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Food and feeding behaviour of Common Rasbora (*Rasbora daniconius*) in three Sri Lankan reservoirs

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Abstract
The feeding behaviour of indigenous small pelagic *Rasbora daniconius* was studied in three Sri Lankan reservoirs namely Udawalawe, Minneriya and Victoria. *Rasbora daniconius* (Cyprinidae) is a riverine fish species, widely spread in most of Sri Lankan reservoirs and river systems. *Hemiramphus limbatus* (Hemirhamphidae) is the next dominant small pelagic zooplanktivorous fish species in Sri Lankan reservoirs (Piet, 1998). In all studied reservoirs, the main food items of *R. daniconius* were microcrustacean zooplankton, flying insects and larval stages of the insects. Size selective feeding on zooplankton and other food organisms were investigated by comparing the food composition and measuring those items in the gut and in the environment. *R. daniconius* mainly feed on large proportions of microcrustacean zooplankton such as cladocerans, calanoid and cyclopoid copepods when they were inhabiting in pelagic zone of the reservoirs. Considerably positive size selective predation was observed for the microcrustacean zooplankton and insects. The selective feeding on the large cladocerans was also strongly positive.

Introduction

In the South East Asia, most of the water bodies are man made and natural lakes are almost absent (Fernando 1980). Most of these reservoirs have riverine fish species that generally inhabit in the littoral zone, are poorly adapted to feed on zooplankton. Therefore, zooplankton production may be inefficiently utilised. There is also a possibility that the quantity of zooplankton production itself limits the zooplanktivorous fish abundance (Vijverberg. *et al.* 2000). The zooplanktivorous fish in the temperate region are generally dominating the pelagic zone of lakes and reservoirs and play an important role in the food web. It is generally assumed that most reservoirs in SE Asia support only a very limited numbers of pelagic zooplanktivores, most reservoirs have a riverine fish species composition, which inhabit the littoral zone, leaving a large pelagic zone mainly unoccupied (Fernando and Holcik 1982, Sarnita 1987, Fernando 1994).

The main objectives of this study are to 1) study the feeding behaviour of riverine *R. daniconius* in three different inland water bodies, 2) observe the selective feeding of *R. daniconius* and 3) study the diurnal pattern of feeding behaviour.

Study Area

Three Sri Lankan reservoirs (Minneriya, Udawalawe and Victoria) were selected for this study. Minneriya (8^0 02'N: 80^0 53'E) is a shallow ancient eutrophic reservoir, located in the North-Central dry zone at 96 m above mean sea level. Udawalawe (6^0 27'N: 80^0 50'E) is a recent mesotrophic reservoir, located in Southern Sri Lanka. Victoria, a recent

oligotrophic/mesotrophic reservoir (7^0 13'N: 80^0 47'E) is located in the Central Highland of the country, at 438 m above mean sea level (Silva *et al.* 2002).

Materials and methods

One fixed sampling site per each reservoir was selected in the open water zone. Routine sampling was carried out once per every two months from April, 1999 to July 2000. To study the diurnal feeding behaviour of fish, one diurnal survey was carried out during the study period for each reservoir. Zooplankton sampling and fishing were done separately.

Quantitative sampling of zooplankton, were carried out with a 12 litre volume type of sampler made from Perspex (Schindler sampler). 80 µm plankton gauze attached to the Schindler sampler was used to sieve zooplankton. Samples were taken at three different stations, simultaneously and in the same area as where the fish was caught. The zooplankton samples were preserved with 4% formalin.

Fish was generally caught with monofilament gill nets with mesh sizes of 6, 8 and 10 mm bar mesh in the open water zone. Exposure time was two hours or less to minimise digestion effects. Routine sampling was generally done during dusk except for few days during dawn. When the gill net catch of *R. daniconius* was poor, beach seine fish were used for the study. The fishes were immediately preserved with 4% formalin till the analysis of gut contents. The diet shifts over 24 h periods were investigated by diurnal sampling with monofilament gill nets. Samples were taken for fish and zooplankton during day, dusk, dawn and night at six hour intervals.

