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SPATIAL DISTRIBUTION AND SEASONAL VARIATION OF THE GASTROPOD MOLLUSC SPECIES ALONG THE SAUDI INTERTIDAL ZONE OF THE ARABIAN GULF

By

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ABSTRACT

The present investigation entails with the spatial distribution and seasonal variation of the gastropod molluscan fauna in the Saudi intertidal zone along the western coast of the Arabian Gulf during 1993. The studied area extended from Jubayl in the North to Salwa in the South. 12 stations were seasonally investigated. 62 gastropod molluscan species were identified. The distribution pattern of these species within the stations showed that: 12 species had a wide range of distribution, 9 species were found in 75 % of the area, 7 species were only limited to 50% and only 1 species was restricted to 25 % of the whole area. The observed seasonal abundance of the gastropod population recorded from the whole studied area showed that: Spring was the season of highest abundance, followed by Summer, Autumn and Winter which showed the least abundance. Furthermore, the relationship between the environmental factors and the population abundance of the gastropod fauna were also discussed.

INTRODUCTION

Gastropoda is the largest class of Phylum Mollusca. Over 35000 sp. were identified, about half of which are marine (Wye, 1989). Like other molluscs; gastropods play an important role in the food chain as well as in the economy of the sea. Large numbers of the edible gastropod species were commercially

cultivated among many countries of the world as being a suitable protein diet for man.

According to the available literature, the majority of the previous studies on the Arabian Gulf molluscs were mainly stressed on the offshore regions. So, there still a considerable lack of information about the mollusc fauna along the intertidal zone of the Arabian Gulf. Yet, the Saudi intertidal zone bordering the Arabian Gulf still requires further investigations to study the inter and intra-specific relationship between the different environmental factors and the population densities of the benthic forms to give an account of their occurrence, abundance, diversity and distribution along such area.

The present work may be considered as a pioneer comprehensive study entailing with spatial distribution as well as seasonal variation in the abundance of the gastropod species and their individuals along the studied Saudi coastal area of the Arabian Gulf particularly after the catastrophic effect of the oil spill in the Arabian Gulf during 1991. There is no doubt that, the Saudi intertidal benthic fauna inhabiting such areas have been greatly and severely affected by the southward drifting of such spill towards the Saudi Coastal areas of the Gulf. Unfortunately, no base line data is available about the Saudi intertidal benthic gastropod molluscs inhabiting such extended southern coast of the Gulf particularly prior to pollution by the oil spill during 1991.

It is worth mentioning that, identification and taxonomy of the gastropod species recorded in the present study were presented elsewhere at the Symposium of Red Sea Environments held in Jeddah (K.S.A) in April, 1984. During May of the same year, another paper dealt with Saudi intertidal bivalved molluscs of the Arabian Gulf was also presented at Gulf Symposium on the Environmental Biology held in Doha, state of Qatar.

INVESTIGATED AREA

The investigated area as presented in Fig. (1) is located in the Saudi Arabian intertidal zone of the Arabian Gulf. It extends from Jubayl (st. 1) in the North to Salwa (st. 12) in the South. 10 other stations were located along this coastal stretch at the following regions: Rahima (st. 2), Ras-Tanura (st. 3), Safwa (st. 4), Qatif (st. 5), Dammam (st. 6), Khobar (st. 7), adjacent to King Fahd Bridge (K.F.B., st. 8), Aziziya (st. 9), Half Moon Beach (H.M.B., st. 10), and Uquayr.

