Article

Occurrence of the ghost shrimp, *Audacallichirus audax* (de Man, 1911) (Decapoda: Axiidea), from the south-eastern coast of India

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Abstract

Three specimens of *Audacallichirus audax* (de Man, 1911)were collected from Mudasal Odai (11°29'06"N 79°46'28"E) fish landing center, Tamil Nadu, South-eastern coast of India in August 2022 and June 2023. The species was recognised by key characters and colour pattern. The identification is further confirmed by 16S rRNA gene sequences. This is the first record from south-east India, outside their known geographical range which is a range extension within the Indian coastal region.

Keywords by-catch; ghost shrimp; *Audacallichirus audax*;new record; South-east India.

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1 Introduction

Members of the infraorder Axiidea are highly specialized decapod crustaceans. They build and live in permanent burrows in sea floor sediments. Their burrows are very complex and may contain multiple compartments (Dworschaket al., 2012). Callichiridae (Decapoda: Axiidea) is one of the seven recognised families which comprises of 17 genera (Poore et al., 2019). Five valid ghost shrimp species belongings to the Callichiridae have been reported from India such as: *Audacallichirus audax* as *Callianassa* (*Callichirus*) *audax* (Rao and Kartha, 1967) in Cannanore and Ratnagiri, Maharastra coast; *Balsscallichirus masoomi* as *Callianassa* (*Callichirus*) *kewalramanii* (Sankolli, 1971) in Ratnagiri, Maharashtra coast; *Karumballichirus karumba* has been reported as *Callianassa* (*Callichirus*) *maxima* (Kemp, 1915; Daniel, 1981) in Chilka Lake, Madras backwaters, salt pans of Tamil Nadu and Andhra Pradesh, as *Callianassa maxima* (Pillai, 1954)in Kayamkulam lake, Kerala, and as *Neocallichirus kempi* (Sakai, 1999) in Kerala; *Michaelcallianassa indica* (Sakai, 2005) in the Bay of Bengal and *Neocallichirus jousseaumei* (Beleemet al., 2019) at Khukri, Diu coast.

Previously, *A. audax* has been recorded from many localities along the West Pacific Ocean, from the Straits of Malacca, Malay Peninsula (de Man, 1911), Siam Penang (Dworschak, 1992), Vietnam (Ngoc-Ho, 2014) and few more reports from the West Indian Ocean such as Pasni, Mekran coast; Clifton, Karachi Pakistan (Timizi, 1967; Fatima and Kazmi, 2008) and Kenya (Robles et al., 2020). The record of *A. audax*

from the East coast of India by Dworschak (1992) and Ngoc-Ho (2014)was in error of Rao and Kartha's (1967) report from the South-west coast of India (personal Communication of Peter C. Dworschak).

After a period of about five decades (Rao and Kartha, 1967), three specimens were collected from Mudasal Odai fish landing center, South-east coast of India. This is the first authentic record of *A. audax* from this region (Fig. 2).

Hence, this current record of *A. audax* confirms the distributional range extension from west coast to east coast. Apart from the morphometric features and colour patterns we have used mitochondrial 16S rRNA gene sequence to confirm the species as *A. audax*.

2 Materials and Methods

Monthly trawl by-catch composition surveys were conducted at the Tamil Nadu coast, South-east India, from August 2022–July 2023, to access the trawl by-catch species diversity. Three specimens of *Audacallichirus audax* were obtained from the bottom trawler which aimed silver bellies (*Leiognathus* sp.)(mesh size range, 40–80 mm) at Mudasal Odai (11°29'06"N 79°46'28"E) fish landing center. Hauling was carried out nearshore and offshore over muddy bottom fishing grounds at depths ranging from 10–100 m, at a distance of 1–50 km from shore. After collection, the specimens were cleaned, photographed and subsequently preserved in 95% ethanol. The morphometric measurements were made using Mitutoyo CD-6"ASX® digital Vernier calipers with nearest CL to 0.1 and TL to 1 mm accuracy. Specimens were identified up to genus level using the key in Poore et al. (2019), to species level by using previously published papers such as Rao and Kartha (1967), Tirmizi (1967), Ngoc-Ho (2014). The study materials have been deposited (CASMBTRL764–766) in the reference collections at the Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, India.

