STUDIES ON FILARIASIS IN PAPUA, NEW GUINEA

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Preliminary investigations for this project were started during the months of November and December 1944 while stationed in the Milne Bay area. Upon returning to this area for the month of September 1945 the studies were completed, as far as the limited time permitted.

Evidence presented by previous workers indicated that filariasis in this area is caused by the nocturnal periodic form of *Wuchereria bancrofti,* with its main vector being *Anopheles punctulatus moluccensis.* The existence of the nocturnal periodic form was established by F. Fulleborn in 1908. Observations of Backhouse (1) here and in the Mandated Territory of New Guinea concerned four thousand pre-war Europeans and, except for rare cases of lymphangitis of unknown origin, no clinical or laboratory manifestations of filariasis were observed.

The purpose of these studies was to establish the filarial index among the native population and to further establish or confirm the previous works on the nocturnal periodicity of *Wuchereria bancrofti,* with its possible relationship to military personnel in the adjacent areas. Dissections were made to compile data for some of the possible vectors of filariasis in this area. With the information presented by Backhouse of the apparent lack of filariasis among the white population, observations were made to verify this apparent negative condition.

It was further established by this study that the disease of filariasis is attributed to the presence of adolescent or adult *Wuchereria bancrofti* in the tissue of man and is of the nocturnal periodic form; that within the Papua area of New Guinea filariasis is endemic.

By the thick blood smear technique, it was demonstrated that from 35–55 per cent of the native population harbor the microfilariae in the peripheral circulation.

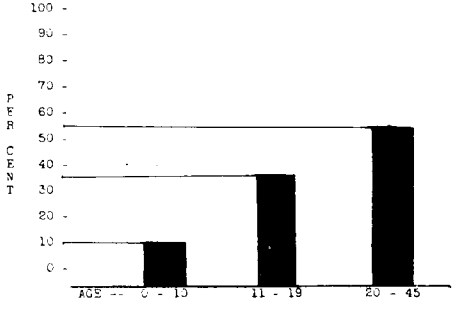
To ascertain the existence of the nocturnal periodicity of *W. bancrofti,* blood smears were taken on the same 200 natives at 1300, 2000, and 2330 hours. In addition to the data supplied in Table 1, it

TABLE 1. Circulating Microfilariae Found at Specified Time Intervals.

Time	Total No. Slides	Positive Slides	Per Cent Positive
1300	200	4	2%
2000	200	70	35%
2330	200	102	51%

should be noted that all persons positive at 2000 were positive at 2330. Those who were positive for microfilariae at 2330 only, had light infections consisting of 3–5 microfilariae per slide, whereas those who were positive at 2000 exhibited 35–40 microfilariae per smear. All smears, as nearly as possible, were made of uniform size (1.5 cm. in diameter); however, it is realized that some were not uniform. The 2 per cent infection which was indicated at 1300 showed a tremendous increase in the number of parasites per smear at 2000. At no time was it evident that the ratio between the sexes varied. The age group which showed the highest rate of infection was that of 20–45 years. Table 2 tabulates the results of the in-

TABLE 2. Graphic Representation of Microfilariae as to Age Groups.



vestigation of *W. bancrofti* in the various age groups.

In spite of the high microfilarial index, the incidence of clinical manifestations of recurrent lymphangitis-lymphadenitis was, as a whole, surprisingly low. The most advanced elephantoid condition never exhibited the tremendous enlargement common in the endemic areas of the non-periodic *W. bancrofti*. Inguinal enlargements were frequent, but not necessarily of filarial origin. In those cases involving the lower extremities, only the area between the ankle and knee was affected, and usually not advanced beyond the early stage. In approximately one-fourth of the natives showing clinical involvement of the lower extremities, microfilariae could not be demonstrated by blood smears.

Observations of thirty-five Europeans who have been in New Guinea from twelve to twenty-five years revealed no evidence of microfilariae by thick blood smears. Upon physical examination no clinical manifestations were evident. Past histories indicated an essentially negative aspect which agrees with the previous works of Backhouse. Nocturnal protection of whites compared with natives was much the same so far as mosquito protection was concerned. Houses for the whites had no screens, with large open spaced walls. Bed nets were used by the whites, which made the difference in protection for the two groups. Segregation of whites from natives here, in general, was the same. The "boy houses," in which the natives were quartered, were usually about 300–500 yards from the estate houses. There were no bed nets or other protection of any type from the mosquitoes in the "boy houses." This distance was not great enough to control the flight range of the mosquitoes investigated here.

EPIDEMIOLOGY

In 1944 Backhouse (1) was of the opinion that *Anopheles punctulatus moluccensis* * is the vector of filariasis in this area; working with Heydon (10) he found experimentally that *Aedes aegypti* and *A. scutellaris* were unsuited as vectors, while *Aedes (Finlaya) kochi* experimentally proved to be an efficient vector. Faust, 1939 (6), lists *Anopheles punctulatus* which is also listed by Strong (7) as being the vector in New Guinea. Byrd *et al.* (8) conclusively established *Aedes scutellaris*, var. *pseudoscutellaris* as the vector in Samoa of the non-periodic form of *W. bancrofti*.

Most of the mosquitoes taken for dissection were collected from the "boy houses" at the Sagarai Plantation. Each house contained approximately sixty natives whose rate of infection for microfilariae was 55 per cent with an average of 25 to 35 microfilariae per smear. The engorged females were collected in the evenings at 1930 to 2030 and in the mornings at 0500.

