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Redescription and new distributional record of Parin's spinyfin *Diretmichthys parini* (Beryciformes: Diretmidae) from the Indian coast

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Original Article

Abstract

A single specimen of Parin's spinyfin *Diretmichthys parini* was collected from the deeper water of west coast of India (Lat. 9°29.3'N; Long.75°45.9'E, depth 230 m). As wide variation in meristic counts of this species reported from other regions was observed, the present specimen is re-described by highlighting the characters overlooked in the original description. We also discuss the geographical variation among the con-specific of *D. parini*. An analysis of its osteology, otoliths, scale morphology and DNA barcode sequence confirmed the species identification. Molecular analysis of the present specimen using mitochondrial cytochrome oxidase subunit I (COI) gene sequences, confirmed the identity as *D. parini* with intra specific divergence of 0.47-3.2%.

Keywords*: Diretmichthys parini, meristic, otolith, DNA barcode, west coast of India*

Introduction

Spinyfins of the family Diretmidae are laterally compressed, with a round (*Diretmus* sp.) to oval body (*Diretmoides* spp.) and with the dorsal and anal fins bearing basal spines. It is a small family in the order Beryciformes that is pelagic or benthopelagic found in continental slopes or seamounts in tropical and subtropical regions between 40°N and 40°S (Post and Quero, 1981; Kotlyar, 1990; Priede, 2017). This family includes 3 genera (*Diretmoides,* Post and Quéro, 1981; *Diretmus* Johnson, 1864; *Diretmichthys* Kotlyar, 1990) and 4 species (*Diretmus argenteus* Johnson, 1864; *Diretmoides pauciradiatus* Woods, 1973; *D. veriginae* Kotlyar, 1987; *Diretmichthys parini* Post and Quéro 1981). Parin's spinyfin *Diretmichthys parini* was described originally as *Diretmoides parini* by Post and Quero (1981) and later it was transferred to the newly described genus *Diretmichthys* by Kotlyar (1990).

Adult specimens of *Diretmichthys parini* are bathypelagic and have been reported from tropical and subtropical areas at the depths of 270-2100 m (Post and Quero, 1981; Kotlyar, 1989; Kotlyar, 2002; Moore *et al*., 2003, Cresson *et al.,* 2017; OBIS database, 2019; Lynghammar *et al.,* 2020), while juveniles are epipelagic or mesopelagic (Post, 1986; Kotlyar, 1988). In South of Iceland, it was found at a temperature of 6°C (Jonsson and Palsson, 2013). The distribution of this species is supposed to be circumglobal in tropical, temperate and Arctic waters, with records from the Atlantic, Pacific and Indian Oceans (Post and Quero, 1981; Kotlyar, 1996; Arronte and Heredia, 2006). In the Indian Ocean, few records have been reported, including the Madagascar Ridge (Shcherbachev *et al*., 1989), off northern Western Australia (Paxton *et al*., 2006) and off

Myanmar (Psomadakis *et al.,* 2019). Unpublished records on *D. parini* may be observed in Indian waters (Venu, 2009), but this record is still in need of confirmation. In the present manuscript, a specimen of *D. parini* from off the southwest coast of India is described, providing a new record of the species from the Indian waters and from the north–western Indian Ocean. The specimen is described and the geographical variations among the pertinent records elsewhere in the world ocean are compared.

Material and methods

A single specimen of this rare deep sea Parin's spinyfish, (Fig.1a) *D. parini* (Post and Quéro, 1981) was caught off the southwest coast of India (Lat. 9°29.3'N; Long.75°45.9'E and 9°32.7'N; Long.75°42.4'E) at the depth range of 226–230 m (Fig. 1), from the high opening cephalopod trawl net (six seam) operated by the survey vessel *M.F.V. Matsya Varshini* of the Fishery Survey of India during March, 2019. Fin ray counts were taken following Fricke (1983) and morphometric measurements taken to the nearest millimetre (mm) with a digital caliper (Mitutoyo ABS lute Digimatte, Japan) following Post and Quero (1981) and Kotlyar (1989). Total weight (TW) was measured by means of a digital balance (0.05g accuracy) and an X-ray photograph was taken to determine the number of vertebrae in the specimen. The specimen was deposited in the Museum of the Fishery Survey of India, Kochi (FSIKM Dp 1,158). Tissue samples were taken from the dorsal portion of the fish and preserved in 95% ethanol for DNA isolation.

