CHAPTER 7

MALARIAL AFTERMATH

(a) MILNE BAY AFTER THE ACTION

THE history of Milne Force after its aggressive defence action against the Japanese, and its military commitments are significant in relation to its malarial experiences. The successful conclusion to the action at Milne Bay did not lift the menace of malaria from the troops in the area. The building of a safe defence organisation was essential, and this could not be done without learning to adapt the pattern of living as a military formation to an equally sound hygienic organisation. In this self-contained place these problems were worked out. One battle had been won against the Japanese; another was nearly lost, against the malarial plasmodium and its vector. Milne Bay provided a classic lesson in malaria prevention, and though an exactly similar situation was never repeated during the war, the lesson remained for the instruction of those who would learn from its practical demonstration of the causes and prevention of epidemic malaria.

The cessation of organised resistance by the Japanese allowed the defending forces a breathing space. At least there was no military enemy to contend with at the moment, but there was still the hostility of nature.

MEDICAL ARRANGEMENTS

In the medical planning for Milne Bay there had of necessity been some extemporisation, but there had also been some discussion about the most practical type of medical unit to use as a hospital in the area. Though a field ambulance can act as a holding unit, it is only a temporary expedient, yet there were logistic difficulties in bringing in a general hospital or a C.C.S. with their added weight of equipment. Even a 200-bed hospital would soon have to expand to hold 500 to 600 patients. Nevertheless the decision to move the 2/1st C.C.S. to Milne Bay was wise, in spite of local difficulties, though it was agreed that the time was not apt for bringing in female nurses.

On the 8th September Lieut-Colonel R. J. Stabback and the staff of the 2/1st C.C.S. had to land their gear and stores in implacable weather, when vehicles were bogged along the roads and all but the higher ground was flooded. Specially made cases protected some of their contents, but not all, and a week passed before tentage and other material could be brought to the unit's temporary site in a rubber plantation. Even then it was hard to keep stores dry; other units had found that when mud was used to camouflage tents moulds were introduced, causing rapid deterioration of the canvas with consequent leakage. Moulds also caused mosquito nets to rot, so that the fabric tore easily, and the nets soon became useless. On the 21st, 210 beds were equipped and 175 occupied,

but two orderlies already had malaria. Much of the equipment was still in an inaccessible dump three miles away; this increased difficulties, especially as the bed state soon rose to 200 patients. By the end of the month more of the staff were going down with malaria and flood rains again inundated the low-lying part of the camp.

The 110th C.C.S. was still working on a temporary site, and needed a brief period of relief in which the unit could move to its correct location. The A.D.M.S., Colonel Maitland, therefore intended to substitute the 2/1st C.C.S. for the 110th while this change was made. This could not easily be done, for the rush of battle casualties was being more than replaced by a spate of illness, chiefly malaria. The strain on the forward companies of the 11th and 2/5th Field Ambulances was at least partly lifted, and the A.D.S. at Gili Gili was able to move west of the Hagita ford, when the 18th Brigade also moved back in reserve. The work of Major J. J. Ryan of the 11th Field Ambulance and Major Lavarack of the 2/5th Field Ambulance was specially commended by the A.D.M.S. Maitland himself had worked under great difficulties, being without a deputy until the end of August, when Whiting was sent to act temporarily, until later replaced by Major J. R. Magarey.

There was a great shortage of staff officers in the A.A.M.C. at this time; in fact Major-General S. R. Burston had pointed out that too many requests were made for officers to fill such posts as D.A.D.M.S. of the new areas and sub-areas that were coming into being with the expansion and dispersion of the Australian Army. Some of these requests simply could not be granted, though this in no way applied to Milne Bay. At first Maitland had no office facilities; practicable transport was sometimes lacking and personal inspection and supervision were hard to maintain.

The 110th C.C.S. was able on the 15th to transfer eighty patients to the M.D.Ss. in the Waigani area, but a few days later, though the weather was fine, the roads to both ambulance units and to the 2/1st C.C.S. were closed to traffic. Figures showed that 1,462 cases of malaria had passed through the medical units since the arrival of the force, and when the D.D.M.S., Brigadier Johnston, revisited Milne Bay on the 23rd he agreed that many of these men needed help towards convalescence rather than hospital attention. A convalescent depot had become a necessity.

Fortunately, though malignant tertian was the prevailing type of malaria, most attacks were mild owing probably to the use of suppressive quinine; nevertheless another death (the second) had occurred from cerebral malaria. One-sixth of the force had contracted malaria within two months. Now that the tension of action was lessened the sense of personal responsibility was slackening; the members of the force were even less malaria-conscious. A local shortage of quinine, atebrin and plasmoquine caused some passing worry at this time: promised supplies lagged, in spite of confirmatory signals from Moresby, but the much wanted quinine arrived just in time to maintain suppression in the force. There were still grave shortages of anti-malarial equipment.

Necessary engineering work was to be carried out, particularly on the site selected for a convalescent depot on the eastern side of the Maiwara River, and on the road of access to the new site of the 110th C.C.S. There was still a present danger of such work increasing the possible breeding grounds for mosquitoes. As the rainfall abated these hazards actually increased. Further, gametocytes, the transmissible sexual stage of the parasite, were rapidly forming a "pool", both in the native labour force, which was making contacts with the soldiers in greater numbers, and in the blood of the soldiers themselves. As malarial diagnosis became more exact with growing facilities and experience, so the true position became more evident. The unidentified pyrexias, and the cases of alleged dengue fever were in truth malaria. Captain A. K. Sewell of the 110th C.C.S. had established a small laboratory and found that using the technique of thick films with Field's stain, parasites could be demonstrated in half the cases submitted, and in 70 to 80 per cent of those in which malaria was suspected. By contrast, another unit using thin films only, could find parasites in 10 per cent of cases of fever.