Investigation indicated that while *Aedes kochi* is an efficient vector experimentally, (10) it was not of importance in the field at this time, due to the almost complete absence either in the larval or adult forms. Only an occasional specimen was taken, agreeing with the work done by Avery (2) 1944. *Aedes scutellaris* was encountered occasionally during the first part of the study in 1944, but for the month of September, 1945, only two adult specimens were collected. From the work done by Byrd *et al.* (8) the feeding time for *A. scutellaris* var. *pseudoscutellaris* was approximately between 1600 and 1630 hours which would conflict with the nocturnal periodic form of *W. bancrofti*, which can not be demonstrated in any number until 1900–2000 hours in this area.

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* Knight, Bohart, and Bohart (3), 1944, list this as a subspecies of *A. farauti farauti* termed *A. farauti moluccensis*. Rozeboom and Knight (4), 1945, have treated the subspecies as a synonym of *farauti*. In this paper the old terminology as listed by Russell, Rozeboom, and Stone (5) is followed.

Of the mosquitoes dissected from these collections 15.4 per cent of all *Anopheles punctulatus moluccensis* proved to be infected. In some instances, these mosquitoes were infected with three distinct development stages, others with two. The majority, however, contained only a single infection. The presence of two or three developmental stages indicates that these mosquitoes seek blood meals after being infected. Specimens collected in native villages showed a filarial incidence of 13.5 per cent.

Culex quinquefasciatus showed a positive incidence of 1.7 per cent for the infective filaria. *Culex annulirostris* was taken occasionally and while some specimens were found harboring microfilariae in the abdomen, none of the infective stages was found in the thoracic muscles or head.

TABLE 3. Record of Dissections.

Species	No. Dissected	Positive for *Wuchereria bancrofti* No.	%
Anopheles punc. moluccensis	275	42	15.3
Culex quinquefasciatus	75	2	1.7
Culex annulirostris	50	0	0.0

Experimental infections with *Anopheles punctulatus moluccensis* had interesting results. Of the seventy-five *A. punctulatus moluccensis* used in this experiment, fifty survived beyond the fourteenth day. Experimentally the rate of infection for this species was 65.3 per cent (Table 4).

TABLE 4. Record of 75 *Anopheles punctulatus moluccensis* Experimentally Infected in the Laboratory.

Days After Infective Blood Meal	No. Dead	No. Killed	Number Determined Positive
4	4	0	3
9	6	8	8
10	2	0	1
11	2	0	1
14	3	0	2
15	0	20	15
17	0	15	11
18	5	10	8

Fifty *Culex quinquefasciatus* were used experimentally with an infective rate of 12.3 per cent.

Density of the mosquito population varied in certain areas. *Anopheles punctulatus moluccensis* as a whole, however, was rather constant. Using human bait, night collections were made with an average of fifty-five bites from *A. punctulatus moluccensis* per hour. *Culex quinquefasciatus* was more abundant at the plantation than in the surrounding native villages. The most abundant species in the villages was *Culex annulirostris*.

The area used for these studies (Sagarai Valley) provided excellent conditions for obtaining a natural index as to filarial and mosquito population because the native population and terrain were not affected by the military activities in any way. The natives from the Sagarai Estate used in this study were, for the most part, from the immediate surrounding area.

Results, both experimentally and in the field establish *Anopheles punctulatus moluccensis* as an efficient vector of filariasis in this area. *Culex quinquefasciatus* does not appear to be of importance. *Aedes kochi* may be of importance during certain times of the year as, from the observations of the writer and others, this species is found almost entirely in the axils of banana plants, which at the time of this work were, as a whole, entirely dry. During the last week of September due to heavy rains, an abundance of first instar larvae were collected from the axils of this plant just prior to the completion of the study. It was not determined that these were *Aedes kochi*, as the larvae were too young for determination.

Having established *Anopheles punctulatus moluccensis* as an efficient vector of filariasis and, added to this, the fact that this species is also responsible for a high percentage of malaria transmissions, the apparent negative filarial index among the white personnel is difficult to explain. Records of Base Hospital 13, up to December 1944, had no history of cases suspicious of recurrent lymphangitis lymphadenitis. Records of Naval Dispensary 167 further substantiate these results.

Among the theories advanced to explain this condition, mosquito control apparently has the most support. This may in part explain the negative condition among military personnel, but it does not appear satisfactory or complete. The Europeans observed by Backhouse and the ones examined during this study, make no effort for the control of the vector with the exception of mosquito nets, and many of these are improperly used. With the length of time that these people have been in a highly endemic area, it is logical to assume therefore, that repeated exposures have been had to filarial mosquitoes, and yet no evidence of filariasis has been confirmed. The evidence thus presented indicates that the theory of the "controlled vector" is not adequate, and that some factor, as yet not known, either in the epidemiology or physiology of the microfilariae in becoming established in the definitive host is more likely responsible.

CONCLUSIONS

1. Filariasis among the natives in this area is highly endemic and is caused by the nocturnal periodic form of *Wuchereria bancrofti*.

2. *Anopheles punctulatus moluccensis* is an efficient vector in this area while *Culex quinquefasciatus* is of no great importance.

3. Among the white population in this area no evidence of filariasis was demonstrated at any time.

4. There is no apparent danger of military personnel becoming infected with this disease in this area.

5. The negative filarial index among the white population is not adequately explained on the basis of mosquito control; it seems more likely that some factors as yet unknown in the epidemiology or physiology is responsible, which either retards or completely controls the development of the microfilariae of the nocturnal periodic form of *Wuchereria bancrofti* within this group of people.

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