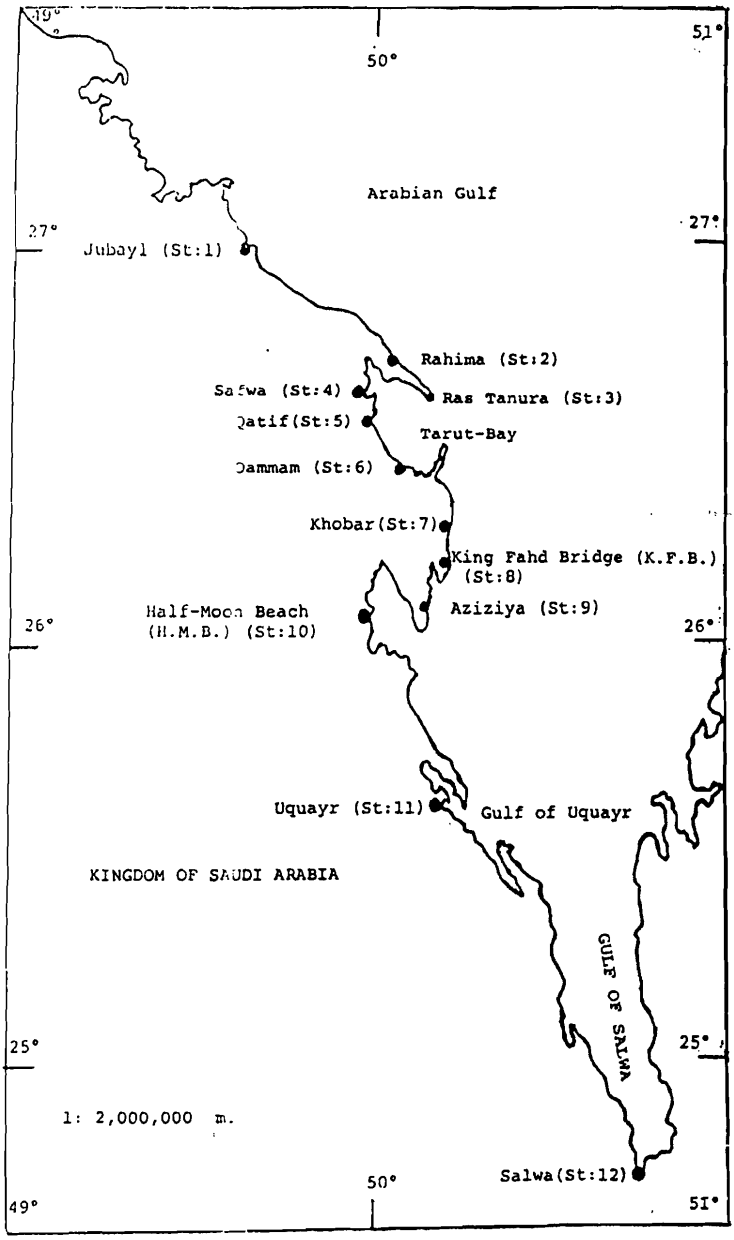

Figure 1: Investigated area.

The nature of the bottom in the investigated area is mainly of an extended rocky flat; mostly covered with sand and muddy sand. Sometimes the extended shore was irregularly interrupted with narrow and shallow rocky depressions covered with scattered patches of algal and seaweed vegetations.

MATERIALS AND METHODS

144 gastropod mollusc samples were quantitatively collected from the whole area by 1 m^2 quadrate metal frame during the whole year (1993). Of these samples 36 were seasonally collected, i.e. 3 samples/station (to get their average numbers). The collected shells which were kept in labeled nylon bags and preserved in 5 % formaline, were washed, cleaned, dried, counted, sorted and identified up to their species levels.

The following Latin numbers were used to explain the variable extents in the spatial distribution of the recorded gastropod species along different stations of the whole studied area. I: found in all stations, II: distributed in 11 stations, III: presented in 10 stations, IV: found in 9 stations, V: recorded from 8 stations, VI: collected from 7 stations, VII: sampled from 6 stations, VIII: Occurred in 5 stations, IX: found in 4 stations, and X: presented in 3 stations.

Another frequency terms were also used to express the % individual abundance of the particular species at the different sampled stations. Such terms were: Dominant (D): >80%, Abundant (A): 80-60%, Common (C); 59-40%, Less common (L): 39-20%, Rare (R): <20%. The letter (S) indicated species not present at the sampled area.

TEMPERATURE AND SALINITY

Surface water temperatures and salinities were measured at each station using a normal thermometer and a refractometer (model 10419 T/C meter Reichert Jung) respectively. The seasonal values of both parameters were listed in Table (1).

Table (1) : Surface water temperature and salinities measured from the sampled stations during the four seasons.

	Seasons	*St.1*	*St.2*	*St.3*	*St.4*	*St.5*	*St.6*	*St.7*	*St.8*	*St.9*	*St.10*	*St.11*	*St.12*
		Jubl	*Rah.*	*Rtan*	*Safw*	*Qat.*	*Damm*	*Khob*	*KFB*	*Aziz.*	*HMB*	*Uqur*	*Salwa*
Surface	Spring	29.0	30.0	29.3	31.7	32.2	28.0	26.5	29.5	26.0	25.5	24.0	25.0
Water	Summer	35.0	34.0	35.0	34.5	34.9	35.0	35.5	35.0	34.5	35.5	36.0	36.5
Temp.	Autumn	25.0	22.0	24.0	23.8	24.0	23.5	23.0	22.7	23.5	23.0	24.0	23.5
(°C)	Winter	12.0	11.5	11.0	13.0	12.5	11.5	11.5	12.8	13.0	12.5	11.5	11.0
Surface	Spring	43.5	45.0	45.0	44.0	43.0	46.5	47.0	44.0	43.0	43.0	52.0	59.0
Water	Summer	45.0	46.0	46.0	45.5	44.0	50.0	51.0	45.0	44.0	44.5	68.2	72.0
Salinity	Autumn	44.0	45.0	45.5	44.2	43.0	48.0	48.5	44.0	43.5	44.0	56.0	63.0
	Winter	43.0	44.0	44.5	43.5	42.5	46.0	46.0	43.5	42.5	42.5	51.0	56.0

RESULTS AND DISCUSSIONS

62 gastropod sp. were recorded from the whole investigated area. The zoogeographic affinities of such sp. showed a clear intimate relation to the Indian Ocean origin. A greater majority of such sp. were formerly reported by some workers as being widely extended from the Arabian to the Indian Ocean (Hatai and Nisiyama 1952; Kira 1955; Habe 1961).

