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First pelagic record of the velvet dogfish *Zameus squamulosus* (Günther, 1877) (Squaliformes) from the southwestern Indian Ocean and some notes on its regional distribution

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ABSTRACT

A pelagic record of a rare deep-water shark, the velvet dogfish *Zameus squamulosus* (Günther, 1877), is described from the southwestern Indian Ocean. This is the first pelagic record from the western Indian Ocean and the eleventh published record of this species from the entire basin. Together with non-published records from museums and online databases the number of verified Indian Ocean records of this species currently exceeds 50 individuals. *Zameus squamulosus* is a benthopelagic species usually occurring on the slopes of the continents and in mid-ocean oceanic ridges, between 400 and 1450 m depth, but it makes rare incursions in open water to the limits of the epipelagic zone.

KEY WORDS

Elasmobranchii,
benthopelagic shark,
deep-water habitat,
pelagic occurrence,
SW Indian Ocean,
new records.

RÉSUMÉ

Première observation pélagique d'un squalo-grogneur velouté, Zameus squamulosus (Günther, 1877) (Squaliformes), de l'océan Indien sud-occidental et quelques notes concernant sa distribution régionale.

La présence en milieu pélagique d'une espèce rare de requin de profondeur, le squalo-grogneur velouté *Zameus squamulosus* (Günther, 1877), est décrite dans le sud-ouest de l'océan Indien. Il s'agit de la première signalisation de cette espèce en milieu pélagique dans l'océan Indien occidental, et de la onzième dans le bassin entier. En comptant les signalisations non publiées à partir des musées et les bases de données en ligne, les signalisations avérées de cette espèce dans l'océan Indien dépassent les 50 individus. *Zameus squamulosus* est une espèce benthopélagique : elle fréquente habituellement les pentes des continents et les dorsales océaniques, entre 400 et 1450 m de profondeur ; elle effectue aussi de rares incursions en pleine eau, à la limite inférieure de la zone épipélagique.

MOTS CLÉS

Elasmobranchii,
requin benthopélagique,
habitat profond,
occurrence pélagique,
SO océan Indien,
nouvelles signalisations.

INTRODUCTION

The squaloid shark *Zameus squamulosus* (Günther, 1877) is a deep-water species, encountered in the benthic and sometimes in the pelagic environment along continental margins of tropical and temperate waters in the Atlantic and Pacific (Compagno 1984; Wetherbee & Crow 1996). Its distribution and occurrence in the Indian Ocean are still obscure. Only few published records of *Z. squamulosus* are known from the undersea ridges of the southern tropical Indian Ocean (Scherbachev *et al.* 1982). Other records, although lacking geo-referencing precision, are attributed to continental slope areas of South Africa, Australia and Java (Indonesia) (Bass *et al.* 1976; Last & Stevens 1994, 2009; White *et al.* 2006). One individual was recently collected at

a landing site in Cochin, India (Akhilesh *et al.* 2011).

Despite its global distribution, biology and habitat of the velvet dogfish are still poorly known: it is listed as “data deficient” on the IUCN Red List of Threatened Species (Burgess & Chin 2006). Therefore information presented in this note is important for the understanding of this species' ecology.

Here we describe the first record of *Z. squamulosus* from the pelagic zone of the tropical southwestern Indian Ocean and present a further nine recent records from the demersal environment. We discuss regional species distribution based on: 1) published data; 2) museum collection inventories; and 3) online sources. Finally, we debate the reliability of information from internet portals.



Fig. 1. — Individuals of *Zameus squamulosus* (Günther, 1877) caught in the pelagic and demersal environment: **A**, MNHN 2012-0188, female (672 mm TL) caught on a pelagic longline set on 25 May 2011 in the southwestern Indian Ocean (black bar at the ruler is equal to 5 cm); **B**, female caught on a demersal longline set on 5 March 2008 in the southeastern Indian Ocean (see Table 2 for details) (ruler length is 30 cm).

MATERIAL AND METHODS

A female of *Zameus squamulosus* (672 mm total length, TL; 640 mm fork length, FL) (Fig. 1A) was caught on 25 May 2011 on a tuna longline set by the commercial fishing vessel *Fournaise* during a research cruise in the framework of the PROSPER Project. E. V. Romanov and A. Le Turc were onboard during the capture, collected accurate fishing and environmental data and preserved the specimen. Approximate capture position ($23^{\circ}17'S$, $52^{\circ}17'E$, mid-point of the pelagic longline gear) is in the proximity of the southwestern limit of the Exclusive Economic Zone of Reunion Island, France (Fig. 2). The research pelagic drifting longline used in this set consists of deep sections (12 hooks between floats, maximum fishing depth [MFD] 215–323 m),

very deep sections (24 hooks between floats, MFD 439–534 m) and surface sections (six hooks between floats, MFD 67–146 m). The shark was caught on a very deep section of the gear by the fifth hook baited with squid, *Illex argentinus* (Castellanos, 1960), at the estimated depth 290–300 m. MFD and estimated hook depth were calculated using corrected catenary curve geometry (Bach *et al.* 2009) with COPAL software v. 2.5.3 (Bach *et al.* 2011), and adjusted using direct measurements of section mid-point depth with temperature-depth recorders (TDR).

