Infection of the Parasitic Isopods on Commercial Fishes of the Northern Part of the East Coast of India

Dipanjan Ray (✉ dipanjan2010@gmail.com)  
Bajkul Milani Mahabidyalaya

Pamasree Mohapatra  
University of Calcutta

Narayan Ghorai  
West Bengal State University

Jaya Kishor Seth  
Berhampur University

Anil Mohapatra  
Zoological Survey of India

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Abstract

The present study report the parasitic isopod infection on commercial fishes of the northern part of the east coast of India collected during the period 2010-2015 from the marine water of Odisha and West Bengal. During the study, 394 isopods were collected after examining 2668 fishes. These include 14 species of isopods, out of which 13 belong to 5 genera under the family Cymothoidae, and a single species *Alitropus typus* belongs to the family: Aegidae. Of these, 03 species viz., *Catoessa boscii*, *Cymothoa eremita* and *Nerocila loveni* are first record to the northern part of east coast of India. Out of the 2668 fishes examined, 326 examples belonging to 34 species under 19 different families were infected by different isopods. Member of the host fish family Carangidae was more parasitized by isopods, followed by Clupeidae, Scoberidae, and Leiognathidae. The dominant isopods were *Nerocila phaiopleura* and *Catoessa boschii*. The total prevalence was 12.21. The prevalence was high on the host fish *Alepes djedaba* and lowest on *Lutjanus johnii*. The total infection caused by genus *Alitropus* was 1.52%, *Anilocra* was 5.07%, *Catoessa* was 24.87%, *Cymothoa* was 0.25%, *Nerocila* was 65.73%, and *Norileca* was 2.55%. The isopod prevention was high during the post-monsoon and low during the monsoon period.

Introduction

The parasitic isopods usually occur in the freshwater, estuarine and marine ecosystem, especially near the coastal environment. In these ecosystems, they play an essential role in the ecological food chain and removal of the decaying matter (Bharadhirajan 2014). Besides this ecological role, the study of these isopods is also important as they cause a range of damages to the fishes, thereby threatening the fisheries sector (Mohapatra et al. 2021; Seth et al. 2020 a, b; 2021). Out of the 144 known isopod families, only a few are parasitic. The family Cymothoidae is one of the most prominent families of the order Isopoda. The representative of the family is the obligate parasites, known to show a high degree of the host and site-specificity to the host fishes Ravichandran et al. (2019). However, in some species, host specificity is weak.

The family Cymothoidae consists of more than 380 species under 43 genera worldwide (Smith et al. 2014). Of these, 48 valid species under 16 genera are reported from Indian water (Ravichandran et al. 2019). The adult forms of the family Aegidae White, 1850 of the order Isopoda, are considered temporary parasites as they often leave their host after a blood meal. Due to this nature, they have been recently classified as free-living micro-predators (Ravichandran et al. 2019). The family Aegidae includes around 152 species under 8 genera worldwide (Al-Zubaidy and Mhaisen 2014). The genus *Alitropus* H. Milne Edwards, 1840 is monotypic contains the only species *A. typus* (Yule and Sen 2004). This species primarily occurs in the coastal ecosystem's fresh water and low salinity zone (Bruce 1983).

In India, most of the reports and records on parasitic isopods are concentrated around the south-east coast of India (Ravichandran et al. 2019). There are reports on the isopods parasites from the northern part of the east coast of India (NPECI), mainly from the state of Odisha and West Bengal (Chliton 1924; Seth et al. 2014; Dev Roy et al. 2015; Behera et al. 2016; Ray et al. 2016; Dev Roy and Rath 2017; Balakrishnan and Tudu 2020; Ray et al. 2020; Seth et al. 2020 a, b; Mohapatra et al. 2021; Seth et al. 2021), but still, a comprehensive report is lacking (Seth et al. 2020 a, b; 2021). Further, on the prevalence of these isopods on the host fish species, there is hardly any report from the NPECI. Therefore, this study was carried out to know the infection and prevalence of these isopods along the NPECI.
Materials And Methods

