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First record of the coloured righteye flounder, *Poecilopsetta colorata* (Teleostei: Poecilopsettidae) from the Sakalaves seamounts in the Mozambique Channel

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Abstract

Background: The coloured righteye flounder, *Poecilopsetta colorata* Günther, 1880 was previously known from the eastern Indian Ocean to the South China Sea and Indonesia. Here, a new record from the western Indian Ocean is reported.

Results: The new record is based on a specimen collected on the Sakalaves seamounts at 375 m in depth in the Mozambique Channel during a recent oceanographic survey. Four other teleost fish species including an uncommon ophidiid species, *Neobythites somaliaensis* Nielsen, 1995 were also collected on the same seamounts.

Conclusions: The presence of *P. colorata* in the Mozambique Channel suggests a broad and Indo-West Pacific wide distribution for this relatively rare deep-sea species. The sequence of the cytochrome oxidase subunit-I for the collected specimen is provided as a genetic reference for further DNA barcoding and systematic studies.

Keywords: Fishes, New record, Distribution, Western Indian Ocean, Mozambique Channel, Sakalaves seamounts, COI, PAMELA-MOZ01 cruise

Background

The bigeye flounders of the genus *Poecilopsetta* Günther, 1880 (Poecilopsettidae) (Sakamoto, 1984; Nelson, 2006) include 15 currently recognized species that inhabit the deep seas of the tropics (Munroe, 2015). Seven species of *Poecliopsetta* occur in the Indian Ocean (*P. albomaculata* Norman, 1939, *P. colorata* Günther, 1880, *P. natalensis* Norman, 1931, *P. macrocophala* Hoshino, Amaoka and Last, 2001, *P. normani* Foroshchuk & Fedorov, 1992, *P. praelonga* Alcock, 1894, *P. vaynei* Quéro et al., 1988, and *P. zanzibarensis* Norman, 1939) (Quéro et al., 1988; Hoshino, 2000; Guibord and Chapleau, 2001, 2002; Hoshino et al., 2001; Evseenko, 2004; Kawai and Amaoka, 2006; Kawai et al., 2010). To date, only three species (*P. natalensis*, *P. vaynei*, and *P. zanzibarensis*) have been recorded from the Mozambique Channel in the western Indian Ocean (Fischer and Bianchi, 1984; Quéro et al., 1988; Foroshchuk and Fedorov, 1992; Evseenko, 2004; Hensley, 1997). The coloured righteye flounder, *P. colorata* Günther, 1880, is a rare bathydemersal species living at depths of 214–800 m (Hensley, 1997; Evseenko, 2004). *P. colorata* is currently known from the eastern Indian Ocean to the South China Sea and Indonesia (Hensley, 1997; Evseenko, 2004).

The authors examined 55 fish specimens collected during the 32-day multi-disciplinary cruise (campaign: PAMELA-MOZ01) in 2014 of the R/V *Atalante* deployed by the French Oceanographic Fleet in the Mozambique Channel in the western Indian Ocean. Among them, one specimen was identified as *P. colorata*.

The purpose of the present work is to record this species in the ichthyofauna of the Mozambique Channel and provide a molecular sequence from a mitochondrial gene as the genetic reference for further DNA barcoding and systematic studies.

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Methods

The materials described in the present paper were collected during the cruise PAMELA-MOZ01 of the PAMELA project in 2014 conducted by the R/V *Atalante* (Olu, 2014) on the collection sites from three of the explored zones, the slope of the Glorieuses islands, the slope of the Mahajanga basin off Madagascar, and the Sakalaves seamounts on the southern Davie ridge (Fig. 1). The Warén dredge, NIWA seamount sledge and beam trawl were used for sampling at a total of eight sites. The geographic coordinates of the sites, depths, and methods for the deployments are listed in Table 1, and the collected samples are listed in Additional file 1 : Table S1. The specimens examined were deposited in the National Natural History Museum of Paris (MNHN). Muscle tissue samples excised from the specimens for genetic studies were preserved in 95 % ethanol and stored at −20 ° C in the Marine Biodiversity and Phylogenomics laboratory at the Institute of Oceanography, National Taiwan University, Taipei with tissue identification numbers from WIO 001 to WIO 055 (Additional file 1 : Table S1).

