J Parasit Dis (Oct-Dec 2016) 40(4):1386–1391
DOI 10.1007/s12639-015-0696-7

ORIGINAL ARTICLE

High prevalence and infestation of *Mothocya renardi* (Isopoda, Cymothoidae) in marine fish *Strongylura leiura* (Bleeker 1850)

Samuthirapandian Ravichandran[1] · Kanagasabapathy Sivasubramanian[1] · Ganapathy Rameshkumar[2] · Narayanasamy Veerappan[1]

Received: 2 April 2015 / Accepted: 6 May 2015 / Published online: 15 May 2015

Abstract Cymothoid isopods are parasites that cause severe damage to the fish species. The present study was focused to carry out the parasitic infestation on the one of the important marine fish *Strongylura leiura* during the 2 years period between June 2009 and May 2011. 272 fish specimens collected and about 157 (57.72 %) fishes were infested by the cymothoid which were concealed under the gill arches of the host. Infested parasite was identified as *Mothocya renardi*. The prevalence rate of parasites during different seasons of the range of host specificity of isopods was studied. Variation of infestation rate also depends on the size, length and weight of the host. The sites of infestation by the parasitic crustaceans are highly specific. The infestation had affected the normal growth of the host fish and also probably leads the high levels of secondary infections.

Keywords Infestation · Prevalence · Isopod parasites · *Mothocya renardi* · *Strongylura leiura*

Introduction

The Slender, or Banded, Needlefish inhabits coastal waters including mangrove inlets, and near-shore marine areas with a sandy bottom. Juveniles primarily inhabit the safer waters of mangroves. Needlefish are predatory and feed primarily on other fish as well as prawns and other free-swimming invertebrates. The Slender Needlefish ranges from East Africa and the Indian Ocean through most of Southeast Asia to northern Australia and the islands of the western Pacific Ocean. Parasitic diseases in fishes seriously limit aquaculture production and its economic viability. Knowledge of fish diseases and parasites is essential for successful aquaculture, particularly in a country like India with long and highly productive coastal waters. However, the tropical coastal and brackish waters, which likely contain many unknown parasites and pathogens, are poorly studied. Parasites play a pivotal role in the biology of fishes and can affect their behaviour, health and distribution (Rohde 1993).

They parasitize numerous marine species of commercial importance, including members of the families Mugilidae, Atherinidae, Serranidae, Carangidae, Sciaenidae, Embiotocidae, Bothidae, Clupeidae, Pleuronectidae, Scombridae and Haemulidae. Many species of fish are infected by cymothoids (Crustacea, Isopoda, Cymothoidae) and those marine cymothoids are almost exclusively inhabitants of shallow water, few being known from bathypelagic or greater depths. Strange attachment positions in cymothoid isopods are of interest because they may grant us insight into how diverse attachment positions originated. The majority of cymothoids which inhabit the branchial and oral cavities of fishes lack the intense pigmentation typical of isopods dwelling on the external surfaces of fishes. The present study was undertaken to estimate the prevalence and infestation of parasite in the needlefish *Strongylura leiura* collected from the Parangipettai, South east coast region of India.

✉ Samuthirapandian Ravichandran
sravicas@gmail.com

Ganapathy Rameshkumar
grkumarcas@gmail.com

[1] Centre of Advanced Study in Marine Biology, Faculty of Marine Science, Annamalai University, Parangipettai 608 502, Tamil Nadu, India

[2] Unit of Toxicology, Department of Zoology, School of Life Sciences, Bharathiar University, Coimbatore 641 046, Tamil Nadu, India