Unit malaria squads were formed, and arrangements were made for these to be trained by the 8th Australian Malarial Control Unit. Captain F. H. S. Roberts of the 1st Mobile Entomological Unit arrived to help Captain S. L. W. Allman in the work being done by his 8th A.M.C.U. Allman drew up a list of measures suggested for immediate application as part of the planning for malaria control. This stated that survey of the area had shown that anophelines bred freely within unit lines in semi-permanent collections of water, particularly slit trenches and old wheel tracks. All these needed treatment with sump oil. Filling in all unused tracks and instituting a consistent track discipline were also advised. Drains were to be kept free, trenches sprayed daily as well as tents, and protective clothing worn to reduce risk of infection. Maitland reported to the commander of Milne Force that the malarial figures were too high, and that breaches of instructions were occurring. These included non-use of nets, the failure to wear slacks and gaiters and to roll the shirt sleeves down after sunset. The missing malaria pamphlets at last arrived from Moresby and were welcomed as part of the campaign.

The general problem of hygiene was worrying in Milne Bay. The action against the Japanese had come at a time when the units barely had time to scramble to their locations, and the physical difficulties of the area were great. Sanitation offered problems; latrines constructed on low ground could not be deepened sufficiently without running into the water table, and were readily swamped. Water supplies were liable to pollution, and though there had been only a few cases of mild dysentery, an outbreak was possible. The supplies of chlorinating chemicals were deficient, and no sodium thiosulphate had been obtained for detasting. In consequence the super-chlorinated water was so unpalatable that the men would not drink it. Individual outfits for water-bottles were not available, nor were there any clarifying filters. The A.D.M.S. pointed out that the risks of pollution of water would be greater as the wet season

receded. He was also perturbed that changes incident on the complete reorganisation of the hygiene system of the army had come just at this time of shortages of men and material. Captain G. H. McQueen had arrived to take up the post of D.A.D.H. on 6th September, but no hygiene personnel had been appointed for attachment to units in the 18th Brigade, or to the other services. Maitland had to fill the gap by appointing men outside the brigade to be used in this capacity. Moreover, no provision had been made for a constructional section, such as was previously so useful in a field hygiene section for making and advising on sanitary appliances. Later, when the rain eased, central water points were set up, and the clearer water needed only a small amount of chlorine without detasting.

Nutrition was given some consideration. Naturally during the previous month or so most food came out of tins, and Maitland applied for tablets of ascorbic acid for general use.

During September scrub (mite-borne) typhus appeared in the force. At the beginning of the month, and perhaps earlier, this infection was suspected, and by the middle of the month its clinical identity was established. It is interesting that both in Milne Bay and Moresby scrub typhus was independently recognised as occurring at the same time. Serological tests in both areas established the identity of this rickettsial infection without doubt, as the blood serum agglutinated *B. proteus OXK*. On the 20th when there were 759 patients in medical units in Milne Bay forty of these had typhus. In all, 103 cases of scrub typhus were treated in the 110th C.C.S. in Milne Bay with only one death.

Milne Bay was well served by dental officers, and following the visit of the A.D.M.S. (Dental) New Guinea Force to the area on the 16th, Major H. S. Sullivan was appointed as D.A.D.M.S. (Dental), and set up in Hagita House; one dental unit acted as a mobile dental centre, so that the battalions might be visited in turn, and work be done there as well as on the patients passing through medical units.

During October the position regarding malaria showed no improvement. The military strength was increasing, particularly when the 17th Brigade brought in its advance groups, followed by its other components. The average strength of Milne Force rose from 10,617 in September to 13,296 in October, and the numbers were then still rising. But there was no decrease in the numbers of sick, although there was no appreciable wastage from battle casualties. The menace of the Japanese had virtually disappeared in the Milne Bay area. At several outposts on the north coast Australian forces were maintained, but these were not involved in major actions. It seemed that the present issue with the enemy was to be decided in the coastal plains behind Buna and Gona, and that the forces in Milne Bay would be sufficient to keep it safe from further invasion. The outposts were subject to the same hazards of disease as Milne Bay itself, but they constituted no serious problem as their numbers were low. Milne Bay was, however, of strategic importance, and it was in danger of losing its garrison from malaria. There was little dysentery there; typhus was not

severe or serious, and most of the patients were sent away if possible. Evacuations to the mainland approached the equivalent of two battalions a month, and there were good reasons for believing that the majority of Milne Force was infected with malaria, M.T. or B.T. or both.

A disturbing feature of the sick rates in Milne Force was the high proportion of members of the A.A.M.C. who were ill; admittedly their work exposed them to infection, especially at night, but this increased the already embarrassing shortages of medical officers and orderlies. Still more disturbing was the observation that medical units which previously had a reasonably low malarial rate were beginning to show a definite rise.

