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SUPPLEMENT TO VOL. 23, No. 11, NOVEMBER, 1977

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Registered at the General Post Office as a Newspaper.
Recent Developments in Environmental Sanitation and Their Role in the Prevention of Bilharziasis

by

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INTRODUCTION

Safe drinking water and effective sanitation, when adequately provided and fully utilised, and when their effects are combined, promote dramatic and long lasting improvements in the state of health of all communities, for their effects are far reaching and play an important role in the prevention of many diseases including bilharzia.

Environmental sanitation has played a minor role in bilharzia control programmes so far however, with much more emphasis being placed on chemotherapy and chemical control of vector snails. Chemical control is very effective when carried out in irrigation schemes and other areas where a systematic approach is practical and the considerable expenses can be met. In the Tribal Trust Lands however, the large areas involved and the complex pattern of natural water make chemical control more difficult. The ever increasing factor of cost, especially when weighed against the resulting health benefit, leads one to suppose that on the long term basis, chemical control may have a restricted, albeit successful, part to play in the fight against bilharziasis.

Since the transmission of bilharzia depends upon the insanitary habits of man, the provision of adequate latrines should in theory stall the cycle of transmission, but in fact there is little if any direct evidence for this. Young children contaminate natural waters long before they have any knowledge of hygiene, and the transmission of the disease is inevitable if snail infested rivers offer the only source of water. Effective latrines cannot in themselves lure people away from rivers, and as Macdonald\(^1\) has stated, even a very successful sanitation programme in terms of reducing the proportion of faeces reaching the water may not in itself be sufficient to stop transmission. However, effective latrines certainly limit the degree of contamination of the ground and water, even if this is not sufficient to stop transmission which is bound to continue until acceptable alternative sources of water are made available, making habitual contact with infected waters unnecessary.

Since African women and children are responsible for over 50 per cent. of the contact with natural waters whilst washing clothes and dishes and collecting water for their homes\(^2\) it seems logical to suppose that both the degree of contact and the extent of transmission of bilharziasis might be substantially reduced if artificial water points and wash slabs could be designed and positioned to divert attention from the river. The fact that this is possible has been shown on many occasions. In St. Lucia, safe drinking water was piped to five villages in 1970 and the prevalence, incidence and intensity of infection of \(S.\) mansoni, together with frequency of human contact with streams, were recorded in test and control areas before and after the water supply was installed. There were very marked reductions in human contact following the installation; the number of contacts fell by 82 per cent.; the contact time by 96 per cent. and significant reductions were also noted in the prevalence and incidence of bilharziasis infection.\(^3\) Similar trends have been noted by Pitchford\(^4,5\) in South Africa who also demonstrated the usefulness of artificial swimming pools for children. Water points have also become very popular in many test localities in Rhodesia, and a good example of their influence on transmission came from a simple study at Epworth Mission.\(^6\) At the mission school, water is taken from taps and wells, and the children do not make habitual contact with the river. At the Chizungu School, only three miles away, there are no wells or taps and water is collected regularly from the river: there is, in other words, habitual contact with the river through necessity. In a study of the pupils, 55 per cent. carried infections of \(S.\) haematobium at the Chizungu School compared to only 15 per cent. at the Epworth
School. In leisure time most of the pupils from both schools made some contact with the river — the differences in the percentage infection are ascribed to the degree of habitual contact.

Whilst the cost of installing safe piped water may be moderately high, it remains a capital investment in a community and provides a much needed facility which, as a form of control, may be more acceptable to public health administrators than schemes directed solely against bilharzia because of the broader spectrum of health improvement. Safe water supplies not only reduce the incidence of bilharziasis but also substantially lessen the risk of infection due to typhoid, bacillary dysentery, cholera and many other related diseases. It must be remembered however that the provision of safe water alone may not completely overcome the problems of gastro-intestinal infections which can also be transmitted by flies. This is why effective latrines are also essential if standards of health are to rise, for flies easily pick up infections in areas where the disposal of human excreta is inadequate.

There has long been a need for new thinking in the field of environmental sanitation especially regarding the design of sanitary hardware, for many existing systems are either inadequate or unsuitable for use in the rural areas. The laboratory has thus embarked on a research programme specifically involved with latrine and water point design. Considerable emphasis has been placed on simplicity, especially from the user’s point of view, since complex designs are more susceptible to breakdown, require more maintenance and, in some cases, a fair degree of understanding. Several prototypes have been developed and these include two latrine systems, a hand wash basin and a hand water pump. In each case a skilled team installs experimental and demonstration prototypes in field conditions and thereafter an assessment is made of the popularity and acceptability of the design. Simultaneously the efficiency of each installation is judged from a mechanical, biological and hygienic point of view. Once an installation is accepted and becomes popular, whether it is a latrine or a water point, it attracts an increasing amount of attention, with correspondingly less attention being paid to areas where the transmission of bilharzia takes place. Indeed the popularity of a new design is equally as important as its efficiency. The following account briefly describes some new designs currently being examined by the laboratory.

