Cephalopod Biodiversity, Ecology and Evolution
Payne, A. I. L., Lipiński, M. R., Clarke, M. R. and M. A. C. Roeleveld (Eds). *S. Afr. J. mar. Sci. 20: 355–361 1998*

DESCRIPTION OF AN *ARCHITEUTHIS* FROM ARGENTINE WATERS

N. E. BRUNETTI, B. ELENA*, G. R. ROSSI*, M. SAKAI†, S. E. PINEDA* and M. L. IVANOVIC**

A specimen of the giant squid *Architeuthis* sp., caught by a trawler on the Patagonian inner shelf (46°30′S–66°00′W) in April 1995, is described. The squid was a mature female of 1 625 mm mantle length with 321 growth lines in the statoliths. Internal and external anatomy and morphometric characters were studied as far as possible, given the very damaged condition of the animal.

The genus *Architeuthis* was erected, without giving any diagnosis, by Steenstrup in 1857 for a specimen stranded on the Danish coast in 1853. In 1880, Verrill gave the first description of the genus. Pfeffer (1912) related this history and also mentioned that traditional narratives and illustrations of the 16th century had already described this animal. Although more than a century has passed since the pioneering cephalopod investigations and great scientific interest has been shown in the animals (Aldrich 1968, 1991, Aldrich and Aldrich 1968, Roper and Young 1972, Pérez-Gándaras and Guerra 1978, 1989, Toll and Hess 1981, Roper and Boss 1982, Brix 1983, Arfelli *et al*. 1991, Roeleveld and Lipiński 1991, Gauldie *et al*. 1994), the taxonomy, distribution and biology of the genus remain poorly known. This knowledge gap has arisen as a result of the lack of specimens examined. Most information came from animals found stranded or floating and near death. Another source of information was squid found in the stomachs of their predators (whales), where the condition was far from adequate for taxonomic investigation. Only occasionally have these squid been caught in fishing nets.

Until recently, there has been just one record of a giant squid in South-West Atlantic (Brazilian) waters (Arfelli *et al*. 1991). Then three specimens of *Architeuthis* sp. were found in Argentine waters (in the San Jorge Gulf) between April 1995 and May 1996. The description of one of them is presented herein.

MATERIAL AND METHODS

The specimen was captured during trawling operations of the F.V. *Arbumasa XIX* inside San Jorge Gulf on 2 April 1995. The ship was fishing for hake at 46°30′S, 66°00′W in 70 m of water and the squid was still alive when the net was hauled in (Fig. 1). The animal was frozen until it was dissected 45 days later, but by then it was in very poor condition. The head, arms and tentacles were broken, the fins and skin were damaged, and the beak had been removed by the fishermen.

A morphological examination was made in as much detail as possible, taking the morphometric measurements in mm and counting some meristic characters. The stomach was dissected and its contents analysed under a binocular microscope after its volume had been determined. The ovary was dissected and weighed in kg. Three ovary samples were extracted, weighed to the nearest 0.0001 g, and the oocytes counted to estimate fecundity. The longest axis of the oocytes was measured (n = 55) using an ocular micrometer with a precision of 0.01 units and transformed to mm.

The statoliths were removed, their measurements (following Clarke 1978) taken at a magnification of 400 ×, and both faces polished to count the increments. They were counted along the axis from the nucleus to the anterior edge of the lateral dome. Finally, the sucker rings of the available arms and rows were extracted, measured and described.

The squid was preserved in formaldehyde and is exhibited at the Bernardino Rivadavia Natural Sciences Museum in Buenos Aires, Argentina.