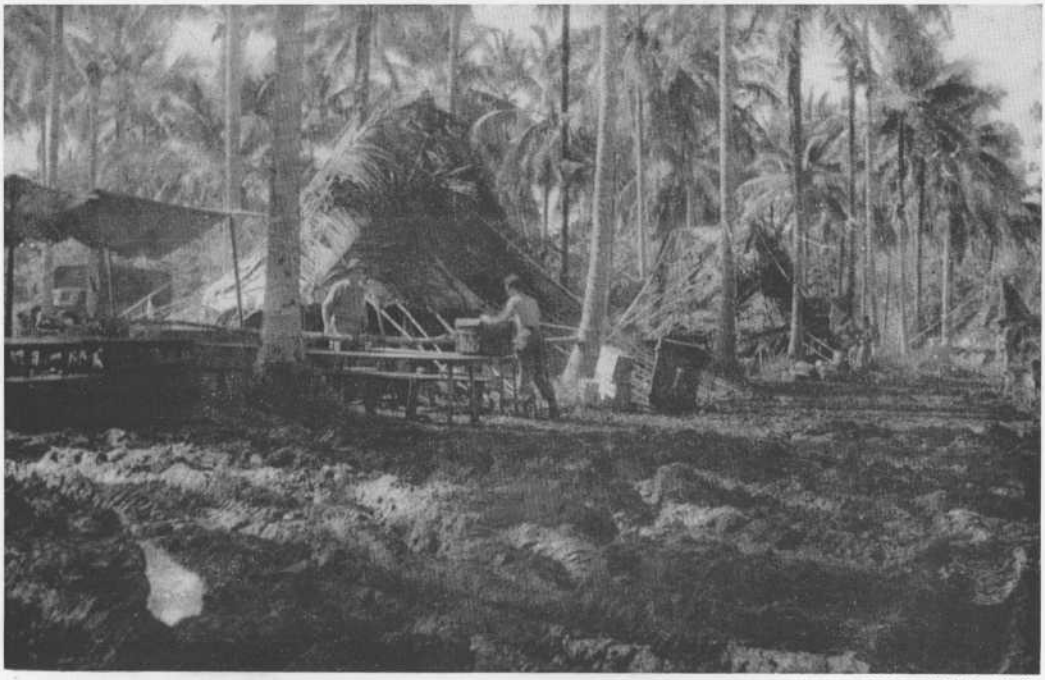
On the 27th the 2/2nd Field Ambulance arrived at Milne Bay under command of Lieut-Colonel R. S. Smibert, and in pursuance of its function with the 17th Brigade, began to establish an M.D.S. with its "B" Company and an advanced station with its "A" Company. The M.D.S. was established in tents slung over poles bolted to trees, and proved airy and capacious. Smibert's staff had experiences similar to those of others. Malaria attacked members of the unit; one orderly who had omitted to take suppressive quinine during the first week contracted malaria after eleven days in the area. The opportunity was taken to send some orderlies to relieve in the 110th C.C.S., where they gained valuable experience. A medical officer was also detailed to the north-eastern posts at Wedau and Taupota.

Medical officers at once began to study malarial diagnosis in the laboratory of the 110th C.C.S. which relinquished its old site on the 14th. Using E.P.I.P. tents and marquees Wall's unit was soon in full swing again, and on the 21st had 274 in hospital. By the end of the month difficulties with the uncompleted road to the site and with water supplies had partly been overcome, and more native huts were being built to accommodate the growing numbers, which reached 321 by the end of October. The 2/1st C.C.S. was still receiving a few casualties from outposts; one was found to have gas gangrene. Troubles with water were still being experienced: Stabback's unit actually built a dam to conserve water from the neighbouring creek, but the dam gave way and all the water was lost.

In anticipation of the opening of the convalescent depot, and to obviate the loss of too many men to the mainland, the numbers sent from the C.C.Ss. by hospital ship were lessened; this rather increased the strain on the units in Milne Bay. From the malarial as well as from the military point of view Milne Bay was mainly a self-contained community. It is therefore interesting to study the rapid rise in malarial incidence which is evident in the accompanying graph. The first indications of an acute outbreak have been described in general terms, and were seen in September and October, but the next month showed that rapid rise to a sharp peak so highly characteristic of the epidemic form of malaria. In this were combined many causes, little-controlled anopheline breeding, rapid increase in adult mosquito population, propinquity and increase of a "pool" of gametocytes in natives and soldiers, inadequate suppression, and

(Colonel F. L. Wall)

The staging camp of the 110th C.C.S. at Gili Gili

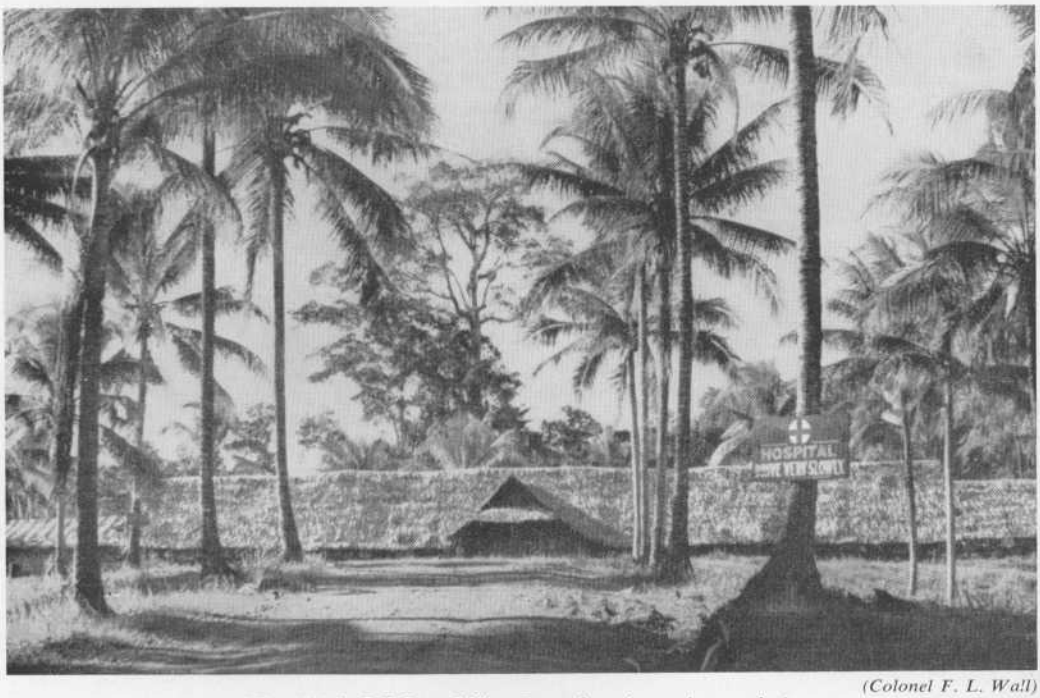


(Colonel F. L. Wall)

The 110th C.C.S. at Milne Bay during the action period.