**Latrines**

The provision of effective latrines has long posed a problem to those working in unsophisticated areas of the world. Any system employing a static water trap can easily become blocked partly because solid objects are often used for anal cleansing and partly because the simple requirement of flushing can be neglected. Mechanical devices employing levers or chains are often abused or destroyed and the maintenance of any moderately sophisticated system can become expensive. The deep pit latrine, amongst all others, has been found to be the most practical toilet in the backward areas of the world: it is cheap to make, easy to use and maintain, it is blockage free and requires almost no water and offers a fair degree of protection against soil and ground water contamination.

Pit privies can become highly odorous and fly ridden however and quite unacceptable to the villager whose only alternative is to go back to the bush. At their worst they represent a considerable health hazard, developing into most efficient nuclei from which disease might spread and offsetting any advantages they might have. Two attempts have been made at the laboratory to revive the status of the pit latrine. One employs a self-flushing water-seal, the other an efficient ventilation pipe.

**Self-flushing Water Seal (Watergate)**

This device overcomes the problems of blockage and high water consumption in many existing waterborne systems. It consists of a shute in combination with a squatting plate, a swivelling pan mounted at the base of the shute and a valve which regulates the level of water in the pan. The squatting plate is supported on a concrete slab covering a pit or septic tank, with the pan and shute suspended through a hole cast in the slab. The pan is pivoted and counterbalanced so that it holds approximately three litres of water to form a seal around the lower rim of the shute. The addition of a further 0.5 litres of liquid or matter sets the

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**Fig. 1.—Self-flushing water-seal unit.**
pan off-balance causing it to tip, ejecting the contents below. The pan then returns to the resting position and refills with water through the valve to form a new seal and remains in such a state until further contents are added to the pan. The device normally flushes once during two visits and thus requires 1.5 litres of water per visit. The lower rim of the shute has a diameter of 20 cm and most objects capable of passing through this aperture can easily be flushed. The pan has been designed so that it opens through a wide angle with a sudden tipping action and the limited amount of water held in the pan flushes out the contents efficiently. Water is supplied from a 200 litre drum at ground level and is fed through a simple filter and plastic piping to the unit which is moulded in polyurethane to form a very rigid structure of relatively light weight.

The automatic flushing, water economy and lack of levers and chains are popular features in this waterborne system: it is no more difficult to use than the ordinary pit privy. One valuable advantage of the system is that water is slowly but constantly added to the pit which accelerates the rates of digestion of the excreta. In many cases completely dry pits were converted into what can best be described as “field septic tanks” or “septic pits”. Installations incorporating the Watergate can be designed to have a very long life which makes them more economical to run. The device is particularly suitable for use in communal blocks fitted in schools, mines, hospitals and other areas where there is a permanent water supply and where the installation can be supervised. The Watergate is protected by patent in over 80 countries and is now mass produced.

The Ventilated Pit Privy

This privy is odourless and almost completely flyproof but does not require water to operate. It was designed for use in areas where water is very scarce or difficult to pipe to waterborne installations. It consists of a reinforced concrete slab placed over a deep pit. Two apertures are cast in the slab, and a darkened superstructure is built around the one used for squatting. The aperture outside the structure is fitted with a specially designed ventilation pipe, the upper section of which is covered with a fibreglass flyscreen. As soon as the vent pipe is mounted over the appropriate aperture a convection updraught draws air from the pit and this causes a downdraught through the toilet aperture. The latrine itself thus remains free of foul air emanating from the pit. When the pipe is operating most of the flies from outside are attracted to the odours passing through the flyscreen and not to the toilet aperture where they might infest the pit. Fly breeding is thus reduced in the pit. Flies emerging from the pit, travel towards the light and travel up the vent pipe if the superstructure is dark enough and eventually die of dehydration. The pipe thus draws out odours, prevents most of the fly-breeding in the pit and traps any emerging flies. It thus operates on purely natural principles.

![Ventilated Pit Privy](image)

The fly output from units of this type is very low and its simplicity and cheapness have made it very popular. It is ideally suited to village compounds and other rural areas where water is scarce and where constant supervision cannot be guaranteed. It can only be built as a single unit and is thus unsuitable for communal blocks. Single units have their advantages however in that they offer more privacy and can be suitably sited over a wide area to serve a scattered community. Dry pits have the disadvantage that they fill up quickly, not only with excreta but also with refuse, and this factor must be taken into consideration when the pit is first dug.

