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Wuchereria bancrofti infection in human and mosquito populations of a Polynesian village ten years after interruption of mass chemoprophylaxis with diethylcarbamazine

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Abstract

In 1991, a study on *Wuchereria bancrofti* microfilariae (mf) and infection rates was carried out in the human and mosquito populations of a Polynesian village where, 10 years before, the mf prevalence rate was 6·4% and twice-yearly mass treatment with 3 mg/kg of diethylcarbamazine (DEC) was interrupted. Venous blood samples were collected from 575 (97%) individuals aged 15 years or more, of whom 122 (21·4%) were mf positive. The mf carrier prevalence rate was 27·4% in males, significantly higher than that of 14% in females; it increased from 7–12% in the youngest age group (15–19 years) to 40–50% in the oldest (≥60 years) for both males and females. 387 mosquito collections were performed and 1748 female *Aedes polynesiensis* were dissected, of which 1176 were parous. Among the latter, 114 (9·7%) were infected with *Wuchereria bancrofti* larvae at L1, L2 or L3 stages. The mean number of larvae per mosquito was 2·46 (range 1–15). Of the 114 infected mosquitoes, 30 harboured L3 larvae, giving a 2·55% infective rate; the mean number of L3 larvae per mosquito was 1·15 (range 1–2). Such findings indicate that the interruption of systematic twice-yearly mass treatment with DEC (3 mg/kg) has resulted, after 10 years, in a substantial increase of microfilarial prevalence in humans, and in high infection rates in mosquitoes.

Introduction

In French Polynesia, lymphatic filariasis due to subperiodic *Wuchereria bancrofti* var. *pacifica* is transmitted by the vector mosquito *Aedes polynesiensis*. Between 1950 and 1970, filariasis control programmes were implemented, based on the distribution of diethylcarbamazine (DEC) using various dosages and schedules, mainly 3 and 6 mg/kg doses of DEC given either daily for 6 d every 6 months or monthly for 12 months to the whole population; in some islands, selective treatments with 3–6 mg/kg of DEC were given to microfilariae (mf) carriers only (SAUGRAIN & OUTIN-FABRE, 1972; MERLIN *et al.*, 1976). Since the mid 1970s the filariasis control strategy has become the twice-yearly administration of single doses of 3 mg/kg of DEC to the whole Polynesian population. As a result of these different strategies, the mf carrier prevalence rate, which was estimated to be around 30% by the beginning of the 1950s, fell to 0·3–2% in the population of Tahiti, the main island (PEROLAT *et al.*, 1986). Nevertheless, in remote valleys and villages of several islands, lymphatic filariasis is still endemic. The aim of this paper is to report the results of a study on the mf carrier prevalence rate in the human population and the *W. bancrofti* infection rate in the mosquito population of Opoa, a remote village of one of the Leeward islands where, because of logistical constraints, systematic twice-yearly administration of DEC was interrupted in 1980.

Material and Methods

The coastal village of Opoa extends over some 12 km between mountain and sea and is located about 30 km from the main town on Raiatea island. According to the 1988 census, its population was 978. The last mf carrier prevalence evaluation, performed in 1980, indicated that, of 414 adults sampled (by 20 mm^3 finger-prick blood samples), 28 (6·4%) were mf positive (mf were seen in stained blood films). That evaluation was routinely performed on as many inhabitants as possible, without using randomization.

In January–February 1991 a team of one physician and one health worker visited each house of the village to update the census, to establish a map indicating the location of each house, and to collect venous blood samples from all inhabitants aged 15 years or more. Samples were sent every day to the Institut Malardé in Tahiti where 1 ml of blood was filtered through a Nuclepore® membrane which was then stained by the Giemsa method for counting microfilariae. The filtration technique was chosen, because it is by far the most sensitive for determination of mf (DESOWITZ *et al.*, 1973); microfilaraemia was determined only in subjects aged 15 years or more on the assumption that the mf carrier prevalence in a population reaches a plateau at the age of 10 years (SOUTHGATE, 1974) and because of the reluctance of parents to have venous blood samples collected from children.

Simultaneously, a team of 2 entomologists and 3 local workers spent 3 weeks in the village. Every day, wild *Ae. polynesiensis* were caught using the human bait collection technique (BONNET *et al.*, 1956) at 182 predetermined collection sites (149 inside and 33 outside the village, the last mainly in plantations and at bus stops); at each site, mosquito biting collection was performed at least twice during the study, at different hours of the day. Mosquitoes were dissected daily and assessment of parity made by examination of the ovaries. Parous females were then dissected for counting *W. bancrofti* larvae in the stomach (L1 larvae), in the thorax (L1 'sausage' stage, L2 and L3 larvae) and in the head (L3 larvae). Mosquitoes which could not be dissected on the spot were kept on silica gel and subsequently dissected at the Institute.

Results

The house-by-house census indicated that, in 1991, the population usually living in the village was 935 (495 males and 440 females), distributed in 146 houses. Among these 935, 595 (327 males and 268 females) were aged 15 years or more, of whom 577 (97%) permitted venous blood collection. Microfilaraemia was determined with 571 samples (314 males and 280 females): 122 subjects were mf positive, which gives a mf carrier prevalence rate of 21·4%. The distribution of mf positive individuals was uniform in the village, the 122 carriers living in 72 of the 146 houses. The maximum number of mf carriers per house was 5 (2 houses), followed by 4 (2 houses), 3 (5 houses), 2 (26 houses) and finally 1 (37 houses).

Numbers and percentages of mf carriers and microfilarial counts according to sex and age are shown in the Table. The percentage of carriers was significantly higher in males than in females, whether considering the whole population sampled ($P<0·001$) or the specific age groups ($P<0·001$). Roughly, this percentage increased steadily from 7–12% in the youngest age group (15–19 years) to 40–50% in the oldest (>60 years).

