

First record of oarfish, *Regalecus russellii* (Actinopterygii, Lampriformes, Regalecidae), from Sri Lankan waters, Indian Ocean

Mahadurage I. G. RATHNASURIYA^{1,2}, Thennakoon H. I. S. HAPUARACHCHI²

1 Department of Fisheries and Marine Sciences, Faculty of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Mahawela Road, Tangalle 82200, Sri Lanka

2 PO Box 81A Broadway, Bassendean, WA 6054, Australia

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Corresponding author: Mahadurage I. G. Rathnasuriya (ishara.ruh@gmail.com)

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Abstract

Oarfishes, representing the family Regalecidae, are poorly known from the tropical Indian Ocean and are of exceptional interest in terms of their distribution. This study presents the first detailed morphological description of *Regalecus russellii* (Cuvier, 1816) based on the single specimen (2580 mm total length) collected from Sri Lankan waters on 27 October 2021. The morphological characters of the presently reported specimen well matched the key identification features of *R. russellii* reported from the eastern and western Pacific Ocean, and the Atlantic Ocean. This report of *R. russellii* from the Indian Ocean provides vital information on their biology and distribution.

Keywords

Diversity, Indian Ocean, mesopelagic fish, morphological description, Regalecidae

Introduction

Oarfishes, representing the family Regalecidae, are well-known sea creatures connected with numerous mythological beliefs, but a fish family is little known about their biology and distribution. The family Regalecidae is characterized by an extremely slender, laterally compressed, and very elongated ribbon-like body and is recognized for being the longest bony fish in the world (Olney 2002; Roberts 2012). The family is classified into two genera, *Regalecus* Ascanius, 1772, and *Agrostichthys* Phillipps, 1924, and there are three known species i.e., *Agrostichthys parkeri* (Benham, 1904), *Regalecus glesne* Ascanius, 1772, and *Regalecus russellii* (Cuvier, 1816). Species of *Regalecus* are oceanic fishes that occur from surface waters to greater depths in temperate and tropical waters, and

are rare in nature (Wiley et al. 1998; Roberts 2012, 2017; Lee et al. 2023). The limited sightings, incomplete notes on sightings, limited number of voucher specimens, mis-identifications or uncertain identifications, and incomplete specimens lead to inadequate information on the diversity, taxonomy, ecology, and distribution of oarfish (*Regalecus*) species (Wiley et al. 1998; Roberts 2012; Lee et al. 2023).

Two species of *Regalecus* occur in all three oceans, Pacific, Atlantic, and Indian. In the Pacific Ocean, two species show contrasting distribution, where numerous records of *R. russellii* were documented from the North Pacific and all the records of *R. glesne* were concentrated in to the South, except one *R. russellii* record from northern New Guinea. In contrast, such a pattern is not evident in the Atlantic Ocean. While *R. glesne* has been documented exclusively in the North Atlantic and Mediterranean, both

species are known to occur in the South Atlantic (Psomadakis et al. 2008; Roberts 2012; Feeney and Lea 2018; Lee et al. 2023). Moreover, two species exhibit distinct habitat preferences related to water temperature and ocean currents: *R. glesne* is typically associated with colder waters, whereas *R. russellii* is commonly found in warmer regions (Schmitter-Soto 2008; Roberts 2012). *Regalecus russellii* was originally described as *Gymnetrus russellii* Cuvier, 1816 from Vizagapatam (Visakhapatnam), India from the Bay of Bengal (Fricke et al. 2025); however, the reports are few and rare from the Indian Ocean. Few records of *Regalecus* are scattered over the Indian Ocean and only two specimens have been identified to species level as *R. russellii* (see Roberts 2012). The limited observations of *Regalecus* from the Indian Ocean highlight the importance of the current report. In the present study, we report the first record of *R. russellii* from Sri Lankan waters of the northern tropical Indian Ocean, along with a detailed morphological analysis of the specimen.

