MALARIA PREVENTION METHODS IN JAVA.

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BY MAJOR W. J. F. CRAIG,
Royal Army Medical Corps.

INTRODUCTORY.

The delegates attending this part of the course were seven in number. We arrived at Batavia on June 1, where we were met by Dr. R. Soesilo, the Director of the Malaria Prevention Bureau, Java, and Dr. J. L. Hydrick, of the Rockefeller Foundation, adviser in Public Health matters to the Government of the Netherlands East Indies. All arrangements for travelling, hotels, etc., were made for us very well and economically by Dr. Soesilo.

The course was very comprehensive and went far beyond the subject of malariology. We were shown museums, medical schools and hospitals, plague laboratories, vitamin manufacturing methods, cancer research laboratories, ruined temples, and so on. This was probably done partly to seize the opportunity of showing the medical work being carried out in the island to medical visitors from other countries, and partly to avoid undue repetition when showing us malaria prevention work. As some of us were engaged in Public Health work in addition to anti-malaria work, this was no hardship, but for the purpose of this report it will hardly be necessary to describe in detail these brief visits to various public health institutions.

While in Batavia our first visit was to the office of the Director of the Public Health Service (Dienst der Volksgezondheid—referred to generally as D.V.G.)—and the organization of this Service in the Island Empire was explained.

I was interested to learn that in connexion with this Service much use was made of the Army medical officers stationed in the Dutch East Indies. This Service, like our Indian Medical Service, is a full-time Colonial Service, and Army medical officers are seconded to the Public Health Service for two or three years at a time, and in many cases these officers are transferred entirely to the D.V.G. Native medical officers, if trained in Europe, may rise to the highest positions in the Service.

The Malaria Division is highly centralized and has its headquarters and research laboratory in Batavia. The well-known names of Schüffner, Swellengrebel and the late Professor Walch figure in the list of its past Directors. The headquarters sends out expert malaria officers and trained teams to epidemic districts anywhere in the island when they are called 17
for, and the results are co-ordinated at the head office. This system is probably the most efficient method at present possible for dealing with malaria outbreaks in such a widespread tropical colony.

On the same day a visit was paid to the Ethnographical Museum of Batavia, a semi-official institution of high repute. Sir Stamford Raffles, when Governor of Java, played a large part in the development of this museum, and although he was an enemy of the nation at present ruling the island, his name is still honoured by it there, and a bust of him stands in the Director's room. I shall not describe the many treasures gathered there, but amongst other things we saw a partly finished and very large relief map of Java on which the Director was engaged, and it may be convenient here to recapitulate the main facts about the population, climate and natural features of the island, all of which were being well brought out in this section of the museum.

In Java, with an area of 48,000 square miles, there is a population of some 42,000,000. The density of population is greater than in any other country in the world, and in a number of areas in mid-Java the density of population amounts to over 700 per square kilometre (i.e. over 2,000 per square mile). In this connexion it is, moreover, important to observe that the population of Java is essentially a rural one, there being only some half-a-dozen towns with a six-figure population.

It is clear, therefore, that, with a rural population of such an extreme density in a highly endemic malarial country, the anti-malaria measures adopted will differ from those taken in a thinly populated country such as Malaya, and this we find pretty generally to be the case.

The outstanding physical features of the island are the presence of over 150 volcanoes, although most of these are not now active, and the series of wide and open plains running along the length of the island at altitudes of 2,000 feet and over. Owing to its volcanic nature the soil is wonderfully fertile, and the high, well-watered plains are available for rice growing, providing the food necessary for such a large population.

In the coastal plains the temperature is like that of Malaya and runs from 80° to 90° F., while in the upland plains it is proportionately cooler. The rainfall generally is about one hundred inches per annum. There are two monsoons, in direction the exact reverse of those in Singapore. From November to March, the north-west monsoon blows steadily and brings a copious rainfall with it, while a south-east monsoon blows from May to October; this is a much drier wind than the other; inter-monsoon periods are marked by heavy showers of rain and thunderstorms.

Racially, the Javanese are, of course, of Malaysian stock and are a docile, tolerant, industrious people, and unhampered by fettering traditional customs, points of great importance in furthering the teaching of rural hygiene by propaganda, which the D.V.G. is now commencing to carry out on a large scale throughout the country.

