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Research Application Summary

Using a molluscivorous cichlid from Lake Malawi as a biological control agent of schistosomiasis snail hosts

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Abstract

A breeding program for *Trematocranus placodon*, a Lake Malawi molluscivorous cichlid that can be used as a biological control agent of snails in schostosomiasis control programs, was initiated at Lilongwe University of Agriculture and Natural Resources in 2003. Artificial breeding of *T. placodon* resulted in fish that had poorer molariform teeth development and less efficient in eating snails than their wild counterparts. We hypothesized that the poor molariform teeth development on the pharangeal bones was because of the soft diets used in the hatchery and that snails were quick to sense the presence of the predator or predation on their conspecifics in laboratory settings, which improved their hiding ability. We present preliminary findings of quantifying behavioral responses of snails in the presence of cues from the predator *(T. placodon*) or killed conspecifics.

Key words: *Bulinus tropicus,* molluscivorous, schistosomiasis*, Trematocranus placodon*

Résumé

Un programme d’élevage pour *Trematocranus placodon*, un mollusque du lac Malawi pouvant être utilisé comme agent de lutte biologique dans les programmes de lutte contre la schistosomiase, a été initié à l’Université de l’agriculture et des ressources naturelles de Lilongwe en 2003. L’élevage artificiel de *T. placodon* a entraîné un poisson qui avait un développement de dents molaires moins efficaces pour manger les escargots, que leurs homologues sauvages. Nous avons émis l’hypothèse que le développement médiocre des dents molaires sur les os était à cause des régimes doux utilisés dans l’écloserie et que les escargots ont rapidement détecté la présence du prédateur ou la prédation sur leurs conspecifics en milieu de laboratoire, ce qui a amélioré leur capacité de dissimulation. Nous présentons les résultats préliminaires de la quantification des réponses comportementales des escargots en présence du prédateur (*T. placodon*).

Mots clés: B*ulinus tropicus*, molluscivore, schistosomiase, *Trematocranus placodon*

Background

Aquaculture projects have the negative effect of increasing the habitat for disease vectors that transmit water-borne diseases. One such disease in Malawi is schistosomiasis, whose parasite *(schistosomes*) uses snails as their intermediate hosts. Physical destruction of snails is time consuming and chemotherapy is costly and requires repeated treatment due to rapid re-infection. Furthermore, both physical and chemical measures are not an option since it is extremely difficult to kill the snails at the depths at which they occur. Biological control methods like use of molluscivorous fishes are probably the only realistic measures that can currently be undertaken to reduce schistosomes.

There are many molluscivorous fishes in Malawi but *Trematocranus placodon* (Regan 1922) is considered the most active biological control agent. It has strong molariform teeth on the pharyngeal bone that are used in crushing the snails. It has sensors below the cheek that could be used to detect movements in the sand. This makes *T. placodon* eat snails that hide in the sand. The suitability of *T. placodon* in controlling snail hosts in aquaculture ponds was demonstrated by Chiotha *et al.* (1991). *Trematocranus placodon* is a facultative molluscivore, that is, it can survive on diets other than snails. This makes it suitable to grow in a fish hatchery where snails may be scarce to use as feed.

In 2003, a mass breeding program for *T. placodo*n was developed at Lilongwe University of Agriculture and Natural Resources so that the fingerlings could be distributed in aquaculture ponds, irrigation schemes and tourist attraction areas where snail population was very high. However, it emerged that the hatchery-bred *T. placodon* had poor molariform teeth development. This was hypothesized to be due to the phenotypic plasticity of the pharyngeal bone. Initial studies had shown that feeding the hatchery-bred *T. placodon* with hard or course feeds resulted in development of strong molariform teeth. This called for studies to identify suitable artificial diets that could induce molariform teeth development. It also emerged that the hatchery-bred *T. placodon* was less efficient in detecting snails than their wild counterparts. It was hypothesized that the snails were able to increase their hiding ability or crawl-out behaviour in laboratory settings. Studies were initiated to quantify the hiding ability or crawl-out behaviour of snails in the presence of predators or their killed conspecifics.

