

Deep-sea Chondrichthyans associated with the Patagonian toothfish *Dissostichus eleginoides* fishery off the coast of Peru

Condriictios de aguas profundas asociados con la pesquería de bacalao de profundidad *Dissostichus eleginoides* frente a la costa de Perú

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Abstract. The deep-sea fishery for Patagonian toothfish (*Dissostichus eleginoides*) in Peru offers the opportunity to document species that may be new or rare to the region, or possibly new to science. Here, we report specimens caught, photographed and discarded in a vessel operating in the deep-sea fishery for *D. eleginoides*, during two fishing trips in 2019 and 2020. Five specimens of three chondrichthyan species were caught incidentally at an average depth of 1,489 m. Species identification was done from photographs as specimens were discarded, and they include *Centroscyllium* cf. *nigrum*, *Bathyraja* cf. *spinosissima*, and *Hydrolagus melanophasma*. All are new records for Peruvian waters. Continuing the collaboration with commercial fisheries as a source of information for deep-sea species could greatly contribute to improving our understanding of marine biodiversity in Peru and inform conservation decision-making.

Key words: Chondrichthyans, elasmobranchs, deep-sea species

INTRODUCTION

Chondrichthyan biodiversity in the southeastern Pacific deep-sea is relatively low compared to other regions (Ebert 2013, 2015, 2016; Ebert & van Hees 2015) despite a wide geographic extension and the presence of geological features such as deep-sea trenches. The increasing exploration and exploitation of the deep-sea (especially for fisheries resources) has provided an opportunity to document species that may be new or rarely reported in the region, or possibly new to science. The deep-sea fishery for Patagonian toothfish (*Dissostichus eleginoides*) is one such example that has yielded several incidentally caught species, including invertebrates such as spider crabs (*Lithodes* sp. and *Paralomis longipes*), octopuses (*Octopus mimus*, *Benthoctopus* sp.), jumbo squid (*Dosidicus gigas*) and a variety of bony and chondrichthyan fishes (Bustamante 1997, Aramayo 2016, SUBPESCA 2020¹).

In the southern hemisphere, the fishery for Patagonian toothfish occurs in countries such as Peru, Chile and Argentina (Aramayo 2016). The Peruvian Patagonian toothfish fishery has been operating along the Peruvian coast since 1996 (Bustamante 1997, IMARPE 2018) using deep water longlines as the main fishing gear and fishing at depths between 1,230 and 1,380 m in the Peruvian 200 nm Exclusive Economic Zone (Aramayo 2016). The artisanal fleet consists of 7 vessels that do not exceed 32.56 m³ of hold capacity and exports 100% of its catch (IMARPE 2018). Toward the end of 2019 and in early 2020, we had access to information regarding the bycatch (*i.e.*, incidentally caught) species from this fishery. This provided a unique opportunity to investigate the diversity and composition of deep water chondrichthyans. The objective of this study was to report the first findings of three chondrichthyan species taken incidentally in this fishery.

¹SUBPESCA 2020. Memo Técnico (R.PESQ.) Nro. 262. 2020. Establece nómina de especies objetivo, de fauna acompañante y pesca incidental sometidas a los artículos 7a y 7c de la Ley General de Pesca y Acuicultura para la pesquería del bacalao de profundidad al sur del paralelo 47° LS, Año 2021. Ministerio de Economía, Fomento y Turismo de Chile, Subsecretaría de Pesca y Acuicultura, Valparaíso. <https://www.subpesca.cl/portal/616/articles-109946_documento.pdf>



MATERIALS AND METHODS

The data was accessed through a collaboration with fishermen who provided images and associated information of incidentally caught species of the Patagonian toothfish fishery during two fishing trips carried out between December 2019 and March 2020. All reported specimens were photographed, with information such as catch depth (Table 1) and geographic location (Fig. 1) recorded. Specimens were reviewed using the images and regional identification guides for deep-sea species (Ebert & Mostarda 2016, Ebert 2016). Specimens were not retained during this initial survey.

Table 1. Data from each extraction of chondrichthyan that were part of the bycatch in the Patagonian toothfish *Dissostichus eleginoides* fishery during December 2019 and March 2020 off the coast of Peru / Datos de cada extracción de condricios que fueron parte de la fauna acompañante en la pesca de bacalao de aguas profundas *Dissostichus eleginoides* durante diciembre 2019 y marzo 2020 frente a la costa de Perú

Species	Latitude	Longitude	Depth (m)	Code
<i>Hydrolagus melanophasma</i>	11°44'S	78°17'W	1618	JKR-057
<i>Hydrolagus melanophasma</i>	11°28'S	78°23'W	1370	JKR-058
<i>Hydrolagus melanophasma</i>	10°45'S	78°48'W	1380	JKR-001
<i>Bathyraja cf. spinosissima</i>	10°38'S	78°55'W	1560	JKR-003
<i>Centroscyllium cf. nigrum</i>	12°12'S	77°46'W	1360	JKR-066

