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Short Communication

On the presence of *Illex argentinus* (Castellanos, 1960) (Cephalopoda: Ommastrephidae), paralarvae and juveniles in near-shore waters of Nuevo Gulf, Argentina

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ABSTRACT. In this study we report the presence of paralarvae and juveniles of *Illex argentinus* in the waters of Nuevo Gulf (42°45'S-64°45'W, Argentina) during three consecutive years (2004-2007). Paralarvae were caught using a Hensen net of 295 µm mesh size. Juveniles were found stranded on the coast in September 2007. These findings show that the species uses near-shore waters for breeding.

Keywords: early life stages, Ommastrephid, near-shore waters, nursery grounds, Argentina.

Presencia de paralarvas y juveniles de *Illex argentinus* (Castellanos, 1960) (Cephalopoda: Ommastrephidae) en aguas costeras del Golfo Nuevo, Argentina

RESUMEN. En este estudio reportamos la presencia de paralarvas y juveniles de *Illex argentinus* en aguas del Golfo Nuevo (42°45'S-64°45'W, Argentina) durante tres años consecutivos (2004-2007). Las paralarvas fueron capturadas usando una red Hensen de 295 µm de malla. Los juveniles se hallaron varados en la costa en septiembre de 2007. Estos registros son evidencia de que esta especie utiliza aguas costeras para la cría.

Palabras clave: estadios tempranos de vida, Ommastréfido, aguas costeras, áreas de cría, Argentina.

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The location of spawning and nursery grounds of squids from the genus *Illex*, as well as that of other ommastrephids, has been frequently associated to areas subjected to the influence of major oceanic currents (*e.g.* Gulf Stream, Kuroshio-Oyashio) because of the favorable hydrographic conditions for egg mass and paralarvae survival they generate (*e.g.* high primary productivity, particle retention and transport, adequate temperatures for embryonic development) (Bakun & Csirke, 1998). The geographic area of distribution of *Illex argentinus* (Castellanos, 1960), the second most important cephalopod fishery in volume of captures (FAO, 2008), is also under the influence of an interactive system comprising two major currents. The southward-flowing Brazil current dominates the northern part of the region while the northward-flowing Malvinas (Falkland) current affects the southern part (Olson *et al.*, 1988). According to several authors (Brunetti & Ivanovic, 1992; Haimovici *et al.*, 1998; Waluda *et al.*, 2001), their confluence, near the mouth of La Plata River, generate oceanographic conditions that support embryonic and paralarvae development.

Based on information about the presence of mature and spent individuals, egg masses and paralarvae, it has been reported that mature *I. argentinus* from the outer-shelf and slope populational units (South Patagonic and Bonaerensis-North Patagonic Stoks) concentrate and spawn on the slope, egg masses are transported northward by the Malvinas (Falkland) Current, and hatching occurs near the confluence with the Brazil Current (Haimovici *et al.*, 1998; Arkhipkin, 2000; Laptikhovsky *et al*., 2001; Waluda *et al.*, 2001, 2005). Additionally, the presence of juveniles reveals the existence of a populational unit (Summer Spawning Stock) spawning on the mid-shelf (Brunetti & Ivanovic, 1992; Haimovici *et al.*, 1998).

Nevertheless, it has been suggested that this unit represents only a small fraction of that of the whole population (less than 1%) (Bakun & Csirke, 1998; Carvalho & Nigmatullin, 1998). It has been demonstrated that several areas along mid and outer shelf off Argentina present physical and biological conditions such that they act as spawning and nursery grounds (*e.g.* tidal frontal zones) (Brunetti, 1990; Brunetti & Ivanovic, 1992; Haimovici *et al.*, 1998; Waluda *et al.*, 2001; Rivas *et al.*, 2006; Romero *et al.*, 2006). In contrast, efforts directed to determine if near-shore waters are suitable habitats for early-life stages of the species have been sparse and unsuccessful in detecting their presence (Brunetti & Ivanovic, 1992; Leta, 1992; Haimovici *et al.*, 1998). To improve this situation, we examined the presence of paralarvae and juveniles of *I. argentinus* in waters of Nuevo Gulf (NG) (Fig. 1), one of the three northern Patagonian gulfs (along with San José and San Matías gulfs), by sampling zooplankton during two consecutive years (2005 to 2006).

