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THE ROLE OF MOLLUSCICIDES IN BILHARZIA CONTROL

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INTRODUCTION

The rôle of molluscicides in the control of bilharzia is one of correcting an imbalance.

Essentially the problem of bilharziasis is an ecological one. Any association between an animal and its environment must lead to some form of stability, to an ecological balance in which the factors which influence mortality do not outweigh the capacity for increase. The natural tendency is towards harmony. This is equally true with regard to parasites for it is of little survival value for a parasite to kill, or to incapacitate its host to a point where the host can no longer provide a satisfactory milieu for the parasite. With regard to the schistosomes, the recent history of agricultural development in Africa, the settling of the population and its subsequent increase, has caused an upset in this natural balance. In the past permanent waterbodies were sparse, most rivers being seasonal in flow. Thus a succession of flood and desiccation were the natural catastrophies to which an aquatic organism was exposed annually, and these factors influenced the distribution and abundance of the aquatic snails which served as intermediate hosts for schistosomes.

More recently in Southern Africa, the need to conserve natural resources and the implementation of soil and water conservation procedures have caused an amelioration of conditions. Construction of dams in very large numbers has stabilized waterflow and reduced the natural catastrophies of the environment. Snail habitat has expanded and this, together with an increased, settled human population, is producing an increasing spiral of bilharzial infection.

Epidemiology and Climate

The extent and density of snail populations are dependent on many ecological factors of which the availability of water and temperature are important. The influence of these conditions has a direct bearing on the transmission of schistosomes in the resident human population. Clarke (1966) has studied the prevalence of bilharzia among several communities in Rhodesia and his data show the interrelationships very clearly. FIGURE 1 shows the prevalence, or the distribution of *Schistosoma haematobium* in people of various age groups, from five different communities. The

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graph shows the per cent infection from each age group tested. The communities are from two middleveld areas (2000-4000 feet) one in a well-watered area and one in an area where surface water and river flow is seasonal. The second group are from the highveld (above 4000 feet),one in a well-watered region and the other in the more arid south-western area. The last example is taken from a lowveld (under 2000 feet) irrigation farm and shows the extent to which transmission can rise in a hot area where there is substantial human contact with perennial water.

In each circumstance, the greater the extent of surface water, the higher the prevalence; similarly, the warmer the area, the higher the prevalence. A note of warning is indicated here; and that is, any irrigation system, particularly in the warmer areas of the country, should be designed with a view to minimizing transmission of bilharzia.

The increasing problem of bilharzia in Southern Africa is intimately involved with the breakdown of an ecological equilibrium, and one of the reasons for this is the increasing snail population. As the life cycle of the bilharzia parasite cannot be completed in the absence of the appropriate intermediate host snails, an approach directed against those particular species should have some influence in correcting this imbalance.

One of the methods of attacking the snail population is to use molluscicides. To date there have been four major chemicals used as molluscicides; copper sulphate, sodium pentachlorophenate, Bayluscide (5-2 dichloro-4 nitro salycyclic anilide) and Frescon (n-trityl morpholine). The first two chemicals - copper sulphate and sodium pentachlorophenate - have major drawbacks in field use, and have been discarded in most snail control programmes. They are general biocides and have been shown (Shiff and Garnett - 1961) to destroy most aquatic organisms. They have high mammalian toxicity, and the durability of copper may result in a build-up of copper salts in the water after prolonged treatment. There are practical considerations, too, which militate against the widespread use of these chemicals. For example, copper sulphate is required in such large amounts that portage becomes a problem and the extent of habitat that can be covered by a spray gang is limited by the load of chemical that can be carried. Sodium penthachlorophenate is highly irritant and the inhalation of the powder produces acute symptoms. Sprayers continually using this substance suffer from lacrymation and chronic coughs. Points such as these should be considered in the production and formulation of any potential molluscicides.

There are certain general characteristics that are desirable in a molluscicide i) it should be of low mammalian toxicity; ii) it should selectively destroy snails and their eggs at low concentrations, leaving fish and other fauna unharmed; iii) it should be reasonably stable and safe enough to be handled by relatively unskilled personnel; iv) it should not be phytotoxic; v) it should disperse easily in water.

These are, for the most part, met by the other two compounds which are now widely used in most snail control programmes. In fact, if used carefully, these chemicals can be applied without any substantial influence on the biotope apart from the removal of certain mollusca. Harrison, together with co-authors, has studied the biological effects of mollusciciding natural waters (Harrison (1966); Harrison and Rattray (1966); Harrison and Mason (1967)), and has concluded that the application of Bayluscide or Frescon, particularly under the system of snail surveillance, produced no short-term or long-term imbalance in the habitat.

Snail surveillance

Once it has been decided that snail control measures are to be carried out, up-to-date maps are obtained and a detailed survey of all waterbodies is carried out. In the first instance, the waterbodies are blanket-sprayed with molluscicide using a rule of thumb method to achieve minimum effective dose, and applying the chemical by means of knapsack sprayer or stirrup pumps. For this work Bayluscide has been preferred because it is not only effective in destroying snails, but it is ovicidal as well. After the initial treatment, the waterbodies are surveyed for residual snail populations on a six to eight week cycle, only those foci where host snails are found, being retreated. This system of snail surveillance which is practised in Rhodesia has evolved from a study of snail behaviour and population dynamics - both in the laboratory and in the field - and observation of natural populations under the influence of molluscicides. The rationale for this technique is based on several factors:

i. Infected snails are more susceptible to molluscicides than healthy snails;

ii. If a population of snails reaches dangerous proportions it will be discovered by the ranger teams on their normal rounds;

iii. Uninfected snails surviving a surveillance cycle will, if exposed to miracidia, take an average of six weeks before producing numbers of cercariae;

iv. As molluscicides are applied to restricted regions of waterbodies, and seldom to complete river systems, interference with the biota will be minimal. (Shiff and Clarke, 1967).

