

Marine Record

Cite this article: Williams CT, Arostegui MC, Braun CD, Gaube P, Shriem M, Berumen ML (2022). First records of two large pelagic fishes in the Red Sea: wahoo (*Acanthocybium solandri*) and striped marlin (*Kajikia audax*). *Journal of the Marine Biological Association of the United Kingdom* **102**, 505–508. <https://doi.org/10.1017/S0025315422000820>

Received: 13 May 2022

Revised: 23 August 2022

Accepted: 20 September 2022

First published online: 1 November 2022

Key words:

Billfish; biodiversity; fisheries; Gulf of Aqaba; Jordan; marine predator; pelagic; Red Sea; Saudi Arabia; Scombridae

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First records of two large pelagic fishes in the Red Sea: wahoo (*Acanthocybium solandri*) and striped marlin (*Kajikia audax*)

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Abstract

This report provides the first confirmed identifications of wahoo (*Acanthocybium solandri*) and striped marlin (*Kajikia audax*) in the Red Sea, expanding the known ranges of these species into the basin. Potential mechanisms responsible for the lack of regional documentation of the two species are further discussed. These findings illustrate the need for systematic biodiversity surveys of pelagic fish assemblages in the Red Sea.

Introduction

The Red Sea is a semi-enclosed marine basin. Its connection to other bodies of water is limited to two shallow, narrow passages: the Bab el-Mandeb Strait and the Suez Canal, which connect to the Indian Ocean and Mediterranean Sea, respectively. This partial physical isolation corresponds to marked biogeographic patterns among marine organisms in the Red Sea (e.g. endemism and reduced gene flow) and the basin is widely considered a distinct ecological unit (Spalding *et al.*, 2007; DiBattista *et al.*, 2016, 2020; Bogorodsky & Randall, 2019). It is therefore critical to understand the composition of biological assemblages within the Red Sea when developing localized frameworks for management and ecological functioning. Here, we contribute to the current knowledge of pelagic ichthyofauna in the Red Sea by providing evidence of range extensions for wahoo (*Acanthocybium solandri* (Cuvier, 1832)) and striped marlin (*Kajikia audax* (Philippi, 1887)) into the basin.

Methods and Results

Three specimens (two *A. solandri* and one *K. audax*) were captured in the Red Sea using conventional hook-and-line gear and then photographed (Figures 1–3). One *A. solandri* specimen was captured near an offshore reef north-west of Thuwal, Saudi Arabia (22.55389203N 38.915995E) on 19 March 2022. Another *A. solandri* and one *K. audax* specimen were captured off the Jordanian coast of the Gulf of Aqaba, an embayment at the northern extent of the Red Sea, during August 2015 and August 2021, respectively. Exact coordinates of Jordanian collections are unavailable, although the territorial waters of Jordan constitute a relatively small area (20 × 5 km). No tissues were available for genetic analysis, and species were identified based on distinct morphological characteristics.

The *A. solandri* specimens documented from the Red Sea in this study were identified by their elongated fusiform body, sharply pointed head, a very long dorsal fin with XXIII–XXVII spines and 12–16 rays, 8–9 finlets dorsally and ventrally along the caudal peduncle, vertically aligned second dorsal and anal fins, and dark vertical bars along the body (Figure 2) (Fischer & Bianchi, 1984b; Collette & Graves, 2019). Specimens were distinguished from the morphologically similar narrow-barred Spanish mackerel (*Scomberomorus commerson* (Lacepède, 1800)) by a longer first dorsal fin (XXIII–XXVII versus XV–XVIII spines), lateral line curving abruptly downward below middle of the first dorsal fin (versus lateral line distinctly sloping ventrally below second dorsal fin in *S. commerson*), and a pre-orbital length (i.e. distance from the tip of the snout to the anterior edge of the eye) approximately the same length as the rest of the head (i.e. distance from the anterior edge of the eye to the posterior edge of the opercle), whereas the snout is shorter than the rest of the head in *S. commerson* (Figure 2) (Fischer & Bianchi, 1984b; Collette & Graves, 2019).

