

The spreading of lessepsian fish migrants into the Aegean Sea (Greece)*

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SUMMARY: The number of the Lessepsian fish migrants colonizing the eastern Mediterranean increases continuously. At least 11 species have reached the Aegean Islands (Dodecanese, Cyclades) by following the Asiatic coasts. The Lessepsian migrants fished in Greek territorial waters are: *Sargocentron rubrum*, *Siganus rivulatus*, *Siganus luridus*, *Lagocephalus spadiceus*, *Stephanolepis diaspros*, *Upeneus moluccensis*, *Leiognathus klunzingeri*, *Saurida undosquamis*, *Pempheris vanicolensis*, *Hemiramphus far* and *Parexocoetus mento*. Almost all of them came from the Dodecanese Sea area, five were found in the south Aegean Sea (Cyclades Islands) and only one in Patraikos Gulf (Western Greece). The spreading of Lessepsian migrants in the Aegean Sea and the presence of some fish species of Black Sea origin contributes to the division of the Aegean Sea into two zoogeographical zones, south and north of the line connecting the islands of Eubia and Peara.

Key words: Fishes, Aegean Sea, Lessepsian migrants, Lessepsian migration, fauna, Greek fishfauna.

RESUMEN: MIGRACIÓN DE PECES. A TRAVÉS DEL CANAL DE SUEZ, AL MAR EGEO (GRECIA). — El número de peces que emigran a través del canal de Suez y colonizan el Mediterráneo oriental va en aumento de forma continuada. Por lo menos 11 especies han llegado a las islas del mar Egeo (Dodecaneso, Cícladas) siguiendo las costas asiáticas, y han poblado las aguas territoriales griegas: *Sargocentron rubrum*, *Siganus rivulatus*, *Siganus luridus*, *Lagocephalus spadiceus*, *Stephanolepis diaspros*, *Upeneus moluccensis*, *Leiognathus klunzingeri*, *Saurida undosquamis*, *Pempheris vanicolensis*, *Hemiramphus far* and *Parexocoetus mento*. Casi todas capturadas en el mar del Dodecaneso, cinco fueron encontradas al sur del mar Egeo (islas Cícladas) y tan solo una en el golfo de Patraikos (oeste de Grecia). La distribución de estos peces en el mar Egeo y la presencia de algunas especies del mar Negro dan lugar a la división del mar Egeo en dos zonas zoogeográficas: al sur y al norte de la línea que une las islas de Eubia y Peara.

Palabras clave: peces, mar Egeo, migración por el canal de Suez, fauna ictícola griega.

INTRODUCTION

With the opening of the Suez Canal in 1869, two markedly different zoogeographical areas were joined; the subtropical Mediterranean Sea, which connects with the Atlantic, and the tropical Red Sea, the norther most extension of the Indian Ocean. In order to pass between these areas organisms must be able to bridge the difference in adaptive requirements, and also withstand the extreme conditions in the Canal itself.

The term "Lessepsian migration" was first used by POR (1964) to characterize a new phenomenon of

unidirectional and successful biotic advance from the Red Sea to the Eastern Mediterranean. POR (1969) also coined the term "Lessepsian migrant" for Red Sea species that have passed through the Suez Canal and settled in the Eastern Mediterranean. The Lessepsian migrants are assumed to number around 200 species, now concentrated mainly along the Levant coast. Fish and decapod crustaceans, as well as a few molluscs, have advanced beyond the limits of the Levant basins.

On the basis of the above considerations, the purpose of this paper was to examine the distribution and the abundance of the Lessepsian immigrants in

* Received June 28, 1990. Accepted September 17, 1990.

the Greek Seas, and especially in the Aegean, taking into account some new data on their presence and abundance and on the variation of some abiotic parameters during recent years.

MATERIAL AND METHODS

The study was based mainly on material collected in the framework of research projects conducted by the National Centre for Marine Research (N C M R) using different fishing gears (trawlers, purse seine, trammel or gill net, long line) since 1976. Other sources of data were amateur and professional fishermen who supplied specimens for identifications. The material is being kept in 70 % alcohol in the N C M R museum. During this study data from the literature concerning the spreading of Lessepsian migrants in Greek seas were also analysed. The latter information was compared with data from other sources before being presented here.

