The resurgence of lymphatic filariasis in the Nile delta

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A study of 325 000 residents of 314 villages in six governorates of the Nile delta area of Egypt revealed that the prevalence of lymphatic filariasis increased from <1% in 1965 to >20% in 1991, especially in the governorates of Qalyubiya, Monufiya, Dakhaliya, and Giza. The distribution of the communities with endemic filariasis is focal. Clusters of villages with high prevalences are surrounded by others in which the disease is absent, although their environmental, social, and agricultural features appear similar. The article analyses why the significant decline in filariasis between 1945 and 1965 in Egypt has been followed by a resurgence of the disease.

Introduction

Periodic lymphatic filariasis caused by *Wuchereria bancrofti* has been endemic in Egypt since Pharaonic times. However, before the discovery of the *W. bancrofti* life-cycle all evidence of the occurrence of the disease was based on sporadic observations of its clinical manifestations, i.e., elephantiasis of the limbs and genitals (*1*). A comprehensive account of the history of filariasis in Egypt up to 1978 has appeared previously (*2*).

Although clinical, pathological, and parasitological research on filariasis was carried out in Egypt during the early part of this century, significant epidemiological and entomological studies were not carried out before the 1930s (*3, 4*). These investigations led to the identification of *Culex pipiens* as the main vector of the disease and also revealed that the distribution of filariasis in the country was highly focal (*1, 5*).

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In Egypt, surveys of filariasis using combined measurements of the microfilarial (mf) rate and of the frequency of clinical manifestations were conducted in many non-randomly selected communities. The results provided a sketchy panorama of the distribution of the disease. Foci with high levels of endemicity were scattered in the densely populated area of the Nile delta, and mf rates of 20% or more occurred, especially in the governorates of Qalyubiya, Sharkiya, Dakhaliya, and Damietta. In contrast, filarial infections appeared to be absent in most parts of middle and upper Egypt, with the exception of a small hypoendemic area in the governorate of Asyût. By 1936, filariasis was recognized as a major public health problem in Egypt and measures for its control were taken by the Ministry of Health.

Between 1950 and 1965, a large-scale filariasis control programme was carried out in the endemic areas. The control methods comprised mass treatment with diethylcarbamazine citrate, vector control by residual house-spraying and larviciding, and source reduction through the elimination of artificial *C. pipiens* breeding sites. General public health measures with a broad impact on disease prevention were also introduced on a national scale. These measures included the creation of safe water supply systems, as well as better sanitation, waste disposal, and agricultural irrigation practices. The improvements in the health status resulting from these changes were further strengthened by a nationwide health education programme. The effects of widespread application of insecticides against agricultural pests in the rapidly expanding areas of land that were cultivated for cash crops also helped to reduce both the size of the vector population and the intensity of filariasis transmission.

The impact of all these activities on filariasis was mirrored by a steady decline of the disease in all previously identified endemic areas of the country (*5–8*). Between 1955 and 1964, the decrease in the mf rates and in the prevalence of clinical filariasis was investigated in a series of epidemiological surveys in most of the affected areas. A sample consisting of more than 500 000 persons was involved, from whom blood specimens were taken and who underwent a brief physical examination (*9, 10*). Although the decrease in the prevalence was impressive in all parts of the country, the residual prevalence was never reduced to zero in many of the old endemic foci in the Nile delta.

The public health importance of these communities with low endemicity levels of filariasis appeared insignificant to the authorities and the medical profession. This impression was enhanced by health statistics which used the small numbers of reported cases of filariasis in individual communities as numerators to calculate the prevalence for populations of whole districts and governorates. Because of the focal distribution of the disease, the filariasis rates reported for the larger administrative divisions were too low and not representative of the real situation. Eventually, use of this approach led to the erroneous conclusion that filariasis was a rapidly disappearing disease in Egypt. This opinion was also expressed by the WHO Expert Committee on Filariasis in 1984 when it stated that the microfilaraemia rate in Egypt was less than 1% in the population of the endemic areas (*11*).

