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IMPACTS OF NAVAL TRANSPORT DEVELOPMENT ON MARINE ECOSYSTEMS AND INVASIVE SPECIES PROBLEMS

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Abstract. The paper presents the consequences of naval transport development upon coastal ecosystems. As navigation is, as a rule, a transboundary activity, its ecological consequences will be pre-eminently transboundary. Taking into account the complexity of the problems linked to the impact of naval transport upon marine environment, the author mentions losses of habitats – losses of biodiversity by building harbours — and discusses, based on the examples from the Black sea, the problem of invasive species penetrated via ships' ballast water or attached to ships' hulls. Having in view the problem of invasive species which is a global, urgent and real one, the author points out the necessity for a better co-operation among the scientists from the South-Eastern Europe and for establishing a working group on the invasive species in the framework of B.EN.A.

Keywords: invasive species, the Black sea, biodiversity, ballast water, maritime transport.

ON THE COMPLEXITY OF MARITIME TRANSPORT AND ITS POTENTIAL IMPACT ON THE ENVIRONMENT

It is well known that maritime transport represents an economic activity of great complexity having a high potential of negative impacts on marine ecosystems. Rapidly increasing world trade means a huge development of maritime navigation. As navigation is a transboundary activity, its consequences will be pre-eminently transboundary.

Naval transport development (which should be a sustainable one) means not only the intensification of the exchange between the harbours all over the world by using larger, faster ships that complete their voyages in ever shorter time. It also represents the industrial and economic development of the coastal zones as a consequence of building ships, industrialisation, coastal urbanisation, accompanied by all their impacts on the environment, building harbours with their facilities, including canal digging as well as the diversification of marine activities (fishing, drilling, etc.) (Fig. 1).

ON THE ECOLOGICAL CONSEQUENCES OF NAVAL TRANSPORT DEVELOPMENT

Naval transport development can trigger numerous ecological changes like a chain reaction or web reaction. The ultimate target of the chain reactions or the final

link of modifications represents the condition for biodiversity and bioproductivity: state, distribution and abundance of aquatic organisms. Some of the chains strongly react, but for a short period; for example, enlarging or building new harbours. Other chains act permanently having increasing potential effects; for example, shipping activities with their high potential for the translocation of organisms arise one of the most important problems in present days – the problem of invasive species, which is a global, urgent and real one.

By building harbours and port facilities, habitats and their dwellers will be dramatically changed as some of them will disappear forever. Large areas in the coastal shallow water are filled and at the same time the limited ecosystems will be buried and the larger ones will be affected at their contact zones with hydrotechnical works:

- building harbours → loss of habitats → loss of biodiversity;
- building harbours → changes of the coastline → changing patterns of water circulation and sediment distribution → changes in the life conditions of organisms → changes in the qualitative and quantitative structure of the populations → changes in bioproductivity.

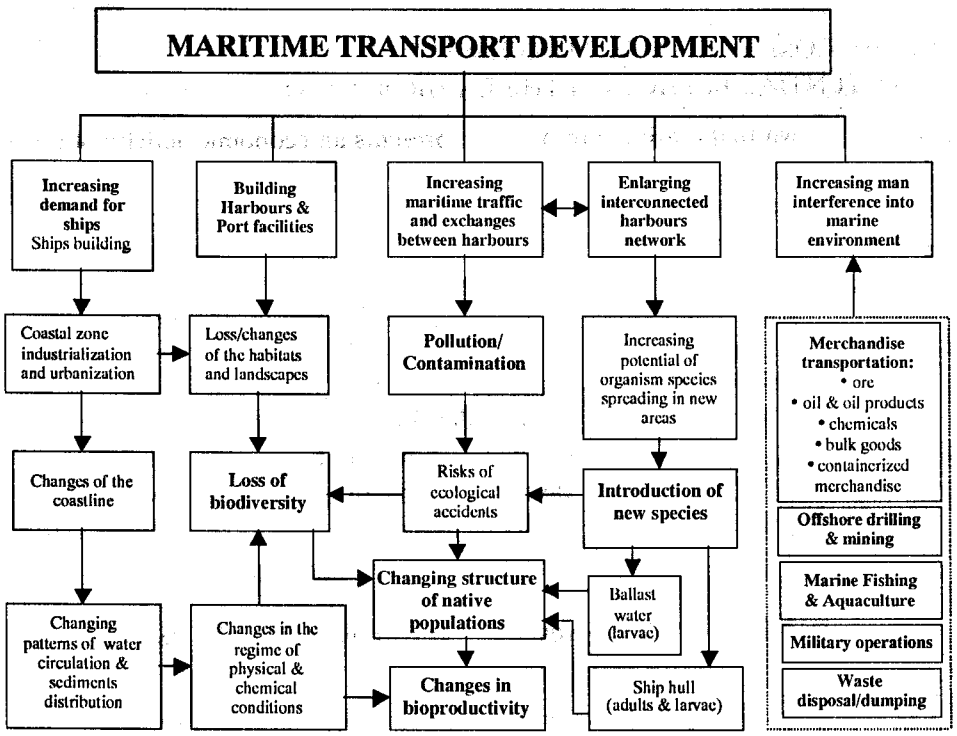

Fig. 1. Main ecological chain changes triggered by the development of maritime transport

