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PARASITOLOGIC AND CLINICAL FEATURES OF BANCROFTIAN FILARIASIS IN A COMMUNITY IN EAST SEPIK PROVINCE, PAPUA NEW GUINEA*

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Abstract. Bancroftian filariasis has been reported in several areas of Papua New Guinea. The epidemiologic features and natural history of *Wuchereria bancrofti* infection in this geographic region, however, have not been well-defined. The objective of this study was to assess the parasitological and clinical features of bancroftian filariasis in a community in East Sepik Province, Papua New Guinea. In a village of 99 individuals, the overall prevalence of microfilaremia was 68%. The microfilarial carrier rate was high in those ≤10 years (62%), remained elevated in the 11–20, 21–30, and 31–40 age groups (42–55%), and peaked in subjects ≥41 years old (90%). The geometric mean level of parasitemia in all subjects with patent infection was 3,198 microfilariae/ml blood. This value was 78 parasites/ml in the ≤10-year-old age group, increased to 1,753 in 21 to 30-year-olds and was markedly elevated in subjects ≥41 years old (6, 792 microfilariae/ml). Acute symptoms of filariasis (lymphadenitis and lymphangitis) were initially noted in individuals between the ages of 11 and 20 years (30%). Obstructive disease, manifested as elephantiasis and hydroceles, was present in 64 and 79% of 31–40 and ≥41-year-olds, respectively. These data suggest that intense transmission of *W. bancrofti* infection occurs at an early age in this area of East Sepik Province; patent infection remains high in older age groups. Irreversible lymphatic obstruction develops 20–30 years after initial infection and may be associated with either amicrofilaremia or microfilaremia.

The development and implementation of control programs for lymphatic filariasis are in large part dependent upon an accurate assessment of the clinical and parasitologic features of this infection in endemic areas. Bancroftian filariasis has been noted in several areas of Papua New Guinea, particularly in coastal and low-lying regions and some islands off the mainland.[1–4] The public health significance and natural history of *Wuchereria bancrofti* infection remain poorly understood, however, since the majority of these surveys were not performed on permanent residents of well-defined communities. Knight et al.[5] recently studied bancroftian filariasis in two villages in the Middle Fly River region. Using 20-μl and 0.85-ml blood samples to detect microfilaremia, these workers found that 51% of villagers were microfilaremic; 40% demonstrated clinical evidence of "late filarial disease" (lymphedema). The prevalence and morbidity of bancroftian filariasis in other regions of Papua New Guinea have not, however, been systematically studied. The present study was undertaken in East Sepik Province with the objective of defining the prevalence of patent infection, intensity of microfilaremia and disease manifestations of *W. bancrofti* infection in this geographic area.

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MATERIALS AND METHODS

Location and subjects

The study was undertaken near Dreikikir, a village in the East Sepik Province of Papua New Guinea. This province is located in the northwest of the country and is about 50–100 km east of

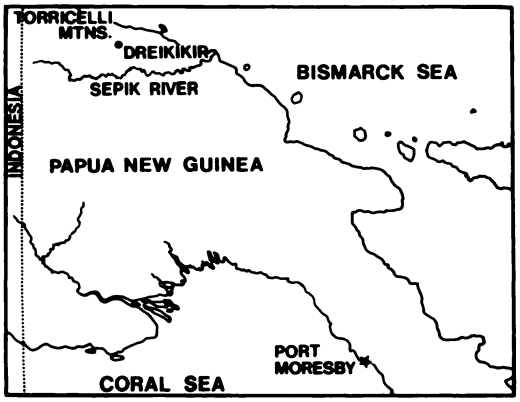

FIGURE 1. Location of Dreikikir, East Sepik Province, Papua New Guinea.

the border with Irian Jaya, Indonesia. Dreikikir lies in hilly terrain (elevation approximately 200 m) between the Torricelli Mountains to the north and the Sepik River to the south (Fig. 1). The average annual rainfall is 200 inches. The study population resides in two hamlets, Yuautong and Albalum, near Dreikikir. The inhabitants are local tribal people who speak "ples-tok" (local language) as well as pisin, the major *lingua franca* of Papua New Guinea. Villagers live in mud huts which are located in clusters of 5–10 and connected by footpaths. Houses have no screens, electricity or waste disposal systems. Mosquito nets were used in only one household. Daily activities include maintenance of the home and subsistence agriculture. The major foodstuffs include taro, yams and coconuts. Malaria control programs or systematic filariasis studies have not been conducted in this area. The age, sex, and family relationship of the 99 subjects living in these hamlets were recorded by household survey with local health workers.