For molecular level identification, the genomic DNA was isolated from two ethanol preserved samples by the standardized procedure (Sambrooket al., 1989). The 16S rRNA gene was amplified using primers *16ar* (5'-CGCCTGTTTATCAAAAACAT-3'), *16br* (5'-CCGGTCTGAACTCAGATCACGT-3') (Palumbiet al., 1991). The amplification reaction was carried out in a 25-µl reaction volume containing 10 mM Tris-HCl (pH 8.3), 1.5 mM$MgCl_2$, 100µM each of dNTPs, 0.2 µM of each primer, 1 U of Taq DNA polymerase, and 25 ng of template DNA. DNA was denatured initially at 95°C for 2 min, then 35 cycles of amplification were carried out under the following conditions: 94°C denaturation for 1 min, 43°C annealing for 1 min, and 72°C extension for 1.5 min. Final extension at the same temperature for 5 minutes. The purified DNA product was bidirectionally sequenced and similarity was checked by BLAST search to NCBI database. Subsequently the sequences were submitted in to NCBI database through BankIt and got the accession numbers OR398531 and OR398532.

3 Results

3.1 Systematics

Infraorder : Axiideade Saint Laurent, 1979
Family : Callichiridae Manning and Felder, 1991
Genus : *Audacallichirus* Poore, Dworschak, Robles, Mantelatto and Felder, 2019
Type species : *Callianassa audax* de Man, 1911 by original designation.
Type locality : The Straits of Malacca.
Gender : Masculine.

Included species : According to Poore et al. (2019) the genus *Audacallichirus* consists of four valid species, namely *A. audax* (de Man, 1911), *A. mirim* (Rodrigues, 1971), *A. monody* (de Saint Laurent and LeLoeuff,

1979) and *A. pentagonocephala* (Rossignol, 1962).

***Audacallichirus audax*(de Man, 1911)**

Callianassaaudax – de Man 1911: 223; – Dworschak 1992: 190, fig. 1a–d; – Tudge et al., 2000: 138, 143.

Callianassa (*Callichirus*) *audax* – de Man, 1928: 1, 28, 113, 179, pl. 20, fig. 31-31i;– Rao and Kartha, 1967: 279, figs 1, 2; – Tirmizi, 1967: 151–154, figs 1, 2.

Callichirus audax – de Saint Laurent and LeLoeuff, 1979: 97.

Neocallichirus audax – Sakai 1999: 95, fig 21d, f;– 2005:17; – Fatima and Kazmi, 2008: 123–124, pl. 1; – Ngoc-Ho, 2014: 554, fig. 4.

Audacallichirus audax – Poore et al., 2019: 107–108; Robles et al., 2020: figs 1, 4, 7, tables S1, S2.

3.2 Material examined

1 female (CASMBTRL764, CL 22.2 mm, TL 79 mm, collected on 24th August 2022, by Ragul S);1 male and 1 female (CASMBTRL765, CL 16.3 mm, TL 25.1 mm) 1 female (CASMBTRL766, CL 48 mm, TL 85 mm, collected on 17th June 2023, by Ragul S and Kartick A).

3.3 Description

Body sub-cylindrical (Fig. 1A). Pleon longer than cephalothorax region. Carapace short compared to total length of pleomeres; with prominent branch iostegal ridge and line athalassinica. Triangular flat eye stalks, cornea on mid dorsal surface. Short triangular rostrum lacking anterolateral spines, pointed between eyestalk and the antennular peduncle.Three and five-segmented antennular and antennal peduncle, respectively. Maxilliped 3 narrow without exopod; ischium and merus, more than twice as long as wide; propodus also wider than long.