RESULTS

The specimen was a mature female (Stage V) of dorsal mantle length *ML* 1 625 mm. Its data are listed

* Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP), Paseo Victoria Ocampo Nº 1, 7600 Mar del Plata, Argentina. Email: calamar@inidep.edu.ar
† Japan International Cooperation Agency (JICA), INIDEP, Paseo Victoria Ocampo Nº 1, 7600 Mar del Plata, Argentina. Email: sakai@argenet.com.ar

Manuscript received: September 1997

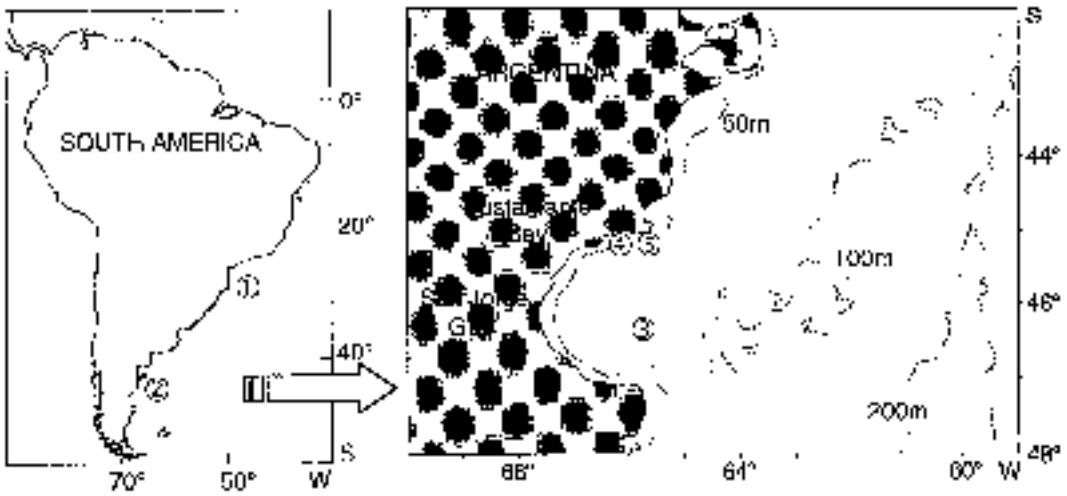

Fig. 1: Location of *Architeuthis* findings in the South West Atlantic – 1. Arfelli *et al.* (1991), 2. San Jorge Gulf, 3. currently described specimen, 4. Ruiz and Fondacaro (1996), 5. Rè *et al.* (1998)

in Table I. The total mass could not be determined, but it was estimated to be around 100 kg. The mantle and fins were silvery white and the head, arms and tentacles reddish brown.

The mantle was cylindrical from the anterior margin to its halfway point, from where it gradually tapered to an acute tip. The mantle thickness was 64 mm at the midpoint of the mantle length and 19 mm at its anterior margin. The fins were damaged, but they seemed to be small, oval, moderately wide (about 34% of *ML*), and they reached the extremity of the mantle. They were thick basally and thin marginally.

The head was as long as it was broad, with prominent eyes. It was broken off at the arm crown. The funnel groove was deep, with conspicuous lateral edges extending posteriorly, and continued to the dorsal side of the head. A membranous sac, described by Lipiński (1998) as the external diverticulum of the anterior vena cava, was observed protruding into the funnel groove, between the funnel bridles. The nuchal cartilage was wide and rounded anteriorly, but narrow posteriorly.

The funnel was conical and large (302 mm along the ventral midline, Fig. 2a). The funnel and mantle-locking cartilages were simple, straight and long (groove length 204 mm, ridge length 196 mm). The funnel-locking cartilage was pointed and slightly curved anteriorly, but rounded posteriorly. The funnel-retractor muscles were strong and circular in section at the funnel insertion.

