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The Influence of the Invertebrate Drift on the Communities of the Danube Delta Marine Edge

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Abstract: The taxonomic structure of the invertebrates drift and the communities in the seaside water areas between the Bystryi and Vostochnyi branches were compared. A rich complex of aquatic organisms was transported into the coastal sections of the sea. The larger part of it perished in the sea, while many invertebrates of the drift, mainly euryhaline and eurytopic organisms, found favourable conditions for living in the less saline bays of the estuary.

Keywords: Drift, invertebrates, Kyliya delta

Introduction

The river transports not only non-living material (suspended particles and eroded alluvia), but also a large biotic component (*e.g*. plants, invertebrates, the larvae of Cyclostomata and Amphibia). The living aquatic organisms that are transported by the currents, are commonly referred to as *drift*. The drift plays an essential role in the population dynamics of the waterways organisms. The input of aquatic organisms from upstream provides capacity for the restoration of devastated biota and the development of new ones.

The main runoff of the branches in the Kyliya delta occurs in the east delta shore. Here some sea areas, characterised by varying salinity and wave impacts, are a "disaster area" with impoverished animal and plant communities. The inflow of the branches transports freshwater organisms into these areas, with a part of the organisms being perished, while others survive and represent a valuable supply to the seaside communities.

The aim of this study is the investigation of the invertebrate drift and its impact on the communities in the water bodies of the marine edge of the delta. The data on the invertebrate drift in the Ukrainian part of the Danube River are scarce, and the results of these studies were published in several papers (Tseyeb 1961, Olivari 1961, Polishchuk 1974).

Material and Methods

The research on the structure of the invertebrate communities in Bystryi Kut Bay and the adjacent marine zone (Fig. 1) was carried out by applying traditional methods (Romanenko 2006) during 2009 and 2011. The zooplankton samples were collected by filtering 100 litres of water through an Apstein net with the mesh size of 0.07 mm and the filtrate was preserved in 4% formalin. Twelve zooplankton samples were collected. The macrozoobenthos was collected with a bottom-grab, while the epifauna was scraped off the flooded wood; in both cases, the sampling area was 10x10 cm^2. Twenty one macroinvertebrate samples were collected.

At the same time, the invertebrate drift in the Bystryi and Vostochnyi branches was investigated. The samples were collected using the drift net sam-

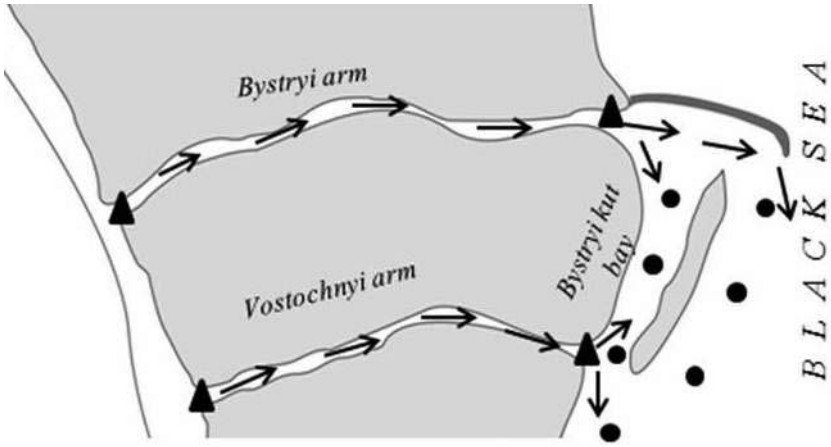

Fig. 1. Map of sampling stations
▲ – drift;
● – zooplankton, zoobenthos, epifauna;
→ – direction of water flow

pler of Levanidov with the mesh size of 0.07 mm; the area of the trap opening was 0.049 m^2. Samples were taken at four sections of the delta (the headstream and the mouth of branches), from two horizons (the surface layer and ½ of the depth), and the exposition time was 3 minutes. The samples were poured into a bottle and preserved in 4% formalin. Fifty one drift samples were collected.

The biotic indices were calculated applying "ASTERICS 3.1.11" (Manual for the application of the AQUEM system 2002). The structure of the invertebrate community in relation to the salinity was determined by the calculated indices as well as by the reference values (Kuticova 1970, Manuilova 1964, Monchenko 1974, Vodianitskyi 1968, 1969). The invertebrate species were grouped as follows: freshwater, freshwater-oligohaline, freshwater-mesohaline, freshwater-polyhaline, freshwater-euhaline, oligo-euhaline and meso-euhaline species.