Clinical studies

History and physical examination was carried out as outlined by the protocol of the World Health Organization.[6] Subjects reported if they had a history of filariasis symptoms (in the local terminology) and if they experienced lymphangitis, lymphadenitis, lymphedema (particularly of a lower extremity) or chyluria. Physical assessment included genital examination and measurements of the circumferences of the lower and upper extremities 4 cm distal to the inferior border of the patella and antecubital fossa, respectively. These studies were approved by the Human Investigation Committee of Case Western Reserve University, Cleveland, Ohio, USA and by the Papua New Guinea Institute of Medical Research, Goroka.

Parasitologic studies

Four milliliters of blood was drawn into EDTA-containing tubes between 2200 and 0200 hours (*W. bancrofti* has been shown to have nocturnal periodicity in Papua New Guinea[7]). Blood was passed through a 5-μm Nuclepore filter placed in a Swin-Lok holder (Nuclepore Corporation, Pleasanton, California, USA). The filter was washed twice with water, fixed with methanol, mounted on a glass slide and stained with Giemsa solution.[6] The filters were examined by microscopic inspection and microfilariae were enumerated. When microfilarial counts exceeded 500, several representative areas were selected, parasites were enumerated and the total number was calculated from the known surface area of the filter paper (parasites were evenly distributed). In children <4 years old, two 20-μl blood samples were obtained by finger prick and collected in heparinized capillary tubes (Fisher Scientific, Pittsburgh, Pennsylvania, USA). A 20-μl sample was placed in a Sedgewick-Rafter chamber (Curtin-Matheson, Cleveland, Ohio, USA), water was added to lyse red cells and microfilariae were enumerated. Individual microfilarial counts were transformed to $\log_{10}$ and geometric means and standard deviations were calculated for various age groups. Results are given as the anti-log of the geometric mean in microfilariae per milliliter blood.

Statistical methods

Determination of the significance of difference for results between various age groups was done by chi-square analysis (microfilarial carrier rates, disease manifestations) and Student's *t*-test (intensity of parasitemia).

RESULTS

There was a total of 99 inhabitants residing in 20 households. History and physical examinations were performed on 100% of the population

TABLE 1

Prevalence of positive histories and results of physical examinations for bancroftian filariasis in Dreikikir, Papua New Guinea

Age group (yrs)	History of acute lymphangitis			Enlarged inguinal lymph nodes			Obstructive diseases		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
≤10	0/17 (0)*	0/11 (0)	0/28 (0)	1/17 (6)	1/11 (9)	2/28 (7)	0/17 (0)	0/11 (0)	0/28 (0)
11–20	3/10 (30)	2/7 (29)	5/17† (30)	4/10 (40)	3/7 (43)	7/17† (41)	1/10 (10)	0/7 (0)	1/17 (6)
21–30	8/14‡ (57)	1/10 (10)	9/24† (38)	5/14 (36)	4/10 (40)	9/24† (38)	2/14 (14)	5/10 (50)	7/24† (29)
31–40	2/7 (29)	2/4 (50)	4/11 (36)	3/7 (43)	1/4 (25)	4/11 (36)	6/7 (86)	1/4 (25)	7/11† (64)
≥41	5/8 (63)	6/11 (55)	11/19† (58)	5/8 (63)	5/11 (45)	10/19† (53)	5/8 (63)	10/11 (91)	15/19† (79)
Total	11/56 (32)	11/43 (26)	29/99 (29)	18/56 (32)	14/43 (33)	32/99 (33)	14/56 (25)	16/43 (37)	30/99 (30)

* Figures in parentheses = percentage of individuals in age group with this finding.
† $P < 0.01$ vs. the 10-year-old group.
‡ $P < 0.02$ vs. females.

(99 people). Blood for parasitologic examination was obtained from 80% of the subjects (79 people).

Clinical examination

A history of acute lymphangitis or lymphadenitis was obtained in 29% of the population (Table 1). This symptom appeared initially in the 11- to 20-year age groups (30% of subjects had a positive history). More than 50% of subjects ≥41 years old experienced lymphangitis or lymphadenitis (Table 1). Males and females were equally affected, except in the 21- to 30-year old group in which more males than females noted this symptom ($P < 0.02$). Enlarged inguinal lymph nodes (≥ 2 cm in diameter) were observed in 33% of the subjects (Table 1). Only two children ≤10 years old had this finding compared to 40% of adolescents (11- to 20-year-olds) ($P < 0.01$). This physical finding remained common in later decades of life and reached a peak frequency of 53% in those ≥41 years old. The frequency of enlarged inguinal lymph nodes was similar in males (32%) and females (33%). Obstructive disease, defined as elephantiasis of an extremity or breast or genital swelling (hydrocele or labial enlargement) was present in 30% of the study population (Table 1). Individuals less than 20 years old rarely displayed this disease manifestation (1 of 45 subjects). However, 29% of the 21- to 30-year-old age group had evidence of obstructive disease. The frequency of this finding increased to 64% in 31- to 40-year-olds and 79% in people ≥41 years old ($P < 0.01$ vs. 21- to 30-year-old group). Males and females were equally affected.

