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Macrozoobenthos in the inshore zone of the Northern Aral Sea

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Abstract. The macrozoobenthos was investigated at eight sites in the Aral Sea inshore zone and in the lower reaches of the Syrdaria river. In the sea, the benthos comprised bivalve molluscs *Syndosmya segmentum* Recluz and *Cerastoderma isthmicum* Issel, gastropods from *Caspiohydrobia* Starob., the polychaete *Nereis diversicolor* O.F. Müller and the crab *Rhithropanopeus harrisii tridentatus* (Maitland). In the Syrdaria, Mysidae *Paramysis lacustris* (Czern.) and Gammaridae *Dikerogammarus aralensis* (Uljanin) were found. These taxa have not been recorded from the Sea since the 1970s. The total zoobenthos biomass and density varied between the investigated Sea areas from 92 to 582 g/m^2 and from 1,600 to 39,000 ind./m^2, respectively. Spatial and temporal salinity changes within the range 20–41 g/L did not affect macrozoobenthos composition and structure. The conclusion is that the benthic ecosystem of the Aral Sea was in a state of comparative stability from the middle of the 1980s to the middle of the 1990s. Analysis of the zoobenthos in the inshore zone is proposed as a convenient and accessible method for monitoring the status of the zoobenthos of the entire Aral Sea.

Key words: Aral Sea, salinization, zoobenthos

Introduction

The Aral Sea is one of the largest inland water-bodies of the world and has attracted close public and scientific attention in recent years. The uncritical approach to the use of its water resources had led to the alteration of the hydrological balance of the basin and finally to an ecological disaster of enormous scale. From 1960 to 1989, the Aral Sea has decreased in volume by 40 per cent, salinity has increased by 20 g/L (Micklin, 1991), and the ecosystem has undergone major changes (Aladin et al., 1991). The dimensions of these changes and their catastrophic consequences for both the natural systems of the Priaralie and for the economy of adjacent regions has attracted close attention in recent years. Nevertheless, in spite of the wide interest in the Aral Sea problem and considerable financial support allocated to its study, the real ecological situation in the Aral Sea region, and particularly the state of the Aral Sea ecosystem itself, remains poorly investigated.

From the middle of the 1940s until the end of the 1970s, hydrobiological sampling in the Aral Sea was performed regularly across a large network of stations (Yablonskaja, 1960a, b; Yablonskaja et al., 1973; Proskurina, 1979; Andreeva, 1989). As a result, the species composition and abundance of the macrozoobenthos were fairly well explored during the period of comparatively stable water-level and salinity and during the initial period of salinization. In the 1980s, however, regular hydrobiological investigations ceased and observations continued at only a few locations, mostly in the inshore zone (Aladin, 1989; Bekmurzaev, 1991). At the end of the 1980s, the fall in water-level had led to the situation where investigations of the open water zone have become practically impossible for technical reasons, or demanded too much effort and expenditure. Thus, we continued explorations of the inshore zone since this was more accessible.

The present work focuses on the determination of species composition and abundance of bottom macroinvertebrates and on some peculiarities of their spatial distribution in the Aral Sea inshore zone in contemporary polyhaline conditions.

Materials and methods

The field investigations on the Aral Sea were conducted from 1990 to 1994. Benthos was collected at eight sites of the inshore zone in the northern Aral Sea (Figure 1): in the Large Sea around Barsakelmes Island and in the Tsche-Bas Bay, in the Small Sea – in the Bay of Butakov, near the Tastubek Peninsula, in the Bay of Shevchenko, near the Bugun Village, in the Sarycheganak Bay and in the former Berg's Strait. In addition, 15 samples were collected in 1992 in the lower stream of Syrdaria (Figure 2, Table 1). At depths of more than 2 m, samples were generally collected using a Petersen bottom sampler. At shallower depths where the substratum was too hard, a pole tube bottom corer was used. In the Bay of Butakov and near Barsakelmes Island in 1990, benthos was collected using a diving bottom sampler. The sediments were washed out through a 0.4 mm sieve and collected animals were fixed using 4 per cent formaldehyde. A total of 555 quantitative macrozoobenthos samples were collected and treated.

The depth at sampling stations varied between 0.5–8.5 m (see Table 1). Sediments were represented mostly by sand silt, which at depths less than 2 m were often hard and contained a surface salt crust. Most of the shallow sites near Barsakelmes Island contained sandy sediments. Temperature at the time of our investigations was 18–25°C, salinity between the different sites varied from 13 to 41 g/L (see Table 1). Vertical and horizontal gradients of salinity and temperature within the investigated sites were not observed as a rule.