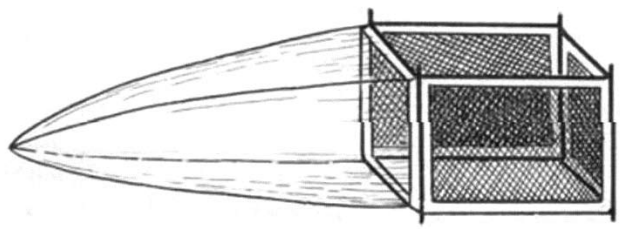

Fig. 2. Drift net sampler of Levanidov (after Bogatov 2005)

Results

The marine edge of the delta between the Bystryi and Vostochnyi branches is characterised by shallow waters, an instable hydrodynamic and hydrochemical balance, the absence of vegetation and sandy bottom sediments (Table 1).

The Bystryi Kut Bay is sheltered from the sea by the Ptashyna Kosa Island. The passages from the Bystryi and Vostochny branches provide the inflow of both marine and river waters. As a result of this, the salinity in the bay, as well as in the marine zone, varies between freshwater and oligohaline waters. The protection from the sea considerably reduces the wave influence, which promotes the build-up of softer sediments and the development of submerged plants (*Myriophyllum spicatum*, *Potamogeton perfoliatus*, *P. pectinatus*).

Twenty-four invertebrate species were recorded in the marine zone, among which the Ponto-Caspian Malacostraca prevailed (Amphipoda: *Pontogammarus, Stenogammarus, Gmelina,* and *Corophium*; Mysidacea: *Paramysis kroyeri* (Czer.) and *Paramysis lacustris* (Mart.); Cumacea: *Pterocuma pectinata* (Sowin) and *Schizorhynchus scabriusculus* (Sars)). The species *Abra ovata* (Philippi) (Mollusca), *Nereis diversicolor* O. F. Müller (Polychaeta) and *Bathyporeia qulliamsoniana* (Bate) (Gammaridae) were representatives of the Mediterranean complex. The freshwater fauna was represented by two species of Chironomidae: *Cricotopus sylvestris* (Fabricius) and *Glyptotendipes gripekoveni* (Kieffer). These species can tolerate higher water salinity (mesohaline waters). The marine zone zooplankton was extremely poor, three

Table 1. The main hydromorphological characteristics of the marine zone and Bystryi Kut Bay. * - the limits of fluctuation of the salinity index are specified; the average values are in brackets

Characteristics	Water area	
	Marine zone	Bystryi Kut Bay
Prevailing depth, m	1.5	1.5
Wave influence	powerful	practically absent
Type of bottom substrata	sand	silted sand
Salinity, ‰*	0.44-3.05 (1.43)	0.17-4.72 (0.81)
Vegetation	absent	mainly submerged plants