While in Batavia a number of visits were paid to various institutions,
such as the medical college, the civil hospital and the vitamin B manufacturing laboratory. These places were of no special interest except the laboratory; this is the one originally used by Eyckmann who was the first man to detect the fact that fowls fed on polished rice grains developed neuritis while those on unpolished rice grains remained healthy. The plant in the place is still that devised by Eyckmann and is somewhat crude but efficient. Here tablets with a high vitamin B content are turned out by the thousand and are distributed free to areas whenever an outbreak of beri-beri occurs. This disease is common on the island and it is by this means that it is combated.

We next met together in Dr. Soesilo's own office, the headquarters of the Malaria Prevention Bureau, where he outlined the methods employed by his sub-department. Afterwards we visited various fish-ponds, villages, etc., in the neighbourhood of Batavia.

The anopheline mosquitoes found in the Netherland Indies make a formidable list, numbering thirty-eight in all. The dangerous species are principally:

1. *Anopheles sundaicus* (formerly known as *A. ludlowi*) which haunts the salt water fish ponds and the coastal swamps;
2. *A. maculatus* which, as in Malaya, is found in the inland hill ravines and in the streams, in rubber and tea estates;
3. *A. aconitus* in the wet rice fields; and
4. *A. hyrcanus*, varieties *nigerrima* and *sinensis*, have been lately incriminated in outbreaks in rice-field areas in Sumatra and Java.

The methods employed in dealing with these particular species will be described later. Of the four enumerated, Nos. 1 and 3 are the most dangerous, while No. 4 is the least harmful.

In investigating the extent of the infection of malaria in the human population of a district much use is made of spleen examination of the most susceptible element in the population, viz., children under three years of age. This method is obviously a great saving of time in such a dense population; it is supplemented by blood examination as much as possible. For estimating the degree of enlargement of the spleen Schüffner's method is generally employed.

By this method, a line (or imaginary line) is drawn along the left costal margin, and a second line parallel to the first is drawn through the umbilicus. A perpendicular is dropped from the left costal margin immediately below the nipple to the second line. The apex of an enlarged spleen roughly follows this line. This line divided into four gives four degrees of splenic enlargement. For grossly enlarged spleens a second perpendicular is dropped from the umbilicus and running parallel to the first across the lower right quadrant of the abdomen. By dividing this line into four degrees of gross splenic enlargement from five to eight can be readily ascertained, as the apex of the spleen in the course of progressive enlargement moves downwards towards the right. Enlarged spleens are numbered according to the section in which they are palpated (see fig. 1). By this
method the degree of enlargement recorded is proportionately the same for both children and adults.

According to the spleen rate as thus determined and the parasite rate in representative sections of the population, the malaria which occurs in a district is classified as follows:

(1) True Chronic Endemic Malaria.—In this type the spleen rate is very high both in children and adults and the number of greatly enlarged spleens is also very high in both, while the parasite rate is relatively low, particularly in the case of adults.

(2) Epidemic Superimposed on Chronic Endemic Malaria.—In this type the spleen rate in both children and adults is again high although great enlargement of the spleen is less marked, while the parasite rate is considerably higher, particularly in the case of the children.

(3) Acute Epidemic Malaria.—Here the spleen rate is low in both cases and the degree of splenic enlargement very low, while the parasite rate in both cases is very high.

The degree of splenic enlargement found in an investigation, a point which is somewhat stressed in the above classification, is also used in determining whether an anti-malaria campaign in a district has been efficacious to any extent or not. It happens sometimes that a district has a high spleen rate; then a campaign is instituted against malaria, and if after two years another investigation shows the spleen rate to be still high, it would appear that these particular methods have been of no avail. But
a careful examination may show that the number of greatly enlarged spleens was high in the first examination and low in the second, in which case a campaign may really have been successful to quite a degree.

The treatment of the civil population is, of course, still being carried out by the issue and administration of quinine tablets. Quinine is largely grown in the island and its manufacture is a Government monopoly. Tablets are issued free to districts where serious outbreaks occur. These tablets are coloured black to prevent their being sold illegally in the local market. Atebrin is on trial and though no official pronouncement on its value has yet been made, it is thought that it will prove to be probably a more valuable drug than quinine in the treatment of the disease, but it is not likely to replace the latter while its price remains at its present level.

**Anti-Larva Sanitation.**

The anti-larva measures employed in Java, as might be expected in a country which has been well cleared of jungle and which has a dense population, are for the most part on a large scale, and the elaborate sub-soil draining of small valleys as carried out in Malaya is not much in evidence here.

The two chief methods used are : The Engineering Method, and the Biological Control Method.

