

Comparison of morphomeristical variations of Mediterranean and Red Sea populations of the Suez Canal migrant *Sargocentron rubrum*

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ABSTRACT

Nine morphomeristical characters of squirrelfish, *Sargocentron rubrum* (Forsskal 1775) were compared between Mediterranean and Red Sea populations to examine changes caused by different environments. The significantly lower number of lateral line scales and vertebrae in the Mediterranean fishes is attributed to the higher temperature during the spawning season. The significant difference of the proportion of suborbital spinulation and the shape of the anterior tip of the nasal bone is inferred to be due to a founder effect. No significant difference was found in the relationship between eye diameter and preopercular spine length and standard length, nor in the number of dorsal and anal rays and nostril spinulation.

Introduction

The opening of the Suez Canal in 1869 created a faunistic passageway between the Red Sea and the Mediterranean Sea, two bodies of water which differ considerably in many hydrological and faunistic aspects. It is now apparent that the so-called "Lessepsian migration" involves movement mainly from the Red Sea into the Mediterranean, although some organisms, possibly of Mediterranean origin, have been found in the Red Sea. Most species are limited to the Levant region of the eastern Mediterranean (Por, 1978).

The influx of tropical Indo-Pacific organisms into the sub-tropical eastern Mediterranean has enabled a scientific monitoring of short term dispersal and colonization processes that under natural conditions occur over far longer periods. In

particular, the establishment of new populations, separated from their source, has provided a unique opportunity to study aspects of speciation in nature.

MacArthur and Wilson (1967) claimed that a colonizing species was likely to undergo adaptive changes within a few generations. Recently, findings of Parsons (1983) supported this hypothesis. Tortonese (1973) and Kosswig (1974) postulated that both phenotypic and genotypic changes may have occurred in fish of Red Sea origin which colonized the Mediterranean Sea, although they could not substantiate their hypothesis.

Among the various known Red Sea colonizers, forty-one species of fish have been recorded in the eastern Mediterranean (Golani and Ben-Tuvia, 1986). Some of the immigrant fish, e.g., *Upeneus moluccensis*, *Siganus rivulatus* and *Saurida undosquamis*, have established large populations, contributing considerably to the local fishery (Ben-Tuvia, 1985).

The squirrelfish, *Sargocentron rubrum* (also known in older literature by the generic name *Holocentrus* or *Adioryx*), was one of the first Indo-Pacific fish to be recorded in the Mediterranean (Haas and Steinitz, 1947). Its known distribution in the Mediterranean reaches Greece in the northwest (Laskaridis, 1950) and Libya in the southwest (Stirn, 1970). Various aspects of the biology of *S. rubrum* have been recently studied along the Israeli coastline (Ben-Eliahu, *et al.*, 1983; Golani, *et al.* 1984; Golani and Ben Tuvia, 1985).

In the present study, the morphomeristical characters of Red Sea and Mediterranean populations of *S. rubrum* were compared, in order to determine whether morphomeristic changes had occurred as a result of colonization.

Materials and Methods

Specimens longer than 40 mm SL were examined in this study, since it has been found (Golani and Ben-Tuvia, 1985) that above this size the morphomeristic changes are negligible. Most Mediterranean fish were obtained during the period October 1979 to October 1980 from commercial trammel nets in the fishing harbour of Akko (Acre). The remaining Mediterranean fish and all of the Red Sea fish were preserved specimens from the museum collections of the Hebrew University of Jerusalem, Tel-Aviv University (Israel), the Field Museum of Natural History, Chicago (USA), and the Rijksmuseum van Natuurlijke Historie, Leiden (Holland). Of the 80 Red Sea specimens, 69 originated from its northern part, i.e., the Gulf of Aqaba (Gulf of Eilat) and 11 were collected in central and southern regions. No differences were found in the fish originating from these various regions of the Red Sea. Basic meristic counts follow Hubbs and Lagler (1947), adjusted to the genus *Sargocentron* adopted from Shimizu and Yamakawa (1979) and Randall and Heemstra (1985). Standard length was measured to the nearest mm. Eye diameter and preopercular spine length were measured to the nearest 0.1 mm.

