ISRAEL SOUTH RED SEA EXPEDITION 1962, REPORTS
No. 21

ECHINODERMS FROM THE RED SEA, PART 2 (CRINOIDS, OPHIUROIDS, ECHINOIDS AND MORE ASTEROIDS)* **

by
AILSA M. CLARK
British Museum (Nat. Hist.)

The collections upon which this report is based were made in recent years at Eilat Israel, and at various localities in the southern part of the Red Sea. I am indebted to DR. STEINITZ of the Hebrew University, Jerusalem and MR. LEWINSOHN of Tel-Aviv University for the opportunity of studying this interesting material. No new species are included in the report but there are several records of species new to the Red Sea, as follows:

Choriaster granulatus LÜTKEN—previously known from Fiji, the Pelew (Palao) Islands, Celebes, the Philippines and Okinawa.
Paracrocnida persica MORTENSEN—known from the Persian Gulf.
Ophiactis carnea LJUNGMAN—known from South Africa and southern Arabia.
Placophiothrix proteus (KOEHLER)—known from the East Indies and the Arabian coast.
Ophiomastix pusilla BROCK—known from the East Indies.
Ophionereis porrecta LYMAN—known from the Seychelle and Amirante Islands, Mauritius, the Maldive Islands and further east.
Ophiopeza fallax PETERS—which is not in the present collection but was taken at Port Sudan by a recent Nottingham University Expedition—known from the Persian Gulf and East Africa.
Chaetodiadema granulatum MORTENSEN—known from the Maldive Islands and further east.
Salmaciella dussumieri erythacis (H. L. CLARK), here reduced to subspecific rank —known from off Cape Gardafui and further south, also in the British Museum collections from Mukalla on the south Arabian coast.

[In the headings to individual species which follow, some general works are given in full, in order not to overload the final list of *references* with titles having little to do with the Red Sea.]

CRINOIDEA

Capillaster multiradiatus (LINNAEUS)

Asterias multiradiata LINNAEUS, 1758, *Systema naturae*, ed. X: 663.

Received: September 1964.

* The paper by E. TORTONESE 1960, *Echinoderms from the Red Sea. I. Asteroidea*, is regarded as the first part of the study of our Echinoderm collection from the Red Sea (Editor).

** Aided by Contracts No. 62558-2985 and No. 62558-3335 between the U.S.A. Office of Naval Research, Department of the Navy, and Tel-Aviv University.

Capillaster multiradiata: A. H. CLARK, 1931: 173–209 pl.iii fig. 5, pl.xi fig. 30, pl.xiii fig.34, pl. xiv figs. 35, 36, pl. lxxxi figs. 222, 223; A. M. CLARK, 1952: 210. [Non *Comatula multiradiata*: AUDOUIN, 1826, which is *Heterometra savignii* (J. MÜLLER)].

MATERIAL. N.S. 813, N.S. 867, N.S. 906, N.S. 908, N.S. 912, E62/10202* (pt.), Eilat, 8 specimens; E58/248, Jebel Attair, South Red Sea 1 specimen. Known depth records 1–10m.

The Jebel Attair specimen is broken but the eight from Eilat have 37, 29, 28, 24 (possibly 26), 23, 20(?+), 20(?+) and 20 arms. The specimen from Dahab in the Gulf of Eilat (Aqaba), taken by the "Manihine" and recorded by me in 1952, has 36 arms. Of the 210 specimens enumerated by A. H. CLARK, only 10 have 30 or more arms, the maximum number being 43 in one from the Kei Islands. I can find no records of the species from the western half of the Indian Ocean.

Heterometra savignii (J. MÜLLER)

Comatula multiradiata: AUDOUIN in SAVIGNY, 1826: 205 pl. i. fig. 1, [Non *Asterias multiradiata* LINNAEUS].

Alecto savignii J. MÜLLER, 1841, *Mber. Akad. wiss. Berl.*, **1841**: 185.

Antedon savignyi: CHADWICK, 1908: 47.

Heterometra savignyi: TORTONESE, 1936: 209; GISLÉN, 1940: 110–111.

Heterometra savignii: A. H. CLARK, 1941: 235–241 pl. xxi figs, 82–84, pl. xxii figs. 85–88.

MATERIAL. — N.S. 899, N.S. 900a, N.S. 901, N.S. 904, E60/62.15, E62/10202* (pt.) and E62/10213* (pt.), Eilat, 7 specimens; E58/198, and E58/254, Jebel Attair, South Red Sea, 4 specimens. Known depth records 0.5–30m.

Three of these specimens, one from Eilat and two from Jebel Attair (E58/198 and E58/251) are unusual in having only ten arms though in the one from Eilat the arms exceed 100mm in length. The usual number for adults of the species is twenty.

Another difference from the descriptions given in A. H. CLARK's monograph (1941) is that there *is* a short crest on the basal segments of the first two or three pinnules, running along the side towards the arm tip and usually extending from segments two to four of P_1 but sometimes also involving segments one, five and six much as described in the holotype of *H. atra*, also from the Red Sea. This is true not only of specimens of this collection but also of others in the British Museum collections including two from the Gulf of Suez collected by MCANDREW and examined at one time by AUSTIN CLARK himself. As a result of the presence of these crests, relatively inconspicuous though they are, all these specimens run down to *H. africana* in the keys given in A. H. CLARK's monograph, being precluded from *H. atra* by the proportions of the cirrus segments, the longer ones being half again as long as broad, not broader than long.

* Collected by J. H. STOCK

Since few published details on the variation of this species exist, the following table is included here.

Specimen No.	Locality	No. of arms	Arm length (mm)	Arm breadth (mm)*	Maximum cirrus segments	P_1 Segs	P_2 Segs	P_3 Segs
E58/254(pt.)	Jebel Attair	14	c.55	1.2	—	—	—	18
E58/254(pt.)	" "	11	—	1.3	28	24	22	c.18
E58/251	" "	10	c.70	1.4	30	24	25	21
E58/198	" "	10	c.90	1.5	—	23	21	19
69.7.8.29(pt.)BM	Suez	19(?20)	50+	1.6	30	c.24	—	—
69.7.8.29(pt.)BM	"	19	70+	1.7	25+	22	—	—
1951.5.7.19 BM	Sudan	12+(?20)	—	1.7	29	30	—	—
E60/62.15	Eilat	10	c.120	1.85	26+	21	—	—
E62/10202	"	20	—	—	33	32	23	21
N.S.900a	"	20(?+)	120	1.9	37	26	23	20
N.S.899	"	19	180	2.0	34	28	34	35
N.S.904a	"	19	140+	2.1	35	27	24	24
N.S.901	"	20	160	2.2	37	32	34	31

* The arm breadth is taken at segments 3 + 4 on arms arising from a IIBr division series except where there are only ten arms. Unfortunately I omitted to measure the arms of the 20-armed Eilat specimen before returning it to DR. STOCK.

The longest segments of the peripheral cirri (usually the seventh or eighth) have the ratio of length: median breadth c. 1.5: 1. Up to about 24 of the distal segments have a sharp dorsal spine, abruptly lacking on about the twelfth segment and those proximal to it. In the smaller specimens the cirri number only about XV and form a single staggered row round the centrodorsal.

The 11-armed specimen from Jebel Attair has the single IIBr series consisting of only two ossicles rather than the usual four; also one of the B.M. specimens from Suez has two corresponding IIBr series each of two ossicles although all the seven other such series consist of four.

P_2 is consistently stouter than P_1 and tapers evenly from the base whereas P_1 tapers very rapidly along the basal crested segments and the rest of it is attenuated or even whip-like, this being particularly true of no. E60/62.15. P_3 may be similar to P_2 or slightly smaller. In the 20-armed Eilat specimen (E62/10202) P_1, P_2 and P_3 (also the preceding P_D) all measure 16mm. in length but in most of the other specimens P_1 is shorter than the next two.

GISLÉN (1940) has recorded as *H. savignii* some specimens from the Persian Gulf with 'almost smooth proximal pinnules'. He clearly suspected that some of the nominal species of *Heterometra* distinguished by A. H. CLARK and originating from the western half of the Indian Ocean will prove to be synonyms. I think that the morphological as well as geographical limits between *savignii* and *africana* (which

has been recorded from Kenya and Zanzibar on the one side and Karachi on the other) would repay study, since the occurrence of basal crests on the proximal pinnules is not diagnostic, though admittedly in the type specimen of *H. africana* the crest extends from the second to about the tenth of the 29 segments, rather than for only three or four segments.

A. H. Clark in his monograph reproduced several descriptions of the type material of *H. savignii* but none of them are very satisfactory. The type in the Berlin Museum, together with that of *H. atra* (originally described under the name of *Craspedometra ater* without any reference to *Heterometra savignii* by A. H. Clark) would repay re-examination. The occurrence of slight pinnule crests in the present specimens while their cirrus segments appear to have the proportions more characteristic of *savignii* suggests that in the description of the cirri in the holotype of *H. atra* the wording 'half again as long as broad' was reversed to 'as broad as long'. However, *H. atra* also appears to differ in having P_2 very much smaller than P_3, not similar in size.

Lamprometra klunzingeri (HARTLAUB)

Antedon klunzingeri HARTLAUB, 1890, *Nacht. Ges. Wiss., Göttingen*, **5**: 175.

Antedon imparipinna: CHADWICK, 1908: 46 [Non *A. imparipinna* P.H. CARPENTER, 1882].

Lamprometra palmata: MORTENSEN, 1926: 127 [Non *L. palmata* (J. MÜLLER), 1841].

Lamprometra klunzingeri: A. H. CLARK, 1937: 89; GISLÉN, 1940: 111; A. H. CLARK, 1941: 527–536, pl. lv fig. 256; TORTONESE, 1953: 26–27 pl. i fig. 1.

MATERIAL.—NS. 812, NS. 866, NS. 868, NS. 869, NS. 870, NS. 914, E62/10212*, E62/10213*(pt.), E62/10214*, also FISHELSON collection, Eilat, 16 specimens; E62/3020, E62/3021, E62/3022, Nocra, Eritrea, 3 specimens; E62/1894, Entedebir, Eritrea, 1 specimen. Known depth records 0.5–1.5m.

Three of the specimens from Mr. FISHELSON were sent to me as albinos and were of particular interest as bearers of albino myzostomes. Mr. FISHELSON said that they were the only pale crinoids he had seen at Eilat. However, another specimen from Eilat (collected by DR. STOCK) was yellowish in life while three others were banded alternately brown and yellowish and one only was uniformly dark. No colour notes were supplied for the Eritrean specimens, but TORTONESE (1953) recorded a similar range of colour in his specimens from Nocra.

There appears to be some difference in the proximal pinnules between the Eilat specimens as opposed to those from Eritrea. The latter have relatively longer pinnules with slightly rugose surfaces, not smooth and shiny like the Eilat specimens. The number of segments in P_1 and P_2 is 27 in the specimen from Entedebir and 31 and 35 in one from Nocra but only 21 in a specimen from Eilat (N.S. 812). Some specimens in the British Museum collection from Muscat in the Gulf of Oman have relatively long proximal pinnules like the Eritrean ones but their surface texture is smoother. Still others, from Ibn Abbas Island in the Sudanese Red Sea, have sharp

* Collected by J. H. STOCK

crests on segments two to four or five of the proximal pinnules, much as in *Lamprometra palmata gyges*, known primarily from Australian waters. The proximal pinnules are also extraordinarily variable in the closely related *palmata*, of which *klunzingeri* might be more correctly ranked as a subspecies comparable to *L. palmata gyges*.

Lamprometra klunzingeri and *Heterometra savignii* have the first three pinnules of similar relative proportions, P_1 being more slender and usually also shorter than P_2 and P_3. The two species are most easily distinguished by the shorter second division series (IIBr) in *L. klunzingeri* with only two ossicles developed, though, as pointed out under *H. savignii*, that species may also have occasional IIBr series of two rather than four ossicles. Other differences include the more numerous cirrus segments with sharper dorsal spines of *H. savignii* and the rounded cross-section of its division series, lacking the ventro-lateral flanges commonly shown by *Lamprometra klunzingeri*.

Oligometra serripinna (P. H. CARPENTER)

Antedon serripinna P. H. CARPENTER, 1881: 182.

Oligometra serripinna: A. H. CLARK, 1947: 217–246, pls.

MATERIAL. N.S. 903(pt.), 907, 910(pt.) and 910b, 911 and 913(pt.), Eilat, 7 specimens. Known depth records 25–40m.

