Tropical Agricultural Research Vol. 8 1996, 370-376

Spatial distribution of *Dactylogyrus vastator* Nybelin, 1924 on the Gills of *Cyprinus carpio* L.

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ABSTRACT. Dactylogyrus vastator Nybelin, 1924 is a common, economically significant pathogenic monogenean parasite of European carp (Cyprinus carpio L.). D. vastator is found attached to the gills of the host by means of an attachment organ, the opisthaptor, which carries two large hamuli, a connecting bar and fourteen peripheral marginal hooks.

The parasites were not randomly distributed over the gill apparatus. There were no significant differences in the number of parasites between separate gill arches. But in some instances parasites aggregated in certain areas of the gills, in particular the ventral proximal secondary filaments on both sides of the hemibranch are favoured.

INTRODUCTION

Some parasites have a greater affinity or specificity for certain sites on or in the host (Hanek and Fernando, 1978 a, b). Cerfontaine (1896, 1898) was the first to record the avoidance of gill ventilating current in *Diclidophora denticulata*, a gill parasite of *Pollachius virens*. The existence of affinities for certain regions of the gill apparatus by monogeneans has been subsequently reported by many authors, including Frankland (1955), Llewellyn (1956), Llewellyn and Owen (1960) and Suydam (1971). The *Urocleidus ferox* Muller, 1934 preferred the median sector of the hemibranch compared with the upper and lower sections of the gill arch of *Lepomis gibbosus* L. (Hanek and Fernando, 1978 b).

Dzika and Szymanski (1989) found that in bream, *Abramis brama* L., three species of *Dactylogyrus, D. falcatus, D. wunderi* and *D. auriculatus* mostly occurred on the median sector of the proximal parts of the gill arches, whereas *D. zandti* mostly occurred on the extreme distal portion of the filaments of all regions. This study has aimed to find out the most preferred site by *D. vastator* on it's fish host.

MATERIALS AND METHODS

One hundred carp with a mean standard length of 2.95 ± 1.00 cm (Mean ± SD) and mean weight of 1.25 ± 0.77 g and with a mean of 24.63 (2 - 308) *D. vastator* per fish were used to study the spatial distribution of the parasite. Fish were decerebrated and gill arches were separated individually and placed separately. The numbers of *D. vastator* from each gill arch, each side of each hemibranch and each area of hemibranch surface were recorded.

Wilcoxon's signed rank test (paired samples) was performed to test the difference between the right and left sets of gill arches (Wilcoxon and Wilcox, 1964). The nonparametric STP test and Dunns test were employed to test the difference in the numbers of parasites between the arches and between hemibranches and hemibranch areas.

RESULTS

The total numbers of *D. vastator* on the different parts of the gill apparatus of hundred fish are given in Table 1. As it is evident from total numbers, more *D. vastator* were found on the left than on the right set of gills. Comparing the four gill arches, most parasites occurred on the first arch, with decreasing numbers on arches II, III and IV in that order. The surface area of the gill arches decreases from I to IV. The ventral segment of the hemibranches carried the greatest number of *D. vastator* and there were more parasites on the proximal rather than the distal parts of the filaments. Within individual hemibranches *D. vastator* was found to be aggregated so that a large number of parasites were often found in close proximity.

Left and right gill arches

The collected data did not show a normal distribution, therefore Wilcoxon's signed ranked test (for paired samples) was applied to compare the number of *D. vastator* between the left and right sets of gill arches. There is no significant difference between the number of *D. vastator* on the right and left gill arches. Therefore, data for the right and left gill arches were pooled for further analysis.

Table 1. **The total number of *D. vastator* found on different regions of the gill apparatus of hundered *Cyprinus carpio.***

	Right Gill Set		Left Gill Set	
No. of *D. vastator* observed	627		828	
Gill arches	1	2	3	4
No. of *D. vastator* observed	471	387	323	274
Halves of primary lamella	Proximal		Distal	
No. of *D. vastator* observed	826		629	
Segments of hemibranches	Ventral	Median		Dorsal
No. of *D. vastator* observed	648	551		256

Gill arches I-IV

The data did not show a normal distribution, and thus the non-parametric STP test, and Dunn's test were used to test the number of *D. vastator* on separate gill arches. Both tests showed that there is no significant difference in the number of *D. vastator* between gill arches I-IV.

