Occurence And Morphological Study Of *Norileca Indica*

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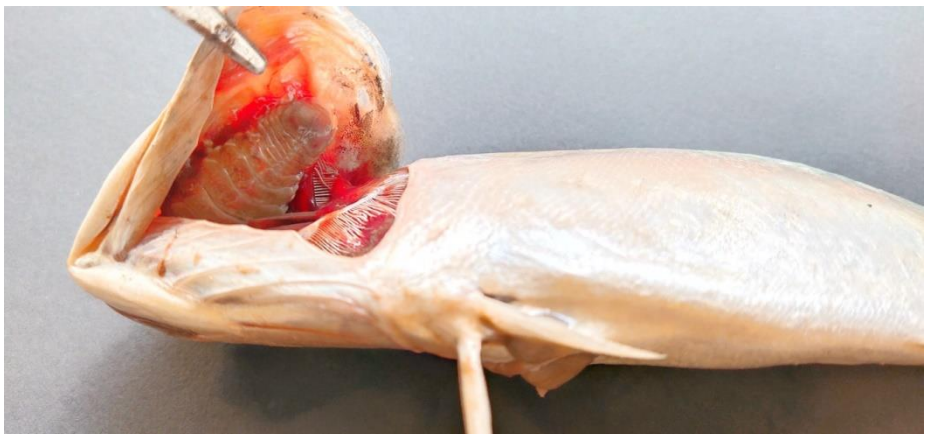
ABSRACT
Crustecean parasites on marine fishes are found in diverse forms; they infect many species of fishes and cause considerable damage to the host. The commercially and economically important marine fish species *Rastrelliger kanagurta* were examined for crustecean parasites infection. Cymothoid Isopoda, *Norileca indica* were collected and identified from the body (branchial chamber) of a Scombrid fish, *Rastrelliger kanagurta*. Detail morphological features and life stages of *N.indica* are described with their incidence and prevalence in *Rastrelliger kanagurta*.

Keywords: - Crustecean parasites, Cymothoid Isopoda, *Norileca indica*, *Rastrelliger kanagurta*, Morphological features, Life stages.

1. INTRODUCTION

Marine fish parasitology is a developing field of Aquatic science. The growing importance of marine life cultivation, issues on pollution effects on fish health enhances the importance of this study (Moller and Anders, 1986).
Crustacean ectoparasites on marine fishes are diverse. Most of marine fishes are infected by crustacean isopod belonging to family Cymothoidae. Cymothoid isopods are a widespread family of blood feeding crustaceans found in South America, Asia, Africa and Australia that parasitize both marine and freshwater fishes(Anandkumar G Rameshkumar, Ravichandran S, Priya ER, Nagarajan R, Leng AGK, 2013; Rameshkumar G, Ravichandran S, Sivasubramanian K, 2013b; Rameshkumar G, Ramesh M, Ravichandran S, Trilles JP, Subbiah S., 2014a; Rameshkumar G, Ravichandran S, Sivasubramanian K., 2014b; Smit NJ, Bruce NL, Hadfield KA., 2014; Trilles JP, Ravichandran S, Rameshkumar G., 2011). Isopod parasites of the family Cymothoidae are reported in 350 species of fishes (Sethi, S., 2012). There are about 330 species and 40 recognized genera of isopods reported worldwide belonging to the family Cymothoidae (Trilles, J.P., Ravichandran S., and Rameshkumar G., 2011). However, only around 56 species are reported from Indian waters. Literature survey says that, almost all of the descriptions of cymothoids are based only on ovigerous females.
In captive fish populations, isopods can cause morbidity and mortality (Anandkumar G Rameshkumar, Ravichandran S, Nagarajan R, Prabhakaran K, Ramesh M., 2017). They have attracted the interest of researchers all over the globe because they have a negative impact on the health of host fishes, severely limiting productivity and economic viability (Anandkumar G Rameshkumar, Ravichandran S, Nagarajan R, Prabhakaran K, Ramesh M.,2017; Aneesh PT, Sudha K, Helna AK, Arshad K, Anilkumar G, Trilles JP., 2013; Aneesh PT, Sudha K, Helna AK, Anilkumar G, Trilles JP., 2014; Panakkool- Thamban, Kappalli S, Kottarathil HA, Gopinathan A., 2016).
Most cymothoid are highly host and site specific. They are protandric hermaphrodites and holoxenic as they complete their lifecycle in a single host. They reside in the skin, buccal, branchial and body cavitites and take advantage of the host blood. (Trilles, J.P., Ravichandran S., and Rameshkumar G., 2011; Ramdane, Z., Bensouilah, M.A. and Trilles, J. P.,2007; Trilles, J. P., 1994). The bulk of cymothoids are found in fish branchial and oral cavities. They also lack extreme pigmentation compared to isopods found on fish external surfaces (Ravichandran S, Sivasubramanian K, Rameshkumar G, Veerappan N., 2016). Parasitism by cymothoids has been found to decrease the fecundity in adult fishes (Fogelman, R. M., Kuris, A. M. and Grutter, A. S., 2009). These large size parasites retard growth and cause emaciation followed by death (Trilles, J.P., Ravichandran S., and Rameshkumar G., 2011) thus causing significant economic losses to fisheries.
While parasitic crusteceans form increasingly intimate association with their hosts, they presumably undergo considerable morphological and structural changes associated with their attachment site and feeding habits (Saarinen and Taskinen, 2005). Norileca- host interactions are noteworthy because the parasite features a preference for attaching to the branchial cavity of the host fish during its parasitic mode of life (Bruce, 1990; Javed and Yasmeen, 1999; Ghani, 2003; Panakkool-Thamban et.al., 2016).
Site specifically is decided by the wants of the parasite and also the limitations exerted by the host morphology and habits (Morton, 1974). *Norileca indica* is additionally adapted with hook like pereopods to clutch the host tissue; the

