



## Morphological variability of the rare bush-club squid *Batoteuthis* (Cephalopoda, Batoteuthidae)?

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With 7 figures and 2 tables

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**Abstract:** A specimen of Batoteuthidae was caught during the research cruise ATLANTIS 2009 on 21 March 2009 at 45°09.51' S - 45°08.07' S - 59°29.04' W - 59°27.98' W (Patagonian slope), depth 1195–1221 m. This specimen is a juvenile male, 105 mm mantle length. It is the largest *Batoteuthis* with complete tentacles captured to date. It shares the main diagnostic characters of the family. We compared that specimen with the types of *Batoteuthis skolops*, the only known species in the family. Our specimen has several differences from the types (lower tail length index, different fin shape, arm length indices 3–4 times longer, tentacles and clubs 4 or 5 times longer than the types, distinct arrangement of suckers in ventral arms, and different number, size and disposition of suckers in tentacular clubs) suggesting that it might be a different species. However, we cannot refute the alternative hypothesis that the differences are ontogenic. Until additional good specimens become available or molecular analyses are undertaken, we recommend a conservative approach of considering our specimen tentatively to be a growth form of *Batoteuthis skolops*.

**Key words:** Systematics, *Batoteuthis skolops*, cephalopods, Patagonian slope.

### 1. Introduction

Proper identification of organisms is necessary to understand biodiversity at any level (VECCHIONE et al. 2000). Although a key goal of biodiversity exploration is the discovery of new species, it is a responsibility of the expert to distinguish correctly when a new species can confidently be distinguished. This is the problem which we face in the present work.

The family Batoteuthidae was erected by YOUNG & ROPER in 1968 based on four specimens. Only a single species is known in the family, the bush-club squid *Batoteuthis skolops* Young and Roper, 1968. This family is considered a member of the Chiroteuthid group of families (YOUNG & VECCHIONE 2008) many

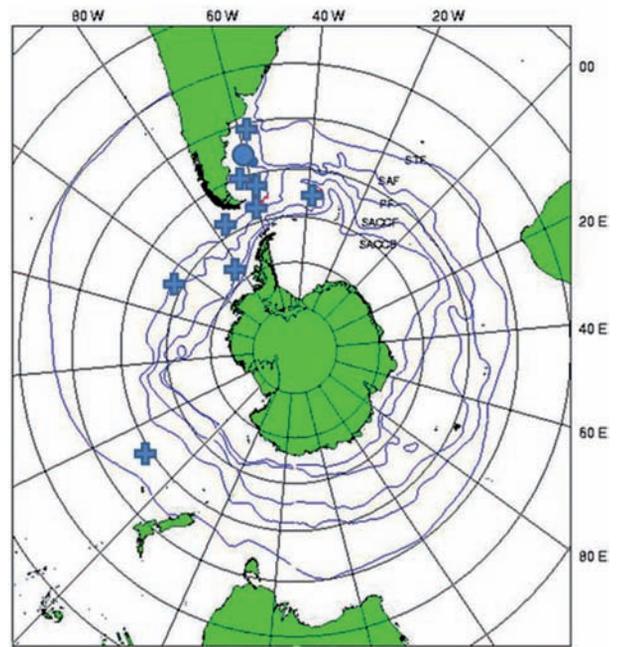
of which have unusual modifications in the tentacular clubs. In the original description, the tentacular clubs of *B. skolops* were characterized by suckers in six series. Other noteworthy characters of the species, as currently defined, include: club length about 80% of tentacle length; arms suckers biserial; funnel locking-apparatus distinctly curved; short fins, about 20% of mantle length (ML); gladius and tail long, secondary conus of gladius forming the core of a long, slender tail (length greatest in paralarvae). Large aboral photophores occupying the tips of ventral arms in large subadult males and small aboral photophores occupying the tips of ventral arms in large subadult females have been described online subsequent to the original published description (YOUNG & ROPER 2009).

The smallest known individual is 30 mm ML and the largest 350 mm ML. Unfortunately, the largest specimen described with intact tentacles is the holotype (51 mm ML). Only a few growth stages have been described and neither the earliest paralarvae nor mature individuals are yet known (YOUNG & ROPER 2009).

The type locality of *B. skolops* is the South Pacific Ocean about 1000 km southeast of Wellington, New Zealand in the region of the Antarctic Convergence (49° 57'S; 169° 01'W). The species is found only in Antarctic and subantarctic waters. Fig. 1 shows the sites of the previous records (RODHOUSE et al. 1992; ANDERSON & RODHOUSE 2002; JACKSON et al. 2002; NESIS 1987, 2003; VEGA 2009; YOUNG & ROPER 2009). *Batoteuthis skolops* is a pelagic species apparently occupying deep water but no definitive information is available on its vertical distribution, and little is known of its biology.