Sea surface temperature (SST) measured during vertical profiling of the water column with TDR before and after the fishing operation ranged within 25.9 – 26.2 °C, T °C at a depth of 300 m varied from 15.4 to 16.1 °C. Ocean floor topography

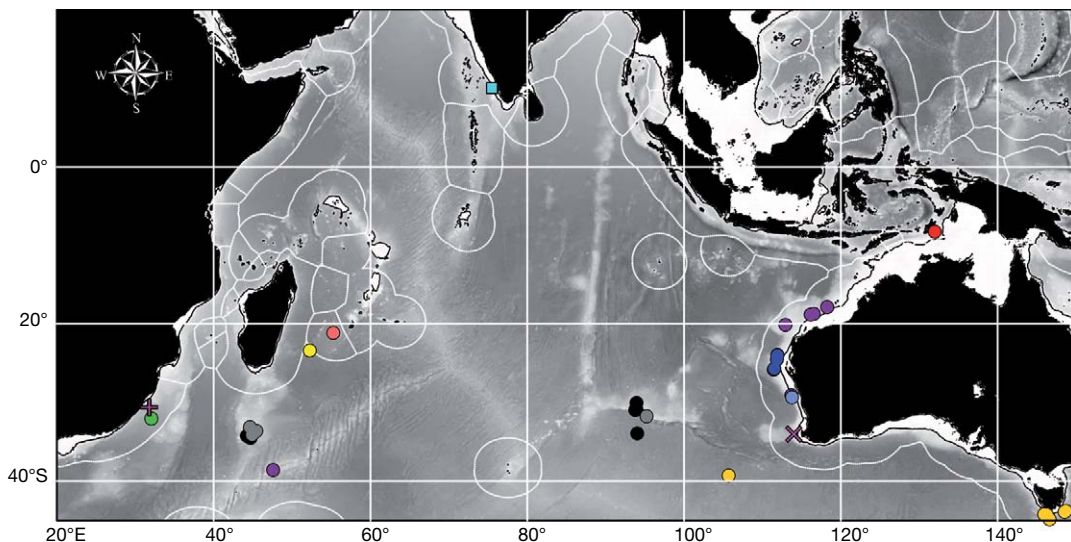


FIG. 2. — Geographic position of *Zameus squamulosus* (Günther, 1877) from the Indian Ocean (Table 2): **Pelagic** records: yellow dot (this study) and orange dots (CSIRO); **Demersal** records: black dots (YugNIRO, this study), grey dots ZM MGU (Scherbachev *et al.* 1982), pink dot (MNHN), purple dots (CSIRO), blue (AM), light blue (MV), green (Iziko SAM), red dot (IRD bottom survey), please note superposition of several CSIRO, AM and MV records; **Sperm whale** stomach records: straight cross is Bass *et al.* (1976) and oblique cross is WAM; **Bright blue** square is landing site recovery (Akhilesh *et al.* 2011). Approximate position of the 200-mile Exclusive Economic Zones (EEZs) of coastal states (dotted line) and 200 m isobath are shown. Coastline and bathymetry data are from GEBCO (2010), EEZs are from VLIZ (2011).

data taken from the GEBCO database (GEBCO 2010) suggests that the fishing gear was deployed and drifted over a deep-water canyon (bottom depths 5000-5400 m) surrounded by deep-water seamounts (minimum depth 3500-3800 m), and by an abyssal plain of 4500-4900 m deep.

The shark was frozen and stored for 30 days before examination. The specimen was deposited in the collections of the Muséum national d'Histoire naturelle, Paris (catalogue number MNHN 2012-0188).

Measurements were taken to the nearest mm following Bass *et al.* (1976) and Compagno (1984) approaches and expressed as percentage of TL. Total length used for calculation of body proportions was measured for "stretched" caudal fin as presented in Compagno (1984) in alternative to "natural" position as suggested by Bass *et al.* (1976). Denticles from left side of the trunk (Fig. 3A) were examined under a light microscope (Olympus SZ61 under $\times 45$ magnification) and photographed with digital camera Olympus SP510UZ resolution 7.1 Mpx.

Another eight specimens of this species were caught by demersal longlines during commercial fishing operations in the southern Indian Ocean in March-April 2008. Individuals were sampled and identified by S.T. Rebik as *Scymnodon obscurus* Vaillant, 1888 (a synonym of *Zameus squamulosus*) using keys in Compagno (1984) (Fig. 1B). Denticles from left side of the trunk were also photographed using a light microscope (Fig. 3B). Occurrence, fishing depth and some biological observations were recorded and used here to illustrate both spatial and vertical species distribution (Figs 2; 4).

One more individual (female, 710 mm TL) preserved in the MNHN collections (catalogue number MNHN 2007-1658, identified by B. Séret as *S. obscurus*) was caught on the slope of Reunion Island using a demersal longline baited with squid on 22 February 2005 by the commercial fishing vessel *Ludo* (Fig. 2).

The Indian Ocean area is considered here according to FAO definitions of fishing areas 51 and 57, with its western border off South Africa at 30°E and eastern border off Southern Australia at 150°E.