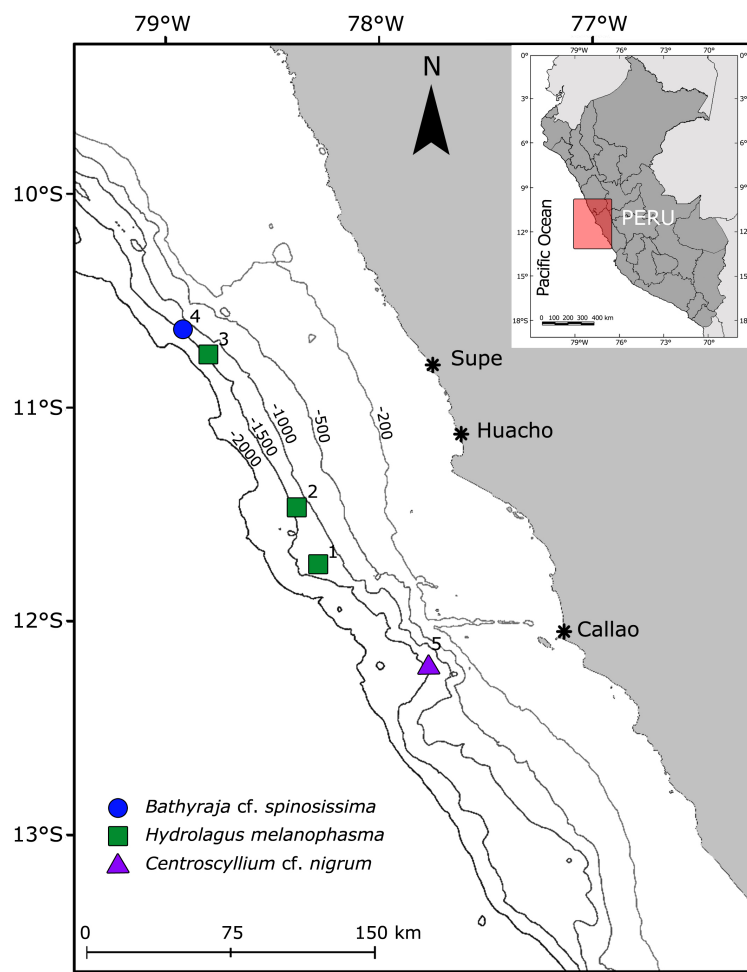


Figure 1. Locations of specimens of chondrichthyan reported as incidentally caught in the Patagonian toothfish *Dissostichus eleginoides* fishery off the coast of Peru / Ubicación de los especímenes de condricios reportados como captura incidental en la pesquería del bacalao *Dissostichus eleginoides* frente a las costas del Perú

RESULTS AND DISCUSSION

Five chondrichthyan specimens were captured at an average depth of 1,489 m (min= 1,360 m, max= 1,618 m, SD= 121.9 m, see Table 1). Three of the five specimens were identified as *Hydrolagus melanophasma*, however the other two specimens could only be tentatively identified. The tentative identifications were based on a single specimen of each species and corresponded approximately to *Centroscyllum* cf. *nigrum* and *Bathyraja* cf. *spinosissima*, (Table 1).

CENTROSCYLLIUM CF. *NIGRUM* Garman, 1899

Combtooth Dogfish

Centroscyllum nigrum Garman, 1899 (*Memoirs of the Museum of Comparative Zoology*, 24: 28, pl. 1, pls 4-5). Syntypes: Museum Comparative Zoology, (2 specimens) MCZ-106-S, 295 mm TL female and MCZ-107-S, 120 mm TL immature male. Type localities: off Pacific coast of Panama, MCZ-106-S 07°09'30"N, 81°08'30"W, 999 m, and MCZ-107-S 06°30'N, 81°44'W, 1,016 m.

Material examined. Specimen caught 80 km off Callao (12°12'S, 77°46'W) at a depth of 1,360 m. The specimen was photographed and discarded.

Diagnosis. Body small, moderately stout, skin firm, with a dorsal ventrally flattened head, broadly arched mouth, and teeth similar in both jaws, with large central cusp flanked by one or two lateral cusplets. Dorsal fins each preceded by a fin spine, the first dorsal fin is low, subangular, with a short fin spine, its height about equal to fin apex, and much shorter than second dorsal fin height; second dorsal fin height equal to or higher than first, with a fairly high fin spine, much higher than second dorsal fin apex. Coloration is a uniform blackish brown without conspicuous black markings on ventral surfaces or sides of tail; fins with prominent white tips and margins.

