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Larval and juvenile rearing of common sole (*Solea solea* L.) in the Northern Adriatic (Italy)

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Abstract

Research on the rearing cycle of the common sole, *Solea solea*, was done at an experimental hatchery in the Lagoon of Venice (Italy). The aim was to develop rearing schedules suitable for market production and document any technical problems. Larval metamorphosis studied on 9 groups of larvae reared at 18 °C demonstrated high temporal variability. Caudal metamorphosis and eye migration occurred between 9 days after hatching (DAH) and 24 DAH, and between 13 DAH and 25 DAH, respectively. A larval rearing schedule based on live-food feeding was set at 18–19 °C, which achieved an average survival rate of 40% at 28 DAH.

Three weaning trials comparing two commercial feeds were carried out on larvae about 30 DAH. One of these feeds was sufficient in itself to complete juvenile weaning, reaching average survival rates of 85%, which are comparable to those obtained in the control groups fed with live *Artemia*. Average survival rates of 43% were obtained with the second commercial feed. Both commercial feeds enabled superior juvenile growth on average to that in the control groups.

An on-growing trial in extensive conditions was done in an earthen pond of 370 m^2, stocking juveniles with an average weight of 3.6 g at a density of 1.5 juveniles/m^2. The trial started in mid-September and lasted until the following August, when it was stopped because of high mortality due to viral encephalopathy and retinopathy infections. Growth was negligible during winter and began again in spring, reaching the maximum incremental rate between May and June, at temperatures of between 20 and 25 °C. The specific growth rate never exceeded a daily value of 2%, while the average final size reached after 10 months rearing was 12 g.

A double replicate trial of intensive rearing was carried out starting with soles of 7 g, reared at a density of 150 juveniles/m^2 in circular fibreglass tanks of 10 m^2 surface. This trial was also stopped during the following summer because of the considerable mortality due to viral infection. The soles had reached an average size of 54 g in August, after 300-day rearing.

Sole can be bred and reared with good efficiency related to its survival rate, but the results of the growth trials, both intensive and extensive, do not allow conclusions to be made on the growth performance in the experimented conditions. The health problems compromised the growth trials towards the middle of the favourable growing season. The trials highlight both the high susceptibility of sole to viral encephalopathy and retinopathy infections, and the scarce tolerance of this species to temperatures of above 25 °C, which caused the onset of frequent bacterial infections.
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Keywords: *Solea*; Larval rearing; Metamorphosis; Weaning; On-growing

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1. Introduction

The common sole (*Solea solea* L.) is a species appreciated by the market and is a candidate for rearing on a commercial scale, although no significant productions presently exist in Italy. Some studies on different aspects of the biological development and husbandry of this species have been published, most of which were aimed at formulating a diet suitable for supporting high sole larvae survival through the critical weaning stage (Bromley, 1977; Mackie et al., 1980; Métailler et al., 1981; Cadena Roa et al., 1982; Métailler et al., 1983; Appelbaum, 1985; Day et al., 1997). There are few data on the growth performance of common sole and almost none for the on-growing stage of the rearing cycle. Howell (1997), in an interesting analysis of the literature, pointed out that nutritional requirements and bacterial pathologies represent the technical difficulties which researchers must overcome in order to encourage the farming of sole. More recently, Imsland et al. (2003) published a review of the culture potential of *S. solea* in comparison with *Solea senegalensis*. More information is available on the commercial husbandry of *S. senegalensis* (Dinis et al., 1999; Imsland et al., 2003), but this flatfish presents important differences in growth performance and optimal thermal regime.

Our research focused on survival and growth performances of common sole in mass culture conditions, starting with the fertilised eggs and continuing the trials for 18 months. The aim was to apply rearing techniques commonly adopted in commercial fish farming, adapting them to sole on the basis of the information reported in the scientific literature. The aim was to propose suitable rearing methods for common sole farming and also to verify the data, generally obtained from small-scale trials, reported in the literature.

Several groups of larvae were also studied in order to describe morphological and chronological development of the larvae through metamorphosis. Larval survival was assessed in a large-scale hatchery, supplying technical feeding regimes based on live food and weaning diets available on the market. Juveniles were reared in extensive and intensive conditions, testing growth performances and tolerance to environmental conditions in the northern Italian lagoons.

2. Material and methods

The research was performed in the Veneto Agricoltura hatchery sited in the lagoon of Venice (Northern Adriatic). All tanks utilised in the experiment, except the extensive pond, were integrated in recirculation systems with a total volume of about 50 m^3 each and equipped with mechanical–biological filters. Salinity ranged from 33‰ to 35‰.

The trials were designed to collect data on survival and growth rates of common sole through both the larval and juvenile stages. Methods based on the current state of knowledge were tested and adapted to make them suitable for large-scale productions, according to the following sequence:

- larval rearing from fertilised egg until 28 days after hatching (DAH), adopting a feeding regime based on live food only;
- weaning trials performed on juveniles aged 30 and 40 DAH using commercial weaning diets;
- juvenile growth for about 12 months in extensive and intensive stocking conditions.

2.1. Larval rearing

After a series of preliminary trials, a feeding regime was obtained that guaranteed high survival rates even in groups of larvae of different ages (Fig. 1). The efficiency

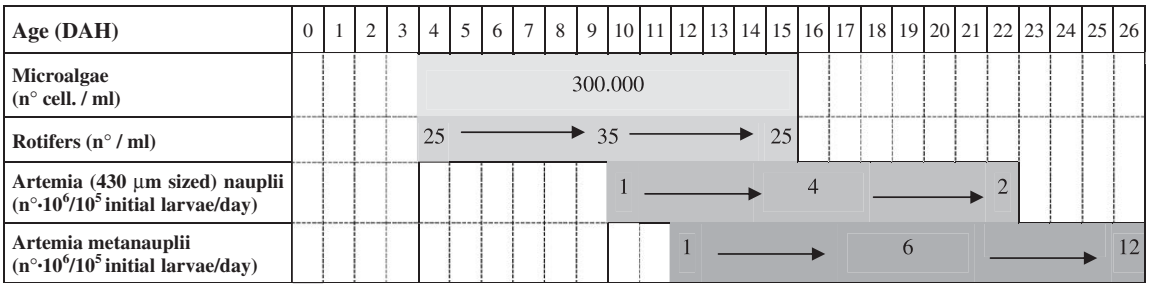

Fig. 1. Feeding schedule adopted for larval rearing until 28 days after hatching (DAH), microalgae and rotifers densities were maintained at the values reported throughout the day.

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