Cross-sections at the bases of the arms were rectangular for Arms I, II and III, but triangular for Arms IV. Their circumferences ranged between 220

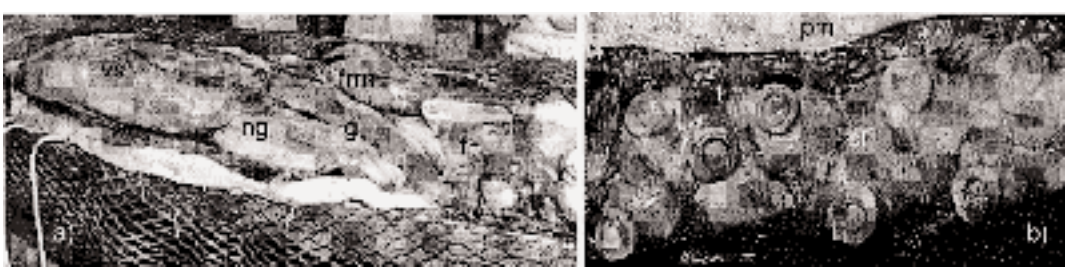

Fig. 2: (a) General view of the mantle cavity and visceral sac (VS). (b) Oral view of Arm IV (g – gill, ng – nidamental glands, f – funnel, frm – funnel-retractor muscle, pm – protective membrane, t – trabeculae, sf – skin folds)

Table I: Morphometric, meristic and other relevant data recorded from the *Architeuthis* studied

Structure	Measurement	Index and value
Mantle		
Dorsal length	1 625 mm	
Ventral length	1 590 mm	*VMLI* 0.98
Maximum width	635 mm	*MWI* 0.39
Thickness at the anterior margin	19 mm	
Thickness half-way along	64 mm	
Mantle-locking cartilage		
Length	196 mm	
Width	18 mm	
Head		
Width	542 mm	*HWI* 0.33
Fins		
Width	553 mm	*FWI* 0.34
Funnel		
Ventral length	302 mm	*FuLI* 0.19
Width at the base	302 mm	*FuWI* 0.19
Width at the midpoint	194 mm	
Width at the opening	185 mm	
Funnel-locking cartilage		
Length	204 mm	
Width	47 mm	
Arms (left) circumference at the base		
Arm I	220 mm	
Arm II	250 mm	
Arm III	260 mm	
Arm IV	220 mm	
Tentacles		
Width at the base	80 mm	
Gills (left)		
Length	532 mm	*GLI* 0.33
Width at the base	137 mm	
Width at the tip	139 mm	
Number of lamellae per demibranch	60 mm	
Stomach		
Length	472 mm	*SLI* 0.29
Volume of contents	± 1.5 l	
Ovary		
Length	1 055 mm	*OLI* 0.65
Width	447 mm	*OWI* 0.28
Mass	21.45 kg	
Oocytes		
Major axis mean length	1.998 mm	
Nidamental glands		
Length	446 mm	*NLI* 0.27
Width	182 mm	*NWI* 0.11

Table II: Diameter, number of teeth and type of the sucker rings of *Architeuthis*

Left arm	Basal ring sucker diameter (mm)	Largest ring sucker diameter (mm)	Number of teeth and type of basal ring	Number of teeth and type of largest ring
I	4.1	20.0	8, 6 distal rounded on 1/4 ring, 2 lateral ± fused, smooth proximal edge	52 subequal, triangular to sagittate
II	3.8		8, 6 distal rounded on 1/4 ring, 2 lateral ± fused, smooth proximal edge	
III		10.3		38–40, 6 distal sagittate, 32–34 proximal rounded
IV		13.0		36, 8 distal triangular, 28 proximal smaller and triangular

and 260 mm, with Arms II and III the thickest and Arms I and IV more slender. The formula for attachment of the buccal membrane connectives was DDVD. No suckers were present on the buccal membrane.

The oral surfaces of the arms carried two oblique rows of suckers, but the distal halves of the arms were missing. The suckers were placed on pad-like elevations that left a depression along the midline and between successive suckers. There were distinct folds of skin surrounding the sucker pads (Fig. 2b) and well-developed protective membranes with two trabeculae placed proximally and distally to each pad. The membranes appeared on the ventral side from the bases of Arms I and II, but they could be seen from the first pair of suckers on the dorsal side. In the case of Arms III and IV, they appeared from the first pair of suckers on the ventral side, but from the base of Arms III and from the second pair of suckers of Arms IV on the dorsal side. Keels were only observed on Arms III and IV.