Table 2. Common species in the drift and Bystryi Kut Bay

Group of species	Total number	Taxon	Species
Marine	2	Polychaeta	*Polydora limicola* (Annenkova)
		Mysidacea	*Mesopodopsis slabberi* (van Beneden)
Freshwater-euhaline	1	Hydrozoa	*Cordylophora caspia* (Pallas)
Freshwater-polyhaline	1	Gammaridae	*Pontogammarus maeoticus* (Sowinsky)
Freshwater-mesohaline	20	Rotifera	*Asplanchna priodonta* Gosse, *Keratella quadrata* (Müller)
		Cladocera	*Daphnia longispina* Müller, *Sida crystallina* (O. F. Müller), *Simocephalus vetulus* (O. F. Müller)
		Copepoda	*Acanthocyclops americanus* (Marsh), *A. viridis* (Jurin), *Calanipeda aqua-dulcis* (Kriczagin), *Eucyclops serrulatus* (Fishe), *Thermocyclops crassus* (Fisch.)
		Polychaeta	*Hypaniola kowalewskii* (Grimm)
		Oligochaeta	*Chaetogaster diaphanus* (Gruithuisen), *Limnodrilus hoffmeisteri* (Claparede), *Nais elinguis* (Müller)
		Gammaridae	*Pontogammarus crassus* (Sars)
		Corophiidae	*Corophium curvispinum* (Sars), *C. robustum* (Sars), *C. volutator* (Pallas)
		Chironomidae	*Cricotopus sylvestris* (Fabricius), *Glyptotendipes gripekoveni* (Kieffer)
Freshwater-oligohaline	18	Rotifera	*Brachionus quadridentatus* Hermann
		Cladocera	*Bosmina longirostris* O. F. Müller
		Copepoda	*Acanthocyclops vernalis* (Fischer), *Eurytemora velox* (Lilljeborg), *Macrocyclops albidus* (Jurine)
		Gastropoda	*Theodoxus danubialis* (Clessin)
		Oligochaeta	*Nais barbata* (Müller), *N. communis* (Piguet), *N. variabilis* (Piguet), *Stylaria lacustris* (Linnaeus)
		Gammaridae	*Chaetogammarus ischnus* (Stebbing), *Ch. warpachowskyi* (Sars), *Dikerogammarus haemobaphes* (Ehrenberg)
		Isopoda	*Asellus aquaticus* (Linnaeus)
		Mysidacea	*Limnomysis benedeni* (Czerniavsky)
		Trichoptera	*Ecnomus tenellus* (Rambur)
		Chironomidae	*Cricotopus algarum* (Kieffer), *Psectrocladius psilopterus* (Kieffer)
Freshwater	4	Cladocera	*Daphnia cucullata* Sars, *Pleoroxus aduncus* (Jurine)
		Oligochaeta	*Nais pardalis* (Piguet)
		Chironomidae	*Paratanytarsus lauterborni* (Kiffer)

species of Cladocera and three species of Copepoda being present, while Rotifera were absent.

The Bystryi Kut Bay fauna was richer and more diverse. One hundred and five species of invertebrates were recorded. The macrozoobenthos was represented by 22 Oligochaeta and 20 Malacostraca species. More insects, especially Chironomidae (17 species), Heteroptera, Trichoptera, and Ephemeroptera were recorded. The species richness of zooplankton increased remarkably compared to the marine zone: Rotifera appeared and the species richness of Cladocera and Copepoda increased two and four times respectively. Freshwater species predominated in the bay (81%), the Ponto-Caspian species represented 14%, while the Mediterranean species 3%. Two invaders: *Balanus improvisus* (Darwin) and *Corbicula fluminea* (O. F. Müller) were recorded as well.

Seventy-seven species were recorded in the invertebrate drift of the delta branches (Fig. 4). Crustaceans were characterised by the greatest species richness comprising: 18 Copepoda, 13 Cladocera, 12 Amphipoda, two Mysida and one Isopoda. Ten species of Oligochaeta, six of Chironomidae, and 2 species of Polychaeta, Trichoptera and Hydrozoa each were also found in the drift.

The spring drift was most extensive; 49% of all invertebrate species (*i.e*. 38 species) were recorded only during the spring season: *e.g. Cordylophora caspia* (Pallas) (Hydrozoa), *Hypaniola kowalewskii* (Grimm) (Polychaeta), *Limnodrilus hoffmeisteri* (Claparede), *Nais barbata* (Müller), *N. variabilis* (Piguet) (Oligochaeta), *Chaetogammarus warpachowskyi* (Sars), *Pontogammarus maeoticus* (Sowinsky), *Corophium robustum* (Sars) (Amphipoda), *Limnomysis benedeni* (Czerniavsky) (Mysidae), *Hydropsyche ornatula* (Mc Lachlan) (Trichoptera), *Paratanytarsus lauterborni* (Kiffer), *Psectrocladius psilopterus* (Kieffer), and *Chironomus* sp. (Chironomidae). The majority of Rotifera, Copepoda and Cladocera were present in the spring drift only. Ten percent of the drift species were reported during all seasons: Oligochaeta *Chaetogaster diaphanus* (Gruithuisen) and *Stylaria lacustris* (Linnaeus), Isopoda *Asellus aquaticus* (Linnaeus), Corophiidae *Corophium curvispinum* (Sars), Cladocera *Bosmina longirostris* (Müller), and Copepoda *Acantocyclops americanus* (Marsh), as well as juvenile and naupliar stages of copepods. In general, freshwater species capable to tolerate saline waters (oligohaline - 45% of the drift species, mesohaline - 37% of the drift species), predominated in the drift.