Since 1974, a number of small spot surveys for microfilaraemia and clinical signs of filariasis have been carried out in several parts of the Nile delta. The results revealed that the downward trend of the disease had stopped. Moreover, in some of the villages of Qalyubiya governorate there were clear indications that both the prevalence and the intensity of microfilaraemia had increased (*12–15*). These observations prompted the Ministry of Health to reorganize and intensify its active surveillance of filariasis. The results of these surveys and of some intensive epidemiological studies in selected villages are reported in this article.

Materials and methods

Between 1985 and 1991, Ministry of Health surveillance teams took blood samples from 324 552 individuals who lived in 314 villages and towns in the Nile delta area. From each person a 20-μl fingerprick sample of blood was taken during the peak of periodic microfilaraemia, preferably between 22 h 00 and 02 h 00. The blood samples were stained with Giemsa and examined for *W. bancrofti* microfilariae; the results were recorded as positive or negative. Physical examinations for clinical manifestations of filariasis were not carried out by the survey teams.

The population samples ranged from 1550 to 27 837, and included only persons above 1 year of age who resided in the administrative districts shown in Table 1. Although attempts were made to obtain representative samples from all residents in each community, the necessity of visiting the families late at night reduced the compliance rate and introduced an unknown degree of bias. Follow-up examinations in some of the villages by teams from Ain Shams University 1–2 years after the Ministry of Health visits yielded mf rates that were similar to those found previously. Table 1 summarizes the demographic data for the population in the districts that were covered by sample surveys up to July 1991. The demographic data were obtained from the official report of the 1986 census (*16*).

Estimates of the prevalence of filariasis based on mf rates in fingerprick samples of blood are insensitive, since this approach does not permit detection of patent infections where the mf density is low, and the results are negative also for the majority of clinical cases. Efforts were therefore made to improve the prevalence estimates by applying an adjustment factor to the crude mf rates determined in the Ministry of Health surveys. This factor was calculated using the results of a study of 427 residents of the village of Kafr Tahoria, where the following diagnostic tests were compared by independent groups of investigators (*19*): physical examination for the clinical lesions caused by filariasis; standard microscopic examination for microfilariae in 50-μl samples of stained, thick blood smears; Nuclepore ® filter concentration using 1-ml venous blood samples to detect microfilariae; and a monoclonal antibody assay that had been thoroughly evaluated in the laboratory and under field conditions in India and Egypt (*17, 18*). Fig. 1 summarizes the estimated frequency of filariasis obtained using each of these methods. A detailed description of the evaluation has been published previously (*19*). The antigen test had the highest relative sensitivity, covering the entire spectrum of filariasis. However, both the parasitological and the antigen tests failed to detect the majority of clinical cases. To date, there have been no indications of false-positive reactions in the continuing validation of the filarial antigen test using blood samples from persons with patent *Schistosoma haematobium, S. mansoni, Ascaris lumbricoides, Trichuris* spp., *Oxyuris* spp., hookworm, or intestinal protozoal infections. The high specificity of the monoclonal antigen assay is further supported by reports of significant reductions in antigen titres following effective antifilarial treatment (*19*). The systematic validation of this assay is continuing.

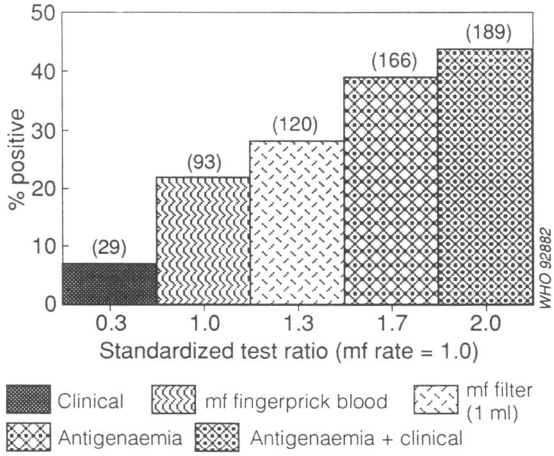
Table 1: **Census populations and sample sizes of the populations included in the filariasis surveillance programme**

