



First record of the crocodile shark *Pseudocarcharias kamoharai* (Chondrichthyes: Lamniformes) in the coastal waters of Andhra Pradesh, India

Первая находка ложнопесчаной акулы *Pseudocarcharias kamoharai* (Chondrichthyes: Lamniformes) в прибрежных водах штата Андхра-Прадеш, Индия

K. Silambarasan, A.B. Kar, G.V.A. Prasad & S.K. Pattnayak

К. Силамбарасан, А.Б. Кар, Г.В.А. Прасад, С.К. Паттняк

Krishnan Silambarasan , Annada Bhusan Kar , Gummadi Venkata Ankineedu Prasad & Sujit Kumar Pattnayak ,
Fishery Survey of India, Fishing Harbour, Beach road, Visakhapatnam 530001, Andhra Pradesh, India. E-mail:
silambuplankton@hotmail.com

Abstract. The crocodile shark *Pseudocarcharias kamoharai* is recorded for the first time from the Visakhapatnam waters, Andhra Pradesh, India, based on three female specimens collected in December 2017 from commercial gillnetters. The morphological, morphometric and meristic characteristics of the specimens are provided in the present paper.

Резюме. Ложнопесчаная акула *Pseudocarcharias kamoharai* впервые обнаружена в водах около Вишакхапатнама, штат Андхра-Прадеш, Индия, – три самки были собраны в декабре 2017 промысловыми жаберными сетями. В настоящей работе представлены морфологические, морфометрические и прочие количественные характеристики этих экземпляров.

Key words: India, Andhra Pradesh, morphometrics, distribution, *Pseudocarcharias kamoharai*, new record

Ключевые слова: Индия, Андхра-Прадеш, морфометрия, распространение, *Pseudocarcharias kamoharai*, новая находка

ZooBank Article LSID: 18118CE8-9D15-4288-8917-4A1C0D98B066

The crocodile shark, *Pseudocarcharias kamoharai* (Matsubara, 1936), is a pelagic species belonging to the order Lamniformes, family Pseudocarchariidae. The species is a moderately small shark, whose total length ranges from 730 to about 1075 mm in males and from 870 to 1220 mm in females (Fujita, 1981; White, 2007; Oliveira et al., 2010; Compagno, 2001; Weigmann, 2016). It inhabits the sea surface to a depth of at least 590 m in the tropical and subtropical waters of the Atlantic, Indian, and Pacific Oceans. It is usually found offshore, although it can sometimes occur inshore and near the bottom (Compagno, 2001). The

deep-water chondrichthyans are the most vulnerable group due to their biological characteristics. There is no commercial or targeted fishery for the species due to its low commercial value. *Pseudocarcharias kamoharai* is usually caught as a by-catch at the time of fishing gear retrieval and is not retained for commercialisation (Lack & Sant, 2009; Coelho et al., 2012). The species is also recorded as a by-catch in the longline gear aiming at tuna and allied resources. The liver of this species is very large and very high in squalene, and hence is of potential value (Compagno, 1984; Hazin et al., 1990; Romanov & Samorov, 1994). Because of

the high level of exploitation, the stocks of these apex predators are decreasing globally (Kyne & Simpfendorfer, 2010; Akhilesh et al., 2014). *Pseudocarcharias kamoharai* has been assessed for The International Union for Conservation of Nature (IUCN) Red List of Threatened Species in 2018 as Least Concern (Kyne et al, 2019).

Although *P. kamoharai* distribution is known to extend to the Indian Ocean, it is recorded on very few occasions from the West and East Indian Ocean, including South Africa (D'Aubrey, 1964), the Seychelles (Nevill et al., 2007), Pakistan (Moazzam & Osmany, 2021), Madagascar (Compagno, 1984), Sri Lanka (Moron et al., 1998), and the Maldives (Adam et al., 1998).