Several of these specimens were mixed with others of *Decametra chadwicki*, with which *O. serripinna* can easily be confused. The two species can be distinguished by the relatively shorter cirri of *O. serripinna*, which are wide and flat on the dorsal (incurled) side with curved transverse ridges, sometimes resolved into a pair of small blunt tubercles (when a few segments may also have a third, median, tubercle), rather than the distinctly separate and sharp paired dorsal spines regularly found on the laterally compressed and more slender cirri of *D. chadwicki*. Also the proximal pinnules of *D. chadwicki* are much more slender, their segments being distinctly longer than wide, compared with the stouter, strongly serrated and prismatic pinnules, especially P_2, of *O. serripinna*. In *D. chadwicki* P_2 and the following pinnules have a more or less well-developed dorsal crest and the distal ends of the segments are somewhat flared and spinous, but the resulting profile is never so saw-like as that of the comparable pinnules in *O. serripinna*. Thirdly, there is a marked difference in the occurrence of P_a, the pinnule on the inner side of the fourth brachial. In *Oligometra* this is present on most or all of the arms, whereas in *Decametra* it is frequently absent altogether. However, at least two of the Eilat specimens otherwise identifiable as *Decametra chadwicki* have more arms with a P_a than without.

A. H. CLARK distinguishes a number of varieties of *Oligometra serripinna*, recording two of them—var. *electrae* and var. *occidentalis* from the Red Sea. The former has 'extravagently developed processes' on the proximal pinnules whereas in the latter the profile of P_2 is 'scarcely serrate'. The Eilat specimens are sufficiently variable in the form of P_2 to leave me dubious as to the value of these varieties.

Decametra chadwicki (A. H. CLARK)

Antedon serripinna: CHADWICK, 1908: 44 [Non *A. serripinna* P. H. CARPENTER, 1881].
Colobometra chadwicki A. H. CLARK, 1911: 30–31.
?*Decametra mollis*: TORTONESE, 1936: 209–210 [Non *D. mollis* (A. H. CLARK), 1912].
Decametra chadwicki: A. H. CLARK, 1937: 100; 1947: 176–178, pl. xxvi, figs. 139, 140.
MATERIAL. N.S. 897, 898, 900, 903(pt.) and 903b, 904c, 905a, 909(pt.), 910(pt.) and 913(pt.), Eilat, 26 specimens. Known depth records 15–40m.

This species was previously known only from the holotype, taken at Suez and housed in the U.S. National Museum. It is therefore worthwhile including here some descriptive remarks and a table of numerical details to indicate the range of variation and for comparison with the closely-related species *Decametra arabica* A. H. CLARK and *D. mollis* (A. H. CLARK) besides *Oligometra serripinna* (P. H. CARPENTER), which was taken at Eilat together with *D. chadwicki* and is easily confused with it. Also included in the table are similar details of *Colobometra arabica* and of the single specimen which I can name only 'Colobometrid sp.', also collected at Eilat.

The specimens dealt with in the table are respectively:—the holotype of *Decametra chadwicki* from Suez (as described by A. H. CLARK); 14 specimens of *chadwicki* from Eilat; the holotype of *D. mollis* from Karachi (as described by A. H. C.); the holotype of *D. arabica* from Muscat: 12 paratypes of *arabica*; 6 specimens of *arabica* from Karachi (mentioned under the name of *D. mollis* in A. H. CLARK's monograph); 4 specimens of *Oligometra serripinna* from Eilat; the unnamed Colobometrid from Eilat; the holotype of *Colobometra arabica* from the southern tip of the Red Sea and the two specimens of *C. arabica* from Eilat.

The paired dorsal tubercles or spines on the cirrus segments in *D. chadwicki* first appear at the sixth or seventh segment. They are sharp and distinctly separated, giving way to a single median spine for rarely more than one segment before the penultimate one. Sometimes the middle segments have two spines each side, the four forming an arc, or else there may be a median spine between the two usual ones. Although in profile the longer segments appear distinctly longer than wide, if the height of the spine is included in the width then this just exceeds the length. For instance, the eight segment of one mature cirrus has length: median width (including the dorsal spine) 12:13 but without the spine the ratio is 12:11; similarly the ratio in the distal segments of the same cirrus is 10:13 or 10:10, with and without the height of the spine. In another specimen the distal segments have length: width 13:14 or 13:11.5. [The numbers are the scale units of my micrometer eyepiece, of which 19 = 1 mm].

The colour in spirit may be purple all over or banded with yellow, the bands either corresponding to single segments or to several consecutive ones in different specimens.

From the figures given in the table, the range in maximum number of segments of mature cirri in *D. chadwicki* of arm length > 70mm. is 22–26, whereas in *D. arabica* of this size it is 21–28 segments (in fact an immature regenerating cirrus in one of the Eilat specimens of *chadwicki* has as many as 29 segments). There is thus

Arm length (mm)	Br at 3 + 4 (mm)	Cirri No.	Cirri Segs.	Cirri Length (mm)	P_1 Segs.	P_1 Length (mm)	P_2 Segs.	P_2 Length (mm)	P_3 Segs.	P_3 Length (mm)
Decametra chadwicki										
90	—	XVI	22–24	12–14	16	7.5–8.0	20, 21	13.0	15	7.5
c.75	1.0	XIV	19–22	11	14	3.5	15	8.0	12	5.5
c.90	1.15	XVII	25	13.5	15	5.0	20	9.5	15	6.5
110	1.15	XIV	25, 26	13–14	15	5.0	17	8.0	16	6.0
65+	1.2	XV	21, 22	12	14	4.5	16	6.5	13	5.5
100	1.2	XVII	21, 22	9.5	15	6.0	22	12.0	18	9.0
110	1.2	XV	24	12	19	7.5	19	9.5	18	7.0
110	1.2	XVIII	23	13	18	7.0	18	9.0	16	7.0
125	1.2	XIII	22	11.5	17	6.5	22	14.0	18	7.0
90	1.25	XIV	22, 23	13	15	5.5	18	8.0	—	—
100	1.25	XV	23–25	14.5	17	7.0	18	9.0	17	7.0
110	1.25	XIX	20–22	11–12	14	5.0	19	9.5	14	5.5
80	1.3	XVII	24, 25	16	16, 17	6.5	19	11.0	14, 15	6.0
120	1.3	XV	21–23	12–13	15	5.5	17	9.0	14	7.0
120	1.4	XVI	25	15	14	4.5	21	11.0	20	8.0
Decametra mollis										
65	—	XX	20–22	10	14	4.0	17	13.0	15	6.0
Decametra arabica										
c.110	1.4	XXII	25–27	13	15	5.5	17	8.5	14	6.0
c.50?	1.1	XVII	18–21	8	10–12	3.0–4.0	14	6.0–6.5	11	3.5–4.0
75	1.15	XIX	22, 23	12	—	—	—	—	15, 16	6.5–7.5
80	1.25	XXII	20–23	11	15	5.0	15	7.0	14	6.0
c.80	1.3	XXI	25–27	12.5	13	5.0	15	6.0	13	5.5
c.80	1.3	XXI	21–25	12	—	—	—	—	—	—
100	1.25	XXII	23–27	11	14	5.5	17	8.0	16	7.0
c.100	1.25	XXII	25–27	12	13–15	5.0–5.5	18	10.5	—	—
c.80	1.4	XXI	25–27	11	14	5.0	16	8.0	16	7.0
100	1.4	XXI	20–25	12.5	15	5.5–6.0	15–17	5.5–7.5	14–16	5.0–6.0
105	1.5	XXII	26, 27	13	14, 15	5.5–6.0	15, 16	7.0–9.0	14, 15	5.5–6.5
100	1.4	XXI	20–25	12.5	15	5.5–6.0	15–17	5.5–7.5	14–16	5.0–6.5
130	1.5	XXI	26–28	14.5	15	5.5	17	8.0	14	5.0
c.60	1.25	XVII	21–23	10	13	4.0	14–16	6.5	14	4.0
c.60	1.25	XVII	19, 20	9	12	4.0	12	5.0	11	4.0
70	1.25	XIX	20, 21	9.5	14	4.5	16	7.0	14	5.0
70	1.25	XX	22–24	11	12–14	4.0–4.5	13, 14	5.5–6.5	12	4.0–4.5
75	1.25	XVII	23–25	11.5	13	4.0	14	5.5	13	4.0
65	1.3	XIX	22–24	11.5	14, 15	4.5	15–17	7.0–7.5	12–14	4.0–5.0
Oligometra serripinna										
c.70	1.3	XIX	16–20	9.0	15	5.5	16	8.0	15	5.0
110	1.3	XX	19	8.5	15	5.0	13	5.0	15	5.0
110	1.3	XV	18	9.5	14–16	4.5–5.0	15–18	6.0–7.0	13–15	4.5–5.0
120	1.5	XIV	17, 18	10.5	—	—	—	—	—	—
Colobometrid sp.										
95	1.15	XV	20, 21	12	12	4.5	15–17	7.0–8.0	14	6.0–6.5
Colobometra arabica										
—	1.5	XXII	36–41	22.5	15, 16	5.5	—	—	—	—
c.140	1.8	XXII	44–48	40	18, 19	7.5–8.0	20–22	17.5–18.0	17	14.0–15.0
c.150	1.75	XIX	42–45	33	17	9.0	c.20	15.0	15	13.0

some overlap in the segment number so that A. H. CLARK's division of the species of *Decametra* by the presence of more or fewer than 25 segments is not satisfactory.

Secondly, the relative length of the first two pinnules varies to a considerable extent on either side of the ratio of P_1: P_2 = 1:1.6 found in the holotype of *D. chadwicki*. In the fourteen Eilat specimens given in the table it ranges from 1:1.3 to 1:2.3 with a mean of 1:1.8. Also in one individual it may show considerable variation, the fourth Eilat specimen having alternative measurements for P_1 and P_2 of 7.0 and 11.0 mm (the latter correlated with a segment number of 22) rather than the 7.5 and 9.5mm given in the table, yielding a ratio of 1:1.6 rather than 1:1.3. Similarly the size of P_3 relative to P_1 varies from 1:0.9 to 1:1.6, though the latter figure applies only to the smallest specimen; the mean is 1:1.2.

In the material of *D. arabica* the ratio of P_1:P_2 = 1:1.1–1:2.0 with a mean of 1:1.5.

Clearly then, neither the number of cirrus segments nor the proportions of the proximal pinnules can be used to distinguish between *D. chadwicki* and *arabica*. However, the number of cirri, XIII–XIX with a mean of between XV and XVI in *chadwicki*, compares with XVII–XXII, with a mean of XX (probably lower than the true value for adults owing to the smaller size of some specimens) in *arabica* and may provide a valid distinction.

Unfortunately there are sometimes discrepancies between my counts of cirri and those of AUSTIN H. CLARK after examination of the same specimen, mine being usually somewhat higher. For instance, his estimate in the Karachi specimens of *D. arabica* (mentioned by him under the name of *D. mollis*) was XII–XV, whereas I found XVII–XX. I think that he can have counted only the mature cirri actually present, whereas I include the perforated sockets from which cirri have only recently been lost as well as making allowance for regenerating and immature cirri, adding two or three of the latter together according to size to make the equivalent of one mature cirrus.

As for the Karachi specimens, these were labelled as '*Decametra arabica* ???' before I came to the museum; there is no clue to whether or not A. H. CLARK was responsible for this and had second thoughts based on their origin at the type-locality of *D. mollis* before publication of his monograph. Since none of them have P_2 approaching the relatively large size of that of the type of *D. mollis* I am inclined to leave them under the name of *arabica*. TORTONESE (1936) has referred a specimen from Suez to *D. mollis* and likewise GISLÉN (1940) 51 others from the Persian Gulf (nearer the type-locality of *D. arabica*). GISLÉN remarked only that his specimens agreed with the description of the holotype of *D. mollis* but TORTONESE gave some details of his specimen, which evidently had XX cirri with 20 segments and the arms distinctly carinate basally (a feature not noticeable in the Eilat specimens), agreeing in these points with the holotype of *D. mollis* rather than with the available details for either *chadwicki* or *arabica*.

A proper survey of these and related nominal species of *Decametra* will have to await another occasion when more material is available from other parts of the western Indian Ocean.

Colobometra arabica A. H. CLARK

Colobometra arabica A. H. CLARK, 1937:89 pl. i fig. 2; 1947:132–133 pl. xxx fig. 161

MATERIAL. N.S. 897, 45 meters, N.S. 915, Eilat, 2 specimens. Known depth records 25–30 m.

Some numerical details of these specimens together with those of the holotype are given in the table under the heading of *Decametra chadwicki*. The colour of these specimens (in spirit) is almost uniformly purple whereas the type, from Eritrea, is banded purple and white but predominantly pale.

A. H. CLARK's description of the holotype was very brief; he gives P_1 as 5 mm long with 14 or 15 segments and P_2 8.5 mm long with 14 segments. However, there is an abrupt reduction in size due to regeneration from about the sixth segment in the few remaining apparently intact P_2s and P_3s, which explains the apparent discrepancy in relative proportions between the proximal pinnules of the type and these two Eilat specimens.

The proportions of the cirrus segments and development of the paired dorsal spines are similar in all three specimens. In one from Eilat, the longest cirrus segment, the seventh, has length: median breadth 1.2: 0.85 mm and the antepenultimate segment is 0.55:0.58, this width being without the dorsal spine which adds another 0.16 mm to the width. The longer proximal cirrus segments are slightly but abruptly flared into a finely spinous frill at their distal ends; the paired dorsal spines develop from about the twelfth segment. P_1 is smooth for its whole length and tapers more abruptly proximally than distally. P_2 is slightly carinate from the third to seventh segments with frills of very fine slender spinelets at the distal ends from the fourth segment onwards; it is much stouter than P_1. P_3 is similar to P_2 but slightly smaller.