Only one sucker smaller than the rest was present at the base of Arms I and II. Their rings (diameter 3.8–4.1 mm) had eight teeth, six distal rounded, two lateral fused and a smooth proximal edge (Fig. 3a, Table II). The paired suckers from Rows 1–3 and 15–20 of Arms I, III and IV were available. The ring diameters of the largest ranged between 10 and 20 mm, and the tooth number between 36 and 52. The largest sucker rings from Arms I were 20 mm in diameter and had 52 subequal teeth, whereas those from Arms III were 10.3 mm in diameter with 38–40 teeth, six distal sagittate and 32–34 proximal rounded (Fig. 3b, c). The largest sucker rings from Arms IV were 13 mm in diameter with 36 teeth, eight distal triangular and 28 proximal smaller and triangular (Fig. 3d).

The tentacles were mutilated at the base, where

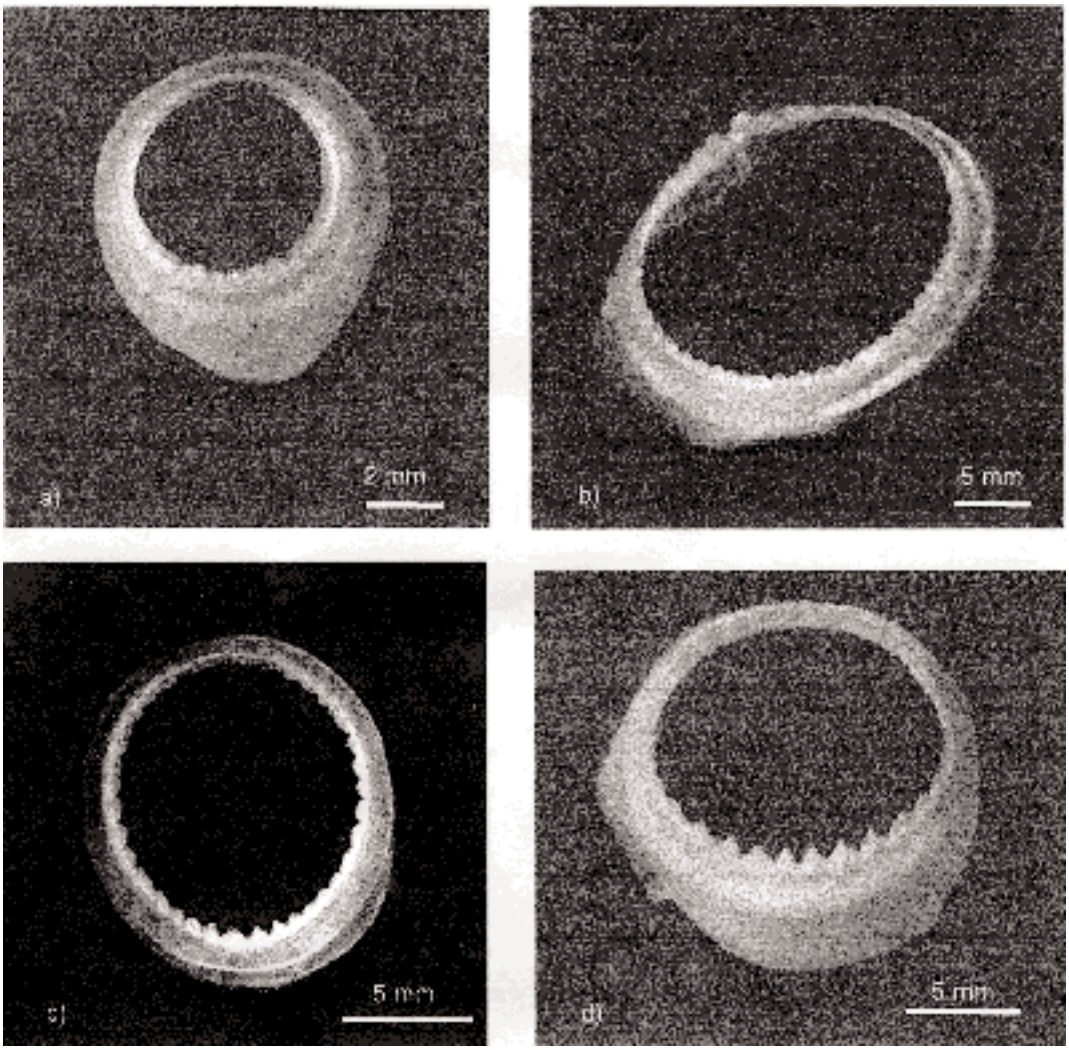

Fig. 3: Sucker rings of left arms – (a) Arm I basal, (b) Arm I largest available, (c) Arm III largest available, (d) Arm IV largest available

they were laterally compressed and 80 mm wide.

The mantle cavity was lined with a reddish brown integument. The gills were long (532 mm), with 60 lamellae in each demibranch and no distinctive branchial hearts (Fig. 2a).

The stomach was long (472 mm, Fig. 4c) with a strongly folded inner cuticle. It contained about 1.5l of brownish fluid but no evidence of food. The caecum was represented by a four-coil spiral but no evidence of a caecal sac (Fig. 4b, c). Two long anal papillae were present at the end of the rectum (Fig. 4d). The digestive gland was flat and brownish grey. A large ink sac extended up to the base of the digestive gland (Fig. 4c).

The ovary was very large (1 055 mm long), occupying the posterior half of the body, and yellow (Fig. 4a). It weighed 21.45 kg. The oocytes were slightly oval and the mean length of the long axis was 1.99 mm. They were obviously in advanced oogenesis (vitellogenesis), because longitudinal yolk stripes were clearly observed

