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New record of *Abralia (Heterabralia) siedleckyi* Lipinski, 1983 (Cephalopoda: Enoploteuthidae) from south-eastern Arabian Sea with some remarks about its biology

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Original Article

Abstract

Specimens of oceanic squid, *Abralia (Heterabralia) siedleckyi* Lipinski, 1983 were collected from the south-eastern Arabian Sea using midwater trawl (horizontally at 200 m depth) during night operations in two cruises on 18 April 2015 and 26 February 2017. Description and morphological measurements of the specimens are provided. The record of this mesopelagic squid from the Arabian Sea is an addition to the cephalopod fauna of the Indian Ocean and India. The statolith based age analysis indicates that a 29.1 mm dorsal mantle length specimen had 93 day's age with a growth rate of 0.31 mm DML/day.

Keywords*: Arabian Sea, Enoploteuthidae, statolith, mesopelagic, India, photophore*

Introduction

Squids of the family Enoploteuthidae are recognised as "myctophid fishes" of the squid world (Young and Harman, 1985) and they play significant role in the trophic web of the epipelagic and mesopelagic zones of the open ocean (Santo *et al.,* 2001; Guerra *et al.,* 2010). Squids of the genus *Abralia* Gray 1849, family Enoploteuthidae, are key members in the micronektonic groups in the tropical and subtropical world oceans (Reid *et al.,* 1991).

Twenty nominal species of *Abralia* are known worldwide (Young and Tsuchiya, 2018). Eight enoploteuthid squids of the genus *Abralia* Gray, 1846 have been recorded from the Indian Ocean. They are, *Abralia armata* (Quoy and Gaimard, I932), *A. and amanica* Goodrich, 1896, *A. steindachneri* Weindl, 1912, *A. renschi* Grimpe, 1931, *A. spaercki* Grimpe, I931, *A. lucens* Voss, 1963, *A. marisarabica* Okutani, 1983, *A. trigonura* Berry, 1913 and *A. fasciolata* Tsuchiya, 1991 (Silas, I968; Okutani, 1983; Silas *et al.,* 1985; Nesis, 1986; Okutani and Tsukada, 1988; Tsuchiya, 1991). Tsuchiya and Okutani, (1988) suggested that *A. lucens* is a junior synonym of *A. multihamata*.

Abralia siedleckyi is assessed as "Data deficient", in the IUCN Red List of threatened species, therefore further research is

recommended in order to determine the precise distribution, population dynamics, life history and ecology, and potential threats, if any, affecting this species (Barratt and Allcock, 2014).

Recent studies highlight the need of dedicated research to improve knowledge of oceanic cephalopods of Arabian Sea and Indian EEZ (Sajikumar *et al.,* 2018). *Abralia siedleckyi* is a poorly known species and Hidaka and Kubodera (2000) recommend further investigation to understand the range and distribution for the species. Herein, we report the first record of small enoploteuthid squid *A. siedleckyi* from south-eastern Arabian Sea.

Material and methods

Three individuals of *A. siedleckyi* Lipinski, 1983 were collected from the south-eastern Arabian Sea by "*FRV Silver Pompano"* on 18 April 2015 and 26 February 2017. During the four cruises a total of sixteen stations were covered. Specimens were collected using a mid-water trawl with a 10m^2 mouth opening and an 18 mm mesh codend towed horizontally for 1h at a depth of 200 m at night (23.00 to 24.00 h).

The animals were stored initially in 90% ethanol, after one month transferred to 5% formalin. Morphometric measurements such as dorsal mantle length (DML), mantle width (MW), arm length (AL1, AL2, AL3, and AL4), fin length (FL), fin width (FW), tentacle length (TL) and club length (CL) of specimens were measured to the nearest mm as recommended by Roper and Voss (1983). Indices of length were expressed as percentage of dorsal mantle length. One individual was damaged so it could not be measured. Photographic images were taken with a Nikon stereozoom microscope (SMZ-25). Vertical water column profiles were determined at stations by using an underway CTD system (Ocean Science, USA) with sensors for pressure, temperature and conductivity. Data were converted to Pressure=depth and conductivity=salinity by using Sea-Bird software.