The size range of fish was 3.1-12.0 cm in total length. To track possible ontogenetic diet shifts, fish sample was sub divided into three size classes: (sc1= 3.1-6.0, sc2= 6.1-9.0, sc3=9.1-12.0). Ten fishes or less were included in each size class. Gut contents of first 1/3 of the fish gut were analysed. Size and species composition of zooplankton in the fish guts of the zooplanktivorous fish species were compared with those in the environment. The selective feeding on size and species by zooplanktivorous fish on microcrustacean zooplankton was studied by comparing the zooplankton in the environment with the zooplankton in the fish guts. The electivity index (E) was used according to Ivlev (1961) in equation 1 to calculate food selection:

$$E = r_i - p_i / r_i - p_i \qquad (1)$$

Where, r_i is the relative abundance (%) of a specific food item in the gut or stomach and pi the relative abundance of the same food item in the environment. Values range from +1 (strong positive selection) via zero (no selection) to –1 (strong negative selection or avoidance).

Results

Food categories of *R. daniconius* were microcrustacean zooplankton, a mixed diet of cladocerans, calanoid copepods and cyclopoid copepods. In addition to microcrustacean zooplankton, flying insects and larval stages of the insects were the other main food items in three studied reservoirs. As in percentage numbers of prey, *R. daniconius* was mainly feeding on large proportions of cladocerans, calanoid and cyclopoid copepods (Figure 1a). However, if we compare the composition of the diet on the basis of biomass,

65% of the contents were insects (adult flying insects and larval stages of the insects) and 35% of microcrustacean zooplankton (cladocerans, calanoid copepods and cyclopoid copepods) (Figure 1b). The adult insects were probably eaten as floating insects from the water surface or from the upper surface water layers. Insect larvae were eaten to a lesser extend.