The Engineering Method, described by the late Professor Walch as "sanitation on a mechanical or hydraulic basis," is the method of choice for the coastal plain areas where river mouths get silted up and the stream is forced to deviate to the right or left and so brackish lagoons are formed which make ideal breeding grounds for *A. sundaicus*. At the larger river mouths there is usually a town and hitherto these sea-ports have suffered badly from malaria. The treatment by filling, draining, bunding, etc., is naturally expensive, but the Public Health Department is careful to obtain financial assistance from other departments in carrying out these schemes, and in this case the municipality concerned is only too willing to help and the Department of Roads and Waterways likewise gains in the end by giving financial assistance. The Chief Sanitary Engineer of the Health Department draws up the scheme in co-operation with other departments or bodies concerned. Such schemes are, of course, common to sea ports all over the tropical world and the expense is usually recovered later by the value of building sites formed on recovered land and, as in Java, by drawing rents from areas thereby made available for rice growing.

In Java the main problem to be dealt with in work of this nature is, as already mentioned, the silting up of the river mouths. Of the various methods used in dealing with this problem, the two which have proved most successful are the following :—

1. A river which does not carry enough water to keep its mouth open is connected with a neighbouring, more powerful, river by digging a canal
parallel to the coast line. This is the best means of dealing with the problem if considerations of distance makes such a course feasible.

(2) In the case of a small river with a sea port at its mouth, the river is diverted towards the harbour channel, which in the interests of navigation has to be kept open by dredging.

In the case of large sea ports such as Batavia and Sourabaya the methods devised have been drawn up to meet the local conditions and these particular schemes would not necessarily be generally applicable excepting in so far as the salt water fish-breeding ponds there form part of the problem. This matter is being dealt with separately elsewhere in this paper.

The methods used in the sea ports of Tegal, on the north coast, and Tjilatjap, on the south coast of Java, will be briefly described. Both are

![FIG 2.—Tjilatjap.—Low-lying creek filled and canalised.](image)

small sea ports of under 50,000 inhabitants and in both cases the spleen rate dropped from over 80 per cent to under 20 per cent after the work had been carried out.

In Tegal the river, which was liable to silting up, was led into the harbour which was dredged, and piers were constructed at the original mouth. The dangerous lagoons near the river mouth were filled in and certain other in-lying areas drained and filled. The whole work cost 400,000 guilders.

In Tjilatjap the river runs for some distance into the town near to and parallel with the seashore. The left bank on the seaward side is banked by fairly high sand-dunes. Previously the right bank was often subject to overflowing and so a large area of land was merely a useless brackish water swamp lying close to the town on the north side. For a long distance this bank was bunded, and just about the northern boundary of the town a
canal was made, running into the bunded river more or less at right angles. At the entrance of this canal into the river a strong tidal gate was constructed and closed for some hours each day against the incoming tide. This gate is worked by a workman who has a hut on the spot. Into the canal run irrigation channels from rice fields fed by another stream flowing from the north into this low-lying area enclosed between bund and canal. As a result of this scheme a dangerous swamp has been converted into a prosperous, rice-growing district and the expense of the scheme is being rapidly recovered in the form of rents and rice-tax.

While in Tjilatjap we were shown another and smaller system to the west of the town, unconnected with the above system, which had been dealt with by canalizing and filling. This was a mere creek, but as the town had spread the mangrove in the mouth of it had been cleared and it had become infected with A. sundaicus, and the houses on both banks had a spleen-rate of over 90 per cent and a high mortality rate. The banks were raised about four feet and canalized, and the sides sloped to an angle of forty-five degrees and faced with roughly-squared stone blocks found locally, without being pointed with cement. This method of treating the sides of an artificial channel is not recommended in Malaya, but it is very commonly adopted in Java and seems to work well there. It has the advantage of being cheaper than facing with concrete slabs, if suitable stone is available nearby. Then the ground on both banks was filled up to the level of the banks of the central channel by sand and mud taken from the harbour by dredgers and deposited there by them through pipes. By these means this bad area has been freed almost entirely from malaria.

THE ENGINEERING METHOD IN INLAND DISTRICTS.

During the course of our tour we were given the opportunity of studying the working of this type of anti-larva sanitation when on a visit to the Tjihea Plain, a rice-growing district in the West Java Plateau lying about half way between Bandoeng and Buitenzorg at an elevation of about 1,000 feet. The Tjihea Plain is a triangular area of land, about thirty square miles in extent, which lies between two rivers flowing north-west and north-east to their meeting place. The base of the triangle to the south is formed by the foothills of a mountain range. This area is part of the larger Tjiandjoer Plain, but up to the present only the sanitation of the Tjihea Plain has been completed. Three departments, viz. Health, Roads and Waterways, and Agriculture, combined in carrying out this project. On the original expenditure a return of 4½ per cent is being regularly obtained annually from a rice tax. The danger was the rice-field-loving A. aconitus, which thrives exceedingly in wet rice fields left lying fallow and neglected after the harvest.