The last soft rays of the dorsal and anal fins, which are usually divided almost to the base, were considered to be one ray. Lateral line scales included only scales with tubes. Preopercular spine length was measured from the vertical line of the preoperculum to the tip of the spine. Vertebrae of the Mediterranean specimens were counted after removing the musculature of the fleshy exterior, while the vertebrae of Red Sea and preserved Mediterranean specimens were counted from X-ray plates.

Other morphology examined were nasal fossa spinulation, suborbital spinulation and shape of anterior nasal bone. These features are considered specific to diagnosis of

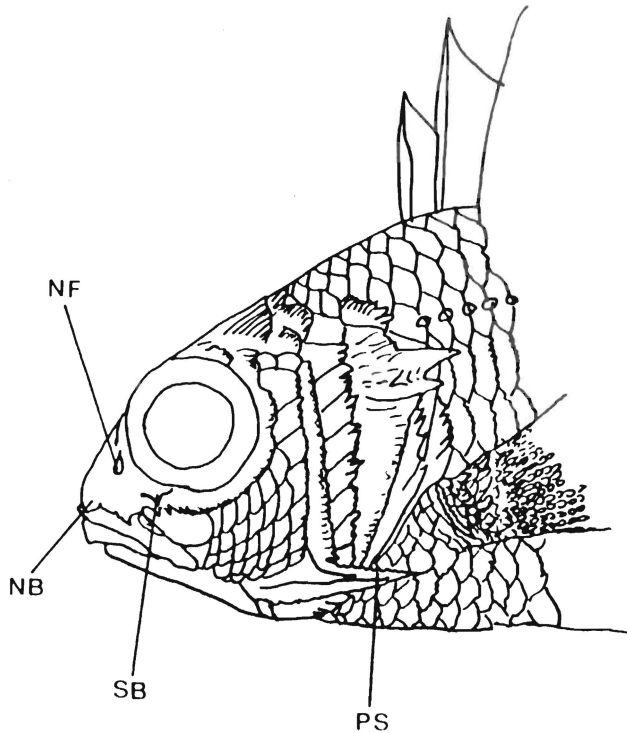


Fig. 1. Head of *Sargocentron rubrum*. NF, nasal fossa; NB, nasal bone; SB, suborbital bone; PS, preopercular spine.

S. rubrum and have been often used in literature to differentiate it from closely related species (Montilla, 1938; Shimizu and Yamakawa, 1979; Shen, *et al.*, 1980). Counts of nasal fossa spinulation included both sides. Spinulation of the suborbital bone was counted on the left side only; three variations were observed: one outward spine, two outward spines, or serrated, i.e., a series of three or more such spines. The anterior part of the nasal bone was usually rounded or ended in a blunt spine, which were considered as one category. The other categories were two or three diverging spines on each side of the symphysis (Fig. 1).

Relationship of eye diameter and preopercular spine length to standard length was tested by analysis of covariance, while all the other character variations were tested by chi square test for independence in contingency tables.

Results

The relationship between eye diameter (E) and standard length (SL) was calculated as the regression line:

$$E = 0.084 SL + 3.904 \quad (r = 0.678, N = 282)$$

for the Mediterranean fish, and

$$E = 0.082 SL + 4.483 \quad (r = 0.934, N = 60)$$

for the Red Sea. The test showed no significant difference ($P > 0.999$, $F = 0.00$) between the two populations.

