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THE BLACK SEA IN CRISIS

An Encounter of Beliefs: A Single Objective

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THE BLACK SEA IN CRISIS

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The Black Sea: Status and Challenges

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From the ancient Greek age to the 1950s the marine environment of the Black Sea was more or less stable. However, studies have shown that since 1950 to 1960 there have been significant transformations in the Black Sea ecosystem. These changes have put an end to a millennial period of relatively stable ecological balance and have marked the beginning of a new era in Black Sea biology and ecology. Its main manifestations are eutrophication (over fertilisation) chemical pollution, accidental introduction of exotic species, bacterial pollution, coastline changes and overexploitation of marine living resources.

Man-made eutrophication of coastal waters and shelf zones has been the most harmful impact on the sea both in terms of scale and its consequences (Zaitsev 1992a, 1993). The major sources of nutrients entering the sea include fertilisers from fields, discharges from animal husbandry, untreated urban sewage and atmospheric fall-out. The area most affected by eutrophication is the north-western part of the sea, where the three largest rivers, the Danube, Dniester and Dnieper are incoming.

Increase in nutrients in the river discharge triggered the mass development of phytoplankon and an expansion in the area of its blooms. This phenomenon has been thoroughly studied by Ukrainian, Romanian and Bulgarian scientists. A large algal biomass provides good feeding conditions for plant-eating animal plankton (zooplankton) and a sharp increase in the numbers of some zooplankton species occurred in the 1970s and 1980s. The most obvious reaction of zooplankton in eutrophic conditions was the mass development of so called gelatinous organisms, whose bodies consist of up to 98 to 99% water.

A high number of the large jelly-fish, ***Rhizostoma pulmo,*** was observed in the coastal zone of the north-west Black Sea in the late 1960s and early 1970s. Later, in 1973-1974, the population of this species dropped back and almost immediately there was an outburst in the population of another jelly-fish, the moon jelly, ***Amelia aurita.*** Until the 1960s the total average biomass of ***Aurelia*** in the Black Sea was 0.7 million tons. In the late 1970s it rose to an average of220 million tons and in the early 1980s it reached 500 million tons. It is difficult to say what the fate *of* ***Aurelia*** would have been and how its relations with other species would have developed had not another gelatinous species, the exotic ctenophore ***Mnemiopsis leidyi,*** unexpectedly appeared in the early 1980s. By the late 1980s it had reached a total biomass of close to one billion tons. The ***Aurelia*** population collapsed almost immediately, the biomass of other zooplankton dropped sharply and the catches of the main Black Sea commercial fish, anchovy, sharply decreased.

The precise role that ***Mnemiopsis*** played in these events and whether it was the only culprit is still to be resolved, but it is commonly held responsible for much of what happened (Zaitsev and Mamaev, 1997).

One of the consequences of eutrophication is the decreasing in transparency of water as the result of greater quantities of phytoplankton, ***Noctiluca,*** jelly-fish, ctenophores and organic debris. The amount of sunlight reaching the bottom in the shelf zone is directly dependent on the transparency of the water. The result has been severe degradation of bottom communities of algae.

The fate of the Zernov's ***Phyllophora*** field, considered the largest aggregation of red agar-bearing algae of ***Phyllophora*** genus in the world ocean, is significant in this sense. In the 1950s, this meadow of red algae was occupying an area of 11,000 km^2 in the central part of the north-west shelf. The total biomass of algae was variously estimated at 7 to 10 million tons. By the early 1980s the algal field had shrink to 3,000 km^2 and its biomass to 1.4 million tons. By the early 1990s, the field was only 500km^2 and its biomass did not exceed 300,000 to 500,000 tons (Zaitsev, 1992 (a)) This decline represented not only the loss of valuable raw material which was harvested for the extraction of agaroid, a gelling agent, but also the disappearance of an important generator of oxygen at depths of 20 to 60 metres where Zernov's ***Phyllophora*** field was situated. It has been estimated that the photosynthesis in this field in its unthreatened state produced up to two million cubic meters of oxygen per day (Zaitsev, 1992 (a)). Moreover, ***Phyllophora*** was the nucleus of a bottom community known as the ***Phyllophora*** biocoenosis which included up to 120 species of invertebrates and 50 species of fish. Many of these animals have evolved a protective dark red and reddish coloration and this has led to the concept of'***Phyllophora*** fauna'. With the disappearance of key species, the entire biocoenosis collapsed.

Similar changes have also taken place in the coastal zone. The large brown alga ***Cystoseira barbata,*** which is intolerant of eutrophication, has virtually disappeared. It is no longer found along the coast of Ukraine (except at Crimea) or Romania and has become scarce along the Bulgarian coast. ***Cystoseira*** is the keystone species of the ***Cystoseira*** biocoenosis, which included dozens of species of invertebrates and several species of fish.

The most damaging effects of man-made eutrophication for bottom animals (zoobenthos) was the appearance of zones with reduced (hypoxia) or no (anoxia) dissolved oxygen in the near-bottom layer of water.

Large-scale mortality of bottom-living animals was first recorded in the Black Sea in August-September 1973 in the north-west shelfacross an area of3,500km^2. Subsequently mass mortalities became an annual occurrence and the area of the north-west shelf over which they extended increased to 30,000 to 40,000 km^2 (Zaitsev, 1992b). It was established

that between 100 and 200 tons of bottom organisms died from a depletion of oxygen per square kilometre of shelf. In the period between 1973 and 1990 the loss of biomass amounted to 60 million tons of bottom-living animals including 5 million tons of fish, both young and adult, commercial and non-commercial species.

The death of vast quantities of benthic animals is not just a question of the disappearance of important commercial fish species, with the resulting economic losses. The environmental damage is also enormous and includes the consequences of the mass mortalities of filter-feeding organisms such as the mussel.