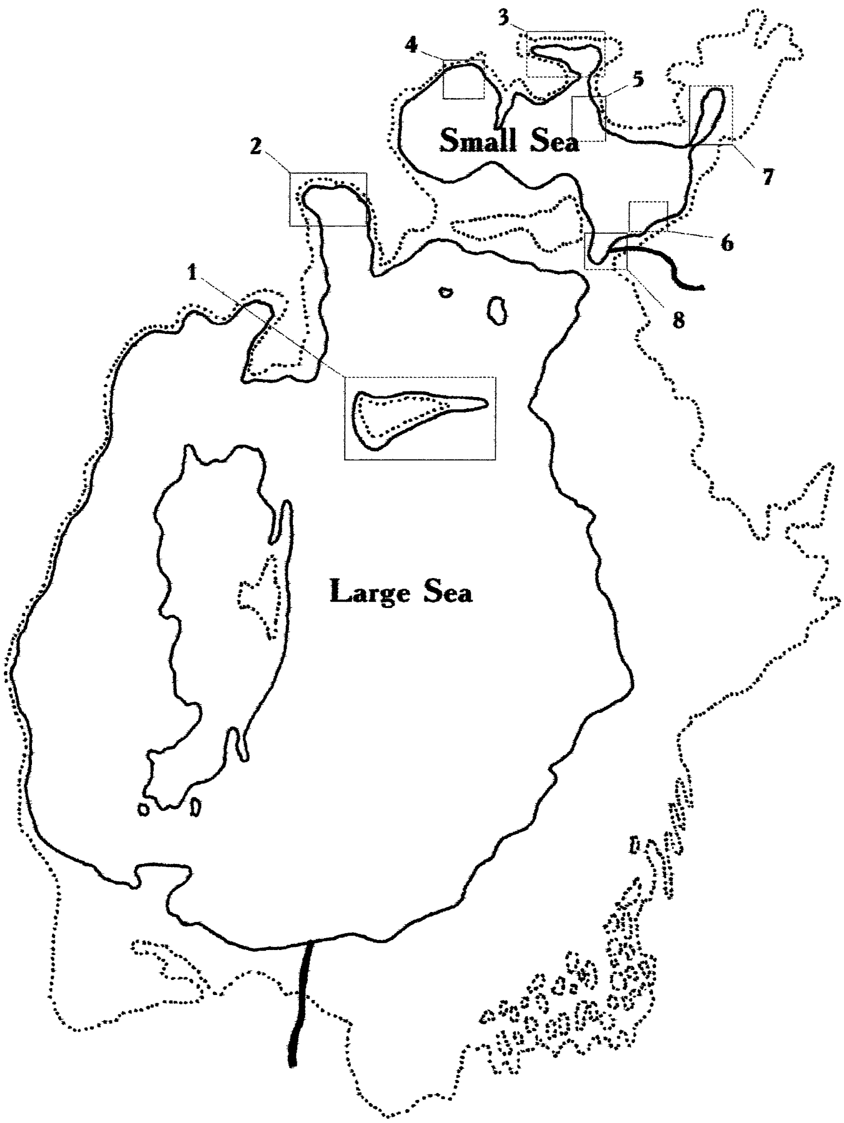

Figure 1. Location of sampling sites in the Aral Sea: 1 – Barsakelmes Island; 2 – Tsche Bas Bay; 3 – Bay of Butakov; 4 – Bay of Shevchenko; 5 – Tastubek Peninsula; 6 – near the Bugun Village; 7 – Sarycheganak Bay; 8 – Former Berg's Strait. Dotted line marks the shoreline in 1960.

Results

A. Large Sea

The macrozoobenthos of the Large Aral Sea comprised the bivalve molluscs *Syndosmya segmentum* Recluz (=*Abra ovata* (Phil.)) and *Cerastoderma*