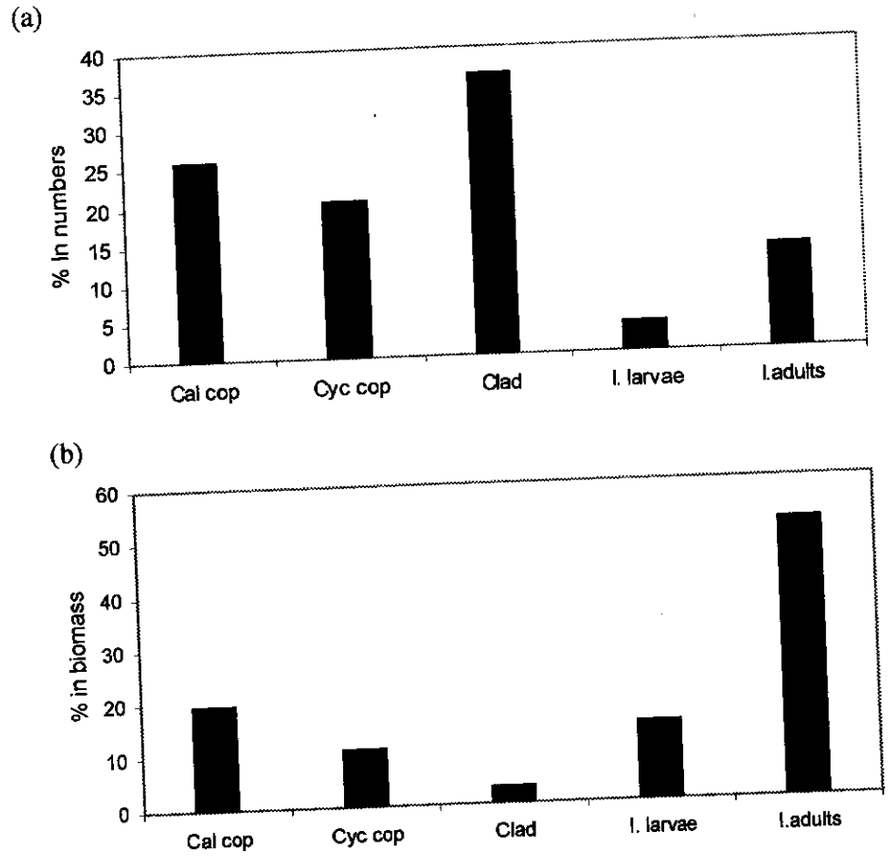

Figure 1. Mean diet composition (%) during dusk and dawn of *R. daniconius* in Minneriya (N_d= 7; N_f= 193), Udawalawe (N_d= 6; N_f= 136) and Victoria (N_d= 7; N_f= 126) a) on basis of numbers, and b) on basis of biomass. (N_d= number of sampling dates, N_f= number of fish gut contents).

Diurnal variation in feeding behaviour

The diurnal pattern of feeding behaviour of *R. daniconius* shows a considerable variation with the time of the day. The fish feeds on a low proportion of insects during the day. During dusk this proportion increased a little and it remained more or less at the same level during night and dawn. The fish was feeding the whole day and night on flying midges, but insect larvae were not eaten during daytime. There are small differences among diets composition of *R. daniconius* in the three reservoirs, but the same diurnal trends were observed (Figure 2).

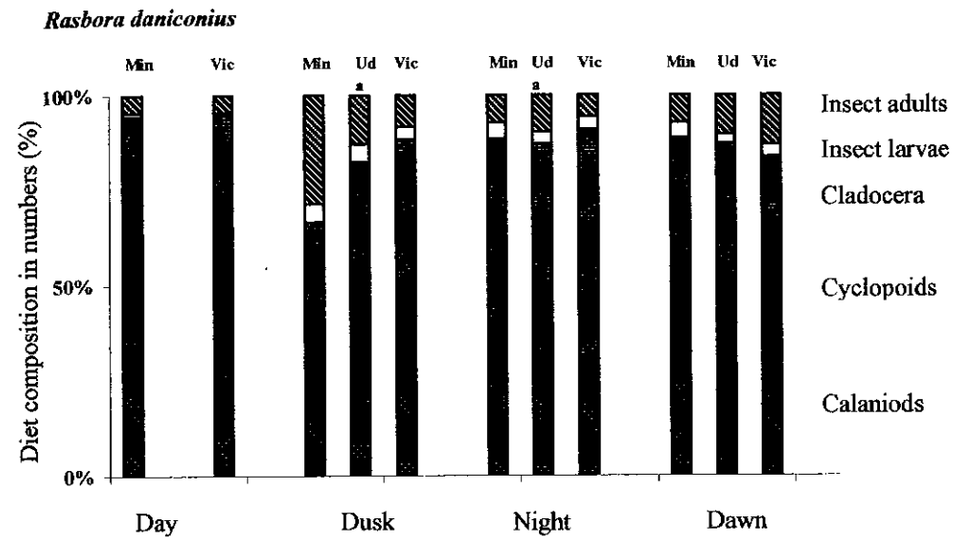

Figure 2. Diurnal variations of diet composition (%, numbers) of *R. daniconius* in Minneriya (Min) (N_d= 1; N_f= 86), Udawalawe (Uda) (N_d= 1; N_f= 72) and Victoria (Vic) (N_d= 1; N_f= 70). N_d = number of sampling dates, N_f= number of fish gut contents

Selective feeding

Selective feeding on zooplankton taxa, insect larvae and adults by three size classes of fish was studied. Generally, *Moina micrura*, a medium sized cladoceran, is strongly positively selected by *R. daniconius* in the three reservoirs. Furthermore, most size classes show a positive selection for adult insects when these are available in the environment. The fish generally avoids copepods. There was not much difference in selective feeding among the three size classes. There are a few exceptions. The smallest size class of *R. daniconius* show a positive selection for the smallest cladoceran species (*Bominopsis dietersi*, *Ceriodaphnia cornuta*) whereas the larger fish sizes show a negative selection. The opposite trend is observed for *R. daniconius* feeding on the relative large cladoceran *Diaphanosoma* spp and the large adult insects, the smaller fish sizes show a negative selection whereas the larger sizes show a positive selection (Figure 3). A similar trend was observed for insect larvae, strong avoidance by the smallest size class and weak positive or weak negative selection by the larger size classes.

