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Diurnal variation in the feeding patterns and food preferences of Dwarf panchax *(Aplocheilus parvus)*

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Abstract

The food and feeding studies of fish are useful to explore the possibilities of using them for various purposes such as aquaculture and biological control of problematic organisms. In the current study feeding patterns and diet composition of *Aplocheilus parvus* (E: Killi fish/Drawft panchax), a common surface feeding predator inhabiting freshwater systems were explored. *A. parvus* was collected from an abandoned brick pit in Pannala in 2012. Twelve fish were caught every two hours for 24 hours. Plankton net was used to obtain a representative sample of food items present in the system. Gut fullness, total and standard length of fish, total weight and gut weight were determined and using copepod as an arbitrary unit, total numbers of food items of individual fishes were estimated. The time at which active feeding occurred was established from total food particle amount and relative gut weight. Diet of *A. parvus* mainly consisted of adult or larval stages of insects and copepods. Also, gut had a higher fullness in day time compared to night. The peak gut fullness occurred during 1630 in males whilst females had the peak gut fullness at 1230. Copepods were detected mostly during late morning, whilst insect parts and coleopterans were present in all time periods. Main food items detected in the environment in descending order of abundance were copepods, filamentous algae and insects. This study demonstrated that *A. parvus* selectively preys on insects compared to other aquatic food sources during day time.

Keywords: *Aplocheilus parvus*, biological control, Drawft panchax, gut analysis, insects

Introduction

Diverse food habits among different fish species are responsible for effective utilization of available food items in the natural environments to manage the carrying capacity (Kumar et al. 2012). Extensive studies have been conducted on food and feeding habits of economically and ecologically important fish species (Johnson and Dropkin 1993; Alkahem et al. 2007). Food and feeding also reveal species interactions (Sivadas and Bhaskaran 2009), prey selectivity (Zandona et al. 2011) prey-predator relationships and ontogenitic trophic shifts (Day et al. 2011). As such, fish stock assessment, ecosystem modeling (Lopez-Peralta and Arcila 2002; Kumar and Hwang 2006) and community ecology studies (Shallof and Khalifa 2009) depend on broad knowledge regarding this aspect of fish. Further, understanding the food and feeding of fish is also used in algal control programmes (Xie 2001), aquaculture and fisheries management practices (Awasthi et al. 2006; Banaru and Harmelin-Vivien 2009) and biological control such as mosquitoes (Louca et al. 2009; Kweka et al. 2011).

Diverse fish assemblages are distributed in a variety of lentic and lotic freshwater habitats throughout Sri Lanka (Jayaratne and Surasinghe 2010; Goonathilake 2012). Up to now 91 freshwater fish species have been recorded, which consist of 50 endemics and 24 exotics (Goonathilake 2012). Amongst these species, attention has recently been directed towards surface dwelling predatory fish species and their feeding, since Sri Lanka is looking for alternatives to control vectors such as mosquito larvae of some diseases such as malaria and dengue (Konradsen et al. 2000).

Of known predatory fish, killifish or panchax (Order: Cyprinodontiformes, Family: Aplocheilidae) such as *A. panchax* (blue panchax), *A. lineatus* (striped panchax) (Frenkel and Goren 2000; Chandra et al. 2008) are used elsewhere. However, feasibility of such approaches in Sri Lanka is hindered by lack of systematic studies on their feeding. Killfish species found in Sri Lankan water bodies are *Aplocheilus parvus*, *A. dayi* and *A. werneri*. *A.dayi* and *A.werneri* are endemic while the smallest *A. parvus* is indigenous and relatively common (Pethiyagoda 1991). *A. parvus* is available in both lotic and lentic systems in the low country wet, intermediate and dry zones both in moderately saline and freshwaters. It is a surface feeding, hardy and adaptable predator (Pethiyagoda 1991).

The successes of adoption of *A. parvus* as a biological control agent rely on detailed knowledge regarding the temporal fluctuations of feeding and prey selectivity and synchronizations between prey availability at active feeding of the fish. Since feeding activities of many species are often cyclic, diet composition vary over a 24 hour period (Polacik and Reichard 2010). Accordingly, feeding and food selectivity of *A. parvus* inhabiting abandoned brick pits, which is one of the preferred habitats of *A. parvus* were studied for 24 hour period.

