

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS, ARABIAN GULF

BY

JASSIM, A. AL-KHAYAT* AND FATIMA, A. AL-KHAYAT

**University of Qatar, Faculty of Science, P. O. Box 2713 Doha – Qatar*

Keywords: Invertebrate, composition, diversity, Qatar, Arabian Gulf.

ABSTRACT

Nineteen stations located in the exclusive economic zone of Qatar water were selected and sampled for a macro-invertebrates study. More than 270 species of benthic fauna were recorded from the Qatari waters in the Arabian Gulf. Molluscs form the main predominant group (201 species) among the benthic fauna, followed by Crustacea (26 species), Echinodermata (17 species), Annelida (14 species), Ascidiacea (6 species) and Hydrozoa (4 species). The faunal diversity index showed a small variation between the stations. Over all species diversity index was greater at St. 101 ($H' = 3.683$) and lowest at St. 602 ($H' = 1.669$).

INTRODUCTION

Marine invertebrates are generally widely distributed in the shallow waters of the Arabian Gulf and the majority of them are benthic and few are planktonic organisms. The present knowledge on marine invertebrates, their abundance and distribution in the Gulf waters is based primarily on the works of: Biggs and Grantier (1960), Biggs (1973), Basson, *et al.* (1977), Jones *et al.* (1978), Smythe (1972; 1979 & 1982), Farmer (1983), Jones & Clayton (1983), McCain (1984a; b), Glayzer, *et al.* (1984), Jones & Richmond (1992) and Hassan (1995). The available literature reveals that the benthic invertebrates (onshore and offshore) of Qatar has not been dealt with until recently. However, there are studies pertaining to specific areas and locations. These include, Jones (1985)

report on intertidal and shallow subtidal fauna and flora species, at Ras Laffan in the north east of Qatar; Mohammed and Al-Khayat (1996) record of the common marine intertidal Mollusca at 7 sites on the east coast and 2 sites on the west coast of Qatar and Al-Khayat's (1997) record of the common Mollusca from different habitats of the eastern and southern coast of Qatar. In the present work the occurrence of macrobenthic fauna in 19 stations of offshore Qatari waters has been undertaken.

MATERIALS AND METHODS

The area under investigation extends from the north of the Qatar peninsula (lat. 25° 00' N) to Messaieed (lat. 27° 00' N) parallel to the shore line. The area extends offshore between longitudes 51° 10' E and 52° 30' E with a width of about 76-93 km according to the shoreline (Fig.1). The depth of water varied from 6m to 44m. 19 representative stations were chosen in the Qatari exclusive economic zone and collections were made for a period of one year (October 1998 to September 1999) by the R/V of Qatar University "Mukhtabar Al-Bihar".

Bottom samples were taken using a Van-Veen grab of 0.05m² surface area. For separating the organisms from the sediments, hand sieving was employed using a 0.5 mm sieve. The residue retained in the sieve was preserved in 5% sea water formalin solution. In the laboratory, the organisms in the samples were sorted using a stereomicroscope. The identification of the macro-benthic taxa was based mainly on Jones (1986), Vine (1986), Oliver (1992), Green (1994) and Bosch *et al.* (1995).

Species diversity (H') at each station was measured using the Shannon wiener index (Shannon and Wiener, 1963), which is calculated as :

$$H' = - \sum P_i \log_2 P_i$$

Where P_i is the proportion of animals of the *i*th species.

Two additional measures, the evenness (E) and species richness (R), were also calculated as follows:

$$E = H' / H_{\max}$$

$$\text{And } R = S - 1 / \ln N$$

$$\text{Where, } H_{\max} = \log_2 S$$

Where S is the number of species, and N is the total number of individuals (Krebs, 1978).

