CHAPTER 3

ASPECTS OF THE ECOLOGY OF *LAMPROGLENA CLARIAE* (COPEPODA: LERNAEIDAE) FROM THE VAAL RIVER SYSTEM, SOUTH AFRICA

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Lamproglena clariae (Fryer, 1956) is an ectoparasite infecting the gills of *Clarias gariepinus* (Burchell, 1822), the sharptooth catfish, occurring in stagnant waters such as pools of seasonal rivers, ponds, dams and lakes and it is common and widely distributed throughout most of Africa (Skelton, 2001). *Lamproglena clariae* was first described from material collected from Lake Malawi (Fryer, 1956). Discovery of specimens from Lake Victoria and White Nile (Fryer, 1961, 1964) added morphological details, such as the number of setae on the furcal rami and the armature of legs. Marx and Avenant-Oldewage (1996) redescribed *L. clariae* from specimens collected in the Olifants River, Kruger National Park, South Africa and the Cuando River in the Caprivi strip (Namibia).

This study refers to the ecology of *L. clariae* and specifically aimed to investigate the effect of the host size on the parasite size and abundance; the effect of water quality on the survival of the parasite and the parasite attachment site preference on the gill arch of the host.

MATERIALS AND METHODS

Study area and hosts

Two areas were chosen, one subject to industrial pollution and one relatively unpolluted that is the Vaal River Barrage (S 26° 45.786', E 27° 41. 280') and the Vaal Dam (S 26° 52.249', E 28° 10.249') respectively (Fig. 1). Water quality data for the chosen sites were analysed and expressed as an Aquatic Toxicity Index value according to the methods described by Wepener *et al*. (1992). This index gives a single weighed value from all variables, which increase with general water quality. Temperature and pH (units) of water at both sites were also recorded.

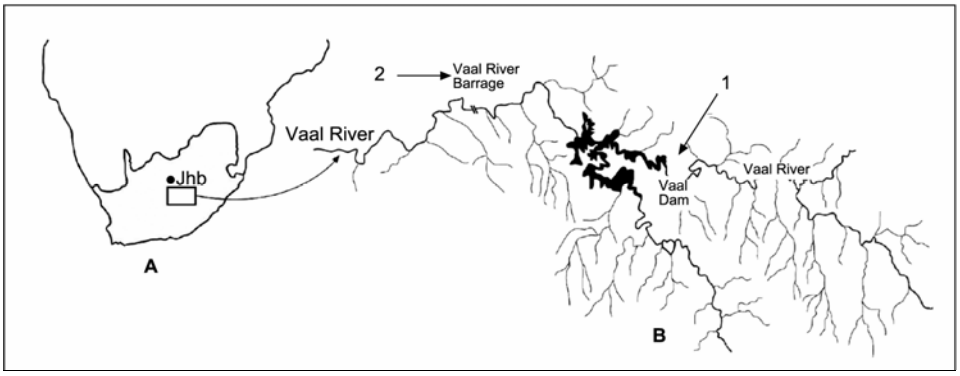

Figure 1: Maps of South Africa (A) and the Vaal River System (B) showing the two collection sites; Vaal Dam (1) and Vaal River Barrage (2). Jhb=Johannesburg.

Specimens of *C. gariepinus* were collected together with specimens of *Labeo capensis* (Smith, 1841), *L. umbratus* (Smith, 1841), *Cyprinus carpio* (Linnaeus, 1758), *Labeobarbus aeneus* (Burchell, 1822), *Lb. kimberleyensis* (Gilchrist and Thompson, 1913), and *Micropterus salmoides* (Lacepède, 1802) by means of gill nets. Even though it was already known that *L.clariae* infects *C. gariepinus*, all the other collected fish were also examined for *Lamproglena* (Von Nordmann, 1832). Sampling was done bimonthly from Vaal Dam and Vaal River Barrage in 1999 and monthly from Vaal Dam in 2000. Fish were killed by a single cut through the spinal cord, after which the gills were dissected and examined, with the aid of a dissecting microscope. Collected parasite specimens were preserved in 70% ethanol.

The ecology of *L. clariae*

The sex and size of the host was determined in the field. The size was determined by weighing and measuring the total length of the fish. The position of parasites on each gill arch was noted by dividing it into three areas: anterior, median and posterior. Gills from each chamber were numbered 1--4, from the anterior to the posterior. The parasite specimens and gill filaments were measured in the laboratory with the aid of a microscope with a drawing tube attachment. The length of the parasites' maxillipedes was also measured.