Materials and Methods

A. parvus were collected in January 2012 from a brick pit located in Pannala (80°2.5' E, 7°19.7' N) area in the North western province of Sri Lanka. The brick pit was an area of 1992 m^2 at full capacity level and a perimeter of 233.1 m at the time of sampling. *A. parvus* were collected in 2 hour-intervals starting from 8.30 am to 6.30 am on the following day. Fish were caught by hand nets. In each sampling occasion, 12 fish (males and females) were caught and they were immediately transferred to 10% buffered formalin for further analysis.

A plankton net (110 µm with the diameter of 26.4 cm) was dragged for 5 m at each sampling occasion to collect the natural food items and the contents were preserved in 5% buffered formalin and Lugol's Iodine solution for further analysis (Goswami 2004; Suthers and Rissik 2009).

In the laboratory, the fish were blotted and weighed using an analytical balance to an accuracy of 0.1 mg. Standard length and total length were measured. Then each fish was carefully dissected and the gut of fish was taken out. The gut length was measured up to nearest millimeter with a measuring board and weight was measured to an accuracy of 0.1 mg using an analytical balance. Gut fullness (fraction filled out of 10 parts) and sex of each individual were also recorded. Gut was then placed in a watch glass and dissolved with 1 ml of distilled water and the contents were then transferred to a Sedgewick Rafter cell. Common copepod was taken as the arbitrary unit. The total number of food particles (Hyslop 1980) in each gut was recorded to the order level (Fernando 1990). Relative gut weight [(gut weight/total fish weight)×100], time of peak feeding for each sex, contribution of each food type at different time intervals were compared using one way ANOVA.

Water samples were also examined using the standard procedures of dilution and were examined by Sedgewick Rafter cell method (Suthers and Rissik 2009) to record the food items available in brick pit Index of prey selectivity was calculated as follows:

$$L_i = r_i - p_i$$

Where L_i is the index of prey selectivity for the taxon i, r_i is the relative abundance of prey item in the fish gut and p_i is the relative abundance of the food item in the water body (Zandona et al. 2011). MINITAB 14 and GenStat Release 12.2 statistical software packages were used in data analysis.

Results

Diet of *A. parvus* consisted of adult or larval stages of class Insecta (Figs 1a, 1b and 1c) class Maxillopoda (Fig. 1d) and plant parts. Both adult and larval stages of Coleopterans (Fig. 1a) and hymenopterans (Fig. 1b) were detected as insects. In terms of prey abundance, 79.9% were insect adults, 4.3% were insect larvae, 4.3% were copepods and 11.49% were other food items (plant parts, eggs, detritus and unidentified material (Figure 2). The highest number of average food items was detected during day time around 1230 hrs (Fig. 3).