No attempt is made to eradicate the snail population and because attention is paid only to intermediate host snails, other snail species survive within the control area so that the ecological niche is not left vacant. The goal of surveillance is to keep the snail population at a level low enough to render the transmission of bilharzia no longer a problem of public health importance.

More recently it has become necessary to combat the transmission of bilharzia in the new expanding irrigation areas of Rhodesia. In these regions, conditions are optimal for the development of high intensity transmission. They are warm regions and large human populations are becoming settled in close proximity to man-made waterbodies, both static and flowing. In these areas water contact and water pollution by humans becomes a real problem, and because of the vast areas and the large numbers of people involved, it is often difficult to provide adequate facilities during development stages of the projects. The use of molluscicides, although a recurrent expense in these areas, can produce an overall control of the snail populations, particularly in high contact areas.

Using constant flow devices, molluscicide can be metered into the inflow water and distributed through the irrigation system. The actual details of this type of work entails accurate control of water, and absolute co-operation between Irrigators and the Health Authorities to prevent wastage and to ensure proper distribution of adequate dosages of molluscicide. However, successful control of the irrigation system does not require that treatment should be repeated more than once or twice a year. As with control on highveld areas, once the blanket treatment has been done, surveillance can be used to keep down snail populations throughout the area, in drains and nearby streams. This is being done in the Rhodesian lowveld at a cost of approximately 5/- (five shillings) per acre per annum. As much of this work is still of an investigatory nature, the cost can be expected to decline as methods become more efficient.

A consideration of practical importance in the production of molluscicidal chemicals is their formulation. For example, a wettable powder is convenient for surveillance work where large distances must be covered by operators. The powder can be measured into conveniently sized packets each sufficient to treat a few hundred cubic feet of water, and accidental wastage should be minimal. An emulsifiable concentrate is better suited for work in irrigation schemes where operators work over shorter distances treating shallow drains; and the liquid is often more suitable for use in constant flow dispensers. It should also be noted that formulation as an emulsifiable concentrate often increases the activity of the compound in relation to the powder formulation. This has been noted with both Bayluscide (Shiff et al; in Press) and Frescon (personal communication).

As research and control projects continue, the need for more specialized formulations arises. An innovation from America is a slow release system based on the incorporation of a toxicant in a polymer such as rubber (Cardarelli; 1969). This may be of use in helping to remove snails from certain restricted regions of a habitat.

Assessment

Assessment of this type of snail control is difficult unless the human population is sufficiently settled in the protected area. If there is considerable movement of people it is very likely that individuals, although protected on their home range, may become infected by contacts made out of the controlled area. During the period 1960-1967 assessment was carried out in all snail control areas in Rhodesia and the most reliable data were obtained from single urine surveys carried out in the Kyle Catchment area which covered some 1430 square miles. These surveys done in 1960, 1962 and 1966 show a dramatic reduction of transmission in the area (FIGURE 2). This is purely as a response to snail surveillance using molluscicide (Shiff and Clarke, 1967).

The rôle of molluscicides in the control of bilharzia and other trematode diseases is clearly very important. With care, they can be applied to the biotype to exert a negative pressure on the increasing snail populations and in this way reduce the hazard of bilharzia transmission. However, this approach is directed against only one phase of the life cycle of the parasite. It is far better to approach the problem as one of overall improvement of human health. Bilharzia can be avoided if contamination of water is prevented and water contact reduced. Molluscicides are a stopgap to provide a breathing space; to prevent the problem from becoming too great while our orientation towards environmental control, sanitation, health education and self-discipline must develop.

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REFERENCES

1. CARDARELLI, N.F. Biologically active rubber. A C S (Elast.and Plas.Group) Camb., Mass. 1969.
2. CLARKE, V. de V. The influence of acquired resistance in the epidemiology of Bilharziasis. Cent.Afr.J.med.12, no.6 supplement, 1966.
3. HARRISON, A.D. The effects of Bayluscide on Gastropod snails and other aquatic fauna in Rhodesia. Hydrobiol. 28, 1966, pp.371-384.
4. HARRISON, A.D. and E.A. RATTRAY. Biological effects of Mollusciciding natural waters. S.Afr.J.Sci. 62, 1966, pp.238-241.
5. HARRISON, A.D. and M.H. MASON. The effects on the fauna of natural waters of surveillance treatment with Bayluscide in Rhodesia. Hydrobiol. 29, 1967, pp.149-155.
6. SHIFF, C.J. and CLARKE, V.de V. The effect of snail surveillance in natural waterways on the transmission of Schistosoma haematobium in Rhodesia. Cent.Afr. J.med. 13, 1967, pp.133-137.
7. SHIFF, C.J. and GARNETT, B. The short-term effects of three molluscicides on the microflora and microfauna of small, biologically stable ponds in Southern Rhodesia. Bull.Wld.Hlth.Org. 25, 1961, pp.543-547.
8. SHIFF, C.J. and BARNISH, G, YIANNAKIS, C. and VAN EEDE, R.J.(In Press). Preliminary trials with Bayer 6076,a new liquid formulation of Bayluscid.Pflanzenschutz Nachrichten Bayer (In Press).