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ECHINODERMS FROM THE GULF OF SUEZ AND THE NORTHERN RED SEA*

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THE Gulf of Suez is the northwesternmost area of the vast Indo-west Pacific region. Because of its northerly position and shallow depth, the Gulf of Suez is relatively temperate in character and large seasonal changes occur. The surface sea temperatures at the shore in the northwestern Gulf of Suez range from means of about 18°C. in the winter to about 28°C. in the summer (Pearse, 1969a). Accordingly, the Gulf of Suez region may be of special interest to zoogeographers and physiologists, and the presence and especially the absence of Indo-Pacific species may provide indications about some of their limiting tolerances. Moreover, because the Gulf of Suez links the Suez Canal and the eastern Mediterranean to the Red Sea, its fauna is of special importance in any consideration of migration of species through the canal.

The specimens reported herein were collected between August, 1965 and April, 1967. During that period, the reproduction of several common invertebrates, including echinoderms, was followed in the Gulf of Suez and the northwestern Red Sea (Pearse, 1967, 1968b, 1969a, 1969b, 1970). A representative collection was made of all species of echinoderms that were found. Particularly intensive collections were made at Wadi el Dom (29°26′ N., 32°30′ E) on the North Qalala Plateau coastline of the northwestern Gulf of Suez (Fig. 1). This site was visited monthly during the 21-month study period and specimens of virtually all species of echinoderms there were collected. Other areas in the northwestern Gulf of Suez where small collections were made included : an oil-polluted reef at Ataqa (29° 57′ N., 32° 28′ E.) ; an area of coral rubble and sand south of Ras Abadiya (29° 50′ N., 32° 29′ E.) ; and the northern limit of growing coral reefs in the western Gulf of Suez at Ain Sukhna (29°34′ N., 32° 21′ E.). Echinoderms were also collected from the northwestern coast of the Red Sea at : the reef on the northern side of the point between the port and administrative centre of Al-Ghardaqa (27° 15′N., 33° 49′ E.) ; the intertidal reef beside a small mangrove colony (26° 37′N., 34° 00′E.) 15.5 km. south of Safaga ; and the reef beside a small natural boat harbour (26° 17′N., 34° 11′E.) 21 km. north of Quseir. All these collections were made while wading at low tide or snorkel diving. We also include in this report a small collection of echinoderms taken from Port Eilat, Israel, by Dr. R. L. Seggev of the Hebrew University of Jerusalem.

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Of the 43 species of echinoderms reported in this paper, none are new and only one, *Ophicomella sexradia,* is recorded for the first time from the Red Sea. *Echi-*

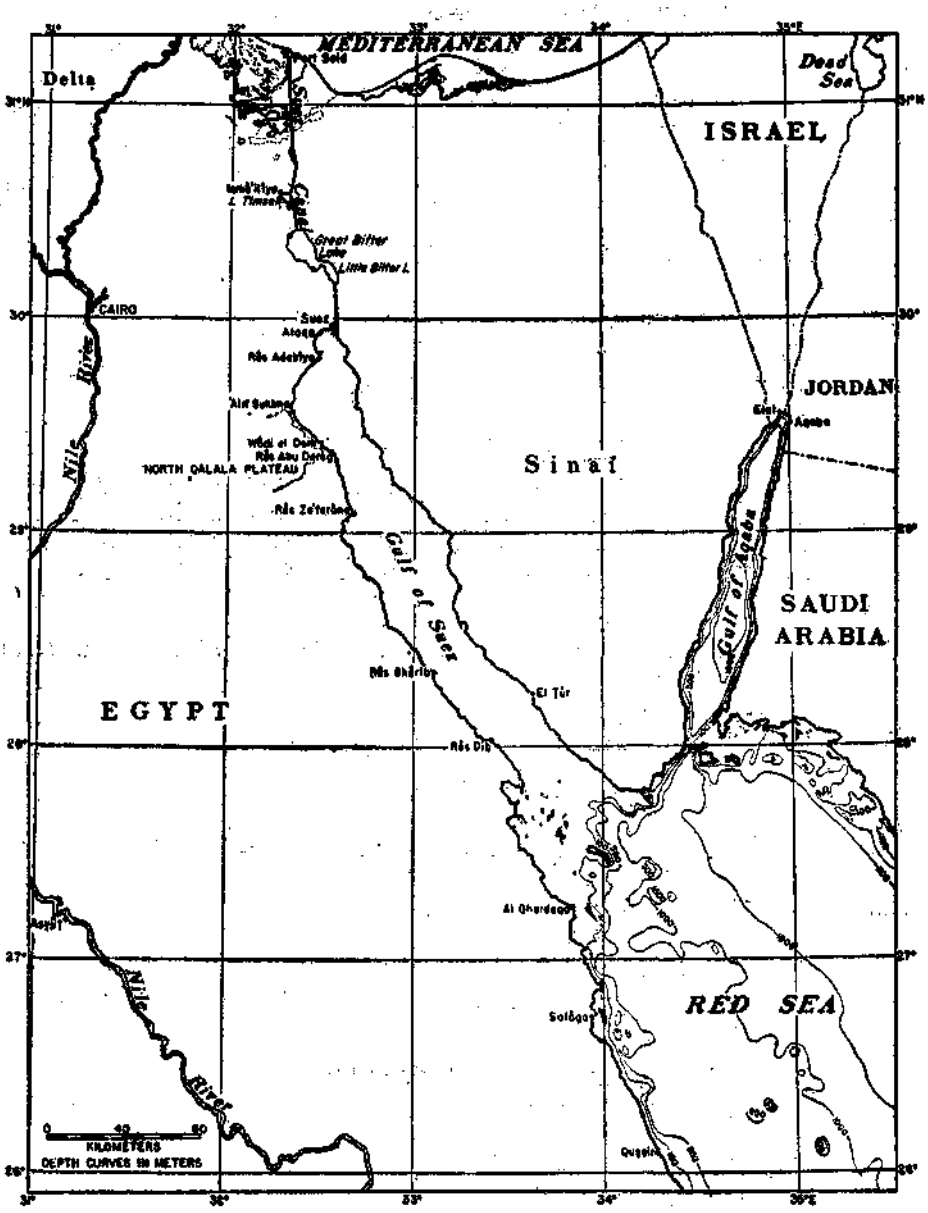

FIG. 1. Map showing the location of the collecting sites and other areas mentioned in the text.

nothrix calamaris, Fibularia volva, Echinodiscus bisperforatus and *Brissopsis luzonica* are new records from the northern Red Sea, however, and *Astropecten orsinii* is a new record from the Gulf of Suez.

CRINOIDEA

Lamprometra klunzingeri (Hartlaub)

Antedon klunzingeri Hartlaub, 1890, p. 175.

Antedon imparipinna Chadwick, 1908, p. 46. (Non *A. imparipinna* P.H. Carpenter, 1882).

Lamprometra palmata Mortensen, 1926, p. 127. (Non *L. palmata* J. Müller, 1841).

Lamprometra klunzingeri A. H. Clark, 1937, p. 89.
Gislen, 1940, p. 111.
A. H. Clark, 1941, pp. 527-536.
Tortonese, 1953a, pp. 26-27.
A. M. Clark, 1967a, pp. 29-30.

Material : Wadi el Dom, 4 specimens.

Remarks : All four specimens were collected on beds of sea grass *Diplanthera wrightii* Arscherson, identified by Dr. M. U. Rao of Central Marine Fisheries Research Institute, Mandapam Camp. The spawning behaviour and other aspects of the biology of this criroid at Eilat has recently been described by Fishelson (1968 a, b).

Distribution : Red Sea (Suez Canal, Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Persian Gulf.

ASTEROIDEA

Luidia maculata Müller and Troschel

Luidia maculata Müller and Troschel, 1842, p. 77.
Walter, 1885, p. 368.
Bell, 1887b, p. 648.
Doderlein, 1888, p. 830.
Bell, 1902, p. 228.
Herdman and Herdman, 1904, p. 143.
Goto, 1914, p. 278.
Fisher, 1919, p. 108.
H. L. Clark, 1921, p. 28.
Russo, 1929, p. 4.
Mortensen, 1940a, p. 63.
H. L. Clark, 1946, p. 71.
James, 1969, p. 52.

Material : Wadi el Dom, 3 specimens.

Description : R/r=300 mm./75 mm.=4/1. Two specimens have seven arms and one has eight arms. The paxillae at the centre of the disc are 3 mm. in size and those at the margin are 5 mm. in a specimen of r 75 mm. The granules at the centre of the paxillae are larger than those at the margin and there are about 20 granules at the centre and 30 granules at the margin of each paxillae. Four rows of square-shaped paxillae are present on each side of the basal three-fourths of the arm. In the mid-region of the arm are smaller, polygonal paxillae.

The adambulacral armature consists of a small, curved spine followed by a slender, long spine. This is followed by two or three large pedicellariae. In addition, there are several small spinelets along the transverse margin of the plates.

The infero-marginal plates have four spinelets at the base of the ray. At the tip of the ray there are only two or three spines. There are one or two pedicellariae between these spines.

Remarks : Specimens of this large species were conspicuous and common on the sand bar at Wadi el Dom. They were found feeding on the echinoid *Lovenia elongata*, engulfing them whole. There were two colour varieties. Most specimens were brown and grey mottled abactinally and pale actinally, but occasionally specimens were solid black abactinally with conspicuous white terminal ossicles.

Distribution : Red Sea (Gulf of Suez) ; Persian Gulf ; Maldives[1] ; southeast coast of India ; Ceylon ; East Indies ; Philippines; Torres Strait ; Australia. Russo (1929) recorded this species from Suez but it has not been recorded from the Red Sea area since that time, and A. M. Clark (1967a) did not include it in her list of Red Sea species.

Luidia savignyi (Audouin)

Asterias savignyi Audouin, 1826.

Luidia savignyi Gray, 1840, p. 183.
Perrier, 1875, p. 324.
Koehler, 1910, p. 10, pl. i, fig. 5 ; pl. vi, fig. 3.
Russo, 1929, p. 4.
A. M. Clark, 1953a, p. 385.
James, 1969, p. 52.

Luidia marcarena Döderlein, 1920, p. 261.

Material : Wadi el Dom, 2 specimens.

Distribution : Red Sea (Gulf of Suez, northern and southern Red Sea) ; North of Zanzibar ; northeast of Durban ; Mauritius ; Ceylon (Palk Bay).

[1] Refers to Mandapam and surrounding areas.

Astropecten orsinii Leipoldt

Astropecten orsinii Leipoldt, 1895, p. 645.
Döderlein, 1917, p. 122.
James, 1969, p. 51.

Material : Wadi el Dom, 10 specimens.

Description : The dorsal side of the disc is covered with paxillae, each with one to five spines at the centre and eight to twelve small spines surrounding the central ones. The paxillae at the centre of the disc are very closely arranged.

There are about 27 supero-marginal plates on each side of the arm. They are rectangular and covered by small spiny stumps. In all the specimens the first supero-marginal plate has a stout spine. In some of the specimens the distal supero-marginal plates have spines.

Each infero-marginal plate has a sharp, long, flattened spine. Below this spine there are four or five rows of spines of which only the first two rows are distinct. Each row has two or three spines. Each plate is bordered by a row of small spines on all sides.

The ambulacral armature usually consists of two rows of spines, although these rows are not always clear. Each row consists of three spines.

The colour of live specimens is pale grey.

Remarks : This species was abundant on the sand bar at Wadi el Dom. Usually specimens were buried just below the surface of the sand but on one occasion, at dusk, they were seen on the surface of the sand ; this suggests that a circadian activity rhythm occurs that is similar to that described for *A. polyacanthus* by Mori and Matutani (1952).

Distribution : *A. orsinii* was previously known from only two records from the Red Sea and is now recorded for the first time from the Gulf of Suez.