Single mature female preserved in ethanol was aged using statolith microstructure according to Arkhipkin and Shcherbich (2012).

Oviducal egg counts were made on preserved specimens. The oviducts were removed from the squid and then eggs were counted. Oocyte diameters (n=30) were measured using a microscope. The gonadosomatic index (GSI) was calculated as

$$GSI = (GW/BW) \times 100$$

Where *GW* is gonad weight and *BW* is body weight.

Results

Three individuals (one mature female and two mature male) of *A. siedleckyi* were collected from 200 m depth during night by using mid water trawl net in the south-eastern

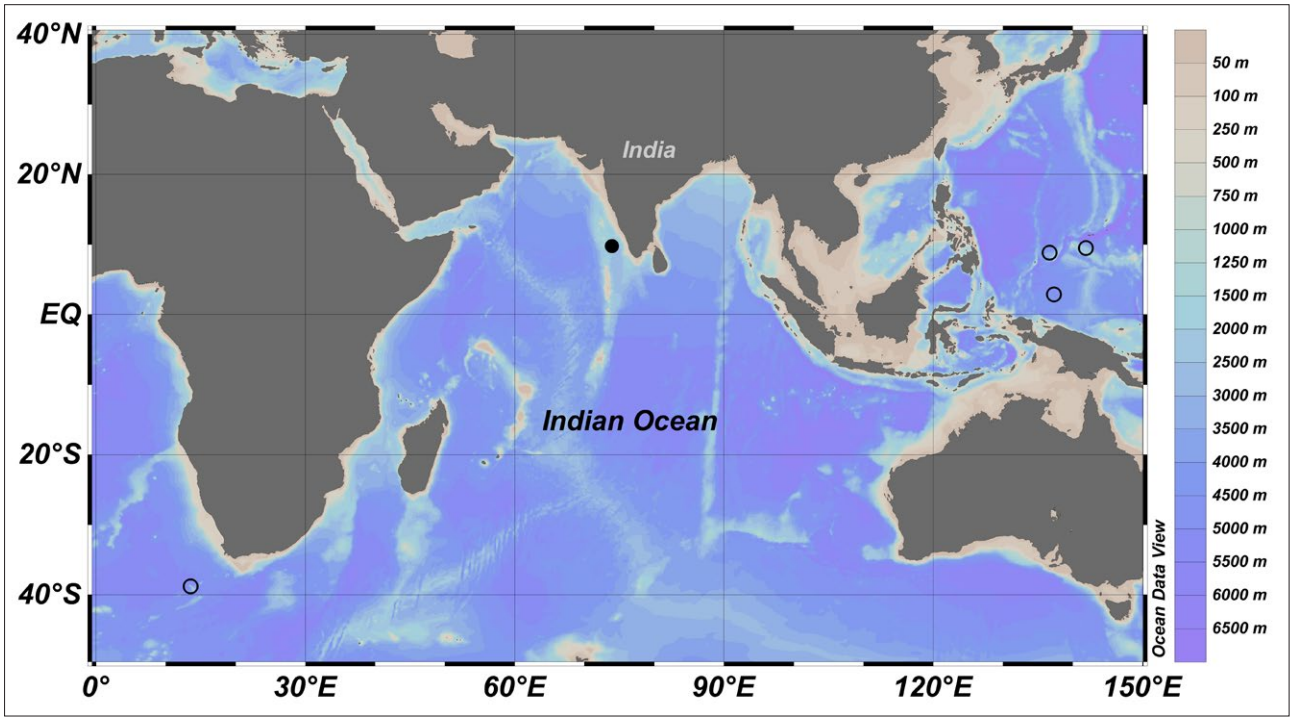

Fig. 1. Map showing the location of earlier distribution records of *A. siedleckyi* (open circle) and the new distribution records (closed circle).

