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THE USE OF STATOLITHS IN AGE DETERMINATION OF THE LONG - FINNED SQUID, LOLIGO VULGARIS (CEPHALOPODA: LOLIGINIDAE)

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ABSTRACT

This paper presents some information on the ageing of *L. vulgaris*, using the increment countings on statoliths. The increments were identified using a semi-automatic image analysis system and a light microscope. The results of this study indicate that the dorsal mantle length is significantly correlated with both, the statolith length and the increment numbers. However there are differences in respects to total statolith length when comparing male and female statolith growths.

The growth rate of the statolith decreases with the growth. This result is related with the onset of the sexual maturation.

Key words: *Loligo vulgaris*, ageing, statoliths, growth, South Portugal

Introduction

The long-finned squid, *Loligo vulgaris*, is the most important loliginid species, in terms of total landings in southern Portugal.

Studies on the biology of this species (Natsukari & Komine, 1992; Coelho *et al.*, 1994; Rocha, 1994) indicate that *L. vulgaris* is a species with a short life cycle, and both, the variability of the growth rates and the extended spawning season contribute to a complex structure of the populations.

Published information on the age determination of *L. vulgaris* is restricted to Natsukari & Komine (1992) and Guerra & Rocha (1994). These studies show that the analysis of the increments of the statoliths can be used in the ageing of this species.

This paper provides complementary information on the use of the statoliths in the age determination of *L. vulgaris*. The general morphology of the statolith is provided and the number of increments are related with statolith length, sex and maturity stages of the individuals.

Materials and methods

A total of 419 long-finned squid was collected from commercial catches in Olhão (southern Portugal) during March and May 1993 and from July to September 1993.

The distance between the antero-dorsal protuberance and the apex of the tail fin (DML) was measured to the nearest 1 mm.

The maturity stages were accessed according to Ngoile (1987) for both sexes.
The statoliths were removed and measured the total statolith length with a binocular dissecting microscope. After that, the statoliths were grinded and polished on both sides, using a commercial sand paper with 30 mm and 1 mm grain, respectively.

A semi-automatic image analysis system and a light microscope have been used to identify the growth increments in the right statolith, from the hatching ring to the end of the rostrum. According to Guerra *et al.* (1993), the statoliths that presented more than 20% with white zones were rejected. A total of 161 statoliths has been used in the age readings. The hypothesis of the daily deposition of the increments was assumed in this study.

The DML was related with the total statolith length (TSL) and with the increment number (IN), for males and females, separately. The statolith length (TSL) was related with the increment numbers (IN), irrespectively of the sex or the stage of maturity. The growth index (GI) of each statolith (GI=TSL/IN x 100) was related with the DML in the immature and in the mature individuals, separately.

The regression lines were fitted by the least squares method and compared by covariance analysis and the F test (Sokal & Rohlf, 1981).

Results

The statoliths of *L. vulgaris* show prominent dorsal and lateral lobules, and a long and finger-like rostrum. The wing is white and easily removed from the remaining statolith.

The statolith length ranged from 0.93 mm (DML=32 mm) to 2.24 m (DML=345 mm) and from 1.16 mm (DML=101 mm) to 2.16 mm (DML=386 mm), for females and males, respectively.

Figure 1 shows the relationship between the DML and the TSL. There is a significant correlation between these two variables, with higher values of r^2 (0.80) for the females. The regression equations fitted are significantly different between males and females ($F=14.78$; $p<0.0001$).

Figure 2 shows the relationship between the DML and the IN, for males and females. No differences were found ($F=0.78$; $p>0.38$).

Figure 3 shows the relationship between the TSL and the IN. No differences were found between males and females ($F=0.57$; $p>0.45$).

Figure 4 shows the relationship between the GI and the DML, for immature (figure 4a) and mature individuals (figure 4b). The regression coefficient indicates that the growth rate of the statoliths is higher in the immature animals, decreasing in mature squids.

Discussion

The preparation of the statoliths is a highly time consuming task. Nevertheless, the analysis of the statoliths seem to be the most appropriate approach in the ageing of *L. vulgaris*. The use of both, the image analysis system and the light microscope is strongly suggested for this type of analysis.

This study indicates that the males live longer than the females and that the statolith grow faster in the former and slower in the latter. Similar results are referred to by Lipinski & Durholtz (1994) for *L. vulgaris reynaudii*. Thus, the statolith length can be considered as an indicator of the age of the individuals.