Colobometrid sp.

MATERIAL. N. S. 909(pt.), Eilat, 1 specimen. 40 m.

This specimen was collected with one of *Decametra chadwicki*. Some numerical details of it are given in the table under the heading of that species. It can be seen from this that the proportions of the proximal pinnules are not unlike those of *D. chadwicki* and P_2 similarly has the distal ends of the segments moderately flared and spinous; also P_a is present only on one arm, a deficiency common in *Decametra*. The ten arms are smooth as in *Decametra* as opposed to *Colobometra*. The main difference lies in the cirri which have very different dorsal processes to those of *D. chadwicki*, so much so that I am not entirely certain that the specimen is referable to the family Colobometridae, characterised by the presence of paired dorsal spines or a transverse ridge on many of the cirrus segments. Whereas the specimens of *D. chadwicki* from Eilat rarely have more than one of the distal cirrus segments with a single median spine replacing the paired ones, this specimen has median processes from about the eighth or ninth segment. The first three segments are smooth dorsally but the fourth has a crescentic transverse ridge near the distal end; on the fifth segment this has given way to three small pointed tubercles, the median one more proximal in

position than the two lateral ones, sometimes with a fourth small tubercle even further proximal to it. On the sixth segment these four tubercles, arranged as it were at the tips and centre of a distally-facing Y, are well-developed but on the seventh segment the two median ones have been replaced by a continuous longitudinal ridge and the two latero-distal tubercles are smaller. The eighth to tenth segments have only a median ridge, which becomes progressively shorter so that the eleventh to eighteenth or ninteenth segments have only a single median sharp spine, triangular in side view. On some cirri the sequence of modification of the processes varies slightly or several of the middle segments may have a Y-shaped elevation.

None of the cirrus segments are conspicuously longer than wide; in side view the longer ones, about the eighth to tenth, have the ratio of length: width 13:14 including the height of the median dorsal ridge or 13:12 without it.

The opposing spine is large and conical and the terminal claw fairly sharp.

The fact that the dorsal processes begin as a transverse ridge and paired tubercles, even if these are very transitory, suggests that this specimen is referable to the Colobometridae, some species of which, unlike *Decametra chadwicki*, have only a few more proximal cirrus segments with the paired tubercles or transverse ridge characteristic of the family. Possibly the specimen can be referred to the widely-distributed *Cyllometra manca*, of which about 20% of individuals similarly have only ten arms. However, the westernmost record of *C. manca* is from the Persian Gulf; also the cirri of the only specimens in the British Museum collections lack the proximal extension of the dorsal processes on the earlier segments, though similarly the paired tubercles quickly give way to single median spines.

ASTEROIDEA

Leiaster leachi (GRAY)

Ophidiaster leachii GRAY, 1840, *Ann. Mag. nat. Hist.* 6: 284.
Leiaster glaber PETERS, 1852:177.
Leiaster leachii: de LORIOL, 1885: 40-43 pl. xiv figs. 1, 2; H. L. CLARK, 1921: 73-74; HAYASHI, 1938, *Bull. Biogeogr. Soc. Japan* 8:211–213, pl. ii fig. 6; H. L. CLARK, 1946, *Publ. Carneg. Instn.* 566 : 119; TORTONESE, 1953: 29-30 pl. i fig. 3; 1960: 20.
Leiaster speciosus: SLADEN, 1889, Asteroidea, *Rep. Sci. Res. Challenger, Zool.* 30:408 [?Non *L. speciosus* VON MARTENS, 1867].

MATERIAL. E55/224c, Eilat, 1 specimen.

This specimen does not run down at all in H. L. CLARK's key to the species of *Leiaster* (1921, p.72) since it has both *three* groove-less furrow spines on most adambulacral plates and possesses pedicellariae, a combination matching none of the species as dealt with in the key. This emphasises the unreliability of using occurrence of pedicellariae as diagnostic of species. In the same key, *L. leachi* (previously generally spelled with a superfluous second 'i') is distinguished as having only two furrow spines. Nevertheless I think it advisable to designate the present specimen by this name until more material is forthcoming, both from the Red Sea and from the type locality of *L. leachi*–Mauritius.

Some characteristics of the specimens available to me or recorded in print are given in the following table, the first one being the holotype.

Specimen No.	Locality	R	r	br	R/br	Furrow spines	Pedicellariae
1938.6.23.33	Mauritius	200–225	18	19	11.2/1	2(3)*	—
85.2.25.9	"	170–180	14	15	11.6	(2)3	—
de LORIOL's	"	135–147	12	15	9.4	2(3)	—
H. L. CLARK's	"	225	—	c.21	10.7	2(3)	(+)
1957.6.21.3.	Maldive Is.	85	9	9	9.4	2	(+)
61.4.5.10.	Red Sea †	130	c. 11	c.12	11.0	3,2	+
E55/224c	Eilat	92	11	12	7.7	3(2)	+
TORTONESE's	Nocra	65	c. 7	—	—	2,3	+
90.5.7.621	Fiji	c.175	15	15	11.6	2	(+)

* Figures or symbols in brackets indicate occasional occurrence.
† This is from the CUMING collection and the locality might be a mistake for the Philippines.

If the number of furrow spines, predominantly either two or three, is a reliable character, as the very sparse information available suggests, then the specimens from the Red Sea should be distinguished, perhaps as a separate subspecies of *L. leachi*, comparable to FISHER's subsp. *hawaiiensis*, which similarly has three furrow spines and usually pedicellariae present. Further material is needed for a true appreciation of the variation in furrow spine number. Although de LORIOL states that specimens from Mauritius have no pedicellariae (and indeed I can find none in the two such specimens available to me), H. L. CLARK (1921) found a few in a very large specimen from Mauritius belonging to the South African Museum. When the skin is very thick specimens may need partial drying or treatment with a bleach or clearing agent to reveal the presence of pedicellariae, which would otherwise be concealed.

H. L. CLARK (1921) notes that *Leiaster leachi* and *speciosus* VON MARTENS, 1867, are closely related but distinguishes them by the stouter rays and pedicellariae of the latter (despite having just noted an example of *leachi* from the type locality which did have pedicellariae). The 'Challenger' specimen from Fiji which SLADEN identified as *L. speciosus* has a few pedicellariae but its arms are relatively narrow. I cannot distinguish it specifically from the holotype of *L. leachi* and agree with DÖDERLEIN (1926), HAYASHI (1938) and TORTONESE (1953) who think that *speciosus* will probably prove to be a synonym. This must await reexamination of the holotype (from Flores in the East Indies). In 1946 H. L. CLARK distinguished the two only by colour, giving *speciosus* as 'uniformly crimson' and *leachi* as 'variegated orange-yellow and bright red, with or without magenta'.

A specimen in the British Museum collections from the Amirante Islands (mid-way between Mauritius and the Gulf of Aden) formerly labelled *Leiaster leachi* unfortunately proved to be in fact *L. coriaceus* PETERS, having the 3 (sometimes 4) furrow spines grooved longitudinally, the skin thin enough to show the pedicellariae without special treatment, and no trace of the 'Krystallkörper' on the central parts of the

skeletal plates when de-nuded, these last giving a granular texture to the plates and being found in all the specimens of *L. leachi* which I have examined.

Fromia ghardaqana MORTENSEN

Fromia monilis: TORTONESE, 1936: 213–214 [Non *F. monilis* PERRIER, 1875].
Fromia ghardaqana MORTENSEN, 1938, *K. Danske Vidensk. Selsk. Skr.*7(3): 37; A. M. CLARK, 1952: 205–206, pl. xxxi, figs.a–c; TORTONESE, 1953: 27–28; 1960: 18–19.
MATERIAL. E51/50, E55/388d, E55/528b, E55/797a, E59/159, Eilat, 7 specimens; E62/1893, Entedebir, 1 specimen; E62/1957, Nocra, 1 specimen; E62/2000, Cundabilu, 1 specimen; E62/2250, Um Aabak, 1 specimen.

Although in 1952 I found the maximum value of R/r in examples of this species from the Gulf of Aqaba to be about 4.0/1 TORTONESE (1953) found this to be nearer the mean for specimens from Nocra, which ranged from 3.7 to 4.5/1. In the two specimens from Cundabilu and Entedebir in the present collection, the arms are relatively longer still with ratios of 4.8 and 5.0/1 respectively, the latter being the largest specimen, R 50mm. The mean of the nine specimens having R over 20mm is 4.25/1.

Choriaster granulatus LÜTKEN

Choriaster granulatus LÜTKEN, 1869, *Museum Godeffroy*, Hamburg: Catalog IV: xxxv; GOTO, 1914, *J. Coll. Sci. Tokyo Imp. Univ.* **29**:604–610, pl. xvii, fig. 263, pl. xviii, figs. 264–269; FISHER, 1919, *Bull. U.S. nat. Mus.* **100** (3): 367; DOMANTAY & ROXAS 1938, *Philipp. J. Sci.* **65**: 217, pl. xv, figs. 86,87.
MATERIAL. NS. 872, Eilat (collected by D. FRIEDMAN), 1 specimen. 20m.

The discovery of this specimen extends the known range of *Choriaster granulatus* right across the Indian Ocean. The previous localities from which the rather sparse material originated are Viti in the Fiji Islands, the Pelew (Palao) Islands, Celebes in the Moluccas, Puerto Galera and Zamboanga in the Philippines and Okinawa in the Riu-Kiu Islands. Fisher mentions a record from New Zealand but I have been unable to trace this.

The Eilat specimen has been dried and is somewhat distorted. The limits of its papular areas do not show up as well as in the three spirit specimens in the British Museum collections, one of which originated from the Godeffroy Museum in 1869 and was probably seen by LÜTKEN. I can find no significant differences not attributable to the dried condition.

Asteropsis carinifera (LAMARCK)

Asterias carinifera LAMARCK, 1816, **2**: 556.
Asterope carinifera: MÜLLER and TROSCHEL, April 1840, *Mber. Akad. wiss. Berl.* **1840**: 104; H. L. CLARK, 1921: 33, pl. v, fig. 2.
Asteropsis carinifera: MÜLLER and TROSCHEL, September 1840, *Arch. Naturgesch.* **6**: 322; 1842: 63.
Gymnasteria inermis and *spinosa* GRAY, December 1840, *Ann. Mag. nat. Hist.* **6**: 278.
Gymnasteria carinifera: DE LORIOL, 1885: 67–69, pl. xx, figs. 7–10; LEIPOLDT, 1895: 649–651, pl. xxxii, fig. 13.

Pentaceraster mammillatus (part): TORTONESE, 1960: 17–18, figs. A,B.

MATERIAL. E55/120a, E55/224b, E55/800, E60/49, N.S. 807, Eilat, 7 specimens; E62/2257, E62/10074, E62/10161, Um Aabak, 4 specimens; E62/3032, Nocra, 3 specimens. Known depth records 0.5–1.5m.

As SLADEN (1889) and FISHER (1911) have pointed out, MÜLLER and TROSCHEL's unexplained emendment of the generic name *Asterope* to *Asteropsis* in the second version of their 1840 paper may have been evoked by the preoccupation of the first name for a crustacean by PHILIPPI, also in 1840, but FISHER showed that PHILIPPI's paper is of later date than April of that year. However, *Asterope* MÜLLER and TROSCHEL is definitely antedated by *Asterope* HÜBNER, 1819 (a Lepidopteran). I am indebted to Mr. HURWORTH, formerly of the Department of Entomology of this museum, for notice of this fact, which necessitates a reversion to *Asteropsis*, disused since 1911.

The two specimens (E55/224b and E55/750) from Eilat illustrated by TORTONESE (1960) under the name of *Pentaceraster mammillatus* appeared to me to have enlarged marginal spines very like those of *Asteropsis carinifera*, as Professor TORTONESE himself noted. Fortunately, the British Museum collection includes samples of *P. mammillatus* of considerable size range, the smallest ones comparable in size to the two from Eilat (R 36 and 45 mm), which have been lent to me by Dr. STEINITZ together with the much larger specimen, E?/9, also from Eilat, collector unknown. A comparison between the smaller specimens has convinced me that the two from Eilat should be referred to *A. carinifera*. The granular appearance of their plates is exaggerated by their dried condition, which allows the 'krystallkorper' embedded in the surface of the plates to stand out in relief through the rather thick skin, normally smooth in wet specimens. However, direct comparison shows that the granulation of young *Pentaceraster* is far more coarse and superficial and there are a number of wide bi-valved pedicellariae among the granules, such as are not found in either the two from Eilat or other specimens of *Asteropsis*, where the pedicellariae are all of the narrow forceps type. The marginal tubercles of *Pentaceraster* at this size are much less prominent than in adults and also the subambulacral spines number two, at least proximally, and the furrow spines about seven, rather than one and four respectively, as in the Eilat specimens, or one and five in larger specimens of *Asteropsis*. Professor TORTONESE's large specimen, E?/9, is an undoubted *P. mammillatus*. On a recent visit to the British Museum he examined the specimens here and agreed with my conclusions; his own studies had been handicapped by the lack of small examples of *mammillatus* for comparison.

