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A STUDY TO DETERMINE FACTORS WHICH COULD INFLUENCE THE POPULATION OF THE ECTO–COMMENSAL TEMNOCEPHALID *PARACARIDINICOLA PLATEI* (FERNANDO, 1952) BAER, 1953.

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Abstract : The prevalence and abundance of *Paracaridinicola platei* an ecto–commensal on the atyid shrimp *Caridina fernandoi* was studied in two distinct sites in the Kandy Lake over a period of one year. Infection was influenced by environmental factors like rainfall, and host factors such as size and sex. Female shrimps were more susceptible to infection than males, while non–ovigerous females showed a higher percentage of infection with the ecto–commensal.

1. Introduction

Paracaridinicola platei is an ecto–commensal temnocephalid found on the atyid shrimp *Caridina fernandoi.*[1] While sometimes found in the branchial chamber it is also seen crawling about in a leech–like manner on the antennae and carapace of the shrimp.

The general morphology of this temnocephalid has been described by Fernando.[5] Apart from certain aspects of reproduction[3] and feeding (Nathanael and Breckenridge (1991) unpublished data), nothing is known about factors affecting the ecto–commensal population in the Kandy Lake.

The aim of this study was to assess the effects of (1) environmental factors like temperature, rainfall and pH (2) host factors such as size, sex, colour and reproductive conditions of the female which could influence the infection of the shrimp.

2. Materials and Methods

The site chosen for this study was the Kandy Lake, situated in the Hill Country of Sri Lanka.

Bi–monthly (twice–monthly) collection of shrimps was carried out in two different sites chosen for this study over a period of one year.

The shrimps were collected by repeatedly sweeping the water along the edge of the lake with a scoop net having a long wooden handle. Sampling was carried out in the morning at a water depth of about 55 cm. The samples collected separately from sites 1 and 2 were transported as quickly as possible to the laboratory in glass jars. On each occasion of sampling, the temperature, depth, and pH of the water were monitored. Rainfall data for

the period of study were obtained from the Meteorological Department, Colombo.

In the laboratory, the contents of the jars collected from the two sites were emptied into separate trays. Handfuls of shrimps were then randomly picked out from each tray, until fifty shrimps from each site were put into two separate compartmentalised dishes. Since the ecto–commensals were observed to drop off no sooner the shrimps died, the compartments were helpful in ensuring the accuracy of counts. A pair of jeweller's forceps was employed for collecting the ecto–commensals from the host.

Each host shrimp was measured, sexed and its colour noted. Only a very small proportion of the shrimps of the size class (6–10 mm) in the sample could be analysed. This was inevitable for two reasons. Firstly, some of these shrimps drawn into the mesh net were intermingled with the roots and other plant debris and were discarded with them. Secondly, some were too small to be sexed accurately, and had to be discarded. Unlike the other size classes the percentage infection reported for this particular size class (6–10 mm) is based only on the number which could be sexed accurately. The reproductive condition of the females was also checked, the presence of a brood pouch being taken as an indication that they were ovigerous.

3. Results

Factors studied which could influence the ecto–commensal population could be categorised into two groups–namely the environmental and the host factors.

Effects of environmental factors:

Figure 1 depicts variations in average water temperature, pH, rainfall and also the monthly variations in the abundance of *P. platei*.

The results indicate that the water temperature showed a very small fluctuation ranging from 26^0C to 30^0C. ($\bar{X}$ = 27.8; standard error = 0.10). Since temperature fluctuations are markedly low, it is possible to infer that temperature exerts little influence on the fluctuation of the ecto–commensal population. Rainfall on the contrary, showed a wide fluctuation. The unpredictability of climatic conditions was accentuated during the study period by the failure of the South West monsoon, and an unusually high rainfall in February 1986. ($\bar{X}$ = 117.5; standard error = 19.07). After periods of heavy rain (October, 1986) there was an increase in the abundance of ecto–commensals, and consequently in the proportion of shrimps infected. The breeding of the host shrimp seemed to be enhanced after periods of heavy rains, since the samples were observed to contain multitudes of tiny shrimps.