According to the available literature, the previous studies on gastropod molluscs of the Arabian Gulf and its adjacent basins showed that: Melville (1889) and (1928) listed 27 sp. and 287 sp. from (Arabian and Omani Gulfs) and from (both Gulfs and Indian ocean) respectively. Biggs, Grantier (1960) found 32 sp. in Ras Tanura (K.S.A.) Basson ***et al.***, (1977) reported 236 sp. from the southern biotopes of the Gulf. Smythe (1979) and (1982) mentioned 121 sp. and 180 sp. from the U.A.E. and from the Arabian Gulf respectively. Sharabati (1981) determined 26 selected genera and species from the Saudi waters of the Gulf. Bosch and Bosch (1982) and (1989) identified 286 sp. and 175 sp. from Oman Gulf and from U.A.E. respectively. Glayzer ***et al.*** (1982) throughout 3 years sampling programme found 291 sp. in Kuwait. McCain (1984a) and (1984b) collected 32 sp. and 132 sp. from cores and infauna in the northern Saudi sandy coast of the Gulf respectively.

The lower number of the gastropod species recorded during the present study than most of the previously mentioned records may be explained according to the following reasons:

1. The four seasons programme adopted during the present study was only restricted to such a narrow limited intertidal zone bordering the Arabian Gulf.

2. The lower productivity characterizing the inshore area of the Arabian Gulf due to its lower nutrient contents and biomass incomparable to that of the open gulf water (Halim 1984 and Durgham and Moftah 1989).

3. The rapid changes in amplitudes of most of environmental factors characterizing the intertidal zone of the Gulf, greatly and severely affect their fauna and flora than that acted upon the subtidal Gulf communities.

According to kinne (1972); temperature and salinity are the most dominant ones limiting the distribution, abundance and survival of the inhabitant species.

4. The southward drifting of the 1991 gulf oil spill towards teastern coasts of Saudi Arabia and the subsequent oil diffusion with the shore sediments have severely affected and damaged most of the littoral flora and fauna of which the planktonic larvae and the adult forms of the sedentary gastropod molluscs are related, thus limiting their survivals and fates at such area. Getter ***et al.*** (1984) pointed out to the long acting effect (lasting to over a period of decades) of the toxic materials resulted from a severe oil spill affecting the whole ecosystem. Again, Ehrhardt, Burns (1993) also pointed out to the harmful and lethal effect of the 1991 oil spill in the Arabian Gulf and the severe damage for the different sorts of marine life particularly in the extended salt marshes along the Saudi Arabian coast due to the incorporation of substantial amounts of toxic materials in the shore sediments.

The study of the spatial distribution extent of the sampled gastropod species among the whole area during the whole year were expressed into the following categories as presented in (Table 2).

I : 9 sp. (14.5%) were extended in the whole area,
II : 12 sp. (19.4%) in 91.7% of the area,
III : 7 sp. (11.3 %) in 8.3% of the area,
IV : 9 sp. (14.5 %) in 75% of the area;
V : 4 sp. (6.5 %) in 66.7% of the area,
VI : 8 sp. (12.9 %) in 58.3% of the area,
VII : 7 sp. (11.3 %) in 50% of the area,
VIII: 3 sp. (4.8 %) in 41.7% of the area,
IX : 2 sp. (3.2 %) in 33.3% of the area,
X : 1 sp. (1.6 %) in about 25% of the area.

In fact, both the spatial and temporal distributions of the recorded sp. along the whole studied area were mainly affected by several environmental factors such as: current regime and water circulation in the Gulf, the extremely temperature and fluctuating salinity, the excess water evaporation, dehydration and desiccation characterizing such arid zone, variable changes in nutrient

Table (2): Variable extents in the ecological distribution of the bivalve species and the % abundance of the bivalved individuals recorded from the different stations of the investigated area.