Fig. 1 *Audacallichirus audax* (de Man, 1911), colour in life. A, male, overall dorsal view (25.1 mm CL & 85 mm TL) (CASMBTRL 766); B, major chela, lateral view; C, telson, dorsal view (Scale = 10 mm).

Pereiopod 1(Fig. 1B) chelate, unequal, carpus articulating with merus by narrow suture. Major cheliped: broad carpus and propodus; palm quadrate; merus proximally convex at lower margin as serrated blade, with

small denticles. Minor cheliped compressed, much thinner than major one, carpus longer than propodus, fingers shorter than palm. Soft integument, except for that of first pereiopods. Pereiopod 2 flat chelate, heart-shaped carpus. P ereiopod 3 simple triangular carpus which is transversely oval, broad propodus. Propodus Posterior lobe markedly extended beyond link of ventral margin of carpus. Pereiopods 4 & 5 simple, weakly subchelate. Fifth Pereiopod much narrower than the fourth, chela projected from dactylus with distal margin of propodus. Pereiopodalepipods absent.

Pleon stretched, first two pairs of pleopods differ from posterior three pairs of fan-like appendages. First two pairs sexually dimorphic. Pleopod 1 simple, wide and apically notched in male, finger-like projection at the distal part with long setae in female. Pleopod 2 narrower with protruded appendix interna (broader in male); less setation than pleopod 1 in female. Pleopods 3–5 with inclining peduncles, oval endopods, exopods attached laterally.

Telson (Fig. 1C) truncate posteriorly,composed of two dorsal plates and bearing setaceous posterior margin. Exopod (outer ramus) also with integument dorsal plates. Short rectangular telson (9.28–11.50% of pleonal length) which is comparably broader (109–110.5% of telson length), forming tail-fan shape with pair of uropod, which are longer in length to the telson. Uropod and endopod lanceolate, slightly shorter than triangular exopod, widest proximally.

3.4 Colouration

Colourof live specimens. Pinkish chelipeds (Fig. 1B); pereiopods 2–5, whitish or opaque; first pleomere yellowish (Fig. 1A).Opaque pleopods; telson and uropods deeply pinkish (Fig. 1C). *Colour of preserved specimen.* Body turns paler than the live specimen, pink colour lost.