A few reports are available on its distribution in Indian waters. *Pseudocarcharias kamoharai* was first reported off the Chennai coast and confirms its distribution in Indian waters (Kizhakudan & Rajapackiam, 2013). Subsequently, Akhilesh et

al. (2013) reported the species from Kochi, on the south-western coast of India, and Pradeep et al. (2017) reported it from the Andaman Sea. Recently, Kannan et al. (2019) reported the morphological and diagnostic characters of *P. kamoharai* from the Gulf of Mannar. The present investigation of the crocodile shark is the first record from Visakhapatnam waters (Andhra Pradesh coast). The records from four different locations suggest that the species occurs on all coasts in Indian waters.

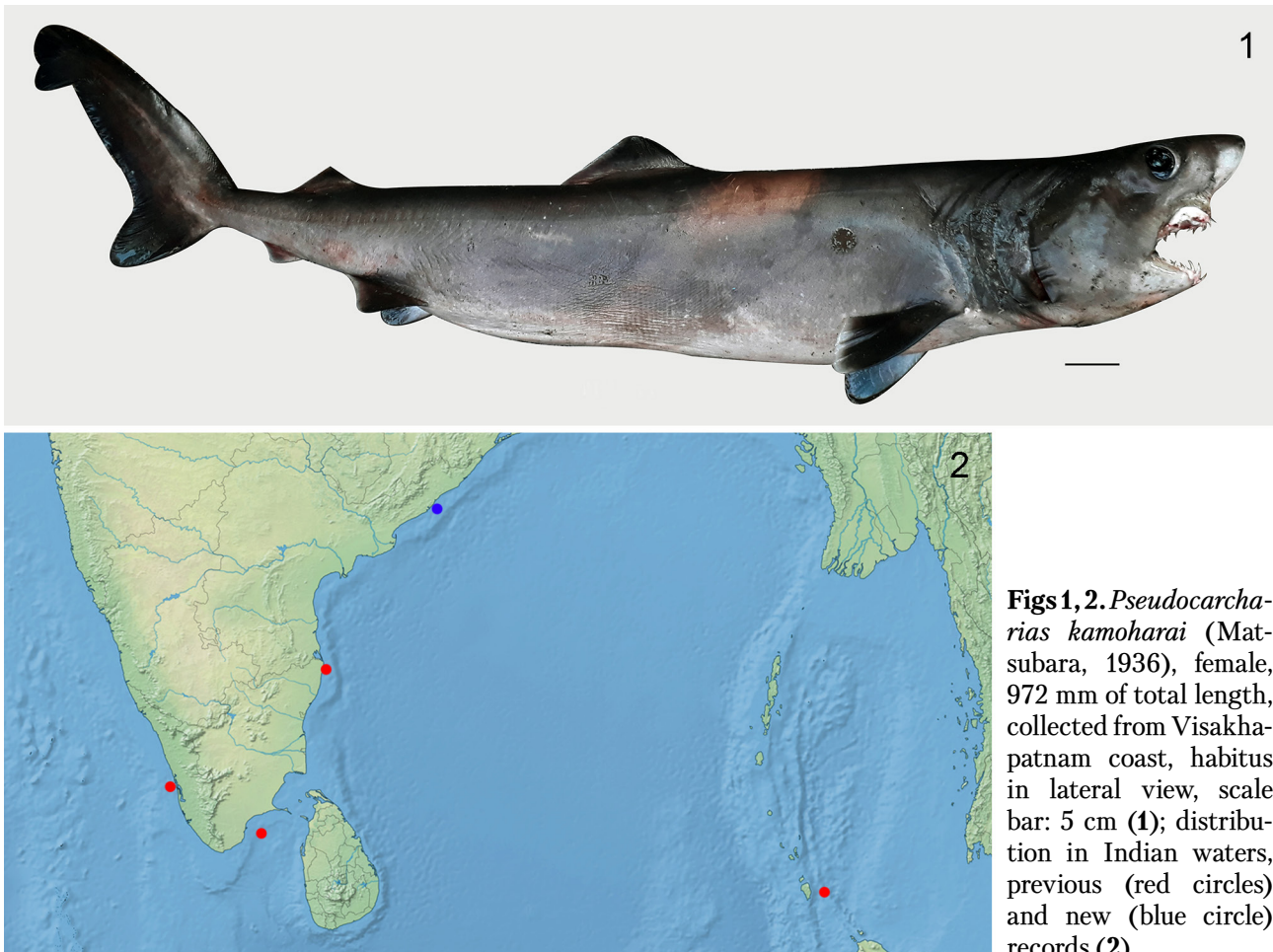
Order **Lamniformes** (Berg, 1958)