Arabian Sea on 18 April 2015 (09° 54′ 57′′ N; 73° 39′ 18′′ E) and (10° 18′ 50′′ N; 73° 50′ 22′′ E) on 26 February 2017 (Fig. 1). Bottam depths at these stations were 2229 and 1870 m respectively. The surface water temperature was 30.4 and 30.8° C and salinity were 34.06 and 34.2 psu respectively. Temperature and salinity at 200 m depth in both stations were 15.2 and 14.8°C and 35.2 and 34.9 psu respectively. Single mature female individual was deposited in the Designated National Repository (DNR), CMFRI, India with accession number (DH. 1.1.1.1).

Description

The present specimens agree with the description of Lipinski (1983). The animal had DML 18.3, 20.5 and 29.1 mm and weighed 1.6, 1.8 and 2.1 g respectively. The mantle is conical and wide at the anterior margin. Ventral mantle is covered with small photophores arranged longitudinally (Fig. 2). Fins are large and extending to posterior tip of tail (FLI=47 to 59; FWI= 90 to 92). The distal tip of ventral mantle is semi-gelatinous, lacking chromatophores. The funnel is large. The mantle funnel locking apparatus consists of a straight groove on the mantle. The arm formula was 4>2>3>1 and arm 1 to 3 are keeled. Arms bear two rows of hooks with bi-serial rows of suckers on distal portion. The detailed morphometric measurements and indices are provided in Table 1.

Photophore pattern of the ventral region of the eyeball is the most distinct character. There are five photophores; posterior extra-large, oval, creamy white; small round orange; small-medium round orange; small round orange; anterior larger than medial, slightly oval, creamy white (Fig. 3 (A)). The dorsal part of eyelid bears 16 black photophores.

Table 1. Morphometric measurements and indices in relation to mantle length of *A. siedleckyi* from southeastern Arabian Sea

	Female		Male	
Measurements	(mm)	Indices	(mm)	Indices
Dorsal mantle length	29.1		18.3	
Ventral mantle length	27.4	94.1	16.2	88.5
Head length	10.1	36.8	8.3	45.3
Head width	10.3	35.4	7.25	39.6
Fin length	17.4	59.7	8.7	47.5
Fin width	26.4	90.7	17	92.9
Mantle width	10.6	36.4	7.2	39.3
First arm length	10.3	35.4	5.8	31.6
Second arm length	13	44.6	6.8	37.1
Third arm length	12.8	43.9	6.6	36.1
Fourth arm length	13.1	45.1	7.5	40.9
Tentacle length	30.3	104.1	20.2	110.4
Tentacular club length	4.8	16.5	3.5	19.1

The tentacle is long, slender, length greater than mantle length (TLI=104 to 110). Tentacular clubs small with two to three hooks (TCI=16 to 19) (Fig. 3 (B)). The photophores were present on the ventral part of the arms IV, head, eyeballs, funnel and mantle.

The highest morphometric index was found for tentacle length (TLI=104.12), while the lowest was observed for the tentacular club (TLI=4.8). The fin width index was 90.72 and lengths were 50.79. Males had left arm hectacotylised, there were 10 normal hooks proximally. After hooks,

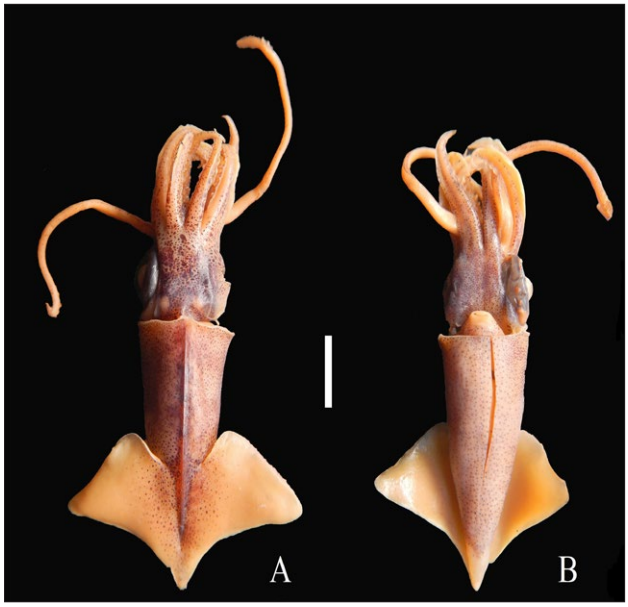

Fig. 2. *A. siedleckyi*: A) Dorsal view; B) Ventral view of 29 mm DML specimen (Scale bar =1 cm)