Identification and methods for taking counts and measurements of the specimen generally followed Hensley (1997) and Quéro et al. (1988) for the pleuronectiform fishes. All other specimens were identified according to the following taxonomic references: Fischer and Bianchi (1984) (most fishes); Nielsen (1969, 2002) and Nielsen et al. (1999) (Ophidiiformes); Cohen et al. (1990) (Macrouridae).

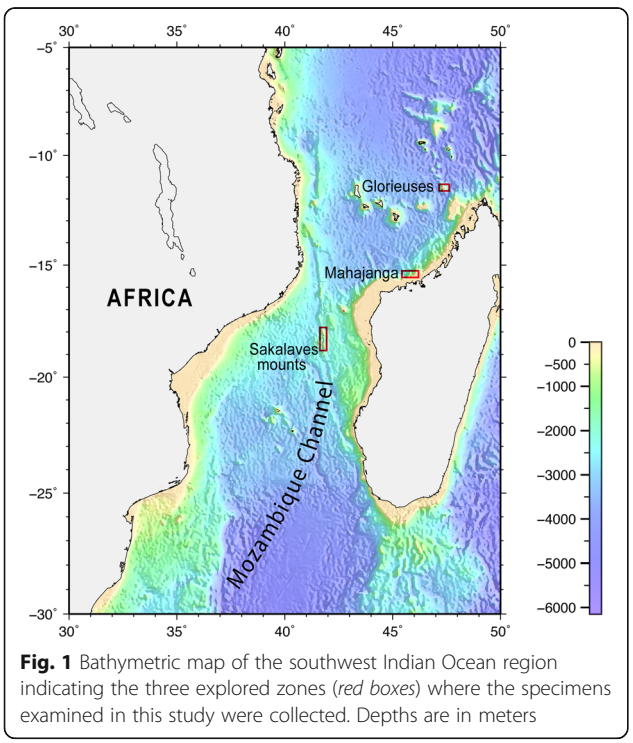

Fig. 1 Bathymetric map of the southwest Indian Ocean region indicating the three explored zones (*red boxes*) where the specimens examined in this study were collected. Depths are in meters

Whole genomic DNA was extracted from the tissue sample (WIO 041) of the *P. colorata* specimen using an automated extractor: *LabTurbo 48 Compact System* and *LGD 480–500* kits (Taigene Biosciences Corp.) following the manufacturer's protocol. A fragment of the mitochondrial protein-coding gene cytochrome oxidase subunit I (*COI*) was amplified and sequenced for this study. Protocols for collecting molecular data follow those outlined in Ward et al. (2005). Six available *COI* sequences from two congeneric species (*P. natalensis* [$n = 5$] and *P. hawaiiensis* [$n = 1$]) were retrieved from Genbank and compared with our obtained sequence. The sequence alignment was conducted manually using Se-Al v2.0a11 (Rambaut, 2002). The variable nucleotide sites and genetic distance (uncorrected pairwise *p*-distance) among sequences and were calculated using PAUP* (Swofford, 2002).

