadopora*	*Steganopora*	Total
1. Alaska, Bering Sea	4	13	—	—	1	—	—	1	—	2	—	—	21
2. Okhotsk Sea	1	4	—	—	—	—	—	—	—	1	—	—	6
3. Japan	11	7	—	—	2	1	—	1	—	1	—	—	23
4. Philippine Is.	4	—	—	—	1	—	1	3	—	—	—	—	9
5. East Indies	11	—	3	—	5	1	—	2	2	—	—	1	25
6. New Guinea	7	—	1	—	2	1	—	2	—	—	—	—	13
7. Solomon Is.	1	—	—	—	—	—	—	2	—	—	—	—	3
8. New Hebrides	—	—	—	—	—	—	—	2	—	—	—	—	2
9. New Caledonia	1	—	—	—	—	—	—	1	—	—	—	—	2
10. N.E. and E. Australia	5	1	—	—	—	—	—	5	—	—	1	—	12
11. New Zealand	6	—	1	—	1	1	—	—	6	—	2	—	17
12. Canada	—	3	—	—	—	—	—	—	—	1	—	—	4
13. United States	—	4	—	1	—	—	—	—	—	1	—	—	6
14. Tropical E. Pacific	—	1	1	—	4	—	—	—	1	—	—	—	7
15. Chile	—	—	—	—	—	—	—	—	2	—	—	—	2
16. Tuamotu Is.	1	1	—	—	—	—	—	2	—	—	—	—	4
17. Society Is.	—	1	—	—	—	—	—	3	—	—	—	—	4
18. Cook Is.	—	—	—	—	—	—	—	2	—	—	—	—	2
19. Samoa Is.	3	1	—	—	1	—	—	1	—	—	—	—	6
20. Tonga Is.	—	—	—	—	1	—	—	—	—	—	—	—	1
21. Fiji Is.	1	—	—	—	1	—	—	3	—	—	—	—	5
22. Gilbert Is.	1	1	—	—	—	—	—	6	—	—	—	—	8
23. Marshall Is.	2	—	—	—	—	—	—	5	—	—	—	—	7
24. Caroline Is.	1	—	—	—	—	—	—	—	—	—	—	—	1

Number of species and formae of Stylasterina occurring in the various regions of the Pacific.

The table gives rise to the following comments.

1. The region of Alaska, the Aleutian Islands, and the Bering Sea is one of the best known as far as concerns the occurrence of Stylasterina. Of the 21 species and subspecies (including one forma), one, *Stylaster rosso-*

americanus Brandt (1872), is invalid, the name being a nomen nudum only. A second species described from the region, *Allopora moseleyi* Dall (1884), was placed by Fisher (1938) in the synonymy of *A. verrilli* Dall from the same region. The remaining 19 species and forms of infraspecific level all are dealt with in Fisher's (1938) paper, the majority of these belong to the genus *Allopora*.

2. The occurrence of Stylasterina in the Okhotsk Sea was first established by Broch (1932, 1935), who identified one coral as *Stylaster eximius* forma *minor* Hicks. & Engl., and described 5 new species. These were dealt with in more detail in later papers (Broch, 1936, 1942); notes on four of these species from the Okhotsk Sea are contained in Fisher (1938).

3. The large number of records of Stylasterina for the seas around Japan (23) do not implicitly indicate that this number of separate species and formae indeed occur here. Many of the older records may be based on erroneous identification, and some of the described species eventually may prove to be synonyms of previously described species. The 9 species or formae from Japanese waters treated in the important papers by Broch (1936, 1942), all collected on Dr. Th. Mortensen's Pacific Expedition 1914-16, are systematically of good standing. On the other hand it is open to doubt whether all the Stylasterina recorded for Japanese waters by Eguchi (1941) are correctly identified, among the 16 species or formae, e. g., *Allopora* cf. *subviolacea* Kent is mentioned; previously this species was recorded from South and West Africa only.

No Stylasterina are known from the regions bordering the coasts of Korea, China, Formosa, Indo-China, Thailand, and the Malay Peninsula.