Other Asteroid records:

Astropecten polyacanthus MÜLLER & TROSCHEL

E55/639, E55/960e, E55/960f, E60/62,13, Eilat, 9 specimens; E58/35, E58/52, E58/92, E58/101, Jebel Attair, 13 specimens. One depth record, 60m.

Astropecten hemprichi MÜLLER & TROSCHEL

E?/231 (pt.), South Red Sea, 1 specimen.

Astropecten sp. indet.

E57/549, North Massawa, 1 specimen; E57/649,2, Massawa, 1 specimen. One depth record, 70m.

Stellasteropsis fouadi DOLLFUS

E?/231 (pt.), South Red Sea, 1 specimen.

Stellaster equestris (RETZIUS)

E57/458, E57/548, North Massawa, 4 specimens; E58/67, Dvu-l-kurush, 2 specimens. Known depth records 58 – 72m.

Linckia multifora (LAMARCK)

E55/388b, E55/797d, Eilat, 16 specimens (including 6 comets); E57/550, Massawa, 1 specimen; E62/1956, Nocra, 1 specimen; E62/2261, E62/10080, E62/10105, Um Aabak, 6 specimens; E62/10129, Harmil I., 10 specimens; E62/10116, Entedebir, 1 specimen. Known depth records 0.5–4m.

Ophidiaster hemprichi MÜLLER & TROSCHEL

E62/10137, Entedebir, 1 specimen. 3m.

Gomophia egyptiaca GRAY

E55/416, E59/158, NS 809, Eilat, 3 specimens. 1.0–1.5m.

Pentaceraster mammillatus (AUDOUIN)

NS 871, Eilat (collected by a fisherman), 1 specimen.

Culcita coriacea MÜLLER & TROSCHEL

E62/135, E62/136, E62/215, E62/1896, E62/1945, E62/2352, E62/3909, E62/10068, Entedebir, 8 specimens; E62/3034, E62/10043, Nocra, 2 specimens. Known depth records: intertidal to 4 m.

Asterina burtoni GRAY

E55/84, E55/101, E55/919, E60/46, Eilat, 6 specimens.

Echinaster purpureus (GRAY)

E62/1927, Entedebir, 1 specimen; E62/1974, E62/1976, Eritrea, 2 specimens; E62/2207, E62/3024, Nocra, 2 specimens.

Acanthaster planci (LINNAEUS)

NS 819, Eilat, 1 specimen; E62/2272, E62/10098, Um Aabak, 2 specimens; E62/10019, Entedebir, 2 specimens. Known depth records 2–6m.

Mithrodia clavigera (LAMARCK)

NS 802, Eilat, 1 specimen; E62/2214, Nocra, 1 specimen.

OPHIUROIDEA

Paracrocnida persica MORTENSEN

fig. 1.

Paracrocnida persica MORTENSEN, 1940a: 86–88, fig. 14, pl. i, fig. 8.

?*Ophiophragmus sacensis* BALINSKY, 1957, *Ann. Natal Mus.* **14**:9–10, fig. 4, pl. ii, figs. 5, 6.

MATERIAL. NS 803, NS 804, Eilat, 5 specimens (2 lacking the disc).

A specimen of *P. persica* from the Trucial Coast of Oman (that is within the Persian Gulf) collected by Dr. G. EVANS of Imperial College, London, is in the British Museum collections and available for comparison with these specimens from Eilat. It shows that the row of oral papillae is curved, not straight as shown in MORTENSEN's figure;

also the second papilla (the one next to the infradental) is larger than the other three and the fourth is slightly spaced from the third.

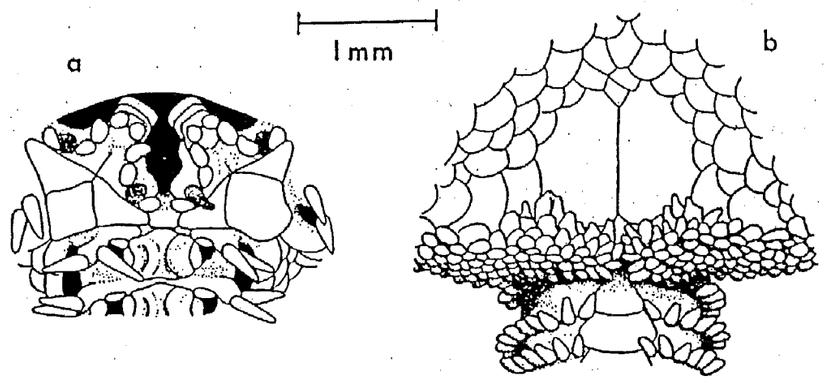

Fig. 1. *Paracrocnida persica* MORTENSEN. N. S. 804, Eilat; disc diameter 7mm. a) Ventral view of two jaw angles and the base of an arm, b) dorsal view of part of the disc and the base of an arm.

The very thick marginal and ventral disc scales of this species contrasting with the abruptly smoother dorsal scales, the sculptured ventral arm plates and the distally bilobed dorsal arm plates give a very characteristic appearance and, though these points are not brought out by BALINSKY's description of the type of *Ophiophragmus sacensis*, his photographs leave me in no doubt that his specimens are congeneric and probably even conspecific with *Paracrocnida persica* and cannot be referred to *Ophiophragmus*. In the latter genus the marginal 'fence' consists of a single row of papillae articulated to the scales, rather than a row of erect scales. (Species showing the latter condition, such as *Ophiophragmus japonicus* MATSUMOTO are better referred to other genera, in that case to *Amphioplus*, in my opinion). *Ophiophragmus* also has only three oral papillae and, although BALINSKY describes only this number in *sacensis*, his figure and phtograph show that a fourth based on the first ventral arm plate is also present, just as in *Paracrocnida*. The only difference of any possible significance between BALINSKY's description of *sacensis* and the present material of *P. persica* is that he gives the number of arm spines as only seven, the disc diameter being 5–6mm. Of the three Eilat specimens with intact discs two have the diameter 6mm and one of them has up to ten spines though the other has no more than nine. (The third with diameter 7mm has up to ten spines also).In the type of *P. persica* (d.d. 7mm) the number was up to nine. The type had all the arms broken but MORTENSEN surmised that their length was between five and six time the disc diameter. This compares with a proportion of 1: 7–8 for the types of *sacensis* but the well-preserved Eilat specimens show that the intact arms have unexpectedly attenuate tips and also measure from seven to eight times the disc diameter.

A third nominal species which is clearly congeneric with *P. persica* is *Ctenamphiura sinensis* A. H. CLARK (1917), the unique holotype of which I have examined at the Smithsonian Institution. It too has the markedly thickened, outstanding marginal

and ventral scales, sculptured ventral and bi-lobed dorsal arm plates characteristic of *P. persica*. The type had up to eleven arm spines, its disc diameter being 9.5mm, which is what would be expected from *persica* at this size. However, the type locality of *sinensis* is Hong Kong (though this has yet to be confirmed by further material).

Amphilycus scripta (KOEHLER)

fig. 2

Amphiura scripta KOEHLER, 1904, *Mem. Soc. zool. Fr.* **17**: 70–71, figs. 23–24.

Amphilycus androphorus MORTENSEN, 1933, *Vidensk. Medd. Dansk. naturh. Foren.* **93**: 185–188, figs. 4–6; TORTONESE, 1936: 221; BALINSKY, 1957: 11.

This species is not represented in the present collection but thanks to Dr. MADSEN of the Copenhagen Museum I was able to borrow a specimen of *Amphiura scripta* KOEHLER from Suez, obtained through the Berlin Museum. The extraordinarily small slightly sunken oral shields and peculiar oral papillae — the infradental ones irregular and the distal papilla apparently forming a continuous flange with the first oral tentacle scale — came to my mind when later studying MORTENSEN's figures of the dimorphic *Amphilycus androphorus*. Besides several specimens from Burma, the British Museum's collection includes others identified as *androphorus* from Inhaca Island, near the type locality of MORTENSEN's nominal species, Polana Beach, Delagoa Bay, Mozambique. All these I find have fine parallel grooves patterning the edges of the radial shields and many disc scales as well, such grooves being characteristic of *Amphiura scripta*, though not mentioned in MORTENSEN's description of *androphorus;* in the Inhaca specimens they are much less conspicuous than in the others. The type locality of *A. scripta* is Oman.

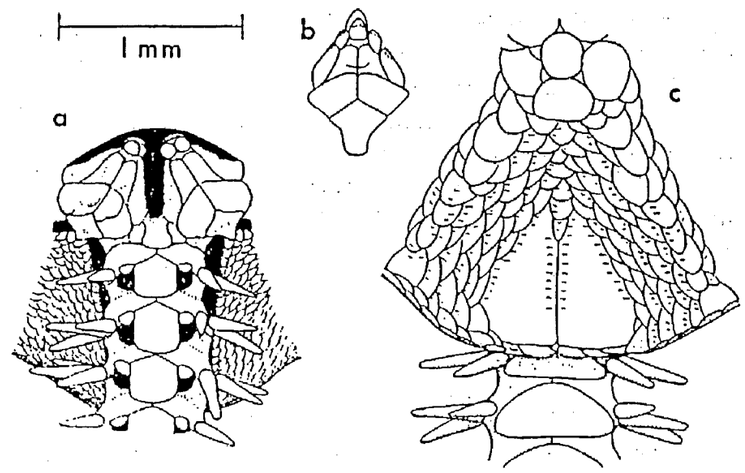

Fig. 2a) and c) *Amphilycus scripta* (KOEHLER). Specimen lent by the Universitetets Zoologiske Museum, Copenhagen, collected by Dr. BANNWARTH at Suez, disc diameter 3mm. a) Ventral view of two jaw angles and the base of an arm, c) dorsal view of part of the disc and the base of an arm showing the small grooves on many of the disc scales as well as on the radial shields. b) *Ophiodaphne materna* KOEHLER, Holotype, lent by the Copenhagen Museum, one jaw angle.

Accordingly I have no hesitation in stating my considered opinion that *Amphilycus androphorus* is a synonym of *Amphiura scripta*. The species must take the generic name *Amphilycus* since its dimorphic form accompanied by modification of mouth parts and of the arm spines in the males provide ample justification for considering it as representative of a distinct genus.

I also suspected that *Ophiodaphne materna* KOEHLER (1930) might be congeneric, if not conspecific, with *A. scripta* and Dr. MADSEN kindly lent me KOEHLER's type specimen, which has no dwarf male concealing the mouth parts. This shows that the two species are superficially very alike in the size and shape of the disc scales and radial shields, the very large and somewhat irregular (often fragmented) adoral shields slightly sunken to accommodate the male and the fused oral papillae with fringed edges. However, the teeth of *Ophiodaphne* are much narrower than those of *Amphilycus*, not at all Amphiurid-like, also the disc scales are much thicker with no trace of grooving, the oral shields are less reduced in size and have a large distal lobe and the tentacle scale is longer. Probably at least some of the similarities are due to the androphorous habit common to both species.

Amphiodia (*Amphispina*) *microplax* BURFIELD
fig. 3

Amphiodia microplax BURFIELD, 1924: 146–149, figs. 1, 2; MORTENSEN, 1940a: 90–91 figs. 16.

MATERIAL. E62/3098, E62/3099 (pt.), E62/3100, E62/3101, Um Aabak, 4 specimens; E62/4233, Eritrea, 1 specimen.

All the specimens have lost their discs except one from Um Aabak (E62/3101) and even this is probably regenerating. However, it shows that the disc scales of the marginal row are modified into spikes, a characteristic of NIELSEN's subgenus *Amphispina*, to which the species must therefore be referred. Of the three other species

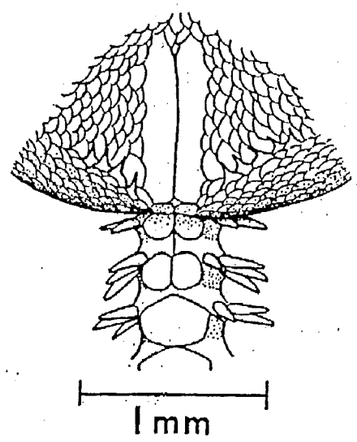

Fig. 3. *Amphiodia* (*Amphispina*) *microplax* (BURFIELD). E62/3101, Um Aabak. Dorsal view of the disc and the base of an arm showing the spike-like prolongations of the uppermost row of ventral scales.

of the subgenus, *A. urtica* and *A. digitata* are both from the East Pacific but *A. duplicata* (KOEHLER), 1930, comes from Amboina in the East Indies. *A. microplax* is closely related to *duplicata* but is distinguished by the single rather than double spikes formed by the modified scales.