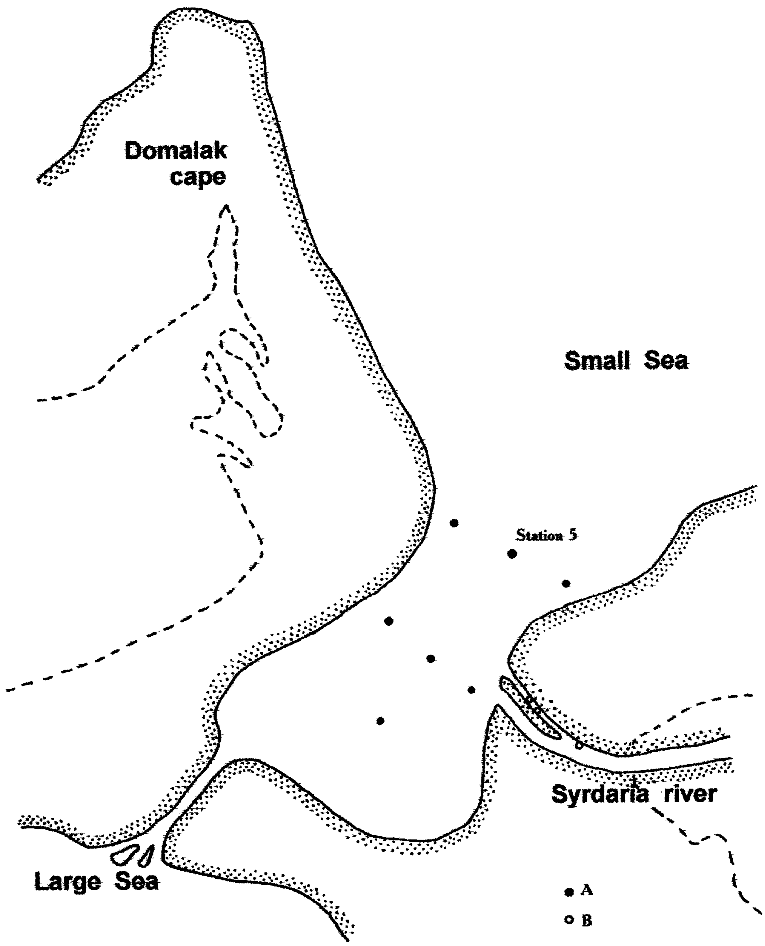

Figure 2. Location of sampling sites at former Berg's Strait (A) and in the low stream of Syrdaria (B).

isthmicum Issel, gastropods of *Caspiohydrobia* Starob., polychaete *Nereis diversicolor* O.F. Müller and the crab *Rhithropanopeus harrisii tridentatus* (Maitland). Identification by S.I. Andreeva of gastropods collected near the Barsakelmes Island in 1990 (personal communication) indicated that at least 9 species occurred there: *Caspiohydrobia husainovae* Star., *C. aralensis* Star. *et* Andreeva, *C. obrutchevi* Star. *et* Andreeva, *C. sidorovi* Star. *et* Andreeva, *C. behningi* Star. *et* Andreeva, *C. oviformis* (Logv. *et* Star.), *C. subconvexa* (Logv. *et* Star.), *C. kazachstanica* Star. *et* Andreeva and *C. gemmata* (Kol.). At other sites investigated, the species of gastropods were not determined.

Table 1. Characteristics of sampling sites.

Site	Date	Depth (m)	Salinity (g/L)	Number of samples
Large Sea				
Barsakelmes Island	05.90	0.5–4.5	30	35
	05.91	1.0–5.0	35	60
Tsche-Bas Bay	10.92	1.0–6.0	41	20
	06.93	1.6–6.0	41	45
Small Sea				
Bay of Butakov	09.90	1.0–3.2	38–41	40
Tastubek Peninsula	09.91	1.0–6.0	26	45
	09.93	1.5–8.5	18–20	60
Bay of Shevchenko	09.92	1.5–8.0	23–25	90
Near Bugun Village	05.93	1.5–8.0	19–25	65
Sarycheganak Bay	06.94	0.5–1.7	21–26	30
Former Berg's Strait				
Pre-mouth area	05.92	0.8–4.0	13–25	40
	05.93	1.5–4.0	15–25	10
Syrdaria River				
Lower stream	05.92	1.0–2.5	<1	15

Overall zoobenthos biomass and density near Barsakelmes Island was least for all sites investigated (with two exceptions of Berg's Strait) (Table 2). *S. segmentum* was dominant at most stations. The biomass of *C. isthmicum* was second in spite of its lower density. The contribution of *Caspiohydrobia* spp. and *Nereis diversicolor* to the total biomass was relatively low (Figure 3). Crabs observed at shallow depth were not caught by the bottom sampler.

Zoobenthos abundance in the Tsche-Bas Bay was much higher than that observed near Barsakelmes Island (see Table 2). *S. segmentum* and *C. isthmicum* dominated in terms of biomass, each comprising 45 per cent of total value both in 1992 and 1993. As at Barsakelmes Island, the contribution of *Caspiohydrobia* ssp., *N. diversicolor* and *R. harrisii* to total zoobenthos biomass was much lower (see Figure 3). The densest species at all stations was *S. segmentum*.

B. Small Sea

In the Small Aral Sea, the macrozoobenthos comprised the same taxa as in the Large Sea with the exception of crabs, although the abundance of benthic invertebrates was significantly higher as a rule (see Table 2).

Table 2. Average density (N, ind/m) and biomass (B, g/m) of zoobenthos at the sites investigated in the Aral Sea in 1990–1994.