4. The scanty data on the occurrence of Stylasterina in the Philippine Islands (9 records) are far from exhaustive, undoubtedly numerous species will become known with further studies on the fauna of the region. Four apparently different species of *Stylaster* have been recorded for the region, one as *Stylaster* sp., the remaining three are evidently good species, including *S. duchassaingi* f. *typica* Broch, obtained in 1914 during Dr. Th. Mortensen's Pacific Expedition off Jolo in 20-25 fathoms (36-45 m). It is interesting that among the material collected in 1929 during the Snellius Expedition there are specimens, obtained at Sipankot near Sibutu in the Sulu Islands at a depth of 3 to 6 meters, of a shape similar to the various formae ("facies") of *S. duchassaingi* (*S. eximius*) described by Hickson & England (1905). If future examination of these specimens might prove that the preliminary identification is correct, we have here the first altogether reliable record of occurrence of the species in shallow water of the Pacific. A peculiar species of *Distichopora, D. irregularis* Moseley, up till now is known

from the Philippine Islands only, moreover the only known recent species of the genus *Astya, A. subviridis* (Moseley), is known to occur in this region only, it was collected by the Challenger Expedition in 500 fathoms off Meangis Island in the southeastern part of the Philippine Islands area.

5. Notwithstanding the fact that from the East Indian Archipelago more species are known than from any other region of the Pacific, our knowledge of the occurrence and distribution of the Stylasterina of this region is far from satisfactory. 22 of the 25 records are based on the material of the Siboga Expedition (Hickson & England, 1905), collected in depths of 22 to 1901 meters (the record of *Stylaster eximius* facies *altus* from Sta. 282 "27-54 m or from reef" cannot be considered a distinct indication of the depth). The remaining records are those of *Stylaster flabelliformis, Distichopora violacea,* and *D. coccinea.* Of these the first named was reported from the "Océan des Indes orientales" by Lamarck (1816); Dana (1848) indicates the locality as "East Indies". The first note on a coral of the order Stylasterina for the East Indian region undoubtedly is the record of *Lithodendrum saccharaceum rubrum* by Rumphius (1750); according to Pallas (1766) this name is a synonym of his species *Millepora violacea,* later to become the type of the genus *Distichopora* Lamarck. Von Martens (1902) argued that because of the red colour Rumphius's coral had to be identified as *Distichopora coccinea* Gray. Later *D. violacea* of the typical form has been found on islands of the East Indian Archipelago, e. g., by Hickson (1899, p. 52) in North Celebes. These notes at first sight might indicate that shallow water Stylasterina are extremely scarce in the East Indian Archipelago. The data indeed are few, but in all probability owing to the fact that on the whole the fauna of the coral reefs and of the rocky shores of most of the islands of this region has never been studied to any extent. We may therefore safely conclude that though the East Indies have the largest number of described species or formae of all the here recognized areas, they are one of the least known as far as concerns the real facts. On the other hand the region may compete with the North Pacific in abundance of species and formae from the deeper parts of the sea.

6. New Guinea forms with the adjacent Torres Strait a more or less well defined zoogeographical region, on the other hand the fauna in many respects has distinct affinities to that of groups of islands in a more easterly direction, the Solomon Islands, and the New Hebrides. From New Guinea and its surrounding seas 11 species and formae were recorded, 10 of these were obtained in various depths by the Siboga Expedition, the eleventh is *Distichopora livida,* stated to occur in New Guinea by Tenison-Woods (1879b). From the Torres Strait two species of Stylasterina are known

(Hickson, 1892), viz., *Stylaster gracilis* M. E. & H., and *Distichopora violacea* (Pallas). This brings the total number for the region up to 13, too small a number to warrant the conclusion that our knowledge of the occurrence and the distribution of the Stylasterina in this region is well advanced.

From New Britain, New Ireland, and the Admiralty Islands not a single Stylasterine coral has become known.

7. Three species of Stylasterina were reported to occur in the Solomon Islands or their near vicinity, viz., *Stylaster flabelliformis* Lmk. by Studer (1877), *Distichopora livida* Tenison-Woods (1879a, described after specimens from the Solomon Is. and from the Marshall Is.), and *D. ochracea* Quelch (1885, type specimen from the Solomon Islands). More recent notes on Stylasterina from the Solomon Islands have not appeared, the marine fauna of the group is too insufficiently known to conclude that here Stylasterina are as scarce as the available data seem to indicate.

8. Only two species of Stylasterina have been mentioned as occurring in the New Hebrides, both in a paper by Tenison-Woods (1879b): *Distichopora livida* T.-Wds., and *D. violacea* (Pallas). The former differs from the latter by a more upright growth and by forming much thicker stems, moreover by its leaden colour, not violet as in *D. violacea*. It is not altogether certain that the two forms really are specifically distinct.

