Sri Lanka J. Aquat. Sci. 3 (1998): 11-25

The Parasites of *Etroplus suratensis* (Bloch) (Pisces: Cichlidae) and Their Effects on Aquaculture Management

N. NILAKARAWASAM[1] and C. SOMMERVILLE[2]

[1] Department of Zoology
University of Ruhuna
Matara, Sri Lanka

[2] Institute of Aquaculture
University of Stirling
Stirling FK9 4LA, UK

Abstract

The parasitic fauna of the cichlid *Etroplus suratensis* (Bloch), a typical estuarine fish capable of withstanding salinities ranging from freshwater to brackish and considered as a promising candidate for aquaculture in the range, was investigated with a view of understanding their importance in aquaculture. The study was carried out in Koggala lagoon and Udawalawa reservoir in Sri Lanka. Parasites were identified and their importance in aquaculture was estimated by considering their ability to appear in fresh and brackishwater systems, their population levels, the effects of environmental parameters on population fluctuations, the possibility of building up of population levels and their pathological effects.

A considerable number of parasites are newly recorded for *E. suratensis*. Most of the digeneans, all nematodes, and all crustaceans are new records for Sri Lanka. Of ectoparasites, *Ichthyobodo* sp. and all monogeneans were shown to be tolerant of wide range of salinity. Most of the parasites with indirect life cycles were unable to survive in both habitats, probably due to the absence of suitable intermediate or final hosts. Drastic fluctuations in abundance levels of parasites were not observed seasonally. Monsoon rain was the main factor which brought about the changes and a slight fall in temperature appeared to influence cercarial release. Of ectoparasites, *Ichthyophthirius* sp., *Ichthyobodo* sp., and gill monogeneans seemed to thrive in freshwater systems whilst gill monogeneans and copepods were abundant in brackishwater. However, the possibility of having high infection levels with other parasites cannot be eliminated in conditions which favour high densities of intermediate host. Some parasites were considerably pathogenic, whilst the importance of others cannot be eliminated at high infection levels.

Introduction

Etroplus suratensis (Bloch) is an estuarine fish indigenous to South India and Sri Lanka. This euryhaline cichlid has been transplanted in lowland irrigation reservoirs of Sri Lanka early this century in order to develop inland fisheries (Wiley 1910). Today, *E. suratensis* flourishes well in freshwater and contributes to fisheries in both fresh and brackish water to a significant extent (Costa 1983; De Silva et al. 1984). Recently it was considered as a promising candidate for aquaculture as well (Jayaprakas 1980; Sumitra-Vijayaraghavan et al. 1981).

Only four monogeneans and one trematode of *E. suratensis* has been previously described (Gussev 1963; Gussev & Fernando 1973; Zhukov 1972). Monogenea is the only group that has completely been recorded. There has been no systematic surveys on parasites, their ecology and pathogenicity. This study was undertaken with the aim of estimating the suitability of *E. suratensis* for aquaculture in relation to its vulnerability to parasitic diseases.

Materials and Methods

Two localities in southern Sri Lanka, i.e., a brackish water habitat (Koggala Lagoon), and a freshwater habitat (Udawalawa Reservoir) were selected for the study. Live fish were collected from fishermen in alternative months from each locality for a period of one year (April 1990 - May 1991). Collected fish were left in aquaria with water of salinities similar to that of the respective natural habitats at the time of collection. These specimens were observed for parasites. A total 94 specimens from Koggala lagoon and 78 specimens from Udawalawa reservoir were investigated, the size of the samples varied from 8 - 20 fish. The mean standard lengths of fish in the samples varied from 8.1 - 9.9 cm.

Encountered parasites were identified and the number of parasites present in pre-determined quantifying areas were counted for each species. These areas of quantification are given in Table 1. Data were collectively taken for a locality to calculate the parasite population levels, i.e. prevalence, mean intensity and abundance for each parasite as described by Margolis et al. (1982). Prevalence is the percentage of fish infected by a particular parasite. Mean intensity is the mean number of parasites present in fish infected by a particular parasite. Abundance is the mean number of parasites present in all fish investigated.

The results recorded for each parasite in each locality were considered separately to find out the population fluctuations within the period of study. The abundance values of samples were statistically tested with Kruskal-Wallies non-parametric test to find out parasites with significant population fluctuations. Samples with significant differences were discovered by Dunn multiple comparison test (Zar 1984). The rainfall data were obtained from Meteorological department and temperature, pH and salinity were measured.

The ability of the ecto-parasites to build up in confined water bodies and their salinity tolerance were checked by leaving fish infected with parasites in tanks with salinities 0, 8, 16 and 24 ppt. for three weeks and investigating the initial and final populations of the parasites. General pathological effects with high infection levels and histopathological observations were used to find out the extent of pathogenicity caused by the parasites.

Results

Parasites and Population levels in the two localities

The parasites found on *E. suratensis*, the method of quantification, the locality and the infection levels of parasite populations are given in Table 1. Since fish were left in holding tanks for 5-7 days, the infection levels of ectoparasites with direct, short life cycles may have changed and the data do not necessarily represent the original level of natural infection. Further, it should be noted that the mean intensity and abundance values indicate the number of parasites per quantifying area and not the numbers per fish.

Five protozoan parasites, two flagellates and three ciliates, were present in this host. Except *Ichthyophthirius multifillis* Fouquet 1876, others were found in both localities. Detailed taxonomy of some protozoan parasites could not be carried out as they could not be obtained in sufficient numbers to prepare smears. As such it was not possible to determine whether the same species occurred in both the localities. As *Ichthyobodo necator* (Henneguy 1883) Pinto 1928 is a cosmopolitan euryhaline species (Lom 1984), it can be assumed that the same species was present in both the localities. *Trichodina* specimens obtained from the two localities were the same in dimensions, thus assumed to be same.