mouth part complex consists of paired maxillule, maxilla, maxilliped and mandibles that are modified for blood feeding. The oesophageal side gland in *Norileca indica* also facilitate blood sucking, as obvious from the basophilic and secretory nature of its cells, likely the anticoagulant.



1.1. *Norileca indica* attached to the gills of the fish

1.2.

1.2. Dorsal view of *Norileca indica*

1.3. Ventral view of *Norileca indica*.

The objective of this study is to investigate the occurrence of *Norileca indica* in commercially and economically important host fish, *Rastrelliger kanagurta* and diagnose the infestation by studying the detailed morphological features and life stages of *Norileca indica* in the host.

2. REVIEW OF LITERATURE

Norileca indica (Milne-Edwards, 1840), a cymothoid isopod, is reported to be cosmopolitan within the pelagic marine teleosts of Thailand (Nagasawa, K. and Petchsupa, N.,2009) off Sumatra in Indonesia, Phillipines, New Guinea (Trilles, J.P., 1976; Yamauchi, T., Ohtsuka, S. and Nagasawa, K., 2005), Pakistan (Ghani, N., 2003), China (Yu, H. Y., Li, X. Z., 2003), Mozambique (Rokicki, J., 1982) additionally as eastern and western Australian waters (Avdeev, V.V., 1978; Bruce, N. L., 1990). Within the Indian seas, *N. indica* has previously been observed from *Rastrelliger kanagurta* off south-eastern India (Rameshkumar G, Ravichandran S, Sivasubramanian, K. and Trilles, J.P., 2012) and from *Selar crumenopthalmus* off Mumbai coast (Neeraja, T., Gayatri, T. and Ummey, S., 2014).

Host specificity is one in all the foremost important factors within the host parasite interactions, and it reflects host ecology, chorology and phylogeny (Cressy et.al., 1983). All three valid species of Norileca [*Norileca borealis* (Javed and Yasmeen,1999), *N. triangulate* (Richardson, 1910) and *N. indica* (Milne Edwards,1840)] are reported from at least one scombrid fish, indicating the affinity of the genus Norileca to infect scombrid fishes.

3. MATERIALS AND METHODS

Fishes were collected from local fish markets of Kalyan, Dombivili and Thane and also from fish landing centers Versova dock, Sassoon dock of Mumbai. Ectoparasites isopods were removed from the branchial chambers of host species *Rastrelliger kanagurta* (Cuvier, 1817): Indian Mackerel. After collection fresh photos were been taken. Isopods were preserved in 70% ethanol. Isopods were identified by using standard keys and features as provided in Ravichandran et al.2019.The identified Isopods are deposited in the national repository of Esturine Biology Regional centre, Zoological Survey of India, Gopalpur- on- Sea, Odisha.

3.1. DESCRIPTION OF OVIGEROUS FEMALE

The body of ovigerous female members of *Norileca indica* are right or left hunched, depending on whether they are located in right or left branchial cavity. Since most of the reported cymothoids/ parasitic isopods infecting the branchial region of the host fish have this type of left/ right asymmetry, it is apparently an adaptation for the parasite to permanently occupy the brachial chamber of the host fish.