Parasitologic findings

Sixty-eight percent of subjects had microfilaremia (Table 2). The proportion of subjects with

TABLE 2

Microfilarial carrier rates and intensities of microfilaremia in Dreikikir, Papua New Guinea

Age groups (yrs)	Microfilarial carrier rates (no. with parasitemia/ no. examined)			Intensity of microfilaremia (parasites/ml blood)	
	Males	Females	Total	Geometric mean	Range
≤10	4/9 (44)*	6/7 (85)	10/16 (62)	78	4–10,864
11–20	2/6 (33)	3/6 (50)	5/12 (42)	77	1-4,575
21–30	10/11 (91)	6/10 (60)	16/21 (76)	1,753	1–16,588
31–40	4/7 (57)	2/4 (50)	6/11 (55)	542	2–9,295
≥41	8/8 (100)	9/11 (82)	17/19 (89)	6,792†	1–35,750
Total	28/41 (68)	26/38 (68)	54/79 (68)	3,198	1–35,750

* Numbers in parentheses = percentage of subjects examined who had microfilariae in their blood.
† $P < 0.05$ vs. subjects ≤ 10 years old.

TABLE 3

Age, sex, clinical, and parasitological data on subjects with obstructive lymphatic disease in Dreikikir, Papua New Guinea

Age (yrs)	Sex	Disease manifestation	Intensity of microfilaremia (microfilariae/ml blood)
40	Male	Hydrocele	0
31	Male	Hydrocele	0
37	Female	Elephantiasis of leg	0
54	Female	Labial enlargement	0
62	Female	Elephantiasis of leg, breast	0
48	Male	Hydrocele	9,295
30	Female	Elephantiasis of leg	3,575
42	Female	Elephantiasis of leg	183
32	Male	Elephantiasis of leg	2,868
26	Male	Hydrocele	2,145
46	Male	Hydrocele	28,600

patent infections was high in all age groups, ranging from 55% in the 31- to 40-year-olds to 90% in the ≥41-year-olds. The microfilarial carrier rates were equal in males and females (68%). The geometric mean intensity of microfilaremia for all subjects with patent infection was 3,198 parasites/ml blood (range 1–35,750). The level of parasitemia was lowest in subjects less than 20 years old (78 microfilariae/ml blood) and highest in the group ≥41 years old (6,792 microfilariae/ml blood, $P < 0.05$ compared to subjects ≤10 years old) (Table 2). There was no difference in the level of microfilaremia in males vs. females.

Lymphatic obstruction

Ten of 11 subjects with elephantiasis in whom clinical and parasitologic data were available were ≥30 years old. Physical evidence of obstructive lymphatic disease, such as elephantiasis and hydroceles, was present in microfilaremic individuals as well as those who were amicrofilaremic (Table 3).

DISCUSSION

Previous studies in Papua New Guinea indicate that bancroftian filariasis is endemic in multiple areas and that *Anopheles punctulatus* and possibly *Culex fatigans* are the major vectors of this infection.[8–10] As many of these field surveys included only transient or adult residents and were done before the increased sensitivity of filtration techniques for detecting microfilaremia was appreciated,[11] a renewed effort to define the natural history and public health significance of bancroftian filariasis in Papua New Guinea is warranted. The results of the present survey indicate that foci of intense transmission of *W. bancrofti* infection exist in East Sepik Province. In an area where systematic studies of filariasis have not previously been done, 62% of children ≤10 years old were found to be microfilaremic; this value remained high in all age groups and reached a peak of 90% in subjects ≥41 years old. This pattern of infection is similar to that reported for other geographic regions in the Pacific where filariasis is hyperendemic. Desowitz and Hitchcock, for example, found that the microfilarial carrier rate in Tonga was 71% in 5- to 9-year-olds and 70% in subjects >50 years.[11] In the Middle Fly River region of Papua New Guinea, located approximately 300 km south of East Sepik Province, 39 and 21% of 1- to 4- and 5- to 9-year-olds, respectively, were noted to be microfilaremic.[5] In subjects over 45 years old, the frequency of microfilaremic individuals was 85%.

