

	Page
Pattern of experimental	
.. ..	1047-1055
.. ..	1057-1078
.. ..	1079-1080
.. ..	1081-1085

Studies on the echinoderm fauna of the western Arabian Gulf

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Introduction

The echinoderm fauna along the eastern Arabian Gulf was studied extensively during the Danish Scientific Investigations in Iran. From collections made at a large number of stations, primarily along the Iranian coast, 68 species were recorded (Gislén 1940, Heding 1940, Mortensen 1940). A few species have also previously been recorded for the Gulf (see Clark and Rowe 1971, Mortensen 1940), although details of the exact locality are often lacking, and some records may relate to the Gulf of Oman rather than to the Gulf itself (Mortensen 1940).

In contrast, echinoderm studies along the western Arabian Gulf have been less extensive. Apart from basic information on the ecology of echinoderms obtained during a recent large scale study of the western Arabian Gulf (Basson *et al.* 1977), the only report on the echinoderm fauna of the area is that of Clark and LeBaron Bowen (1949), based on collections at a number of sites in the Tarut Bay area of Saudi Arabia. Relatively limited studies on echinoderms have also been made in southern regions of the Gulf (Evans *et al.* 1973, Hughes Clarke and Keij 1973).

The present paper is an annotated species list along with notes on certain aspects of the ecology of western Arabian Gulf echinoderms collected by Arameco biologists from 1971-1979. It supplements the information on echinoderms provided by Basson *et al.* (1977). In addition, the echinoderm fauna was studied at the Tarut Bay sites investigated in 1945-47 (Clark and LeBaron Bowen 1949), in an attempt to determine whether changes in species distribution and abundance have occurred over the years.

Methods

Material for the general study was collected at a number of intertidal, nearshore and offshore locations, between Safaniya and al-Uqayr (fig. 1). Collections were made using different types of trawls, grabs and dredges. Specimens were also collected by hand, both along the shore and during diving operations. At each location details of the habitat type, water depth, and the number of echinoderms (and other organisms) were recorded.

The sampling sites chosen for the comparative study correspond with those of Clark and LeBaron Bowen (1949) where possible (fig. 2 and table 1). Stations 1-7 and Station 9 are situated near the low tide mark in Tarut Bay and near Ras Abu Muraykhah respectively.

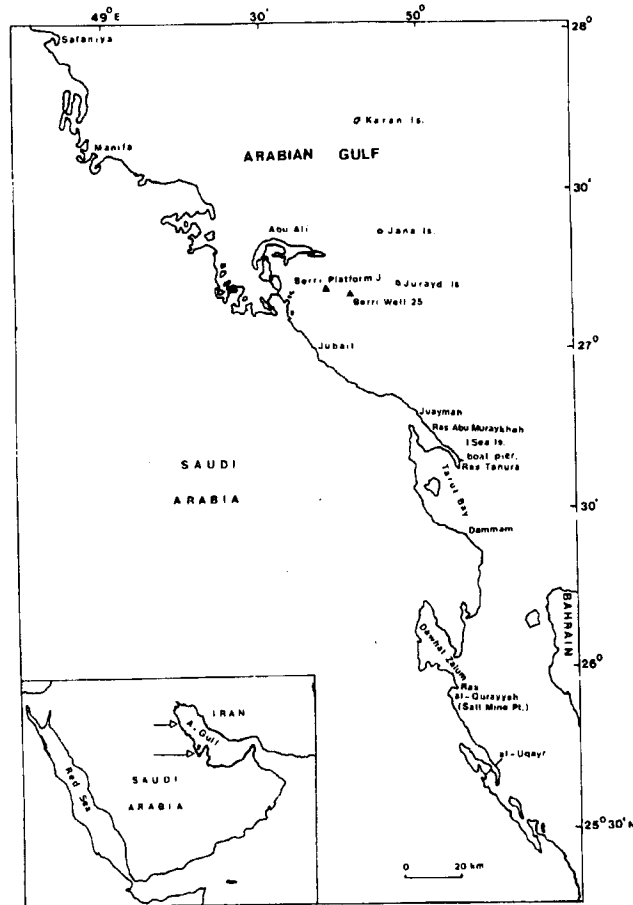


FIG. 1. Map of Arabian Gulf showing location of sampling sites for the general study.

Station 8 is a vertical piling in 12 m depth at the boat pier previously known as East Pier (Clark and LeBaron Bowen 1949). At each station, details of habitat type, water depth, temperature and salinity were recorded (table 1), along with the number of each echinoderm species (table 2). At the shallow water stations, collections were made by hand at low tide during approximately 1 hour periods, using snorkelling equipment where necessary. Material was collected from Station 8 by hand using Scuba gear.

Specimens that could not be clearly identified in the field were kept on ice or preserved, and taken to the Aramco laboratory. Identifications were carried out using the keys of Clark and Rowe (1971), and other literature. Specimens of uncertain identity were positively identified at the British Museum (Natural History).

Table 1. Physical characteristics of sampling sites.