The aim of this paper is to describe a specimen captured during the ATLANTIS 2009 research cruise in comparison with the types of *Batoteuthis skolops*. There are previous records of *Batoteuthis* from the Patagonian slope, relatively close to the area where our specimen was captured (Fig. 1) (RODHOUSE et al. 1992; YOUNG & ROPER 2009). However, because this new specimen has unusual characteristics, we consider the possibility that it is a second species of Batoteuthidae.

### *Batoteuthis skolops*



**Fig. 1.** *Batoteuthis skolops*. Previous records (crosses) and record of the specimen caught in ATLANTIS 2009 cruise (circle). STF: Southern Transition Front; SAF: Southern Antarctic Front; PF: Polar Front; SACC: Southern Antarctic Circumpolar Current; SAACB: Southern Antarctic Circumpolar Current Boundary.



**Fig. 2.** Dorsal view of the *Batoteuthis skolops* caught in ATLANTIS 2009 cruise. Juvenile male of 105 mm mantle length.

**Table 1.** *Batoteuthis skolops*. Details of the trawl where the specimen was caught during the ATLANTIS 2009 survey. March 2009. HN: haul number; T: time (hours); ILS: Initial Latitude South; FLS: Final Latitude South; ILoW: Initial Longitude West; FLoW: Final Longitude West; ID: Initial Depth (m); FD: Final Depth (m); SST: Sea Surface Temperature (°C); SBT: Sea Bottom Temperature (°C).

HN	T	ILS	FLS	ILoW	FLoW	ID	FD	SST	SBT
111	13.31-14.01	45°09.51'	45°08.07'	59°29.04'	59°27.98'	1195	1221	9.8	2.8

**Table 2.** Measurements and indices of the specimen of *Batoteuthis skolops* caught in the ATLANTIS 2009 cruise. ML: mantle length; TaL: tail length; TaLI: tail length index; MW: mantle width; MWI: mantle width index; HW: head width; HWI: head width index; TtL: tentacle length, right-left; TtLI: tentacle length index; CL: club length; CLI: club length index; FL: fin length; FLI: fin length index; FW: fin width; FWI: fin width index; RAI, RAII, RAIII and RAIIV: length of the right arms; ALI: arm length index; SDAIV: diameter of the suckers on arm IV; PL: photophore length on the fourth (IV) arms; PLI: photophore length index (photophore length/arm IV length x100). All the measurements are in mm. Indices calculated as percentage (%) of the mantle length except PLI.

ML	TaL	MW	HW	TtL	CL	FL	FW	RAI	RAII	RAIII	RAIV	SDAIV	PL
105	25.4	42	11	325-330	200	18	34	55	56	64	72	0.67	19
	TaLI	MWI	HWI	TtLI	CLI	FLI	FWI	ALI (I)	ALI (II)	ALI(III)	ALI (IV)		PLI
	24.2	40.0	10.5	309.5	190.5	17.1	32.4	52.4	53.3	60.9	68.6		25.7

## 2. Material and methods

One specimen of *Batoteuthidae* was caught during the research cruise ATLANTIS 2009. This cruise was carried out by the Instituto Español de Oceanografía (IEO) in the High Seas of the Southwest Atlantic Ocean, including the outer Patagonian shelf and the upper and middle slope (GUERRA et al. 2011). On board, catches were sorted immediately after capture. Cephalopods were stored in labeled plastic bags and frozen at -20 °C. Specimens were subsequently transported from the R/V *Miguel Oliver* to the Instituto de Investigaciones Marinas (IIM, CSIC) in Vigo, Spain for detailed examination.

After thawing at room temperature the specimen was identified as *Batoteuthis skolops* following the original description (YOUNG & ROPER 1968) and the description in YOUNG & ROPER (2009). The specimen was preserved in 70% ethanol. At present, the specimen is in 50% isopropanol at the US National Museum of Natural History (USNM 2056737). The mantle and fin lengths were measured as indicated by YOUNG & ROPER (1968). The indices were estimated as percentage of the mantle length also following YOUNG & ROPER (1968). A new index is included here: the Photophore Length Index (PLI);  $PLI = \text{Photophore Length} / \text{Length Arm IV} \times 100$ .