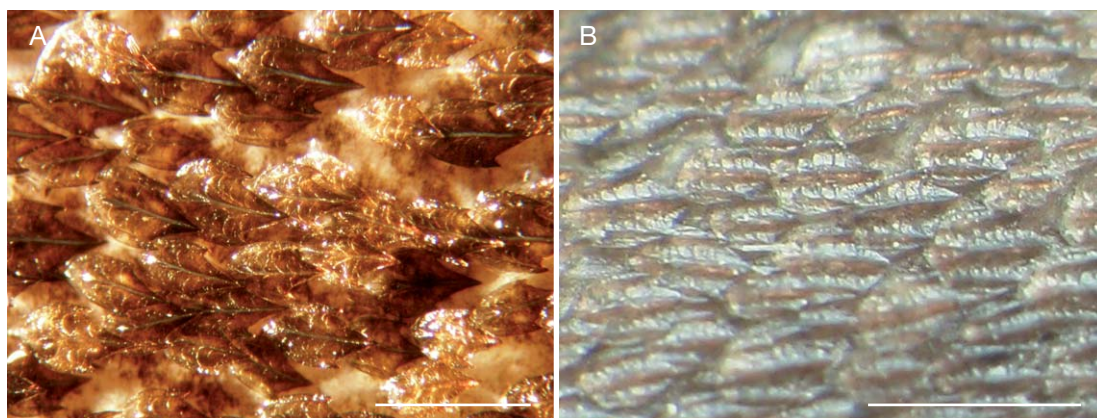


FIG. 3. — Dermal denticles from the trunk region of *Zameus squamulosus* (Günther, 1877) caught in the pelagic and demersal environment: **A**, MNHN 2012-0188, female, 676 mm TL; **B**, female from demersal zone of the southeastern Indian Ocean shown on the Figure 1B. Scale bar: 1 mm.

ABBREVIATIONS

Institutions, collector

AM	Australian Museum, Sydney;
NHMUK	The Natural History Museum, London (formerly BMNH, British Museum of Natural History);
CSIRO	CSIRO-Ichthyology Castray Esplanade, Hobart;
IRD	Institut de Recherche pour le Développement;
Iziko SAM	Iziko South African Museum – Fish collection, Cape Town;
MNHN	Muséum national d'Histoire naturelle, Paris;
MV	Museum Victoria Ichthyology, Melbourne;
STR	S. T. Rebik collector;
WAM	Western Australian Museum, Perth;
YugNIRO	Southern Scientific Research Institute of Marine Fisheries and Oceanography;
ZMH	Biocenter Grindel und Zoological Museum, University of Hamburg, Hamburg;
ZM MGU	Zoological Museum of the Moscow State University, Moscow.

Databases, programs

Discover Life	An interactive encyclopedia of life. http://www.discoverlife.org ;
FishBase	World Wide Web electronic publication. http://www.fishbase.org ;
GBIF	Global Biodiversity Information Facility. http://data.gbif.org ;
ITIS	Integrated Taxonomic Information System. http://www.itis.gov .

OBIS	The Ocean Biogeographic Information System. http://www.iobis.org ;
PROSPER	Prospection et habitat des grands pélagiques de la ZEE de La Réunion;
WoRMS	World Register of Marine Species http://www.marinespecies.org .

Measurements

FL	fork length;
PP2	Prepelvic fin length;
SVL	Snout-vent length;
TDR	temperature-depth recorder. Model: SPT2T600-PI, NKE instrumentation, rue Gutenberg, Z.I. Kérandré, 56700, Hennebont, France;
TL	total length.

SYSTEMATIC ACCOUNT

Family SOMNIOSIDAE Jordan, 1888
Genus *Zameus* Jordan & Fowler, 1903

Zameus squamulosus (Günther, 1877)
(Figs 1; 3)

Synonyms: *Centroscyrnus obscurus* Vaillant, 1888, Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883. Poissons, 67-68, pl. 2, fig. 2a-e. Holotype: Muséum national d'Histoire naturelle, Paris, MNHN-84-388, 590 mm female, 'côtes du Soudan', 1400-1435 m.

TABLE 1. — Total length and body proportions (in % of total length *sensu* Compagno (1984) of *Zameus squamulosus* (Günther, 1877) from the southwestern Indian Ocean and from specimens collected in the Atlantic and Pacific. Measured dimensions are given following terminology of Compagno (2001), except for terms and measurements adopted from Bass *et al.* (1976) given in italics, and spine measurements adopted from Clarke, Irvine (2006), given in bold italics.

