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Control Methods for Snail-Borne Zoonoses

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Abstract

All trematodes which cause infections and diseases in humans (zoonoses) require snails for their first intermediate host. Some have additional intermediate hosts such as crustaceans, fishes and frogs.

In this paper I have discussed the use of various procedures for controlling snail populations thereby reducing the population of trematodes whose cercariae penetrate the skin of man, or which are acquired by eating raw aquatic vegetation such as watercress, or which cause pathology in fish. Biological, chemical, and physical snail control techniques are discussed. The most promising molluscucides are copper compounds, Bayluscide, biocidal rubber and molluscicidal bait.

As far as known, all zoonotic trematodes of man require snails as their first intermediate hosts. Some have additional intermediate hosts which are fishes, crustaceans, and frogs. In this report only those trematodes whose cercariae penetrate the skin of man or those which are acquired by ingesting the metacercariae on aquatic vegetation will be discussed.

The liver flukes *(Fasciola, Fascioloides)* and the large intestinal fluke *(Fasciolopsis)* are acquired regularly by man only in those countries (S.E. Asia, Cuba) where aquatic plants are often eaten raw. *Fasciola hepatica* has also been reported from man in Venezuela, Chile, Argentina, Puerto Rico, Greece, Turkey, France, Hungary, Italy, Rumania, Spain, Scotland, USSR, Algeria, French Somaliland, Turkestan, Syria, and Australia.[4] Commercially produced and home-grown watercress in the United States is probably not contaminated because infected ungulate final hosts (deer and cattle) and human excreta are excluded from the production sites. *Fasciola hepatica,* the liver fluke, develops in snails of the genera *Lymnaea, Physopsis, Galba, Fossaria, Bulinus, Ampullaria, Succinea, Pseudosuccinea,* and *Practicolella. Fasciolopsis buski,* which infects man and swine in southeastern Asia, develops in the snails *Segmentina* and *Hippeutis;* the cercariae usually encyst on the water caltrop, water hyacinth, water chestnut and water bamboo. Further details may be found in medical parasitology text books.

The schistosomes (blood flukes) are probably the most important snail-borne zoonotic agents. The cercariae of *Schistosoma mansoni* (Carribean, S. America, Africa), *S. haematobium* (Africa, Iraq, Madagascar) and *S. japonicum* (Eastern Asia), emerge from the snail hosts and penetrate the skin of man causing serious pathology. The responsible snails are *Australorbis, Tropicorbis, Biomphalaria, Bulinus,* and *Physopsis* for *S. mansoni; Physopsis, Bulinus, Lymnaea,* and *Planorbarius* for *S. haematobium;* and *Oncomelania* for *S. japonicum.*

Many schistosomes of wild mammals and birds are capable of penetrating human skin, from fresh or marine water. In humans the larvae soon die but cause an allergic sensitization (swimmers' itch). This has been reported from many places in the world. This condition has been so serious in some parts of Wisconsin, Michigan and Minnesota (U.S.A.) that swimming areas have had to be treated with molluscicides.

Because I work on fish parasites, my concern also has been with the snail intermediate hosts of fish trematode diseases. The control methods that work on the snail hosts of schistosomes and other human parasites in rivers and lakes, should work on the snail hosts of fish parasites and *vice versa.* To my knowledge little work is being done on the control of snail hosts of fish trematodes, so, fish parasitologists must utilize general information made available by human schistosome researchers. However, some differences between these bodies of research are that: (1) some schistosome snails are amphibians, whereas all fish trematode snails are strictly aquatic and (2) in some schistosome areas, fish are not present, or are considered of no conequence, so that fish-killing molluscicides may be applied. Fortunately for those of us working in fish parasitology some schistosome workers are searching for non-piscicidal molluscicides. The World Health Organization publishes periodical reviews of molluscicide work (see WHO, 1965).[23] The ideal molluscicide would be one which would kill only snails. Recent ecological problems involving persistent pesticides such as DDT or heavy metals such as mercury will necessitate caution in use of molluscicides.

The following snail control methods have been reported to be effective for controlling schistosomiasis; they could be applied to the control of snail-borne fish parasites.

