

Parasitic copepods infestation on commercially exploited fishes from Kayamkulam backwater, Kerala, India

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Abstract Parasitic copepods infestation on three species of commercially important fishes belonging to the family Mugilidae (*Liza parsia*) and Cichlidae (*Oreochromis mossambicus* and *Etroplus suratensis*) from Kayamkulam backwater were analysed between February 2015 and January 2017, covering all the three seasons. A total of 2305 fishes were analysed for parasites. Out of these, 299 fishes were infested with different species of parasitic copepods. The analysis revealed the presence of ten species of parasites comprising of *Ergasilus parvitergam*, *Ergasilus sieboldi*, *Ergasilus* sp, *Caligus epidemicus*, *caligus* sp, *Dermoergasilus hoi*, *Dermoergasilus* sp, *Nothobolochus* sp, *Lerneae* sp and *Lepiophtherius* sp. The infestation dynamics of parasitic copepods in terms of prevalence, mean intensity and mean abundance were calculated to determine the degree of infestation on each species. A higher prevalence (40%), mean intensity (13.2) and mean abundance (5.3) were found in *Liza parsia* while *Etroplus suratensis* had the lesser prevalence. There is a significant difference in the prevalence ($p < 0.05$), mean intensity ($p < 0.05$) and mean abundance ($p < 0.01$) in the rate of infestation of *Liza parsia* among the stations during the year 2015–2016, where as *Oreochromis mossambicus* and *Etroplus suratensis* shows no significant difference in the rate of infestation. The rate of infestation with parasitic copepod was higher in 2015–2016 than in 2016–2017. A higher proportion of fishes were more infested in Choolatheruvu (Station 3) as compared to Ayiramthengu (Station 1) and Valiyazheekal (Station 2).

Keywords Copepod · Parasites · Prevalence · Mean intensity and infestation

Introduction

The parasites of aquatic organisms are ubiquitous and major components of ecosystem, which are closely related to several characteristics of the biotic and abiotic environment in which they exist (Lacerda et al. 2017). Most vertebrate species serve as a host of one or more parasitic species (Lagrué et al. 2011). Among vertebrates, fish have the highest rates of parasitic infestation because of the unique characteristics of their aquatic environment, which facilitate the spread, reproduction and life cycle completion of each parasitic group (Emily et al. 2018). The backwaters of Kerala possess high species richness and diversity of organisms, including parasites of fish populations. Parasites are components of most ecosystems and are involved in numerous food webs.

Parasitic copepods constitute one of the major group among parasitic arthropods that affect wild fish are of commercial significance as they affect host survival or cause changes in the flesh. Ergasilid copepod damages the gills and cause epizootics in cultured and wild populations of fishes (Lester and Hayward 2006). According to Kabata (1988), parasitic copepods belong to the suborder Siphonostomatoida (75%), Poecilostomatoida (20%) and Cyclopoida (5%). Most of the parasitic copepods are external parasites commonly found on the gills, skin and operculum and these copepods negatively affect the fish production, both from the wild and fish farms, thus making them difficult to market (Nike et al. 2013). Knowledge about the parasitic fauna of fishes in Kayamkulam

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backwater is scarce. Therefore the aim of the study was to evaluate the parasitic copepod infestation on commercially important fishes of Kayamkulam backwater such as *Liza parsia* (Hamilton, 1822), *Oreochromis mossambicus* (Peters, 1852) and *Etroplus suratensis* (Bloch, 1790).

Materials and methods

Study area

The study area, Kayamkulam backwater or Kayamkulam estuary (latitudes 9°2'N and 9°16'N & longitudes 76°25'E and 76°32'E) is a shallow brackish water lagoon. Kayamkulam backwater occupies area in both Alapuzha district and Kollam of the total 1652.33 hectares. For the purpose of study, three stations were considered as sampling areas within the estuary: Ayiramthengu (Station 1), Valiyazheekal (Station 2) and Choolatheruvu (Station 3). The first sampling station (S1) is the Ayiramthengu mangrove and this mangrove area was declared as environmental hot spot after ravaged by the Tsunami in 2004. Station 2 is at Valiyazheekal near to pozhi, connecting to the Arabian Sea. Kayamkulam backwater opens into the Lakshadweep Sea through Valiyazheekal Azhi. Station 3 is the Choolatheruvu, a part of Kayamkulam backwater near to National Thermal Power Corporation (NTPC).

