Turkish Journal of Fisheries and Aquatic Sciences 4: 01-04 (2004)

# A Preliminary Study on the Effects of Different Light Intensities on Hatching of European Squid (*Loligo vulgaris* Lamarck, 1798) Eggs

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Received 15 July 2004
Accepted 22 October 2004

**Abstract**

In this study, effects of different light intensities on development and hatching success of European squid (*Loligo vulgaris* Lamarck, 1798) eggs were investigated. In the experiments, *L. vulgaris*'s eggs were separately incubated at 600 lux, 140 lux, 33 lux, 9.5 lux, and 2.5 lux light intensity levels for 24 h. During the experiments, sea water temperature and salinity were measured as 14.3±1.8°C and 37±0.5 ppt. The hatching occurred between 36 and 49 days at 600 lux, 39 and 54 days at 140 lux, 39 and 53 days at 33 lux, 43 and 61 days at 9.5 lux, and 40 and 55 days at 2.5 lux light intensity levels. The maximum hatching rates and hatching success of the eggs were determined as 99.7% at 33 lux and 95.2% at 9.5 lux, respectively.

*Key Words: Loligo vulgaris*, squid, egg, hatching, light intensity.

## Introduction

*Loligo vulgaris* (Lamarck, 1798) is one of the most common squids along the northeastern Atlantic and the Mediterranean coasts (Worms, 1983), as well as the Aegean Sea coasts (Mangold and Boletzky, 1987; Salman *et al*., 1997; Akyol and Metin, 2001). It is distributed at depths between 20 and 250 m and is found from 55° N to 20° S (Roper *et al*., 1984).

Embryonic development and hatching of *L. vulgaris* are well known at different incubation temperatures; after spawning, hatching occurs 28 days at 22°C (Naef, 1928), 45 days at temperatures slightly above 14°C and this duration takes 21 days at 22.5°C (Jecklin, 1934), 40 to 45 days at 12-14°C, 26-27 days at 22°C and 30 days at 17°C (Mangold-Wirz, 1963), 40 days at 15°C (Boletzky, 1974), 70 days at 10°C and 25 days at 20°C (Boletzky, 1987).

Egg masses of *L. vulgaris* occur in capsules of 60-160 mm in length and each string contains 50 to 130 eggs (Mangold-Wirz, 1963; Marthy and Aroles, 1987; Martins, 2001). Egg diameter ranges in size for *L. vulgaris* between 2.0 and 2.7 mm (Boletzky, 1987; Naef, 1928, Worms, 1983).

Light intensity has an important effect on hatching and development of marine fish eggs. For this reason, marine fish eggs are mostly incubated at dark conditions during this period. Several studies were performed on rearing of *L. vulgaris* (Boletzky, 1974; 1979; 1987; Turk *et al*., 1986; Villanueva, 1994; 2000), however, the effects of different light intensities on the hatching of *L. vulgaris* were not studied.

The aim of this study was to determine effects of different light intensities on development and hatching of eggs in *L. vulgaris* under controlled conditions.

## Materials and Methods

Egg capsules of *L. vulgaris* were collected from local fishermen inshore of Izmir Bay on December 16, 2001. Experiments were carried out in the indoor facilities of the Fisheries Faculty at Ege University, Izmir, between December 16, 2001 and February 15, 2002. During the experimental period, embryonic developmental stages of the eggs were observed under a binocular microscope (20-40X magnification, NOVEX AP-RANGE) at regular intervals. Naef's (1928) and Arnold's (1965) criteria were used to describe the embryonic development stages of the eggs. The Arabic numeral stage represents the stage proposed by Arnold (1965) and the Roman numeral stage represents the stage proposed by Naef (1928), and at the beginning of the experiment, embryonic development stage of the eggs was determined as stage 12 (III), or the early gastrulation stage.

A total of 25 egg capsules were separated into 5 clusters of 5 capsules each, and they were divided into 5 groups based on experimental light intensity levels (600 lux, L1; 140 lux, L2; 33 lux, L3; 9.5 lux, L4; and 2.5 lux, L5). These levels were measured 1 cm below the water surface in the experimental tanks by LI-400 data LOGGER LI-COR. The results were obtained in $\mu mol.s^{-1}.m^{-2}$, then they were converted to lux. All experiments were started at the same water temperature (15.5°C) and were maintained at seawater temperature during the experimental period. The egg capsules were separately hung on strings in the 10-litre incubators, which had been placed

previously in cylindrical polyester tanks (900 L) with a continuous flow-through filtered sea water supply (90 $L.h^{-1}$) and aeration. Tungsten bulbs were used to illuminate the experimental tanks, which were located 50 cm above the water surface of the tanks, and a dimmer was used for adjusting light intensities. The tanks were isolated from natural light using black polyethylene or PVC curtains, and 24 hour photoperiodicity was applied.

