First record of the *Gloiopotes huttoni* (Thomson, 1890) (Copepoda: Caligidae) parasitic on the swordfish *Xiphias gladius* along the southeast coast of India

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Abstract Parasitic copepods infect a large number of fishes. In particular, the family Caligidae (Crustacea) comprises more than 450 species worldwide, some of which are harmful to cultured and wild fishes. Recently, we found a parasitic copepod on the host swordfish *Xiphias gladius* (Xiphidae) in the coastal waters of Parangipettai, southeast coast of India. It was identified as *Gloiopotes huttoni* by its morphological features, and it belongs to the family Caligidae (order Siphonostomatoida). The swordfish was highly infected with about 72 caligids on a single host. Both male and female forms of *G. huttoni* were colonized on the beak of the swordfish and distributed mostly along the upper and lower jaws of the host, with 42 and 30 copepod parasites, respectively. Most of the copepods were ovigerous, and more females than males were recorded. It is the first record of the occurrence of *G. huttoni* in India.

Keywords *Gloiopotes* · Swordfish · Copepods · Caligidae · Beak

Introduction

Parasitic copepods are common in marine and freshwater fishes, both cultured and wild (Ho and Lin 2004; Johnson et al. 2004; Venmathi Maran et al. 2009, 2012). To date, more than 100 species of caligids of the family Caligidae have been reported in Asia (Ho and Lin 2004; Dojiri and Ho 2013), with 60 species reported in India (Pillai 1985; Dojiri and Ho 2013). However, members of the genus *Gloiopotes* Steenstrup & Lütken, 1861 have not been reported around Asia. Two species of *Gloiopotes* have been reported from India, Japan, Australia and Korea (Yamaguti 1963; Pillai 1985; Parker and Martini 2014; Venmathi Maran et al. 2015).

The host sword fish *Xiphias gladius* (Linnaeus, 1758) (Perciformes: Xiphidae) is mostly found in deep sea and cannot be easily collected. The epipelagic and mesopelagic species of swordfish are usually found in surface waters warmer than 13 °C. The species, however, can tolerate a temperature range of 5–27 °C and are able to move down to a maximum depth of 1000 m (Froese and Pauly 2018). Here we report for the first time that *X. gladius* is the new host for *G. huttoni* in Indian waters.

Materials and methods

Sample collection and examination of copepods

The sword fish *X. gladius* ($n = 1$) (total length 172 cm) was collected during our parasitological survey along the Annankoil fish landing centre (11°43' N; 79°48' E), Tamil Nadu, southeast coast of India. The host was found with 72 parasites on its beak and body surface. These parasites were removed using fine forceps and transferred into vials

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containing filtered sterilized seawater before being transported to the laboratory where they were preserved in 70% ethanol for further analysis. Identification was done in accordance with the guidelines of Pillai (1985) and Dojiri and Ho (2013); the length and width of the parasites were measured under a binocular microscope. All collected specimens were deposited in the museum of Centre of Advanced study in Marine Biology, Annamalai University, Parangipettai, India (AUCR).

Results

We collected a total of 72 copepods of both sexes of the caligid *G. huttoni* from a sword fish (*X. gladius*) (Fig. 1). A study of the morphological features confirmed the identification of copepod as *G. huttoni* (Thomson 1890) (Siphonostomatoida: Caligidae). The key features are: (1) abdomen is longer and (2) the tip of leg 5 does not extend towards the end of abdomen.

The other major morphological characteristics are spines on the dorsal surface of the genital segment and abdomen. The spine arrangement was not consistent among specimens, varying from specimen to specimen. The dorsal surface of the cephalon was observed to have rows of hair and spinules, while the dorsal thoracic segment had wing-like plates on the fourth leg. The lateral edges of the plates were maintained at an angle to the anterior posterior axis of the body. The fifth leg extended posterior to about the middle of the abdomen.