During the study period (August 2010-January 2015), a routine observation (at the rate of 3-5 days per month/seasons) of the marine fishes from different selected fish landing stations of the NPECI viz. West Bengal (Digha, Shankarpur, Junput, Hijli-Dariapur, Kakdwip-Namkhana, and Sagar Island) and Odisha (Talsari, Chandipur, Dhamra, Paradip, Puri, Chilika, and Gopalpur) were conducted. Fishes and isopod were collected from fish landing centers where trawl net and gill net generally operated; some samples were also collected from shore seine nets. Fishes were checked carefully for ectoparasitic infection on their body surface, fins, gill, and buccal cavity. After photography, isopods were removed from their attachment sites with the help of fine forceps and placed into 70% ethanol. The isopods were examined using Leica-EZ4 microscope. Isopods were identified according to Trilles (1975 and 1979), Bowman and Tareen (1983), Bruce (1887), Rameshkumar et al. (2011) and (2012), and Trilles et al. (2013). The prevalence was calculated according to Margolis et al. (1982). Host species identification was based on Fischer and Bianchi (1984), Talwar and Kacker (1984), Froese and Pauly (2020). Specimens were deposited and registered in the Marine Aquarium and Regional Center (MARC), Zoological Survey of India, Digha. The specimens of *A. typus* was deposited and registered in Estuarine Biology Regional Centre, Zoological Survey of India, Gopalpur-on-Sea, Odisha. The registered specimens along with their voucher number are presented in table 1. The seasonal impacts of the parasites on the host were also examined.

Results

During the study, 14 species of parasitic isopods were found (Figure 1); from those, 13 species belong to family Cymothoidae and 01 species to the family Aegidae. Out of theses 14 species, 03 species viz., *Catoessa boscii*, *Cymothoa eremita* and *Nerocila loveni* are first record to the NPECI. Few selected photographs of hosts and their parasites collected during the study period are presented in figure 2. A comprehensive list of the isopods species along with their host collected during the study period and earlier report form Indian water are presented in Table 2. During this study, it was observed that isopods parasitized 34 species of host fishes under 19 families. Number of host fish species examined and parasitized by isopods are presented in Figure 3. Most of the isopod attached with host species mainly three regions: body surface, buccal cavity, and inside the gill membrane (Branchial parasite). Host family-wise infection by isopods is provided in figure 4. Member of the family Carangidae are more parasitized by the isopods followed by Clupeidae, Scomberidae, and Leiognathidae (Figure 4). The percentage of dominating isopods genus wise and species wise are provided in figures 4 and 5 respectively. The dominating genus was *Nerocila* (Figure 5), *Nerocila phaeopleura* and *Catoessa boscii* are the main dominant isopod in these areas (Figure 6). The seasonal variation of isopod infection is presented in figure 7. The Isopod prevalence was high during October to February (Post monsoon season of the study areas) and very low during April to August (monsoon season of the study areas) (Figure 7). The prevalence is provided in table 3. Total prevalence was 12.21. The prevalence was highest on *Alepes djedaba* (34.95) and lowest on *Lutjanus johnii* (1.29).

Discussion And Conclusion

The parasitic isopods viz., *Catoessa boscii*, *Cymothoa eremita*, and *Nerocila loveni* were not recorded earlier from the NPECI; therefore, this is the first materials evidence of these parasites from these regions. Further, the host record of *Alepes djedaba*, *Alepes kleinii*, and *Leiognathus blochii* for the parasite *Catoessa boscii*; the host record of *Sardinella longiceps*, *Lactarius lactarius*, and *Leiognathus blochii* for the parasite *Anilocra*
dimidiata; the host Carangoides malabariicus for the parasite Nerocila depressa, the host Equulites leuciscus for the parasite N. loveni, the host fish species Siganus javas, and Epinephelus coioides for the parasite N. phaiopleura, the host fish species Alepes djedaba for the parasite N. poruvae, the host fish species Arius arius, and Terapon jarbua, Plotosus lineatus, Nibea maculate for the parasite N. serra, and the host fish species Nemipterus japonicus, and Priacanthus tayneus for the parasite N. sigani are the new host records for the northern part of east coast of India (Table2).

