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Short Report

Migration and dispersal of lymphatic filariasis in Papua New Guinea

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Lymphatic filariasis is among the 6 diseases which the World Health Organization has recently declared can potentially be eliminated as public health problems (OTTESEN *et al.*, 1997). Reaching this target with the available interventions, notably drugs such as diethylcarbamazine (DEC), ivermectin and albendazole, which are not totally effective as macrofilaricides, will require widespread and sustained effort. In Papua New Guinea, any community with a single case of lymphoedema or hydrocoele meets the Department of Health's criterion for inclusion in the mass treatment programme (ANONYMOUS, 2000). This programme is currently in an assessment phase, determining endemicity. Although successful models are available (BOCKARIE *et al.*, in press), implementation throughout the necessary rural areas will be challenging. Any areas in which control is not maintained could act as reservoirs for dispersal to other parts of the country. Similar phenomena have already been observed in India (SHRIRAM *et al.*, 1996), and recognized as a risk in Brazil (BRACCO *et al.*, 1999). The problem could be compounded if filariasis is not an existing well-recognized problem in the destination areas.

To investigate the potential magnitude of this phenomenon in Papua New Guinea, we analysed migration data from a community-based trial of DEC and ivermectin in rural parts of the Urat and Urim census districts of East Sepik Province (BOCKARIE *et al.*, 1998). The study area consists of steep forested ridges, where most people engage in shifting subsistence agriculture, with some cultivation of cash crops. We considered long-distance movements beyond the 2 (East and West) Sepik provinces, a region not linked to the rest of the country by road. In practice, such movements require embarking by sea or air from Wewak, the capital of East Sepik Province, which can be reached from the study area by a partially paved road. Travel to Madang town, the nearest main destination (Figure), takes 5 h by road and 18 h by sea (residents of the study area would invariably travel by sea rather than air).

The Table shows such movements which occurred between 1994 and 1997 and lasted for a continuous period of at least 6 months. This type of mobility can reasonably be characterized as 'permanent or semi-permanent' and hence as migration (PRESSAT, 1985). Despite the expense and distance, at least 2·5% of the total population out-migrated beyond the Sepik region each year. Common destinations included Morobe, New Britain, the highlands region, National Capital District (NCD), Oro and Madang (Figure). The vast majority of migrants to Morobe went to the provincial capital Lae, while those to New Britain commonly engaged in the oil palm industry. Most (61%) of the migrants were male, and the average age was 23 years for males and 22 for females. To quantify the potential transfer of infection, the Table includes the microfilarial status of the 255 (78%) who were tested (by membrane filtration) before any treatment. The overall pre-treatment prevalence was 39%. Since some people did not move until after treatment, this represents the potential transfer, had treatment not occurred.

To assess the impact of migration from endemic rural areas to urban settlements, we studied the infection status of migrants, from different parts of the country, living in one hamlet in a squatter settlement located on the outskirts of Madang town. We used the filter paper-based, *Wuchereria bancrofti*-specific, antigen ELISA method (TROPBIO, 1996) to determine infection prevalence in the hamlet, which had a population of 126 migrants. High population density and poor-quality makeshift housing characterized the settlement, as they do in other unplanned locations elsewhere in the country

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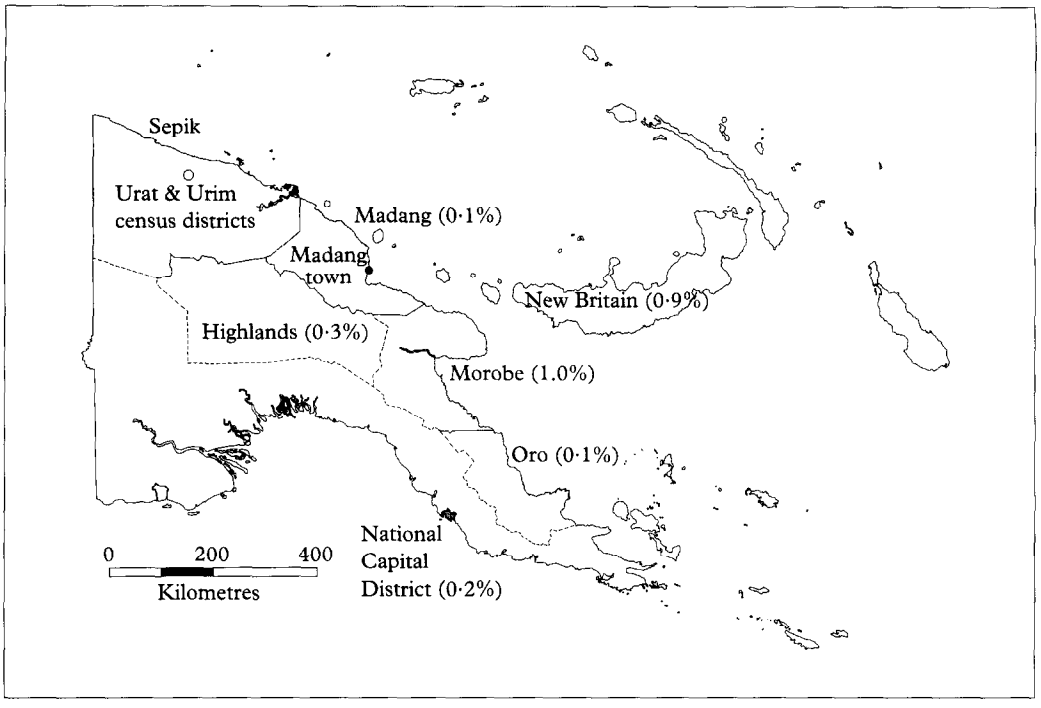

Figure. The most common out-migration destinations from Urat and Urim census districts of East Sepik Province, Papua New Guinea (1994–97). The figures in parentheses are the annualized out-migration rates, the denominator being the mid-period total population of the study in Urat and Urim census districts. The study of urban settlement was done on the outskirts of Madang town.

