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SOME EMERGENCY ANTI-MALARIAL MEASURES

We have been using anti-malarial oil for so long that the possibility of there being a shortage of supply has come as a shock. Oil has been for many years *par excellence* our great standby in emergencies; even against mosquitoes which live in fast running streams. Until 1914 no one thought that oil could be used on streams, as it was believed that a permanent and unbroken film was necessary if mosquito larvæ were to be killed by oil, and obviously a permanent and unbroken film is unobtainable on running water.

In Malaya, research led to the discovery of a compound of oils which killed larvæ in running water by poisoning them, rather than by suffocating them which takes much longer to act. It was, in fact, the discovery of the perfect anti-malarial mixture. It proved of incalculable value to Malaya, in terms of thousands of lives and hundreds of thousands of pounds. One of the great advantages of oil is that within a few days every larvæ in an area can be destroyed, a large number of adults returning to lay their eggs are also destroyed, and those that do not alight on oiled backwaters and seepages have to travel a considerable distance before they can find a congenial oil-free breeding place. It would have been impossible to construct the Panama Canal without anti-malarial oil, as it would have been impossible to extend the rubber industry in Malaya as was done in so short a time without oil.

The War in the East, and the unlooked-for capture by the Japanese of the great Dutch oilfields like Tarakan, Balik Papan, Palembang and Langkat, the interruption of the oil supply from Burma, and the possible interference with oil supplies to East Africa from both Persia and the Western Hemisphere by Japanese warships in the Indian Ocean, has raised the question of what could be done in an area in which the control of malaria depends on an ample supply of anti-malarial oil, should that supply be reduced or cut off temporarily or permanently, during the War.

Apart from a total or partial interruption of the supply of oil to control mosquitoes, there is an urgent call to use as little oil as possible in order to conserve shipping space for oil required by engines and for other purposes for which no alternative to oil can be employed. It is the duty therefore of those who use anti-malarial oil to consider whether, at least for the duration of the War, an alternative method of controlling anopheline larvæ is possible. I am not suggesting that the alternative method should be used if it is so inferior to oil that an outbreak of malaria would follow its use. That would be poor economy, and unwise. But if the alternative can be effective, even for only a few months in the malarial season, and so save oil, its use would be fully justified and would contribute to winning the War. There are many different methods of controlling malaria apart from drainage and oiling. Some, like subsoil drainage and the growing of hedges, take money or time, or both.

In this note I propose to discuss more particularly, but briefly, the method of sluicing or flushing which has given valuable results in some places, and which there is reason to believe would give similar results in others.

SLUICING OR FLUSHING.

Although sluicing has been used in various places and at various dates in the past, it is without dispute the work of Professor K. B. Williamson, between 1930-32 at Cameron Highlands in Malaya, in destroying *A. maculatus* under extremely difficult conditions which demonstrated the value and efficiency of the method as a practical measure. The realisation in 1909 that *A. maculatus* could live in the steepest mountain streams despite the highest standard of what the planters call " clean weeding," i.e., removal of every blade of grass, presented the sanitarian in the tropics with perhaps the most difficult malarial problem which had yet confronted him. It meant not only the complete failure of drainage, which had been the recognized measure of destroying anopheles breeding in swamps, but that the drainage system itself had actually permitted one of the most dangerous malaria-carrying anopheles in the world to enter into places and streams where it had not previously been. Subsoil drainage of valleys, i.e., putting every seepage and stream underground in a valley scoured by tropical storms, requires time and money and skill. The oiling of running water had not yet been proved to be possible: although both measures were developed and widely used in Malaya within a few years with great advantage to the country. Sluicing or flushing came much later. From Malaya it has spread to Ceylon, North and South India, and undoubtedly it will spread all over the malarial world, tropical, semi-tropical and temperate, as its value is better understood. But like other anti-malarial measures it has its value and its limitations ; it cannot be used with success everywhere ; indeed, for success anywhere understanding is required.