Length 33.0 mm, width 16.0 mm. Body twisted to the right side, 2.2 times as long as greatest width, dorsal surfaces smooth and polished in appearance, widest at pereonite 4, most narrow at pereonite 1. Pereonite lateral margins posteriorly protruding. Cephalon 1.1 times longer than wide, visible from dorsal view, triangular. Frontal margin thickened and ventrally folded. Eyes oval with distinct margins, one eye 0.3 times the width of the cephalon, 0.3 times the length of the cephalon. Pereonite 1 smooth, with anterior border indented and anterolateral angle weakly produced, extending to middle of cephalon. Coxae 2–3 wide with postero-ventral angles rounded; coxae 4–7 acute, posteriorly pointed, not extending past pereonite margin. Pereonites 6 and 7 narrower than pereonites 1–5. Pleon with pleonite 1 slightly wider than other pleonites, visible in dorsal view; pleonites posterior margin not smooth, medially produced. Pleonite 2 partially overlapped by pereonite 7 posterolateral margin; posterolateral angles of pleonite 2 rounded. Pleonites 3–5 similar in form to pleonite 2; pleonite 5 free, not overlapped by lateral margins of pleonite 4. Pleotelson as long as anterior width; dorsal surface smooth; lateral margins weakly convex, posteriorly narrow; posterior margin converging to caudomedial point.

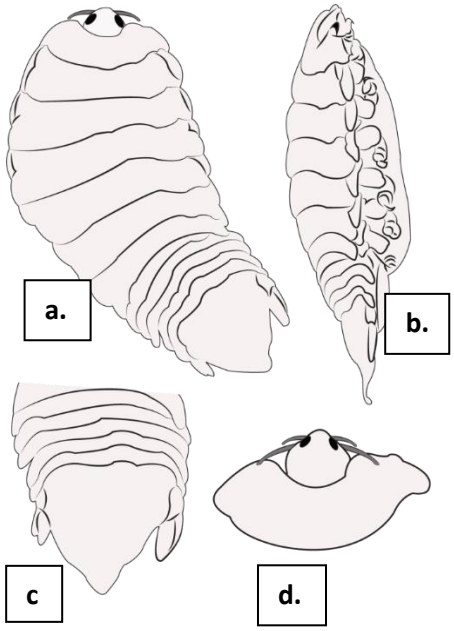
Antennula consists of 8 articles; peduncle articles 1 and 2 distinct and articulated; article 2 1.1 times as long as article 1; article 3 1.6 times as long as wide, 0.5 times as long as combined lengths of articles 1 and 2; flagellum with 5 articles, extending to posterior margin of eye with tufts of simple setae on articles 3–6 and 8. Antenna consists of 9 articles; peduncle article 3 1.0 times as long as article 2; article 4 2.2 times as long as wide, 1.4 times as long as article 3; article 5 twice as long as wide, 0.7 times as long as article 4. Antenna flagellum with 6 articles, terminal article with 1–5 short simple setae, extending to anterior margin of pereonite 1. Mandibular molar process present, with no simple setae; mandible palp article 2 and 3 without setae. Maxillule simple with 4 terminal robust setae. Maxilla medial lobe partly fused to lateral lobe; medial lobe with 2 recurved robust setae, lateral lobe with 1 large recurved robust setae. Maxilliped palp article 2 without setae; article 3 with 4 recurved robust setae.

Pereopod 1 basis 1.8 times as long as greatest width; ischium 0.7 times as long as basis; merus proximal margin with bulbous protrusion; carpus with straight proximal margin; propodus 1.1 times as long as wide; dactylus slender, 3.8 as long as propodus, 3.8 times as long as basal width. Pereopods 3–6 similar to pereopod 2, gradually increasing in size towards posterior, all without setae. Pereopod 7 basis 0.6 times as long as greatest width; ischium 0.8 as long as basis, without protrusions; merus proximal margin with large bulbous protrusion; 0.4 times as long as wide, 0.3 as long as ischium; carpus 0.4 times as long as wide, 0.2 as long as ischium, with slight bulbous protrusion; propodus as long as wide, 0.4 as long as ischium; dactylus slender, 1.9 as long as propodus, 2.7 times as long as basal width.

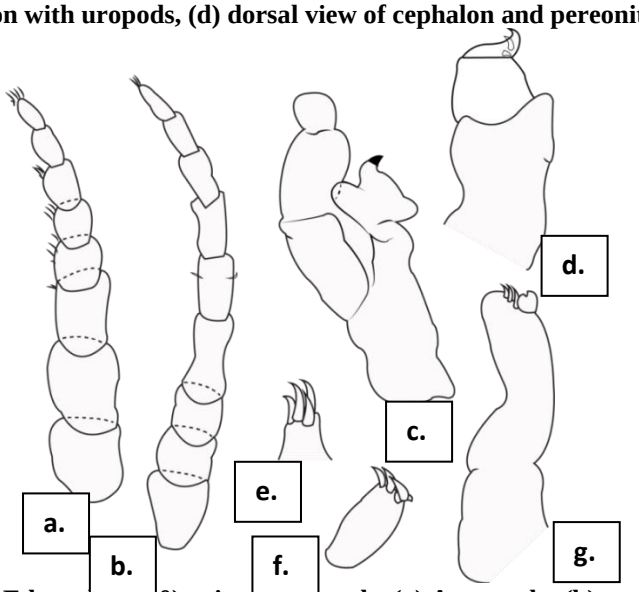
Pleopods without setae, exopod larger than endopod. Pleopod 1 exopod 1.1 times as long as wide, lateral margin weakly convex, distally broadly rounded, medial margin strongly convex; endopod 1.2 times as long as wide, lateral margin convex, distally broadly rounded, medial margin straight; peduncle 0.3 times as wide as long. Pleopods 2–5 similar to pleopod 1. Pleopods 3–5 with fleshy folds present, 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 0.7 times longer than rami, lateral margin without setae; rami not extending beyond pleotelson, marginal setae absent, apices narrowly rounded. Endopod 2.3 times as long as greatest width, without setae. Exopod not extending to end of endopod, 3 times as long as greatest width, without setae.

