

Some Aspects of the Epidemiology of Malaria in the Different Regions of Saudi Arabia

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Our results showed variation in the intensity of malaria between the different regions of the kingdom. In the Northern Region, the incidents of malaria were scarce and in the Middle Region, no incidents were observed. The Western Region, shows a regular and uniform occurrence of the disease throughout the year. The Eastern Region, although it provides favourable environments for the breeding of mosquitoes and the transmission of the disease, yet the incidents seemed to be lower than normal, this could be due to the provision of sufficient health services which led to the limitations in the spread of the disease. The situation in the Southern Region, specially Jizan sector, is very serious, this sector according to our investigations, is considered to be hyperendemic and three Anopheline species out of five identified in Saudi Arabia, were distributed throughout Jizan area.

Malaria has been a threat to mankind for many centuries. About 200 million human beings die of malaria every year (Garnham 1966). The parasite does not only kill, but it also affects the birth rate and the vitality of the infected patients. Statistical surveys show the prevalence of malaria between 45°N latitude and 40° South. The term "Malaria" embraces a group of diseases caused by several species of the genus "Plasmodium" (Laveran 1880). Some of these species, such as: *Plasmodium vivax*, *P. falciparum*, *P. malariae* and *P. ovale*, are cosmopolitan in distribution; the former three species being more common than the 4th one. The chief clinical features of the disease include chills, fever and sweats at intervals that may be as short as 36 to 38hr or as long as 72hr (Young *et al.* 1975). Thus the disease is clinically classified as benign tertian, malignant tertian and quartan. The benign tertian malaria, caused by *Plasmodium vivax* is widely

distributed in temperate zones and in the island of New Guinea (Radford *et al.* 1976). West Africa is immune to that parasite; the infection is absent from this region. The malignant tertian malaria, caused by *Plasmodium falciparum* is chiefly in the tropics where it is a great killer; it spreads up to subtropics and Europe, but practically common in Central Africa and East Asia (Garnham 1966). Both infections can occur in one person in the endemic areas. The mosquito can be infected with two or more species of the malarial parasites.

Plasmodium parasites spread to human beings by means of specific female anopheline mosquitoes; in the body of these insects the parasites, as demonstrated by Ross (1897) and Taliaferro and Taliaferro (1949), undergo a complete cycle of sporogony leading to the formation of the infective stages which propagate the infection during the feeding process of the mosquito. The efficiency of transmission of the disease depends mainly on the presence of the suitable anopheline mosquito in the first place and the occurrence of favourable environmental, ecological, physiological and biological conditions in the second place.

Malaria in Saudi Arabia

Saudi Arabia is a country that suffers from the spread of malaria disease in some regions which have suitable climatic conditions for the breeding and multiplication of mosquito vectors. Our survey studies confirmed the occurrence of the disease in some areas of West Coast up to "Khaiber" and in places like "Gatif" and "Al Hassa" in the Eastern Region and was found also in "Sikaka", "Arur" and "Tabuk" in the Northern Region. It is also quite common in the South and South Eastern Regions.

The results of some investigations carried out by United Nations experts in the field of Entomology proved the existence of fifteen species of anopheline vectors. During our current survey studies in Saudi Arabia, we have been able to identify five species of mosquitoes capable of transmitting malaria in the different regions of the country (Fig. 3 & 4).

1. *Anopheles sergenti*

It is considered as a principal vector of malaria in the Eastern Region, it has also been found in places lying along Yamen border. It becomes more active at the beginning of winter, at about October, and in summer its numbers are greatly reduced mainly because during this season dry conditions prevail and the breeding places for mosquitoes hardly exist.

2. *Anopheles gambiae*

Occurs in the South-western part of the country specially in the areas lying along the

Red Sea Coast such as "Jizan", "Tihama of Asir", "Najran" and in the valleys which extend up to 200 miles south of "Jeddah". It has also been identified in small numbers at the top of mountains (6000ft high) around "Madena". *An. gambiae* is considered to be the most efficient vector for the transmission of malaria disease. It has got high degree of tolerance and adaptability to various environmental conditions; it exists throughout the year in many areas of the country, but reaches maximum activity in November and December.