## 3. Results

Capture data of the specimen are given in Table 1. Table 2 shows the main measurements and indices. Our specimen measures 105 mm mantle length (ML) and is a juvenile male. It is the largest *Batoteuthis* captured to date with complete tentacles (Fig. 2). We compared our *Batoteuthis* specimen with the types of *B. skolops* and other specimens archived at the US National Museum of Natural History. The most comparable specimen is the holotype (USNM 576029), which has the head with tentacles, although our specimen is larger. Our specimen is more comparable in size to the non-type specimens described by YOUNG & ROPER (1968; USNM 577094 and 577095), but, unfortunately, neither of those specimens has a head. It shares many of the general diagnostic characters of *B. skolops*. However, we found many differences, which can be summarized as follows:

1. The tail (Fig. 3). The tail length index (TLI) of our specimen is low (24 vs 85) compared to that of the 30 mm ML paratype.
2. The fin shape on our specimen (Fig. 3) differs from any of the previously described *B. skolops*. This does not appear to be a result of fin damage.
3. The arm formula (4>3>2>1, Table 2) matches that of the holotype. However, the arm length indices (ALI)



**Fig. 3.** *Batoteuthis skolops*, ATLANTIS 2009. Dorsal view of the specimen showing some details of the mantle, fins and tail.

of our specimen (Table 2) are 3 times the ALI of the paratype and about 2 times the ALI of the holotype.

4. Among the most obvious morphometric differences between our specimen, the holotype and the paratype of *B. skolops* are the lengths of the tentacles and the tentacular clubs. The tentacle length index (TtLI) of our specimen (Table 2) is 5 times that of the holotype (309.5 vs 58.9) and 4 times that of the paratype (309.5 vs 73.4). The tentacular stalk is very thin and circular in cross-section, representing approximately 38 % of the total length of the tentacle (Fig. 4). The club length index (CLI) of our specimen (Table 2) is 4 times the CLI of the holotype (190.5 vs 48.0) and approximately 3 times the CLI of the paratype (171.4 vs 66.7).

5. The large photophores on the tips of the ventral arms (Fig. 4) were not mentioned in the original description (YOUNG & ROPER 1968) and are not present on the type specimens. However, that character is illustrated in the web page (YOUNG & ROPER 2009). These ventral-arm photophores occupy approximately 26 % (photophore length index; PLI 25.7) of the length of the arm of our specimen (Table 2, Fig. 4).

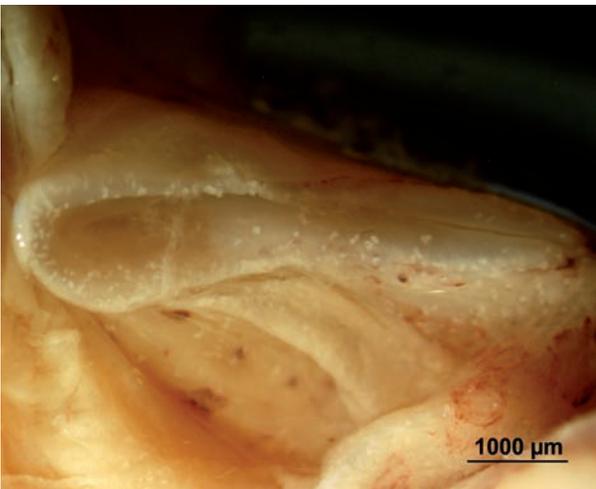
6. We describe here for the first time the presence of stalked suckers arranged in a zigzag pattern along the ventral arms; these diminish in size in the area of the photophores, but reaching the tips of these arms.

7. The funnel-mantle locking cartilage of our specimen (Fig. 5) is distinctly curved, but it is slightly different from the drawing by YOUNG & ROPER (1968).

8. The number, disposition and size of the suckers in the tentacular clubs seem not to coincide with the original description of the types of *B. skolops*. The extremely long clubs occupy approximately 55-60% of the tentacle length in our specimen (Fig. 4); there are trabeculae and traces of protective membrane, but not so clearly marked as they are in the holotype and the paratype, perhaps because the clubs of our specimen are not as flattened (Fig. 4) as in the specimens described by YOUNG & ROPER (1968). From the lateral margins of the club are projected groups of 3 suckers with very long stalks, the stalk of the central sucker of these marginal groups is thicker than those of the adjacent ones; both lateral suckers are of smaller size than the central one and the chitinous rings give the lateral

