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BRIEF COMMUNICATIONS

Egg cases of the graytail skate *Bathyraja griseocauda* and the cuphead skate *Bathyraja scaphiops* from the south-west Atlantic Ocean

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Egg cases of *Bathyraja griseocauda* were larger (140–142 mm in length) than those of *Bathyraja scaphiops* (88–90 mm in length) and their surface was relatively smooth, without denticles, prickles or any ornamentation. Egg cases of *B. scaphiops* had a relative coarse surface, covered with prickles of similar size. An identification key for the all described egg cases from *Bathyraja* occurring in the south-west Atlantic Ocean is provided.

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Key words: *Bathyraja*; egg cases; identification key; skates; south-western Atlantic Ocean.

Skates of the genus *Bathyraja* Ishiyama, 1958 are circumglobally distributed and this genus may be the most diverse among skates, with more than 50 nominal species currently recognized (Last *et al.,* 2016; Weigmann, 2016). Bathyrajids occur mainly in the waters of continental shelves at temperate and cold temperate latitudes and on continental slopes down to *c.* 3000 m depth (Priede *et al.,* 2006). *Bathyraja* species are a dominant by-catch in teleost fisheries in the south-west Atlantic Ocean (SWA) and are also exploited as a target species (Colonello *et al.,* 2002; McCormack *et al.,* 2007*a*; Arkhipkin *et al.,* 2012).

All skate species (order Rajiformes, after Eschmeyer & Fong, 2016) are oviparous. This reproductive mode is characterized by the production of fertilized eggs that are encapsulated in a structurally complex protein capsule produced by the mother and deposited onto the seafloor (Hamlett *et al.,* 2005). Egg case morphology is species-specific (Ishiyama, 1958; Ebert & Davis, 2007; Oddone & Vooren, 2008;

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Mabragaña *et al.,* 2011; Concha *et al.,* 2012), which has made egg cases a useful tool not only for species identification, but also for understanding reproductive biology and phylogenetic relationships (Ishiyama, 1958; Jañez & Sueiro, 2007; Luer *et al.,* 2007; Hoff, 2010; Ishihara *et al.,* 2012; Fischer *et al.,* 2014; Mabragaña *et al.,* 2015; Vazquez *et al.,* 2016).

The genus *Bathyraja* is represented in the SWA by 11 species (Menni & Stehmann, 2000; Díaz de Astarloa & Mabragaña, 2004; Cousseau *et al.,* 2007; Arkhipkin *et al.,* 2012). Egg cases of only four species of *Bathyraja* occurring in the SWA have been described in detail. Paesch & Oddone (2008*a*) characterized the egg cases of *Bathyraja brachyurops* (Fowler 1910) and *Bathyraja macloviana* (Norman 1937) based on specimens from the Argentinean–Uruguayan common fishing zone. Mabragaña *et al.* (2011) described the egg cases of four species of *Bathyraja*: *B. brachyurops*, *B. macloviana*, *Bathyraja albomaculata* (Norman 1937) and *Bathyraja magellanica* (Philippi 1902) from specimens collected throughout the Argentine continental shelf (ACS) and provided a key to distinguish among them and other SWA skate cases. Here, the egg cases of *Bathyraja griseocauda* (Norman 1937) and *Bathyraja scaphiops* (Norman 1937), two skate species assessed by the IUCN as endangered and near threatened, respectively (McCormack *et al.,* 2007*a*, *b*), are described for the first time. Differences between the egg cases of these species and congeners from the SWA are highlighted and an identification key for all described egg cases of SWA *Bathyraja* species is provided.