RESULTS AND DISCUSSION

The number of Lessepsian fish migrants colonizing the eastern Mediterranean has been increasing continuously. BEN TUVIA (1978) reported 36 species. Five additional species were found since then (BEN TUVIA, 1985; GOLANI & BEN TUVIA, 1986). Today there are 43 Indo-Pacific species known that evidently reached the Mediterranean Sea via the Suez Canal (GOLANI pers. comm.). These recent additions show that the Suez Canal immigration is a continuous process, with species new to the area appearing every year. The proportion of Lessepsian fish migrants relative to the total number of species constitutes 8 % of the total Mediterranean fish-fauna species and 14 % of the Levant basin fish fauna.

New and careful investigations are desirable for both an exact understanding of the geographical



FIG. 1. — Distribution of Lessepsian fish migrants in Greek territorial waters.

S. undosquamis (□), *S. diaspros* (●), *S. rivulatus* (○), *L. spadiceus* (▲), *U. moluccensis* (□), *P. vanicolensis* (△), *S. luridus* (■), *S. rubrum* (○), *L. klunzingeri* (○), *H. far* (▶◀), *P. mento* (○).

distribution, variations and migrations of Mediterranean species and for ascertaining the spreading of those migrating from the Red Sea through the Suez Canal. Much less is known about the occurrence of the immigrants along the African coast to the west of the Levant basin.

At least 11 Lessepsian migrants (Table 1) have reached the Aegean islands (Fig. 1), 800-900 miles from Port Said, following the Israelian and Anatolian coast and a few, crossing the Ionian Sea, have appeared in southern Italy, Libya and Tunisia (TORTONESE 1967, 1970, PAPAConstantinou, 1988). The prevailing currents appear to direct the spreading of fishes along the Asiatic coasts northward and then westward toward the Aegean Islands.

The eastern Mediterranean is usually defined as a very heterogenous oceanic area. It contains the Adriatic and the Aegean Seas, each with a peculiar history and a particular hydrography. In these two basins, the temperatures and salinities are as a rule lower than those of the rest of the Mediterranean. The process of immigration is highly selective. Common species of the home seas are not necessarily successful immigrants to a new region. Similar effects have been shown to occur in many forms of colonization (MAC ARTHUR & WILSON, 1967). The adaptation of a species to a new area requires adjustment of its reproductive processes, especially with regard to the correct timing of spawning in order to ensure suitable physical and ecological conditions for the development and survival of the young stages.

There are no data that enable us to analyse the complicated ecological relationship between the fish

TABLE 1. — List of Lessepsian migrants fished in Greek seas.

<i>Sargocentron rubrum</i> (Forsskal, 1775)
<i>Siganus rivulatus</i> (Forsskal, 1775)
<i>Siganus luridus</i> (Ruppell, 1828)
<i>Lagocephalus spadiceus</i> (Richardson, 1844)
<i>Stephanolepis diaspros</i> Fraser-Brunner, 1940
<i>Upeneus moluccensis</i> (Bleeker, 1855)
<i>Leiognathus klunzingeri</i> (Steindachner, 1898)
<i>Saurida undosquamis</i> (Richardson, 1848)
<i>Pempheris vanicolensis</i> Cuvier, 1831
<i>Hemiramphus far</i> (Forsskal, 1775)
<i>Parexocoetus mento</i> (Valenciennes, 1846).

communities and their habitats. The small number of species makes it almost impossible to establish such relationships. For example, the appearance of the *U. moluccensis* in the Dodecanese area does not seem to influence the abundance of the native *Mullus barbatus* Linnaeus, and *Mullus surmuletus* Linnaeus. On the other hand, along the Libyan coast, *S. rivulatus* seems to outcompete *Boops boops* Linnaeus, reducing the abundance of the latter, since both species feed upon algae (TORTONESE, 1969). Quite likely, the same is true for the S.E. Aegean Sea. Many of the species that have successfully colonized the Aegean Sea, such as *S. rivulatus* and *U. moluccensis*, and abound there, also predominates on trawling grounds in the Suez area.