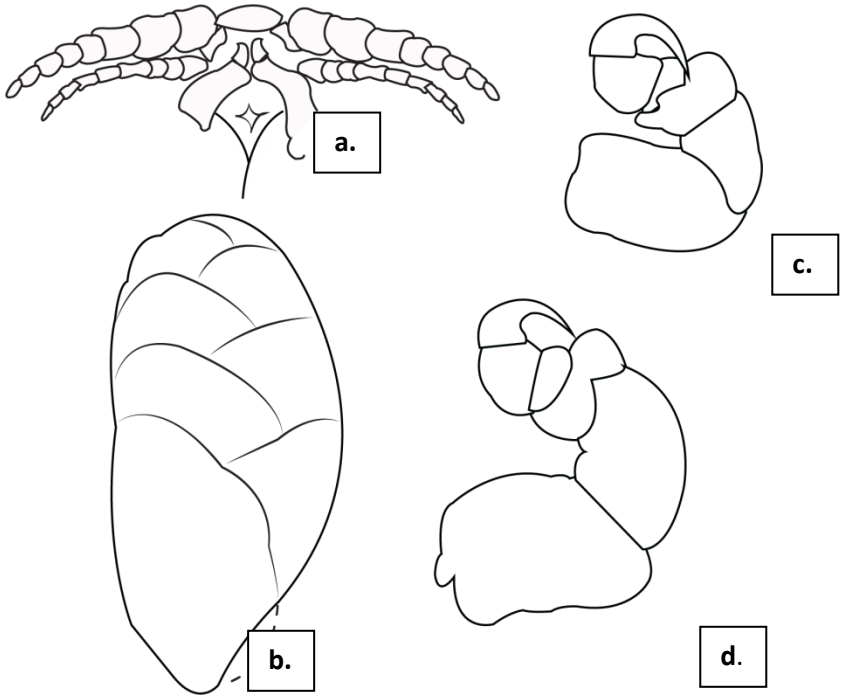
3.1.(a). Ovigerous Female of *N. indica*



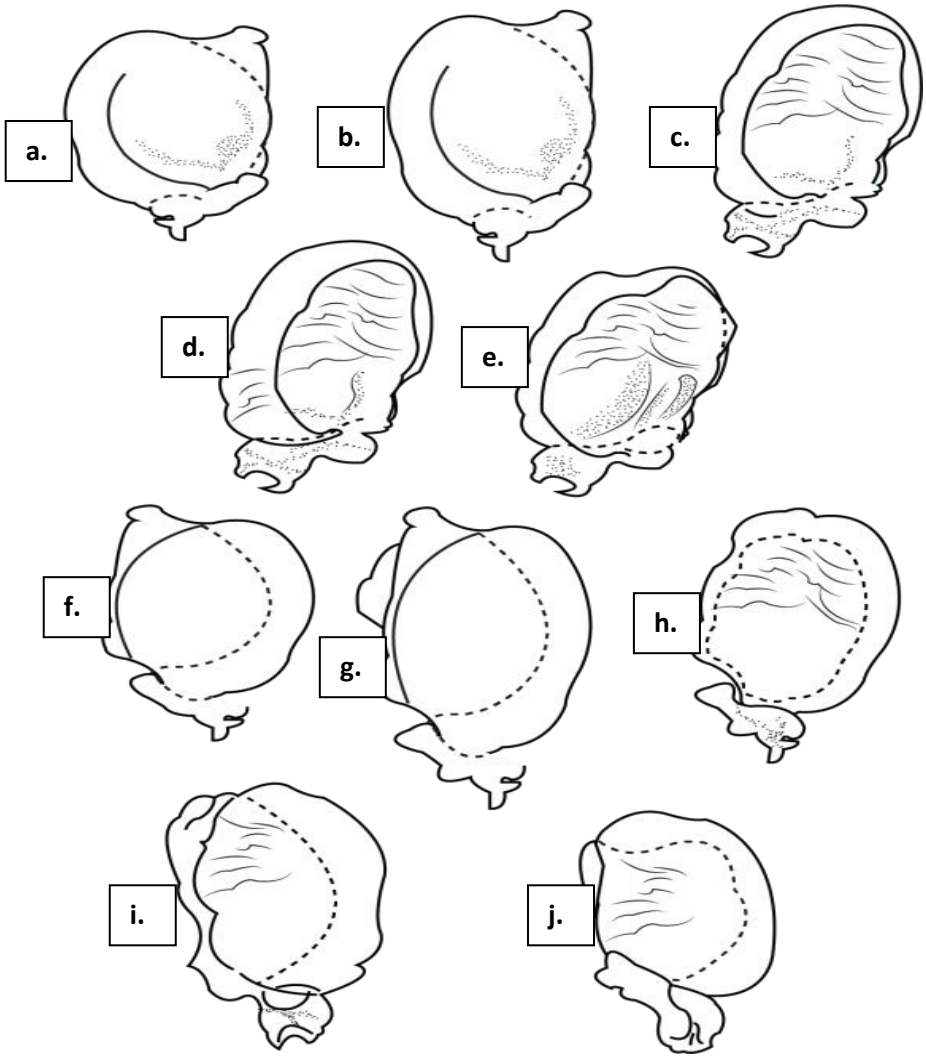
3.1.(b). *Norileca indica* (Milne Edwards, 1840) ovigerous female (a) Dorsal body, (b) lateral body, (c) dorsal view of pleotelson with uropods, (d) dorsal view of cephalon and pereonite 1.



