SOME SOLITARY CORALS FROM THE INDIAN OCEAN.

By C. J. VAN DER HORST, *University of the Witwatersrand, Johannesburg.*

(Plates I, II.)

The following is a report on a small collection of solitary corals, the majority of which belong to the Indian Museum at Calcutta and form part of the " Investigator " collections. Others were collected by Professor Stanley Gardiner in the western part of the Indian Ocean (" Sealark " Expedition) and, as they are few in number, it is considered advisable that they should be included in the same report as the " Investigator " corals. With regard to the literature, only those references are cited that give the most important details.

Caryophyllia clavus Scacchi.

Caryophyllia clavus, Marenzeller, 1904; Döderlein, 1913.
Caryophyllia ambrosia, Alcock, 1898.

13° 17′ N., 93° 7′ E., Andaman Sea, 90 fms., " Investigator ", 1 specimen.
7° 11′ N., 76° 35′ 30″ E., Laccadive Sea, 1006 fms., " Investigator ", 2 specimens.
9° 20′ N., 75° 24′ E., Laccadive Sea, 930 fms., " Investigator " 1 specimen.
8° 43′ 30″ N., 76° E., off Travancore Coast, 400 fms., " Investigator ", 1 specimen.
Cargados, 30 fms., " Sealark ", 1 specimen.
Mauritius, over 80 fms., " Sealark ", 1 specimen.

In view of the adequateness of the description of this species, given by Marenzeller and Döderlein, it need only be stated here that *C. ambrosia* Alcock, the description of which entirely agrees with one of my specimens, is undoubtedly synonymous with *C. clavus*.

Caryophyllia arcuata M.-Edw. et H.

Caryophyllia arcuata, Marenzeller, 1904; Döderlein, 1913.
Caryophyllia ephyala Alcock, 1898.

Providence, 70 fms., " Sealark ", 2 specimens.
Seychelles, 44 fms., " Sealark ", 1 specimen.
Saya de Malha, 300-500 fms., " Sealark ", 1 specimen.

The two specimens from Providence are in good condition and agree in every respect with Marenzeller's description. In the specimens from the Indian Ocean studied by Marenzeller, as well as in those among my material, the calicle is deeper than it is in specimens from the Mediterranean described by Lacaze-Duthiers.

Caryophyllia ephyala Alcock is undoubtedly synonymous with *C. arcuata*; Marenzeller is also of this opinion.

Caryophyllia cincticulatus (Alcock).

? *Thecocyathus cincticulatus*, Alcock, 1898.

13° 17′ N., 93° 7′ E., Andaman Sea, 90 fms., " Investigator " 1 specimen.
Saya de Malha, 150 fms., " Sealark ", 1 specimen.
Providence, 70 fms., " Sealark ", 1 specimen.

Alcock in describing this species put a query in front of the name and it therefore seems that he was rather doubtful as to its generic name. The genus *Thecocyathus* was established by Milne-Edwards and Haime and is, according to them, a.o. characterised by the presence of " plusieurs couronnes de palis." In Pourtalès' figure of *Thecocyathus cylindraceus* two rings of pali are clearly visible, but in Alcock's figure of *Th. cincticulatus* only a single ring of pali is evident. Alcock writes: " In addition to the true pali there is an outer crown of almost paliform thickenings of the edges of the 9 or 10 principal septa," but these thickenings are not present at all. The inner edges of the septa are markedly wavy, as is quite evident from Alcock's figure as well as from my specimens. Seen from above this inner edge seems to be thickened, but in reality it is sharp and does not in the least resemble a palus. The single row of pali, arising only in front of the septa of higher order, immediately removes this species from *Thecocyathus* and places it in the genus *Caryophyllia*.

Gardiner described *Trochocyathus cincticulatus* from South Africa (*Thecocyathus* is often regarded as merely a subgenus of *Trochocyathus*). This seems to be a different species than Alcock's as it has pali in front of the primary septa.

Caryophyllia cincticulatus is closely allied to *C. cyathus* from the Mediterranean, which is also recorded by Marenzeller from South Africa. The principal difference seems to be that in *C. cyathus* the pali are much thickened in older specimens, whereas in *C. cincticulatus* they have the form of thin wavy ribbons. Moreover the fine undulating lines on the epitheca distinguish the present species from *C. cyathus*.