Materials and methods

The study was carried out in Parangipettai, South–east coast of India (11°29′N, 79°46′E) (Fig. 1). The needle fish *S. leiura* were obtained by captured during beam-trawl, bottom trawl and beach seine samplings. The fish samples were examined for the parasite infestation during the period between June 2009 and May 2011. After the examination, all isopod specimens were initially fixed in 4 % formalin, and then preserved in 70 % alcohol for later analyses back in the laboratory. Morphological characteristics obtained from collected isopod specimens were used for the identification of parasites (Bruce and Harrison-Nelson 1988; Trilles 1977). Parasitic isopods were deposited at Centre of Advanced Study in Marine biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, India under Annamalai University Collection of Ravichandran (AUCR). Prevalence and intensity were calculated using the indices of (Margolis et al. 1982) Length range frequency in relation to prevalence within the sample was analyzed. The dependence of infection on sex was statistically determined using χ^2 analysis. The condition factor (K) was calculated and defined as $K = 100w/L^3$ where w is the weight and L as total length in cm (Bakare 1970).

Results

A total of 272 slender needle fish *S. leiura,* ranging between 40 and 53 cm in length, were collected between June 2009 and May 2011 along the coastal region of south India

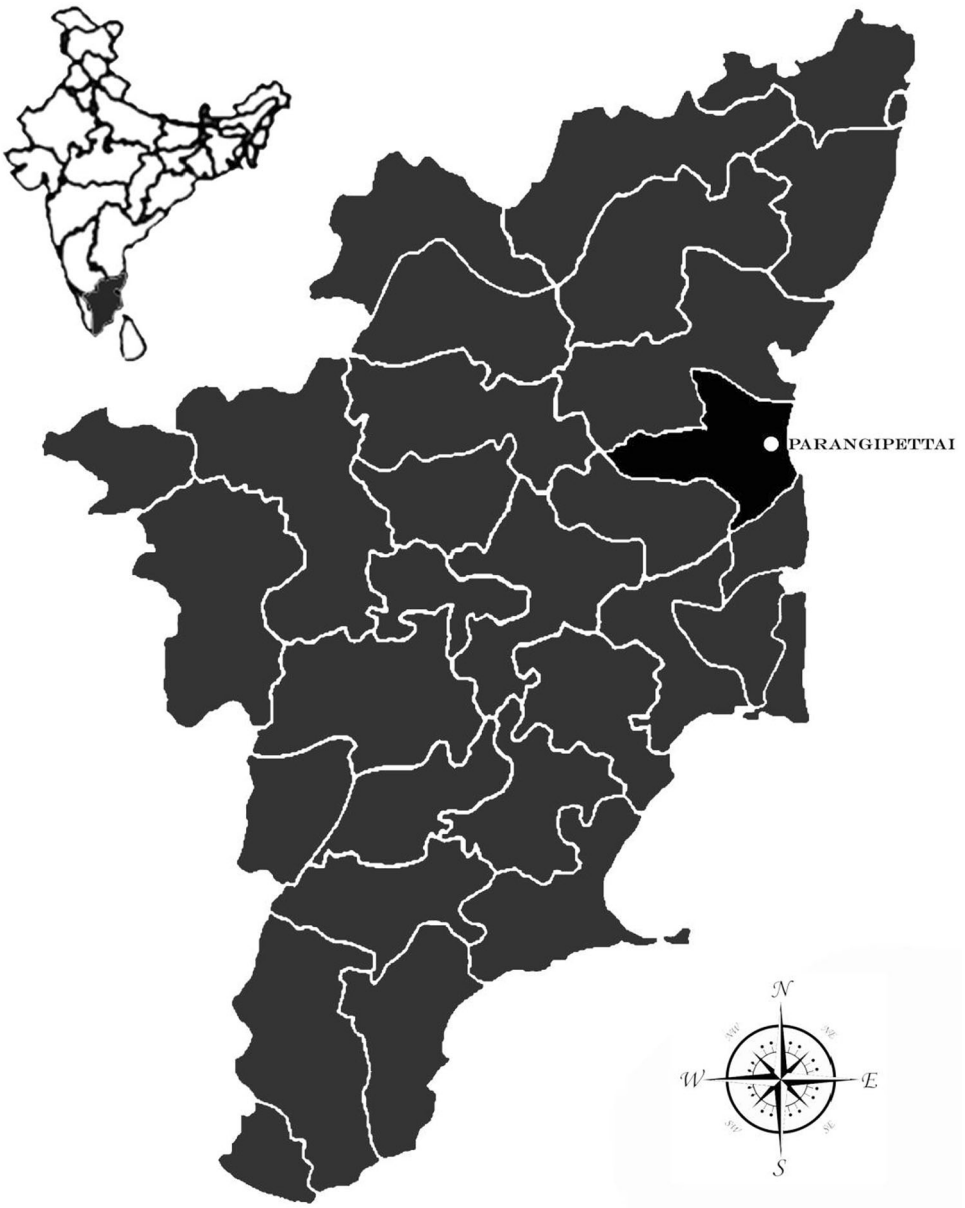

Fig. 1 Map showing the present study area and sampling site

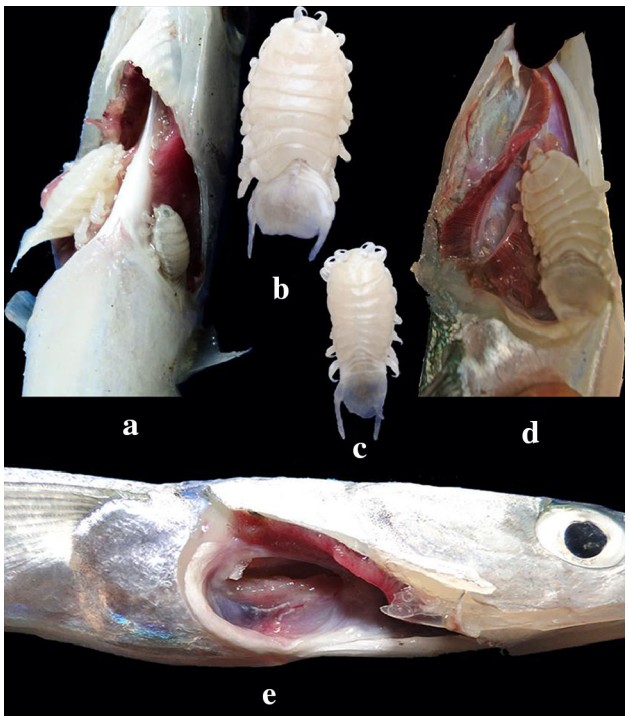