	Bivalve species	Distrib extent of sp.	% abundance of the bivalved mollusc individuals collected from the different stations of the investigated area											
			St.1 Jub.	St.2 Rah	St.3 Rast.	St.4 Safwa	St.5 Qatif	St.6 Dammam	St.7 Khobar	St.8 KFB.	St.9 Aziz	St 10 HMB	St.11 Uqr.	St.12 Salwa
1	Amaea acuminata	VI	R	R	L	R	R	S	S	L	R	S	S	S
2	Ancilla castanea	II	C	C	C	L	A	L	R	C	D	D	S	L
3	Architectonica perspectiva	I	C	C	C	C	L	C	L	A	R	R	R	L
4	Atys cylindrica	III	L	S	R	L	A	R	S	L	L	C	L	R
5	Babylonia spirata	III	R	L	S	R	L	R	R	L	R	C	R	S
6	Bulla ampulla	III	C	R	S	R	C	L	R	R	R	C	L	S
7	Bullia mauritiana	II	L	R	S	R	L	R	R	R	R	R	R	R
8	Calyptraea pellucida	IV	S	S	R	R	A	R	R	R	L	L	S	R
9	Crepidula walshii	III	S	S	L	R	L	R	R	C	L	L	R	R
10	Cerithidea cingulata	II	A	R	C	A	D	C	R	A	D	D	A	S
11	Cerithium scabridum	III	C	R	C	C	L	S	R	C	D	C	R	S
12	Cypraea arabica	III	R	C	R	R	C	S	S	R	R	L	R	R
13	Cypraea chinensis	II	C	R	R	R	C	S	R	R	C	L	L	R
14	Cypraea grayana	II	R	R	R	R	C	L	R	R	R	L	R	S
15	Cypraea turdus	II	C	L	R	R	C	R	L	R	R	L	L	S
16	Diodora funiculata	II	L	R	S	C	L	R	R	R	D	R	R	R
17	Duplicaria duplicata	II	C	L	A	R	R	C	R	S	A	C	R	R
18	Fusinus arabicus	IV	C	C	L	R	R	S	S	S	R	L	C	R
19	Hexaplex kusterianus	IV	L	R	S	R	R	L	S	R	R	S	R	R
20	Mitrella blanda	VII	S	S	L	L	L	S	S	R	C	R	S	S
21	Monilea obscura	VI	R	L	S	C	L	S	R	C	I.	S	S	S
22	Mures scoloplax	III	C	R	L	R	C	R	R	S	R	L	R	S
23	Murex malabricus	IV	S	R	C	R	C	R	S	R	L	R	S	R
24	Nassarius albescens gemmulifer	VI	S	L	S	R	D	S	R	S	C	S	R	R
25	Nassarius arcularis plicatus	IV	C	S	R	L	A	S	R	C	C	C	S	L
26	Nassarius coronatus	IV	R	S	S	C	R	C	R	C	C	R	C	S
27	Natica pilicaris	V	S	L	S	R	R	C	S	R	C	R	S	L
28	Natica vitellus	VII	R	S	S	C	R	S	S	S	C	R	S	L
29	Nerita ablicilla	I	C	A	L	A	C	R	C	L	C	A	L	C
30	Niso venosa	VII	S	S	S	L	R	S	S	C	R	C	R	S
31	Neverita didyma	VIII	S	S	L	R	R	S	S	S	C	S	I	S
32	Oliva bulbosa	I	R	A	R	C	L	L	R	C	C	R	C	R
33	Peristerina massatula Forskalii	V	R	L	S	R	R	S	S	C	R	R	S	S
34	Pirenela conica	I	D	R	L	C	L	R	R	C	C	A	R	R

Table (2) : cont.

	Bivalve species	Distrib extent of sp.	% abundance of the bivalved mollusc individuals collected from the different stations of the investigated area											
			St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10	St.11	St.12
			Jub.	Rah	Rast.	Safwa	Qatif	Dammam	Khobar	KFB	Aziz	HMB	Uqr	Salwa
35	Planaxis sulcatus	VII	S	S	S	R	L	R	R	R	R	S	S	S
36	polinices tumidus	VII	S	C	S	R	R	S	S	R	S	R	S	R
37	Ranularia boschi	VI	S	S	R	L	R	R	S	R	R	A	S	S
38	Rapana bulbosa	II	C	L	R	D	R	R	L	A	C	A	S	R
39	Salinator fragilis	VIII	S	S	S	R	R	S	S	R	C	R	S	S
40	Semicassis faurotis	VI	L	R	S	L	R	S	R	L	R	S	S	S
41	Siphonaria laciniosa	IX	S	S	S	S	R	L	R	S	S	A	S	S
42	Siphonaria tenuicostulata	VI	L	S	R	S	R	R	R	C	S	S	C	S
43	Strombus decorus percicus	I	R	L	R	R	R	R	R	R	L	L	R	R
44	Strombus fasciatus	I	R	C	R	R	L	R	L	R	R	R	R	R
45	Strombus gibberulus	VI	R	R	R	A	C	S	S	A	R	S	R	R
46	Strombus plicatus sibbaldi	V	S	S	R	R	R	R	R	C	R	R	S	S
47	Terebralia palustris	VIII	L	L	R	S	R	S	S	S	L	S	S	S
48	Thais mancillata	VII	L	C	S	R	R	S	S	A	L	S	S	S
49	Thais mutabilis	IV	R	L	R	S	R	R	R	L	R	L	S	S
50	Thais savigny	IV	R	R	R	S	R	R	R	R	S	S	S	R
51	Tibia tissoti	V	R	R	S	S	R	R	R	R	R	S	S	R
52	Tibia fusus	IX	R	S	R	S	S	S	S	S	S	R	R	S
53	Tonna insulaechorab curta	X	S	S	R	S	R	S	S	S	S	S	R	S
54	Tonna dolium	V	R	S	C	R	R	S	S	A	R	A	S	R
55	Turbo erythraeus	I	C	C	C	R	D	R	R	A	A	L	R	A
56	Turbo radiatus	I	R	R	R	L	C	R	C	L	C	R	L	R
57	Turritella cochlea	II	R	R	R	R	R	R	R	R	R	R	R	S
58	Turritella turulosa	II	R	R	R	R	R	S	L	L	C	R	R	R
59	Umbonium vestiarium	VII	S	S	S	R	R	R	S	R	L	R	S	S
60	vermetus sulcatus	II	R	R	L	C	R	L	R	L	L	R	S	R
61	Vexillum acuminatum	VI	S	R	R	R	R	S	S	R	R	R	S	S
62	Volema pyrum	I	R	R	R	R	R	R	L	R	R	R	R	R

LEGEND:

Distribution extent of sp.