The method adopted was to make a canal along the bottom of the slope of the foothills joining the two rivers, the difference of levels allowing this.
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The canal is twenty-four kilometres in length and has a capacity of seven cubic metres per second. This forms the primary irrigation system. On the canal, at intervals, are sluice gates, and leading northward into the plain from these there are a number of fairly large earth channels which form the secondary system of irrigation. From these the farmers dig their own small irrigation channels for their rice fields, thus forming the tertiary irrigation system. The Department of Roads and Waterways controls the issue of water.

The scheme was completed in 1904 as an agricultural scheme at a cost of nearly a million florins; at first, what had been previously an unfertile plain produced rich and abundant crops, but as no provision had been made for the draining off of superfluous water, and the farmers were left to manage their irrigation themselves, the plain soon became waterlogged, and malaria, which was not unknown before, became terribly severe; more and more of the malaria-stricken population deserted the plain and, as they left their fields neglected, malaria became worse and worse.

In 1920 onwards, therefore, the following measures were taken to improve this state of affairs:

(1) The drainage system was improved to facilitate the leading away of the irrigation water to its natural outlets in the two river courses at the sides and to the north of the area.

(2) The sides and beds of the grassy irrigation ditches and rice field fishponds were frequently cleaned at regular intervals.

(3) Planting of rice was allowed only once a year by all the people at the same time. Thus during the dry season no breeding of A. aconitus occurs.

(4) The Government established a large experimental farm in the lowest lying area in the centre of the plain, on which the above measures were very strictly enforced, and this served as a model for the district. Here, although rice was only planted once a year, the yield increased from eighteen to thirty-three quintals per hectare.

As some hardship is being experienced owing to the farmers being allowed to grow only one crop of rice a year, further experiments are being carried out to allow of their combining fish-breeding with rice-growing in the rice fields during the dry season.

From the health point of view the results obtained by these methods have been excellent.

Biological Control Methods.

By these methods the forces of Nature are utilized as allies in the war against the anopheline mosquito. For instance, sunshine kills algae which have been laid bare by draining off the water of ponds; plants with luxuriant foliage are used to shade streams in which the sunshine-loving larve of A. maculatus breed; larva-eating fish are put into ponds in which other fish are being bred for the food of the human population.
Naturally such methods are cheaper than expensive engineering schemes, and so, especially since the financial depression of 1929, it is these methods which anti-malaria experts in the Netherlands Indies are tending to develop more than others. But, even before this date, these methods were being forced on the consideration of the Health Authorities by the difficulty of dealing with anopheline larvae in the very numerous fish-breeding ponds, both salt and fresh water, which provide so many people with a living.

The danger in such ponds is the brackish-water breeding *A. sundaicus*, formerly erroneously known as *A. ludlowi*, a mosquito dreaded as much in Malaya as in the Netherlands Indies for its malaria carrying propensities.

Fish-breeding ponds are very numerous all around the coast of Java, the total acreage in the island amounting to 1,300,000 acres. They are especially numerous around Batavia and Sourabaya where the market for fish is great. The ponds are irregular in shape but usually rectangular. The depth of water in them is only about three feet and they ultimately drain into the sea through sluice gates; but when managed by the farmers themselves this drainage is usually inadequate and inefficient, and where there is a main channel draining into the sea, there is usually no lock at the sea end.

A start was actually made to treat these fish-pond systems by engineering methods, but the cost of this was soon found to be prohibitive because not only did these depressions have to be filled with earth and a system of drainage put in over the filled areas, but the owners had also to be compensated. Thus it is easy to understand how the area of 3,500 acres just to the north of the old town of Batavia which has been so successfully treated by the biological control method at a cost of 5,600,000 guilders, would have cost 26,000,000 guilders if treated by engineering methods as estimated.

The problem of draining these ponds is more simple at Sourabaya where there is a 10 ft. tide than at Batavia where there is only a 3 ft. tide. The method employed in treating these places is the so-called Pasoerœan method, from the place of that name in East Java. Actually this method, which I am about to describe in a little detail, is a combination of biological control with the engineering method and I shall take these separately, starting with the former.