Material and methods

A single, fresh, complete specimen of *Regalecus russellii* (2580 mm total length) (Fig. 1) was caught by the surface tuna gillnet operated by multiday fishing boat from the off western coastal waters (6°32'14"N, 79°25'16"E) of Sri Lanka on 27 October 2021 and landed at Beruwala Fishery Harbor. The specimen was preserved in the 5% formaldehyde and deposited in the National Faunal Repository, Colombo National Museum, Sri Lanka (Repository Number: 2024.05.01NH).

The morphological methodologies follow Psomadakis et al. (2008) and morphometric measurements were collected to 1 mm using calibrated tape and Vernier caliper. The specimen weight was measured to the nearest 1 g using a digital weighing balance.

The specimen was radiographed by dividing it into six overlapping sections using a static X-ray machine (Dongmun-DIG 650 Single Phases) (Fig. 2) at the Faculty of Veterinary Medicine and Animal Science, University of Peradeniya. The X-radiograph images of all six sections were processed to create the full image using image processing software (Photoshop). The X-radiograph images were used to count the vertebrae and dorsal count and fin rays arrangement of the specimen.

Results

Systematic position

Order: Lampriformes

Family: Regalecidae

Genus: *Regalecus* Ascanius, 1772

***Regalecus russellii* (Cuvier, 1816)**

English common name: oarfish

Figs. 1–3; Table 1

Specimen examined. 2024.05.01NH, 2580 mm TL, off western coastal waters of Sri Lanka (6°32'14"N, 79°25'16"E) (Fig. 3), 27 October 2021.

Description. Total length 2580 mm. Other measurements, counts, and proportional measurements in Table 1. Dorsal fin with 337 total soft dorsal rays; two dorsal crests (1 crest: 5 rays united by fin membranes; 2 crest: single ray free from other rays); preanus dorsal fin rays 77; pectoral fin rays 12; pelvic fin rays 1 stout, damaged; non-anal fin rays; caudal fin rays not evident; number of gill rakers on first gill arch 55 (12 + 43), elongated gill rakers with minute ridges projecting on the inner and outer margin (12 ridges on one side of longest gill raker); body long, deeply compressed, ribbon-like, tapered towards tail, without scales but covered with dermal tubercles with circular bases, either with



Figure 1. *Regalecus russellii* (A) fresh specimen (B) preserved specimen from the off western coastal waters of Sri Lanka on 27 October 2021 (2580 mm TL).

Table 1. Morphometric and meristic data of *Regalecus russellii* from the off western coastal waters off Sri Lanka on 27 October 2021, compared with specimens of *R. russellii* from eastern Pacific (Lee et al. 2023) and *R. glesne* from the Mediterranean (Psomadakis et al. 2008).