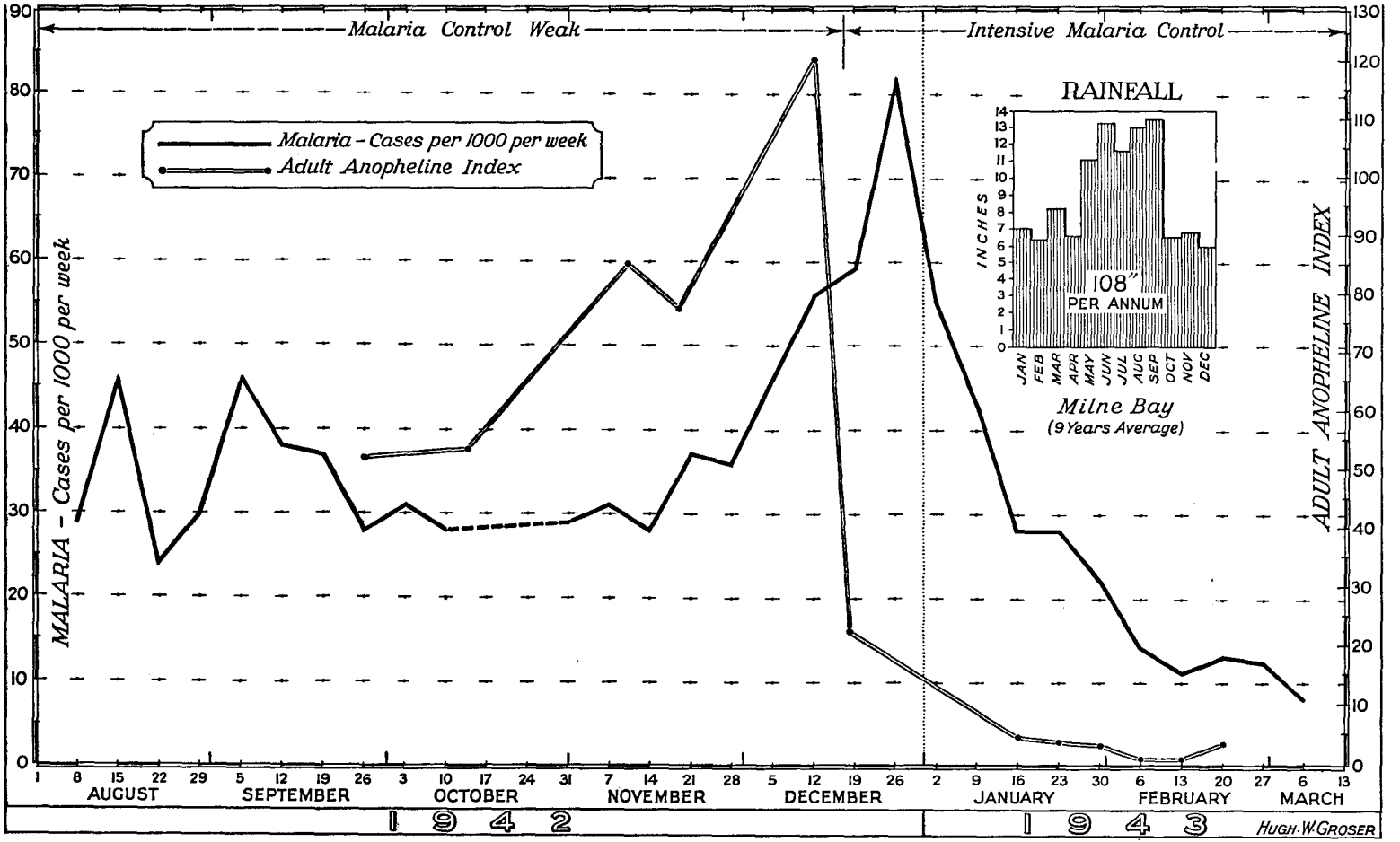
(Colonel F. L. Wall)

Malaria control Milne Bay.



(Colonel F. L. Wall)

The 110th C.C.S. at Milne Bay after the action period.



Milne Bay: malaria in 1942-1943

inadequate personal protection. Even in the base hospitals in Australia enquiry among patients showed that control needed to be tightened in endemic areas. The D.G.M.S. reported that consulting physicians had obtained evidence from patients transferred from New Guinea that anti-malarial precautions were being poorly implemented by combatant officers. This applied to Milne Bay as well as to other areas, though in justice it must be remembered that adequate anti-malarial supplies had not yet reached that area, a riddle not yet solved.

ADVANCES IN MALARIA CONTROL

It was evident to experienced administrators that measures of several kinds were needed; those designed to secure regular supply of material and stores for anti-malarial work, the provision of manpower for essential work and the establishment and maintenance of a discipline which springs from a true conviction of its need and importance. An important step was taken when Major R. C. Townley was sent from Land Headquarters in Melbourne to investigate questions of supply. The establishment of a properly constituted advanced depot of medical stores was needed in order to remove most of existing local difficulties, and once a flow of materials was assured these troubles were adjusted. Townley investigated the cause of delays on the mainland and found that indented stores had arrived in Townsville, but these were stowed in sheds where they were discovered only after several months. Faulty handling by movement control and docks' operating units, and lack of sufficient precautions in marking had caused this delay. Improved methods were introduced, and direct indents from Milne Force to Land Headquarters were advised.

On the scientific side administrative improvements in the malaria control units increased the efficiency with which preventive methods were applied, and the creation of entomological sections was followed by the setting up of a directorate of entomology under Mackerras, who had been in charge of entomological work at Land Headquarters since May 1942. He was sent to Milne Bay to make special investigations and to supervise the entomological side of the work.

Administrative assistance was given to the force by the coordinating work of the Advanced Land Headquarters at Brisbane, where the A.D.M.S. was Colonel A. L. Dawkins. Evacuations of the sick and allotment and delivery of supplies were accelerated by the Combined Operational Service Command, to which Lieut-Colonel Macdonald as A.D.M.S. was the Australian medical representative.