Parasitological examination

The fishes *Liza parsia*, *Oreochromis mossambicus* and *Etroplus suratensis* from the three stations were obtained by the assistance of fishermen. Between February 2015 and January 2017, a total of 2305 individuals from different species were examined for parasitic copepod. Scraping from the skin, fins, tail and operculum of the fishes were done for the detection of parasites. After dissection, stereomicroscopic observation was made on gills for the presence of parasitic copepod.

Parasitic species identification was based on morphological features according to Pillai (1985), Yamaguti (1985), Kabata (1988), Boxshall and Halsey (2004) and Ho and Lin (2004). The parasite number and place of their attachment were recorded. The collected parasites were fixed in glacial acetic acid (Pritchard and Kruse 1982) and preserved in ethanol (70%). The parasitological terms such as prevalence, mean intensity and mean abundance follow Bush et al. (1997) and Margolis et al. (1982). Results of all parameters were expressed as mean \pm standard deviation. Data were analysed using one-way analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS version 20). Tukey's HSD test was used to determine differences between groups at 95% confidence level.

Results

During the present study, parasitic copepods belonging to the family Bomolochidae, Ergasilidae (Poecilostomatoida), Caligidae (Siphonostomatoida) and Lernaeidae (Cyclopoida) were collected from the Kayamkulam backwater. A total of 2305 fishes (*Liza parsia*-768, *Oreochromis mossambicus*-725 and *Etroplus suratensis*-812) were examined for the presence of parasites. Among the examined fishes, 299 fishes (*Liza parsia*-160, *Oreochromis mossambicus*-102 and *Etroplus suratensis*-37) were infested with different parasitic species. The prevalence, mean intensity and mean abundance of infestation were recorded to calculate the degree of infestation during the year February 2015 to January 2017 (Tables 1, 2).

- a) *Prevalence* Prevalence is the proportion of infested host among all the hosts examined. The prevalence of infestation by parasitic copepod on different fishes during the study period were presented in Tables 1 and 2.
 - a.1 *Prevalence of parasitic copepod infestation on fishes during February 2015–January 2016.* During the period February 2015 to January 2016, the prevalence of parasitic copepod on *L.parsia* at station 1, station 2 and station 3 varied from 18.4–26.5%, 7, 12.5–18.6% and 21.6–40%. The prevalence of infestation of parasitic copepod in *L.parsia* during different season is shown in Fig. 1 and the parasites showed maximum effect in the monsoon period (40%) at station 3 (Fig. 1). The prevalence of parasitic copepod infestation in *O. mossambicus* at station 1, station 2 and station 3 were varied from 8.1–20.9%, 4.7–17.1% and 14.3–24.4% respectively. The higher prevalence was found in station 3 during monsoon season (24.4%) (Fig. 2). Regarding the prevalence of parasitic copepod infestation on *E. suratensis*, higher value was recorded from station 3 during monsoon period (11.6%) (Fig. 3). The infestation of copepod parasites on *E. suratensis* was low during the study period while the parasitic incidence in *L. parsia* was found high.
 - a.2 *Prevalence of parasitic copepod infestation on fishes during February 2016–January 2017.* During the period February 2016–January 2017, the higher prevalence of parasitic copepod in *L. parsia* was reported in monsoon (31.8%) at station 3 and the prevalence of infestation at station 1 (25%) and station 2 (14.9%) were found higher during the monsoon period (Fig. 1). In *O. mossambicus*, the higher prevalence of parasites was reported from the

Table 1 Prevalence, Mean intensity and Mean abundance of parasitic copepod on commercially exploited fishes from Kayamkulam backwater during February 2015–January 2016