Very little information is available on the rate of increase of the migrant population and the ecological influence of their appearance in the new region. The first record of *S. rivulatus* in Rhodes was made by BRUNELLI & BINI (1934), but the population explosion occurred between 1942 and 1944. Recent investigations in the Kastellorizo area (PAPACONSTANTINO *et al.*, 1988) revealed that *S. rivulatus* was less abundant than *S. luridus*. It dominated the Dodecanese waters in the 1960's (KAVALLAKIS, 1968), where it was not found before 1956. Then the fish suddenly appeared to be fairly common in the area, exceeding in number the previous Lessepsian migrant *S. rivulatus*. So far, no explanation exists for the recent appearance of that species in the E. Mediterranean. It seems probable that *S. luridus* remained rare for many years after entering the Mediterranean Sea through the Suez Canal, and became abundant later, when its living conditions became more or less similar to those of its original surroundings. The discernible rise of the sea temperature in the E. Mediterranean in the 1950's might be responsible for the appearance of Lessepsian species and the northward extension of existing species as well. The decline of the salinity (MORCOS, 1960) acts as a natural barrier mediating the northward spread of *S. luridus* in the Mediterranean Sea. It is a common feature of invading organisms, that, after an initial period of successful adaptation to the new and basically favorable environment, they may suddenly increase in number and spread to adjacent areas.

The sudden appearance of *P. vanicolensis* is worth mentioning. The species was reported for the first time in the Mediterranean Sea off the Lebanon coast (MOUNEIMNE, 1979). Recent observations and reports show that *P. vanicolensis* spread rapidly in the Levant basin and it was noted along the Israeli

coast (GOLANI, & BEN TUVIA, 1986). No *Pempheris* species has been recorded in the Aegean Sea since 1987. Hence, the finding of *P. vanicolensis* off the northern coast of Kastellorizo and Ro islands (Dodecanese Islands) presents particular interest (PAPACONSTANTINO & CARAGITSOU, 1987), since this shows its rapid spreading. It is remarkable that, in a relatively short time, this Red Sea immigrant has grown to such a population as to occupy the entire coast of the Levantine basin.

Almost all the Lessepsian migrants in the Dodecanese area are fishes. Only five of these were found in the Central Aegean Sea. From the area of Izmir, BEN TUVIA (1972) recorded three fishes: *S. undosquamis*, *S. luridus* and *U. moluccensis*. KASPIRIS (1976) fished *S. luridus* in the Gulf of Patras. This is the first record of a Lessepsian migrant in the Greek Ionian Sea. Another fish, *L. spandiceus*, was reported off the Island of Samos. The same species was fished by LASKARIDES (1948) in the Dodecanese islands. *S. diaspros* was recorded by many authors in the Dodecanese. Recently, I have identified as *S. diaspros* five specimens fished in the Saronikos Gulf, near the opening of the Canal of Korinthos and off Salamina island.

POR (1978) claims that the statement found in several papers that Lessepsian migrants have spread into the Aegean Sea is generally wrong and that the farthest point reached along the Anatolian coast is the Island of Rhodes. However, the gradual increase in the number of Lessepsian migrants in the Aegean Sea suggests rather that their restricted records are due to inadequate sampling. In fact, in the zoogeographical sense, the Aegean Sea is defined by PERÈS (1967) and FREDJ (1972) only as the sea to the north of the line connecting the Islands of Eubia and Psara; Izmir is approximately on this line. The sea area to the south of the Eubia-Psara line, the Sea of Cyclades or the Sea of Crete, is an area of warm-water fauna according to PERÈS (1967); the cold-water fauna characteristic of the Aegean Sea starts only north of the above line. PAPACONSTANTINO & TORTONESE (1980), on the basis of the spreading of some fishes as *Platichthys flesus luscus* Pallas, *Merlangius merlangus euxinus* Nordmann, *Huso huso* Linnaeus, *Syngnathus tenuirostris* Rathke, *Knipowitschia caucasica* (Kawrajsky in Berg, 1916) and *Proterorhinus marmoratus* Pallas, recognized the difference in fish fauna between the north and the south of the Aegean Sea but without accurately defining the boundary line. The above species, with the exception of the last one which is endemic in the north Aegean Sea, are also

found in the Black Sea, and some of them in the Adriatic Sea (HUREAU & MONOD, 1973; WHITEHEAD *et al.*, 1984-1986). This observation corroborates the view that the fauna of the last two areas show some similarity. The Black Sea received from the Aegean Sea more than 1/3 of its fauna and from the Mediterranean Sea about 1/5 (SLASTENENKO, 1959). The only record of Lessepsian migrants (KOUKOURAS, 1978) to the north of this line is that of *Synalpheus hululensis* Coutiere.

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Scient. ed. J. Lleonart