A New Wash Basin

Amongst more sophisticated people hands are nearly always washed after visiting the
toilet — a habit which goes a long way to stopping the passage of enteric disease. However, less sophisticated people have not adopted this habit to any extent, and this is undoubtedly a factor of importance in the spread of faecal contamination.

![Diagram of tapless hand basin](image)

**Fig. 3.—Tapless hand basin.**

The conventional wash basin is a remarkably successful device used throughout the world. Yet this same device, like the flush toilet, can be badly abused if improperly maintained. Taps can be left running, to waste water, where water may be precious. The plug, a standard fitting on every basin, might be left in place to retain water that could be used over and over again — a perfect source of contamination of the hands. This new basin is simple enough for less sophisticated people to use, does not waste water and does not retain water that might be contaminated. It has done away with the tap and the plug.

**Brief Description**

The user presses a hemispherical rubber dome within the basin to release a limited quantity of water which is used to wash the hands (or drink). By depressing the dome, the user also activates a standard ball valve in a casing below the basin. The ball float of this valve rises and falls within a hemispherical cup, so that when the cup is filled with water the ball valve rises and shuts off the water supply. When the cup is empty the valve opens. Pressure on the rubber dome forces the ball of the valve into the cup and squeezes out water, thus opening the valve, enabling water to pass through a conduit which leads to the upper section of the basin. Most of this water pours down through an aperture into the basin where the hands are washed, and then runs to waste. The remaining portion of water is led down a special conduit to fill the cup, and thus shut off the water supply. The water runs for approximately 15 seconds when about 0.25 litres of water is used. A further charge of water can be delivered immediately after the first simply by depressing the rubber dome again.

A prototype has been in use at the Henderson Research Station School for over 12 months and during that time it has operated perfectly and has proved to be a very popular and heavily used installation. The design is protected by patent.

**A Simple Water Pump**

Wells are known to offer a very attractive alternative to river water and where they are functional can play an important part in preventing contact with infected waters. Wells are a very familiar feature in the Tribal Trust Lands, but unfortunately many of these are unprotected, and provide water of low quality. When wells are protected and fitted with standard hand pumps, water quality is often excellent and eagerly sought by the villagers. The standard hand pump is designed to pump water from wells 50 ft. or more in depth, a feature which necessitates the use of levers and water tight washers. These two parts, especially the lever, are very vulnerable to abuse if improperly maintained. A surprisingly large number of wells are shallow however, i.e. less than 20 ft. deep — and in cases such as these, experiments at the laboratory have shown that neither the leather nor the lever are essential to pump water to the surface.

A simple hand pump, designed at the laboratory, without levers or leathers, is now undergoing trials in field conditions. The pump uses standard water pipe fittings and consists of a piston made of PVC piping with a non-return valve fitted in it. The valve is attached to a water pipe which also acts as a pushrod. The piston and pushrod move up and down within a cylinder made of PVC piping with another non-return valve at the bottom. When the pushrod is forced down the lower valve
closes forcing water through the valve in the piston and up through the hollow pushrod to the surface. The cylinder is mounted in a concrete base on the slab covering the well. The force used to pump the water is directed down the line of the pump and not across it and these forces are buffered by the water itself.

![Diagram of Simple Water Pump]

Fig. 4.—Simple water pump.

All the valves can easily be removed and replaced if necessary from the surface in only a few minutes. Only a small part of the pump is situated above ground level which minimises abuse, a factor which is wise to anticipate in the design of sanitary hardware.

**Summary**

It has long been acknowledged that no programme of health improvement could be completely successful and long sustained unless the people themselves participated in the development. The WHO acknowledges that the promotion of health is linked with the promotion of social and economic endeavours in which even the most backward people must play their part. Bilharziasis, which is largely socially determined, might more rapidly come under control if community development was allowed to play a more important role. Most community leaders are aware of the advantages improvements in hygiene offer, especially if these improvements lie within the scope of the people themselves. For the simple villager, confrontation with more sophisticated technology, familiar to those who have grown up with it, represents a bewildering experience. In the quest for health improvement in the less developed nations, the need for simple technology is essential. By considering the villagers’ point of view, by providing less sophisticated but effective hardware that is easy to install, understand and maintain, the chances of success in drawing community interest and participation are far greater.

Some new designs are already stimulating considerable interest and even creating public demand. This is encouraging and certainly a step in the right direction for it demonstrates that research in this field can bear fruit. If simple low cost water supplies and latrines can be made sufficiently attractive to create public demand at the level of the villager, then the chances of sustained success in the prevention of bilharziasis and many other debilitating diseases are considerable.

**Acknowledgements**

Sincere thanks are due to Mr. Ivor Williams, Mr. Norman Johnstone, Mr. Ephraim Chimbunde and many other members of the research staff for their interest and encouragement. I wish to thank the Secretary for Health for permission to publish this article.

**References**