1. Biological Control

Biological control methods are important because they would leave no toxic residue and a self-perpetuating control system might be established.

Most notable in this category are the successes of schistosomiasis control in the laboratory and in Puerto Rico with the sometimes carnivorous tropical Columbian ramshorn snail, *Marisa cornuarietis.*[19,21] In Puerto Rico I saw a stream where the introduction of this snail had controlled the snails harboring schistosome cercariae. It is my understanding that it feeds on vegetation and the eggs of other snails.

Some predatory fish are effective in reducing snail populations. The redear sunfish *(Lepomis microlophus)* is most notable in this respect.[1,6] A mollusc-eating fish, *Haplochromis mellandi,* controlled the snail vector of *Diplostomulum* parasitizing *Tilapia* in the Congo.[11] Carp and suckers have also been reported to reduce snail populations.

Some leeches feed on snails[7,15] and some bacteria are pathogenic for snails.[17] Perhaps these agents could be cultured and used for snail control as well.

A haplosporidian protozoan, *Minchinia pickfordae* is probably pathogenic to *Physa, Lymnaea,* and *Helisoma,* but not *Goniabasis.*[3] A microsporidian, *Plistophora husseyi,* also shows promise as a biological control agent of aquatic pulmonate snails.[18]

Larvae of sciomyzid flies, *Egliva* spp., are predators of aquatic pulmonate snails belonging to the Lymnaeidae, Physidae and Planorbidae and have potential as biological control agents.[12]

A pathogenic nematode, *Daubaylia potomaca,* has been reported from *Helisoma trivolvis* and is transmissible to the schistosome snail, *Australorbis glabratus.*[8]

The import of foreign animals intended for biological control presents the necessity that they be cleared for entry by the proper authorities.

2. Chemical Control

The perfect molluscicide would kill all snails but would harm no other aquatic life. Although no such compounds are known some of the following are very useful:

A. *Copper compounds:* Although copper sulfate, copper carbonate and other copper compounds are far from perfect, they have been used extensively and usually leave no residue that is toxic to other animals. At proper dosage they do not kill fish. They have been used extensively in control of tropical schistosomiasis and in the control of swimmers' itch in the upper-midwestern U.S.A.[9,14,22]

B. Bayluscide* *(Aminoethanol dichloro nitrosalicylanilide).* The 5% heavy granulation form of this molluscicide has recently been given U.S. governmental clearance for use in Michigan, Minnesota, and Wisconsin. In tests, snails, clams, and darters were killed, but not bluegills, perch or shiners. Apparently most wild fish do not feed on granules and the toxic material is not released fast enough to be toxic to non-bottom-dwelling fish. Darters usually "sit" on the bottom, and so are probably vulnerable to the toxin which leeches out of the granules. It is not known if cultured fish would feed on the granules.

*Chemagro Co., Kansas City, Missouri.

C. *Chlorophos (Dylox, Neguvon, Dipterex).* Musselius and Laptev (1967)[20] have reported that *Chlorophos* killed *Lymnaea* and *Planorbis,* but not fish in Russia; this has not been confirmed elsewhere. This chemical has been used successfully in the U.S.A. to control monogenetic trematodes, leeches and parasitic copepods of fish.[16]

D. *Bait-Poison concept.* Bayluscide and a snail attractant, incorporated in an insoluble acrylic polymer, was shown to be effective as molluscicidal bait against aquatic and amphibious snails.[13]

E. *Biocidal rubber.* Organotin and conventional molluscicides can be incorporated in rubber formulations so that they will diffuse slowly from the rubber.[5]

3. Physical Control

A. *Water level manipulation.* Rapid draw-down of reservoirs may leave snails stranded to die.[10]

B. *Flushing of drained ponds.* Washing down with high pressure water hoses reduced snail populations sufficiently to eliminate a serious eye fluke problem of fish at a trout hatchery.

These three methods are perhaps the most promising to date although about 25 others have been reported. Further research should demonstrate that some of these can be used to control snails without endangering other aquatic life. Accelerated screening of potential molluscicides should be encouraged.

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