MORTENSEN (1940) recorded this species from the Persian Gulf; in only one of his specimens was the disc retained.

Ophiactis parva MORTENSEN

Ophiactis parva MORTENSEN, 1926: 123–124, fig. 12; 1940: 70–71, fig. 5; BALINSKY, 1957, *Ann. Natal Mus.* **14**: 15.

Ophiactis plana: H. L. CLARK, 1939: 76–77 [Non *O. plana* LYMAN, 1869].

MATERIAL. E57/517, Dahlak, 7½ specimens; E57/609, Massawa, 3 specimens; E62/3913, Cundabilu, 1 specimen. One depth record, 70m.

H. L. CLARK suspected that *Ophiactis parva* is a synonym of *plana* but MORTENSEN pointed out that there is a difference in the relative size of the ventral scaling. An examination of the John Murray Expedition specimens named by H. L. CLARK and MORTENSEN's types of *O. parva* together with the present material inclines me to believe that MORTENSEN is right and there is a difference between *O. plana* as found in South Africa and *O. parva* from the Red Sea, Gulf of Aden and Persian Gulf. Unfortunately the Murray specimens are all small and their discs are somewhat shrunken in drying. The colour difference described by MORTENSEN, consisting of a greyish line along the arms broadening into a transverse band at intervals in *O. parva* is unfortunately not distinct in some of the specimens seen by me though the band on the arm spines can usually be made out.

Ophiactis carnea LJUNGMAN*
fig. 4

Ophiactis carnea LJUNGMAN, 1867, *Ofv. K. Vetensk. Akad. Forh.* **1866**: 324; MORTENSEN, 1933, *Vidensk. Medd. Dansk. naturh. Foren*, **93**: 343–345, figs. 54–56; H. L. CLARK, 1939: 76.

?Ophiactis versicolor H. L. CLARK, 1939: 81–82, fig. 36.

MATERIAL. E58/280, 44 (pt.), Jebel Attair, 2 specimens.

The smaller one of these two specimens has six arms rather than the usual five, completing a resemblance to the holotype of *Ophiactis versicolor* H. L. CLARK, the drawing of which in the Murray Report is quite misleading since it shows most of the pairs of radial shields as being in contact for more than half their lengths whereas in fact they touch only at the distal end, as in *O. carnea*. The only one of the three paratypes of *versicolor* to be retained in the British Museum collection has five arms, a fact not mentioned by H. L. CLARK.

Further material from the Red Sea and north-western part of the Indian Ocean is needed to clarify the limits of the species of *Ophiactis* (other than the very distinctive

* May, 1966. In recent weeks study of two good samples from Mauritius and Zanzibar conspecific with the holotype of *O. versicolor* and including c.95% of six-armed specimens leads me to discard the synonymy of *versicolor* with *carnea*.

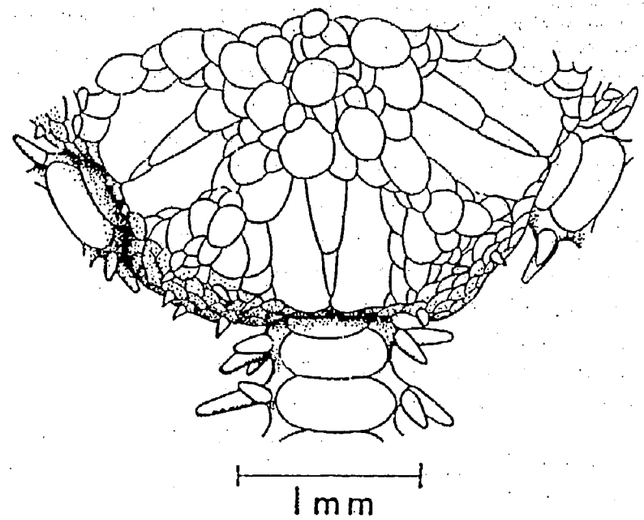

Fig. 4. *Ophiactis carnea* LJUNGMAN, holotype of *O. versicolor* H. L. CLARK, from John Murray Expedition station MB1b, Red Sea. Dorsal view of half the disc and the adjacent arm bases (one arm broken off).

O. savignyi) occurring in this area. Most of the specimens available already are so small as to be of little assistance.

If my identification of these specimens is correct, it extends the range of *O. carnea* into the Red Sea from the southern coast of Arabia and South Africa.

Ophionereis porrecta LYMAN

Ophionereis porrecta LYMAN, 1860, *Proc. Boston Soc. nat. Hist.* **7**: 260; H.L. CLARK, 1939: 94; A.M. CLARK, 1953, *Proc. Zool. Soc. Lond.* **123**: 80–81.

MATERIAL, E55/884, Eilat, 1 specimen.

In 1953 I recorded this species from the Amirante and Seychelle Islanus and Mauritius. Soon after this I identified as *O. porrecta* a specimen from Aqaba collected by Dr. STEINITZ but this record was not published. The known range therefore extends from the Hawaiian Islands to the Red Sea and to South Africa (H. L. CLARK, 1923).

The Eilat specimen is unusual in having a finely spotted colouration, much as I described for *O. fusca* BROCK in 1953, each disc scale having a spot. However, the distal genital papillae are inconspicuous, as in *porrecta*.

Ophiocoma valenciae MÜLLER & TROSCHEL

Ophiocoma valenciae MÜLLER & TROSCHEL, 1842: 102; H. L. CLARK, 1921: 131–132; TORTONESE, 1936: 223; MORTENSEN, 1940a: 73–74; TORTONESE, 1949: 223; 1954: 32.

MATERIAL. E51/65, E51/67b, E55/296b, E55/308,1b, E55/308, Ic, E55/393c, E55/937. NS 798, NS 800, Eilat, 10 specimens. Known depth records 1–1.5m.

H. L. CLARK (1921) comments that the arm length in this species rarely exceeds 5.5 times the disc diameter. However, in a specimen from Natal in the British Mu-

seum collections the ratio is 8.0:1, in another from the Red Sea it is 8.5:1 and in seven of the Eilat specimens it ranges from 5.25 to 8.4:1, with a mean of 7.0:1.

Ophiomastix pusilla BROCK
fig. 5

Ophiomastix pusilla BROCK, 1888, *Z. wiss. Zool.* **47**: 499–500; KOEHLER, 1905, *Siboga Exped.* **45b**: 65, pl. vi figs. 9,10, pl. xiii fig. 3.
Ophiocoma pusilla: H. L. CLARK, 1921: 131.
Ophiocoma sp., A.M. CLARK, 1952: 208.

MATERIAL. E49/8, E51/66, E55/123(pt.), E55/167, E55/799b, Eilat, 8 specimens.

The two previously published records of this species were both from the East Indies so the present one represents a considerable extension of range. Since all the specimens known are small, the largest (BROCK's type) having the disc diameter 8 mm, the species may have been overlooked among the larger species of *Ophiocoma*, most of which exceed or at least reach double this disc diameter.

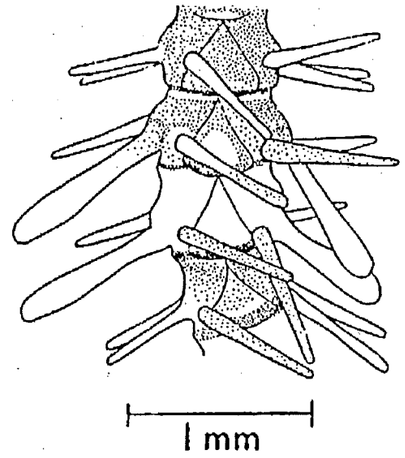

Fig. 5. *Ophiomastix pusilla* BROCK. E55/167, Eilat. Dorsal view of part of an arm from free segment six to segment nine showing the clavate second spines (of the seventh and eighth segments in this case); the colour pattern is indicated by stippling.

The generic position of *O. pusilla* is controversial. Without having seen a specimen, H. L. CLARK (1921) transferred the species to *Ophiocoma* since he considered that the presence of granules rather than spines on the disc outweighed the presence of clavate arm spines. Although it is the second rather than the uppermost arm spines which are modified, their occurrence is so abrupt and conspicuous that I am inclined to agree with BROCK and place *pusilla* in *Ophiomastix*, particularly as several species of *Ophiomastix* have continuous coats of granules over the disc with spinelets intermingled and often not very sharply differentiated from the granules. Nevertheless, it should be noted that *pusilla* has some resemblance to *Ophiocoma brevipes*, particularly in colour pattern, variable though this is in both, and in the extension of the

fine disc granulation on to the ventral side. Unfortunately the smallest specimen of *brevipes* available to me has the disc diameter already 12 mm whereas in the largest one of *pusilla* it is only 7 mm. *O. brevipes* has no trace of clavate second arm spines and the uppermost spines especially are much shorter than in *pusilla*, hardly, if at all, exceeding the corresponding arm segment in length in the 12 mm specimen, whereas in the largest *pusilla* the dorsalmost arm spines on the basal segments are up to 2.5 mm long while the corresponding segment length is only 0.75 mm. Admittedly, in the larger specimens of *O. pusilla* (d.d. about 7 mm) the few clavate arm spines are less conspicuous than they are in smaller specimens (d.d. about 5 mm), which leads one to speculate whether they may become indistinguishable in larger specimens still, if these exist.

In the eight specimens of the present collection, three others from Aqaba received earlier from Dr. STEINITZ and the 'Manihine' specimen from Sherm Sheik (near the entrance to the Gulf), there is considerable variation in the number and to a lesser extent the position of the clavate spines. On some arms they may not be developed at all or only on one side of a single segment but usually they occur on both sides of one to three consecutive segments, most often on the seventh and eighth free segments (counting from the edge of the disc) but in one case on the fifth, sixth and seventh and in another on the eighth and ninth. No specimen was seen with three pairs of clavate spines on every arm. BROCK described the type as having two segments with clavate second spines, situated at about a fifth or quarter of the arm length from the base at about the eleventh segment. Without an illustration it is not clear whether he counted in the arm segments within the disc (which would number about four in the holotype); thus in the largest Aqaba specimen the single clavate spines come on the twelfth segment counting from the oral frame. Judging from KOEHLER's diagrammatic figures, the 'Siboga' specimens have clavate spines on either the eighth or tenth free arm segments. In the Aqaba specimens the number of arm spines is up to usually five each side. There may be two tentacle scales to each pore for almost the entire arm but, when the disc diameter is less than 6 mm, the pores of the distal half of the arm usually have only one scale.

The colour in spirit is dark brown with paler or even white markings, the pattern being rather variable. Sometimes the disc has a fine brown reticular pattern or dark brown spots ringed with white on a light brown background and in one specimen it is white except for a few brown spots and some peripheral markings, but usually the dorsal side of the disc is dark brown with irregular light patches towards the margin. The arms are prettily patterned, usually with a brown patch in the middle of each dorsal plate bordered by a white ring and an almost black chevron following the convex distal edge of the plate. The ventral plates have a slightly hour-glass shaped central brown patch and are white laterally. There may be a coarser banded colour effect produced by some entire segments being almost white.

Other Ophiuroid records:

Astroboa nuda (LYMAN)

E62/10082, Um Aabak, 1 specimen; Eury. 5, Eilat, 1 specimen.

Astroboa nuda forma *nigra* DÖDERLEIN

Eury. 3, Eilat, 1 specimen.

Amphiura dejectoides H. L. CLARK

E58/300,19, Moharib, South Red Sea, 3 specimens; E58/224,11, South Red Sea, 1 specimen.

Amphipholis squamata (DELLE CHIAJE)

E49/3, Eilat, 6 specimens.

Amphioplus laevis (LYMAN)

E58/299,4, Shab Shags, South Red Sea, 1 specimen. 22m.

Amphioplus timsae MORTENSEN

E62/3099 (pt.), Um Aabak, 1 specimen.

Amphioplus hastatus (LJUNGMAN)

E59/71,3, Eilat, 1 specimen.

Ophiactis savignyi (MÜLLER and TROSCHEL)

E55/123 (pt.), Eilat, 2 specimens; E58/59, E58/280,44 (pt.), Jebel Attair, 2 specimens; E58/117, South Red Sea, 2 specimens; E 62/3988, Entedebir, 64 specimens. Depth records: intertidal to 60m.

Ophionereis dubia (MÜLLER and TROSCHEL)

E51/69, E55/848, Eilat, (1 specimen, 3 bits).

Ophiocoma pica MÜLLER and TROSCHEL

E49/7, E49/9, E51/26, E51/27, E51/30, E51/33, E51/64, E55/300b (pt.), E55/799a, E55/960g (pt.), NS 801, Eilat, 15 specimens; E62/2204, Entedebir, 1 specimen. Known depth records 1–1.5m.

Ophiocoma erinaceus MÜLLER and TROSCHEL

E55/960g (pt.), NS 799, Eilat, 2 specimens; E62/119, E62/1892, Entedebir, 2 specimens; E62/2259, E62/2644, Um Aabak, 4 specimens. Known depth records 1–1.5m.

