CHAPTER 1

PREAMBLE

1.1 Rationale

Lamproglena clariae specimens used in the current study were collected from the Vaal Dam and the Vaal River Barrage in the Vaal River system. The Vaal River is one of South Africa's largest rivers, supplying water to highly populated and industrialised areas. Demands on the Vaal River System for water are exceptionally high and the river and its tributaries are the only water bodies into which effluents from the Johannesburg, Vereeniging and Sasolburg regions can be discharged (Braune & Rogers 1987). The Vaal River has been described as a nutrient enriched river system (Janse Van Vuuren 2001). With the estimated increase in South Africa's population, sustainable resource management is vital to enhance economic stability in Southern Africa. In order to manage the Vaal River as a sustainable resource, it is essential to investigate the occurrence of, and factors leading to blooms of nuisance species closely (Venter et al. 2003).

The chemical and biological quality of the water is of extreme importance for the future economic development of South Africa in general, and in the catchment of the Vaal River in particular. The ecology of Vaal River phytoplankton, representing one aspect of biological quality has been investigated since 1984 in considerable detail. Seasonal succession of algal populations and the development of algal blooms have been studied in relation to physical and chemical environmental variables, representing aspects of chemical water quality. Algal blooms occurring in the Vaal River result in the production of unpleasant odours and tastes, and a general decline in water quality that can in some cases be aggravated by the production of toxins. These problems are costly to alleviate, may pose health risks to humans and animals alike (Pieterse 1997). Water pollution continues to degrade both marine and freshwater ecosystems, which in turn causes difficulty in obtaining safe drinking water (Cooke & Carlson 1989).

Lamproglena clariae is one of the ectoparasitic copepods that Avenant-Oldewage (2003) concluded can be used in the development of the biological index for environmental integrity. However, for this parasite to be used as a biomarker in this river, knowledge of its biology and ecology is essential. Hence, the current study aimed at elucidating ecological aspects, which are currently unknown.

Other unknown aspects of the biology of this parasite are life cycle and pathology. The only life cycle published for members of the genus *Lamproglena* is that of *Lamproglena chinensis*, however this life cycle differs from that of *Lernaea cyprinacea*, another member of the family Lernaeidae. This difference suggests that it can not be assumed that all members of the family follow the same life cycle. According to Kabata (1979) morphology of adult females of the genera of family Lernaeidae is difficult to understand and also tend to obscure the phylogenetic affinities of this family and the true nature of lernaeid copepods can be revealed only through knowledge of their developmental stages. The study of the life cycle of *L. clariae* would also contribute to the phylogenetics of the family as the knowledge of larval development of crustaceans is of increasing importance in attempts to reconstruct crustacean phylogeny and how the stemline radiated into the highly divergent forms displayed by both extinct and extanct Crustacea (Moller et al. 2003).

Describing aspects of the pathology of this parasite would also be important in determining the effect of this parasite on its host fish. In South Africa this copepod has been found to parasitize *Clarias gariepinus* (Burchell, 1822). This catfish is most widely distributed in Africa and extremely economically important, valued in subsistence fisheries, aquaculture and angling (Skelton 2001). It seemed to be enjoying revived attention with a 1998 production of 40 tons in South African aquaculture compared to 15 tons in 1996. However, this was still far below the levels of 1991 (1180t), where after a rapid decline in the production of this species was experienced due to marketing constraints (Hoffman et al. 2000). Many species of parasitic copepods are pathogenic to freshwater fish and they are especially important in regions where there is intensive aquaculture (Woo & Shariff 1990). In aquaculture fish are often maintained at high densities, facilitating copepod transfer amongst hosts (Bowers et al. 2000) and parasites have the chance to multiply and increase in numbers achieving heavy burdens (Khalil 2003). Attachment of *L. clariae* to the gill filaments (where gaseous exchange occurs) might affect respiration and ultimately weakens the fish. This study on aspects of ecology, life cycle and pathology of this parasite is an addition to the extensive studies previously done on its morphology.

1.2 Description of the study area

The Vaal River rise near Lake Chissie near Breyton on the western slopes of the Drakensberg escarpment (Braune & Rogers 1987). It flows in a west-south-west direction across the interior plateau and joins the Orange River near Douglas after some 1200km (Department of Water Affairs and Forestry 1993). The Orange River in turn spills into the Atlantic Ocean at Alexander Bay. The Vaal River has a catchment area of 192000 km^2 which can be divided into four zones on the basis of water quality problems (Braune & Rogers 1987). These are in order of decreasing water quality, the Vaal Dam, the Vaal River Barrage, the Bloemhof Dam and the Douglas Weir subcatchments. Rainfall also decreases in this order, as proceeding down the Vaal River from its headwater region, the climate becomes progressively more arid and warmer (Helgren 1979). The Drakensberg area exhibits the highest rainfall (800 to

1000 mm per annum) as well as the lowest evaporation (Braune & Rogers 1987). This is also the major catchment area. Rainfall decreases and evaporation increases steadily westward. The lower reaches of the river receive approximately 300mm rain per annum and thus largely depend on the eastern catchments for water supply. As a result of the change in climate a change in vegetation also occurs. This river is thus characterised by a diversity of landscapes that result in a diversity of scenic characteristics, fauna and flora (Department of Water Affairs and Forestry 1993).

