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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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.

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-oceanic ridges, between 400 and 1450 m depth, but it makes rare incursions in open water to the limits of the epipelagic zone.

RÉSUMÉ

Première observation pélagique d’un squale-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 squale-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 dépasse 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.
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**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°17'S, 52°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
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.

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**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 2M 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).
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*Zameus squamulosus* (Günther, 1877) (Figs 1; 3)

**Synonyms:** *Centroscymnus 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.

**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:** Somniidae Jordan, 1888
- **Genus:** *Zameus* Jordan & Fowler, 1903

**Zameus squamulosus** (Günther, 1877)

(Figs 1; 3)
Measurements

| Measurements | Codes of measurements | This paper, MNHN 2012-0188 | holotype NHMUK 1880-5-1:1 | Wetherbee & Crow 1996 | Yano & Tanaka 1994 | Tanuchi & Garrick 1986 | Krefft 1980 |
|--------------|-----------------------|----------------------------|---------------------------|----------------------|---------------------|----------------------|-------------|
| N            | -                     | 1                          | 1                         | 1                     | 8       | 4        | 3           |
| Sex          | -                     | ♀ ♀ ♀                     |                           |                       | σ σ σ, 4 ♀♀        | 2 σ σ, 2 ♀♀       | 2 σ σ, 1 ♀  |
| Maturity     | -                     | not available             | mature                    | mature                | not available     | not available     | σ σ, ♀, ♀   |
| 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   |
| Distance from snout tip to lower caudal origin | –                  | 79.9                      | 78.1                      | 79.1                  | 75.4-80.4         | 73.8-79.0         | –           |
| Interspace between 1st and 2nd dorsal spines | –                  | 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                      | –                     | –                    | –                    | –           |
| Distance between origins of pectoral and pelvic fins | –                  | 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     |
| Distance between inner corner of preoral clefts | –                  | 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 heigh | GS1               | 1.6                       | 1.5                       | 1.7                   | 0.9-2.1           | 1.3-1.8            | 1.3-1.7     |
| Fifth gill slit heigh | 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                       | –                     | –                    | –                    | –           |
| First dorsal fin external spine length | 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                       | –                     | –                    | –                    | –           |
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**Table 1.** — Continuation.

| Measurements | Codes of measurements | This paper, MNHN 2012-0188 | holotype NMHUK 1880-5:1 | Wetherbee & Crow 1996 | Yano & Tanaka 1984 | Tanochi & Garrick 1986 | Krefft 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 |

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**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. — 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, ♀, 730 mm TL (coll. STR); 30°59’0S, 93°47’0E, 1048-1134 m, ♀, 730 mm TL (coll. STR); 30°04’0S, 93°56’0E, 1062-1169 m, ♀, 810 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 (dd°mm.m) | Sampling gear | Species as given in the source | Collector / Museum | Capture depth | Catalogue number | Sex, maturity | Vessel | Source |
|--------------|--------------------|--------------------|---------------|--------------------------------|-------------------|--------------|-----------------|--------------|--------|--------|
| 05.VII.1971  | 30°38'0S           | 31°47'0E           | SPW           | Scymnodon obscurus*            | –                 | –            | NA              | ✈            | –      | Bass et al. 1976 |
| 05.VII.1971  | 30°38'0S           | 31°47'0E           | SPW           | S. obscurus*                   | –                 | –            | NA              | ✈            | –      | Bass et al. 1976 |
| 05.VII.1971  | 30°38'0S           | 31°47'0E           | SPW           | S. obscurus*                   | –                 | –            | NA              | ♂            | –      | Bass et al. 1976 |
| 25.VI.1971   | 31°45'0S           | 95°13'0E           | TRAWB         | Zameus squamulosus*            | –                 | –            | –               | ✈            | –      | Scherbachev et al. 1982 |
| ?2007-2008   | 10°00'0N           | 75°30'0E           | –             | Zameus squamulosus*            | K. V. Akhilesh / -| –            | –               | –            | –      | Akhilesh et al. 2011 |

This paper

| Capture date | Latitude (dd°mm.m) | Longitude (dd°mm.m) | Sampling gear | Species as given in the source | Collector / Museum | Capture depth | Catalogue number | Sex, maturity | Vessel | Source |
|--------------|--------------------|--------------------|---------------|--------------------------------|-------------------|--------------|-----------------|--------------|--------|--------|
| 26.V.2011    | 23°24'2S           | 52°15'8E           | LLP           | S. squamulosus                 | EVR / MNHN        | 300          | MNHN 2012-0188  | ✈            | –      | –      |
| 04.III.2008  | 30°55'0S           | 93°26'0E           | LLB           | S. obscurus                    | STR / –           | 1027-1122    | Not collected   | ✈            | –      | Antillas Reefer |
| 05.III.2008  | 30°55'0S           | 94°02'0E           | LLB           | S. obscurus                    | STR / –           | 1138-1152    | Not collected   | –            | –      | Antillas Reefer |
| 12.III.2008  | 30°59'0S           | 93°47'0E           | LLB           | S. obscurus                    | STR / –           | 1048-1134    | Not collected   | ✈            | –      | Antillas Reefer |
| 17.II.2008   | 30°04'0S           | 93°56'0E           | LLB           | S. obscurus                    | STR / –           | 1062-1169    | Not collected   | ✈            | –      | Antillas Reefer |
| 04.IV.2008   | 34°13'0S           | 44°14'0E           | LLB           | S. obscurus                    | STR / –           | 1414-1456    | Not collected   | ✈            | –      | Antillas Reefer |
| 09.IV.2008   | 34°30'0S           | 44°34'0E           | LLB           | S. obscurus                    | STR / –           | 1278-1556    | Not collected   | ✈            | –      | Antillas Reefer |
| 21.IV.2008   | 34°26'0S           | 44°33'0E           | LLB           | S. obscurus                    | STR / –           | 1450-1528    | Not collected   | ✈            | –      | Antillas Reefer |
| 22.II.2005   | 21°09'1S           | 55°15'1E           | LLB           | S. obscurus                    | Lausin Bebot / MNHN | 400          | MNHN 2007-1658  | ✈            | –      | Ludo |

