Ecological significance of sea grass meadows (*Posidonia oceanica* (L.) Delile) in Bozyazı-Kızılliman marine protected area

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Abstract- In 1999, 16 X 12 n. miles coastal stretch was reserved for the protection of the Mediterranean monk seal (*Monachus monachus*) Cilician colony. The eastern most boundary of the endemic sea grass *Posidonia oceanica* that is the key species of the Mediterranean coastal marine ecosystem lies within this protected area. The high rate of colonization by Lessepsian immigrants in the area is another important feature. In this study, the area between Tasucu and Anamur was visually surveyed in order to determine the eastern border of the sea grass meadows. The findings of the surveys were than compared with the macrofauna compositions of the region obtained from bottom-trawl surveys to examine the percent occurrence of Lessepsian species in and outside the meadows. A sharp contrast between the percentages of Lessepsian immigrants present in and outside the meadow led us to suggest that *Posidonia oceanica* have a patriotic role in the Mediterranean against alien invasion.

Keywords-*Posidonia oceanica*, Lessepsian migration, Eastern Mediterranean

Introduction

Although the Mediterranean Sea is, in general, located in the temperate climate band, the northeastern Levant basin (36°-37°N) shows subtropical characteristics, with a 23.9°C mean annual surface temperature. In addition to its high temperature, the region is characterized by high salinity and extreme oligotrophy. Subtropical climate prevailing on the region has adverse influence on the species richness. As a consequence of its historical evolution, the Mediterranean was disconnected from the Indo-Pacific in Pliocene, which was the tropical entrance for the biota. For the modern Mediterranean Sea, the main source of the inhabiting species is the Atlantic Ocean (Tortonese, 1964), in which tropic originated species are very few. Today, the established species are thought to be, in fact, at the limit of their ecological tolerance and species richness is relatively low (Galil,1993).

The faunal composition of the Levant Sea has been drastically altered after two man-made events, the construction of the Suez Channel and the Aswan reservoir, after which the region was subject to invasion of new species from the Indo-Pacific. The immigrant species from the Indo-Pacific entering the Mediterranean through the Suez Channel has been studied by several authors (Ben-Tuvia, 1983; Spanier et al., 1989; Galil, 1993). Today, this new component of the ecosystem

attained to very high levels of importance in the fish community and related fishery (Oren, 1957; Ben-Tuvia, 1972; 1973; Ben-Yami and Glaser, 1974; Golani, 1992; Gücü, et al., 1994).

The fishes inhabiting the Mediterranean Sea, especially coastal zones, are well known on a global basis (Riedl, 1970; Whitehead et al., 1984; 1986a; 1986b; Fischer, 1987). The community structure of the western and the eastern parts are also well documented (Tortonese, 1964; Ben-Tuvia, 1971; Peres, 1985; Ros et al., 1985; Gorenshtain Galil and Lewinsohn, 1979; Spanier et al., 1989). However on a regional scale, there are discontinuities in the knowledge, especially on the flora and fauna of the shallow continental shelf area of the northeastern Levant Sea. There are only very few attempts to describe the faunal structure of this region (Akyuz, 1957).

In this study, the distribution of *Posidonia oceanica* along the Cilician Basin were investigated. Why Lessepsian immigrants are so successful in colonizing the eastern Mediterranean sea and who are the defenders of the native ecosystem were also questioned.

Materials and Methods

Data used in this work has been collected from 1980 to 2002 during various fisheries surveys carried out by the Middle East Technical University, Institute of Marine Sciences. Four different trawl boats have been used in different periods. The detailed enrollment of the 2000 trawl hauls are given in Table 1.

Table 1. List of trawl surveys

Date	Period	# of Stations	Area Coverage
May 1980 - Nov 1982	Monthly	7 subareas X 4 stations	East of Göksu river
Oct.1983 - Oct. 1984	Seasonal	180 stations	East of Cape Anamur
Apr.89	Single	40 stations	East of Göksu river
Nov.96	Single	20 stations	East of Göksu river
June 1996 - December 1999	Monthly	3 stations	Tırtar - Erdemli
Mayıs 1999 - Mayıs 2002	Seasonal	6 stations	Kızılliman Bozyazı

In addition to the trawl surveys, scuba dives has been carried out along the coast between Erdemli - Gazipasa to determine the eastern boundary of the *Posidonia oceanica* meadows distribution. Sea-grass shoot density, leaf size, the meadow's maximum depth, fragmentation, and percentage cover was monitored through regular scuba-dives in selected stations on vertical transects.