When untreated these ponds are almost filled with a greyish-green or blue scum of a floating surface alga (*Enteromorpha*) which the farmers believe to be the food of the Bandeng, the fish which is bred for sale as food. This fish is a vegetarian and does not eat larvae. Larva-eating fish such as the *Haplochilus panchax* are usually present in the ponds; but they cannot get at the larvae, because their gills are caught in the filaments of the green algae under which larvae hide.

The Pasoerœan people found that the remedy for this state of affairs
was to feed the Bandeng on the blue "bottom algeae" (Cyanophycææ) which remains at the bottom of the pond and forms together with diatoms a muddy cream, at first light brown and later blue. Patches of the algeæ form a compact mass which cannot be penetrated by the larvæ. The algeæ is acceptable to the Bandeng whose true food, in fact, it forms.

To obtain the growth of the bottom algeæ and prevent the growth of the surface algeæ, the ponds have to be drained once a month for two or three days. During this time the sun's rays dry and kill the exposed surface algeæ, leaving them as a light brown or white powder. When the pond is freed from the surface algeæ, the pond is again drained periodically in order to promote the growth of the bottom algeæ; only a little water is left on the bottom, as the earth has to remain humid for some time if a rich growth of the blue algeæ is to be obtained. A ditch is dug around each pond into which the fish retire while the pond is empty.

The ponds are also stocked with Panchax, which are larva-eating fish, as well as Bandeng. If Panchax is not already present in the pond, the number of these fish put into the pond is at the rate of 115 per acre.

In brief, therefore, the principle of biological control used in these salt-water fishponds is as follows:

1. Bottom algeæ which grow in compact masses are substituted for loosely floating surface algeæ as food for the edible fish bred in these ponds.
2. The ponds are stocked with larva-eating fish.
3. If the surface algeæ threaten to reappear they are destroyed by draining off the water in the pond and drying such algeæ in the sun.

The engineering methods taken to supplement the biological control methods in Batavia are as follows:

1. All the fish ponds lying between the parallel lines of the drainage channels are made a regular rectangular shape. To allow of this being done it has been necessary to buy a certain number of the ponds. This the Government has done, and since the improvement these ponds bring a return of 2½ per cent per annum by being rented out.
2. A certain amount of filling has been necessary for levelling purposes.
3. A system of channels and sluice-gates has been made to enable a whole area to be drained dry at the time of the monthly spring tides. This system includes large concrete sluice-gates at the sea outlet of the main channel of the system which is level to the outlet. There are also openings at the mouths of the subsidiary channels, and each pond has a sluice-gate with two openings, each one metre wide.

**THE TREATMENT OF FRESH WATER FISH PONDS BY BIOLOGICAL CONTROL METHODS.**

The problem of dealing with these ponds, although essentially the same, differed in a number of respects. Treatment by filling and draining the areas was again impossible owing to the high cost and the necessity for compensation.
The most dangerous mosquito was *A. aconitus*, but a number of others, such as *A. barbirostus* and *A. philipinensis*, were also present.

The fish previously bred in these ponds were *Cyprinus carpio*, the large gold fish, and the gorami (*Osphromenus olfax*). These fish do not feed on the water plants naturally found growing in the ponds, but are fed by the pond owners with papaya leaves, rice waste, etc. Thus, the mosquito larvae could hide amongst the leaves of the aquatic plants and so come to maturity unscathed. So, on the advice of Mr. Reyntjes, a fishery expert, a fish called the Tawes (*Punctius javanicus*), which incidentally makes good eating but which feeds voraciously on the submerged aquatic plants, was introduced into these ponds and where the fish are in sufficient numbers the vegetation in the ponds soon disappears completely.

The larva-eating Panchax now gets his chance and together with a fresh-water fish called the *Lesbistes reticulatus* feeds on the mosquito larvae.

Thus the method of biological control used in this case is as follows:—

Three types of fish are stocked into the ponds: (1) The gorami and the goldfish are bred for the pot; (2) the Tawes feeds on the water plants; and (3) the Panchax and the *L. reticulatus* feed on the mosquito larvae.

The method is as yet new, but it seems to be entirely successful.

THE SHADING OF STREAMS BY PLANTS AS A BIOLOGICAL CONTROL METHOD.

The method of planting the banks of small streams in hilly districts did not originate in Java as it was used first in Assam; but we were given the opportunity of seeing it put into practice in the course of a visit to the tea and rubber estate of Tjitalahab near Soekaboemi in West Java.