During the 3 week entomological survey, 387 mosquito collections were performed and 1787 female *Ae. polynesiensis* were caught, of which 1748 were dissected. These 1748 comprised 572 nulliparous (32·7%) and 1176

Table. Distribution of *Wuchereria bancrofti* carriers and microfilarial counts according to sex and age, amongst the inhabitants of Opoa village, French Polynesia, 1991

Age group (ycars)	Total				Males				Females			
	Carriers		Microfilaraemia[a]		Carriers		Microfilaraemia[a]		Carriers		Microfilaraemia[a]	
	No.	Percent	Mean[b]	Range	No.	Percent	Mean[b]	Range	No.	Percent	Mean[b]	Range
15–19	12	9·4	125	1–4131	8	11·8	360	1–4131	4	6·6	15	1–221
20–29	17	11·1	98	1–7055	17	18·9	98	1–7055	0	0	–	–
30–39	21	21·6	1280	295–6954	17	34	1256	510–5897	4	8·5	1385	295–6954
40–49	18	29	131	1–8160	11	29·7	234	1–8160	7	28	52	1–5304
50–59	26	37·7	861	3–7769	19	55·9	789	3–7344	7	20	1091	5–7769
≥60	28	45·2	373	2–7616	14	40	291	2–7616	14	51·8	479	12–6664
Total	122	21·4	352	1–8160	86	27·4	387	1–8160	36	14	280	1–7769

[a]Microfilariae/ml.
[b]Geometric mean micrfilaraemia.

parous females, of which 114 (9·7%) were infected with *W. bancrofti* larvae at L1, L2 or L3 stage. The mean number of larvae per mosquito was 2·46 (range 1–15). Among the 114 infected mosquitoes, 30 harboured L3 larvae, thus giving an infective rate of 2·55%; the mean number of L3 larvae per mosquito was 1·15 (range 1–2).

Discussion

With respect to *W. bancrofti* infection in the human population, the first finding to emerge from our data is the high (21·4%) mf prevalence rate compared to that of 6·4% in 1980 (evaluated by mf counts in 20 mm^3 finger-prick blood samples) at the time when systematic distribution of DEC to the population was stopped. From early and recent studies (YORKE & BLACKLOCK, 1917; EBERHARD *et al.*, 1988) it is assumed that distribution of microfilariae between venous and capillary blood systems is very uneven and that conversion from capillary to venous mf counts might be misleading. In fact, while examination of larger volumes of venous blood permits the detection of higher number of infected persons (DESOWITZ *et al.*, 1973; SOUTHGATE, 1974), mf concentrations are very likely to be higher in finger-prick than in venous blood (EBERHARD *et al.*, 1988). However, from the results of the present study, it may be assumed that the interruption of the twice-yearly mass chemoprophylaxis has resulted in a substantial increase of mf prevalence in the adult population of Opoa village.

Higher mf prevalence rates in males than in females have already been reported (SOUTHGATE, 1974; SAMARAWICKREMA *et al.*, 1987b), the explanation being that males are more often exposed to mosquito biting during their daily activity, mainly in plantations. Moreover, at the beginning of 1990, about 100 persons, mainly pregnant women and their young children, were given a dose of 3 mg/kg of DEC. This may also explain the absence or scarcity of microfilaraemia in females between 20 and 39 years of age. The fact that mf prevalence rate increased steadily with age to reach a maximum in both males and females of 50 years of age or over remains difficult to explain. Such a constant increase is not consistent with the findings of SOUTHGATE (1974) in Fijian *W. bancrofti* carriers. From the results of that study, using the membrane filtration technique, the maximum mf prevalence rate was in the 10–12 years age group; in older age groups only mf densities fluctuated. Also, in a recent study in India by PANI *et al.* (1991), a maximum mf prevalence rate of 10–12% was observed in both male and female *W. bancrofti* carriers in the 10–19 years age groups, and it remained roughly stable in the older age-groups. In another recent study in China (LIU *et al.*, 1991) the mf prevalence rate rose with age in *W. bancrofti* carriers but not in *Brugia malayi* carriers; microfilaraemia was not determined by the membrane filtration technique. Finally, in one study only the mf carrier rate peaked in the oldest age group (≥41 years) of a Papuan population to a level as high as 90%, but it was already 62% in the ≤10 years age group (KAZURA *et al.*, 1984).

Concerning *W. bancrofti* infection in mosquitoes, the 9·7% rate we found in *Ae. polynesiensis* is not very different from those found in *Culex quinquefasciatus*, either in north Trinidad (NATHAN *et al.*, 1987) or in China (FAN, 1990), which were respectively 6·4 and 10·3%, but much higher than that of 0·84% found in *Ae. polynesiensis* in Samoan villages (SAMARAWICKREMA *et al.*, 1987a). Also, the 2·48 mean worm load per mosquito found in the current study was roughtly similar to those observed in *Cx quinquefasciatus* in China and in Trinidad (6·4 and 5 respectively). Finally, the 2·55% rate of infective L3 larvae in *Ae. polynesiensis* was not very different from that of 6·4% observed in *Cx quinquefasciatus* in China, but much higher than those observed in *Cx quinquefasciatus* in Trinidad (0·1%) or in Samoan *Ae. polynesiensis* (0·27%).

In conclusion, our findings indicate that, after 10 years, the interruption of mass treatment with DEC spaced doses has resulted in a substantial increase of the mf prevalence rate in humans, which has reached a level higher than 20%, and in high infection and infective rates in mosquitoes. They also show that the transmission of lymphatic filariasis is very active in the village and that adequate mass treatment should be promptly resumed, the efficacy of which should be evaluated in humans and mosquitoes.

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