I. Distributed in all stations
II. Distributed in 11 stations
III. Distributed in 10 stations
IV Distributed in 9 stations
V Distributed in 8 stations
VI. Distributed in 7 stations
VII. Distributed in 6 stations
VIII. Distributed in 5 stations
IX. Distributed in 4 stations
X. Distributed in 3 stations

% Individual abundances:

D: Dominant Sp. (> 80%)
A: Abundant Sp. (80 - 60%)
C: Common Sp. (59 - 40%)
L. Less common Sp. (39-20%)
R: Rare Sp. (20%)
S Not present

contents, available of suitable, sufficient diet, and presence of suitable substrata required for larval settlement and adult establishment particularly for sedentary forms such as the gastropods.Grasshoff(1986) correlated between the distribution pattern of the gulf sp.& variations occurred in the nutrient contents as well as in the general circulation and water movement acted in the gulf water.

The seasonal variations of the gastropod fauna recorded from the whole studied area showed that: Spring was enriched by 59 sp. and 36.8% individuals, while Winter showed the least population of 48 sp. and 14.1% individuals. Summer and Autumn fauna were 53 sp., 28.2% individuals and 50 sp., 20.9% individuals respectively.

According to the variable amounts in seasonal abundance of the gastropod fauna/station among the whole studied area (Fig. 3), the sampled stations were classified into the following 4 groups: Group - 1: of a remarkable richest abundance (St: 5- Qatif, 9- Aziziya), group- 2: of a prominent high abundance (st: 4 - Safwa, 8- K.F.B. and 10-H.M.B), group- 3: of more or less considerable abundance (st: 1- Jubayl, 2-Rahima and 3-Ras Tanura) and group-4: of least abundance (st: 6-Dammam, 7- Khobar, 11- Uquayr and 12-Salwa). It was noticed that Spring and Winter fauna of different stations related to these groups always showed the maximum and minimum fauna respectively.

Among group-1, maximum and minimum abundance for St: 5, and 9 were: (59 sp., 14.2% ind.), (48 sp., 15.8% ind.) st. 5 and (56 sp., 14. 1% indi) (47 sp., 12.7% ind.) st. 9 respectively. Their higher Summer and lower Autumn fauna were: (52 sp., 15% ind). st. 9 respectively. As regards to group-2, maximum and minimum abundance values for st: 4,8 and 10 were: (54 sp., 10.4 % ind.), (38 sp., 11.1 % ind.) st.4; (51 sp., 11.9 % ind.), (40 sp., 11.8% ind.) st. 8 and (48 sp., 11.5% ind.), (40 sp., 11.4 % ind.) st. 10. Their higher Summer and lower Autumn fauna were: (47 sp., 11% ind.), (44 sp., 11.5% ind.). st. 4, (49 sp., 12.2 % ind.), (41 sp., 11.8% ind.) st. 8; and (44 sp., 11.7% ind.), (42 sp., 12% ind.) st. 10. Among group-3, st: 1,2 & 3, their maximum and minimum abundance were: (45 sp., 10.3% ind.), (32 sp., 6.5% ind.) st. 1; (43 sp., 7.1% ind.), (31 sp., 6.5% ind.) st.2; and (41 sp., 5.8% ind.), (33 sp., 7.8% ind.) st. 3 respectively. Their higher Summer & lower Autumn values were: (42 sp., 8.3% ind.), (40 sp., 7% ind.) st. 1; (41 sp., 4.5% ind.), (37sp., 6.4% ind.) st.2; and (40 sp., 7% ind.), (34 sp., 6.9 % ind.) st. 3 respectively. The seasonal

highest and lowest numbers of species recorded in st: 6,7,11 and 12 (group-4 of least abundance) were: 39 sp. (st.7), 32 sp. (st. 12) in Spring; 34 sp. (st. 6,7), 30 sp. (st. 12) in Summer; 31 sp. (st. 6), 24 sp. (st. 7) in Autumn; and 27 sp. (st. 7), 21 sp. (st. 12) in Winter. Furthermore, their maximum and minimum individual abundance were recorded in Salwa (st. 12) as 36.6 % and 8.5% respectively (Fig. 4 and 5).

The continuous seasonal predomination of the gastropod fauna recorded from st: 5 & 9 (group-1) during the whole year may exactly reflect prevailing of rather best environmental conditions too much favored by the gastropod fauna presented in both regions such as temperature, salinity, nutrients and fertility. The maximum Summer and minimum Winter surface water temperatures & salinities recorded at both regions were: 34.9-12.5°C & 44-42‰. respectively (Table 1). It was also noticed that, both areas were always provided by scattered growth of dense algal seaweed vegetations during most of the year. Such conditions may result in higher fertility of water for such regions, thus favoring the larval nourishment, growth and survival rates of the adult gastropod forms inhabiting both regions. Basson ***et al.*** (1977) and Sharabati (1981) pointed out to the higher productivity of Qatif (st. 5) as being Shrimp nursery ground. Hunter (1986) correlated between increased rates in population density of the organisms and the higher protection degrees provided from the dense algal growth. Hussein (1991) collected abundant population of gastropod larvae from the Qatari gulf water during the whole year round.

