The biological control of snail intermediate hosts of schistosomiasis by fish

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Introduction

An estimated 200 million people are infected world-wide by the five known species of human schistosomes, trematode worm parasites which are transmitted by freshwater snails of the genera Bulinus (Schistosoma haematobium in Africa and the Middle East,
and *S. intercalatum* in Central Africa), *Biomphalaria* (*S. mansoni* in Africa, Caribbean region and South America), *Oncomelania* (*S. japonicum* in the Far East) and *Tricula* (*S. mekongi* in South East Asia) (Jordan and Webbe, 1982). The resulting disease, schistosomiasis (or bilharzia), causes significant morbidity to Man. Several other snail-transmitted trematode parasites (e.g. *Fasciola* spp.) infect domestic animals and can cause economic loss.

Efforts to reduce the morbidity and adverse economic impact caused by the parasites are centred around health care facilities where the use of effective single-dose medicines can contribute significantly to the control of schistosomiasis. However, the rapid reinfection that often occurs after treatment and the high cost of repeated medication has tempered expectations of the efficacy of medication campaigns in the longer term. Actions to reduce the risk of transmission by controlling the intermediate hosts often remain necessary. Snail control can be realized by means of (1) application of molluscicides, (2) habitat modification (e.g. removal of vegetation, concrete lining of irrigation canals, etc.), and (3) biological control. Molluscicides have the disadvantage of being expensive and unspecific (e.g. Corbet et al., 1973); they also kill fish and other useful organisms such as competitors of snails (Hairston et al., 1975), and therefore cannot be used in aquaculture ponds (Slootweg et al., 1993) or places where fish are introduced to control mosquitoes. Habitat modification is of limited applicability, usually only in man-made environments. Against this background, the present paper focuses on the biological control of snail vectors.

The influence of fish on the invertebrate fauna, snails in particular, cannot be denied. Louda et al. (1985) and McKaye et al. (1986) have shown that predation by molluscivorous cichlids is a significant factor in the distribution of Lake Malawi gastropods. Brown and DeVries (1985) state that fish predators can dramatically alter the population dynamics of a single snail species, although in their research, predation pressure never reached levels where snails were completely eradicated from their environment. Palmer (1979) and Vermeij and Covich (1978) give evidence that the evolution of snails with elaborate shell sculpture is largely induced by fish predation.

Michelson (1957), Malek (1958), Berg (1973), Hairston et al. (1975), Ferguson (1978) and McCullough (1981a) have reviewed and discussed methods of biological snail control, but there does not exist as yet a critical review of the empirical material available from actual field and/or laboratory trials on the use of fish as a biological control agent. In this paper we will review the role of fish in snail control. Special attention will be paid to one particular species that has often been mentioned in the literature as a possible candidate for biological control. Several well-documented field studies with varying degrees of success exist which will be discussed extensively. Furthermore, new ecomorphological data on the pharyngeal jaw apparatus of the fish will be presented. The reasons for failure of this fish in snail control will be discussed from an ecological and morphological viewpoint. Finally we will summarize the remaining possibilities and research questions in snail control by fish that need to be addressed in future.

### Table 1: Summary of Research on Snail-Eating Fish Since 1945

Table 1 summarizes research on snail-eating fish since 1945. It must be noted that the table is not exhaustive with respect to stomach contents research (field observations category), because we limited our literature search to the relation between fish and snail