Site (year)	*S.segmentum*		*C.isthmicum*		*Caspiohydrobia*		*N. diversicolor*		R. harrisii		Total	
	N	B	N	B	N	B	N	B	N	B	N	B
Large Sea												
Barsakelmes Is. (90)	1798	65.93	28	14.75	389	1.35	452	10.31	0	0.00	2667	92.34
Barsakelmes Is. (91)	1079	102.47	24	19.32	286	0.88	258	3.26	0	0.00	1647	125.93
Tsche-Bas Bay (92)	4237	99.28	87	102.12	874	1.73	1870	11.93	42	6.86	7111	221.92
Tsche-Bas Bay (93)	4420	156.09	79	146.76	729	2.22	1379	19.20	63	1.55	6670	325.82
Small Sea												
Bay of Butakov	14310	338.75	304	105.69	8507	30.89	1328	26.11	–	–	24449	501.45
Tastubek P. (91)	7145	268.30	602	270.42	18302	40.12	779	3.56	–	–	26828	582.41
Tastubek P. (93)	12547	365.11	478	109.49	7539	17.08	2053	10.16	–	–	22616	501.84
Bay of Shevchenko	9353	284.27	952	149.59	27803	43.40	1065	6.05	–	–	39173	483.30
Near Bugun Village	5604	192.15	273	66.72	10774	15.53	785	4.01	–	–	17435	278.41
Sarycheganak Bay	3264	51.48	994	14.17	2704	11.24	3195	28.52	–	–	10157	105.41
Former Berg's Strait												
Pre-mouth area (92)	1383	27.03	19	6.35	1896	6.16	2489	21.46	–	–	5787	61.01
Pre-mouth area (93)	800	55.20	0	0.00	1916	8.24	770	23.40	–	–	3486	86.84

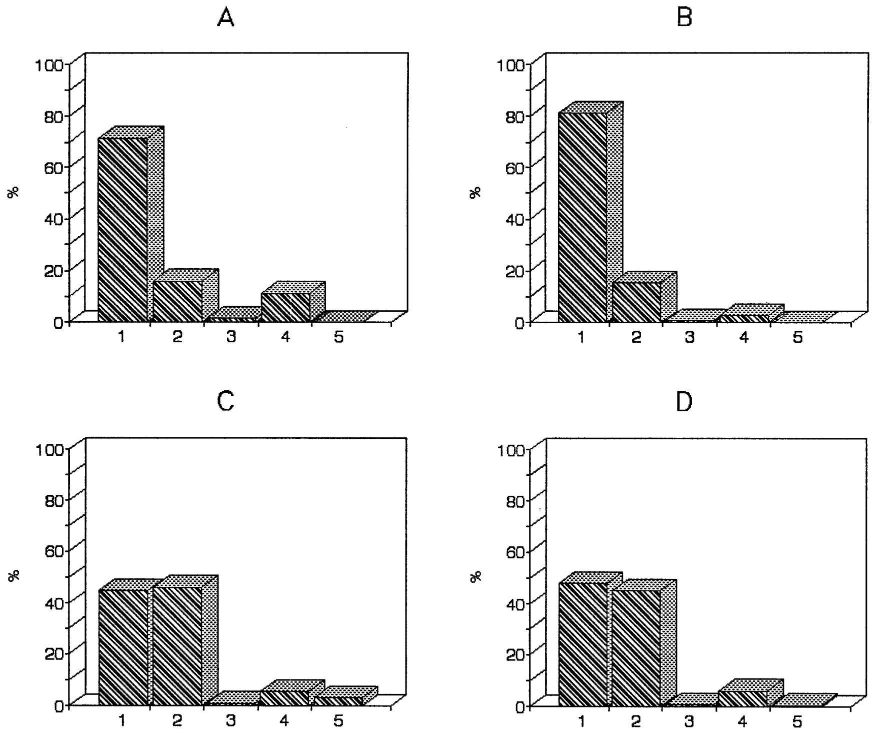

Figure 3. Relative biomass of macrozoobenthic main components at the sites investigated in the Large Aral Sea: A – Barsakelmes Island (1990), B – Barsakelmes Island (1991), C – Tshe-Bas Bay (1992), D – Tshe Bas Bay (1993); 1 – *S.segmentum*, 2 – *C.isthmicum*, 3 – *Caspiohydrobia* spp., 4 – *N.diversicolor*, 5 – *R.harrisii*.

Zoobenthos structure in the Bays of Butakov and Shevchenko, around the Tastubek Peninsula in 1993, and near Bugun Village was similar (Figure 4). In terms of biomass, *S. segmentum* was dominant, followed by *C. isthmicum*. Polychaetes and gastropods provided only a small contribution to the total zoobenthos biomass.