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS

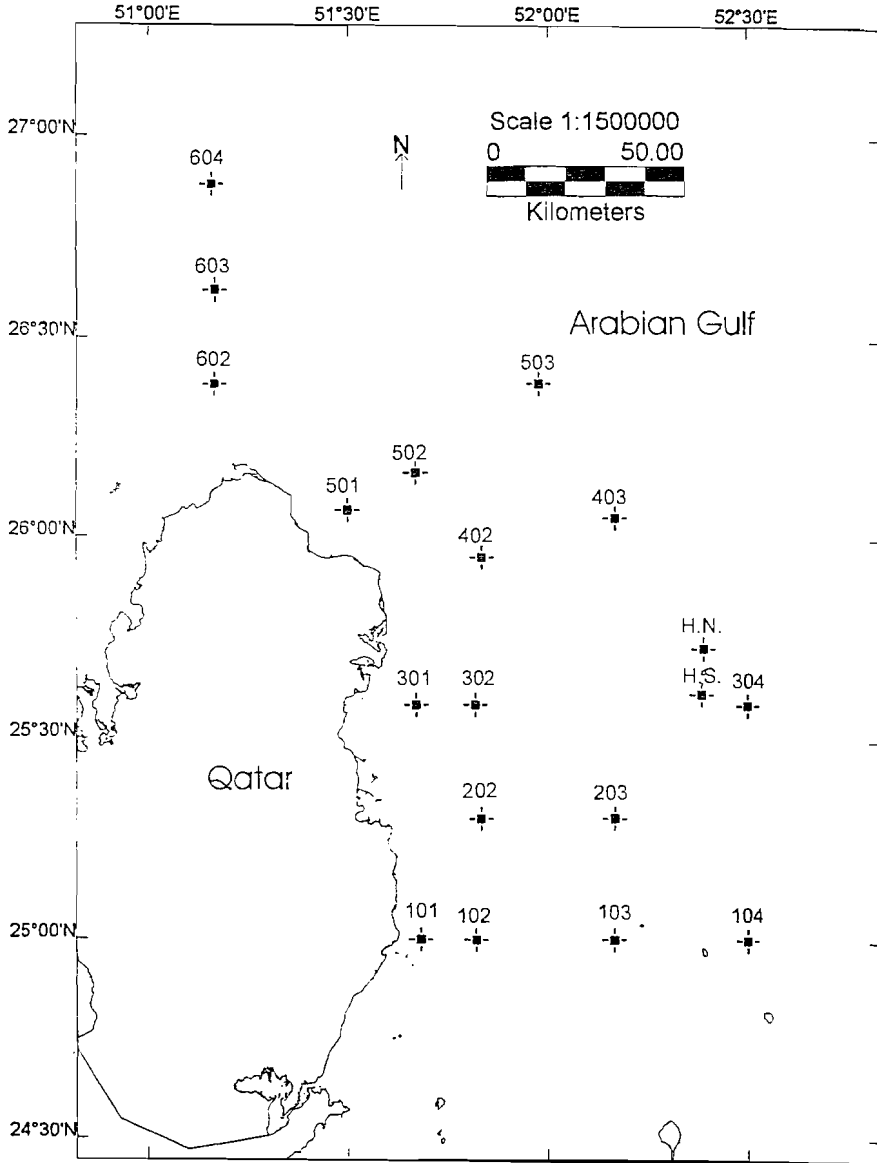


Figure 1. Locations of sampling stations

RESULTS

Physical Parameters

The results obtained are given below. These cover Physical parameters, the benthic fauna and the findings at the 19 stations (101-104; 202 & 203; 301-302 & 304; 402 & 403; 501-503; 602-604; HN (Halul North station) and HS (Halul South station)). The minimum water temperature (19.0°C) in all investigated stations was recorded during the winter season (Dec.- Jan.). During most of the year the temperature was high and in summer it reached over 34.7°C. The difference in water temperature between the surface and the bottom was about 1-2°C in summer season and about 0.1-0.5°C in winter season. The salinity value was high due to the shallowness of water, intense radiation and high air temperature. The pH values were in the alkaline range (8.10-8.27) and oxygen values ranged between 4.0-5.52 mg/l (Tab.1). The nature of the sediment varied being sandy or sandy-muddy.

Benthic Fauna

A total of 270 species of benthic invertebrates were identified. Molluscs comprised the most abundant group with 201 species, followed by crustaceans, annelids and echinodermates with 26, 14 and 17 species respectively. Ascidiars and hydrozoas were represented by 6 different species each. Comparing the maximum species count among stations 70 sp. to 80 sp. were found at stations 101 and 301, respectively (Tab. 1). Stations 104, 302 and 402 were with 20, 19 and 22 species respectively. The least species (7 species) appeared at station 602.

Details of the dominance and for all stations as follows:

faunal composition and diversity

The organism identified from the biotopes samples collected from each station is presented in Table 2 and the percentage frequency of the different animal groups is presented in Figure 2.

Station 101 to 104

It is apparent that molluscs contributed between 65%-85.7% of the biota at stations 101 to 104 and are considered as the most predominant groups. Among the molluscs species density varied in the different samples. *Cerithium scabridum* occurred by 19- 13 individuals from each grab sample (St.101 & 103) (Tab.3). *Turritella cochlea* was collected in greater numbers

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS

Table 1: Mean value of environmental parameters and sediment type at different stations in Qatari waters during the period of study.

Station	Position	Depth (m)	Temp. (°C)	Salinity ‰	Dis. oxy (ml l ⁻¹)	pH
101	Lat. 25° 57' 00" Long. 51° 41' 00"	8	28.10	43.3	5.38	8.10
102	Lat. 25° 00' 00" Long. 51° 49' 16"	12.5	27.9	43.8	5.18	8.13
103	Lat. 25° 00' 00" Long. 52° 10' 00"	16.5	27.9	42.7	5.24	8.17
104	Lat. 25° 00' 00" Long. 52° 30' 00"	10	26.7	43.0	5.36	8.16
202	Lat. 25° 18' 00" Long. 51° 50' 00"	19	26.6	41.3	5.31	8.16
203	Lat. 25° 18' 06" Long. 52° 10' 04"	14	27.3	41.9	5.38	8.18
301	Lat. 25° 35' 05" Long. 51° 40' 13"	6	28.5	40.5	5.36	8.16
302	Lat. 25° 35' 08" Long. 51° 49' 07"	21	26.2	40.2	5.14	8.20
304	Lat. 25° 35' 00" Long. 52° 30' 00"	22	28.7	40.5	5.10	8.13
402	Lat. 25° 57' 00" Long. 51° 50' 00"	25	27.1	39.9	4.92	8.22
403	Lat. 25° 59' 00" Long. 52° 10' 04"	31	26.9	40.1	5.13	8.27
501	Lat. 26° 04' 00" Long. 51° 30' 00"	14	26.2	40.6	5.48	8.17
502	Lat. 26° 09' 40" Long. 51° 40' 03"	18.5	27.0	40.2	5.09	8.18
503	Lat. 26° 23' 20" Long. 51° 58' 38"	40	26.1	40.1	5.09	8.22
602	Lat. 26° 30' 03" Long. 51° 10' 01"	12	26.5	40.5	5.26	8.19
603	Lat. 26° 37' 00" Long. 51° 10' 03"	23.3	26.0	40.5	5.25	8.19
604	Lat. 26° 52' 45" Long. 51° 09' 36"	44	29.9	40.2	5.17	8.27
H.N	Lat. 25° 43' 29" Long. 52° 23' 14"	24	28.0	N.R	N.R	8.22
H.S	Lat. 25° 36' 49" Long. 52° 23' 03"	20	26.3	N.R	N.R	8.22

* H.N= Halul North station and H.S= Halul South station

*N.R= Not recorded

Table 2: Number of species in each station (S), species diversity (H'), evenness (E), and species richness (R) at different stations in Qatari waters.

Station	Diversity index (H')	Evenness (E)	Richness (R)	No. of species (S)
101	3.683	0.867	12.64	70
102	2.841	0.776	7.60	39
103	3.772	0.910	10.92	63
104	2.649	0.884	4.69	20
202	3.228	0.825	8.74	50
203	3.294	0.919	7.72	36
301	3.546	0.811	12.23	79
302	2.531	0.831	4.50	21
304	3.581	0.878	11.39	59
402	2.829	0.890	4.85	24
403	3.128	0.880	7.59	35
501	3.255	0.865	7.97	43
502	3.489	0.839	11.63	64
503	3.453	0.930	8.13	41
602	1.669	0.858	1.73	7
603	3.002	0.831	8.00	37
604	2.935	0.924	4.92	24
H.N	3.206	0.909	8.03	34
H.S	2.854	0.887	6.10	25