3.1.(c). *Norileca indica* (Milne Edwards, 1840) ovigerous female. (a) Antennula, (b) antenna, (c) mandible, (d) maxilliped, (e) tip of maxillule, (f) tip of maxilliped article 3, (g) maxilla



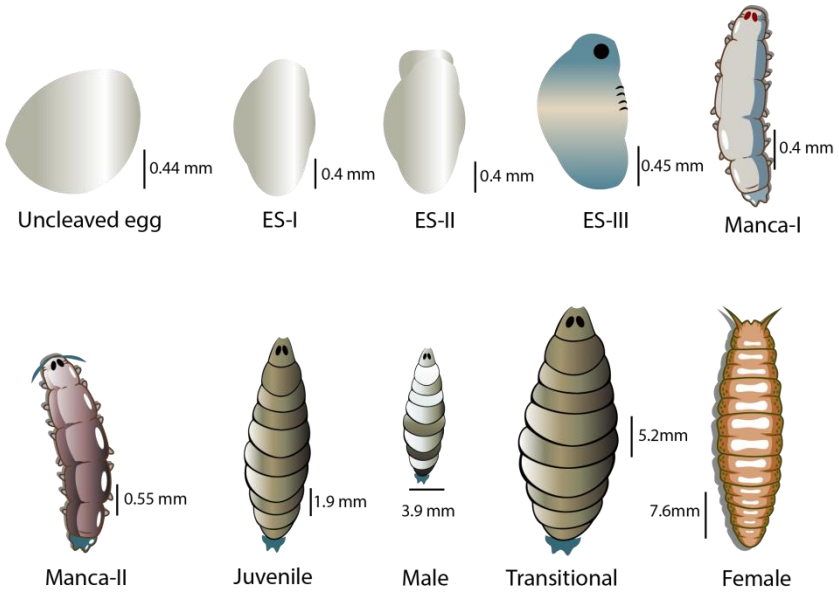
3.1.(d). ***Norileca indica*** **(Milne Edwards, 1840) ovigerous female (a) Ventral cephalon, (b) oostegites, (c) pereopod 1, (d) pereopod 7**



3.1.(e). ***Norileca indica*** **(Milne Edwards, 1840) ovigerous female. (a) Pleopod 1 dorsal view, (b) pleopod 2 dorsal view, (c) pleopod 3 dorsal view, (d) pleopod 4 dorsal view, (e) pleopod 5 dorsal view, (f) pleopod 1 ventral view, (g) pleopod 2 ventral view, (h) pleopod 3 ventral view, (i) pleopod 4 ventral view, (j) pleopod 5 ventral view**

After oviposition, the eggs and subsequently formed larvae are maintained within the brood pouch of female until it's released as a water as a competent settling larvae (Manca- II), presumably an adaptive strategy to settle immediately on the host for its parasitic life. Yet, the relatively low number of mating groups suggest that settling of larvae is either rare or chemically controlled so no more than a pair settle next to each other (of the other sex).

Once the parasite settles within the host, through a series of moulting it becomes juvenile, then male, transitional and feminine.