The growth index of the statolith decreases gradually with the growth of the individuals, particularly between the immature and the mature period. This result might be related with the onset of the sexual maturation and with higher energetic demand caused by the growth of the gonads. Similar results are described for other cephalopods by Guerra &

Sanchez (1985), Morris & Aldrich (1985), Lipinski (1986), Arkhipkin & Scherbich (1991) and Raya (1994).

Due to the high unreadable number of increments which were observed in the statoliths of *L. vulgaris*, it was concluded that, the accuracy of the age readings depends on the proper mounting, grinding and polishing of the statolith. So, great care is necessary during these tasks. Furthermore, the increments have been considered as daily growth rings. Further investigation is necessary to validate this assumption.

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References

Arkipkin A.I. and Scherbich Z.N., 1991. Crecimiento y estructura intraespecifica del calamar, *Illex argentinus* (Castellanos, 1960) (Ommastrephidae) en invierno y primavera en el Atlántico sudocidental. *Scienta Marina* **55(4)**: 619-627.

Coelho, M. L.; Quintela J.; Bettencourt V.; Mattos Silva G.& Villa H. 1994 Population biology of the squid *Loligo vulgaris* in the coastal waters of the Algarve, Southern Portugal. *Fisheries research* **(21)**: 87 - 102.

Guerra A. y Sánchez P., 1985. Crecimiento relativo del estatolito de *Sépia officinalis* (Cephalopoda, Sepioidea) de la Ria de Vigo. *Investigatión Pesquera,* **49(4)**: 545-557.

Guerra A., Rocha F., and Castro B. G., 1993. *Statolith Workshop.* Eurosquid Report. Vigo, 30 June - 2 July, 1993. Instituto de Investigaciones Mariñas (CSIC), Vigo. Spain: 10pp.

Guerra A., Rocha F., 1994. The life history of *Loligo vulgaris* and *Loligo forbesi* (Cephalopoda: Loliginidae) in Galician waters (NW Spain). *Fisheries research* **(21)**: 43-69.

Lipinski M. R. and Durholtz M. D., 1994. *Problems associated with ageing squid from their statoliths: towards a more structured approach.* In: Rodhouse P. G., Piatkowski U. & Lu C. C., (eds.). Southern Ocean cephalopods: life cycles and populations. *Antartic Science,* **6**: 215-222.

Morris C. C. and Aldrich F. A., 1985 Statolith length and increment number for age determination in squid *Illex illecebrosus* (Le Sueur, 1821) (Cephalopoda: Ommastrephidae) *NAFO Sci. Counc. Studies,* **9**: 101-106.

Lipinski M., 1986. Methods for the validation of squid age from statoliths. *Journal mar. biol. Ass. U.K.,* **66(2)**: 505-526.

Natsukari, Y and Komine, N., 1992. Age and growth estimation of the European squid, *Loligo vulgaris*, based on statolith microstructure. *J. Mar. Biol. Assoc. UK,* **(72)**: 271 - 280.

Ngoile M. A. K., 1987. *Fishery biology of the squid Loligo forbesi (Cephalopoda: Loliginidae) in Scotthis waters.* Tesis Doctoral, Universidad de Aberdeen, 218 pp.

Raya C.P., Fernandéz-Nuñuz M.M., Balguerias E. and Hernández-González C.L. , 1994. Progress towards ageing cuttlefish *Sepia hierreda*, from Northwestern African coast using statoliths. Marine Ecology Progress Series, 114: 139-147.

Rocha, F. 1994. *Aspectos biológicos y ecológicos de Loligo vulgaris y L. forbesi (Cephalopoda, Loliginidae) en las costas de Galicia (NW de España).* Tesis Doctoral. Universidad de Oviedo. 240 pp.

Sokal R. R. and Rohlf F. J., 1981. *Biometry*. 2 nd. Ed. W. H. Freeman and Company. N. Y.: 859pp.