Data was statistically analysed for correlation and comparisons using the SPSS statistical Program (Zar, 1984). The correlation between parasite length and the dimensions of the host's gill filament was determined. The correlation between the size of the host and the length of parasite as well as the size of the host and the number of parasites was determined. A correlation between the parasite length and maxillipede length was also determined. Gender preference was also investigated. Infestation levels were expressed as abundance, prevalence at the 95% confidence interval and mean intensity (±SE) in accordance to the definitions of Margolis *et al*. (1982) and Busch *et al*. (1997).

RESULTS

Data of fish species collected from the two sites during the study period is summarised in Table 1.

Table 1: Species and number of fish specimens inspected for the presence of *Lamproglena clariae* from the Vaal Dam and Vaal River Barrage respectively

Vaal Dam		Vaal River Barrage	
Fish species	Number of fish	Fish species	Number of fish
Labeo capensis	20	*Labeo capensis*	40
L. umbratus	36	*L. umbratus*	21
Cyprinus carpio	10	*Cyprinus carpio*	25
Labeobarbus aeneus	119	*Labeobarbus aeneus*	15
L. kimberleyensis	36	*L. kimberleyensis*	25
Clarias gariepinus	276	*Clarias gariepinus*	100
		Micropterus salmoides	20

Only *C. gariepinus* harbored *L. clariae*. Of the 276 *C. gariepinus* collected from the Vaal Dam, 52% were males and 48% were females. In the Vaal River Barrage 60% of 100 fish were males and 40% females. There was no significant gender preference expressed by the parasite for either Vaal Dam (P = 0.156) or Vaal River Barrage (P = 0.358).

Fish collected from the Vaal Dam ranged between 40.6--121cm in length and between 0.4--11.8kg in weight. In Vaal Barrage length ranged between 40.9--99.3cm and the weight between 0.48--7.0kg. There was a positive correlation between the weight and length of the fish hosts in the Vaal Dam (r^2 = 0.9518) and Vaal River Barrage (r^2 = 0.9534). A positive correlation was also shown between the length of the fish and its gill filament length (r^2 = 0.6128) and width (r^2 = 0.4809) in the Vaal Dam. A positive correlation between the parasite length and maxillipede length was also shown (r^2 = 0.0002).

A total of 1652 *L. clariae* were collected from the Vaal Dam, 44% from the left and 56% from the right gills. Of the 379 parasites collected from the Vaal River Barrage, 49% were collected from gills on the left and 51% from right gills. Their length ranged between 3.6mm--7.2mm with an average of 6.1mm and a standard deviation of 1.25mm.

No significant difference was found in the number of parasite specimens collected from the left and right gill arches from the Vaal Dam (P = 0.9997) and Vaal River Barrage (P = 1).

From both sites 52% of the parasite specimens were attached to the median part of the gill arch. The anterior and posterior parts of the gill arches had 14% and 34% of parasites respectively (Fig. 2).

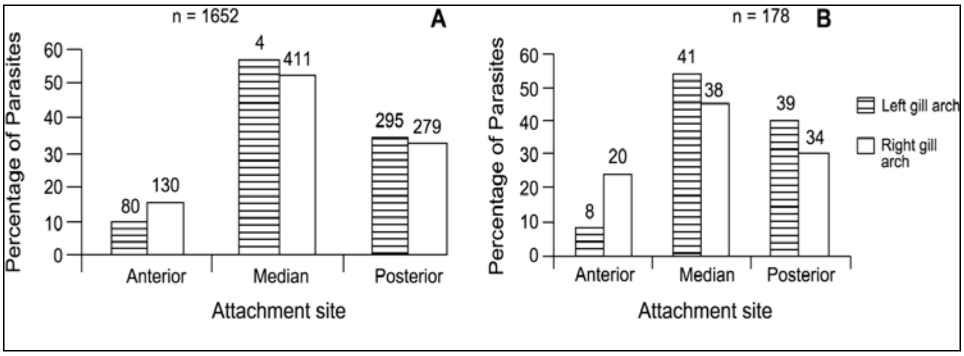

Figure 2: A comparison of *Lamproglena clariae* attachment on the anterior, median and posterior parts of the gill arches of *Clarias gariepinus* in terms of percentage of parasite occurrence from the Vaal Dam (A) and Vaal River Barrage (B).