High population levels were evident in some samples for *I. necator* and *I. multifiltis* due to the quick population build up in aquarium. Even at these times, the first few specimens investigated had low number of parasites. This indicates considerable low levels of parasite populations in natural habitats even at times with favourable weather conditions. The other ecto-parasite populations were low in both localities at all times. However, the population levels of the blood parasitic *Trypanosoma* sp. were considerably high in the freshwater locality when compared with the brackishwater locality.

Two monogenean species, *Ancyrocephalus etropli* Gussev 1963 and *Ceylanotrema colombensis* Gussev 1963 were present on gills. Their levels in the two localities were more or less equal. They had high prevalence values, hence, most of the fish were infected by both species. However, the mean intensity and abundance of *A. etropli* was considerably higher than that of *C. colombensis* in both localities. The population levels of the two stomach monogeneans *Enterogyrus globidiscus* (Kulkani 1969) Gussev & Fernando 1973 and *Enterogyrus paperni* Gussev & Fernando 1973 could not be found out separately as *E. paperni* specimens were not detected at initial surveys, thus, they have been erroneously counted together with *E. globidiscus*. Later, it was estimated that 8-30% of stomach monogenean population consists of *E. paperni* and the majority was *E. globidiscus*. Their population levels in Udawalawa reservoir were lower than in Koggala lagoon.

Metacercariae of seven species and two adult species of trematodes were parasitizing the fish. Acanthostomid, *Exorchis* and *Centrocestus* metacercariae were found only in Koggala lagoon whilst diplostomum, renicolid and strigeid metacercariae were found only in Udawalawa reservoir. Cyathocotylid metacercaria was common to both localities. A very few number of specimens (2-5) of *Centrocestus* metacercaria (Cryptogonimidae) and diplostomum metacercaria (Doplostomatidae) were found through out the survey and hence their population levels were not calculated. All other metacercariae, except cyathocotylid metacercaria, were found in low infection levels. However, the prevalence of some were considerably high. The infection level of cyathocotylid metacercaria was higher in Udawalawa than in Koggala lagoon. Both the adult trematodes, *Transversotrema patialens* Soparkar 1924 and *Malabarotrema indica* Zhukov 1972 were found in Koggala lagoon. *T. patialense* was found in low prevalence and low intensity. Though the intensity of *M. indica* was low, it had moderate prevalence. Cysticercus stage of the cestode *Paradilepis soclecina* (Rud. 1819) was found in the freshwater locality in high prevalence and low intensity.

L_3 larval stage of a *Contracaecum* sp. was found in both localities. Its prevalence and mean intensities were high in Udawalawa whilst very low in Koggala. However, it is not clear whether the larval stages found in both localities belong to the same species. A spirurid nematode, *Rhabdochona* sp. was found only in Koggala in moderate prevalence, but with low intensity.

Crustacean parasites were found only in Koggala lagoon. Two ergasailids, *Dermoergasilus amplectens* (Dogiel & Akhmerov 1952) Ho & Do 1982 and an *Ergasilus* sp., and one *Argulus* sp. were found during the present survey. The ergasilid, *D. amplectens*, was found in high prevalence and intensities whilst the others were found in low levels.

Seasonal changes

In the two localities, the rainy periods coincide with each other. However, the south-west monsoon gives more rain to Koggala from April to July, whilst the north-east monsoon gives more rain to Udawalawa from October to January. In both localities, the pattern of change of temperature reciprocally followed the rainfall pattern, and the seasonal differences of temperature are too small to influence fluctuations of animal populations. In Koggala, the pattern of salinity change was reciprocal with the rainfall.

Ichthyophthirius multifiliis population increased in Udawalawa in rainy spell in December (Fig. 1A). In June and August, both *I. multifillis* and *Ichthyobodo necator* infections were high when very low water levels prevailed in Udawalawa reservoir (Table 2). The population levels among the samples of *I. multifilus* were significantly different from each other though these were not significantly different for *I. Necator*.

Variations in *A. etropli* population followed the rainfall pattern fairly closely in Udawalawa (Fig. 1C). In Koggala, the variation among samples was not significantly different from each other and somewhat close relationship with rainfall pattern was evident (Fig. 1D). In *C. colombensis*, a little increase was observed during June-July period (Table 2) and it is difficult to correlate this to any of the environmental parameters. Statistically significant fluctuations were observed in the populations of *Enterogyrus* spp. in both localities. Their populations peaked when monsoon rains receded (Figs 1E and 1F).

The populations, of cyathocotylid metacercaria displayed significant seasonal variations with peaks after rainy seasons in both localities (Figs 1G and 1H). Renicolid, acanthostomid and *Exorchis* metacercariae showed low, but significantly high levels in December and February (Table 2). No significant seasonal variations were observed in adult trematodes as well as in cysticercus stage of the cestode *P. scolecina*. No seasonal variations were evident for L_3 larva of *Contracaecum* sp. in both localities. A statistically significant peak which cannot be correlated with any of the environmental parameters was evident for *Rabdochona* sp. in July (Table 2).

The levels of *D. amplectens* declined just after the rains and increased before the onset of the next. Its population fluctuation is in accordance with the salinity change of the lagoon (Fig. 1B). No seasonal population fluctuations were evident for *Ergasilus* sp. and *Argulus* sp.

Tendency of building up of ecto-parasite populations and their salinity tolerance

Since the common parasites with direct life cycles are more involved with disease problems in aquaculture systems, their tendency for quick population build up and their salinity tolerance were investigated together in experimental tanks. The results are given in Table 3.