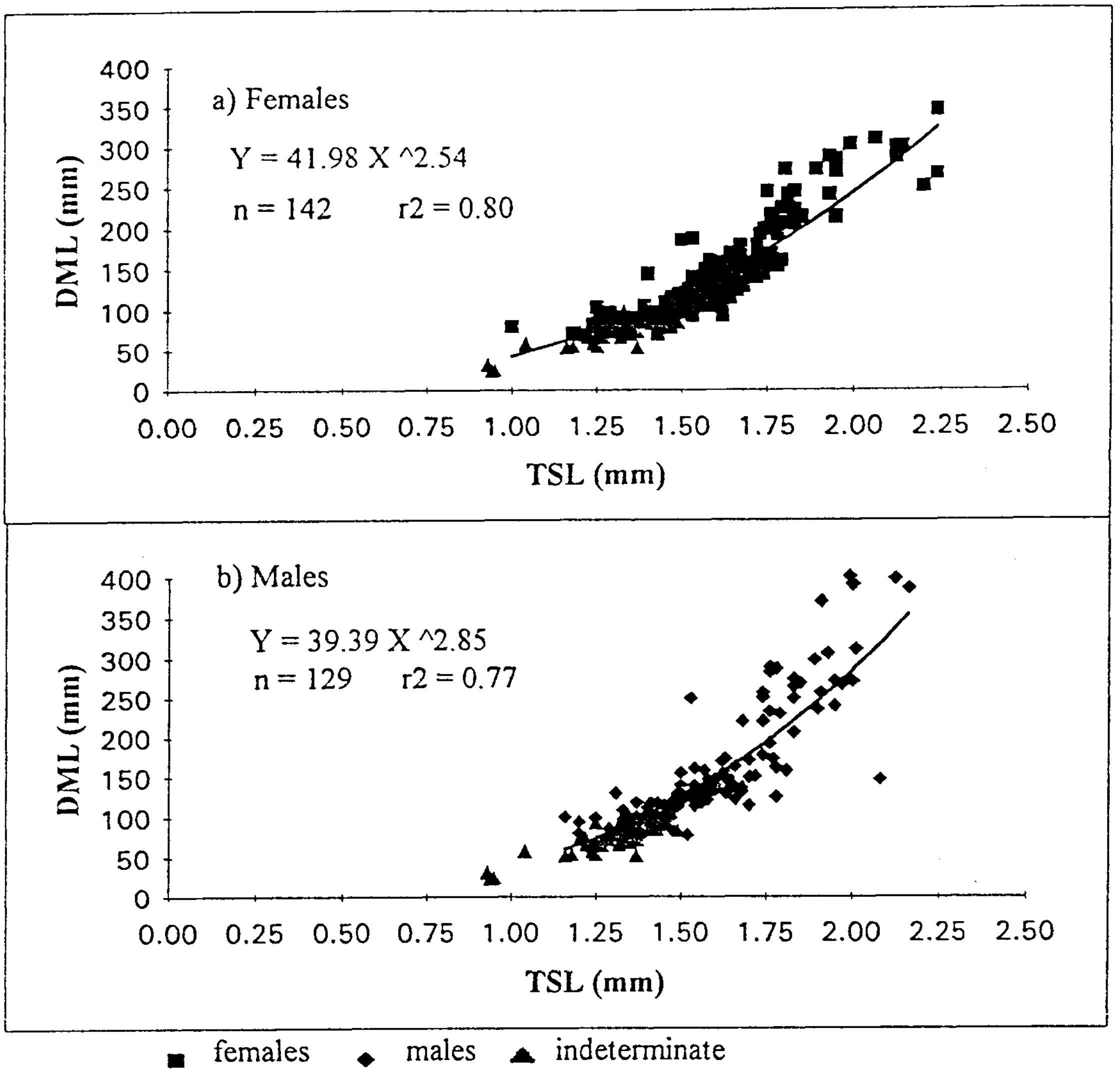


Figure 1 - DML - TSL relationship from a) females and b) males.

