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The occurrence and redescription of cymothoids (Wagele, 1989) parasites in commercially available fishes from markets of Vadodara, Gujarat, India

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Abstract

Parasitic crustaceans infesting fishes excite the interest of researchers all over the world as they have the potential to harm the health of food fishes. Cymothoids are ectoparasitic isopods that parasitize teleost fish in different ways, including freshwater, brackish water, and marine seas. They are found mainly inhabiting the branchial, oral cavities and on body surface of host fishes. Their exoskeletons are stiff, segmented, and they feature two pairs of antennae, seven pairs of jointed limbs on the thorax, and five pairs of branching appendages on the abdomen for respiration.

The protandrically hermaphroditic cymothoid *Mothocya renardi* (Bleeker, 1857) parasitizing the banded needlefish *Strongylura leiura* (Bleeker, 1850), whereas the species *Norileca indica* (H. Milne Edwards, 1840) parasitizing *Rastrelliger kanagurta* (Cuvier, 1816) and *Selar crumenophthalmus* (Bloch, 1793), from the Western coast, India, has been reported. There has been no report of parasitic isopods being found in fish sold in Vadodara's markets. Hence, the aim of this study was to redescribe the two isopod species, *Mothocya renardi* and *Norileca indica*, based on their morphology and meristic characteristics.

Keywords: cymothoids, isopod, fish parasites, taxonomy

Introduction

Isopods are crustaceans that are flattened dorsoventrally. Parasitic isopods are one of the most common groups of crustacean ectoparasites of fish, with approximately 450 species parasitizing both marine and freshwater fish [16]. Cymothoid isopods are a widespread family of blood-feeding crustaceans found in South America, Asia, Africa, and Australia that parasitize both marine and freshwater fish [1, 23, 24, 25, 33, 36]. Cymothoids are obligate ectoparasitic isopods comprising 40 recognized genera and more than 380 species [15, 27]. Most cymothoids are highly host and site-specific. They are protandric hermaphrodites and holoxenic as they complete their life cycle in a single host [7]. From the literature survey, it is evident that most of the descriptions of cymothoids are based only on ovigerous females. In captive fish populations, isopods can cause morbidity and mortality [2]. They have attracted the interest of researchers all over the world because they have a negative impact on the health of host fishes, severely limiting aquaculture productivity and economic viability [2, 3, 4, 20]. The majority of cymothoids found in fish branchial and oral cavities lack the intense pigmentation compared to isopods found on fish external surfaces [27].

According to Bruce [8, 9], Strongylura leiura (Bleeker, 1850) is the most common host, whereas the records from Tylosurus crocodilus crocodilus (Pe´ron & Lesueur, 1821) and Strongylura strongylura (Van Hasselt, 1823) are still unconfirmed for the Mothocya renardi species [3, 4, 5, 20]. Species of Norileca inhabit the branchial cavity of fish hosts and are commonly recorded from pelagic fishes. The cymothoid genus Norileca comprises three reported species: N. borealis (Javed and Yasmeen, 1999), N. triangulata (Richardson, 1910), and N. indica (Milne Edwards, 1840) [15]. In this report, N. indica is found parasiting Rastrelliger kanagurta (Cuvier, 1816) as host fish. Therefore, the objective of the present study was to identify the isopod parasite, which has been recorded from the Vadodara, with there Morphology and Meristic characteristics.

Materials and methods

During the study, local fish markets were surveyed for the parasitic infestation. Mainly, the Jetalpur fish market (22º30’75.0” N, 73º17’80.1” E), Panigate fish market (22º29’89.2” N, 73º21’85.8” E) and Karelibaugh fish market (22º31’05.3” N, 73º19’97.9” E) are major fish markets in the city and other than that, usually are the local shops selling fishes. While surveying, the ectoparasites were found from Jetalpur fish market parasiting the marine fish species. For collection, fixation, and identification of parasites, standard methods were used. Isopods were removed alive from the body surface of the fish hosts and immediately placed in 70% ethanol. According to Froese and Pauly [11], the taxonomy and fish names have been updated. The attachment sites of the parasites to their hosts was also observed. This cymothoid isopod specimen is kept in a personal collection and is deposited at the Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara. Their total length and fish length measurements are given in centimetres in (Table 1). The hosts of the fish were not preserved.

