Black Sea Oceanography

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A REVIEW OF THE GENERAL FOOD WEB IN THE BLACK SEA

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ABSTRACT. In this article, an attempt is made to briefly review the basic food web in the Black Sea. The emphasis is put primarily on the commercially important fish species, their distribution in the Black Sea and position in the food chain.

1. Introduction

Life in the Black Sea is restricted to a zone between surface and 80-160 meters depth due to the existence of poisonous hydrogen sulphide gas. No living organisms are encountered other than anaerobic bacteria in the deeper water. In the well oxygenated upper zone, a food web is established by pelagic and benthic organisms.

2. Result

Trophic relations in an ecosystem never follow a monotonous chain reaction. Species dietary habits usually include a high level of variety. The complex relations among living organisms are exemplified by their flexibility in trophic level (Kışlalıoğlu and Berkes, 1985). This situation can be observed in the Black Sea.

2.1. THE PRINCIPAL ORGANISMS

The bacterial flora of the Black Sea are composed of 298 species and 36 subspecies (Lebedeva and Mironov, 1979). The bacterial plankton is of particular interest on account of its role in the

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productive process. Petypa (1975) reported that the large biomass and high productivity of aerobic bacteria were utilized as food by the zooplanktonic organisms, especially the filter-feeder species. Thus, the low abundance of phytoplankton as food for the zooplankton is compensated by bacteria. A high concentration of sulphur metabolizing bacteria was found in the boundary layer between the oxygenated and hydrogen sulphide areas, then it decreased considerably at about 250 m. Thereafter the numbers increased again at great depths and near the bottom. The quantities of microflora in the mud are also considerable (Ivanov and Beverton, 1985).

The phytoplankton is represented with five taxonomic orders, containing 185 genera and 746 species (Table 1). Diatoms (Chrysophyta, Bacillariophyceae) are the most abundant with a total of 342 species and (Pitzky et al., 1979; Benli, 1987). Some species of this class (of the genera *Chaetoceros, Ditylum, Rhizosolenia* and others) and of Dinophyceae (Pyrrophyta, of the genus *Exuvialle* and others), and also *Emiliania huxleyi* (Chrysophyta, Prymnesiophyceae) show in some years an extraordinary abundance, the so-called "bloom" (Sorokin, 1983; Ivanov and Beverton, 1985; Benli, 1987). Lower limit of the phytoplankton distribution coincides in most cases with the upper limit of the hydrogen sulphide zone (Morozova, 1957). Greze (1979) has estimated the average annual phytoplankton production to be at 1200 x 10^6 t.

TABLE 1. Number of phytoplankton species in the Black Sea (from Pitzky et al., 1979, modified after Bold and Wynne, 1985)

Taxonomic groups	Genera	Species and varieties
Cyanophyta	12	34
Chlorophyta	36	91
Euglenophyta	7	17
Chrysophyta	94	399
Pyrrophyta	36	205
Total	185	746

The zooplankton of the Black Sea consists basically of 98 species (Table 2). The number is enriched with the larval stages of molluscs, polychaetes, crustacea and other benthic and pelagic animals. In winter fewer species of zooplankton are found (Greeze and Fedorina, 1979). The components of zooplankton can be grouped as cold, warm and eurytherm groups on the basis of their origin and ecology (Ivanov and Beverton, 1985). *Aurelia aurita* (Medusae) is one of the most abundant macrozooplankton species, which could be exploited commercially (Mironov, 1971; Ivanov and Beverton, 1985). The vertical distribution of zooplankton is determined by temperature, salinity, currents and other factors, basically the depth of hydrogen sulphide layer. Medusae, Sagittae and Ctenophores are important zooplanktonic carnivores (Ivanov and Beverton, 1985).