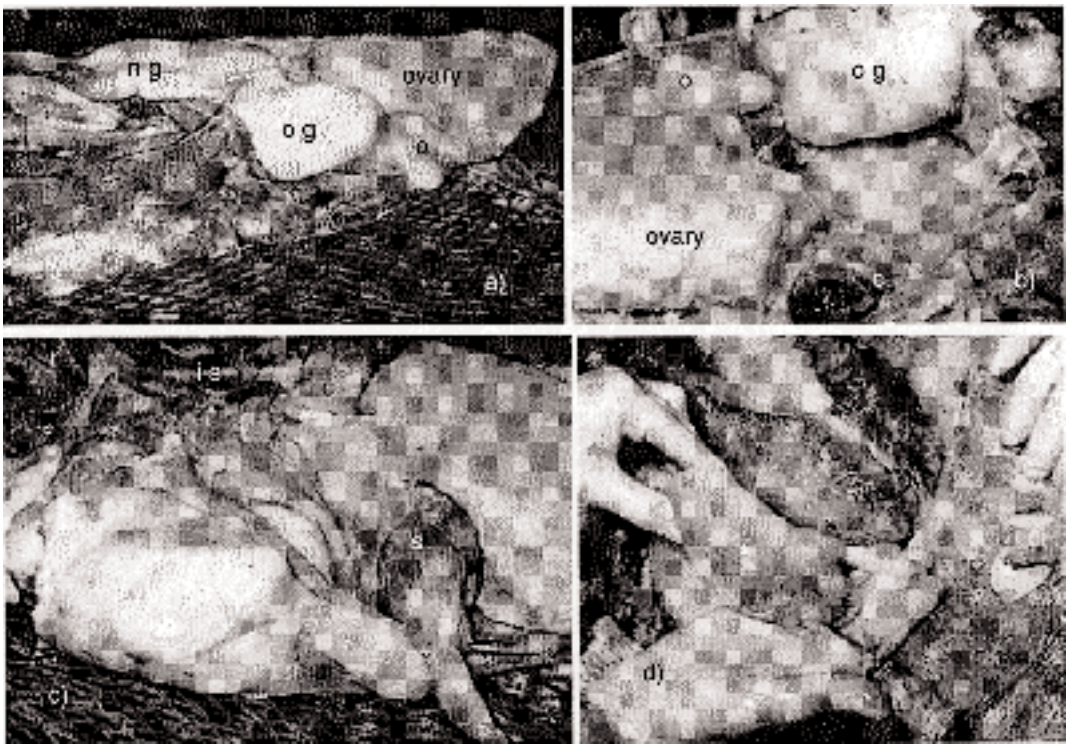

Fig. 4: (a), (b) Reproductive system, (c) digestive system, (d) anal papillae of *Architeuthis* (ng – nidamental glands, og – oviducal gland, o – oviduct, s – stomach, c – caecum, r – rectum, is – ink sac)

on the surface. The short oviducts were attached to the visceral sac integument and contained oocytes (Fig. 4b). They opened into large, globular and white oviducal glands. The nidamental glands were fused, white and short (*NLI* = 0.27).

Based on a mean estimation of 554.53 (*SD* = 36.23, *n* = 3) oocytes per gramme of ovary, the estimated mean absolute fecundity was about 12 million (*SD* 777 155) oocytes.

The statoliths were long (*STL* 1.91 mm) and exhibited well-developed dorsal and lateral domes and rostra (Fig. 5a, b, Table III). The rounded dorsal dome was clearly separated from the lateral dome and slightly laterally inclined. The lateral dome was long, its length 61% of *STL*, and it bore three lobes. A noticeable central groove on the anterior face demarcated the lateral dome as a prominent ridge, the thickness of which decreased from the inferior to the superior lobe. The prominent inferior lobe contained the nucleus. The rostrum was long (34% of *STL*) and the rostral angle obtuse. The wing was very well developed in the left statolith (35% of *STL*), but broken in the right one. There was a large attachment area, prominent dorsal and ventral spurs and a deep medial fissure.

Even though the nucleus was diffuse in the polished statolith, it seemed to have lobes, from which the growth axis radiated to each lateral dome lobe and dorsal dome (Fig. 5c, d). The increments were clearly visible and their widths varied from 2.1 μm around the nucleus to 1.2 μm at the outer margin. A total of 321 increments was counted.

DISCUSSION

Given the damaged nature of this specimen, detailed description of all characters important to systematics of this group could not be made. Nevertheless, some characters could be described that add to knowledge of the biology of the species, especially considering that this was, when caught, only the second record of an animal from the South-West Atlantic. Even now,