Nuevo Gulf (Fig. 1) is a semi-enclosed basin $2.44x10^9$ m^2 in surface area and $2{,}54x10^{11}$ m^3 in volume, with mean and maximum depths of 90 and 170 m respectively (Rivas & Ripa, 1989; Rivas, 1990). Its narrow mouth, 16 km in width and $7{,}13x10^5$ m^2 in transverse section, opens to the inner shelf off northern Patagonia. Estimations of mean monthly chlorophyll-*a* concentration at its western sector range within 0.20- 4.20 mg m^{-3} (Gil, 2001).

From August 2004 to April 2006, 70 plankton hauls (2-3 knots of towing speed) were performed with a 295 µm-mesh size Hensen net (70 cm of diameter) equipped with a flowmeter (Ogawa Seiki) on board of the research vessel CENPAT I and the coastal guard vessel Lago Musters (Prefectura Naval Argentina) in waters of Nuevo Gulf. From August 2004 to July 2005, 24 tows were performed in day hours. Nine of them were horizontal and conducted at sub-surface near the west coast of Nuevo Gulf (between 6 and 10 m bottom depth), and 15 were oblique, from deeper waters (between 35 and 50 m bottom depth) to surface. In the oblique hauls, the net was held during five minutes at approximate depths of 30, 15, and 2 m. From August 2005 to April 2006, 46 stratified horizontal tows were performed in areas with 35 and 85 m bottom depth (18 during night hours and 28 during day hours). The net was towed at different depths on each haul to sample different strata in the water column (3, 10, 30, and 70 depth approximately). Additionally, stranded juveniles of *I. argentinus* were collected in September 2007. Both paralarvae and juveniles were identified by comparison with reference material and descriptions available on the literature (Brunetti, 1990; Wormuth *et al.*, 1992; Vidal, 1994). For each specimen a number of body dimensions were measured (Fig. 2). All of the specimens were included in the catalog of the marine invertebrate collection of the Commercial Fish and Shellfish Laboratory of the National Patagonian

