Research Note

Observations on the reproductive biology of the octopod *Eledone gaucha* Haimovici, 1988, in southern Brazil

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Abstract: Maturation, fecundity and reproductive cycle of the octopod *Eledone gaucha* Haimovici, 1988, were studied based on preserved samples collected during groundfish surveys conducted off southern Brazil. The patterns of sexual maturation of males and females and low fecundity were similar to the congeneric and sympatric *E. massyae* Voss, 1964. It is suggested that *E. gaucha* does not exhibit a marked seasonal reproductive cycle and more than one breeding group overlap on the continental shelf.

Key words: Octopoda, *Eledone*, sexual maturation, Brazil

The small congeneric octopods, *Eledone massyae* Voss, 1964, and *E. gaucha* Haimovici, 1988, coexist year-round on the sandy and muddy bottoms of the middle and outer continental shelf off southern Brazil (Haimovici and Andriguetto, 1986; Haimovici and Perez, 1991a, b). A series of groundfish surveys conducted between 1982 and 1987 by the R/V "Atlântico Sul" of the Rio Grande University (Table 1), collected both species between 33°45' and 30°43' S and the isobaths of 40 and 160 m. Specimens of *Eledone* were fresh-frozen or preserved on board, for comparative genetic and morphological studies (Haimovici, 1988; Levy *et al.*, 1988) and basic descriptions of their population structure, reproductive biology, and ecology (Perez *et al.*, 1990; Perez and Haimovici, 1991, 1995). A more detailed study on maturation and reproductive cycle was conducted on the larger and more commonly trawled *E. massyae* (*fide* Perez and Haimovici, 1991). Less information was available on the smaller and scarcer *E. gaucha*. Our observations on the reproductive biology of this species are summarized in this note.

A total of 88 males and 95 females of *Eledone gaucha* (Table 1) were fixed in 10% formalin and preserved in 70% ethanol. All specimens were weighed, measured (ML, dorsal mantle length) in millimeters, and their gonads and gonoducts dissected out and weighed to the nearest 0.1 g. Macroscopic maturity stages were assigned to males and females according to the scale proposed for *E. massyae* (*fide* Perez and Haimovici, 1991). For females the stages were: I, immature; II, early maturation; III, maturing; IV, advanced maturity. The female maturity scale does not consider fully mature or spawned ovaries, because these were not found in the samples. For males the stages were: I, immature; II, maturing; III, mature (with functional spermatophores in the spermatophore sac); IV, spent. In females, all eggs were counted and length measured to the nearest 0.1 mm and the presence of sperm sacs (evaginated spermatophores) and free sperm within the ovary were recorded as evidence of mating. In males, all spermatophores stored in the spermatophore sac were counted.

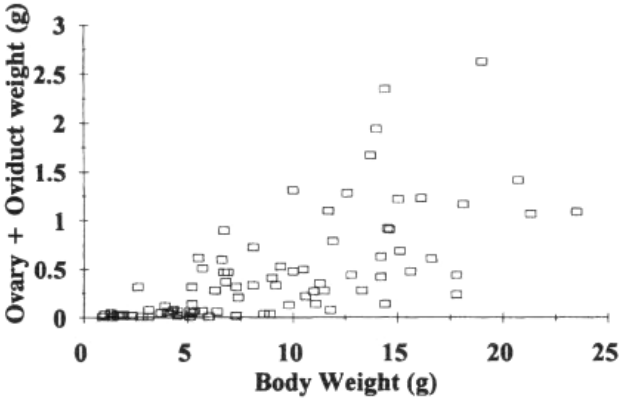

Fig. 1. Ovary and oviduct weight as a function of total body weight of female *Eledone gaucha* collected off southern Brazil.