Literature summary

Schistosomiasis has long plagued Malawi and this has been recognized for more than 80 years (Dye, 1924). Both urinary and intestinal schistosomes are endemic to Malawi. Schistosomiasis is a neglected disease because it lacks adequate research and funding. Historically, in Lake Malawi, transmission of schistosomes occurred in swampy areas and backwaters adjacent to the shorelines where snail hosts, which harbour *Schistosoma haematobium*, are relatively abundant while the open waters of the lake were free. From mid-1980's, there has been a dramatic increase in snail population in the open waters of

Lake Malawi which was correlated to a decline is molluscivorous fish species (Stauffer *et al.,* 1997). The frequency of infections is now consistently high throughout the year (Kellogg *et al.,* 2001). In recent years, there have been a lot of travel warnings among tourists and resident expatriates about increased schistosomiasis infection in Malawi (Moore and Doherty, 2005).

Study description

Experimental design. Research was conducted in a wet laboratory. Sixty *Bulinus tropicus* snails were put in each of the nine 30-litre glass aquaria. *Bulinus tropicus* was used because it is not a host of *S. haematobium*. There were three treatments. In Treatment 1, no chemical cues were applied, Treatment 2 had cues from killed conspecifics while Treatment 3 had cues from the predators. Each treatment was replicated thrice in a completely randomized design.

Preparation of cues. Chemical cues from killed conspecifics were prepared by killing five snails after administering an anaesthetic and leaving them in a 1 litre beaker of water for an hour. The water was then added to Treatment 2. Chemical cues from the predator were prepared by putting five 40.32 ± 0.27 grams fish in 30 litre tanks for 24 hours and removing them just before the snails were put in.

Experimental set up and data collection. The aquaria had half of the bottom covered with stones. Twenty snails were then put in all the nine aquaria. After one hour, the number of snails that were on the open bottom, under stones and outside the water was recorded.

Research application

The result showed a significant (p-value = 0.0001) association between application of cue and behavioural response of *B. tropicus*. Cue application resulted in snails moving away from the open water. Hiding behaviour was higher when the snails sensed the cues from killed conspecifics than from the predators. Cues from conspecifics may have alarm signals to induce behavioural response. Hiding was least in treatment with cues from predators. Possible reasons may be because of the few numbers of fish that were used

Table 1. Hiding and crawl-out behavioural responses of *Bulinus tropicus* in 30-litre aquaria to chemical cues after one hour of cue application

Type of cue	Number of snails in open bottom	Number of snails hiding in rocky environment	Number of snails that had crawled out of water
No cue	34	12	14
Cues from killed conspecifics	11	37	12
Cues from predators	21	28	11

Chi-square = 24.96; degrees of freedom = 4, p-value = 0.0000 to produce cues and that snails had not co-evolved with the predator to recognise predator cues.

The study team is currently conducting a series of experiments on use of cues from non-predatory fishes, behavioural responses of snails that have co-evolved with the predator and those that have not, shape analysis and determination of morphological modification between snails that have co-evolved with the predator and those that have not. In addition to *T. placodon,* a breeding program of *Metriaclima lanistocola* ((Burgess, 1976), another molluscivore from Lake Malawi, has just been started.

Conclusion

The study demonstrated that killed conspecifics increase hiding behaviour of snails which may reduce the ability of the predatory fish in controlling the snails. This has implications on the number of predatory fish that have to be introduced into an aquatic environment in order to reduce snails.

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References

Chiotha, S.S., McKaye, K.R. and Stauffer Jr., J.R. 1991. Prey handling in *Trematocranus placodon*, a snail-eating cichlid fish from Lake Malawi. *Ichthyological Exploration of Freshwaters* 2: 203 – 208.

Dye, W. H. 1924. Splenomegaly and schistosomiasis in Central Africa. *Journal of the Royal Army of Medical Corps* 43: 161 – 181.

Green, C. and Baden, S. 1994. Women and development in Malawi. Bridge Development – Gender. Report No. 23. ISBN: 1 85864 158 6.

Kellogg, K. A., Stauffer Jr., J.R. and McKaye, K.R. 2001. Using cichlids to control parasitic diseases. *Journal of Aquaculture and Aquatic Sciences* 9: 79 – 88.

Moore, E. and Doherty, J.F. 2005. Schistosomiasis among travellers returning from Malawi: a common occurrence. *QJM* 98: 69 – 71.

Stauffer, J.R., Arnergard, M.E., Cetron, M., Sullivan, J.J., Chitsulo, L. A., Turner, G.F., Chiotha, S. and McKaye, K.R. 1997. Controlling vectors and hosts of parasitic diseases using fishes. A case study of Schistosomiasis in Lake Malawi. *BioScience* 47 (1): 41 – 49.