The *K. audax* specimen captured in the Red Sea possessed several morphological characteristics consistent with this species that differentiate it from other Indo-Pacific istiophorids (Fischer & Bianchi, 1984a; Collette & Graves, 2019), including a long, round bill (distinguishing it from shortbill spearfish [*Tetrapturus angustirostris* Tanaka, 1915]), sharply pointed, elongate pectoral fins that fold against the body and are non-sickle shaped (distinguishing it from black marlin [*Istiompax indica* (Cuvier, 1832)]), a pointed first anal fin, moderately

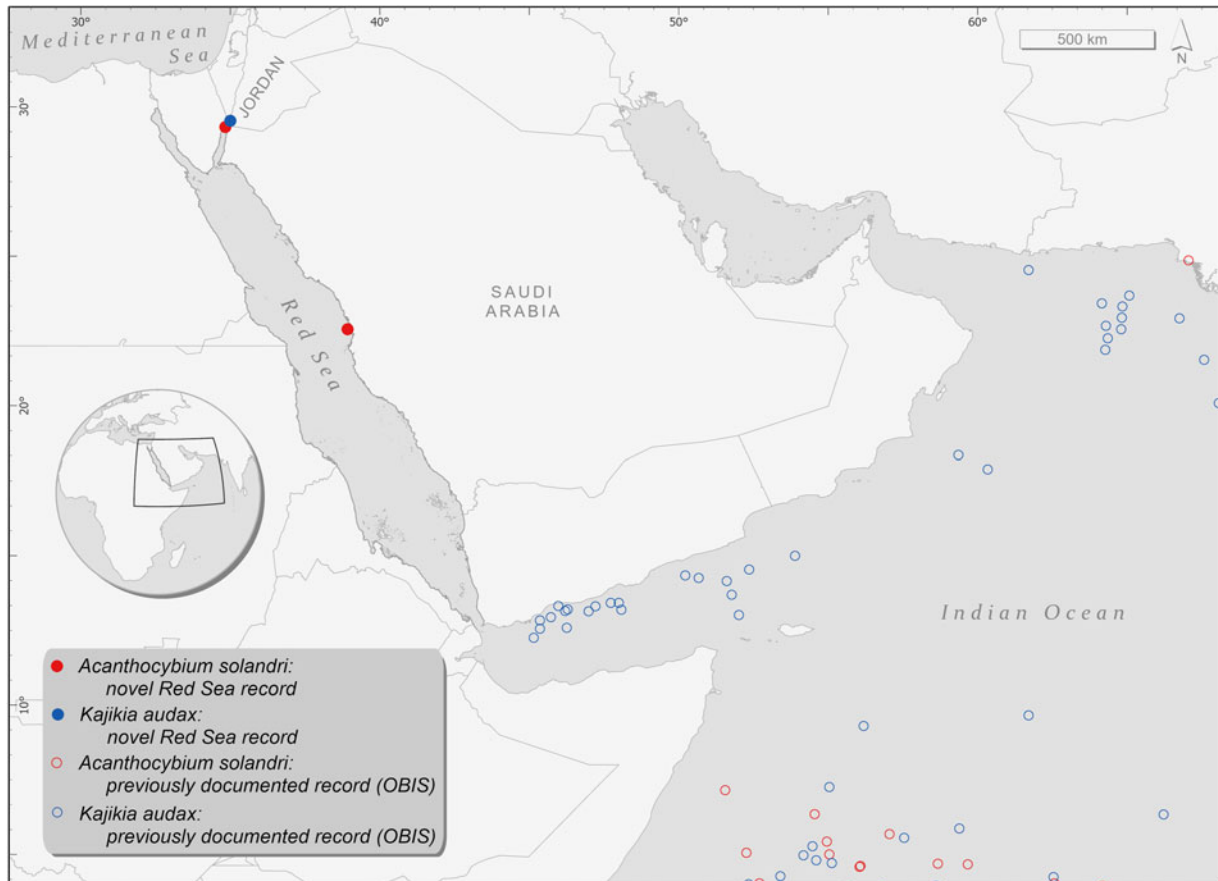


Fig. 1. Documented locations of wahoo (*Acanthocybium solandri*) and striped marlin (*Kajikia audax*) from the north-western Indian Ocean derived from the Ocean Biodiversity Information System (OBIS; 30 March 2022) and records described in the current study.



Fig. 2. Photographs of wahoo (*Acanthocybium solandri*) specimens captured in the Red Sea. The specimen in panel (A) was collected near Thuwal, Saudi Arabia, while panels (B, C) correspond to a collection in the Gulf of Aqaba, Jordan.