As these isopods are connected with many host species during the study period (Figure 3 and 4, Table 2 and 3), it indicates higher diversity of fishes in the NPECI. The Nerocila is the dominating genus during the study period (Figure 5 and 6), which shows the high adaptability of the species of the genus to a range of environmental conditions prevailing in these regions. The high prevalence of isopod on the host species Alepes djedaba (Table3) may be due to the higher host-specificity of parasitic isopods for this host species in these regions.

The Isopod prevalence was high during post-monsoon than monsoon (Figure 7). It may occur due to the lesser salinity of the water in these sampling areas during the monsoon period compared to post-monsoon. During monsoon, lower salinity is due to higher rainfall and freshwater discharge through estuarine influence. During post-monsoon, salinity gradually increases, and this condition facilitates the isopods infestation. During this study, it is observed that most of the Nerocila species were ovigerous throughout the year, but the prevalence was high during post-monsoon; thus, optimum salinity may be the reason and is helping in larval development. In many free-living crustaceans, post-monsoon plays a vital role in their breeding, and climatic conditions affect the reproduction of Cymothoidae (Sudha and Anilkumar 1996; Syama et al. 2010; Leanarods and Trilles 2003).

In recent times, study on the infection and prevalence of parasitic isopods on commercial fishes were reported from Paranagipettai coast, India (Bharadhirajan, 2014), Malabar Coast, India (Aneesh et al. 2016; Rijin et al. 2017), Mirri, East Malaysia (Anand Kumar et al.2015, 2017), Atlantic menhaden (Rose et al.2020) and other parts of the globe as well. However, before the present report, no such comprehensive study based on the infection parasitic isopods on the commercial fishes of NPECI was reported. Therefore, the extension of this work on the infection pattern and other aspects of the host-parasite relationship in these regions will provide more insight into the isopods biology.

**Declarations**

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**Conflict of interest statements**

Authors declare that they have no conflict of interest.

**Research involving human participants and/or animals**

Since the animals are not under schedule lists/protected categories, so ethical clearance is not applicable.
Informed Consent
Not applicable

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**Tables**

**Table 1: Specimens along with their voucher numbers**
| Name of the species | Voucher number         |
|---------------------|------------------------|
| *Anilocra dimidata* | MARC/ZSI/A3962         |
| *Catoessa boschii*  | MARC/ZSI/A3963         |
| *Cymothoa eremita*  | MARC/ZSI/A3964         |
| *Nerocila depressa* | MARC/ZSI/A3965         |
| *Nerocila exocoeti* | MARC/ZSI/A3659, MARC/ZSI/A3966 |
| *Nerocila phaeopleura* | MARC/ZSI/A3969     |
| *Nerocila poruvae*  | MARC/ZSI/A3660, MARC/ZSI/A3970 |
| *Nerocila longispina* | MARC/ZSI/A3967      |
| *Nerocila loveni*   | MARC/ZSI/A3661, MARC/ZSI/A3968 |
| *Nerocila serra*    | MARC/ZSI/A3971         |
| *Nerocila sigani*   | MARC/ZSI/A3972         |
| *Nerocila sundaica* | MARC/ZSI/A3973         |
| *Norileca indica*   | MARC/ZSI/A3662, MARC/ZSI/A3974 |
| *Alitropus typus*   | EBRC/ZSI/ Cr-13291     |