	<i>Liza parsia</i>				<i>Oreochromis mossambicus</i>				<i>Etroplus suratensis</i>			
	¹ S	² M ± S.D	³ F	⁴ Sig.	S	M ± S.D	F	Sig.	S	M ± S.D	F	Sig.
Prevalence	S1	20.4 ± 10.1	5.266	0.010*	S1	12.5 ± 8.8	1.947	0.159	S1	3.9 ± 6.0	1.598	0.218
	S2	14.4 ± 10.9			S2	9.8 ± 9.3			S2	3.4 ± 5.2		
	S3	29.6 ± 13.4			S3	17.5 ± 11.1			S3	8.1 ± 9.3		
Mean Intensity	S1	8.5 ± 4.0	3.451	0.044*	S1	1.8 ± 1.3	1.443	0.251	S1	0.8 ± 1.1	0.807	0.455
	S2	6.1 ± 4.9			S2	2.0 ± 2.0			S2	0.8 ± 1.3		
	S3	10.8 ± 4.0			S3	2.9 ± 1.8			S3	1.4 ± 1.5		
Mean Abundance	S1	1.8 ± 0.9	9.445	0.001**	S1	0.3 ± 0.2	4.858	0.014*	S1	0.1 ± 0.1	2.135	0.134
	S2	1.3 ± 1.1			S2	0.3 ± 0.3			S2	0.1 ± 0.1		
	S3	3.5 ± 1.7			S3	0.6 ± 0.3			S3	0.2 ± 0.3		

¹Stations

²Mean ± standard deviation

³F-value

⁴P-value (Significance), **< 0.01, *< 0.05

Table 2 Prevalence, Mean intensity and Mean abundance of parasitic copepod on commercially exploited fishes from Kayamkulam backwater during February 2016–January 2017

	<i>Liza parsia</i>				<i>Oreochromis mossambicus</i>				<i>Etroplus suratensis</i>			
	¹ S	² M ± S.D	³ F	⁴ Sig.	S	M ± S.D	F	Sig.	S	M ± S.D	F	Sig.
Prevalence	S1	17.8 ± 12.8	2.637	0.087	S1	7.7 ± 7.5	2.080	0.141	S1	2.6 ± 5.1	0.512	0.604
	S2	11.3 ± 8.9			S2	14.7 ± 10.2			S2	4.0 ± 6.2		
	S3	22.0 ± 12.3			S3	15.6 ± 12.8			S3	5.2 ± 7.1		
Mean Intensity	S1	2.8 ± 1.9	1.215	0.310	S1	1.8 ± 1.8	0.673	0.571	S1	0.7 ± 1.3	0.455	0.639
	S2	3.2 ± 2.5			S2	2.4 ± 1.7			S2	0.9 ± 1.4		
	S3	4.2 ± 2.1			S3	2.5 ± 1.7			S3	1.2 ± 1.6		
Mean Abundance	S1	0.7 ± 0.5	3.822	0.032*	S1	0.2 ± 0.2	2.481	0.099	S1	0.1 ± 0.2	0.591	0.560
	S2	0.5 ± 0.4			S2	0.4 ± 0.3			S2	0.1 ± 0.1		
	S3	1.1 ± 0.6			S3	0.5 ± 0.4			S3	0.2 ± 0.2		

¹Stations

²Mean ± standard deviation

³F-value

⁴P-value (Significance), *< 0.05

post monsoon (25.6%) at station 3 (Fig. 2). In *E. suratensis*, the higher prevalence of parasites was observed in monsoon (6.8%) at station 2 (Fig. 3).

b) *Mean Intensity* Mean intensity is mean number of parasites from infested hosts. Mean intensity of infestation on fishes were summarized in Tables 1 and 2.

b.1 *Mean Intensity of parasitic copepod infestation on fishes during February 2015–January 2016.* Seasonal variation of mean intensity of parasitic copepod in

fishes from three stations during the year February 2015–January 2016 was determined. In *L. parsia*, higher mean intensity was reported in monsoon (13.2) at station 3 (Fig. 4). In *O. mossambicus*, maximum mean intensity was found in the pre monsoon period (5.5) at station 2 (Fig. 5). There was no incidence of parasitic copepods in *O. mossambicus* in the month of March at all the stations. The mean intensity of parasitic copepods in *E. suratensis* was varied 0–3. The higher mean intensity was reported from station 2 and station 3 (3)

