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Abstract

The scientific evidence accumulated on the migrations that zooplankton make from the Red Sea to the Mediterranean through the Suez Canal was analyzed. A conclusion was reached that some of the zooplankton, e.g. copepods Pontellina plumata, Calocalanus pavoninus, Arietellus pavoninus, reported in the literature as immigrants from the Red Sea, may in fact come from the Atlantic. The assumption is based on the fact that these organisms occur both in the eastern and the western Mediterranean. They inhabit the Atlantic Ocean, the Gibraltar Strait and the adjoining seawater, but are absent from the Suez Canal.

It can be presumed that some zooplankton species widespread in the world ocean entered the Mediterranean Sea through the Gibraltar Strait and the Suez Canal.

Keywords: Lessepsian immigrations; Copepods; Suez Canal; Gibraltar Strait; Mediterranean Sea; Red Sea.

Introduction

The role that migrations of algae and animals from the Red Sea play in the formation of the flora and fauna of the Mediterranean Sea has been repeatedly discussed. General conclusions were presented by POR (1978), FURNESTIN (1979), ZENETOS *et al.* (2005), GALIL (2006), LAKKIS (1998). According to POR (1978), the Mediterranean Sea harboured 204 species of Red Sea algae and animals known as Lessepsian immigrants (after Lesseps, the author of the project on construction of the Suez Canal). Of these,128 species were highly possibly immigrants. However, while aware that the available knowledge was incomplete, POR (1978) presumed that in the Mediterranean Sea about 500 species might be immigrants from the Red Sea. More recently (LAKKIS, 1998), the number of Red Sea organisms that had immigrated into the Mediterranean Sea was determined as 300 species, that is 26% of the species diversity in the Levantine basin. Ongoing investigations in the Mediterranean Sea have yielded more data about increasing fauna diversity in general and Lessepsian migrants in particular. For example, in the eastern Mediterranean near the Turkish shore, more than 30 copepods have been registered as new for the area; presumably many of them are Lessepsian migrants (KOVALEV *et al.* 2002).

Data on alien species in the Mediterranean Sea belonging to all groups of animals and plants including Lessepsian immigrants

of different levels of probability are summarized in a paper by ZENETOS *et al.* (2005), according to which 963 alien species are listed in the Mediterranean Sea. However, ZENETOS *et al.* (2005) remark that the species names of some species are probably confused with those of other species noted. On the other hand in their opinion, the number of alien species could be underestimated due to poor knowledge of the systematics of some groups.

The recent scientific evidence about distribution of the presumed Lessepsian immigrants in the world ocean and in the Mediterranean Sea gives a reason for revising some of the species as originating from the Levantine basin (KOVALEV, 1991; LAKKIS, 1998). Taking some zooplankton organisms as an example, this paper intends to prove that such a revision is timely and essential.

Materials and Methods

The present contribution is mainly based on data from the literature, including of works of the Institute of Biology of the Southern Seas. All investigators used different planktonic nets. However, this was practicable, given our aim.

Results

Zooplankton that entered the Mediterranean Sea through the Suez Canal are relatively few. Seven tintinnids (*Tintinnopsis aperta, T. dadayi, T. gracilis, T. mortensenii, T. tocantinensis, Codonelopsis bulbulosus, Metacilis annulifera*), three copepods (*Acartia centrura, Calanopia elliptica, C. media*) are regarded as exotic with high probability (POR, 1978). These organisms were reported from the seawater adjoining the mouth of the canal and from the narrow coastal seawater area of Israel. LAKKIS (1998) added more tintinnids to the list - *Tintinnopsis compressa, Epilocylis reticulatea, Codonaria* sp. and *Steenstruricela* sp. Other zooplankton that immigrated into the Mediterranean through the Suez Canal are the copepods, *Arietellus pavoninus* (MORAITOU-APOSTOLOPOULOU, 1969), *Labidocera madurae, L. detruncata, L. pavo, L. agilis, Pontellina plumata, Acartia fossae* (LAKKIS, 1981, 1998), *Euchaeta concinna* (Casanova, 1973), *Paracalanus crassirostris* and *Calocalanus pavoninus* (GREZE *et al.*, 1982)*, Centropages furcatus* (RAZOULS *et al.*, 2007); 11 medusae, for example, *Laodicea fijiana, Euphysora bigelowi, Turritopsis nutricula* and *Rhopilema nomadica*; the salp, *Salpa cylindrica*, and the chaetognath, *Sagitta neglecta* (FURNESTIN, 1979, LAKKIS, 1998).