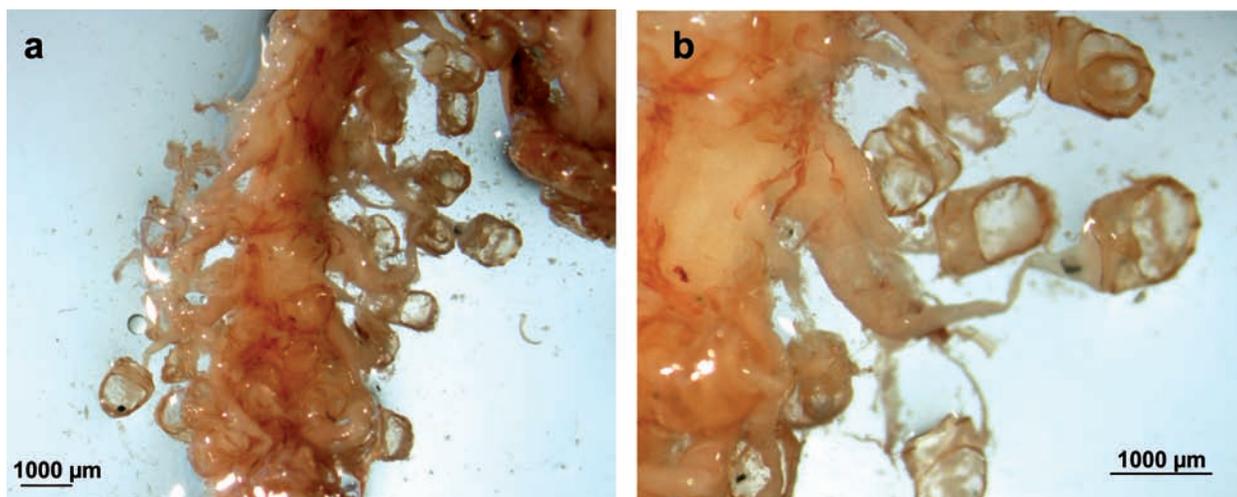


**Fig. 4.** *Batoteuthis skolops*, ATLANTIS 2009. Details of the tentacles and photophores on each fourth arm. Ventral-arm photophores occupy approximately 26% of the length of the arm.



**Fig. 5.** Funnel-mantle locking cartilage of *Batoteuthis skolops*, ATLANTIS 2009.

suckers a quadrangular aspect, whereas of the central one is circular. This disposition results in six longitudinal series of small, closely packed suckers, whose stalk bases join with the bases of the trabeculae. However, in the middle of the central field of the tentacular club there are two additional series of stalked suckers smaller than the marginal ones and arranged in a zigzag pattern. The dentition of these central suckers is similar to that of the marginal suckers. Therefore, the club is actually provided with longitudinal series of suckers composed by eight elements, two groups of three marginal series and one group of two central series (Fig. 6). Another difference is in the number of teeth in the chitinous ring of the club suckers. In the original description YOUNG & ROPER (1968) indicated that it bears 6 small, conical, widely spaced teeth. The number of teeth in our specimen was 10 (Fig. 7).

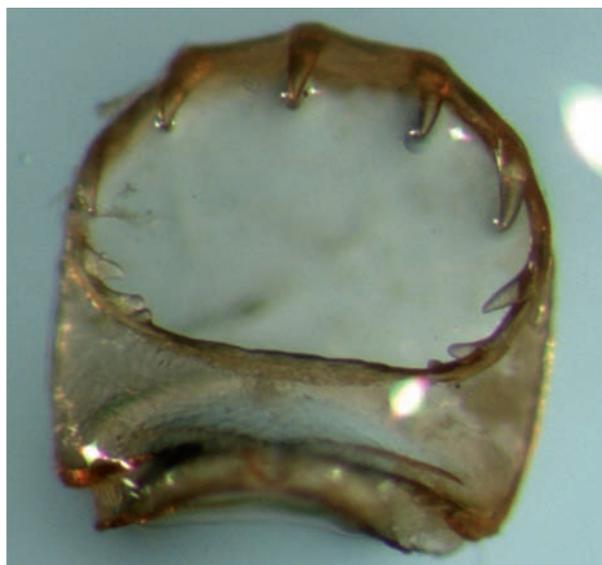


**Fig. 6.** *Batoteuthis skolops*, ATLANTIS 2009. Each tentacular club have longitudinal series of suckers composed by eight elements, two groups of three marginal series and one group of two central series.

#### 4. Discussion

An ideal description of a species would include five categories of characters: gross morphological, anatomical, histological, biochemical and behavioral. Moreover, good descriptions should also include whenever possible the ontogenic stages of the species (VECCHIONE 1998; NIXON 1998).