The maximum and minimum length of female specimens was recorded as 10.99 and 10.1 mm, respectively. For males, the maximum and minimum length was 10.61 and 7.7 mm, respectively. Copepod parasites were found to be attached on the beak. Some of the parasites were mature, and egg sacs were found in all females (Fig. 2). The dorsal and ventral views of both sexes of the *G.*

huttoni specimens are shown in Figs. 3a, b and 4a, b. The copepods were distributed mostly along both jaws, with 42 along the upper and 30 along the lower jaws of the host.

Discussion

According to Dojiri and Ho (2013), members of the genus *Gloiopotes* can easily be distinguished from members of all other caligid genera by the combination of general body morphology, the styliform caudal ramus, the accessory tine on the sternal furca, the structure of the outer spine on the first exopodal segment of leg 3 and the structure of leg 5. The morphology of leg 1 is unique to the family Caligidae. The bifid spines (with the middle hyaline setiform process) of the terminal exopodal segment are also unique to *Gloiopotes*. In *G. huttoni*, the leg 1 endopod is small and two segmented with three setae at the tip (Cressey 1967; Dojiri and Ho 2013).

The ectoparasite *G. huttoni* has high host specificity to bill fishes and sword fishes of the Indo-Pacific Ocean (Cressey 1967; Dojiri and Ho 2013; Venmathi Maran et al. 2015). However, *G. hygomianus* Steenstrup & Lütken, 1861 has been found only on the scombrid fish *Acanthocybium solandri* (Scombridae) from different parts of the Indo-Pacific Ocean, including India (Pillai 1985; Dojiri and Ho 2013). Cressey (1967) studied the host specificity of five species of *Gloiopotes*, which are to date recorded as *G. americanus* Cressey, 1967, *G. huttoni*, *G. hygomianus*, *G. ornatus* Wilson, 1905 and *G. watsoni* Kiritisinghe, 1934. Among these five species, *G. huttoni* is closely similar to *G. watsoni*. Recently, *G. huttoni* was reported from the body surface of the black marlin *Istiompax indica* (Cuvier, 1832) (Perciformes: Istiophoridae) obtained from Korean waters (Venmathi Maran et al. 2015). The appearance of our specimen is similar to that of the Korean specimens

Fig. 1 Parasitic copepod *Gloiopotes huttoni* (Caligidae) infection on the beak of a sword fish *Xiphius gladius*

Fig. 2 Adult *G. huttoni* carrying egg sacs (indicated by arrows)

Fig. 3 Dorsal view (a) and ventral view (b) of *G. huttoni* female

Fig. 4 Dorsal view (a) and ventral view (b) of *G. huttoni* male

based on the morphological features and body size. Rao and Satyanarayana (1951) reported the presence of *G. zeugopteri* on the host *X. zeugopteri* off Waltair, India.

However, this species was synonymized with *G. huttoni* by Cressey (1967), as was *G. costatus* Wilson, 1919 and *G. longicaudatus* (Marukawa, 1925). Pillai (1985) reported that *G. huttoni* had never been collected from India and further stated that there were only two other species in India, *G. watsoni* and *G. hygomianus*. Pillai (1985) considered the new species illustrated by Rao and Satyanarayana (1951) to be *G. watsoni*; however, Dojiri and Ho (2013) reported it as *G. huttoni*. We denote the specimen of Rao and Satyanarayana (1951) as *G. watsoni*. Hence, the present finding represents the first record of occurrence of *G. huttoni* in India and a new host record. Consequently, *G. huttoni* is the third species of *Gloiopotes* to be reported in India (Table 1), and all three species have been collected from the southern part of India (Pillai 1985). *G. huttoni* is highly distributed along the Indo-Pacific Ocean, Japan and Korea (Yamaguti 1963; Pillai 1985; Ho and Nagasawa 2001; Dojiri and Ho 2013; Venmathi Maran et al. 2015). It could be a cosmopolitan species, but pertain to bill and sword fish families.

Conclusion

In this study, parasitic copepods belonging to the family Caligidae were collected from the beak of sword fish *X. gladius*. Based on the morphological features, we identified the copepod as *G. huttoni* belonging to the family Caligidae. It is the first record of its occurrence in India. This is the third species of *Gloiopotes* to be reported from India, and all three have been collected from the southern coast of India. This caligid is prevalent in the Indo-Pacific Ocean. Since the identification of *G. watsoni* and *G. huttoni* is a challenging process, we need to use molecular techniques and phylogeny analysis for further confirmation, which could be useful for future researchers. Likewise, more studies are needed to collect and identify parasitic copepods from India using molecular techniques.