Two egg-bearing females of *B. scaphiops* and *B. griseocauda* were caught by commercial bottom-trawl vessels operating in the SWA between 41° and 43° S and depths ranging between 74 and 383 m (Fig. 1). The *B. scaphiops* female was caught on February 2016 and measured 810 mm total length (L_T). The female of *B. griseocauda* was caught on September 2016 and measured 1225 mm L_T. In the laboratory, two egg cases from each species were analysed and 10 morphometric characteristics were recorded following Ebert & Davis (2007) and Mabragaña *et al.* (2011): egg case length without horns (L_{EC}), maximum egg case width (W_{max}), minimum egg case width (W_{min}), anterior horn length (L_{AH}), posterior horn length (L_{PH}), lateral keel width (W_{LK}), keel thickness (T_{LK}), anterior apron (A_A), posterior apron (A_P) and straight distance from anterior apron to apex of anterior horn (L_{AH2}). All measurements were taken with vernier callipers at 0·1 mm precision before fixing in 4% formalin and preservation in 75% ethanol. In order to describe and photograph the surface of the cases, a Leica EZ4E stereomicroscope (www.leica.com) with camera was used. Egg cases were catalogued and deposited in the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP, Mar del Plata, Argentina) Fish Collection, as INIDEP 858 and INIDEP 859, respectively.

Measurements of each egg case are provided in Table I. Egg cases of *B. griseocauda* ($n = 2$) [Fig. 2(a)] were 140 and 142 mm in length, with W_{max} 58–60% of L_{EC}. The egg case surface was relatively smooth, finely striated, without denticles, prickles or any ornamentation [Fig. 2(b)]. The surface was covered with soft woven-like fibres. Respiratory fissures were relatively large (30 mm in length). Each anterior horn had an internal and transparent flange at its end. The posterior horns curved inwards with a hard flange that supported attachment fibres. Attachment fibres were observed at the bases of the posterior horns. The T_{LK} was relatively thin (<1·5 mm). The W_{LK} was narrow (6–7% of W_{max}). The posterior apron was wider (4·2–4·6 times) than the anterior apron. Posterior horns were slightly longer (1·6 times) than the anterior ones.

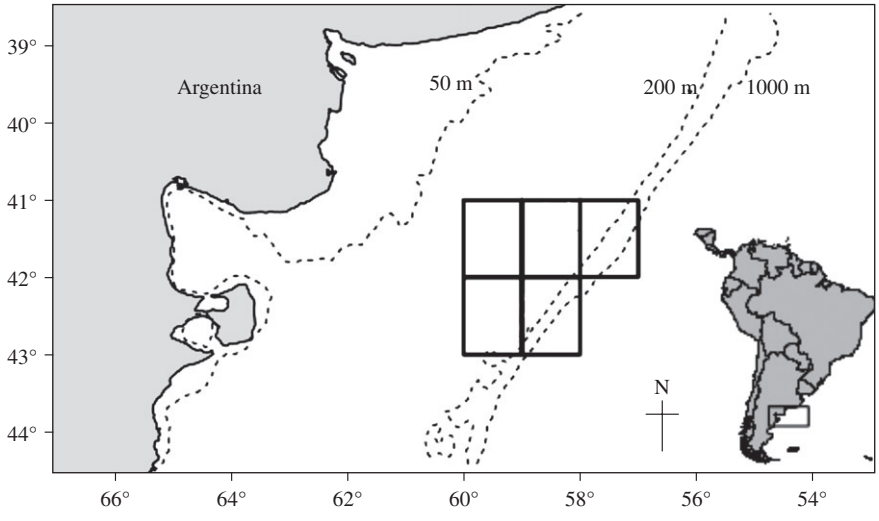

FIG. 1. Fishing areas on the Argentinian continental shelf (□) where adult females of *Bathyraja griseocauda* and *B. scaphiops* were collected.

Colour before fixation was uniformly gold, with no differentiation between keel, apron and case.

Egg cases of *B. scaphiops* ($n = 2$) [Fig. 2(c)] measured 88 and 90 mm in length, with W_{max} 57–60% of L_{EC}. The egg case surface was relatively coarse, rough to the touch, with ordered longitudinal ridges with prickles of similar size [Fig. 2(d)]. Attachment fibres were observed at the base of both anterior and posterior horns. Respiratory

TABLE I. Measurements (mm) of the egg cases of *Bathyraja griseocauda* and *Bathyraja scaphiops* from Argentinian waters (with Instituto Nacional de Investigación y Desarrollo Pesquero, INIDEP, catalogue numbers)