We recorded size selective feeding of 1-3 size classes of *R. daniconius* (size class 1 =3.1-6.0 cm, size class 2 = 6.1-9.0 cm and size class 3 = 9.1-12.0 cm) during dusk and dawn in comparing mean size of the food organisms in the water column, and the mean size of the food organisms in the fish guts (Figure 4).

The different size classes of fish, however, showed different degrees of positive size selection, the larger the fish the larger the food items were eaten. However, Considerable size selective predation was observed in *R. daniconius*. We recorded the maximum size of the ingested food items in relation to length for three size classes. The smallest *R. daniconius* showed clear food size limitation

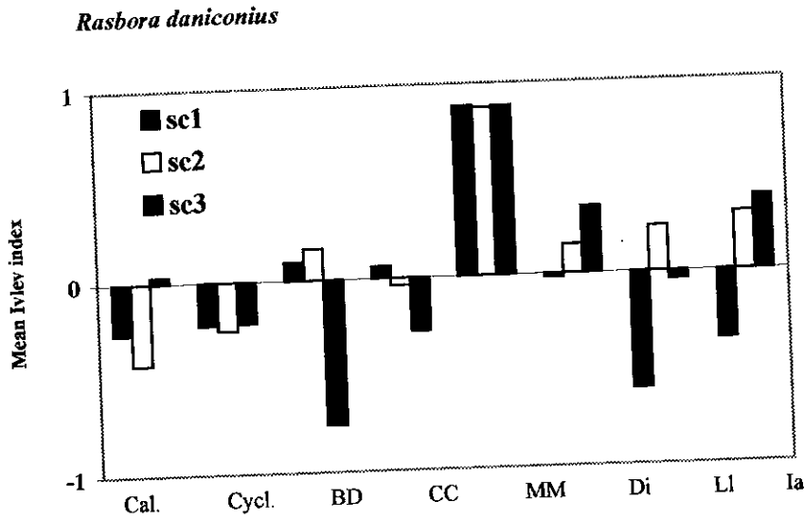

Figure 3. Selective feeding during dusk and dawn of three size classes of *Rasbora daniconius* (size class 1=3.1- 6.0, 2 = 6.1-9.0 and 3 = 9.1-12.0 cm) on zooplankton species and taxonomic groups of food organisms. For number of observations see Fig. 1 (Abbreviations used: Cal = calanoid copepodites, Cyc = cyclopoid copepodites, Bd = *Bosminopsis dietersi*, Cc = *Ceriodaphnia cornuta*, Mm = *Moina micrura*, Di = *Diaphanosoma* spp., LI = insect larvae, Ia = adult insects).

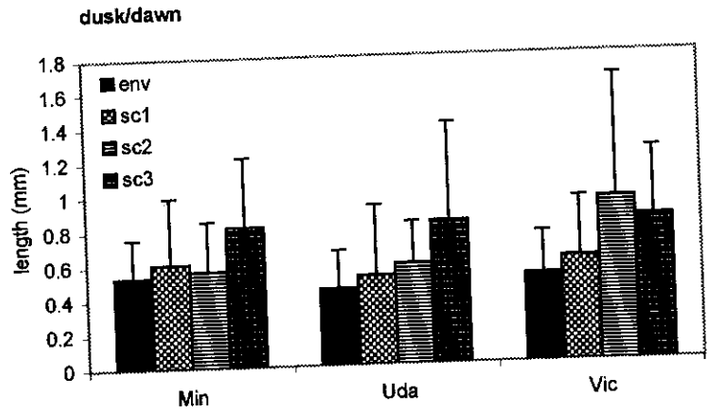

Figure.4. Size selective feeding of 1-3 size classes of *R. daniconius* during dusk and dawn. (sc1=3.1-6.0 cm, sc2=6.1-9.0 and sc3=9.1-12.0) Left hand bars show mean size of the food organisms in the water column, right hand bars show the mean size of the food organisms in the fish guts.