The seaweeds are found mainly at depths between 0 and 20 meters, represented by mostly green (Chlorophyta), and some brown (Phaeophyta) and red (Rhodophyta), algae with a total of 304 species (Kalugina, 1979). *Phyllophora, Cystoseira* and *Ulva* are the most common and commercially important genera (Ivanov and Beverton, 1985; Cirik and Cihangir, 1987). Two representatives of Phanerogamia, *Zostera marina* and *Zostera nana* construct facies in the infralittoral zone. The total annual macrophytobenthos production has been calculated as 17.6 x 10^6 t (Greeze, 1979).

TABLE 2. Number of holoplankton species in the Black Sea (from Greeze and Fedorina, 1979)

Taxonomic groups	Genera	Species
Tintinoidea	9	25
Hydrozoaria	10	10
Scyphozoaria	2	2
Ctenophorae	1	1
Rotatoria	9	35
Cladocera	4	8
Copepoda	13	15
Chaetognatha	1	1
Appendicularia	1	1
Total	50	98

The zoobenthos is composed of 1520 invertebrate species (including only foreminifera from Protozoa), as shown in Table 3 (Kiseleva, 1979). The total annual production of zoobenthos reaches some 53.6 x 10^6 t (Greze and Fedorina, 1979).

TABLE 3. Number of invertebrate species in the benthic fauna of the Black Sea (from Kiseleva, 1979, modified after Barnes, 1980)

Taxonomic groups	Species	Taxonomic group	Species
Foraminifera	26	Copepoda	154
Porifera	28	Cirripedia	5
Hydrozoa	25	Decapoda	32
Anthozoa	5	Cumacea	23
Turbellaria	103	Tanaidacea	6
Nemertinia	33	Isopoda	29
Gastrotricha	23	Amphipoda	103
Rotifera	40	Insecta	11
Kinorhyncha	10	Sipuncula	1
Nematoda	240	Tardigrada	5
Gastropoda	118	Phorinida	1
Polyplacophora	3	Bryozoa	18
Bivalvia	88	Entoprocta	2
Scaphopoda	1	Asteroidea	1
Polychaeta	182	Ophiuroidea	4
Oligochaeta	39	Echinoidea	1
Arachnida	27	Holothuroidea	8
Pycnogonida	8	Ascidiacea	8
Ostracoda	109	Total	1520

Two Molluscan species *Raphana thomasiana* (Gastropoda) and *Mytilus galloprovincialis* (Pelecypoda) are very abundant and exploited commercially in the Black Sea.

The fish fauna of the Black Sea comprise 165 species and subspecies, of which 119 are exclusively marine, 24 are anadromous or semi-anadromous, and 22 are freshwater species. Some 15 other freshwater species are found rarely (Denhik, 1979). Some 15 species have commercial importance. Three pelagic fish species: anchovy, sprat and horse mackerel, comprised together 87 percent of the total catch by weight in 1976-79 and 91 percent in 1980 (Ivanov and Beverton, 1985). The anchovy *Engraulis encrasicholus* (Engraulidae) is the most abundant pelagic fish species in the Black Sea, feeding mainly on zooplankton. In winter, it congregates in big shoals in the warmest parts of the Black Sea, off the Anatolian and Soviet Crimean coasts. It leaves the wintering areas in spring and migrates to the north where feeding and spawning take place. In years of poor food supply, the fish enters the Sea of Azov (Shul'man, 1974; Ivanov and Beverton, 1985). There is also a relatively small stock of anchovy which reproduces and feeds in the Sea of Azov. It never migrates to the Anatolian coast for overwintering, but hibernates along the coasts of the northern Caucasus and, partly, of the Crimea (Ivanov and Beverton, 1985).

The Mediterranean horse mackerel *Trachurus mediterraneus ponticus* (Carangidae) is the second most abundant pelagic fish species, which inhabits the Black Sea. The main wintering areas are in the warm water along the coasts of the Crimea, Caucasus, Anatolia, and parts of the Marmara Sea (Ivanov and Beverton, 1985). Another species of the genus *Trachurus*, the Atlantic horse mackerel *T. trachurus* also occurs, especially in the western Black Sea, in a lower abundance (Smith-Vaniz, 1989). Unlike anchovy, horse mackerel has a mixed diet including zooplankton and small fish.