Family **Pseudocarchariidae** (Compagno, 1973)

Genus ***Pseudocarcharias*** Cadenat, 1963

Pseudocarcharias kamoharai (Matsubara, 1936) (Figs 1, 3)

New record. Three female specimens of the crocodile shark *P. kamoharai* were collected from



Figs 1, 2. *Pseudocarcharias kamoharai* (Matsubara, 1936), female, 972 mm of total length, collected from Visakhapatnam coast, habitus in lateral view, scale bar: 5 cm (1); distribution in Indian waters, previous (red circles) and new (blue circle) records (2).

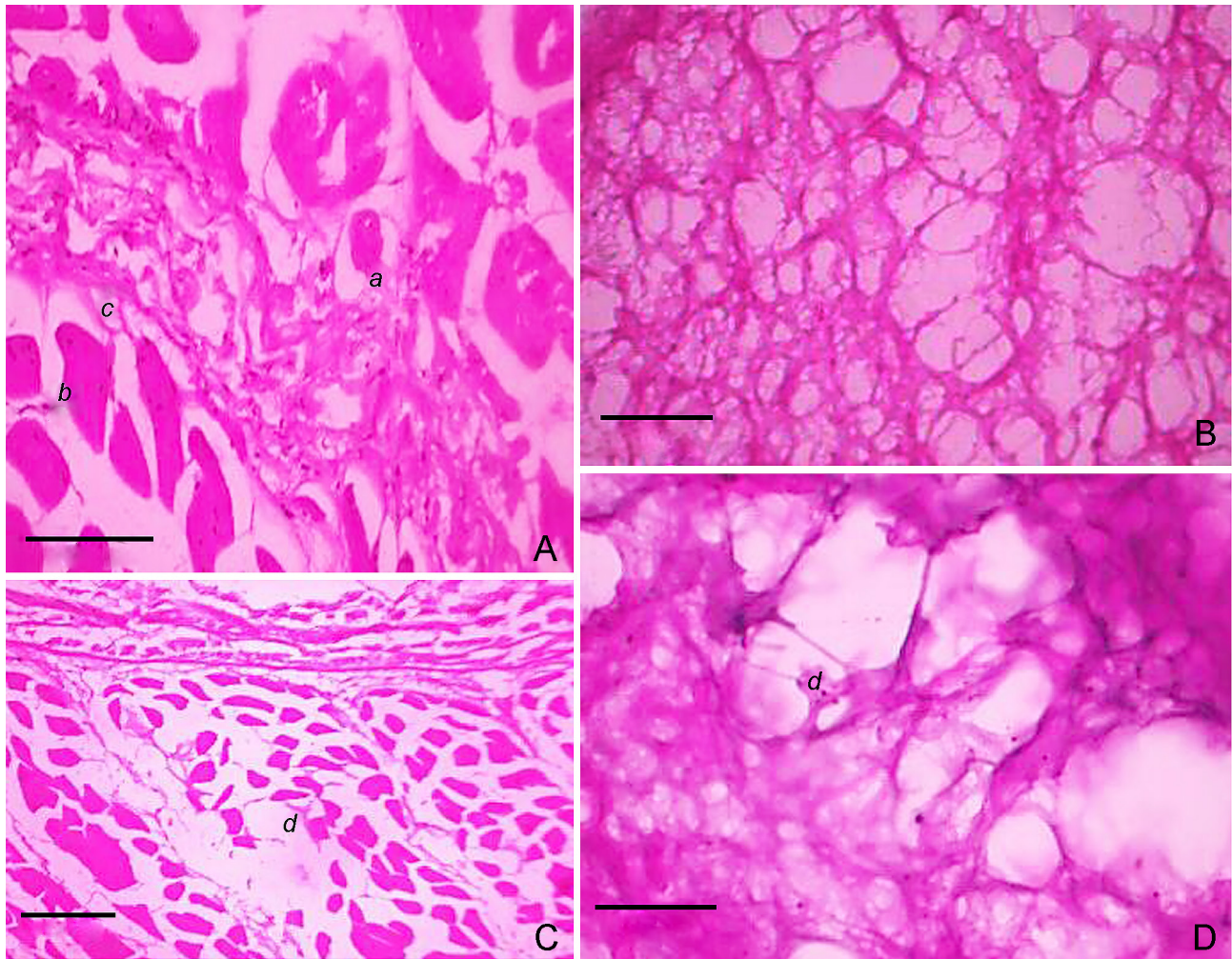


Fig. 3. Dentine histology of *Pseudocarcharias kamoharai* (Matsubara, 1936). All samples are transverse slices of the skin. **A**, dorsal fin region; **B**, tip of the snout; **C**, ventral fin region; **D**, oral skin. *a* – pulp cavity, *b* – crown of denticle, *c* – base of denticle, *d* – dermis. Scale bars: 250 μ m.

the gill net catch on 24 December 2017 at early hours from Visakhapatnam fisheries harbor (Fig. 2). The morphometric measurements were taken following Compagno (1984), and the specimens were identified according to the keys by Matsubara (1936) and Compagno (2001). After taking the necessary morphometric measurements, the specimens were transported to a laboratory for studies. Three specimens were later deposited in the museum collections of the Fishery Survey of India, Visakhapatnam (FSI/VIZAG/FISH-232).

Identification. Three female shark specimens were identified as *Pseudocarcharias kamoharai* based on the following characters: (a) cylindrical trunk; (b) long, bluntly pointed snout; (c) size and shape of the first dorsal fin (see below); (d) small

pectoral fin; and (e) gill opening extending onto the dorsal surface of the head. All the measurements and diagnostic characters agree well with the previously recorded specimens.

Morphology. The first specimen is a large female of 972 mm total length (Fig. 1). The second specimen is nearly the same size as the third, a small female of 925 mm total length, with little damage. The detailed morphometric data are presented in Table 1, and the morphometrics of other earlier published records are also provided for comparative purpose. A detailed morphological description of the examined specimens is presented below.

Relatively small, slender, and spindle-shaped shark with a cylindrical trunk and very large eyes

Table 1. Comparison of measurements of *Pseudocarcharias kamoharai* with earlier reports.