Measurements	Codes of measurements	This paper, MNHN 2012-0188	holotype NHMUK 1880-5-1:1	Wetherbee & Crow 1996	Yano & Tanaka 1984	Taniuchi & Garrick 1986	Krefftt 1980
N	–	1	1	1	12	4	3
Sex	–	♀	♀	♀	8 ♂♂, 4 ♀♀	2 ♂♂, 2 ♀♀	2 ♂♂, 1 ♀
Maturity	–	not available	mature	mature	not available	not available	♂ mature, ♀ juv.
Total length	TL	672	670	786	263-634	256-667	316-493
Prenarial length	PRN	2.3	2.5	2.3	1.2-2.8	1.6-2.1	1.3-1.4
Preorbital length	POB	5.8	5.6	5.6	4.1-6.4	4.6-6.6	–
Prespiracular length	PSP	11.4	11.2	11.1	10.0-12.8	10.8-13.9	–
Preoral length	POR	8.6	7.6	7.5	7.0-10.7	7.2-9.6	7.8-9.0
Prebranchial length	PG1	18.2	17.2	16.7	15.5-19.9	16.9-20.5	–
Head length	HDL	21.9	21.2	20.8	20.1-23.7	20.5-24.4	–
Prepectoral fin length	PP1	23.0	21.0	21.1	20.8-24.1	20.7-24.8	22.6-23.7
Prepelvic fin length	PP2	61.4	59.3	60.6	55.7-61.0	53.8-58.6	57.6-58.3
Snout-vent length	SVL	68.4	63.7	65.0	59.9-65.9	–	–
Pre-first dorsal fin length	PD1	40.5	35.4	41.4	39.5-43.5	33.1-40.4	40.8-42.9
Pre-second dorsal fin length	PD2	68.0	62.1	68.3	64.8-69.7	58.6-63.6	65.2-66.8
Precaudal fin length	PCL	81.6	82.2	81.9	77.1-83.1	75.0-81.3	78.5-80.7
<i>Distance from snout tip to lower caudal origin</i>	–	79.9	78.1	79.1	75.4-80.4	73.8-79.0	–
<i>Interspace between 1st and 2nd dorsal spines</i>	–	26.1	–	25.5	18.1-24.9	–	19.4-22.4
Dorsal-caudal fin space	DCS	9.6	9.0	8.7	6.4-9.1	–	9.7-10.0
Pelvic fin-caudal fin space	PCA	11.5	–	12.4	10.5-14.3	–	10.7-12.9
Pectoral fin – pelvic fin space	PPS	32.1	30.1	–	–	–	–
<i>Distance between origins of pectoral and pelvic fins</i>	DPI+ DPO	38.6	–	34.8	31.7-39.5	–	32.2-34.6
Internarial space	INW	4.1	3.3	3.7	3.3-4.8	3.0-5.5	4.3-4.6
<i>Distance between inner corner of preoral clefts</i>	–	4.0	–	3.9	4.1-6.1	–	–
Mouth width	MOW	7.0	7.1	7.1	7.3-9.9	7.0-8.8	7.7-7.8
First gill slit height	GS1	1.6	1.5	1.7	0.9-2.1	1.3-1.8	1.3-1.7
Fifth gill slit height	GS5	1.8	1.6	1.8	1.1-2.1	1.5-2.1	1.7-2.0
Eye length	EYL	4.9	4.1	3.7	4.2-6.1	4.0-5.9	5.0-5.7
Interorbital space	INO	7.4	7.8	6.8	8.2-11.1	–	–
First dorsal fin anterior margin	D1A	8.8	–	–	–	–	–
First dorsal fin base	D1B	6.2	8.5	4.1	3.3-4.4	5.8-8.4	2.9-3.9
First dorsal fin posterior margin	D1P	3.1	–	3.7	2.8-4.7	4.1-5.3	–
First dorsal fin inner margin	D1I	5.1	4.5	–	–	–	–
<i>First dorsal fin external spine length</i>	D1ESL	0.6	1.5	0.7	0.3-1.1	–	0.2-0.4
First dorsal fin height	D1H	2.4	2.7	2.9	2.0-3.5	2.2-2.9	2.1-2.2
Second dorsal fin anterior margin	D2A	7.3	–	–	–	–	–
Second dorsal fin base	D2B	6.6	10.6	5.9	4.6-7.6	7.5-9.1	5.0-5.3
Second dorsal fin posterior margin	D2P	6.5	–	6.6	5.3-7.9	4.4-5.4	–
Second dorsal fin inner margin	D2I	5.3	4.9	–	–	–	–

TABLE 1. — Continuation.

Measurements	Codes of measurements	This paper, MNHN 2012-0188	holotype NHMUK 1880-5-1:1	Wetherbee & Crow 1996	Yano & Tanaka 1984	Taniuchi & Garrick 1986	Kreff 1980
Second dorsal fin external spine length	D2ESL	0.3	1.5	0.5	0.2-1.1	–	0.3-0.4
Second dorsal fin height	D2H	3.1	3.7	3.7	3.0-3.8	2.8-3.5	3.0-3.6
Pectoral fin anterior margin	P1A	11.5	11.6	10.4	9.5-12.5	10.5-12.2	–
Pectoral fin posterior margin	P1P	5.2	–	5.2	4.3-6.3	–	–
Pelvic fin anterior margin	P2A	6.6	7.0	6.1	4.5-8.2	5.8-8.3	–
Pelvic fin height	P2H	3.5	–	3.1	2.8-4.1	–	–
Pelvic fin posterior margin	P2P	7.6	6.9	–	–	–	–
Dorsal caudal fin margin	CDM	18.4	19.1	17.6	17.3-23.2	19.6-24.2	20.1-20.5
Preventral caudal fin margin	CPV	11.3	12.7	11.2	10.2-13.5	12.2-13.5	12.7-12.8
Depth of caudal fin notch	CST	2.9	–	2.2	2.7-4.3	–	–
Trunk width at pectoral origin	–	10.0	–	10.4	11.0-15.3	11.3-12.5	11.4-12.6
Head height	HDH	12.5	–	7.6	8.8-13.4	8.6-10.2	10.6-11.2

Other combinations: *Scymnodon squamulosus* (Regan, 1908), *Scymnodon obscurus* Bigelow and Schroeder (1957).