Table 2: A comprehensive host-parasite list and localities with references to 13 isopod species of family Cymothoidae and one species of the family Aegidae found along the northern part of the east coast of India and other regions of India (Note: * indicates new host record to the northern part of the east coast of India)
| Isopod species | Host species | Localities | References |
|----------------|--------------|------------|------------|
| **Buccal Parasites (Family:Cymothoidae)** | | | |
| *Catoessa boschii* | *Carangoides malabaricus* | Parangipettai Coast and South-east coast | Trilleset al. 2012, Rameshkumaret al. 2016, Ravichandran et al. 2019 |
| *Alepes djedaba*, *Alepes kleinii*, *Leiognathus blochii*, *Carangoides malabaricus* | | Present study | |
| *Cymothoa eremita* | *Eleutheronema tetractyllum*, *Lutjanus johnii*, *Lutjanus argentimaculatus*, *Mystus gulio*, *Nemapteryx nenga*, *Nematalosa nasus*, *Chanos chanos*, *Platycephalus indicus*. | Pulicat Lake | Jayadev Babu and Sanjeeva Raj, 1984. |
| *Etroplus suratensis* | | Goa Coast | Parveen Rattan and Parulekar, 1998. |
| *Lutjanus johnii*, host (Unknown) | | Present study | |
| **Body Surface parasites (Family:Cymothoidae)** | | | |
| *Anilocra dimidiata* | *Lactarius lactarius* | Travancore | Pillai, 1954. |
| | *Sardinella longiceps*, *Leiognathus sp.* | Vedaranyam Coast, Southeastern Coast | Rameshkumar, *et al.*, 2011. |
| | | | |
| | *Karalla daura* | Gopalpur-on-Sea, Odisha coast | Seth *et al.* 2020a |
| | *Sardinella longiceps**, Lactarius lactarius**, *Leiognathus blochii* * | | Present Study |
| *Nerocila depressa* | *Opisthopterus tardoore* | Mumbai Coast | Bal and Joshi, 1959; Parimala, 1984 |
| | | | |
| | *Sardinella gibbosa* | Parangipettai Coast and South-east coast | Trilles, *et al.*, 2013 |
| | | | |
| | *Scleroides leptolepis*, *Carangoides malabaricus* | Parangipettai Coast and South-east coast | Rameshkumar, *et al.*, 2016. |
| Host Name | Location | Reference |
|-----------|----------|-----------|
| Coilia dussumieri | Malabar coast | Aneesh, et al., 2013. |
| Selaroid leptolepis, Megalaspsis cordyla | Gopalpur-on-Sea, Odisha | Seth et al. 2020 |
| Lagocephalus lunaris, Lepturalanthus pantalui | Digha, West Bengal | Balakrishna and Tudu, 2020 |
| Sardinella gibbosa, Opisthopterus tradoore, Carangoides malabariicus* | Present study |
| N. exocoeti | Exocoetus volitans | Parangipettai Coast and South-east coast | Sivasubramanian, et al, 2011 and Trilles et al. 2013 |
| Parexocoetus brachypterus | Travancore | Pillai, 1954 |
| Parexocoetus brachypterus | Chennai, Tamil Nadu | Aneesh et al. 2017 |
| Rhynchorhampus brachypterus | Malabar Coast | Aneesh et al. 2017 |
| Hemirhampus far | Parangipettai Coast, South-east coast | Sivasubramanian and Ravichandran, 2013 |
| Host (Unknown) | Present Study |
| N. longispina | Terapon puta, Otolites ruber | Vedaranyam, Southeastern Coasts of India | Rameshkumar, et al., 2011. |
| Ambassis ambassis | Malabar coast | Aneesh, et al., 2013. |
| Host (Unknown) | Present study |
| N. loveni | Eubleekeria splendens | Parangipettai; Nagapattinam and Tamilnadu coast | Trilles, et al., 2013; Rameshkumar, et al., 2013a and 2013b. |
| Carangoides malabaricus | Parangipettai | Rameshkumar, et al., 2016 |
| Thryssa malabarica, Escualosa thoracata | Malabar coast | Aneesh, et al., 2013. |
| Equulites leuciscus*; Deveiximentum insidiator, Escualosa thoracata, Eubleekeria splendens | Present study |
| N. phaiopleura | Ilisha melastoma, Parastromateus niger | Kakinada, Tamil Nadu, Bay of Bengal, India | Bruce and Harrison-Nelson, 1988. |
| Fish Species                              | Location                        | Reference                      |
|------------------------------------------|---------------------------------|--------------------------------|
| *Chirocentrus dorab, Sardinella*         | Parangipettai Coast             | Veerapan and Ravichandran, 2000.|
| *S. longiceps, S. sindensis, S. brachysoma,* |                                 |                                |
| *Dussumeria acuta, Thryssa dussumieri,*  |                                 |                                |
| *T. mystax, Scomberomorus guttatus*      |                                 |                                |
| *Chirocentrus dorab*                     | Parangipettai Coast             | Ravichandran, *et al.*, 2001.  |
| *Stolephorus commersonii*                | Parangipettai Coast             | Rajkumar and Perumal, 2004;    |
|                                          |                                 | Rajkumar, *et al.*, 2006.      |
| *Arius jella*                            | Parangipettai Coast             | Rajkumar, *et al.*, 2008.      |
| *Istiophorus platypterus*                | Bay of Bengal                   | Barnard, 1936.                 |
| *Istiophorus platypterus*                | Chennai                         | Ramakrishna and Venkata Ramaniah, 1978. |
| *Rastrelliger kanagurta*                 | Parangipettai, Southeast Coast  | Rameshkumar and Ravichandran, 2010. |
|                                          |                                 | Seth, *et al.*, 2014           |
| *Carangoides malabaricus, Chirocentrus dorab* | Tamil Nadu coast                | Trilles, *et al.*, 2013        |
| *Dussumeria acuta, Gazza minuta, Eubleekeria splendens, Rastrelliger kanagurta, Sardinella gibbosa, S. longiceps, Scleroides leptolepis, Sphyraena jello, Tenualosa ilisha, Thryssa mystax.* | | |
| *Istiophorus platypterus*                | South 24 Parganas, West Bengal  | Ghatak, 1998                   |
| *Liza parsia, Thryssa dussumieri, Sardinella albella* | Parangipettai | Bharadhrirajan, *et al.*, 2014. |
| *Thryssa mystax, Thryssa setirostris, Thryssa malabarica, Opisthopterus tardoore* | Malabar coast | Aneesh, *et al.*, 2013 |
| *Sardinella gibbosa*                     | Tamil Nadu coast                | Rameshkumar, *et al.*, 2013a.  |
| *Chirocentrus nudus*                     | Cuddalore, Tamil Nadu           | Raja, *et al.*, 2014           |
| *Siganus javas*, Sardinella gibbosa, Sardina longiceps, Dussumeria acuta, Opisthopterus tardoore, Carangoides malabaricus, Epinephelus coioides*, Thryssa dussumieri, Scleroides leptolepis,* | Present study | |
### Rastreliger kanagurta, Parastromateus niger, Leiognathus splendens

