FIVE YEARS OF ANTI-MALARIA WORK AT BARWADIH RAILWAY SETTLEMENT

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General.—Barwadih, a railway settlement on the Gomoh-Sone East Bank branch of East Indian Railway, is 18 miles south-west of Daltonganj. It is situated 348 miles west of Calcutta in the hilly tracts of the Ranchi plateau in the Palamau district of Bihar province. The range of hills to the south of the colony is a branch of the Vindhyas.

Physical geography and meteorological data.—Latitude 23.5°, longitude 85°, elevation 900 to 1,800 feet, temperature maximum 108° to 118°, minimum 38° to 32°F., humidity varies from 15 to 20 in the hot weather to 90 during the monsoon. The subsoil water rises from 4 to 6 feet during the monsoon as compared to the summer level of 26 to 30 feet. The humidity of soil is at its height during the four months of the rains. It falls very low in late winter and summer and often rises a little in the early part of spring. The winds are westerly and north-westerly in summer and winter and purely easterly—full of moisture and heat—in the monsoon.

Rainfall.—Average 50 inches in a year, four-fifths of which fall during the monsoon and half of it in July and August and a few showers in winter. Malaria infection and its manifestations always begin three to four weeks after the initial fall of rain. Early and heavy rains used definitely to mean an early and heavy infection but since adequate anti-malaria measures have been taken at Barwadih the increase in rainfall has no adverse effect on the rate and intensity of infection as the comparison of the figures for 1934, 1935 and 1936 shows. The rainfall was 51.74, 36.04 and 60.07 inches respectively but the heavy showers in 1936 did not bring the intensity of 1933 and the malaria figures continued to go down.

Table to show that rainfall has no effect on malaria in a well-controlled area

	Year		
	1934	1935	1936
Rainfall in inches	51.74	36.04	60.07
Malaria sickness (new cases).	130	103	101

Telluric conditions.—The soil is porous of 'Morrum' variety interspersed with rock. On the south is a range of hills rising from 500 to 700 feet high, densely wooded. The foothills are covered with light jungle. The open spaces between the hills are under rice cultivation. There are collections of water shaded with overgrowth, bowers of shrubbery and branches of trees.

Site of the railway colony.—The level of the highland at the foothill drops from 50 to 100 feet at places to a plot of land 1½ miles in length east-west and ¼ to ½ mile in breadth north-south. This is the site of the railway colony.

On the north are swamps, cultivated lands and *bustees.* On the west are low-lying land, culverts, a high embankment, swamps, rice fields and a few villages.

Natural drainage.—Natural drainage of the area is by two hill streams. One a fairly big one running east to west about half a mile in front of the station joins with the smaller one on the north-west which in turn drains into the Koel river, three miles west of Barwadih, in the bed of which the storage wells and pumping station for the water supply of Barwadih are located.

Malaria.—According to Christopher's malaria map of India, Barwadih lies in a region known for 'moderate to high endemicity of more or less static character, the intensity depending on local surroundings'. The following description will show how adverse local conditions made it a hyperendemic place :—

The area was originally under rice and maize cultivation having big bunds for catchment and shallow ponds for storage of water for the fields. On the Central India Coalfields railway acquiring the land for construction of a railway line, abandoned and neglected fields and ponds became shallow pools and swamps with weeds and tall grass which served as excellent breeding places for mosquitoes; these found ideal conditions for the primary meal of blood necessary for the oviposition in the large staff of labourers who were engaged upon the construction of the line, and who were living under conditions that made them readily accessible to biting insects by night or day.

After the construction work was over a chain of borrow-pits, excavated land and dilapidated old *kutcha* buildings occupied by the construction staff were left behind and added to the already existing breeding places.

When the East Indian Railway took over the section for working in 1929, we were faced with the problem of housing our staff in one of the most unhealthy parts of the country.

The normal balance of infection was so materially changed by this that malaria broke out in epidemic form in 1930; over 95 per cent of our railway population at this station was found to be infected, the parasitic index was 78 and the splenic index was 95, and Barwadih was rapidly becoming uninhabitable. This state of affairs roused all departments of the railway and within 5 years the parasitic index fell from 76 to 0.7, the splenic index from 95 to 0.5 and

the malaria sickness from 676.9 to 99.5 per mille. The method by which this most satisfactory result was obtained is best described in its two stages, first in 1931 to 1934 when the measures taken were inadequate and spasmodic, and 1934 to 1936 when scientific organization and control was instituted against this disease.