Astropecten polyacanthus Müller and Troschel

Astropecten polyacanthus Müller and Troschel, 1842, p. 69.
Döderlein, 1917, p. 134.
Mortenson, 1956.
Russo, 1929, p. 4.
Tortonese, 1936b, p. 210.
H. L. Clark, 1946, p. 74.
Tortonese, 1947, p. 836.
A. H. Clark and Bowen, 1949, p. 3.
Tortonese, 1953a, p. 27.
Tortonese, 1960, p. 17.
A. M. Clark, 1967a, p. 54.
James, 1969, p. 51.

Material : Wadi el Dom, 1 specimen ; Great Bitter Lake, 1 specimen.

Distribution : Red Sea (Suez Canal, Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Zanzibar ; Mozambique ; Mauritius ; Seychelles ; south-east coast of India ; Ceylon ; Andamans ; Mergui Archipelago ; Hong Kong ; China ; East Indies ; Australia (Port Jackson, New South Wales) ; New Zealand ; Japan ; Fiji ; Samoa ; Hawaii.

Fromia ghardaqana Mortensen

Scytaster milliporellus Müller and Troschel, 1842, p. 35. (Non *Asterias milliporella* Lamarck, 1816, p. 564).

Fromia monilis Tortonese, 1936b, pp. 213-214. (Non *F. monilis* Perrier, 1875).

Fromia ghardaqana Mortensen, 1938, p. 37.
A. M. Clark, 1952, p. 205.
Tortonese, 1953a, p. 27.
Tortonese, 1960, p. 18.
A. M. Clark, 1967a, p. 37.
James, 1969, p. 53.

Material : Al-Ghardaqa, 3 specimens.

Remarks : The colour in life is bright red with pale blue spots. This species was common under rocks at a depth of one metre along the outer edge of the reef at Al-Ghardaqa.

Distribution : Known only from the Red Sea, including the Gulf of Aqaba but not from the Gulf of Suez.

Linckia multifora (Lamarck)

Asterias multifora Lamarck, 1816, p. 565.

Linckia multifora Bell, 1902, p. 226.
Fisher, 1919, p. 400.
H. L. Clark, 1921, p. 56.
Tortonese, 1936a, p. 6.
Tortonese, 1936b, p. 204.
Hayashi, 1938, p. 435.
Engel, 1938, p. 16.
Ely, 1942, p. 19.
Tortonese, 1953a, p. 28.
Tortonese, 1960, p. 19.
A. M. Clark, 1967a, p. 39.
James, 1969, p. 53.

Material : Wadi el Dom, 5 specimens ; Al-Ghardaqa, 5 specimens ; 21 km. north of Quseir, 3 specimens.

Remarks : This was the most common asteroid along the western coast of the Gulf of Suez and the northern Red Sea. It occurred subtidally on coral rubble and cobble. Comet forms were common suggesting asexual reproduction through fissiparity. Many had their small cardiac stomach everted when collected although no recognizable food was present. It is likely that these were feeding by ciliary-mucoid means as do other Ophidiasterids (Anderson, 1960).

Distribution : Red Sea (Gulf of Aqaba, Gulf of Suez, northern and southern Red Sea) ; Mozambique ; Mauritius ; Laccadives ; Maldives ; southeast coast of India ; Ceylon ; Port Blair (Andamans) ; Sulu Archipelago ; Celebes ; Molucca Islands ; Amboina ; New Caledonia ; Fiji ; Samoa ; Guam ; Japan ; Hawaii.

Asterina burtoni Gray

Asterina burtoni Gray, 1840, p. 289.
H. L. Clark, 1921, p. 96.
Mortensen, 1926, p. 121.
G. A. Smith, 1927, p. 641.
Tortonese, 1936b, p. 215.
H. L. Clark, 1946, p. 133.
A. M. Clark, 1952, p. 207.
Tortonese, 1960, p. 20.
A. M. Clark, 1967a, p. 37.
James, 1969, p. 54.
Achituv, 1969a, p. 119.
Achituv, 1969b, pp. 329-342.

Asterina cepheus Müller and Troschel, 1842, p. 41.
Döderlein, 1888, p. 825.
Fisher, 1919, p. 411.
Tortonese, 1949, p. 36.

Asterina wega Perrier, 1869, p. 294.
Perrier, 1875, p. 102.
Tortonese, 1936b, p. 215.
Achituv, 1969b, pp. 329-342.

Material : Wadi el Dom, 3 specimens (all regenerating) ; Al-Ghardaqa, 2 specimens, 7-rayed (not regenerating) ; 21 km. north of Quseir, 7 specimens, 5-rayed (not regenerating).

Remarks :* This species was also common along the western shores of the Gulf of Suez and northern Red Sea ; it was found under rocks in the coral rubble and cobble zone just below low tide level from all sampling sites. Their colour was dull brown, red or grey and often mottled. Four to eight-rayed specimens were found. Five-rayed (non-regenerating) specimens were typical in the Red Sea proper, although two seven-rayed, non-regenerating specimens were taken at Al-Ghardaqa. Regenerating specimens with more than five rays were abundant in the Gulf of Suez including Wadi el Dom. It appeared as if they were broken in half along the interradii and most of them had three or four fully formed rays and three or four small regenerating rays, as described by A. M. Clark (1967b) for specimens from the Maldives.

Samples were collected in the winter, spring and summer from Wadi el Dom. They were fixed in Bonin's solution and paraffin sectioned whole. No trace of gonads was found in any of the animals. It is likely that in the Gulf of Suez region, at least, reproduction of this species is wholly by fissiparity (Pearse, 1968b).

Distribution : Eastern Mediterranean ; Red Sea (Suez Canal, Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Zanzibar ; Mauritius ; Maldives ; southeast coast of India ; Ceylon ; Nicobar Islands ; Mergui Archipelago ; Java ; Philippines ; Torres Strait ; Australia ; New Guinea ; New Caledonia.

OPHIUROIDEA

Ophiocomella sexradia (Duncan)

Ophiocnida sexradia Duncan, 1887, p. 92.

Amphiacantha sexradia Matsumoto, 1917, p. 178.
H. L. Clark, 1946, p. 206.

Ophiocomella sexradia R. E. Parslow and A. M. Clark, 1963, p. 43.
James, 1969, p. 56.

Material : 21 km. north of Quseir, 1 specimen.

Description : There are six arms of which three are small and three are large. The disc is round and covered by imbricating scales. There are a number of small, granuliform spines over the disc. The radial shields are small and separate.

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* Since sending this paper to the press we have come across the paper of Achituv (1969b). He separated *Asterina wega* Perrier, 1869 from *A. burtoni* Grey, 1840 on the basis that (a) *A. burtoni* are always 'pentaradiate' with five rays of equal length while *A. wega* are pluriradiate' with three to eight rays of unequal length, (b) *A. burtoni* have only one madreporite while *A. wega* have more than one madreporite, (c) *A. burtoni* reproduces sexually while *A. wega* reproduces mainly by fissiparity and (d) a parasitic barnacle, *Dendrogaster* sp., is found only in *A. burtoni*. Although we have no exact data, it can be stated that almost all the specimens seen in the Gulf of Suez were pluriradiate and seemed to reproduce wholly by fissiparity. In contrast, pentaradiate forms were common in the northern Red Sea, especially at the Qusier site. Achituv (*op. cit*) found only pluriradiate forms in the Mediterranean while the ratio of pentaradiate to pluriradiate forms at Eilat, Gulf of Aqaba was 1 : 4. At the present time it is difficult to decide whether we are dealing with two distinct species, as Achituv concluded, or one species with the fissiparous pluriradiate forms reflecting adverse conditions as A. M. Clark (1952) believed. The apparent gradation from pentaradiate forms in the tropical Red Sea to pluriradiate forms in the more temperate Gulf of Suez and Mediterranean supports the later interpretation.

The interbrachial areas on the ventral side are covered by small, imbricating scales.

The dorsal arm plates are fan-shaped and just touch each other. The ratio of breadth to length of the seventh plate is 1 : 1.4.

The ventral arm plates are pentagonal and just touch each other. The sides of the plates are slightly concave. The ratio of breadth to length of the seventh plate is 1 : 2.7. There is a single tentacle scale for each tentacle pore.

The proximal lateral arm plates have four spines and the rest of the plates have three. The spines are short, smooth and pointed with a rounded base. The ratio of the length of the fourth segment to the longest spine is 1 : 1.6.

White in rectified spirit.

Distribution : Minicoy (Laccadives) ; southeast coast of India ; Port Blair (Andamans) ; Shark Bay (Western Australia) ; the species is recorded here for the first time from the Red Sea.

Ophiocoma scolopendrina (Lamarck)

Ophiura scolopendrina Lamarck, 1816, p. 544.

Ophiocoma scolopendrina Müller and Troschel, 1842, p. 101.
Bell, 1902, p. 228.
Herdman and Herdman, 1904, p. 146.
Matsumoto, 1917, p. 345.
H. L. Clark, 1921, p. 125.
Tortonese, 1936b, p. 222.
Engel, 1938, p. 26.
Ely, 1942, p. 52.
H. L. Clark, 1946, p. 243.
Tortonese, 1949, p. 38.
Tortonese, 1953a, p. 34.
Tortonese, 1953b, p. 70.
A. M. Clark, 1952, p. 207.
A. M. Clark and Davies, 1966, p. 603.
A. M. Clark, 1967a, p. 47.
James, 1969, p. 56.

Ophiocoma molaris Lyman, 1861, p. 79.

Ophiocoma lubrica Koehler, 1898, p. 76.

Material : Al-Ghardaqa, 18 specimens ; 15.5 km. south of Safaga, 1 specimen ; 21 km. north of Quseir, 5 specimens ; Eilat, 1 specimen.

Remarks : This species was the most conspicuous intertidal ophiuroid on the Egyptian coast of the Red Sea. In contrast it was rare or absent on the western shore (at least) of the Gulf of Suez. At Al-Ghardaqa, Safaga and Quseir it was extremely abundant in crevices and under rocks on the mid-intertidal reef flat region. Feeding on the surface scum of the incoming and outgoing tides as described by Magnus (1962) was conspicuous. Gonads full of mature gametes were found in some individuals in the winter, spring and summer but not in the fall. Storch and Niggemann (1967) have described the association between this ophiuroid and a polychæte, *Gyptis ophiocomae*.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea) ; East Africa ; Iranian Gulf ; Maldives ; Laccadives ; southeast coast of India ; Ceylon ; Andamans ; Torres Strait ; Australia ; Japan ; Hawaii ; Paumotus.

Ophiocoma erinaceus Müller and Troschel

Ophiocoma erinaceus Müller and Troschel, 1842, p. 98.
Bell, 1902, p. 228.
H. L. Clark, 1921, p. 127.
Tortonese, 1936b, p. 223.
Engel, 1938, p. 26.
H. L. Clark, 1946, p. 22.
A. M. Clark, 1952, p. 208.
Tortonese, 1953a, p. 35.
A. M. Clark and Davies, 1966, p. 603.
A. M. Clark, 1967a, p. 55.
James, 1969, p. 56.

Material : Al-Ghardaqa, 4 specimens ; 21 km. north of Quseir, 1 specimen.

Remarks : This large species was also common in crevices and under rocks along the Egyptian coast of the Red Sea (but not in the Gulf of Suez). It can be distinguished from *O. scolopendrina* in the field by its uniform black colour both dorsally and ventrally.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea) ; East Africa ; Laccadives ; Maldives ; Ceylon ; Andamans ; Torres Strait ; Australia ; Japan ; Hawaii.

Ophiocoma valenciae Müller and Troschel

Ophiocoma valenciae Müller and Troschel, 1842, p. 102.
H. L. Clark, 1921, p. 131.
Tortonese, 1936b, p. 223.
Mortensen, 1940a, p. 73.
Tortonese, 1949, p. 39.
Tortonese, 1953b, p. 70.
A. M. Clark, 1967a, pp. 44-45.
James, 1969, p. 56,

Material : Al-Ghardaqa, 8 specimens ; 21 km. north of Quseir, 3 specimens.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea) ; east coast of Africa ; Mozambique ; Mauritius.