| **N. poruva** | **Trichurus leturus; Thryssa mystax** | Vedaranyam Coast, Rameshkumar, et al., 2011. | **Southeastern Coast** |
|---------------|---------------------------------------|---------------------------------------------|-----------------------|
| **Setipinna tenuifilis** | | Bakkhali and Digha | Dev Roy, et al., 2012. |
| **Siganus canaliculatus** | | Paradip, Odisha | Ray et al. 2020 |
| **Setipinna taty, Ablennes hians, Rhynchirhampus gorgii, Pampus argentus** | | Digha, West Bengal | Ray et al. 2020 |
| **Siganus canaliculatus, Alepes djedaba*, Rhynchirhampus gorgii, Setipinna taty** | | Present study | |

| **N. serra** | **Hexanematichthys sagor** | Off Devi River, Odisha Coast, Vizagapatam, Canjam Coast (Odisha) | Barnard, 1936. |
|---------------|---------------------------|---------------------------------------------------------------|------------------|
| **On several species of shoal fishes** | | Travancore | Pillai, 1954. |
| **Arius maculatus** | | Nagappatinam | Trilles, et al., 2013 |
| **Host (Unknown)** | | West Bengal, Odisha, Andhrapradesh | Ghatak, 1998. |
| **Enhydrina schistose (Sea snake)** | | Parangipettai Coast | Saravanakumar, et al., 2012. |
| **Arius arius*; Arius maculatus, Terapon jarbua*, Plotosus lineatus*, Nibe maculate*** | | Present study | |