Measurements (mm)	Present study (FSI/ VIZAG/FISH/232)			Stewart (2001)	Kizhakudan & Rajapack- iam (2013)	Akhilesh et al. (2013)	Pradeep et al.(2017)	Kannan et al. (2019)	
	Female	Female	Female	Male	Male	Female	Female	Female	Male
Sex									
Total length	972.0	950.0	925.0	1096.0	910.0	945.0	805.0	860	845.0
Precaudal length	747.0	715.0	690.0	850.0	705.0	720.0	650.0	655.0	650.0
Pre-first dorsal length	427.0	403.0	343.0	422.0	350.0	350.0	330.0	327.0	320.0
Pre-second dorsal length	637.0	613.0	589.0	715.0	585.0	610.0	555.0	556.9	548.0
Head length	253.0	231.0	210.0	271.0	216.0	230.0	212.0	209.0	206.0
Preorbital length	86.0	62.0	53.5	75.0	65.0	58.5	–	51.9	51.0
Interorbital length	74.0	51.0	44.3	–	–	48.8	–	–	–
Prebranchial length	190.0	164.0	15.6	209.0	165.0	160.0	175.0	137.9	140.0
Prespiracular length	128.0	109.0	10.3	147.4	–	–	–	–	–
Prepectoral length	247.0	223.0	201.0	263.0	210.0	220.0	201.0	200.0	172.0
Prepelvic length	572.0	546.0	523.0	633.0	510.0	545.0	510.0	486.9	482.0
Preal anal fin length	676.0	655.0	625.0	–	–	650.0	–	–	–
Snoutvent length	557.0	531.0	509.0	681.0	–	–	–	–	–
Interdorsal space	205.0	183.0	157.0	209.0	–	178.0	–	–	–
Second dorsal to caudal space	83.0	78.0	68.0	93.0	–	76.0	–	–	–
Pectoral to pelvic space	315.0	286.0	263.0	–	–	288.0	–	–	–
Pelvic to anal space	77.0	53.0	42.0	108.0	–	50.0	–	45.0	433.5
Anal to caudal space	81.0	60.0	45.0	–	–	54.0	–	–	–
Pelvic to caudal space	155.0	133.0	103.0	–	–	128.0	–	–	–
Prenarial length	73.0	61.0	39.8	61.0	70.0	45.9	54.0	40.9	40.5
Preoral length	91.5	72.0	56.0	89.7	45.0	65.0	58.0	58.0	59.0
Internarial space	34.3	31.2	18.9	39.8	28.0	21.5	32.0	–	–
Eye length	29.0	25.0	20.0	32.0	–	25.0	–	–	–
Eye height	30.4	29.0	22.0	35.0	33.0	28.2	30.0	25.8	25.4
Mouth length	39.8	36.2	29.7	44.8	–	37.3	–	–	–
Mouth width	62.1	58.1	53.4	66.7	–	59.3	–	–	–
Nostril width	11.1	11.0	10.7	11.1	–	11.2	–	–	–
First gill slit height	64.3	62.8	57.3	66.2	–	63.8	–	–	–
Second gill slit height	65.6	64.0	61.0	67.3	–	–	–	–	–
Third gill slit height	68.1	66.0	64.0	70.0	–	–	–	–	–
Fourth gill slit height	64.0	62.0	62.0	66.0	–	–	–	–	–
Fifth gill slit height	64.5	63.0	63.1	66.8	–	61.2	–	–	–
Intergill length	61.4	60.0	59.7	63.2	–	–	–	–	–
Caudal fin dorsal margin length	242.0	237.0	222.0	250.0	–	235.0	–	–	–
Pectoral fin length	79.6	77.3	71.2	–	32.0	76.1	66.0	–	–
Preventral caudal margin length	110.0	104.0	94.0	850.0	–	100.0	–	–	–
Subterminal caudal margin length	43.0	41.0	38.0	31.6	–	40.0	–	–	–
Subterminal caudal width	28.3	28.0	26.0	31.3	–	28.0	–	–	–
Terminal caudal margin length	47.1	46.0	43.0	56.6	–	45.0	–	–	–
Terminal caudal lobe length	58.0	55.0	50.0	59.0	–	60.0	–	–	–

Measurements (mm)	Present study (FSI/ VIZAG/FISH/232)			Stewart (2001)	Kizhakudan & Rajapack- iam (2013)	Akhilesh et al. (2013)	Pradeep et al.(2017)	Kannan et al. (2019)	
Sex	Female	Female	Female	Male	Male	Female	Female	Female	Male
First dorsal fin height	35.6	34.1	30.2	49.8	58.0	33.5	48.0	29.5	30.0
First dorsal fin base	86.0	84.0	81.0	85.7	65.0	85.2	70.0	82.0	79.9
First dorsal length	78.0	75.0	70.0	119.1	—	72.0	—	—	—
Second dorsal fin height	20.5	19.0	17.0	29.2	28.0	19.1	25.0	17.5	16.5
Second dorsal fin base	42.0	41.0	39.2	41.9	30.0	42.4	37.0	38.4	39.0
Second dorsal fin length	41.0	39.3	37.4	72.2	—	38.2	—	64.0	63.5
Pelvic fin anterior margin length	51.3	50.3	47.1	66.0	—	49.4	—	—	—
Pelvic fin height	35.1	33.6	30.6	42.6	45.0	33.4	38.0	31.5	30.0
Pelvic fin base length	60.3	58.3	55.8	56.7	45.0	62.3	40.0	56.9	54.9
Anal fin height	18.0	17.0	14.8	25.0	24.0	15.9	26.0	13.4	12.9
Anal fin base length	23.8	21.0	20.3	25.2	15.0	22.6	20.0	20.5	19.9
Anal fin length	25.1	24.0	21.7	46.8	—	24.1	—	40.0	39.0

without nictitating eyelids. Head is short, with a moderately long bluntly pointed snout. Five pairs of gill slits present in front of pectoral-fin bases; all gill slits long and nearly extending onto dorsal surface of head, measuring 8.3 to 8.8% of precaudal length. Gill rakers absent, but internal gill slits present.

