Assessing life-cycle and longevity of cold water octopods (Cephalopoda: Octopoda) using growth marks on hard body structures

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Introduction
Life cycle investigations on cephalopods have focused mainly on commercially important species and octopods. Age and growth studies for these sea-sentinel marine molluscs are based on the interpretation of growth marks in hard body parts such as statoliths, gladius, beaks and styles. For several species, the periodicity of incremental deposition has been validated to be daily (Adelung, 2003; Hernández et al., 2010; Rodríguez-Dominguez et al., 2013). Most studies to date have focused on shallow and warm water species. These studies revealed fast growth and short life spans, the latter exceeding 2 years. However, many cephalopods inhabit deep-sea and polar regions and for these species few attempts to determine longevity and growth rates have been made. Recent studies on the reproductive attributes of deep-sea octopods, show exceptionally long brooding times (Robinson et al., 2014) and more than one reproductive cycle (Pa vene, 2015), both suggesting that these animals may live much longer than their shallow and warm water relatives. In order to assess how vulnerable or flexible deep water cephalopods are, and how they can cope with environmental change, it is crucial to understand their life cycle length and pace.

The objectives of this ongoing study are:
- to test the hypothesis that octopods inhabiting cold waters (pelagic, deep sea and benthic: Antarctic) live longer and grow slower than warmer water species, by determining which hard body structures are suitable for interpretation and quantification of growth marks in cold water octopods,
- to compare life length and growth in octopods with different modes of life (benthic, pelagic, benthopelagic) and phylogenetic groups (cirrate, incirrate, vamponomorph).

Aim

Benthic Antarctic octopods: Pteroctopus oregonensis, Mesodactylus setiferus, Norway-giant octopus

Polagic deep-sea octopods: Bathyteuthidae and Lampyroteuthis infantula.

Material

Beaks

The interpretation and quantification of growth marks in the surfaces of the beak lateral walls (LWS) and central sulcal sections (RSS) followed the methods described by Hernández-López et al. (2001) and Pérez-Raya et al. (2010).

Stylists

The optimization of the technique for visualization of growth marks in stylists is still in progress but will follow the method developed by Barratt (2010).

Results

The first results demonstrate that it is not possible to observe and quantify growth marks on the LWS in all species and specimens analyzed. Of the 34 beaks selected for methodology development, only 26 were readable, and it was impossible to visualize increments in the LWS of M. setiferus. Only in M. rigbyae, RSS preparations produced observable growth marks. Depending on the degree of beak segmentation, we used reflected or transmitted light under stroboscopic, from 50% magnification and above. In the Antarctic species (M. rigbyae and P. oregonensis), animals ranging from immature to fully mature stages showed between 318 and 540 narrow and regular growth marks (between 10 and 30 pax). The examined pelagic octopus sample were composed only of juvenile immature animals. In these small specimens quantification of growth marks in beaks revealed 84 to 522 increments. Styles were absent in deep-sea pelagic species and in Antarctic animals, only M. setiferus presented this structure suitable for application of the methodology proposed by Barratt (2010), but no preparation produced satisfactory fields of view for visualization of growth marks. Scatterplots of increment number and weight are presented in figure 5.

Discussion

Although the deposition periodicity of the beak growth marks in the examined octopods are not validated, it has been demonstrated for several octopod species that such marks are formed on daily basis. Assuming daily deposition of beak increments for the studied species in this study would imply that they live longer than 1 year. The long brooding periods necessary for incubation of the eggs in cold water, could further extend the longevity of mature females.

These are the first attempts of age estimations using growth marks observation in beaks for the species analyzed here. Using the presented methodology, we aim to determine age at size for 300 more individuals. We also plan to perform age estimations in cirrate octopods, which will allow comparisons between lifespan in cold water octopods from different habitats.

References


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Figure 4 – A schematic representation of how the stylets are extracted and prepared for visualization of growth marks, adapted from Barratt (2004) and Barratt (2010).

Figure 5 – Weight vs number of beak growth marks of the 26 specimens examined in this study. A: Antarctic octopus species. Immature and mature animals of both sexes were plotted together. B: Increment observations in juvenile specimens of pelagic deep-sea octopods.