Ophiocoma pica Müller and Troschel

Ophiocoma pica Müller and Troschel, 1842, p. 101.
H. L. Clark, 1921, p. 127.
Engel, 1938, p. 27.
Ely, 1942, p. 54.
A. M. Clark, 1952, p. 207.
A. M. Clark and Davies, 1966, p. 599.
A. M. Clark, 1967a, pp. 47, 55.
James, 1969, p. 56.

Ophiocoma lineolata Müller and Troschel, 1842, p. 102.
Tortonese, 1953b, p. 71.

Ophiocoma sannio Lyman, 1861, p. 81.

Material : Al-Ghardaqa, 1 specimen ; 15.5 km. south of Safaga, 2 specimens ; 21 km. north of Quesir, 6 specimens.

Remarks : This beautifully lined brittle-star was found under subtidal rocks at 1-2 metres at Al-Ghardaqa and near the reef edge at Safaga and Quseir. At Safaga it was collected from the coral *Stylophora* sp.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea) ; east coast of Africa ; Laccadives ; Maldives ; Ceylon ; Andamans ; Torres Strait ; Australia ; Japan ; Paumotus ; Hawaii.

Ophiocoma sp.

(Fig. 2 A & B)

Material : A single specimen, 3 mm. in disc diameter ; length of arm, 8 mm.

Locality : Al-Ghardaqa ; it was found under a rock on the inter-tidal reef flat.

Description : The disc is round with imbricating scales (Fig. 2 A). At the centre of the disc there is a circular scale. The radial shields are transversely elongated and separated from each other by a few scales. The ratio of length to breadth of each radial shield is 1 : 3.5. The ratio of the length of the radial shield to the diameter of the disc is 1 : 1.4. The granules on the disc are not yet developed.

The interbrachial areas on the ventral side are fully covered by large, imbricating scales.

There are four oral papillae on each side of the jaw (Fig. 2 B). The first papilla the largest of the four and the other three are small and more or less of the same

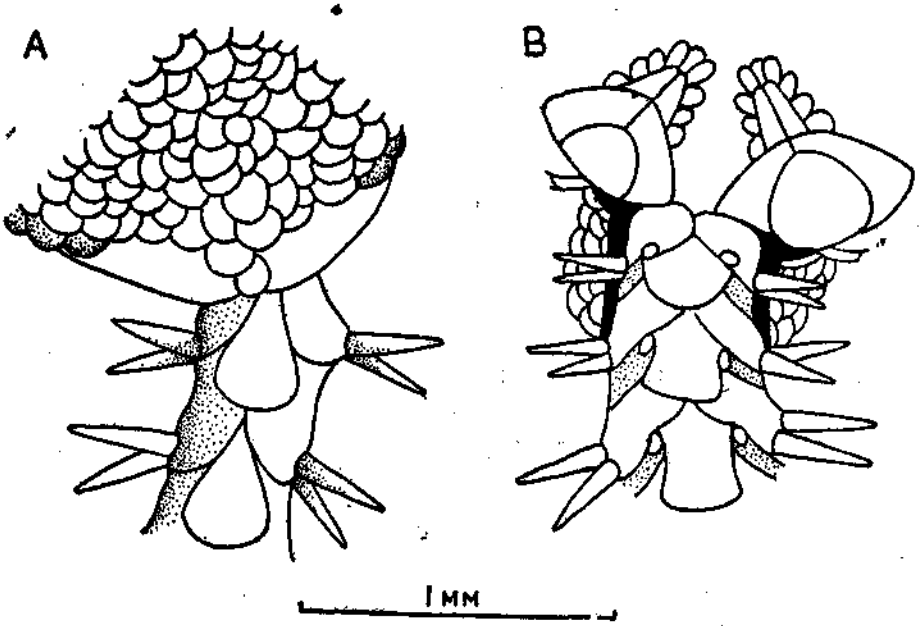


FIG. 2. *Ophiocoma* sp. A. A portion of disc and one arm, dorsal view.
B. Two jaws and part of an arm, ventral view.

size. The regular tooth papillae are not developed. However, just below the first papilla on one of the jaws there is a small tooth papilla. The teeth are large and rectangular. The oral shields are three-sided and the adoral shields are triangular and meet interradially.

The dorsal arm plates are fan-shaped and separate. The ratio of breadth to length of the fourth free plate is 1 : 1.4.

The ventral arm plates are five-sided with the lateral margins slightly concave. The first ventral arm plate is small. The ratio of breadth to length of the fourth free plate is 1 : 1.4. There is a single tentacle scale for each tentacle pore.

On each lateral arm plate there are three short, smooth and pointed spines. The ratio of length of the fourth free segment to the longest spine is 1 : 1.1.

The preserved specimen has a brown disc and light brown and white banded arms. On the ventral side, the interbrachial areas are brown and the arms banded with light brown and white.

Remarks : H. L. Clark (1921) stated that the specific characters in very young specimens of *O. scolopendrina* are not easily seen and hence cannot be definitely identified. The present specimen from Al-Ghardaqa, where adult specimens of *O. scolopendrina* were common, has the characteristic colour pattern of *O. scolopendrina*. The absence of granules, the presence of a single tentacle scale and the

apparent absence of tooth papillae may be due to the very young age of the specimen. Even in adult *O. scolopendrina* the granules on the disc are very sparsely distributed (9 to 16 per sq. mm.).

Ophiothrix savignyi (Müller and Troschel)

Ophionyx savignyi Müller and Troschel, 1842, p. 117.

Ophiothrix beata Koehler, 1907, p. 330.

Ophiothrix savignyi Mortensen, 1926, p. 121.
Tortonese, 1936b, p. 216.
Mortensen, 1940a, p. 67.
Tortonese, 1947, p. 837.
A. H. Clark and Bowen, 1949, p. 4.
Tortonese, 1953a, p. 31.
A. M. Clark, 1967a, pp. 48, 55.
James, 1969, p. 55.

Material: Great Bitter Lake, 1 specimen ; Wadi el Dom, 4 specimens ; Al-Ghardaqa, 2 specimens.

Remarks: This species was the only ophiuroid found within the Gulf of Suez. The specimens collected at Wadi el Dom were within coral heads. Those from Al-Ghardaqa were under rocks off the edge of the reef. The single specimen from the Great Bitter Lake was collected in an encrusting sponge identified as *Tadania anhelans* (Liberkuhn) by Dr. P. A. Thomas of the Central Marine Fisheries Research Institute.

Distribution: Red Sea (Suez Canal, Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Persian Gulf ; east coast of Africa.

Macrophiothrix hirsuta hirsuta (Müller and Troschel)

Ophiothrix hirsuta Müller and Troschel, 1842, p. 111.
Tortonese, 1936b, p. 218.
Tortonese, 1949, p. 37.
A. H. Clark and Bowen, 1949, p. 4.

Macrophiothrix hirsuta H. L. Clark, 1938, p. 285 (part).
A. M. Clark, 1952, p. 209.
Tortonese, 1953a, pp. 33-34.
Tortonese, 1953b, p. 70.
A. M. Clark, 1967a, pp. 47, 55.

Macrophiothrix hirsuta hirsuta A. M. Clark, 1968, pp. 294-296,
James, 1969, p. 55.

Material : Al-Ghardaqa, 3 specimens.

Remarks : The colour in life is uniform pale purplish. The specimens were collected under rocks off the reef edge at about 1-2 m. depth.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea); Persian Gulf; Zanzibar.

Ophionereis dubia (Müller and Troschel)

Ophiolepis dubia Müller and Troschel, 1842, p. 24.

Ophiocrasis marktanneri Matsumoto, 1915, p. 90.
H. L. Clark, 1946, p. 239.

Ophionereis dubia Mortensen, 1926, p. 122.
Tortonese, 1936b, p. 222.
Tortonese, 1949, p. 38.
A. H. Clark and Bowen, 1949, p. 5.
A. M. Clark, 1953b, p. 83.
A. M. Clark, 1967a, p. 47.
James, 1969, p. 56.

Ophionereis stigma H. L. Clark, 1938, p. 325.

Material : Al-Ghardaqa, 1 specimen under a rock off the reef edge 1-2 metres depth.

Distribution : Red Sea (Suez Canal; Gulf of Aqaba, northern and southern Red sea); Persian Gulf; east coast of Africa; Maldives; southeast coast of India; Ceylon; China; Japan.

ECHINOIDEA

Prionocidaris baculosa (Lamarck)

Cidarites baculosa Lamarck, 1816, p. 55.

Rhabdocidaris baculosa Mazetti, 1894, p. 225.
Fourtau, 1903, p. 410.

Prionocidaris baculosa Mortensen, 1926, p. 126.
Mortensen, 1928, pp. 437-452.
Russo, 1931, p. 5.
Tortonese, 1936a, p. 7.
Tortonese, 1936b, p. 225.
Tortonese, 1953a, p. 35.
A. M. Clark, 1967a, p. 48.
James, 1969, p. 57.

Material : Wadi el Dom, 7 specimens.

Remarks : Although abundant at Wadi el Dom, this species was rarely found in other parts of the Gulf of Suez ; occasional specimens were found in other areas of the North Qalala Plateau coastline and a few were found south of Ras Abadiya. None were found along the Red Sea coast of Al-Ghadaqa, Safaga or Quseir. At Wadi el Dom they were found in and around the small fringing reef and often on the offshore and sand bar. The animals fed on both live and dead coral and other assorted animal and plant material. They spawned during July and August (Pearse, 1969a). The spines were usually encrusted with various epiflora and fauna, including small bivalves and stalked barnacles. Often specimens of a brachyuran crab, identified as *Edmedonus vicinus* Rathburn (Parthenopidae) by Dr. J. S. Garth of the Allan Hancock Foundation, were clustered around the peristome. Also, occasionally an amphipod, identified by Dr. T. E. Bowman of the U.S. National Museum as *Amphithoe* sp., was found among the spines.

Distribution : Red Sea (Gulf of Suez, Gulf of Aqaba, southern Red Sea) ; east coast of Africa ; Madagascar ; Mauritius ; Seychelles ; Moluccan Sea ; Philippines.

Diadema setosum (Leske)

Echinometra setosa Leske, 1778, p. 35.

Cidaris savignyi Audouin, 1826, p. 13. (Non *Diadema savignyi* Michelin, 1845, p. 15.)

Diadema savignyi Tortonese, 1936b, p. 225.
Tortonese, 1953b, p. 71.

Diadema setosum Mazetti, 1894, p. 222.
Fourtau, 1903, p. 412.
Tortonese, 1936a, p. 8.
Tortonese, 1936b, p. 226.
Mortensen, 1940b, p. 257.
Tortonese, 1953a, p. 35.
A. M. Clark, 1967a, pp. 49, 50.
James, 1969, p. 58.

Diadema sexatile Koehler, 1927, p. 61.

Aspidodiadema annulatum Koehler, 1927, p. 61.

Centrechinus setosus H. L. Clark, 1932, p. 211.
H. L. Clark, 1946, p. 297.

Remarks : A. M. Clark and Owen (1965) opined that there is every indication that *Diadema savignyi* (Audouin) is a synonym of *D. setosum* (Leske). A. M. Clark (1967a) considers the specimens named by Audouin (1826) from the Red Sea as *Cidarites savignyi* as a synonym of *D. setosum* (Leske) since none of the specimens

from the Red Sea have broad valved tridentate pedicellariae which is characteristic of *D. savignyi* Michelin known from the Mauritius and other regions of the Indo-Pacific. H. L. Clark (1925) considered that *D. setosum* (Leske) can be separated from *D. savignyi* Michelin on the basis of different colour patterns. The colour pattern of the various species of *Diadema* in the Indo-Pacific also certainly change in response to light intensity as shown by Milliot (1953) for *D. antellarium* Phillipi occurring in the West Indies. It will be interesting to study whether the differences pointed out by Mortensen (1940b) in the apical system in *D. setosum* (Leske) and *D. savignyi* Michelin are correlated to the shape of the valves of the tridentate pedicellariae in the two species.