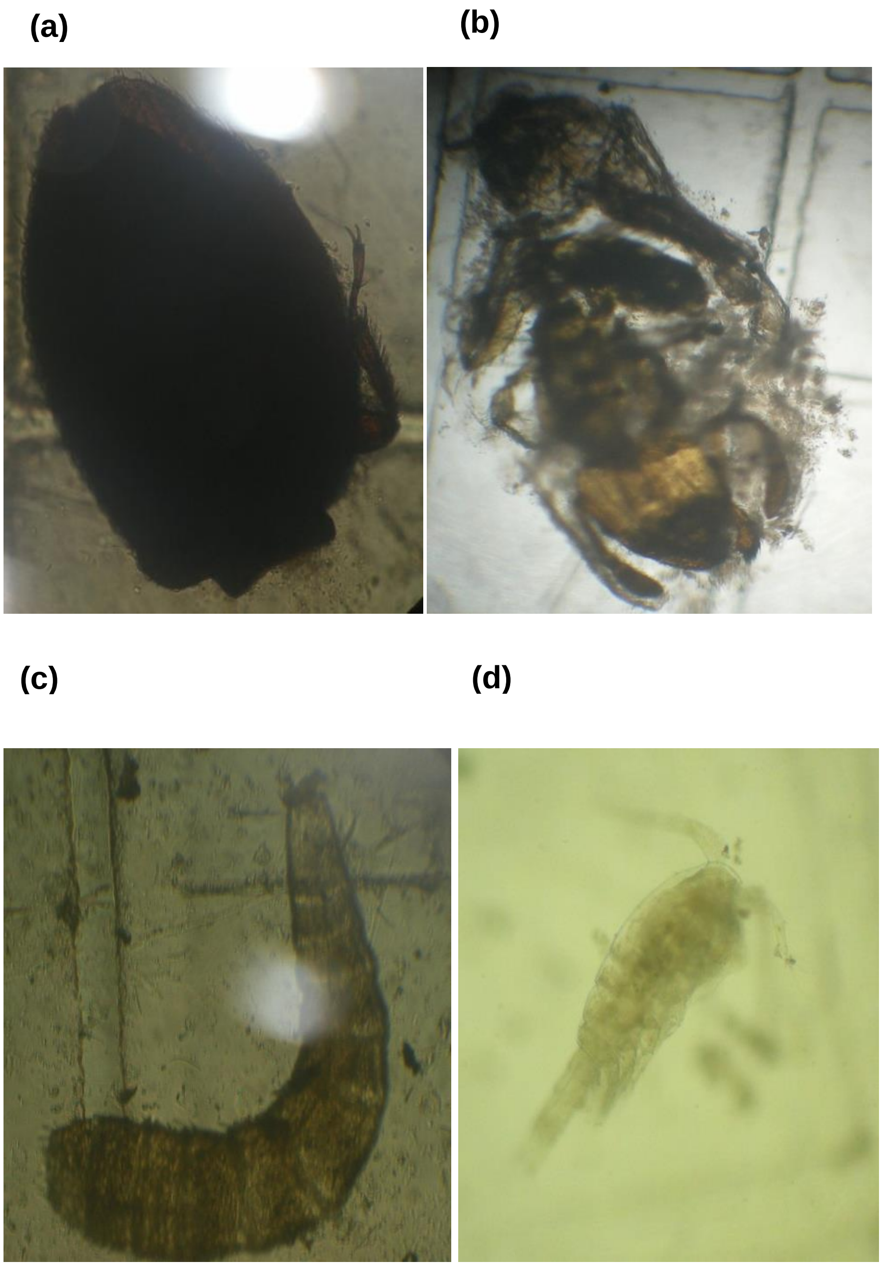

Figure 1. (a) Hymenopteran (×4); (b) Coleopteran (×4); (c) Insect larval stage (×10); (d) Copepod (×10)

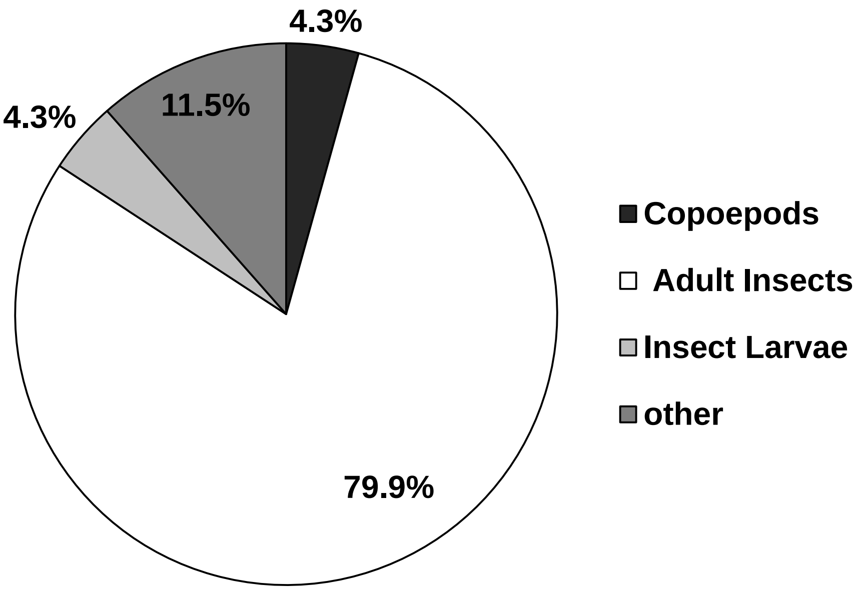

Figure 2. Percentage contribution of food items in the gut content of *A. parvus*.

