ANTI-MALARIAL WORK AT THE CENTRAL MENTAL HOSPITAL, TANJONG RAMBUTAN, MALAYA.

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THE subject of anti-malarial work in the tropics is one of paramount importance, but I am somewhat diffident in bringing such a subject before the Royal Medico-Psychological Association. However, if not of value, the paper may be of interest.

In dealing with anti-malarial work one can more or less confine one's attention to the anopheline mosquito. It is, however, advisable to deal with other varieties as well, since, though they do not carry malaria, they carry other diseases, for instance *Culex fatigans* carries filaria, and *Stegomyia* carries yellow fever. Fortunately, there is very little filaria in Malaya, and no yellow fever; but it has been found that *Stegomyia fasciata* carries dengue. Also with the opening up of fast new air routes, one has no guarantee that yellow fever will not be introduced into the country, and, seeing the large number of *stegomyia* there is in Malaya, the result would be disastrous.

However, when I first started drainage, it was as an anti-malarial measure pure and simple.

The breeding-grounds of the different mosquitoes vary. The anophelines prefer clear running water, so that they are found in the edges of small streams and in seepage. Again, the various species of anopheline differ in the stream they prefer. Some like open streams where there is plenty of light—*maculatus*, for instance, the most dangerous of the Malayan anopheline. Others, *e.g.*, *A. umbrosus*, prefer shady places—streams in light jungle.

It has been found by Strickland, late entomologist to the Federated Malay States, that if heavy jungle is undisturbed, the anophelines do not breed in it. Even in thick blukar they do not breed. The anophelines, however, are capable of changing their habits as *A. maculatus* has actually been found breeding in cisterns in Kuala Lumpar.

The *Culex* and *Stegomyia* prefer still water, and that frequently brackish—old tins, large leaves, neglected latex cups, coconut

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shells, etc.—so that it is up to the householder to see that nothing which will hold water is left lying about. However, even when the householder has done his best, there are still places where the mosquito can breed; *e.g.*, a badly fitted gutter which holds water for a few days after rain. For this reason I had all the gutters removed from the existing building, and refused to allow gutters on any of the new ones.

Some very large leaves hold water for an indefinite time. Holes in trees which are capable of holding water are also breeding-grounds. These holes can be filled up with cement.

From this it will be seen what a problem it is to deal with the mosquito.

When I first moved into Tanjong Rambutan, I found that rain-water from my quarters merely drained into a swampy stream at the foot of the small hill on which the house was built.

I was fortunate in persuading the P.W.D., although the budget for 1912 had already been sent in, to see the necessity for making a drain through this swamp, and they managed to get the work included in the 1912 estimates. Nevertheless, when they made the drain they did not cut it nearly deep enough, since they only aimed at draining the surface water and carrying it from the house to the river, instead of turning it loose in the swamp, as was previously done. Still, things were greatly improved.

I next began filling holes where water lay in spite of the drain, and then noticed seepage round the edge of the drain. I had no pipes and no money wherewith to buy them, so I had to find a substitute to remove the seepage.

We consumed, even in those days, a considerable amount of tinned milk, and the disposal of the tins was rather a problem, but the seepage provided a method of disposal.

I here made my first attempt at subsoiling, and dug small trenches above where the seepage first showed, to a depth of 4 or 5 in. below the top of the concrete drain. I then placed end to end rows of tins, the bottoms and tops of which had not been cut out, and thus did not collapse. The bottom row consisted of 4 tins, the next of 3, the top row of 2 tins, the gaps between the various rows forming the channel for the water. These tin subsoil-drains proved most efficient, and lasted for years. Of course, they would be only satisfactory where there was only a short distance with which to deal, and not too great a flow of water.

However, their cheapness was a recommendation, as Government was not anxious to vote money for this sort of thing to an amateur,

and the P.W.D. had so much other work to do that it could not be induced to ask for money to do anti-malarial drainage.

As things progressed and we opened up more and more land and our farms began to spread to distant parts of the reserve, which contains 573 acres, we were faced with new problems.