The fourth gills on both sides (left and right) had higher mean intensity and abundance than the other gills of examined fish from both localities (Fig. 3).

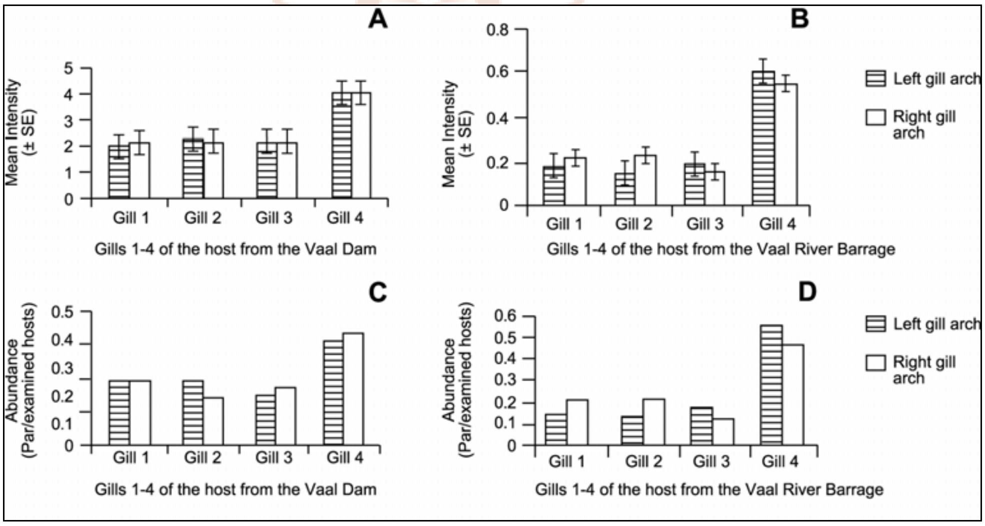

Figure 3: A comparison of *Lamproglena clariae* attachment on the gills of *Clarias gariepinus* in terms of mean intensity (A and B) and abundance (C and D) from the Vaal Dam (A and C) and Vaal River Barrage (B and D).

Results from the Vaal Dam showed positive, but non-linear correlation between parasite length and fish length and weight (Fig. 4), parasite length and the filament length and width (Fig. 5).

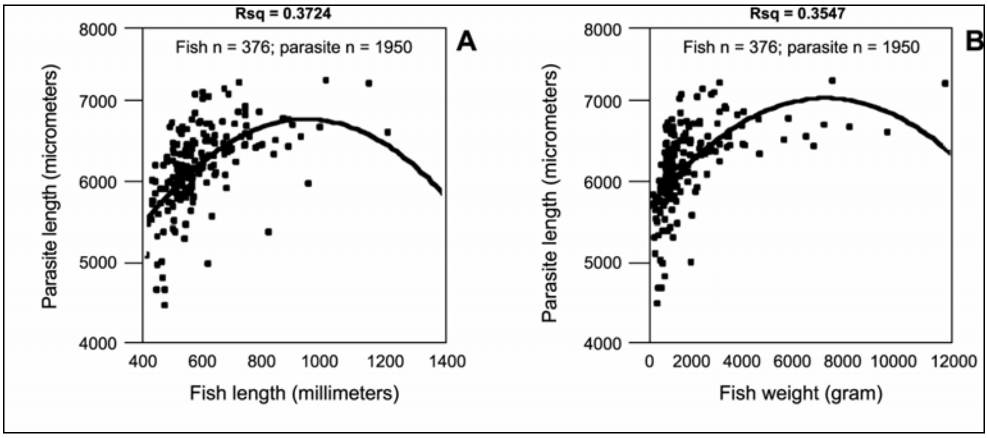

Figure 4: A correlation between the length of *Lamproglena clariae* and the length (A) and weight (B) of *Clarias gariepinus* in the Vaal Dam.