Distribution. Scattered Eastern and Central Pacific Ocean records from off southern California, U.S.A., to the Straits of Magellan, Chile, including the Galápagos Islands and Hawaii (Ebert 2003, 2016; Ebert *et al.* 2017).

Habitat. Occurs in deep water, generally on continental and insular slopes, or near the bottom at depths of 269 to 1,145 m (Ebert 2003, 2016; Ebert *et al.* 2017). Usually caught on soft mud and sand bottoms (Ebert 2016).

Remarks. Presently, two *Centroscyllum* species are known from the southeastern Pacific, *C. granulatum* and *C. nigrum*. Both species are similar morphologically, exhibiting subtle differences, most notably by the presence (*C. nigrum*) or absence (*C. granulatum*) of prominent white margins and tips on the fins. The photographed specimen appears to have white on the dorsal and pelvic fins, but it is unclear if the

pectoral fins have white margins. However, only *C. nigrum* has so far been reported from Peru, while *C. granulatum* is known from central Chile to the Magellan Straits. Therefore, it was concluded that the photographed specimen is most likely *C. nigrum*.

BATHYRAJA CF. *SPINOSISSIMA* (Beebe and Tee- Van, 1941)

Pacific White Skate or Spiny Skate

Psammobatus spinosissimus Beebe and Tee- Van, 1941, *Zoologica: Scientific Contributions of the New York Zoological Society* 26 (pt 3, no. 26): 259, Pl. 2. Holotype (unique): CAS-SU 46500 [ex NYZS 6132] (embryo). Type locality: 60 miles south of Cocos Island, eastern Pacific, 4°50'N, 87°00'W, 1,400 m.

Material examined. Specimen caught 100 km off Supe (10°38'S, 78°55'W) at a depth of 1,560 m. The specimen was photographed and discarded.

Diagnosis. A very large skate with a broadly rhombic-shaped disc that is slightly wider than long, and a relatively short, flexible snout. Disc surfaces densely covered with numerous dermal denticles giving it a rough to the touch texture; dorsal disc surface without thorns, tail with a single, median row of thorns. Color uniform dark gray background with numerous scattered white blotches and spots on dorsal surface, and mostly gray ventrally except for white blotches around mouth, gills, abdomen, and pelvic areas.

Distribution. The previously known range of this species extended from the Galapagos Islands to off the coast of Ecuador to the Cocos Islands, Costa Rica, and to Bering Sea, Alaska, and likely to the Sea of Okhotsk (Ebert 2016, Ebert *et al.* 2017, Orr *et al.* 2019).

Habitat. One of the deepest living skate species, it occurs from about 800 to 2938 m deep (Ebert 2016, Kuhnz *et al.* 2019, Orr *et al.* 2019). It appears to associate with rocky substrate and areas of high relief, especially areas of boulders and rocks, and is commonly found around hydrothermal vents and other geologically active sites. The species appears to be quite active and is usually observed swimming from 1-3 m off the bottom (Ebert 2016, Salinas de León *et al.* 2018, Kuhnz *et al.* 2019).

Remarks. Typical coloration for this species is uniform whitish to pale grey on dorsal and ventral surfaces, without any distinct blotches or spotting patterns. The distinct difference in coloration on the photographed specimen is either anomalous, a color morph not previously observed for this species or may be that of a similar, but different species. Comparison of this specimen to a description of *B. spinosissima* by Ebert (2016) suggest it maybe a different species. However, until more detailed information is available it was tentatively identified as *B. cf. spinosissima*.

HYDROLAGUS MELANOPHASMA James, Ebert, Long, and Didier, 2009

Eastern Pacific Black Ghostshark

Hydrolagus melanophasma James, Ebert, Long, and Didier, 2009, *Zootaxa*, 2218: 59-68, tabs. 1-2. Holotype: SIO 77-211, adult male, 926 mm total length, 577 mm body length. Type locality: Punta Pescadera, 23°48'N, 109°42'W, Baja California, Mexico, 31 m.

Material examined. Three specimens caught 83 km off Huacho (11°44'S, 78°17'W) at a depth of 1,618 m; caught 80 km off Huacho (11°28'S, 78°23'W) at a depth of 1,370 m; caught 93 km off Supe (10°45'S, 78°48'W) at a depth of 1,380 m. These specimens were photographed and discarded.

Diagnosis. A very large species, body trunk stout, tapering posteriorly behind pectoral-pelvic insertions to filamentous caudal tail. Snout blunt, sloping only slightly from eyes to snout tip, a large slightly curved dorsal-fin spine extending beyond first dorsal-fin apex, and a long second dorsal fin of uniform height throughout, and with pectoral fins large, reaching beyond pelvic-fin insertions when laid flat. Color uniformly black with no distinctive markings or mottling, except for a lighter band across snout to midpoint between eyes in life that fades quickly after death; claspers of adult males slightly lighter in color.