The mackerel *Scomber scombrus* (Scombridae) is a carnivorous, pelagic fish, feeding on zooplankton and some small pelagic fishes such as anchovy and sprat (Nalbantoğlu, 1957). This species has a distinct migration pattern, in spring aggregates in schools and migrates to the Black Sea for feeding and in autumn back to the Sea of Marmara for spawning and overwintering (Krotov and Vinogradov, 1940; Demir and Acara, 1955; Demir and Arım, 1957). It becomes vulnerable to fishery during migrations.

The bluefish *Pomatomus saltator* (Pomatomidae) is a predatory, pelagic fish, feeding on anchovy, sprat, mackerel, etc., migrating in spring to the Black Sea for feeding and propagation. After spawning in summer, it migrates back to the Sea of Marmara and the Mediterranean Sea in autumn (Ivanov and Beverton, 1985). Bluefish is exploited commercially.

The goby *Gobius* spp. (Gobiidae) is a euryhaline and eurythermal, carnivorous, demersal fish species, distributed in shallow waters, feeding on some crustaceans, worms, etc.

The whiting *Merlangius merlangus euxinus* (Gadidae) is a commercial, demersal fish species, distributed in the shallow waters of the Black Sea. It spawns throughout the year, but especially in winter. Whiting shows small migrations in depth depending on changes in temperature. It preys on small fish as well as some crustaceans (Shul'man, 1974).

The turbot *Psetta maxima maeotica* (Scophthalmidae) is the most important commercial, demersal fish in the Black Sea. Turbot reproduces in spring and food spectrum consists of small fish, crustaceans and bivalves. It performs the same vertical migration as its prey species (Svetovidov, 1964). The turbot stocks have been heavily exploited (Ivanov and Beverton, 1985).

The spiny dogfish *Squalus acanthias* (Squalidae) is a demersal and viviparous, cartilaginous fish, distributed all over the Black Sea. It preys, most frequently in schools, on various fishes, molluscs, some crustaceans, etc. (Svetidov, 1964).

Three species of dolphins live in the Black Sea, *Phoceana phoceana* (Phoceanidae) and *Tursiops tursio*, *Delphinus delphis* (Delphinidae). The last species is the most abundant and

distributed mainly along the Caucasian and Anatolian coasts, where the winter concentrations of anchovy and horse mackerel are found. Dolphins most often gather in schools and prey on anchovy, horse mackerel, mackerel, bluefish, etc (Ivanov and Beverton, 1985). No quantitative data are available on the amount of fish consumed by dolphins in the Black Sea. It is clear that dolphins have played a major role in the food chain as top predators. Golenchenko (1948) estimated the number of dolphins to be ca. one million, before the dolphin populations were depleted. If the average weight of a dolphin is 30 kg, and it is assumed that an adult individual eats around 5 percent of its actual weight per day, the dolphin populations would have consumed half a million tons of food per year (Ivanov and Beverton, 1985).

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4. References

Barnes, R. D. (1980) Invertebrate Zoology, Saunders College, Philadelphia, 4th Ed., 1089 p.

Benli, H. A. (1987) 'Investigation of plankton distribution in the southern Black Sea and its effect on particle flux', in E. T. Degens, E. İzdar and S. Honjo (eds.), Particle Flux in the Ocean, Mitteilungen des Geologish-Paläontologischen Institut der Universität Hamburg, 62, 77-87.

Bold, H. C. and Wynne, M. J. (1985) Introduction to the Algae, Prentice-Hall, Inc., New Jersey, 2nd Ed., 720 p.

Cirik, Ş. and Cihangir, B. (1987) 'Note Preliminaire sur la vegetation Marine Benthique de l'environ d'Inceburun (Sinop) de la Mer Noire', E.Ü. Su Ür. Derg. 4, 106-112.