All the specimens examined by us had large tridentate pedicellariae with long narrow valves which is characteristic of *D. setosum* (Leske) (Mortenson, 1904). There appears to be considerable variation in colour pattern since different specimens had interambulacral blue lines, dashes or spots. An orange ring round the anal cone was either present or absent as were the white patches on the peristome.

This species occurred commonly around reefs and rocks all along the western coast of the Gulf of Suez and northwestern Red Sea. They were cryptic by day and foraged at night as described by Thornton (1956) and Magnus (1967). Large aggregations in the open, as occur in the west central Pacific (Pearse and Arch, 1969), were not seen although Fox (1926) reported aggregations at Suez. The animals seemed to be unselective omnivores and ingested loose substrate and scraped films off rocks. Spawning occurred between early June and mid-September in both the Gulf of Suez and northern Red Sea, and, although apparently rhythmic, spawning did not seem directly related to lunar phases (Pearse, 1968a, 1970) as reported earlier by Fox (1924). The spines of most animals at Wadi el Dom, but not those of animals in the Red Sea, carried numerous specimens of platyctenid ctenophores.

Distribution : Red Sea (Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; east coast of Africa ; Madagascar ; Mauritius ; Laccadives ; Maldives ; Andamans ; Malay Archipelago ; Singapore ; East Indies ; Hong Kong ; South Sea Islands ; Japan.

Echinothrix calamaris (Pallas)

Echinus calamaris Pallas, 1774, p. 31.

Echinothrix desorii A. Agassiz, 1873, p. 451.
Russo, 1893, p. 160.
Bell, 1902, p. 230.

Echinothrix calamaris A. Agassiz, 1873, p. 413.
Meijere, 1904, p. 51.
Döderlein, 1906, p. 168.
H. L. Clark, 1921, p. 146.
H. L. Clark, 1923, p. 373.
Koehler, 1927, p. 47.
H. L. Clark, 1932, p. 213.
Mortensen, 1940b, p. 285.
Mortensen, 1940c, p. 37.
Tortonese, 1953a, p. 36.
A. M. Clark, 1967a, p. 51.
James, 1969, p. 58.

Material : 21 km. north of Quseir, 1 specimen ; Eilat, 1 specimen.

Remarks : The single specimen of this beautiful sea urchin from the Quseir site was collected from the outer edge of the reef.

Distribution : Red Sea (Gulf of Aqaba, northern and southern Red Sea) ; east coast of Africa ; Madagascar ; South Africa ; Laccadives ; Maldives ; Chagos Archipelago ; Andamans ; East Indies ; Philippines ; Japan ; Tahiti ; Hawaii. Although recorded previously from Eilat, this record is the first from the northern Red Sea.

Nudechinus scotiopremnus H. L. Clark

Echinus verruculatus Mazetti, 1894, p. 222.
Fourtau, 1903, p. 416.

Nudechinus scotiopremnus H. L. Clark, 1912, p. 227.
H. L. Clark, 1925, p. 128.
Mortensen, 1926, p. 126.
Russo, 1931, p. 4.
H. L. Clark, 1938, p. 401
Mortensen, 1943a, p. 401.
Tortonese, 1947, p. 837.
Tortonese, 1953b, p. 71.
A. M. Clark, 1967a, p. 51.
James, 1969, p. 57.

Material : Ataqa, 2 specimens (empty tests only) ; Great Bitter Lake, 2 specimens (one collected alive, one empty test).

Remarks : This echinoid is very common in the Suez Canal (Fourtau, 1903; Mortensen, 1926 ; Tortonese, 1947) and the empty test collected was one of many that littered the southwestern shore of the Great Bitter Lake in June, 1966. The live specimen was found in about $\frac{1}{2}$ m. of water on a sand and rubble bottom. No live animals were seen in the Gulf of Suez or Red Sea ; the two empty tests collected at Ataqa were on the beach.

Distribution : Red Sea (Suez Canal, Gulf of Suez, Gulf of Aqaba, northern Red Sea) ; Australia.

Tripneustes gratilla (Linnaeus)

Echinus gratilla Linnaeus, 1758, p. 664.

Hipponoe variegata A. Agassiz, 1872, p. 136.
Bell, 1903, p. 249.

Tripneustes angulosus Bell, 1884, p. 121.
Bell, 1902, p. 231.

Tripneustes variegatus Döderlein, 1888, p. 838.

Tripneustes gratilla Meijere, 1904, p. 95.
H. L. Clark, 1915, p. 90.
H. L. Clark, 1921, p. 34.
Koehler, 1927, p. 108.
Tortonese, 1936b, p. 227.
Mortensen, 1943b, p. 500.
Tortonese, 1949, p. 39.
A. M. Clark, 1952, p. 211.
Tortonese, 1953a, p. 36.
Tortonese, 1953b, p. 71.
A. M. Clark and Davies, 1966, p. 399.
A. M. Clark, 1967a, p. 51.
James, 1969, p. 57.

Material : Al-Ghardaqa, 2 specimens ; Eilat, 2 specimens.

Remarks : This species was abundant in the middle zone of the reef flats at Al-Ghardaqa and the Safaga and Quseir sites. Most were hidden in crevices and under ledges along with specimens of *Echinometra mathaei*, and they covered their tests with bits of rocks, shells and debris. They were not found in the Gulf of Suez. There was a bewildering variety of colour and colour patterns among the different animals. Colours ranged from dark through pale shades of purple, grey, brown, or red ; some of the specimens were nearly white. Often the podia and pedicellariae were different colours from those of the spines and test. Spawning occurred only during winter (about November to April) at Al-Ghardaqa (Pearse, 1967, 1968b).

Distribution : Red Sea (Gulf of Suez (?), Gulf of Aqaba, northern and southern Red Sea) ; east coast of Africa ; Laccadives ; Maldives ; Ceylon ; southeast coast of India ; Andamans ; East Indies ; Australia ; South Sea Islands ; Hawaii.

Echinometra mathaei (Blainville)

Echinus mathaei Blainville, 1825, p. 94.

Echinometra lucunter Mazetti, 1894, p. 222.
Bell, 1902, p. 231. (Non *Echinometra lucunter* Linnaeus, 1758, p. 665).
Fourtau, 1903, p. 415.

Echinometra mathaei Meijere, 1904, p. 101.
Koehler, 1927, p. 121.
Mortensen, 1940c, p. 51.
Mortensen, 1943b, p. 381.

Echinometra mathaei H. L. Clark, 1915, p. 91.
H. L. Clark, 1921, p. 151.
Mortensen, 1926, p. 126.
H. L. Clark, 1932, p. 216.
Tortonese, 1936a, p. 9.
Tortonese, 1936b, p. 227.
Mortensen, 1940c, p. 51.
Mortensen, 1943b, p. 381.
A. M. Clark and Bowen, 1949, p. 6.
Tortonese, 1953a, p. 37.
Tortonese, 1953b, p. 72.
A. M. Clark, 1967a, p. 56.
James, 1969, p. 58.

Echinometra mathaei Russo, 1931, p. 3.

Material: Wadi el Dom, 3 specimens; Al-Ghardaqa, 2 specimens; Safaga, 3 specimens; Eilat, 2 specimens.

Remarks: This was the most abundant echinoid along the western shore of the Gulf of Suez. More than 700 specimens were collected from a small area (about 10×100 m.) at the Wadi el Dom site during the 21-month study period, and there was no noticeable decrease in population density. Most of the specimens occurred in the open on the coral rubble and cobble between the shore and offshore reef. They were numerous along the whole North Qalala Plateau coastline except at Ain Sukhna where the animals may have been depleted by swimmers who often collected large numbers and piled them on the shore. Specimens of *E. mathaei* were also common and in the open near Ras Gharib and Ras Dib within the Gulf of Suez. Specimens of *E. mathaei* were also common at Al-Ghardaqa but most were hidden under ledges and in burrows in the middle and lower portions of the reef flat. South of Al-Ghardaqa, at the Safaga site, the animals were also cryptic under ledges and in burrows, and at the Quseir site, most were completely hidden under rocks. A similar change in habitat was noted by A. H. Clark and Bowen (1949) in the Persian Gulf area. Within the semi-enclosed Tarut Bay (26°N., 59°E.), specimens of *E. mathaei* occurred commonly on top of rocks and on the bottom, while along the exposed coast of the Persian Gulf specimens 'tended to be ensconced in rock caves'. A crytic burrowing habit is typical of individuals in more tropical populations.

As noted by Fourtau (1903) and Mortensen (1926) all the individuals of *E. mathaei* in the Gulf of Suez had very dark, nearly black spines. Some of the animals at Al-Ghardaqa had paler brown or greenish spines; and well over half of the specimens at the Safaga and Quseir sites had pale spines. Some of the animals at the Quseir site had nearly white spines. A wide variation in spine colouration among different individuals is typical of tropical populations of *E. mathaei* (Mortensen, 1943b). No specimens with white-tipped, purple-banded spines, often found in the tropics, were found in either the Gulf of Suez or northern Red Sea.

The animals near the mouth of the Gulf of Suez, at Ras Dib and Al-Ghardaqa, were exceptionaly large (Pearse, 1969b); the largest animal collected during the 21-month study period was taken from Ras Dib and measured 84 mm. in length. As

noted previously (Pearse, 1968a), animals 20° latitude or more from the equator tend to reach much larger sizes than those closer to the equator.

The guts of the specimens of *E. mathaei* contained small pellets of silt, sand, diatoms, algæ, phanerogams and amorphous material. Spawning occurred in the summer and fall within the Gulf of Suez, but different individuals spawn at different times throughout the year in the northern Red Sea and farther south (Pearse, 1969b).

The alpheid shrimp *Athanus indicus* (Coutiere) commonly occurred under specimens of *E. mathaei* at Wadi el Dom ; usually one to three shrimps were found under each urchin.

Distribution : Red Sea (Gulf of Aqaba, Gulf of Suez, northern and southern Red Sea); east coast of Africa ; Persian Gulf; Mauritius ; Laccadives ; Maldives ; southeast coast of India ; Ceylon ; Andamans ; Nicobar ; East Indies ; Amboina ; Torres Strait ; Australia ; Philippines ; Japan ; Solomon Islands ; Tahiti ; Gilberts ; Hawaii ; Clarion, Galapagos.

Heterocentrotus mammillatus (Linnaeus)

Echinus mammillatus Linnaeus, 1758, p. 667.

Heterocentrotus mammillatus A. Agassiz, 1873, p. 428.
Mazetti, 1894, p. 222.
Fourtau, 1903, p. 414.
Meijere, 1904, p. 102.
Tortonese, 1936b, p. 228.
Mortensen, 1940c, p. 52.
Mortensen, 1943a, p. 409.
H. L. Clark, 1946, p. 333.
Tortonese, 1953a, p. 38.
A. M. Clark and Davies, 1966, p. 603.
A. M. Clark, 1967a, p. 56.
James, 1969, p. 58.

Material : 21 km. north of Quseir, 2 specimens.

Remarks : These specimens were found hidden deep within the growing coral on the outer reef edge : they were not common. No specimens were found at Al-Ghardaqa, but many were seen off the southeastern side of Giftun al Kebir Island near Al-Ghardaqa. They were not seen in the Gulf of Suez ; Fourtau (1903) reporetd that they were rare north of the mouth of the Gulf of Suez.