Governorate and district	Population: Census total[a]	Population: Sample size
Qalyubiya		
Shibin	192 751	21 213 (11.0)[b]
Khanka	76 281	14 486 (19.0)
Qalyub	160 992	15 076 (9.4)
Kaireiha	148 686	7702 (5.2)
Benha	217 161	16 727 (7.7)
Tukh	246 944	27 288 (11.1)
Shubeira	300 416	5898 (2.0)
Kafr Shukr	76 282	1550 (2.0)
Subtotal	1 419 514	109 940 (7.7)
Dakhaliya		
Mit Gahmr	303 981	11 575 (3.8)
Monofiya		
Qisna	204 600	14 221 (7.7)
Ashmun	319 673	13 866 (4.3)
Bagur	167 505	15 243 (9.1)
Monofiya	213 137	6156 (2.9)
Shuhada	130 956	10 725 (8.2)
Subtotal	1 035 871	60 211 (5.8)
Gharbiya		
El Santa	100 000	5587 (5.6)
Zifta	100 000	18 437 (18.4)
Subtotal	200 000	24 024 (12.0)
Giza		
Badrashein	163 824	13 469 (8.2)
Ayat	170 979	10 505 (6.1)
Saff	130 729	4050 (3.1)
Giza	79 227	23 416 (29.6)
Imbaba	595 482	27 837 (4.7)
Subtotal	1 140 241	79 277 (7.0)
Sharkiya		
Zkalik	58 696	4053 (6.9)
Abu Hammad	214 802	11 157 (5.2)
Bilbeis	100 887	10 615 (10.5)
Minya El Kam	86 182	13 700 (15.9)
Subtotal	460 567	39 525 (8.6)
Total	4 560 174	324 552 (7.1)

[a] Census totals are for 1986; see ref. *16*.
[b] Figures in parentheses are percentages.

Determination of the mf rate has been the basic method used in the surveillance programme in Egypt and has remained the most widely used screening test elsewhere (*20*). Therefore, in calculating the adjustment factor for estimating the prevalence of filariasis we assigned a relative test ratio of 1.0 to the crude mf rate (Fig. 1). By comparison, the corresponding value of the relative test ratio for the combined tests was 2.0. Accordingly, the crude mf rates for the Ministry of Health surveys were adjusted by this factor to obtain a more realistic estimate of the prevalence of filariasis in the Egyptian communities studied. The adjusted figures obtained are conservative estimates of the prevalence, because in the Ministry of Health surveys the mf rates were based on 20-µl fingerprick blood samples instead of the 50-µl samples used in the evaluation study of the four diagnostic tests.

Fig. 1. **Estimated frequency of filariasis in the village of Kafr Tahoria, according to the results of various diagnostic tests**. Figures in parentheses are the number of positive tests for filariasis in a sample of 421 persons.



To obtain a comprehensive overview of all the results of the surveillance programme in the southern Nile delta, we determined the exact latitude and longitude of each village from detailed maps of the area. The estimated prevalence ratios were then coded into four categories of endemicity. Using a digitizer and Generic Cadd 5 ® software,[a] we plotted these values on a computerized scale map of the area, using the exact geographical coordinates of each village.

Results

Of the 324 552 persons examined by the Ministry of Health teams, 8191 (2.5%) had *W. bancrofti* micro-

[a] Available from: Generic Software Inc., Bothwell, WA 98011, USA.

filariae in the 20-µl fingerprick blood samples. The crude mf rates for the 314 villages examined by the teams ranged from 0% to 23%. The frequency distributions of these rates are shown separately for each of the six governorates in Fig. 2.

A comprehensive map with the adjusted estimates for the prevalence of filariasis in each village is depicted in Fig. 3. The observed distribution of filariasis in the southern Nile delta is prominently focal, with clusters of high endemicity in the governorate of Qalyubiya. Individual foci of high prevalence exist also in the governorates of Giza, Monufiya and Dakhaliya. The clustering of filariasis in Egypt has previously been noted by Khalil et al. (*5*), Baz (*4*), and Shawaby et al. (*9*). The reasons for these large differences in prevalence between apparently similar villages that are located only a few miles apart are not clear. A tendency for familial aggregation of filariasis cases has also been observed within individual communities.

Fig. 2. **Frequency distribution of crude microfilarial (mf) rates in 314 villages in six governorates in the Nile delta**. Figures in parentheses are the number of villages surveyed in each governorate.

