Morphology of the frilled shark *Chlamydoselachus anguineus* (Chondrichthyes: Hexanchiformes) in the South Pacific Ocean (#107364)

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Morphology of the frilled shark *Chlamydoselachus anguineus* (Chondrichthyes: Hexanchiformes) in the South Pacific Ocean

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Abstract

Frilled sharks are rarely observed, and limited information is available regarding their life history. The global number of records for these sharks does not exceed 40, with most sightings reported in the western Pacific Ocean. To date, two specimens have been documented along the western coast of the American Pacific Ocean, one of which was recorded in Chile in 1977. This study provides new evidence for the presence of *C. anguineus* in Chilean waters, extending its distribution range by 850 km south of the previous record. The morphological features of all specimens from Chile are discussed, supplementing previous observations and adding to the existing knowledge about this species in the Pacific Ocean.

Introduction

The frilled shark Chlamydoselachus anguineus Garman 1884 is one of the two deep-water extant sharks in the family Chlamydoselachidae (Ebert et al., 2021). This species has a wide-ranging but sporadic distribution in the Atlantic and Pacific Oceans, usually inhabiting the outer continental and insular shelves and continental slopes at depths between 120 and 1,500 m (Shirai, 1996; Ebert et al., 2021). Although rarely observed, frilled sharks have been documented as bycatch in trawl and bottom longline fisheries throughout its range (Smart et al., 2016). The Chlamydoselachidae are considered a “living fossil” and its life history and biology remain poorly documented despite the published research available (Ebert et al., 2021). Global reports of this shark species are limited, with no more than 40 specimens documented since its initial description, suggesting its relatively scarce presence across the oceans. Although most of these observations came from the west coast of the Pacific Ocean (Ebert et al., 2009), two sharks have been reported from the east coast of the Pacific Ocean. One female caught off

California in 1948 (Noble, 1948) and another female caught off central Chile in 1977 (Morillas, 1977). Here, the second specimen of *C. anguineus* found in Chilean waters is reported. Additionally, the body morphometrics of both Chilean specimens were analysed, supplementing the extant knowledge of the species in the Southeast Pacific Ocean.

Materials & Methods

In February 2015, a male frilled shark was caught during trawling by a fishing vessel off Cucao, Chiloé Island. The specimen was obtained from a depth of 500 m, preserved in formalin and stored in a private collection until 2023. A review of the diagnostic characteristics was performed following Compagno (1984) and Ebert *et al*. (2021). In addition, a set of 48 morphometric measurements were recorded as species descriptors, following the recommendations of Ebert *et al*. (2009) for comparative studies of the genus. Additionally, the morphometric set was obtained from the Morillas specimen which was deposited at the National Museum of Natural History (MNHN-CH, Catalogue Number P-5815).

Examined material: *Chlamydoselachus anguineus* Garman 1884
MNHN-CH-5815: Female, 140.5 cm total length. Isla Santa María (37°03'S, 73°31'W), Concepción, Chile. Caught by longline at 550 m depth on 8 April 1976. Deposited at the Museo Nacional de Historia Natural de Chile (MNHN).
CHALLWA-UA-024: Male, 123.5 cm total length. Cucao (42°37'S, 74°07'W), Chiloé Island, Chile. Caught by trawling at 500 m depth on 2 February 2015. Deposited at the Colección Ictiológica de la Universidad de Antofagasta (CHALLWA-UA).

Results

Based on external morphology (Figure 1A–D), the specimen was identified as *C. anguineus* after recent recommendations on its taxonomic status: the frilled shark is characterised by an elongated eel-like body, terminal mouth with narrow tricuspid teeth in jaws, a single dorsal fin, small, lobe-like, originating far back on body, anal fin larger than dorsal fin, pectoral fins small, saddle-shaped, caudal fin with a weak ventral lobe, and no subterminal notch (Tanaka, 1990; Compagno, 1984; Ebert *et al*., 2009). Although the maturity of the female specimen was not recorded, the male was assessed as mature based on the calcification of claspers and testis development (Figure 1E). The morphometric set of the Chilean specimens is presented in Table 1, supplementing previous observations of the species. Molecular data remained undocumented for the samples, as no DNA was obtained from the tissue due to formalin-related issues.