MATERIAL EXAMINED. — Southwestern Indian Ocean, 23°17'S, 52°17'E, 25.V.2011, ♀, 672 mm TL, MNHN 2012-0188. — Japan, off Imosiina, holotype of *Centrophorus squamulosus* Günther, 1877, adult ♀, 670 mm TL, NHMUK 1880-5-1:1. — Broken Ridge, southeastern Indian Ocean, 04.III.2008, 30°55'0S, 93°26'0E, 1027-1122 m, ♀, 830 mm TL (coll. STR); 30°55'0S, 94°02'0E, 1138-1152 m, 05.III.2008, unsexed, 600 mm TL (coll. STR); 30°59'0S, 93°47'0E, 1048-1134 m, 12.III.2008, ♀, 730 mm TL, unsexed, 810 mm TL (coll. STR); 30°04'0S, 93°56'0E, 1062-1169 m, 17.III.2008, gravid ♀, 900 mm TL (coll. STR). — Southwest Indian Ocean Ridge, 34°13'0S, 44°14'0E, 1414-1456 m, 04.IV.2008, unsexed, 620 mm TL (coll. STR); 34°30'0S, 44°43'0E, 1278-1556 m, 09.IV.2008, ♂, 530 mm TL (coll. STR); 34°26'0S, 44°33'0E, 1450-1528 m, 21.IV.2008, unsexed, 830 mm TL (coll. STR).

DISTRIBUTION. — Worldwide over continental slopes and undersea ridges in tropical and temperate waters.

DESCRIPTION

Individual caught in pelagic environment (MNHN 2012-0188) is a medium-sized, black-coloured shark with bright green eyes. It was alive at the time it was taken onboard but quickly died afterwards. Body proportions of our specimen are shown in Table 1. Dental formula: 27-27/21-21.

Our specimen well corresponds to the original description given by Günther (1877) and later by Yano & Tanaka (1984). Body measurements are within the ranges presented in other studies, except PP2, SVL (slightly higher than reported earlier) and trunk width (slightly lower) (Table 1). The latter could be explained by post-defrosting deformation.

DISCUSSION

To date, 10 individuals of this species are reported in the literature from the Indian Ocean region (Table 2). First record by Bass *et al.* (1976) who reported four semi-digested individuals taken from the stomach of a sperm whale *Physeter macrocephalus* harpooned 112 km southeast of Durban (Fig. 2). Consequently no exact data on both shark location and habitat depth were recovered. Another five individuals were caught by bottom trawls along deep-water ridges of the southern tropical Indian Ocean during Soviet research cruises in 1976-79 (Scherbachev *et al.* 1982). One more individual was recently recovered at the landing site in Cochin Fishing Harbour (India), but precise capture position is apparently unknown (Akhilesh *et al.* 2011) (Fig. 2; Table 2).

TABLE 2. — Details of capture positions of the Indian Ocean *Zameus squamulosus* (Günther, 1877) presented in Figure 2. Non geo-referenced occurrences are not mapped and not given here. Abbreviations: **TRAWB**, bottom trawl; **LLP**, pelagic longline; **LLB**, bottom /demersal longline; **SPW**, sperm whale *Physeter macrocephalus*; **TL**, total length; *, capture position was estimated from description available in the source; **, size range of five individuals stored under the same catalogue number.