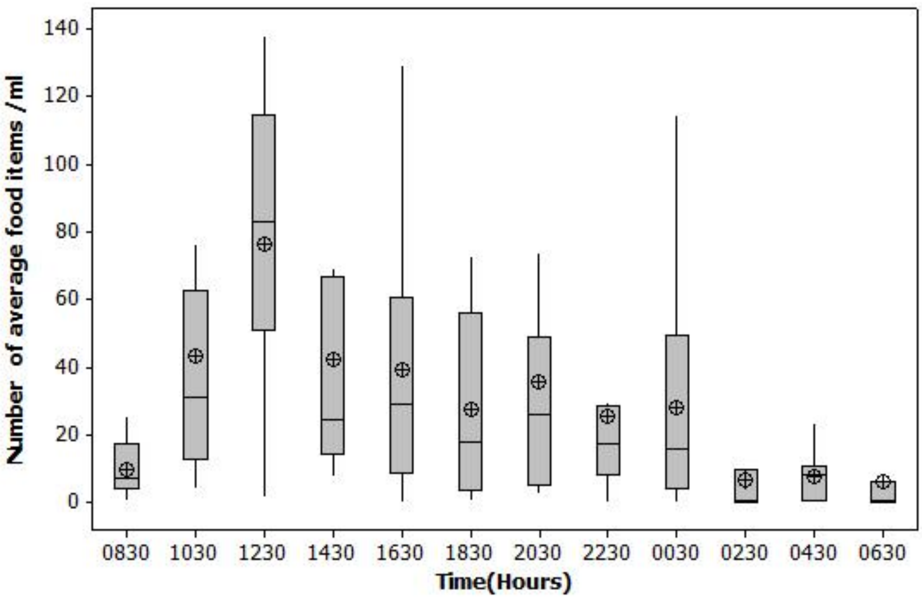

Figure 3. Fluctuations in number of average food items with time. The box plot whiskers depict the range and circled crosses depict the mean at each time.

The gut had a higher fullness ratio during day time (4.3±0.121) compared to night (2.4±0.120) ($p<0.001$) (Fig. 4). The males had peak gut fullness at 1630 hours (Fig. 4). In the case of females; there were two peak feeding times, one at around 1230 and the other at around 1830. The gut fullness of both male and female decreased towards night.

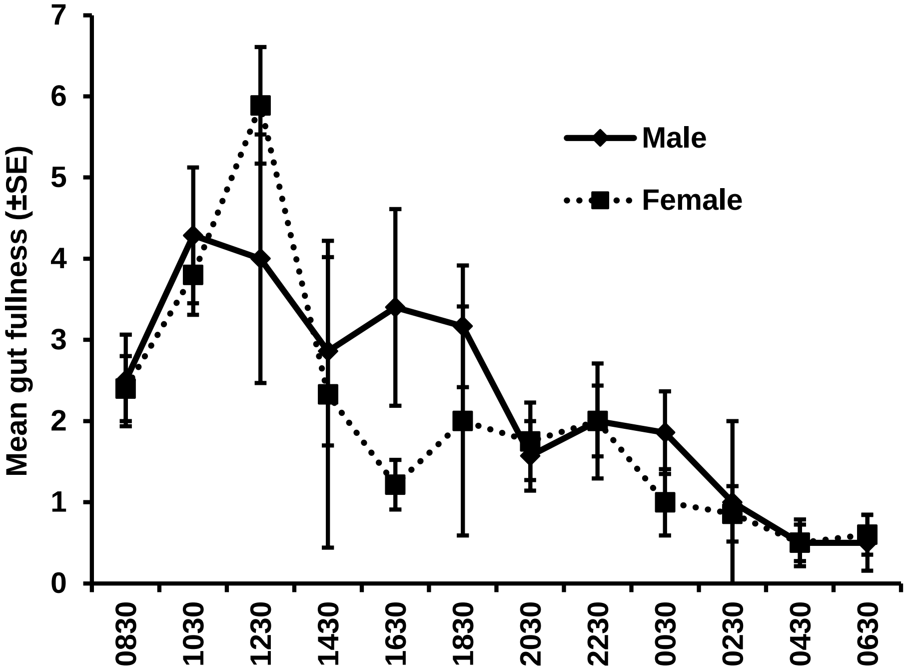

Figure 4. Fluctuations in mean gut fullness (±SE) with time for females and males.

In the gut contents, copepods were detected mostly during late morning (830-1030) ($p<0.001$), whilst insect parts and coleopterans were present at all time periods ($p<0.001$). Insect larval stages were detected mostly at 0830 (Fig. 5).