The purpose of this procedure is to prevent the breeding of the larvae of *A. maculatus*, which breeds in the clear water of hill streams and needs sunshine for its development. In this estate, which employed a large number of coolies, thirteen kilometres of stream bed had been planted with the ordinary marigold (*Thitonia diverfolia*) and in these streams, where the larvae of *A. maculatus*, which is our most dangerous carrier of malaria in Malaya, used to breed plentifully, they cannot now be found.

The cost of the treatment was stated by the manager of the estate to be 4 cents for twelve feet or only about 20 dollars a mile. This is a ridiculously low cost compared with the subsoil-drainage methods in Malaya and so the treatment seems entitled to serious consideration.

The procedure is exceedingly simple. Cuttings a few inches in length are taken from the growing marigold plants, care being taken to cut aslant, and these cuttings are simply pushed into the soft ground root-side downwards about one foot apart along the edge of the stream in one or several rows. In the course of twelve months they have grown to a height of six feet and their luxuriant foliage completely prevents the sunshine from reaching the stream.
The manager has also experimented with other plants for places where
the valleys had broadened out and were swampy. Of these, two species
of acacia, viz: Cassia multijuga and C. alata are the best, but as they are
trees, sunshine can penetrate between the trunks and so they are not so
good as the marigold which is only a shrub. The C. alata, which has very
large leaves, is the better of the two.

This experiment, which was carried out almost entirely by the manager
of the estate himself, was not supported by figures which might have
afforded evidence of the value of the method, as the estate was isolated
and was only visited by the Health Officer at intervals, but I think there
is no reason to disbelieve the assurance that malaria is now very much
less and larvae are difficult to find.

The employment of this method in Malaya would seem to offer
possibilities which should not be ignored, but as I was inclined to suspect,
Dr. Scharff, the Chief Health Officer, has informed me that the marigold
does not grow so luxuriantly in the soil of Malaya as it does in Java.
But there is no reason why other plants should not be tried, for the banks
of jungle streams in Malaya are covered with a vegetation which is very
dense, and I am sure that botanical experts, if consulted on the subject,
would not be lacking in suggestions.

The method is open to one objection which it was possible to recog­
nize on the spot, and that is that the shade has to be broken wherever
a path crosses the stream. This might be a serious objection, but in
practice it seemed not to be so. It is perhaps not a method on which
great reliance should be placed, but from an Army point of view I think
it would be suitable for valleys in the neighbourhood of outlying posts,
batteries, etc., which are occupied only once or twice a year, or which
are only lightly manned.

CULTURE OF CINCHONA AND THE MANUFACTURE OF QUININE.

This practically completes the account of the course in Java dealing
directly with the subject of malaria and its prevention. But as quite a
number of days during the tour were devoted to the culture of cinchona
trees a brief account of this work in the Netherland Indies is given.

While in Bandoeng we paid a visit to the Government quinine planta­
tion at Tjiniroean, a large estate about 5,000 feet up in the hills to the south
of the Bandoeng Plain. Although there are 120 quinine estates in all, this
is the only Government one, but here all the experimental and research
work in connexion with the subject is carried out.

The most striking feature observed on this visit was the profitable use
made of plant grafting. The two chief trees grown in order to obtain
the quinine-containing bark are the succirubra and the ledgeriana. The
former is a hardy tree, but its bark contains only about 2 per cent of
quinine. The latter is a delicate tree with a bark containing up to 14 per
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percent of quinine. So cuttings of young ledgeriana trees are grafted on to young succirubra trees just above the root, and after the graft has successfully taken, the remaining stem of the succirubra is cut off, and then we have the valuable but delicate ledgeriana tree growing on a succirubra root, and so remaining healthy in spite of temporary unsuitability of soil, or adverse weather conditions, etc. Another strong impression made was the work of the Javanese girls sorting out the seeds. As these seeds are sold on a guarantee that the bark of trees grown from them will contain so much quinine, great care must be taken in the sorting. To see flaws in the seeds an untrained person would almost require a microscope, but these sharp-eyed girls with a feather in their deft fingers pick out the good seeds unerringly on frosted glass slabs lit from beneath in the darkened room.

The stripping of the bark is carried out very simply by tapping lightly with a wooden hammer; the various processes used in preparing the bark for sending to the factory call for no special note.

The manufacture of quinine in its medicinal forms is carried out in a large factory at Bandoeng and this is entirely a Government monopoly. A visit was also paid to this place and we were most courteously shown the various processes employed in the manufacture of quinine by the Director and his staff.