

МОРСЬКА ГІДРОБІОЛОГІЯ

УДК 543.31:574.633(262.5)

B.G. ALEKSANDROV

Odesa Branch A.O. Kovalevsky Institute of Biology of Southern Seas, National Academy of Sciences of Ukraine
37, Pushkinskaya St., Odesa 65125

MODERN TENDENCIES OF THE BLACK SEA BIOLOGICAL POLLUTION

The results of the analysis of the reasons for increasing cases of registration of alien organisms in the Black Sea are given. The quantitative characteristics of them for the past 150 years have been determined. Data is represented on the biological pollution of territorial waters of the six Black Sea countries.

Key words: biological pollution, aquatic ecosystems, invasion, Black Sea, prognosis

The motivation to write this overview was the rising scientific interest from the beginning of the new millennium to the problem of biological pollution of aquatic ecosystems when conducting a number of international programs under the auspices of the United Nations, European Union, Global Environmental Fund: "GloBallast", "GISP", "ALARM" etc., the publication of large summaries [8, 12,14]; creation of regional and international data bases on alien species (DAISIE, NOBANIS etc.); elaboration of an international system of controlling the biological pollution process (MARPOL, EU Marine Strategy Framework Directive) and consequently an increase in the number of publications on alien species of Black Sea countries.

The Secretariat of the International Commission for Protection of the Black Sea Against Pollution (BSC) began to complete a register of alien species marking their first registration in national waters.

The aim of this work is to analyze the main reasons for increasing cases of registry of alien species in the Black Sea and to assess the tendencies of this process in the near future.

Materials and Methods

The data for analysis of the work on Black Sea alien species was the information collated and summarized by the author for the BSC on the basis of numerous publications and BSC data [3]. At present experts of the Advisory Group on conservation of biological diversity of BSC are working and checking the preliminary list of the Black Sea alien species.

Results of Studies and Discussion

The analysis of the main reasons for the high increase in cases of registration of cases of invasion of new aquatic organisms in the Black Sea shows three factors which have been widely discussed in scientific publications and mass media: 1) the increase in the volume of marine cargo transport, 2) the global climate change, 3) the development of hydroecological investigations.

The increase in marine transport of cargoes. One of the main conclusions of the UNDP, GEF, IMO "GloBallast" projects was the evidence that the main reason which has led to a rise in biological pollution in different areas of the World Ocean was the increase in the volume of transporting cargoes by ships carrying water ballast. Besides, the EC "ALARM" project has shown the high risk of invasion of alien species through transport corridors. This was the reason for the invasion recently into the Black Sea of the large crustacean *Saduria entomon* [7] from the Baltic Sea. It is quite possible that in this way the Chinese mitten crab *Eriocheir sinensis* appeared in the Black Sea which was first registered in the Baltic Sea in 1930s and in the Black Sea in 1997 [8], and later from 1995 regularly recorded in the Hungarian part of the Danube [11].

The global climate change. The tendency for the increasing temperature of sea water due to the global climatic change in the past decade is mostly linked with the increasing invasion of Mediterranean species into the Black Sea, as the jellyfish, *Chrysaora hysoscella* and the comb jelly, *Bolinopsis vitrea* [10]. The consequences of Black Sea climatic changes on marine organisms were discussed at the 38th meeting of the Mediterranean Science Commission CIESM (Turkey: Trabzon, 3-6 June 2009). Analysis of the hydrological changes has shown that due to the geographic position of the Black Sea, seasonal changes in its temperature and salinity vary more than the inter annual from the beginning of the new millennium changes [9] which does not allow to explain the intensification of biological pollution from that point.

The development of hydroecological investigations. The increase in cases of registration of new Black Sea species is also linked with the development of studies in the fields of systematic and biology of aquatic organisms. On the one hand, this became evident after a more careful study of ordinary mass species. In plankton, *Acartia tonsa* [1] was encountered resembling *A. clausi*, in benthos – the Atlantic *Mytilus edulis* and the Pacific *M. trossulus* mussels [18], differing from the Black Sea *M. galloprovincialis* only on careful examination by specialists. The analysis of live not fixed in formaldehyde samples allowed to study thoroughly the composition of the unarmored dinophyte algae in plankton among which 13 aliens [17] were revealed. On the other hand, the study of a less known group of marine fungi, and minute Harpacticoida crustaceans also led to the increase in new species encountered in the Black Sea: 13 Harpacticoida species [17] and 12 species of marine fungi [6] some of which can be attributed to cryptogenic species.