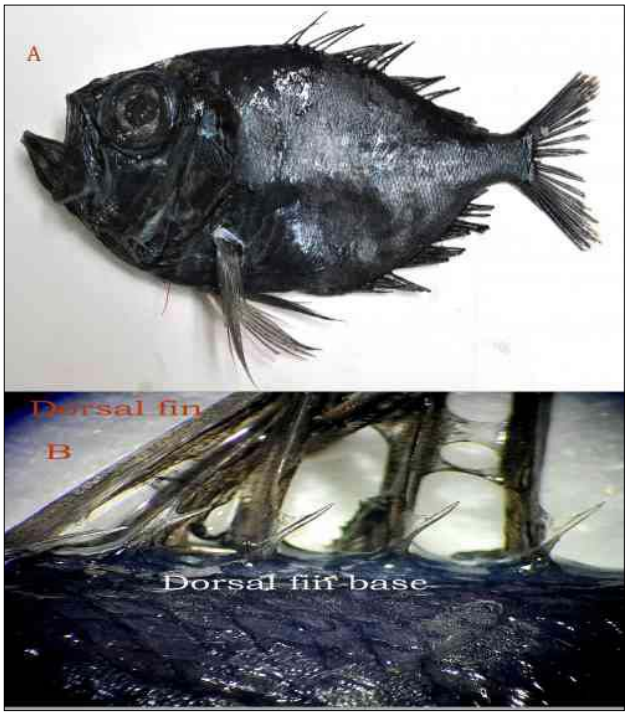

Fig.1.a. *D. parini* 158 mm TL b. Spines on the dorsal fin base

DNA barcoding and phylogenetic analyses

The total genomic DNA was extracted from the tissue sample by the customized protocol (DNeasy Blood & Tissue Kits, Qiagen Inc.). Further, the quality and quantity of DNA were estimated with Nanodrop BioSpectrometer (Eppendorf Pvt. Ltd). The DNA barcoding regions: mitochondrial cytochrome oxidase subunit I (COI) gene was amplified with the universal primer WARD 1(Ward *et al*., 2005). The PCR amplification was conducted in 25 μl reaction cocktails which includes 70 ng of genomic DNA, 1.5 mM MgCl2 and 0.3 mM of each primer solution. Next, the PCR amplification was implemented with an initial denaturation in 94ºC for 5 minutes, followed by 35 cycles (includes denaturation at 94ºC for 30s, annealing for 45s at 52ºC and extension at 72ºC for 1 min). Further, the final extension kept at 72ºC for 5 min. Finally, PCR amplification was verified with agarose electrophorsis (1.5% agarose gels with ethidium bromide) and visualized in UV transilluminator. The generated sequence was edited with the BIO Edit software (Hall, 1999) using Clustal W algorithm. Then, the phylogenetic tree was constructed with maximum likelihood (ML) analysis using 1000 bootstraps with available sequences from Genbank and Bold System. The Pairwise genetic divergences were estimated using Kimura-2-parameters (K2P) model in MEGA X tool (Kumar *et al.,* 2018).

Material examined: -FSIKM 1,158 (SL 138 mm), Arabian Sea, off Kerala, India, 9°29.3'N; 75°45.9'E–9°32.7'N; 75°42.4'E, 226–230 m depth, March 2019.

Holotype:- ISH 295/71, Eastern Atlantic Ocean, off Western Sahara, 23°47'N, 20°59'W, 0 to 2100-1800 m depth, Station "Walher Herwig" 506/71, 19 Apr. 1971. Data from Post and Quero, 1981.

Paratypes:–"WH" 190/56; 23.5.1966; 17 ° 36'5, 28 ° 53'W; MT 1600; 660 m; ISH 745/66 (2 copies fig. 10O); "Anton Dohrn" 25-III / 74; 19.7.1974; 11001'N, 26 ° 07'W; 15H 387/74 (1); "WH" 106-II / 76; 8.1.1976; 39 ° 08.4'5, 39 ° 59.8'W; MT 1600; 1800 1850 m; 15H 626/76 (1);–"Thalassa" st. Z 125 28.6.1973 26 ° 49'N, l4 ° 09'W; bottom trawl 35/55, 565 -690 m; cost no. ISH 24/80 (1) and MNHN 1980-1184 to 1980-1186 (3). Data from Post and Quero, 1981.