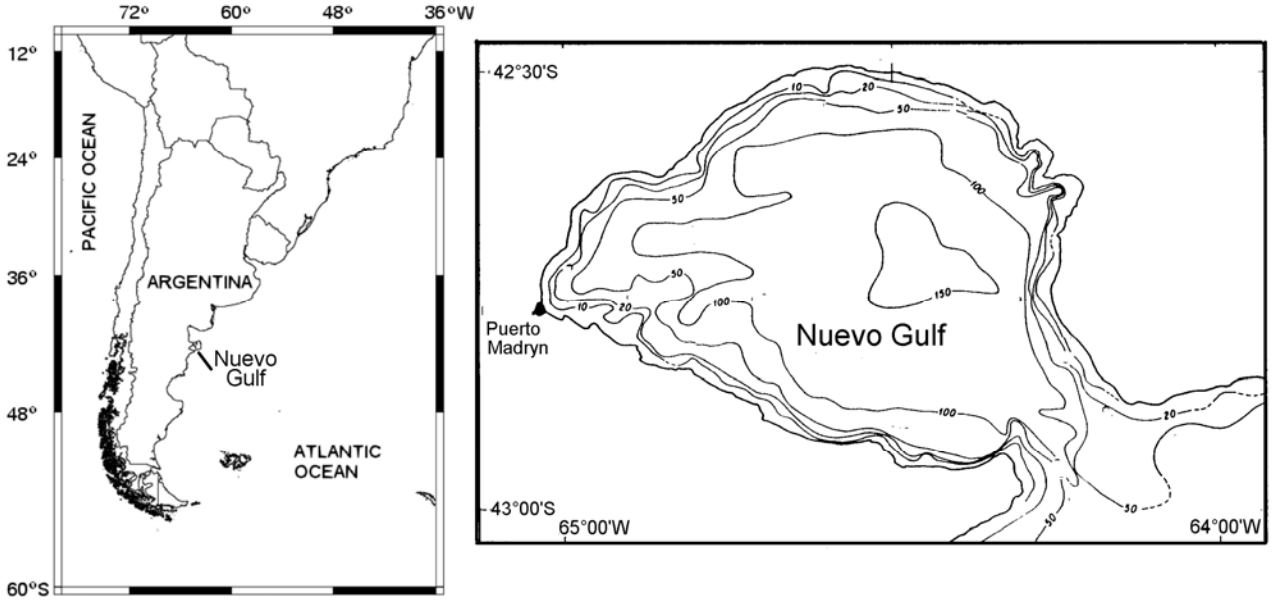

Figure 1. Map of Nuevo Gulf. Left: geographic location; right: bathymetry (m).

Figura 1. Mapa de Golfo Nuevo. Izquierda: ubicación geográfica; derecha: batimetría (m).

Table 1. Locations and dimensions (in milimeters) of paralarvae and juveniles of *Illex argentinus* obtained in Nuevo Gulf. FW: fin with, ML: mantle length, FL: fin length, HW: head with, AL: right arms length, TL: tentacle or proboscis length (juveniles/paralarvae or rhynchoteuthion respectively). Depth is expressed in meters and distance to shore in kilometers. SST: sea surface temperature in (ºC) obtained from AVHRR Pathfinder satellite sensed temperature database (http://poet.jpl.nasa.gov/). r: rhynchoteuthion, p: paralarva, j: juvenile, H: horizontal, O: oblique, ph: plankton haul, st: hand-collected stranded individuals, PD: proboscis division length, S: range of the diameter of the eigth suckers present in the proboscis nm.

Tabla 1. Localización y medidas (en milímetros) de las paralarvas y juveniles de *Illex argentinus* obtenidas en el Golfo Nuevo. FW: ancho de la aleta, ML: largo del manto, FL: longitud de la aleta, HW: ancho de la cabeza, AL: largo de los brazos del lado derecho, TL: largo de los tentáculos o proboscis (juveniles/paralarvas o rhynchoteuthion respectivamente). SST: temperatura superficial del mar (ºC) obtenida de las imágenes satelitales del sensor AVHRR Pathfinder (http://poet.jpl.nasa.gov/). r: rhynchoteuthion, p: paralarva, j: juvenil, H: horizontal, O: oblicuo, ph: arrastre de plancton, st: individuos varados colectados manualmente, PD: longitud de la división de la proboscis, S: rango del diámetro de las ocho ventosas presentes en la proboscis nm.

Ontogenetic stage	Sampling method	Date (SST °C)	Haul type / maximum depth	Bottom depth (m)	Distance to shore (km)	Latitude (S)	Longitude (W)	FW (mm)	ML (mm)	FL (mm)	HW (mm)	AL I (mm)	AL II (mm)	AL III (mm)	AL IV (mm)	TL (PD) (mm)	S (mm)
r	ph	Mar 2005 (17.8)	O/30 m	40	1.85	42°43'	65°00'	0.46	2.61	0.15	1.38	0.46	0.43	0.43	0.42	0.92 (0.2)	0.3-0.35
p	ph	Apr 2006 (16)	H/1 m	85	5.5	42°42'	64°55'	3.13	10.63	1.88	3.75	2.50	2.55	2.49	2.51	3.13	-
p	ph	Apr 2006 (16)	H/1 m	85	5.5	42°42'	64°55'	3.13	9.38	1.75	3.75	3.13	3.78	3.73	3.72	3.75	-
p	ph	Apr 2006 (16)	H/1 m	85	5.5	42°42'	64°55'	3.13	10.64	1.25	3.74	2.50	2.10	2.23	2.52	3.13	-
r	ph	Apr 2006 (16)	H/1 m	85	5.5	42°42'	64°55'	2.38	5.00	0.63	2.50	1.25	1.24	1.40	1.43	1.88 (0.3)	0.3-0.35
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	14.01	41.64	8.98	7.07	6.98	7.01	6.50	6.80	7.37	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	13.86	37.51	7.89	7.28	11.02	10.96	10.98	11.00	15.05	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	7.83	43.08	9.75	7.51	6.88	7.01	6.87	6.85	11.7	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	12	40.31	7.83	7.72	5.8	5.82	6.21	5.98	12.5	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	4.95	30.34	7.4	5.85	7.62	7.30	7.98	7.71	10.47	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	8.77	25.54	7.06	5.57	6.67	6.32	6.46	6.60	14.03	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	13.88	39.99	10.2	7.74	6.6	7.32	7.15	6.98	14.06	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	10.22	36.18	10.5	7.44	10.39	9.45	11.01	10.70	22.74	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	6.61	32.38	5.94	6.38	11.98	10.98	9.98	-	-	-
j	st	Sep 2007 (9.8)	-	-	-	42°45'	65°00'	13.98	35.3	9.51	8	10.95	11.85	10.67	-	-	-