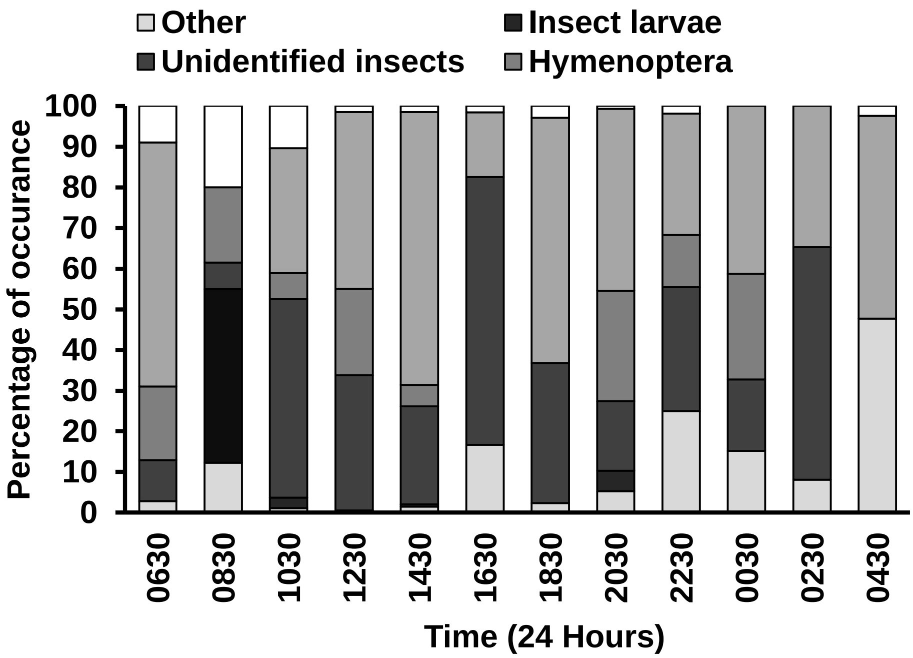

Figure 5. Diurnal variations of the abundance of different food types in the gut content.

Abundance of main food items detected in the plankton samples were copepods, filamentous algae and Coleopteran parts respectively. No Hymenopteran or insect larval stages were detected in sampled water although these food items were present in the gut.

Discussion

The gut content of *A. parvus* revealed the opportunities exploited by this species in term of food selection due to its surface living nature. Diet consisted clearly of both aquatic and terrestrial food items such as hymenopterans. Similar results were also found for killifish species *Rivulus marmoratus* by Taylor (1992) where fish collected from east central Florida had comparative amounts of mosquito larvae.

Polacik and Reichard (2010) reported that the diet of three killifish (*Nothobranchius* sp.) comprised largely of aquatic invertebrates. Similarly, banded killifish (*Fundulus diaphanus*) (Johnson and Dropkin 1993), blue fish (*Pomatomus saltatrix*) (Friedland et al. 1988) and *Aplocheilus lineatus* (Jacob and Nair 1982) are known to consume insects as their diet .Hence it could be concluded that *A. parvus* displays insectivorous nature in abandoned brick pits.

There is no direct reason identified for the difference of the peak gut fullness of male and female observed in this study. Also such differences were rare in literature. As Izquierdo et al. (2001) mentioned that egg quality and fecundity depend on nutritional intake. Green et al. (1984) also indicated that male cunners

(*Tautogolabrus adspersus*) feed significantly less often than females and concentrate their feeding activity to morning, whilst females feed as frequently in the afternoon as in the morning. However, an interaction between sex and peak feeding among fish is little explored.

It is clearly seen that most of the commonly available food items found in the water body were not found in the *A. parvus* guts which indicates the nature of active selectivity of prey. Fish seldom ingest prey in proportion to their abundance in the environment. A substantial amount of literature demonstrates that many freshwater and marine fish species selectively feed on relatively large prey (Schabetsberger et al. 2003). According to the Clements and Livingston (1984), patterns of the prey selectivity are the result of predator preferences and /or differences in prey accessibility. As such, it is clear that *A. parvus* is a highly selective and mainly prefer insect borne diets. In *A. parvus* stomach fullness peaked during morning hours and reached a minimum at night, suggesting a predominantly diurnal feeding pattern. The fish species feeding on adult insects such as *Hyporamphus gaimardi*, *Rasbora danicoius* are also mainly have high gut fullness around noon (Piet and Guruge 1997) which supports our finding further. Due to the nature of the diurnal feeding and surface predation, highly selectivity on insects, many species had been used in mosquito control programs. Chandra et al. (2008) described the use of several surface feeding predators such as *Aplochilus blockii*, *A. lineatus*, *A. panchax* in controlling malaria larvae. Ghosh et al. (2011) indicated that the important of using surface feeding predators like *Poecilia reticulata* and *Gambusia affinis* in chikungunya vector control programs. Further the patentability of annual killifish, *Nothobranchius guentheri* on mosquito control in temporary water bodies was proposed by Matias and Adrias (2010) due to surface living and insectivore nature of these fishes.

In summary, this study demonstrates that, *A. parvus* selectively preys on insects Therefore we can suggest this species as a potential candidate for mosquito vector control. However, further studies have to be carried out to confirm their preference for mosquito larvae in natural environment.

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