Station	Details
1	Upper Tarut Bay mud/sand; grass <i>Halodule</i> along shore
2	East side of <i>H. uninervis</i> sandy bottom along shore
3	Tarut Bay station; exposed sand bar
4	Tarut Bay Club; occasional rubble over sand
5	Tarut Bay over sand
6 & 7†	Tarut Bay rubble and cleaner sand
8	Arabian Gulf boat pier
9	Arabian Gulf Muraykhah occasional <i>uninervis</i> .

† Not

Results

Western Arabian Gulf

The following details of the western Arabian Gulf (Bass) have been encountered:

Intertidal habitats are rocky flats. Exposed beach and subtidal shallows, are that usual in this habitat. Collections were made from exposed rocky beaches are left with sand. Again gastropods and many other taxa were collected.

Much of the Saudi Arabian coast containing expansive productive mud or fine sand support a greater diversity of life groups in this habitat.

Subtidal habitats are rocky bottom habitats, grass

Table 1. Physical characteristics of the study sites in the Tarut Bay area of Saudi Arabia (1977).

Station	Details of locality and habitat	Depth (m)	Temp. (°C)	Salinity (‰)
1	Upper Tarut Bay; outcrops of rock on mud/sand flat; occasional beds of sea grass <i>Halodule uninervis</i> .	0.5	31.0	45
2	East side of Zaal Is., Tarut Bay; patches of <i>H. uninervis</i> and <i>Halophila ovalis</i> over sandy bottom; outcrops of rock near and along shore.	0-1	29.2	42
3	Tarut Bay, near spit at coastguard station; coral reef running parallel to sand bar; coral debris and rock.	0-1	30.4	42
4	Tarut Bay, near Sandy Hook Yacht Club; occasional patches of coral and rubble over fine muddy sand.	1	30.4	42
5	Tarut Bay; outcrops of rock and coral over sand.	0.5-1	29.2	41
6 & 7†	Tarut Bay; coarse sand with coral, coral rubble and rock; also sand bars of cleaner sand of finer grain size.	0.5-1.2	30.2	41
8	Arabian Gulf; piling under Ras Tanura boat pier.	12	31.6	38
9	Arabian Gulf, near Ras Abu Muraykhah; outcrops of rock over sand; occasional patches of seagrass <i>H. uninervis</i> .	1-1.5	33.3	41

† Not considered separately during the present investigation.

Results

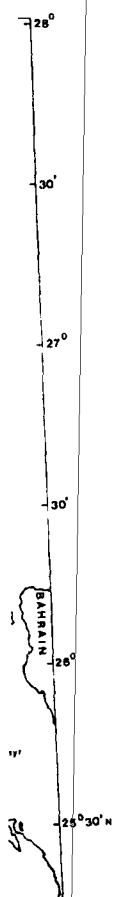
Western Arabian Gulf habitats and substrates

The following description of habitats available to benthic organisms of the western Arabian Gulf is based on the detailed account in *Biotope of the Western Arabian Gulf* (Basson *et al.* 1977). Apart from mudflats and tidal creeks, echinoderms have been encountered in all benthic habitats present.

Intertidal habitats may be divided into exposed coastal beaches and intertidal flats. Exposed beaches along this coast are protected from heavy wave action by subtidal shallows, and therefore consist of relatively fine-grained sand compared to that usual in this habitat type. More than 200 species of macrofauna have been collected from exposed sand beaches, with gastropods being the dominant group. Rocky beaches are less common, and consist of soft sedimentary rock often mixed with sand. Again gastropods are the dominant group, although rock-dwelling species of many other taxa are also present.

Much of the Saudi Gulf coastline is associated with a complex bay system containing expanses of intertidal flats. Most of these flats consist of highly productive mud or fine sand. Intertidal flats of coarser sand are less common, but support a greater diversity of organisms. Intertidal rock flats occur extensively along the coast, often made up of a soft-grey limestone known as 'faroush'; dominant groups in this habitat are polychaetes, gastropods, bivalves and decapods.

Subtidal habitats of the western Arabian Gulf can be divided into hard and soft bottom habitats, grass beds, coral reefs and artificial structures. Rocky bottom



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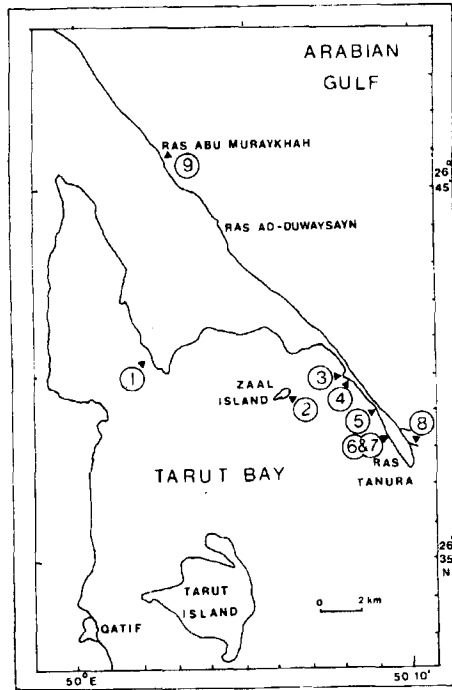


FIG. 2. Map of the Tarut Bay area of Saudi Arabia showing location of sampling sites for the comparative study.

habitats exhibit great variability, but may be broadly classified into rough and smooth rock bottoms. Rough rock bottoms often support a heavy growth of algae and great variety of animals, whereas on smooth rock bottoms there is little marine life except in the joints or fissures.