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS

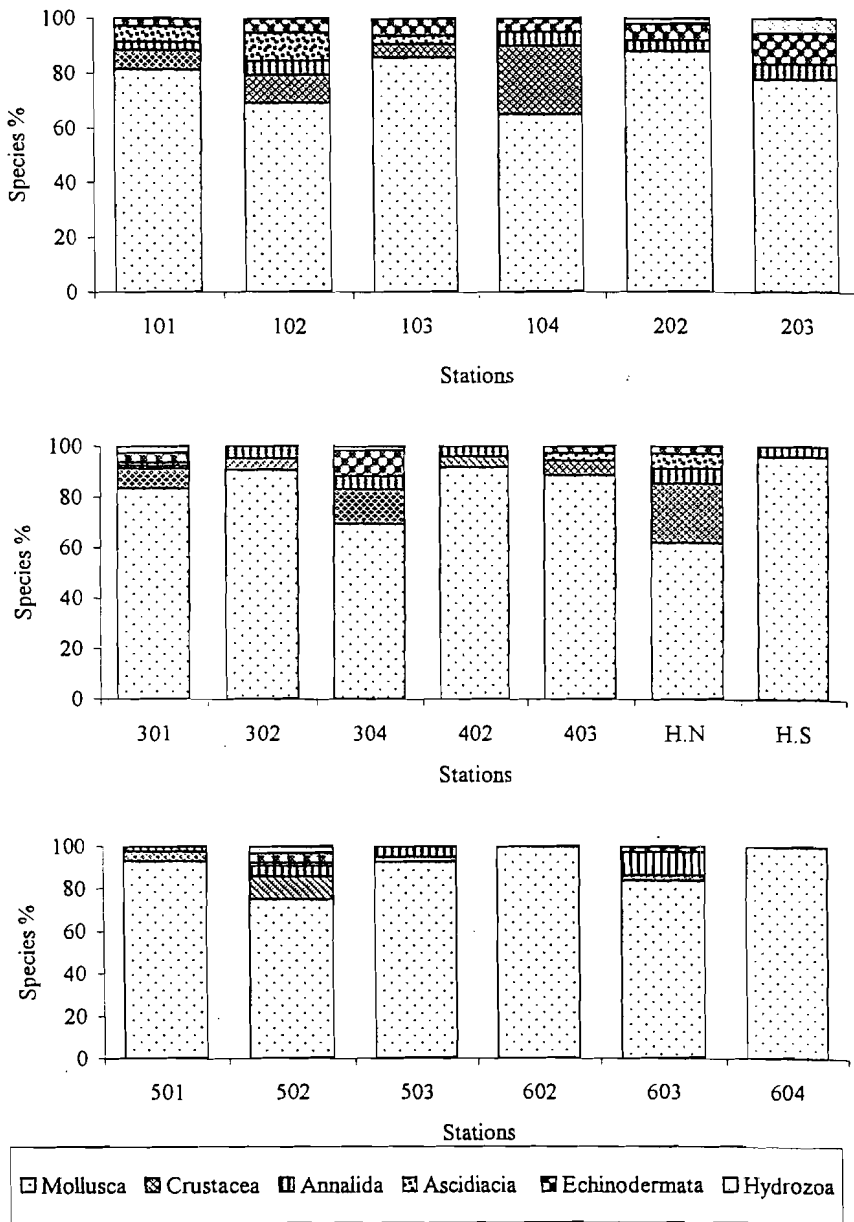


Figure 2: Frequency percentage of different groups in the study stations.

(50 individuals/grab sample) at Station 102. *Nassarius arcularius plicatus* varied from 2 to 14 individuals/grab sample. *Ancilla ampla*, *Glycymeris pectunculus maskatensis*, *Dosinia* sp. and *Thracia (Angulus) adenensis* occurred with 10, 26, 11 and 15 individuals/grab sample respectively. *Sunetta effossa* at stations 101 to 103 was represented by 28, 11 and 10 individuals/grab sample respectively. *Callista multiradiata* (11 individuals/ grab sample) and *Dosinia caelata* (10 individuals/ grab sample) were dominant only at station 101.

Of the 26 crustacean species encountered at all stations, 3-5 species were found at stations 101 to 104. The remaining phyla were only represented by 1-4 species for each phylum.

The overall faunal diversity index based on the numbers of individuals was the highest at St. 103 (3.772) and the least (2.649) at St. 104. The evenness values (E) ranged from 0.776 (St. 102) to 0.910 (St. 103) (Tab.2).

Station 202 to 203

The fauna was equally dominated by molluscs with 44 species at St. 202 and 28 species at St. 203. The gastropods *Turritella cochlea* (28 individuals/ grab sample) and *Nassarius* sp. (16 individuals/ grab sample) formed the second dominant class at St. 202 with fewer *Nassarius* sp. (8 individuals/ grab sample) at St. 203. The most common bivalves at St. 202 were *Glycymeris* sp. (36 individuals/ grab sample), *Anadara* sp. (26 individuals/ grab sample), *Cardium* sp. (22 individuals/ grab sample), *Pecten* sp. (16 individuals/ grab sample), *Glycymeris pectunculus maskatensis* (14 individuals/ grab sample), and *Callista* sp. (14 individuals/ grab sample). *Malleus malleus* (10 individuals/ grab sample) *Tapes* sp. (8 individuals/ grab sample) were found at St. 203. The annellids were represented by 2 species only; *Eunice* sp. and *Neries* sp., while the echinodermites were represented by 4 species; *Ophithrix savignyi*, *Ophithela danae*, *Ophithela vemusta*, and *Linkia multiflora*. The least find was 2 species, *Obelia dichotoma* and *Obelia* sp. of the hydrozoa (Tab. 3).

Station 301, 302 and 304

Similarly, the fauna was dominated by gastropod and bivalve molluscs represented by 65, 19 and 41 species at the stations 301, 302 and 304 respectively. Among the bivalves *Cucullaea labiata*, *Pinctada radiata*, *Pteria marmorata*, *Malleus malleus*, *Diplodonta cf. globosa*, *Cardium reeveanum*,

Cardium sp. and *Trachycardium lacunasum*, *Tellina* sp., *Sunetta effossa*, *Dosinia caelata*, *Veneridae* sp. *Callista* sp., occurred in high numbers (between 11 –30 individual from each grab sample) specially at station 301. Most molluscs were represented by 1-8 individual/grab sample at these stations. Crustaceans were represented by 6, 1 and 8 species at stations 301, 302 and 304 respectively. Amphipoda sp. was found to be the most abundant (21 individuals/ grab sample) at station 304. Other taxa (annelids, ascidians, echinodermates and hydrozoas) varied in their numbers between the 3 stations and generally formed 1.3-10 % of the recorded biota.