It can be supposed, however, that for some of the cited species, primarily those widespread in the open oceanic waters of the world ocean, the fact of immigration through the Suez Canal is questionable. For example, *Pontellina plumata* occurs all over the Mediterranean Sea (KOVALEV & SHMELEVA, 1982), in the temperate Atlantic (ROSE, 1933) and, in particular, in the seawater close to the Gibraltar Strait (VIVES, 1982). *Calocalanus pavoninus* is abundantly found both in the eastern and in the western Mediterranean Sea and at both ends of the Gibraltar Strait – in the Mediterranean and in the Atlantic sectors (VIVES, 1982, GREZE *et al.*, 1985). Copepods of this species were also found in samples collected in the Alboranean Sea during the 90th expedition of the RV Akademik Kovalevsky in 1980, and are usual for the tropical and subtropical Atlantic Ocean (GORDEEVA & SHMELEVA, 1974, GREZE *et al.*, 1984). Another inhabitant of the tropical Atlantic is *Arietellus pavoninus* (GORDEEVA & SHMELEVA, 1974), also found in the seawater around the Canary Islands (VIVES, 1982). These species are also known in the Indian Ocean (RAZOULS & DE BOVEE, 1998). Therefore it is only reasonable to suggest that *Pontellina plumata, Calocalanus pavoninus,* and *Arietellus pavoninus* immigrated from the Atlantic into the Mediterranean Sea through the Gibraltar Strait, especially in consideration of the fact that these open-sea species have never been

registered in the Suez Canal (POR, 1978). Even assuming that copepods from the Indian Ocean were accidentally brought with the ballast water of a ship, it is unlikely that their acclimation would be a success. The insignificant numbers of the low-motile organisms and their fast dispersion over the unusual environment with turbulent seawater make their mass reproduction and therefore the formation of a viable population almost impossible. Other above-cited zooplankton might have actually penetrated through the Suez Canal. However, the absence of scientific evidence of their occurrence in the Suez Canal and the scarcity of scientific literature on their distribution over the World Ocean prevents the makingof a definite statement.

Thus, the presently available scientific evidence suggests that the holoplankton accidentally transferred from the Red Sea contribute a minor share to the plankton zoocenosis of the Mediterranean Sea. Only combined with larvae of sea-bottom invertebrates and fish, do the Red sea immigrants make up a significant component of the pelagic community in the coastal seawater of the eastern Mediterranean; moreover, not all of these species may be found in the open sea and the registered findings are rare.

Discussion

While connecting the Red and the Mediterranean seas, the Suez Canal is also a geomorphological and hydrological barrier that impedes immigration of marine organisms from the open Indian Ocean and the Red Sea into the Mediterranean. In this context two factors are of special significance – very saline seawater and the shallowness of the canal. In Lake Great Bitter which lies along the canal the salinity is estimated 68-80‰ near the bottom and 50-52‰ on the surface, which is fatal to the majority of Red Sea organisms moving towards the Mediterranean Sea. Therefore *Pontellina plumata, Calocalanus pavoninus* and *Arietellus pavoninus,* the prevalent species in the world ocean and in the Atlantic sector close to Gibraltar, might have entered the Mediterranean through the Gibraltar Strait (KOVALEV, 1991; LAKKIS, 1998, (RAZOULS *et al.*, 2007).

The route through the Suez Canal was usual for near-shore immigrant species. Brought into the Mediterranean with the along-shore current originating from the mouth of the canal, they inhabit the coastal seawaters of Israel, Lebanon and Syria (POR, 1978; LAKKIS, 1998).

As the salt covering the bottom of Lake Great Bitter dissolves, the salinity of the water decreases to 45-46‰ near the bottom and to 43-44‰ on the surface. More than 1000 algae and animals occur in the canal and in lakes nearby (POR, 1978). At the same time, the shallowness and salinity of the Suez Canal do not permit holoplankton from the open Red Sea to enter the canal and to expand further into the Mediterranean Sea (POR, 1978).

During the 1960s and the 1980s the canal was deepened and broadened. This invited a larger influx from the Red Sea into the Mediterranean. Besides, construction of the Aswan dam reduced influx from the Nile which made the seawater near Port Said more saline; as a result immigration of Red Sea organisms into the Mediterranean Sea increased. By 1970 the number of non-native species that had immigrated for the previous forty years had increased 9-fold compared with the earlier six-decade period (GALIL, 2006). It is reasonable to expect that in future plankton organisms, mostly neritic, will be among immigrants.

Conclusion

Red Sea species play an important role in formation of the flora and fauna of the eastern Mediterranean, especially along the southeastern coast. After the dredging and widening of the Suez Canal and the construction of the Aswan dam that regulates the Nile inflow, the significance of Red Sea immigrant organisms has increased.

All information about further migration from the Red Sea into the Mediterranean should be thoroughly checked; studying the distribution of those species over the world ocean - the tropical Atlantic in particular – from which they can be transferred with a current into the Gibraltar Strait and into the Mediterranean Sea, may shed more light on the topic. It is very likely that some widespread species would enter the Mediterranean through the Gibraltar Strait and the Suez Canal.