3.1.(f). Life Stages of *N. indica*

3.2. MORPHOLOGICAL DESCRIPTION OF FEMALE

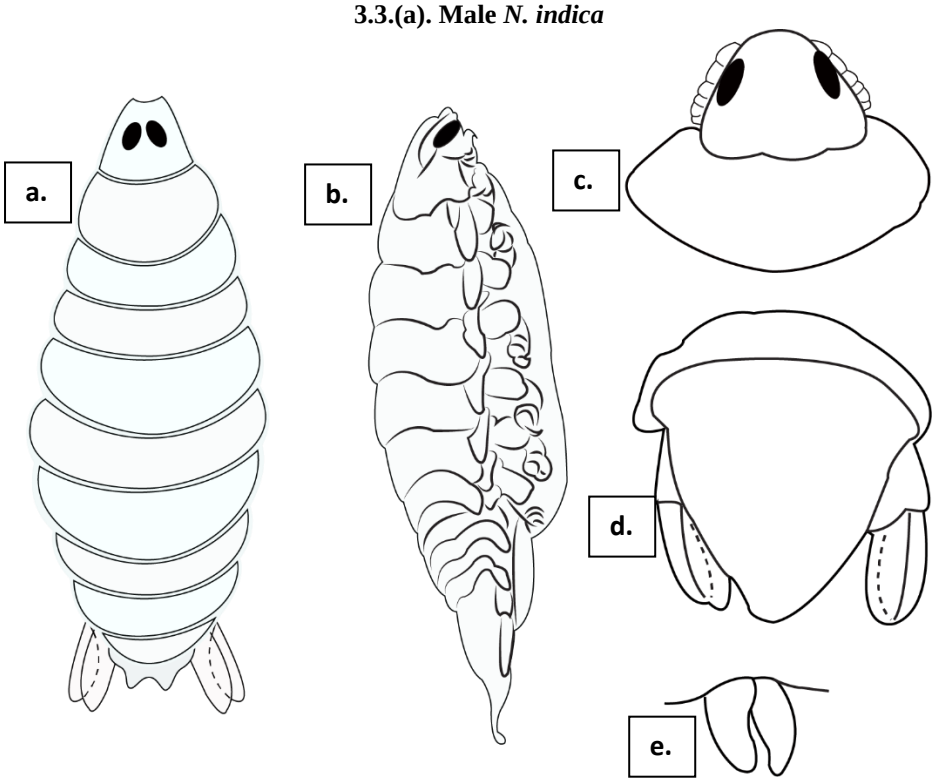
Body twisted to left, smooth and polished dorsal surfaces, broadest at pereonite 4, narrowest pereonite 1; pereonite lateral borders posteriorly projecting. Coxae 2-3, wide with posteroventral angles rounded; coxae 4-7 acute, posteriorly pointed, not extending past pereonite margin; Cephalon longer than wide, visible from dorsal view, triangular, eyes oval with distinct margins. The pereonite 6 and 7 are narrower than the pereonite 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 4 terminal strong setae. Maxilla medial lobe partially united to lateral lobe; medial lobe with 2 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 black, 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 and lateral border, a widely rounded distal margin, and a highly convex medial margin. Pleopod 2-5 are similar to pleopod 1; pleopod 3-5 have fleshy folds, increasing in size from pleopod 3-5; peduncle lobes are present, increasing in size from 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 is an endopod, and there are no setae (Wal S, Smit NJ, Hadfield KA., 2017).

3.2.(a). Female *N. indica*

3.3. MORPHOLOGICAL DESCRIPTION OF MALE

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 1.0-2.0mm and width of 2.0mm. The pereonites number 7, the pleonites number 5. Pleotelson has a length of 2.9-3.2mm and a width of 2.5-3.2mm. Males have larger eye diameter in proportion to their head than females. Body is not twisted. All of the order characters are female (Seth JK, Mohapatra SK, Mohanty SR, Behera RK, Mohapatra A., 2021). Penes are prominent, measuring 2.3 times the width of the base, and tubercules are connected at the base (Wal S, Smit NJ, Hadfield KA., 2017).

3.3.(a). Male *N. indica*



3.3.(b). *Norileca indica* (Milne Edwards, 1840) male (a) Dorsal body, (b) lateral body, (c) dorsal view of cephalon and pereonite 1, (d) dorsal view of pleotelson with uropods, (e) penes

4. RESULTS AND DISCUSSION

Rastrilleger kanagurta is usually distributed and occurring throughout the year within the Arabian Sea. In general, parasitic infection of fish mainly depend on host factors like size, maturity stage, feeding and breeding, life cycle. Isopods inhabiting the branchial chamber inflict damage to gills through attachment and feeding can cause harm to the host. *Norileca indica* is one of the biggest fish parasites, which causes considerable damage to its hosts. Infestation causes serious problems either directly or indirectly affecting the physiological status of host.

The prevalence and intensity of crustacean parasites, *Norileca indica* along the Mumbai coast of India were comparatively more in female fishes than that of male fishes (Radhakrishnan, T. and N.B. Nair, 1983). Parasites occupies the complete branchial chamber of the host and produce pressure on the gill surface thus affecting the efficiency of respiration. Although the infestation may not lead to the immediate death, it affects the normal growth of the host fish. This results in economic losses among some infected fish species.