Distribution. Wide-ranging, occurs in the eastern Pacific from southern Chile to Monterey Bay, California, USA, and including the Gulf of California (Ebert 2016).

Habitat. Commonly occurs on soft bottom or cobble patch substrates with little vertical relief. It appears to be closely associated with the sea floor and has been observed with other chimaera species including *Harriotta raleighana*. Its known depth range is from 31 to 1,720 m (Ebert 2016).

Remarks. The genus *Hydrolagus* has been known in Peru since 1997, associated with the Patagonian toothfish fishery (Bustamante 1997), however it was not identified to species level. Another specimen recently identified as *H. melanophasma* was collected from the same fishery (Kanagusuku K, pers. comm)². The Eastern Pacific black ghost shark *H. melanophasma* was described only in 2009 (James *et al.* 2009) from specimens collected off southern Baja California, Mexico and southern California, U.S.A. The species has also been observed *in situ* through remotely operated vehicles between the Gulf of California and the central California coast (Ebert 2016). Later, specimens were

collected in the sablefish *Anoplopoma fimbria* fishery with bottom longlines (Márquez-Farías & Lara-Mendoza 2014). Its diagnosis is based, among other characteristics, on the absence of the anal fin, a snout blunt and a large, slightly curved spine, extending beyond the apex of the first dorsal fin, as well as a second long dorsal fin of uniform height (James *et al.* 2009); subsequently it has been reported in Chile as incidental catch on longlines targeting Patagonian toothfish in depths that range between 565 and 1,667 m (Bustamante *et al.* 2017). It usually inhabits the continental slope, mainly on soft bottoms or in rocky patches (Aguirre-Villaseñor *et al.* 2013).

Studies in upwelling regions have revealed a great abundance of deep-water chondrichthyans (Paramo *et al.* 2015). In the Southeast Pacific, deep-sea chondrichthyan fauna known to occur consists of 33 sharks, 26 batoids, and nine chimeras (Ebert 2016). It is likely that the Humboldt Current upwelling system along the coasts of Peru and Chile may hold a higher diversity of deep-sea chondrichthyans. This upwelling system has high concentrations of nutrients (*e.g.*, phosphates, nitrates and silicates) that reach deep layers of the water column (Graco *et al.* 2007), thus offering favorable conditions for deep-sea species.

In Peru specifically, Cornejo *et al.* (2015) reported 115 species of chondrichthyans, including 66 species of sharks, 43 species of batoids, and six species of chimaeras. The information here presented would add one new species record and two tentatively identified species to the Peruvian fauna: *H. melanophasma* and *C. cf. nigrum*, *B. cf. spinosissima*. Aramayo (2016) also documented incidental captures for this fishery in Peru, but only reported *Bathyraja* sp. and *Hydrolagus* sp. to the genus level.

Reports of *B. spinosissima* suggest an association with the distribution of hydrothermal vents in waters of the eastern Pacific (Salinas de Leon *et al.* 2018). The species appears through scattered records from the Bering Sea in Alaska to southern Chile (Bustamante *et al.* 2014, Ebert 2016, Ebert *et al.* 2017), but until now was absent in Peru. The discontinuous distribution of the Pacific white skate may be related more to the scarcity of reports than to a true geographical structure of populations. Similarly, the combtooth dogfish *C. nigrum* has been reported in many regions of the Pacific, from southern California (U.S.A.) to Chile (Ebert 2003, Rubio *et al.* 2005, Ruiz-Campos *et al.* 2010, Gatica & Acuña 2011), and it is likely that their report in Peru is related to the limited knowledge of deep-water species.

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Chimaeras of the genus *Hydrolagus* are distributed throughout the world's oceans, but for the eastern Pacific, only six of the 23 described species have been reported (Jew *et al.* 2019). In Peru specifically, the *Hydrolagus* genus was represented only by *H. macrophthalmus*, and with this work *H. melanophasma* is added.

In general, information about deep-sea chondrichthyans remains scarce, so access to data collected from opportunistic platforms such as commercial fishing vessels is of great value. All the species here reported were found at circa 1,480 m and concur with depth distribution information reported previously for these species (Ebert 2016, Ebert *et al.* 2017). The Peruvian Patagonian toothfish fisheries that operate from Punta La Negra in the north (6°S) to Morro Sama (18°S) in the south, at depths of circa 1,500 m (Bustamante 1997, IMARPE 2018) offers potential for geographically distributed sampling. Further collaborations with commercial fisheries as a source of information for deep-water species could greatly contribute to improving our understanding of marine biodiversity in Peru and inform conservation decision-making.

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