Results

A total of 55 collected samples were examined. Among them, 49 specimens belong to the 15 following recognized teleost species: *Coloconger raniceps* Alcock, 1889 (Colocongridae) ($n = 6$), *Coloconger scholesi* Chan, 1967 (Colocongridae) ($n = 1$), *Hoplostethus melanopus* (Weber, 1913) (Trachichthyidae) ($n = 3$), *Nezumia semiquincunciata* (Alcock, 1889) (Macrouridae) ($n = 3$), *Ventrifossa johnboborum* Iwamoto, 1982 (Macrouridae) ($n = 2$), *Lophiodes triradiatus* (Lloyd, 1909) (Lophiidae) ($n = 1$), *Neoscopelus macrolepidotus* Johnson, 1863 (Neoscopelidae) ($n = 20$), *Aldrovandia affinis* (Günther, 1877) (Halosauridae) ($n = 1$), *Aldrovandia phalacra* (Vaillant, 1888) (Halosauridae) ($n = 1$), *Barathronus diaphanus* Brauer, 1906 (Aphyonidae) ($n = 1$), *Monomitopus conjugator* (Alcock, 1896) (Ophidiidae) ($n = 2$), *Neobythites somaliaensis* Nielsen, 1995 (Ophidiidae) ($n = 3$), *Pentaceros capensis* Cuvier, 1829 (Pentacerotidae) ($n = 1$), *Poecilopsetta colorata* (Poecilopsettidae) ($n = 1$), and *Paratriacanthodes retrospinis* Fowler, 1934 (Triacanthodidae) ($n = 3$). Six other specimens can only be identified to the genus *Symphurus* (Cynoglossidae) in two morpho-types ($n = 4$ and 2, respectively) based on the available keys of the species identification. Among the identified species, all expect one (described below) have been recorded in the western Indian Ocean.

Poecilopsetta colorata Günther, 1880, new record (Fig. 2)

Material examined

MNHN2016-0180, one specimen, Sakalaves mounts (Fig. 1), 18°0.08589'S 41°46.32208'E, 375 m depth, R/V *Atalante*, NIWA seamount sledge, Station MOZ1_DN5 (Table 1), 100 mm standard length (SL), 44.3 mm body depth, 25.3 mm head length, 7.9 mm upper-jaw length, lateral line scales: ca. 102–105, dorsal soft fin rays: 58,

Table 1 Information of the operations during the campaign of PAMELA-MOZ01

Code of operation	Date	Zone	Latitude	Longitude	Type of operation	Depth (m)
MOZ1_DW1	28/09/2014	Glorieuses	11°22.75604'S	47°16.40977'E	Warén dredge	789
MOZ1_CP1	4/10/2014	Mahajanga	15°21.46148'S	45°59.28908'E	Beam trawl	722
MOZ1_CP2	8/10/2014	Mahajanga	15°21.72712'S	45°57.65218'E	Beam trawl	869
MOZ1_CP3	8/10/2014	Mahajanga	15°21.71867'S	45°57.52781'E	Beam trawl	971
MOZ1_CP4	9/10/2014	Mahajanga	15°31.00558'S	45°41.95738'E	Beam trawl	806
MOZ1_DN4	14/10/2014	Sakalaves mounts	18°0.07689'S	41°46.31995'E	NIWA seamount sledge	376
MOZ1_DW4	14/10/2014	Sakalaves mounts	18°0.06847'S	41°46.3343'E	Warén dredge	376
MOZ1_DN5	14/10/2014	Sakalaves mounts	18°0.08589'S	41°46.32208'E	NIWA seamount sledge	375

anal soft fin rays: 48, pectoral fin rays: 10 (8 on blind side), pelvic fin rays: 6, number of nucleotides of the obtained *COI* sequence (Genbank accession number: KX611099): 648.

Diagnosis

The counts of dorsal and anal fin rays and lateral line scales are considered as key features for diagnosing species of *Poecilopsetta* (Hoshino et al., 2001; Kawai et al., 2010). These counts in our examined specimen were 58, 48, and ca. 102–105, which fall into the ranges of the three characters for *P. colorata* (55–62, 46–53, and 90–124) and *P. praelonga* (57–65, 45–55, and 91–113) as being described in Kawai et al. (2010). The former species can be easily distinguished from the latter in having a deeper body (body depth 1.9 to 2.6 times in SL vs. body depth 3.8 to 4 times in SL) and a longer upper-jaw (upper-jaw length 3 to 3.5 times in head length vs. upper-jaw length 3.6 to 3.7 times in head length) (Hensley, 1997). Our specimen was diagnosed with body depth 2.3 times in SL and upper-jaw length 3.2 times in head length. All these characteristics combined together indicate our specimen is *P. colorata.*