Caryophyllia gigas, n. sp.

(Plate II, figs. 1, 4.)

Mauritius, 100-200 fms., " Sealark ", 1 specimen.

This single specimen is gigantic in size for a *Caryophyllia*. It is broken off from its base and if the break has taken place near the base, which seems probable, its height is slightly over 10 cm. The diameter near the base is about 8 mm., but owing to some irregularities this could not be measured with absolute certainty. Although somewhat irregularly curved, the corallum widens gradually and regularly towards the calicular margin, becoming at the same time more and more elliptical in cross-section. At the margin it has a diameter of 40 × 32 mm. There are 12 principal septa of similar size and form; these are therefore the sepra

of the first and second orders. They are exsert for about 3 mm. above the margin. Their margins are entire, showing no waves; the septa are thin and are no thicker near the periphery than at their inner margin; their sides are covered with blunt granules, which are arranged more or less in rows perpendicular to the septal edge. These principal septa reach nearly as far inwards as the inner side of the pali and are at this point very close to the columella. The septa of the third order only differ from the principal septa in being somewhat narrower and less exsert. The septa of the fourth order are smaller than, but do not differ in form from the tertiaries except by the pali being in front of the quaternaries. These pali are separated from the septa by a well marked, though not very deep, incision. The septa of the fifth order are narrower than the quaternaries. They are all present, so that, there being no septa of the sixth order, the total number of septa is 96. Those septa of the fifth order adjoining the principal septa are broader and more exsert than those adjoining the tertiaries and they are more exsert than the quaternaries. All these septa of higher order are, like the principal septa, covered with granules. The pali, of which there should be 24 in all, are broad, thin plates, the edges of which are straight and the sides of which are covered with granules. The columella is formed by a dozen irregularly curved ribbons. The pali may extend between the lobes of the columella, so that there is no sharp demarcation between pali and columella, as is found, for example, in *Caryophyllia clavus*. The surface of the columella is about 5 mm. below the upper edge of the pali. The depth of the calicle is about 16 mm.

Ribs are faintly visible as mere striae over the whole of the outer surface, except in places covered by other animals. It is only in the upper part, down to about 15 mm. from the calicular margin, that the ribs are well developed. They have a rather sharp crest in the middle, without any denticulations. The ribs corresponding to the principal septa project rather more than the others; those corresponding to the septa of the fifth order are usually only indicated by slightly projecting crests, so that an alternation in size of the ribs is plainly visible.

Pourtalès in describing the genus *Thecocyathus* mentions hollow roots, starting from the interseptal chambers, not visible externally, and forming a concentric circle round the original base of attachment. As the coral grows, new roots are formed and a new circle, concentric with the preceding, arises. He gives some excellent figures of these peculiar structures (*Ill. Cat. Mus. Comp. Zool.* IV, 1871, pl. v, figs. 3 and 4). In *Caryophyllia* (*Thecocyathus*) *cincticulatus* Alcock also found a series of diverticula from the interseptal spaces. Similar structures are present in *Caryophyllia gigas*; they are clearly visible where the coral is broken off from its base, although they are not so regularly arranged as in Pourtalès' figures. The regularity in their formation is also disturbed by two young corals attached to the base of the specimen. These young corals are to some extent overgrown by the subsequently formed roots and in consequence look like buds. I do not, however, think that they are buds, because these never occur in *Caryophyllia* and, moreover, some more young corals have attached themselves higher up on the wall of the specimen.

Acanthocyathus grayi M.-Edw. et H.

Acanthocyathus grayi, Alcock, 1893 and 1898.

15° 25′ N., 93° 45′ E., off C. Negrais, Burma, 40-49 fms., " Investigator ", 9 specimens.

Andamans, 53 fms., " Investigator ", 1 specimen.

8 miles W of Interview Island, Andamans, 45-270 fms. " Investigator ", 1 specimen.

Off Port Blair, Andamans, 100 fms., " Investigator ", 1 specimen.

The locality of the type-specimens of Milne-Edwards and Haime is unknown. Alcock reported the species from the Andamans and it is also found in the East Indies. The full-grown specimens are entirely free, but younger ones are attached by a narrow base that seems to break off later on. Of two small specimens in the present collection the one is attached to a piece of shell, the other to a Serpulid.