The value of sluicing was proved at Cameron Highlands by Professor K. B. Williamson using simple forms of tippers and sluices. He proved it completely destroyed larvæ in every local drain and stream where it was used. After a time even the adult anopheles disappeared. He also showed the conditions required for success, which will be discussed later.

Following this work on Cameron Highlands, the method was next used in Penang. Praise must be given to Mr. J. S. De Villiers, Chief Sanitary Inspector, Penang, for his keen interest in the subject, and his invention, after many experiments, of a satisfactory automatic syphon for flushing streams (See Appendix).

When I visited Penang in 1937 I learned that close on 200 streams were being flushed along 15 miles of the hill which rises out of the centre of the island. I spent two days visiting streams in this area and saw many of the sluices in operation, some automatic and some hand-operated. Formerly, so malarial as to be only sparsely inhabited, this area had been practically freed from malaria; land values had gone up; and many people had moved into it especially along the north end of the island where the sea road rivals in beauty the Riviera.

In this work Mr. De Villiers had the strong support of Dr. Scharff, Dr. Faris, Dr. Eveson and Dr. Baez, who at various times held the appointment of Chief Health Officer, Penang Island.

Sluicing by Peasants.

One of the sights of special significance was the interest taken by the Malay peasants in the work. The photograph shows one of the many simple automatic sluices made by a Malay and used in his holding (Figs. 2*a* and 2*b*). Here, too, I saw the Malays packing subsidiary drains with grass and weeds and covering them over with the long coconut fronds. This measure, although temporary, in terms of months, cost the Malay no money, but little in labour, and was 100 per cent. successful. One old Malay, who for long had rather looked down his nose at the anti-malarial proceedings of his neighbours, became converted, and proudly showed me in a little hut open to the road an *anti-mosquito museum* which he had erected for the education of the public. The credit of starting this work among the Penang Malays belongs to Professor K. B. Williamson.* It has spread throughout the Malay Peninsula. During the last two years, through the personal interest of Mr. de Moubray, British Adviser of the State of Trengganu on the China Sea, it has become the official policy of that Government, and is being increasingly used. Its many advantages for the control of malaria in poor rural areas are obvious.

From Penang flushing has spread throughout the Malay Peninsula, not merely on mountain streams, but in almost flat-land drains where *A. maculatus* was breeding—*vide* Fig. 1.

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* Professor Williamson insists that the chief share of the credit for the successful propagation of this anti-malarial work among the peasants was due to the unflagging enthusiasm, ability and tact of his assistant, Mr. Mohamed Zain.

Ceylon.

Following a visit to Malaya, Dr. G. McDonald designed an automatic syphon incorporating the De Villiers syphon in the concrete dam. After various experiments, the syphon was standardised, so that when the dam was full a flush of 475 gallons per minute was delivered. The syphon was sold as a unit block at the price of Rs.25 each. In wider streams several were used in parallel. The syphon has not proved as useful in Ceylon as was expected ; not because of any inherent defect in itself, but because during droughts there was in many streams not enough water to fill the dam that operated the syphon. Where there was enough water the syphon, when properly installed, proved satisfactory. In Ceylon the malarial areas are those where the rainfall is below 100 inches per annum. But even in the areas with a higher normal precipitation drought sometimes comes, the rivers dry and pool, *A. culicifacies* begins to breed, and malaria soon appears. But when the rains begin again the mosquitoes disappear, and the danger is past.

South India.