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For example, by building the new port Constanta – South Agigea at the Romanian coast of the Black sea, the habitats of the mid-littoral medium-coarse sands and infralittoral rocky bottoms became land of the harbour. The extinction of the unique community dominated by the polycaeta *Ophelia bicornis* and the bivalve *Donacilla cornea* populations, then the algal populations with their associated invertebrates and fishes represents one of the most important consequences at the Romanian coast by building harbours.

Invasive species penetrated via ships ballast water or attached to the ships hulls can have unforeseeable effects upon native biodiversity. In this respect the effects of opening of the Suez and Panama Channels upon translocation are very well known. Hundreds of examples of major ecological, economic and human health impacts across the globe can be mentioned. Changing biodiversity means ecological and economical risks as are, among others, disturbances in the structure and function of native ecosystems, changes in populations interactions (competition for resources – food, space, spawning area), losses of initial biodiversity (extinction or drastic reduction of the population size of native species), explosive development of harmful, toxic species, changes in habitat, genetic effects of indigenous species, losses in commercial fishing resources down to the collapse of fisheries, etc. Severe environmental, economic and health threats posed by harmful organisms carried in the ships ballast water have led to the large developments in science, engineering, shipping, law and other issues to the problem of introduced marine species and many disciplines are involved in their studies.

ON THE NEW SPECIES ACCIDENTALLY PENETRATED INTO THE BLACK SEA

As it is well known today, in the last decades in the Black sea have come some marine species originating beyond the Mediterranean sea, from Far-East seas or from the Atlantic ocean[1-5]. The immigrants are quite well studied and they are still under observation. However, our knowledge of the alien species is limited; usually our attention was oriented only toward the large body size forms. We do not know very well what is happening with microflora or microfauna and surprises can appear in the future.

Some immigrants have produced major disturbances in the structure and functioning of ecosystems[6]; there are known facts more or less understood. The most common hypotheses regarding the causes of accidental penetration of alien species imply naval transport. This way is mentioned also for the Ponto-Caspian species, largely distributed today in other aquatic basins. The development of maritime transport, a very important economic sector, comprises numerous activities forming a complex network of causes with consequences ending in two directions: loss of native species, accompanied by appearance of new, free, empty ecological niches, and increasing the potential of alien species penetration.

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What we want to underline is the possibility that the Black sea gates for exotic organisms – Aegean sea, Marmara sea and Bosphorous have been permanently open; along the time, when the Black sea was in a healthy ecological state, all the niches were occupied and the chances for new-comers to develop in the Black sea sustainable populations were at minimum. When the ecological conditions were drastically damaged as a consequence of pollution/eutrophication processes, the empty niches were ready to absorb new populations. Now, the Black sea environmental resistance is very weak.

Based on the dynamics of alien species accumulation into the Black sea (Fig. 2), we consider that the process could continue more or less rapid (Fig. 3); anyway, a more attentive checking is absolutely necessary.