Ophiocoma scolopendrina (LAMARCK)

E51/1, E51/58, E51/61, E55/300b (pt.), E55/308Ia, E55/960g (pt.), NS 816, 817, 818, Eilat, 11 specimens; E62/234, E62/10008, Entedebir, 2 specimens. Known depth records: low tide mark to 1.5m.

Macrophiothrix hirsuta (MÜLLER and TROSCHEL)

E57/517, Dahlak, 2 specimens; E57/610 (pt.), Massawa, 1 specimen; E62/331, Entedebir, 1 specimen; E62/2265, E62/2648, Um Aabak, 5 specimens; E62/2689 (pt.), Cundabilu, 1 specimen; E62/3017 (pl.), E62/3018 (pt.), E62/3019, E62/3044, Nocra, 4 specimens.

Ophiotrichoides propinqva (LYMAN)

E55/799c, Eilat, 1 specimen; E58/250, E58/253 (pt.), South Red Sea, 2 specimens; E62/2689 (pt.), Cundabilu, 1 specimen; E62/3017, E62/3018 (pt.), Nocra, 3 specimens.

Placophiothrix purpurea (VON MARTENS)

E58/127, Moharib, South Red Sea, 1 specimen, E58/198 (pt.), Jebel Attair, 1 specimen; E58/230 (pt.), E58/253 (pt.), South Red Sea, 3 specimens.

Placophiothrix proteus (KOEHLER)

E58/39 (pt.), Jebel Attair, 1 specimen; E?/219,1, E58/253 (pt.), South Red Sea, 2 specimens.

Ophiothrix savignyi (MÜLLER & TROSCHEL)
E57/517 (pt.), E57/524, Dahlak, 46 specimens; E57/610, Massawa, 2 specimens; E58/39, E58/59 (pt.), E58/280,44 (pt.), Jebel Attair, 3 specimens; E58/65, Um el Sarig, South Red Sea, 6 specimens; E58/82, Dvu-l-kurush, South Red Sea, 4 specimens; E58/117 (pt.), E58/230 (pt.), E58/253 (pt.), South Red Sea, 5 specimens; E62/1935, E62/1936, Entedebir, 2 specimens; E62/2645, Um Aabak, 2 specimens; E62/3016, Nocra, 2 specimens. Known depth records 1.5–60m.
Ophiolepis cincta MÜLLER and TROSCHEL
E51/31, E51/34, E51/67a, E55/393a, E55/752, NS 805, Eilat, 11 specimens; E62/2258, E62/2643, Um Aabak, 3 specimens; E62/3023, Nocra, 2 specimens; E62/3894, Cundabilu, 5 specimens. Known depth records 1–1.5m.
Ophiolepis superba H. L. CLARK
E62/2205, Entedebir, 1 specimen; E62/2651, Um Aabak, 4 specimens.
Ophiura sp. juv., prob. *O. kinbergi* LJUNGMAN
E56/110a, Eilat, 1 specimen.

ECHINOIDEA

Prionocidaris baculosa (LAMARCK)

Cidarites baculosa LAMARCK, 1816, **3**: 55.
Prionocidaris baculosa: MORTENSEN, 1928: 437–452, figs. and pls.; TORTONESE, 1936: 225; 1953: 35.
MATERIAL. E55/137a, E55/406a, E55/528d, Eilat, 3 specimens; E57/461, Massawa, 1 specimen; E62/118, E62/1966, Entedebir, 2 specimens; E62/1990, Nocra, 1 specimen; E62/3854, Um Aabak, 1 specimen.

All three specimens from Eilat have the primary spines strongly verticillate with more than six whorls of stout thorns along their lengths approaching the condition in *P. verticillata*. The Eritrean specimens in contrast have much smoother spines with a more or less well developed terminal crown; only one of the two from Entedebir has a suggestion of the verticillate condition.

Chaetodiadema granulatum MORTENSEN

Chaetodiadema granulatum MORTENSEN, 1903, *Vidensk. Medd. Dansk. naturh. Foren.*, **1903**: 1; 1940: 218–223, figs. 125a, b, d, 126, pls. xxix–xxxi, pl. xxxii, figs. 1, 2.
MATERIAL. E58/66, Dvu-l-kurush, South Red Sea, 1 specimen; E62/4255, Archico Bay, Eritrea, 4 specimens. One depth record, 58m.

The Dvu-l-kurush specimen is in good condition with the test inflated; its horizontal diameter is 47 mm. Instead of the isolated blue spots running down each interambulacrum aborally supposedly characteristic of *C. granulatum*, it has dark brown spots. In the Archico Bay specimens, which are larger (h.d. about 90 mm) but collapsed into flat pancakes, the spots are blue but two of them have a very dark brown interambulacral line underlying the blue spots. Such a dark brown line is present in the type of *C. africanum* H. L. CLARK from Natal though Dr. CLARK supposed that it had been blue in life (as in the other species of *Chaetodiadema* excepting *C. granulatum*). Another specimen of *C. africanum* from Natal in the British Museum

collections has interrupted reddish-brown lines down the interambulacra aborally. Further material is needed from the western part of the Indian Ocean to show how much these colour differences are due to differences in preservation or of light intensity at the time of death, if the blue spots are iridophores and can be masked by melanin as in *Diadema*.

The present records provide an extension of the known range of *C. granulatum* into the Red Sea, the nearest reliable record previously being from the Maldive Islands, since MORTENSEN believes BROWN's record from Mozambique represents rather *C. africanum*. The latter species has been recorded from as far north only as the Pemba Strait (off Tanganyika) on the east African coast.

Diadema setosum (LESKE)

Echinometra setosa RUMPHIUS, 1705, *d'Amboinischer Rariteitkamer*, Amsterdam: 35 pl. xiii, fig. 5; LESKE, 1778, *Additamenta ad J. T. Klein Naturalem Dispositionem Echinodermatum*, Lipsiae: 35 pl. xxxvii, figs. 1, 2.

Cidarites savignyi AUDOUIN, 1826: 13, SAVIGNY's pl. vi. [Non *Diadema savignyi:* MICHELIN, 1845, *Mag. Zool., Paris* (2) **1845**, Zoophytes: 15–16, nec MORTENSEN, 1940: 265–269; see below.]

Diadema setosum: MORTENSEN, 1940: 256–264 figs. 140, 141a, pls.

MATERIAL. E55/27, E55/393d, E55/659a, Eilat, 9 specimens; E62/257, Entedebir, 1 specimen.

Seven of the nine specimens of *Diadema* from Eilat in the present collection are very small but the other two have large tridentate pedicellariae with long narrow blades of the kind said by MORTENSEN to be characteristic of *D. setosum*; the same is true of all the other specimens in the British Museum collections from the Red Sea in which such pedicellariae can be found. Nor did MORTENSEN obtain any examples in the vicinity of Ghardaqa with tridentate pedicellariae having broad spoon-shaped valves such as he had in 1904 declared to be characteristic of *D. savignyi* when he separated it from *setosum*, with which it had long been amalgamated. No large tridentate pedicellariae can be found in the specimen from Entedebir.

The Red Sea, probably the Gulf of Suez or just south of it, must be the type locality for *D. savignyi* (AUDOUIN) (see under 'Zoogeography') and MORTENSEN assumed that *D. savignyi* with broad-bladed pedicellariae, as defined by him, does occur at Suez because BOUTAN (1892) had stated that specimens of *Diadema* from Suez show a colour pattern of blue lines; these two characters MORTENSEN believed to be correlated. *D. setosum* he described as having isolated blue or white spots instead of lines. H. L. CLARK (1925) put even more weight on the colour pattern and, disregarding the broad-bladed pedicellariae of some specimens from Mauritius, referred them to *setosum* solely on account of their colour. However, MILLOTT (1953) has shown that a spotted pattern in a specimen of the closely related species *D. antillarum* can give way either to continuous lines of blue colour with a circum-apical ring or conversely may disappear altogether by dispersal of melanic pigment over the spots, all this

simply in response to changes in light intensity. Such physiological colour change almost certainly occurs in the Indo-Pacific species of *Diadema* as well as the antillean one, so that I doubt if much reliance can be placed on such a colour pattern as a specific character.

Thanks to the kindness of Prof. H. ENGEL I have been able to study several specimens of *Diadema setosum* from Amboina, the type locality. Like the Red Sea specimens these proved to have long narrow blades to the large tridentate pedicellariae, the ratio of length:median breadth being 14 or 15:1 in representative pedicellariae of two specimens, compared with 4.5:1 in a specimen from Mauritius figured by MORTENSEN (1940, pl. lxxiv fig. 14) under the name of *savignyi*. In the absence of any specimens with broad-bladed valves to the large tridentate pedicellariae from collections in the northern part of the Red Sea, I consider that *D. savignyi* (AUDOUIN) should be referred to the synonymy of *D. setosum* (LESKE). This would leave nameless those specimens from the other parts of the Indo-West Pacific with pedicellariae of this kind, though with such a minor (and somewhat variable) character alone to distinguish them they should perhaps be ranked only as a subspecies of *Diadema setosum*. As a solution to this problem, the International Commission on Zoological Nomenclature has been asked (CLARK & OWEN, 1965) to suppress the name *Cidarites savignyi* AUDOUIN, 1826 (which was never described, the only 'indication' being provided by SAVIGNY's figure of the oral side which might represent either subspecies) in order to validate *Diadema savignyi* MICHELIN, 1845. MICHELIN gave a diagnosis of the species based on material from Mauritius, where specimens with broad-bladed valves to the tridentate pedicellariae have been taken (MORTENSEN, 1940, also H. L. CLARK, 1925).

If the respective specimens of SAVIGNY and of MICHELIN are preserved in the Paris Museum, this problem could be satisfactorily resolved. MORTENSEN actually gives MICHELIN as the author of *savignyi* in the captions to his figures and plates, although he does include AUDOUIN in brackets as well as MICHELIN in the heading to the text.

Much work remains to be done on Indo-West Pacific specimens of *Diadema* to determine to what extent the two subspecies are sympatric. MORTENSEN gives details of specimens of both from Banda, otherwise only from neighbouring places such as Delagoa Bay (*setosum*) and Durban (*savignyi*). The limits of the two seem to coincide approximately.

Salmaciella dussumieri erythracis (H. L. CLARK)

Salmacis erythracis H. L. CLARK, 1912, *Mem. Mus. comp. Zool. Harv.* **34** (4): 315–316, pl. cxi, figs. 4–6; MORTENSEN, 1939a: 26–27.

Salmaciella erythracis: MORTENSEN, 1943: 144–146, pl. vi, figs. 9–13.

MATERIAL. E57/459, Massawa, 2 specimens; E58/34, Jebel Attair, 1 specimen; E?/230 South Red Sea, 4 specimens.

This is a new record for the Red Sea although the John Murray Expedition collected *erythracis* in the vicinity of Cape Gardafui and there are three specimens in the British Museum collections from Mukalla on the opposite shore of the Gulf of Aden. All have the secondary spines orange or vermilion in colour at the base, turning greenish for the main part of the spine. The primary spines at and below the ambitus

have short bands of dark brown or sometimes purple towards the tip, though the predominant colour of the primaries is green. In general, the colour pattern is the same as that found in specimens of *S. dussumieri* from Tuticorin in the south of India, though there the secondary spines are brown rather than orange basally, giving way to grey or pale green and the primaries are more purple than green in colour. Before H. L. CLARK distinguished *erythracis* from *dussumieri* on the basis of the different colouring of a specimen from Zanzibar, MORTENSEN had identified as *dussumieri* another specimen from that locality in the British Museum collections, which was subsequently referred by H. L. CLARK to *erythracis*. The basally red or orange colour of the secondary spines seems to be consistent in and restricted to specimens of *Salmaciella* from the western part of the Indian Ocean. Nevertheless, unsupported by morphological differences, I do not consider that it warrants a specific difference and accordingly I am reducing *erythracis* to the rank of a subspecies of *dussumieri*.

The three specimens from Mukalla in the Aden protectorate are unfortunately broken but the largest has the horizontal diameter about 56 mm., which seems to be a record for *dussumieri* or *erythracis*.

Pericosmus akabanus MORTENSEN

Pericosmus akabanus MORTENSEN, 1939a: 38–42, pl. iii figs. 1–6 pl. iv figs. 1–16
1951: 178–182, figs. 84a, 85, 86a, b, 87 pl. xv figs. 1–8 pl. I figs. 16, 19, 21, 22, 28–30, 32

MATERIAL. E59/66, Eilat, 1 specimen.

The ratio of length: breadth: height is 40 mm: 37 mm: 24 mm, the proportions similar to those of MORTENSEN's specimens.

Other Echinoid records:

Eucidaris metularia (LAMARCK)
E55/120c, E55/554, E55/923b, Eilat, 5 specimens.

Asthenosoma varium GRUBE
Ec.140, Eilat (A. GITAY, Hebrew University of Jerusalem), 1 specimen. 4m.