Result

The Isopods belong to the Phylum: Arthropoda, Subphylum: Crustacea, inhabiting majorly the marine fishes, although

some freshwater species have also been discovered. The Cymothoidae are a family of isopods in the suborder Cymothoida and are found in both marine and freshwater environments. Cymoithoids are ectoparasites, usually of fish, also known as “tongue-biter" (Cymothoa exigua) which attaches to a fish's tongue causing it to atrophy, and replaces the tongue with its own body. The sites for attachment chosen by different cymothoids species of parasite include the skin, the fins, the gills, and the mouth, while some species bore into muscle. Hence, the species collected were found attached beneath the pectoral fins [3, 4].

Fig 1: Map showing the study site

Fig 2: Infestation of S. leiura and R. kanagurta with isopods

The present study reports the occurrence of *Mothocya renardi* (Bleeker, 1857) from the *Strongylura leiura* (Bleeker, 1850) and the *Norileca indica* (H. Milne Edwards, 1840) from the Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1816) collected from the Fish market of Vadodara for the first time. The specimens collected were one of an ovigerous female of *Mothocya renardi* species and one male and two ovigerous females of the *Norileca indica* species respectively. The descriptions of the identified species are as specified below.

Table 1: Parasitological index of the cymothoids collected

Name of the parasites	Host	Location in the host	Date of collection	Size of the host (cm)	Size of the parasite (cm)	No. of parasites collected
Mothocya renardi	*Strongylura leiura*	Body surface	25.03.2019	54.3	3.4	1
Norileca indica	*Rastrelliger kanagurta*	Body surface	25.03.2019	23.7	3.9	3

Systematics

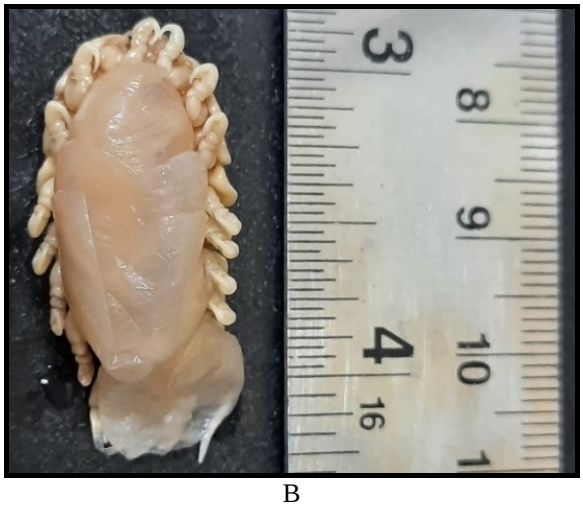
Class: Malacostraca Latreille, 1802
Suborder: Cymothoida Wägele, 1989
Order: Isopoda Latreille, 1817
Superfamily: Cymothoidae Leach, 1814
Family: Cymothoidae Leach, 1818

1. *Mothocya* Bruce, 1986

Mothocya renardi (Bleeker, 1857)

Strongylura leiura (Bleeker, 1850), according to Bruce [8], is the most common host for *M. renardi* species.
Ovigerous female (34 mm Total length; 17 mm Width)

A



B

Fig 3: *Mothocya renardi* Ovigerous Female specimen (A. Dorsal view and B. Ventral view)