On the western side of Southern India the malarial season is the pre-monsoon period, when the rivers are running at a slow speed, and are not flushed by rain storms. Once the monsoon breaks there is no need for any mosquito control of the streams. On a number of estates which I visited I saw a very simple way of sluicing the streams. It consisted of an earth dam with one or more oil drums, the ends of which had been removed, to form openings through the dam for releasing the flush. The upper end of the oil drum was closed by a sheet of wood until the dam was full. Then the wood was removed by hand and the stream was flushed. On one estate there were 60 of these dams across various streams, the largest of which was about 20 feet wide (see Fig. 3). The dams were operated in succession, beginning at the top. The fall in the malaria as the result of this simple procedure was remarkable indeed. The largest of these dams cost three rupees for labour. When the monsoon broke all the dams were swept away, but to replace them at the end of the rains cost only 60 rupees. Except for the wages of the two or three men who operated the sluices this was practically the whole cost of the control of malaria on this estate for the year. Nothing would have been gained by erecting concrete dams : they would have been merely so many obstructions during the torrential rains of the Western Ghats.

In South India I also saw many simple sluices made of wood, where the gate was lifted by hand out of the slit which held it (Fig. 4). These, too, were in earth dams, which were washed away when the floods came. The sluice gate was saved by being tethered to the bank by a wire. It is important that the sluices are water-tight, otherwise in drought not enough water is collected to flush the stream. It is also important that the flush should not exceed the amount of water in normal wet weather. If it does the banks of the stream are eroded. The quantity of water released depends on the size of the openings in the dam and capacity of the reservoir.

There were also very effective concrete dams, which flushed rocky streams 20 feet wide for fully a mile. The length flushed depended on the nature of the stream bed. Where the gradient was flat, and the bed full of large boulders, the flush was effective for a shorter distance. The sites of the dams should be the end of the flatter portions of the stream bed. In this position the dams will hold the maximum amount of water, and so will be most effective. Where, after flushing, larvæ are found lower down in a stream it indicates that another dam should be erected. Before building permanent dams it might be wiser in some places to begin with temporary earth dams. These would be a guide to the best sites for the dams, to the required capacity of the dams, and the results likely to be obtained by sluicing. Fig. 5 shows a type of dam in South India which has been giving satisfaction for a number of years. At one place where the river had an unusual number of obstructions and the desired results were not obtained, a special procedure was adopted. The gate was opened, and the dam half emptied. Then the gate was closed, the dam oiled, and after a short time the gate was reopened and the oiled water rushed down. This was effective in removing larvæ which previously managed to maintain themselves in this very rough stream bed.

North India.

In Assam, in Northern India, Mr. Lloyd, a tea planter, was, if my memory is correct, the first to use sluicing. He erected a series of dams in a ravine about 40 feet wide. The openings were controlled by sluices, as seen in the photograph (Fig. 6). What was a dangerous valley from the many seepages in its bed was effectively controlled by the dams and the sluicing.

Many new dams are now being erected in Northern India, in which an automatic sluice is incorporated in the concrete, like those designed by Dr. McDonald for Ceylon. But instead of a flush of 475 gallons per minute from each syphon, some sluices are designed to deliver four times this quantity of water (Fig. 7). They have to be constructed on the site, as the various pieces are too large to be cast at a central spot, as in Ceylon. But despite this want of mass production, they cost much less than a battery of the Ceylon type which would deliver the same amount of water. Another difference, as the result of the experience in Ceylon, is the incorporation of a hand-operated sluice gate in the dam, as well as the automatic syphon. This allows the débris and silt, which has collected in the dam, to be scoured out during heavy rains. It will probably be wise to incorporate a hand-operated sluice in all dams, along with automatic syphons ; so that if in a partial drought there was not enough water in the dam to operate the automatic sluices often enough, the stream might still be kept harmless by opening the hand sluices.

ROTTING VEGETATION.

When sluicing fails for want of water in the stream, and pools in its bed breed anopheles, like *A. culicifacies* in Ceylon or *A. gambiæ* in Africa, what can be done ? The most obvious answer is oil ; but that we want to avoid.