Distribution : Red Sea (Gulf of Suez (?) ; Gulf of Aqaba, northern and southern Red Sea) ; Madagascar ; Mauritiue ; Laccadives ; Maldives ; East Indies ; Torres Strait ; Australia ; Philippines ; Fiji ; Bonin Island, Hawaii.

Clypeaster humilis (Leske)

Echinanthus humilis Leske, 1778, p. 121.

Clypeaster humilis A. Agassiz, 1873, p. 510.
Bell, 1884, p. 122.
Mazetti, 1894, p. 219.
Herdman and Herdman, 1904, p. 141.
Koehler, 1922, p. 51.
Tortonese, 1936a, p. 10.
Tortonese, 1936b, p. 228.
Mortensen, 1940a, p. 105.
H. L. Clark, 1946, p. 337.
A. H. Clark and Bowen, 1949, p. 6.
Tortonese, 1953a, p. 38.
A. M. Clark, 1967a, p. 52.
James, 1969, p. 58.

Clypeaster rosaceus Fourtau, 1903, p. 420 (Non *Echinus rosaceus* Linnaeus 1758).

Clypeaster (*Stolonoclypus*) *humilis* Mortensen, 1948a, p. 88.

Material : Al-Ghardaqa, 4 specimens ; Eilat, 1 specimen.

Remarks : The specimens from Al-Ghardaqa were collected at 1-2 metres depth from a wide, sand-filled lagoon between the shore and the outer reef flat. The polychæte *Podarke pugettensis spinnapendens* was often found on specimens of *C. humilis* (Storch and Niggemann, 1967).

Distribution : Red Sea (Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Persian Gulf ; South Africa ; southeast coast of India ; Ceylon ; East Indies ; Malay Archipelago ; Philippines ; Banda Sea ; New Caledonia ; Australia.

Echinodiscus bisperforatus Leske

Echinodiscus bisperforatus Leske, 1778, p. 196.
Mazetti, 1894, p. 220.
Koehler, 1922, p. 128.
H. L. Clark, 1923, p. 394.
Tortonese, 1936b, p. 233.
Mortensen, 1948a, p. 406.
A. M. Clark, 1967a, p. 56.
James, 1969, p. 59.

Tetrodiscus bisperforatus Fourtau, 1903, p. 426.

Material : 10 km. southeast of Ain Sukhna, 4 specimens ; Al-Ghardaqa, 2 specimens.

Remarks : The specimens from near Ain Sukhna were found at ½-1 m. depth in a sandy cave ; those from Al-Ghardaqa were found in the same area as *C. humilis*. Many broken tests occurred on the sand bar at Wadi el Dom but no live animals were found. Colour in life is pale purple.

Distribution : Red Sea (Gulf of Suez, northern and southern Red Sea) ; East Africa ; southeast coast of India ; Ceylon ; New Caledonia. It is recorded here for the first time from the northern Red Sea, although it had been previously reported from the Gulf of Suez and Southern Red Sea.

Echinodiscus auritus Leske

Echinodiscus auritus Leske, 1778, p. 138.
A. Agassiz, 1873, p. 531.
Mazzetti, 1894, p. 220.
Herdman and Herdman, 1904, p. 142.
Meijere, 1904, p. 138.
H. L. Clark, 1915, p. 91.
Koehler, 1922, p. 123.
H. L. Clark, 1923, p. 395.
Tortonese, 1936a, p. 11.
Tortonese, 1936b, p. 231.
Mortensen, T., 1948a, p. 400.
A. H. Clark and Bowen, 1949, p. 6.
Tortonese, 1953a, p. 38.
A. M. Clark, 1967a, p. 56.
James, 1969, p. 59.

Tetradiscus auritus Fourtau, 1903, p. 425.

Material : 10 km. southeast of Ain Sukhna, 1 specimen.

Distribution : Red Sea (Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; Persian Gulf ; east coast of Africa ; Madagascar ; southeast coast of India ; Ceylon ; west coast of India ; Malay Archipelago ; Amboina ; East Indies ; Philippines ; Australia.

Fibularia volva L. Agassiz and Desor

Fibularia volva L. Agassiz and Desor, 1841, p. 142.
A. Agassiz, 1872, p. 130.
Bell, 1884, p. 122.
Bell, 1902, p. 232.
Meijere, 1904, p. 111.
Bell, 1909, p. 20.
H. L. Clark, 1915, p. 91.

H. L. Clark, 1921, p. 152.
Koehler, 1922, p. 139.
H. L. Clark, 1925, p. 164.
H. L. Clark, 1938, p. 421.
H. L. Clark, 1946, p. 348.
Mortensen, 1948a, p. 213.
A. M. Clark, 1967a, p. 56.
James, 1969, p. 59.

Material : Al-Ghardaqa, 5 specimens, collected by Dr. Volker Storch from sandy, subtidal flats near the Marine Biological Station of the Egyptian Institute of Oceanography and Fisheries.

Distribution : Red Sea (northern and southern Red Sea) ; Torres Strait ; Banda Sea. It is recorded here for the first time from the northern Red Sea.

Lovenia elongata (Gray)

Spatangus elongatus Gray, 1845, p. 436.

Lovenia elongata Bell, 1884, p. 123.
Döderlein, 1888, p. 834.
Mazetti, 1894, p. 221.
Fourtau, 1903, p. 429.
Meijere, 1904, p. 193.
Herdman and Herdman, 1904, p. 142.
Döderlein, 1906, p. 265.
H. L. Clark, 1921, p. 154.
H. L. Clark, 1923, p. 404.
H. L. Clark, 1946, p. 381.
Mortensen, 1948b, p. 136.
A. H. Clark and Bowen, 1949, p. 6.
Mortensen, 1951, p. 97.
A. M. Clark, 1967a, p. 52.
James, 1969, p. 59.

Material : Wadi el Dom, 2 specimens ; Elat, 1 specimen.

Remarks : Specimens of this heart urchin were abundant in the offshore sand bar at Wadi el Dom from February 1965 to June 1966. They burrowed just below the surface of the sand and often could be detected by a short track leading to a characteristic oval depression. In June and July, most animals were clumped together in groups of two or three. Many dead animals with spines still intact were found in August and clean, empty tests were abundant in September. The animals were very scarce from September through March, 1967. Males full of spermatozoa could be found throughout the year but, on the basis of oocyte sizes, spawning probably occurred mainly in the spring and summer (Pearse, 1969a).

Distribution : Red Sea (Gulf of Suez, Gulf of Aqaba, northern and southern Red Sea) ; East Africa ; Madagascar ; Maldives ; southeast coast of India ; Ceylon ; East Indies ; Philippines ; Australia ; Japan.

Brissopsis luzonica (Gray)

Kleinia luzonica Gray, 1851, p. 133.

Brissopsis luzonica A. Agassiz, 1872, p. 95.
A. Agassiz, 1873, p. 593.
Meijere, 1904, p. 188.
Döderlein, 1906, p. 258.
Koehler, 1914, p. 207.
H. L. Clark, 1925, p. 213.
H. L. Clark, 1946, p. 371.
Mortensen, 1948c, p. 13.
Mortensen, 1951, p. 397.
A. M. Clark, 1967a, p. 57.
James, 1969, p. 59.

Material : 21 km. north of Quseir, 1 specimen (test only).

Distribution : Red Sea (northern and southern Red Sea) ; East Africa ; Maldives ; East Indies ; Australia ; New Caledonia ; Tahiti ; Eastern New Zealand ; Japan ; Hawaii.

HOLOTHUROIDEA

Ohshimella erhenbergi (Selenka)

Urodemas erhenbergi Selenka, 1868, p. 114.

Phyllophorus erhenbergi Théel, 1886, p. 151.
Cherbonnier, 1955, p. 169.

Phyllophorus frauenfeldi Théel, 1886, p. 151.
H. L. Clark, 1923, p. 417.

Cucumaria turbinata Pearson, 1903, p. 189.

Ohshimella erhenbergi Heding and Panning, 1954, pp. 133-137.
A. M. Clark and Davies, 1966, p. 603.
Cherbonnier, 1967, p. 57.
James, 1969, p. 60.

Material : Al-Ghardaqa, 12 specimens.

Remarks : These small, bluish-black holothuroids were common under rocks in 1-2 m. water on the outer edge of the reef.

Distribution : Red Sea ; South Africa ; Maldives ; Ceylon.

Stichopus monotuberculatus (Quoy and Gaimard)

Holothuria monotuberculatus Quoy and Gaimard, 1833, p. 131.

Stichopus monotuberculatus Cherbonnier, 1952, p. 23.
Cherbonnier, 1955, p. 161.
Cherbonnier, 1963, p. 5.
James, 1969, p. 61.

Material : Wadi el Dom, 1 specimen.

Remarks : The single specimen was found dead on the inner side of the offshore sand bar. It had probably been washed in from deeper waters.

Distribution : Red Sea ; Mauritius.

Stichopus variegatus Semper

Stichopus variegatus Semper, 1868, p. 73.
Ludwig, 1887, p. 1224.
Pearson, 1903, p. 205.
Koehler and Vaney, 1908, p. 23.
H. L. Clark, 1921, p. 187.
H. L. Clark, 1922, p. 67.
Engel, 1933, p. 11.
Tortonese, 1936b, p. 239.
Heding, 1940, p. 124.
Cherbonnier, 1947, p. 187.
Tortonese, 1953a, p. 46.
Domantay, 1961, p. 99.
Cherbonnier, 1967, p. 57.
James, 1969, p. 61.

Material : Al-Ghardaqa, 1 specimen, uncommon near the outer reef edge.

Distribution : Red Sea ; Persian Gulf ; Gulf of Oman ; Madagascar ; Maldives ; southeast coast of India ; Ceylon ; Andamans ; Philippines ; Torres Strait ; Australia.

Actinopyga mauritiana (Quoy and Gaimard)

Holothuria mauritiana Quoy and Gaimard, 1833, p. 138.

Muelleria mauritiana Selenka, 1867, p. 315.
Ludwig, 1882, p. 134.
Bell, 1884, p. 510.
Sluiter, 1901, p. 24.

Muelleria varians Selenka, 1867, p. 310.

Actinopyga mauritiana Théel, 1886, p. 201.
Pearson, 1903, p. 199.
Fisher, 1907, p. 648.
Koehler and Vaney, 1908, p. 22.
Tortonese, 1936a, p. 12.
H. L. Clark, 1946, p. 440.
Cherbonnier, 1952, p. 41.
Cherbonnier, 1955, p. 139.
Domantay, 1961, p. 94.
A. M. Clark and Davies, 1966, p. 603.
Cherbonnier, 1967, p. 55.
James, 1969, p. 61.

Holothuria (*Actinopyga*) *mauritiana* Panning, 1929, p. 128.

Material : Al-Ghardaqa, 1 specimen.

Remarks : This species grows to over 400 mm. and has conspicuous black and white blotches. It was relatively common on the outer edge of the reef flat.

Distribution : Red Sea ; Zanzibar ; Mozambique ; Laccadives ; Maldives ; Ceylon ; Andamans ; East Indies ; Philippines : Japan ; Torres Strait ; Australia ; Tahiti ; Paumotus ; Fiji ; Hawaii.

Microthele nobilis (Selenka)

Muelleria nobilis Selenka, 1867, p. 313.

Actinopyga nobilis Fisher, 1907, p. 647.
Mitsukuri, 1912, p. 48.
H. L. Clark, 1921, p. 189.
H. L. Clark, 1946, p. 440.

Microthele nobilis A. M. Clark, 1952, p. 212.
Cherbonnier, 1955, p. 140.
A. M. Clark and Davies, 1965, p. 603.
Cherbonnier, 1963, p. 5.
Cherbonnier, 1967, p. 56.
James, 1969, p. 61.

Holothuria (*Microthele*) *nobilis* Rowe, 1969, p. 162.

Material : Al-Ghardaqa, 1 specimen.

