

Analysis of fecundity of some bobtail squid of the genus *Sepiola* (Cephalopoda: Sepiolida) in the Aegean Sea (eastern Mediterranean)

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A total of 39 *Sepiola intermedia*, *Sepiola robusta* and *Sepiola steenstrupiana* samples (11 female, 28 male), from the eastern Mediterranean and the Aegean Sea have been examined. The potential fecundity, relative fecundity and index of potential reproductive investment were calculated.

The Sepiolid order known as the bobtail squid is represented by 17 species in the Mediterranean. Except in Heteroteuthinae, they have benthic and nectobenthic life styles (Bello, 1995). *Sepiola intermedia* and *Sepiola robusta* are among the commonest bobtail squid in the Mediterranean. However, *Sepiola steenstrupiana* is reported to be a rare species of the western Mediterranean (Orsi Relini & Bertuletti, 1989).

In this study some reproductive features of Sepiolidae samples from the eastern Mediterranean have been examined.

Samples were collected during 1988 and 1998 on-board the RV 'K. Piri Reis', from the Aegean Sea and the eastern Mediterranean Sea coasts of Turkey. A total of 39 samples belonging to three species, *Sepiola intermedia* (5 females, 8 males), *Sepiola robusta* (4 females, 9 males), and *Sepiola steenstrupiana* (2 females, 11 males) was examined. Samples were preserved in 4% formalin. Squid were dissected and identified according to Bello (1995) by the bursa copulatrix of the female and by the hectocotylus of the male. Mantle lengths were measured to the nearest 1 mm and weights to the nearest 0.001 g.

Reproductive systems (Needham sacs, gonads and spermatophores for males and gonads, oviduct and eggs for female) were taken and measured using a micrometric ocular with the total lengths measured to the nearest 0.05 mm. The entire oocyte stock was taken into account including the smallest oocytes. The presence of either ripe eggs in the oviduct, and/or empty follicles in the ovary was considered to be proof that a particular female had achieved full maturity. The number of spermatophores occurring in the bursa copulatrix following copulation was measured. The maturity stages of gonads and oocytes (yolk, large and ripe oocytes) were determined in accordance with Mangold-Wirz (1963).

The gonadosomatic index ($GSI = GW \times 100 / TW$) was determined for both sexes for all three species. Potential fecundity (PF) was calculated as the sum of total oocyte number in the ovary and egg number in the oviduct. Relative fecundity (RF) was estimated as the ratio of PF to body weight (BW). An index of potential reproductive investment (PRI) was calculated as the product of RF and the weight of an individual ripe egg (Laptikhovsky & Nigmatullin, 1993). For males of all three species, the relative spermatophore length (SpL index = $SpL \times 100 / ML$) was calculated.

Sepiola intermedia

Female. Mantle lengths (MLs) ranged between 16 to 20 mm. A single female with a ML of 16 mm was found to be maturing, whereas the rest were mature and probably spawning. The

diameters of the maturing eggs in *S. intermedia* females varied between 0.11 to 2.83 mm (yolk oocytes <1.4 mm). The diameters of the mature eggs were 2.25–2.94 mm (mean 2.60 mm). The mean weight of the ripe eggs was 5.27 mg. The RF was estimated to be between 69.94–186.27 egg/g (mean 123.90 egg/g). The PF varied from 111 to 407 (mean 231) of oocyte. The PRI was calculated to be 0.28–0.86 (mean 0.58), whereas the GSI was found to be 0.75–8.53% (mean 4.85%).

Male. Mantle length ranged between 20 to 26 mm. All males were found to be mature. Spermatophore numbers in the Needham sacs were determined to be between 98 and 217 (mean 156) and the lengths were in the range 8.39 and 10.4 mm (mean: 9.06 mm). GSI values were 1.03–2.53% (mean: 1.78%). The calculated MLSpL was 36.65%–47.27% (mean: 40.57%).

Sepiola robusta

Female. Mantle length ranged between 24 to 28 mm. All females were in the mature spawning phase, except the smallest animals (24 mm ML) which was maturing. Diameters of the maturing eggs in the ovary were between 0.1 and 5 mm (yolk oocytes <2.5 mm).

Ripe eggs were found in the oviduct of only one female (28 mm ML) and the diameters were between 2.7 and 5.8 mm (mean 4.95 mm).

The average weight of the ripe eggs was 30.33 mg. The RF was estimated to be 27.61–66.43 egg/g (mean 45.99 egg/g). The PF varied from 117 to 245 (mean 159) of oocyte. The PRI was calculated to be 0.83, whereas the GSI was found to be 12.8–22.3% (mean 17.5%).