Brigadier Johnston next took the direct step of enlisting the personal help of the Commander-in-Chief. Lieut-Colonel Ford, the Assistant Director of Pathology to New Guinea Force, a highly experienced malariologist, though not yet officially appointed as such, interviewed General Blamey at the beginning of December, and placed the position before him. Blamey not only showed sympathetic interest in this appeal, but also ordered an official report of the interview to be prepared and took immediate action on certain vital matters.

The main points in this discussion were concisely stated in the war diary of the D.D.M.S. New Guinea Force for 4th December:

(a) That there was no deep consciousness in the force that malaria could destroy it as a fighting body and bring disaster to its operations. It was basically necessary that this should be understood by all ranks.
(b) That the malaria discipline was bad, and imperilled the success of our arms.
(c) That it was necessary that officers should realise their responsibility in regard to malaria discipline, and the order should be observed in every detail. No officer was fit to command in a hyperendemic malarial area who did not realise the menace of malaria, and take every step to combat it.
(d) The importance of personal protection was stressed as the most important means of malarial prevention in the field, and defaults and omissions in carrying out the orders in regard to this were quoted.
(e) Suppressive quinine treatment—its importance in maintaining troops in the field and the necessity for care and speed in distribution, necessity for priority in transport and anti-malarial drugs.
(f) Preparation of troops for tropical service—supply of mosquito nets before embarkation—important to be able to commence protective measures immediately on arrival.
(g) The alarming position as regards casualties at Milne Bay, and the steps considered necessary to overcome it, were discussed.

Ford emphasised that malaria could destroy our force as an effective instrument and that as the heavily malarious areas recently occupied by our soldiers were characteristic of many in Melanesia, these should be vital training grounds where they could learn how to fight in the tropics in relative safety. Nets should be available to them immediately they arrived in endemic areas, and their use ensured.

In Milne Bay anophelines were breeding over forty square miles of the area; engineering work was urgently needed for drainage and elimination of breeding grounds. Most of the malaria control unit's material was not yet to hand several months after the arrival of the unit; there was pressing need for this, and also for more assistance from unit squads and malaria control units, and from the personal collaboration of an engineer and an entomologist. At least 1,000 men were needed to make Milne Bay safe, and adequate supplies of nets, sprays and other requisites were wanted urgently. This reasoned appeal produced immediate action by direction of Blamey.

Native labour was made available, and 500 men were immediately set to work on drainage and similar work. In the middle of December Captain C. Brasher arrived with the 2/2nd Malaria Control Unit, and following up Townley's investigations, made a special visit to the mainland and was successful in bringing back a plane load of anti-malarial material. This was promptly put to use under expert supervision. At the same time the 17th Brigade was moved to Moresby, preparatory to attachment to Kanga Force; this relieved the pressure on medical units in Milne Bay.

Some weeks passed before the full effect of adequate and generally applied anti-malarial measures was felt, but this period was a crucial one in the fight against malaria in Milne Bay. During the month of December

the strain on the 2/1st C.C.S. was somewhat eased by the transfer of 255 patients to the mainland by sea ambulance transport. Half of the staff of this unit had already contracted malaria, and though badly needed reinforcements arrived during the month, on the 22nd, 533 beds were occupied in the 2/1st C.C.S.

The opening of the convalescent depot in the Waigani area was a measure of great value. It had been observed that the incidence of tropical diseases, in particular malaria, was greater among the 7th Brigade; this was believed to be related to the greater time the formation had been in Milne Bay, exposing its men to greater risk of infection and to greater fatigue. The convalescent depot provided an opportunity for rehabilitation for such men, and before long it was accommodating 300 men under command of Lieut-Colonel K. C. Purnell, until through illness he was followed by Lieut-Colonel J. N. Freedman. An unusual feature of the programme laid down for the patients was the organisation of trips on luggers into the China Strait. This helped to make the men interested and self-reliant and proved popular and valuable.

It was unfortunate, though illustrative of the risks of a hyperendemic area, that the D.A.D.M.S., the A.D.M.S. and the G.O.C. all fell victim to malaria about this time. At the end of December the malarial incidence rate, which had reached 33 per 1,000 per week in September (1,716 per 1,000 per year) rose to 82 per 1,000 per week (4,264 per 1,000 per year): at this rate the force would have fallen to zero in three months. During the third week of December 1,083 out of 12,000 men contracted malaria. The strain of dealing with this number of sick was intensified by the growing unfitness of the force.

A further serious consideration was the bad effect of the steady drift of men to the mainland. Clowes had stated that infection by malaria should be regarded as a self-inflicted wound, but at that time the capacity of malignant tertian malaria to break through suppression by quinine was not as clearly recognised as it was later. Even conscientious commanders were not proof against this risk. Yet in the last few months of 1942 malaria was coming to be regarded with an air of inevitability by the force in Milne Bay, a feeling that could not be dispelled even by the energy and optimism of the senior officers, among whom should be specially mentioned Colonel Maitland. One medical commander noted the feeling of claustrophobia engendered by the dullness of low-thatched native hut wards and the gloom of rubber plantations beneath a leaden sky. It was fortunate that the brief campaign had come so early, otherwise the saturation of the force by malaria would have been a serious drawback to the success of those sharp conflicts which turned back the Japanese.

The effect of Blamey's authority was soon felt. The over-night appearance of a growing labour force, the clearing up of the hitherto obscure delays in supplies, the provision of a special officer to speed on these vital items to their destination and the emphasis laid on personal responsibility of all ranks brought about welcome changes. Of great importance too was the recognition of the principle that patients suffering from malaria

should be as far as possible retained for treatment in New Guinea, and not sent back to Australia.

But the corner was turned in December and vigorous measures, supplemented early in 1943 by the substitution of the more effective suppressive atebrin for quinine, produced good results. This statement needs some qualification, for supplies of suppressive drugs were still restricted, and the troops stopped taking quinine and started on atebrin without a "lap-over" period in which the atebrin could have built up an efficient blood level. Some immediate increase in malaria was observed at first: had this occurred at a less quiet period the malarial incidence might have shown more rise than it did. Further the men temporarily lost faith in the new suppressive until its protective power was later evident. In addition, the initial dosage of 0.6 gramme weekly, then regarded as adequate, could have been higher at first with advantage.

