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New records of the scaled squid, *Lepidoteuthis grimaldii* Joubin, 1895 in the Canary Islands, Eastern Atlantic Ocean.

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Abstract

Two well conserved female specimens of the uncommon soft-scaled squid *Lepidoteuthis grimaldii* Joubin, 1895 (Lepidoteuthidae, Oegopsida) were caught in Canary island waters: a maturing female of 580 mm dorsal mantle length found dead on the surface at 27°38'N, 18°01'W (near El Hierro Island); an immature female of 350 mm dorsal mantle length captured by commercial open midwater trawl at 28°48'N, 16°00'W (north of Tenerife Island), between 342 and 487 m depth. This is the first report of an adult of this species from the Canary Islands. Morphological data are presented and the bathymetric distribution of this species in Canary waters is discussed.

Introduction

Our knowledge on the biodiversity, biology and distribution of oceanic cephalopod species is unequal. Pelagic species with high fishery potential, such as Ommastrephidae, have been intensively studied (Hoving 2008; Jereb & Roper 2010) in contrast to those with low commercial value. For different reasons (small mouth areas of midwater nets, trawl speeds, evasion behaviour, etc.), large oceanic and deep-sea cephalopods are rarely caught using direct sampling techniques at sea (Clarke 1977; 2006). However, there are several effective techniques for paralarvae or juvenile stages of large species and adults of small species (e.g. Moreno et al. 2009).

At present, one of these poorly known species is the scaled squid, *Lepidoteuthis grimaldii* Joubin, 1895. This large squid reaches sizes of up to 100 cm dorsal mantle length (DML) and is characterised by its distinctive hexagonal shaped dermal cushion, formerly called “scaled”, that covers the mantle except for the posteroventral part under the posterior half of the fins. Adults are also characterised by the loss of tentacles (Nesis & Nikitina 1990; Jereb & Roper 2010). *Lepidoteuthis grimaldii* is a sexually dimorphic species in which mature females attain twice the size of mature males. Mature males lack a hectocotylus and have a relatively long terminal organ (penis), which projects freely for a considerable portion of the organ’s length (Jackson & O’Shea, 2009).

Lepidoteuthis grimaldii inhabits tropical and subtropical oceans with disjunct records in the Pacific Ocean (Hawaii, Japan, New Caledonia, New Zealand, Australia, and Tasmanian Sea) and a broad distribution in the Atlantic Ocean (Clarke 1962; Clarke 2006; Jereb & Roper 2010). The vertical distribution of this species is unclear. Paralarvae have been fished as shallow as 100 m at night while young and subadult

stages have been collected at 700 m day and night. Until now, only three large specimens have been fished, all of them in bottom trawls between 812-1100 m depth suggesting that *L. grimaldii* is a demersal species (Jackson & O'Shea, 2009; Jereb & Roper 2010; Young & Vecchione 2016). In contrast, scaled squid has been commonly reported in predator stomach contents, such as sperm whales, *Physeter macrocephalus* Linnaeus, 1758. and as young stages in plankton hauls (see Table 2).

Clarke (1964) reported for the first time the capture of two young individuals in the "Canary Islands region". Other records of this species in the archipelago are beaks found in stomach contents of stranded cetaceans (Fernández et al. 2009; Hernández-García & Martín 1994) and slender alfonsino, *Beryx splendens* Lowe, 1834 (Dürr & González 2002), captured in the area.

The captures of two large scaled squid in the Canary Islands, which we present in this communication, represent the first record of adult specimen in the region. These individuals allow us to report additional morphometric and biological data from this uncommon deep-sea squid species.

Methods

Two specimens of the scaled squid were captured in Canary Archipelago waters. Specimen 1 was found dead in El Hierro Island (Mar de Las Calmas) surface waters at 27°38'N; 18°01'W, during cetacean photo-identification surveys on 25 May of 2013. Specimen 2 was caught on 20 April 2012 by *RV Cornide de Saavedra* during the "CETOBAPH" mesopelagic survey, at 28°48'N, 16°00'W (north of Tenerife) at a fishing depth between 342 to 487 m over a seafloor of 2000 m. The fishing gear employed was a commercial open midwater trawl with a modified cod-end (10 mm mesh size). Both specimens were frozen on board. Identification was based on the

diagnostic characters given by Nesis & Nikitina (1990) and Jereb & Roper (2010). After defrosting specimens at room temperature, sex was identified and measurements were taken following Roper & Voss (1983). Radula and beaks from each specimen were removed and measured following Clarke (1962). Beak pigmentation stage was determined using the scale of Fang et al. (2016). Maturity was assessed according to Lipinski (1979).