Subtidal sand habitats occur in high energy environments and support a diverse assemblage of organisms, including species of heart urchins and sand dollars which are found in abundance. Mud bottom habitats occur in environments of lower energy and also support a diverse biota. Two distinct communities have been found in mud bottoms, one of which is dominated by 2 species of echinoderms.

Grass beds represent one of the most extensive habitats along the western Arabian Gulf, commonly occurring in shallow coastal areas. This habitat is extremely productive, supporting a diverse fauna including many species of echinoderms.

Coral reefs in the Arabian Gulf occur as patch reefs, and as fringing reefs surrounding the coral islands. More than 500 species have been recorded among Gulf coral reefs, including species from the 5 classes/subclasses of echinoderms. Aggregations of the sea urchins *Diadema setosum* and *Echinometra mathaei* are often a conspicuous feature around coral reefs, although these species also occur in other habitats.

Artificial structures, such as oil platforms, provide a substrate for many forms of marine life, acting as an 'artificial reef'. More than 170 species have been recorded from such habitats in the Gulf.

Western Arabian
CLASS CRINOID
FAMILY COLOB
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CLASS STELLER
SUBCLASS ASTER
FAMILY LUIDI
Luidia hardwick
15 m depth fr
Luidia maculata
5-11 m depth;
Bay: 7 specimens.

FAMILY ASTRO
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Channel; 1 specim
Astropecten pol
0-15 m depth;
subtidal rock, sand
flat and grass bed;
and al-Uqayr: 63
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4-15 m depth:
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FAMILY OPHIDI
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3-15 m depth: f
Ali, Juaymah and

† Since this paper
fallax arabica A. M.

Western Arabian Gulf echinoderm species†

CLASS CRINOIDEA

FAMILY COLOBOMETRIDAE

Decametra mollis (A. H. Clark)

15 m depth from coral reef base sand at Jana Island: 1 specimen. Other crinoid species photographed, but not collected, at bottom of Berri Well 25 attached to various solid objects (Basson *et al.* 1977, p. 156).

CLASS STELLEROIDEA

SUBCLASS ASTEROIDEA

FAMILY LUIDIIDAE

Luidia hardwicki (Gray)

15 m depth from subtidal sand at Manifa: 1 specimen.

Luidia maculata Müller and Troschel

5–11 m depth: from subtidal sand and grass beds: Dammam Channel and Tarut Bay: 7 specimens.

FAMILY ASTROPECTINIDAE

Astropecten indicus Döderlein

15 m depth: from subtidal sand at Manifa: 2 specimens.

Astropecten monacanthus Sladen

New record for Arabian Gulf: ca. 11 m depth from subtidal sand in Dammam Channel: 1 specimen.

Astropecten polyacanthus phragmorus Fisher

0–15 m depth: common starfish encountered in subtidal mud, subtidal sand, subtidal rock, sand beach, rock tidal flat, sand tidal flat, mixed sand and rock tidal flat and grass bed: Safaniya, Abu Ali, Tarut Bay, Dammam Channel, Dawhat Zalun and al-Uqayr: 63 specimens.

Astropecten polyacanthus polyacanthus Müller and Troschel

5–10 m depth from subtidal mud: Safaniya and Tarut Bay: 3 specimens.

Astropecten pugnax Koehler

15 m depth from subtidal sand near Manifa: 1 specimen.

FAMILY OREASTERIDAE

Pentaceraster mammillatus (Audouin)

4–15 m depth: from coarse sand or coral rubble either on or near coral reefs: Jurayd Island, Jana Island, Karan Island, Abu Ali and Tarut Bay: 7 specimens.

FAMILY OPHIDIASTERIDAE

Leiaster leachi (Gray)

New record for Arabian Gulf: 7–15 m depth from coral reef; Karan Island, Jurayd Island and Jana Island: 6 specimens.

Linckia multifora (Lamarck)

3–15 m depth: from coral reef and subtidal sand; Jana Island, Karan Island, Abu Ali, Juaymah and Dammam: 29 specimens.

† Since this paper went to press, *Astropecten hemprichi* Müller and Troschel and *Ophiopiza fallax arabica* A. M. Clark have also been recorded.

FAMILY ASTEROPSEIDAE

Asteropsis carinifera (Lamarck)

New record for Arabian Gulf: 2-7 m depth from coral reef; Jurayd Island and Jana Island: 5 specimens.