1.2.1 Study sites

Field work was conducted in two study sites, the Vaal Dam (S 26° 52.249', E 28° 10. 249') and the Vaal River Barrage (S 26° 45.786', E 27° 41. 280'). The position of the study sites in relation to each other is depicted in Fig. 1, indicated as numbers 1 and 2.

Approximately 99% of all water abstracted and treated by the Rand Water Board is obtained from the Vaal Dam and Vaal River Barrage. The other percent is obtained from dolomitic underground sources (Gardiner 1988).

1.2.1a The Vaal Dam

The Vaal Dam is the fourth largest storage reservoir in South Africa with a surface area of 32 107 hectares and capacity of 2 535.5 x 10^6 m^3 (Braune & Rogers 1987). The Dam supplies high quality water for power station requirements in the Vaal Dam subcatchment (Braune & Rogers 1987). The Vaal Dam catchment is important for water supply in the Gauteng Province, South Africa. It is estimated that annual runoff over the catchment raised to a power between 4 and 5 (Kriel 1992). Thus, an increase of 10% in the annual rainfall would lead on average to an increase

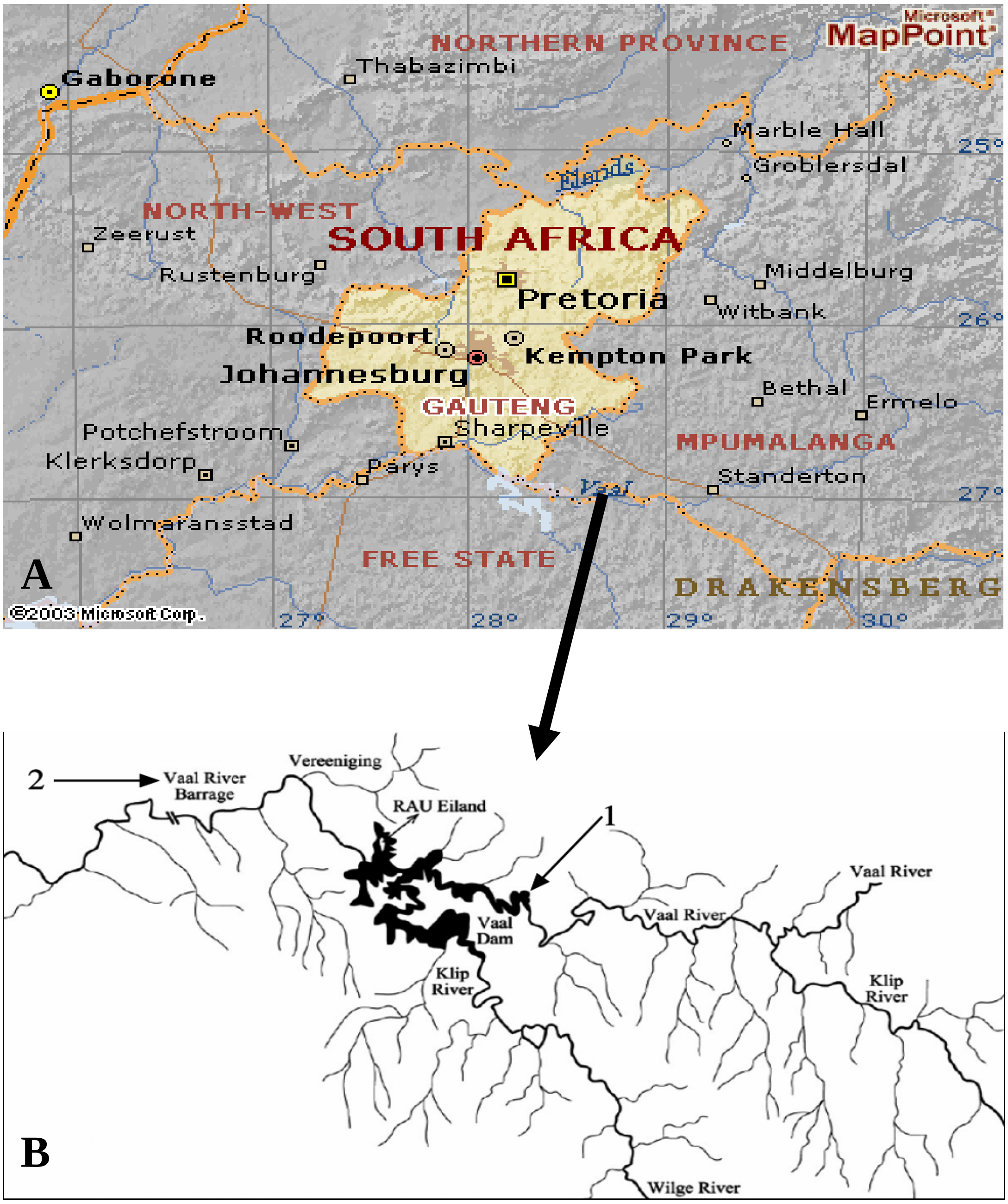

Fig. 1. Map of the Gauteng province (A) depicting where the Vaal River system (B) is located, 1& 2 represent the study sites of the current study. Map A downloaded from the website http://www.goafrica.com.

of about 50% in annual runoff. This prompted suggestions concerning continuing feasibility studies on artificial rainfall stimulation. Potential long-term threats to this important Vaal Dam catchment are pollution from diffuse agricultural sources, further industrial development and atmospheric pollution. Atmospheric pollution arises from the enhanced atmospheric additions of sulphate, which characterise the former eastern Transvaal Highveld (Water Research Commission 1994). This also attributes to acid rain, one of the most detrimental effects resulting from air pollution.

1.2.1b The Vaal River Barrage

The Vaal River Barrage contains South Africa's economic heartland, the Pretoria-Witwatersrand-Vereeniging area (PWV) complex (Braune & Rogers 1987, Department of Water Affairs and Forestry 1993). It is the main metropolitan, industrial and mining complex in South Africa. Raw water abstracted from the Vaal River Barrage at Vereeniging is normally of inferior quality when compared to that from the Vaal Dam (Gardiner 1988). The Rivers, Suikerbosrand, Klip, & Rietspruit, that feed into the Vaal River Barrage Reservoir flow from industrial and heavily populated areas such as Johannesburg, Vereeniging and Sasolburg. Contaminated water reaches the Vaal River Barrage via theses tributary streams, mainly the Klip River and Suikerbosrand River (Gardiner 1988). Eutrophication and salinity have become a problem in the Vaal River Barrage and Bloemhof Dam catchments (Department of Water Affairs and Forestry 1993).