Results and discussion

Morphometric characters of the body and beak, weight, sex and maturity stage of both specimens are presented in Table I.

Specimen 1 (Fig. 1A) was a 580 mm DML, stage III female (Fig. 2A). Its enlarged nidamental glands (180 mm length) covered some internal organs; no mature oocytes were observed in the oviducts, which were still not very swollen. Immature oocytes were observed in the ovary (Fig. 2A). Specimen 2 was a 350 mm DML stage II (immature) female (Fig. 2B). Internal organs of both specimens were in very good condition.

The radula is formed by seven rows of teeth, with a tricuspid rachidian tooth; small lateral cusps. First lateral tooth externally bicuspid; small lateral cusp. Second lateral and marginal row with conical teeth, slightly curved towards the middle row, in agreement with Clarke & Maul (1962).

Beaks of specimen 1 and 2 were at pigmentation stages 5 and 3 respectively (Fang et al. 2016). In comparison, beaks of female *Ommastrephes bartramii* (Lesueur, 1821) between 330-430 mm DML were at pigmentation stages 3 and 4, while adults over 400 mm DML were at pigmentation stages 6 and 7 (Fang et al. 2016). The dissimilarity in pigmentation pattern may be due to the different maximum sizes of the two species,

which is 600 mm in *O. bartramii* and 1000 mm in *L. grimaldii*, but may also be due to distinct growth rates and feeding habits (Fang et al. 2016).

The cause of death of the specimen 1 is unknown. It was found in very good condition and floating in the surface waters of El Hierro Island (Mar de Las Calmas). This is an area of the Canary Islands frequently used by a resident beaked whale population, and where mesopelagic and benthopelagic fauna remains floating at the surface; for example, hatchet fish *Argyropelecus* spp. Cocco, 1829 and histioteuthid squid are frequently found (Escáñez et al. 2011). The depth where specimen 2 was caught is consistent with the known bathymetric distribution of *L. grimaldii*, which is reported as a mesopelagic to bathypelagic species (Jereb & Roper, 2010).

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TABLES.

| | Specimen 1 | Specimen 2 |
|-----------------------|-------------------|-------------------|
| | El Hierro | Tenerife |
| Measurements | 25/05/2013 | 20/04/2012 |
| DML | 580 | 330 |
| VML | 545 | 310 |
| MW | 183 | 110 |
| FL | 225 | 158 |
| FW | 215 | 150 |
| HL | 100 | 95 |
| HW | 60 | 45 |
| Fun. L | 90 | 45 |
| Fun. W | 80 | 35 |
| FCL | 50 | 27.58 |
| Right Arms | | |
| AL-I | 355 | sectioned |
| AL-II | 320 | 270 |
| AL-III | 300 | 130 |
| AL-IV | sectioned | sectioned |
| Left Arms | | |
| AL-I | 315 | sectioned |
| AL-II | 355 | sectioned |
| AL-III | 335 | sectioned |
| AL-IV | 280 | 293 |
| Weight (g) | 2700 | 545.89 |
| Upper beak | | |
| UHL | 32.45 | 19.96 |
| URL | 15.75 | 9.35 |
| UCL | 58.80 | 30.96 |
| Lower beak | | |
| LHL | 7.50 | 5.92 |
| LRL | 15.20 | 8.48 |
| LCL | 19.40 | 13.10 |
| LWL | 12.00 | 8.91 |
| Sex | Female | Female |
| Maturity stage | III | II |

Table 1. Measurements of *Lepidoteuthis grimaldii* specimens caught in the Canary Islands between 2011 and 2013. DML: Dorsal Mantle length. VML: Ventral mantle length. MW: Mantle width. FL: Fin length. FW: Fin width. HL: Head length. HW: Head

width. Fun. L: Funnel length. Fun. W: Funnel width. FCL: Funnel cartilage length. AL: Arms length. UHL: Upper hood length. URL: Upper rostrum length. UCL: Upper crest length. LHL: Lower hood length. LRL: Lower rostrum length. LCL: Lower crest length. LWL: Lower wing length. All morphometric measurements in mm.

