The Ostracoda community in hypersaline channels in Al-Khiran, Arabian Gulf

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ABSTRACT - A community of ten ostracod species characterizes the hypersaline channels of Khor Al-Mufateh and Khor Al-Mamlaha. The dominant species in Khor Al-Mufateh are *Loxoconcha (Loxoconcha) indica* Jain, 1978; *Gibboborchella venosa* Gurney, 1979; *Gibboborchella alata* Gurney, 1979; and *Hemicytheridea paiki* Jain, 1978. L.(L.) indica, along with *Neomonoceratina* sp., dominate Khor Al-Mamlaha. Other species ranging from common to rare, include *Carinocythereis (Carinocythereis) batei* Jain, 1978; *Callistocythere* cf. *flavidofusca intricatoides* (Ruggieri), 1953; *Loxoconcha (Loxoconcha) multiornata* Bate & Gurney, 1981; *Tanella* cf. gracilis Kingma, 1948; and Xestoleberis rotunda Hartmann, 1964.

Khor Al-Mufateh and Al-Mamlaha are divided into zones according to the distribution of ostracod species, which are dependant upon the richness and distribution of algae and the type of sediment. The ten ostracod species are salinity-tolerant and occur in the upper third of Khor Al-Mufateh and the lower half of Khor Al-Mamlaha with salinity ranging between 55-70‰ and 45-70‰, respectively. These zones are rich in algal growth with sediments varying from muddy carbonate sands to sandy mud. Most ostracod species are found in abundance during the summer exhibiting a rich diversity of algae genera and species.

INTRODUCTION

Khor Al-Mufateh and Khor Al-Mamlaha are two channels that extend several kilometres inland as part of a network of tidal channels and lagoons in the Al-Khiran area 90km south of Kuwait. Marine water from the Arabian Gulf flows into Khor Al-Mufateh through a narrow deep channel. Water in the lower half of the khor flows in a southwest direction, and in the upper half in the northwest direction. The Khor Al-Mamlaha joins the central part of the Khor Al-Mufateh and has no direct outlet to the Arabian Gulf (fig.1).

The Khor Al-Mufateh stretches inland for approximately 6km. It has a deep (6-7m) and wide (55m) access channel that extends for about one kilometre. Further inland, it widens and shallows to as little as 3cm depth. Beyond the main channel, a complex network of less than half-a-metre wide channels extends further inland. The Khor Al-Mamlaha extends inland for about 3km. The depth of the channel varies between a few cm to about 1m, and the width between 5-10m in the lower half of the khor, narrowing beyond to 1-5m.

There is a dearth of published literature on the Ostracoda of Al-Khiran. To date there is only one publication, Al-Abdul-Razzaq & Bhalla, 1987, that specifically focuses on this subject, while other publications have dealt with the macrofauna, carbonate and evaporite sediments of Al-Khiran (Clayton & Pilcher, 1983; Collins et al., 1984; Gunatilaka et al., 1980, 1984, 1985, 1987; Gunatilaka & Mwango, 1987; Jones & Clayton, 1983; Khalaf, 1984; Picha, 1978; Picka & Saleh, 1977).

Khors Al-Mufateh and Al-Mamlaha constitute a unique microenvironment in the Arabian Gulf providing an opportunity to understand the ecology and distribution of some ostracod species in hypersaline environments. A total of 684 samples, from 49 sampling sites, were collected in 1987 during the summer and winter months (fig.1). Of these, 234 sediment and algae samples were for ostracod study, 337 flora samples for micro- and macroalgae study, and 113 sediment samples for sediment distribution study. The physical and chemical parameters of each sampling site were also measured. The details of field and laboratory investigations are presented in Al-Abdul-Razzaq et al. (1988).

ENVIRONMENTAL FACTORS

The Al-Khiran area is an arid hot zone with temperatures varying between 40° C - 55° C during summer and 20° C - 35° C during winter. Average annual rainfall is about 100mm. The water depth in the Al-Khiran varies from 7m at the entrance to the Khor Al-Mufateh to only a few centimetres inland. The mean tidal range is 1.3m.

Temperature

Water temperature in Khor Al-Mufateh and Al-Mamalaha ranges between 13° C - 30° C during winter, and 25° C - 38° C during summer. During the winter temperature was found to vary between 15° C at the entrance of Khor Al-Mufateh to 25° C at its terminal point; the difference is attributed to variation in water depth. The temperature of the shallow waters quickly rises under the direct impact of the sun's rays. However, continuous atmospheric heat during summer regulates the temperature along the khor's entire length of the khor.

The shallowness of the Khor Al-Mamlaha sustains temperature uniformity throughout. Minor variations observed at



Fig 1. Location map of Khor Al-Mufateh and Khor Al-Mamiaha

different locations are due to the sampling time. The mean temperature of water, during summer and winter, was recorded to be 18.2°C and 28.5°C, respectively.