Of protozoans, *Ichthyophthirius multifiliis* and *Ichthyobodo necator* populations increased in tanks whilst there were no significant increase for *Trichodina* and *Apiosoma* species. All others ectoparasitic protozoans except *I. necator* could not survive in salinities

Table 1: Parasites of *Etroplus suratensis* with their ecological data (Mean ± SD) at the two localities. Number of specimens for Udawalawa = 78; for Koggala = 94

Parasite		Site of Infection	Method of Quantification	Locality	Prevalence	Mean Intensity	Abundance
Flagellate Parasites							
Bodonidae	*Ichthyobodo necator*	Skin & gills	10 cm^2 body surface	Udawa.	32.1	110.1 ± 199.0	35.4 ± 122.8
				Kogga.	6.0	1.5 ± 0.5	0.1 ± 0.4
Trypanosomidae	*Trypanosoma* sp.	Blood	total in 3 microscopic areas of mag. 100	Udawa.	94.9	15.0 ± 19.1	14.2 ± 19.0
				Kogga.	37.2	2.9 ± 2.6	1.1 ± 2.1
Ciliate Parasites							
Ophryoglenidae	*Ichthyophthirius multifilis*	Skin & gills	10 cm^2 body surface	Udawa.	40.5	187.8 ± 289.3	76.0 ± 204.6
Urceolariidae	*Trichodina* sp.	Skin & gills	10 cm^2 body surface	Udawa.	35.7	5.1 ± 9.1	1.8 ± 6.0
				Kogga.	13.0	1.3 ± 0.5	0.2 ± 0.5
Scyphidiidae	*Apiosoma* sp.	Skin	10 cm^2 body surface	Udawa.	4.8	3.5 ± 2.5	0.2 ± 0.9
				Kogga.	17.0	4.4 ± 3.7	0.8 ± 2.2
Monogenean Parasites							
Dactylogyridae	*Ancyrocephalus etropli*	Gill filaments	2^{nd} gill arch of one side	Udawa.	100.0	108.4 ± 82.5	108.4 ± 82.5
				Kogga.	100.0	117.9 ± 122.6	117.9 ± 122.6
	Ceylonotrema colombensis	Gill filaments	2^{nd} gill arch of one side	Udawa.	91.7	5.2 ± 4.8	4.8 ± 4.8
				Kogga.	63.0	3.1 ± 4.0	2.0 ± 3.5
	Enterogyrus spp.	Stomach	Entire stomach inner surface	Udawa.	88.5	41.0 ± 35.5	36.2 ± 35.9
				Kogga.	100.0	76.4 ± 86.1	76.4 ± 86.1

Parasite		Site of Infection	Method of Quantification	Locality	Preva-lence	Mean Intensity	Abundance
Trematode Parasites							
Acanthostomidae	Acanthostomid metacercaria	Fin rays & gill cartilage	2nd gill arch of one side	Kogga.	28.0	2.1 ± 1.2	0.6 ± 1.2
Heterophyidae	*Exorchis* sp. (metacercaria)	Scales, fins & gill filam.	2nd gill arch of one side	Kogga.	67.0	2.5 = 2.3	0.6 ± 2.2
Cyathocotylidae	Cyathocotylid metacercaria	Muscle, liver & mesentery	Entire muscle, liver & mesentery	Udawa.	98.7	21.4 ± 27.1	21.1 ± 27.1
				Kogga.	91.5	8.4 ± 6.7	7.7 ± 6.8
Strigeidae	Strigeid metacercaria	Mesentery	Entire mesentery	Udawa.	41.0	4.5 ± 5.0	1.8 ± 3.9
Renicolidae	Renicolid metacercaria	Liver	Entire liver	Udawa.	15.4	1.3 ± 0.7	0.2 ± 0.5
Transversotrematidae	*Transversotrema patialens*	Under scales	10 cm^2 body surf.	Kogga.	37.0	1.7 = 1.3	0.6 ± 1.1
Waretrematidae	*Malabarotrema indica*	In intestine	Entire intestinal & rectal cavity	Kogga.	78.7	6.4 ± 8.2	5.0 = 7.7
Cestode Parasites							
Dilepididae	*Paradilepis scolecina* (cysticercus)	Mesentary (duodenum)	Entire abdominal cavity	Udawa.	69.2	3.5 ± 2.6	2.4 ± 2.7
Nematode Parasites							
Rhabdoconidae	*Rabdochona* sp.	Duodenal wall tissue	Inner surface of small intestine	Kogga.	48.9	5.8 = 7.3	2.8 ± 5.8
Anisakidae	*Contracaecum* sp. (L_3 larva)	mesentary, liver, spleen	Entire abdominal cavity, liver & spleen	Udawa.	96.2	6.4 ± 3.7	6.1 ± 3.9
				Kogga.	3.2	1.0 ± 0.0	0.3 ± 0.2
Crustacean Parasites							
Ergasilidae	*Dermoergasilus amplectens*	Primary gill filament tips	2nd gill arch of one side	Kogga.	98.0	24.8 ± 16.0	24.3 ± 16.2
	Ergasilus sp.	Primary gill filaments	2nd gill arch of one side	Kogga.	28.0	1.5 ± 0.9	0.4 ± 0.8
Argulidae	*Argulus* sp.	Skin	Entire body surface	Kogga.	19.0	1.6 ± 0.9	0.3 ± 0.7

Table 2. The abundance levels of parasites (Mean ± SD) within the period of study. Since fish were left in holding tanks for 5 -7 days, the infection levels of direct, short duration life-cycle ectoparasites may have changed. Therefore, the data do not necessarily represent the original level of natural infection. Significance levels; * P (probability) < 0.05, ** $P < 0.01$, *** $P < 0.001$, n.s. - not significant at 95% level.