Comparison of different areas of gill arches I-IV

Dunn's test and STP test (paired test) were carried out for each gill arch individually, to determine if there was any significant difference in numbers of *D. vastator* between separate areas. For gill arches I, II and III there was no apparent difference between the areas under study. Only in gill arch IV there was a significant difference between area 1 and area 4 at 0.05 level.

Comparison of gill arch areas

The data on different areas for separate gill arches was pooled. Then this was subjected to Dunn's test to elucidate any significant differences. The results are shown in Table 2.

Table 2. Summary of Q values from the Dunn's test for comparison of all areas.

Area \ Area	1	2	3	4	5	6
1						
2	0.628$_{NS}$					
3	1.159$_{NS}$	0.53$_{NS}$				
4	4.23****	3.601***	3.071*			
5	2.491$_{NS}$	1.862$_{NS}$	1.332$_{NS}$	1.739$_{NS}$		
6	2.879$_{NS}$	2.251$_{NS}$	1.72$_{NS}$	1.351$_{NS}$	0.388$_{NS}$	

Tabled Q values at 0.05(6) = 2.936, 0.01 = 3.403, 0.005 = 3.588 and 0.001 = 3.988

* - significant at 0.05 level *** - significant at 0.005 level
**** - significant at 0.001 level

NS - non significant

Thus, there is a significant difference between area 4 and areas 1, 2 and 3. Similarly the STP (Paired analysis) also indicated the same result.

DISCUSSION

This study showed no significant differences in the numbers of *D. vastator* between the gill arches of carp, although such differences in other host-parasite systems exist. Wiles (1968) found that *Diplozoon paradoxum* occurred most often on gill arches I and II of *Abramis brama* and Suydam (1971) showed that the site specificity of *Diclidophora macclumi* was similar to that of *D. paradoxum*. *D. amphibothrium* prefers gill arches II and III of *Gymnocephalus cernua* (Wootten, 1974).

The speed of the respiratory current may have an influence on the settlement of the infective larval stage or of immature worms entering the gill chamber via the respiratory current. The geometry of the gills changes constantly throughout the breathing cycle (Shelton, 1970); therefore, the gill sieves are alternatively exposed to and protected from the water flow.

Some authors have suggested that the water current flowing through the gills may have an influence on the parasite spatial distribution (Paling, 1968; Wootten, 1974; Hanek and Fernando, 1978 a,b; Buchmann, 1988 a,b, 1989). Wootten (1974) reported that the spatial distribution of *Dactylogyrus amphibothrium* over the gills of ruffe *G. cernua*, was at not random, parasites being aggregated on certain areas of the gill apparatus. There were significantly more parasites attached to the right set of gills compared to the left set and significantly greater numbers of monogeneans occurred on the middle two gill arches and on the dorsal segment of the gill compared with the median and ventral segments. *D. amphibothrium* occurred in significantly greater numbers on the distal halves of the gill filaments (Wootten, 1974).

Based on the relative areas of the gill arches it might be expected that most *D. vastator* would be found on the first gill arch of carp and this was indeed the case. The gill arches decreases in area from I to IV and the number of *D. vastator* also decreased between the arches in the same order. Although there was no significant difference in number of parasites between the arches, if parasites per unit area of gill had been analyzed it may have shown a significant difference between arches.

CONCLUSIONS

Many monogeneans and crustaceans are known to be restricted to specific parts of the gill apparatus of their hosts. In this study, there were no significant differences in the distribution of *D. vastator* over the different gill arches, left and right side and internal and external hemibranches. There was a significant difference between the ventral proximal sector and the dorsal distal sector. This may reflect differential water flow over the gills. The fact that *D. vastator* showed relatively little spatial separation in this study may reflect the small size of the carp used, which perhaps have a more uniform flow of water over the parts of the gill apparatus. Where *D. vastator* did occur, parasites were often clustered together and this may reflect the need to successfully mate.

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