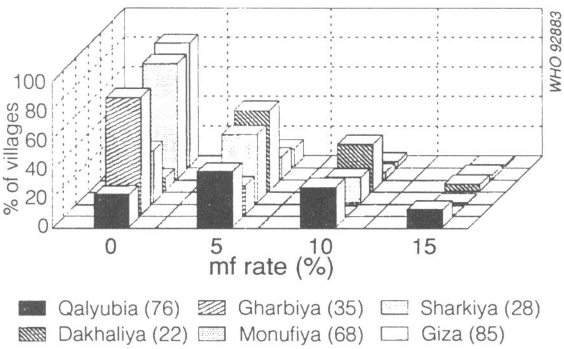
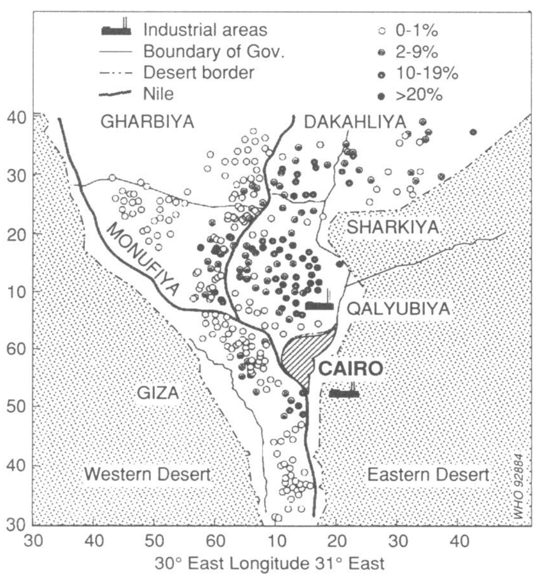


Fig. 3. **Map showing the geographical distribution and prevalence of filariasis caused by *Wuchereria bancrofti* in the southern Nile delta.**



The main vector of filariasis in Egypt in the Nile delta, *C. pipiens*, has an uneven distribution in natural and artificial breeding sites in endemic and non-endemic villages. Recent findings have identified the relative importance of indoor breeding of the vector as a significant risk factor in the transmission of *W. bancrofti* (A.M. Gad, unpublished findings, 1992).

Using the value for the prevalence of filariasis together with the latest census data for the districts in which sample surveys were performed, we estimated the total number of cases expected and the population at risk. The number of filariasis cases was estimated by applying the prevalence ratios for the individual districts to their corresponding populations. For this purpose, the population data were trimmed to include only the rural segments of the district and only those aged >1 year. The numbers of the expected cases in the districts were then combined for each governorate; the results are shown in Table 2.

Based on the available data, the total size of the population at risk was estimated to be 3.65 million. These calculations are confined to the currently known endemic areas and provide a conservative assessment of the magnitude of the recurrent filariasis problem in the Nile delta. In many villages where polyparasitism has prevailed, filariasis is now the most prevalent parasitic infection, surpassing even schistosomiasis.

Table 2: **Estimated number of filariasis cases in six governorates in the southern Nile delta**[a]

	No. of cases estimated[b]	
Governorate	1986[c]	1991
Qalyubiya	87 100	99 300
Dakhaliya	28 500	32 500
Monufiya	24 700	28 100
Gharbiya	3300	3700
Giza	19 200	21 900
Sharkiya	49 900	56 900
Total	212 700	242 400

[a] Includes only persons >1 year of age from districts with recent surveillance records.
[b] Based on a crude annual growth rate of 2.65%.
[c] Based on the 1986 national census report.

Discussion

As late as 1990, when it was already known that there were foci of filariasis with high levels of endemicity in Egypt (*1, 9, 12, 16*), the general belief still prevailed that filariasis was a disease of little public health importance in the country. This opinion was held also by many doctors who no longer included filariasis in their differential diagnostic considerations (A. Khjer, personal communication, 1991). Of the many factors that have been associated with the decline and subsequent resurgence of lymphatic filariasis in Egypt, a few have been identified as major determinants in the epidemiology of the disease.

The environmental improvements that took place between 1936 and 1965 in Egypt, combined with specific measures to control filariasis over this period, led to sizeable reductions in the prevalence of the disease (*9*). However, even in 1965 there were districts in the eastern Nile delta where the mf rates were >1% (*9*).