As to chemical pollution of the Black Sea, this kind of man-made influence is not a basin-scale phenomenon, but in some coastal areas (near so-called industrial hot spots) there are elevated concentrations of heavy metals. Some higher concentrations of the insecticide lindane were found in the Danube discharge zone but most samples were comparable with those in the Mediterranean.

For oil pollution, the Danube river accounts for 48% of the 110,000 tons of oil entering the Black Sea each year. Most of the remainder is introduced from land-based sources through inadequate waste treatment and poor handling of oil products. Concentrations of this pollutant in the surface layer of the western Black Sea is one order of magnitude higher than in the Mediterranean.

Bacterial pollution of coastal marine waters is connected with untreated sewage. In the Black Sea coastal region approximately 10.4 million people discharge an estimated 571 million mVyear of sewage into the Black Sea. As a result, there are regular beach closures in some Black Sea hot spots and increasingly frequent outbreaks of serious water-borne diseases such as cholera and hepatitis A. Not all Black Sea bathing waters are below standard, however.

The accidental introduction of harmful exotic species is a very specific kind of biological pollution. Because of its unpredictability, the involuntary introduction of species is one of the most serious man-made impacts. It can have considerable biological, ecological, economic and social repercussions.

The Black Sea has become home for a large number of alien marine organisms. Three of the most significant examples are ***Rapuna thomasiana*** from the Sea of Japan, the soft-shelled clam, ***Mya arenaria,*** from the Atlantic Ocean and the exotic ctenophore, ***Mnemiopsis leidyi.***

Rapuna thomasiana, a large gastropod mollusc and notorious predator that feeds on oysters, mussels and other bivalve molluscs, was recorded in Novorossiysk Bay in 1946. In the 1950s it depleted the Gudauta oyster bank on the Caucasian shelf and began to feed on the mussels on the Crimean shelf and in Bulgarian waters. In the 1970s it

penetrated the Sea of Marmara. At first the only factor limiting the ***Rapuna*** population growth was the local souvenir industry. In the 1980s it was discovered that there is a demand for ***Rapuna*** meat on the Asian market. Massive commercial catches of the ***Rapuna*** along the Turkish and Bulgarian coasts were undertaken and after several years the number of this snail diminished to such a level that its commercial fishing became unprofitable.

Mya arenaria, a large bivalve mollusc, was recorded in 1966 on the Odessa Gulf. It became widespread on the Black Sea shelf, especially at low salinities and out-competed the local small bivalve ***Lentidium mediterraneum,*** which had been an important food source for the fry of many species of fish. Today, ***Lentidium***\habitat is restricted to a narrow coastal strip. In the 1970s, ***Mya*** biomass became greatly diminished because of hypoxia.

The 1980s was the golden age of ***Mnemiopsis leidyi.*** Now it continues to be a dominant species in the pelagic zone but its population seems to be in decline, at least in the north-western Black Sea, where commercial catches of anchovy were seen to be gradually increasing over 1995 and 1996. The population of the anchovy-eating bird shearwater, ***Puffinuspuffinus,*** has also increased since 1994.

At the edge of the sea, different man-made changes occur. This coastline zone is very sensitive to human impact. It has been suggested that as a narrow peripheral strip whose edge represents only an infinitesimal part of the total surface of the Black Sea, the coastal zone may be ignored when considering measures to protect the sea's living resources. But such a view is mistaken for two fundamental reasons. Firstly, the narrow coastal zone is not peripheral but a focal point containing the highest densities and the greatest variety of organisms and is home to biological processes of critical importance. Secondly, the coastal zone is the part of the marine environment where people come into direct contact with the sea and where the health of people is directly dependent on the health of the sea.

During the last 20 to 30 years the Black Sea coastal zone has been affected by a number of direct and indirect anthropogenic influences which have produced different responses from the ecosystem.

Large scale anti-landslide and coast protection works have been undertaken in the Odessa area and as a result destructive landslides have been halted, the beach area increased ten-fold and a recreational infrastructure has been developed. However, these measures have created stagnant zones in the sea where the sand became silted and the bottom biocoenoses fundamentally changed.

The construction of dams for hydropower stations on several Caucasian rivers has led to a sharp reduction in solid discharges and an acceleration of coastal erosion processes.

Unmanaged exploitation of the Black Sea biological resources is another kind of man-made impact on its ecosystem. This happened to the largest flatfish, the turbot, ***Psetta maeotica,*** whose commercial fishing was prohibited in Russia and Ukraine in the 1980s. Overfishing was also the main reason for the sharp decline in sturgeon ***(Acipenseridae)*** populations and four species of fishes have been included in the Ukrainian Red Data Book (1994) of endangered species.

In the 1950s the population of all three species of Black Sea cetaceans was estimated at one million individuals. By the middle of the 1960s their populations had dropped to 300,000 individuals as a result of an increase in catches. In 1966 an agreement was reached by the former USSR, Romania and Bulgaria to stop dolphin fishing and in 1983 it was stopped in Turkey. The present population of these mammals needs to be estimated, but according to visual observations it continues to decline. The Black Sea population of the monk seal, ***Monachus monachus,*** is about to become extinct. The major factor critical to its fate is not overcatching (this species is internationally protected) but the lack of adequate sites for reproduction on shore. This is a very careful and apprehensive animal which avoids populated and reconstructed coastal zones.

While overcoming these objective and subjective factors is a constituent part of the national and regional implementation of the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea, it is a vast spiritual problem as well as a practical one. Success depends to a considerable extent on the understanding, readiness and persuasion of the general public. For natural and especially for human reasons, the modern Black Sea has become a kind of sombre symbol of impacted marine areas in the world.

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