| **N. sigani** | **Parastromateus niger** | Formio niger | Bruce and Harrison-Nelson, 1988. |
|---------------|--------------------------|--------------|----------------------------------|
| **Siganus oramin** | | Parangipettai and Nagapattinam | Trilles, et al., 2013 and Rameshkumar, et al. 2013b. |
| **Terapon threps** | | Paradip, Odisha | Dev Roy and Mitra, 2013. |
| **Lutjanus lutjanus** | | Gopalpur-on-Sea, Odisha | Seth et al. 2020 |
| **Lutjanus lutjanus, Nemipterus japonicas*, Priacanthus tayneus*, Parastromateus niger.** | | Present study | |
| Species                  | Taxonomy                        | Location and Reference                      |
|-------------------------|---------------------------------|---------------------------------------------|
| *N. sundaica*           | Unknown                         | off Godavari (Sacraments mouth), Ganjam Coast, Barnard, 1936. |
| *Otolithes ruber, Terapon jarbua, Thryssa mystax,* | *Epinephelus quoyanus, Ilisha melastoma, Sardinella fimbriata* | West Coast of India, Chidambaram and Devidas Menon, 1945. |
| Estuarine fishes        |                                 | West Bengal, odisha, Ghatak, 1998           |
| *Carangoides malabaricus, Ilisha melastoma, Otolithoides ruber, Scleroides leptolepis, Terapon puta, Opisthopterus tardoore* | | Tamil Nadu Coast, Trilles, et al., 2013; Rameshkumar, et al., 2016; Rameshkumar, et al., 2013b |
| *Otolithes ruber*       |                                 | Nagapattinam, Southeast coast, Rameshkumar, et al., 2015b. |
| *Terapon jarbua*        |                                 | Present study                               |
| *Norileca indica*       | *Rastrelliger kanagurta*        | Parangipettai and Cochin, Rameshkumar, et al., 2013a & 2013b and 2015a. |
|                         |                                 | Malabar coast, Aneesh et al. (2016)         |
|                         |                                 | Visakhapatnam, Behera et al (2016)          |
|                         |                                 | Shankarpur, West Bengal, Ray et al. (2016)  |
|                         |                                 | Cochin coast, Jemi et al. (2020)            |
| *Atule mate*            |                                 | Gopalpur-on-Sea, Seth et al. 2021           |
| *Selar crumenophthalmus*|                                 | Off Mumbai coast, Neeraja, et al., 2014     |
| *Selar crumenophthalmus*|                                 | Great Nicobar Island, Seepana (2021)        |
| *Deveuximentum insidiator, Nemipterus randalli* | | Visakhapatnam, Behera et al. (2016) |
| *Rastreliger kanagurta* |                                 | Present study                               |
### Body Surface parasites (Family:Aegidae)

| Alitropus typus | *Channa striata* | Tamil Nadu | Nair and Nair 1983 |
|-----------------|------------------|------------|-------------------|
| *Oreochromis mossambicus* | | Tamil Nadu | Rameshkumar and Ravichandran 2010 |
| *Badis badis* | | Damoder river | Mitra and Deb Roy 2011 |
| *Etroplus suratensis, Oreochromis mosambicus* | | Present Study | |