Deltocyathus andamanicus Alcock.

Deltocyathus andamanicus, Alcock, 1898; Vaughan, 1907.

Off Andamans, 185 fms., " Investigator ", 1 specimen.

This specimen agrees in every respect with Alcock's specimen from the same locality.

Deltocyathus rotulus (Alcock).

Trochocyathus rotulus, Alcock, 1898.

8° 53′ 15″ N., 81° 20′ 30″ E., East of Ceylon, 1,086 fms., " Investigator ", 1 specimen.

This species is best included in the genus *Deltocyathus*. It closely resembles *D. magnificus* Moseley, but can immediately be distinguished from the latter by its margin which is scallopped by the exsert septa and costae, whereas in *D. magnificus* the septa are not exsert and the margin is simple. According to Alcock " this singularly beautiful species has no close resemblance, except in general shape, to *Deltocyathus* ". It can indeed be easily distinguished from *D. andamanicus*, but it is nevertheless a species of *Deltocyathus*. Milne-Edwards and Haime who established the genus *Deltocyathus* write : " Sous les autres rapports, le Deltocyathe paraît se rapprocher des Trochocyathes ; mais la base pédicellée de ceux-ci et leur fossette calicinale toujours bien marquée les en distinguent tout de suite." It is somewhat doubtful whether the pedicellated base is really a distinguishing character. Moseley mentions one out of a great number of specimens of *D. magnificus* " with a most distinct pedicle and scar of attachment that evidently remained fixed up to a period of full maturity." On the other hand Lindström and Pourtalès do not mention any attached specimen. Alcock, however, reports in *D. andamanicus* a small central scar, a feature also found by Vaughan and which is also present in my specimen. Although traces of a former attachment may be left in some specimens and occasionally a full grown attached specimen may be found, the characters distinguishing *Deltocyathus* from *Trochocyathus*, as pointed out by Milne-Edwards and Haime, are valid and are even clearer in *D. rotulus* than in *D. andamanicus*.

Paracyathus.

Pourtalès writes: "Like *Caryophyllia*, this genus presents so many points of variation that it is very difficult to define a species." Quite a number of species of *Paracyathus* have been described and I feel very doubtful as to their validity. Owing to the amount of variation it is extremely difficult to recognize a species merely from a description. Duncan's descriptions are particularly inadequate. He describes any aberrant specimen as a new species. His numerous species from the Mediterranean seem to be all based on young and imperfect specimens. Like Lacaze-Duthiers and Döderlein I am greatly in doubt as to their validity.

I have before me quite a number of different forms, most of which can be identified as known species, but a few are doubtful.

Paracyathus pulchellus Philippi.

(Plate I, fig. 7; Plate II, fig. 2.)

Paracyathus pulchellus, Döderlein, 1913; Gravier, 1920.

Mauritius, over 80 fms., "Sealark", 1 specimen.

This is a fine specimen undoubtedly belonging to the above-named species, which was previously known only from the Mediterranean, Atlantic and West Indies.

Paracyathus stokesi M.-Edw. et H.

(Plate I, figs. 1—6; Plate II, fig. 3.)

Paracyathus stokesi, Milne-Edwards et Haime, 1848.

8° 51′ 30″ N., 81° 11′ 52″ E., off Ceylon, 28 fms., "Investigator", 2 specimens.
Puri Beach, "Investigator", 1 specimen.
W of Mangalore, 26-31 fms., "Investigator", 12 specimens.
Off Akyab, Arracan Coast, 17 fms., "Investigator", 7 specimens.
Entrance to Palk Strait, 3 miles N. N. W of St. Pedro, 6-8 fms., "Investigator", 1 specimen.
6° 1′ N., 81° 16′ E., S. of Ceylon, 34 fms., "Investigator", 2 specimens.
Mergui, 3 specimens.

The type-specimen of Milne-Edwards and Haime was from an unknown locality. Typical specimens in the present collection conform entirely to the original description and figure, leaving no doubt regarding the identity and, therefore, the locality of the species. This species has had no further mention by later authors. Perhaps some species, described later, *e.g.*, *P. caeruleus* Duncan, are synonymous with *Paracyathus stokesi*. This is undoubtedly the case in *P. rotundatus* Semper.