The anopheline index of the area fell sharply as larval and adult control of the vector reduced the mosquito population, and a corresponding sharp fall occurred in the clinical incidence of the disease. It was also an advantage to have the relatively dry season in which to establish roads and carry out other engineering projects. The incidence of malaria among the air force also declined sharply, though its members had the disadvantage of not having an adequate supply of protective clothing. Mackerras in a report on the entomological and epidemiological aspects of Milne Bay, found that the prompt reduction in malaria was undoubtedly directly related to the control of vectors. Other measures which were effective were the use of gametocidal drugs, in particular plasmoquine, the segregation of native labour forces, carriers of gametocytes, and the retention in New Guinea of men under treatment for malaria as far as this was possible and advisable.

RELIEF OF MILNE FORCE

The time had now come to substitute other troops for those who had been in Milne Bay for some time and were showing obvious fatigue. Therefore, during January, Milne Force was relieved by the 5th Division, under command of Major-General E. J. Milford and with Colonel S. H. Lovell as A.D.M.S. The advantage of a new force taking up the tasks was great, especially as the 5th Division had had experience of a local epidemic of B.T. malaria in Cairns, and was well-trained in preventive methods. It should be clearly realised that the effects of control put into operation by Milne Force became evident by definite improvement in the malarial position before the force was relieved by the 5th Division. The changeover came at an auspicious time, and full advantage of this was taken by the fresh formation in pressing on with all effective control measures. The results were striking. Within a month the infection rate had fallen from thirty per week to ten per week, and it fell still further. The subsequent medical history of Milne Bay was satisfactory. Like all hyperendemic areas, it produced a certain incidence of malaria in spite of all precautions, but after control was established this was never immoderate.

In March, arrangements with Angau made it possible for all natives in working parties in the military area to be transported each evening to a prepared native village, Baraga. This prevented dangerous contacts of vector and carrier and lowered the sporozoite rate of anophelines of the area. A difficulty arose in the siting of a convalescent depot, which was too close to Baraga for safety, but another site was chosen. The malarial rate in March was 8.2 per 1,000 per week; this fell to 3.8 per 1,000 per week during the next month, and for a short period in June was as low as 1 per 1,000. In July the 5th Division was moved to Moresby for other duties in the Salamaua campaign.

There is no doubt that the fresh 5th Division seized an opportunity in applying all the recognised methods of malaria prevention practicable to a force in the field, and set an excellent example, which had still to be supplemented by the attainment of comparable results by a force in action. This highly successful experiment in malaria control was backed by authority at all levels; it was well designed, as it attacked all biological phases of the malarial parasite, from breeding to transmission from the carrier. The first essential step was destruction of the vector mosquito, and immediately after the term of incubation in the human subject was completed the dramatic fall in clinical incidence began. The introduction of atebrin as a suppressive was coincidental with other events in Milne Bay, but the superior suppressive power of atebrin over quinine exerted its effect with growing force from January 1943, when the change began, to March when it was complete.

Another forward step was the official appointment of three malariologists to the Australian Army. In March Lieut-Colonel Ford and Majors J. C. English and F. J. Fenner were appointed in this capacity. Between them they were able to bring a combination of experience in military hygiene, scientific knowledge of pathology and parasitology, and of first-hand experience of work on malaria in the field, and their official status raised the standard of anti-malarial work. The introduction of a new repellent, dimethyl phthalate ("Mary") must also be mentioned, as this was an important advance in the technique of personal protection.

During the succeeding quarters of 1943 there was really little difference between Milne Bay and any other tropical area where malaria flourished but could be controlled. As the war centre shifted north and east, Milne Bay became less important to the army, but it continued to be a bastion of defence and was used by all three Services at later periods.

The general hygienic standard of Milne Bay remained satisfactory once the necessary control was maintained. Early in 1943 English reported on the hygienic standard of Milne Bay. Water supply had given some anxiety, but when men and materials were available no trouble was encountered. One case of typhoid fever occurred among men who had been neglecting chlorination of water. Dysentery showed only a low incidence, 0.45 per 1,000 per week; throughout the whole period it was not a serious danger. English found only a few rubbish dumps in the area and pointed out that the best remedy for this breach of rules was to

make an incriminated unit bury the entire dump. The food was good, and included a good white bread made by the local bakery, though a wholemeal loaf would have pleased the nutritional experts more. Reserve rations were for a time held in excessive amount; this resulted in deterioration, but the defect was avoidable. Adequate refrigeration space was available. General anti-malarial discipline was then good in the area, in fact the only weak spot was that spraying of messes was often neglected.

The transformation of a dangerous area to a relatively safe one was virtually complete, except for that constant supervision which is imperative, and indeed is part of a good organisation. In the beginning there were immense difficulties in the way of applying preventive measures with any consistency, but the outcome showed that the problems could finally be solved.

GOODENOUGH ISLAND

Goodenough Island lies seventy miles north-east of Milne Bay and has features similar to other parts of Papua, with mountainous areas, especially to the north-west, and undulating plains with forest and kunai grass intersected by rivers.

The Japanese invasion convoy to Milne Bay, leaving Rabaul on 24th August, included some 200 of a marines unit, the remainder of whom had previously landed at Buna and were now planned to move round the coast in landing craft to Taupota, and thence to march on Gili Gili. Next morning the Buna detachment was seen landing on Goodenough Island, and as soon as the bad weather cleared, the R.A.A.F. attacked and destroyed their barges. Here this section of the invasion force was left stranded on Goodenough, maintained by submarine, until 22nd October when the 2/12th Battalion landed on the island with the task of expelling them and preventing further occupation.

The operation was planned so that one company would attack from Taleba Bay, and the remainder of the battalion would attack from Mud Bay. Both assaults were delivered on the night of 22nd-23rd October and, although they were not successful in driving back the Japanese, the enemy withdrew during the night of 24th-25th and left the island. The resemblance of these tactics to those employed by the Japanese at Milne Bay will be noted. Once in possession, the battalion carried out an elaborate simulation of an active and considerable occupation force.

