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# BRIEF COMMUNICATIONS

## Juvenile recruitment, growth and maturation of *Lipophrys pholis* (Pisces: Blenniidae), from the west coast of Portugal

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Data on the juvenile recruitment, growth and size at maturation of *Lipophrys pholis* in Portuguese waters are compared with the information available on the biology of this species at higher latitudes. In Portugal, recruitment extends for a much longer period, young fish grow faster and sexual maturation is earlier than at higher latitudes. There is a delay of 2–3 months between the appearance of the first eggs on the shore and the recruitment of the first juveniles to the pools. 

Key words: recruitment; growth; size at maturation; breeding season; *Lipophrys pholis*; Blenniidae.

The biology of *Lipophrys pholis* (Linnaeus, 1758) has been studied intensively in the northern part of its range, especially around the British Isles (Qasim, 1957; Bowers *et al.*, 1961; Dunne, 1977; Shackley & King, 1977; Milton, 1983), where it breeds from March/April to August. *L. pholis* is a winter and spring spawner in Portugal (Almada *et al.*, 1990), in sharp contrast to the situation found around the British Isles. In this paper, we present data on the growth, size and age at maturity, and timing of juvenile recruitment of *L. pholis*, from the west coast of Portugal.

From January 1993 to June 1995, non-destructive samples were taken quarterly from 16 tide-pools at St Cruz (38°56′ N, 9°27′ W), and monthly from 27 tide-pools at Parede and São Pedro do Estoril (38°41′ N, 9°22′ W). During each inspection, all the fishes that could be collected with a 20-cm hand-net were taken from the tide-pool. For each fish, total length (TL), sex (when possible), and presence of ripe eggs in females, were recorded. The presence of ripe eggs in a female was assessed by a swollen abdomen, and the release of eggs when a gentle pressure was applied to the sides of the abdomen. After inspection, all fishes were returned to their original pool. The presence of nests and eggs on crevices and holes on the shore was also monitored during low tide. We used 31 nests that were mapped and visually inspected on a monthly basis, using the method described in Almada *et al.* (1990).

Additional sites were selected for destructive samples: Cabo Raso (38°42′ N, 9°29′ W) and Arrábida (38°28′ N, 8°59′ W). A total of 146 fishes (69 females and 77 males) was collected in November 1992, March, August, October and December 1993, and April 1994. An additional sample of 28 juveniles (fishes of the size classes 1–2 and 2–3 cm was collected in October 1993, at Parede. After collection, fishes were killed with an overdose of quinaldine and measured to the nearest mm. They were dissected immediately. Gonadal maturation assessment and otolith readings followed the methods described by Qasim (1957).

The breeding season lasted from October/November to May (Fig. 1). The first juveniles appeared in the pools in January/February, 2–3 months after the first eggs were

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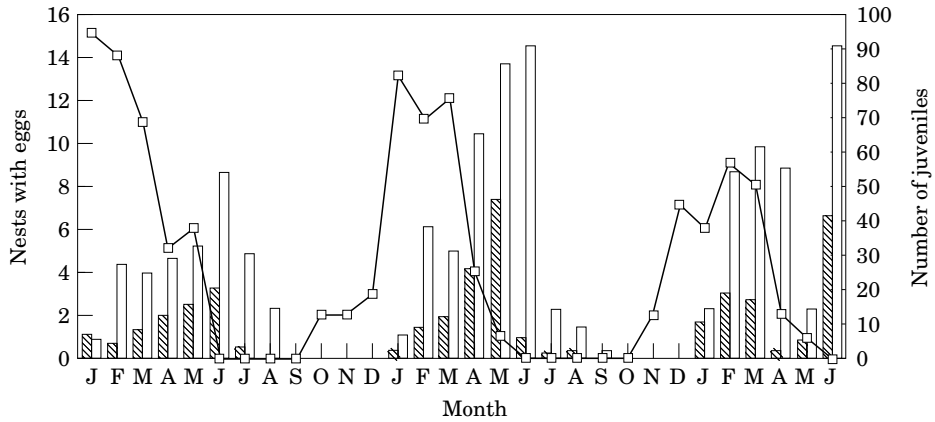


FIG. 1. Number of nests containing eggs (——) and number of juveniles of size classes 1–2 cm (▨) and 2–3 cm (□) observed in pools, from January 1993 to June 1995.

Table I. Size distribution (total length classes in cm) of fishes collected monthly in tide-pools, during 1993

| | 1–2 | 2–3 | 3–4 | 4–5 | 5–6 | 6–7 | 7–8 | 8–9 |
|---|---|---|---|---|---|---|---|---|
| January | 7 | 5 | 6 | 13 | 29 | 36 | 24 | 2 |
| February | 4 | 27 | 15 | 17 | 19 | 24 | 10 | 5 |
| March | 8 | 25 | 28 | 18 | 9 | 19 | 12 | 3 |
| April | 12 | 29 | 31 | 24 | 15 | 16 | 12 | 4 |
| May | 15 | 32 | 35 | 34 | 18 | 12 | 9 | 9 |
| June | 20 | 54 | 58 | 55 | 40 | 16 | 6 | 2 |
| July | 3 | 30 | 107 | 64 | 49 | 7 | 3 | 0 |
| August | 0 | 14 | 54 | 53 | 43 | 14 | 4 | 1 |
| September | 0 | 0 | 16 | 64 | 65 | 21 | 9 | 2 |
| October | 0 | 0 | 1 | 28 | 53 | 54 | 15 | 15 |
| November | 0 | 0 | 2 | 7 | 39 | 40 | 11 | 5 |
| December | 0 | 0 | 4 | 4 | 22 | 35 | 13 | 5 |