Order: Beryciformes
Family: Diretmidae Gill, 1893
Genus: *Diretmichthys* Kotlyar, 1990

Species: *Diretmichthys parini* Post and Quero, 1981 (Fig.1)
Synonym: *Diretmoides parini* Post and Quero, 1981

Results and discussion

Description

Body moderately flattened laterally (Fig.1a), large eyes, deep and oblique mouth, tip of pelvic fin reaching origin of anal fin; posterior rays of dorsal fins basally with a single lateral row of long spines (Fig.1b); abdomen with ventral scutes (Fig. 4b, c &d.); scales ctenoid (Fig. 4a) lateral line absent, anus about midway between the origins of the pelvic and anal fins.

Dorsal fin rays: 26; anal fin rays: 20; pectoral fin rays: 18; pelvic fin rays: I,6 (no true fin spines although pelvic fins have 1 laminar serrate spine); caudal fin rays (ii),i,22,i,(iii); branchiostegal rays, 8 (4 in epihyal; 4 in ceratohyal), gill rakers on first gill arch (Left- 7+1+13/Right-7+ 1+15 (Fig. 5), vertebrae 31 (including urostyle); body scales ctenoid each bearing 8-9 spines posteriorly (Fig. 4a); there are 12 scutes ventrally between pelvic fin and anus each with posterior spines varying a single spine on the anterior four scutes and two to three spines (with a long central spine and short lateral spines) posteriorly (Fig. 4c & d), the last scale strongly attached to the skin, reaching to the fleshy anterior portion of the anus; 10 scales between anal fin and anus, each posteriorly with five spines (middle spine long and stout) (Fig. 4b), vertebrae 31 (including urostyle). All the anal fin rays bear a small spine laterally at their base, which is directed posteriorly. All dorsal-fin rays except the first bears, a long basal spine which is directed posteriorly (Fig. 1b).

Otolith oval (length 8 mm; width 5 mm), its dorsal edge with

Fig. 2. Dorsal view of right otolith (length 8 mm, max. width 5 mm)

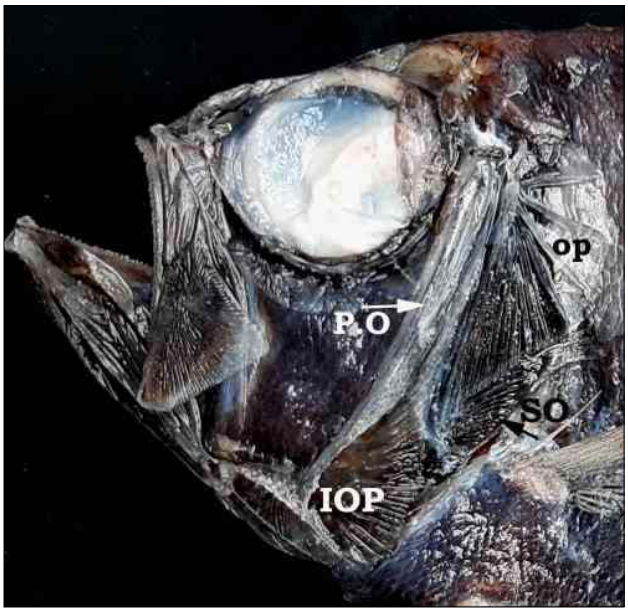

Fig. 3. Lateral view of head of *D. parini*; P.O-preopercle,op-opercle,IOP-interopercle, SO-subopercle.

