J. Univ. Kuwait (Sci.) **16**, 1989

The status of malaria in Bahrain, Arabian Gulf

OMAR M. AMIN

Department of Biological Sciences, University of Wisconsin-Parkside, Box 2000, Kenosha, Wisconsin 53141, U.S.A.

ABSTRACT

Indigenous malaria, endemic in Bahrain for many decades, has been eliminated since 1980. Imported cases associated with expatriate labor, first reported in 1948, have reached a stable plateau of over 300 cases a year since 1977. This report critically examines the current practices of malaria control activities in Bahrain and puts forth, in light of the present maintenance phase, a set of recommendations for a more efficient and cost-effective program. These recommendations deal with the application of integrated pest control management principles, mechanical and biological control, reduced residual spraying, selectivity of blood sampling to screen gametocyte carriers, and the establishment of a new Medical Zoology facility to conduct basic systematic, seasonal, distributional, and insecticide resistance studies.

INTRODUCTION

The situation regarding indigenous malaria in Bahrain was first surveyed in 1938 (Afridi 1938). Larvicidal measures started in 1938, drainage and filling in 1942, DDT spraying in 1947 and residual spraying in 1954. Annual reports of the Bahraini Public Health Directorate list the first imported case in 1948 but systematic documentation of imported cases began only in 1963. Changes in the state of malaria in Bahrain were documented by various WHO observers (Delfini 1977; Shidrawi 1978; Oddo & Payne 1982). This report assesses and characterizes the current status of malaria in Bahrain and proposes certain measures for its control. It is based on the findings of research conducted during the autumn and winter of 1986–1987 (Amin 1986).

BACKGROUND AND METHODS

The archipelago of Bahrain comprises 35 low-lying islands which were once part of the northeastern seaboard of the Arabian Peninsula in earlier geological times; similarities in the composition of the arthropod vector fauna are marked. The total land area is 678 km^2 most of which makes up the main island of Bahrain (50 by 13–26 km). The population is approximately 400,000 of whom roughly one-third are non-Bahrainis. Extremes of daytime temperatures, relative humidity and rainfall are reached in winter (20°C, 83%, 3·1 mm) and summer (40°C, 67%, 0 mm). A minimum

of 14°C is reached in January. Cultivation is limited to a narrow strip of palm trees and vegetable gardens along the northern coast of the main island. A number of natural springs and artesian wells irrigate these gardens and their overflow forms many mosquito breeding places. The subsurface water level is shallow (often less than one meter from soil surface) and becomes more shallow in the autumn. A general reduction in the water table has been observed during the last few years. The rapid development of the country since 1960 contributed to the creation of many mosquito breeding places, e.g. construction sites, pits, landfills, storage tanks, etc. as well as poorly attended privately owned swimming pools. The southern part of the main island is semi-desert and is largely uninhabited.

Participation in and inspection of all aspects of the malaria surveillance and control activities covered all six sanitary districts (four in the main island and two in the adjacent smaller islands of Sitra and Muharraq) during the autumn and winter of 1986–1987.

RESULTS AND DISCUSSION

EPIDEMIOLOGY

The total number of indigenous cases of *Plasmodium vivax* malaria reached peaks of 197 and 329 in 1954 and 1959, respectively (Fig. 1). These peaks corresponded to and probably were a function of peaks of *Anopheles* breeding activity during the same years (Fig. 2). The seasonality of indigenous malaria showed a peak in the spring and a larger peak in the autumn corresponding with the seasonal abundance and increased breeding activity then of the local *Anopheles* mosquitoes, e.g. *A. stephensi*. The higher water table in the autumn significantly contributed to the greater mosquito population then. *Anopheles stephensi* is also known to breed in freshwater in domestic wells, storage containers and home pools where *Anophales*