FAMILY ASTERINIDAE

Asterina burtoni Gray

0-10 m depth: common starfish encountered in subtidal rock, subtidal sand, coral reef, grass bed, rock tidal flat and rock beach: Karan Island, Jurayd Island, Juaymah, Ras Abu Muraykhah, Tarut Bay and al-Uqayr: 150 specimens.

FAMILY PTERASTERIDAE

Euretaster cribrosus (v. Martens)

New record for Arabian Gulf: 20 m depth from coral rubble near reef base at Jana Island: 2 specimens.

SUBCLASS OPHIUROIDEA

FAMILY AMPHIURIDAE

Amphilycus scripta (Koehler)

Sexually dimorphic species, often occurring in pairs with dwarfed male clasped to ventral surface of female's disc; individuals collected were attached to sand dollars, *Clypeaster humilis* (Leske) and *Echinodiscus auritus* Leske, in subtidal sand: 0.7-5 m depth; Tarut Bay: 44 specimens. (*A. scripta* was not recorded at other localities where these sand dollars occurred, but may have been overlooked).

Amphiodia (Amphiodia) oblecta Mortensen

Material in general accordance with the description and drawing of this species given by Mortensen (1940, 89-90, fig. 15), although the radial shields are not encroached by the disc scales as shown by Mortensen: 34 m depth from subtidal sand S.E. Jana Island: 1 specimen (disc only).

Amphioplus (Amphioplus) seminudus Mortensen

9-11 m depth from subtidal mud at Manifa: 391 specimens.

Amphioplus (Lymanella) hastatus (Ljungman)

2.6-15 m depth: from subtidal sand and grass bed: Safaniya, Abu Ali, Ras Tanura and Tarut Bay: 9 specimens.

Amphipholis squamata (D. Chiaje)

New record for Arabian Gulf: 10 m and 34 m depth from grass bed and subtidal sand: Tarut Bay and S.E. Jana Island: 4 specimens, also 1 specimen without details of locality, habitat or depth, and another from al-Qurayyah without details of habitat or depth.

Amphiura (Amphiura) crispa Mortensen

5 m depth from coral reef at Safaniya: 1 specimen.

Amphiura (Amphiura) fasciata Mortensen

Material in general accordance with the description and drawing given by Mortensen (1940, 76-77, fig. 8), although the oral shields are not so pointed distally, and in one specimen there appears to be a greater density of scales on the ventral side of the disc than shown by Mortensen: 2.6 m depth from grass bed in Tarut Bay: 1 specimen, and 1 specimen from al-Qurayyah without details of habitat or depth.

Amphiura (Amphiura) sp.

0 m depth: from rock tidal flat and mixed rock and sand beach: Juaymah and Tarut Bay: 2 specimens (in poor state of preservation).

Amphiura (Amp

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4 specimens.

FAMILY OPHIAC

Ophiactis savigny

0.5-15 m depth:
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FAMILY OPHIOT

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ventral arm plates:
and Jurayd Island:

Ophiothela danae

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Ophiothela venus

New record for A
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Manifa, Berri Well 2:
24 specimens.

Ophiothrix savigny

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FAMILY OPHIONE

Ophionereis dubia

0.5-7 m depth: fr
Jurayd Island: 11 sp

FAMILY OPHIURIE

Ophiura kinbergi (J

ca. 1 m and 11 m c
Tanura: 2 specimens.

Amphiura (*Amphiura*) ?sp. nov.

9-4 m depth from subtidal mud at Manifa: 1 specimen (poorly preserved).

Paracrocnida persica Mortensen

0 m and 5 m depth: from sand beach and subtidal mud; Juaymah and Tarut Bay; 4 specimens.

FAMILY OPHIACTIDAE

Ophiactis savignyi Müller and Troschel

0.5-15 m depth: from coral reef, coral reef base, subtidal rock, subtidal sand and epizoic in sponge on artificial structure; Safaniya, Jana Island, Jurayd Island, Juaymah, Ras Tanura boat pier and Tarut Bay; 242 specimens.

FAMILY OPHIOTRICHIDAE

Macrophiothrix elongata H. L. Clark

0-15 m depth: under rocks in mixed subtidal sand and rock, coral reef base and mixed rock and sand tidal flat; Jana Island and Tarut Bay; 3 specimens.

Macrophiothrix sp. aff. *hirsuta cheneyi* (Lyman)

New record for Arabian Gulf: under rock at 0.3 m depth from mixed rock and sand tidal flat in Tarut Bay; 1 specimen.

Macrophiothrix sp.

Material showing some intermediate characters between *M. elongata* and *M. hirsuta cheneyi* with regard to arm length, arm spines and the shape of the dorsal and ventral arm plates: 1 m and 7 m depth from subtidal rock and coral reef; Tarut Bay and Jurayd Island; 8 specimens.

Ophiothela danae Verrill

12 m and 32 m depth: epizoic on gorgonians attached to coral reefs and artificial structures; Jana Island and Berri Well 25; 13 specimens.