Near the Tastubek Peninsula in 1991, the contribution of *C. isthmicum* to the total biomass was about the same as that of *S. segmentum* and reached about 46 per cent. Abundance of other zoobenthos components did not differ markedly from that observed in other Small Sea areas. Due to the large numbers of *C. isthmicum*, the highest total zoobenthos biomass (582 g/m^2 was recorded at this site.

In Sarycheganak Bay, the lowest total zoobenthos biomass and density was recorded among all sites investigated in the Small Aral Sea. *S. segmentum* prevailed here, followed by *N. diversicolor*. However, *C. isthmicum* density was unusually low.

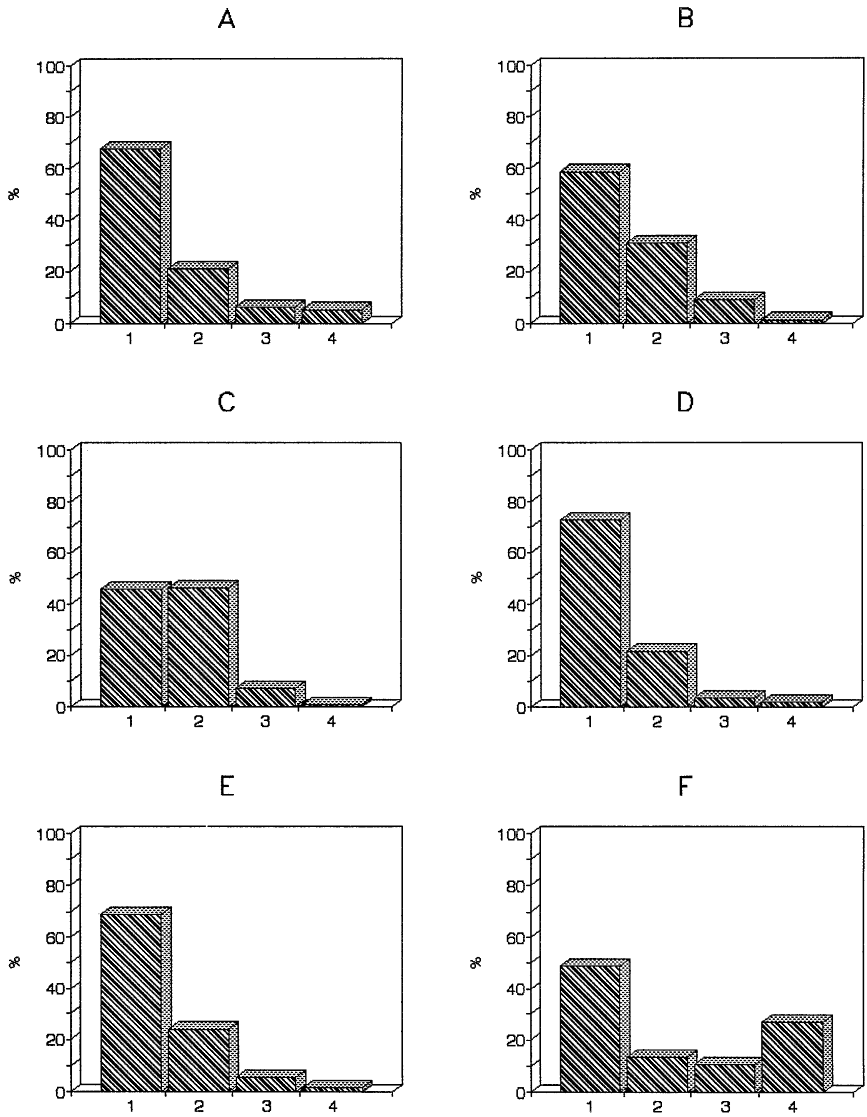

Figure 4. Relative biomass of macrozoobenthic main components at the sites investigated in the Small Aral Sea: A – Bay of Butakov, B – Bay of Shevchenko, C – Tastubek Peninsula (1991), D – Tastubek Peninsula (1993), E – near the Bugun Village, F – Sarycheganak Bay.

C. Former Berg's Strait

The composition of the macrozoobenthos in the former Berg's Strait was the same as that observed in other parts of the Small Aral Sea although there were some differences in the abundance and spatial distribution of some benthic