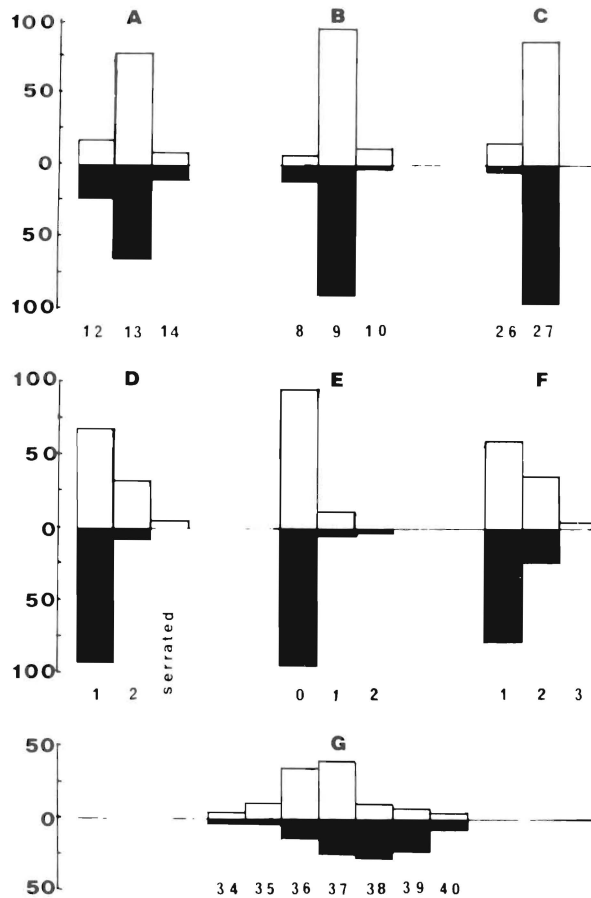


Fig. 2. Comparison of the frequency of occurrence of morphomeristical variations of Mediterranean (open bars) and Red Sea (solid bars) populations of *Sargocentron rubrum*. A – dorsal rays, B – anal rays, C – vertebrae, D – suborbital spinulation, E – nostril spinulation, F – spines on tip of nasal bone, G – lateral line scales.

A similar result was reached concerning the relationship between preopercular spine length (PS) and SL. It was calculated as the regression lines:

$$PS = 0.086 SL + 0.657 \quad (r = 0.522, N = 282)$$

for the Mediterranean, and

$$PS = 0.096 SL + 0.203 \quad (r = 0.835, N = 60)$$

for the Red Sea. No significant difference ($P > 0.518$, $F = 0.44$) was found in this character between the Mediterranean and Red Sea fish.

Frequency of occurrence, expressed as the percentage of each variation in both populations, is shown in Fig. 2. The number of fish examined and significance levels of difference are given in Table 1.

In three cases, the number of dorsal rays, anal rays and the nasal fossa spinulation, no significant differences were found between the two populations. However, the

number of lateral line scales and vertebrae, suborbital spinulation and the shape of the anterior nasal bone differed significantly (Table 1).

Discussion

Testing the applicability of the theory that a colonizing population will tend to differ from the source population due to necessary adaptive changes to their new hydrological condition, is one of the most interesting questions arising from study of the phenomenon of Lessepsian migration.

Table 1. Sample sizes and results of χ^2 test comparing morphomeristical variations of Mediterranean and Red Sea populations of *Sargocentron rubrum*

	dorsal rays		anal rays		l.l. scales	
Mediterranean	249	χ^2 0.130,2	249	χ^2 0.108,2	78	χ^2 0.002,7
Red Sea	80		80		79	

	Vertebrae		nostril spinulation		suborbital spinulation		nasal bone shape	
Mediterranean	70	χ^2 * 0.016,1	204	χ^2 0.136,2	204	χ^2 * 0.0007,2	204	χ^2 * 0.022,2
Red Sea	53		57		57		57	

* significant difference

The significantly lower number of lateral line scales and vertebrae in the Mediterranean population is probably due to the higher water temperature during the spawning season. Golani and Ben-Tuvia (1985) showed that the spawning season of *S. rubrum* in the Levant extends from July to August. The water temperature at that time reaches a monthly average higher than that of any month in the Gulf of Aqaba (northern Red Sea) (Oren, 1962). This negative correlation between water temperature and number of vertebrae and lateral line scales is a well-documented phenomenon (Hubbs, 1922; Kwain, 1975; Lindsey and Arnason, 1981).

The variation of the suborbital spinulation and the shape of the anterior tip of the nasal bone is significantly different between the two populations. None of these characters appears to have any ecological advantage in either the old or the new habitat. Mayr (1963) and MacArthur and Wilson (1967) theorized that genetic differences in a colonizing population may be due to accidental differences in gene proportions in the individual founders as compared to those in the source population. Thus it may be inferred that the changes were not caused by natural selection but rather by founder effect.

Five of the characteristics compared in this study, eye diameter, preopercular spine length, dorsal and anal rays, and nostril spinulation, showed no significant difference.

In summation, the results of this study suggest that as a result of its colonization of the Mediterranean Sea, some morphomeristical changes have occurred in *S. rubrum*. Additional comparative studies, especially electrophoretic analysis must be done in order to evaluate the magnitude of the differences between the two populations. This initial separation of the Mediterranean population may lead eventually to formation of a new taxon.

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