Character	<i>Regalecus russellii</i>			<i>Regalecus russellii</i> PKU			<i>Regalecus glesne</i>		
	This study 2024.05.01NH [mm]	[% in TL]	[% in HL]	62973 (Damaged) [mm]	[% in TL]	[% in HL]	MSNG 12307 [mm]	[% in TL]	[% in HL]
MORPHOMETRIC VALUES									
Total length (TL)	2580	—	1102.6	3860	—	—	1180	—	1864
Standard length (SL)	2575	99.1	1093.2	—	—	—	—	—	—
Preal length	780	30.2	333.3	1380	—	17.2	398	33.7	629
Predorsal length	78	3	33.3	49	—	—	120	1	19
Postanal length	1800	69.8	769.2	—	—	—	782	66.3	1235
Prepelvic length	211	8.2	90.2	—	—	—	650	5.5	103
Head length (HL)	234	9.1	—	285	—	—	630	5.4	—
Head height (through center of eye)	155	6	66.2	225	—	79.0	50	4.3	80
Body height (at posterior margin of opercle)	160	6.2	68.4	277	—	—	48	4.0	75
Body height (at vent)	117	4.5	50	173	—	—	32	2.7	51
Preorbital length	104	4	44.4	—	—	—	15	1.2	23
Supraorbital length	43	1.7	18.4	—	—	—	12	1	19
Postorbital length	2443	94.7	1044	Doubtful	—	—	1170	99.2	1848
Suborbital length	72	2.8	30.8	—	—	—	21	1.8	33
Greatest body height	156	6	66.6	—	—	—	51	4.4	81
Ocular diameter vertical	33	1.3	14.1	—	—	—	16	1.3	24
Ocular diameter horizontal	33	1.3	14.1	40	—	14	17	1.4	26
Interorbital space	34	1.3	14.5	—	—	—	12	1	19
Internarial space	17.5	0.7	7.5	—	—	—	4	0.3	6
Preopercular max height (vertical)	75	2.9	31.2	—	—	—	23	1.9	36
Preopercular max length (diagonal)	117	4.5	50	—	—	—	42	3.5	66
Opercular max height	82	3.2	35	—	—	—	25	2.2	40
Maxillary length	70	2.7	29.9	—	—	—	23	2.0	37
Maxillary width	40	1.6	17.1	—	—	—	8	0.7	13
Pectoral fin length	63	2.4	26.9	—	—	—	NM	—	—
Pectoral fin base length	20.5	0.8	8.8	—	—	—	8	0.7	12
Maximum dorsal fin height (occipital crest excluded)	77	3	32.9	—	—	—	32	2.7	51
Pelvic fin length (including distal lobe)	NM	—	—	—	—	—	327	27.7	517
Occipital ray length (maximum)	535	20.7	228.6	—	—	—	—	—	—
First gill arch length	74	2.9	31.6	—	—	—	32	3.2	59.7
Longest gill filament length	28	1.1	12	—	—	—	10	0.8	15.2
Shortest gill filament length	3.35	0.1	1.4	—	—	—	3	0.2	4.1
Longest gill raker length	19	0.7	8.1	—	—	—	6	0.6	11.4
Shortest gill raker length	5.1	0.2	2.2	—	—	—	—	—	—
Length of esophageal caecum from vent (anus) towards end of the body	955	37	408.1	—	—	—	—	—	—
MERISTIC VALUES									
Number of rays in occipital crest	6	—	—	—	—	—	5 + 7 = 12	—	—
Number of rays in 2nd crest	1	—	—	1	—	—	—	—	—
Total dorsal fin rays (including occipital rays)	337	—	—	243	—	—	397	—	—
Total dorsal fin rays up to anal opening	77	—	—	73	—	—	105	—	—
Vertebrae count	114	—	—	—	—	—	—	—	—
Caudal fin rays	Not evident	—	—	0	—	—	0	—	—
Pectoral fin rays	12	—	—	13	—	—	13	—	—
Pelvic fin rays	1	—	—	1	—	—	—	—	—
Anal fin rays	0	—	—	0	—	—	0	—	—
Caudal end	Intact	—	—	Mutilated	—	—	Intact	—	—
Spiny nubbins on caudal tip	Not evident	—	—	—	—	—	5	—	—
Gill rakers on the first arch (upper + lower)	12 + 43 = 55	—	—	12 + 40 = 52	—	—	8 + 35 = 43	—	—
Small rakers between larger ones	yes	—	—	—	—	—	yes	—	—
Number of ridges on longest gill raker	12	—	—	—	—	—	—	—	—

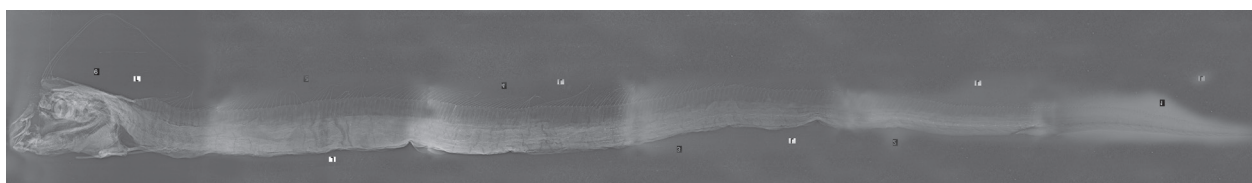


Figure 2. Radiograph of *Regalecus russellii*, off western coastal waters of Sri Lanka on 27 October 2021 (2580 mm TL).