UDAWALAWA

	April	June	August	October	December	February	Significance Level
NUMBER OF FISH	11	8	17	13	17	18	
Ichthyobodo necator	15.4 ± 36.3	225.6 ± 327.9	26.3 ± 83.9	29.2 ± 53.5	3.2 ± 8.6	6.8 ± 22.4	n.s.
Ichthyophthirius multifilis	0.5 ± 1.0^{a}	65.3 ± 95.6^{ab}	114.4 ± 195^{b}	0.0 ± 0.0^{a}	229.4 ± 365^{a}	0.9 ± 1.9^{a}	***
Ancyrocephalus etropli	109.4 ± 76^{ab}	113.1 ± 31.3^{b}	66.7 ± 57.2^{a}	137.2 ± 96^{bc}	161.7 ± 108^{c}	73.5 ± 48.9^{b}	**
Ceylonotrema colombensis	4.2 ± 3.4^{a}	14.3 ± 7.0^{b}	4.2 ± 4.4^{a}	2.8 ± 1.5^{a}	4.5 ± 4.2^{a}	3.2 ± 1.8^{a}	***
Enterogyrus spp.	8.0 ± 8.0^{a}	7.8 ± 7.1^{a}	8.2 ± 24.2^{a}	26.5 ± 19.1^{b}	55.0 ± 29.6^{c}	72.6 ± 33.5^{c}	***
Cayathocotylid metacer.	12.6 ± 7.6	15.6 ± 14.7	12.6 ± 16.6	18.5 ± 13.2	34.1 ± 35.8	23.6 ± 37.6	n.s.
Renicolid metacercaria	0.2 ± 0.4^{ab}	0.0 ± 0.0^{a}	0.1 ± 0.3^{a}	0.1 ± 0.3^{a}	0.0 ± 0.0^{a}	0.7 ± 0.9^{b}	**

KOGGALA

	May	July	November	January	March	May	Significance level
NUMBER OF FISH	10	18	20	16	20	16	
Ichthyobodo necator	0.4 ± 0.8	225.6 ± 327.9	26.3 ± 83.9	29.2 ± 53.5	3.2 ± 8.6	6.8 ± 22.4	n.s.
Ancyrocephalus etropli	152.0 ± 95.4	163.4 ± 216.9	91.2 ± 112.4	102.8 ± 94.2	90.9 ± 72.8	127.6 ± 57.4	n..s.
Ceylonotrema colombensis	3.1 ± 1.5^{c}	5.6 ± 6.7^{a}	0.6 ± 0.7^{a}	2.5 ± 2.0^{ab}	0.4 ± 0.7^{a}	1.5 ± 1.0^{bc}	***
Enterogyrus spp.	19.9 ± 6.9^{a}	109 ± 143^{bc}	27.1 ± 15.7^{a}	119.5 ± 106^{c}	126.2 ± 70.8^{c}	43.6 ± 20.3^{ab}	***
Cayathocotylid metacer.	4.1 ± 4.6^{a}	11.3 ± 7.8^{bc}	6.4 ± 5.7^{ab}	10.6 ± 6.7^{c}	7.2 ± 5.8^{abc}	$6.5 \pm 8..5^{a}$	*
Acanthostomidd metacer.	0.0 ± 0.0^{a}	0.0 ± 0.0^{a}	1.1 ± 1.5^{ab}	1.9 ± 1.3^{b}	0.2 ± 0.7^{a}	0.3 ± 0.6^{a}	***
Exorchis metacercaria	0.9 ± 1.1^{a}	1.0 ± 1.1^{a}	1.1 ± 1.5^{a}	4.1 ± 3.9^{b}	1.9 ± 1.4^{ab}	1.1 ± 1.4^{a}	**
Rabdochona sp.	13.7 ± 11.6^{b}	2.5 ± 3.8^{a}	2.1 ± 3.6^{a}	0.4 ± 0.6^{a}	1.8 ± 2.5^{a}	0.9 ± 1.1^{a}	**
Dermoergasilus amplectance	21.0 ± 18.4^{ab}	15.7 ± 14.3^{a}	34.4 ± 16.1^{c}	20.3 ± 9.8^{bc}	30.6 ± 17.1^{bc}	19.4 ± 13.3^{bc}	***

other than 0 ppt. However, the population build up of *I. necator* was lower in high salinities than in 0 ppt. and it was entirely absent in salinity 24 ppt. All 4 species of monogeneans could survive well in all 4 salinities tested. *D. amplectens* population in 0 ppt. unlike in the other 3 salinities tested, declined than the initial levels when left for 3 weeks. Further, it was observed that at salinities other than 0 ppt, the second copepodid stage of next progeny temporarily attached to the gills of fish.

Pathological effects

As the pathology of the two protozoans, *Ichthyophthirius multifilus* and *Ichthyobodo necator* which were found in high levels, is well established and the other protozoans were found in very low levels, pathological effects of protozoans were not taken into consideration in this study.

The adult of *A. etropli* was mostly a stationary parasite and where ever the parasites occurred, hyperplasia was evident. The hyperplasia occurred at the site of attachment, however, seemed helping to push the parasite away to detach them (Fig. 2A). Other than the chronic hyperplastic reaction, no inflammatory response was observed. The compression due to attachment of stomach monogeneans were damaging the columnar epithelium, the tubular part of the gastric glands and the secretary part of them lying just beneath the epithelium. The mobile *E. globidiscus* was observed not to provoke host response and hence, causing less damage by feeding far away to its attachment site and low sinking of the opisthaptor (Fig. 2B). *E. paperni*'s attachment, feeding close to its attachment site and its more sedentary nature seemed responsible for more host reaction. Patchy infiltrations of inflammatory cells were observed directly under the attachment sites (Fig. 2C). However, even the fish with high densities of stomach monogeneans did not show any signs of ill effects.

Of the trematodes, pathologically more important are the liver parasitizing renicolid metacercaria and abdominal cavity parasitizing strigeid metacercaria. The renicolid metacercaria destroys the liver tissues at the area occupied, but there was less host reaction in surrounding tissue with no capsule of host origin around the parasite cyst (Fig. 2D). Though the host reaction is low, the destruction of tissue would be detrimental at high infection levels. In contrast, there was an extensive host reaction against strigeid metacercaria to subdue its effects and finally to kill it (Fig. 2E). The case with *P. scolecina* cysticercus was similar to this. In the field, it was observed that the fish with heavy infection of above metacercariae were lethargic and moribund. The destruction of tissues and the expenditure of energy on host reaction would have debilitated the fish.