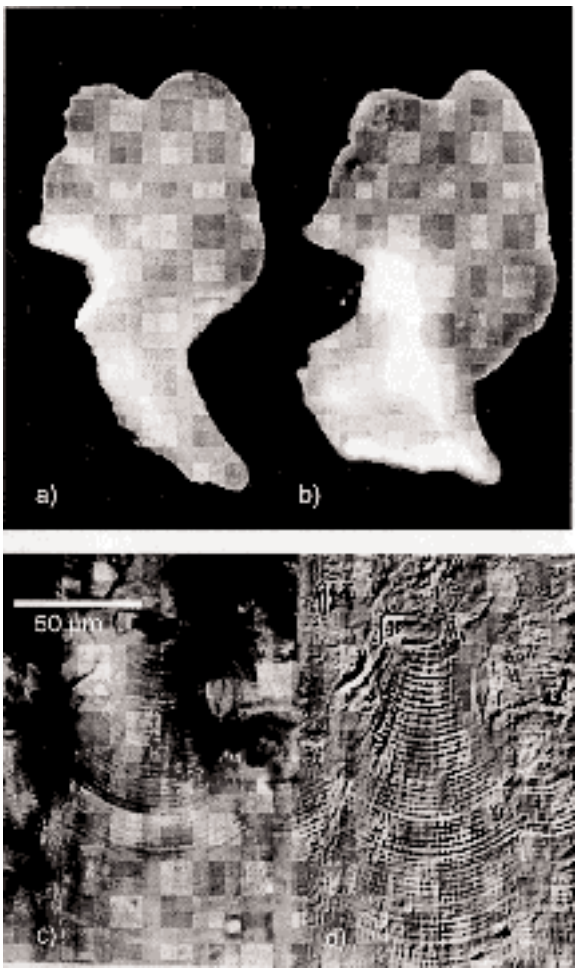

Fig. 5: (a) Posterior view of right and (b) anterior view of left statolith of *Architeuthis*. (c), (d) Sections of the polished left statolith

there are only four records documented from that area.

There were no signs of pigmentation on the external surface of the mantle or fins. Instead, there was a silvery-white fibrous tissue, as described by Roper and Young (1972) for two juveniles from the Atlantic and Pacific oceans.

The cross-sections of Arm IV and the tentacles, triangular and laterally compressed respectively, were different from those reported before, although the differences could be relative because the cross-sections were probably taken at different points. Aldrich (1991) described the cross-section of the tentacles of a specimen he examined as triangular, whereas Roeleveld and Lipiński (1991) reported the cross-section of Arms IV to be rectangular.

Table III: Measurements taken on the anterior face of the left statolith of *Architeuthis*, and its indices

Parameter	Measurement (µm)	Index	Value
Total length	1 911.28		
Ventro-lateral length	1 437.02	*SVLI*	0.75
Dorso-lateral length	829.74	*SDLI*	0.43
Lateral dome length	1 163.24	*SLDI*	0.61
Rostral length	650.20	*SRLI*	0.34
Maximum width	1 051.91	*SMWI*	0.55
Wing width	672.71	*SWWI*	0.35

As the sucker-ring dentition varies depending on the arm and sucker row (Roeleveld and Lipiński 1991), no detailed comparisons could be made with the available data, but the number and type of teeth agree in general with those of the South African specimens (Pérez-Gándaras and Guerra 1989, Roeleveld and Lipiński 1991).

This is one of the very rare records of a fully mature female *Architeuthis*. The ovary and oviducal oocytes (1.99 mm) were larger than those of the Durban specimen (1.2–1.8 mm) reported as a mature female, whereas the nidamental gland indices were comparable (0.27 in this case, 0.26 for the Durban specimen; Roeleveld and Lipiński 1991).

Of particular interest was that the statoliths very much resembled those of *Architeuthis kirki* of New Zealand, not only in their morphology, but also in the number of increments counted (Gauldie *et al*. 1994, Fig. 4a, b). However, they appeared to be different from those of the South African specimen (Roeleveld and Lipiński 1991) in having a well-developed wing.

From an area where, until recently, *Architeuthis* had not been recorded, three specimens have been identified within a period of just 14 months. Ruiz and Fondacaro (1996) reported the second specimen found on the Argentine shelf. It was found on a mat of seaweed inside Bustamante Bay (San Jorge Gulf, 45°12′S, 66°30′W) on 15 July 1995 (Fig. 1). The third giant squid was found stranded at almost the same place (Bustamante Bay, 45°08′S, 66°31′W) on 24 May 1996 (Ré *et al*. 1998). Both were immature or maturing females of 1 300 and 1 940 mm *ML* respectively, and their descriptions agreed in general with this one.

ACKNOWLEDGEMENTS

We are very grateful to the *El Marisco* fishing company (F.V. *Arbumasa XIX*) and Dr N. B. Bellisio

(Museo de Ciencias Naturales Bernardino Rivadavia, Buenos Aires) for providing us with the opportunity to examine the animal.

LITERATURE CITED

ALDRICH, F. A. 1968 — The distribution of giant squids (Cephalopoda, Architeuthidae) in the North Atlantic and particularly about the shores of Newfoundland. *Sarsia* **34**: 393–398.