9. In the description of *Distichopora coccinea* the locality is noted as "Pacific Ocean, near New Caledonia, in deep water" (Gray, 1860, p. 245). England (1926) studied the gonophores of a species of *Stylaster* from Sandal Bay, Lifu, Loyalty Islands, identified as *S. filogranus* Pourt., originally described from the West Indies. No other records of Stylasterina from New Caledonia or from the Loyalty Islands are known, so that here too must be concluded that further research is badly needed.

10. North East and East Australia, including the Great Barrier Reef area. Milne Edwards & Haime (1850) described the species *Stylaster sanguineus, S. granulosus,* and *S. gracilis,* adding as locality: "Habite l'Australie" (the second now must be named *Allopora granulosa*). Tenison-Woods (1883) described *Allopora incompleta* (present name *Stylaster incompletus*) from East Australian waters; Ritchie (1911) identified material from the same region as *Stylaster eximius* Kent (present name *St. duchassaingi* Pourt.); there is reason to believe that Ritchie's specimens are conspecific with Tenison-Woods's species. In 1871, Kent described *Distichopora rosea* from the East coast of Australia, in 1893 the same author identified a red coloured specimen from the Great Barrier Reef as *D. coccinea*; possibly here too the two forms are not specifically distinct. Moreover *D. livida* and *D. violacea* are reported to occur in Australia (Tenison-Woods, 1879b). This

brings the number of described species for the Australian area up to 9. To these must be added the fossil representatives of the group described by Hall (1893, 1898) from the Miocene (the first occurring in the Eocene too) of Victoria: *Deontopora mooraboolensis* (present name *Stylaster mooraboolensis*), *Sporadopora dichotoma* (Moseley), and *Distichopora* spec.

In marine zoogeography the regions noted with the numbers 6-10 may be united as one faunal province. The number of recent species and formae of Stylasterina of this larger region then amounts to 11 *Stylaster,* 1 *Allopora,* 1 *Stenohelia,* 2 *Crypthelia,* 1 *Conopora,* and 5 *Distichopora,* yielding a total of 21, astonishingly low in comparison to the large area concerned (the total is arrived at by eliminating the extra records of occurrence in more than one of the regions 6-11). Undoubtedly many more species occur here than is known at present.

11. New Zealand, including the Kermadec Islands and the Chatham Islands, forms a region that is somewhat better known in respect to the occurrence and the distribution of the Stylasterina. The only coral of the group known from the Chatham Islands is a fossil from the Upper Eocene, *Sporadopora marginata* Tenison-Woods (1880). Studer (1877) reported upon 4 species from the deep-sea of the New Zealand region, Moseley (1879) listed 6 species from deep water off the Kermadec Islands, 2 of which were already mentioned for the region by Studer. The total number of recent species and formae here occurring is 16; especially the genus *Errina* (3 species, one divided into 4 formae) appears to be characteristic of the region; the systematics of the New Zealand species of the genus *Errina,* however, still need a thorough revision, although important results on material from this region were obtained by Hickson (1912).

12 and 13. The comparatively few species known to occur along the Pacific coasts of Canada and the United States are identical with or closely allied to species occurring in the Alaskan region, the Aleutian Islands, and the Bering Sea. *Stylantheca porphyra* Fisher, here regarded as representing the only species of a separate genus, in many respects is structurally alike tc certain species of *Allopora* from the Pacific region of North America.

From the Pacific coast of Mexico, of Central America, and of South America to the southern part of Chile, not a single Stylasterine coral is known.

14. Some species of Stylasterina are known from the tropical region of the East Pacific around the Galapagos Islands. Von Marenzeller (1904) described the species *Errina macrogastra* and *Stylaster divergens* (obviously an *Allopora*), and published notes on *Stenohelia profunda* (Moseley) (probably a different species of the genus), and on *Crypthelia pudica* M. E. &

H. from this region. Fisher (1938) described the species *Crypthelia gigantea* from this locality. To these must be added two unpublished records of species of the genus: *C. platypoma* Hicks. & Engl. and *C. stenopoma* Hicks. & Engl., material of which, dredged off the Galapagos Islands, is present in the collections of the United States National Museum, Washington, D. C., identified by Dr. W. K. Fisher. It is highly probable that besides those known at present many other species of Stylasterina are to be found in the region of the Galapagos Islands, on the whole very little is known of the Eastern Pacific region off the coast of America south of California.