Although *Rhabdochona* sp. is a very active tissue invader, infecting the mucosa and sub-mucosa of duodenal wall, their low infection levels and the difficulty of revealing their presence before fixing the tissues for histology prevented having the tissues with parasites in histological slides. Haemorrhages were not evident during gross pathological investigations. However, destruction of the tissues by its movement and feeding would obstruct the digestive function of duodenum, thus weakening the host.

Adult *D. amplectens* is sedentary and inhabits tips of primary gill lamellae. Their feeding as well as their movements irritate the gill tissue and cause extensive hyperplasia at the site (Fig. 2F).

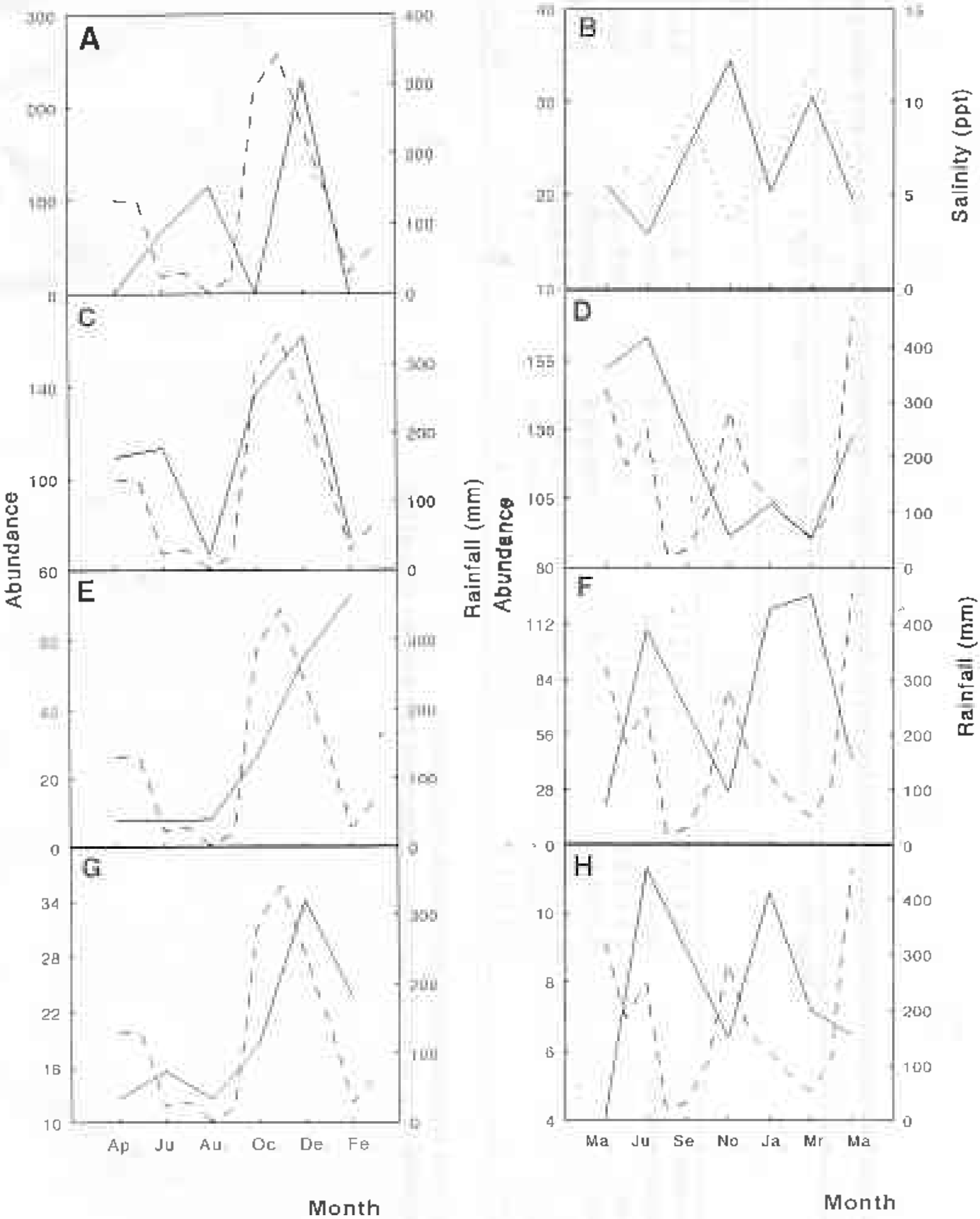

Figure 1. The variation of abundance values (—) of some parasite with the rainfall (- - -) or the salinity (   ) of the relevant locality; *Ichthyophthirius multifiliis* at Udawalawa (A), *D. amplectens* at Koggala (B), *A. etropli* at Udawalawa (C) and at Koggala (D), *Enterogyrus* spp. at Udawalawa (E) and at Koggala (F), Cyathocotylid metacercaria at Udawalawa (G) and at Koggala (H).

Table 3. The initial parasite numbers and population building ups of direct life-cycled ectoparasites after three weeks with their salinity tolerance.