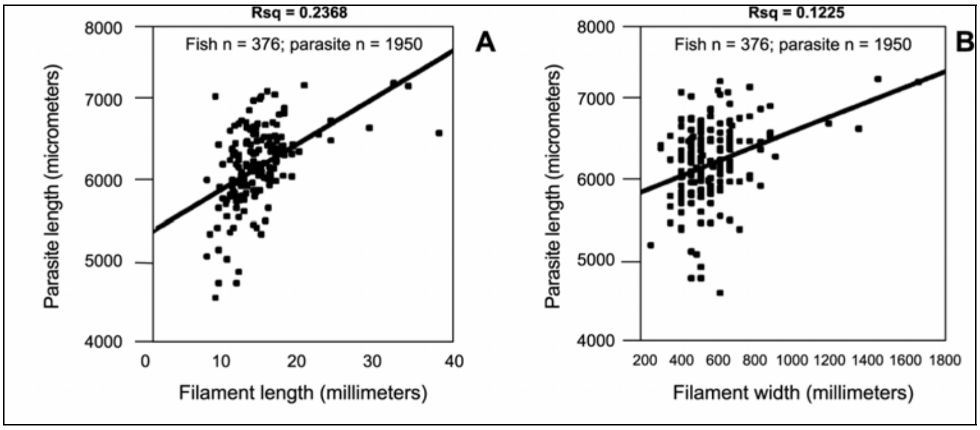

Figure 5: A correlation between the length of *Lamproglena clariae* and the length (A) and width (B) of the gill filament of *Clarias gariepinus*.

The filament length and width correlated positively with the length of maxillipedes (Fig. 6), as it was the case with the correlation between the parasite length and maxillipede length ($r^2 = 0.0002$).

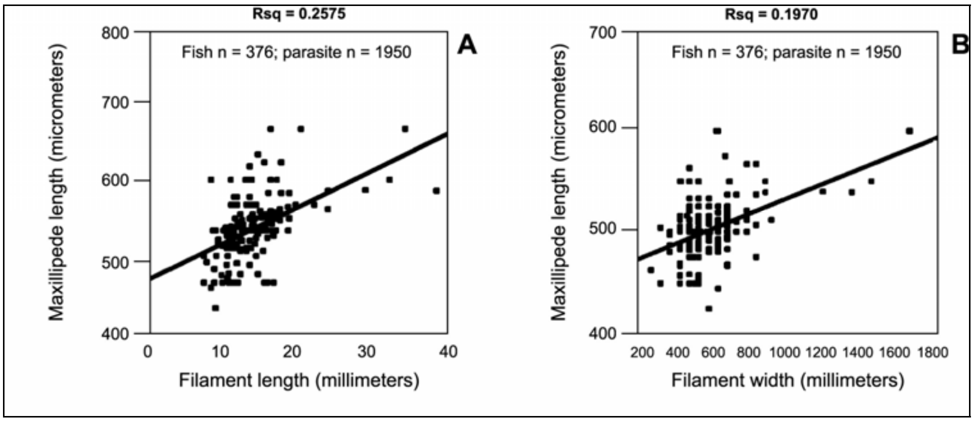

Figure 6: A correlation between the length of the maxillipede of *Lamproglena clariae* and the length (A) and width (B) of the gill filament of *Clarias gariepinus*.

There was however, no correlation ($r^2 = 0$) observed between the host size and the number of parasites from both localities. Although slightly higher mean abundance (Fig. 7a), mean intensity (Fig. 7a) and prevalence (Fig. 7b) values were observed in the data from the Vaal Dam than that of the Vaal River Barrage (Fig. 7), the statistical analysis showed no significant differences in prevalence (P = 0.2897), abundance (P = 0.3563) and mean intensity (P = 0.6510) between the two localities.

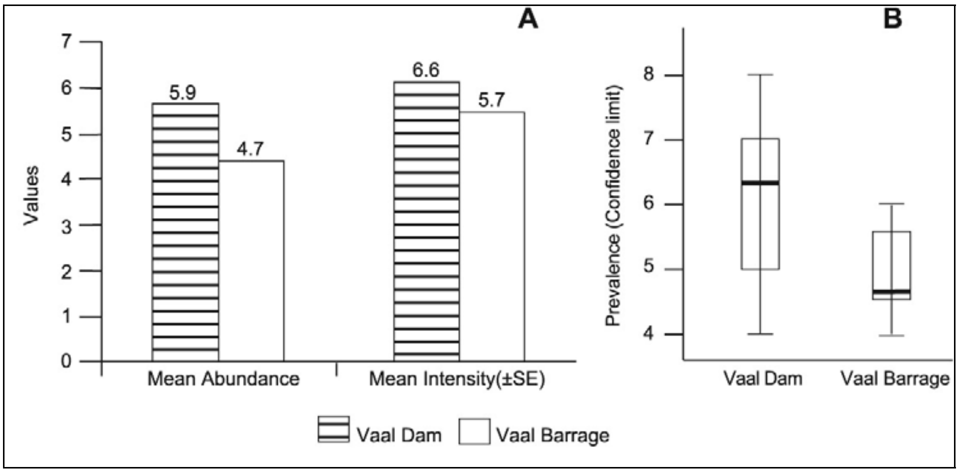

Figure 7: A comparison of Vaal Dam and Vaal Barrage in terms of abundance (A), intensity (A) and prevalence (B) for all seasons combined.