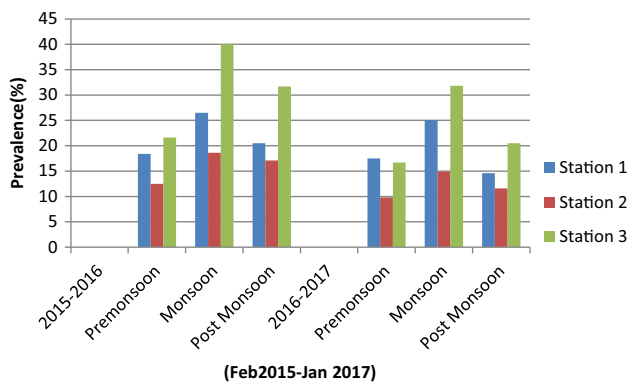


Fig. 1 Seasonal fluctuation of Prevalence of parasitic copepod on *Liza parsia* during the year Feb 2015–Jan 2017

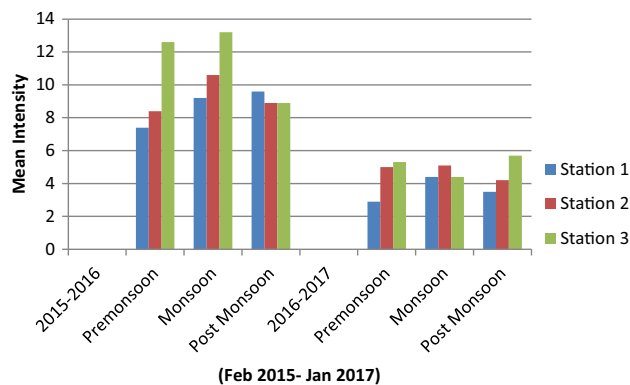


Fig. 4 Seasonal fluctuation of Mean intensity of parasitic copepod on *Liza parsia* during the year Feb 2015–Jan 2017

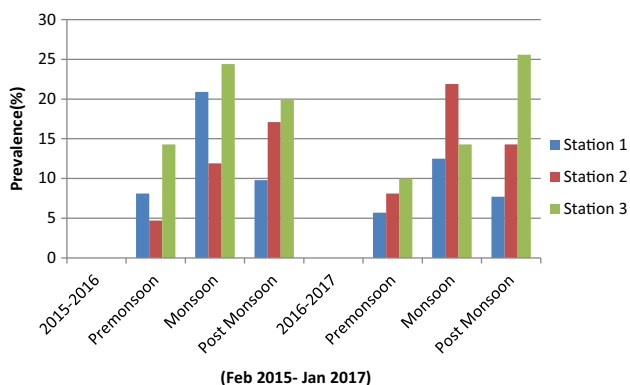


Fig. 2 Seasonal fluctuation of Prevalence of parasitic copepod on *Oreochromis mossambicus* during the year Feb 2015–Jan 2017

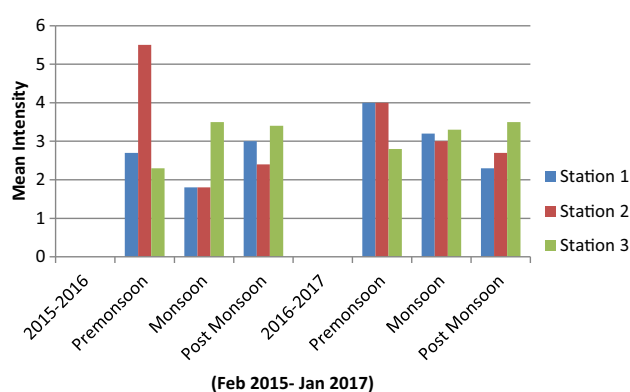


Fig. 5 Seasonal fluctuation of Mean intensity of parasitic copepod on *Oreochromis mossambicus* during the year Feb 2015–Jan 2017