On the contrary, the poorest gastropod fauna characterizing group-4 (st: 6-Dammam, 7-Khobar, 11-Uquayr and 12-Salwa) may be a normal reflection of the unfavorable circumstances prevailed there which greatly affected the richness and abundance of their gastropod fauna. The maximum Summer and minimum Winter surface water temperatures and salinities recorded at these regions were: 35.5-11.5°C (all stations) and 51-46‰. (st. 6,7), 72-51%. (st: 11,12) for salinities respectively (Table 1). However, most of group-4 sp. such as those of Uquayr (st. 11) and Salwa (st. 12) are hypersaline tolerant, i.e. euryhaline sp. According to Biggs (1973), Purser (1973), Basson ***et al.*** (1977), Smythe (1979) and Sharabati (1981), the higher salinity of the southern water of the Arabian Gulf is one of the most important factors controlling and limiting occurrence and existence of the sp. to those which can tolerate hypersaline

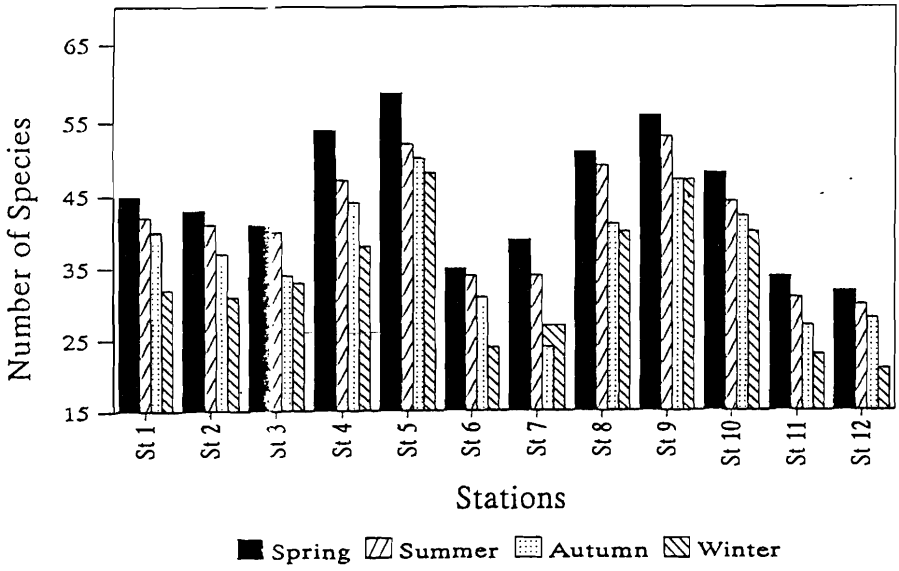

Figure 2 : Seasonal occurrence of gastropod species in the sampled stations.

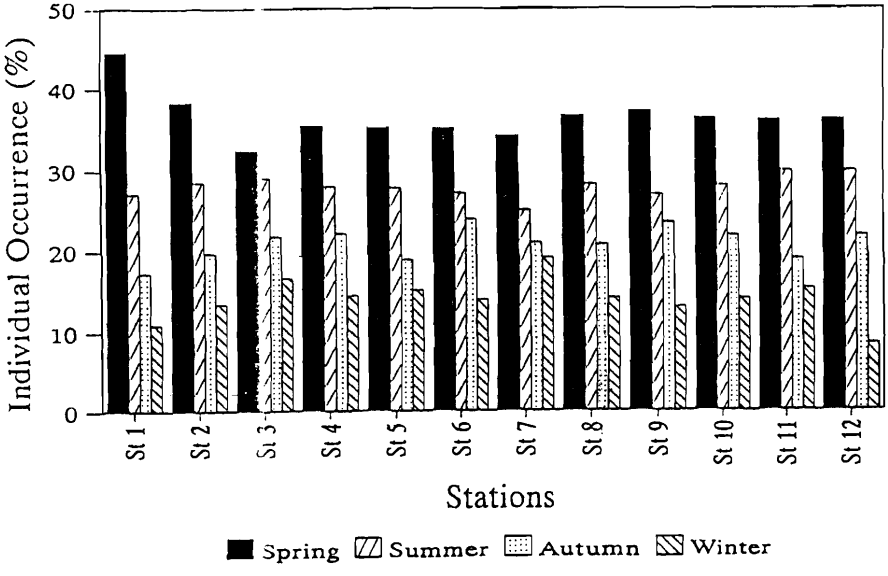

Figure 3 : Seasonal variation in percentage individual abundance of gastropods in the sampled stations.