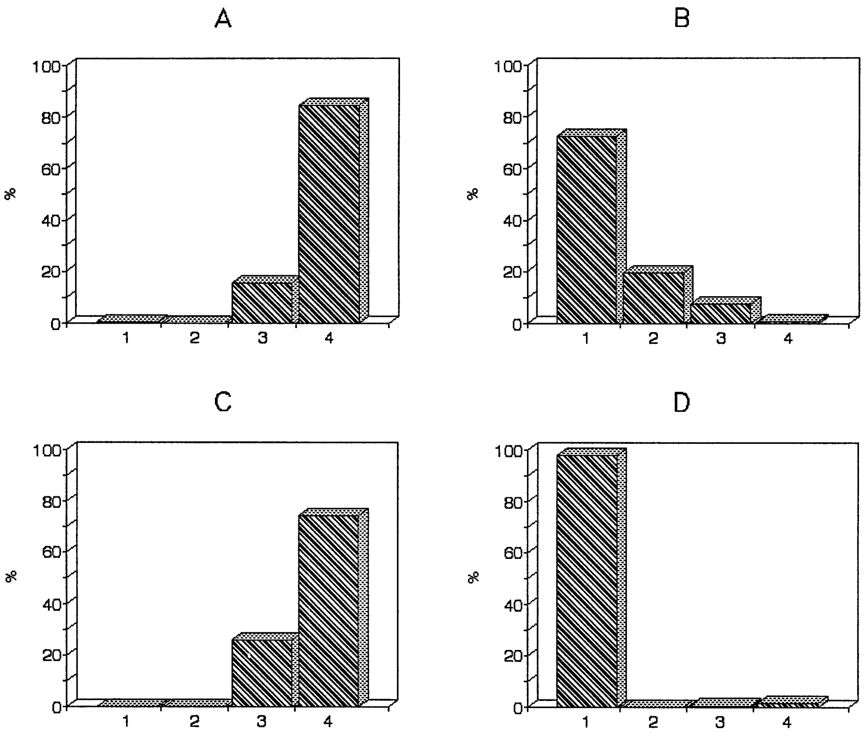

Figure 5. Relative biomass of macrozoobenthic main components at the sites investigated at the Former Berg's Strait: A – 1992, without st.5, B – st.5 in 1992, C – 1993, without st.5, D – st.5, 1993.

invertebrates. The shallow (0.8–2.0 m) region close to the Syrdaria inlet was only inhabited by *N. diversicolor* and *Caspiohydrobia* spp. The polychaete biomass here exceeded that in most other sites investigated (see Table 2). Bivalve molluscs, dominant in other inshore areas, were not recorded here. Total zoobenthos biomass and density was very low and varied between stations from 19 to 46 g/m^2 and from 2,400 to 6,800 ind./m^2. Apparently, the main reasons for these observations was the low salinity, varying between stations from 13 to 20 g/L, or the instability of the hydrobiological regime during the year because of the influence of the Syrdaria flow.

At a distance of about 5 km from the river mouth toward the Small Sea, at a salinity of 25 g/L and a depth of 4 m (station 5, see Figure 2), the zoobenthos structure was quite different (Figure 5). Here, *S. segmentum* was dominant and total zoobenthos biomass and density was much higher: 264 g/m^2 and 20,500 ind./m^2. In 1992, the abundance of the various taxa was similar to values recorded in the other parts of the Small Aral Sea. In 1993, the relative abundance of taxa was slightly different here, but these differences were probably connected to some spatial differences in the place where the samples were collected in 1992 and in 1993 than with real annual variability of macrozoobenthos in this region.

D. Lower stream of Syrdaria

Zoobenthos in the river itself comprised Oligochaeta (species undetermined), Chironomidae larva (*Polypedilum nubeculosum* (Meigen)), Mysidae (*Paramysis lacustris* (Czern.)) and Gammaridae (*Dikerogammarus aralensis* (Uljanin)). Zoobenthos biomass and density were extremely low – 29 mg/m^2 and 24 ind/m^2. It is considered that the low abundance of benthic organisms in the Syrdaria is connected with the extreme instability of the riverbed sediments (Konstantinov, 1986).

Discussion

All species of benthic invertebrates recorded in the Sea at the end of the last crisis period reported in the middle 1980s (Aladin and Kotov, 1989; Aladin et al., 1992) were also recorded in the present study. Thus, the Sea benthic ecosystem has apparently been in a state of comparative stability in term of species composition from the middle 1980s to the time of our investigation.

The discovery in the lower reaches of the Syrdaria of *D. aralensis* and *P. lacustris* is noteworthy for they were widespread in the Aral Sea before the beginning of its salinization but have not been reported from the Sea since the middle 1970s. During our investigation, they were found in abundance in pools and drying channels along the main Syrdaria riverbed. Obviously, these areas form important refugia for these species and in the event of sea-level stabilization and a restoration of the former low salinity, Mysidae and Gammaridae might again become an important part of the Seas ecosystem.