Morphological description: Body is creamy-white, 16–34 mm long, and roughly 2.2–2.4 times as broad as it is long, widest at pereonite 3. The cephalon is larger than it is long, and it is accommodated in deeply depressed pereonite 1. Eyes are tiny and distinct, with a width of 0.35–0.45 the

breadth of the cephalon. Coxae 2–7 are thin and noticeable in the dorsal view; 2–4 are shorter than the segment; 5–7 are longer than the segment. Pereonite 1 is the widest; pereonites 1–3 grow in width; pereonites 4–7 decrease in breadth progressively; and pereonite 7 is extensively recessed. Pleonite 1 and most of pleonite 2 are hidden by pereonite 7; one side of pleonite 3 and most of pleonite 4 are covered by coxal plates of pereonite on its side. Pleon is larger than pereonite 7. Pleotelson is roughly 1.1–1.29 times as long as it is broad, with a rounded posterior border. Antennule is larger than the antenna and is made up of 8 articles: article 3 is the longest, articles 1–3 are somewhat broader than the rest, and the apex of article 8 is curved with multiple terminal aesthetascs. Antenna with 9 articles, decreasing in breadth progressively, article 9 with few terminal aesthetascs. Palp 3 of the mandible is segmented, without setae, and extends beyond the incisor. Maxillule with four somewhat recurved apical spines. Maxilla has two spines on the inner median lobe and three spines on the outer lateral lobe. Maxilliped article 3 with three big terminal recurved spines and a tiny spine on the proximomedial surface. Pereopods 1–7 are spineless. Pereopod 1 is small and strong; pereopods 2–6 are subequal; and pereopod 7 is longer than the rest. Pleopodite exopodite (without seta) of pleopods 1–5. Pleopod 2 is missing the appendix masculina. Pleopod 1 has a thin peduncle and underdeveloped lateral lobes; pleopods 2–5 have peduncles with well-developed lateral lobes; and pleopod 3 and 4 endopods have a well-developed proximomedial lobe. Pleopod 5 endopod with a broad proximomedial lobe. Uropod rami are lengthy; the exopod and endopod reach beyond the distal border of the pleotelson; the rami taper gradually; and the apex is narrowly rounded. Exopod is approximately 1.8–1.99 times longer than endopod.

In female, brood pouch composed of four overlapping oostegites originating from the bases of pereopods 2, 3, 4, and 6. 420–1,280 eggs or larvae per brood pouch, depending on female size [13, 20].

Male

Morphological description: The body is not twisted, it is around 2"2 to 2.9 times longer than broad, and the pleon is correspondingly thinner than the female. Appendages are the same as in females, although the buccal appendages are positioned more posteriorly than in females, and all males have an appendix masculina on pleopod 2. Rostrum is more robustly formed, and the eyes are bigger. Penes on sternite 7 are invariably short and do not protrude posteriorly between pleopods [8].

2. *Norileca* Bruce, 1990

Norileca indica (H. Milne Edwards, 1840)

Species of *Norileca* Bruce, [9, 10] mainly inhabit the branchial cavity of fish hosts and are frequently found from pelagic fishes. There are three known species: *Norileca borealis* Javed & Yasmeen, 1999, *N. triangulata* Richardson, 1910 and *N. indica* (Milne Edwards, 1840) [37]. *Rastrelliger kanagurta* (Cuvier, 1816), is the common host for *N. indica* species, also many times found as parasites in *Selar crumenophthalmus* (Bloch, 1793) [18].

Ovigerous Female (39 mm Total length; 15 mm Width)