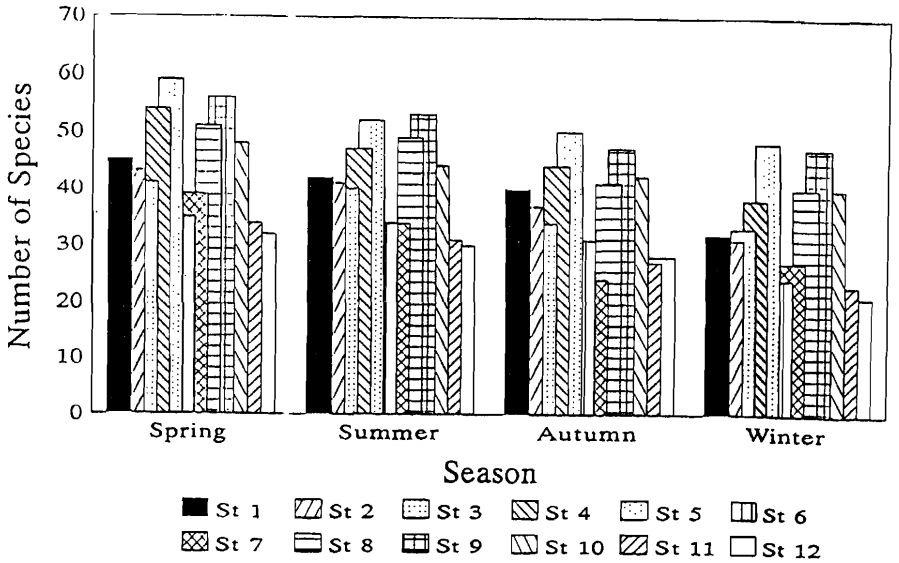

Figure 4: Spatial and temporal variation in the number of gastropod species.

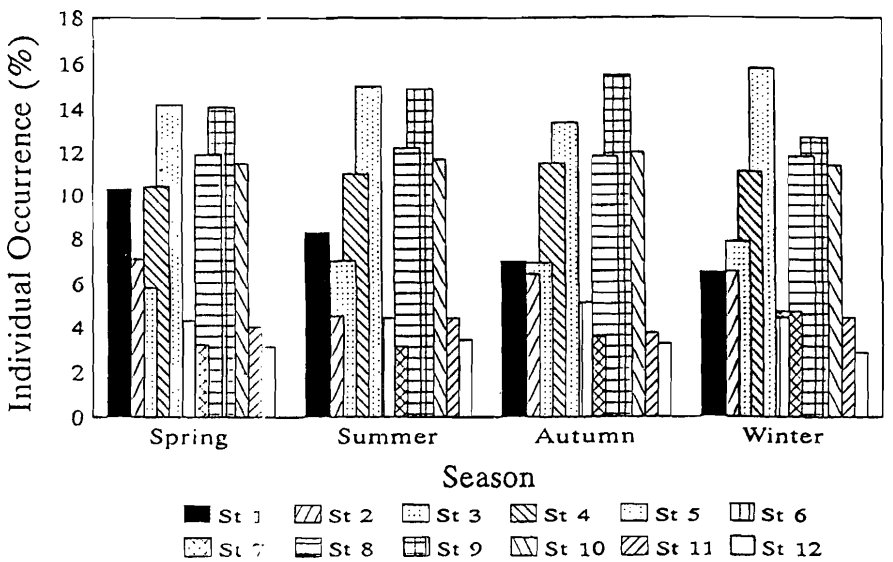

Figure 5: Spatial variation in the richness of gastropod individuals in the different seasons.

circumstances. Also Hunter (1986), John ***et al.*** (1991) attributed the hypersaline conditions in the southern Gulf coast particularly those extended shallow bays at Salwa, due to excess evaporation, as well as the limited effect of water movement either through vertical mixing or horizontal exchange with that of the open gulf water. The seasonal variable abundance observed in the populations of group-2 (st: 4,8 and 10), and group-3 (st: 1,2 and 3) can also be explained in the light of less and the least amplitudes of the favored environmental factors directly affect the populations presented at such areas, respectively. Table (1) showed the seasonal surface water temperatures & salinities recorded at such regions.

According to the annual richness of the gastropod species and the annual average of their % individual abundance/station among the whole studied area was provided with the suggested frequency terms, the following results were concluded: The recorded population abundance of group-1: Qatif (st. 5) and Aziziya (st. 9) were always dominating those of the other stations, while group-4: Dammam (st. 6), Khobar (st. 7), Uquayr (st. 11) and Salwa (st. 12) were the regions of the remarkably least population abundance.

Qatif's population showed 14.8% ind., 61 sp. (3D, 4A, 11C, 12L and 31R) and that of Aziziya reached 13.9 % ind., 56sp. (4D, 2A, 15C, 10L and 25R). The other stations were descendingly arranged according to their population abundance into the following order: Safwa (st. 4): 10.8 % ind., 54 sp. (1D, 3A, 9C, 8L and 33R), K.F.B. (st. 8); 11.9% and., 52 sp. (7A, 12C, 9L and 24R), H.M.B. (st. 10): 11.5 % ind., 48 sp. (2D, 6A, 7C, 11L and 22R), Jubayl (st. 1): 8.4% ind., 45 sp. (1D, 1A, 13C, 8L and 22R), Rahima (st.2): 6.8% ind., 43 sp. (2A, 8C, 11L, 22R), Ras Tanura (st. 3): 6.6% ind., 42 sp. (1A, 7C, 9L and 25R). The % individual abundance of group-4 st: 6 (Dammam), 7(Khobar), 11 (Uquayr), and 12 (Salwa) were varied from 4.5 % (st. 6) to 3.1 % (st. 12), while their sp. compositions were: 39 sp. (2C, 6L and 31R) Khobar (st. 7), followed by 38 sp. (5C, 7L, 26R) Dammam (st. 6), 35 sp. (1A, 4C, 7L and 23R), Uquayr (st. 11) and 33 sp. (1A, 1C, 5L and 26R) Salwa (st. 12), (Table 2, figs. 6 and 7). According to Al-Kaisi (1976); Huq ***et al.*** (1978); Jacob & Zarba (1979) and Halim (1984) a significant variable distribution of the biomass was found along the western side of the Gulf. Grasshoff (1976), Hunter (1986) and Durgham & Moftah (1989) considered that, the change in the nutrient contents and the water