Discussion

We observed that the small pelagic *R. daniconius* was eating large proportion of adult insects and insect larvae. These flying insects started swarming in the evening, became trapped on the water surface and drowned. Larval insects were eaten in much smaller amounts. A shift to insect diets with the growth of fish observed for *R. daniconius*.

However, the shift usually occurred at a smaller size. *R. daniconius* shifted from zooplankton towards insects at a length of ca. 45 mm (Figure 5). Diurnal variations in diet composition of *R. daniconius* shows that the fish was feeding on adult insects during day and there was only a small increase in the proportion of insects in their diet during dusk This continued during night and dawn. Night feeding of this fish species is normally not the case. Generally, freshwater sardines stop feeding when it becomes dark (Iongh *et al.* 1995). This pattern is disrupted only during full moon and sardines feed intensively on the available zooplankton during the night (Gliwicz 1986). We observed that *R. daniconius* feed upon drowned flying insects floating at the water surface or located very high in the water column.

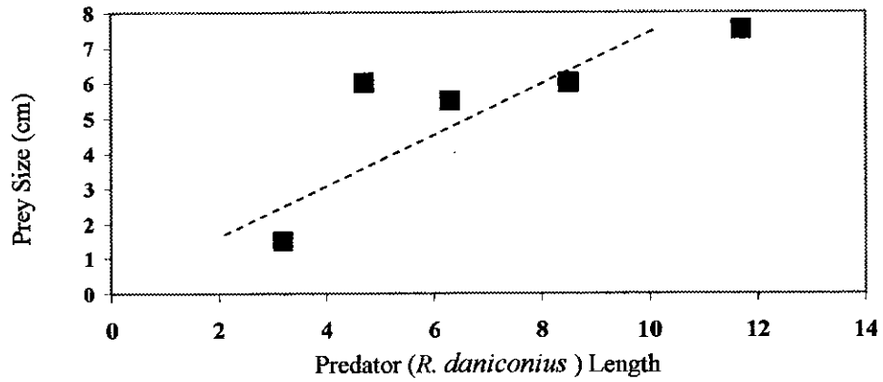

Figure 5. Maximum size of food organisms (including insects) relative to the length of *R. daniconius*

Riverine cyprinid fishes (*R. daniconius,*) in studied reservoirs are less efficient in feeding on zooplankton than marine origin zooplanktivores (Hemiramphidae: *Hemiramphus limbatus*). This is based on the notion that in the sea, microcrustacean zooplankton is common, but in rivers they are extremely scarce (Fernando 1980). As a result riverine fish feeds mainly on benthic food organisms and on insects, which are falling out of the trees. Therefore, fish from marine origin should be better adapted to feeding on zooplankton than riverine fish species, but riverine fish should be better adapted to feeding on adult insects. Our results showed that this fish species seem to be adapted in some degree to the available size distribution of food organisms. Zooplankton selective feeding by *R. daniconius,* catching calanoid copepods is not an easy task compared with cladocerans. Calanoid copepods are fast swimmers and will swim against water currents, cyclopod copepods come next, and cladocerans show the lowest swimming speed (Bergstrand 1990). The fish catches the prey by sucking it in one by one and therefore calanoid copepods, followed by cyclopod copepods and caldocerans have the best chances to escape predation (Drenner and McComas 1984). Of the riverine species is *R. daniconius* probably the most successful; it is a common species in the Sri Lankan reservoirs (De Silva and Sirisena 1987, Amarasinghe 1985, 1990, Pethiyagoda 1991, Piet and Vijverberg 1998, Wijeratne and Perera 2000).

Conclusions

Riverine small pelagic Cyprinid *R. daniconius* is common in Sri Lanka. Although *R. daniconius* seems to be as a zooplanktivorous fish species, we showed that it feeds on

large proportion of insects in the studied reservoirs. *R. daniconius* actively feeds on insects in the dusk and dawn. Size selective feeding was positive for microcrustacean zooplankton and insects and showed food size limitation in relation to the fish length.

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