Salinity

The mean salinity values, during winter and summer at Khor Al-Mufateh do not show much variation (48.0% and 46.1%, respectively). However, salinity values are found to progressively increase from the entrance of the khor from 39% to 50% towards the middle, reaching approximately 70% towards the end of the khor. This pattern is largely due to the channel's increasing isolation from the open sea as one goes further inland. Beyond the main channel, salinity reaches as high as 170% in the network of narrow channels.

At Khor Al-Mamlaha the mean water salinity during winter is 66.7% and during summer 58%. The mean salinity of this khor is higher than that of the Khor Al-Mufateh as it has no direct link with the Arabian Gulf. Since the inner part of the channel is more isolated, restricting daily inflow to its inner part, there is a very high increase in salinity values from 45% at the beginning of Khor Al-Mamlaha to 205% towards its end.

pН

The mean pH values in Khors Al-Mufateh and Al-Mamlaha are 8.0 and 7.6, respectively, with little seasonal variation. Similar pH values are observed throughout the khors, with the exception of the terminal point of Khor Al-Mamlaha where it drops to 5.7 due to the influx of meteoric water and biological deterioration of cyanobacteria.



Fig 2. Distribution of surface sediment types in Khor Al-Mufateh and Khor Al-Mamlaha

Sediments

Oolites and skeletal fragments constitute the bulk of the sediments in the upper half of Khor Al-Mufateh (sample sites 1-13) a large fraction of which is composed of skeletal grains. The sand fraction towards the end of the upper part is composed of oolites, pellets and pseudo ooides (peloids) (sample sites 13-18). The upper half of Khor Al-Mufateh (sample sites 18-27), and the lower third of Khor Al-Mamlaha (sample sites 1-8), are covered by muddy carbonate sands. The upper third of Al-Mamlaha (sample sites 9-16), and the end of Al-Mufateh (sample sites 27-29), grade into aragonitic mud, pellets and detrital quartz. The extreme landward part of the two khors is characterized by gypsiferous mud, eolian silt and algal mats (fig.2).

Algae

Epiphytic filamentous algae species dominate Khors Al-Mufateh and Al-Mamlaha. Bivalve and gastropod shells, skeletal remains and small pieces of rock constitute the algae substrate. In the lower half of the Khor Al-Mufateh, algal growth is confined to the seagrass bed on the northern bank of the channel (sample sites 14-17). In the upper half of the khor (sample sites 18-29), algae are found growing in the channel. Between sample sites 22-29, algae are found in abundance and its growth flourishes between sample sites 27-29. Algae are confined to the lower half of the Khor Al-Mamlaha (sample sites 1-13). Its growth flourishes between sample sites 4-8.

During winter the dominant algal species in Khors Al-Mufateh and Al-Mamlaha are *Cladophora sercoides* and *Polysiphonia crassicollis*. These two species are also found to occur on a



Fig 3. Frequency of Ostracoda species in (A) Khor Al-Mufateh, (B) Khor Al-Mamlaha

seagrass bed of Haolodule univervis towards the end of the lower half of Khor Al-Mufateh.

During summer the most dominant algae species in Khor Al-Mufateh are *P. crassicollis, Acetaboloria clyculus, C. sercoides,* and *Chaetomorpha* spp. In Khor Al-Mamlaha the former two species, along with *Chondria dasyphylla*, are predominant. In Khor Al-Mufateh *Spyridia filamentosa* and *C. dasyphylla* are found on a seagrass bed of *H. univervis* and *Halophila ovalis*.

OSTRACOD DISTRIBUTION IN KHORS AL-MUFATEH AND AL-MAMLAHA.

Ten ostracod species have been recognized and found living in Khors Al-Mufateh and Al-Mamlaha. These are: Loxoconcha (Loxoconcha) indica Jain, 1978; Hemicytherida paiki Jain, (1978); Gibboborchella venosa Gurney, 1979; Gibboborchella alata Gurney, 1979; Tanella cf. gracilis Kingma, 1948; Carinocythereis (Carinocythereis) batei Jain, 1978; Callistocythere cf. flavidofusca intricatoides (Ruggieri), 1953; Loxoconcha (Loxoconcha) multiornata Bate & Gurney, 1981; *Xestoleberis rotunda* Hartmann, 1964; and *Neomonoceratina* sp. The seasonal variation and distribution of this ostracod community in the two khors are discussed below.

Khor Al-Mufateh

Ostracod species are found to flourish in the upper third of Khor Al-Mufateh between sample sites 22-29. Of these, *G. venosa*, *G. alata*, *H. paiki*, and *L. (L.) indica* (fig.3A) are the dominant species. The existence of other ostracod species varied between common to rare and includes C.(C.) batei, *C.* cf. flavidofusca intricatoides, *L. (L.) multiornata*, *X. rotunda*, *T.* cf. gracilis and *Neomonoceratina* sp.

Seasonal variation affects the frequency of dominant species especially, *H. paiki*, *L.* (*L.*) *indica* and *G. venosa* (fig.3A). Of these, the former two were found to be more abundant during summer, and G. venosa during winter. The latter species is regarded as living on algae.

Three species of this community, L. (L.) indica, L. (L.) multiornata and G. venosa, were found living on algae on a

seagrass bed, between sample sites 14-17, on the north bank of the channel. These species occurred in greater abundance in samples taken during summer than those taken during winter.