Echinothrix calamaris (PALLAS)
E55/138, E55/140, E55/658, E55/974, E62/10217*, E62/10219*, NS. 873, Eilat, 11 specimens; E62/297, Entedebir, 1 specimen. Known depth records 1–2m.

Microcyphus rousseaui L. AGASSIZ
Ec.158, Eilat (M. TSURNAMAL, Hebrew University of Jerusalem), 1 specimen. 5m.

Salmacis bicolor L. AGASSIZ
E57/457, Massawa, Eritrea, 2 specimens; E58/31, Jebel Attair, South Red Sea, 1 specimen. One depth record, 60m.

Nudechinus scotiopremnus H. L. CLARK
E51/47, Eilat, 1 specimen.

? Gymnechinus sp.
E49/1, Eilat, 2 specimens.

Tripneustes gratilla (LINNAEUS)
E51/151, E55/90a, E55/114c, E55/133, E55/371, E55/393f, E55/393g, E55/406b,

* Collected by J.H. STOCK

E55/406c, E62/10201*, NS 806, NS 808, Eilat, 28 specimens; E62/177, Cundabilu, 8 specimens. Known depth records 0–2m.

Echinometra mathaei (de BLAINVILLE)
E51/42, E55/29b, E55/46, E55/906, E55/114d, E55/619d, E55/802, E62/10209*, Eilat, 16 specimens; E62/2225, E62/10170, Um Aabak, 4 specimens; E62/166, Entedebir, 3 specimens. Known depth records 0.5–1m.

Heterocentrotus mammillatus (LINNEAUS)
NS 814, Eilat, 1 specimen. 0.5m.

Clypeaster humilis (LESKE)
NS 810, Eilat, 2 specimens; E62/1898, Massawa, 1 specimen; E62/3000, Nocra, 1 specimen; E62/3846, Melita Bay, Eritrea, 3 specimens; E62/10099, Um Aabak (24. iii. 1962), 1 specimen.

Clypeaster rarispinus de MEIJERE
E57/426, E57/427, South Red Sea, 4 specimens; E57/460 (pt.), E57/529, E57/649.1, Massawa, 5 specimens; E58/252 (pt.), Kamaran, 3 specimens; E62/4192, Entedebir, 1 specimen; E62/4254, Archico Bay, 2 specimens. Known depth records 22–55m.

Clypeaster reticulatus (LINNAEUS)
E57/460 (pt.), Massawa, 1 specimen; E58/30, E58/98, E58/99, E58/102, Jebel Attair, 5 specimens. One depth record, 54m.

Laganum depressum Lesson *in* L. AGASSIZ
E60/62,14, Eilat, 1 specimen; E58/88, Jebel Attair, 21/2 specimens; E58/252 (pt.), Kamaran, 1 specimen. One depth record, 25m.

Echinodiscus auritus LESKE
NS 811, Eilat, 2 specimens; E62/3515, Zula Bay, Eritrea, 1 specimen. One depth record, 1.5m.

Lovenia elongata (GRAY)
E51/51, E51/52, E51/ 53, E51/72, E51/73, E51/74, E51/75, E55/26, Eilat, 14 specimens.

Brissopsis luzonica (GRAY)
E57/510, Massawa, Eritrea, 1 specimen.

ZOOGEOGRAPHY

The intensive collecting carried out at Eilat in recent years coupled with the collections of the 'Manihine' in 1949 further down the Gulf of Aqaba and at its entrance to the Red Sea, give a fair idea of the echinoderm fauna of the Gulf for comparison with that of the Red Sea proper. Unfortunately many of the old records give no details beyond 'Red Sea'. However, we can fairly assume that SAVIGNY's material was collected either at Suez or at Qoseir (Kosseir) south of Ghardaqa, since these were the two localities on the Red Sea where NAPOLEON's expeditionary force concentrated its efforts. Unfortunately most of MÜLLER and TROSCHEL's Red Sea types were from HEMPRICH and EHRENBERG's collections and although these were made primarily in the vicinity of Tor in the south-west of the Sinai peninsula (as well as nearer Suez) some of their material came from other parts of the Red Sea including Massawa in Eritrea.

* Collected by J.H. STOCK

The table given here provides a fauna list of the echinoderm species (except holothurians) for which reliable records from the Red Sea exist. Since most of the records for the Red Sea proper come either for the northern end, including the vicinity of Ghardaqa, Qoseir and the southern tip of Sinai with the islands of Tiran and Sanafir, or from Eritrean waters in the south, two separate columns are given for records from north and south of the thirty-fifth parallel (chosen as a convenient though artificial dividing line) as well as columns for the Gulfs of Suez and Aqaba and the two adjacent areas outside the southern end of the Red Sea.

Of the 113 species included, 51 are known from the Gulf of Aqaba, most of them from other parts of the Red Sea as well, while the remaining 62 have not yet been taken in the Gulf although 29 of them are known either from the Gulf of Suez or from the adjacent northern end of the Red Sea (or both).

As many as 30 species also appear from the table to be endemic to the Red Sea, there being no records in the last two columns, i.e. from Aden to the Persian Gulf or from East Africa. However, 15 of these are in fact known further afield, in other parts of the Indian Ocean or West Pacific, leaving 15 only as endemic to the Red Sea as far as present records go. These are:

Commissia hartmeyeri
Decametra chadwicki
Dorometra egyptica
Astropecten orsinii
Stellasteropsis fouadi
Amphiura dejectoides
Ophiocirce mabahithae
Clypeaster amplificatus
Heterometra atra
Colobometra arabica
Astropecten bonnieri
Monachaster umbonatus
Fromia ghardaqana
Amphioplus timsae
Pericosmus akabanus

Of these, *Ophiocirce mabahithae* and *Pericosmus akabanus* are known only from deep water, 717–1135 and 272–486 metres respectively. Owing to inadequate material or description I regard six of the other species as being of uncertain validity. These include *Commissia hartmeyeri*, *Heterometra atra*, *Dorometra egyptica*, *Astropecten bonnieri*, *A. orsinii*, *Monachaster umbonatus* and *Clypeaster amplificatus*. The first one is known from eight specimens but the largest of these had arm length only 39 mm, which is small for a Comasterid, while the last-named may well prove to be based on a giant specimen of *Clypeaster humilis*, as MORTENSEN has suggested, its peculiarities being attributable to heterogonic growth.

In addition several species are known from the Red Sea and from the Persian Gulf but not elsewhere. These include *Heterometra savignii*, *Lamprometra klunzingeri*, *Paracrocnida persica* (if BALINSKY'S '*Ophiophragmus*' *sacensis* from Mozambique proves to be distinct) and *Amphiodia microplax*.

FAUNA LIST OF THE ECHINODERMS (EXCEPT HOLOTHURIANS) RECORDED FROM THE RED SEA

Name	Gulf of Aqaba	Gulf of Suez	Northern end of Red Sea	Red Sea S. of 35°N.	Aden E. to Persian Gulf	East Africa
CRINOIDEA						
Capillaster multiradiatus (LINNAEUS)	+			+		
Comissia hartmeyeri A. H. CLARK		+				
Heterometra atra (A. H. CLARK)[1]		? ←	? →	?		
Heterometra savignii (J. MÜLLER)	+	+	+	+	+	
Stephanometra indica (SMITH)		+		+		+
Stephanometra spicata (P. H. CARPENTER)				+		
Lamprometra klunzingeri (HARTLAUB)	+	+	+	+	+	
Decametra chadwicki (A. H. CLARK)	+	+				
Decametra mollis (A. H. CLARK)		+			+	
Oligometra serripinna (P. H. CARPENTER)	+			+	+	+
Colobometra arabica A. H. CLARK	+			+		
Tropiometra carinata (LAMARCK)		+	+	+	+	+
Dorometra egyptica (A. H. CLARK)		+				
ASTEROIDEA						
Astropecten bonnieri KOEHLER				+		
Astropecten hemprichi M. & TR.[1]		? ←	? ←	+	+	+
Astropecten monacanthus SLADEN				+	+	+
Astropecten orsinii LEIPOLDT				+		
Astropecten polyacanthus M. & TR.	+	+	+	+	+	+
Luidia prionota FISHER		+			+	
Luidia savignyi (AUDOUIN)[2]		+	+	+		+
Ogmaster capella (M. & TR.)				+		
Monachaster umbonatus MACAN		+				
Stellaster equestris (RETZIUS)				+	+	+
Stellasteropsis fouadi DOLLFUS		+		+		
Linckia multiflora (LAMARCK)	+	+	+	+	+	+
Ophidiaster hemprichi M. & TR.[1]		? ←	? ←	+		+
Gomophia egyptiaca GRAY[3]	+	+ →	?			+
Fromia ghardaqana MORTENSEN	+		+	+		
Leiaster leachi GRAY	+			+		+
Pentaceraster mammillatus (AUDOUIN)[4]	+	? ←	+	+	+	+
Pentaceraster tuberculatus (M. & TR.)[1]		? ←	? ←	+	+	+
Culcita coriacea M. & TR.[1]		? ←	? ←	+		+
Choriaster granulatus LÜTKEN	+					
Asteropsis carinifera (LAMARCK)	+		+	+	+	+
Asterina burtoni GRAY	+	+	+	+	+	+

FAUNA LIST OF THE ECHINODERMS (EXCEPT HOLOTHURIANS) RECORDED FROM THE RED SEA (Cont.)

Name	Gulf of Aqaba	Gulf of Suez	Northern end of Red Sea	Red Sea S. of 35°N.	Aden E. to Persian Gulf	East Africa
Echinaster purpureus (GRAY)	+	+	+	+		+
Acanthaster planci (LINNAEUS)	+			+	+	+
Mithrodiaclavigera (LAMARCK)	+			+		+
OPHIUROIDEA						
Astroboa nuda(LYMAN)	+	+		+	+	+
Amphipolis squamata (D. CHIAJE)	+	+		+		+
Paracrocnida persica MORTENSEN	+				+	?
Amphilycus scripta (KOEHLER)		+		+	+	+
Amphiodia microplax (BURFIELD)				+	+	
Amphiura dejectoides H. L. CLARK				+		
Amphioplus hastatus (LJUNGMAN)	+			+	+	+
Amphioplus integer (LJUNGMAN)				+		+
Amphioplus laevis (LYMAN)				+	+	
Amphioplus timsae MORTENSEN		+		+		
Ophiactis carnea LJUNGMAN*				+	+	+
Ophiactis hexacantha H. L. CLARK				+		
Ophiactis parva MORTENSEN[5]		+		+	+	+
Ophiactis savignyi (M.& TR.)	+	+		+	+	+
Ophiorthrix savignyi(M.&TR.)[6]		+	+	+	+	+
Placophiothrix proteus (KOEHLER)				+	+	
Placophiothrix purpurea (VON MARTENS)	+			+	+	+
Macrophiothrix galatheae (LÜTKEN)		+		+		+
Macrophiothrix hirsuta (M. & TR.)[7]	+	?	+	+	+	+
Ophiotrichides propinqua (LYMAN)[8]	+		+	+	+	+
Ophiothela danae VERRILL				+		
Ophiomaza cacaotica LYMAN			+	+	+	+
Ophiopsammuim rugosum KOEHLER				+		
Ophiocoma erinaceus M. & TR.	+		+	+	+	+
Ophiocoma pica M. & TR.	+		+	+	+	+
Ophiocoma scolopendrina (LAMARCK)	+		+	+	+	+
Ophiocoma valenciae M. & TR.	+		+	+	+	+
Ophiomastix pusilla BROCK	+		+			
Ophiopsilla pantherina KOEHLER				+		
Ophionereis dubia (M. & TR.)[4]	+	? ←	+	+	+	+
Ophionereis porrecta LYMAN	+					+
Ophiurodon cupidum (KOEHLER)				+		+
Ophiopeza fallax PETERS[9]				+	+	+

* See footnote on p. 43.

FAUNA LIST OF THE ECHINODERMS (EXCEPT HOLOTHURIANS) RECORDED FROM THE RED SEA (Cont.)