References

CASANOVA, J., 1973. Pénétration du copépode *Euchaeta concinna dana* en Méditerranée orientale par le canal de Suez. – *Rapports et Procès-Verbaux des Réunions. Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée, 21. – f. 8.:513-514.*

FURNESTIN, M.L., 1979. Aspects of the zoogeography of the mediterranean plankton 191-254. In: *Zoogeography and diversity of plankton.* Van der Spoel & A.C. Pierot-Bults.(Eds.), - Utrecht: Bunge Science Publications.

GALIL B.S., 2006. The marine caravan – the Suez Canal and the Erythre: an invasion. In: Gollasch, B. Galil, A Cohen. Bridging divides: maritime canals as invasion corridors. Springer (Monographie Biological, 83.). Part 4: The Suez Canal. pp. 207-300.

GORDEEVA, K.T. & SHMELEVA A.A., 1974. Pelagic copepods of the tropical Atlantic and the distribution of their mass species. The species composition and the distribution of oceanic plankton (ed. K.V. Beklemishev). – Moscow, Nauka Publishing House: 109-143 (in Russian).

GREZE, V.N., PAVLOVA, E.V., SHMELEVA, A.A. & DELALO, E.P. 1982. Zooplankton of the eastern Mediterranean and its quantitative distribution. *Ecologia Morya*, 8:37-46 (in Russian).

GREZE, V.N., (Ed.), 1984. *The bioproduction system of a large-scale oceanic gyre* - Kiev, Naukova Dumka Publishing House. p. 264 (in Russian).

GREZE, V. N., KOVALEV, A.V., BALDINA, E. P., BILEVA, O.K. & SHMELEVA, A.A., 1985. Zooplankton transfer through the Gibraltar Strait and peculiarities of its taxonomic composition and distribution in the adjacent areas. I*nvestigationes Pesquera.* 9, N 1: 3-13.

KOVALEV, A.V., 1991. The structure of zooplankton communities in the Atlantic and in the Mediterranean basin. Kiev, Naukova Dumka Publishing House: 141: (in Russian).

KOVALEV, A.V., SHMELEVA, A.A., 1982. The fauna of copepods (Copepoda) in the Mediterranean Sea. *Ekologiya Morya,* 8: 82-87 (in Russian).

KOVALEV, A.V., SHMELEVA, A.A., KIDEYS, A.E., UYSAL, Z., & UNAL, E., 2002. Fauna copepoda of the Mediterranean: replenishment of the new species. A*bstract 8th International Conference on Copepoda.* Taiwan, 84.

LAKKIS, S., 1981. Le plankton des eaux Libanaises (Med. orientale): caractéristiques biogéographiques. Presented at Ves Journées d'Etudes sur les Pollutions Marines en Méditerranée, Cagliari, (Italy), Octobre 9-13, 1980. In:Workshop on pollution of the Mediterranean, Cagliari, (Italy), October 9-13, 1980. Published by: CIESM, Monaco, 59-63.

LAKKIS, S., 1998. Biogeography of the plankton from Lebanese waters (eastern Mediterranean): the Levantine basin and species of Indo-Pacific origin. Pelagic biogeography. *ICOPB II. Proceedings of the 2nd International Conference*. A.C. Pierrot-Bults & S. Van der Spoel (Eds.): 233-238.

MORAITOU-APOSTOLOPOULOU, M., 1969. Sur la présence en Mer Egée d'*Arietellus pavoninus* copépode pélagique citée pour la premiére fois en Méditerranée. *Biologia Gallo-hellenica*, 2 (2): 189-191.

POR, F., 1978. Lessepsian Migration. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal, Berlin, Ecological Studies Springer_Verlag, 123 p.

RAZOULS, C., & DE BOVEE, F., 1998. Diversity and geographical distribution of pelagic copepoda. 3. - An overview and initial interpretation. *Annales de l'Institut Oceanographique* Paris, 74 (2): 139-200.

RAZOULS, C., DE BOVEE, F., KOUWENBERG J. & DESREUMAUX N., 2005-2007. Diversity and geographic distribution of marine planktonic copepods. See http://copepodes.obs-banguls.fr.

ROSE, M., 1933. Copépodes pélagiques. Paris: 374. (Fauna de France; vol. 26).

VIVES, F., 1982. Sur les copépodes de la région SINECA (parties nords et centrales). *Rapports et Procès-Verbaux des Réunions. Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée: 289-296.*

ZENETOS, A., CINAR, M.E., PANCUCCI-PAPADOPOULOU, M.A. et. al., 2005. Annotated list of marine alien species in the Mediterranean with a record of the worst invasive species. *Mediterranean Marine Science*, v. 6/2; 63-118.

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