In 1914, when Horton farm was being built, I came up against the Sungei Bulat, which was a very swampy stream, in parts more swamp than stream, flowing right through the reserve from the railway line on the north-east to a neighbouring rubber estate on the south. After passing through the estate the stream again passed under the railway line, which I may explain is on three sides of us, and thence to the Kinta river.

If we built farms there it would be necessary to deal with the Sungei Bulat and its tributaries, of which there are five.

At first we merely cut a channel in which to confine the stream; this dried up a considerable part of the swamp. We cleared the bed of the stream through the estate as well as through our own reserve—a work for which the manager of the estate readily gave permission.

It was not long, however, before we discovered that the clearing of the bed of the stream was not sufficient, as, when rain-storms occurred—storms in which 2 in. of rain might fall in one hour—sand was washed down the stream, and the banks, if at all high, would be scoured out and collapse, with the result that in a very short time the stream would return to its old zig-zag, swampy course.

Something had to be done, so I decided to invert the stream with concrete inverts and slope and sod the banks. The next question was how to procure the money, as we had no vote for such work. The moulds for the inverts were made in the carpenter's shop, sand and metal were to be had on the reserve, but it would be necessary to buy cement. We managed to make a saving on one of our votes, known as "Equipment," and from this saving bought cement, and braved the audit department, which eventually found us out and queried the purchase.

However, this action of the audit department was a blessing in disguise, as it became necessary to ask Government for a vote to purchase cement. Fortunately, we could point to the work already done. By that time, too, people in authority had seen some of the inverts, with the result that Government approved a small vote which was sufficient for the purchase of all the cement we could use to satisfy our labour, which was wholly patient, save for the

attendants in charge of the working parties. As time went on the patients and attendants became quite adept at the work.

We began our inverted stream about six chains below our boundary. The method we followed was first to lay a concrete invert 2 ft. long by 1 ft. deep by 1 ft. wide, and having filled round this we laid a cement shelf 2 ft. wide, sloping slightly upwards, and outwards from the invert; outside each of these shelves we built a wall 6 in. in height. From the top of the wall the bank was sloped and sodded. We thus had a pilot drain with a storm channel, which, with the bank, would carry all the water that was likely, except in the heaviest rain, to travel down the stream. It must be mentioned that in the first place where the original stream was, we lowered the bed about 18 in. or 2 ft. Now we lowered the bed another 3 to 4 ft. It can thus be seen that the stream should drain the land well, and at the same time be deep enough to allow of subsoil pipes being put in when necessary. It may be of interest that, as we had no one to give us levels, we had to depend on a spirit level to get the fall.

Trouble was soon experienced along the banks, but it was easily dealt with by the tin method.

In places our cuttings were 10 ft. deep, so it can be seen that the work was heavy and tedious; nevertheless, it progressed steadily.

In the course of this first section we had to build a bridge to carry the road to Horton Farm and Highfield. This was done successfully to Mr. Ah Fatt's design. Those of you who read the paper I published some years ago on Tanjong Rambutan will remember the name of Mr. Ah Fatt, Inspector at the Central Mental Hospital and my right-hand man. This bridge is still in existence, and is carrying lorries.

All went well until 1925, when I went on leave. On my return I found that the work, instead of going ahead, had retrograded. I understand that there had been a very heavy rainy season, which impeded the work, but the chief trouble was that long sections of channel were cut at a time, and a large number of inverts put in before any attempt at dealing with the sloping and sodding of the banks was made. The result was that when heavy rains came the banks were undercut and collapsed, burying the inverts. Also, sand from the bank was washed down and buried the work already done. The net result was, that not only the section in hand, but part of the work that had been completed before I went on leave was buried.

I collected all the available working parties and put them on to clearing the inverts of sand. Fortunately the weather dried up just then, so we were able to get the sand removed, though it took us nearly three months. In places there were 3 ft. of silt over the inverts.

When the channel was clear, I gave strict orders that no more than six inverts (12 ft.) were to be laid at a time, and that the banks of each section should be sloped and sodded before another section was begun.