Name	Gulf of Aqaba	Gulf of Suez	Northern end of Red Sea	Red Sea S. of 35°N.	Aden E. to Persian Gulf	East Africa
Ophiura kinbergi (LJUNGMAN)	+ ?			+	+	
Ophiolepis cincta M. & TR.[10]	+	? ←	+ ←	+	+	+
Ophiolepis superba H. L. CLARK				+	+	+
Ophiocirce mabahithae MORTENSEN			+			
ECHINOIDEA						
Eucidaris metularia (LAMARCK)[11]	+	+	+	+		+
Prionocidaris baculosa (LAMARCK)	+	+		+	+	+
Phyllacanthus imperialis (LAMARCK)			+	+		+
Asthenosoma varium GRUBE	+			+	+	
Diadema setosum (LESKE)	+	+	+	+	+	+
Echinothrix calamaris (PALLAS)	+			+	+	+
Echinothrix diadema (LINNAEUS)				(+)	+	+
Chaetodiadema granulatum MORTENSEN				+		
Salmacis bicolor L. AGASSIZ				(+)		+
Salmaciella dussumieri erythracis H. L. CLARK				+		+
Microcyphus rousseaui L. AGASSIZ	+			+	+	+
Tripneustes gratilla (LINNAEUS)	+	+	+	+	+	+
Nudechinus scotiopremnus H. L. CLARK	+	+	+			
Parasalenia poehli PFEFFER		+		+		
Echinometra mathaei (DE BLAINVILLE)	+	+	+	+	+	+
Heterocentrotus mammillatus (LINNAEUS)	+		+	+	+	+
Echinolampas ovata (LESKE)		+				
Clypeaster amplificatus KOEHLER				+		
Clypeaster fervens KOEHLER	+				+	
Clypeaster humilis (LESKE)	+	+	+	+	+	+
Clypeaster rarispinus DE MEIJERE		+		+	+	+
Clypeaster reticulatus (LINNAEUS)		+		+	+	+
Fibularia ovulum LAMARCK		+	+	+		
Fibularia volva L. AGASSIZ				+		
Echinocyamus crispus MAZETTI				+	+	
Laganum depressum LESSON *in* L. AGASSIZ	+	+	+	+		+
Laganum joubini (KOEHLER)			+			+
Echinodiscus auritus LESKE	+	+	+	+	+	+
Echinodiscus bisperforatus LESKE[12]		+		+	+	+
Maretia planulata (LAMARCK)				+	+	+
Lovenia elongata(GRAY)	+	+	+	+	+	+
Periconsmus akabanus MORTENSEN	+					
Paraster gibberulus (L. AGASSIZ)[13]			+	+		+

FAUNA LIST OF THE ECHINODERMS (EXCEPT HOLOTHURIANS) RECORDED FROM THE RED SEA (Cont.)

Name	Gulf of Aqaba	Gulf of Suez	Northern end of Red Sea	Red Sea S. of 35°N	Aden E. to Persian	East Africa
Diploporaster savignyi (FOURTAU)		+				+
Moira stygic LÜTKEN *in* A. AGASSIZ		+				+
Brissopsis luzonica (GRAY)				+		+
Metalia spatagus (LINNAEUS)		+				+
Metalia sternalis (LAMARCK)		+			+	+

[Plusses in bold type represent records from the present collections; brackets signify old records requiring recent confirmation.]

Notes:

1. HEMPRICH and EHRENBERG's specimens may have come from the Gulf of Suez or northern end of the Red Sea if not the main part.
2. The record in column four is based on a specimen in the British Museum collections from Ibn Abbas Island in the Sudanese Red Sea.
3. GRAY's specimen was from 'Egypt' and may have been from south of the Gulf of Suez.
4. SAVIGNY's specimens may have been from Suez if not from Qoseir.
5. Including *Ophiactis plana* records of H. L. CLARK, 1939.
6. With synonyms *Ophiothrix beata* KOEHLER, *O. otiosa* KOEHLER and possibly *O. comata* MÜLLER and TROSCHEL.
7. Including *Ophiothrix demessa* records of H. L. CLARK, 1939.
8. I consider that *Ophiothrix triloba* von MARTENS is a synonym of *Ophiotrichoides propinqua*. The median white spot on each dorsal arm plate and the trilobed shape of these plates in the type of *triloba* are mirrored by many specimens of *propinqua*. MORTENSEN has recorded *triloba* from Ghardaqa; the type locality was 'Red Sea'.
9. The record in column four is based on a specimen in the British Museum collections from Port Sudan obtained by a recent Nottingham University expedition.
10. As 1; MORTENSEN has recorded it from Ghardaqa.
11. The record in column four is based on a specimen in the British Museum collections from Mersa Halaib in the Sudanese Red Sea.
12. The record in column five is based on specimens in the British Museum collections from the Gulf of Aden.
13. The type specimen was collected by LEFEBVRE in the Red Sea, presumably in the southern part around Eritrea since most of the marine fishes from his Abyssinian expedition were taken at Massawa.

REFERENCES

AUDOUIN, J. V., 1826. Explication sommaire des planches d'Echinodermes de l'Egypte et de la Syrie publiées par J. C. SAVIGNY, etc. *In*: *Description de l'Egypte; Histoire naturelle*. I.4, Paris: 203–212.

BOUTAN, L., 1892. Voyage dans la Mer Rouge. *Rev. biol. Nord Fr.* 4: 173–182, 210–223, 266–272, 315–362, 403–410, 463–468, 502–510, pls. vii-x: 5: 40–44, 53–69.

BURFIELD, S. T., 1924. A new species and a new variety of Ophiuroid with notes on a collection of Ophiuroidea from the Sudanese Red Sea. *Ann. Mag. nat. Hist.* (9) **13**: 144–154, 2 figs.

CARPENTER, P. H. 1881. The Comatulae of the Leyden Museum. *Notes Leyden Mus.* 3: 173–217.

CHADWICK, H.C. 1908. Reports on the Marine Biology of the Sudanese Red Sea. VII. The Crinoidea. *J. Linn. Soc. Lond.* (*Zool.*) **31**: 44–47.

CLARK, A. H., 1911. The recent crinoids of the coasts of Africa. *Proc. U.S. nat. Mus.* 40: 1–51.

CLARK, A. H., 1917. Two new ophiurans from the China Sea. *Proc. biol. Soc. Wash.*, 30: 13–16.

CLARK, A. H., 1931–1947. A monograph of the existing crinoids. *Bull. U.S. nat. Mus.* 82. 1.3: 1–816, pls. 1–82 (1931); I.4a: 1–603, pls. 1–61 (1941); I.4b: 1–473, pls. 1–43 (1947).

CLARK, A. H., 1937. Crinoidea. *Sci. Rep. John Murray Exped.* IV. 4: 88–108, 1 pl.

CLARK, A. M., 1952. The 'Manihine' Expedition of the Gulf of Aqaba. 1948–1949. VII. Echinodermata. *Brit. Mus.* (*nat. Hist.*) *Zool.* 1: 203–214, pls. 31–32.

CLARK, A. M. & OWEN, H. G., 1965. *Eucidaris* POMEL, 1883, *Papula* BAYLE, 1878, *Cidaris papillataconoidea* PARKINSON, 1811, and *Cidaris savignyi* AUDOUIN, 1826, proposed suppression; coupled with validation of *Eucidaris* DÖDERLEIN, 1887, *Stereocidaris* POMEL, 1883, and *Diadema savignyi* MICHELIN, 1845 (Class Echioidea). *Bull. zool. Nom.* **22**: 237–242.

CLARK, H. L., 1921. The Echinoderm fauna of Torres Strait. *Pap. Tortugas Lab.* 10: 1–223, 38 pls.

CLARK, H. L., 1925, *A catalogue of the recent sea-urchins* (*Echinoidea*) *in the collection of the British Museum* (*Natural History*). London: xxviii + 250, 12 pls.

CLARK, H. L., 1939. Ophiuroidea. *Sci. Rep. John Murray Exped.* VI. 2: 29–136, 62 figs.

DOLLFUS, R. P., 1936. *Stellasreopsis fouadi* n. gen., n. sp., Stelleride commun dans le Golfe de Suez. *Bull. Soc. zool. Fr.* **61**: 151–158, 3 figs.

FOURTAU, R., 1904. Contribution à l'étude des Echinides vivant dans le Golfe de Suez. *Bull. Inst. Egypt* (4) 4: 407–446, 1 pl.

GISLÉN, T., 1940. Crinoidae. *In* Echinoderms from the Iranian Gulf. *Danish. Scient. Investigations Iran.* Copenhagen. 2: 110–111.

GRAY, J. E., 1872. List of Echinoderms collected by ROB. M'ANDREW in the Gulf of Suez in the Red Sea. *Ann. Mag. nat. Hist.* (4) **10**: 115–124.

KOEHLER, R., 1905. Echinides, Astéries et Ophiures recueillis par M. GRAVIER dans la Mer Rouge (Golfe de Tadjourah). *Bull. Mus. Paris* **1905**: 184–185, 1 fig.

KOEHLER, R., 1906. Echinides, Stellérides et Ophiures recueillis par MM. BONNIER et PEREZ dans la Mer Rouge (Côtes d'Arabie). *Bull. Mus. Paris* **1905**: 458–463.

KOEHLER, R., 1907. Revision de la collection des Ophiures du Museum d'Histoire naturelle de Paris. *Bull. sci. Fr. Belg.* **41**: 279–351, 5 pls.

KOEHLER, R., 1930. Papers from Dr. TH. MORTENSEN's Pacific Expedition, 1914–16. LIV. Ophiures recueillis par le Docteur TH. MORTENSEN dans l'Archipel Malais. *Vidensk. Medd. dansk. naturh. Foren.* **89**: 1–295, 20 pls.

LAMARCK, J. B. P. A. de, 1816. *Histoire naturelle des animaux sans vertèbres*. Paris. Ed. 1. 3 vols.

LEIPOLDT, F., 1895. Asteroidea der "Vettor-Pisani" Exped. Mit Anhang: Die von F. ORSINI im rothen Meere gesammelten Asteroideen. *Z. Wiss. Zool.* **59**: 545–654, pls. 31, 32.

LORIOL, P. de, 1885. Catalogue Raisonné des Echinodermes recueillis par M. V. de ROBILLARD à l'Ile Maurice. II. Stellérides. *Mem. Soc. phys. Hist. nat. Genève.* 29(4): 1–84, pls. 7–22.

LUDWIG, H., 1880. Echinodermata. *In* KOSSMANN, R., *Zoologische Ergebnisse einer im Auftrage der Königlichen Academie der Wissenschaften zu Berlin ausgeführten Reise in die Küstengebiete des Rothen Meeres*. II.5, Leipzig: 1–7.

MILLOTT, N., 1953. Colour pattern and the definition of the species, *Diadema antillarum* PHILIPPI. *Experientia* **9**: 98–99, figs.

MORTENSEN, T., 1904. The Danish-Expedition to Siam, 1899–1900. II. Echinoidea. *Danske Selsk. Skr.* (7) 1 (1): 1–124, 7 pls.

MORTENSEN, T., 1926. Cambridge Expedition to the Suez Canal, 1924. VI. Report on the Echinoderms. *Trans. zool. Soc. Lond.* **22**: 117–131, figs. 11–13.

MORTENSEN, T., 1928–1951. *Monograph of the Echinoidea*, Copenhagen. I. Cidaroidea, 551 pp. 173 figs., 88 pls. (1928); III. I. Aulodonta, 370 pp. 196 figs, 77 pls. (1940); III. 2. Camarodonta I, 553 pp., 321 figs., 56 pls. (1943); III. 3. Camarodonta II, 446 pp., 215 figs., 66 pls. (1943a); V.2.Spatangoida II, 593 pp. 286 figs., 64 pls. (1951).

MORTENSEN, T., 1939. Two new deep-sea Echinoderms from the Red Sea. *Publs. Mar. biol. Sta. Ghardaqa*. **1**: 37–46, figs. 1–5, pls. 3–4.

MORTENSEN, T., 1939a and 1948. Report on the Echinoidea of the John Murray Expedition. *Sci. Rep. John Murray Exped.* VI (1): 1–28, figs. 1–10, pls. 1–6(1939); IX (1): 1–15, pl. 1 (1948).

MORTENSEN, T., 1940a. Echinoderms from the Iranian Gulf. Asteroidea, Ophiuroidea and Echinoidea. *Danish Scient. Investigations Iran.* Copenhagen. 2: 55–110, figs. 1–24, pls. 1–2.

MÜLLER, J. & TROSCHEL, F.H., 1842. *System der Asteriden*. 1. Asteriae and 2. Ophiuridae. Braunschweig. xx+134 pp., 12 pls.

SAVIGNY, M.J.C.L.de, 1809–17. *Description de l'Egypte*. Paris. Histoire naturelle. II. Atlas. Echinodermes, pls. 1–9.

TORTONESE, E., 1936. Echinodermi del Mar Rosso. *Ann Mus. Stor. nat. Genova*. **59**: 202–245, figs. 1–8.

TORTONESE, E., 1936a. Ricerche sulla fauna del Mar Rosso. Missione R. Santucci 1932–33. 1. Echinodermi. *Mem. Com. talassogr. ital.* **235**: 3–14, 4 figs.

TORTONESE, E., 1947. Ricerche zoologiche nel Canale di Suez e dintorni. 1. Echinodermi. *Rend. Accad. lincei* (8) 2: 835–838.

TORTONESE, E., 1949. Echinodermi della Somalia Italiana. *Ann. Mus. Stor. nat. Genova*. **64**: 30–42, 1 fig., 1 pl.

TORTONESE, E., 1953. Spedizione subacquea italiana nel Mar Rosso. Ricerche zoologiche. II. Echinodermi. *Riv. Biol. colon.* **13**: 25–48, 6 figs. 1 pl.

TORTONESE, E., 1960. Echinoderms from the Red Sea. I. Asteroidea. *Bull. Sea Fish. Res. Sta. Israel*. **29**: 17–23, 1 pl.