During the brief period of action there were twenty-seven battle casualties, including thirteen men who were killed. The system of medical evacuation was by water. Ketches made the trip between Goodenough Island and Milne Bay and transported sick and wounded after initial treatment in an aid post. Among the casualties in Drakeforce, as the battalion group was called, there was one case of gas gangrene. Malaria and typhus both occurred on the island: patients needing hospital care were sent to Milne Bay by the same sea route, and occasionally by air if opportunity offered.

Early in 1943 the installations on Goodenough Island were considerably extended, but also were widely dispersed to give the impression from

the air that the island was strongly held. The buildings and tracks were tactically disposed, therefore when the site for a camp dressing station of 125 beds was to be chosen for "B" Company of the 4th Field Ambulance, care was taken to fulfil these requirements. Medical care of Drakeforce on Goodenough Island was carried out by Captain G. A. Goding, R.M.O. of the 47th Infantry Battalion, at the aid post, and further treatment was given at the ambulance dressing station. The R.A.A.F. also had medical facilities on the island.

(b) THE BUNA AREA

The satisfactory conclusion reached by combined effort in Milne Bay could not be duplicated on the coastal plains of the north coast of Papua, for conditions were entirely different. The country and climate in each area suited the infective agent of malaria well, likewise its insect vector, and transmission of the disease was thus maintained at a high level in both places. But there were essential differences. The devastating epidemic struck Milne Bay at a time when the immediate menace of attack had been removed or at least much reduced, whereas a bitter struggle ensued for Buna and Sanananda even after Gona had fallen. Moreover, the delimited area of Milne Bay presented problems quite different from those of the coastal swamps, which were all the more treacherous because the troops approached them from high ground, virtually safe from malaria. We have seen how the suspension of suppressive quinine, and the subsequent mishaps of non-receipt and non-distribution of supplies started the troops downhill from Kokoda in more ways than one. Further, the men on the plains had been through exhausting experiences and their resistance flagged.

As the troops reached the coastal plains the prevalence of malaria was soon evident. It is true that from the point of exact diagnosis the precise incidence of malaria could not be ascertained at the time, for even if the facilities for pathological examination were present, there was frequently no time for its application. Of the short-term pyrexias dengue fever was considered the most probable if the specific vector was present in the area, but, as was found in Milne Bay, the fallacy in this diagnosis was often revealed by subsequent blood examination or by the occurrence of malarial relapses. As most of the primary malaria was of the malignant tertian type, adequate treatment usually cured it without permitting relapse, but if relapse occurred, it was rather of the nature of recurrence, and any subsequent attacks were found to be due to benign tertian fever breaking through. Medical units soon became aware that many of their members were suffering from malaria. Occasionally it was possible for them to carry on with a brief intermission from work during which they were given a routine course of treatment. These workers were especially prone to contract infection by exposure to the mosquito during the night hours.

At the end of December quinine ceased to be the officially approved suppressive drug, and atebrin took its place, but the troops involved in

active operations in most instances continued to take quinine until their relief. The high incidence of malaria, which continued till the end of the Sanananda campaign, was not solely related to the particular suppressive used, though had atebrin been persistently taken, the prevalence of overt malaria should have decreased within a short time.

The increasing size of New Guinea Force and the greater numbers of fresh formations brought in to end this expensive and difficult campaign demanded more hospital care. Ever since the 2/9th A.G.H. had been opened in Moresby during September the call for beds had increased. This hospital grew to 2,000 beds, and in addition the 5th C.C.S. had been working in the area since May and the 2/2nd C.C.S. at Koitaki since November. Yet at the end of December Brigadier Disher stated in his diary that: "Medical units are swamped with malaria, and I have just discovered that hospitals *et cetera* are discharging them to units to complete treatment with plasmoquine." He further remarked that he thought that 100 per cent of the men at Milne Bay and in the Buna area had been infected. The only consolation was that the constant diminution of the forces from malaria was helping considerably to a more realistic view of the position. In January the 2/5th A.G.H. was brought to Moresby, and within a month was taking patients; also the 2/1st Field Ambulance, which for a time ran an A.D.S. in the lower Moresby area, and was engaged in other various tasks, had also established a series of medical wards holding 400 patients in what was virtually a malaria hospital. The 3rd Field Ambulance was discharging a like function, and holding some 600 patients, many with malaria. Evacuation to the mainland was a possible means of relief, but not one in accordance with military policy, for since Blamey's ruling on this important question, all efforts had been made to keep men in New Guinea who were considered fit to return to duty after a course of treatment for malaria.

The Atherton camps were now in working order, and debilitated troops were being transferred there for rehabilitation.

But, though the end of the Sanananda campaign was in sight in January 1943 the flood of malaria was not stayed, and the losses were serious. The bed state in medical units of New Guinea Force on 24th December had reached the high figure of 3,570, excluding 1,021 in the convalescent depot, and a further number in Milne Bay, which was in a sense self-contained. The daily admissions were seldom under 200. Hospital ships and aircraft returning to Australia supplied some of the demand for transport to the mainland, but more planes and ships were needed.

A month later when Sanananda had fallen, and only "mopping up" operations remained, figures showed that the casualties among the Australian and American troops in Papua were as follows:

Troops	Tropical Diseases	Malaria	Battle Casualties
Australian . .	29,101	21,600	6,154
American . .	8,259	6,292	1,598
Total . . .	37,360	27,892	7,752

It will be seen that tropical diseases gave a ratio of 4.8 to 1 to battle casualties. For malaria alone the ratio was 3.6 to 1. These figures are definitely understated, as they take no account of many men who had latent malaria which only became manifest on return to the mainland and on cessation of suppression. Further, numbers of others kept on their feet and were not recorded as hospital admissions, though they received treatment. In early December Hobson had his M.D.S. at Soputa occupied to the last available shelter, with 200 battle casualties admitted in twenty-four hours, yet the sick rate among the 2/4th Ambulance staff, and the attached 2/6th Ambulance staff was so high that on occasion only forty-two men from these units were able to work. A week later, out of a total strength of seven officers and seventy-six men of the 2/4th Ambulance, three officers and thirty-seven men were being treated for proven malaria. Such instances could be paralleled in other units exposed to the full risk of malarial infection, and the visible shrinking of the fighting forces illustrated the same lesson.