Ophiothela venusta (de Loriol)

New record for Arabian Gulf: 1.5-32 m depth; found associated with gorgonians in subtidal sand, grass bed and artificial structures; (probably always epizoic); Manifa, Berri Well 25, Ras Tanura boat pier, station near Sea Island and Tarut Bay; 24 specimens.

Ophiothrix savignyi (Müller and Troschel)

Common brittlestar found in subtidal rock, subtidal sand, mixed subtidal rock and sand, subtidal mud, coral reef, artificial structure, sand tidal flat, rock tidal flat and mixed rock and sand beach: 0-32 m depth; Safaniya, Jana Island, Jurayd Island, Berri Platform J, Berri Well 25, Abu Ali, Jubail, Juaymah, Ras Tanura boat pier, Tarut Bay and Dammam Channel; 379 specimens.

FAMILY OPHIONEREIDIDAE

Ophionereis dubia (Müller and Troschel)

0.5-7 m depth: from subtidal rock, grass bed and coral reef; Tarut Bay and Jurayd Island; 11 specimens.

FAMILY OPHIURIDAE

Ophiura kinbergi (Ljungman)

ca. 1 m and 11 m depth: from grass bed and subtidal sand; Tarut Bay and Ras Tanura; 2 specimens, and 2 specimens without details of locality, habitat or depth.

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CLASS ECHINOIDEA

FAMILY CIDARIDAE

Prionocidaris baculosa (Lamarck)

5–32 m depth: from coral reef, coral reef base and artificial structure: Safaniya, Manifa, Jana Island, Jurayd Island, Berri Well 25 and Tarut Bay: 13 specimens; (a species typical of corals or rubble areas).

FAMILY DIADEMATIDAE

Diadema setosum (Leske)

0–7–8 m depth: from coral reef, coral reef sand, subtidal rock, artificial structure and grass bed: Jana Island, Jurayd Island, Ras Tanura boat pier and Tarut Bay: 5 specimens, and also many individuals observed but not collected. An abundant species.

FAMILY TEMNOLEURIDAE

Temnopleurus toreumaticus (Leske)

0–15 m depth: from subtidal sand, subtidal mud, grass bed, rock tidal flat and mixed rock and sand tidal flat: Safaniya, Abu Ali, Ras Tanura, Tarut Bay and Dammam Channel: 47 specimens.

Temnotrema siamense (Mortensen)

11–13 m depth: from coarse, high energy subtidal sand only: Abu Ali and Ras Tanura: 22 specimens.

FAMILY ECHINOMETRIDAE

Echinometra mathaei (de Blainville)

0–31 m depth: from subtidal rock, artificial structure, coral reef, grass bed, rock tidal flat, and mixed rock and sand beach; Safaniya, Karan Island, Berri Platform J, Abu Ali, Jubail, Juaymah, Ras Abu Muraykhah, Tarut Bay and Dammam: 19 specimens, and also many observed but not collected. A species often common in rocky habitats.

FAMILY CLYPEASTERIDAE

Clypeaster humilis (Leske)

0–5 m depth: from subtidal sand, subtidal mud, grass bed, sand beach and sand tidal flat: Jana Island, Abu Ali, Tarut Bay and Dammam Channel: 61 specimens.

Clypeaster reticulatus (Linnaeus)

22.5 m depth from subtidal sand at Jana Island: 1 specimen.

FAMILY ASTRICLYPEIDAE

Echinodiscus auritus Leske

0–5 m depth: from subtidal sand, mixed subtidal rock and sand, grass bed, sand tidal flat, mixed sand and rock tidal flat and sand beach: Abu Ali, Juaymah, Ras Abu Muraykhah, Tarut Bay and Dammam Channel: 29 specimens.

FAMILY LOVENIIDAE

Lovenia elongata (Gray)

1–5 m depth from coarse sand on coral reef flat sand at Jana Island: 2 specimens, and 1 specimen without details of locality, habitat or depth: individuals also observed at Ras Tanura.

FAMILY BRISSID

Brissopsis persica

6–15 m depth: 6 specimens, and 2 sq

Metalia sternalis

0–11.5 m depth: flat: Jana Island, A

Metalia townsenda

0–11.5 m depth: Safaniya, Abu Ali, .

CLASS HOLOTHURIA

FAMILY HOLOTHURIDAE

Labidodemas sem

New record for specimen.

Holothuria (Cysti)

Spicules of mate species given by Roy 34) for *Holothuria*

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New record for Aral Bay and Jana Islar

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Holothuria (Haloc

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Holothuria (Haloc

New record for A Island: 2 specimens.

Holothuria (Merte

ca. 6–13 m depth and Jurayd Island:

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New record for A sand and rock, sand

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Holothuria (Thym

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FAMILY STICHOPUS

Stichopus variegat

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FAMILY BRISSIDAE

Brissopsis persica Mortensen

6–15 m depth: from subtidal mud and subtidal sand: Manifa and Tarut Bay: 48 specimens, and 2 specimens from Abu Ali without details of habitat or depth.