5. ACKNOWLEDGEMENT
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6. REFERENCES

1. Moller, H. and K. Anders, 1986. Diseases and parasites of Marine fish. Kiel: Moller, pp: 365.
2. Sethi, S., Occurrence of isopod parasites in clupeids off Chennai coast, India. *Indian J. Fish*., 59(3) (2012): 153-155.
3. Trilles, J.P., Ravichandran S., and Rameshkumar G., A checklist of the Cymothoidae (Crustacea, Isopoda) recorded from Indian fishes. *Acta. Parasitol*. 56(4) (2011) 446-459.
4. Moller H, and Anders K. "Diseases and parasites of Marine fish", German Federal Republic: Verlag Moller, 1986,365.
5. Anandkumar G Rameshkumar, Ravichandran S, Priya ER, Nagarajan R, Leng AGK. "Occurrence of cymothoid isopod from Miri, East Malaysian marine fishes," Journal of Parasitic Diseases, 2013: 39:206-210.
6. Rameshkumar G, Ravichandran S, Sivasubramanian K, Trilles JP. "Invasion of parasitic isopods in marine fishes," J Coast Life Med, 2013b: 1:99-105.
7. Rameshkumar G, Ramesh M, Ravichandran S, Trilles JP, Subbiah S. "Host-parasite relationships: Mothocya JP plagulophora parasitizing Hemiramphus far in the Southeast coast of India," J Parasit Dis, 2014a:39(4)645-648.
8. Rameshkumar G, Ravichandran S, Sivasubramanian K. "A new record of parasitic isopod for the Indian fauna (Mothocya karobran, Bruce, 1986) from Strongylura strongylura in the Pazhayar region, Southeast coast of India," J Parasit Dis, 2014b:38(3):328-330.
9. Smit NJ, Bruce NL, Hadfield KA. "Global diversity of fish parasitic isopod crusteceans of the family Cymothoidea," International Journal for Parasitology: Parasites and Wildlife, 2014:3(2):188-197.
10. Anandkumar G Rameshkumar, Ravichandran S, Nagarajan R, Prabhakaran K, Ramesh M. "Distribution of isopod parasites in commercially important marine fishes of the Miri coast, East Malaysia, "Journal of parasitic diseases, 2017: 41:55-61.
11. Aneesh PT, Sudha K, Helna AK, Arshad K, Anilkumar G, Trilles JP. "Simultaneous multiple parasitic crustecean infestation on Banded Needlefish, Strongylura leiura (Belonidae) from Malabar coast, India," International Journal of Scientific and Research Publications, 2013:3:1-9.
12. Aneesh PT, Sudha K, Helna AK, Anilkumar G, Trilles JP. "Multiple parasitic crustecean infestation on belonid fish Strongylura strongylura," Zookeys, 2014, 2014:457:339-353.
13. Panakkool- Thamban, Kappalli S, Kottarathil HA, Gopinathan A. "Mothocya renardi (Bleeker, 1857) (Crustecea: Isopoda: Cymothoidae) parasitizing Strongylura leiura (Bleeker) (Belonidae) off the Malabar coast of India: Redescription, occurrence and life-cycle," Systematic Parasitology,2016:93(6):583-599.
14. Trilles, J.P., Ravichandran S., and Rameshkumar G., 2011; Ramdane, Z., Bensouilah, M.A. and Trilles, J. P., The cymothoidae (Crustacea, Isopoda), parasites on marine fishes, from Algerian fauna. *Belgian J. Zool*., 137(2007) 67-74.
15. Trilles, J. P., Les Cymothoidae (Crustecea, Isopoda) du monde. Studia Marina, 21/22(1994) 5-288.
16. Ravichandran S, Sivasubramanian K, Rameshkumar G, Veerappan N." High prevalence and infestation of Mothocya renardi (Isopoda, Cymothoidae) in marine fish Strongylura leiura (Bleeker, 1850)," Journal of Parasitic Diseases, 2016:40(4):1368-1391.
17. Fogelman, R. M., Kuris, A. M. and Grutter, A. S., Parasitic castration of a vertebrate: effect of the cymothoid isopod, *Anilocra apogonae*, on the five- lined cardinal fish. *Cheilodipterus quinquelineatus. Int. J. Parasitol*., 39 (2009)577-583.
18. Milne- Edwards H. 1840. Histoire naturelle des Crustaces: comprenant I' anatomie, la physiologie et al classificication de ces animaux. Librairie Encyclopedique Roret, Paris, s III, 605 pp. doi: 10.5962/bhltitle. 16170.
19. Nagasawa, K. and Petchsupa, N., *Norileca indica* (Isopoda, Cymothoidae) parasitic on Bigeye Scad, *Selar crumenophthalmus* in Thailand. *Biogeography* 11 (2009) 131-133.
20. Trilles, J.P., Les Cymothoidae (Isopoda, Flabellifera) des cotes Francaises. III. Les Lironecinae Schiodte et Meinert, 1884. Bull du Mus Nat d'hist Nat Paris 3- serie, no. 392. *Zoologie* 272(1976) 801-820.
21. Yamauchi, T., Ohtsuka, S. and Nagasawa, K., Ectoparasitic Isopod, *Norileca indica* (Crustecea, Isopoda, Cymothoidae), obtained from the Stomach of *Coryphaena hippurus* (Perciformes, Coryphaenidae) in the Phillippines. *Biogeography* 7(2005) 25-27.
22. Ghani, N., Isopod parasites of marine fishes of Pakistan, *Proc. Pakistan Con. Zool*., 23 (2003)217-221.
23. Yu, H. Y., Li, X. Z., Study on the Cymothoidae from Chinese waters. *Stud. Mar. Sin*. 45(2003) 223-238.
24. Rokicki, J., *Lironeca indica* Edwards, 1840 (Crustacea, Isopoda) from *Selar crumenopthalmus* (Bloch). *Wiad. Parazytol*. 38 (1982) 205-206.
25. Avdeev, V.V., Notes on the distribution of marine Cymothoidae (Isopoda, Crustacea) in the Australian- New Zealand region. *Folia Parasitol.* 25 (1978) 281-283.
26. Bruce, N. L., The genera *Catoessa*, *Elthusa*, *Enispa*, *Ichthyoxenus*, *Idusa*, *Livoneca* and *Norileca* n. gen. (Isopoda, Cymothoidae), crustacean parasites of marine fishes, with descriptions of eastern Australian species. *Rec. Aust. Mus.*, 42(3) (1990)247-300.
27. Rameshkumar G, Ravichandran S, Sivasubramanian, K. and Trilles, J.P., New occurrence of parasitic isopods from Indian fishes. *J. Parasit. Dis*., 37(2012) 42-46.