Results and Discussion

Results of the fisheries survey carried out between 1983 and 1984 were presented in Fig. 1. As may be recognized from the larger circles, the highest percentage biomass of Lessepsian fish species within the overall catch was observed in the Gulf of Iskenderun (Fig. 1). Their occurrence in the total catch decreased towards Mersin Bay and further towards the Goksu Delta. There was a drastic decline in the percentage biomass of Lessepsian fish species at the 33.5th

longitude, and to the west of this point percentages of the immigrants became almost negligible in the overall catch.

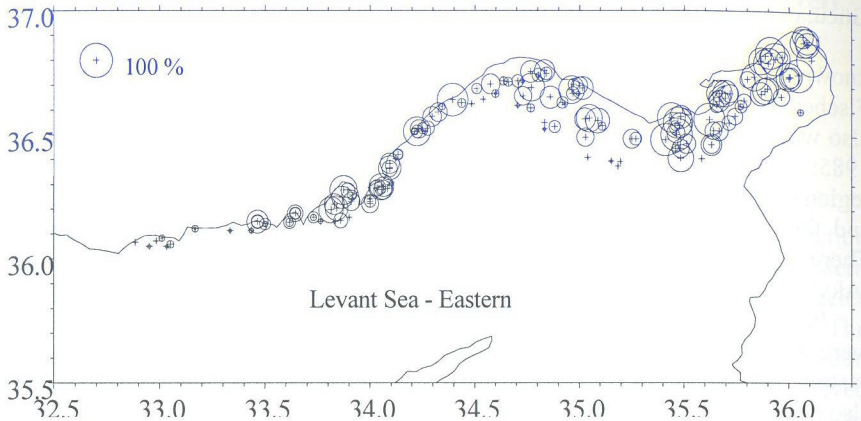

Fig. 1. Percentage biomass of Lessepsian fish species (O) in the total catch between 1983--1984. (+) indicates position of the trawl stations.

The scuba dives carried out in the region showed that the 33°26.476' E longitude is with the eastern boundary of *Posidonia oceanica* meadows in the Mediterranean Sea. It was also observed that up to this boundary the meadow extended down to 33 m (Fig. 2). Below 27m, getting closer to the lower limit, the matte of the meadow become less dense.

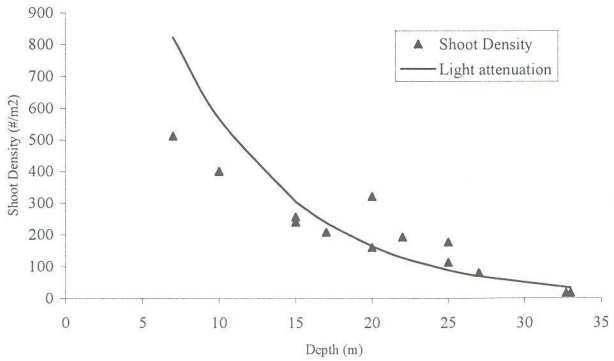

Fig. 2. Vertical profile of shoot density of the *Posidonia oceanica* and the lower limit of the meadow extension.

The distribution of the percentages in the Fig. also reflects that the higher percentages were observed in the shallow stations (25m>) while the deep stations (25m<) were nearly always presented by fewer Fig.s. As the percentage of Lessepsian species within the total fish species plotted against depth, the numbers

decreased with increasing depth (Fig. 3). In the same Fig. the stations on the west of 33.5th longitude were presented by a diamond symbol. Surprisingly, at the stations below 33 m depth only very low percentages of Lessepsian species were observed. In fact, this finding is quite consistent with the earlier statement proposed by Gucu and Bingel (1995) that the *Posidonia oceanica* plays patriotic role against invasive immigrants.

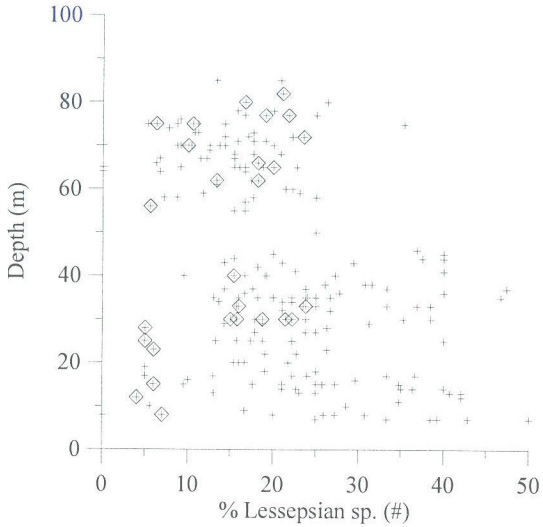

Fig. 3. The changes in the percentage number of Lessepsian fish species with relation to depth. (◊) indicate the stations west of 33.25th longitude where *Posidonia oceanica* meadows are present.