1.3 Objectives of the study

1.3.1 ASPECTS OF THE ECOLOGY OF LAMPROGLENA CLARIAE determined by:

a. Investigating the effect of the host size on the parasite size and abundance.

b. Investigating the parasite attachment preference.

c. Investigating the effect of water quality on the prevalence, mean intensity and abundance of the parasite.

1.3.2 ASPECTS OF THE LIFE CYCLE OF LAMPROGLENA CLARIAE determined by:

a. Studying the number of both free living and parasitic life stages of *Lamproglena clariae*

b. Describing each life stage of *Lamproglena clariae*

1.3.3 *ASPECTS OF THE PATHOLOGY OF LAMPROGLENA CLARIAE determined by:*

a. Investigating the effect of the attachment of *Lamproglena clariae* on the gills of *Clarias gariepinus*.

1.4 An outline of scription of the document

Different aspects of this study are discussed in separate chapters. Each chapter succeeding chapter 2 consists of an introduction, material and methods, discussion and conclusion. These chapters are organised as follows:

Chapter 2 contains a general literature review about the studied parasite, *Lamproglena clariae*.

Chapter 3 deals with aspects of the ecology of *Lamproglena clariae*. These aspects were determined through both field and laboratory observations. This chapter is already accepted for publication and will occur in November 2004 in the Journal of Crustacean Biology.

Chapter 4 deals with aspects of the life cycle of *Lamproglena clariae*. This aspects were also determined through both field and laboratory observations. This chapter was prepared for publication.

Chapter 5 deals with aspects of the pathology of *Lamproglena clariae* on the gills of *Clarias gariepinus* determined through laboratory procedures. This chapter has been submitted for publication.

Chapter 6 deals with the general discussion of the study giving an overview of the study as well as suggestions for future research on *Lamproglena clariae*.

The Reference section deals with all literature cited in the different chapters of the thesis.

This document is written according to the format of the *African Zoology*, Journal of the Zoological Society of Southern Africa, except for Chapters 3 and 4, which are written according to the format of *Journal of Crustacean Biology* as they were prepared for publication in the journal.