Male. Mantle length ranged between 19 to 28 mm, with all males being mature. Needham sacs contained 109 to 386 (mean 231) spermatophores. The lengths of the spermatophores were 5.81 mm–8.19 mm (mean 7.26 mm). The GSI values were found to be 0.55–1.89% (mean 1.67%). The MLSpL index varied from 24.57% to 37.23% (mean 31.74%).

Sepiola steenstrupiana

Female. Only two females (12 and 14 mm ML) were mature. Maturing eggs had diameters between 0.1 mm and 3.8 mm (yolk oocytes <1.9 mm). Diameters of the ripe eggs were between 2.8 and 4.8 mm (mean 3.43 mm). The average weight of the mature eggs was 12.58 mg.

The RF was estimated to be 155.1–179.6 egg/g (mean 167.34). The PF varied from 163 to 191 (mean 177) of oocyte. The PRI

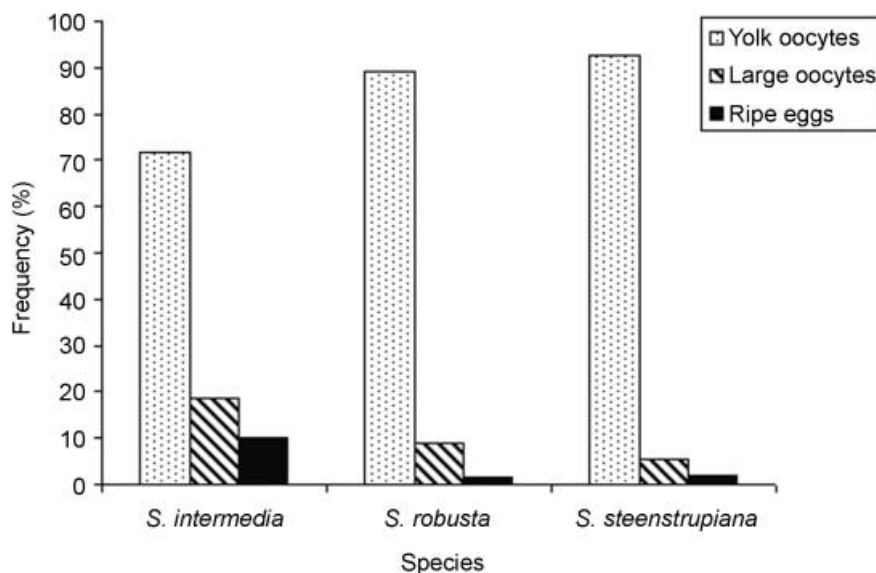


Figure 1. Occurrence of eggs at the different stages of oogenesis in mature females.

was estimated to be between 1.50 and 2.77 (mean 2.14), whereas the GSI was found to be in the range 8.3 to 10.1% (mean 9.21%).

Male. Mantle length ranged between 12 to 18 mm. All were in the mature phase. Spermatophore counts of these individuals were between 13 and 377 (mean 143). The lengths varied between 3.52 and 7 mm (mean 5.2 mm). The GSI values were found to be 0.22–2.23% (mean 1.32%). MLSpL had values varying between 29.33% and 41.13% (mean 35.16%).

The total lengths of spermatophores found in the mature males were found to be very similar to those of other representatives of the genus, including existing data on *S. robusta* (Boletzky, 1983).

Sepiola steenstrupiana, which has spermatophores 5.2 mm long, produces shorter spermatophores than the other two species, *S. intermedia*, and *S. robusta* that we examined. An inverse relationship results when related to the length of the animal. In this study, we found it more convenient to use spermatophore lengths in the comparison.

The egg diameters measured for two mature females of two species, *S. robusta* and *S. intermedia*, are similar to those of Orsi-Relini & Bertuletti (1989).

Occurrence of oocytes at different stages of maturation in the ovaries of mature females is shown in Figure 1. A similar finding was reported by Boletzky (1983) for *S. robusta*.

As the percentage of ripe eggs of the species studied was less than that of other egg groups, it was thought that these species are spawning more than once. This is consistent with the review by Rocha et al. (2001) whereas reported studies suggest that other bobtail squids are intermittent spawners.

The female reproductive features were generally found to be similar to those of other investigated representatives of the genus, including a positive relation between egg size and female ML for each species. This relationship was also noted for other Sepiolid species by Gabel-Deickert (1995).

Despite the fact that a given species may have different egg diameters and fecundity in various ecosystems (Laptikhovskiy & Nigmatullin, 1993), the spawning characteristics of members of the genus *Sepiola* (*S. robusta* and *S. intermedia*) investigated in this study from the eastern Mediterranean did not exhibit consider-

able differences, when compared with studies from different areas such as those conducted in the western Mediterranean (Mangold-Wirz, 1963; Gabel-Deickert, 1995). It should be noted that, *S. steenstrupiana* could not be compared due to the lack of reproduction studies on the species in the Mediterranean.

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