A typical specimen is attached by a rather broad, expanded base, above which it is narrowed into a pedicle. It then spreads out regularly towards the calicular margin. Ribs are faintly visible externally over the whole surface. They are broad, round, scarcely projecting, separated by very narrow grooves and covered with blunt granules. All the ribs are equal in size. Towards the base of the coral they become less and

less visible, until on the base they are hardly visible or may be recognized only by the rows of granules. Near the calicular margin the principal ribs, corresponding to the septa of the first, second, third and fourth order, project more than the intervening ones; there is thus a very apparent alternation. Near the margin the ribs have a sharp edge, while lower down they are rounded.

Although the pedicle is cylindrical, the calicle is oval. The relation between the short and the long axis is as 7 : 10. The margin of the calicle may even be somewhat inwardly curved along the longer side of the oval. The longer axis is on a lower level than the shorter.

The fifth order of septa is nearly always complete. The principal septa, *i.e.*, those of the first and second order, are exserted above the calicular margin for 2 mm. at the most and may be scarcely exsert at all. The exsertion of the other septa diminishes according to their order, but even those of the fifth order may be exsert for 1 mm. The septal edge is entire, sharp and often somewhat undulating, with very small waves, so that striae perpendicular to the edge may be distinguished on the faces of the septa. The septa are, in addition, densely covered with blunt granules. In places, where septa have been broken, they appear to be thickest near the wall and that from there they gradually become thinner towards their inner edge. The principal septa, although thicker than the adjoining interseptal space, are rather thin. Without taking the granules into consideration, the septa of the third order are at the most as thick as the adjoining space. The septa are broadest at the level or slightly below the level of the calicular margin. The septa of higher order are similar to the principal septa in form and shape, but differ from them in being smaller in every way.

The pali in front of the principal septa have on the whole the form of flat lamellae, somewhat pointed at their upper ends, whence they are directed almost perpendicularly or more gradually into the interior of the calicle. The incision between these pali and the septa is not deep. The principal pali are often divided by incisions into two or three lappets. The part of the principal septa projecting above the upper end of the palus is about twice as long as the palus. The pali corresponding to the tertiaries are more divided into lappets than are the principal pali; otherwise they are similar to the latter. They reach to a higher level, so that the part of the septum above them is almost equal in height to the palus. The pali of the quaternaries again are about twice as high as the upper end of the septum; these pali are divided into about 5 or 6 lobes, the upper lobes being broader and the lower lobes either narrow or merely in the form of small columns. Further at the lower end of the pali of the third order, one or two of these small columns is present and there may also be one at the lower end of each of the principal pali. The quaternaries fuse with the tertiaries; in the majority below the point of fusion there are two more small columns. The septa of the fifth order are short and soon fuse with the quaternaries. Their edges are usually entire, but there may be one or two palus-like protrusions immediately in front of the place of fusion. When the septa of the fifth order are absent and those of the fourth are short, the latter are of a form resembling that which is otherwise characteristic of the fifth order.

The columella is oval, concave, and is formed by a number of small columns that are placed more or less closely together. These columns of the columella are exactly like the inferior pali and there is no limit between the columella and the crown of pali, so that the columella seems to be continuous with the septa of the third order.

The largest specimen of the collection is 26 mm. high ; the diameter of its pedicle is 7 mm.; the longer axis of the calicle is 19 and the shorter 13 mm.; the bottom of the calicle is 8 mm. below the upper edge of the septa in the shorter axis.

The general shape of the coral is extremely variable. Some specimens are rather slender with a long narrow pedicle, while others are almost cylindrical. The ribs, except near the calicular margin, may be hardly or not at all distinguishable. In other specimens the ribs extend as highly projecting ridges over the greater part of the outer surface and in these instances the alternation is very marked. The two axes of the calicle may be almost on the same level and the calicle may be almost round instead of oval. The septa are more or less exsert. The interior of the calicle shows a greater constancy.

Paracyathus pruinosus Alcock.

(Plate I, figs. 9, 11 ; Plate II, fig. 6.)

Paracyathus pruinosus, Alcock, 1902.