Capture date	Latitude (dd°mm.m)	Longitude (ddd°mm.m)	Sampling gear	Species as given in the source	Collector / Museum	Capture depth	Catalogue number	TL	Sex, maturity	Vessel	Source
05.VIII.1971	30°38'0S	31°47'0E	SPW	<i>Scymnodon obscurus</i> *	—	—	NA	550	♀	—	Bass et al. 1976
05.VIII.1971	30°38'0S	31°47'0E	SPW	<i>S. obscurus</i> *	—	—	NA	560	♀	—	Bass et al. 1976
05.VIII.1971	30°38'0S	31°47'0E	SPW	<i>S. obscurus</i> *	—	—	NA	620	—	—	Bass et al. 1976
05.VIII.1971	30°38'0S	31°47'0E	SPW	<i>S. obscurus</i> *	—	—	NA	720	—	—	Bass et al. 1976
25.VII.1976	33°45'7S	45°14'8E	TRAWB	<i>S. squamulosus</i>	— / ZM MGU	1100-1115	Unknown	415	♂	Zvezda Kryma	Scherbachev et al. 1982
28.VII.1976	33°36'2S	45°26'7E	TRAWB	<i>S. squamulosus</i>	— / ZM MGU	1200-1230	Unknown	480	♂	Zvezda Kryma	Scherbachev et al. 1982
28.VII.1976	34°05'5S	44°54'0E	TRAWB	<i>S. squamulosus</i>	— / ZM MGU	1200-1205	Unknown	670	♀	Zvezda Kryma	Scherbachev et al. 1982
02.VIII.1976	33°06'8S	44°37'0E	TRAWB	<i>S. squamulosus</i>	— / ZM MGU	1110	Unknown	482	♂	Zvezda Kryma	Scherbachev et al. 1982
1979	31°45'0S	95°13'0E	TRAWB	<i>S. squamulosus</i>	— / ZM MGU	940-1125	Unknown	695	♀	Professor Mesyatsev	Scherbachev et al. 1982
?2007-2008	10°00'0N	75°30'0E	—	<i>Zameus squamulosus</i> *	K. V. Akhlesh / —	—	—	—	—	—	Akhlesh et al. 2011
This paper											
26.V.2011	23°24'2S	52°15'8E	LLP	<i>S. squamulosus</i>	EVN / MNHN	300	MNHN 2012-0188	672	♀	Fournaise	PROSPER
04.III.2008	30°55'0S	93°26'0E	LLB	<i>S. obscurus</i>	STR / —	1027-1122	Not collected	890	♀	Antillas Reefer	YugNIRO
05.III.2008	30°55'0S	94°02'0E	LLB	<i>S. obscurus</i>	STR / —	1138-1152	Not collected	600	—	Antillas Reefer	YugNIRO
12.III.2008	30°59'0S	93°47'0E	LLB	<i>S. obscurus</i>	STR / —	1048-1134	Not collected	730	♀	Antillas Reefer	YugNIRO
12.III.2008	30°59'0S	93°47'0E	LLB	<i>S. obscurus</i>	STR / —	1048-1134	Not collected	810	—	Antillas Reefer	YugNIRO
17.III.2008	30°04'0S	93°56'0E	LLB	<i>S. obscurus</i>	STR / —	1062-1169	Not collected	900	♀ mature	Antillas Reefer	YugNIRO
04.IV.2008	34°13'0S	44°14'0E	LLB	<i>S. obscurus</i>	STR / —	1414-1456	Not collected	620	—	Antillas Reefer	YugNIRO
09.IV.2008	34°30'0S	44°43'0E	LLB	<i>S. obscurus</i>	STR / —	1278-1556	Not collected	550	♂	Antillas Reefer	YugNIRO
21.IV.2008	34°26'0S	44°33'0E	LLB	<i>S. obscurus</i>	STR / —	1450-1528	Not collected	—	—	Antillas Reefer	YugNIRO
22.II.2005	21°09'1S	55°15'1E	LLB	<i>S. obscurus</i>	Lausin Beboit / MNHN	400	MNHN 2007-1658	710	♀	Ludo	MNHN
Museum collections											
12.XII.1973	?34°00'0S	?114°00'0E	SPW	<i>S. obscurus</i>	— / WAM	—	WAM P. 24497-001	—	—	—	Sue Morrison pers. comm. 2011
07.IV.1982	18°43'3S	116°33'1E	TRAWB	<i>Z. squamulosus</i>	— / OSIRO	610-612	CA 3352	278	♀	—	Alastair Graham pers. comm. 2011
07.IV.1982	18°43'3S	116°33'1E	TRAWB	<i>Z. squamulosus</i>	— / OSIRO	610-612	CA 3353	245	♀	—	Alastair Graham pers. comm. 2011
II.1988	29°05'0S	113°41'0E	TRAWB	<i>Z. squamulosus</i>	— / OSIRO	880	H 1201-3	—	♂ juv.	—	Alastair Graham pers. comm. 2011
06.VI.1989	43°47'0S	148°42'0E	LLP	<i>Z. squamulosus</i>	— / OSIRO	—	H 2133-1	770	♀	—	Alastair Graham pers. comm. 2011
08.VI.1989	43°55'0S	148°32'0E	LLP	<i>Z. squamulosus</i>	— / OSIRO	—	H 2142-1	489	♀	—	Alastair Graham pers. comm. 2011
23.I.1991	20°07'8S	112°56'3E	TRAWB	<i>Z. squamulosus</i>	— / OSIRO	854-868	H 2543-08	—	—	—	Alastair Graham pers. comm. 2011

TABLE 2. — Continuation.

