

Bancroftian filariasis in an isolated hunter-gatherer shifting horticulturist group in Papua New Guinea*

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A survey for Wuchereria bancrofti microfilaraemia using membrane filtration was carried out among the Hagahai, a recently contacted Papua New Guinea group of hunter-gatherer shifting horticulturists. Adult men had a significantly higher microfilaraemia rate than women. Children aged >15 years had significantly fewer infections than adults and the microfilaraemia densities were considerably lower. Two subjects exhibited matutinal microfilarial periodicity, peaking at approximately 06 h 00. The possible reasons for the epidemiological and microfilarial findings are discussed.

Introduction

Discrimination of the factors that contribute to the epidemiology of lymphatic filariasis (or any vector-borne disease) in isolated hunter-gatherer shifting horticulturist groups is a challenging problem that requires a multidisciplinary approach involving parasitology, anthropology, and entomology. Confronted with a high infection rate in such a population, epidemiologists must investigate the mechanism of parasite exchange between the mosquito vectors and humans. For example, does the mobile population stay in one place long enough for mosquitos to acquire the infection, and do they remain in the locale sufficiently long for the parasite to complete its extrinsic developmental cycle? Are the group's movements so limited that they fall within the flight range of the infected mosquitos, or are the group's movements sufficiently rapid in returning to a base homestead that there is a reservoir of infected mosquitos to await them on their arrival? Do these epidemiological factors have any effects on the immunological and—as a consequence—the clinical responses that can result in differences from those of settled populations in endemic settings?

There have been few studies of lymphatic filariasis in hunter-gatherer groups. Tanaka et al. found that the *Wuchereria bancrofti* microfilaraemia

rate was 23% among the Mamamawa and Aeta Negrito groups in northern Mindanao, the Philippines, with few differences in the rates by sex or age (1). In Guyana, Hawking noted the rarity of bancroftian filariasis among Amerinds, compared with the relatively high rates in village populations.^a In a comprehensive account of the global epidemiology of human filariasis Sasa made no mention of the infection in isolated hunter-gatherer groups (2).

This article describes the results of a survey of bancroftian filariasis among the Hagahai, a small, isolated group of hunter-gatherer shifting horticulturists in the fringe highlands of Papua New Guinea. The Hagahai have a total population of approximately 300 people, and consist of five territorial groups who speak the same language and consider themselves, for customary purposes, to be one tribal entity. They occupy a territory on the north side of the Yuat river, in the far western corner of the Schrader Range in Madang Province, consisting of primary and secondary forest and grasslands that range in altitude from 350 m to 2400 m. While there is still no road or air (other than helicopter) communication to the larger population centres, there is an extensive system of bush tracks, and the Hagahai are not, and probably never have been, totally isolated. There is a long history of trade with adjacent tribal groups, although this has been more in the nature of brief encounters rather than sustained contacts. A marked change in the degree and kind of contact has occurred since 1982, when missionaries, government patrols, and medico-social scientists began entering and establishing themselves in

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^a Hawking, F. *The distribution of filariasis throughout the world. Part IV: America.* Unpublished WHO document WHO/FIL/75.136.

Hagahai territory. A detailed account of the history of the Hagahai has appeared (3) and the cultural and health changes that have occurred since 1982 have also been described (4).

Materials and methods

Venous blood samples, collected in syringes containing ethylenediaminetetraacetic acid (EDTA) anticoagulant, were obtained from 106 Hagahai between 20 h 00 and 22 h 00. Aliquots (2 ml) were passed through a 5- μ m porosity, 25-mm diameter membrane filter,^b washed three times with distilled water, fixed with methanol, stained with Giemsa and, after drying, mounted under a coverslip on a glass slide using CoverBond[®].^c The entire membrane was scanned microscopically using a $\times 10$ objective and the microfilariae counted. If the microfilariae were too numerous to be counted in this way, the number in a square ocular grid was enumerated. Five such grids, under random fields, were counted, averaged, and the value obtained multiplied by the number of precalculated squares within the entire membrane to give an estimate of the total number of microfilariae. These directly counted and estimated numbers were then halved to give the number of microfilariae per ml of blood. The blood expressed through the membrane was collected, centrifuged, and the plasma stored in liquid nitrogen for further studies.