Remarks : This was a relatively uncommon large, black holothurian with a very thick body wall.

Distribution : Red Sea ; Natal ; Maldives ; Laccadives ; Australia ; Fiji ; Samoa ; Hawaii.

Microthele difficilis Semper

Microthele difficilis Semper, 1868, p. 92.
Panning, 1929, p. 136.
Deichmann, 1958, p. 288.
A. M. Clark and Davies, 1966, p. 603.
Cherbonnier, 1967, p. 57.
James, 1969, p. 61.

Holothuria whitmaei Bell, 1887c, p. 532.
Rowe, 1969, p. 164.

Holothuria altimensis H. L. Clark, 1921, p. 172.

Actinopyga bedfordi Deichmann, 1922, p. 212.

Holothuria (*Microthele*) *excellens* Panning, 1929, p. 132.

Holothuria (*Microthele*) *bedfordi* Panning, 1929, p. 136.

Holothuria (*Holothuria*) *altimensis* Panning, 1935, p. 94.

Holothuria difficilis H. L. Clark, 1946, p. 436.

Holothuria (*Platyperona*) *difficilis* Rowe, 1969, p. 144.

Material : Al-Ghardaqa, 1 specimen.

Distribution : Red Sea ; East Africa ; Mauritius ; Maldives ; Laccadives ; Torres Strait ; Australia ; Japan ; Samoa ; Fiji ; Easter Island ; Clipperton.

Holothuria arenicola Semper

Holothuria humilis Selenka, 1867, p. 339.
Théel, 1886, p. 218.
Fisher, 1907, p. 660.

Holothuria maculata Selenka, 1867, p. 331.
Théel, 1886, p. 198.
Sluiter, 1901, p. 9.
Koehler and Vaney, 1908, p. 11.
Pearson, 1913, p. 80.

Holothuria arenicola Semper, 1868, p. 81.
Théel, 1886, p. 222.
Fisher, 1907, p. 662.
H. L. Clark, 1921, p. 173.
Tortonese, 1936b, p. 234.
H. L. Clark, 1946, p. 438.
Tortonese, 1953a, p. 44.
Cherbonnier, 1955, p. 152.
Cherbonnier, 1967, p. 56.
James, 1969, p. 61.

Holothuria rathburni Théel, 1886, p. 68.

Holothuria lineata Bell, 1887, p. 140.

Holothuria (*Holothuria*) *arenicola* Panning, 1934, p. 88.

Holothuria monsuni Heding, 1939, p. 217.

Brandtothuria arenicola Deichmann, 1958, p. 291.

Holothuria (*Thymiosycia*) *arenicola* Rowe, 1969, p. 147.

Material : Wadi el Dom, 1 specimen ; Al-Ghardaqa, 2 specimens, collected under rocks subtidally.

Distribution : The species is circumtropical in occurrence and is reported from the Red Sea ; Zanzibar ; Mauritius ; Maldives ; East Indies ; Andamans ; Philippines ; Loyalty Islands ; New Guinea ; Torres Strait ; Australia ; Japan ; Fiji ; Tahiti ; Hawaii ; Galapagos ; Cocos ; Curaçao ; Gulf of Mexico.

Holothuria impatiens (Forskål)

Fistularia impatiens Forskål, 1775, p. 121.

Holothuria botellus Selenka, 1867, p. 305.

Holothuria impatiens Selenka, 1867, p. 340.
Théel, 1886, p. 179.
Sluiter, 1901, p. 9.
Koehler and Vaney, 1908, p. 8.
Pearson, 1913, p. 85.
H. L. Clark, 1921, p. 178.
Tortonese, 1936b, p. 234.
Heding, 1940, p. 121.
H. L. Clark, 1946, p. 434.
Tortonese, 1947, p. 837.
Tortonese, 1953a, p. 44.
Cherbonnier, 1955, p. 148.
Domantay, 1961, p. 88.
Cherbonnier, 1963, p. 5.
A. M. Clark and Davies, 1966, p. 603.
Cherbonnier, 1967, p. 56.
James, 1969, p. 61.

Holothuria sphanes Sluiter, 1901, p. 16.

Holothuria (Holothuria) impatiens Panning, 1935, p. 86.

Brandtothuria impatiens Deichmann, 1958, p. 293.

Holothuria (Thymiosycia) impatiens Rowe, 1969, p. 146.

Material : 5 km. south of Abadiya Point, 1 specimen ; Al-Ghardaqa, 3 specimens.

Remarks : This mottled brownish species can be distinguished in the field from *H. arenicola* by the presence of a rough body wall with a granular texture.

Distribution : Circumtropical in occurrence and reported from the Mediterranean Sea ; Red Sea ; Persian Gulf ; Zanzibar ; South Africa ; Mozambique ; Maldives ; Laccadives ; Ceylon ; Andamans ; Great Cocos-Keeling ; East Indies ; Philippines ; Torres Strait ; Australia ; Loyalty Islands ; Fiji ; Tahiti ; Hawaii ; Galapagos ; Panama ; Tortugas ; Curaçao ; Bahamas ; Mexico.

Holothuría pardalis Selenka

Holothuria subditiva Selenka, 1867, p. 338.
Théel, 1886, p. 225.

Holothuria pardalis Selenka, 1867, p. 336.
Bell, 1884, p. 509.
Théel, 1886, p. 224.
Sluiter, 1901, p. 12.
Fisher, 1907, p. 664.

Pearson, 1913, p. 78.
Helfer, 1912.
Helfer, 1913, p. 433.
H. L. Clark, 1921, p. 181.
Tortonese, 1936b, p. 238.
Heding, 1940, p. 123.
Cherbonnier, 1955, p. 150.
A. M. Clark and Davies, 1966, p. 600.
Cherbonnier, 1967, p. 56.
James, 1969, p. 61.

Holothuria lineata Bell, 1884, p. 152.
Théel, 1886, p. 225.
Fisher, 1907, p. 664.

Holothuria insignis Théel, 1886, p. 226.

Holothuria peregrina Théel, 1886, p. 225.

Holothuria (*Holothuria*) *pardalis* Panning, 1935, p. 3.

Lessonothuria pardalis Deichmann, 1958, p. 296.

Holothuria (*Lessonothuria*) *pardalis* Rowe, 1969, p. 150.

Material : Wadi el Dom, 1 specimen ; Al-Ghardaqa, 3 specimens.

Remarks : The colour of the species is pale tan and grey-speckled. The one from Wadi el Dom was buried in the outer edge of the sand bar while those from Al-Ghardaqa were under rocks on the outer edge of the reef. All specimens were collected from 1-2 m. depth.

Distribution : Red Sea ; Persian Gulf ; Somalia ; Zanzibar ; Laccadives ; Maldives ; Gulf of Kutch ; southeast coast of India ; Andamans ; East Indies ; Torres Strait ; Australia ; Japan ; Hawaii ; Galapagos ; Cocos.

Holothuria poli Delle Chije

Holothuria polii Delle Chiaje, 1823, p. 80.
Panning, 1934, p. 48.
Cherbonnier, 1951, p. 24.
Cherbonnier, 1955, p. 143.
James, 1969, p. 62.

Holothuria (*Lessonothuria*) *poli* Rowe, 1969, p. 149.

Material : Wadi el Dom, 1 specimen.

Remarks : The single specimen was found buried in the sand on the inner side of the sand bar. The body outline was evident in the sand and both the mouth and the anus were open to the surface. The colour was very dark brown, nearly black body with pale tan, nearly white papillae and tentacles.

Distribution : Mediterranean Sea ; Red Sea.

Holothuria albiventer Semper

Holothuria albiventer Semper, 1868, p. 83.
Erwe, 1919, p. 185.
Panning, 1935, p. 103.
H. L. Clark, 1946, p. 431.
Cherbonnier, 1955, p. 155.
Cherbonnier, 1963, p. 5.
Cherbonnier, 1967, p. 56.
James, 1969, p. 62.

Holothuria (*Metriatyla*) *albiventer* Rowe, 1969, p. 160.

Material : Great Bitter Lake, 1 specimen.

Remarks : The single large, grey-speckled specimen was found on a sand and gravel bottom near the shore on the southwest side of the Great Bitter Lake. Mortensen (1926) did not record this species from the Suez Canal.

Distribution : Red Sea ; Kerimba Archipelago ; Philippines ; Australia.

Holothuria leucospilota (Brandt)

Stichopus leucospilota Brandt, 1835, p. 51.

Holothuria vagabunda Selenka, 1867, p. 343.
Ludwig, 1882, p. 135.
Bell, 1884, p. 510.
Théel, 1886, p. 180.
Sluiter, 1901, p. 12.
Pearson, 1903, p. 201.
Fisher, 1907, p. 660.
Koehler and Vaney, 1908, p. 17.
Heding, 1940, p. 121.
Cherbonnier, 1955, p. 145.
Cherbonnier, 1967, p. 56.

Holothuria fusco-rubra Théel, 1886, p. 182.

Holothuria leucospilota H. L. Clark, 1923, p. 423.
Tortonese, 1936a, p. 14.
H. L. Clark, 1946, p. 438.
Deichmann, 1958, p. 337.
Tortonese, 1953a, p. 41.
Cherbonnier, 1963, p. 6.
A. M. Clark and Davies, 1966, p. 603.
James, 1969, p. 62.

Holothuria (*Holothuria*) *vagabunda* Panning, 1934, p. 67.

Holothuria fasciata Cherbonnier, 1952, p. 27.

Mertensiothuria leucospilota Deichmann, 1958, p. 297.

Holothuria (*Mertensiothuria*) *leucospilota* Rowe, 1969, p. 148.

Material: Al-Ghardaqa, 1 specimen.

Remarks: Specimens of this large, reddish-brown or black holothuroid were abundant and conspicuous in the open on the middle region of the reef flat at Al-Ghardaqa. The body wall was relatively thin and flaccid, and copious amounts of white Cuvierian tubules were discharged with slight provocation. Specimens were occasionally seen along the North Qalala Plateau coastline of the Gulf of Suez (near Ain Sukhna) but they were not found at Wadi el Dom. At Al-Ghardaqa, specimens with mature gametes were found only during the summer (Pearse, 1968b, =*Bohadschia* sp.)

Distribution: Red Sea; Persian Gulf; Zanzibar; South Africa; Laccadives; Maldives; southeast coast of India; Ceylon; Andamans; Mergui Archipelago; East Indies; Philippines; Australia; Fiji; Loyalty Islands; Society Islands; Tahiti; Hawaii; Galapagos; Clipperton.

Chondrocloea reciprocans (Forskål)

Synapta reciprocans Forskål, 1775, p. 121.
Selenka, 1867, p. 364.
Semper, 1868, p. 14.

Synaptula reciprocans Mortensen, 1926, p. 117.
Heding, 1928, p. 160.
Tortonese, 1936b, p. 241.
Tortonese, 1947, p. 838.
Tortonese, 1953a, p. 46.

Synaptula reciproquans Cherbonnier, 1955, p. 173.
Cherbonnier, 1967, p. 57.

Chondrocloea reciprocans James, 1969, p. 62.

Material : Great Bitter Lake, 2 specimens ; Wadi el Dom, 1 specimen ; Al-Ghardaqa, 2 specimens.

Remarks : As reported by Mortensen (1926) and Tortonese (1947), this synaptid was abundant within the Suez Canal. It was especially common on a phanerogam bed on the sandy bottom along the northwest shore of the Great Bitter Lake. It was not common either at Wadi el Dom or at Al-Ghardaqa. All the specimens in the Great Bitter Lake and at Wadi el Dom were solid black in colour, while one at Al-Ghardaqa was pale tan and brown-speckled and the other was banded with dark brown and pale tan.

Distribution : Known only from the Red Sea.

Patinapta dumasi Cherbonnier

Patinapta dumasi Cherbonnier, 1955, p. 174.
Cherbonnier, 1967, p. 57.