In 1910 I pointed out that several dangerous species of anopheles are not to be found in water where there is much rotting vegetable matter. In some places dangerous anopheles have been controlled in pools and ponds by throwing in cut *fresh green vegetation*. It seems to me that in places where there is likely to be a shortage of oil experiments should be made by some competent person, either the medical officer or the anti-malarial officer, to discover if in his area particular small pools could not be rendered harmless by such a simple measure. It may be that some harmless species of anopheles will come into the pool in place of the dangerous species, or more likely that some culex will come in. For even in the stinking water in which rubber has been soaked, or in cesspools, or in the black filth below the kitchen of a Malay house, mosquitoes of several species are to be found breeding. It is, however, the species of anopheles that counts, not just any mosquito. I mention this, even at so late a date, since this is not fully realized by everyone. Indeed, black and offensive filth is still regarded by some as a source of malaria ; whereas the fact is that all the dangerous species of anopheles that I know of avoid such places.

THE FAGGOT DRAIN.

I cannot remember just when the faggot drain was introduced : perhaps by the Romans. It is one of the lineage of covered drains, which were employed by the agriculturist, and developed into the special Malayan anti-malarial subsoil drainage system. On a mine in Africa I advised filling some drains with lengths of bamboos complete with leaves as they were cut from the trees. Drains so filled in 1932 I saw again in 1935 and 1939. They were running effectively, and had received no repairs or upkeep. They have also been used in many places in Malaya.

ANTI-MALARIAL HEDGES.

Many thousands of miles of drain are covered by hedges in India, in climatic conditions much like East and Central Africa : that is, in a country where there is a period of rain followed by about six months drought. These hedges have to be planted at the beginning of the rains and carefully tended. They do not become effective for about two years, so cannot be classed among the emergency measures for the War. There is little doubt, however, that they are suitable for many places in Africa. *Lantana* grows well in Africa, as it does in Assam, Ceylon, Malaya and elsewhere, and forms a good hedge. Those interested and skilled in garden growing might try the growing of a hedge in Central Africa over a drain 6 or 8 feet wide. There is one advantage in Africa: the absence of cattle so abundant in India and so destructive of hedges made of shrubs without thorns. For protection from cattle such hedges have to be fenced. Fig. 8 shows one over a central drain in a rice field. The central drain above was the danger: the actual rice-growing patch, although full of semi-stagnant water, is harmless. This picture was taken in Assam. We owe the development of the anti-malarial hedge, among other things, to Dr. G. C. Ramsay, whose great work for the prevention of malaria is not sufficiently known outside of India.

APPENDIX.

The following is a description of the simplest form of Automatic Syphon for anti-malarial sluicing invented by Mr. De Villiers and used in many streams on Penang Island.

The component parts are:—

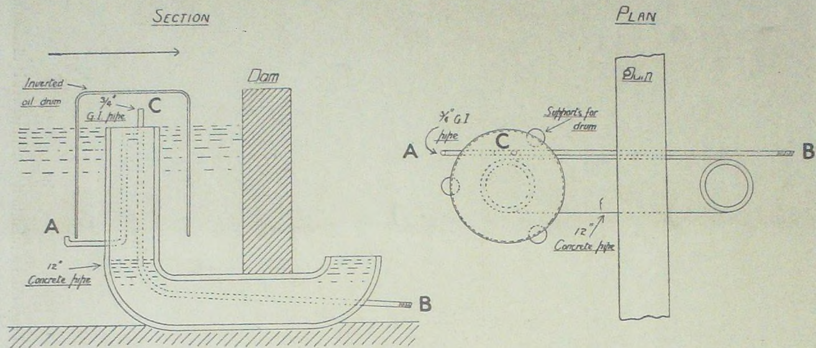
(1) An oil drum—which stands inverted on three concrete blocks.

(2) The main syphon made of concrete or earthenware pipes which runs under the dam.

(3) The secondary syphon consisting of ¾ inch galvanized iron pipe A.C.B.

When the water rises behind the dam it also rises inside the drum, because air passes out of the drum through B in the secondary syphon.

Before the water falls over the top of the main syphon some water will have entered at A in the secondary syphon and flowed out by the opening B. This water sucks air out of the drum through opening C, and reduces the air pressure in the drum. Water now splashes over into the main syphon; this leads to a still greater reduction in the air pressure inside the drum. Water and air have now commenced to flow from the outlet of the main syphon. Usually in less than a minute the main outlet is discharging a torrent of water which flushes the stream.