found. Their mean length was 2·27 cm (S.D. = 0·332; range 1·6–2·9 cm; $n = 188$). These fishes were still undergoing the transformation in colour pattern from larvae to juveniles, but were already benthic. Recruitment of fish <2 cm long ceased 3 months after the end of the breeding season. Fishes of 2–3 cm were absent after August/September.

The monthly size–frequency distributions did not differ significantly between years [Kolmogorov–Smirnov two sample test: (1993/1994) DN = 0·214, $P > 0{\cdot}05$, $n_{1993} = 1943$, $n_{1994} = 2540$; (1993/1995) DN = 0·231, $P > 0{\cdot}05$, $n_{1993} = 919$, $n_{1995} = 1114$], nor between sites (Kolmogorov–Smirnov two sample test: DN = 0·444, $P > 0{\cdot}05$, $n_{S.\ Pedro} = 820$, $n_{St\ Cruz} = 413$). Fishes that recruited to the pools in January could reach 7 cm by October (Table I). Some fishes, however, were still only 3–4 cm long in January, when the next recruitment started.

These results are consistent with the findings on otolith readings that showed that 0+ class fishes could reach 7·8 cm (mean = 4·21 cm; S.D. = 1·62; range = 2·0–7·8 cm; $n = 31$). The analysis of frequency distribution could not be extended to other year classes, since fishes >7 cm began to leave the pools (particularly after September), seeking other microhabitat types as shelter (e.g. crevices), where sampling is very difficult (unpublished data).

Qasim (1957) reports a mean size of 4·54 cm for 0+ fishes 6 months after recruitment. In our study area, 6 months after the months of strongest recruitment (April to June), the modal class was 5–6 cm long, which suggests that growth of 0+ fishes is faster than

in Britain. The mean sizes of fishes in our study area were also significantly higher for year-classes 1+ ($mean_{this\ study}$=8·73 cm, $n$=30; $mean_{Qasim}$=7·46 cm, $n$=118; $t$-test: $t$=7·084, $P$<0·001), 2+ ($mean_{this\ study}$=10·61 cm, $n$=60; $mean_{Qasim}$=9·47 cm, $n$=122, $t$-test: $t$=8·709, $P$<0·001) and 3+ ($mean_{this\ study}$=12·53 cm, $n$=26; $mean_{Qasim}$=11·46 cm, $n$=89; $t$-test: $t$=6·504, $P$<0·001) (sample sizes of older classes were too small to allow statistical comparison).

The previous studies of *L. pholis* at higher latitudes report that both sexes mature when they are 2–3 years old (Qasim, 1957; Dunne, 1977; Milton, 1983). All fishes of year class 1+ collected during the spawning season (three males and six females), proved to be mature upon gonadal inspection, and two of the males were found guarding eggs. Furthermore, we collected a total of 16 females of <8 cm (mean=7·09 cm; S.D.=1·71; range 6·2–7·8 cm), being presumably about 1 year old, containing ripe eggs.

Conover (1992) analysed the seasonal spawning patterns of inshore fishes at varying latitudes, and found that at higher latitudes breeding tends to start later and to end sooner. He proposed that at higher latitudes breeding should start when conditions become favourable for larval and juvenile growth. The end of the breeding season should come when the time available is too short for late-born juveniles to reach a size that ensures sufficiently high probabilities of survival during winter.

In *L. pholis*, a decrease in latitude is related to a lengthening of the breeding season and of the period of juvenile recruitment. This lengthening is due mainly to a very marked advance in the onset of breeding. Similar results were obtained for *Coryphoblennius galerita* (Linnaeus, 1758), *Gobius paganellus* (Linnaeus, 1758) and *Gobius cobitis* (Pallas, 1814) (Almada *et al.*, 1996; Faria & Almada, 1995). These results agree with the model. In *L. pholis*, however, the end of the breeding season occurs earlier in Portugal, which is not explained by the model.

Many of Conover's findings are concerned with Cyprinodontiform fishes that often die after 1 year of adult life. However, for species with a longer reproductive life, like *L. pholis*, it is probably important to limit the duration of each breeding season in order to restore reserves and to allow growth of the adult itself, since fecundity tends to increase with body size (Wootton, 1990). In many fishes, the attainment of sexual maturity does not occur at a fixed age, but rather when the fishes reach a minimum critical size (Miller, 1979; Wootton, 1990). The juveniles of *L. pholis* that are born in the summer in Britain only have a few months of fast growth before the winter comes, and it is likely that they are too small to respond to the eventual environmental cues that initiate gonadal maturation. Juveniles recruited in early winter in Portugal, are probably able to reach the minimum size necessary to respond to those stimuli, since they could grow almost without interruption for many months.

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