Capture date	Latitude (dd°mm.m)	Longitude (ddd°mm.m)	Sampling gear	Species as given in the source	Collector / Museum	Capture depth	Catalogue number	TL	Sex, maturity	Vessel	Source
27.I.1991	23°57'6S	111°54'3E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1061-1071	H 2560-03	-	-	-	Alastair Graham pers. comm., 2011
27.I.1991	23°57'6S	111°54'3E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1061-1071	H 2560-04	-	-	-	Alastair Graham pers. comm., 2011
29.I.1991	25°49'5S	111°26'5E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1254-1277	H 2570-18	544	♂ mature	-	Alastair Graham pers. comm., 2011
29.I.1991	25°49'5S	111°26'5E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1254-1277	H 2570-19	504	♂ mature	-	Alastair Graham pers. comm., 2011
29.I.1991	25°49'5S	111°26'5E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1254-1277	H 2570-20	732	♀	-	Alastair Graham pers. comm., 2011
29.VIII.1991	38°17'0S	105°41'0E	LLP	<i>Z. squamulosus</i>	- / CSIRO	-	H 2768-01	710	♀	-	Alastair Graham pers. comm., 2011
24.IV.1992	37°35'0S	169°29'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	1000-1043	H 2935-01	480	♂	-	Alastair Graham pers. comm., 2011
29.II.1992	17°52'0S	118°16'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	545	H 3141-17	320	♀	-	Alastair Graham pers. comm., 2011
29.II.1992	17°52'0S	118°16'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	545	H 3141-18	325	♀	-	Alastair Graham pers. comm., 2011
29.II.1992	17°52'0S	118°16'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	545	H 3141-19	260	♀	-	Alastair Graham pers. comm., 2011
10.III.1992	18°49'0S	116°09'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	550	H 3143-03	335	♀	-	Alastair Graham pers. comm., 2011
10.III.1992	18°49'0S	116°09'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	550	H 3143-04	335	-	-	Alastair Graham pers. comm., 2011
10.III.1992	18°49'0S	116°09'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	550	H 3143-05	305	♂	-	Alastair Graham pers. comm., 2011
30.XI.1992	44°13'0S	145°56'0E	LLP	<i>Z. squamulosus</i>	- / CSIRO	-	H 3267-01	680	♀	-	Alastair Graham pers. comm., 2011
28.XI.1992	44°16'0S	146°16'0E	LLP	<i>Z. squamulosus</i>	- / CSIRO	-	H 3271-01	190-210	♂	-	Alastair Graham pers. comm., 2011
08.VII.1994	44°52'0S	146°38'0E	LLP	<i>Z. squamulosus</i>	- / CSIRO	-	H 4105-01	770	♀	-	Alastair Graham pers. comm., 2011
11.III.2001	38°35'0S	47°35'0E	TRAWB	<i>Z. squamulosus</i>	- / CSIRO	885-1122	H 5850-01	630	♂ juv.	-	Alastair Graham pers. comm., 2011
09.II.2002	32°03'0S	032°03'0E	TRAWB	<i>Z. squamulosus</i>	- / Iziko SAM	773	SAMC-MBF-015643	-	-	-	Michael Bougaardt pers. comm., 2011
09.II.2002	32°03'0S	032°03'0E	TRAWB	<i>Z. squamulosus</i>	- / Iziko SAM	773	NA	-	-	-	Michael Bougaardt pers. comm., 2011
09.II.2002	32°03'0S	032°03'0E	TRAWB	<i>Z. squamulosus</i>	- / Iziko SAM	773	NA	-	-	-	Michael Bougaardt pers. comm., 2011
Electronic references											
27.I.1991	24°00'4S	111°54'4E	-	<i>Z. squamulosus</i>	J. Paxton / AM	1060-1064	I31157-004	-	-	Southern Surveyor	OBIS/GBIF
28.I.1991	24°32'2S	111°50'4E	-	<i>Z. squamulosus</i>	J. Paxton / AM	895-901	I31161-003	-	-	Southern Surveyor	OBIS/GBIF
29.I.1991	25°42'4S	111°30'3E	-	<i>Z. squamulosus</i>	J. Paxton / AM	1115-1125	I31167-001	-	-	Southern Surveyor	OBIS/GBIF
06.II.1991	29°21'8S	113°46'6E	-	<i>Z. squamulosus</i>	- / MV	942-970	A 14192	-	-	-	OBIS
06.II.1991	29°21'8S	113°46'6E	-	<i>Z. squamulosus</i>	- / MV	942-970	A 9481	-	-	-	OBIS

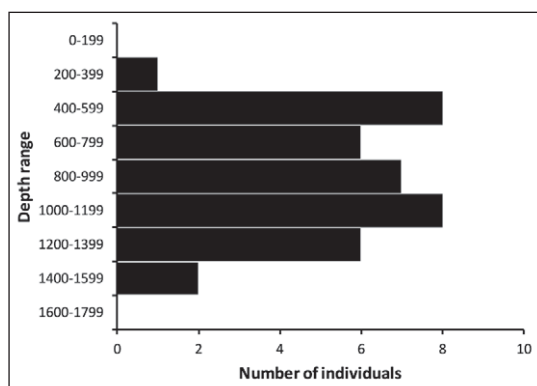


FIG. 4. — Depth distribution of *Zameus squamulosus* (Günther, 1877) with known capture depth recorded in the Indian Ocean ($n = 42$). For non-precise depth of capture, shallower depth in the range of values was used.

Last & Stevens (2009) mentioned captures of *Z. squamulosus* along the shelf of Western Australia by trawls and off Southern Australia by Japanese longliners in pelagic waters. Numbers of individuals caught and positions of capture were not presented in the source.

Similarly White *et al.* (2006) reported occurrences of this species in Indonesia (off western Java).

Direct correspondence with museums allowed us to obtain data on 35 records from the Indian Ocean (CSIRO, 31 ind.; Iziko SAM, 3 ind.; WAM, 1 ind.). Among these records twelve originated from pelagic gears, 22 were caught in the demersal environment, and one (WAM) was found in the stomach of a sperm whale (Fig. 2; Table 2).