Metalia sternalis (Lamarek)

0–11.5 m depth: from subtidal sand, coral reef flat sand and rock and sand tidal flat: Jana Island, Abu Ali and Tarut Bay: 10 specimens.

Metalia townsendi (Bell)

0–11.5 m depth: from subtidal sand, grass bed, sand tidal flat and sand beach: Safaniya, Abu Ali, Jubail and Tarut Bay: 20 specimens.

CLASS HOLOTHURIOIDEA

FAMILY HOLOTHURIIDAE

Labiodemas semperianum Selenka

New record for Arabian Gulf: 7 m depth from coral reef at Jurayd Island: 1 specimen.

Holothuria (Cystipus) rigida (Selenka)

Spicules of material in general accordance with drawings of the spicules of this species given by Rowe (1969, fig. 18), and also to that given by Cherbonnier (1955, pl. 34) for *Holothuria jousseaumei*, a species first described by Cherbonnier (1954). As pointed out by Rowe (1969), however, the two species may prove to be conspecific. If so, the name *H. (Cystipus) rigida* (Selenka 1867) would have priority. New record for Arabian Gulf: 0.5 m depth from subtidal rock and coral/rock: Tarut Bay and Jana Island: 2 specimens, and 3 specimens without details of habitat or depth from Tarut Bay.

Holothuria (Halodeima) atra Jaeger

The common black *Holothuria* of grass beds and subtidal mud was tentatively referred to this species by Basson *et al.* (1977); but no specimens are found in the collections and this identification obviously requires confirmation.

Holothuria (Halodeima) edulis Lesson

New record for Arabian Gulf: 8 m depth from coral rubble and coral sand at Jana Island: 2 specimens, and also several individuals observed but not collected.

Holothuria (Mertensiothuria) leucospilota Brandt

ca. 6–13 m depth: from subtidal ? sand/mud and coral reef: Damman Channel and Jurayd Island: 8 specimens.

Holothuria (Thymiosycia) arenicola Semper

New record for Arabian Gulf: 0–7 m depth: from subtidal sand, mixed subtidal sand and rock, sand beach, mixed sand and rock beach and coral reef: Jana Island, Jurayd Island, Juaymah and Tarut Bay: 12 specimens.

Holothuria (Thymiosycia) hilla Lesson

1–15 m depth: from coral reef at Jana Island: 3 specimens.

Holothuria (Thymiosycia) impatiens (Forsk.)

7 m depth from coral reef at Jurayd Island: 2 specimens.

FAMILY STICHOPODIDAE

Stichopus variegatus Semper

5 m and 7 m depth from coral reef: Jana Island and Jurayd Island: 2 specimens, and also 1 damaged specimen, probably the same species, but without details of locality or habitat. This or similar species is very commonly seen on reef and rubble.

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Ali, Juaymah, Ras Abu
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OPHIUROIDEA										
<i>Amphilycus scripta</i> §	9				11					1 abundant
<i>Ophiactis savignyi</i>	1		1		157		2	2		
<i>Macrophiothrix elongata</i>										
<i>Macrophiothrix</i> sp. aff. <i>hirsuta cheneyi</i>	1			4						
<i>Macrophiothrix</i> sp.					2					
<i>Ophiothela venusta</i>	8	14	5	2	13	6	ca. 48	16	8	20
<i>Ophiothrix savignyi</i>							5			
<i>Ophionereis dubia</i>	4	5					1	4		
<i>Ophiopezella fallax</i> ¶										

Table 2 continued

ECHINOIDEA										
<i>Diadema setosum</i> ††		> 10	> 10	3	> 10	2				abundant
<i>Temnopleurus toreumaticus</i>										2
<i>Echinometra mathaei</i>	1	> 10	> 10	> 10	> 10	> 10	100s	abundant	2	
<i>Clypeaster humilis</i>	(3)				3		1			abundant
<i>Echinodiscus auritus</i>	1		(1)	(1)		(2)	2	dozens		3
<i>Lovenia elongata</i>								1		§§
<i>Metalia townsendi</i>										abundant

HOLOTHURIOIDEA										
<i>Holothuria (Cystipus) rigida</i>	1									
<i>Holothuria (Thymiosycia) arenicola</i>				1						
<i>Ohshimella ehrenbergi</i>			1							

† Recorded as *Astropecten polyacanthus* by Clark and LeBaron Bowen (1949), although the species description probably relates to *A. polyacanthus phragmorus*.

‡ Referred to as *Asterina cephea* var. *Iranica* by Clark and LeBaron Bowen (1949).

§ Referred to as *Amphilycus androphorus* by Clark and LeBaron Bowen (1949).

|| Recorded as *Ophiothrix hirsuta* by Clark and LeBaron Bowen (1949), although the species description probably relates to *Macrophiothrix elongata*.

¶ Referred to as *Ophiopezella fallax* by Clark and LeBaron Bowen (1949).

†† Recorded as *Diadema* sp. by Clark and LeBaron Bowen (1949) and probably relates to *D. setosum*.

§§ Species recorded but without details of the number of individuals.