The intensity of parasitemia in subjects with patent infection in Dreikikir was remarkably high: the geometric mean level for all subjects was 3,198 microfilariae/ml blood. This high microfilarial density was primarily related to the extreme elevation of parasitemia in older age groups. Whereas the main level of parasitemia in children ≤10 years old was 78 microfilariae/ml, it was 1,753 and 6,792 in 21–30 and ≥41-year-olds, respectively. The marked increases in microfilarial densities and carrier rates in older subjects in East Sepik Province and other areas of Papua New Guinea[12] suggests that resistance against the microfilarial stage of *W. bancrofti* does not develop in this endemic area, despite repeated exposure to infective larvae. Investigations of vector biting patterns and immunologic studies of humans in various age groups will be needed to elucidate the possible mechanisms of this phenomenon.

Disease manifestations attributable to *W. bancrofti* infection appeared in the teen years as acute lymphangitis and lymphadenitis. The frequency of these symptoms increased with age and resulted in elephantiasis or hydroceles in 79% of subjects older than 40 years. This pattern of disease, in which irreversible lymphatic obstruction occurs 20–30 years after the appearance of

patent infection, has been noted in Papua New Guinea and other endemic areas.[13,14] Further analysis of subjects with "late" manifestations of filarasis (i.e., elephantiasis) showed that subjects with and without microfilaremia were included in this group (Table 3). These results are similar to those of Desowitz et al.,[15] who found that lymphatic disease was equally frequent in amicrofilaremic and microfilaremic adults.

Further epidemiologic studies in East Sepik Province are needed to determine if bancroftian filariasis is hyperendemic in other communities. Results similar to those obtained in the present survey suggest that vector-oriented investigations should be initiated and control schemes planned to prevent infection and the development of disease in young individuals.

REFERENCES

1. Hawking, F., and Denham, D. A., 1976. The distribution of human filariasis throughout the world. Part I. The Pacific region, including New Guinea. *Trop. Dis. Bull., 73:* 347–373.
2. Backhouse, T. C., and Heydon, G. A. M., 1950. Filariasis in Melanesia: Observations at Rabaul relating to incidence and vectors. *Trans. R. Soc. Trop. Med. Hyg., 44:* 291–306.
3. Ewers, W. H., 1972. Parasites of man in Papua New Guinea. *S.E. Asian J. Trop. Med. Public Health, 3:* 79–86.
4. Desowitz, R. S., Saave, J. J., and Sawada, T., 1966. Studies on the immuno-epidemiology of parasitic infections in New Guinea. I. Population studies on the relationship of a skin test to microfilaremia. *Ann. Trop. Med. Parasitol., 60:* 257–264.
5. Knight, R., McAdam, K. P. W. J., Matola, Y. G., and Kirkham, V., 1979. Bancroftian filariasis and other parasitic infections in the Middle Fly River region of Western Papua New Guinea. *Ann. Trop. Med. Parasitol., 73:* 563–576.
6. WHO Expert Committee on Filariasis, 1974. Third Report. *WHO Tech. Rep. Ser. No. 542.*
7. Saave, J. J., and Desowitz, R. S., 1966. Studies on filariasis in New Guinea: Observations on periodicity. *Med. J. Malaysia, 20:* 335–336.
8. McMillan, B., 1961. Bancroftian filariasis in the Pacific Region. *Trop. Dis. Bull., 58:* 238.
9. Peters, W., and Christian, S. H., 1963. The bionomics, ecology, and distribution of some mosquitoes (Diptera : Culicidae) in the territory of Papua New Guinea. *Acta Trop., 20:* 35–51.
10. McMillan, B., 1960. The importance of *Culex fatigans* as a vector of *Wuchereria bancrofti* in New Guinea. *Trop. Geogr. Med., 2:* 283–285.
11. Desowitz, K. S., and Hitchcock, J. C., 1974. Hyperendemic bancroftian filariasis in the Kingdom of Tonga: The application of the membrane filter concentration technique to an age-stratified blood survey. *Am. J. Trop. Med. Hyg., 23:* 877–879.
12. Hornabrook, R. W., Kelly, A., and McMillan, B., 1975. Parasitic infection of man on Kar Kar Island, New Guinea. *Am. J. Trop. Med. Hyg., 24:* 590–595.
13. Ottesen, E. A., 1980. Immunopathology of lymphatic filariasis in man. *Springer Semin. Immunopathol., 2:* 373–390.
14. Piessens, W. F., and Partono, F., 1980. Host-vector-parasite relationships in human filariasis. *Semin. Infect. Dis., 3:* 131–152.
15. Desowitz, R. S., Berman, S. J., and Puloka, T., 1976. Hyperendemic subperiodic bancroftian filariasis: A search for clinical and immunologic correlates of microfilaremia. *Bull. W.H.O., 54:* 565–571.