15. The Chilean region. The description of *Labiopora moseleyi* by Ridley (1881) was based on specimens from S. W. Chile, the same author, moreover, reported upon specimens of *L. antarctica* Moseley from the same locality; the two species now are classified in the genus *Errina,* which is especially abundant in the Antarctic region.

The now following notes refer to various groups of islands in the central region of the Pacific.

16. The Tuamotu Islands (Paumotu Islands). *Allopora bella* Dana, indicated with this name in the legend of the plate (Dana, 1848, Pl. 60 fig. 6), regarded as a forma of *Allopora gemmascens* (Esper) in the text of the cited work, is the only species of *Stylaster* known to occur in the islands. Moreover an unidentified *Allopora* was mentioned by Agassiz (1903) as common in from 12 to 13 fathoms, the scanty data concerning this coral seem to indicate that it possibly was a species of *Stylaster.* The only known specimen of *Distichopora gracilis* Dana came from the Tuamotu Islands, further *D. violacea* is known to occur in the group (Dana, 1848; Tenison-Woods, 1879b). In later literature no Stylasterina from the Tuamotu Islands were mentioned.

17. Society Islands. The first record of a Stylasterine coral from Tahiti is the description of *Stylaster stellulatus* (present name *Allopora stellulata*) by Stewart (1878). The next is *Distichopora violacea* (Pallas), mentioned for Tahiti by Hoffmeister (1929). Fisher (1938) examined Tahitian material of *D. violacea* f. *coccinea,* Broch (1942) of *D. violacea* f. *typica.*

18. Cook Islands. Quelch (1885) described *Distichopora conferta* from Raratonga, and *D. granulosa* from Raratonga as uncertain locality. No other Stylasterina have been reported from any of the islands of the group.

19. Navigator Islands. Studer (1877) mentions specimens of *Crypthelia pudica* M. E. & H. from deep water off Samoa. Krämer (1897) observes that *Stylaster granularis* and *S. roseus* occur in Samoa. The first, if correctly identified, should bear the name *Allopora granulosa* (M. E. & H.), the second name belongs to a West Indian coral from shallow water, of

which the occurrence in the Pacific is highly problematical. *S. sanguineus* M. E. & H. was mentioned for Samoa by Ward (1892) and by Studer (1901), *Distichopora coccinea* Gray by von Martens (1902). *Stylaster tenuis* was described from Upolu in the Navigator Islands (Verrill, 1864).

20. The only record for a Stylasterine coral from off the Tonga Islands is a note by Studer (1877) concerning *Crypthelia pudica* M. E. & H. No shallow water species of the group are known to occur in the islands.

21. From deep water off the Fiji Islands *Crypthelia pudica* M. E. & H. was reported by Studer (1877). Shallow water species known to occur here are *Stylaster sanguineus* M. E. & H. (Broch, 1936), *Distichopora violacea* (Pallas) (Gräffe, 1866; Schmeltz, 1866, 1875), *D. livida* Ten.-Wds. (Tenison-Woods, 1879b), and *D. fisheri* Broch (1942).

22. Gilbert Islands (Kingsmill Islands). Wright (1882) was the first to deal with Stylasterina from the Gilbert Islands; he described the two species *Distichopora brasseyae* and *D. allnutti,* of which the latter does not seem specifically distinct from the former. Ward (1892) lists *D. coccinea* Gray and *D. nitida* Verrill for the islands. In the material collected in the Gilbert Islands by Dr. Sixten Bock in 1917, Broch (1936, 1942) found the new species *Stylaster bocki,* and the formae *typica* and *cornuta* of *Distichopora violacea* (Pallas); probably the forma *cornuta* is conspecific with *D. coccinea* Gray. Finally, a species of *Stylaster* from the Onotoa Atoll was identified by Wells (1952) as *S. sanguineus* M. E. & H.

23. Marshall Islands. *Stylaster elegans* and *Distichopora nitida* were described from Ebon Island (Verrill, 1864). The Marshall Islands were mentioned as one of the localities in the original description of *D. livida* Tenison-Woods (1879a); Schmeltz (1875) stated that here occur *D. coccinea* Gray and *D. purpurea* Ltk. (original description, by Lütken?, not known to the present author). Von Martens (1902) mentions *D. coccinea* from Jaluit in the Marshall Islands. From Dr. Sixten Bock's Expedition in 1917 the following Stylasterina, from Jaluit Island, were examined by Broch (1936, 1942): *Stylaster sanguineus* M. E. & H. and *Distichopora violacea* f. *typica* Broch.