Head much shorter than trunk, snout long, pointed, bulbously conical, blade-like. Eyes very large, measuring 2.9 to 4.1% of precaudal length. Mouth very long, angular, extending beyond posterior margins of eyes; jaws highly protrusible, extending almost to tip of snout, containing large, awl-like, narrow teeth; laterals more compressed and blade-like, with 26 teeth in upper jaw and 22 teeth in lower jaw, symphysials absent. Precaudal pits present. Lateral keels on caudal peduncle poorly developed. Dermal denticles very small and smooth, with flat crowns, small ridges and cusps present, with cusps on lateral denticles, directed posteriorly (Fig. 3). Pectoral fins small and broad. Pelvic fins smaller than pectoral and first dorsal fins. First dorsal fin low and angular, located in middle of body; pectoral fin skeleton aplousonic. Second dorsal fin smaller than first one but larger than anal fin. Caudal fin short, strongly asymmetrical, with a pronounced sub-terminal notch and a short ventral lobe.

Coloration. Colour dark gray brown on dorsal surface and pale on ventral side. Fin tips with dark margins narrowly outlined with white.

Size. Total length of examined specimens ranged from 925 to 972 mm.

Acknowledgement

We thank Dr R. Jeyabaskaran, Director General, the Fishery Survey of India, Mumbai, Government of India, Ministry of Fisheries, Animal Husbandry & Dairying, Dept. of Fisheries, for providing the necessary permission and facilities. The authors are grateful to Shri K. Govindaraj, former Zonal Director, and other colleagues at the Fishery Survey of India, Visakhapatnam, for their help during the preparation of the manuscript. The authors wish to express their gratitude to the editor, Dr Boris Levin (Zoological Institute of the Russian Academy of Sciences, St Petersburg), and to an anonymous reviewer for his recommendations that improved the quality of the manuscript.

References

- Adam M.S., Merrett N.R. & Anderson R.C. 1998. Additions to the fish fauna of the Maldives Islands. Part 1: an annotated checklist of the deep demersal fishes of the Maldives islands. *Ichthyological Bulletin J.L.B. Smith Institute of Ichthyology*, **67**: 1–19.
- Akhilesh K.V., Bineesh K.K., Ganga U. & Pillai N.G.K. 2013. Report of crocodile shark *Pseudocarcharias kamoharai* (Pseudocarchariidae) from deep waters off the south-west coast of India. *Marine Biodiversity Records*, **6**: 1–3. <https://doi.org/10.1017/S1755267213000778>