Stations 402 and 403

Molluscs formed the most dominant fauna at these stations and were represented by 22 and 23 species at the two stations 402 and 403 respectively. Station 402 was dominated by the gastropod *Turritella cochlea* and the 2 bivalves *Cardita bicolor* and *Cardium* sp. while St. 403 was dominated by the gastropod *Strombus (Conomurex) persicus* and the bivalve *Apolymetis* sp. As for the remaining classes these were represented by 1 or 2 species only [Crustacea (1-2 species), Annelida (1 species), Ascidiacea (1 species) and Echinodermata (1 species)] (Tab.3).

Stations 501, 502 and 503

Gastropod and bivalve molluscs accounted for 89%, 75% and 93% at stations 501 to 503. Station 501 was dominated by 3 gastropods *Umbonium vestiarium*, *Strombus decorus decorus* and *Nassarius arcularius* and 2 bivalves *Cardita bicolor* and *Cardium* sp. The Crustacea was dominated by 2 species *Portunus pelagicus* and *Penaeus* sp. Annelida was represented by one species (*Neries* sp). (Tab.3). Station 502 was characterized by the dominance of the gastropod *Turritella cochlea* (46 individuals/ grab sample) and 2 bivalves *Anadara ehrenbergi* (20 individuals/ grab sample) and *Tapes texturatus* (10 individuals/ grab sample). Crustaceans (7 species), annelids (3 species), ascidians (1 species) and echinodermates (3 species).

Station 503 was dominated by the 2 gastropod *Rhinoclavis (Proclava) kochi* and *Nassarius arcularius plicatus* and one bivalve *Cardita bicolor*. Crustaceans and annelids were represented by 1 and 2 species respectively (Tab.3).

Stations 602, 603 and 604

As in the previous stations the fauna was dominated by gastropods and bivalve molluscs where they were represented by 7, 31 and 24 species at

stations 602 to 604 respectively. Station 603 is characterized by the dominance of the gastropod *Xenophora* sp. (19 individuals/ grab sample) and the 2 bivalves *Cardium* sp. and *Callista* sp. whereas in St. 602 *Pinctada radiata* occurred with 8 individuals / grab sample and *Cardium* sp. occurred with 8 individuals / grab sample. Station 604 was characterized by the dominance of *Cardium* sp. (13 individuals / grab sample). Other taxa were not found at stations 602 and 604, Crustacea, Annelida, Echinodermata and Hydrozoa were occasionally recorded in low frequency as compared to molluscs at St. 603.

Stations H.N and H.S

In both the stations the gastropods and bivalve molluscs were the most dominant species and were represented by 21 (station H.N) and 24 (station H.S) species. Among the gastropods, *Umbonium vestiarium* and *Strombus* (*Canarium*) *fusiformis* occurred with 10 and 12 individual from each grab sample at stations H.N and H.S respectively. Among the recorded taxa from station H.N, crustaceans (8 species), annalids (2 species), ascidians (2 species) and echinodermates (1 species) were collected in low numbers (1-7 individuals) for each species (Tab.3).

The distribution extents of species collected from investigated stations in Qatari waters showed that some species have a wider distribution while others were limited. The benthic fauna that has the widest distribution extent and species diversity along the whole study stations can be summerised in the following: The gastropod, *Turritella cochlea* was widespread in the 12 stations; *Hexaplex kuesterianus* in 11 stations; *Nassarius* sp., *Nassarius arcularius plicatus* and *Crassispira* sp. in 10 stations.; *Thais tissoti* in 9 stations; *Strombus* (*Conomarex*) *persicus*, *Thais* sp., *Mitra pretiosa* and *Turridrupa cincta* in 6 stations. The bivalve *Cardium* sp. showed another extended distribution since they were recorded from 13 stations; *Pinctada radiata* (11stations); 4 species were common in 10 stations, these were *Laevicardium papyraceum*, *Cari* sp., *Dosinia* sp. and *Tapes texturatus*; 4 species were common in 9 stations, these were *C. ruschenbergerii*, *N. aurantiacum*, *T. lacunasum* and *S. effossa*; 9 species showed another extended distribution where they were recorded at 7 stations, these were *Acra plicata*, *Anadara ehrenbergi*, *Glycymeris lividus*, *Glycymeris pectunculus maskatensis*, *Cardita bicolor*, *Apolymetis* sp., *Tellina* sp., *Circe scripta* and *Callista* sp.

The Crustacea, *Crangon* sp., *Penaeus* sp. and *pilumnus* sp. were extended in 4, 4 and 6 stations respectively.

Polychaete annelids are important members of the benthic community in most marine areas. *Nereis* sp. (Annelida) showed a considerable wide distribution where it was recorded from 12 stations. The remaining taxa showed less frequency where they were only recorded from 1-5 stations (Tab.2).

Ascidiacea and Hydrozoa were represented by 6 and 4 species respectively. The highest number of species 70 and 79 were found at stations 101 and 301, respectively (Tab. 1). The lower numbers were found at stations 104, 302 and 402 were 20, 19 and 22 species were recorded respectively. The lowest number of species was found at station 602 where 7 species were only recorded.

Species Diversity

Species diversity indices based on number of individuals for all the stations investigated were calculated. These showed a small variation between the investigated stations (Tab.2). The overall species diversity index was greater at St. 101 ($H' = 3.683$), while the lowest species diversity index is recorded at St. 602 ($H' = 1.669$). The overall evenness (E) based on the number of individuals was the highest at St. 503 ($E = 0.930$), while the lowest value ($E = 0.776$) was estimated at St. 102.

There was a significant difference in species richness between the investigated stations. [highest St. 101 ($R = 12.64$) and lowest at St. 602 ($R = 1.73$)].

DISCUSSION

The Arabian Gulf is considered as one of the most saline seas in the world (Sheppard *et al.*, 1992), because of its relatively shallow depth and higher rates of evaporation during the summer months, when water temperatures may reach 32°C or higher. The salinity in the Gulf waters range from normal seawater, 35-37‰ near the Straits of Hormuz, to about 38.99‰ near the Kuwait and Saudi coasts, and higher values were recorded in protected coastal embayments and lagoons (70-120‰) (Basson *et al.*, 1977; Shriadah, 1997). The pH values displayed very limited variation in the Gulf waters. Low pH measured in the summer season were matched by a relative decrease in the concentrations of

dissolved oxygen. The seawater in the Gulf was more oxygenated (6.47 mg/l) during the winter season due to decrease in water temperatures and water agitation whereas, less oxygenated seawater (5.18 mg/l) were observed in the summer season (Shriadah, 1997).

Previous records of offshore water temperature around the east coast of Qatar during the winter varied between 18-22°C and the highest sea temperatures were recorded for June-August (33-34.7°C). Salinity in the study area ranged between 38-45‰.

