Recent findings of the giant squid *Architeuthis* in northern Spanish waters

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There are just a few records of giant squid of the species *Architeuthis* captured alive. Two living sub-adult females of *Architeuthis* of 180 and 135 cm mantle length with total weights of 148 and 81 kg respectively, were caught 34 miles offshore in northern Spanish Atlantic waters (43°52.54'N–05°18.74'W) in December 1999 and January 2001. From April 1999 to January 2000 in the same area, another giant squid of 102 kg as well as a single tentacle measuring 5 m, and another tentacle of 2 m long were caught. Another five living specimens were captured and 11 more animals were caught dead during the last 15 years in the same area.

INTRODUCTION

There is very little information on the life cycle and number of species of the giant squid *Architeuthis* sp. They are often stranded near the coast and constitute a major food supply for sperm whales in the North Atlantic (Clarke, 1996). Occasionally, pelagic trawling nets catch giant squid but knowledge about the life history, physiology and ecology is fragmented. These studies are based on either dead stranded animals, or those captured alive by nets or from the remains found in the stomach contents of their predators, mainly sperm whales (Roper & Boss, 1982; Clarke, 1996).

The aim of this paper is to contribute to the biological and ecological knowledge of the giant squid *Architeuthis* and to discuss the possibility of the existence of a resident population of these animals just a few miles off the northern Iberian Peninsula coast.

MATERIALS AND METHODS

The pair trawler 'Minchos V', for which target species was the blue whiting *Micromessistius poutassou*, caught two specimens of *Architeuthis* alive on 9 December 1999 and 12 January 2001 (Figure 1A) at depths ranging from 300 to 600 m, approximately 34 miles from Gijón (43°52.54'N–05°18.74'W; Figure 1B). They represented the first records of living specimens collected in Spanish Atlantic waters. The specimens were taken on shore and frozen immediately after measurement. The animals were defrosted, dissected and immediately 'reconstructed', placed in a transparent glass case and fixed for 48 h in 4% formalin.

The statoliths of specimen 2 (Table 1) were removed, mounted in Crystalbond resin and measured to the nearest 0.01 mm. Both sides of the statolith were ground to reveal growth increments. Two independent readers made three blind counts each in order to quantify the number of growth increments in the statolith using a semi-automatic image analysis system (TNPC 3.0®). The semi-automatic counting was carried out using a

high-resolution digital camera (Sony DCR-PC11E) mounted on a compound microscope (Nikon OPTIPHOT-2). Video images made with 400× magnification were then processed with TNPC 3.0®. Growth increments in each statolith were counted in transects extending outward, from the nucleus (underneath the dorsal dome) to the dorsal dome.

Three samples of 0.033, 0.027 and 0.023 g from three different parts of the ovary (proximal, medial and distal, respectively) were obtained from specimen 2 to estimate potential fecundity by extrapolation to the total ovary weight (250 g). Total number of oocytes in the sample was counted and measured to the nearest 0.01 mm under a binocular microscope (20×).

RESULTS AND DISCUSSION

Each growth increment consisted of two components: an optically translucent ring and a dark ring as previously cited for other cephalopod species (Lipinski et al., 1991).

The specimens in this study were identified as *Architeuthis* sp. This species reaches a mantle length (ML) of up to 3 m (more frequently between 1 and 2 m), possess very large tentacles. The medial rows of the manus are much larger than the marginal ones. Furthermore, these animals had a straight simple funnel-locking cartilage, buccal connectives attached to the dorsal border of arm IV and small fins, semiround or semioval. Measurements and weights of the two specimens are summarized in Table 1. The digestive tract of both specimens lacked prey remains. As shown in Figure 1A, specimen 2 was captured intact.