Numbers in brackets indicate dead specimens recorded.

FAMILY CUCUMARIIDAE

Thyone sp.

2.6–15 m depth: from subtidal sand, mixed subtidal sand and rock, subtidal mud and grass bed: Abu Ali, Ras Tanura and Tarut Bay: 8 specimens.

FAMILY PHYLLOPHORIDAE

Ohshimella ehrenbergi (Selenka)

New record for Arabian Gulf: 0.3 m depth from subtidal rock/coral in Tarut Bay: 1 specimen.

FAMILY SYNAPTIDAE

Leptosynapta chela Mortensen

New record for Arabian Gulf: 1.5–8.8 m depth: from subtidal sand, coral reef flat sand and grass bed: Jana Island, Tarut Bay and al-U'qayr: 8 specimens, and 1 specimen from al-Quarayyah without details of habitat or depth.

Protankyra pseudodigitata (Semper)

9.4 m and 10.3 m depth from subtidal mud at Manifa: 2 specimens.

The echinoderm fauna of the Tarut Bay area in 1977

From observations and collections made at the sampling sites, at least 15 echinoderm species were recorded (table 2). Of the 2 asteroid species encountered the most common was the rockstar *Asterina burtoni*, a species often present on the underside of rocks. During the present survey it was widely distributed, being particularly abundant at Stations 1 and 2. Another starfish, *Astropecten polyacanthus phragmorus*, was found in sand, but recorded only at Stations 4 and 6 & 7, in very low numbers (table 2).

At least 6 species of ophiuroids were collected from the sampling sites. *Macrophiothrix* sp. aff. *hirsuta cheneyi*, *Macrophiothrix* sp., *Ophiomeris dubia*, *Ophiothrix savignyi* and *Ophiactis savignyi* were found under rock or coral fragments, the latter 2 species also occurring in sponge at Station 8 (table 2). Of the 2 remaining species, *Ophiothela venusta* was collected from a gorgonian at Station 8, whereas *Amphilycus scripta* was found attached to the surface of the sand dollars *Echinodiscus auritus* and *Clypeaster humilis* (table 2). The most ubiquitous ophiuroid was *Ophiothrix savignyi* which occurred at 5 localities, sometimes in high numbers (table 2). Other species, however, were less widely distributed and not represented by more than a few individuals (table 2), apart from *Ophiactis savignyi* which was found in high numbers epizoic in a sponge at Station 8 (table 2).

The urchins *Echinometra mathaei* and *Diadema setosum* were found under or around rock, coral and coral debris. Both species were widely distributed, often occurring in dense aggregations (table 2). At Stations 1 and 2, however, both species were absent or extremely rare (table 2). The sand dollars *Echinodiscus auritus* and *Clypeaster humilis*, in contrast, were not widely distributed (table 2). Each species was present in low numbers at a single locality only, although dead specimens were also encountered at other stations (table 2).

Although 3 species of holothurians were recorded, each species was represented by a single individual only (table 2). *Holothuria (Cystipus) rigida* and *Ohshimella ehrenbergi* occurred under rock/coral fragments, whereas *Holothuria (Thymiosycia) arenicola* was buried in sand.

Discussion

The previously listed species are indicated below

Astropecten monac.
Leiaster leachi—M
Asteropsis carinifer
Euretaster cribrosu
Amphipholis squa
Macrophiothrix hir
Ophiothela venusta
Labidodemas sempi
Holothuria (Cystip)
 East Indies eastwards
Holothuria (Halode
Holothuria (Thymio
Ohshimella ehrenbe
Leptosynapta chela

The occurrence of the Gulf fauna in ge

During the 1945–1977 total of 16 and at least the greatest number of species, with the exception of Station 1, during both investigations. Diversity may not have been indicated nevertheless indicate

The asteroid *Asterina burtoni* than during the 1945–1977 (table 2). In 1945–1977 (table 2), whereas aggregations. In corals *Clypeaster humilis*, in the past 30 years. Although they were abundant (Clarke 1966), however, neither *M. setosum* nor *Echinodiscus auritus* (table 2).

During both surveys, *Echinodiscus auritus* was somewhat more abundant than *Ophiactis savignyi*. Both species tended to be present in large numbers during both surveys (table 2).

The observed differences in species may be due to changes in water quality or population changes in the Gulf for the years between

Discussion

The previously known limits of range of the species newly recorded from the Gulf are indicated below:

- Astropecten monacanthus*—E. Africa to S. Arabia and from Maldives eastwards.
Leiaster leachi—Mascarenes, Red Sea; Maldives and East Indies eastwards.
Asteropsis carinifera—Islands of W. Indian Ocean; Ceylon area and East Indies eastwards.
Euretaster cribrosus—E. Africa to Gulf of Aqaba, Red Sea (doubtfully eastwards).
Amphipholis squamata—cosmopolitan.
Macrophiothrix hirsuta cheneyi—E. Africa to S. Arabia.
Ophiothela venusta—S. Arabia and Singapore only.
Labidodemas semperianum—E. Africa; Maldives and Bay of Bengal eastwards.
Holothuria (Cystipus) rigida—Islands of W. Indian Ocean to Red Sea; Maldivian area and East Indies eastwards.
Holothuria (Halodeima) edulis—E. Africa to S.E. Arabia and from Maldives eastwards.
Holothuria (Thymiosycia) arenicola—E. Africa to Red Sea; Maldives eastwards.
Ohshimella chrenbergi—E. Africa to S. Arabia; Pakistan eastwards.
Leptosynapta chela—Red Sea.