This survey along the east coast of Qatar from 19 stations resulted in the identification of 270 species of which 201 mollusc species were gastropods and bivalves. Al-Khayat (1997) had reported 246 mollusc species from 11 stations in Qatari waters including 115 gastropods, 124 bivalves, 4 scaphopods and 3 polyplacophores. Earliest records include: Melvill (1928) a total of 365 mollusc species from Oman and north Arabian Gulf, Smythe (1982) a total of 384 mollusc species from the Arabian Gulf, and 230 from United Arab Emirates and Basson *et al.* (1977) with a total of 404 mollusc species from the western Arabian Gulf.

In general, approximately 1000 species of molluscs are known for the Arabian region (Sharabati, 1984; Mastaller, 1987). Of these, only a few are endemic to the Red Sea [cowries (Cypraeidae) and strombids (Strombidae)], and a handful are known only from the Arabian Gulf or Arabian Sea (Bosch and Bosch, 1982 & 1989). Mastaller (1987) who surveyed shallow molluscs along almost the entire length of the Red Sea, concluded that their distributions within this body of water was entirely related to local habitat availability and abundance. Sheppard *et al.*, (1992) reported that no zoogeographical trend has been detected within the Red Sea for this very diverse group. Between the Red Sea and its neighbouring areas, little is known, with the exception of deep water species of the Red Sea which are markedly different from deep water species from the Arabian Sea (Sheppard *et al.*, 1992). Mastaller (1987) attributes this to the fact that deep Red Sea water has a temperature closer to that of its shallow water, while the deep Arabian Sea temperature is much cooler. Smythe (1972) recorded 49 gastropod and 36 bivalve species from Bahrain Island, while Vousden (1987) reported 100 gastropod, 87 bivalves, 3 scaphopods and 1 Amphineura from all habitats around Bahrain Island. Price (1982) describes the

echinoderm fauna of Arabian Gulf and Red Sea coasts, including a number of endemic species.

Annaleidia and Echinodermata were represented by 26, 14 and 17 species respectively. Echinoderms of the Arabian seas were comprehensively covered by Price (1982, 1983) who gave about 350 recorded species for the region. The Red Sea has about 170 species of which 5.3% are endemic, while in the Arabian Gulf they represent 12.1%. This group is unusual, however, in that the highest endemism values (13.2%), as well as the greatest total numbers, are found in the Arabian Sea (Sheppard *et al.*, 1992).

The shallow waters of the Arabian Gulf has high temperature which plays an important role in the distribution of its fauna and flora. It also has the paucity of fresh water coupled with high evaporation, which produces highly saline waters of about 40-48 ‰, and over 100 ‰ in some estuaries and shallow bays. Broadly speaking, although there is a wealth of suitable biotopes in the Arabian Gulf, life is hard for many organisms. The marine invertebrates seem to be plentiful in Qatari waters and similar to the other places in the Arabian Gulf. But they are less diverse than those elsewhere as in the Gulf of Oman and the Red Sea.

ACKNOWLEDGEMENT

We are grateful to all scientific staff and crews on board R/V "Mukhtaber Al-Bihar" of the University of Qatar for their assistance. Thanks are extended to Mr. Muzaffer A. Sain for his assistance in sorting benthos samples. we are also grateful to Professor Ekhlās M. Abdel Bari from Department of Biology, who kindly read the manuscript.

Table 3: Macro-invertebrates of Qatari waters, Arabian Gulf.

Species	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	HN	HS	
Stations	8	13	14	35	21	14	6	20	22	25	38	11	15	40	13	23	44	24	20	
Water depth (m)																				
<i>Mollusca</i>																				
<i>Dreolina funiculata</i>							1													
<i>Dreolina nagevelli</i>							3													4
<i>Trochus (Atrichobius) keritensis</i>	1	1					2													1
<i>Trochus</i> sp.							6													
<i>Prionoxystus obesus</i>										1										2
<i>Limbomus vestitum</i>												18	3							10
<i>Clancolus pharaonicus</i>							3													
<i>Atrichia gubata</i>	1						3													
<i>Calyptraea edgerlyana</i>									1		1		1							
<i>Calyptraea</i> sp.																				1
<i>Cerithium scaberrimum</i>	19		13	1																
<i>Cerithium</i> sp.					4		1				1	1	1							
<i>Khioscylus (Proculva) kashii</i>	4		6	1			6		1		3		10							
<i>Cerithideixis cingulata</i>	2	1																		
<i>Turzella coxackea</i>	3	50	8		28				3	15	1	1	46	1	1	1				4
<i>Strombus (Dakosera) ypicatus sibirskii</i>									1		2									3
<i>Strombus decorus decorus</i>											7	12								1
<i>Strombus (Cammara) presicus</i>											3	3	1							1
<i>Strombus (Cammara) fastidiosus</i>									6		12		3							2
<i>Strombus</i> sp.														2						5
<i>Terbellium terbellum</i>		2							1	1										
<i>Terbellium conygea</i>																				
<i>Xenophora</i> sp.									4	8										19
<i>Cypraea</i> sp.		2					1													1
<i>Natica (Naticarius) alagaplanensis</i>																				
<i>Natica lineata</i>									1											
<i>Natica viridula</i>											2	1								3
<i>Natica</i> sp.													3							
<i>Eunaticina pyralis</i>																				
<i>Polinices tumidus</i>																				
<i>Cypraea pilosus</i>																				
<i>Limacilla cingulata</i>																				1