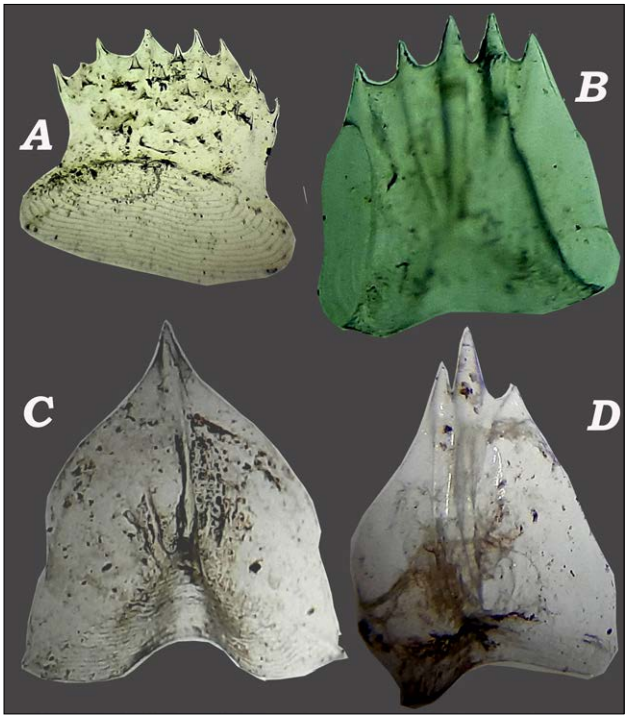

Fig. 4. A. body scale; B. scute between anus and anal fin; C. scute among the first fourth between pelvic fin base and anus, D. twelfth scute present between pelvic fin base to anus.

Fig. 5. Anterior right gill arch of *D. parini*

uneven serrations, larger indentations on ventral edge, laterally flat to weakly concave (Fig. 2).

Ventral edge of upper jaw with two rows of teeth, outer row with numerous small villiform teeth, which are very closely arranged. Inner row with 56 widely arranged teeth pointing backwards; posterior part of maxilla concealed by the broad supra-maxilla; a single canine tooth at centre of vomer, few canini on laterals. Tip of the lower jaw with three rows of teeth, posteriorly followed by another two rows. Upper and lower jaws with two rows of small teeth. Eyes circular, large and their horizontal and vertical diameter almost similar, equalling 40% of head length. Two pairs of nostrils in front of the eyes, the anterior one small and circular, the posterior one oval and larger, both separated by a thick muscular plate.

Operculum with 3 dermal crests, which are widely separated dorsally, but closer together ventrally (Fig. 3). Lower edge of operculum ventrally attached to suboperculum. Suboperculum 'v'shaped with the right arm extending dorsally, occupying dorsolaterally on operculum more than 1/3 of its length (Fig. 3). Pre-operculum larger, spatula shaped, covered with bony ridges (Fig. 3); lower edge of inter operculum with a series of 22 spines (Fig. 3). Pelvic fins with a small, colourless

Table 1. A comparison of meristic characters of *D. parini* with pertinent literatures

Meristic counts	Present specimen	Lynghammar *et al.*, 2020	Arronte and Heredia, 2006	Post and Quero, 1981	Kotlyar, 1988	Kotlyar, 2002
Dorsal fin	26	28	28	26-29	26-30	26
Pectoral fin	18	17	19	17-20	17-19	19
Pelvic fin	7	7	7	7	-	7
Anal fin	20	21	22	20-23	20-23	
Caudal fin rays	29 including Procur. rays	26-28	23	-	-	-
Gill rakers	22 (L) -23 (R)	18	17	16-20	18-20	19
Vertebrae	31			29-31	30-32	-
Scales between Anal fin to anus	10-triple spine	10-11	12	9-13	8-12	-
Scales between pelvic fin to anal	12 single spine	14-15	14	14	10-16	-
Branchiostegal Rays	8	-	-	8	8	-
Interopercle spine	22	-	-	-	-	-
Transverse scales from anus to Dorsal fin base	45	-	-	-	48-60	60
Scales on Caudal peduncle	11	-	-	-	-	-
Predorsal scales	38	-	-	-	-	32-45

scalar process on the spine; remaining rays covered with black pigment.