Discussion

Eight species were common in the drift (10% of the drift species) and in the marine zone (33% of the marine zone invertebrates): Crustacea *Bosmina longirostris* O. F. Müller, *Eucyclops serrulatus* (Fishe), *Pontogammarus maeoticus* (Sowinsky), *Gammaridae* sp. juv., *C. curvispinum*, *C. robustum*, as well as the Chironomidae larvae *C. sylvestris* and *G. gripekoveni*. These are widely spread freshwa-

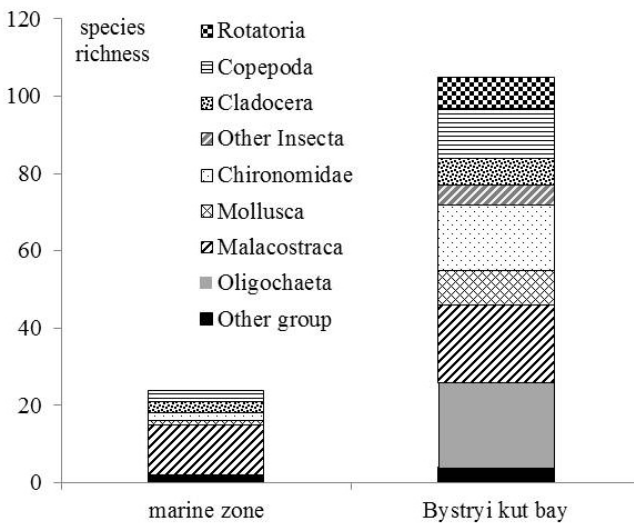

Fig. 3. The taxonomic structure of invertebrates in the marine zone and the Bystryi Kut Bay

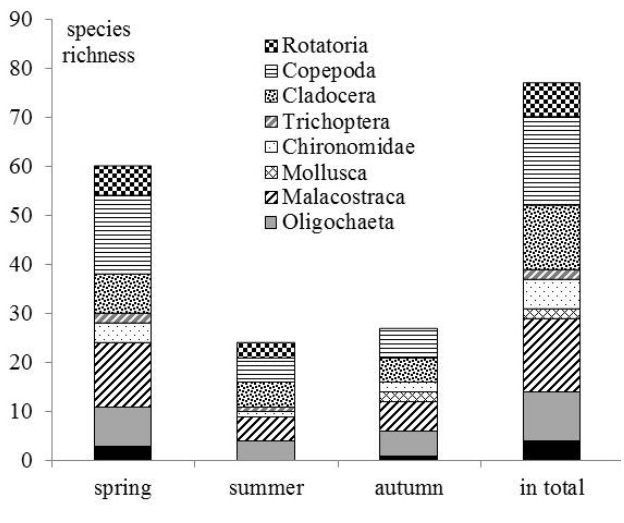

Fig. 4. The structure of invertebrate drift during various seasons of the study

ter mesohaline species often occurring in the delta, with *P. maeoticus* being able to survive even in polyhaline waters. Sixty-seven percent of the marine zone fauna is represented by sea and saltwater inhabitants. These are mainly the representatives of the Ponto-Caspian and Mediterranean macrofauna, as well as the euryhaline zooplankton species. The similarity in species composition between the drift and the marine zone invertebrates reveals 16% (according to Soerensen).

Forty-six species (Table 2) were common in the drift (60% of the species) and Bystryi Kut Bay (44% of the species). The number of species common in the drift and the freshwater bay is considerably higher than in the case of drift and marine zone. In general, these are freshwater organisms adapted to the life in waters with increased mineralisation. The majority of them are freshwater-mesohaline species. Altogether, the similarity index of the species composition of invertebrates in the drift and Bystryi Kut Bay is 51% (according to Soerensen).

Conclusions

The study reveals that a rich complex of aquatic organisms is transported with water from the Danube River branches into the coastal sections of the sea. The majority of them perish in the sea and only 10% of the species, which are euryhaline and eurytopic organisms, mainly Crustacea, seem to be adapted to exist in the open waters of the marine zone. The bays in the mouths of hydrodynamic active branches provide areas isolated from the sea, with less saline and hydrodynamic waters that offer conditions favourable for the development of freshwater species. The invertebrates that arrive with the water increase the food supply of the coastal water areas and promote the colonisation of newly formed structures in the water. On the other hand, the perishing part of the animals is an additional organic polluter.

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