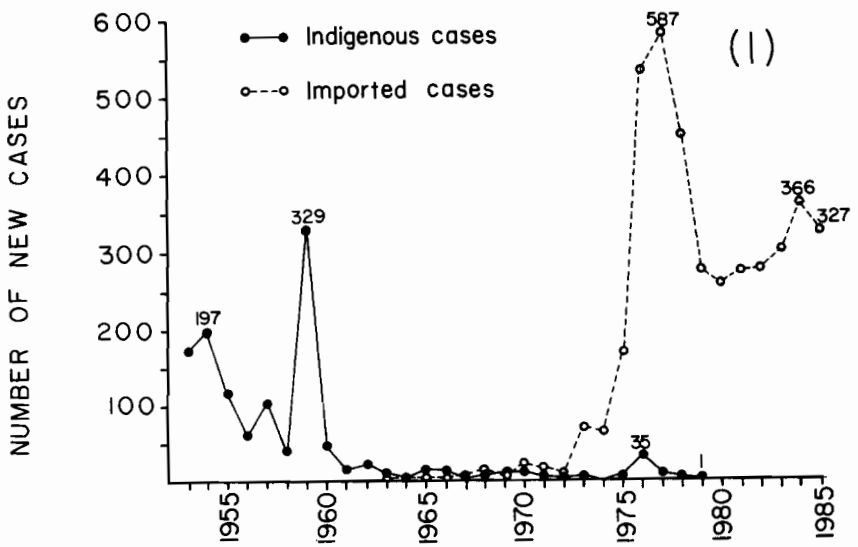

Fig. 1. Annual distribution of new cases of malaria, 1953–1985. Data were compiled from Public Health Directorate annual reports.

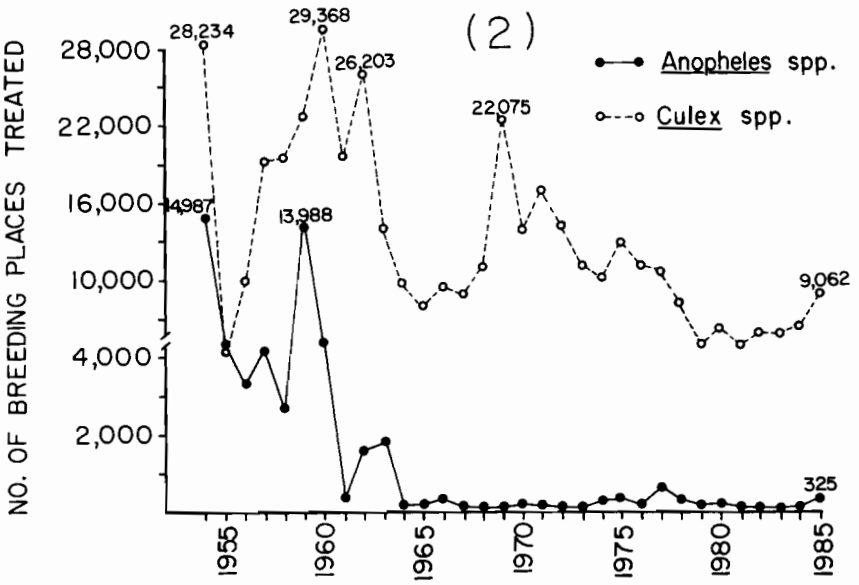

Fig. 2. The breeding activity of *Anopheles* and *Culex* mosquitoes in Bahrain, 1953–1985. Data were compiled from Public Health Directorate annual reports.

spp. were collected. No information on the seasonal or annual adult mosquito density is available.

Imported malaria was first recognized in 1948 but its systematic documentation only began in 1963 after which it progressively increased, reaching two peaks in 1977 (587 cases) and in 1984 (366) (Fig. 1) corresponding with the influx of expatriate labour, mostly from India and Pakistan. Infections are mostly with the Asian *P. vivax* strain, but occasionally other species are reported. For example, 95% of the 327 cases reported in 1985 were imported from India (174 cases) and Pakistan (137). The countries of origin of the remaining cases were Oman (4), Bangladesh (3) Sri Lanka (7), Nepal (1) and Tanzania (1). Of the above, 13 were *P. falciparum* cases from India (5), Pakistan (6), Oman (1) and Tanzania (1) (Public Health Directorate 1985). The above statistics indicate the possibility of importation of the multiple drug-resistant *P. falciparum*. The observed summer seasonal peaks of imported cases correspond with the seasonality of labour movement into Bahrain and not with the local mosquito activity. Most of these cases are reported in and around the capital city of Manama where many of the activities utilizing foreign labour are centered. The practice of screening expatriate workers, coming from malaria endemic areas, for potential gametocyte carriers was discontinued. The problems with watering practices in gardens and home pools remain significant. The present plateau of case numbers will most probably persist so long as there is a continuous importation of foreign labour from malarious areas.

The success of the malaria control program in eliminating indigenous transmission of malaria since 1980 (Fig. 1) largely by controlling the level of breeding activity of local *Anopheles* mosquitoes (Fig. 2), among other measures, is noted. In view of this, the program is considered to have reached a "maintenance" phase which

requires a fresh look at its management and reassessment of its past practices and future objectives in order to maximize its efficiency and improve cost effectiveness.