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS

Stations	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	I.N.	I.L.S.	
Water depth (m)	8	13	14	35	21	14	6	20	22	25	38	11	15	40	13	23	44	24	20	
<i>Cyathium</i> sp.											1									
<i>Veneratus sulcatus</i>					1	1							1							
<i>Epicurium</i> sp.													1							1
<i>Hesuperlet lucetarius</i>	1	5	1	1	4	2	5	2	1				1							
<i>Murex spinosus</i>													1							
<i>Chlorocera ramus</i>					2	1			1											2
<i>Hemioconcha scopio</i>																				
<i>Murex scoloplax</i>								1												
<i>Murex malabaricus</i>											1									2
<i>Thais fassoi</i>	5	4	2	4		2	2		2		2									2
<i>Cyprina kunkunensis</i>		1																		
<i>Thais</i> sp.							2	1	1		4		5							4
<i>Thais munda</i>								2												
<i>Mytilus thunda</i>	1	1							2											1
<i>Pisania tiqua</i>		1																		
<i>Hindsa brinckerhousi</i>							6													
<i>Nassarius arcuatus pilosus</i>	5	2	14	3			6							13	4	8				1
<i>Nassarius albicans gemmiferus</i>							1	6												
<i>Nassarius nudifens</i>			1																	
<i>Nassarius deshayesi</i>																				
<i>Nassarius</i> sp.			4																	
<i>Fusinus foreps</i>	5	5			16	8	3		1	4	3	7		2						
<i>Fusinus tonsuseni</i>						1					1									1
<i>Fusinus varbius</i>	1																			
<i>Fusinus</i> sp.					1					1										
<i>Anacella (Spartella) caerulea</i>																				
<i>Anacella anapa</i>	1		4		2															
<i>Anacella scopella</i>	1		10																	
<i>Anacella ovalis</i>	2						4													
<i>Anacella</i> sp.							6													
<i>Mina pretiosa</i>			3						3				1	2						
<i>Mina</i> sp.																				
<i>Mina hilentia</i>																				
<i>Mina scutellata</i>																				
<i>Mina fasciolata</i>																				
<i>Pista ovialis</i>							1													
<i>Mina</i> sp.													5							2

Stations	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	I.H.N.	I.H.S.	
Water depth (m)	8	13	14	35	21	14	6	20	22	25	38	11	15	40	13	23	44	24	20	
<i>Trigonostoma vestitum</i>			1		1															
<i>Coelus</i> sp.											1		1	2	1					2
<i>Crassostrea giffithi</i>													2	2						
<i>Crassostrea</i> sp.	1		6		2			2	1	1		2	2	2	2	2	1			1
<i>Turritopora canis</i>			2						1	1			1							
<i>Crassostrea cf. Faurielius</i>							2													
<i>Dalmanella cecchi</i>							1													
<i>Caucella isabellei</i>														2						
<i>Geumula</i> sp.														1						
<i>Pyramidella acuta</i>							1					1								
<i>Pyramidella sulcata</i>																1				
<i>Pyramidella</i> sp.								2				4								
<i>Limnæolum nitidum</i>			1				3													2
<i>Limnæolum</i> sp.																1				
<i>Siphanaria tenuicostellata</i>																				
<i>Littorina lineata (ahliensis)</i>							3													
<i>Acteona</i> sp.							1													
<i>Acteona affinis</i>											1									
<i>Pupa affinis</i>																				
<i>Bullaria ampulla</i>			5		5		4													
<i>Atrypa cylindrica</i>					1								1							
<i>Dentalium octangulatum</i>																1				
<i>Barbatia laetlingi</i>											1									
<i>Barbatia fovea</i>											1									
<i>Barbatia</i> sp.																				7
<i>Arcyia</i> sp.																				
<i>Acer plicata</i>						6	5				3	6	2	2						7
<i>Arcyia ventricosa</i>											1									
<i>Amudra eltonbeigi</i>					8		1		2		1	2	20							1
<i>Amudra nitescens</i>							2				2									
<i>Amudra urologioides</i>												4								1
<i>Amudra sectirostrata</i>					5															
<i>Amudra</i> sp.							26													
<i>Cucullaea labiata</i>					7		1		23											1
<i>Glycymeris livida</i>	9				1			2			5	3								1
<i>Glycymeris pectinatus muskatensis</i>	3		26		14	5	49				3	9								1

STUDY OF MACROBENTHIC INVERTEBRATES IN THE QATARI WATERS

Station	Water depth (m)	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	11N	11S
<i>Chironomus</i> sp		8	13	14	35	21	14	6	20	22			11	15	40	13	23	44	24	20
<i>Branchiobdella emarginatus</i>		5				36		44					4							
<i>Limnolochmoxes</i> sp		2														7				
<i>Ampylodora limonicum</i>				9				1					2							
<i>Amytilus viridis</i>								2												
<i>Mosdefus phidipparum</i>													1						1	1
<i>Amytilus</i> sp																				1
<i>Pisina</i> sp.				1		1		3						1						1
<i>Pisina bicolor (P. auricaria)</i>										2										
<i>Pinctada radaria</i>		1		1		3	5	30		3	1		6	6		8				1
<i>Pinctada margaritifera</i>							2													
<i>Pinctada</i> sp								1												
<i>Pincta auricularia</i>								1		19		3	3							
<i>Malilus nullius (Mf regular)</i>		1	4			6	10	30	3											
<i>Malilus</i> sp						1														
<i>Isopanum deumilera</i>		2	1			2		1		1				3						
<i>Isopanum lezuana</i>		1								2				3						
<i>Isopanum</i> sp						9														
<i>Pisina</i> sp																				
<i>Osirex</i> sp		1						5												1
<i>Pecten erythraeus</i>														2	1					
<i>Pecten</i> sp				1		16		1												
<i>Chilonyx</i> sp						3	2													3
<i>Chilonyx corallinoides</i>																				1
<i>Chilonyx maculobreviter</i>						1	3	2		2		1		5	1					1
<i>Chilonyx scaberrimus</i>																				1
<i>Decapodosten biluca</i>																				3
<i>Decapodosten</i> sp						1	1													1
<i>Plicatula amblicata</i>																				2
<i>Spoudylus exilis</i>		2		3	1	2	3						3							1
<i>Ammonia nebulosa</i>				1				6	1	4										
<i>Ammonia</i> sp																				
<i>Cochka nigra</i>								6												
<i>Diplodonta c. rubra</i>					6			19		1				1						1
<i>Diplodonta ruficornis</i>													2	5						
<i>Diplodonta</i> sp			2																1	4