The problem of the study of alien species is challenging for all Black Sea countries. Corresponding overviews for analysis of biological pollution in national waters were published practically in all Black Sea countries [2, 13, 15, 16, 17]. Special attention was paid to the alien species after the last edition of the Transboundary Diagnostic Analysis [3] issued by BSC. In Annex 6 of that document there is a list of 217 species with their origin, path of possible invasion, and first registration in the Black Sea. The list was revised and supplemented by the Advisory Group on conservation of biological diversity. Also additions of new aliens encountered till the present have been given. Information was added on cases of the first registration of exotic species in the national waters of the Black Sea countries.

In contrast to the TDA-2007 among the aliens neither terrestrial mammals nor many species of higher semi aquatic vegetation were taken into consideration. Fresh water and brackish species were recorded only in areas of river deltas where regularly there occurred a mixing of river and sea waters.

By May 2010 the general list of Black Sea aliens numbered 254 species. Moreover, 20,5% were registered in the free territorial waters of Bulgaria, 6,3% – Georgia, 39,0% – Romania, 12,6% – Russia, 18,8% – Turkey, 66,5% – Ukraine which is attributed to the shelf area, length of the shore line and level of study of the aquatic ecosystems. An average 63±7% of species diversity of aliens occurs in macrobenthos among which crustaceans and molluscs dominate. A marked twofold increase in aliens (exceeding 20 new species every decade) was observed after 1960 due to eutrophication and loss of stability in the Black Sea ecosystem, and changes in species composition when transferring to a new trophic status. The following twofold increase in the number of registered aliens (exceeding 50 every decade) was observed after 1990 (Fig. 1).

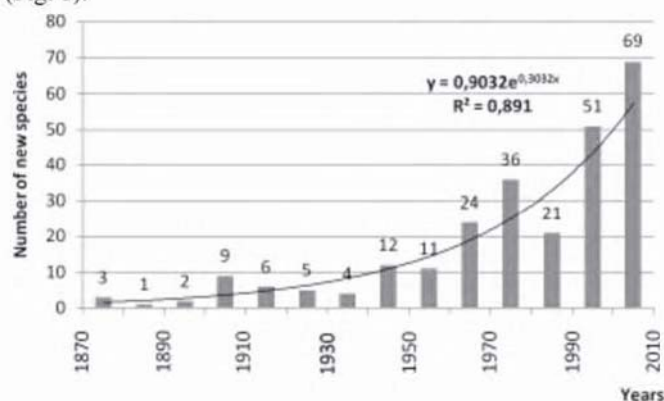


Fig. 1. The long period dynamics of cases of registration of new alien species in the Black and the Azov seas

One of the first attempts to make a wide scale prognosis of invasion of non-indigenous species was realized for the coastal zone of North America where 298 species were registered [4]. It was thus used the accumulative abundance of alien species for the selected time intervals. As to the territorial waters of Romania and the Black Sea a similar approach was used, however, for a limited amount of alien species from 50 [5] to 115 [16]. The use of this type of approximation and the data on hand allowed describing the

existing trend in biological pollution of the Black Sea (Fig.1). This can be used for prognosis of new invasions for future consideration of the development of marine transport and hydrobiological studies. Taking into consideration the alien species accumulation for each of the studied decades, the prognostic equation in Fig. 1 will be changed to $y=2,775 \cdot e^{0,331x}$ ($R^2=0,977$).

