CORRELATING INCIDENCES OF *Dreissena polymorpha* COLONIZATION WITH TREMATODE LARVAE INFECTION IN *Stagnicola emerginata* SNAILS

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Abstract - The invasive zebra mussel (*Dreissena polymorpha*), has negatively impacted many northern Michigan aquatic species in the past 20 years (Strayer, 2009). One of the species affected has been *Stagnicola emerginata,* a freshwater snail. This species of snail also acts as the intermediate host for the larvae of a number of trematode species which increase the size of the snail, possibly making them more vulnerable to zebra mussel colonization (Horak and Adema, 2002).The purpose of this study was the determination of a correlation between schistosome parasitism, and *Dreissena polymorpha* colonization on *Stagnicola emerginata*. Over 2000 snails were collected from Burt Lake MI, and where individually examined for cercarial emergence using fluorescent lighting to induce shedding. Rates of schistosome parasitism were correlated with presence or absence of *D. polymorpha* on each specimen. Based upon the analysis of these data, it has been concluded that no link, positive or negative, between schistosome parasitism and *D. polymorpha* colonization on the snails may be supported. The lack of negative effects on the *S. emerginata* seems to indicate prudent parasitism by the larvae.

Key Words – Stagnicola emerginata, Dreissena polymorpha, schistosome, parasites, zebra mussel, prudent parasitism.

INTRODUCTION

The invasive *Dreissena polymorpha,* commonly known as the zebra mussel, has become an increasingly problematic issue in the Great Lakes region for more than 20 years (Strayer, 2009). The mussels have caused population declines in many species in the lakes including the native amphipod *Diporeia* spp., once the dominant benthic organism in Lake Michigan (Nalepa et al., 2009). *D. polymorpha* attaches to solid surfaces, biotic or abiotic, during its juvenile stages using byssel threads, and prefers to remain in place (Stoeckel et al., 2004). *D. polymorpha* growth on fresh water snails has been shown to decrease both mobility and burrowing ability, leading reduced ability to feed or avoid predation (Van Appledorn et al., 2007). One species of freshwater snail which has been known to be colonized by *D. polymorpha* is *Stagnicola emerginata*. In northern Michigan *S. emerginata* also acts as the intermediate host for at least eight species of parasitic trematode larvae in the family Schistosomatidae (Blankespoor and Keas, 1997). These larvae hatch from eggs deposited in the fecal material of waterfowl, and as miracidia seek out an intermediate mollusk host. Upon entering a suitable host they develop into cercariae which, when mature, shed from the mollusk in search of a waterfowl host to complete their lifecycle (Horak and Adema, 2002).

Schistosome parasitism has been shown to increase freshwater snails' size, among other physiological changes (Horak and Adema, 2002). However, the presence of *D. polymorpha* has been shown to result in directional selection for decreased shell size in multiple fresh water snail species (Van Appledorn et al., 2007). Therefore a parasite induced increase in surface area would

logically lead to a higher probability of juvenile zebra mussels colonizing a snail's shell, compared to the smaller non-parasitized snails. The purpose of this study was to determine whether in fact parasitism by trematode larvae does increase the incidence of zebra mussel colonization on *S. emerginata* snails.

MATERIALS AND METHODS

During the course of 5 separate collections, each at different sites, 2587 *S. emerginata* snails were collected from White Goose Bay, Burt lake MI. Schistosome larvae have been shown to emerge from their snail hosts primarily in the first 6 hours after dawn (Anderson et al., 1976). Accordingly, snails were collected by hand from 6:00 am until aprox. 7:00 am from sandy offshore areas of no greater than 1m of depth. All specimens were placed in buckets containing lake water during collection, and subsequent transport to the laboratory.

Once moved to the lab the total number of snails was tallied as well as the number with zebra mussel colonization present. Each snail was placed into an individual, transparent plastic communion cup which was half filled with filtered and aerated Douglas Lake water. All of the cups containing snails were placed in a rack together, and left to shed cercariae for 2 hrs under fluorescent lighting. After the shedding time elapsed, each cup containing a snail was examined under a dissecting scope to determine the presence or absence of larval infection. The number infected was recorded, with regard to *D. polymorpha* presence on the snails. All of the equipment and techniques mentioned above were based on Blankespoor and Reiminik (1998). Upon completion of the infection survey, snails were returned to the transport buckets and subsequently released at their respective collection sites. Chi-Squared analysis was performed comparing the number of schistosome infected snails with *D. polymorpha* colonization, and

those without, to the numbers of non infected snails and their respective mussel colonization rates.