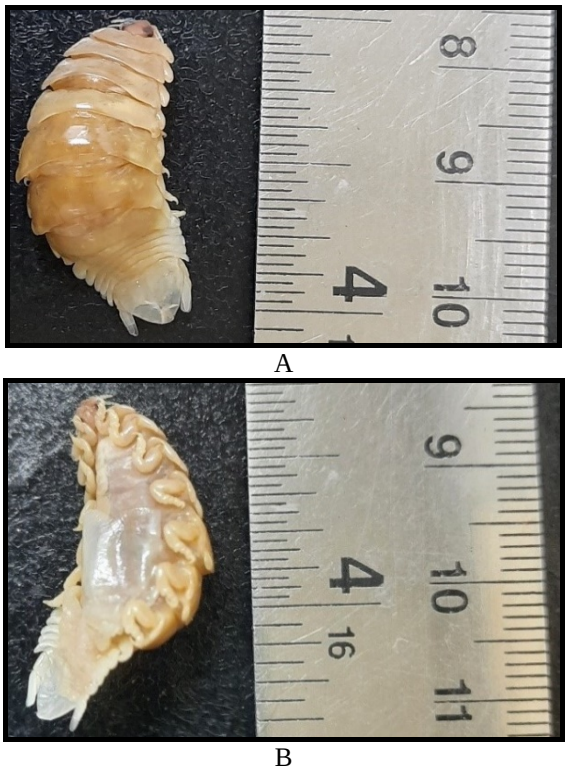


Fig 4: *Norileca indica* Ovigerous Female specimen (A. Dorsal view and B. Ventral view)

Morphological description: Body twisted to the left, smooth and polished dorsal surfaces, broadest at pereonite 4, narrowest at pereonite 1; pereonite lateral borders posteriorly projecting. Coxae 2–3, wide with posteroventral angles rounded; coxae 4–7 acute, posteriorly pointed, not extending past pereonite margin; Cephalon longer than wide, visible from dorsal view, triangular; eyes oval with distinct margins; coxae 2–3, wide with posteroventral angles rounded; coxae 4–7 acute, posteriorly pointed, not extending past pereonite margin; The pereonites 6 and 7 are narrower than the pereonites 1–5. Pleotelson as long as anterior breadth; smooth dorsal surface; weakly convex lateral borders, posteriorly thin; posterior margin converging to a caudomedial tip; Antennula has 8 articles; peduncle articles 1 and 2 are distinct and articulated, reaching to the posterior border of the eye, with tufts of simple setae on articles 3–6 and 8; antenna has 9 articles. There is a mandibular molar process present, but no simple setae; Mandible palp articles 2 and 3 are setae-free; maxillule is simple with four terminal strong setae. maxilla medial lobe partially united to lateral lobe; medial lobe with 2 recurved robust setae, lateral lobe with 1 big recurved robust setae; maxilliped palp article 2 without setae; article 3 with 4 recurved robust setae pereopod 1 basis, longest and widest; Pereopods 3–6 are similar to pereopod 2, gradually increasing in size towards the back, and are all devoid of setae. Pleopods lack setae, and the exopod is bigger than the endopod. Pleopod 1 exopod is long and wide, with a moderately convex lateral border, a widely rounded distal margin, and a highly convex medial margin. Pleopods 2–5 are similar to pleopod 1; pleopods 3–5 have fleshy folds, increasing in size from pleopod 3–5; peduncle lobes present, increasing in size from pleopod 1–5; uropod more than half the length of pleotelson; peduncle longer than rami, lateral margin

without setae; rami not extending beyond pleotelson, marginal set Without setae, it's an endopod. Exopod does not reach to the end of the endopod, and there are no setae [37].

Male (19 mm Total length; 6 mm Width)

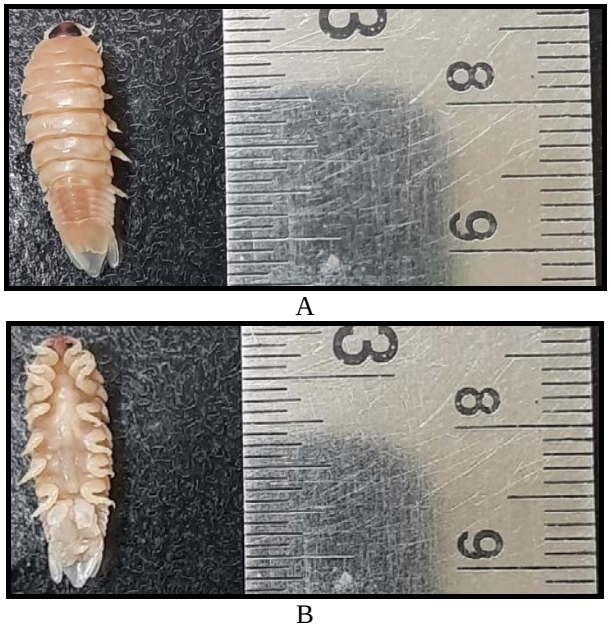


Fig 5: *Norileca indica* Male specimen (A. Dorsal view and B. Ventral view)