From the aligned *COI* sequences for the samples of the three *Poecilopsetta* species included in this study (see methods), 28 variable sites were observed along the 684-bp long sequenced fragments (Fig. 3). This represents 2.76 % interspecific nucleotide divergence on average (evaluated by uncorrected pairwise p-distance). The nucleotide divergence among five *P. natalensis* samples collected from South Africa ($n = 4$) and from the South China Sea ($n = 1$) was estimated to be 0.64 %. Diagnostic nucleotides of *P. colorata* to *P. natalensis* are site numbers 046, 126, 225, 252, 315, 360, 420, 444, 477, 510, 513, 565, 612, 618, 621, and 639. Diagnostic nucleotides of *P. colorata* to *P. hawaiiensis* are site numbers 210, 225, 313, 315, 369, 390, 477, 505, 510, 513, 537, 549, 561, 594, 603, 618, 621, and 678 (Fig. 3). The available genetic data further confirm that our specimen is distinguishable from the co-occurring species from the region, *P. natalensis.*

Fig. 2 *Poecilopsetta colorata* Günther, 1880, MNHN2016-0180 from the Sakalaves seamount, collected on Oct. 14, 2014. Standard length 100 mm

Species	Nucleotide position																										
Samples, locality, GenBank no.	0	1	2	2	2	3	3	3	3	3	4	4	4	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6
	4	2	1	2	5	1	1	6	6	9	2	4	7	0	1	1	3	4	6	6	9	0	1	1	2	3	7	7
	6	6	0	5	2	3	5	0	9	0	0	4	7	5	0	3	7	9	1	5	4	3	2	8	1	9	5	8
P. natalensis																												
HQ945815, South Africa	?	C	A	T	G	C	A	T	G	C	A	T	G	A	T	A	T	A	C	C	C	C	G	C	A	T	A	T
HQ945811, South Africa	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GU804926, South Africa	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.
GU804911, South Africa	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
JQ700099, South China Sea	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. colorata																												
KX611099, Mozambique Channel	T	T	.	C	A	.	G	C	.	.	G	C	A	.	C	G	.	.	.	T	.	.	T	T	G	C	.	.
P. hawaiiensis																												
DQ521023, Hawaii	?	T	G	.	A	T	.	C	A	T	G	C	.	G	.	.	C	G	T	T	T	T	T	.	.	C	.	A

Fig. 3 Polymorphic nucleotide sites at the cytochrome c oxidase subunit-I locus in three *Poecilopsetta* species. Numeration of nucleotide sites starts from first nucleotide of the corresponding gene. Genbank accession numbers of the sequences are given

Remarks

Based on the new record in this study, the distribution of the species extends to the western Indian Ocean from its previously reported area. The four other teleost fish species also collected from the same seamounts are: *Neobythites somaliaensis* (Ophidiidae), *Pentaceros capensis* (Pentacerotidae), *Symphurus* sp. 2 (Cynoglossidae), and *Paratriacanthodes retrospinis* (Triacanthodidae) (Additional file 1: Table S1). *N. somaliaensis* is an uncommon ophidiid species that was described based on specimens collected on the upper continental slope in the Gulf of Aden (Nielsen, 1995). The present record in the Mozambique Channel is new. This species is most similar to the common *Neobythites* species, *N. analis* Barnard 1927, from this region (Nielsen et al. 1999; 2002); it differs from *N. analis* by the distal parts of both dorsal and anal fins being black (Fig. 4).