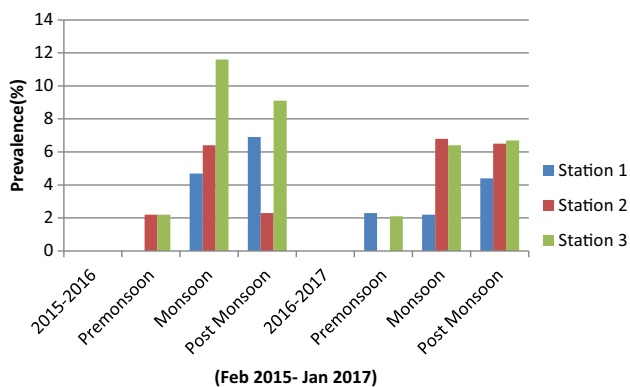


Fig. 3 Seasonal fluctuation of Prevalence of parasitic copepod on *Etroplus suratensis* during the year Feb 2015–Jan 2017

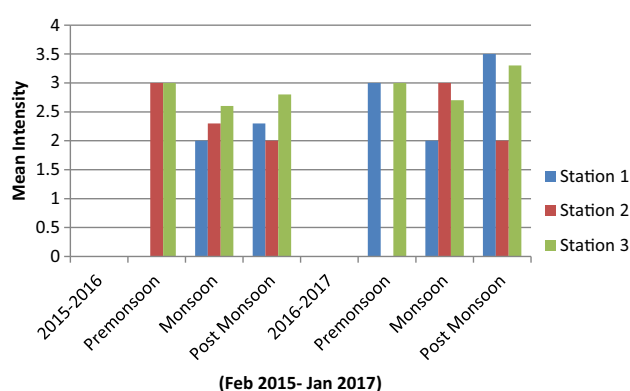


Fig. 6 Seasonal fluctuation of Mean intensity of parasitic copepod on *Etroplus suratensis* during the year Feb 2015–Jan 2017

during premonsoon period (Fig. 6). In all the stations, the infestation with parasitic copepods on *E. suratensis* was poor (Fig. 6).

b.2 *Mean Intensity of parasitic copepod infestation on fishes during February 2016–January 2017.* During the period February 2016 to January 2017, the mean intensity of parasitic copepod in *L. parsia* at station 1,

2 and 3 were ranged from 2.9–4.4, 4.2–5.1 and 4.4–5.7 respectively. The higher value of mean intensity was observed at station 3(5.7) during post monsoon (Fig. 4). In the case of *O. mossambicus*, maximum mean intensity was observed during pre monsoon period (4) at station 1 and 2 (Fig. 5). Throughout the study period, mean intensity of

parasitic copepods in *E. suratensis* was very low in all the stations. However station 1 and 3 shows highest mean intensity of parasitic copepods in *E. suratensis* during post monsoon period (3.5 and 3.3) (Fig. 6).

c) **Mean Abundance** Mean abundance is the mean number of parasites present in all hosts examined. Mean abundance of infestation during February 2015 to January 2017 was summarized in Tables 1 and 2.

c.1 **Mean Abundance of parasitic copepod infestation on fishes during February 2015–January 2016.** Mean abundance of parasites on *L. parsia* at station 1, 2 and 3 during February 2015–January 2016 was ranged from 1.4–2.4, 1.1–1.9 and 2.7–5.3 respectively. Higher mean abundance was reported from station 3 (5.3) during monsoon (Fig. 7). In *O. mossambicus*, higher mean abundance was observed in monsoon period (0.9) at station 3 (Fig. 8). The mean abundance of parasitic copepod on *E. suratensis* was varied from 0 to 0.3. Higher mean abundance was reported from station 3 (0.3) during monsoon period (Fig. 9).