Fig. 3. Photographs of a striped marlin (*Kajikia audax*) captured in the Red Sea (Gulf of Aqaba, Jordan).

sized eyes, and vertical bars along the body (Figure 3) (Fischer & Bianchi, 1984a). The specimen was further distinguished from the morphologically similar sailfish (*Istiophorus platypterus* (Shaw, 1792)) by its first dorsal fin which is elevated anteriorly, abruptly decreasing in height backward (the first dorsal fin rays of *I. platypterus* are all quite elongate with the middle rays longest, about twice the body depth), and from the blue marlin (*Makaira nigricans* Lacepède, 1802) by the anterior part of its first dorsal fin which is elevated higher than the depth of its comparatively compressed body (fin folded back but visible in Figure 3) (Fischer & Bianchi, 1984a).

Discussion

The captures of two large pelagic species described in this study represent the first confirmed documentation of *A. solandri* and *K. audax* in the Red Sea. Comprehensive checklists of Red Sea fish species and the Ocean Biodiversity Information System show no evidence of these species in the basin (Golani & Fricke, 2018; OBIS, 2022a, 2022b). A school of *A. solandri* was purportedly caught in the southern Red Sea in 2012 (GBIF, 2022); however, this observation cannot be verified because no photographs or tissues are available. Similarly, the range of *K. audax* has previously been expected to extend into the southern Red Sea (Nakamura, 1985). Yet, no data have been presented to support this claim and the model-predicted distribution of *K. audax* does not include the Red Sea (Thoya *et al.*, 2022).

There are multiple possible explanations why *A. solandri* and *K. audax* have remained undocumented in the Red Sea until now, including species misidentifications, a lack of targeted research and fishery sampling, and low regional abundances. Two common pelagic fish species in the Red Sea, *S. commerson* and *I. platypterus*, exhibit similar morphological features to *A. solandri* and *K. audax*, respectively. It is possible that misidentifications between these species have resulted in the absence of *A. solandri* and *K. audax* from scientific records in the Red

Sea. Fisheries in the Red Sea also primarily harvest coastal and reef-associated species (Tsfamichael & Pauly, 2016) and, to our knowledge, no systematic surveys of large pelagic fish diversity have been conducted in the basin. Furthermore, sea surface temperatures within the Red Sea are typically above the optimal thermal niche of both *A. solandri* (18–28°C; Theisen & Baldwin, 2012) and *K. audax* (21–24°C; Boyce *et al.*, 2008); in the central and southern portions of the basin, the mean sea surface temperature does not decrease below 28 and 29°C, respectively, except in winter (Shaltout, 2019). Thus, we expect low abundance (driven by habitat unsuitability), coupled with minimal pelagic fishing and research effort, to decrease the likelihood of detection for *A. solandri* and *K. audax* in the Red Sea.

Acanthocybium solandri is distributed circumglobally across tropical and sub-tropical marine environments, whereas the range of *K. audax* is restricted to the Indo-Pacific region. We can conclude that the *K. audax* specimen described in this study represents a connection to the Indian Ocean proper. However, we cannot determine whether the *A. solandri* specimens documented here are derived from Mediterranean or Indian Ocean stocks. In any case, it remains surprising that such large animals have evaded detection in close proximity to populated Red Sea coastlines until now. Our findings demonstrate how little is currently known about pelagic predators in the Red Sea and emphasize the need for biodiversity surveys of pelagic fish assemblages in this under-studied region.

Data. The data supporting this research are fully available within the article.

Acknowledgements. Foremost, a great deal of appreciation is owed to Ibrahem Alkaraki, who captured the *K. audax* specimen documented in this study and has graciously granted permission for his photographs to be published. The authors also thank Ute Langner for creating the map presented in this publication, Ashlie McIvor for editing the photographs, and Prof. Burton Jones for his insightful discussion regarding our findings. The authors further thank Sergey V. Bogorodsky (SMF) and one anonymous reviewer for their reviews of the manuscript.

Author contributions. M.S. captured the *A. solandri* specimen in the Gulf of Aqaba and alerted other authors to the capture of *K. audax*; C.T.W., M.C.A., C.D.B. and P.G. captured the *A. solandri* specimen near Thuwal, Saudi Arabia; C.T.W. recognized the novelty of these observations and wrote the first draft of the manuscript; C.T.W. and M.C.A. morphologically verified the identity of both species; M.L.B. supervised the research and provided funding resources; all authors contributed to the refinement of the final manuscript.

Financial support. This research was supported by KAUST (baseline research funds to M.L.B.). M.C.A. was supported by the Postdoctoral Scholar Program at Woods Hole Oceanographic Institution with funding provided by the Dr George D. Grice Postdoctoral Scholarship Fund.