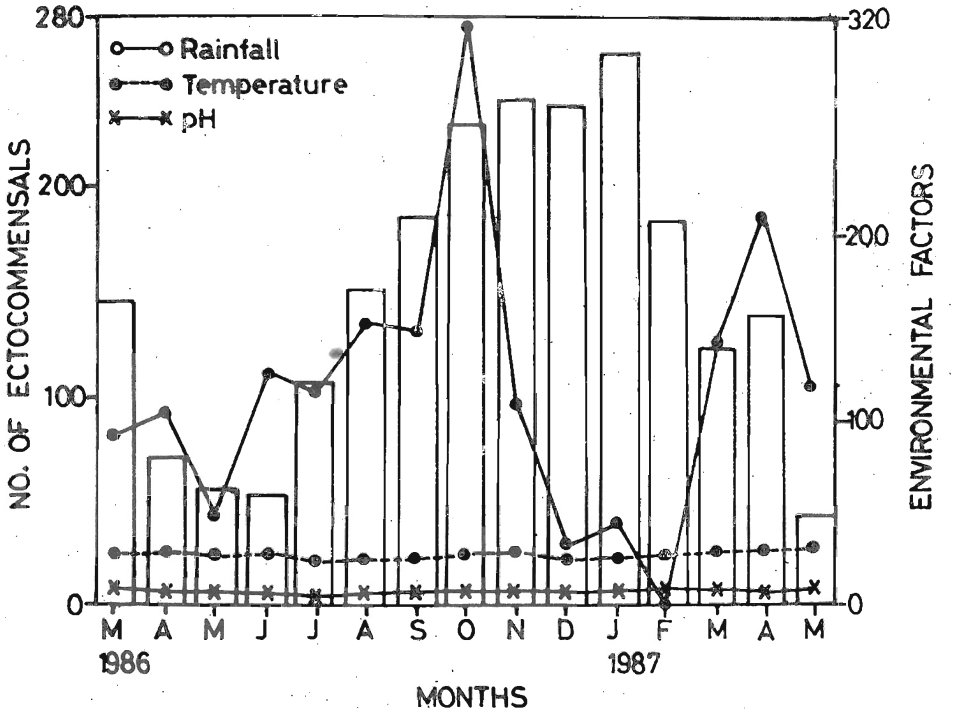

Figure 1: Variation in average water temperature, pH, monthly rainfall and fluctuation in the ecto–commensal population (March 1986 – May 1987.)

The pH of the water did not show any significant monthly variations ($\bar{X}$ = 7.6; standard error = 0.08) but remained between 7.1 and 8.5 within the period of study. Although somewhat higher pH values were obtained during January and February 1987, no positive inference could be drawn as to whether or not they influence the ecto–commensal population in any way.

3.1 Effects of Host Factors:

Although the relationship between the shrimp and *Paracaridinicola* is not a permanent one, it was interesting to observe some of the responses shown by the ecto–commensal to different species and sizes of shrimps, to the sex and reproductive condition of the females and to the colour of the host in assessing whether or not these factors could influence infection.

3.2 Shrimp Species

The study sites contain two species of atyid shrimps, namely *Caridina fernandoi* and *Caridina simoni*. Apart from the almost negligible infection of *C. simoni*, *P. platei* was found to have a very high degree of host specificity

for *C. fernandoi*. (*C. fernandoi* % infection = 45.43, n = 2, 536; *C. simoni* % infection = 1.95, n = 564).

3.2.1 Size

For ease of analysis, and to facilitate ready comparison the host shrimps collected were categorised into five size groups on their lengths, measured from the tip of the rostrum to the end of the telson (Table 1).

Table 1 : Infection with *Paracaridinicola platei* in different size groups of shrimps

Size category of shrimp (in mms)	Total number of shrimps	Number infected	Number uninfected	Number infected (as % of Total)	Number uninfected (as % of Total)
6–10	39	22	17	56.4	43.6
11–15	521	267	254	51.2	48.8
16–20	1,379	558	821	40.5	59.5
21–25	993	287	706	28.9	71.1
26–30	168	24	144	14.3	85.7

It is evident from Table 1 that as the shrimps increased in size the proportion of infection within each size class decreased. A chi–square test indicated ($\chi^2 = 123.44$, $p < 0.001$) that there was a very significant statistical correlation between size and the degree of infection. It could be relevant to mention here, that the largest size class (26 – 30mm) was found to contain large numbers of ovigerous females.