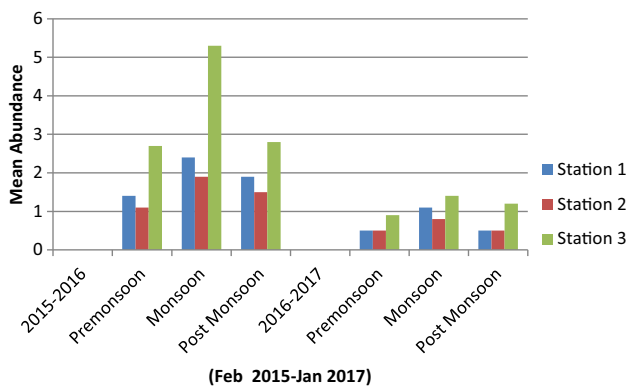


Fig. 7 Seasonal fluctuation of Mean abundance of parasitic copepod on *Liza parsia* during the year Feb 2015–Jan 2017

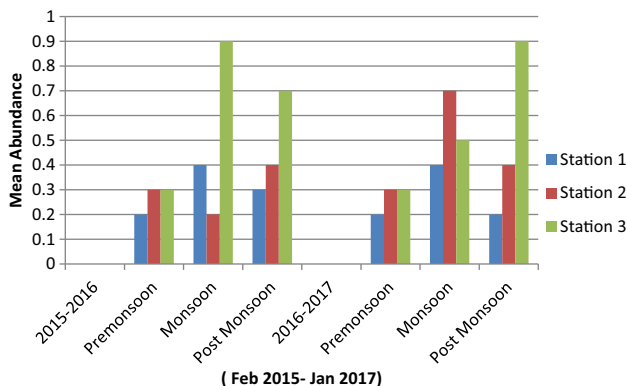


Fig. 8 Seasonal fluctuation of Mean abundance of parasitic copepod on *Oreochromis mossambicus* during the year Feb 2015–Jan 2017

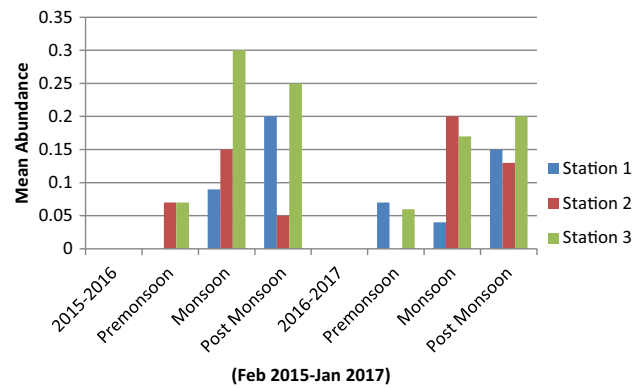


Fig. 9 Seasonal fluctuation of Mean abundance of parasitic copepod on *Etroplus suratensis* during the year Feb 2015–Jan 2017

c.2 **Mean Abundance of parasitic copepod infestation on fishes during February 2016–January 2017.** From February 2016 to January 2017, mean abundance of infestation on fishes examined was varied 0.5–1.4 (*L. parsia*), 0.2–0.9 (*O. mossambicus*) and 0–0.2 (*E. suratensis*). In *L. parsia*, higher mean abundance was reported in monsoon (1.4) at station 3 (Fig. 7). Mean abundance of parasites on *O. mossambicus* was highest in post monsoon (0.9) at station 3 (Fig. 8). In *E. suratensis*, higher mean abundance was recorded during monsoon (0.2) and post monsoon (0.2) at station 2 and station 3 respectively (Fig. 9). The study showed that mean abundance was high in *L. parsia* than *O. mossambicus* and *E. suratensis* (Fig. 10).