Morphological description: The colour of the body is brownish. The length of the body is roughly 2.7 times the width. Cephalon is 0.5–1 times the width of the brain. The eye is large and noticeable. Cephalon has a length of 1.0–2.0 mm and a width of 2.0 mm. The pereonites number seven, while the pleonites number five. Pleotelson has a length of 2.9–3.2 mm and a width of 2.5–3.2 mm. Males have a larger eye diameter in proportion to their head than females. Body is not twisted. All of the other characters are female [32]. Penes are prominent, measuring 2.3 times the width of the base, and tubercules connect at the base [37].

Geographical distribution

Three species of Mothocya are reported from the east coast of southern Africa: *Mothocya plagulophora* (Haller, 1880) from Maputo, Mozambique, from the gills of *Hemiramphus far* (Forsskål, 1775); *Mothocya renardi* (Bleeker, 1857) from diverse localities in South Africa and Mozambique, from the hosts *Strongylura leiura* (Bleeker, 1850) and *Tylosurus choram* (Rüppell, 1837) [13].

The isopod *Norileca indica* was recorded from Sumatra, Philippines, Indonesia, New Guinea, North Western Australia, and eastern Australia, off Mozambique, Pakistan, china and Thailand [6, 10, 12, 17, 30, 34, 35, 38]. Also from both the Southern coasts of India [7, 19, 22, 23, 28], and Andaman Islands [21, 31].

Discussion

The studies on the parasitic infestation of fishes are scanty, especially from Vadodara, Gujarat. Cymothoid parasites detrimental effects on the host may vary depending on the species and their position on the host. *S. leiura, S. incise* and *S. anastomella* are confirmed fish hosts of *M. renardi*, although it has been found in *T. crocodilus crocodilus* and *S. strongylura* according to Bruce [8]. The negative effects of cymothoid parasites on the host may vary depending on the species and location on the host. Atrophied gills and large pit-like depressions in the host's branchial cavity are seen as a result of *M. renardi* infection [26].

The *Norileca indica* is found throughout the IndoPacific region and infests a variety of carangids, the most common of which are *Selar crumenophthalmus* and *Rastrelliger kanagurta* (Cuvier, 1816) [5, 7, 14, 26, 29, 37]. As previously reported [7, 10, 19, 26, 21], the parasitic isopods attached to the ventral part of the host branchial cavity facing the branchial operculum, causing slight swelling and damage to the gill tissues. Although parasitic isopods occupy more space in the gill chamber as they grow and press against the gill arch, resulting in stunned growth of gill filaments [19, 21], no significant difference in growth was observed in the current study. Because there have been few studies on the prevalence and occurrence of isopod fish parasites in Gujarat, this is the first report from Vadodara. As a result, Gujarat needs to do more research and status extension on fish parasites.

Conclusion

In general, host parameters like as age, size, sex, maturity, stage, behaviour, feeding and breeding, lifecycle, physicochemical, and especially environmental factors influence parasite infection in fish. Because the parasite takes up the whole branchial chamber of the host, pressure is exerted on the gill surface, reducing the efficiency of breathing as seen in this research. Although the infestation did not result in immediate death, it had an impact on the host fish's normal development and most likely contributed to the high levels of secondary infections. The prevalence of *Mothocya renardi* on *S. leuria* resulted in a reduction in the layer of the fish gill rack using their mouthparts and feeding on the muscle tissue beneath the respiratory surface area of the host fish [27, 29], whereas *Norileca indica*, an obligatory cymothoid parasite that infests *Rastrelliger kanagurata* (Bloch, 1793). Further research on this cymothoid using modern biological approaches would reveal the complexities of host-parasite interactions as well as the molecular mechanism of protandrous hermaphroditism, allowing for the formulation of critical strategies to effectively control cymothoid parasitism in aquaculture.

Data Availability

The data of the present work comprise a part of the database of a doctoral research that is in progress. The specimen data is available with the first author and shall be provided as and when required.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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