The length of the incubation period (D), total hatching [TH = (number of hatching eggs / number of incubated eggs) * 100], and hatching success [HS = (number of viable paralarvae / number of incubated eggs) * 100] of the eggs were estimated for each experimental group. New hatchlings (paralarvae) were removed from the tanks and counted daily. Dorsal mantle lengths (DML) of the paralarvae were also measured.

The lengths of the egg capsules were measured with a measurement board (±1 mm), egg dimensions and DML of paralarvae were measured using a millimetric ocular, and the number of eggs per capsule was counted by macrometric observation. The obtained data were given as mean ± sd values in the text. Differences between grouped data were analyzed by the $\chi^2$ test.

## Results

During the experiments, water temperature levels were regulated by incoming sea water and ranged between 8°C and 16.9°C. Mean temperature value was recorded as being 14.3 ±1.8°C (Figure 1). The mean ± sd. values of the egg capsule lengths, egg dimensions, and DML of the paralarvae are given in Table 1.

Embryonic development of the eggs was investigated in all experimental groups. Hatching took place between 36 and 49 days in L1, 39 and 54 days in L2, 39 and 53 days in L3, 43 and 61 days in L4, and 40 and 55 days in L5, so that D in L1, L2, L3, L4, and L5 was estimated as 49, 54, 53, 61, and 55 days, respectively (Figure 2).

TH of the eggs was calculated as 84.4% in L1, 92.6% in L2, 99.7% in L3, 99.5% in L4, and 98.7% in L5. HS of the eggs was estimated as 28.2% in L1, 54.2% in L2, 67.6% in L3, 95.2% in L4, and 58.5% in L5.

It was found that there were significant differences between HS in all experimental groups ($\chi 2$ test; $p<0.05$). The hatching periods in L1, L2, L3, L4 and L5 were found to be 13 days, 15 days, 14 days, 18 days and 15 days, respectively (Figure 3).

**Table 1.** Mean ± sd. values of the egg capsules length, the egg dimensions and the DML of paralarvae

| Values | CL (mm) | EL (mm) | EW (mm) | $E.C^{-1}$ | DML(mm) |
|---|---|---|---|---|---|
| N | 25 | 30 | 30 | 2036 | 30 |
| Min. | 110 | 2.36 | 1.64 | 53 | 2.56 |
| Max. | 175 | 2.8 | 1.88 | 116 | 3.0 |
| $\overline{X}$ | 146 | 2.54 | 1.8 | 81.4 | 2.74 |
| Sd | 18.5 | 0.12 | 0.07 | 19.7 | 0.09 |
| V | 12.7 | 4.7 | 3.9 | 24.2 | 3.3 |

$\overline{X}$, mean; Sd, stardart deviation; V, coefficient of variance; CL, capsule length; EL, egg length; EW, egg width; $E.C^{-1}$, number of eggs per capsule).