Discussion

Although some flatfishes including poecilopsettids have large and presumably long-lived larvae that could enhance the probability of achieving long-distance dispersal over large areas (Evseenko, 2000), widespread species crossing two oceans are rare in poecilopsettids (Munroe, 2005). In *Poecilopsetta*, *P. colorata* and *P. praelonga* are the only two species known to have a wide distribution ranging from the eastern Indian Ocean to the western Pacific Ocean (Quéro et al., 1988; Hensley, 1997). The record of *P. colorata* in the western Indian Ocean presented here confirms a wide and an extended distribution for this poorly known deep-sea species. The African righteye flounder, *P. natalensis*, also occurs in the western Indian Ocean. The extension of its distribution into the western Pacific has been suspected because of an unconfirmed record reported in Taiwan (Hensley, 1997). In this study, one of our compared *COI* sequences of *P. natalensis* was from the South China Sea (Fig. 3), confirming the presence of this species in the western Pacific Ocean. It is worthy to mention that the genetic distance between this sample of *P. natalensis* and others from South Africa is very low, from zero to 0.64 % of nucleotide divergence (corresponding to a single nucleotide difference), despite the large distance between the two sampling sites (Fig. 3). A genetic break corresponding to the geology that separates the Indian population from the Pacific one is often present in widespread marine Indo-West Pacific species (Borsa et al., 2016); it was not observed in *P. natalensis*.

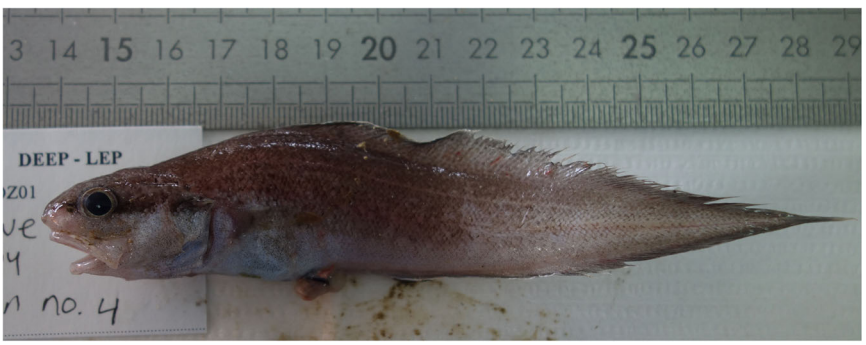

Fig. 4 *Neobythites somaliaensis* Nielsen, 1995, MNHN2016-0176 from the Sakalaves seamount, collected on Oct. 14, 2014. Standard length 140 mm

Conclusions

The first record of *P. colorata* from the Sakalaves seamounts on the southern Davie Ridge in the Mozambique Channel is reported. This record extends the known range of *P. colorata* to the western Indian Ocean. The occurrences of this species elsewhere include the Bay of Bengal to the South China Sea and Indonesia. The individuals are known to live at depths of 214 to 800 m (375 m in this study). The *COI* sequence for the collected *P. colorata* specimen is also provided as a genetic reference. Its availability can permit DNA barcoding work for fish identification purposes and future systematic or other advanced research such as biogeography or studying the evolutionary dynamics of species across the oceans.

Additional file

Additional file 1: Table S1. List of the samples collected during the cruise (campaign: PAMELA-MOZ01) and examined in this study. CP: Beam trawl. DN: NIWA sledge. DW: Warén dredge. (DOCX 27 kb)

Abbreviations

R/V: Research vessel; SL: Standard length; *COI*: Cytochrome c oxidase subunit-I; DNA: Deoxyribonucleic acid; Bp: Base pair

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Availability of data and material

Sequence data are available in GenBank from National Center for Biotechnology Information; specimens are available from National Museum of Natural History, Paris, France.

Authors' contributions

WJC contributed to the conception and design of the work, analyzed, interpreted the data, and wrote the paper; JNC collected the data and wrote the paper; JEP collected and managed the samples; KO led the cruise of sample collection and revised the paper. All authors read and approved the final manuscript.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

The research was performed at National Taiwan University in accordance with the National Taiwan University's guidelines regarding animal research. As this project had no experiment involved live fishes (conducted based the preserved specimens from Museum), no ethics statement was required.

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