ALDRICH, F. A. 1991 — Some aspects of the systematics and biology of squid of the genus *Architeuthis* based on a study of specimens from Newfoundland waters. *Bull. mar. Sci*. **49**(1–2): 457–481.

ALDRICH, F. A. and M. M. ALDRICH 1968 — On regeneration of the tentacular arm of the giant squid *Architeuthis dux* Steenstrup (Decapoda, Architeuthidae). *Can. J. Zool*. **46**(5): 845–847.

ARFELLI, C. A., AMORIM, A. F. and A. R. G. TOMÁS 1991 — First record of a giant squid *Architeuthis* sp. Steenstrup, 1857 (Cephalopoda, Architeuthidae) in Brazilian waters. *Bolm Inst. Pesca, S. Paulo* **18**: 83–88.

BRIX, O. 1983 — Giant squids may die when exposed to warm water currents. *Nature, Lond*. **303**(5916): 422–423.

CLARKE, M. R. 1978 — The cephalopod statolith - an introduction to its form. *J. mar. biol. Ass. U.K.* **58**(3): 701–712.

GAULDIE, R. W., WEST, I. F. and E. C. FÖRCH 1994 — Statocyst, statolith, and age estimation of the giant squid, *Architeuthis kirki*. *Veliger* **37**(1): 93–109.

LIPIŃSKI, M. R. 1998 — The external diverticulum of the anterior vena cava in some cephalopods: a preliminary description. In *Cephalopod Biodiversity, Ecology and Evolution*. Payne, A. I. L., Lipiński, M. R., Clarke, M. R. and M. A. C. Roeleveld (Eds). *S. Afr. J. mar. Sci*. **20**: 37–40.

PÉREZ-GÁNDARAS, G. and A. GUERRA 1978 — Nueva cita de *Architeuthis* (Cephalopoda: Teuthoidea): descripción y alimentación. *Investigación pesq., Barcelona* **42**(2): 401–414.

PÉREZ-GÁNDARAS, G. and A. GUERRA 1989 — *Architeuthis* de Sudáfrica: nuevas citas y consideraciones biológicas. *Scientia Mar., Barcelona* **53**(1): 113–116.

PFEFFER, G. 1912 — *The Cephalopoda of the Plankton Expedition* (2 volumes), English translation 1993. Boletzky, S. von and C. F. E. Roper (Eds). New Delhi; Amerind Publishing Co.: 618 pp. + 97 pp. of Plates.

RÉ, M. E., BARON, P. J., BERON, J. C., GOSZTONYI, A. E., KUBA, L., MONSALVE, M. A. and N. H. SARDELLA 1998 — A giant squid *Architeuthis* sp. (Mollusca, Cephalopoda) stranded on the Patagonian shore of Argentina. In *Cephalopod Biodiversity, Ecology and Evolution*. Payne, A. I. L., Lipiński, M. R., Clarke, M. R. and M. A. C. Roeleveld (Eds). *S. Afr. J. mar. Sci*. **20**: 109–122.

ROELEVELD, M. A. C. and M. R. LIPIŃSKI 1991 — The giant squid *Architeuthis* in southern African waters. *J. Zool., Lond*. **224**(3): 431–477.

ROPER, C. F. E. and K. J. BOSS 1982 — The giant squid. *Scient. Am*. **246**(4): 82–89.

ROPER, C. F. E. and R. E. YOUNG 1972 — First records of juvenile giant squid, *Architeuthis* (Cephalopoda: Oegopsida). *Proc. biol. Soc. Wash*. **85**(16): 205–222.

RUIZ, A. and R. FONDACARO 1996 — Un calamar gigante en aguas de la plataforma patagónica. In *Jornadas Patagónicas de Medio Ambiente, Universidad Nacional de la Patagonia, 9–11 Octubre 1996*: p. 95.

TOLL, R. B. and S. C. HESS 1981 — A small, mature male *Architeuthis* (Cephalopoda: Oegopsida) with remarks on maturation in the family. *Proc. biol. Soc. Wash*. **94**(3): 753–760.