Table. Number of people migrating out of the Sepik region of Papua New Guinea for spells of more than six months, broken down by destination and year

Destination[a]	Year of departure 1994	1995	1996	1997	Total[b]	Pre-treatment microfilarial prevalence (%)
Morobe	33	20	28	40	118	38
New Britain	18	30	38	25	108	35
Highlands	11	13	7	10	41	33
NCD	6	5	2	9	22	31
Oro	4	2	2	10	18	64
Madang	8	3	2	2	14	57
Other	3	2	1	1	7	40
Total[b]	83	75	80	97	328	39
Mid-period population[c]	2927	3007	3073	3109	3040	
Annual migration (%)[d]	2·8	2·5	2·6	3·1	2·7	

[a] 'Highlands' combines Eastern, Western, and Southern Highlands Provinces, plus Enga and Simbu Provinces; 'New Britain' combines East and West New Britain Provinces; and 'NCD' is an abbreviation of National Capital District.
[b] The sum of the row totals (328) is 7 less than the sum of the column totals (335), because 7 people migrated for multiple spells between 1994 and 1997.
[c] The population sizes are taken on 1 July for each of the 4 individual years, and on 31 December 1995 (mid-point of the 4-year period) for the total column.
[d] The overall migration rate for the 4 years (2·7%) is 328/3040 divided by 4.

(DUNCAN & BUKENYA, 1995). ELISAs were performed on daytime finger-prick blood samples collected on filter paper. The role of the urban filariasis vector, *Culex quinquefasciatus*, in filariasis transmission in this settlement was also investigated. Lack of a proper waste-disposal system, high rainfall and poor drainage produced favourable breeding conditions for *Cx. quinquefasciatus*. Mosquitoes were caught using the night-landing catch method; they were preserved in alcohol and later processed to determine infection with *W. bancrofti* as described by BOCKARIE *et al.* (1998).

Blood samples were obtained from people aged >9 years in April 1999. Of the 80 people involved, 39 had migrated from East Sepik Province, 32 from Madang Province and 9 from the highlands provinces. Only 2 people (2·5%) were found positive for *W. bancrofti*, one from Sepik and one from Madang Province. Two nights of mosquito collections, each of 12 h, yielded 165 mosquitoes comprising 15 *Anopheles punctulatus s.l.*, 50 *Cx. annulirostris*, 80 *Cx. quinquefasciatus* and 20 *Aedes* sp. Infective L3 larvae were not observed in any of the mosquitoes but 1 *Cx. quinquefasciatus* was infected with

a single L2 stage larva. The potential for transmission is clearly present.

Cx. quinquefasciatus, the most frequently found mosquito in this study, can be a very efficient vector of *W. bancrofti* and is also common in other parts of the country (BRYAN, 1986; LEE *et al.*, 1989). It is more capable than *Anopheles* vectors of initiating filariasis transmission under conditions of low prevalence and intensity of microfilaraemia (WHO, 1992). Urbanization favours breeding of this species, which is an increasingly important vector of filariasis in other parts of the world (WHO, 1992). This species (formerly known as *Cx. fatigans*) has only relatively recently been introduced to New Guinea (DE ROOK & VAN DIJK, 1959), and local strains of *W. bancrofti* have so far been unable to use it efficiently (MCMILLAN, 1960; BRYAN, 1986). Nevertheless, some larvae do succeed in reaching the infective stage, both experimentally and in the wild (BACKHOUSE & HEYDON, 1950; BRYAN *et al.*, 1995), and the consequent potential for establishment of urban foci has been recognized since the 1950s (DE ROOK & VAN DIJK, 1959).

It has been suggested that areas from which filariasis has been eradicated are not necessarily re-infected rapidly from neighbouring uncontrolled ones (KWAN-LIM *et al.*, 1990). This may be the case where *Anopheles* mosquitoes are the only vectors, for example where eradication was a by-product of residual insecticide spraying against malaria (BOCKARIE, 1994). On the other hand, Indian migrants have been observed to initiate transmission at their destinations where *Cx. quinquefasciatus* was the only vector (SHRIRAM *et al.*, 1996). Our findings suggest that even relatively small areas omitted from control programmes, perhaps for logistical reasons such as inaccessible terrain (which applies to parts of Urat and Urim), may have the potential to disperse filariasis. Health authorities should be alert to the possible appearance of new foci, including urban ones which would be of particular concern (MOTT *et al.*, 1990). The present data suggest that this may be an emerging problem in Papua New Guinea.

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