This species has a circum-global distribution in tropical and temperate waters of the world oceans, but excluding the north-eastern Pacific (Post and Quero, 1981; Priede, 2017; Fricke *et al.,* 2020). Around India, *Diretmoides veriginae* was previously the only species reported (Kotlyar, 1987; Nikki *et al.,* 2018). Although this species has an appearance quite similar to *D. parini,* it can be easily distinguished by the absence of scutes on the isthmus (versus scutes present in *D. veriginae*) and an oval-shaped otolith (versus otolith triangular). The meristic counts of *D. parini* (see Table 1) are quite variable (Post and Quero, 1981; Kotlyar, 1989, 2002; Arronte and Heredia, 2006; Cresson *et al.,* 2017; Lynghammar *et al.,* 2020), although due to the low number of known specimens from individual areas and this may not be significant. Kotlyar (1989) analysed total of 44 specimens from various parts of the world ocean; the meristics of the present specimen fall within the range except the gill raker count of 22-23 (versus 17-20) (Table 1), which may be due to different counting methods. In comparison with other species of the family Diretmidae, we find the following gill-raker

Table 2. A comparison of meristic characters of *D. parini* with pertinent literatures

Morphometry	Present specimen	Lynghammar *et al*., 2020	Arronte and Heredia, 2006	Post and Quero, 1981	Kotlyar, 1988
Body parts (times) in standard length					
Body depth	2.12	-	-	-	2.2
Head Length	2.76	-	-	-	2.7
Head depth	2.38	-	-	-	2.2
Upper Jaw length	1.8	-	-	-	1.6
In percentage of standard length					
Anus to Anal fin	9.4	-	13	-	9.3
Snout to anus	50.7	-	-	-	-
Snout to anal fin	62	-	65.9	64-73	62.2
Body depth	47.1	44.4	45.1	-	44.5
Caudal peduncle Depth	10.1	-	10.2	-	10.2
Caudal peduncle length	11.59	11.8	11.3	-	12.9
Dorsal fin base length	43.4	46.6	46.4	42.4-49.0	43.3
Eye diameter	14.5	14.8	-	16.2	16.2
Head depth	42	-	-	-	44.5
Head length	36.23	-	36.9	35.7	37.6
Inter orbit width	6.5	-	5.1	7.0	6.3
Lower jaw length	26.08	-	23.5	-	26.6
Upper jaw length	22.4	-	22.2	22.5-28.5	23.1
Pre dorsal length	42.7	-	45.4	45.2-59.2	48.9
Pectoral fin length	29.7	23.1	-	-	29.7
Pelvic fin length	28.2	26.3	-	-	34.1
Post orbital length	14.5	-	-	-	14.6
Pelvic fin to anal fin	25	-	-	-	24.3
Pelvic fin to anus	11.6	-	11.9	-	12.1
In percentage of Head length					
Snout length	20	-	-	-	22.6
Eye diameter	40	-	-	-	43.1
Post orbital length	40	-	-	-	38.7
Head depth	116	-	-	-	118.2
Inter orbit width	18	-	-	-	16.7
Upper jaw length	62	-	-	-	61.3
Lower jaw length	72	-	-	-	70.8