3. *Anopheles stephensi*

It is of limited distribution. It occurs in the Eastern Region in places like "Gatif" and "Al Hassa"; it has also been identified in Gasiem district of the Middle Region. This insect increases in population in October and November and then in April and May.

4. *Anopheles fluviatilis*

Before the year 1959, this mosquito was of rare occurrence in Saudi Arabia. Gradually, with time, it increased in density in the Western Region (Madena district) and in the Southern Region (Jizan district). The seasonal activity of *An. fluviatilis* was found to be similar to that of *An. stephensi*.

5. *Anopheles superpictus*

Its distribution was only limited to the Northern Region (Sikaka sector). It increases in number in autumn (during October and November) and decreases in summer. It is interesting to point out that the activity of this fly is only limited to the autumn season.

Descriptive Epidemiological Data

1. Eastern Region

The occurrence of malaria in this region is mainly due to the improperly maintained irrigation canals and drainage ditches which create mosquito breeding places in and around the human residence. The predominant species of malaria parasite is *Plasmodium falciparum* and the main vector in both "Gatif" and "Al Hassa" oasis is *Anopheles stephensi*; *An. fluviatilis* is also present in the area, but its value of transmission has not yet been confirmed.

The movement of people, especially the influx of labourers from Yemen, South East Pacific or from other parts of the country helped a great deal in the persistence of the disease in the area. Mention should also be made that, in Hassa sector, an extensive irrigation and drainage project started in 1967 and completed in 1971, which had effectively converted all large swamps into cultivation lands. This had created scattered

breeding places (for mosquitoes) in and around the cultivated lands in the oasis. This might have also resulted in changes in the ecology and bionomics of the vector in the area, thus leading to the increase of populations of these insects in the farms around the villages. It seems likely that the proper concept of irrigation and drainage of water has not been well understood by cultivators and farmers who still tend to follow the old system of retaining excess water in the farm land for a long time without being drained. The presence of such water creates a suitable environment for the active breeding and multiplications of mosquitoes.

2. The Northern Region

Few cases of malaria have been detected in this region. Small populations of *Anopheles sergenti* and *An. superpictus* were detected in places like "Sikaka", "Nobk", "Hayil", and "Tabuk" (Fig. 3). Some of these mosquitoes, specially those collected from "Sikaka", were found to transmit malaria.

3. The Western Region

The region, according to topography and climatic conditions, could be subdivided into two sectors:

a. Madena Sector

It extends up to Tabuk territory from the North and down to Jeddah area from the South. Our visits covered Madena City and its suburban areas, Khayber town and its surrounding villages. These areas were dominated by *Anopheles sergenti* which was found to transmit very actively the parasite *Plasmodium falciparum*. Numerous breeding places for mosquitoes exist in the different valleys forming Khayber subsector where seven villages are distributed. Large numbers of adult *An. sergenti* and its larval stages were frequently collected by our team from this area.

b. Jeddah and Mecca Sectors

Anopheles gambiae was commonly found in the urban suburban and rural areas of these sectors; small populations of *An. sergenti* was also observed in most valleys in the area. Certain parts of the highlands in the area offered potential mosquito breeding sites and both species of Anopheles (*An. gambiae* and *An. sergenti*) were detected in such environments.

4. Southern Region

Again this region, according to geographical and climatical conditions, consists of (a) a South-western strip of the "Hijaz" mountain ranges along the Red Sea Coast and (b) a South-eastern high plateaus and their water edges. The coastal strip includes "Tihama" and it covers, from North to South, places like "Lith", "Qunfidah" and "Jizan" sectors; it also covers Najran sector to the East. This strip, according to our survey studies, is

dominated by *An. gambiae* and few populations of *An. sergenti* and hence it is considered to be a highly endemic zone for malaria. The high plateaus, known as "Asir province", hardly show the existence of any mosquitoes, and malaria incidence according to our investigations seems to be very rare in this locality.