28. Neeraja, T., Gayatri, T. and Ummey, S., Occurrence of the isopod , *Norileca indica* (Isopoda: Cymothoidae) on big eye scad, *Selar crumenopthalmus* (Bloch) off Mumbai coast, India. *Indian J. Fish*., 61(1) (2014) 49-56.
29. Cressey RF, Collette BB, Russo JL. 1983. Copepods and scombrid fishes: A study in host-parasite relationships. Fishery bulletin United States, National Marine Fisheries Service.
30. Javed W, Yasmeen R. 1999. A new parasitic isopod of the genus Norileca (Crustacea, Cymothoidae) from the Arabian Sea. Pakistan Journal of Marine Sciences 8(1):55–60.
31. Richardson H. 1910. Marine isopods collected in the Philippines by US fisheries steamer Albatross in 1907–1908. Department of Commerce and Labor, Bureau of Fisheries Document 736:1–44.
32. Ghani N. 2003. Isopod parasites of marine fishes of Pakistan. P Pak Con Z 23:217–221.
33. Bruce NL. 1990. The genera Catoessa, Elthusa, Enispa, Ichthyoxenus, Indusa, Livoneca and Norileca n. gen. (Isopoda, Cymothoidae), crustacean parasites of marine fishes, with descriptions of eastern Australian species. Rec Aust Mus 42(3):247–300.
34. Panakkool-Thamban A, Kottarathil HA, Kappalli S. 2016. Branchial cymothoids infesting the marine food fishes of Malabar Coast. J Parasit Dis 40(4):1270–1277. doi:10.1007/s12639-015-0666-0.
35. Morton B. 1974. Host specificity and position on the host in *Nerocila phaeopleura B*leeker (Isopoda, Cymothoidae). Crustaceana 26:143–148.
36. Saarinen M, Taskinen J. 2005. Local adaptation in a crustacean parasite–molluscan host interaction: a field experiment. Ecol Ecol Res 7(8):1191–1199.
37. Wal S, Smit NJ, Hadfield KA. "Redescription and molecular characterisation of the fish parasitic isopod *Norileca indica* (Milne Edwards, 1840) (Crustacea: Isopoda: Cymothoidae) with a key to the genus," Afr Zool,2017:52:163-175.
38. Seth JK, Mohapatra SK, Mohanty SR, Behera RK, Mohapatra A. "Confirmation on the occurrence of *Cymothoa indica*, and first record of *Norileca indica*, with a note on new host records of *Nerocila arres*, and *Nerocila depressa* (Isopoda: Cymothoidae) from Odisha coast, India," Journal of Parasitic Diseases, 2021, 1-8.
39. Radhakrishnan, T. and N.B. Nair, 1983. Nature of crustacean infestation of fish along the south west coast of India. Aeta. Incti. Et-pise, 13: 93-115.