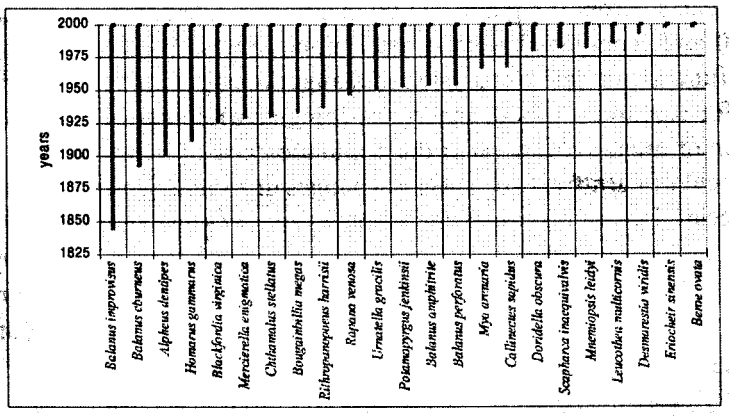

Fig. 2. Invasive species penetrated accidentally into the Black sea

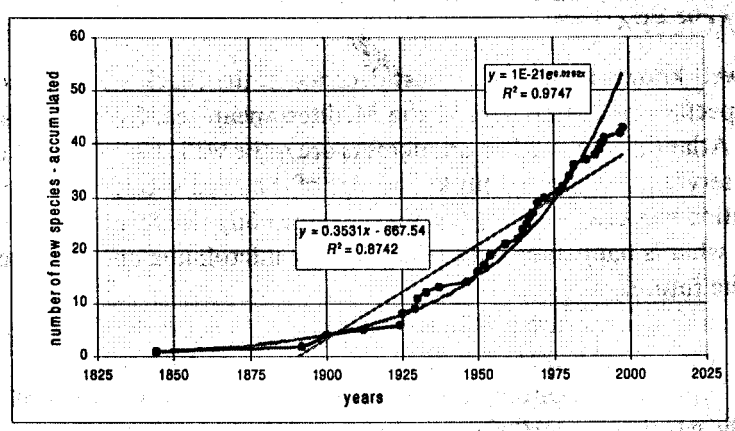

Fig. 3. Alien species accumulation in the Black sea – tendency

The scientific problems of alien species in the Black sea are still open. Which are the lessons we have learned from the stories of the Black sea as a receptor for new exotic species? This could be discussed in detail, but now we will summarise only the following:

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– the process of penetration is still open – attention to the toxic and harmful species;

– the impact of alien species is complex and unpredictable;

– species biodiversity monitoring is absolutely necessary, a special attention must be directed mostly to the proper monitoring of microflora and microfauna;

– there are necessary legal measures and regulations for limiting the invasive species;

– training human resources in biological taxonomy and systematics is of high priority.

The old generation of marine botanists and zoologists is getting diminished and to understand correctly the Black sea ecosystems and what must be done for its protection, we have to know deeper their biota only through young educated specialists – marine biologists.

MORE RESEARCH NEEDED FOR THE ASSESSMENT OF THE IMPACT OF NAVAL TRANSPORT ON THE MARINE ECOSYSTEMS

The problem of invasive species in the terrestrial and aquatic ecosystems, although known and studied for a long time, will remain very important being at the same time global, urgent and real.

In the past few decades, the preoccupation of the researchers for the study of exotic species penetrated into several aquatic basins as well as for limiting the risks caused by the involuntary presence of these species in the host ecosystems has increased permanently. Specialists have drawn attention to the potential danger represented by the transport of new species into various marine zones and this fact has found a large audience, for instance, in the action of International Council for the Exploration of the Sea (ICES), International Maritime Organisation (IMO) and International Oceanographic Commission (IOC), the establishment of scientific groups studying the biological invasion, developing special programs (Global Invasive Species Program – GISP), editing new scientific journals (Biological Invasions – Kluwer Academic Publishers) or decreeing laws (President Clinton's 1999 Executive Order 13112 on Invasive Species). The objectives of GIPS[7] are particularly eloquent to demonstrate the necessity of new tools and approaches for dealing with invasive species; among these objective we have to mention the following:

– synthesizing current knowledge on invasive species;

– current status of invasive species;

– new methods of assessing their changing distributions and abundance;

– how society views and values invasive species;

– how global change will impact the success of invaders;

– development of new tools and approaches for dealing with invasives;

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– development of a global early warning system for the most serious invasive species;

– analyses of the changing pathways of trades as they provide vectors for invasive;

– developing risk analyses dealing with the introduction of a new biotic material;

– assessment of the best practices for management and control of invasives;

– educating the general public on the potential danger of invasive species;

– economic consequences of invasive species;

– legal and institutional frameworks for dealing with invasives.

South-Eastern European ecologists, facing the many challenges of the global problem of aquatic and terrestrial alien species introduction, should establish, in the framework of B.EN.A., a group of study after the example offered in Europe by the Baltic scientists (including Russian ones)[8,9]. Such a group can be affiliated to other international organizations, the problem of biological invasion being a global one, requiring a networking system to be solved. The aims of this group should include, among others, the following issues:

– developing both basic and applied biological invasions researches;

– studying the taxonomy, distribution and the life history of established alien species and species showing significant range expansions;

– researching community and ecosystem effects of alien species, including modelling of both community and ecosystems levels;

– developing hypothesis of the ecosystem resilience relative to the invasive species;

– developing an Internet based information system on exotic species;

– disseminating information on invasive species for decision-makers, governments and the general public, arising their awareness on the danger represented by the harmful species.

Discussion in organizing the South-Eastern European Group for Studying Alien Species (SEEGSAS) can be made in the near future through e-mail, the "Ovidius" University in Constanta (biologie@univ-ovidius.ro) being highly interested in this respect.

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