Saya de Malha, 150 fms., " Sealark ", 13 specimens.

Although differing somewhat in general form from Alcock's figure, I have no doubt that the specimens before me belong to this species. Alcock's specimens seem to be attached to a rather narrow base, from which they spread out gradually towards the calicular margin. I have only one specimen exhibiting a somewhat similar shape. The remainder expand from a stout pedicle which is attached by a broad, encrusting base ; the longer axis of their oval calicle is on a considerably lower plane than the shorter. Otherwise the specimens agree entirely with Alcock's description.

It is possible that *Paracyathus pruinosus* is synonymous with *P. porphyreus* Alcock (1893) ; further, Folkeson's description and figure of *P. porphyreus* are almost applicable to my specimens, but as I am not fully convinced, I prefer to identify the present specimens as *P. pruinosus*. It is possible that *P. lifuensis* Gardiner is a young specimen of *P. pruinosus*.

Paracyathus indicus Duncan.

(Plate I, fig. 8 ; Plate II, fig. 5.)

Paracyathus indicus, Duncan, 1886 ; Alcock, 1893.

17° 27′ N., 71° 41′ E., Arabian Sea, 56-58 fms., " Investigator ", 2 specimens.

Andamans, 53 fms., " Investigator ", 1 specimen.

With some hesitation I identify three specimens as belonging to this species. It is evident that my specimens are only young ones. Septa

of the fifth order are found only in one system of the largest specimen. In one specimen the costae are, as indicated in Duncan's description, small, nearly equal, rounded, barely projecting, and sparsely and minutely granular. In this specimen the costae extend over the whole outer surface of the corallum. In the second specimen the costae are visible as minute striae in the basal part. Nearer the calicle they project more, the alternation is distinct, and there are no granules. In the third specimen neither costae nor granules are visible in the lower part of the corallum, while near the calicle the costae project, alternate distinctly, and are sparsely covered with granules.

Over their whole extent the septa are thin, much thinner than the interseptal spaces adjoining them ; they are covered with pointed granules. According to Duncan the pali in front of the primaries and secondaries are small and one-lobed and those in front of the tertiaries resemble the outer papillae of the columella. In my specimens the single lobe in front of the principal septa also resembles a papilla of the columella, a fact which may be ascribed to the youth of my specimens.

Bathyactis symmetrica Moseley.

Bathyactis symmetrica, Moseley, 1881.

11° 16′ 30″ N., 92° 58′ E., Andaman Sea, 669 fms., " Investigator ", 1 specimen.

18° 18′ N., 93° 25′ E., Bay of Bengal, 843 fms., " Investigator ", 4 specimens.

Balanophyllia imperialis Kent.

Balanophyllia imperialis, Saville Kent, 1871 ; van der Horst, 1922.

6° 1′ N., 81° 16′ E., S. of Ceylon, 34 fms., " Investigator ", 15 specimens.

Balanophyllia affinis (Semper).

Balanophyllia affinis, van der Horst, 1926.

6° 1′ N., 81° 16′ E., S. of Ceylon, 34 fms., " Investigator ", 4 specimens.

15° 25′ N., 93° 45′ E., off C. Negrais, Burma, 40-49 fms., " Investigator ", 1 specimen.

Entrance to Palk Strait, 3 miles N. N. W of St. Pedro, 6-8 fms., " Investigator ", 1 specimen.

Balanophyllia bairdiana M.-Edw. et H.

(Plate I, fig. 10.)

Balanophyllia bairdiana, Moseley, 1881.

Puri Beach, " Investigator ", 7 specimens.

These 7 specimens are attached to a Gorgonid. Though their bases touch each other, they have not fused. They lack the fine teeth on the ribs, characteristic of typical *B. bairdiana.*

Balanophyllia parallela (Semper).

Balanophyllia parallela, van der Horst, 1922.

26° 22′ N., 56° 10′ E., Persian Gulf, 48-49 fms., " Investigator ", 2 specimens.
Palk Strait, " Investigator ", 1 specimen.
15° 25′ N., 93° 45′ E., off C. Negrais, Burma, 40-49 fms., " Investigator ", 2 specimens.

Balanophyllia cornu Moseley.

Balanophyllia cornu, Moseley, 1881.