MOSQUITO VECTORS

In 1955–1957, *Anopheles stephensi*, *A. pulcherrimus*, *A. sergenti*, *A. fluviatilis*, *A. hyrcanus* and *A. superpictus* were identified from occasional field collections. The first three species and *A. culicifacies* were reported in 1938 (Afridi 1938), but only *A. stephensi* was found infected with sporozoites. Subsequent identifications were (and still are) carried out by pest control officers, but only of larvae and only to the "genus" level (*Anopheles* and "*Culex*"); *Aedes* would be missed. Since the 1950s, the only *Anopheles* species believed to be present was *A. stephensi* until *A. pulcherrimus* was detected in 1983 and 1984. In the absence of systematic collections and identification, the actual composition of the mosquito fauna in Bahrain at the present time remains unknown.

MOSQUITO ABATEMENT

While activities to reduce the number of mosquito breeding places are periodically performed using mechanical means, e.g. clearing irrigation ditches, filling in pits, etc. priority is usually given to chemical methods. The present low level of larval *Anopheles* activity (Fig. 2) was largely achieved through the use of larvicidal oils and spreaders. The total number of potential breeding places examined, the density of larval populations, or species identification are not known. Larvicidal chemicals used in 1985 included larvicidal oil (since at least 1955), temephos (Abate Cyanamid) (since 1983), pybuthrin 8/64, 5/50 (since 1969) and Triton X45 (since 1978). Other larvicidal chemicals used during the last 30 years included DDT (1955–67), gammexane DP520, 99%, 50%, 26% (1955–64), Malastan DP25 (1962–70), Diazinon 60E (1966–68, 72–77), Mosiol (1967), Novniec (1969), floriol oil 60 (1968–77), Nuvan (1970) and dieldrin (1973–77). The lack of a clear, biologically sound, systematic plan to control larval mosquitoes is apparent.

The main active chemicals presently used to control adult mosquitoes are malathion 50% WP (since 1980) as well as pybuthrin 8/64, 5/50 (since at least 1955) and Reslin (since 1976). Other residual insecticides used during the last 30 years included pyrethrum (1955–56), gammexane P520, 99%, 50%, 26% (1955–67), Distox blue powder (1957–63), DDT commercial (1958–71), dieldrin (1961–65, 72–77) Malastan (1961–64), Omnitox (1963–74), Diazinon (1964–77), Nuvan (1967–77), fenitrothion (1971–80), Dustox powder (1974–75), fenthion (1978–80) and DDVP (1979–82). Modest attempts were made to monitor on-the-job-exposure to the potential toxic effects of such chemicals as malathion; protective measures employed were inadequate and poorly enforced. To date, no attempts have been made to establish the current status of sensitivity or resistance of local mosquitoes to insecticides being used.

Excessive reliance on chemicals to control larval and adult mosquitoes was clearly observed. Indiscriminate seasonal application of residual insecticides in whole neighborhoods or expatriate labour camps was a routine practice.

Table 1. Positive malaria cases among "contacts" and among subjects reporting with fever (1978–85)

		Examined at Public Health Laboratory			
		Contacts		Febrile subjects	
Year	Total examined	No. examined	No. positive (%)	No. examined	No. positive (%)
1978	16,052	12,652	10 (0·08)	?	?
1979	10,298	7,566	0	714	56 (7·84)
1980	10,275	6,388	2 (0·03)	995	95 (9·55)
1981	10,671	8,214	0	244	7 (2·87)
1982	9,340	6,907	2 (0·03)	23	2 (8·70)
1983	11,573	9,210	10 (0·11)	24	3 (12·50)
1984	10,864	5,850	12 (0·20)	18	2 (11·11)
1985	6,998	3,148	2 (0·06)	11	2 (18·18)
Total	86,071	59,935	38 (0·06)	2,029	167 (8·23)

BLOOD SAMPLING

Blood sampling to screen suspected "gametocyte carriers" of *Plasmodium vivax* and *P. falciparum*, particularly presumed contacts of index cases residing near mosquito breeding places, was recommended by the WHO observers (Delfini 1977; Shidrawi 1978; Oddo & Payne 1982) to continue to declare Bahrain as a malaria-free country. The numbers of blood smears collected and examined between 1978 and 1985 and the proportion which proved positive are shown in Table 1. While the overall percent positive among contacts was 0·06%, the effectiveness of detection of cases among subjects reporting sick with fever was considerably higher (8·23%). It is not known how many of the 38 positives among contacts (Table 1) were febrile during or before being sampled. Febrile subjects with no malaria were clearly feverish for other etiologies. Properly prepared and Romanovsky-stained thick films would demonstrate parasites in most cases only if taken about the time of or shortly following a bout of fever. It is clear that screening of afebrile subjects is not an effective means of case detection from a clinical or cost-effectiveness standpoint.

RECOMMENDATIONS

The following recommendations were presented to the Bahraini Ministry of Health and steps to implement them are being carried out.