Discussion

New evidence of the presence of *C. anguineus* in Chilean waters has been documented, extending its distribution range to 850 km south of the last record. The observed morphometric range was within the natural variation described for *C. africana* and *C. anguineus* (Ebert *et al*., 2009). However, the head lengths of specimens from Chile (L_{HD} = 18–19%) appeared to be larger than those of specimens from Japan (L_{HD} = 15–16%). Although L_{HD} is one of the diagnostic characteristics used to separate the two species of *Chlamydoselachus* (Ebert *et al*., 2009), the sample size is remarkably low which may lead to bias resulting from both intrinsic

factors, such as sexual dimorphism, and extrinsic factors, including deformation caused by preservation.

The presence of *C. anguineus* has been confirmed in Chilean waters and is distributed in southern Chile between Concepción and Chiloé Island. The present record may promote an integrated ocean basin assessment that considers specimens held in museums and private collections to supplement our knowledge of this elusive shark.

Acknowledgements

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Table 1(on next page)

Measurements of the morphometric characteristics of *C. anguineus* from Chilean Waters

Measurements are expressed as a percentage of total length. Accession numbers for each specimen are indicated in each column, respectively.

Table 1. Measurements ~~(expressed as a percentage of total length)~~ of the morphometric characteristics of *C. anguineus* from Chilean waters. Accession numbers for each specimen are indicated.

Morphometric character	Male (CHALLWA-UA-024)	Female (MNHN-CH-5815)
Total length	123.5 cm	140.5 cm
Precaudal length	80.89	74.80
Pre-narial length	1.33	1.63
Pre-oral length	0.65	0.81
Pre-orbital length	3.17	4.07
Pre-spiracle length	5.28	6.50
Pre-gill length	10.41	11.38
Head length	19.51	18.29
Pre-pectoral length	18.70	16.26
Pre-pelvic length	52.44	51.38
Snout-Vent length	26.67	56.75
Vent-Caudal fin length	33.90	56.91
Pre-anal fin length	65.04	51.06
Pre-dorsal fin length	64.07	65.28
Dorsal-Caudal length	3.98	4.07
Pectoral-Pelvic length	32.52	31.71
Pre-anal length	3.50	3.25
Anal-Caudal length	1.40	3.58
Eye length	1.51	1.38
Eye height	0.41	0.81
interorbital width	4.96	7.72
Nostril width	0.65	0.24
Internarial width	3.33	3.66
Anterior nasal flap	0.77	0.24
Mouth width	6.33	8.54
Mouth length	0.98	0.89
1st gill opening length	6.27	4.07
2nd gill opening length	5.04	4.55
3rd gill opening length	4.64	5.28
4th gill opening length	4.70	4.88
5th gill opening length	4.08	4.39
6th gill opening length	3.83	3.90
Head height	5.53	4.88
Had width	6.93	8.54
Trunk height	7.69	9.76

Trunk width	6.23	12.20
Caudal peduncle height	5.69	4.80
Caudal peduncle width	1.27	1.87
Pectoral fin length	4.89	4.88
Pectoral fin anterior margin	9.45	9.51
Pectoral fin base	4.93	4.88
Pectoral fin height	5.87	5.77
Pectoral fin inner margin	5.48	5.69
Pectoral fin posterior margin	5.33	5.45
Pelvic fin length	11.58	7.56
Pelvic fin anterior margin	8.83	9,92
Tooth count (upper jaw)	13-13	12-12
Tooth count (lower jaw)	12-1-12	12-1-12