Demir, M and Acara, A. (1955) 'Biological and hydrological factors controlling the migrations of mackerel from the Black Sea to the Sea of Marmara', GFCM Proc.Tech. Rap./ Debats Doc. Tech. CGPM. 3(41), 365-376.

Demir, M. and Arim, N. (1957) 'Contribution to the biology of mackerel (*Scomber scombrus*)', GFCM Proc. Tech. Rap. 4(19), 135-139.

Denhik, T. V. (1979) 'The composition of ichthyofauna', in Fundamental principles of the biological productivity of the Black Sea, Kiev, Naukova dumka, pp. 242-267.

Golenchenko, A. P. (1948) 'The wealth of fish in the Black Sea and perspectives for its utilization', Rybn. Khoz. 4, 3-9.

Greze, V. N. (1979) 'On the biproductive system of the Black Sea and its functional characteristics', Gidrobiol.Zh., 15(4), 3-9.

Greze, V. N. and Fedorina, A. I. (1979) 'The Zooplankton', in Fundamental principles of the biological productivity of the Black Sea, Kiev, Naukova dumka, pp. 143-168.

Ivanov, L. and Beverton, R. J. H. (1985) The fishery resources of the Mediterranean. Part 2: Black Sea FAO, Stud.Rew.GFCM, Rome 60, 135 p.

Kalugina, G. A. A. (1975) The phytobenthos of the Black Sea, Kiev, Naukova dumka, 247 p.

Kalugina, G. A. A. (1979) 'Macrophytobenthos', in Fundamental principles of the biological productivity of the Black Sea, Kiev, Naukova dumka, pp. 123-142.

Kışlalıoğlu, M., and Berkes, F. (1985) Ecology and Environmental Sciences, Env. Probl. Found. of Turkey, 361 p.

Krotov, A. V. and Vinogradov, N. N. (1940) The mackerel of the Black Sea, Izd. Unissmakh,

Odessa, 8, 140 p.

Lebedeva, M. N. and Mirenov, O. G. (1979) 'The bacteria population', in Fundamental principles of the biological productivity of the Black Sea, Kiev, Naukova dumka, pp. 176-207.

Mironov, G. N. (1971) 'Biomass and distribution of the medusa (*Aurelia aurita*) according to the catches with the bottom trawl in the Black Sea in the period 1942-1962', Biol. Morja., 14, 49-69.

Morozova, N. V. (1957) 'The phytoplankton of the Black Sea and its quantitative development', Tr. Sevastopol. Biol. Stn. 9, 3-13.

Nalbantoğlu, U. (1957) 'Contents of the stomachs of mackerel (*Scomber scombrus*) caught in the Marmara, the Bosphorus and in the areas of the Black Sea bordering the Bosphorus', Proc. Tech. Rap./Debats Doc. Tech. CGPM, 4(25), 181-192.

Petypa, T. S. (1975) 'Results of the study of the plankton systems of the southern seas', Gidrobiol.Zh., 11(2), 5-11.

Pitzky, G. K., et al. (1979) 'Phytoplankton', in Fundamental principles of the biological productivity of the Black Sea, Kiev, Naukova dumka, pp. 63-108.

Shul'man, G. E. (1974) Life Cycles of Fish, Physiology and Biochemistry, Israel Prog. Sci. Trans. Cat. No. 22107, 257 p.

Smith-Vaniz, W. F. (1989) 'Carangidae', in P. J. B. Whitehead et al (eds.), Fishes of the North-eastern Atlantic and the Mediterranean, Unesco, Richard Clay Ltd., U.K., 2, 815-844.

Sorokin, Y. I. (1983) 'The Black Sea', in B. H. Ketchum (ed.), Estuaries and Enclosed Seas, Ecosystems of the World, Elsevier Sci. Publ. New York, 26, 253-292.

Svetovidov, A. N. (1964) The Fishes of the Black Sea, Opred. Fauna USSR, 86, 550 p.