The Vaal Dam had a higher mean water quality index value (87.19) than Vaal River Barrage (69.15). According to the method described by Wepener *et al*., (1992) these values show that the water in Vaal Dam had better quality than that in Vaal River Barrage. A significant difference (P = 0.0085) was found between the water quality index values of the two localities.

The surface water variables (temperature and pH) between the two sites followed a similar trend (Figs. 8a and 8b). The pH and chemical composition recorded as aquatic toxicity index (Fig. 8c) were affected by the flood that occurred in January 2000 indicated by an arrow in Fig. 8.

In February 2000, following the flood, the aquatic toxicity index in the Vaal Dam became lower than that of the Vaal River Barrage. The pH in the Vaal Dam increased and became higher than that in the Vaal River Barrage. This only affected the parasite prevalence (Fig. 8d), a slightly higher prevalence was recorded in the Vaal River Barrage. Abundance and mean intensity were not affected.

The seasonal pattern observed at both sites was similar in terms of prevalence, abundance (Fig. 8e) and mean intensity (Fig 8f). Although high prevalence (between 80 and 100) was recorded at both localities for most of the collection period, a slight decrease occurred during the second part of the year (June1999-January 2000). In the Vaal Dam a similar slight decrease was also observed in the second year of study between September 2000 and December 2000 (spring and early summer). A similar trend was observed in the abundance and mean intensity at both sites, with a peak observed in May 2000 (late Autumn) in the Vaal Dam.