24. Caroline Islands. Only one species of Stylasterine corals has been reported from this group of islands, viz., *Stylaster sanguineus* M. E. & H. from Ponape Island (Broch, 1936).

Not a single species of Stylasterina has been reported from the following groups of islands of the central Pacific: Marquesas, Austral (Tubuai) Is., Line Is., Phoenix Is., Tokelau Is., Ellice Is., Palau Is., Marianas (Ladrones), and Hawaiian Is. In the last named group of islands the fauna of the shore and the reefs is so well known that Edmondson's (1946, p. 27) remark that

"no hydroid corals are known to occur in Hawaiian shallow waters" indicates that in all probability the Stylasterina are not represented in the islands. As far as concerns the other here mentioned groups of islands it is probable that future research will prove the occurrence of many species.

If now, as has been done above for the numbers 6-10, the regions here numbered 16-24 are combined as one larger faunal region, embracing the whole central part of the Pacific, it appears that the number of Stylasterina of this region, as far as they are known at present, is exceedingly low. Taking into account that certain species have been reported from two or more of the island groups, the total number of species and formae of Stylasterina of the larger area appears to be 22 (5 *Stylaster,* 4 *Allopora,* 1 *Crypthelia,* 12 *Distichopora*). Now there are certain records in the literature that would cause the number to become slightly higher. When Quelch (1884) described the species *Distichopora milesii,* he noted as locality the "South Sea Islands", since that time the species has never again been mentioned. Generally, however, when in the older literature the occurrence of a species was mentioned in vague terms as the South Seas, later data were of a more precise character, so that practically all reliable facts on the distribution of Stylasterina in the Pacific are dealt with above.

The present survey of the occurrence of Stylasterina in the various regions in which the Pacific area here has been divided lacks uniformity in so far as the data concerning regions with numerous species of the group have been treated far more summarily than regions in which the data on corals of the group are extremely scarce. As a general result it may be noted that the region of Alaska and the Bering Sea, the Okhotsk Sea, and the region off the coast of Canada and the United States are among the best examined of the whole Pacific as far as concerns reliability of the identification of the species and the data of their distribution. For Japan and the seas around it there are a great number of valuable data, though of varying importance because many of these are from the older literature; further research in this region certainly will yield important results. Our knowledge concerning the Stylasterina of the New Zealand region is in a rather advanced state, but much has still to be done as a basis for a distinct insight into the systematic relations of the here occurring representatives of the group. The East Indies and New Guinea have yielded numerous data in respect to the members of the group occurring in deeper water, our knowledge concerning the shallow water species is still entirely fragmentary. The small number of species of Stylasterina known from the Philippine Islands are not representing the true state of occurrence of the animals of the group, here again further research is badly needed. In the region of

the Pacific off the coast of America southward of California many more species of Stylasterina may prove to occur besides the two species known from the extreme southern end of this region. The few data known from the tropical East Pacific warrant the conclusion that here a rich field for research remains practically still unexplored.

In the remaining regions of the Pacific hardly any records for a reliable idea of the occurrence of representatives of the group are available. The group of islands comprising the Solomon Is., the New Hebrides, New Caledonia (and other groups of islands from which not a single Stylasterine coral has become known), including numerous islands that with their rocky shores form a suitable substratum for animals of the group, have such a small number of species that many more must be expected to occur in this region. The region of the Australian coast, including the Great Barrier Reef, undoubtedly too has a much richer fauna of Stylasterina than the scanty at present available data seem to indicate. The least known area certainly is the extensive group of islands in the central Pacific. Here records for the deeper parts of the sea are extremely rare, and data concerning shallow water species are exceedingly few. A great deal of research on the fauna of the central Pacific is needed before a general idea of the occurrence and the distribution of the various species can be arrived at.

Some species of Stylasterina are known from one locality or from a restricted region only, many others have been found in several localities, often widely scattered, whilst in the interjacent regions they are altogether unknown. In this respect it is a curious fact that of the numerous species known to be represented in the Pacific not more than seven have been observed in five or more of the regions in which the Pacific area has been divided for purposes of the present paper, viz., *Stylaster duchassaingi, S. gracilis, S. sanguineus, Crypthelia pudica, Distichopora coccinea, D. livida,* and *D. violacea.*

Finally it needs to be repeated that conclusions as endeavoured to arrive at in the present paper in some respects are lacking in evidence because of the fact that many data obviously are based on incorrect identifications. A detailed investigation of previously examined material for this reason undoubtedly will lead to highly interesting results.

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