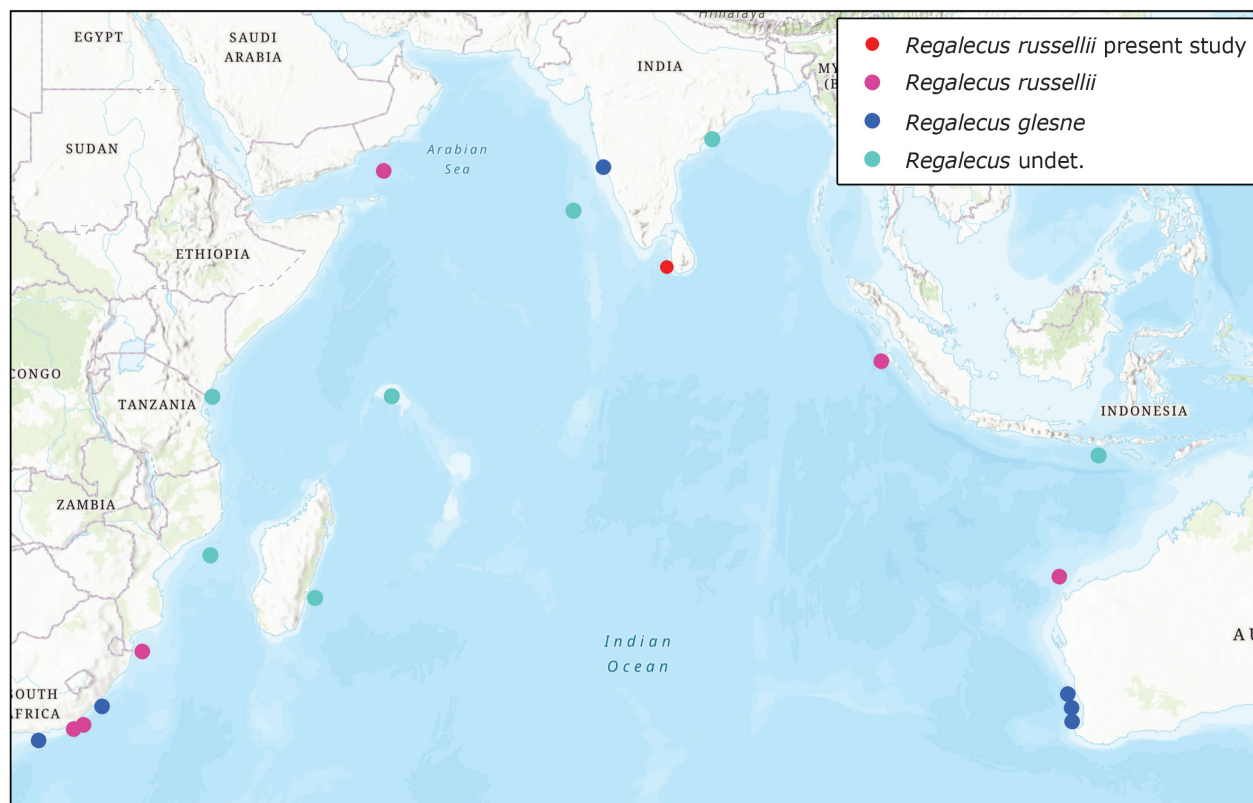


Figure 3. Map of *Regalecus* species recorded from the Indian Ocean.

or without conical or blunt point, tubercles are more prominent towards tail end and lower sides of body (especially lower edge of tail). Anal fin absent. Head small and head length 9.1% in TL. Head profile almost vertical prior to dorsal fin origin. Maximum body depth about 68.1% in head length. Mouth small, vertical, protractible and teeth absent. Single nostril presents on each side of snout. Dorsal fin origin well anterior to orbit; first five dorsal rays of first dorsal crest elongated (first four dorsal rays approximately 18% in TL, fifth dorsal ray approximately 12% in TL) and a single dorsal ray of second dorsal crest and subsequent rays relatively short; cristophore presents and supports to the first dorsal fin crest. Pectoral fins lanceolate, present low as horizontal line of anterior lower margin of preopercle, origin anterior to pelvic fin and horizontally oriented. Esophageal caecum (Roberts 2017) extends towards end of body, and its body length 37% in TL.