Table 1 The genus *Gloiopotes* and their host records from India

Copepoda: Caligidae	Host: order: family	References
<i>Gloiopotes huttoni</i> (Thomson, 1890)	<i>Xiphius gladius</i> (Perciformes: Xiphidae)	Present study
<i>G. hygomianus</i> Steenstrup & Lütken, 1861	<i>Acanthocybium solandri</i> (Perciformes: Scombridae)	Pillai (1985)
<i>G. watsoni</i> Kirtisinghe, 1934	<i>Xiphias zeugopteri</i> (Perciformes: Xiphidae) <i>Makaira indica</i> , <i>M. nigricans</i> (Perciformes: Istiophoridae)	Rao and Satyanarayana (1951), Pillai (1985)

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Author's contribution D Karthick Rajan carried out the sample collection, processing and prepared the manuscript. S Ravichandran identified the species and revised the manuscript. BA Venmathi Maran contributed to confirmation of the species identity and editing the manuscript.

Compliance with ethical standards

Ethical statement Not applicable to this study. No experimental studies were carried out on the host fish *X. gladius*. The only action was to collect the copepod parasites *G. huttoni* from the host.

Conflict of interest The authors declare that they have no conflict of interest.

References

- Cressey RF (1967) Genus *Gloiopotes* and a new species with notes on host specificity and intraspecific variation (Copepoda: Caligoida). *Proc US Natl Mus* 122:1–22
- Dojiri M, Ho JS (2013) Systematics of the Caligidae, copepods parasitic on marine fishes. *Crustac Monogr* 18:1–448
- Froese R, Pauly D (2018) Fish base. <http://www.fishbase.org>. Retrieved 20 July 2018
- Ho JS, Lin CL (2004) Sea lice of Taiwan (Copepoda: Siphonostomatoida: Caligidae). The Sueichan Press, Taiwan
- Ho JS, Nagasawa K (2001) New records of parasitic Copepoda from the offshore pelagic fishes of Japan. *Bull Nat Res Inst Far Seas Fish* 38:1–5
- Johnson SC, Treasurer JW, Bravo S, Nagasawa K, Kabata Z (2004) A review of the impact of parasitic copepods on marine aquaculture. *Zool Stud* 43:229–243
- Parker AR, Martini N (2014) Diffraction gratings in caligoid (Crustacea: Copepoda) ecto-parasites of large fishes. *Mater Today Proc* 1:138–144
- Pillai NK (1985) The fauna of India. Copepod parasites of marine fishes. Zoological Society of India, Calcutta
- Rao TS, Satyanarayana (1951) On a new caligid parasite, *Gloiopotes zeugopteri*, sp. nov., from *Xiphias zeugopteri*, Lawson's Bay, Waltair. *Proc Indian Acad Sci B* 34(5):248–255
- Venmathi Maran BA, Leong TS, Ohtsuka S, Nagasawa K (2009) Records of *Caligus* (Crustacea: Copepoda: Caligidae) from marine fish cultured in floating cages in Malaysia with a redescription of male *Caligus longipedis* Bassett-Smith, 1898. *Zool Stud* 48:797–807
- Venmathi Maran BA, Oh SY, Soh HY, Choi HJ, Myoung JG (2012) *Caligus sclerotinosus* (Copepoda: Caligidae), a serious pest of cultured red sea bream *Pagrus major* (Sparidae) in Korea. *Vet Parasitol* 88:355–361
- Venmathi Maran BA, Soh HY, Hwang UW, Chang CY, Myoung JG (2015) First records of parasitic copepods (Crustacea, Siphonostomatoida) from marine fishes in Korea. *Trop Biomed* 32:352–364
- Yamaguti S (1963) Parasitic Copepoda and Branchiura of fishes. Inter-Science Publishers, New York