– Automatic Flushing Siphon De Villiers Type –

SEE APPENDIX.

FIG. 1. A de Villiers' Syphon on an estate drain in Malaya.

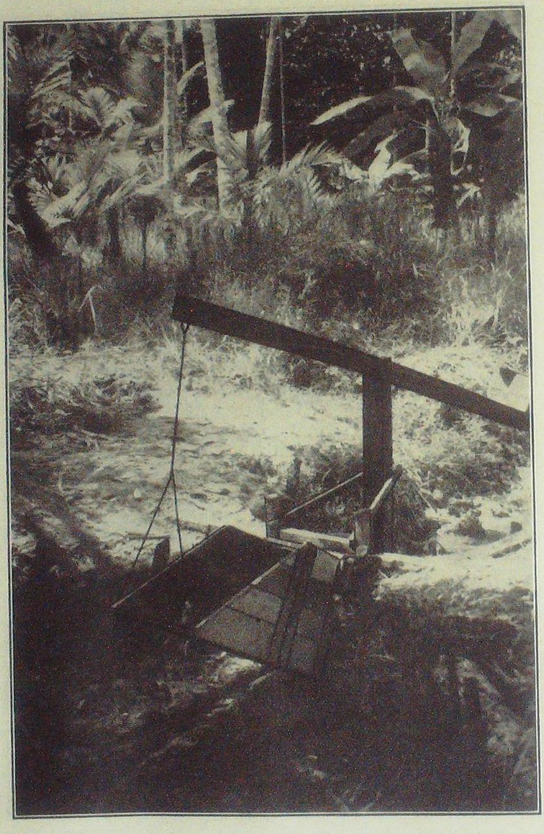
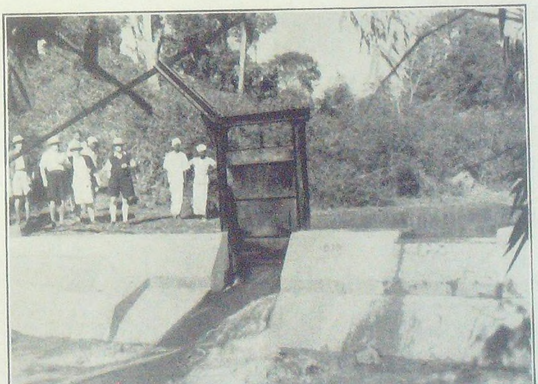


FIG. 2a. Automatic Anti-Malarial Sluice in a Malay garden. The tipper was hinged on a wooden roller like a ship's rudder. Two sheets of rubber made it water tight. Stones in the box balanced the tipper so that it discharged the water (Fig. 2b) at the desired height in the dam.

Fig. 2b.

FIG. 3. Hand-operated Sluices made with oil drums in South India.

FIG. 4. A Sluice made of wood, hand operated, South India.



