Abandoning the ship: spontaneous mass exodus of *Clinostomum complanatum* (Rudolphi, 1814) progenetic metacercariae from the dying intermediate host *Trichogaster fasciatus* (Bloch & Schneider, 1801)

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Abstract The dramatic and spontaneous exodus of live *Clinostomum complanatum* progenetic metacercaria from the gill slits of the dying intermediate host, *Trichogaster fasciatus* is reported. Basic water parameter tests for dissolved oxygen, pH and temperature revealed slightly lower level of dissolved oxygen in tank water used for water change. To the best of our knowledge, it is the first report of a digenean metacercariae, en mass leaving their intermediate host, upon its death in search of an alternative host to support their survival and help in continuing their life cycle.

Keywords *Clinostomum complanatum* · Evolution · Mass exodus · Metacercaria · *Trichogaster fasciatus*

Clinostomum complanatum (Rudolphi, 1814) is a common trematode parasite infecting fish as its intermediate host, and ardeid birds as its definitive host (Abidi and Nizami 1987). In North India, the excysted progenetic metacercaria is found in the forage fish *Trichogaster fasciatus* with the rate of infection as high as 98–100% (Siddiqui and Nizami

1982). Within the definitive avian host, the worms often undergo migration from the crop to the buccal cavity where they remain tenaciously attached, while voraciously feeding on mucous and host blood and becoming ovigerous in 5 days. In experimental definitive host the infection lasted for about 7–8 days, thereafter the worms left a scar on the site of attachment (Abidi and Nizami 1987). The role of proteases of parasite origin has been implicated in the establishment and immune evasion by these parasites within their experimental host (Rizvi et al. 2010).

Here we report, an unusual observation, of mass exodus of *C. complanatum* progenetic metacercaria from its host *T. fasciatus*, immediately upon the death of the host.

Thirty-five *T. fasciatus* were maintained in a fifteen litre aquarium in our laboratory, to be used later for harvesting *C. complanatum* metacercaria for research experiments. Routine water change was carried out with stored water from an over head tank holding potable ground water. The change was carried out as per the method prescribed i.e., by slowly acclimatizing the fish to tank water. The water change resulted in the death of all thirty-five fish within 30 min, and a mass exodus of *C. complanatum* was observed. Within an hour there were 1101 progenetic metacercaria, carpeting the entire aquarium floor, which emerged through the gills of the dying fish (Fig. 1). This report presents an unusual sight, with no precedence recorded in literature. Upon autopsy after the mass exodus, no metacercaria were recovered from the dead fish.

All the metacercaria were seen to be active and motile. An immediate water parameter test was carried out (Table 1). No drastic change was observed, except that there was a slightly lower level of dissolved oxygen in the overhead tank. The water was devoid of chlorine or any other disinfectant, had no obvious smell or taste, or any other detectable pollutant.

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Fig. 1 *Clinostomum complanatum* seen after exiting from the gills of the host fish, *Trichogaster fasciatus*. A total of 1,101 parasites were seen coming out of 35 fish

Table 1 Quality parameters of the water used for change and water prior to change (in which the fish were maintained)

Water quality parameters of fish tank	Prior to water change	Water used for change
Dissolved oxygen (mg/l)	3.8 ± 0.1	3.2 ± 0.1
pH	8.4 ± 0.1	8.5 ± 0.1
Temperature (°C)	33 ± 1.0	34 ± 1.0

Values are a mean of three individual readings ± SEM (standard error of the mean)

We feel that this is an interesting observation for several reasons. To the best of our knowledge it is the first ever report of digenean metacercaria abandoning its intermediate host, upon its death. With the number of worms seen leaving the fish, it was not a chance phenomenon.

In a wider evolutionary perspective, upon the death of the intermediate host, the chances of the parasite continuing its life cycle decrease dramatically, particularly in this case, since the definitive host of this parasite (ardeid bird) only prey upon live organisms. The mass exodus hence, may increase the chances of the parasite continuing its life cycle, particularly since *Clinostomum* is known to have a very loose host specificity (Rizvi et al. 2010 and Rizvi 2011) and chance infections are reported in several reptiles and amphibians dwelling near water bodies, such as *Bufo cognatus*, *Ambystoma tigrinum mavortium*, and *Spea multiplicata* (Miller et al. 2004). This behaviour of the parasite larvae, observed in this study, suggests that the larvae may

have left the intermediate host upon its death to search for an alternative host to support their survival and perpetuating their life cycle.

Besides parasitizing *T. fasciatus* as excysted progenetic metacercariae, *C. complanatum* metacercariae are also found in the encysted state in *Channa punctatus* in the Aligarh region (Shareef and Abidi, unpublished). It has not escaped our notice, that the excysted metacercariae are at a selective evolutionary advantage, as compared to the encysted metacercariae, since the excysted, and hence highly motile metacercariae can leave the dying host and perpetuate their lifecycle in other hosts by causing chance infections. On the other hand, the encysted form can not have this advantage and is doomed to death, upon the death of its intermediate host.

Investigations on the lines of the cues responsible for the mass exodus of the parasite from the intermediate host, and the development of this parasite in the definitive host, are going on in our laboratory. An in depth understanding of these phenomena, besides being of tremendous academic interest, will also expose weak links in the parasite life cycle, thereby allowing the development of new and novel methods/agents of parasite control.

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