Fig. 2 **a** Attachment of both male and female parasite in single fish. **b** Female specimen of *M.renardi*. **c** Male specimen of *M.renardi*. **d** Attachment of the cymothoid isopod on the fish gill rack using their mouth parts fed on the muscle tissue. **e** Eroded skin due to the tissue fed by the isopod

and examined for the presence of ectoparasites. During examination about 157 (57.72 %) fishes were infested by the cymothoid which were concealed under the gill arches of the host. The maximum number of parasite infections was observed as two per host (Fig. 2a). The parasites were identified as *Mothocya renardi* which shows a degree of variability not present in other species of *Mothocya.* Size differences were ovigerous females (Fig. 2b) 24–36 mm (mean 30 mm), non-ovigerous females 26–35 mm (mean 30.5 mm); males (Fig. 2c) 15–23 mm (mean 19 mm). There are also distinct morphological variations in different populations. The population is characterized by being elongate, widest at pereonite 3, with the posterior pereonites being markedly narrow. The pleotelson is as long as wide, with a narrow apex in most specimens. Pereopod 7 has a distinctly lobate propodal palm. The uropods are long and gently tapered. The positions of attachment of the parasites were also observed and were found to be attached only to branchial region of *S.leuria.* At the site of attachment, the cymothoid isopod tore the layer of the fish gill rack using their mouth parts and fed on the muscle tissue beneath (Figs. 2d). The hooks of the pereopods penetrated into the skin and anchored the isopod to the fish host. At the mouthpart or pereopod site of attachment, the skin (epidermis and dermis) was eroded and exposed the