	B. griseocauda		*B. scaphiops*	
	INIDEP 858·1	INIDEP 858·2	INIDEP 859·1	INIDEP 859·2
L_{EC}	139·9	141·8	88·1	89·8
W_{max}	83·5	82·4	52·7	51
W_{min}	65·7	64·6	45·1	44·2
L_{AH}	101	99	75	78
L_{PH}	167	157	97	98
W_{LK}	6·1	5·6	1·7	1·3
T_{LK}	1·1	1·15	1·4	1·3
A_A	7·5	7	5·7	6·4
A_P	31·8	32·2	14·3	16·4
L_{AH2}	54·6	53·4	34·2	33·1

L_{EC}, egg case length without horns; W_{max}, maximum egg case width; W_{min}, minimum egg case width; L_{AH}, anterior horn length; L_{PH}, posterior horn length; W_{LK}, lateral keel width; T_{LK}, keel thickness; A_A, anterior apron; A_P, posterior apron; L_{AH2}, straight distance from anterior apron to apex of anterior horn.

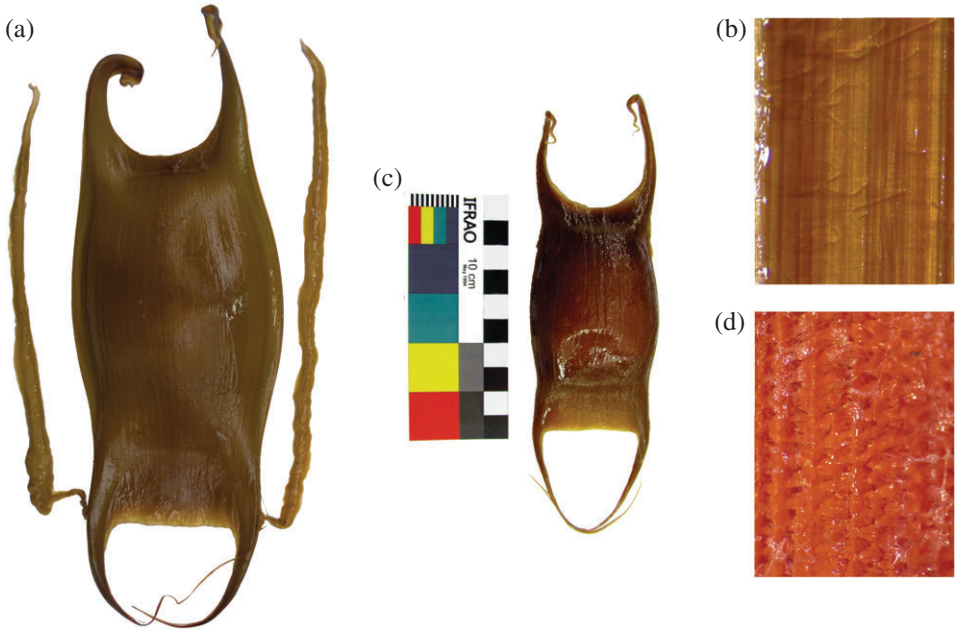

FIG. 2. (a) Dorsal view of *Bathyraja griseocauda* egg case (■□■□, each block 1 cm) with (b) magnified view of capsule surface. (c) Comparable views of *Bathyraja scaphiops* egg case and (d) capsule surface.

fissures were relatively large (25 mm in length). Each anterior horn had an internal transparent flange at its end. Posterior horns curved inward. The T_{LK} was relatively thin (<1·5 mm). The W_{LK} was narrow (3% of W_{max}). The posterior apron was wider (2·5–2·6 times) than the anterior apron. Posterior horns were slightly longer (1·3 times) than the anterior ones. Colour before fixation was uniformly light brownish, with no difference between the lateral keel, apron and case.