If an ecosystem subjected to excess fishing pressure, evidently it is prone to faunal instability. The influence of fishing intensity on the distribution of Lessepsian species is therefore examined analysing the trawl activity data given by Bingel (1987). In his work, trawling activity along the Turkish coast of Levant Sea over a two year period were presented in association with 8 regions. The trawling activity data and the % Lessepsian biomass were combined in Fig. 4. As the number of boats operating in an area increased, the percent Lessepsian biomass also increased. Following this trend, highest % immigrant fish biomass would be expected to occur in where the fishing activity is most intense (the right most of the Fig.). However, in the area where the intensity of the fishery was highest fish stocks were observed to be in near collapse and the Lessepsian organisms other than fish such as *Carybdis longicollis, Orathosquilla desmaresti*, which have no commercial value, and that are not included in this analysis, attained to very high percentages exceeding 65% of the total catch. Therefore, this data pair was disregarded during the statistical analysis. The remaining results showed a

statistically positive correlation between fishing intensity in a region and the colonisation success of the Lessepsian species.

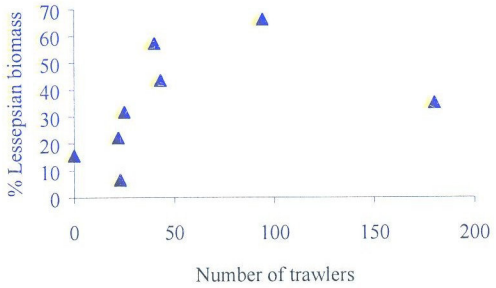

Fig. 4. Impact of fishing pressure on the distribution of Lessepsian fish species.

Another argument tested here was that if immigrant species colonised regions more successfully where native species diversity is relatively low. For this purpose, the number of native fish species in a station were plotted against the percentage of Lessepsian species (Fig. 5). Agreeably, both number of and the total biomass of the Lessepsian species showed an inverse correlation with the number of Mediterranean species. This finding implies that the new comers hardly colonize regions where the ecosystem integrity is healthy and thus, native species diversity is high. This again is in good agreement with the earlier statement that due to the distinctive hydrological features of the Levant Sea the native species are compulsive inhabitants that are at the limit of their ecological tolerance (Galil, 1993). This faunal deficiency might be one of the reasons why Lessepsian species were so successful in the Levant Sea (Gucu and Bingel, 1994).

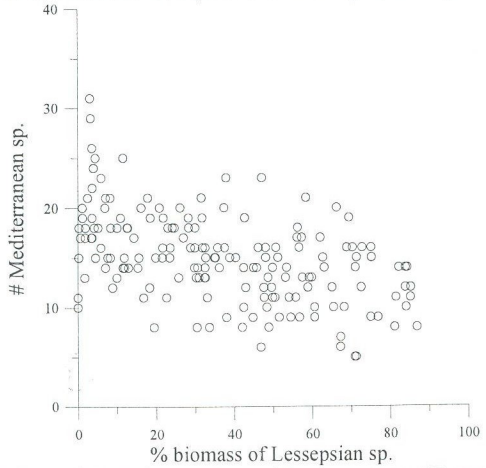

Fig. 5. The relation between native species number and the percentage of Lessepsian fish biomass

Conclusions

The results of the trawl surveys carried out in the region where the colonization rate of Lessepsian species is remarkably high, showed that these species are successful colonizers because :

1) The area is beyond the eastern border of *Posidonia oceanica* (33°26.476' E) in the Mediterranean, and therefore the meadows are absent.
2) The species diversity in the Levant Sea is intrinsically low. It is found that the success, to a certain extent, depends on the ecosystem richness and integrity.
3) The area has long been subjected to excess fishing pressure. Therefore besides its natural character, the near depletion of native species gives way to the easy establishment of new comers in emptied niches.

The findings therefore led us to conclude that as the key species of the near shore littoral zone *Posidonia oceanica* is the primary defender of the Mediterranean Sea against Lessepsian invasion. Another equally effective protector is the native biota of the Mediterranean herself. Unless the ecological integrity is intervened by anthropogenic means, such as excess fishery and eutrophication, sometimes reaching to levels of destruction, she always defends her native inhabitants.

References

Akyuz, E. Observations on the Iskenderun red mullet (*Mullus barbatus*) and its environment. Proc. Gen. Counc. Med., 4, pp.305-326, (1957).

Ben-Tuvia, A. Revised list of the Mediterranean fishes of Israel. Israel J. Zool. 20, pp 1-39. (1971).