Coloration in fresh specimen. The body of the fresh specimen is silvery-grey with amorphous oblique dark streaks and blotches distributed over the body. These dark streaks and blotches are distinct in the first third of the body. Forehead, mouth, preopercle, opercle (except upper front

edge corner), and lower margin of head almost up to 16% of body length, greyish black. Upper body margin and lower margin of body with crimson red luster especially in the first half of the body. Pupil dark and iris light. Dorsal fin and ventral fin crimson red, pectoral fin color less (Dorsal fin crest and ventral fin entirely dark crimson red color) (Fig. 1A).

Coloration when preserved. The body of preserved specimen is yellowish brown with amorphous oblique dark streaks and blotches distributed over body. Forehead, front margin of mouth, and ventral region of head greyish black. Upper body margin beneath the dorsal fin yellowish-brown with darker in color. Dorsal, pectoral and ventral fin colorless (Fig. 1B).

Discussion

This study presents the first comprehensive report on *Regalecus russellii* from the Indian Ocean and provides an account of oarfishes reported from the region. The first documentation of *Regalecus* species was recorded from Visakhapatnam on the eastern coast of India from Eastern

Indian Ocean in 1788 by Patrick Russell (1726–1805) (Russell 1803); this juvenile specimen drawing served for the description of *Gymnetrus russellii* in 1816. However, Russell's specimen was not retained after drawing. The drawing and description of the specimen were inadequate to identify species beyond the genus level. There have been many *Regalecus* species records from the Indian Ocean, although no single specimen has been accepted to use as a neotype for *R. russellii* from the Indian Ocean (Roberts 2012).

To date, only two confirmed *R. russellii* specimens have been recorded from the main part of Indian Ocean. There are no confirmed records of *R. glesne* from the region, with the exception of *Gymnetrus hawkenii* Bloch 1795, described from Goa on the Indian coast of Arabian Sea. This species record is currently synonymized with *Regalecus glesne* Ascanius, 1772. However, spawning grounds of both species of *Regalecus* occur in extreme western end of Indian Ocean, on the southern coast of South Africa, and *R. glesne* in the eastern end of the Indian Ocean, on the coast of Western Australia (Roberts 2012). According to Roberts (2012) the adults and early life stages of *Regalecus* from south coast of South Africa could be part of populations from the South Atlantic.

Seasonal patterns in *Regalecus* strandings and accidental caught records have been observed in a few areas, such as Gulf of Mexico coast of Florida; however, these events have not been clearly linked to environmental factors. In contrast, stranding/ accidental catch reports from Australian waters have shown a clear association with storm events. The few records of *Regalecus* from the Indian Ocean are inadequate to observe any patterns of stranding/ accidental catch but the species recorded are closely associated with upwelling zones of the Indian Ocean (Roberts 2012).

The association of *Regalecus* with upwelling zones is probably due to the surface cold water rich in biological productivity in these areas which can serve as a feeding ground with optimum environmental conditions close to surface waters (Barber 2001). The present specimen was found from shallow waters off the western coastal

waters of Sri Lanka, overlapped with the coastal upwelling region (Yapa 2009; De Vos et al. 2014). There were number of mesopelagic fish species records including family: Trachipteridae from western and southern coastal upwelling zones of Sri Lankan waters during the summer monsoon (Krakstad et al. 2018; Rathnasuriya et al. 2019; Pers. comm. U. Liyanage).

Most records of *Regalecus* species are accidentally caught in fishing gears during their operations and are often discarded without proper documentation (Roberts 2012). There have been many reports of oarfish (*Regalecus* spp.) landings by fishermen at various sites along the Indian and Sri Lankan coastal waters. Many of these accounts have not been published in peer-reviewed publications or made publicly accessible to the scientific community (Pers. comm. K.V. Akhilesh; Pers. comm. U. Liyanage). Advancing technology, along with the widespread accessibility of cameras and smart phone cameras, have significantly improved the frequency of recordings in recent years within the Indian Ocean region. Citizen science programs and knowledge dissemination platforms (e.g., social media, apps, websites) play a crucial role in enhancing public awareness and encouraging the recording of rare or poorly known marine species (Dickinson et al. 2012; Kosmala et al. 2016). Such programs are essential to understand the marine biodiversity and to support conservation strategies, particularly in understudied tropical waters.

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