3.2.2. Sex, reproductive condition of the female and host colour

The population sampled always contained more females than males (around 60 – 65% females). Host factors such as sex, the reproductive condition of the female and colour were separately tested statistically in order to assess their respective association with infection. The results indicate that significantly more females were infected than males ($\chi^2 = 5.51$; $p < 0.010$) and non ovigerous females than ovigerous females ($\chi^2 = 20.58$; $p < 0.0001$). Females showed a higher susceptibility to infection with a high percentage of ovigerous females being not infected, although the population consisted of a significant proportion of ovigerous females. (Likelihood Ratio $\chi^2 = 145.11$; $p < 0.0001$). The colour of the host shrimp was observed to vary from translucent to complete black. The colour factor however, did not show any significant association with infection. ($\chi^2 = 0.60$; $p > 0.439$).

All through the year the proportion of infected females was higher than the proportion of infected males (Figure 2). Since female shrimps with brood pouches were found throughout the year in the samples, there appears to be no reproductive seasonality in the breeding cycle of the shrimp. Apart from the observation that a significant proportion of ovigerous females are manifested it is difficult at this stage to say whether the ecto–commensal is dependent or not on the breeding habits of the host for its propagation. A further point of interest that is evident (Figure 2) is that, when there is an increase in the proportion of infected ovigerous females, there is a corresponding drop in the proportion of infected non–ovigerous females.

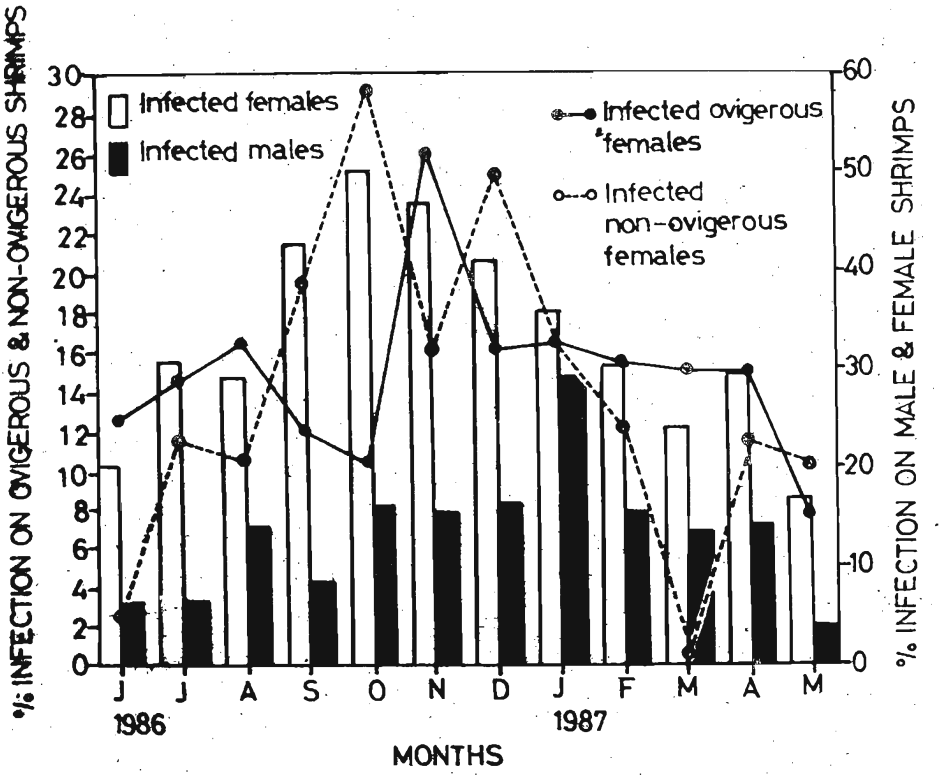

Figure 2 : Monthly fluctuation in the percentage of male and female shrimps and ovigerous and non–ovigerous females infected with *Paracaridinicola platei.*

Regarding the colour of the host, both the translucent and the dark coloured shrimps are equally susceptible to infection with the ecto – commensal (Figure 3(a) and Figure 3(b)).