Previous to this we merely diverted the stream immediately above the spot where we were at work, but we now looked about for a possible diversion of a considerable length. A suitable channel was found; this was deepened, and a diversion of about a quarter of a mile was made. It was also necessary to take precautions against silt collecting in the new channel when heavy rain came. This was done by building a series of bunds across the stream in order to hold up the silt. These proved satisfactory so long as the spaces above the bunds were regularly emptied of silt.

On one occasion we had a very narrow escape from having a great part of our work undone. During a heavy downpour of rain the extern head attendant began to feel anxious about the bund which turned the stream into the diversion. He went to examine it, and found that it was giving way. He was just in time to collect a band of helpers, and by dint of piling up logs and bundles of lalang (coarse grass), they succeeded in saving the bund. Had the bund given way, six months' or possibly a year's work would have been undone.

As the work progressed we learned quite a number of things that we should not do, as well as the best way to do other things, and our attendants and patients became more and more expert at the work.

About this time Mr. Ah Fatt discovered a deposit of China clay in the reserve, not far from the Sungei Bulat. This was a great find, as we could now make porous pipes for subsoil drains. We built a kiln, and in a very short time were turning out subsoil pipes of 2 in., 4 in. and 6 in. diameter. Later we made 8-in. pipes. This enabled us to tackle some of the places which needed sub-soiling, and which were beyond the capacity of our milk-tin method.

For us 1925 was a bad year, as from then dates our worst malaria-producing spot.

When it was decided to build a first-class ward, considerable care was expended in the selection of the site. The Chief Secretary, the Principal Medical Officer and the Senior Health Officer tramped the reserve with me, and we decided on one. A mosquito survey was then made, and it was declared the chosen site was healthy. The only doubtful point was that a potentially dangerous ravine which was thickly grown with blukar lay within a furlong of the wards. This ravine was in a neighbouring estate, owned by a Chinese—a very good neighbour. As long as the ravine remained in thick blukar it was safe, so the owner of the estate was approached, and readily agreed not to interfere with it.

Unfortunately, in 1925 the estate was taken over by a British company, which promptly cleared and planted the ravine. Since then we have had endless trouble with malaria in the neighbourhood of the first-class wards.

This ravine was much too big a proposition for us to tackle, so the Public Works Department got out a plan and an estimate. Then a discussion arose as to whether Government or the estate should pay for the work, and as the point has not yet been decided, the fever goes on.

Now the work has been taken over by the Anti-Malarial Engineer, who, during all the years I had been at work, never visited the place. The Public Works Department's plan has been scrapped, and the Anti-Malarial Engineer's Department has begun again at the beginning making surveys.

Meanwhile we have carried on steadily. Early last year we completed the Sungei Bulat, while later in the year two of the tributaries were completed. In the tributaries we merely laid inverts, and sloped the banks without building a concrete storm channel. Having completed the inverting of the streams, we worked back along the banks and dealt with seepage by means of subsoil pipes. We also drained any persistently swampy places by subsoiling.

A difficulty found in some places was that we could not stop seepage where the banks consisted of very heavy clay. In such places, after digging the trench and laying in the pipes, we did not put back the clay which had been removed, but replaced it by stones, milk tins and sand.

A discovery made at about the same time was that if one wished to deal with seepage in a sloping bank, it was necessary to remove all dead stumps which happened to be buried in it. While dealing with a spot of obstinate seepage we found an old stump

buried in the bank below where the pipes were being put; a previous row of pipes had been a failure. We removed every trace of stumps, and every trace of seepage disappeared also. Now we make a point of looking out and removing all such old buried stumps.

Another point to remember is that even if pipes are buried sufficiently deep to avoid grass-roots, etc., they may get blocked by roots of trees. I have here a photograph of a mass of matted roots taken from a subsoil pipe. Trees are now cleared away for at least 20 ft. on each side of a line of subsoil pipes. It remains to be seen if even this is sufficient.

The work is now almost finished, and could be completed by our own labour in eighteen months to two years. It is rather amusing that the Anti-Malarial Engineer has now discovered there is work to do, and has decided to do it.

I should be distinctly annoyed were I remaining in Tanjong Rambutan, but, seeing that I am retiring, I am merely amused that the crown of the edifice should be erected by an expert on the foundation of an amateur.