Material : Wadi el Dom, 1 specimen ; Al-Ghardaqa, 1 specimen.

Remarks : This small, pale pink synaptid was common at the mid- and low tide level within the gravel and cobble beaches at both Wadi el Dom and Al-Ghardaqa.

Distribution : Known only from the Red Sea.

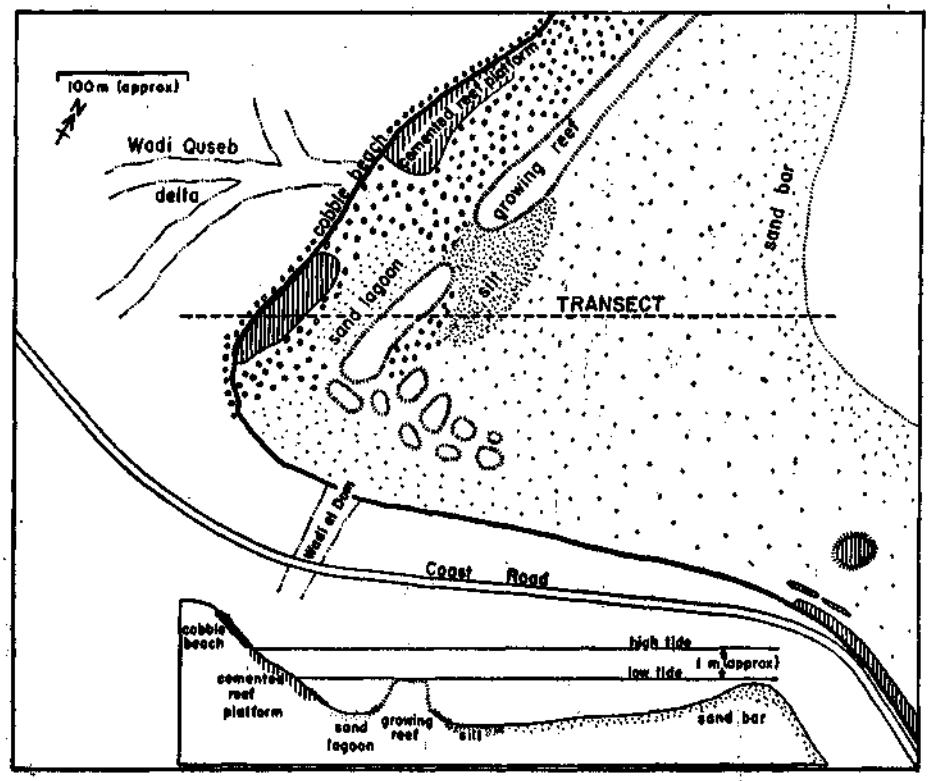
Discussion

Wadi el Dom : The site at Wadi el Dom was visited monthly during the 21-month study period and specimens were collected of all species of echinoderms found there. Because the coast of the Gulf of Suez and its echinoderm fauna are poorly known, a brief description of the site and the distribution of echinoderms found there is presented below.

Figure 3 shows a sketch and relief transect of the Wadi el Dom site during the study period. The Wadi el Dom site was in a small cove on the eastern side of a prominent delta formed by Wadi Quseb, a major drainage system of the North Qalala Plateau. Wadi el Dom itself emptied into the cove and was very small. A sand beach ran along the southern and eastern side of the cove while on the western side there was a cobble beach broken by several intertidal cemented reef platforms. A narrow, growing coral reef fringed the cobble beach and within the head of the cove there were isolated coral clumps. Sea-ward from the fringing reef was a sand bar which was exposed during extreme low tides (tidal range, about 1 m.). There were patches of phanerogams (mainly *Diplanthera wrightii*) on the sand bar, especially on the outer edge.

Live specimens of 17 species of echinoderms were collected and identified from the Wadi el Dom site. Of these, 9 were common. The only intertidal species was the small synaptid *Patinapta dumasi* which was found under rocks on the western beach. Some specimens of the asteroids *Linckia multifora* and *Asterina burtoni* and the echinoid *Echinometra mathaei* were exposed during very low tides, but most of them were observed among the rocks and cobble just below the low

tide level. *E. mathaei* was especially common on the loose subtidal cobble but it also occurred in cracks and crevices of the raised reef platforms and within and



Lamprometra klunzringeri
Luidia maculata
L. savignyi
Astropecten orsinii
A. polyacanthus
Linckia multiflora
Asterina burtoni
Ophiothrix savignyi
Prionocidaris baculosa
Diadema setosum
Echinometra mathaei
Lovenia elongata
Holothuria arenicola
H. pardalis
H. poli
Chondrocloea reciprocans
Patinopta dumasi

FIG. 3. Sketch of the collecting site at Wadi el Dom in the northwestern Gulf of Suez, with a profile transect of the area and a listing of the echinoderms found. The lines and dots to the right of the echinoderm species show where they occurred with respect to the profile.

about the growing coral reef. The echinoids *Diadema setosum* and *Prionocidaris baculosa* were abundant among crevices in the growing coral reef. *P. baculosa*

also occurred in the open on cobble around the coral reef and occasionally on the sand bar. Buried just under the surface of the sand bar were numerous specimens of the asteroids *Luidia maculata* and *Astropecten orsinii* and the echinoid *Lovenia elongata*.

The only ophiuroid found at Wadi el Dom was *Ophiothrix savignyi*; it is perhaps noteworthy that this species was the most common ophiuroid found by A. H. Clark and Bowen (1949) in the semi-enclosed Tarut Bay in the Persian Gulf. It is also common in the Suez Canal (Mortensen, 1926; Tortonese, 1947) and was found there during the present study.

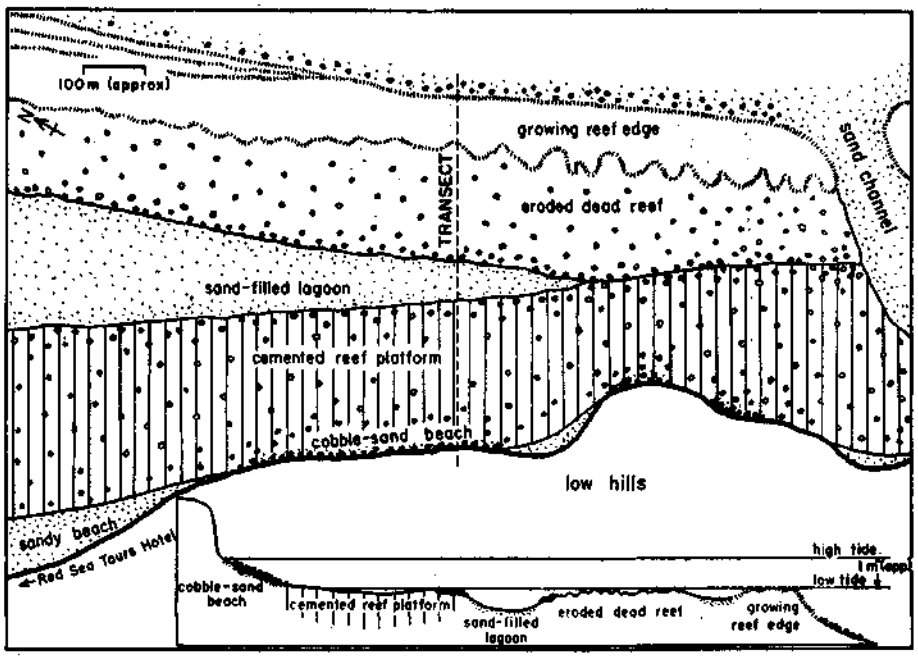
The other species of echinoderms found at Wadi el Dom were not common and all live specimens found were collected. In addition, a dead specimen of the holothuroid *Stichopus monotuberculatus* was found on the inner side of the sand bar and many clean, broken tests of the echinoid *Echinodiscus bisperforatus* were found in the sand on the eastern side of the cove. A single spatangoid echinoid was found buried about 12 cm. below the surface of the silt on the inner side of the sand bar but it was broken beyond identification during shipment.

The area at Wadi el Dom was similar to that of the whole coastline of the North Qalala Plateau from Ain Sukhna to Ras Za'farana. Most of the coastline had a cobble-rubble beach and a narrow, offshore fringing reef. Sand-filled coves intermittently broke the coastline, especially on the eastern sides of small deltas such as at Wadi el Dom. North of Ain Sukhna, the coastline was mainly a sandy beach, although there were a few dead reefs around Ras Abadiya and at Ataqa. From Ras Za'farana south to about Ras Dib, the coastline was mainly a cobble-rubble beach and the offshore fringing reef was poorly developed or absent.

The echinoderm fauna along the North Qalala Plateau appeared to be similar to that at Wadi el Dom. Large numbers of the asteroids *Linckia multifora* and *Asterina burtoni* and the echinoid *Echinometra mathaei* were found on the cobble and rubble inside the fringing coral reef. However, specimens of the echinoids *Diadema setosum* and *Prionocidaris baculosa*, although usually conspicuous, were not as abundant elsewhere as at Wadi el Dom, and specimens of the echinoid *Echinodiscus bisperforatus* (but not *Lovenia elongata*) were common in the sand of the coves east of Ain Sukhna. Several specimens of the holothuroid *Holothuria leucospilota* were also seen in these coves. These observations suggest that, while the Wadi el Dom site was similar to other areas of the North Qalala Plateau coastline, some unusual conditions prevailed there.

Al-Ghardaqa: The site at Al-Ghardaqa was visited only 6 times and the observations made there were very incomplete. Nevertheless, it is instructive to compare the Al-Ghardaqa site, and its echinoderm fauna, with that at Wadi el Dom (Fig. 4). The 'shore reef' system at Al-Ghardaqa has been well described by Crossland (1938) and it is similar to shore reefs found throughout the Indo-Pacific region (see, e.g., Nesteroff, 1955; Wells, 1957; Stoddart, 1969). The system at Al-Ghardaqa was much more extensive than at Wadi el Dom, providing a much wider intertidal area. However, a comparison of Figures 3 and 4 reveals that the general physiography of both areas was similar. The narrow fringing reef at Wadi el Dom was comparable to the growing reef edge at Al-Ghardaqa. Between the shore and the growing reef edge were a cobble-sand beach, an intertidal cemented reef platform and a sand-filled lagoon. All of these features occurred at Wadi el Dom on a much reduced scale. The dead, much-eroded reef zone at Al-Ghardaqa was very much reduced or absent at Wadi el Dom, although smaller versions of it were

seen elsewhere along the North Qalala Plateau coastline (e.g., at Ras Abu Darag). Both the cemented reef platform and the dead, eroded reef zone at Al-Ghardaqa were covered with low-growing red algae, a feature not found along most of the



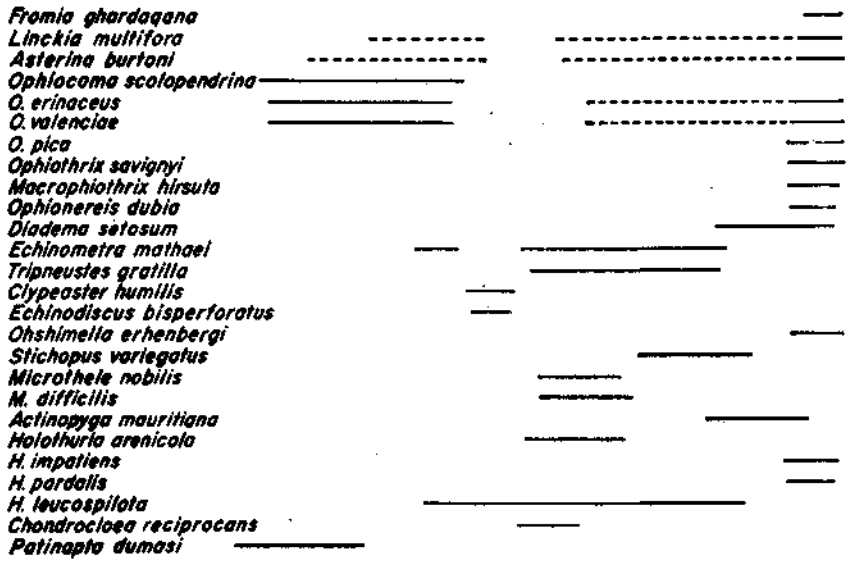


FIG. 4. Sketch of the collecting site at Al-Ghardaqa in the northwestern Red Sea, with a profile transect of the area and a listing of the echinoderms found. The lines and dotes to the right of the echinoderm species show where they occurred with respect to the profile.