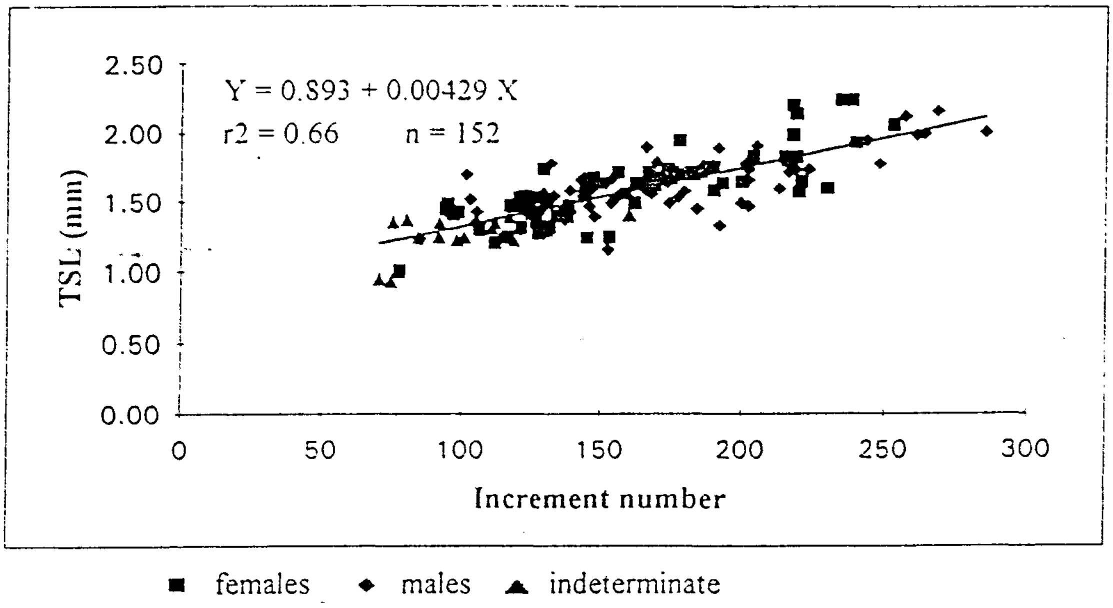
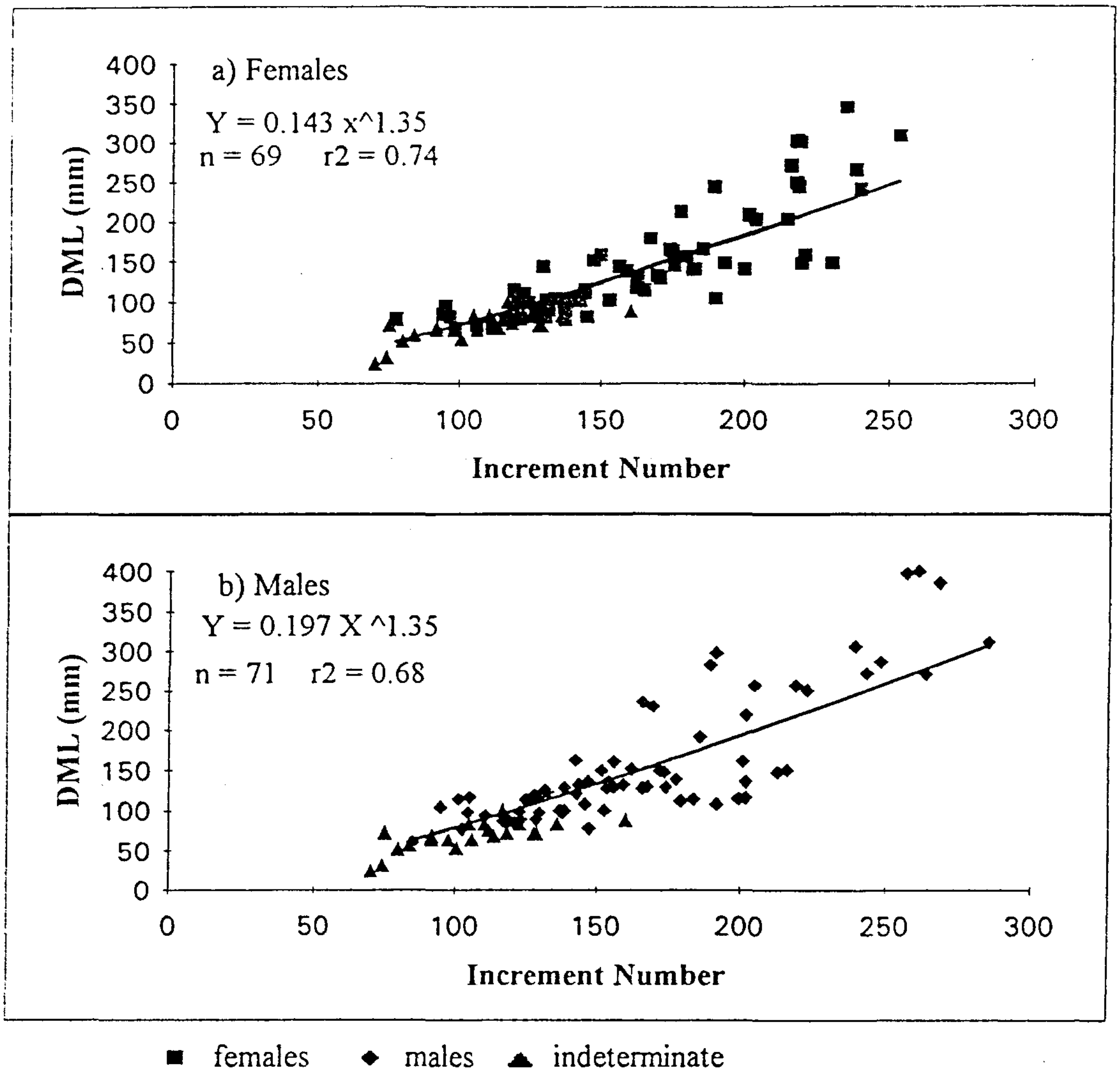


Figure 3 - TSL - IN relationship to total individuals.