Parasite	Initial No.	Population levels after 3 weeks at different salinities (ppt.)			
		0	8	16	24
Ichthyobodo necator	0.0 ± 0.0	50.4 ± 27.1	27.8 ± 18.3	3.8 ± 4.5	0.0 ± 0.0
Ichthyophthirius multifiliis	0.3 ± 0.2	114.4 ± 70.6	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Trichodina sp.	0.1 ± 2.8	1.1 ± 1.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Apiosoma sp.	0.2 ± 0.5	1.4 ± 2.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
A. etropli	68.8 ± 59.2	75.8 ± 30.7	77.5 ± 32.7	64.9 ± 27.8	71.4 ± 26.0
C. colombensis	3.7 ± 6.4	5.75 ± 3.5	5.4 ± 3.6	7.5 ± 4.8	5.3 ± 2.3
D. amplectens†	26.6 ± 18.5	1.2 ± 2.1	31.6 ± 22.3‡	26.5 ± 13.3‡	24.3 ± 21.2‡

† fish brought from Koggala lagoon were used for this parasite

‡ second copepodid stage of next progeny were temporarily attaching the gills of fish

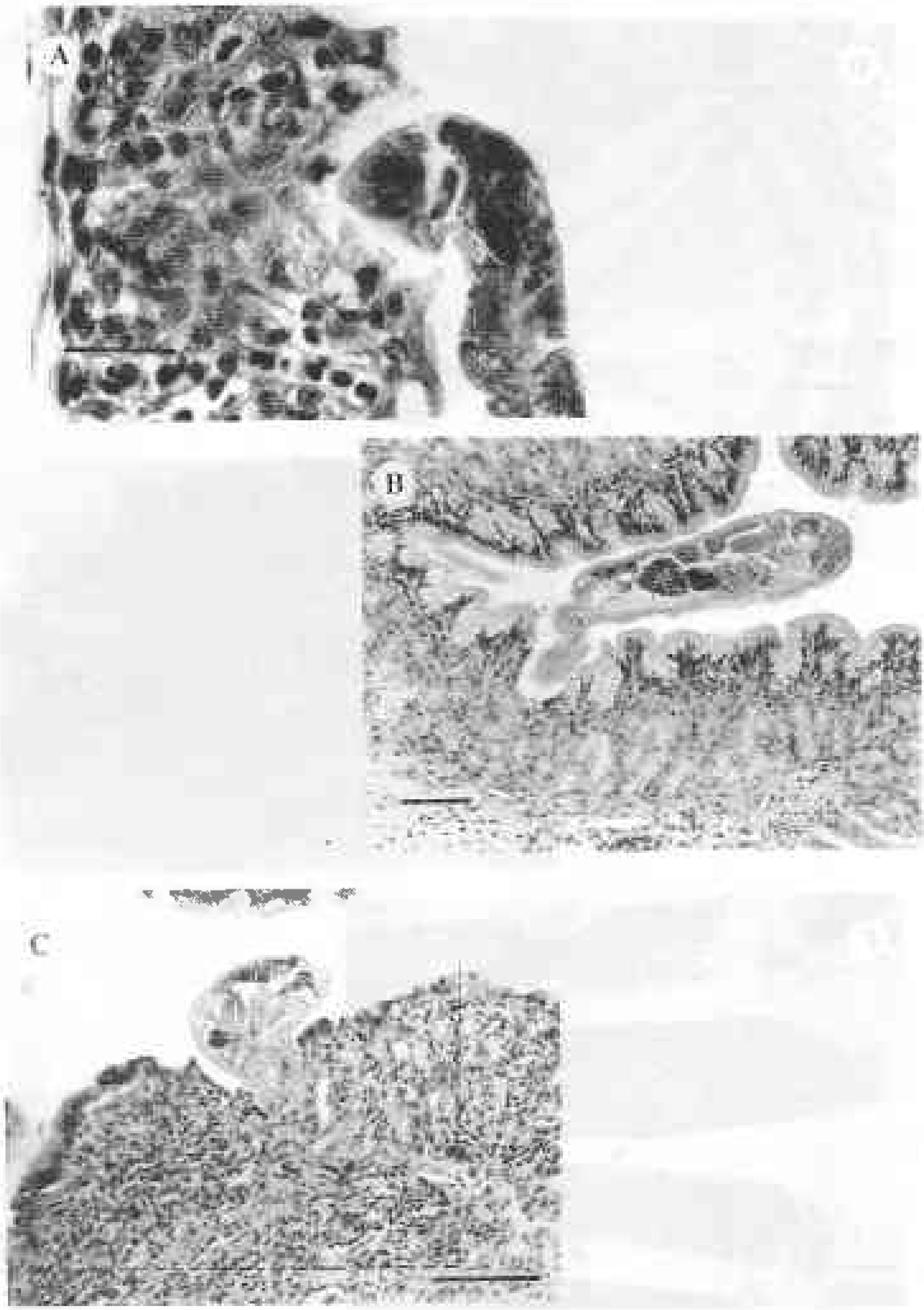

Figure 2. The pathology caused by some parasites of *E. suratensis*. A. The hyperplasia occur at attachment site of *A. etropli* (bar 20 mm); B. *E. globidiscus* destroying attachment site, but with no host response (bar 50 mm), C. The attachment of *E. paperni* with massive host response (area bounded with dotted line) (bar 50 mm)