The differences described above might suggest that our specimen belongs to a different species than *B. skolops*. However, until additional good specimens become available or molecular analyses are undertaken, we recommend a conservative approach of considering our specimen tentatively to be a growth form of *B. skolops*. The most important reasons to adopt this conservative approach are two: i) that a strong allometry in the growth of the mantle, tail, and arms seems to occur during ontogeny. The tail in the juvenile bush-club squid is longer than in the subadults, but the arms shorter. Allometric growth is frequent in cephalopods (VECCHIONE 1998). Additionally, like in many of the Chiroteuthid-type squids, drastic changes in tentacle morphology do occur. This was observed from the paralarval paratype to the holotype and to our specimen with long thin tentacle stalks. These changes seem quite possibly ontogenic. We suspect that the holotype is in transition from the paralarval to adult morphology that is better represented by our specimen; and ii) the possible existence of a sexual dimorphism in *B. skolops*.



**Fig. 7.** *Batoteuthis skolops*, ATLANTIS 2009. Chitinous ring of a sucker of the tentacular club with 10 small, conical, widely spaced teeth.

It seems noteworthy that the two reviewers who commented on a draft of this manuscript reached opposing conclusion about whether our specimen represents an undescribed second species in the genus. This illustrates the lack of conclusiveness on the question provided by this single interesting specimen.

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## References

- ANDERSON, C.I.H. & RODHOUSE, P.G. (2002): Distribution of juvenile squid in the Scotia Sea in relation to regional oceanography. – *Bulletin of Marine Science*, **71**: 97-108.
- GUERRA, A., PORTELA, J.M. & RÍO, J.L. (2011): Cephalopods caught in the outer Patagonian shelf and its upper and medium slope in relation with the main oceanographic features. – *Fisheries Research*, **109**: 179-186.
- JACKSON, G.D., FINN, J. & NICOL, S. (2002): Planktonic cephalopods collected off East Antarctica during the 'BROKE' survey. – *Deep-Sea Research Part I*, **49**: 1049-1054.
- NESIS, K.N. (1987): Cephalopods of the world. – 351 pp.; Neptune City (T. F. H. Publications).
- NESIS, K.N. (2003): Distribution of Recent Cephalopoda and implications for Plio-Pleistocene events. – *Berliner Paläobiologische Abhandlungen*, **3**: 199-224.
- NIXON, M. (1998): Overview of cephalopod characters. – *Smithsonian Contributions to Zoology*, **586**: 7-9.
- RODHOUSE, P.G., SYMON, C. & HATFIELD, E.M.C. (1992): Early life cycle of cephalopods in relation to the major oceanographic features of the southwest Atlantic Ocean. – *Marine Ecology-Progress Series*, **89**: 183-195.
- VECCHIONE, M. (1998): Ontogenic characters and cephalopods systematics. – *Smithsonian Contributions to Zoology*, **589**: 11-20.
- VECCHIONE, M., MICKEVICH, M.J., FAUCHALD, K., COLLETTE, B.B., WILLIAMS, A.B., MUNROE, T.A. & YOUNG, R.E. (2000): Importance of assessing taxonomic adequacy in determining fishing effects on marine biodiversity. – *ICES Journal of Marine Science*, **57**: 677-681.
- VEGA, M.A. (2009): Cefalópodos de aguas chilenas: sistemática y biogeografía. – Ph.D. Thesis of the Universidad de Vigo (Spain). 288 pp.; Santo Tomás (Universidad de Santo Tomás, Chile).
- YOUNG, R.E. & ROPER, C.F.E. (1968): The Batoteuthidae, a new family of squid (Cephalopoda: Oegopsida) from Antarctic waters. – *Antarctic Research Series*, **11**: 185-202.
- YOUNG, R.E. & VECCHIONE, M. (2008): Chiroteuthid families. Version 21 April 2008 (under construction). [http://tolweb.org/Chiroteuthid\\_families/19410/2008.04.21](http://tolweb.org/Chiroteuthid_families/19410/2008.04.21) in *The Tree of Life Web Project*, <http://tolweb.org/>
- YOUNG, R.E. & ROPER, C.F.E. (2009): *Batoteuthidae* Young and Roper, 1968. *Batoteuthis skolops* Young and Roper, 1968. The Bush-club Squid. Version 12. [http://tolweb.org/Batoteuthis\\_skolops/19452/2009.08.12](http://tolweb.org/Batoteuthis_skolops/19452/2009.08.12) in *The Tree of Life Web Project*, <http://tolweb.org/>

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