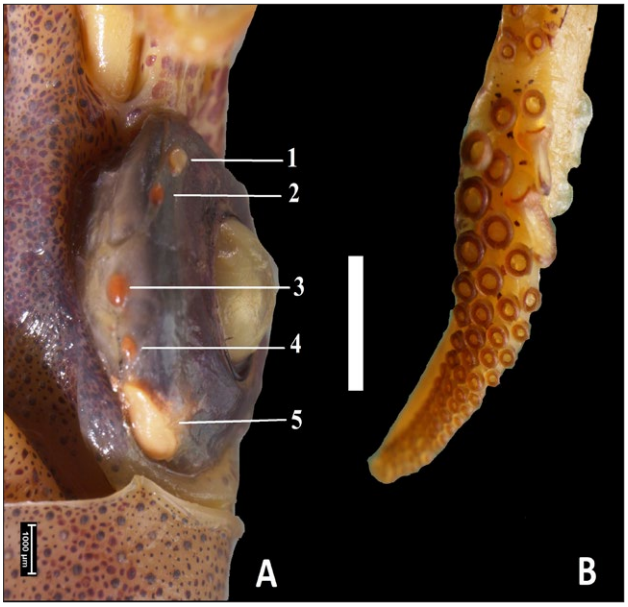

Fig. 3. *A. siedleckyi* A=left eye ball with five ocular photophores, B=oral view tentacular club (scale bar=1 mm)

a semicircular ventral flap lies in distal half of the arm. The dorsal flap lies distally to the ventral one. The mature male squid with 18.3 mm DML have 46 spermatophores (2.97 mm to 3.17 mm length).

Statolith microstructure

The statolith of *A. siedleckyi* has a broadly rounded lateral dome, a fairly straight rostrum and a distinct dorsal dome and large wing. The statolith had a total length of 790 μm. The statolith index was 2.71% in relation to DML. The mature female had 93 increments and the daily growth rate was estimated as 0.31 mm DML/day (Fig. 4).

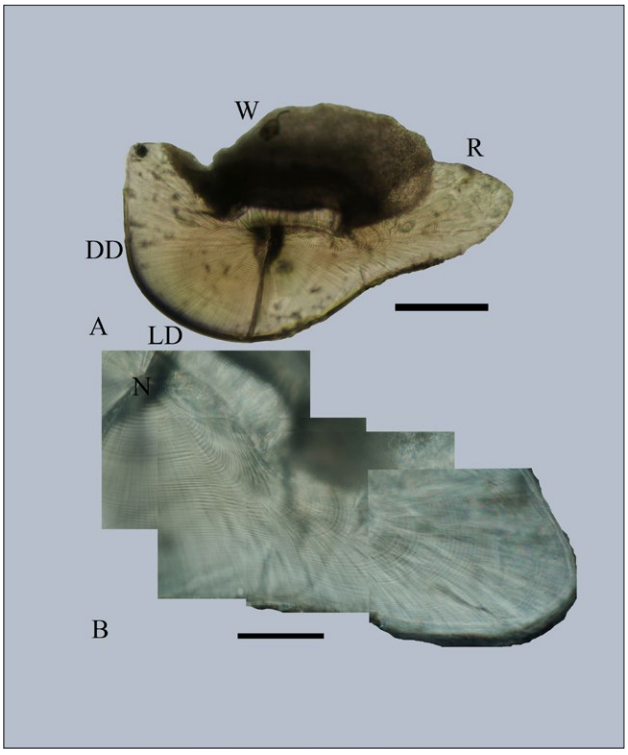

Fig. 4. Statolith microstructure of *A. siedleckyi* female (A= general view of statolith) (DML=29.1 mm): W= wing, R= rostrum, DD= dorsal dome, LD= lateral dome; A=; B=details of periphery of statolith with increments: N= nucleus (scale bar=100 μm)

GSI and number of eggs

The weight of the gonad was 0.49 g and gonadosomatic index was 23.3 %. Number of oviducal eggs was 284 with the diameter range from 590 to 712 μm (mean: 640 μm).