**Table 3: Prevalence of Isopod during the study period**
| Host Species               | Family               | Examined host species | Infected host species | Prevalence |
|---------------------------|----------------------|-----------------------|-----------------------|------------|
| *Sardinella gibbosa*      | Clupeidae            | 125                   | 38                    | 30.4       |
| *Sardinella longiceps*    | Clupeidae            | 119                   | 35                    | 29.41      |
| *Dussumeria acuta*        | Clupeidae            | 34                    | 4                     | 11.76      |
| *Escualosa thoracata*     | Clupeidae            | 78                    | 9                     | 11.53      |
| *Thryssa dussummeri*      | Engraulidae          | 83                    | 7                     | 8.43       |
| *Setipinna tati*          | Engraulidae          | 78                    | 4                     | 5.12       |
| *Opisthopterus tardoore*  | Pristigasteridae     | 121                   | 16                    | 13.22      |
| *Alepes djedaba*          | Carangidae           | 148                   | 51                    | 34.45      |
| *Alepes kleinni*          | Carangidae           | 143                   | 16                    | 11.18      |
| *Carangoides malabariicus*| Carangidae           | 104                   | 20                    | 19.23      |
| *Parastromateus niger*    | Carangidae           | 128                   | 6                     | 4.68       |
| *Scleroides leptolepis*   | Carangidae           | 79                    | 6                     | 7.59       |
| *Rastrelliger kanagurta*  | Scomberidae          | 124                   | 28                    | 22.58      |
| *Rhynchorhamphus georgii* | Hemirhamphidae       | 17                    | 1                     | 5.88       |
| *Ablennes hians*          | Belonidae            | 9                     | 1                     | 11.11      |
| *Lactarius lactarius*     | Lacteridae           | 25                    | 1                     | 4          |
| *Eubleekeria splendens*   | Leiogonathidae       | 61                    | 7                     | 11.47      |
| *Leiognathus blochii*     | Leiogonathidae       | 56                    | 5                     | 8.92       |
| *Equilites lecuciscus*    | Leiogonathidae       | 12                    | 1                     | 8.33       |
| *Secutor insidiatior*     | Leiogonathidae       | 124                   | 12                    | 9.67       |
| *Plotosus lineatus*       | Plotosidae           | 62                    | 7                     | 11.29      |
| *Nibea maculata*          | Sciaenidae           | 89                    | 6                     | 6.74       |
| *Siganus canaliculatus*   | Siganidae            | 65                    | 2                     | 3.07       |
| *Siganus javus*           | Siganidae            | 32                    | 1                     | 3.12       |
| *Lutjanus johnii*         | Lutjaniidae          | 77                    | 1                     | 1.29       |
| *Lutjanus lutjanus*       | Lutjaniidae          | 54                    | 1                     | 1.85       |
| *Terapon jarbua*          | Terapontidae         | 102                   | 8                     | 7.84       |
| *Pryacanthus tayneus*     | Pryacanthidae        | 105                   | 2                     | 1.9        |
| *Nemipterus japonicus*    | Nemipteridae         | 125                   | 11                    | 8.8        |
| Species              | Family     |_count| Length | Percentage |
|---------------------|------------|------|--------|------------|
| Arius arius         | Ariidae    | 98   | 9      | 9.18       |
| Arius maculatus     | Ariidae    | 37   | 2      | 5.4        |
| Epinephelus coioides | Serranidae | 49   | 2      | 2.53       |
| Etroplus suratensis | Cichlidae  | 69   | 5      | 7.24       |
| Tilapia mosambicus  | Cichlidae  | 36   | 1      | 2.77       |
| Total               |            | 2668 | 326    | 12.21      |

**Figures**
Figure 1

Parasitic isopods collected during the study
Figure 2

Host fish species and their parasites, (A) Catoessa boschii on Alepes djedaba, (B) Anilocra dimidiate on Sardinella longiceps, (C) Nerocila serra on Arius arius, (D) C. boschii on Alepes kleinii, (E) C. boschii on Leiognathus blochii. (F) N. loveni on Deveximentum insidiator, (G) N. sigani on Lutjanus lutjanus, (H) N. serra on Nibea maculate, (I) N. serra on Plotosus lineatus, (J) N. sigani on Priacanthus tayneus, (K) N. depressa on Sardinella gibbosa
Figure 3

Number of fish species examined and parasitized by isopods during the study
Figure 4

Fish (family-wise) isopod infection
Figure 5

Pie chart of isopod (genus-wise) infecting the fish species during the study period
Figure 6

Pie chart of isopod (species wise) infecting the fish species during the study period

Number

[Graph showing number of isopods infecting fish species over the study period]
Figure 7

Seasonal variation of parasitic infection during the study period