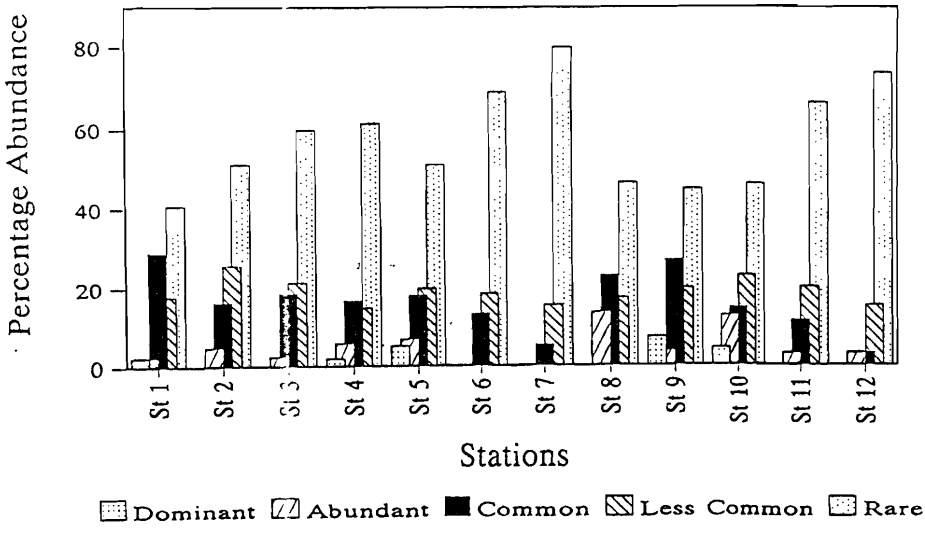

Figure 6: Spatial variation in the percentage abundance of gastropod species recorded in each station all the year round.

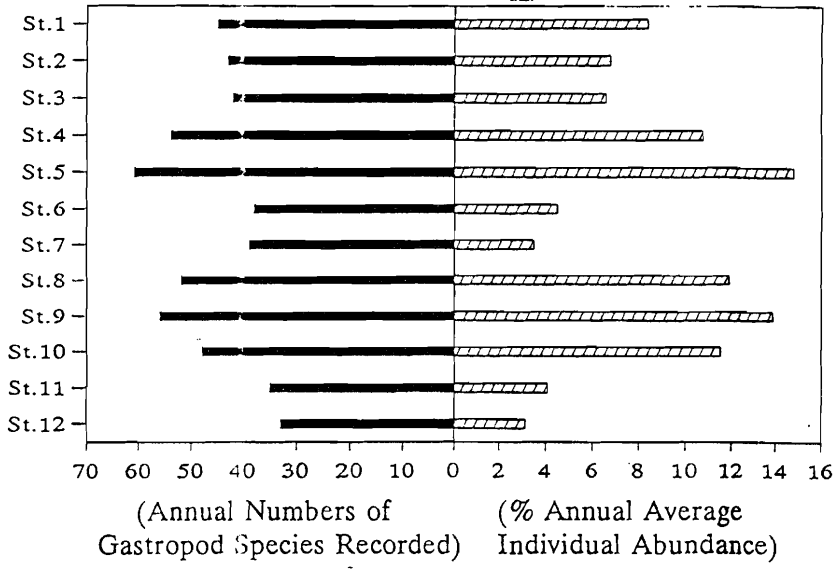

Figure 7: Spatial and temporal variation in the percentage average individual abundance in the whole investigated area.

circulation, were the limiting factors affecting the distribution pattern of the dominant species in the area.

SUMMARY

The present study may be the first one entailing spatial distribution, seasonal variation and abundance of the benthic gastropod mollusc fauna sampled from the Saudi intertidal zone of the Arabian Gulf. The studied area extended to more than 250 Km, started from Jubayl (st. 1), in the North to Salwa (st. 12) in the South. 144 quantitative intertidal samples were collected from 12 stations at seasonal rates during the whole year. 62 gastropod sp. were recorded and spatially distributed among such sampled stations. Spatial and temporal changes in seasonal abundance of the gastropod fauna as well as annual richness of the recorded sp. and percentage of their individual averages were also studied at different stations of the whole area. The present data were thoroughly discussed and argumented with those of other authors.

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