- Akhilesh K.V., Bineesh K.K., Gopalakrishnan A., Jena J.K., Basheer V.S. & Pillai N.G.K. 2014. Checklist of Chondrichthyans in Indian waters. *Journal of Marine Biological Association of India*, **56**(1): 109–120. <https://doi.org/10.6024/jmbai.2014.56.1.01750s-17>
- Coelho R., Fernandez-Carvalho J., Lino P.G. & Santos M.N. 2012. An overview of the hooking mortality of elasmobranchs caught in a swordfish pelagic longline fishery in the Atlantic Ocean. *Aquatic Living Resources*, **25**: 311–319. <https://doi.org/10.1051/alr/2012030>
- Compagno L.J.V. 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part. 1. Hexanchiformes to Lamniformes. *FAO Fish Synopsis*, **125**: 1–249.
- Compagno L.J.V. 2001. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamiformes and Orectolobiformes). In: Bonfil R. (Ed.). *FAO species catalogue for fishery purposes*, **1**: 1–269. Rome: Food and Agriculture Organization of the United Nations.
- Fujita K. 1981. Oviparous embryos of the pseudocarchariid shark, *Pseudocarcharias kamoharai*, from the central Pacific. *Japanese Journal of Ichthyology*, **28**: 37–44.
- Hazin F.H.V., Couto A.A., Kihara K., Otsuka K. & Ishino M. 1990. Distribution and abundance of pelagic sharks in the South-Western equatorial Atlantic. *Journal of Tokyo University of Fisheries*, **77**: 51–64.
- Kannan K., Kannapiran E. & Prabhu N.M. 2019. Report of “Near Threatened” shark *Pseudocarcharias kamoharai* (Pseudocarchariidae) from Indian Exclusive Economic Zone. *Thalassas: An International Journal of Marine Sciences*, **35**: 1–6. <https://doi.org/10.1007/s41208-019-00158-y>
- Kizhakudan S.J. & Rajapackiam S. 2013. First report of the crocodile shark *Pseudocarcharias kamoharai* (Matsubara, 1936) from Chennai, Southeast coast of India. *Journal of Marine Biological Association of India*, **55**: 86–88. <https://doi.org/10.6024/jmbai.2013.55.1.01734-14>
- Kyne P.M., Romanov E., Barreto R., Carlson J., Fernando D., Fordham S., Francis M.P., Jabado R.W., Liu K.M., Marshall A., Pacoureau N. & Sherley R.B. 2019. *Pseudocarcharias kamoharai*. *The IUCN Red List of Threatened Species* 2019 [online]. <https://www.iucnredlist.org/species/39337/171964644> [updated 9 November 2018; viewed 20 June 2023].
- Kyne P.M. & Simpfendorfer C.A. 2010. Deepwater chondrichthyans. In: Carrier J.C., Musick J.A. & Heithaus M.R. (Eds). *Sharks and their relatives II: biodiversity, adaptive physiology, and conservation*: 37–114. Boca Raton: CRC Press. <https://doi.org/10.1201/9781420080483-c2>
- Lack M. & Sant G. 2009. *Trends in global shark catch and recent developments in management*. Cambridge: Traffic International. 33 p.
- Matsubara K. 1936. A new carcharoid shark found in Japan. *Dobutsugaku zasshi*, **48** (7): 380–382.
- Moazzam M. & Osmany H.B. 2021. Species composition, commercial landings, distribution and some aspects of biology of shark (class Pisces: subclass: Elasmobranchii: infraclass: Selachii) from Pakistan: taxonomic analysis. *International Journal of Biology and Biotechnology*, **18**: 567–632.
- Moron J., Bertrand B. & Last P.R. 1998. A checklist of sharks and rays of western Sri Lanka. *Journal of Marine Biological Association of India*, **40**: 142–157.
- Nevill J., Robinson J., Giroux F. & Isidore M. 2007. *Seychelles national plan of action for the conservation and management of sharks*. Victoria: Seychelles Fishing Authority. 59 p.
- Oliveira P., Hazin F.H.V., Carvalho F., Rego M., Coelho R., Piercy A. & Burgess G. 2010. Reproductive biology of the crocodile shark *Pseudocarcharias kamoharai*. *Journal of Fish Biology*, **76**: 1655–1670. <https://doi.org/10.1111/j.1095-8649.2010.02606.x>
- Pradeep H.D., Shirke Swapnil S., Ramachandran S. & Pattanayak S.K. 2017. Report of the crocodile shark *Pseudocarcharias kamoharai* (Matsubara, 1936) from deep waters of the Andaman Sea. *Marine Biodiversity*, **47**: 535–538. <https://doi.org/10.1007/s12526-016-0499-9>
- Romanov E.V. & Samorov V.V. 1994. On discoveries of the crocodile shark, *Pseudocarcharias kamoharai* (Pseudocarchariidae), in the Equatorial Indian Ocean. *Japanese Journal of Ichthyology*, **34**(4): 155–157.
- Weigmann S. 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity. *Journal of Fish Biology*, **88**(3): 837–1037. <https://doi.org/10.1111/jfb.12874>
- White W.T. 2007. Biological observations on Lamnoid sharks (Lamniformes) caught by fisheries in eastern Indonesia. *Journal of Marine Biological Association of United Kingdom*, **87**: 781–788. <https://doi.org/10.1017/S0025315407056391>