The names, sex, and estimated age of each person from whom a blood sample was obtained was recorded on a form prepared for the study. Of the 106 subjects, 45 were adult males aged 18–64 years (average, 32.6 \pm 11.6 years), 36 were adult females aged 18–68 years (average, 32.3 \pm 12.6 years), 17 were male children aged 6–17 years (average, 11.4 \pm 3.5 years), and 8 were female children aged 6–16 years (average, 12.0 \pm 3.8 years).

Microfilarial (mf) periodicity was determined by preparing 20- μ l fingerstick thick blood films every 2 hours for 24 hours from two adult male carrier volunteers. The films were stained with Giemsa and the entire number of microfilariae counted.

Statistical analysis for probability was performed using χ^2 and Fisher's exact tests.

Results

Table 1 shows the findings, analysed by sex and age (adult or child). Adult males had a significantly

Table 1: *Wuchereria bancrofti* microfilarial (mf) rates and average mf densities in Hagahai adults and children

	mf rate (%)	Average density ^a (mf/ml)
Adults		
Males	68.8	1687 \pm 3403
Females	30.5	1462 \pm 2032
Children		
Males	11.7	1 \pm 0
Females	0	0

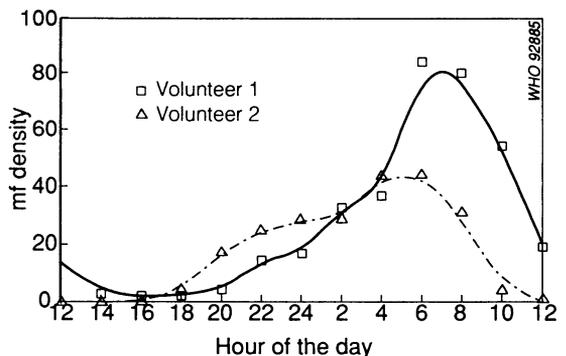
^a The average density refers only to cases with microfilariemia.

greater ($P<0.005$) microfilaraemia rate than females (68.8% and 30.5%, respectively) although the average mf density was approximately the same for adults of both sexes. However, if 50 mf/ml (the density which would be expected to result in 1 mf/ml in the 20- μ l thick blood film) is taken as the threshold for a classification of low density, occult microfilaraemia, 29.0% (9 of 31 membrane-positive cases) of the adult males and 18.1% of the adult females (2 of 11 positives) would be classified as having an occult mf density.

There was also a marked difference ($P<0.0005$) in both the mf rates and densities between adults and children. Only two children (both males, aged 6 and 11 years) were microfilaraemic: the mf density in both was at the occult level (1 mf/ml). Among over-18-years-olds, microfilaraemia was commoner, at least for males: 5 of 10 males aged 18–21 years were positive, compared with only 1 of 4 females in this age group.

The mf periodicity in both carrier volunteers showed a distinct matutinal periodicity, peaking at approximately 06 h 00 (Fig. 1).

Fig. 1. Plot showing the microfilarial (mf) density in 20- μ l thick blood films from two Hagahai adult male volunteers.



^b Millipore Corp., Bedford, MA, USA.

^c Fisher Scientific, Pittsburgh, PA, USA.

Discussion

Relatively few age- or sex-stratified epidemiological studies of filariasis have been carried out in Papua New Guinea. In settled agricultural villages in the Cape Gloucester Peninsula, New Britain, and the Dreikikir district (East Sepik Province), the microfilaraemia rates were high among both males and females in the age groups <10 years and >41 years (6, 7). Average mf densities increased with age in both groups. The parasitological findings for the Hagahai, a hunter-gatherer shifting horticulturist group, showed a distinctly different pattern to those described for settled agriculturists: in the Hagahai the microfilaraemia rate in adult males was significantly higher than that in adult females and for both sexes the infection rate was very low in children and young adults under 18 years of age.