	Stations		Water depth (m)																			
	101	102	103	104	105	202	203	301	302	304	402	403	501	502	503	602	603	604	11N	11S		
<i>Glycymeris</i> sp	8	13	14	35		21	14	6	44													
<i>Brachinotokes emarginatus</i>	5					36																
<i>Unio</i> sp	2																					
<i>Amegdulum lapponicum</i>			9																			
<i>Mytilus</i> sp.								2														
<i>Muschulus philippinarum</i>																						
<i>Mytilus</i> sp																						
<i>Perna</i> sp			1			1			3													
<i>Perna</i> bender (<i>P. auricularia</i>)										2												
<i>Pinctada radiata</i>	1		1			3	5	30		3	1		6	6		8					1	
<i>Pinctada margaritifera</i>							2															
<i>Pinctada</i> sp							3	1					1									
<i>Perna</i> muricata							1			19			3	3								
<i>Mallevia</i> (<i>M. regularis</i>)	1	4				6		10	30	3												
<i>Mallevia</i> sp																						
<i>Lucicutia</i> sp		2	1			2				1	1			3								
<i>Lucicutia</i> sp																						
<i>Lucicutia</i> sp						9																
<i>Perna</i> sp																						
<i>Osirex</i> sp	1							5													1	
<i>Pecten</i> <i>entellanicus</i>																						
<i>Pecten</i> sp						16			1				2	1								
<i>Chlamys</i> sp						3															3	
<i>Chlamys</i> <i>conallinoides</i>													2								1	
<i>Chlamys</i> <i>muschelbergensis</i>						1			3	2			2								1	
<i>Chlamys</i> <i>senatori</i>													5	1							1	
<i>Decussopecten</i> <i>placa</i>													1								3	
<i>Decussopecten</i> sp																					1	
<i>Pisana</i> <i>rubra</i>						1					1										2	
<i>Spondylus</i> <i>exilis</i>	2					3	1	2	3												1	
<i>Anomia</i> <i>albicans</i>						1			6	1			4								3	
<i>Anomia</i> <i>liquida</i>																						
<i>Cadaka</i> <i>rigida</i>									6													
<i>Diplodonta</i> <i>c. fulva</i>							6		19				1								1	
<i>Diplodonta</i> <i>ravennensis</i>													2	5								
<i>Diplodonta</i> sp		2								2											4	

	Stations		Water depth (m)																	
	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	11'N	11'S	
<i>Caularia</i> sp		1		1		4				3										1
<i>Canthia brecher</i>							154			11		33	2	9			1	6		
<i>Menocaulium aurantiarum</i>	1	2	4				5					2		4				3	1	2
<i>Tachycardium laevisimum</i>	6	6	2		2		19		1	8			5							
<i>Canthium</i> sp	7	1	1	1	22		13	8	5	16		8		5	9	13				
<i>Canthium revocatum</i>							14													
<i>Canthium pseudolina</i>																				
<i>Laevicardium papiracatum</i>	4	3	2		5		3				4	3	3	1				2		
<i>Solen</i> sp																				
<i>Siphonax japonica</i>	1	1	2								1			2						
<i>Phaeax calliclavus</i>																				1
<i>Tellina wallisecae</i>			2																	
<i>Tellina triflora</i>			1				1													
<i>Apolymeris angulata</i>		2		4			4					1								
<i>Apolymeris dubia</i>							1													
<i>Apolymeris</i> sp	3				2			1		3	13			2				2		
<i>Tellina</i> sp					3			3	13	6	1			4				4		
<i>Pionax scaphisium</i>		1																		
<i>Pionax</i> sp													3							
<i>Gart maculosa</i>		1		3										3						1
<i>Gart roseus</i>													2							
<i>Gart turgida</i>	1																			
<i>Singulariaria cumingiana</i>	1		3																	
<i>Gart</i> sp	4		5		6							3	1	5						3
<i>Asaphus</i> sp	1																			
<i>Gart sinuosa</i>														2						
<i>Senecle scabra</i>													1							
<i>Senecle</i> sp																				
<i>Cercaria calyppe</i>	19		9																	
<i>Cercaria cornuta</i>	1		1																	
<i>Cercaria uterocula</i>	1																			
<i>Callista florida</i>	1		2																	
<i>Loxostoma ornata</i>	1						1													1
<i>Bassania californica</i>	4		5									1		4						6
<i>Leosia</i> sp	7	8	11											3	5	2				6
<i>Pipidina subcrena</i>	1													1						

	Stations																					
	Water depth (m)		101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	I.I.N	I.I.S	
<i>Dicamnum</i> sp.			1	1																		
<i>Herdmania</i> sp.			1																			
<i>Echinodermata</i>																						
<i>Ophirix savignyi</i>			1	1			1	1	1													
<i>Ophioreis dubia</i>			1																			
<i>Ophirhela danae</i>				1			1	1														
<i>Ophioloba venusta</i>								1														
<i>Ophira kiribegi</i>					5																	
<i>Pentacaster mammillatus</i>										1												
<i>Astropecten polyacanthus</i>										1												
<i>Asterina burtoni</i>															1							
<i>Linkia multiloba</i>								1	1						3							
<i>Marcia planulata</i>					2																	
<i>Echinometra mathaei</i>											2								1			
<i>Clypeaster humilis</i>											2				1							
<i>Laganum depressus</i>														2								
<i>Tripenus</i> sp.					1																	
Unidentified sp.					1												2					
<i>Holothuria</i> sp.							1															
<i>Heterometra savignyi</i>																					2	
Hydrozoa																						
<i>Obelia dichotoma</i>									1													
<i>Obelia</i> sp.									1	1	1											
<i>Clytia linearis</i>																1						
<i>Sertularia</i> sp.									1													

	Station		Water depth (m)																	
	101	102	103	104	202	203	301	302	304	402	403	501	502	503	602	603	604	11'N	11.S	
<i>Leucostea sigurta</i>			3																	
<i>Dardanus</i> sp.		1	2																	
<i>Laobornis parvus</i>									1											
<i>Alpheidae</i> sp.																				
<i>Synalphecia quinnoctonus</i>					1															
<i>Alpheus</i> sp.		1																		
<i>Caribbean parvus</i>																				
<i>Peridiniopsis obscurus</i>																				
<i>Charybdis</i> sp.					2															
<i>Penaeus</i> sp.		1			2															
<i>Metapenaeus affinis</i>																				
<i>Penaeus semisulcatus</i>																				
Unidentified prawns sp.1																				
<i>Gynulidae</i> sp.																				
<i>Amphirodda</i> sp.		1							21		6									
<i>Balanus</i> sp.																				
<i>Annelida</i>																				
<i>Eumecis minutaria</i>																				
<i>Eumecis</i> sp.		3								2	4									
<i>Chelyphus cinctus</i>																				
<i>Eumecis indica</i>																				
<i>Mareis</i> sp.																				
<i>Leptidomereus</i> sp.		2																		
<i>Syllis</i> sp.																				
<i>Eubolia</i> sp.																				
<i>Pseudosquilla verrucosa</i>																				
<i>Hydrobia elegans</i>																				
<i>Hydrobia</i> sp.																				
<i>Vermilionis pyralis</i>																				
<i>Spirorbanchus testaceus</i>																				
Unidentified sp.1		1																		
<i>Aspidictya</i>																				
<i>Phallosia magna</i>		2	2	2																
<i>Colonial asiatica</i>		1	1																	
<i>Syella</i> sp.		1	1	1																
<i>Syella cinquopus</i>																				