Discussion

The Indian Ocean cephalopod fauna is still poorly described and nothing is known about the biology of several species (Piatkowski and Welsch, 1991). Earlier zoogeography of pelagic cephalopods of Arabian Sea was investigated in eastern Arabian Sea (Silas, 1968) and northern Arabian Sea (Piatkowski and Welsch, 1991). Silas (1968) reported occurrence of *A. andamanica* from Arabian Sea throughout the year except January, September and October. Recently some new sighting records of deep-sea cephalopods have been reported from the south-eastern Arabian Sea (Rithin *et al.,* 2015, Sajikumar *et al.,* 2016, 2017, 2018).

Previously *A. siedleckyi* has been recorded from the southern temperate waters of South Atlantic off Cape Town (original description) (Lipinski, 1983) and western tropical Pacific (Hidaka and Kubodera, 2000).

The present record of *A. siedleckyi* is first from Arabian Sea as well as Indian Ocean and the study area shares the occurrence of *A. andamanica*, *and A. marisarabica.* The first two species are reported from south-eastern Arabian Sea and *A. marisarabica* reported from northern Arabian Sea (Silas, 1968; Piatkowski and Welsch, 1991). *A. siedleckyi* is very similar to *A. heminuchalis* which is known from tropical waters of the Pacific Ocean and the two species may be synonymous (Tsuchiya and Young, 2014) (Table 2).

According to Lipinski (1983) *A. siedleckyi* and *A. andamanica* (which is widely distributed) are closely related but differ in characteristics such as size and shape of the photophores on the eyeballs, shape of hectocotylus and proportion of manus/dactylus.

Table 2.Key morphological characters of *Abralia* squids recorded from Arabian Sea

Species	Ocular photophore	Hectacotlyized arm	Mantle apex (tail)	Integumental photophore
Abralia siedleckyi (Present specimens)	Five complex organs: two terminal opaque organs (Posterior is large) and three intermediate orange organs	Left ventral arm with two different sized off-set flaps	Broad and extended beyond the conus of gladius	Ventral mantle, head and arms IV with scattered photophores
Abralia heminuchalis (Synonymised with above by Tsuchiya and Young (2014))	Five complex organs: two terminal opaque organs and three intermediate silvery organs	Left ventral arm with with two different sized off set flaps (proximal flap elongated)	No information	Ventral mantle, head and arms IV with scattered photophores
Abralia andamanica	Two large terminal organ and three intermediate silvery organ	Left ventral arm two different sized off-set flaps	Long conical tail	Ventral mantle and head with scattered photophores
Abralia marisarabica	Five silvery photophore with three to five organ	Right ventral arm with two different sized off-set flaps (large flap bilobed)	No information	Ventral mantle with six longitudinal stripes and ventral head with seven longitudinal stripes

Daily increments for *Abralia trigonura* have been validated (Bigelow, 1992) and we assume that increments are formed daily for *A. siedleckyi* also. The age estimated based on statolith increment analysis agree with earlier studies on *Abralia trigonura* having a maximum life span of ~6 months from Pacific Ocean (Young and Mangold, 1994). The mean egg number determined in the oviduct of *Abralia verany* from eastern Mediterranean Sea was 251 (Salman and Laptikhovsky, 2005), which is comparable to our estimate of 284 eggs.

The present report provides new addition to cephalopod fauna of Arabian Sea as well as Indian Ocean. Further detailed studies are required to understand distribution and biology of deep-sea cephalopods of Arabian Sea.

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