Ben-Tuvia, A.Immigration of the fish through the Suez Canal. Fish. Bull. NOAA/NMFS, 76(1), pp. 245-249, (1972).

Ben-Tuvia, A. Man Made changes in the eastern Mediterranean Sea and their effect on the fishery resources. *Mar. Biol.,(*VBerl), **19**. pp.197-203, (1973).

Ben-Tuvia, A. The Mediterranean Sea, B. Biological aspects. In:KETCHUM, B. H., (Ed.) Ecosystems of the world. Estuarine and Enclosed seas. Elsevier Scien. Publ., New York, 26, pp.239-251, (1983).

Ben-Yami M. and T. GLASER. The invasion of *Saurida undosquamis* (RICHARDSON) into the Levant Basin - An example of biological effects of interoceanic canals. *Fish. Bull.* Vol **72** (2) pp. 359-373, (1974).

Bingel, F., Doğu Akdeniz'de kıyı balıkçılığı av alanlarında sayısal balıkçılık projesi kesin raporu. ODTÜ-DBE, Erdemli, 312 p. (1987).

Fischer, W., Bauchot M.L. and Schneider, M. Fiches FAO d'identification des especes pour les besoins de la peche. (Rev.1) Mediterranee et mer Noire. Rome, FAO, Vol.2: pp.761-1530 (1987).

Galil, S.B., Lessepsian migration. New findings on the foremost anthropogenic change in the Levant basin fauna. In: N.F.R. Della Croce, edt. Mediterranean Seas 2000. Instituto Scienze Ambientali Marine - Santa Margherita Ligure, pp 307-323, (1993).

Golani, D. Intensification of the influence of Red Sea species on eastern Mediterranean fishery. World Fisheries Congress May 3-8 1992, Athens, Greece. (1992).

Gorenshtain Galil, B. and Lewinsohn, C. A numerical analysis of zonation and faunal composition of the epibenthic macrofauna off the southern Mediterranean coast of Israel. *Rapp. Comm. int Mer Medit.* **25/26**, 4, pp 271-272, (1979).

Gücü A.C. And Bingel F. Trawlable species assemblages on the continental shelf of the Northeastern Levant Sea (Mediterranean) with an emphasis on Lesseptian migration. ACTA ADRIAT. 35(1/2):83-100, (1994).

Gücü A.C., Bingel F., Avsar D., And N.Uysal. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean Coast-Northern Cilician basin. ACTA ADRIAT. Vol 34(1/2) pp. 103-113, (1994).

Oren, O.H., Changes in the temperature of the eastern Mediterranean Sea in relation to the catch of the Isreal trawl fisheryduring the years 1954/1955 and 1955/1956. Bull. Inst. Oceanogr. Monaco. Vol 1102. pp.1-12, (1957).

Peres, J. M., History of the Mediterranean biota and the colonization of the depths. In: Margalef, R., edt. Western Mediterranean - (Key Environments). Pergamon Press. U.K. pp.198-232, (1985).

Riedl, R., Fauna und Flora der Adria, Verlag Paul Parey, Berlin, 702 p.(1970).

Ros, J.D., Romero, J., Ballesteros, E. and Gili, J.M., Diving in blue waters. The Benthos. In: Margalef, R., edt. Western Mediterranean - (Key Environments). Pergamon Press. U.K. pp.233-295, (1985).

Spanier, E., Pisanty, S., Tom, M. and Almog-Shtayer, G., . The fish assemblage on a coralligenous shallow shelf off the Mediterranean coast of norhern Isreal. J. Fish. Biol. Vol 35, pp. 641-649, (1989).

Tortonese E, The main biogeographical features and problems of the Mediterranean fish fauna. Copeia, Vol.1, pp.98-107, (1964).

Tortonese, E., Fauna dÍtalia. Officine Grafiche Calderini, Bologna, 636 p.(1975).

Whitehead, P.J.P., Bauchot, M.L., Hureau. J.C.,Nielsen, J. and Tortonese. (Eds), Fishes of the Northeastern Atlantic and the Mediterranean. Vol. I, Paris UNESCO, 510 p.(1984).

Whitehead, P.J.P., Bauchot, M.L., Hureau. J.C.,Nielsen, J. and Tortonese. (Eds), Fishes of the Northeastern Atlantic and the Mediterranean. Vol. II, Paris UNESCO, 490 p.(1986a).

Whitehead, P.J.P., Bauchot, M.L., Hureau. J.C.,Nielsen, J. and Tortonese. (Eds), Fishes of the Northeastern Atlantic and the Mediterranean. Vol. III, Paris UNESCO, 458 p. (1986b).