Our results show that the Small and Large Seas differ in terms of zoobenthos species composition as well as in the abundance of bottom animals. The absence of *R. harrisii* in the Small Sea is probably the result of the action of Berg’s Strait as a barrier to its migration. Crabs were accidentally introduced into the southern bays of the Aral Sea at a larval stage in 1971 during the acclimatization of *Calanipeda aquae-dulcis* Kritsch. (Morduchai-Boltovskoi, 1972; Andreev and Andreeva, 1988). Initially, *R. harrisii* inhabited only the southern parts of the Large Aral Sea but on the beginning of the 1980s it had migrated to the northern regions (Aladin, 1989). At this time, the southward flow through Berg’s Strait of strongly diluted water (due to the Syrdaria influence) presumably restricted its further northward spread into the Small Sea.

Distinctions between the Small and Large Seas in terms of the abundance of bottom invertebrates is apparently connected with the different levels of productivity of these water-bodies. Unfortunately, a systematic assessment of primary production in the Large Sea after the Aral Sea division was not undertaken. It is therefore only possible to suggest that the nutrient inflow with the rivers waters provided more intensive production of organic matter in the Small Sea in comparison with the Large Sea and created more favorable trophic conditions for zoobenthos.

Overall, the total zoobenthos biomass of the Aral Sea in the early 1990s reported by us (92–582 g/m^2) was much higher than that in the 1960s (about 20 g/m^2 according to Yablonskaja (1960a)). This might be connected with both the decrease of fish density and an increase in the trophic state of the Sea in a whole. Some direct assessment of organic matter formation (Orlova, 1993) shows a higher level of productivity in the 1990s in comparison with the 1960s. Hydrological data (Bortnik and Chistjaeva, 1990; Cycarin, 1991) show a considerable increase in the nutrient content in the Sea water since 1960s. In our opinion such an increase of nutrient concentrations in decreasing conditions of river outflow could derive from resuspension of the lake's sediments as a result of the fall in water-level.

It is important to note the absence of significant differences between all sites investigated (with the exception of Berg's Strait) with regard to the relative abundance of different taxa. The similarity of zoobenthos structure between sites was probably determined by the follow factors: (1) extremely homogeneous sediments (most of the Aral Sea is characterized by silty sediments; sand occupies only a limited area, (2) very few species remain in the Sea, and (3) the remaining species are extremely eurybiotic. Some changes in the relative abundance of *S. segmentum* and *C. isthmicum* between years, as noted near the Tastubek Peninsula, seems to be a normal phenomenon. In the Caspian and Azov Seas, where these molluscs also occur together, their biomass is highly variable and changes from year to year in response to minor changes in the environment, particularly changes in dissolved oxygen concentration (Zenkevich, 1947; Romanova, 1979).

The benthic associations in Sarycheganak Bay were characterized by an unusually low biomass and density of species with a long life-history (*S. segmentum, C. isthmicum*) and a relatively high abundance of species with a short life-history (*N. diversicolor*). This seems to be connected to the Bays isolation from the main basin of the Sea during 1987–1992 and this had led to a complete degradation of the characteristic benthic biocenoses. After 1992, the reconnection between the Bay and Sea allowed the original associations of organisms to restore communities gradually. The peculiarities of the benthic associations of 1994 suggested that the Bay ecosystem was in a formative stage.

The general similarity of zoobenthos structure at different sites, in spite of great differences between them in salinity, indicates the absence of any strong impact of spatial salinity changes in the range 20–41 g/L. This is also corroborated by data on long-term changes in the Aral Sea zoobenthos. According to the data of Andreeva (1989), Aladin (1989), Andreev et al. (1992) and our own (Filippov, 1991, 1993, 1995), the relative abundance of the different taxa has remained practically constant since the beginning of the 1980s, i.e. after the salinity had reached 20 g/L.

Comparison of our data with those for the whole Sea obtained by Andreev and co-authors in 1989 (Andreev et al., 1992) shows that species composition, abundance and overall character of the spatial distribution of the zoobenthos in the inshore zone did not differ significantly from that in the offshore zone. This was probably because the depths we investigated were generally characteristic for the Sea as a whole (in 1990–1994, 80 per cent of the Sea had a depth of less than 10 m). Thus, it is possible to regard the inshore zone of the Aral Sea as a convenient and accessible area for monitoring macrozoobenthos status in the whole Sea. Observations of benthic associations in this inshore zone at depths typical for open water regions would allow us to monitor the main changes in the zoobenthos occurring in the whole Sea.

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References

Aladin, N.V. 1989. Zooplankton and zoobenthos in coastal waters near the Isle of Barsakelmes (the Aral Sea). Proceedings of the Zoological Institute of the Russian Academy of Sciences 199: 110–114. Zoological Institute, St. Petersburg [in Russian].

Aladin, N.V., Plotnikov, I.S. and Filippov, A.A. 1991. The past and present of the Aral Sea fauna. Zoological Journal. Scripta Technica Inc.: 33–44.