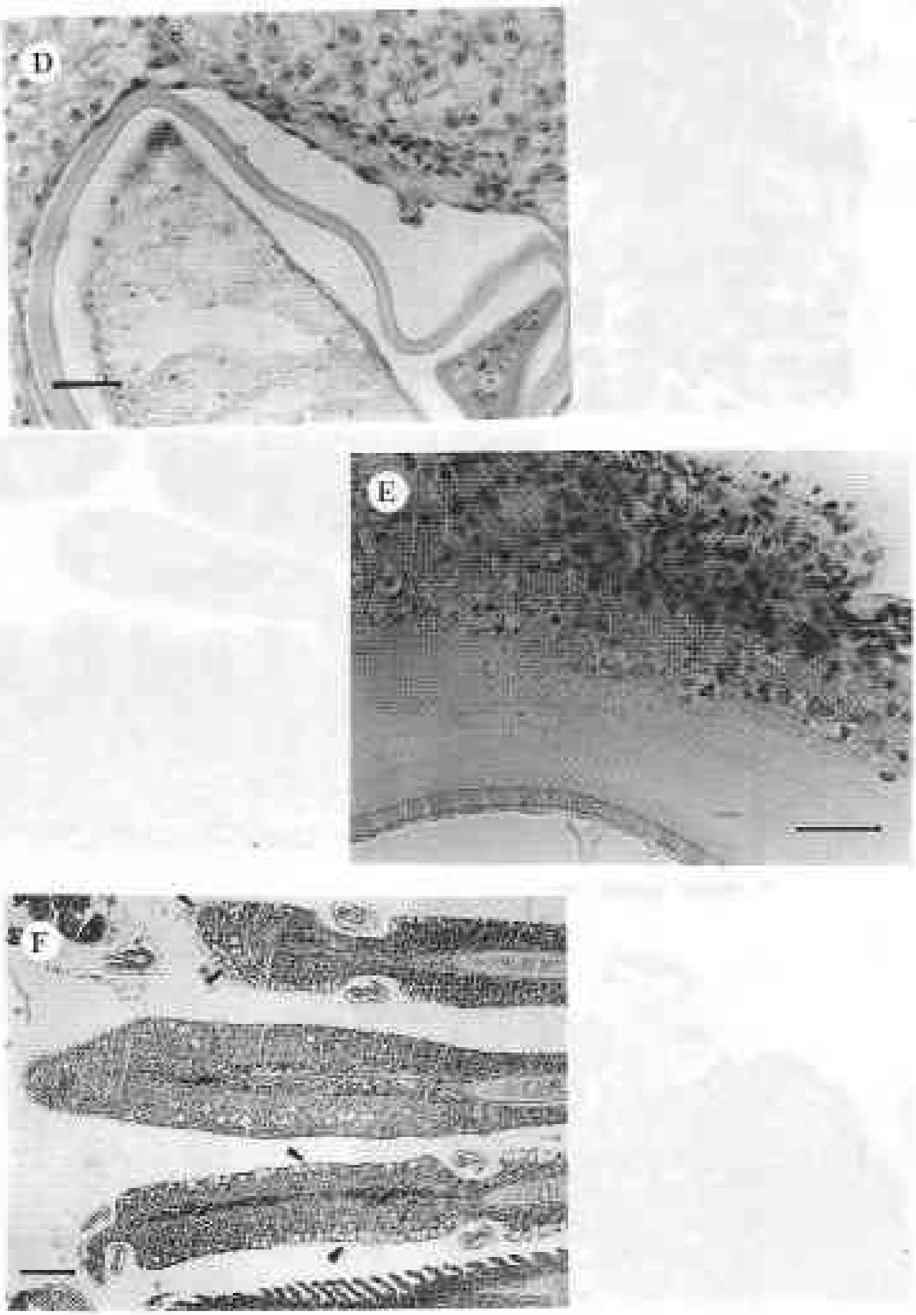

Figure 2. The pathology caused by some parasites of *E. suratensis* (contd.). D. Cyst of renicolid metacercaria without capsule of host origin and inflammatory cells (bar 50 mm), E. Inflammatory response to strigeid matacercarial cyst (bar 40 mm), F. The hyperplasia of gill epithelium and goblet cell proliferation (arrow) due to mechanical irritation caused by *D. amplectens* (bar 100 mm).

Discussion

Of the ecto-parasitic protozoans, *Ichthyophtherius multifiliis* and *Ichthyobodo necator* seem the parasites which can cause problems due to quick building up under aquaculture conditions. Both these parasites favour low water levels which increases the ability of finding a host and further, *I. multifiliis* prefers cold weather. The absence of *I. multifiliis* in high salinities and the preference of *I. necator* for freshwater than for brackishwater show that they mostly cause problems in freshwater. The increased salinity in the lagoon during dry season must be helpful in keeping their populations under check. Though the level of *Trichodina* was low, like the other ecto-parasites with direct life cycle, it has an ability to build up to significant levels.

In Thailand, trichodiniasis was reported to increase during the rainy season (Tonguthai & Chinabut 1987). *Apiosoma* which uses fish only as a substrate for attachment may not become a problem. The high preference for freshwater habitats by *Trypanosoma* sp. may most probably due to the preference for freshwater habitats by its intermediate host which is a leech.

Gill monogeneans were found in both habitats in equal numbers indicating their euryhaline nature and being parasites with direct life-cycle, their ability to establish in new habitats. The increase of *A. etropli* populations in Udawalawe reservoir at the end of the dry periods can be attributed to the increased ability of finding of the host, and the decline after rains, to flushing off of infective stage. This parasite has a high ability to build up in aquaculture systems and damage the host by eliciting extensive hyperplasia in gills. As Paperna (1964) suggested, the hyperplastic response may result in the reduction of mechanical irritation experienced by the fish by keeping the parasite at a distance. In contrast with gill monogeneans, population of *Enterogyrus* spp. differed in the two localities, being higher in the lagoon. Since salinity has negligible effect on this parasite, the long life-cycle (Nilakarawasam 1993) may be hampering the host finding ability in the larger Udawalawa reservoir. The peaks coincided with breeding season of *Etroplus* which occurs in July and February in the lagoons and in February in the reservoirs (Costa 1983). The concentration of host fish in breeding sites for some time during these periods may have increased the host finding ability of this parasite. As the concentration of fish helps to build up these euryhaline parasitic populations, they may potentially cause problems in both freshwater and brackish water habitats. Though there are no serious effects at the observed levels of infections, at high levels fish may be affected considerably.

The limited presence of most of trematodes, cestodes and nematodes in the study sites would perhaps indicate the absence of appropriate intermediate and/or final host for the completion of their life cycles. Of the trematodes present in brackish water habitat, only cyathocotylid metacercaria has been able to establish in freshwater with the introduction of fish. Further, they occur there in higher numbers than in brackish-water. The low prevalence of all other metacercariae in both habitats may be due to the availability of several hosts in the said habitats as this stage is not host specific and/or because of the low host finding ability in a large water body. The population increase in some metacercariae occurred from December to February. The cold temperature prevailed in the season seemed to have influenced the cercarial release. The cyathocotylid metacercaria showed two peaks just after the two rainy periods. Probably their cercarial release is influenced by the rain as indicated by Mohandas (1974). Since cyathocotylid metacercaria inhabits muscle, it is not a very significant parasite unless present in very large numbers. Of the metacercarians, strigeid metacercaria and renicolid metacercaria are highly potential pathogens. The strigeid metacercaria and cestode larva are eliciting a vigorous host reaction which in turn kills them. This reaction against the parasite would cost the host considerable energy. Adult trematodes are not very important as they are not inhabiting vital organs.