The counts made by independent readers revealed a number of increments ranging from 258 to 318. The periodicity of the deposition is not known, but as indicated by Jackson et al. (1991), the increments resemble growth rings that have been laid down in other *Architeuthis* species. Therefore, assuming the daily formation of growth increments, our specimen would be 9–10 months old, which represents a growth rate ranging from 5.72 to 4.24 mm ML per day. These growth rates are greater than those indicated by Gauldie et al. (1994) and Lordan et al. (1998).

Figure 1. (A) Detail of an immature female of *Architeuthis* sp. caught on 12 January 2001 in the (B) northern Spanish Atlantic waters. Asterisk: place where the specimen was caught (Carrandi fishing ground).

Table 1. Measurements (mm) and weights (g) made to two immature specimens of *Architeuthis* fished in Asturias (Northern Spain) in December 1999 and January 2001.

	SPECIMEN 1	SPECIMEN 2
Sex	F	F
Maturity stage	Immature	Immature
Total length	—	8010
Dorsal mantle length	1800	1350
Ventral mantle length	1650	1190
Total weight	1480	810
Maximum mantle width	560	400
Mantle thickness	30	22
Head width	415	260
Arm lengths I (L/R)	n.d./n.d.	2310/2400
II	n.d./n.d.	1791*/1900
III	n.d./n.d.	n.d./n.d.
IV	2160/178*	1870/1920
Tentacle length	n.d./n.d.	6370/6530
Tentacular club length	n.d./n.d.	770/790
Dactylus length	n.d./n.d.	120/160
Manus length	n.d./n.d.	510/490
Carpus length	n.d./n.d.	140/140
Upper rostral length	21.0	16.5
Lower rostral length	20.5	15.9
Pen length	1670	1180
Pen width	200	150
Fin length	690	560
Fin width	515	400
Estimated eye diameter	130	120
Gill length	500	370
Nidamental gland length	340	150
Funnel cartilage length	175	135
Funnel cartilage width	41	25
Funnel length	260	160

*, Not intact; —, not measured; n.d., no data (missing or incomplete).

The female no. 2 had a potential fecundity of $9,161,531 \pm 487$ oocytes. The size of the oocytes ranged from 0.20 to 0.42 mm. This estimation agrees with the estimation made by Boyle (1986) who indicated that the potential fecundity of a submature female of 168 kg, whose ovary weighed 7676 g could have been over 10^7 oocytes. On the other hand, in a submature female of 200 kg captured in South Africa, the oocytes measured between 0.5 and 1.4 mm (Pérez-Gándaras & Guerra, 1978). Boyle (1986) also indicated that the oocytes of the female studied were very small (all <1 mm diameter, most <0.5 mm). In a female of 180 kg stranded in Argentina with a large ovary of 14,024 g, the oocytes measured between 0.65 and 2.52 mm (Ré et al., 1998).

Another five specimens were captured alive and 11 more specimens were collected dead or fragmented during this period. The weights of the animals collected, principally during autumn and early winter, ranged from 75 to 202 kg. However, the most remarkable events were the collection in the same area of another giant squid of 102 kg, a single tentacle measuring 5 m, and another tentacle of 2 m long in one stomach content of the shark *Isurus oxyrinchus*, from April 1999 to January 2000 in the same area.

The topography of the area where the specimens were caught is highlighted by the presence of three canyons (Llanes, Lastres and Avilés) each about 4000 m maximum depth (Figure 1B). Even though primary production in the canyons is not high, there is some production provided by the seasonal upwellings that occurs in the adjacent continental shelf producing an offshore export of organic matter and sedimentation towards the continental margins (Fernández et al., 1993). This process sustains important communities of invertebrates, fish and marine mammals. The most remarkable aspect could be the existence of huge concentrations of juveniles of blue whiting in these canyons, which could constitute an appropriate diet for *Architeuthis*, due to the presence of high quantities of blue whiting in the same trawls and also in the stomach contents of other specimens recently captured (unpublished data).

The capture of these giant squids between 300 and 600 m allows us to assume that these animals inhabit

these canyons or surrounding areas, probably close to the bottom or in mid-water, where nets were hauled.

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