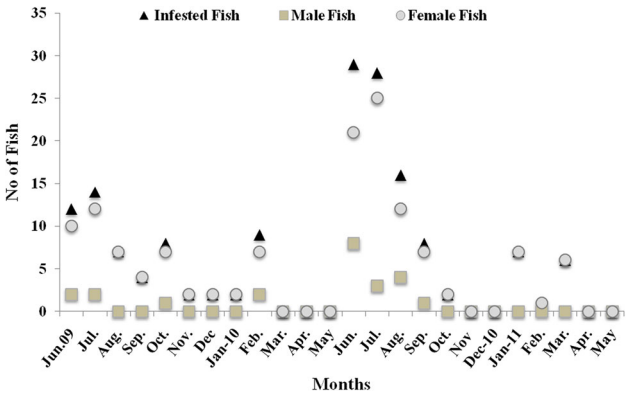

Fig. 3 Infestation of *M.renardi* in *S.leuria* during various months in relation to host sex

underlying tissue, which the isopods were then able to consume (Fig. 2e). The present study suggests that *S. leuria* is an appropriate host for *M. renardi* belonging to the second group.

Prevalence of infestation

Maximum numbers of 29 (58 %) and 28 (56 %) fishes were infested during the month of June 2010 and July 2010 respectively. Least number of one fish was infested during the month of February 2011. In relation to sex of the host, female fishes were infested more when compared to the male throughout the collection. Total of 134 female fishes were infested with maximum number of 25 (71.4 %) fishes were infested during the month of July 2010 and minimum prevalence of 33.3 % in February 2011 (Fig. 3). Twenty-three male fishes were totally infested with high number of eight (40 %) in June 2010 and low 20 % in June 2009, February 2010 and July 2010 (Table 1).

A total of 194 individual parasites were collected from 272 fishes of these 23 were male, 48 were nonovigerous female and the remaining 86 were ovigerous female. Maximum number of individual parasites was collected during the month of June 2010 (44) and minimum in 1 in the months of February 2011. The sex ratio of the female parasites with the male parasites was always high throughout the study (Table 1). Most of the parasites infest on fishes ranges from 42 to 44 cm length, with the high prevalence of 74.6 %. Prevalence of infection according to length increases within the sample as length of fish increases while the overall prevalence was 57.7 %, also the effect of infection on fish condition factor was low as shown (Table 2). The condition factor (K) measures the well being of the fish and is usually close to value 1 for a healthy fish, in this study the K values were below value 1 indicating that all specimens were not healthy considering the high (57.7 %) parasite prevalence.

Table 1 Prevalence and infestation of *Mothocya renardi* in *Strongylura leiura* during June 2009–May2011

Months	No. of fishes examined	No. of fishes infested (prevalence %)	No. of parasites collected (mean intensity)	Male			Female		
				No. of fishes examined	No. of fishes infested (prevalence %)	No. of parasites collected (mean intensity)	No. of fishes examined	No. of fishes infested (prevalence %)	No. of parasites collected (mean intensity)
June 2009	20	12 (60)	12 (1)	10	2 (20)	2 (1)	10	10 (100)	10 (1)
July 2009	20	14 (70)	14 (1)	3	2 (66.6)	2 (1)	17	12 (70.5)	12 (1)
August 2009	10	7 (70)	7 (1)	3	–	–	7	7 (100)	7 (1)
September 2009	10	4 (40)	4 (1)	2	–	–	8	4 (50)	4 (1)
October 2009	10	8 (80)	8 (1)	2	1 (50)	1 (1)	8	7 (87.5)	7 (1)
November 2009	10	2 (20)	2 (1)	4	–	–	6	2 (33.3)	2 (1)
December 2009	5	2 (40)	2 (1)	2	–	–	3	2 (66.6)	2 (1)
January 2010	5	2 (40)	2 (1)	2	–	–	3	2 (66.6)	2 (1)
February 2010	20	9 (45)	9 (1)	10	2 (20)	2 (1)	10	7 (70)	7 (1)
March 2010	–	–	–	–	–	–	–	–	–
April 2010	–	–	–	–	–	–	–	–	–
May 2010	–	–	–	–	–	–	–	–	–
June 2010	50	29 (58)	44 (1.5)	20	8 (40)	8 (1)	30	21 (70)	36 (1.7)
July 2010	50	28 (56)	42 (1.5)	15	3 (20)	3 (1)	35	25 (71.4)	39 (1.5)
August 2010	20	16 (80)	16 (1)	8	4 (50)	4 (1)	12	12 (100)	12 (1)
September 2010	10	8 (80)	12 (1.5)	3	1 (33.3)	1 (1)	7	7 (100)	11 (1.5)
October 2010	5	2 (40)	2 (1)	1	–	–	4	2 (50)	2 (1)
November 2010	–	–	–	–	–	–	–	–	–
December 2010	–	–	–	–	–	–	–	–	–
January 2011	12	7 (58.33)	9 (1.2)	4	–	–	8	7 (87.5)	9 (1.2)
February 2011	5	1(20)	1(1)	2	–	–	3	1 (33.3)	1 (1)
March 2011	10	6 (60)	8 (1.3)	2	–	–	8	6 (75)	8 (1.3)
April 2011	–	–	–	–	–	–	–	–	–
May 2011	–	–	–	–	–	–	–	–	–
Total	272	157 (57.72)	194 (1.23)	93	23 (24.8)	23 (1)	179	134 (75.2)	171 (1.2)