In 1931 the anti-malaria campaign was started in Barwadih, jungle was cleaned, filling of hollows was started, dilapidated buildings were demolished and anti-larval measures were undertaken, a rough malaria survey was performed and the chief enemy was discovered to be *A. culicifacies;* an interesting experiment was also tried this year in the form of 'blanketing' with quinine and plasmochin. The results were encouraging, the splenic index coming down from 95 to 50, the parasitic index from 72 to 24 and the sickness from malaria from 677 to 280 per mille.

In 1932 there was cessation of activity, with the result that the parasitic index rose from 24 to 48 and the sickness from malaria increased from 280 to 445 per mille. The inactivity of this year and its results were a striking object-lesson of the danger of even a temporary cessation of preventive work in a highly endemic area.

In 1933 work started again much on the same lines as in 1931 with the difference that atebrin was first used in treatment, the work of draining the station was continued together with the filling up of low-lying areas, and in October it was decided to 'blanket' with atebrin and plasmochin. Every man, woman and child in the railway colony received a full curative dose of atebrin followed by a full course of plasmochin. This was most thoroughly done by an experienced assistant medical officer and it is in striking contrast to the 'blanketing' supervised later (1937) by an officer who had no experience in this work. The parasitic index was taken before the 'blanketing' and found to be 48, the splenic index was 47, afterwards the parasitic index fell to 6 and the splenic index to 26, the sickness from malaria dropped from 445 to 231 per mille.

In 1934 the second stage of the work started, it was now realized that the measures taken before had been based on most inadequate data, the result of surveys undertaken by inexperienced men, and that it was impossible to expect any permanent benefit from measures founded on such an unsatisfactory basis. Most unfortunately the ignorance even of members of our own profession regarding the cause of malaria adversely affected the results; a statement was made by one of the doctors in charge of the anti-malaria work that 'it is my firm conviction that unless something is immediately done to supply the staff with good filtered water no amount of money spent on any other anti-malaria measures have any chance of success'. As a result of this much time was wasted and much money was spent in the improvement of what was not at all an intrinsically bad water supply.

The measures now undertaken included a survey by experts, the establishment of a laboratory on the spot and expert advice from the School of Tropical Medicine, Calcutta, and the Malaria Research Institute, Kasauli. I will now detail the results of these measures.

Survey.—(1) A general survey of the colony, surrounding land and villages was done by Dr. Strickland and myself. We found that large-scale operations for filling were not necessary as it was possible to drain every inch of low-lying ground. Indiscriminate deforestation was stopped until the possibility of the existence of sun-breeders, such as *A. maculatus,* could be negatived.

(2) A detailed survey was carried out and sectional maps showing the minutest details were prepared. Taking the railway quarters as a centre an inner circle with a quarter-mile radius and an outer circle with a half-mile radius were drawn. Each circle was divided into four quadrants and each quadrant into four sections. All the breeding places found in the colony and half a mile outside it were separately numbered and shown on the sectional maps. Control maps showed various treatments that those breeding places received monthly. Weekly, fortnightly, monthly and annual reports of the work done were submitted regularly.

(3) The splenic index of children under the age of 10 years, in the colony and the surrounding villages, was taken. The estimate of the parasitic index of outsiders could not be taken.

(4) Barwadih had gained such a notoriety for loneliness and bad climate that it was not easy to keep a trained staff for the specialized work there. The first laboratory assistant resigned within 7 days, the second left in 6 weeks and the third is now working. The malaria inspector resigned in 2 months and was persuaded to come back but resigned after 18 months. The new man is still at work.

Engineering.—Most of the filling and levelling operations were done in 1934 before the detailed survey in August. A large tank on the west of the station was filled, subsoil water drains were constructed and thousands of feet of *kutcha* and *pucca* drains were made so that in 1936 there were over twelve thousand feet of excellent *pucca* drain.

