

Resource partitioning of two Red Sea colonizers  
and two indigenous Mullids in the Eastern Mediterranean

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Resource partitioning in most co-evolved fish assemblages occurs along one or more axes (Werner, 1979). The colonization of the eastern Mediterranean Sea by Red Sea fishes provides an unique opportunity to investigate interaction between co-occurring closely related species that did not coevolve (Por, 1978).

The family of Mullidae, which is of considerable commercial importance, constituting more than a third of all Israeli crawl catch (Golani, 1981-85), is represented in the Levant coast by two indigenous species, *Mullus barbatus* and *M. surmuletus*, as well as the two Red Sea colonizers, *Upeneus moluccensis* and *U. asymmetricus*. In the present work, the feeding habits, habitat selection and spawning seasons of these species were studied for the purpose of assessing the nature and extent of resource partitioning.

Habitat selection was determined by the frequency which each species occupied selected depths (20, 40, 55, 70 and 90 m) as sampled by commercial trawlers. Feeding habits of each mullid were determined by calculating the index of relative importance (IRI) of each prey category. Trophic separation was determined by calculating the feeding habits overlap for each pair of species, using IRI.

In addition the predator size-prey size relationship was determined. Spawning seasons were calculated by the gonado-somatic index.

Of the three axes of resource partitioning investigated concerning the eastern Mediterranean mullids, the most important axis is habitat separation. Both colonizers are found in a shallow habitat, *U. asymmetricus* being dominant in the primarily sandy-bottom at 20-30 m and *U. moluccensis* at 40-55 m, at which depth the sea bottom becomes increasingly silty. The indigenous *M. barbatus* is dominant in water deeper than 55 m although it can be found in large quantities from 40 m. *M. surmuletus* appears in small numbers in all depths.

Segregation according to food type or size is much less apparent. The primary prey of all four species is mainly macrurid crustaceans, which constitute 51.4-61.2 % of IRI. The secondary prey is polychaets, constituting 4.3-26.0 % of IRI. The values of diet overlap are rather high ( $T = 0.666-0.928$ ) when including samples from all depths and decrease considerably ( $T = 0.527-0.846$ ) in samples from the area where species are most sympatric (40-55 m), suggesting that trophic separation may also be a means of resource partitioning.

Prey size is also not an efficient means of segregation. Young individuals (SL < 115 mm) of all four species feed upon prey of similar size (60-120 mg). Among larger specimens (SL  $\geq$  115 mm), three species continue to feed mainly upon the same size prey, with occasional larger organisms, while one species, *U. moluccensis*, feeds upon considerably larger prey (600-2200 mg), of which 30.2% of the gravimetric index are benthic fish.

The separation between spawning seasons of local versus colonizing species may also contribute to reduce competition. The local species spawns in March-June while one of the Red Sea species, *U. moluccensis*, spawns in July-October and the other, *U. asymmetricus*, spawns from March to October.

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A prudent assessment of the role of the Suez Canal  
in plankton interchange  
between the Mediterranean and the Red Sea

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Despite the scepticism expressed by some authors (Godeaux, 1974; Por, 1978) about the magnitude and the future of the Lessepsian migration of holoplanktonic organisms, the subject is still attracting much attention and the expectations are high.

New reports of putative migrant Indopacific species are often being quoted in literature. Among the calanoid copepods, the reports of *Arietellus pavoninus* from the Aegean Sea and of *Euchaeta concinna* from the Lybian Coast deal probably with pre-existent circumtropical species. The calanoids reported by Lakkis (1976) from Lebanon need to be confirmed as real Lessepsian migrants. Only species which are sufficiently euryhaline and/or reported also from the Suez Canal waters, such as *Calanopia elliptica*, *C. media*, *Acartia centrura* and *A. fossae* are probable migrants. The siphonophore *Sulculeolaria chuni* (Alvarino, 1974) cannot be considered a migrant. The phtoplanktonic species and the tintinnids reported by the Egyptian colleagues have been all found near the Suez Canal outlet in the Mediterranean. The two hydromedusae reported by Schmidt (1972) are not holoplanktonic and may have been introduced in their polyp instar.

Although very prudent in her conclusions, Furnestin (1979), who quotes several of the above examples, expects that planktonic immigration will increase in the future even to an extent to allow for such organisms like *Euphausia diomedea* to cross over into the Mediterranean. This would be the outcome of the cessation of the Nile flow and especially of the gradual decrease of the salinities in the Suez Canal.

That the situation is not such, has been shown recently by Egyptian scholars and especially by El Sharkawy and Sharaf El-Din (1983). The salinities in the Bitter Lakes maintain a level above 46 ppt and in the summer reach more than 49 ppt. Moreover, saline stratification in the Bitter Lakes persists and during 1973-1974 there were even hypersaline values near the bottom.

The Canal waters have a residence time of about 6 months in the Bitter Lakes and salinity increases there during this time much more because of the high evaporation rate than because of the dissolution of the residual fossil salt bed on the bottom. It is therefore unrealistic to expect future and further improvement in the salinity regime of the Suez Canal: Every organism entering the Bitter Lakes from the Red Sea is submitted at least for the duration of the average residence time of the Red Sea water, to the metahaline salinities of the system.

It results that only organisms able to withstand the extreme neritic and even lagunary conditions of the Bitter Lakes with high salinities, low winter temperatures and which furthermore are able to reproduce in these waters are prone to turn into Lessepsian migrants. The methodological caveat proposed by Por (1978) retains full viability: migrant species should be looked for first of all in the Suez Canal waters.

Planktonic congeners found on both sides of the Suez Canal are probably different at a species level. They probably behave like *Calanus helgolandicus* s.l. which according to Fleminger and Hulsemann (1987) split into sibling species separated by the Bosphorus. If the gene flow between the Aegean and the Black Sea populations in this genus is so reduced, what can one expect of the saline trickle of the Suez Canal?

In conclusion: Indopacific influx of holoplanktonic species from the Red Sea to the Eastern Mediterranean, if possible at all, is restricted to very few special cases.

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