Discussion

Parasites are frequently associated with odd host behaviors such as unusual levels of activity, increased conspicuousness, disorientation and altered responses to stimuli (Holmes and Bethel 1972). In the present overall infested prevalence of *M.renardi* on *S.leuria* in the Parangipettai (57.7 %) found to be higher when compared to results in the Lesina Lagoon (7.7 %) (Bello et al. 1997), near the French coast (12.7 %) (Trilles 1964) and again in the Lesina Lagoon (14 %) (Mariniello and DiCave 1993). Physical parameters were the main factors determining the fish parasite fauna as well as intensity and prevalence of infestation in marine environments (Radhakrishnan and Nair 1983). In previous reports severe parasitism was observed in the buccal cavity of the spot tail needlefish *Strongylura strongylura* by the cymothoid *C. indica* (Rajkumar et al. 2004). In the present study higher rate of infestation was found during the summer and post monsoon seasons where the temperature and salinity suitable for parasite production. Several species of European cymothoids were capable of slowing down the growth in their hosts, although they did not affect weight–size ratios of the fish (Trilles 1979). However, the significant difference in the length and weight relationship of infested and uninfested fishes of Jack Mackeral, *Trachurus decliuis* as infested by *Cerotothea impricatus* (Maxwell 1982). Indian cymothoids were collected from the body surface, the branchial chamber and the buccal cavity of the host fishes. A maximum of species were until now found on the body surface followed by branchial chamber and only very few in buccal cavity. Some buccal or branchial parasites were often reported moving out of their normal localisation, particularly after the capture of host (Trilles et al. 2011).

Erosion and thickening are the two unique morphological changes noticed owing to the infestation. These

Table 2 Length–weight in relation to infection and condition factor (k)

Length range (cm)	Weight average (gm)	No. within the group	No. of infected fish	Prevalance within the group (%)	Condition factor (k)
40–41.5	122.4	35	22	62.8	0.17
42–43.5	123.5	71	53	74.6	0.15
44–45.5	124.8	57	34	59.6	0.13
46–47.5	132.7	46	19	41.3	0.12
48–59.5	128.4	29	13	44.8	0.10
50–51.5	140.6	21	9	42.8	0.10
52–53.5	144.3	13	7	53.8	0.09
Total	–	272	157	57.7	–

changes are mainly due to the heavy pressure exerted by the parasite and also by their feeding nature. Destruction of host tissues as a result of the pressure exerted by the parasite body, when present in the gill cavity was observed (Kabata 1985). The present study showed significant reduction of respiratory surface area due to infestation of cymothoids in the branchial chamber was noticed. Longer stay of parasite within the gill chamber may also prevent and obstruct the normal growth of the gill arches. This may be the reason for the erosion of gill arch and fusion of gill lamellae. The gross size and shape of parasites can act as physical irritants, which may be responsible for the damage of the branchial tissues as noticed in the present study.