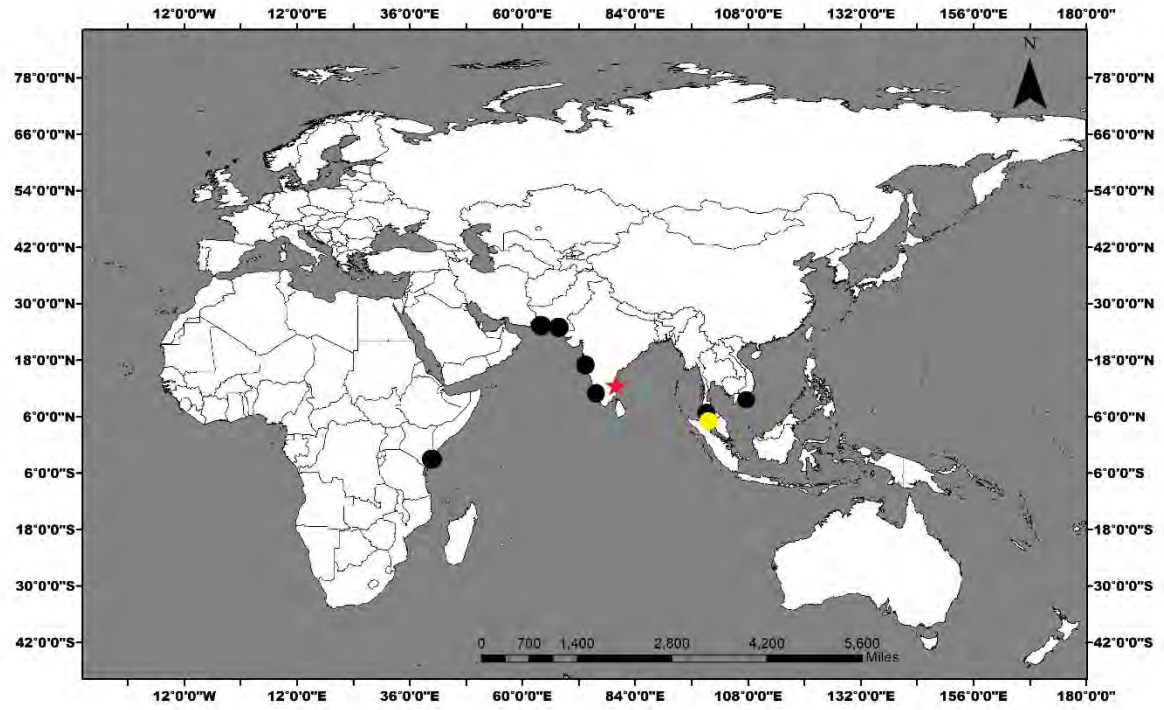

Fig. 2 Distribution range of *Audacallichirus audax* (de Man, 1911). New record (Star), Type locality (Yellow dot), Records from literature and specimens in collections (Black dot).

3.5 Habitat

The known depth range for this species is 1–10 m, but the present specimens were collected at depth of 40–100 m (personal communication with fisherman) which expands the depth range of this species in South-east coast of India (Fig. 2).

3.6 Remarks

Audacallichirus audax differs from *A. Mirim* (Rodrigues, 1971) and *A. monody* (de Saint Laurent and LeLoeuff, 1979) by the smooth posterior margin of the truncate telson (Fig. 1C) (*vs* a depressed pointed tooth and a median tooth in *A. mirim* and *A. monodi* respectively) (Rodrigues, 1971; Sakai, 1999; Sakai, 2005).

*A. audax*is most similar to *A. pentagonocephala* (Rossignol, 1962) in sharing the absence of a median spine on the posterior margin of the telson. However, *A. audax* differs in the shape of telson, short, convex sided (*vs* pentagonal in *A. pentagonocephala*) (de Saint Laurent and LeLoeuff, 1979; Sakai, 2005).

The above-described features of present specimens agree well with the description and illustrations given by Rao and Kartha (1967), Tirmizi (1967), Fatima and Kazmi (2008) except the difference in colour. The colour of live specimen is pinkish, first pleomere yellowish, whereas the colour of the specimen reported by Tirmizi (1967) was pale yellowish body, orange pleopods, bright red chelae and that of Fatima and Kazmi (2008) was a pink specimen with brownish first pleomere.

Table 1 COI gene sequence similarity with related species.

Sl. No	Species	Country	Accession No.	Similarity	Reference
1.	*Audacallichirus audax*	India	OR398531.1		Present study
2.	*Audacallichirus audax*	India	OR398532.1		Present study
3.	*Audacallichirus audax*	Kenya	MN237698.1	99.63%	Robels et al., 2020
4.	*Audacallichirus mirim*	Brazil	MF490166.1	91.91%	Mantelatto et al., 2018
5.	*Audacallichirus mirim*	Brazil	MN237797.1	91.90%	Robels et al., 2020

Table 1 shows the 16S rRNA gene sequence similarity with related species reported as on date in NCBI GenBank data base. *Audacallichirus audax* was identified by morphological features and 16S rRNA gene sequence compared with that of a specimen from Kenya (Robles et al., 2020). In their study, they have used single specimen and size of the 16S rRNA gene sequence was 537 bp. In our study, we have used two specimens to support molecular identification and the 16S rRNA gene sequence was 543 bp. Based on the NCBI-BLAST result, 99.63% similarity and 99% sequence coverage were found and it was identified as *A. audax* without ambiguity. But the sequence similarity is only 91.91% with *A. mirim*, the sister species.

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