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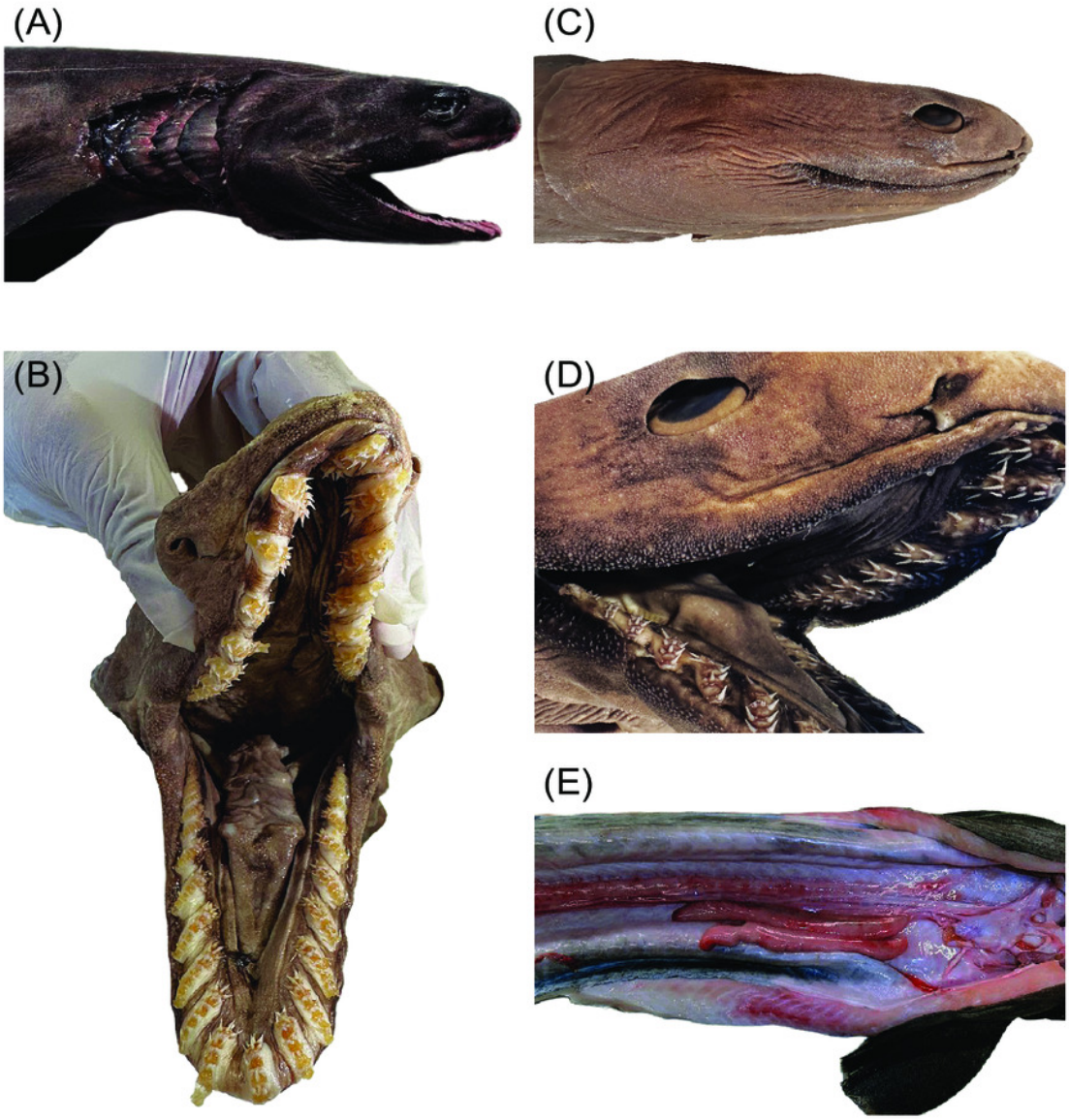
Figure 1

Examined specimens of *Chlamydoselachus anguineus* from Chilean waters.

(**A**) Lateral view of head and (**B**) jaws of male specimen (CHALLWA-UA-024) of *C. anguineus*, in life. (**C**) Lateral view of head and (**D**) jaws of female specimen (MNHN-CH-5815) of *C. anguineus*, in preservation. (**E**) Vental view of testis of male specimen (CHALLWA-UA-024), in life.


(A)
(C)
(B)
(D)
(E)