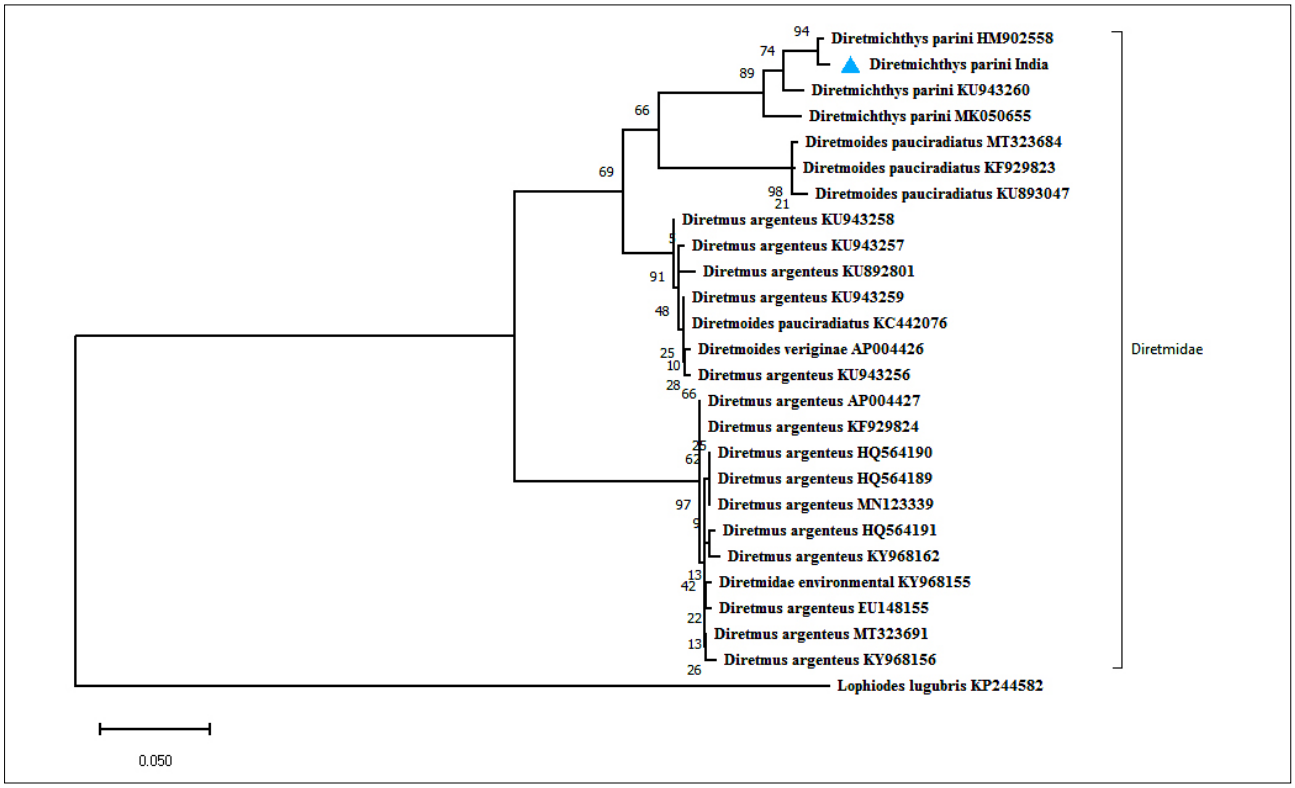

Fig. 6. The phylogenetic tree for *D. parini* using the Maximum Likelihood method and Hasegawa-Kishino-Yano model.

counts: *D. viriginae* 21-24 (Kotlyar, 1988; Nikki *et al*., 2018); *D. pauciradiatus* 12-16 (Post and Quero, 1981; Kotlyar, 1988); *Diretmus argenteus* 17-22 (Abe, 1953; Kotlyar, 1987, 1988). Apart from this, variation in count of gill rakers of the present specimen may also be due to adaptive significance of fishes for foraging, increasing number of gill rakers, which could expedite the utilization of minor prey and also advantageous to its filtering planktivorous habit (Lynghammar *et al*., 2020; Neilson and Perry, 2001; Kahilainen *et al*., 2011). *D. parini* from Indian sea (Venu, 2009) has17 gill rakers, however, the present specimen has 22-23, which revealed a probability of the occurrence of polymorphic population of *D. parini* in Arabian Sea. The morphometric and meristic characters of the present specimen from Arabian Sea corroborated with the review by Kotlyar (1988) confirms the present record as geographical extension of *D. parini* in northern part of Indian Ocean substituted by analysing the DNA sequence (Fig. 6). The COI sequence was generated for the Indian material of *D. parini* and the phylogenetic tree was constructed for this group with available sequences of *D. pauciradiatus*, *D. argenteus* and *Lophiodes lugubris* (KP244582), which was used as an out group. All sequences of *D. pauciradiatus,* and *D. argenteus* were retrieved from the NCBI and Bold System. There were 458 positions in the final dataset for the 26 nucleotide sequences. The phylogenetic tree analysis was inferred by using the Maximum Likelihood method and Hasegawa-Kishino-Yano model. The present Indian specimen strongly forms a monophyletic clade with specimens from Australia (HM902558), Taiwan (KU943260) and Russia (MK050655) with intra-specific genetic divergences 0.47%, 2.4% and 3.4% respectively (Fig. 6). The present study also revealed that *D. parini* is closely related to *D. argenteus* compared with *D. pauciradiatus*. The intraspecific genetic divergences were estimated, which ranged from 8.3 to 15.3%. The overall tree topology closely agreed with the previous report of Davis *et al.* (2016). Finally, DNA Barcoding analysis significantly supports the morphological characterization of the *D. parini* from Indian water.

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