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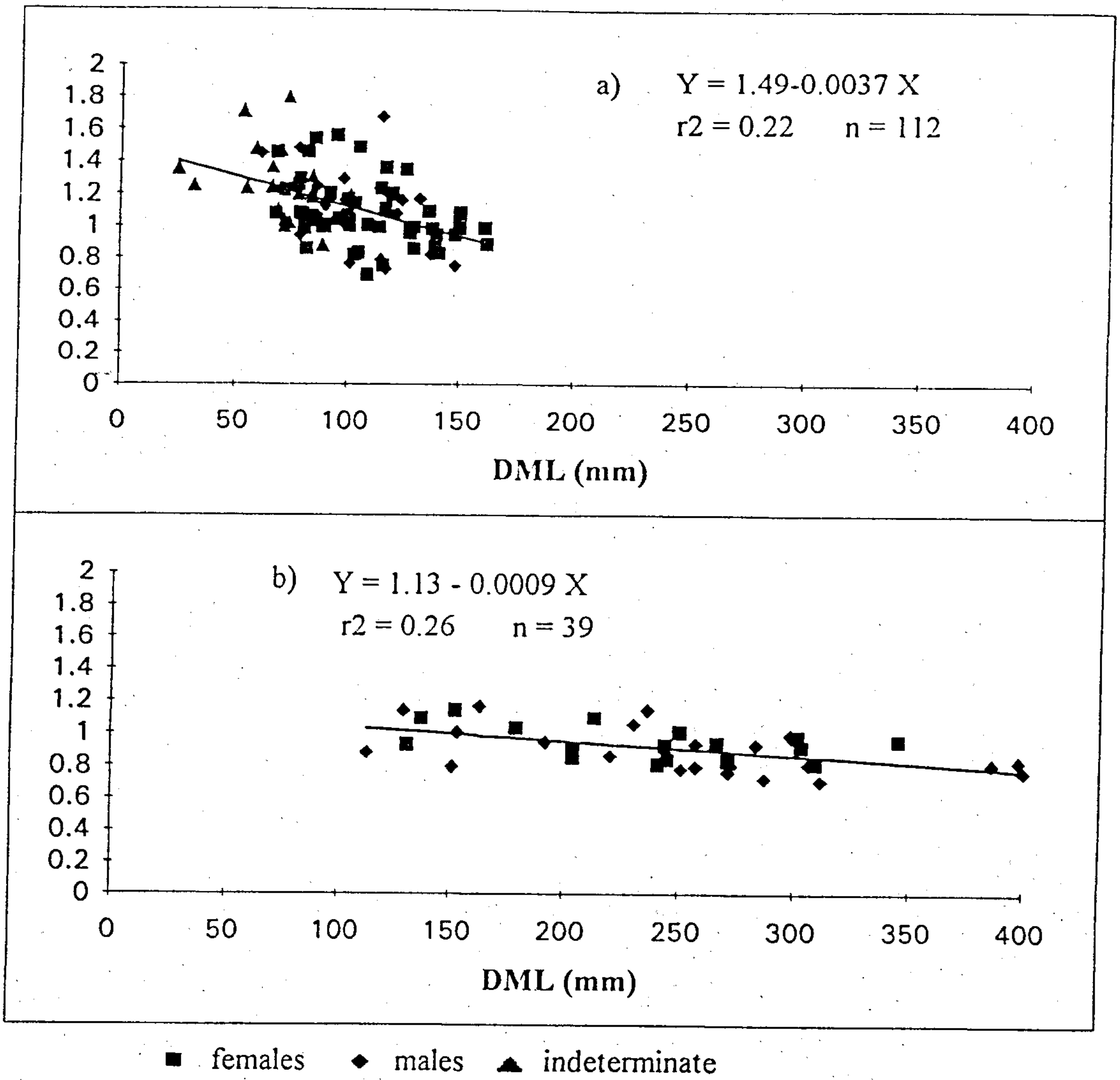

Figure 4 - Growth index of the statolith: a) juveniles imatures and b) adults matures