| Method | Location | N° | Sex | DML (mm) | Depth (m) | Reference |
|-----------------|----------------------------|-----------|-------------------|-----------------|------------------|-----------------------------------|
| Bottom trawl | Tasmania, Cascade Rise | 1 | Male | 442 | 950-1100 | Jackson & O'Shea 2009 |
| Bottom trawl | New Zealand, Chatham Rise | 1 | Female | 617 | 812 | Young & Vecchione, 2016 |
| Bottom trawl | New Zealand | 1 | Immature | 270 | - | Jackson & O'Shea 2009 |
| Bottom trawl | New Zealand | 1 | - | >500 | - | Jackson & O'Shea 2009 |
| Plankton trawl | Gulf of Guinea | 1 | Young stages | 29.4-39.1 | 50-23 | Lu & Clarke, 1975 |
| Plankton trawl | Azores Island | 1 | Young stages | - | - | Clarke, 2006 |
| Plankton trawl | Spain, Galician Bank | 4 | Young stages | - | - | Clarke, 2006 |
| Plankton trawl | Spain, Canary Region | 2 | Young stages | 60-85 | | Clarke, 1964 |
| Plankton trawl | Madeira island | 1 | Young stages | - | - | Clarke, 2006 |
| Plankton trawl | Abyssal plain near Madeira | 1 | Young stages | - | | Clarke, 2006 |
| Stomach content | Azores Island | 3 | 2 females+ 1 ind. | 720-860 | - | Joubin, 1895; 1900 |
| Stomach content | Madeira Island | 9 | 4 females+ 5 ind. | 155-970 | - | Clarke, 1960; Clarke & Maul, 1962 |
| Stomach content | South Atlantic | 1 | Female | 510 | - | Merret, 1963 |

Table 2. Records of *Lepidoteuthis grimaldii* in the literature. N°: Number of specimens. DML: Dorsal Mantle Length. Ind: indeterminate. -: No data.

FIGURES.



Fig. 1. The two *Lepidoteuthis grimaldii* collected in the Canary islands. A) Ventral view of the female caught in El Hierro Island. B) Dorsal view of the females captured on the north side of Tenerife Island. Scale bar, 15 cm.

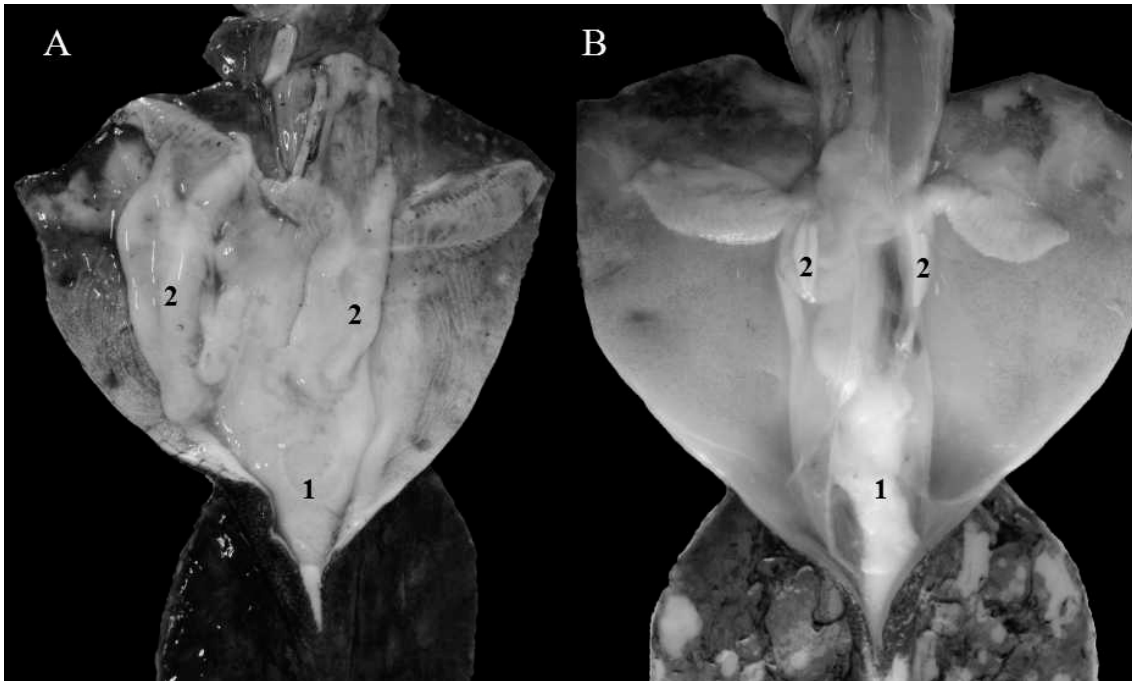


Fig. 2. A: *L. grimaldii* female in stage III of maturation, collected in El Hierro (580 mm DML). B: Female in stage II of maturation captured on the north side of Tenerife Island (330 mm DML). 1: Ovary. 2: Nidamental gland.