Due to the attachment of peropods host tissues were compressed and eroded at the attachment sites, which were surrounded by an inflamed peripheral welt of peropods. Lesions associated with reproduction of parasite to the host are related to the direct activity of the parasites. A marked increase in the size of the parasite may be seen with the development of marsupium full of juvenile isopods. This can significantly increase the pressure atrophy caused by the presence of the parasites. These reproduction related activity in the host increases the chance that the parasite will serve as a vector for microbial parasites such as hematozoans (Smith 1975). The dorsal surface of the parasite was always in close contact with the first gill arch, causing more atrophy of the first gill filament. The pressure exerted towards second to fourth gill arches were comparatively lesser than the first gill arch and the damage was also less. In most cases, the parasite was located between the second and third branchial arches, attached either to the vomerine arch or to the internal wall of the branchial operculum. Such infections induce serious damages to the host's gills particularly in the area on which the female isopods rest their brood pouch (Ravichandran et al. 2011).

In general, parasitic infection of fishes mainly depends upon host factors such as age, size, sex, maturity, stage, behavior, feeding and breeding, lifecycle, physico-chemical and particularly environment factors. The negative impact of parasites on host's growth and survival has been demonstrated for several parasite-host systems, both in aquaculture and in natural populations (Sindermann 1987). However, host parasite relationships are generally very complex and difficult to clarify. With the exception of cases of mass mortalities caused by outbreaks of parasites, assessment of the effects of parasite infection in natural fish populations is particularly difficult because of the presence of predators or scavengers which rapidly remove moribund or dead fish. In the present study, the prevalence of *M. renardi* on *S. leuria* showed reduction in the layer of the fish gill rack using their mouth parts and fed on the muscle tissue beneath respiratory surface area of the host fish.

Similar observation was made in *Epipenaeon elegans chopra* from the Persian Gulf (Dowson 1958) where parasitic infestation was also found to be more in females than in males. The parasitic isopods feed host which severe damages induced to the branchial cavity, the gill filament, the fleshy part of the lower beak, and the inner side of the operculum of the host (Ravichandran 2007; Ravichandran and Ajith Kumar 2008; Rameshkumar et al. 2011, 2013; Aneesh et al. 2013). Such parasite occupies the entire branchial chamber of the host may produce pressure on the gill surface and thus affecting the efficiency of respiration observed in the present study. Although, the infestation did not cause immediate death, it had affected the normal growth of the host fish and also probably leads the high levels of secondary infections.

Acknowledgments Authors (S. Ravichandran) are thankful to Department of Science and Technology (Ref. No.:- SB/SO/AS/063/2013) (DST), Government of India for providing financial support and (G. Rameshkumar) are thankful to UGC, New Delhi for the grant of Dr. D.S. Kothari Post-Doctoral Fellowship No.F.4-2/2006 (BSR)/13-1011/2013(BSR).

References

Aneesh PT, Sudha K, Helna AK, Arshad K, Anilkumar G, Trilles JP (2013) Simultaneous multiple parasitic crustacean infestation on

banded needlefish, *Strongylura leiura* (Belonidae) from the Malabar Coast, India. Int J Sci Res Publ 3(7):367–375

Bakare O (1970) Bottom deposits as food of inland fresh water fish. In: Visser SA (ed) Kainji a Nigerian man-made lake, vol 1., Kainji lake studiesThe Nigeria Institute of Social and Economic Research, Ibadan, pp 65–86

Bello G, Vaglio A, Piscitelli G (1997) The reproductive cycle of *Mothocya epimerica* (Isopoda: Cymothoidae) a parasite of the sand smelt, *Atherina boyeri* Osteichthyes: Atherinidae) in the Lesina Lagoon, Italy. J Nat Hist 31:1055–1066