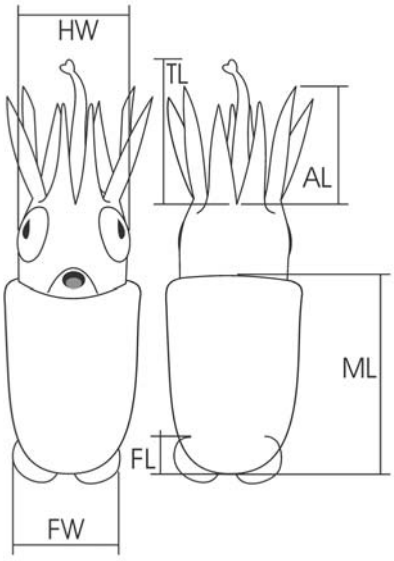

Figure 2. Schematic representation of an *Illex argentinus* paralarvae showing body dimensions registered in this study. FW: fin with, ML: mantle length, FL: fin length, HW: head with, AL: arms length, TL: tentacle length.

Figura 2. Representación esquemática de la paralarva de *Illex argentinus* donde se muestran las dimensiones registradas en este studio. FW: ancho de la aleta, ML: largo del manto, FL: longitud de la aleta, HW: ancho de la cabeza, AL: longitud de los brazos, TL: longitud de los tentáculos.

Center (LAPEMAR-CENPAT) and are available for further examination.

Paralarvae of *I. argentinus* were found in one out of 22 hauls conducted in summer and one out of 17 performed in fall. No paralarvae were found in winter (20 hauls) and spring (9 hauls). A total of five paralarvae (one in March 2005 and four in April 2006) were obtained from an estimated volume of 9674 m^3 of seawater filtered as part of the zooplankton monitoring program in Nuevo Gulf. The paralarvae (mean mantle length: 7.6 mm) were captured at depths lower than 30 m (Table 1). Additionally, in September of 2007, 10 stranded juveniles (mean mantle length: 36.2 mm) were collected on a beach located at the western margin of Nuevo Gulf (Table 1). Also, three paralarvae of *Loligo sanpaulensis*, identified following Barón (2003), were found in the samples.

Previous findings of *I. argentinus* paralarvae were summarized by Haimovici *et al.* (1998), but were all referred to mid and outer shelf and slope samplings. The scarcity of information on the relevance of near-shore waters for the reproduction and breeding of the species may have lead to the sub-estimation of the extension of the spawning and nursery grounds. In a previous study, Crespi-Abril *et al.* (2008) pointed out that *I. argentinus* uses near-shore waters of northern Patagonia (San Matías Gulf) for mating and probably for spawning. The finding of paralarvae in two consecutive years and juveniles in the following year in Nuevo Gulf evidences that breeding of *I. argentinus*, and probably hatching, are viable within the northern Patagonian gulfs. Although the abundance of squid paralarvae in our samples seems to be low, values are not far from those reported in some of the previous studies conducted on the shelf and slope (Haimovici *et al.*, 1998). Some causes for these low captures could be the patchy distribution of these organisms, their low densities and the underestimation of their ability to elude the nets (Haimovici *et al.*, 2002). On the other hand, the seasonality of hatching and breeding could restrict the presence of these life stages in the water column to a limited period of the year. Overall, from our observations it becomes evident that there is a need for more exhaustive and extensive sampling in near-shore waters to determine how significant is the contribution of *I. argentinus* offspring breed in near-shore waters compared to that of the shelf and slope.

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