Aladin, N.V. and Kotov, S.V. 1989. The Aral Sea ecosystem original state and its changing under anthropogenous influence. Proceedings of the Zoological Institute of the Russian Academy of Sciences 199: 4–24. Zoological Institute, St. Petersburg [in Russian].

Aladin, N.V., Plotnikov, I.S. and Filippov, A.A. 1992. The changes of the Aral Sea ecosystem as a result of anthropogenous influence. Hydrobiological Journal 28 (2): 3–11 [in Russian].

Andreev, N.I. and Andreeva, S.I. 1988. Crab *Rhithropanopeus harrisii tridentatus* (Decapoda, Xanthidae) at the Aral Sea. Zoological Journal 67 (1): 135–136 [in Russian].

Andreev, N.I., Andreeva, S.I., Filippov, A.A. and Aladin, N.V. 1992. The fauna of the Aral Sea in 1989. 1. The Benthos. International Journal of Salt Lake Research 1: 103–110.

Andreeva, S.I. 1989. Macrozoobenthos of the Aral Sea in the initial period of its salinization. Proceedings of the Zoological Institute of the Russian Academy of Sciences 199: 53–83. Zoological Institute, St. Petersburg [in Russian].

Bekmurzaev, B. 1991. The influence of the water salinization on zoobenthos of southern part of the Aral Sea. Hydrobiological Journal 27 (5): 27–30 [in Russian].

Bortnik, V.N. and Chistiaeva S.P. (Eds.) 1990. The Aral Sea. In: F.S. Terziev (Ed.) Hydrometeorology and Hydrochemistry of the Seas of the USSR. 7, Hydrometeoizdat, Leningrad [in Russian].

Cycarin, A.G. 1991. Modern state of elements of the Aral Sea hydrological regime. Proceedings of the State Institute of Oceanography (GOIN) 183: 72–91. Moscow [in Russian].

Filippov, A.A. 1991. Zoobenthos in the Butakov Bay (The Aral Sea) in September 1990. Proceedings of the Zoological Institute of the Russian Academy of Sciences 237: 44–48. Zoological Institute, St. Petersburg [in Russian].

Filippov, A.A. 1993. Zoobenthos of the Barsakelmes island coastal zone (the Aral Sea) in 1991. Proceedings of the Zoological Institute of the Russian Academy of Sciences 250: 64–72. Zoological Institute, St. Petersburg [in Russian].

Filippov, A.A. 1995. Macrozoobenthos of inshore zone the Aral Sea North in modern polyhaline conditions: density, biomass and spatial distribution. Proceedings of the Zoological Institute of the Russian Academy of Sciences 262: 103–166. Zoological Institute, St. Petersburg [in Russian].

Konstantinov, A.S. 1986. General Hydrobiology. Vysshaja shkola, Moscow [in Russian].

Miklin, P. 1991. The water management crisis in Soviet Central Asia. The Carl Beck Papers in Russian and East European Studies 905, 120 pp. University of Pittsburgh, Pittsburgh.

Morduchai-Boltovskoi, F.D. 1972. The modern state of the Aral Sea fauna. Hydrobiological Journal 3: 14–20 [in Russian].

Orlova, M.I. 1993. Materials to the general evaluation of the productional-destructional processes in coastal zone of the northern part of the Aral Sea. 1. Results of field observations and experiments in 1992. Proceedings of the Zoological Institute of the Russian Academy of Sciences 250: 21–37. Zoological Institute, St. Petersburg [in Russian].

Proskurina, E.S. 1979. The state and prospects of acclimatized organisms distribution in the Aral Sea. Hydrobiological Journal 15: 37–41 [in Russian].

Romanova, N.N. 1979. About the relationship between *Cerastoderma lamarcki* and *Abra ovata* along the western coast of Northern Caspian. Molluscs. Abstracts of oral presentations, 6, St. Petersburg: 109–110 [in Russian].

Yablonskaja, E.A. 1960a. Food stock of the Aral Sea fishes and its utilization. Proceedings of All-union Scientific Research Institute of Fishery and Oceanography (VNIRO) 43 (1): 150–176. Moscow [in Russian].

Yablonskaja, E.A. 1960b. The modern state of the Aral Sea zoobenthos. Proceedings of All-union Scientific Research Institute of Fishery and Oceanography (VNIRO) 43 (1): 115–149. Moscow [in Russian].

Yablonskaja, E.A., Kortunova, T.A. and Gavrilov, G.B. 1973. The long-term changes in the Aral Sea zoobenthos. Proceedings of All- union Scientific Research Institute of Fishery and Oceanography (VNIRO) 80 (3): 147–158. Moscow [in Russian].

Zenkevich, L.A. 1947. Fauna and biological productivity of a Sea. Seas of the USSR, 2. Moscow-Leningrad, Sovjetskaja Nauka [in Russian].