REFERENCES

- Al-Khayat, Jassim A. 1997. The Marine Mollusca of the Qatari waters, Arabian Gulf. *Qat. Univ. Sci. J.* 17 (2): 479-491.
- Basson, P. W.; Burchard, J. E., J. T. Hardy and Price, A. R. 1977. Biotopes of The Western Arabian Gulf. Marine Life and Environments of Saudi Arabia. Aramco, Saudi Arabia. 284pp.
- Biggs, H. E. J. and Grantier, I. 1960. A preliminary list of mollusca of Ras Tanura, Persian Gulf. *J. Conch. Lond.*, 24:387-392.
- Biggs, H. E. J., 1973. The Marine Mollusca of the Trucial Coast, Persian Gulf. *Bull. Br. Mus. Nat. Hist. (Zool)*. 24: 344-421; 6 pls.
- Bosch, D. and Bosch, E., 1982. Sea shells of Oman. London. 206pp.
- Bosch, D. and Bosch, E., 1989. Sea shells of Southern Arabia. Motivate Publishing, M.A.E. 124pp.
- Bosch, D. T., Dance, S. P., Moolenbeek, R. G. and Oliver, P.G., 1995. Seashells of Eastern Arabia. Motivate Publishing, London. 296 pp.
- Farmer, D., 1983. Marine Life. In: Clayton, D and Pilcher C., (eds), Kuwait's. Natural History: An Introduction. Kuwait Oil Co., pp. 192-247.
- Glazer, B.A., Glazer, D.T. and Smythe, K. P., 1984. The marine mollusca of the Kuwait, Arabian Gulf. *J. Voch., Lond.*, 31:311-330.
- Green, S., 1994. Bahrain Seashells. Arabian Printing & Publishing House. Bahrain. 183 pp.
- Hassan, A.k., 1995. Numerical analysis of changes in the bivalved mollusca fauna along the Saudi intertidal zone of the Arabian Gulf. *Bull. Nat. Inst. Oceanogr. & Fish.*, 2: 413-437.

- Jones, D. A., Price, A. R. G. and Hughes, R. N. A. 1978. Ecology of high saline lagoons, Dawhat as Sayh, Arabian Gulf, Saudi Arabia. *Estuar. Coast. Mar. Sci.* 6: 253-262.
- Jones, D. A. and Clayton, D., 1983. The Systematics and ecology of the crabs belonging to the genera *Cleististoma* De Haan and *Paracleistostoma* De man on Kuwait mudflats. *Crustaceana*, 45(2): 183-199.
- Jones, D. A., 1985. An onshore and offshore environmental survey related to the proposed development of the Qatar north gas field. Ecological survey and report. Unpublished report. University of Wales, Bangor, North Wales, U.K. pp. 1-16.
- Jones, D. A., 1986. A Field Guide to the Seashores of Kuwait and the Arabian Gulf. University of Kuwait 192 pp.
- Jones, D. A. and Richmond, M. D., 1992. Intertidal and Subtidal Marine Habitat Surveys. In: Establishment of A Marine Habitat and Wildlife Sanctuary for the Gulf Region. Final Report for Phase I: 134-161. Jubail and Frankfurt. CEC/NCWCD.
- Krebs, J. R., 1978. Ecology: The experimental analysis of distribution and abundance. Harper and Row, New York, 678pp.
- Mastaller, M., 1987. Molluscs of the Red Sea. In: Edwards, A. J. & Head, S. M. (eds.) *Red Sea*. Pergamon Press, Oxford. Pp. 194-214.
- McCain, J. C., 1984 a. Marine Ecology of Saudi Arabia. The Intertidal Fauna of Sand beaches in the Northern Area, Arabian Gulf. *Fauna of Saudi Arabia*. 6: 53-78.
- McCain, J. C., 1984 b. Marine Ecology of Saudi Arabia. The Nearshore Soft Benthic Communities of the Northern Area, Arabian Gulf. *Fauna of Saudi Arabia*. 6: 79-101.
- Melville, J. C. H. A., 1928. The marine mollusca of the Persian Gulf of Oman and north Arabia sea through the collection of Capt. F. W. Townsend, 1893-1914. *Proc. Mal. Soc. London*: 93-117.

- Mohammed, S. Z. and Al-Khayat, J. A., 1996. A Preliminary Check-list of Benthic Mollusca on the Qatari Coasts, Arabian Gulf. *Qat. Univ. Sci. J.*, 14(1): 201-206.
- Oliver, P. G., 1992. Bivalved Seashells of the Red Sea. *Hemmen & Nat. Mus. Wales, UK.* 330 pp.
- Price, A., 1982. Western Arabian Gulf echinoderms in high salinity waters and the occurrence of dwarism. *Journal of Natural History* 16: 519-527.
- Price, A. , 1983. Echinoderms of Saudi Arabia. Western Echinoderms of the Arabian Gulf coast of Saudi Arabia. *Fauna of Saudi Arabia* 5: 28-108.
- Shannon, G. E. and Weaver, W.W., 1963. The mathematical theory of communities. University of Illinois press, Urbana, 117pp.
- Sharabati, D., 1984. *Red Sea Shells.* Routledge & Kegan Paul, London. 128 pp.
- Sheppard, C., Price, A. and Roberts, C., 1992. *Marine Ecology of the Arabian Region.* London, Academic press. 359pp.
- Shriadah, M. M., 1997. Observation on some Hydrochemical aspects of the United Arab Emirates waters along the Arabian Gulf and the Gulf of Oman. *Qatar Univ. Sci. J.* 17 (2): 471:478.
- Smythe, K. R., 1972. Marine Mollusca from Bahrain Island, Persian Gulf. *J. Conch.* 27: 491-496.
- Smythe, K. R., 1979. The Marine Mollusca of the United Arab Emirates, Arabian Gulf. *J. Conch.* 30: 57-80.
- Smythe, K. R., 1982. Sea shells of the Arabian Gulf. London. 123pp.
- Vine, P., 1986. Red Sea Invertebrates. IMMEL Publishing, London. 224 pp.
- Vousden, D.H., 1987. The Bahrain marine habitat survey- A study of the marine habitats in the waters of Bahrain and their relationship to physical, chemical and anthropogenic influences. R.O.P.M.E. (Kuwait). PP: 95 + Appendices.