Critical life-history information (*e.g.* nursery grounds, size at maturity, reproductive cycles) is urgently needed to carry out effective management plans of SWA skates and a prerequisite to the identification of nursery grounds is the accurate species-level identification of egg cases. The egg cases of *B. griseocauda* and *B. scaphiops*, like all *Bathyraja* cases known to date, have posterior horns curved inwards, although in *B. scaphiops* this feature is weakly developed. The egg case of each species has distinctive characteristics: the cases of *B. griseocauda* are up to 140 mm L_{EC}, the largest recorded so far among congeners in the SWA and are larger even that those of most other genera (<100 mm L_{EC}; Oddone & Vooren, 2008; Paesch & Oddone, 2008*a*; Mabragaña *et al.,* 2011; Colonello *et al.,* 2012). In the SWA, only *Zearaja chilensis* (Guichenot 1848) and *Dipturus trachyderma* (Krefft & Stehmann 1975) possess larger cases than *B. griseocauda*, reaching up to 158 and 220 mm L_{EC} (Paesch & Oddone, 2008*b*; Mabragaña *et al.,* 2011; Concha *et al.,* 2012). Cases of *B. griseocauda* resemble those of *B. brachyurops*. Both species' egg case surface is smooth, without prickles, spines and other ornamentation under magnification. Although appearing smooth, however, the egg cases of *B. brachyurops* possess rasp-like denticles under magnification. Egg cases

of *B. scaphiops* are similar to those of *B. macloviana*, *B. albomaculata* and *B. magellanica*, but differ from these species by several features: They are larger than those of *B. macloviana* (88–90 *v.* 75–85 mm L_{EC}) and smaller than those of *B. albomaculata* (88–90 *v.* 90–96 mm L_{EC}) and they differ from *B. magellanica* in colour of the lateral keel, pattern of ornamentation and width of lateral keel (<2 *v.* >7 mm). From *B. macloviana* and *B. albomaculata* they are also distinguished by pattern of ornamentation (Paesch & Oddone, 2008*a*; Mabragaña *et al.,* 2011).

Nursery sites of *Bathyraja* spp. have been observed during exploratory trawling around the world (Hoff, 2010; Hunt *et al.,* 2011; Treude *et al.,* 2011), including in Antarctic waters (Amsler *et al.,* 2015). Recently, nursery sites of elasmobranch fishes in the SWA, including *Bathyraja* spp. have been recorded in the northern part of the ACS and near Mar del Plata Canyon (Vazquez *et al.,* 2016). Neither egg cases nor egg-bearing females of *B. griseocauda* and *B. scaphiops*, however, have been observed thus far (Mabragaña *et al.,* 2011; Scenna, 2011). Juveniles and egg-bearing females of *B. griseocauda* were recorded on the eastern Patagonian Shelf and slope, but no egg cases were observed in this area (Arkhipkin *et al.,* 2012). On the contrary, no egg-bearing females of *B. scaphiops* have yet been observed in the ACS or on the eastern Patagonian Shelf and Slope (Mabragaña *et al.,* 2011; Arkhipkin *et al.,* 2012).

IDENTIFICATION KEY

1a. Egg case length >110 mm, surface relatively smooth, finely striated, without denticles, prickles or any ornamentation ..... *B. griseocauda.*

1b. Egg case length <100 mm, surface relatively smooth but with denticles under magnification or surface rough to the touch ..... 2.

2a. Surface relatively smooth, finely striated, with rasp-like denticles under magnification but without prickles; attachment fibres on posterior horns only ..... *B. brachyurops.*

2b Surface rough to the touch, with longitudinal striations having prickles; attachment fibres absent or on both anterior and posterior horns ..... 3.

3a. Lateral keel remarkably lighter in colour than rest of the case, >6 mm; lateral keel width (W_{LK}) relatively broad, 12–16% of the maximum egg case width (W_{max}); surface of case with long, thin prickles of similar size ..... *B. magellanica.*

3b. Lateral keel similar in colour to rest of the case, ≤6 mm; W_{LK} relatively narrow (<11% of W_{max}); surface of case with other pattern of ornamentation ..... 4.

4a. Egg case length <85 mm, maximum width <50 mm, surface texture coarse and rough to touch, covered by papillose longitudinal ridges; prickles with different sizes and shapes ..... *B. macloviana.*

4b. Egg case length >85 mm, maximum width >50 mm, surface of case with other pattern of ornamentation ..... 5.

5a. Surface with long and thin prickles of different sizes, giving a velvety texture to touch; attachment fibres are absent; keel width less than 16 times in W_{max} ..... *B. albomaculata.*

5b. Surface with prickles of similar size; attachment fibres on both anterior and posterior horns, keel width more than 30 times in W_{max} ..... *B. scaphiops.*

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