As malignant and benign tertian types coexisted in the hyperendemic areas of New Guinea, overt malaria, when it appeared in men only partly protected by a suppressive drug, was usually of the M.T. type. If due precautions were not taken M.T. might assume an epidemic form. B.T. of course also occurred in acute attacks or with M.T. in a mixed infection. The true position with regard to mixed infections was often only revealed by the subsequent appearance of B.T., especially when treatment was suspended in men being rehabilitated in a safe area. There is little wonder that the troops transferred to the Atherton Tableland showed so high a percentage of B.T. malaria, or that this malarial wastage of men continued for months afterwards. There was good reason for admitting that the infection rate in the northern coastal plains must have been approaching the maximum possible. Later, in August 1943, it was estimated that 20,000 individual members of the Australian Military Forces had been affected by malaria since 1st January 1942. The number of hospital admissions totalled 58,358; this figure of course, includes relapses, and it appeared that the average number of relapses per man was two, though it varied greatly and even reached eleven in some individuals. The ultimate result of treatment was good, for 90 per cent of 3,056 men treated on the Atherton Tableland were returned completely fit to their units. The controlled areas did not yield many cases of malaria by comparison. Practically all malaria treated in Australia was contracted in New Guinea. The static areas in New Guinea, Moresby in particular, were well controlled. First attack rates in the Moresby base were not as low as desirable, and reached 5 per cent per annum, but the first attack rate for all New Guinea, including the forward areas, was 13 per cent.

The suppressive drug used over most of the period was quinine; although atebrin was introduced as the official suppressive at the end of December 1942 the actual change to atebrin was made only gradually as troops involved could not be so readily supplied or instructed. The 18th Brigade, for example, went into action in mid-December, but did not change to

atebrin until their withdrawal from action on 11th to 14th February. An investigation of these men was made at the rest camp at Donadabu when they returned from the northern plains. Some 1,300 men of this brigade who were examined by Major A. A. Ferris were also investigated so as to determine their length of service in New Guinea, and the parts in which they had been. The state of the spleen was ascertained and their blood was examined by Field's stain on thick films to find if trophozoites and gametocytes were present. Some high rates were found in certain of these groups: for example, 29 per cent of one group of men who had been only at Buna showed parasites in the blood, and 18 per cent had gametocytes, in other words, transmissible forms. After five weeks in the Buna-Sanananda area 7.3 per cent of men who had an attack of malaria still showed parasites in their blood, as contrasted with 26 per cent who had not had an overt attack.

At the end of January 1943 the malarial rate for operational areas in New Guinea rose to a peak of 48 per 1,000 per week, that is, 2,496 per 1,000 per year. Here then was the military malarial problem, stating itself in unequivocal terms. Fighting in a hyperendemic area carried a risk of almost certain infection with malaria, unless troops could be trained to carry out anti-malarial precautions as part of their duties as soldiers in action, and in particular, unless an active suppressive drug could be taken without intermission and with complete reliability. The reputation of quinine as a suppressive, never high among expert malariologists, had receded, though it undoubtedly had high therapeutic value. Hopes were now centred on atebrin.

MALARIA IN THE JAPANESE FORCE

Another very different question was raised about this time, the influence, if any, of nationality on immunity. This was, of course, related to the alleged powers of the Japanese to withstand malaria. An investigation was carried out by Intelligence officers on this subject, based on study of captured diaries and records, and interrogation of Japanese medical officers. This showed clearly that the Japanese forces had a high infection rate from malaria, and, more important still, a high death rate. One medical officer stated that 10 per cent of the men affected died, and in one field hospital (*21st Independent Mixed Brigade*) at Mambare 196 deaths were recorded, of these 80 per cent were due to malaria. The commanders of two divisions, the *20th* and *41st,* also died of malaria. Little was known of the nature of some of the proprietary drugs used by the Japanese for treatment of malaria, but there was little doubt on studying their records that they were not using standard and proven methods. Further, individual medical officers appeared to follow their own ideas in their courses of treatment. Intravenous quinine did not appear to be used by them in severe cases. There was no reason to believe that the Japanese had any degree of immunity to malaria; they were not even in the category of the New Guinea natives who were "salted" in infancy and thus acquired some immunity at high cost. It has been pointed out, however, that the

Japanese made little use of wheeled transport in their occupation of areas in New Guinea; therefore these areas were not cut up with wheel tracks to any great extent, and this may have reduced the concentration of vectors.

There was good reason for believing that the Australian Army was better advised and guarded in matters relating to that major enemy, malaria, than the Japanese, but how fallible were these applications of scientific knowledge to military discipline this campaign had clearly shown. There was little doubt that important lessons of malaria prevention were still to be learnt, but this could not be done simply by maintaining a force in this densely infected area, learning by bitter experience the simultaneous defence against two dangerous enemies. These coastal swamps of Buna-Gona were not contained within a circumscribed area, as in Milne Bay, and the application of preventive methods was limited by logistic difficulties of material, and prophylactic discipline of men. Since the vast numbers of sick could not be held north of the dividing mountain range with its ever-threatening curtain of cloud they had perforce to be crowded into the ever-expanding island base hospitals, only to spill over to the mainland. Victory at Sanananda established a degree of ascendancy over the enemy, but the Wau-Salamaua sector still threatened the flank of the Allied forces in New Guinea, and, despite the successes of Milne Bay, the problem of malaria was not yet solved, though the way had been shown.