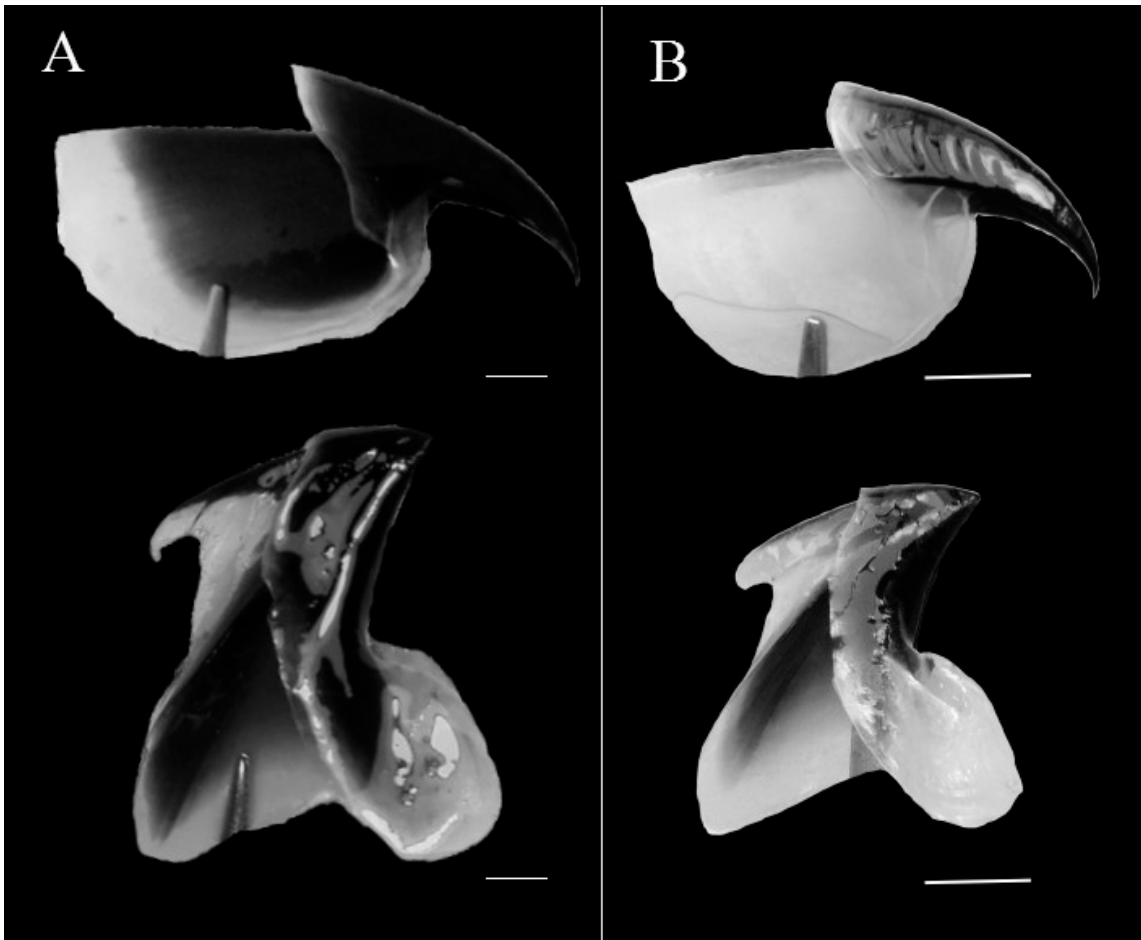


Fig. 3. *Lepidoteuthis grimaldii* beak aspect. A: Upper and lower beak of maturing female (580 mm DML). B: Upper and lower beak of immature female (330 mm DML). Scale bar, 0.5 cm.