Field work—anti-larval measures

Each man in charge of a section started from the centre of his section and systematically treated every breeding place in it. Small holes were filled in, drains were cleaned, such levelling as was necessary was performed and low shrubs, tall grass and jungle were cleared whenever necessary.

Paris green.—We use the 'Genexco' mixer for mixing paris green and soap-stone powder. We have a small measure for paris green and a large

one for soap-stone so made that even a coolie could make a correct mixture.

(2) We made some interesting experiments with Hoyle's and Britway paris green and found 1 per cent mixture of Hoyle's paris green quite sufficient for our work. Britway was not found so efficacious.

(3) 'Junior Savage Duster' was found very handy for small streams, drains and ditches. 'Smith Broadway Duster' and 'Mysto Rotary Blower' both were found very useful for large collections of water. With a few demonstrations and strict supervision in the beginning the coolies are handling these instruments very efficiently.

(4) We found the limitation of paris green distribution during the monsoon. Every fresh shower destroys the film of powder and it is not so efficient as oiling. We therefore rely more on oiling than paris green when the monsoon is very active.

Note.—Two of our coolies at Tatanagar had arsenical dermatitis of the hands due to careless handling in the mixing of paris green with soap-stone. With the 'Genexco' mixer we have had no such accident for the last three years.

Oiling.—We used hydrocarbon, crude oil and crude naphtha till 1935 and it killed larvæ both culicine and anopheline in 48 to 72 hours. In 1936 we used 'Killsall' with crude oil 1 in 20. The effect was excellent. Within one hour the mature larvæ were destroyed and an examination of the treated place after 24 hours showed not a single larvæ alive there. We have found 'Misto Pneumatic Sprayer' for oil a very useful and economical apparatus. It can be handled easily by one man for hours without fatigue. It leaves one hand free and effects great economy in the use of oil.

Anti-mosquito measures

(1) *Spraying of houses with insecticide.*—Tall grass and jungle that grow round the quarters are cut. This deprives mosquitoes of their natural hiding places and they take refuge in the quarters. The trained malaria staff then go to the quarters and efficiently deal with them by closing the rooms and spraying Hick's insecticide. This kills 20 per cent of the mosquitoes outright and makes the rest of them unconscious. After a quarter of an hour dead and dying mosquitoes are collected and destroyed. The trouble of entering *purdah* houses is overcome by appointing a female coolie for the job.

(2) *Railway carriages.*—Railway carriages temporarily stabled at Barwadih were found to become very good hiding places for mosquitoes. They were specially found under the seats. It is worth keeping in mind that railway carriages are one of the means of conveying mosquitoes from one station to another which may be hundreds of miles away. Steps were taken at Barwadih to see that carriages coming in or going out neither became a shelter nor means of conveying mosquitoes to and from Barwadih and other stations on the line.

(3) *Running rooms.*—The running rooms are all provided with mosquito-proof wire gauze doors and windows with automatically closing hinges. Mosquito nets are also provided for guards, drivers and running men stopping at Barwadih for the night. The employees and their families are all advised to use mosquito nets in their houses.

(4) *Propaganda.*—Propaganda work has also been done to teach people the habits of mosquitoes, the danger that they carry and how to deal with them and their breeding places individually.

Methods of check on the work.—(1) A check on the efficiency of anti-larval measures was made by daily collections of anopheline larvæ from water collections in the area, counting the catches, hatching them out and identifying them. The places where anopheline larvæ were found received daily attention till free and then the usual weekly attention was all that was needed. All these operations were marked on newly-made sectional maps.

(2) A check on the anti-mosquito measures was made by counting the systematic daily catches from the houses and comparing them with the successive ones. If results were unsatisfactory extensive search was made for any undetected breeding place around the quarters.

(3) A general check on the work was done by comparing the results of our catches in the colony with those of our daily catches from the huts of the surrounding villages and *bustees* adjacent to our colony.

Malaria and laboratory work.—Having a well-equipped laboratory and an efficient laboratory assistant we could do systematic and scientific work of identification and dissection of mosquitoes and recording of parasitic index. From 1931 to 1934 we did not even know the actual carrier of malaria of the locality nor could we prove the existence or absence of a sun-breeder on which the planning of the nature of our field work depended to a great extent.