The levels of *Contracaecum* sp. in both localities were quite low and as it inhabits less important mesentery, its effects seem negligible. Though *Rhabdochona* sp. is present in low levels, at the peak period its effects may be profound, impairing host by inhabiting a vital organ of alimentary system.

Of the crustaceans, *D. amplectens* seems to be the most important. Since it is a marine parasite which is also reported in *Mugil cephalus* by Ho & Do (1982), in high salinities prevailing during dry periods seem to influence their population growth. In spite of extensive development of hyperplasia at the site of infection, it did not seem to induce inflammatory reactions unlike *Dermoergasilus acanthopagari* Byrens 1985 (Roubal 1989). If the population of this parasite with direct life cycle increases at low water levels, however, the high infection levels will debilitate the fish. The population levels of other crustaceans are low in the natural habitat. However, their importance as parasite cannot be underestimated as these direct life-cycled parasite populations can increase considerably under favourable conditions.

Summary and Conclusions

E. suratensis is parasitized by quite a large number of parasites in both habitats. A few parasites showed high levels of infestations. The low levels of infestations by other parasites are most probably due to the dilution of infective stages or intermediate host by the extent of water bodies. Therefore, the aquaculture which involves rearing of fish at high densities would aggravate problems with parasites. Then the effects of parasites and extensive host reactions against them would debilitate the fish, resulting actual deaths or low growth rates.

When compared the two habitats, monogenean problem exists in both localities and pathogenic protozoan, metacercarial, larval cestode and larval nematode problems occur in freshwater, whilst adult nematode and crustacean problems occur in brackish waters. Hence, of the two habitats, brackish waters seem to be more preferable for fish culture than the other. Therefore, in parasitological view-point, the aquaculture efforts for *E. suratensis* should be directed preferably to brackish water than freshwater aquaculture.

References

Costa, H.H. 1983.
Biological studies of the pearl spot *Etroplus suratensis* (Pisces, cichlidae) from three different habitats in Sri Lanka. Internationale Revue der Gesamten Hydrobiologie 68(4): 565-580.

De Silva, S.S., P. Maitipe & P.R.T. Cumaranatunge 1984.
Aspects of the biology of the euryhaline Asian cichlid, *Etroplus suratensis*. Environmental Biology of Fishes 10(1/2): 77-87.

Gussev, A.V. 1963.
New species of Monogenoidea from the fishes of Ceylon. Bulletin of Fisheries Research Station, Ceylon 16: 53-93.

Gussev, A.V. & C.H. Fernando 1973.
Dactylogyridae (Monogenoidea) from the stomach of fishes. Folia Parasitologica (Praha) 20: 207-212.

Ho, J-S & T.T. Do 1982.
Two species of Ergasilidae (Copepoda; Poecilostomatoida) parasitic on the gills of *Mugil cephalus* (Pisces: Teleostei), with proposition of a new genus *Dermoergasilus*. Hydrobiologia 89: 247-252.

Jayaprakas, V. 1980.
Culture possibilities of pearl spot (*Etroplus suratensis*) in Kerala. Seafood Export Journal 12(II): 13-15.

Lom, J. 1984.
Diseases caused by protistans. In: Diseases of marine animals, Vol. 3 Pt. 1, Pisces (O. Kinne (ed.) Biologische Anstait Helgoland, Hamburg.

Margolis, L., G.W. Esch, J.C. Holmes, A.M. Kuris & G.A. Schad 1982.
The use of ecological terms in parasitology (Report of an *ad hoc* committee of the American Society of Parasitologists). Journal of Parasitology 68: 131-133.

Mohandas, A. 1974.
Studies on the freshwater cercariae of Kerala, 1. Incidence of infection and seasonal variation. Folia Parasitologica 21: 311-317.

Nilakarawasam, N. 1993.
Ecological studies on the parasites of *Etroplus suratensis* (Bloch) (Pisces: Cichlidae) with special reference to *Enterogyrus* spp. (Monogenea: Ancyrocephalinae). Ph.D. thesis, University of Stirling, U.K. 397 p.

Paperna, I. 1964.
Host reaction to infestation of carp with *Dactylogyrus vastator* Nybelin, 1924 (Monogenea). Bamidgeh, Bulletin of fish culture in Israel 16: 129-141.

Roubal, F.R. 1989.
Comparative pathology of some monogenean and copepod ectoparasites on the gills of *Acanthopagrus australis* (family Sparidae). Journal of Fish Biology 34: 503-514.

Sumitra-Vijayaraghavan, L. Krishna Kumari, V.G. Gopinath & R.M. Dhawan 1981.
Aquaculture of pearl spot (*Etroplus suratensis*) in an estuarine pond: environmental characteristics, primary production, growth and cost-benefit ratio. Indian Journal of Marine Science 10: 82-89.

Tonguthai, K. & S. Chinabut 1987.
Recent fish disease problems in Thailand. In: Fish quarantine and fish diseases in South and Southeast Asia; 1986 update (ed., J.R. Arthur), pp. 12-21. Asian Fisheries Society, Manila.

Wiley, A. 1910.
Notes on the freshwater fisheries of Ceylon. Spolia Zeylanica 7: 88-106.

Zar, J.H. 1984.
Biostatistical Analysis, Second Edition: 717 pp. Printice-Hall International editions, New Jersey.

Zhukov, E.V. 1972.
[New genera of trematodes from marine fishes of India]. Parasitologia 4: 346-350 (In Russian).