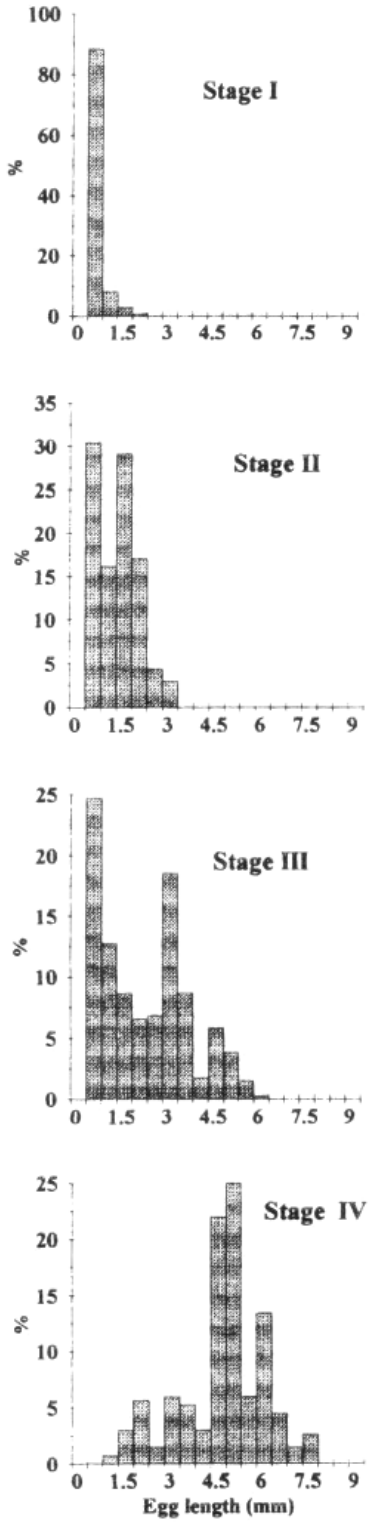

Fig. 2. Length-frequency distribution of ovarian eggs of female *Eledone gaucha* pooled by maturity stages: I, immature; II, early maturation; III, maturing; IV, advanced maturity.

Females ranged from 14 to 55 mm ML and 0.9 to 25.5 g wet weight (Table 1). The ovary and oviducts showed enlargement in females heavier than 5.0 g and reached a maximum of 17% of total weight, varying greatly at a given body size (Fig. 1). In the examined ovaries, most of the eggs enlarged at about the same time throughout maturation (Fig. 2). A bimodal distribution was observed in females at stage III. In the most advanced stage IV, most eggs concentrated around a single mode (5.0 mm). The largest eggs were *ca.* 7.4 mm long as observed in a female (14.4 g wet weight) caught in June 1980. Even these eggs, however, were longitudinally striated indicating that they were not fully mature. Neither mature nor spent females were caught during this study. Mated females, with free sperm and sperm sacks in the ovary, were caught in all sampled months mostly in females in advanced maturity stages. The smallest maturing female with evidence of mating was 16.6 mm ML with mean egg length of 0.84 mm.

The number of eggs present in the ovary ranged from 5 to 58 (n = 91, mean 35 ± 12.7 SD), and the relative fecundity (eggs per gram of total weight) ranged from 0.68 to 51.11 (n = 91, mean 7.4 ± 8.7 SD). No significant linear correlation was found between the number of eggs and female weight ($r = 0.031$; $p > 0.50$) or mantle length ($r = 0.035$; $p > 0.50$).

Males ranged from 14 to 47 mm ML and 1.2 to 17.8 g wet weight (Table 1). Genital bag (testis, spermatophore sac, and spermatophore glandular systems) enlargement had begun in males heavier than 3.0 g and larger than 22.0 mm ML, and reached a maximum of 9.5% of the total weight (Fig. 3). Spermatophores were observed in males as small as 20 mm ML. Half of the males carrying spermatophores in the spermatophore sac, however, were larger than 31 mm ML. A significant positive correlation

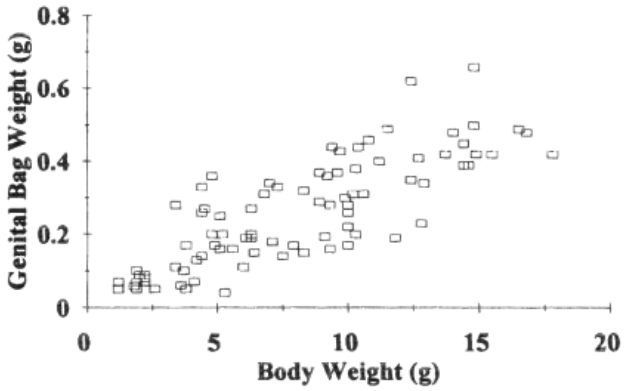

Fig. 3. Genital bag weight (testis, spermatophore glands, and spermatophore sac) as a function of total body weight of male *Eledone gaucha* collected off southern Brazil.

Table 1. Summary of *Eledone gaucha* samples collected in 11 surveys conducted from 1980 and 1985 off southern Brazil. n, sample size; ML, mantle length.

Year	Month	Depth (m)	Males			Females		
			n	ML (mm) min - max	Weight (g) min-max	n	ML (mm) min-max	Weight (g) min-max
1980	June	11-140	2	26	5.2 - 6.1	6	32 - 55	3.1 - 19.0
1980	July	40-120	2	30 - 34	8.9 - 14.8	0		
1981	April	13-89	6	24 -34	6.3 - 10.0	0		
1982	January	10-63	20	14 - 44	1.2 - 13.7	20	14 - 35	0.9 - 10.0
1983	April	13-122	17	18 - 34	2.6 - 10.0	17	15 - 41	1.4 - 14.4
1983	July	—	1	44	13.7	0		
1983	August	14-110	21	26 - 45	3.4 - 14.8	23	25 - 44	1.9 - 25.5
1983	November	10-100	4	17 - 47	1.2 - 17.8	7	31 - 47	1.9 - 18.0
1984	January	12-200	2	24 - 35	6.0 - 11.8	4	30 - 35	10.5 - 15.0
1984	November	10-197	8	20 - 43	2.2 - 16.8	7	41 - 49	14.2 - 25.5
1985	September	—	1	37	12.9	11	25 - 34	5.2 - 12.8
Totals			88	14 - 47	1.2 - 17.8	95	14 - 55	0.9 - 25.5

was found between the number of spermatophores stored in the spermatophore sac and male weight ($r = 0.522$; $p < 0.001$), mantle length ($r = 0.303$; $p < 0.005$) and genital bag weight ($r = 0.446$; $p < 0.001$). The maximum number of spermatophores observed in a single male was 82 (mean 23.9 ± 3.6 SD, n = 86). Males with spermatophores occurred in all sampled months.