Collection of larvæ and mosquitoes (1935 *and* 1936)

Adults.—There were two catches a day, one in the morning and one in the evening, from the colony and from the surrounding *bustees*. To make a comparative study the *bustee* catches were of great benefit. Eleven *bustees* surrounding the colony were taken into consideration, from each a daily catch would come. Catches were taken one after another in order. Total catches from the colony and the *bustees* were 40,011 out of which about 1,500 were hatched from larvæ. The variation in the incidence month by month was recorded and is interesting and instructive.

Larvæ.—Larvæ were caught from all known varieties of breeding places within and outside the colony, hatched out and identified. No

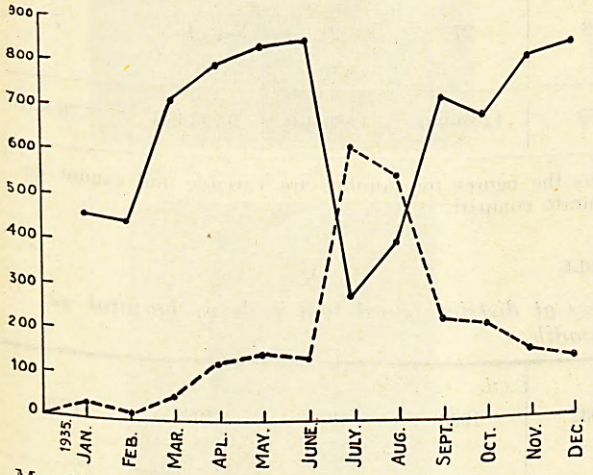
larvæ were found in the colony from April to June and in November and December.

Identification.—There were 13 varieties of anopheline found from adult catches and ten from hatched-out ones. Five of them were dangerous, three of doubtful nature and the rest non-carriers. The highest incidence is of *A. culicifacies* and next comes *A. rossi.*

Anopheline fauna of Barwadih

Dangerous type	Doubtful type	Non-carriers
1. *A. culicifacies.*	1. *A. annularis.*	1. *A. rossi.*
2. *A. funestus.*	2. *A. maculipalpis.*	2. *A. vagus.*
3. *A. stephensi.*	3. *A. pallidus.*	3. *A. theobaldi.*
4. *A. maculatus.*		4. *A. hyrcanus.*
5. *A. listoni.*		5. *A. jeyporiensis.*

The monthly incidence of the local carrier is illustrated in the accompanying graph :—



Monthly incidence of *A. culicifacies* (local carrier)——
Monthly incidence of *A. rossi* – – – – –

Anopheline fauna of Barwadih

Sun-breeders.—The possibility of the existence of sun-breeders such as *A. maculatus, A. listoni* or *A. minimus* in a montane or submontane region is very great. Deforestation in such regions has been known to have caused a severe epidemic of malaria in an otherwise endemic area. They breed in open spaces against which jungle and shade are the best remedies. Hill rivers, such as we have on the north, which swell during rains leaving pools of water in their beds, hill streams and springs among rocks, as we have at the foot of the hill on the south, and collections of water which have no marginal vegetation are all potential sources of *A. maculatus.* We were alive to the danger and took precautions to guard against it till in 1935 we caught *A. maculatus.* An extensive search was made and we hatched out a few larvæ and thus detected breeding places in the colony and outside and adequately dealt with them.

Dissection.—We dissected dangerous and doubtful varieties and when time permitted a few non-carriers as well. In 1935 after dissecting 5,355 mosquitoes we found sporozoites in *A. culicifacies* from the morning catch within the colony on 26th August, 1935. A month later another *A. culicifacies* from an evening catch from the Karia *bustee* outside the colony was found positive. The total number dissected was 20,138 out of which only two *A. culicifacies* were found positive in 1935 and none in 1936.

Parasitic index.—This was recorded twice a year in March and September through examination of the blood of almost all the healthy persons in the colony. A monthly record of all the cases examined was also kept.

Splenic index.—Separate records of the enlargement of the spleen in children below 10 and of persons above 10 years of age were kept. The splenic index given in this paper is of children below 10 years.