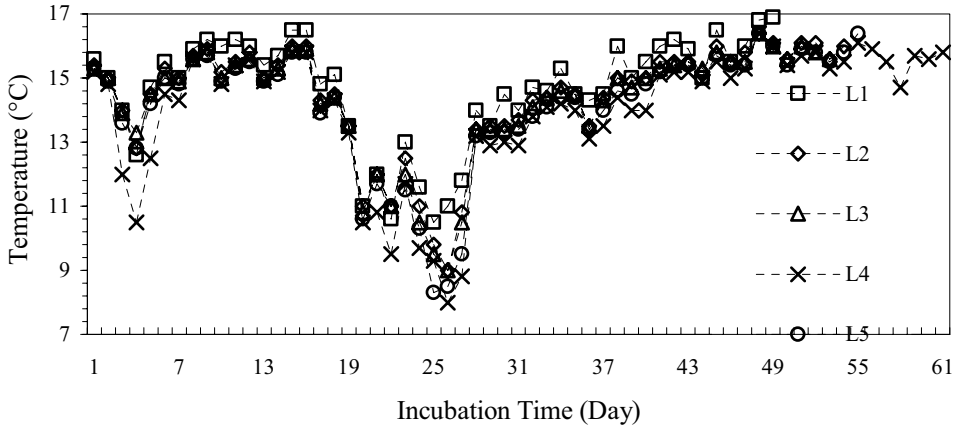


**Figure 1**. Evolution of the water temperature in the experimental groups in during the study.

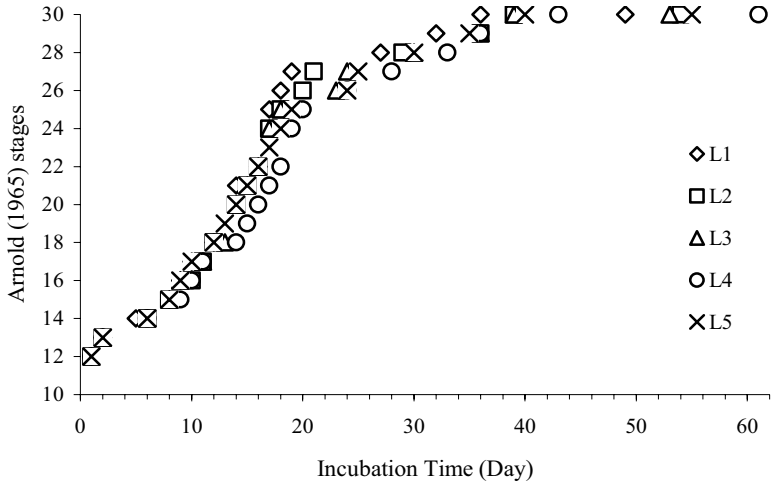


**Figure 2.** The embronic development of *L. vulgaris* from stage 12 (III) to hatching according to the Arnold (1965) stages.

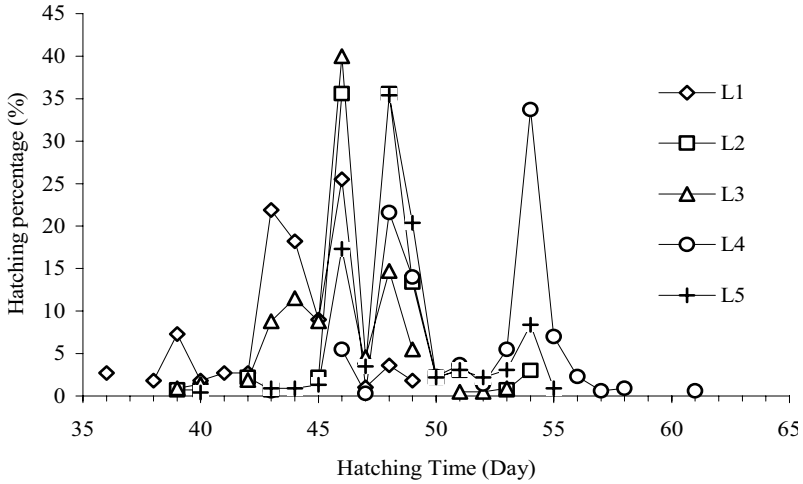


**Figure 3.** Percentages of newly hatchlings in the experimental groups.

## Discussion

Although light intensity affected the eggs' hatching success rate, it did not affect the embryonic development period or length of time between the developmental stages. However, it was observed that the duration of embryonic development and developmental stages were related to incubation temperature. The last finding has been previously stated by many researchers (Naef, 1928; Jecklin, 1934; Mangol-Wirz, 1963; Boletzky, 1974; 1979; 1987).

In this study, the average of the egg capsule lengths was close to the findings of Mangold-Wirz (1963), the egg numbers per capsules were detected were slightly similar to Mangold-Wirz (1963), Marthy and Aroles (1987) and Martins (2001), and the egg dimensions were determined to be closer to the results of Naef (1928), Worms (1983) and Boletzky (1987).

In the present paper, the DML of hatchlings (2.74 ±0.09 mm) was detected to be smaller than those measured by Turk *et al*. (1986) (3.4 mm) and Villanueva (1994) (3.06 mm); this result might stem from regional differentiation and the size of breeders. In other species of the genus, the DML of hatchlings differs widely, from rather small (1.8 mm in *L. pealei*; Summer, 1983) to medium size (2.7 mm in *L. opalescens*; Hixon, 1983), to large and very large (3.9-4.9 mm in *L. forbesi*; Hanlon *et al*., 1989).

In present study, the incubation periods were determined to be close to those of Mangold-Wirz (1963) and Jecklin (1934), but longer than that of Boletzky (1974); high variation of the experimental temperature level (8-16.9°C) might have caused this result.

In conclusion, the present results demonstrated

that there is an inverse relationship between light intensity and the hatching success of *L. vulgaris* eggs. The TH of eggs was calculated to be above 84% for all groups, but the HS was determined to be lower than 30%; probably, these results were obtained due to the effects of light intensity. However, the reason why the HS of L4 was higher than that of L5 could not be fully understood. This may be due to the occurrence of some undetected changes in the experimental conditions in L5. However, more detailed studies on this subject should be performed in the future.

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