1. *Trends of aquatic alien species invasion in Ukraine* / B. Aleksandrov, A. Boltachev, T. Kharchenko [et al.] // Aquatic Invasions, The European Journal of Applied Research on Biological Invasions in Aquatic Ecosystems. – 2007. – Vol. 2, Is. 3. – P. 215–242.
2. *Acartia tonsa: a species new for the Black Sea fauna* / G. Belmonte, M.G. Mazzocchi, I.Yu. Prusova [et al.] // Hydrobiologia. – 1994. – Vol. 292/293. – P. 9–15.
3. *Rilov G. Biological Invasions in Marine Ecosystems. Ecological Management, and Geographic Perspectives* / Rilov G., Crooks J.A. // Ecological Studies (Germany). – 2008. – Vol. 204, Ch. 30. – 642 p.
4. *Black Sea transboundary diagnostic analysis. May, 2007 (Draft)*. – 227 p. – http://www.iwlearn.net/iw-projects/Fsp_112799468895/iwsubproject.2009-05-08.8405514527/reports/black-sea-transboundary-diagnostic-analysis-2007/view.
5. *Alien species on the coasts of Turkey* / M.E. Çinar, M. Bilecenoğlu, B. Öztürk [et al.] // Mediterranean Marine Science. – 2006. – Vol. 6, N 2. – P. 116–146.
6. *Gomoiu M.T. Impacts of naval transport development on marine ecosystems and invasive species problems* / M. T. Gomoiu // J. Envir. Prot. Ecology. – 2001. – Vol. 2, N 2. – P. 475–481.
7. *Leppakoski E. Invasive aquatic species of Europe – distribution, impact and management* / E. Leppakoski, S. Gollasch, S. Olenin. – Dordrecht (Netherlands): Kluwer Academic Publ., 2002. – 583 p.
8. *Ruiz G.M. Invasive species: vectors and management strategies* / Ruiz, G.M. Carlton J.T. – Washington: Island Press Publ., 2003. – 520 p.
9. *Kopytina N.I. Higher marine fungi of pelagic and benthic biotopes of the northwestern area of the Black Sea* / N.I. Kopytina // Thesis for the degree of Candidate of Biol. Sci. by specialty / 03.00.17 “Hydrobiology”. – Sevastopol, 2008. – 22 p. (in Russian).
10. *Kvach Yu. First report of Saduria (Mesidotea) entomon (Linnaeus, 1758) (Isopoda: Chaetiliidae) in the Black Sea* / Yu. Kvach // Aquatic Invasions. – 2009. – Vol. 4, Is. 2. – P. 393–395.
11. *Minicheva G. The response of autotrophic communities of the northwestern Black Sea to the variability of climatic factors* / G. Minicheva, V. Bolshakov, A. Zotov // J. Environ. Protection and Ecology. – 2010.
12. *Öztürk B. On the alien species in the Mediterranean and the Black Sea* / B. Öztürk // General Fisheries Commission for the Mediterranean. – Scientific Advisory Committee: 12 Session. – Budva: Montenegro, 2010. – FAO: Rome. – 147 p.
13. *Recent ecosystem trends along the Bulgarian Black Sea coast* / K. Prodanov, S. Moncheva, A. Konsulov [et al.] // Proceeding of Institute of Oceanology-BAS (Varna). – 2001. – Vol. 3. – P. 110–127.
14. *Puky M. Distribution and conservation status of Decapod (Decapoda) species in Hungary* / Puky M., Schad P. // Acta Biol. Debr. Oocol. Hung. – 2006. – N 14. – P. 195–204.
15. *Invasion of coastal marine communities in North America: apparent patterns, processes, and biases* / G.M. Ruiz, P.W. Fofonoff, J.T. Carlton [et al.] // Annu. Rev. Ecol. Syst. – 2000. – Vol. 31. – P. 481–531.
16. *Shiganova T.A. Non-indigenous species in the ecosystems of internal southern seas of Eurasia* / T.A. Shiganova // Thesis for the degree of Doctor of Biol. Sci. by specialty. 03.00.18 “Hydrobiology”. Institute of Oceanology, Academia of Sci. of Russia. – Moscow, 2008. – 56 p.
17. *Skolka M. Specii invasive in Marea Neagră. Impactul ecologic al pătrunderii de noi specii in ecosistemele avatice* / Skolka M., Gomoiu M.T. – Constanta: Ovidius University Press, 2004. – 185 p.
18. *Zaytsev Yu.P. Base biological investigations of Odessa sea port (August-December, 2001): final report* / Yu.P. Zaytsev, B.G. Aleksandrov, N.A. Berlinskiy [et al.] // Series of monographs of the Odessa demonstration center of the GloBallast program. – Odessa, 2004. – Vol. 7. – 171 p.

Б.Г. Александров

Одеська філія Інституту біології південних морів НАН України

СУЧАСНІ ТЕНДЕНЦІЇ БІОЛОГІЧНОГО ЗАБРУДНЕННЯ ЧОРНОГО МОРЯ

Приведені результати аналізу причин посилення випадків реєстрації чужорідних організмів у Чорному морі. Визначені кількісні данні цього явища за останні 150 років. Представлена характеристика біологічного забруднення територіальних вод 6 чорноморських країн.

Ключові слова: біологічне забруднення, водні екосистеми, вторгнення, Чорне море, прогноз

Б.Г. Александров

Одесский филиал Института биологии южных морей НАН Украины

СОВРЕМАННЫЕ ТЕНДЕНЦИИ БИОЛОГИЧЕСКОГО ЗАГРЯЗНЕНИЯ ЧЕРНОГО МОРЯ

Приведены результаты анализа причин усиления случаев регистрации чужеродных организмов в Черном море. Определены количественные характеристики данного явления за последние 150 лет. Представлена характеристика биологического загрязнения территориальных вод 6 черноморских стран.

Ключевые слова: биологическое загрязнение, водные экосистемы, вторжение, Черное море, прогноз