The epidemiology of filariasis in the Hagahai is not straightforward. Presumably, however, the culturally directed age and sex behaviours of these people place them at a differential risk of exposure to the vector mosquito. No ethnological studies that have a bearing on this problem have been carried out, nor has the vector mosquito been identified. The chief activity carried out only by adult men is hunting. Moreover, pig hunting is often an all-night pursuit, and the hunting is best at dawn. If this male-associated behaviour is indeed a risk factor, it implies that the vector is a forest-dwelling, non-peridomestic species or subspecies. It should also be determined whether contacts with neighbouring, more non-nomadic tribes (who may have suffered from endemic filariasis for a long period of time) are made only by men. That filariasis may be relatively new to the Hagahai is indicated by the apparent absence of late chronic manifestations (notably elephantiasis). Hagahai oral history tells of lymphatic manifestations that could be of filarial origin; the condition is reported to have occurred formerly in the groups living at the lower altitudes, but how long ago this was could not be determined.

Perhaps the most perplexing finding of our study is the matutinal microfilarial periodicity observed in the two volunteers. That bancroftian microfilarial periodicity may be diurnal in strains other than *W. bancrofti* var. *pacifica* has recently been reported by Prasad et al. (7), who found that *W. bancrofti* has a diurnal periodicity, with some carriers showing higher mf densities in the day blood sample in the Shahjahnpur District of Uttar Pradesh, whereas in all other endemic areas of India the mf peak is strictly nocturnal. Prasad et al. commented that in India malaria and filariasis are co-endemic only in Shahjahnpur, and further speculated that malaria may affect microfilarial periodicity. Alternatively, the

matutinal microfilarial periodicity observed in the two Hagahai volunteers may have been a rapid abnormal response of a nocturnally periodic strain to the altered sleep pattern and activity of their hosts. An effect of this type has been reported among individuals infected with *W. bancrofti* in Rabaul, East New Britain Province (8). Clearly, it is essential to establish the true microfilarial periodicity in the Hagahai. For this purpose, additional subjects and sample blood collection procedures will be required.

The elucidation of the epidemiology of filariasis in the Hagahai illustrates the difficulties and requirements of such investigations on isolated hunter-gatherer/semi-settled groups. Our study reveals the necessity of an integrated multidisciplinary effort by biomedical and behavioural scientists. Such an integrated approach will be of even greater importance when control measures, and assessment of the programme, are devised and applied.

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Résumé

La filariose de Bancroft dans un groupe semi-nomade isolé de chasseurs-cueilleurs pratiquant l'horticulture

On sait peu de chose sur l'épidémiologie de la filariose lymphatique dans les groupes isolés de semi-nomades chasseurs-cueilleurs pratiquant l'horticulture. Le présent article expose les résultats d'une étude de la microfilarémie bancroftienne chez les Hagahai, une tribu pratiquant la chasse, la cueillette et l'horticulture dans une région isolée de Papouasie-Nouvelle-Guinée. Ces résultats ont été obtenus par la technique de filtration sur membrane. Le tableau épidémiologique présente plusieurs caractéristiques inhabituelles. Premièrement, dans la population adulte, les hommes ont un taux de microfilarémie nettement plus élevé que les femmes (68,8% contre 30,5%) tandis que la densité microfilarienne moyenne est approximativement la même pour les deux sexes et que la proportion des infestations à faible densité (<50 mf/ml) est de 29% et 18%, respectivement, chez les hommes et chez les femmes. Deuxièmement, on observe très peu de cas de microfilarémie décelable chez les enfants de moins de 15 ans: deux résultats positifs seulement ont été trouvés chez les 25 enfants examinés. Les deux enfants microfilarémiques étaient

des garçons et dans les deux cas la densité microfilarienne était faible (1 mf/ml). On peut supposer que ces différences liées à l'âge et au sexe s'expliquent par des différences de comportement, et notamment par le fait que la chasse est une activité exclusivement masculine.

Une constatation inexplicable est la périodicité matutinale de la microfilarémie. En effet, on a observé un maximum vers 6 heures du matin chez deux volontaires sur lesquels on avait prélevé des échantillons de sang toutes les deux heures pendant 24 heures.

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