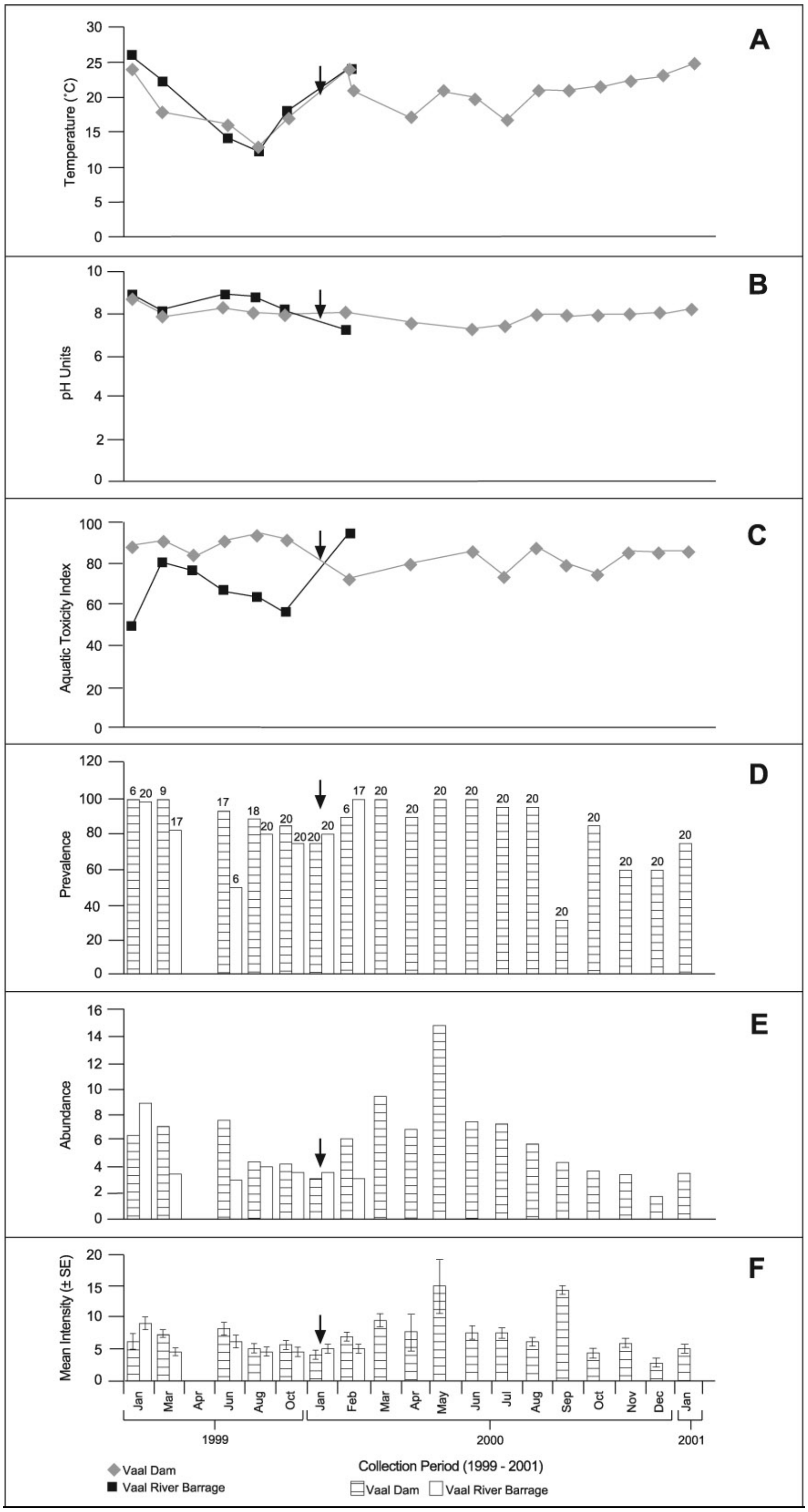

Figure 8: A comparison of water quality values (A--C) of Vaal Dam and Vaal River Barrage over a period of 25 months with prevalence (D), abundance (E) and mean intensity (F) of *Lamproglena clariae* Infestation on *Clarias gariepinus.*

DISCUSSION AND CONCLUSION

From all the fish species examined in this study, *L. clariae* was only collected from *C. gariepinus*, indicating that *L .clariae* may have absolute host specificity. The positive correlation between the weight and length of the fish, gill arch length and filament length, filament length and width at both sites indicate expected proportionality in the size of the fish.

Statistical analysis showed no significant difference regarding left/right gill preference, which shows that *L. clariae* does not have any gill side preference. Similarly, no gill preference was shown by *L. chinensis* (Sproston *et al*. 1950). Preference for a particular gill side is due to the asymmetrical body shape of many gill parasites and can be expected from those species, which have a genetically determined rigid asymmetry and consist of populations with entirely one type of asymmetry (Rohde, 1993). This might explain why the lamproglenids do not prefer either right nor left gill, since they are bilaterally symmetrical.

Distribution of parasites on different gills can vary due to preferences or size of the sites of attachment (Rohde, 1993). The fourth gill arch of *C. gariepinus* is shorter than the others, with fewer, shorter and thinner gill filaments. In this study, most of the parasite specimens were collected from the 4^{th} gill. This is possibly due to the protection or reduced turbulence in this area of the gill chamber as suggested by Sproston *et al*., (1950) which may increase success of attachment to the host. The attachment of 52% of the parasites to the median part of the arches differs from the findings of Sproston *et al*., (1950) and Marx and Avenant-Oldewage (1996) who found that *L. clariae* concentrated near the ends of the gill arches.

The number of parasites collected from male and female fish in the current study did not differ significantly. This confirms the findings of Hanek and Fernando

(1978) on the role of sex of *Ambloplites rupestris* (Rafinesque, 1817) on gill parasites *Achteres ambloplites* (Kellicott, 1880), *Ergasilus caeruleus* (Wilson, 1911) and *Ergasilus centrarchidarum* (Wright, 1882). Kruger and Avenant-Oldewage (1997) also observed this for *Mugilicola smithae* (Jones and Hine, 1978) on *Liza alata* (Steindachner, 1892), *L. macrolepis* (Smith, 1846), *Myxis capensis* (Valenciennes, 1836), *Valamugil seheli* (Valenciennes, 1836), *Oreochromis mossambicus* (Peters, 1852), *Clarias gariepinus* and *Sphyraena barracuda* (Walbaum, 1792). In the order Branchiura, Mbahinzireki (1980) found a higher abundance of *Argulus africanus* (Thiele, 1900) and *Dolops ranarum* (Stuhlmann, 1891) on female hosts of *Bagrus docmac* (Forsskahl, 1775) than on males. He attributed this to the fact that female hosts were larger than males and that the size of the host determines parasite abundance.