Prevalence, Mean Intensity and Mean Abundance of parasitic copepod infestation on commercially exploited fishes of Kayamkulam backwater were summarized in Tables 1 and 2. The results of the study were expressed as Mean \pm standard deviation. Statistical analysis of data showed that the infestation on *L. parsia* was varied significantly among stations during the year 2015–2016. The prevalence ($P < 0.05$), mean intensity ($P < 0.05$) and mean abundance ($P < 0.01$) of parasitic copepods on *L. parsia* were varied among stations during February 2015–January 2016. Tukey’s HSD test shows that 95% confident that prevalence, mean intensity and mean abundance of parasitic copepod on *L. parsia* from station 1 and station 2 were similar, yet these parameters differ from station 3 during 2015–2016. Prevalence ($P > 0.01$) and mean intensity ($P > 0.01$) of infestation on *O. mossambicus* were not varied significantly among stations. But the statistical analysis showed that mean abundance ($P < 0.05$) of parasites on *O. mossambicus* was varied significantly among stations during 2015–2016. Tukey’s HSD test shows that mean abundance of parasitic copepod on *O. mossambicus*



Fig. 10 Gill of fish infested with parasitic copepods

was similar in station 1 and 2. Prevalence ($P > 0.01$), mean intensity ($P > 0.01$) and mean abundance ($P > 0.01$) of parasitic copepod in *E. suratensis* were not varied among stations during February 2015–January 2016 (Table 1). From February 2016 to January 2017, prevalence ($P > 0.01$) and mean intensity ($P > 0.01$) of parasitic copepod infestation on *L. parsia* were not varied significantly among stations. But the statistical analysis showed that mean abundance ($P < 0.05$) of parasites on *L. parsia* was varied significantly among stations. There was no significant difference in the prevalence, mean intensity and mean abundance of parasitic copepod on *O. mossambicus* and *E. suratensis* between the stations ($P > 0.01$) during 2016–2017 (Table 2).

Discussion

The parasite fauna in the host fishes is determined by the environmental conditions, both natural and man-made, as also the composition of host species at a given time (Santhosh and Radhakrishnan 2009). The parasitic fauna of fish can vary in their abundance depending on the host species, its level in the food chain, the age, size and sex of individual fish, and other biotic and abiotic factors (Takemoto and Lizama 2010). Copepods are common parasite fauna of fishes which have been studied extensively in coastal and neritic waters, where as they have become pests of fish species of commercial importance and several factors such as host factors and external factors (temperature, rainfall, salinity etc.) influence the abundance of parasite species on host fishes (Vinoth et al. 2010). According to Iyaji et al. (2009), biotic factors like age and size of host, host size and parasite size, host specificity, feeding habits of host, host sex and immune system can influence

profoundly in the assemblages of parasites on fish hosts. Pollution and other anthropogenic activities of the aquatic environment may affect a parasitic community directly by acting on free-living parasitic stages or on ectoparasites, or indirectly by acting on the intermediate host populations (Moller 1987).

During the two year study period, prevalence, mean intensity and mean abundance were highest in *L. parsia* collected from station 3 of the study area followed by *O. mossambicus* and *E. suratensis*. Prevalence, mean intensity and mean abundance of parasitic copepods on *L. parsia* were statistically different between stations; however there was no significant difference in prevalence, mean intensity and mean abundance of parasitic copepods on *O. mossambicus* and *E. suratensis* between stations. Concerning the variation of parasitic copepod infestation on different host fishes, the parasites were more frequently found in *L. parsia* and parasites were absent in *E. suratensis* during some months and they were least infested. Results obtained from the present study reveals that high infestation on *L. parsia* and low infestation rate on *E. suratensis* were reported elsewhere in Kayamkulam backwater. Feeding habit of the host is significant factor for determining the nature of parasitic fauna in host (Razia Beevi and Radhakrishnan 2012). The study showed variability in the parasitic copepod infestation on different host fishes could be attributed to host specificity of parasite fauna. Most of the parasitic copepods are highly host specific. Highest number of parasites was reported from *L. parsia* and most of the recovered parasites were stenoxenic.

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Author's contribution The first author (Dhanya P) carried out the present study (identification of parasites, statistical analysis and manuscript writing were done by first author. The second author (S. Amina) provided help for identification of copepod parasites to the first author.

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Compliance with ethical standards

Conflict of interest There is no conflict of interest among the authors who have contributed to this study.

Statement on ethical approval for using Fishes in laboratory The fish species selected for the present study was not under the threatened or endangered category. These species were abundant in the study area and used as food fishes. We collected these fish species from local fishermen and from market. Died fishes were used for the detection of copepod parasites.

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