Museum collections

| Capture date | Latitude (dd°mm.m) | Longitude (dd°mm.m) | Sampling gear | Species as given in the source | Collector / Museum | Capture depth | Catalogue number | Sex, maturity | Vessel | Source |
|--------------|--------------------|--------------------|---------------|--------------------------------|-------------------|--------------|-----------------|--------------|--------|--------|
| 12.XI.1973   | 73°40'00"S         | 114°00'00"E        | SPW           | S. obscurus                    | –                 | –            | –              | –            | –      | Sue Morrison pers. comm. 2011 |
| 07.IV.1982   | 18°43'3S           | 116°33'1E          | TRAWB         | Z. squamulosus                | –                 | –            | 610-612        | CA 3352      | ✈      | Alastair Graham pers. comm. 2011 |
| 07.IV.1982   | 18°43'3S           | 116°33'1E          | TRAWB         | Z. squamulosus                | –                 | –            | 610-612        | CA 3353      | ✈      | Alastair Graham pers. comm. 2011 |
| 06.VI.1989   | 43°47'0S           | 148°42'0E          | LLP           | Z. squamulosus                | –                 | –            | H 2133-1       | –            | –      | Alastair Graham pers. comm. 2011 |
| 08.V.1989    | 43°55'0S           | 148°32'0E          | LLP           | Z. squamulosus                | –                 | –            | H 2142-1       | –            | –      | Alastair Graham pers. comm. 2011 |
| 23.I.1991    | 20°07'8S           | 112°56'3E          | TRAWB         | Z. squamulosus                | –                 | –            | 854-868        | H 2543-08    | –      | Alastair Graham pers. comm. 2011 |
| Capture date | Latitude (dd°mm.m) | Longitude (dd°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′6″S         | 111°54′3″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | –            | 1061-1071       | H 2560-03 | –            | –      | Alastair Graham pers. comm. 2011 |
| 27.I.1991    | 23°57′6″S         | 111°54′3″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 1061-1071    | H 2560-04       | –            | –            | –      | Alastair Graham pers. comm. 2011 |
| 29.I.1991    | 25°49′5″S         | 111°26′5″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 1254-1277    | H 2570-18       | 544 | σ mature     | –      | Alastair Graham pers. comm. 2011 |
| 29.I.1991    | 25°49′5″S         | 111°26′5″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 1254-1277    | H 2570-19       | 504 | σ mature     | –      | Alastair Graham pers. comm. 2011 |
| 29.I.1991    | 25°49′5″S         | 111°26′5″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 1254-1277    | H 2570-20       | 732 | –            | –      | Alastair Graham pers. comm. 2011 |
| 29.VII.1991  | 39°17′0″S         | 105°41′0″E         | LLP           | Z. squamulosus                | – / CSIRO         | –            | H 2768-01       | 710 | –            | –      | Alastair Graham pers. comm. 2011 |
| 24.IV.1992   | 37°35′0″S         | 146°29′0″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | –            | 1000-1043       | H 2935-01 | 480 | σ            | –      | Alastair Graham pers. comm. 2011 |
| 29.II.1992   | 17°52′0″S         | 118°16′0″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 545          | H 3141-17       | 320 | –            | –      | Alastair Graham pers. comm. 2011 |
| 10.III.1992  | 18°49′0″S         | 116°09′0″E         | TRAWB         | Z. squamulosus                | – / CSIRO         | 550          | H 3143-03       | 335 | –            | –      | Alastair Graham pers. comm. 2011 |
| 30.XI.1994   | 44°52′0″S         | 146°38′0″E         | LLP           | Z. squamulosus                | – / CSIRO         | –            | H 4105-01       | 770 | –            | –      | Alastair Graham pers. comm. 2011 |
| 08.V.1992    | 38°35′0″S         | 47°35′0″E          | TRAWB         | Z. squamulosus                | – / CSIRO         | 885-1122     | H 5850-01       | 630 | σ juv.        | –      | Alastair Graham pers. comm. 2011 |
| 09.II.2002   | 32°03′0″S         | 303°03′0″E         | TRAWB         | Z. squamulosus                | – / Iziko SAM      | 773          | SAMC-MBF-015643 | –            | –            | Michael Bougaardt pers. comm. 2011 |
| 09.II.2002   | 32°03′0″S         | 303°03′0″E         | TRAWB         | Z. squamulosus                | – / Iziko SAM      | 773          | NA              | –            | –            | Michael Bougaardt pers. comm. 2011 |

**Table 2.** — Continuation.
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 & Fechhelm 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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