Results from the current study showed no correlation between the number of parasites and the host size from both study sites. Similar results have been reported for *Lernaea cyprinacea* (Linnaeus, 1758) (see Marcogliese, 1991) and *Caligus* (Műller, 1785) (see Lo *et al*., 1998). Sproston *et al*. (1950) also observed non-correlation between the length of *Ophiocephalus argus* (Cantor, 1842) and infestation of *L. chinensis*. However, Adams (1984) noted an increase in abundance of *Lernaea cyprinacea* with size of *Fundulus kansae* (Garman, 1895). Nagasawa *et al*., (1998) showed that larger *Salvelinus* sp. had more frequent and heavier infections of *Salmincola carpionis* (Kroyer, 1837). In the study by Lo *et al*. (1998), high correlation coefficients were found between the number of adult *Hatschekia* sp. and the size of *Cephalopholis argus* (Bloch and Schneider, 1801). This was attributed to the increasing gill surface and water flow through the gill chamber with an increase in the size of the fish.

A positive correlation was found between parasite size and fish length and weight in the current study. Therefore it appears that the parasite size is directly correlated to the host size and parasite size correlated with filament length which in turn correlated with fish size. The parasite attaches midway along the length of the gill filament and the genital segment is in line with the apex of the filament. This leaves the abdomen and egg sacs in the water current passing through the gills. The positive correlation between maxillipede length and the gill filament length and width further supports the statement that the size of the host determines the size of a parasite, since the maxillipede are used for attachment and they also correlated positively with the parasite length. They will grow according to the size of the gill filament size after attachment has occurred as suggested by Sproston *et al*., (1950), in which case the total length of *L. chinensis* and *L. carrassii* ranged between 2.40mm--4.09mm and 1.37mm--2.05mm, and the length of their hosts *O. argus* and *Carassius carassius* (Linnaeus, 1758) ranged between 13.5cm--38.8cm and 18cm--24cm. Due to the fact that the collected *C. gariepinus* specimens were larger than the above mentioned hosts, *L. clariae* was also found to be longer than the mentioned lamproglenids.

Although the results in the current study showed that the Vaal Dam had better water quality than the Vaal River Barrage, no significant difference was found between the prevalence, abundance and mean intensity from the two sites. Other than expected this indicates that the fish infestation was not influenced by water quality. This is in contrast to the findings of Marx and Avenant-Oldewage (1996) and Avenant-Oldewage (2003) who suggested that the less polluted water could allow for/cause parasite proliferation, whilst higher level of contamination can have a negative effect on the survival of *L. clariae.* Similarly, Galli *et al*. (2001) found a higher abundance of *L. pulchella* (Von Nordmann, 1832) from the less polluted water. According to Khan and Thulin (1991) ectoparasites directly exposed to water may be more sensitive to contaminants, thereby reducing their survival and reproductive rates. The abundance of Crustacean parasites changes under different environmental conditions and decreases considerably in polluted areas (Kuperman, 1991).

Although Vaal Dam and Vaal River Barrage have different chemical water qualities, they experience the same climatic conditions, since they are in the same bioregion. According to Bruton (1979) *C. gariepinus* awaits suitable environmental conditions for spawning, which usually takes place in summer. Spawning in the wild in South Africa takes place at water temperatures above 18°C, usually above 22°C. It is during this period when hatched parasite larvae are abundant and can infect their hosts, increasing abundance, mean intensity and prevalence in summer (Bruton, 1979), but in the current study parasite abundance and prevalence decreased during this period. An increase in parasite prevalence, intensity and abundance occurred before winter and supports the observation made by Marx and Avenant-Oldewage (1996) that reduced water levels in winter concentrate parasites, which increases the probability of infestation. The period between June and August is a winter season in South Africa (a summer rainfall area) and fish are found in less numbers, since they become less motile and concentrated in dense submerged aquatic macrophytes unreachable by the boat (Kruger and Avenant-Oldewage, 1997), hence lower values were observed during this period.

In conclusion the current study shows that some aspects of the ecology of the parasite are influenced by the host to which it attaches. The size of *L.clariae* was determined by the host size, its attachment preference on the gill was influenced by the position of the gill on the gill chamber. The parasite abundance and prevalence however, were neither dependent on the size of the host nor influenced by the water quality.