Bruce NL, Harrison-Nelson EB (1988) New records of fish parasitic marine Isopod Crustaceans (Cymothoidae, subfamily Anilocrinae) from the Indo-West Pacific. Proc Biol Soc Wash 101: 585–602

Dowson CW (1958) A record of *Epipenaeon elegans chopra* from the Persian gulf. J Parasitol 44:240–242

Holmes JC, Bethel WM (1972) Modification of intermediate host behavior by parasites. Zoo J Linn Soc 51:123–149

Kabata Z (1985) Parasites and disease of fish cultured in the tropics. Isopoda. Taylor and Francis, London, pp 265–271

Margolis L, Esch GW, Holmes JC, Kurris AM, Shad GA (1982) The use of ecological terms in parasitology. J Parasitol 68:131–133

Mariniello L, DiCave D (1993) Isopodi parassiti di specie ittiche di interesse commerciale presenti nel lago di Lesina. Biología Marina 1:233–238

Maxwell JGH (1982) Infestation of jackmackeral, *Trachurus dacliuis* (Jengus), with cymothoid isopod, *Ceratothoa imbricatus* (Labricus) in South-eastern Australian waters. J Fish Biol 29(3): 341–349

Radhakrishnan T, Nair NB (1983) Nature of crustacean infestation of fish along the southwest coast of India. Acta Ichthyologica Piscatoria 13:93–115

Rajkumar M, Santhanam P, Perumal P (2004) Report on new host record of *Cymothoa indica* (Schioedte and Meinert, 1884) (Crustacea: Isopoda) from Parangipettai coastal waters, southeast coast of India. J Aqua Biol 19(2):113–114

Rameshkumar G, Ravichandran S, Trilles JP (2011) Cymothoidae (Crustacea, Isopoda) from Indian fishes. Acta Parasitol 56(1):78–91

Rameshkumar G, Ravichandran S, Sivasubramanian K (2013) Invasion of parasitic isopods in marine fishes. J Coast Life Med 1(2):99–105

Ravichandran S (2007) Infestation of isopod parasite *Lironeca puhi* in slender needle fish *Strongylura leiura*. Res J Parasitol 2(2):87–93

Ravichandran S, Ajith Kumar TT (2008) Secondary microbial infection in *Ilisha melastoma* due to isopod fish parasites. J Fish Aquat Sci 3:92–96

Ravichandran S, Rameshkumar G, Trilles JP (2011) New records of two parasitic cymothoids from Indian fishes. J Parasit Dis 35(2):232–234

Rohde K (1993) Ecology of marine parasites: an introduction to marine parasitology, 2nd edn. CAB International, Wallingford

Sindermann CJ (1987) Effects of parasites on fish populations: practical considerations. Int J Parasitol 17:371–382

Smith FG (1975) The crustacean parasites of marine fishes. In: Ribelin WE, Magaki G (eds) The pathology of fishes. University of Wisconsin Press, Madison, pp 189–203

Trilles JP (1964) Note preliminaire sur quelques aspects de la reproduction chez les isopodes Cymothoidae Mediterrannéens. Archives de Zoologie Expérimentale et Générale 104:127–134

Trilles JP (1977) Les Cymothoidae (Isopoda, Flabellifera; parasites de poissons) du Rijksmuseum Van Natuurlijke Historie de Leiden. Méditerraneé et Atlantique Nord-Oriental. Zool Meded 52:7–17 **(Rijksmuseum Van Natuurlijke Historie te Leiden)**

Trilles JP (1979) Les cymothoidae (Isopoda, Flabellifera, parasites de poissons) du Rijksmuseum van Naturlijke Historie de leidern II. Afrique, Amerique et regions indo-ouest-pacifiques. Zool Meded (leiden) 54:245–275

Trilles JP, Ravichandran S, Rameshkumar G (2011) A checklist of the Cymothoidae (Crustacea, Isopoda) recorded from Indian fishes. Acta Parasitol 56(4):446–459