Off Akyab, Arakan Coast, 17 fms., " Investigator ", 2 specimens.
26° 22′ N., 56° 10′ E., Persian Gulf, 48-49 fms., " Investigator ", 1 specimen.

Endopachys grayi M.-Edw. et H.

Endopachys grayi, Milne-Edwards et Haime, 1848 ; Semper 1872.

26° 22′ N., 56° 10′ E., Persian Gulf, 48-49 fms., " Investigator ", 10 specimens.

Stephanophyllia complicata Moseley.

Stephanophyllia complicata, Moseley, 1881.

Saya de Malha, 125 fms., " Sealark ", 2 specimens.

LITERATURE.

Alcock, A. (1893). On some newly-recorded corals from the Indian Seas. *Journ. Asiatic Soc. Bengal*, Vol. LXII.

Alcock, A. (1898). An account of the deep-sea Madreporaria collected by the Roy. Ind. Marine Surv. Steamer " Investigator " Calcutta.

Alcock, A. (1902). Report on the deep-sea Madreporaria of the Siboga-Expedition. *Siboga Exped.* Monogr. XVIa.

Döderlein, L. (1913). Die Steinkorallen aus dem Golf von Neapel. *Mitt. Zool. Stat. Neapel*, Bd. XXI.

Duncan, P. M. (1878). A description of the Madreporaria dredged up during the Expedition of H. M. S. " Porcupine " in 1869 and 1870, Part II. *Trans. Zool. Soc. Lond.* Vol. X.

Duncan, P. M. (1886). On the Madreporaria of the Mergui Archipelago. *Journ. Linn. Soc. Lond. Zool.* Vol. XXI.

Folkeson, F. (1919). Results of Dr. Mjobergs Swedish Scientific Expeditions to Australia 1910-13. XXII. Madreporaria. *Kungl. Svenska Vet. Ak. Handlingar*, Bd. LIX.

Gardiner, J. Stanley (1898). On the solitary corals, collected by Dr. A. Willey. *Willey's Zool. Res.* Part II.

Gardiner, J. Stanley (1904). The Turbinolid corals of South Africa. *Marine Invest. South Africa*, Vol. III.

Gravier, Ch. (1920). Madreporaires provenant des Campagnes des yachts " Princesse-Alice " et " Hirondelle II " *Res. Camp. Sc. Monaco*, Fasc. LV

Horst, C. J. van der. (1922). The Madreporaria of the Siboga-Expedition. Part III. Eupsammidae. *Siboga Exped.* Mongr. XVIc.

Horst, C. J. van der. (1926). Madreporaria, Eupsammidae. *Trans. Linn. Soc. Lond. Zool.* Vol. XIX.

Kent, W Saville (1871). On some new and little-known species of Madrepores, or stony corals, in the British Museum Collection. *Proc. Zool. Soc. Lond.* 1871.

Lacaze-Duthiers, H. de (1897). Fauna du Golfe du Lion. Coralliaires, Zoanthaires sclerodermes. *Arch. Zool. Exper. Gen.* 3e Ser. Tome V.

Lindstrom, G. (1877). Contributions to the Actionology of the Atlantic Ocean. *Kungl. Svenska Vet. Ak. Handlingar*, Bd. XIV

Marenzeller, E. von (1904). Steinkorallen. *Wiss. Ergebn. d. deutschen Tiefsee-Exped. "Valdivia."* Bd. VII.

Milne-Edwards, H. et Haime, Jules (1848). Monographie des Turbinolides. *Ann. Sc. Nat.* 3e Ser. Tome IX.

Milne-Edwards, H. et Haime, Jules (1857). Histoire naturelle des Coralliaires. Tome II. Paris.

Moseley, H. N. (1881). Report on the Corals. Part III. On the deep-sea Madreporaria. *Rep. Challenger Exped.* VII.

Pourtalès, L. F. de (1871). Deep-sea Corals. III. *Cat. Mus. Comp. Zool.*, Vol. IV

Semper, C. (1872). Ueber Generationswechsel bei Steinkorallen. *Zeits. Wiss. Zool.* Bd. XXII.

Vaughan, T. Wayland (1907). Recent Madreporaria of the Hawaiian Islands and Laysan. *Smith. Inst. Bull.* LIX.