Online resources were assumed to be a handy tool for fast and easy access to taxonomic and biogeographic information (Costello & Berghe 2006). Indeed internet portals appeared to be very useful to find occurrences, which otherwise would remain unknown/inaccessible for us. However we found that online portals handling taxonomic and fish biodiversity information (Discover Life, FishBase, GBIF, ITIS, OBIS, WoRMS) often maintain outdated taxonomic data. The species in question was commonly found either under synonymised names as *S. squamulosus* and *S. obscurus* or both were considered as separate valid species (Vanden Berghe 2007; Appeltans *et al.* 2011; Froese & Pauly

2011; GBIF 2011; Discover Life 2012; ITIS 2013). To some extent such a situation can be explained by the fact that the taxonomic status of this species has only been recently established (McEachran & Fehhelm 1998; Compagno 2003; Last & Stevens 2009).

Despite taxonomic uncertainties, we traced the number of unpublished records. Most of them originated from museum collections already available to us by direct correspondence (CSIRO, Iziko SAM). Additional records are demersal catches from Western Australia (OBIS: AM, 3 ind.; and MV 2 ind.) and southern Indonesia (off Tanimbar Islands) (OBIS, IRD KARUBAR cruise, 2 ind.) (Vanden Berghe 2007) (Fig. 2; Table 2).

The FishBase map (Froese & Pauly 2011) shows more Indian Ocean records for this species (both identified as *S. obscurus* and *Z. squamulosus*), however, links to published references or museum collections are not always evident for several mapped points, therefore their validity cannot be confirmed. Furthermore, some records of *S. obscurus* traced through FishBase and GBIF to specimens from collections of ZMH (e.g., ZMH 112266) should be attributed to other species and/or sampled in other oceans (Ralf Thiel [Curator Ichthyology, Biocenter Grindel und Zoological Museum University of Hamburg] pers. comm., 2011). In addition, capture positions provided by GBIF and OBIS for the same individuals (inventory numbers) from the collections of the Australian Museum and the Museum Victoria were different. Therefore, the reliability of online data sources for reporting of rare species distribution is still questionable as suggested by Eschmeyer & Fricke (2012).

Our records and earlier collected data show that *Z. squamulosus* is distributed within the subtropical area of the southern Indian Ocean from the African to the Australian coasts (Fig. 2). Only few records are from the tropics and only one individual is from the northern hemisphere (Fig. 2). Capture positions are usually associated with continental slopes and mid-ocean undersea ridges.

The majority of Indian Ocean records except our pelagic individual and twelve individuals from CSIRO were caught in demersal environment. Most of the fishes were taken between 400 and

1400 m depth; peak of occurrences is within the 1000-1200 m range (Fig. 4). Such a pattern suggests a benthopelagic life style of *Z. squamulosus* with regular excursions from the benthic to pelagic waters within the upper bathyal habitat.

Meanwhile, our pelagic capture reported here is not an exception. In the Atlantic and Pacific Ocean *Z. squamulosus* is considered as a pelagic species in some areas (Yano & Tanaka 1984; Compagno 1984). Numbers of pelagic records of this species have increased exponentially worldwide from single individuals some decades ago (Krefft 1980; Wetherbee & Crow 1996) to several dozens of individuals reported annually in recent years (Matsuhita & Matsunaga 2002; Dai *et al.* 2009; Zhu *et al.* 2012). Last & Stevens (2009) stated that pelagic records are more common than benthic ones off southern Australia. Such an increased number of recent occurrences cannot be explained only by expanded scientific observers' coverage of fishing operations and improved identification of specimens caught. The archive of high-quality long-term research data collected with pelagic longlines over all the Indian Ocean (Romanov *et al.* 2006) contains no records of this species in the pelagic environment from 1961 to 1989. We may be evidencing a long-term increase in abundance of this species similarly with other mid-sized oceanic predators like crocodile shark (Romanov *et al.* 2008), bramids and gempylids (Polovina *et al.* 2009) in response to the depleted state of large-sized predators or competitors (mesopredator-release effect) (Baum & Worm 2009; Ferretti *et al.* 2010).

At the same time, both pelagic and benthic records of *Z. squamulosus* are still rare over the vast area of the central and western Indian Ocean. Pelagic longline fisheries covering most of the surface of the tropical and temperate Indian Ocean developed an average fishing effort of almost 700 million hooks annually from 2000 to 2010 (Fonteneau 2010; Fonteneau pers. comm., 2012). Only thirteen pelagic individuals of this species recorded during the history of regional fisheries observations under such significant fishing effort suggests that epipelagic excursions should be considered rather as an exception than common habit.

The range of the TL of the Indian Ocean individuals reported in this note is within 415 and 900 mm. Four of eight individuals analysed in the field by STR exceeded the maximum reported length (TL) of 786 mm (Wetherbee & Crow 1996), and one exceeds the maximum length (TL) suggested by Last & Stevens (1994, 2009) (Tables 1; 2). Both sexes were present in catches; some individuals were mature. One gravid female (TL = 900 mm) caught on 17 March 2008 (Table 2) had two embryos at an advanced stage of development. Overall Indian Ocean records show dominance of females: 1.9:1.0, which however non-significantly deviate from 1:1 sex ratio ($\chi^2 = 3.125$, $p = 0.0771$).

The rarity of this species is an apparent consequence of a relatively low fishing effort within its principal depth distribution range and the scarcity of scientific observations in deep-water fisheries. However low fishing pressure is rather beneficial for the conservation of this species taking into account both the high longevity and slow reproduction rate characteristic of most deep-water chondrichthyans (Musick & Bonfil 2005).

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