The occurrence of 13 new echinoderm records is at least partly a reflection that the Gulf fauna in general has not been studied extensively in previous years.

During the 1945-47 and 1977 surveys of the Tarut Bay area of Saudi Arabia a total of 16 and at least 15 echinoderm species respectively were recorded, with the greatest number of species occurring at Station 2 (table 2). Furthermore, with the exception of Station 5, the number of species present at any locality was similar during both investigations (table 2). These data suggest that echinoderm species diversity may not have been appreciably different in 1945-47 than in 1977, but nevertheless indicate certain differences in the actual species composition (table 2).

The asteroid *Asterina burtoni* appeared to be more abundant and widespread in 1977 than during the 1945-47 survey (table 2). Similarly, the echinoids *Echinometra mathaei* and *Diadema setosum* appear to have extended their range of distribution (table 2). In 1945-47 the latter species was reported only at Station 3 (in large numbers), whereas in 1977 it occurred at 5 different localities, also in dense aggregations. In contrast, the abundance of the echinoids *Echinodiscus auritus*, *Clypeaster humilis*, *Metalia townsendi* and *Lovenia elongata* may have declined during the past 30 years. Although not widely distributed in 1945-47 (table 2), these species were abundant (Clark and LeBaron Bowen 1949). During the present investigation, however, neither *Metalia townsendi* nor *Lovenia elongata* were encountered, and *Echinodiscus auritus* and *Clypeaster humilis* were both present in low numbers (table 2).

During both surveys, *Ophiothrix savignyi* was the most common ophiuroid, but somewhat more abundant during the 1945-47 survey (table 2). Other ophiuroid species tended to be less widely distributed and less abundant than *Ophiothrix savignyi* during both surveys (table 2), apart from *Ophiactis savignyi* which was present in large numbers in a sponge attached to the artificial structure at Station 8 in 1977 (table 2).

The observed differences in distribution and abundance of certain echinoderm species may be due to factors such as sampling methods, change in substrate and change in water quality over the years. There may also have been long term population changes in the echinoderm fauna of the area, although systematic data for the years between 1945-47 and 1977 are not available.

Sampling methods used in the surveys may not have provided a true estimate of species distribution and abundance. During the 1977 study, for example, 3 species of holothurians were recorded, but each species was represented by 1 individual only (table 2). Hence, the rarity of these particular species may partly account for their apparent absence in 1945-47. Similarly, since sampling at each site was not always undertaken at comparable times of the year during the 2 surveys, the observed differences in abundance of certain species could be partly due to any seasonal changes. However, although plankton studies in the area suggest that breeding of echinoderms may be confined to certain times of the year (Burchard and Price, unpublished), it is unlikely to account for the gross differences in abundance observed in several echinoids and also *Asterina burtoni* (table 2).

In recent years land fill operations have been taking place in parts of Tarut Bay and along the coast. This may have changed the physical characteristics of available substrates and, consequently, affected the distribution of benthic organisms in the area. Finally, the change in water quality that has occurred in the area may be partly responsible for the observed changes in the echinoderm fauna. In 1945 a refinery was built on the mainland to the north of Zaafar Island. Since that time the resulting effluent has flowed into Tarut Bay 3-5 km N.W. of Station 3. Studies have shown that whereas the diversity of diatoms increases near the effluent (Basson and Hardy, unpublished), the diversity of benthic animal communities is depressed near the outfall (Burchard 1973). Although echinoderms are known to be notoriously sensitive to any reduction in water quality (Nelson-Smith 1972), there appears to have been no decline in the total number of species, despite a slight shift in the species composition (table 2).

The data at present available on the echinoderm fauna of the Tarut Bay sites investigated suggest that between 1945-47 and 1977 there has been little change in the number of species present, although a shift in species composition and change in abundance of certain species may have occurred. It is important to note, however, that the sites under survey do not represent a cross section of Tarut Bay, since species known to be abundant in the bay, such as the pencil urchin *Prionocidaris baculosa* (Burchard, personal communication), were not recorded at these particular localities.

Summary

From echinoderm collections made along the western Arabian Gulf between 1971 and 1979, at least 55 species were recorded. Of these, 13 species are new records for the Gulf, and 1 amphipod possibly a new species to science. Some species show considerable range in depth and habitat preference, while others occur in specific habitat types only. In the Tarut Bay area the total number of echinoderm species does not appear to have changed since 1945-47, although a shift in species composition and change in distribution and abundance of certain species may have occurred.

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