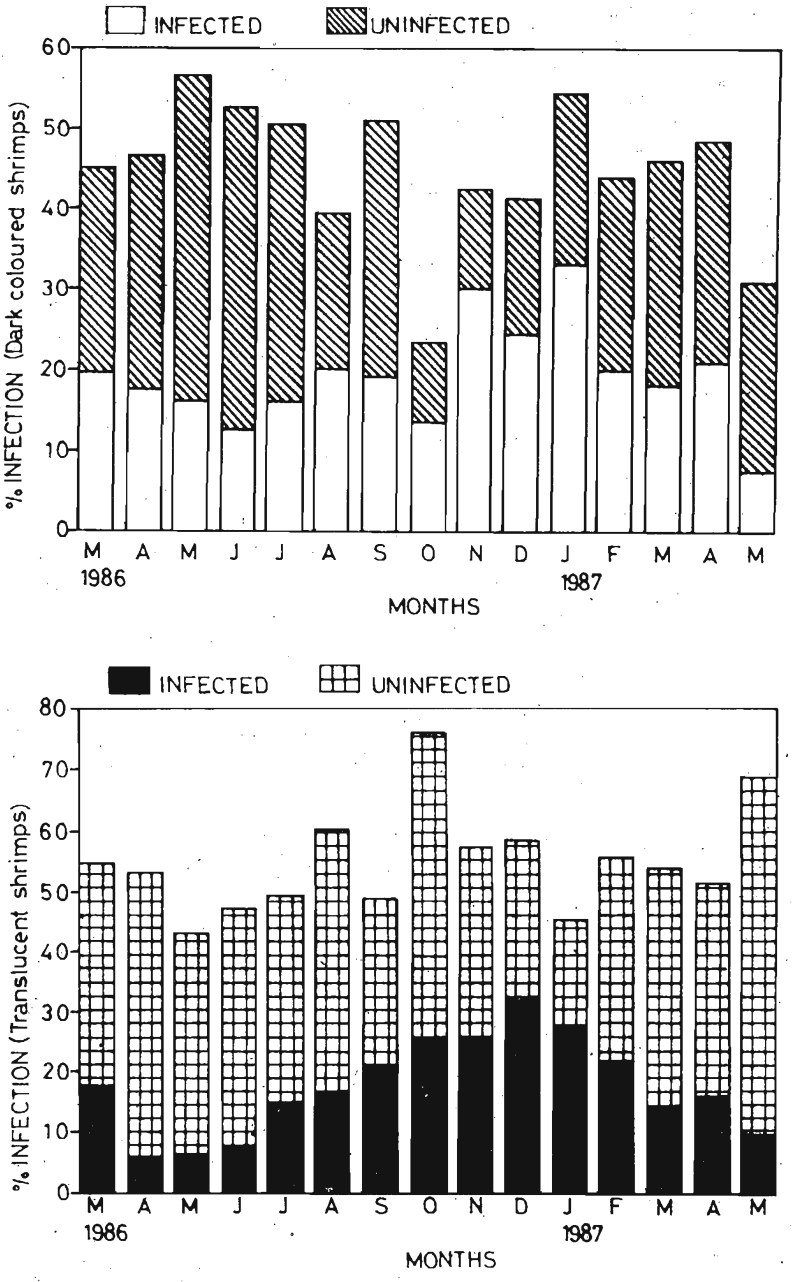

Figure 3 (a) : Comparison of the fluctuation in percentage of "Dark" coloured shrimps (The expression "Dark" has been used to demarcate shrimps with a gradation in colour from light brown to complete black) infected with the ecto–commensal *Paracaridinicola*.

(b) : Comparison of the fluctuation in the percentage of translucent shrimps infected with *Paracaridinicola*.

(Data from sites 1 and 2 have been pooled for Figures 3(a) and 3(b).

4. Discussion

The present study showed that the water temperature is never constant all the year long, but varied both diurnally and according to the monsoons. However, these fluctuations are extremely small, and do not appear to directly influence the ecto–commensal population.