Blood slides of patients.—The blood of all the fever cases was examined. The blood of positive cases was taken every day to note the effect of the remedies on the disappearance of parasites from the blood. The blood was also examined at the end of quinine or atebrin treatment to see if gametocytes persisted and whether a course of plasmochin was indicated or not.

Clinical control.—Man is a reservoir of malaria. Mosquitoes are only carriers. The treatment of infected cases is therefore as important as the destruction of mosquitoes. We have very comfortable indoor accommodation to treat malaria cases in the hospital and have an efficient organization immediately to detect, diagnose and treat the cases occurring anywhere in the colony.

We tried various modes and combinations for administering quinine, atebrin and plasmochin and tonics in an attempt to cut down the actual sick days and recuperation time, and achieved great success. We reduced the days of fever from 10 to 5 and then to 3 and recuperation time from 7.5 to 4.5 days. The question of carriers from amongst the sick was dealt with by examining their blood and if gametocytes were found by giving a course of plasmochin.

Results

(1) We found the local carrier *A. culicifacies* by actual dissection.

(2) We found the sun-breeder *A. maculatus.*

(3) We reduced the number of sick days due to malaria as well as to all other diseases. The parasitic index dropped from 26.5 in 1933 to 0.7 in 1935; splenic index from 26 to 6, total malaria sickness from 231.5 to 99.5 per mille and sick days lost due to malaria from 3,059 to 1,179.

(4) The table below gives all the figures from 1930 to 1936 including the cost of all the operations except the engineering work :—

TABLE

Showing the results obtained by anti-malaria work at Barwadih

Particulars	1930	1931	1932	1933	1934	1935	1936
Strength of staff ..	195	200	200	203	207	219	231
Rainfall in inches ..	51.31	54.61	49.22	53.55	51.74	36.04	60.07
Sickness due to malaria (staff only).	665	618	346	185	130	103	101
Sick days lost due to malaria.	5,643	3,162	3,059	1,696	1,476	1,278	1,179
Sickness due to all diseases.	880	353	536	344	343	338	296
Sick days lost due to all diseases.	6,506	4,675	5,024	3,511	3,478	3,479	3,090
Splenic index (children under 10 years).	95	72	47	26	18	7	6
Parasitic index (taken in health).	72	24	48	27	21	1	7
Cost of operation Rs.	*Nil*	1,561-7-0	*Nil*	1,089-9-0	4,889-4-0	5,743-6-0	5,770-8-0

Note.—The figures given are for the employees only as the figures for families are variable and cannot be relied upon for accurate comparison.

TABLE

Showing comparative figures of malaria sickness at district board and railway hospital at Barwadih

Particulars	1930	1931	1932	1933	1934	1935	1936
District board dispensary	564	573	511	457	711	710	829
Railway colony ..	585	311	346	185	130	103	101

Just outside our colony is a district board dispensary. Cases from neighbouring villages are treated at this dispensary. The figures of malaria and all other diseases treated there year to year as compared to ours are illuminating. Their figures remain practically constant, inclining, if at all, to an increase while we reduced our malaria incidence by 84 per cent and total sickness by 54 per cent in 5 years.

I am much indebted to Dr. F. E. R. Laborda, Chief Medical Officer, E. B. Railway, for his valuable help in the preparation of this paper. I also wish to show my appreciation for the excellent records kept by my colleague Dr. J. R. Bhatia, Divisional Medical Officer in charge, Barwadih, from 1931 to 1934. My thanks are due to Dr. S. C. Chatterjee, Chief Medical Officer, E. I. Railway, for his permission to publish this report.

A CASE OF MONILIASIS WITH A SECONDARY ALLERGIC PATCH OR 'MONILIIDE'

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(From the Medical Mycology Inquiry, Calcutta School of Tropical Medicine under the Indian Research Fund Association)

A HINDU aged 20 years had suffered from extensive ulceration of the vulva and vagina for the last eight years. She had had various unspecified treatments by different doctors with periodical improvement and remission but was never cured. Two years ago she had a child and since then the disease has become much worse. She was of average build but looked miserable and ill on account of her suffering.

Besides the vulvo-vaginitis there were lesions between the toes and a depigmented patch of exfoliation on the back of the right arm.