Khor Al-Mamlaha

Ostracod species were found living in the lower half of Khor Al-Mamlaha between sample sites 1-13, beyond which they do not exist. The dominant species in Khor Al-Mamlaha are L. (L.) indica and Neomonoceratina sp. (fig.3B), while G. alata, H. paiki, C. (C.) batei, C. cf. flavidofusca intricatoides, L. (L.) multiornata, X. rotunda and T. cf. gracilis, range between common to rare.

Seasonal variation in temperature affects the frequency of most ostracod species. During the summer most species were found in abundance. Species, such as *Neonoceratina* sp., are found in summer samples only, while *L. (L.) indica* and *H. paiki* are more frequent in summer than winter samples. (fig.3B).

DISCUSSION AND CONCLUSIONS

The present study necessitated the division of the Khor Al-Mufateh into three parts. Zone I refers to the lower third of the khor, extending from the entrance at sample site 1, to sample site 13. Although the salinity values of Zone I are found to be akin to normal seawater of the Arabian Gulf (mean 40‰), no ostracod species were found living in this area. This is largely due to the high energy level which, in turn, reflects on the type of sediments. Zone I sediments, mainly oolites and skeletal fragments, are devoid of organic matter and unsuitable for the survival of ostracod communities. No algal growth is recorded in this zone.

Zone II refers to the middle third of the khor, extending from sample sites 14 to 21. Here salinities vary between 40-55‰. Despite the occurrence of algae, no ostracod species are found living. However, in the north bank of the channel, three species, L. (L.) indica, L. (L.) multiornata, and G. venosa, were found living in wet areas on algae growing on a bed of seagrass (sample sites 14-17). Hughes, Clarke & Keij (1973) reported the abundance of Loxoconcha species from localities rich in algal growth in Qatar coastal lagoons and the Gulf of Salwa. The present study also reveals the existence of G. venosa on algae. The salinity of this seagrass area ranges between 40-50‰. It appears that although ostracods do not survive here due to the sandy nature of sediments in the channel, the existence of these three species, associated with algae and seagrass, is attributed to the occurrence of a protected microniche in the zone.

Zone III represents the upper part of the khor. It extends between sample sites 22-29. It is characterized by an abundance of algal growth. The sediments vary between carbonate muddy sands to sandy mud. The salinity ranges between approximately 44%, at sample site 22, to about 70‰ at sample site 29. The ostracods are recorded in this part. A strong relationship seems to exist between the abundance of the most dominant ostracod species (*G. venosa*, *G. alata*, and *L. (L.) indica*) and flourishing algal growth. Most ostracod species were found to be abundant in areas of Zone III rich in algae. Many researchers have demonstrated the effect of algae on the frequency and distribution of ostracods.

Based on the occurrence and distribution of ostracod species, Khor Al-Mamlaha is divided into two parts. Ostracods are found living in the lower half of the khor (sample sites 1-13). The sediments in this part vary between carbonate muddy sands to sandy mud. The salinity varies between 45% at the entrance to the khor, to 70% at sample site 13. The distribution of ostracod species is closely related to the distribution of algae and is confined to the lower half. Where algae are most fertile the frequency of certain ostracod species (*G. venosa* and *G. alata*) reaches its peak (sample sites 4-8). The upper half of Khor Al-Mamalaha is devoid of any living ostracods or algae.

Despite higher than normal salinites in Zone III of Khor Al-Mufateh and the lower half of Khor Al-Mamlaha, 45‰ and 70‰ respectively, ostracod species were found living and thriving there. The Al-Khiran channels are characterized by a community of ten ostracod species, regarded as opportunistic species, since they are found to live and flourish in hypersaline environments.

In conclusion, the abundance and distribution of ostracod species in Khors Al-Mufateh and Al-Mamlaha are directly related to the fertility and distribution of algae, and controlled by the energy levels affecting the type of sediments. Ostracods are confined to areas of algal growth and sediments of mainly muddy carbonate sands and sandy mud. Only one species, *G. venosa*, is found to exist on algae.

Seasonal variation affects the abundance of most dominant ostracod species and algae. The majority of species are predominant during the summer especially, *Neomonoceratina* sp., *L. (L.) indica* and *H.paiki*. Only one species, *G. venosa*, is found in abundance during winter in the Khor Al-Mufateh. Since *G. venosa* is known to live only on algae the, observed variation in seasonal abundance can be attributed to the existence and abundance of certain algae species, such as *Cladophora*, in this khor. Likewise, the abundance of most ostracod species during the summer can be related to the decline in salinity values in the two khors.

The seasonal variation also affects the occurrence and fertility of algal growth. There is a greater abundance of *Cladophora* species during the winter, while during summer species of *Chondria* and *Spyridia* are found in abundance. Species of *Acetaboloria* and *Chaetomorpha* are confined to summer, while *Polysiphonia* species occur both in winter and summer. The correlation between seasonal abundance and distribution of ostracods, and the abundance of certain ostracod species with respect to specific algae genera and species, merit further study.

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