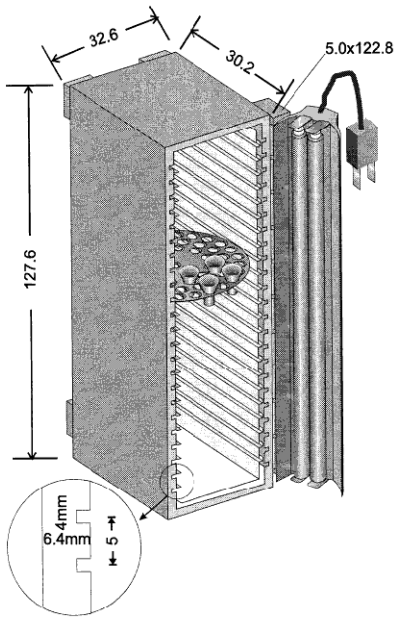

Figure 1. Apparatus used to contain snails, and expose them to fluorescent light during cercarial shedding. All measurements are in cm unless otherwise stated. Image and design from Blankespoor and Reimink, (1998).

RESULTS

Table 1. Describing numbers of snails infected with schistosome larvae, categorized by zebra mussel presence or absence.

	D. polymorpha Present	*D. polymorpha* Absent	Total
Schistosomes absent	575	1965	2540
Schistosomes Present	13	34	47
Total	588	1999	

Based on table 1 it is clear that overall infection rates were low, totaling only 47 out of 2587 snails collected. It is also clear that roughly a 4:1 ratio of *D. polymorpha* free to *D. polymorpha* colonized snails were collected. Chi Squared analysis showed no significant correlation between schistosome parasitism of *S. emerginata* and zebra mussel colonization rates on the snails.

(χ^2= 0.663, df=3, P=0.882)

DISSCUSSION

Based upon the data collected there is insufficient evidence to support the hypothesis that schistosomal infection in *S. emerginata* increases rates of *D. polymorpha* colonization. Nor can the inverse hypothesis, that *D. polymorpha* colonization increases rates of schistosomal parasitism in the snails, be supported. Schistosome parasitism of *S. emerginata* snails does not seem to affect snail physiology to the point of increasing rates of *D. polymorpha* colonization.

It seems likely that in fact, there exists a selective pressure against the schistosomes causing too much negative physiological alteration. This would be because *D. polymorpha* colonized snails would be less able to feed themselves or avoid predators due to the extra burden of the mussels (Van Appledorn et al., 2007). Neither of these conditions would be advantageous to the parasite which gains from, and depends upon, a relatively healthy host. The longer the host's lifespan the more circariae may be shed from it (Horak and Adema, 2002). This may explain selection for parasitism levels below that which would negatively impact the snail's physiology to the point of increased *D. polymorpha* colonization. A study comparing the size of snails vs. the level of schistosome infection would be useful in determining whether there is a maximum level of infection before the snails are unacceptably compromised. If so, it may indicate the presence of a selective pressure creating an upper limit of infection in *S. emerginata*.

The term prudent parasitism refers to parasitic organisms limiting their negative impact upon their host, in order to avoid reducing their own fitness (Holmes, 1983). Such patterns have been known to exist in other freshwater snail species (Minchella et al., 1985). Should such a relationship exist in *S. emerginata*, as seems may be the case, then it would be interesting to determine if the parasitism may in fact be beneficial to the snail in any way. Such beneficial relationships have also been known to exist in similar snail species (Minchella et al., 1985).

Throughout the course of this study, several possible improvements have been noted which may prove useful in future investigations. As shown in Table 1, the rate of infection is fairly limited, comprising only 47 of the over 2000 snails sampled. It is possible that due to the low rate of infection, an increased sample size would have been able to yield more conclusive data. The laboratory methods used in determining whether schistosome infection was present in each snail may also have been somewhat improved. By the conclusion of the screening process it became apparent that in clear cups and white light it was difficult to confirm trematode infections where only one or two cercariae may be present. A more costly technique which has proved effective in detecting as few as 1, and as many as 300 cercariae, is a Polymerase Chain Reaction Assay (PCR) (Driscoll et al., 2005). This level of sophistication was however, outside of the means of this study. An additional source of error may have involved the dislodgment of mussels from snail shells during transport. Counts of *D. polymorpha* and separation thereof from the non-colonized snails during collection may have helped overcome this problem. Despite these possible sources of error, it is likely that the findings proposed in this paper remain valid. Furthermore, although the proposed hypothesis was not supported, it is encouraging to see that schistosomal parasitism does not compound the threat of invasive *D. polymorpha* colonization.

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