Conflict of interest. The authors declare none.

Ethical standards. This research was conducted under KAUST's Institutional Animal Care and Use Committee approval 18IACUC14, regulated by the Saudi National Committee of Bio-Ethics.

References

- Bogorodsky SV and Randall JE** (2019) Endemic fishes of the Red Sea. In Rasul NMA and Stewart ICF (eds), *Oceanographic and Biological Aspects of the Red Sea*. Cham: Springer, pp. 239–265.
- Boyce DG, Tittensor DP and Worm B** (2008) Effects of temperature on global patterns of tuna and billfish richness. *Marine Ecology Progress Series* **355**, 267–276.
- Collette BB and Graves JE** (2019) *Tunas and Billfishes of the World*. Baltimore, MD: Johns Hopkins University Press.
- DiBattista JD, Roberts MB, Bouwmeester J, Bowen BW, Coker DJ, Lozano-Cortés DF, Howard Choat J, Gaither MR, Hobbs JPA, Khalil MT, Kochzius M, Myers RF, Paulay G, Robitzch VSN, Saenz-Agudelo P, Salas E, Sinclair-Taylor TH, Toonen RJ, Westneat MW, Williams ST and Berumen ML** (2016) A review of contemporary patterns of endemism for shallow water reef fauna in the Red Sea. *Journal of Biogeography* **43**, 423–439.
- DiBattista JD, Saenz-Agudelo P, Piatek MJ, Cagua EF, Bowen BW, Choat JH, Rocha LA, Gaither MR, Hobbs JPA, Sinclair-Taylor TH, McIlwain JH, Priest MA, Braun CD, Hussey NE, Kessel ST and Berumen ML** (2020) Population genomic response to geographic gradients by widespread and endemic fishes of the Arabian Peninsula. *Ecology and Evolution* **10**, 4314–4330.
- Fischer W and Bianchi G** (1984a) Volume II bony fishes families: Congiopodidae to Lophotidae. In *FAO Species Identification Sheets for Fishery Purposes – Western Indian Ocean (Fishing Area 51)*. Rome: Food and Agriculture Organization of the United Nations.
- Fischer W and Bianchi G** (1984b) Volume IV bony fishes families: Scatophagidae to Trichiuridae. In *FAO Species Identification Sheets for Fishery Purposes – Western Indian Ocean (Fishing Area 51)*. Rome: Food and Agriculture Organization of the United Nations.
- GBIF** (2022) *Acanthocybium solandri*. In *Global Biodiversity Information Facility Backbone Taxonomy. Checklist Dataset*. Accessed via GBIF.org on 30 March 2022.
- Golani D and Fricke R** (2018) Checklist of the Red Sea Fishes with delineation of the Gulf of Suez, Gulf of Aqaba, endemism and Lessepsian migrants. *Zootaxa* **4509**, 1–215.
- Nakamura I** (1985) FAO species catalogue. Vol. 5. Billfishes of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date. *FAO Fisheries Synopsis* **125**, 1–65.
- OBIS** (2022a) *Acanthocybium solandri*. In *Ocean Biodiversity Information System. Intergovernmental Oceanographic Commission of UNESCO*. Accessed on 30 March 2022. Available at www.obis.org.
- OBIS** (2022b) *Kajikia audax*. In *Ocean Biodiversity Information System. Intergovernmental Oceanographic Commission of UNESCO*. Accessed on 30 March 2022. Available at www.obis.org.
- Shaltout M** (2019) Recent sea surface temperature trends and future scenarios for the Red Sea. *Oceanologia* **61**, 484–504.
- Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, Martin KD, McManus E, Molnar J, Recchia CA and Robertson J** (2007) Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience* **57**, 573–583.
- Tesfamichael D and Pauly D** (eds) (2016) Introduction to the Red Sea. *The Red Sea Ecosystem and Fisheries*, 1st Edn. Dordrecht: Springer Science & Business Media, pp. 1–19.
- Theisen TC and Baldwin JD** (2012) Movements and depth/temperature distribution of the ectothermic scombrid, *Acanthocybium solandri* (wahoo), in the western North Atlantic. *Marine Biology* **159**, 2249–2258.
- Thoya P, Kadagi NI, Wambiji N, Williams SM, Pepperell J, Möllmann C, Schiele KS and Maina J** (2022) Environmental controls of billfish species in the Indian Ocean and implications for their management and conservation. *Diversity and Distributions* **28**, 1–14.