North Qalala Plateau coastline. The offshore sand bar at Wadi el Dom was probably a special feature there attributable to the shape of the cove.

The shore reef system at the Safaga and Quseir sites were similar to, but narrower than, that at Al-Ghardaqa. Moreover, at the Safaga and Quseir sites a wide, cemented reef platform intervened between the dead, eroded reef zone and the narrow, growing reef edge and the water depth dropped off sharply at the edge of the reef. There was a small mangrove colony (*Aviçennia marina*) at the Safaga site and the cobble-sand shore, inner cemented reef platform and sand-filled lagoons were nearly obliterated by the mangroves growing in the mud.

The distribution of several of the common species of echinoderms was similar at the Wadi el Dom and Al-Ghardaqa sites. The asteroids *Linckia multifora* and *Asterina burtoni*, ophiuroid *Ophiothrix savignyi*, echinoids *Echinometra mathaei* and *Diadema setosa* and the holothuroid *Patinapta dumasi* were found in the same general areas at both sites. However, the reef system at Al-Ghardaqa supported a much larger echinoderm fauna than at Wadi el Dom, and many of the most common and conspicuous echinoderms there were rare or absent along the western shore of the Gulf of Suez. These species include the ophiuroids *Ophiocoma scolopendrina*, *O. erinaceus*, *O. valenciae* and *O. pica*, the echinoid *Tripneustes gratilla* and the holothuroids *Stichopus variegatus*, *Actinopyga mauritiana*, *Holothuria nobilis*, *Holothuria difficilis* and *Holothuria leucospilota* (this last species was found elsewhere on the North Qalala Plateau coastline but not at Wadi el Dom).

All of these species are common, widespread Indo-Pacific forms and their rarity or absence along the western shore of the Gulf of Suez suggests that within the Gulf there are markedly different environmental conditions than in the Red Sea. The fact that the echinoid *Echinometra mathaei* in the Gulf of Suez is not cryptic, has a uniformly dark colouration and spawns only in the summer while at Al-Ghardaqa and farther south it is usually cryptic, varies widely in colour and spawns throughout the year (Pearse, 1969b), further points to a marked environmental difference between the Gulf of Suez and the adjacent Red Sea. Moreover, the abalone *Haliotis pustulatus* spawns only in the summer in the Gulf of Suez while it spawns throughout the year in the adjacent Red Sea (Pearse 1968b) ; and as noted in the present paper, the synaptid *Chondrocloea reciprocans* was black in the Suez Canal and at Wadi el Dom, while at Al-Ghardaqa it was paler and had various colour patterns. Perhaps also indicative of marked environmental differences in the area are the absence of the mangrove *Avicennia marina* in the Gulf of Suez and a change in the halophytes along the coast (Kassas and Zahran, 1967). The nature of this environmental difference is not known but it is probably not a difference in seasonal temperature fluctuations. Seasonal temperature changes are nearly identical at Wadi-el Dom and Al-Ghardaqa, although daily fluctuations are more extreme on the shore reefs at Al-Ghardaqa (Pearse 1968b, 1969b).

Comparison of the Gulf of Suez with the Gulf of Aqaba : It should also be noted that the asteroid *Fromia ghardaqana*, the ophiuroids *Ophiocoma scolopendrina*, *O. erinaceus*, *O. valenciae* and *O. pica* and the echinoids *Echinothrix calamaris*, *Heterocentrotus mammillatus* and *Tripneustes gratilla* all occur at Eilat, at the head of the Gulf of Aqaba (A. M. Clark 1967, Fischelson, 1968b). The presence of these species at both Eilat and Al-Ghardaqa, in contrast to their rarity or absence within the Gulf of Suez, suggests that environmental conditions within the Gulf of Aqaba are, or have been, more similar to those of the Red Sea than to those in the Gulf of Suez. Such similarity might be expected since both the Gulf of Aqaba and

the Red Sea are deep basins with average depths in excess of 1000 m. while the Gulf of Suez averages around 35 m. depth (Anonymous, 1922 ; Gohar, 1954 ; Fenton and Steinitz, 1967). The greater depths in the Gulf of Aqaba and Red Sea might allow upwelling and water mass movements that are considerably different from those within the shallow Gulf of Suez. Moreover, it is likely that most or all of the Gulf of Suez was above sea level during the last ice age (about 10,000 years ago) when the sea level was approximately 100 m. below that at present (Gohar, 1954). The Gulf of Aqaba, like the Red Sea, has existed for a much longer period, at least since the Pliocene, and faunal enrichment and diversification have had a much longer time to develop.

Migration into and through the Suez Canal : Although the Suez Canal was opened a century ago to provide a link between the Mediterranean and the Gulf of Suez, surprisingly few echinoderms have penetrated the Canal in either direction. The lack of migration of Red Sea species through the Canal is particularly surprising because most are extremely widespread Indo-Pacific forms, and are probably well adapted for conditions in the eastern Mediterranean. Physically, the eastern Mediterranean is very similar to the Gulf of Suez and seasonal sea temperature fluctuations are nearly identical in the two bodies of water (Oren, 1962 ; Ben-Tuvia, 1966 ; Pearse, 1969a). After the 1924 Cambridge Expedition to the Suez Canal, Fox (1929) suggested that a ' salinity barrier ' within the Bitter Lakes might account for the lack of northerly migration. The high salinities of the Bitter Lakes gradually have been reduced and, except for the bottom layers, are now similar to those in the Gulf of Suez (Krauss, 1958 ; Morcos, 1960 ; E. M. Hassan, pers. comm.). This reduction may have allowed the recent increase of Red Sea fish migration through the Canal (Ben-Tuvia, 1966).

In 1926 Mortensen recorded 8 species of Gulf of Suez echinoderms within the Suez Canal (excluding 4 new species from the Canal which probably were from the Gulf of Suez). At that time, he reported that there was no valid record of any Gulf of Suez species established in the Mediterranean. Steinitz (1967) recently published a tentative list of Red Sea species in the Mediterranean ; he listed only four species of echinoderms. Of these four species, Gauthier's (1874) record of *Heterocentrotus mammillatus* is certainly erroneous (Fourtan, 1903 ; Mortensen, 1926 ; Mortensen and Steuer, 1937 ; Steinitz, pers. comm.), leaving only three valid records. These three records are more recent : *Ophiactis savignyi* from Alexandria (Mortensen, 1937) and Israel (Tortonese, 1953b, 1957) and Lebanon (Tortonese, 1966), *Amphioplus laevis* from Israel (Tortonese, 1953b), and *Asterina burtoni* from Israel and Lebanon (Tortonese, 1966 ; Achituv, 1969a). All three are small forms and they may have been carried through the Canal on boats. Such a means of transport is especially likely for *A. burtoni* because it does not seem to reproduce sexually in the Gulf of Suez region, but rather by asexual fissiparity (Pearse, 1968b). Fissiparity is also common in specimens now occurring on the Levantine coast (Achituv, 1969a), as well as in other parts of its distribution (A. M. Clark, 1967b).

Only one Mediterranean echinoderm, the holothuroid *Holothuria poli*, has so far been recorded from the Red Sea (Cherbonnier, 1952, 1955), and a single specimen of this species was found at Wadi el Dom. The lack of southerly migration into and through the Canal by other species can perhaps best be explained by the generally poorly developed fauna in the eastern Mediterranean giving few candidates for migration and unfavourable current conditions in the Canal (Fox, 1929).

Perhaps most puzzling about the data on the migration of species through the Suez Canal is the apparent inability of most Red Sea species in the Canal to become established in the Mediterranean. Several species have been common in the Canal (to Ismailia) for the past half-century (Mortensen, 1926; Gruvel, 1936; Tortonese, 1947) yet they still have not been recorded from the eastern Mediterranean. These include the asteroid *Astropecten polyacanthus*, the ophiuroid *Ophiothrix savignyi*, the echinoid *Nudechinus scotiopremnus* and the holothuroid *Chondrocloea reciprocans*.

Moreover, most of the abundant echinoderms in the Gulf of Suez have not penetrated into the Suez Canal at all. These include the asteroid *Linckia multifora* and the echinoids *Prionocidaris baculosa, Diadema setosum* and *Echinometra mathaei*. *L. multifora*, like *Asterina burtoni*, reproduces mainly through asexual fissiparity but mature gametes were found in specimens collected in the winter, spring and summer (Pearse, 1968b). The three echinoids spawn only during the summer in the Gulf of Suez, when the current through the Suez Canal flows from north to south (Fox, 1929). Perhaps the southward flow of current at that time prevents the larvae of these common species from entering the Canal. Recent work on *E. mathaei* (Pearse, 1969b) has also shown that while this widespread Indo-Pacific species reproduces throughout the year in most areas of its distribution, including the northern Red Sea, reproduction is restricted to the summer months in the Gulf of Suez. Other species of widespread Indo-Pacific echinoderms (see above) are common at the mouth of the Gulf of Suez but are rare or absent within the Gulf. Such information suggests that environmental conditions may be nearly limiting for these tropical species in the Gulf of Suez; farther north, in the Canal and Mediterranean, they may be completely limiting for growth and reproduction. What these limiting conditions are, if they occur at all, remains to be found.

SUMMARY

Forty-three species of echinoderms belonging to all five extent classes of echinoderms are recorded in this paper. *Ophiocomella sexradia* is reported for the first time from the Red Sea and Russo's (1929) earlier report of *Luidia maculata* in the Red Sea (near Suez) is confirmed. The records of *Echinothrix calamaris, Fibularia volva, Echinodiscus bisperforatus* and *Brissopsis luzonica* are new to the northern Red Sea and that of *Astropecten orsinii* is new to the Gulf of Suez.

The coastal areas of the western Gulf of Suez and north-western Red Sea are compared and contrasted. The reef system of the northwestern Red Sea coast is well developed and similar to those found in many other parts of the Indo-Pacific, and it supports a large number of echinoderm species. Within the Gulf of Suez the coastal reef system is much less developed and there are fewer species. Many species, including the echinoid *Tripneustes gratilla*, ophiuroids of the genus *Ophiocoma*, and several holothuroids, are conspicuous and numerous in the northwest Red Sea but rare or absent in the Gulf of Suez. This decrease in fauna may be related to the shallow depth and the relatively young age of the Gulf of Suez. The faunal composition of the Gulf of Aqaba seems more similar to that of the Red Sea than to that of the Gulf of Suez.

Surprisingly few echinoderms have become established in the Suez Canal at the northern end of the Gulf of Suez, and fewer (only three) have penetrated the Canal to become established in the eastern Mediterranean. Especially notable is

the absence of the echinoids *Prionocidaris baculosa, Diadema setosum* and *Echinometra mathaei* in the Suez Canal because these are very abundant in the northern part of the Gulf of Suez. All spawn in the mid-summer, however, when current flow in the Canal is mainly from north to south ; perhaps the larvae are unable to enter the Canal against the current. Moreover, because there are so few species of echinoderm in the Gulf of Suez and reproduction of *E. mathaei* is restricted to the summer in the Gulf but occurs throughout the year in the Red Sea, it is suggested that environmental conditions may be unfavourable for the establishment of most tropical echinoderms in the Gulf of Suez, the Canal and farther north.

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