This lake receives rain water both from the North East monsoon (approximately October to December) and the South West monsoon (approximately May to July). Inter monsoonal convectional rainfall also constitutes an additional source of water supply for the lake. The effects of rainfall can be directly observed and its indirect effects may influence the ecto–commensal population over a long period of time. For example, after the heavy rainfall in October 1986, the ecto–commensal population continued to remain high during the months of November and December 1986 and January 1987,despite the conspicuous drop in rainfall (Figure1). After heavy showers of rain the water level in the lake rises, submerging the aquatic roots which offer shelter for the host shrimp. After such rains there is an increase in the growth of vegetation with a concomitant increase in the nutrient supply available to both the host and the ecto–commensal. Such favourable conditions could be expected to exert an effect on the breeding of the shrimp and the ecto–commensal populations. The reverse would obtain during periods of drought. One could also expect chemical factors of the environment like the water pH, to exert some sort of influence on the ecto–commensal populations, although these effects are not easily discernible.

From the observations in this study it would appear that the ecto–commensal is discriminating in its choice of host shrimps. Whether or not this is contingent on any special biological characterisation of particular shrimps or any actual resistance to infection is a matter for speculation. At any rate one could not predict how easily these ecto–commensals are acquired or at what rate they are lost. A further point is that some shrimps may be harbouring transient ecto–commensals as probably is the case in the few infected *C. simoni* in the process of finding a suitable host. Those shrimps that do tolerate the presence of the ecto–commensal appear to do so without any apparent adverse consequences to themselves. More than that, they provide temporary shelter, with their branchial chambers serving as an ideal place for egg laying. Further, the ecto–commensals are effortlessly transported to locations favourable for finding food, during locomotion of the host.

This study indicates that host factors–notably the size, sex and reproductive condition of the female, have an influence on the abundance of ecto–commensals on a particular shrimp. It further shows that there is a gradation in the percentage infection from the larger to the smaller size class.

Apart from host size, this study has sbown that the sex of the host appears to play an important role in infection. Dunham[4] states that in

aquatic crustacea pheromones are released from the antennal gland of the female after moulting. The question arises whether these sex pheromones are involved in helping *P. platei* to differentiate between male and female shrimps. In general, most ovigerous females are sluggish, and would be well hidden among the roots during the period of the hatching of the eggs, thereby escaping predation and would apparently provide an ideal environment for egg laying of the ecto–commensal.

It is known that cryptic colouration is advantageous to the host in avoiding predation. In this context, it is interesting to observe that there are more ecto–commensals on shrimps which show a similar colouration to the roots in site 1 (i.e. darker coloured ones) than on translucent shrimps. Again, in site 2 where the roots are of a very light colour more ecto–commensals are found on the translucent shrimps. A possible protective mechanism for the survival of the host would thus seem to benefit indirectly the ecto–commensals as well, in the two different sites.

Nappi and Crawford[6] who studied the occurrence and distribution of the turbellarian *Syndesmis* in sea urchins, report the absence of *Syndesmis* in the sea urchin *Tripneustes ventricosus*, a species found in large numbers in each of the study sites occupied by infected urchins of the species *Lytechinus variegatus*. The authors suggest that there may be certain physiological differences, which account for this type of host specificity. Perhaps this may be true for *Caridina fernandoi* and *Caridina simoni* as well.

Wanninayake and Costa[7] have studied the seasonal variations in the "abundance" of the prawn *Macrobrachium rosenbergii*, as well as the sex ratios in natural populations. They found that there was a positive correlation between the total monthly catch, the breeding season and rainfall. They record as much as 60–90% ovigerous females in the catch during the rainy seasons. In the host shrimp *Caridina fernandoi* too there was an increase in population after heavy rain with many tiny shrimps. The number of females caught were consistently higher all the year round. In *Macrobrachium* this bias towards females was attributed to the migration of prawns for spawning. In the case of *Caridina fernandoi* the presence of ovigerous females throughout the year is indicative of the absence of any breeding seasonality.

The effects of ecto–commensal infection on the abundance of the host shrimp remain unknown. In certain cases of high prevalence of the ecto–commensal and eggs it may be possible that the respiration of the host shrimp is somewhat restricted.

The overall results from these studies suggest that a complex set of environmental and host factors should be taken into consideration, when attempting to explain the distribution of ecto–commensals on their host population.

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