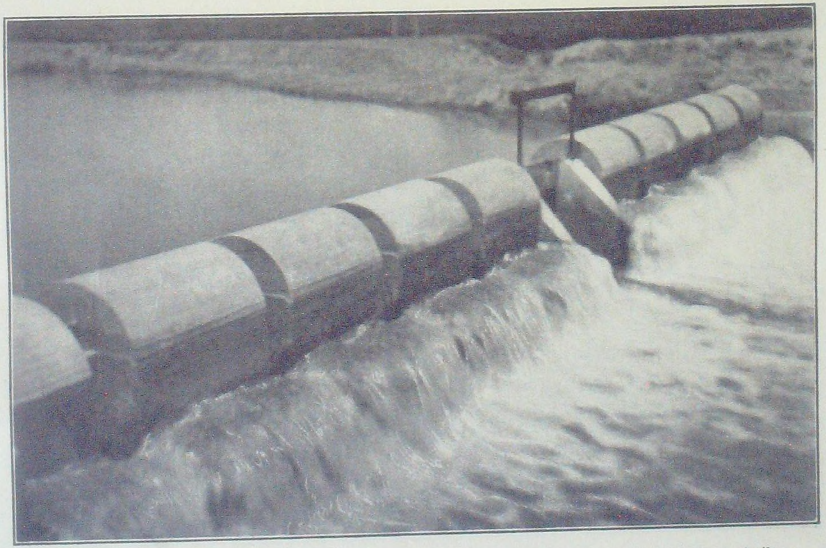


FIG. 7. A Battery of Automatic Syphons with one hand-operated gate clearing the dam of silt.

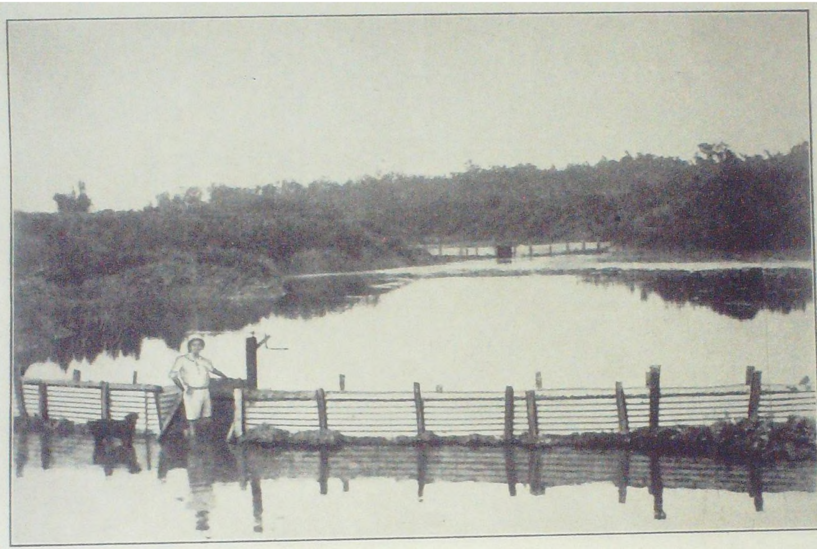


FIG. 6. Hand-operated Sluice erected by Mr. Lloyd in North India.

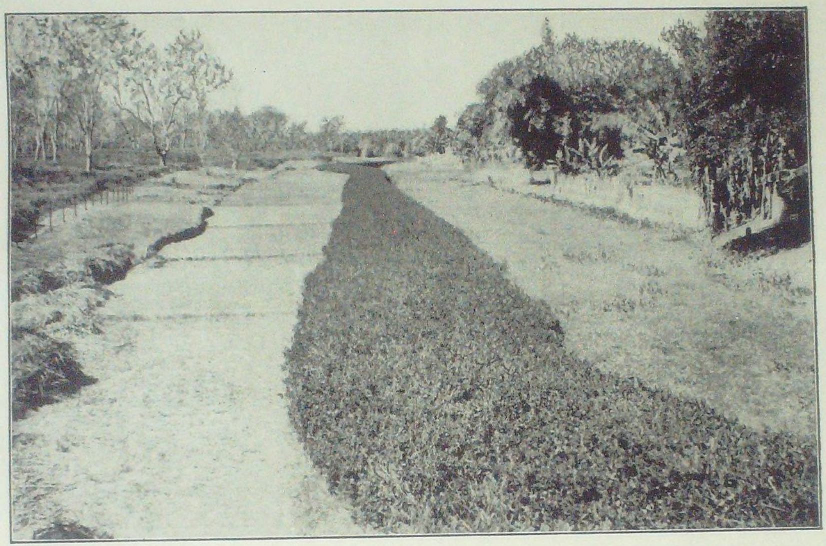


FIG. 8. An Anti-Malarial Hedge of Lantana in the central drain of a rice field in Northern India.