(1) Application of integrated pest control management procedures giving priority to:
   (a) mechanical means for the elimination of mosquito breeding places and systematic use of larvivorous fish in large undrainable pools.
   (b) alteration or elimination of present practices of garden watering.
   (c) mechanization of ditch clearing and coordination of above activities with the Ministry of Agriculture.
   (d) selective application of residual insecticides only if the significant presence of adults in homes, camps, etc. can be satisfactorily substantiated, e.g. 2 females per room.
   (e) observing protective measures for insect controllers and the public.
   (f) adequate clinical and chemical testing of all personnel handling insecticides.

(2) Selectively restricting the practice of blood screening for detection of "gametocyte carriers" to febrile subjects or those reporting recent episodes of fever.
(3) Establishing a new Medical Zoology section within the Public Health Directorate to perform the following entomological studies:
   (a) Proper identification of local mosquito species and conducting systematic surveys in representative geographical locations (pre-designated reference pools and villages) to gain information on the population density, distribution and seasonality of larval and adult mosquitoes.
   (b) Conducting resistance tests on local mosquitoes to the various pesticides being used and those being considered for future use. The case of development of resistance to malathion and its toxicity was made.
   (c) Conduct similar studies on other arthropod vectors of actual and/or potential public health importance in Bahrain.
(4) Other recommendations detailing relevant administrative, educational, training, safety, staffing and sanitary systems needs as well as the setting up of the new Medical Zoology facility were also made and are being carried out.

ACKNOWLEDGEMENTS

I would like to express my appreciation to His Excellency the Minister of Health, Mr Jawad Al Arrayed and his staff at the Ministry of Health for their cooperation throughout the duration of this project. Special thanks are due to Dr Samir Khalfan, Office of Planning and Program; Dr Jim Keen, Adviser to the Minister; Dr Rifaat A. Mahmood, Director of Public Health; Mr Ali Anjawi, Chief of Environmental Health Section; chiefs of other Public Health sections; Mr Ayub Khan, Supervisor of Insect and Rodent Control; and Insect and Rodent control inspectors. The reported findings were developed while the author was a Fulbright Scholar at the Bahraini Ministry of Health during the autumn and winter of 1986–1987.

REFERENCES

Afridi, M.K. 1938. Final report on the Malaria Survey of Bahrain Island. Ministry of Health, Bahrain.

Amin, O.M. 1986. A report on malaria and related activities in the State of Bahrain. Ministry of Health, Bahrain, 33 pp.

Delfini, L.F. 1977. Report on a visit to Bahrain, 29 January to 4 February 1977. Ministry of Health, Bahrain, 9 pp + 4 ann.

Oddo, F.L. & Payne, D. 1982. Report on an assessment of the status of malaria eradication in the Bahrain Emirate, 22 October to 7 November 1982. Ministry of Health, Bahrain, 15 pp + 12 ann.

Public Health Directorate 1985. Annual report. Ministry of Public Health, Bahrain, 81 pp.

Shidrawi, G.R. 1978. Report on a visit to Bahrain, 31 October to 11 November, 1978. Ministry of Health, Bahrain, 16 pp.

(Received 4 October 1987, revised 29 March 1988)

الوضع الحالي للملاريا في دولة البحرين ، الخليج العربي

عمر أمين
قسم علوم الحياة ، جامعة وسكنسن بارك ساید ،
ص . ب . ٢٠٠٠ ، كينوشا ، وسكنسن ٥٣١٤١ ،
الولايات المتحدة الأمريكية

خلاصة

لقد أمكن في عام ١٩٨٠ القضاء على مرض الملاريا الذي ظل متوطنا في البحرين على مدى عدة عقود . ومنذ عام ١٩٧٧ أمكن تثبيت عدد حالات الملاريا المستوردة مع العمالة الوافدة (والتي اكتشفت لأول مرة في عام ١٩٤٨) عند حوالي ٣٠٠ حالة سنويا .

في هذا البحث نعرض للطرق المستخدمة حاليا في البحرين لمقاومة الملاريا ، ونقدم ـ في ضوء مرحلة الثبات الحالية ـ عدة توصيات لزيادة فعالية المكافحة وتخفيض نفقاتها . وتعالج هذه التوصيات استخدام مبادىء المكافحة المتكاملة للآفات ، وطرق المكافحة الميكانيكية والحيوية ، والاقلال من الرش بالمبيدات طويلة المفعول ، وتوخي الانتخابية في أخذ عينات الدم للكشف عن حاملي منشئات الأمشاج ، واقامة مراكز للحيوانات الطبية حيث تجرى دراسات تصنيفية وموسمية وتوزيعية ، ودراسات على مقاومة البعوض للمبيدات الحشرية .