Over the past 25 years significant environmental and demographic changes have taken place that have had a profound effect on the epidemiology of filariasis in Egypt. There have been substantial increases in *C. pipiens* breeding sites in most rural and urban areas, which have considerably increased the probability of vector contact in the resident populations. Many of the environmental changes that have contributed to the explosion of the vector population are directly related to the creation of the Aswan High Dam. There has been an extension and intensification of irrigation for increased agricultural production, and this has raised the groundwater table resulting in poor and delayed drainage of ditches, heavily polluted stagnant pools, and wastewater puddles where the vector mosquitos breed. At the same time, the extensive agricultural use of pesticides has introduced resistance to a broad range of vectors, including *C. pipiens* (*21, 22*).

In the affected areas there have been large increases in the populations of rural and urban communities caused by a natural growth rate of 2.65% per annum and migration.

The impact of the environmental and demographic changes on the quality of sanitation has been considerable, especially in rural communities and in the rapidly growing periurban fringes of metropolitan areas. The ensuing increase in water consumption, accompanied by inadequate disposal of human waste and wastewater have enormously increased the vector breeding sites. The problem is further aggravated by the large number of residents in rural and periurban locations who commute between their homes and places of work. This has led to a steady influx of infected persons from endemic areas close to Cairo into the metropolitan area. The recent report of *C. pipiens* caught carrying *W. bancrofti* L_3 larvae in the outskirts of Cairo (A. Gad, unpublished observations, 1989–90) suggest that active transmission of urban filariasis has probably already occurred.

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Résumé

Résurgence de la filariose lymphatique dans le delta du Nil

Le déclin spectaculaire de la filariose de Bancroft en Egypte entre 1935 et 1965 a été le résultat d'un ensemble de mesures générales de santé publique (adduction d'eau, assainissement, évacuation des déchets et des eaux usées, irrigation) et d'un programme de lutte contre la maladie combinant les traitements de masse et la lutte antivectorielle. A partir de 1965, la surveillance de la filariose est devenue fragmentaire et inefficace. Les résultats d'enquêtes ponctuelles limitées, effectuées dans des villages après 1975, ont montré que la tendance à la régression de la filariose endémique ne s'observait pas partout en Egypte et que la prévalence de l'infestation était en augmentation dans certains foyers anciens. Afin d'évaluer l'ampleur du problème, le Ministère égyptien de la Santé a remis en vigueur son programme de surveillance de la filariose dans le delta du Nil. En 1991, 314 villages de 6 gouvernorats (population totale: 4,5 millions d'habitants) avaient été couverts et des prélèvements de sang nocturnes avaient été faits sur 350 000 personnes pour rechercher la présence de microfilaires de *Wuchereria bancrofti* par examen au microscope.

Les résultats ont confirmé les observations antérieures qui faisaient état d'une augmentation de la prévalence de la filariose dans le sud du delta du Nil, où le taux brut de microfilarémie (mf) atteignait ou dépassait 20% dans certains villages. La distribution géographique des foyers d'endémie était inégale, les gouvernorats de Qalyubiya et Dakhaliya étant les plus touchés. Etant donné la relative insensibilité du test de dépistage utilisé dans ces enquêtes, à savoir l'examen d'un prélèvement nocturne de 20 µl de sang, un facteur de correction a été appliqué au

taux brut pour obtenir une estimation plus réaliste de la prévalence de la filariose. Le facteur de correction a été déterminé lors d'une étude préalable effectuée en aveugle dans un village d'endémie, étude au cours de laquelle 4 tests indépendants portant sur les manifestations cliniques, la microfilarémie et le dosage des antigènes circulants ont été pratiqués.

L'analyse des causes possibles de la résurgence de la maladie a montré que la forte augmentation du nombre et de l'étendue des lieux de reproduction de *Culex pipiens*, principal vecteur de *W. bancrofti*, était le facteur le plus important dans l'épidémiologie de la filariose. Les recherches actuellement en cours portent sur les déterminants comportementaux, parasitologiques, environnementaux et entomologiques qui interviennent dans la dynamique de la transmission et qui régissent les facteurs de risque d'infestation et d'apparition de la maladie.

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