The maturation cycle was assessed by the variation of the gonad index (gonad weight expressed as a proportion of the total wet weight) of individuals collected during all surveys pooled by month (Figs. 4 and 5). Octopods in both initial and advanced stages of maturation co-occurred in all sampled months. The pattern was less clear among males because young individuals were probably not well represented in the samples (Perez and Haimovici, 1995). Whereas the data suggest an overlap of generations within a year, the duration of the maturation cycle could not be defined. The pattern observed, however, could be an artifact of pooling individuals collected in different years by month, specially if the reproductive cycle is shorter than one year, such as that of other small octopodids (Forsythe, 1984). Because the data set available is scarce and sparsely distributed within the five-year period of sampling, an adequate test of the latter hypothesis was not possible.

The maturation processes of *Eledone gaucha* are consistent with those of *E. massyae* (*fide* Perez and Haimovici, 1991) and in the European species, *E. cirrhosa* (Lamarck, 1798) and *E. moschata* (Lamarck, 1798) (Mangold, 1983; Boyle and Knobloch, 1983; Moriyasu, 1988). Females reach maturity later and at a wider range of sizes than males. Females can mate while still not fully mature and store sperm in the apical filaments of the eggs until vitellogenesis is completed (Perez *et al.*, 1990). Mature and spent females were not vulnerable to the trawl

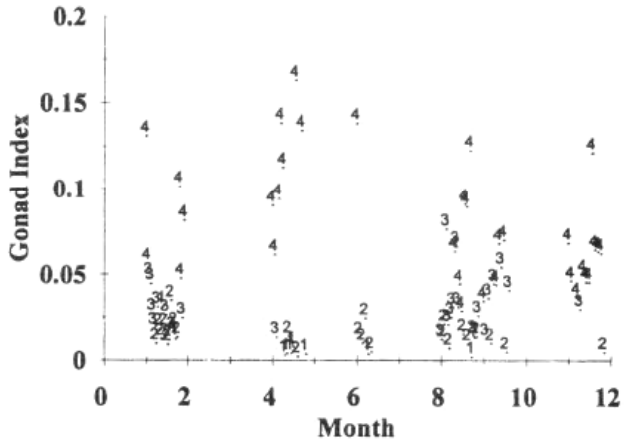

Fig. 4. Monthly variation of gonad indices of female *Eledone gaucha* collected off southern Brazil. The numbers represent maturity stages assigned for each individual: 1, immature; 2, early maturation; 3, maturing; 4, advanced maturity.

net. As pointed out in previous studies (Perez and Haimovici, 1991, 1995), this could relate to migration offshore, out of the study area, towards deep rocky bottoms suitable for spawning. Although few animals were present in each sample of *E. gaucha*, there was no evidence of seasonality in the reproductive cycle in contrast to that of *E. massyae*, in which mating and spawning were concentrated in the spring and autumn, respectively (Perez and Haimovici, 1991). In addition, as discussed in a previous study (Perez and Haimovici, 1995), more than one cohort of *E. gaucha* seem to overlap throughout the year, each of them with reproductive cycles of uncertain duration but possibly sub-annual. If confirmed, this feature plus dietary differences during the adult phase (Perez and Haimovici,

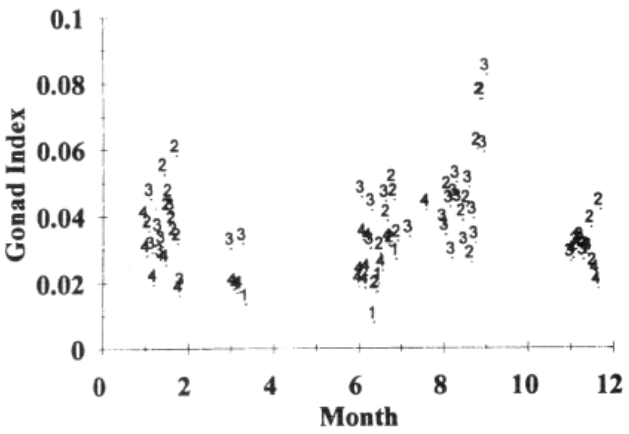

Fig. 5. Monthly variation of gonad indices of male *Eledone gaucha* collected off southern Brazil. The numbers represent maturity stages assigned for each individual: 1, immature; 2, early maturation; 3, mature; 4, spent.

1995) could allow ecological niche divergence between these two sympatric octopods.

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