Malariometry

1. Eastern Region

Table 1 and Fig. 1 show the results of survey incidence of malaria over a period of thirteen years, starting at the beginning of 1965 and continuing up to the end of 1977. During the period 1965–1970, there was a steady rate of parasitic infection ranging between 4.1 to 3.5% respectively. *Plasmodium falciparum* and *P. vivax* were both identified in the blood of the patients, the incidence of the former parasite being three times as high as that of the latter one. Few positive cases of *Plasmodium malariae* were also detected. The results of our survey analysis during the following years (1971–1977), revealed some decrease in the rate of parasitic infections, specially in 1973–1974 during which the infection incidence reached a minimum of 0.2 and 0.6% respectively. The figures presented in Table 1 during the period 1965–73 showed that more than 90% of the positive cases were indigenous while the figures during 1974–77 reflected the dominance of the imported cases.

2. Western Region

Table 2 gives a picture of malaria incidence over a period of ten years. Most of the figures in the table give a range of parasitic infection between 9.2 and 22.3%. In 1969 the parasite rate, as shown in Fig. 1., was 52.3% which when compared with other figures seemed to be very high. *Plasmodium falciparum*, *P. vivax* and *P. malariae* were all detected in the positive blood smears taken from patients at different times from different localities in the same region. The over all picture, however, reflected the predominance of *Plasmodium falciparum*. The disease reaches its peak of transmission during August and September.

3. Southern Region

The seasonal blood surveys carried out in the rural localities revealed that *Plasmodium falciparum* is the predominant species of malaria parasites; *P. vivax* and *P. malariae*, as shown in Table 3, were also detected. The annual positive rates of the findings in 1974–77 ranged from 17.8–23.4%. According to our present investigations, the coastal strip of Jizan is considered to be the most highly endemic zone in the whole of Saudi Arabia.

4. Northern Region

Before the year 1975, malaria was extremely rare in the region; only recently during the last two years (1976–1977) fifty cases of *Plasmodium falciparum*, hundred of *P. vivax* and twenty seven of *P. malariae* were detected in "Tabuk" and "Sikaka" sectors. It is interesting to mention that no cases of *P. vivax* were recorded during 1977.

Discussion

With the limited facilities available to us in the Department of Zoology and in the Faculty of Science, we have started our field survey studies at the very beginning of 1976. Our main project of study deals with field investigations on the most important parasites and parasitic infections of human and animal populations in the different regions of Saudi Arabia. During last year we have accomplished a report on the occurrence of *Fasciola gigantica* and *F. hepatica* in Saudi Arabia (Magzoub and Kasim 1978).

Our present work on malaria started at the beginning of last year by carrying out frequent country tours for the purpose of studying the distribution of the different species of Anopheline vectors in the Kingdom. The adult mosquitoes and their larval stages were collected, identified and their role, in transmitting malaria, was determined. Our studies covered frequent visits to the main and subsidiary hospitals and also to the Public Health Offices in the main cities and their branches in small towns and villages. Our visits were also directed to the malaria stations in the different regions of the country. Useful information from these sources, regarding the history of the disease was obtained. Our team, accompanied by a medical official in each area, was able to visit all towns and villages lying in the endemic areas for the purpose of examining blood smears from persons suspected with malaria.

Our results presented in this paper revealed variations in the intensity of malaria between the different regions surveyed. In the North, at about more than three years ago, malaria cases were very scarce; but, at present, the incidents are increasing, specially in places around Tabuk city and in Sikaka area. In the middle region, Riyadh City and its rural surroundings, no incidents of malaria were observed and anopheline vectors were practically absent from the area. The Western Region shows a regular and uniform occurrence of malaria throughout the year and the principal vectors for the transmission of the disease, according to our findings, are equally distributed in the main valleys and foothills of the region. The Eastern Region, as it were, provides favourable environments for the breeding of mosquito vectors and the transmission of the disease; but the incidents, as shown in Fig. 1 and Table 1, seemed to be lower than normal. It looks as though the construction of good roads and the existence of easy means of communications helped the malaria eradication programme teams to control the disease in the area. Moreover efficient health services were provided which led to the limitations of the spread of the

disease. Thus it appears quite clearly from the data in Table 1 that between 1974 and 1977, there were no indigenous cases of malaria being reported and nearly all the positive cases detected during this period come from foreign workers. However, the situation in the Southern Region, specially Jizan sector, is very serious. According to our findings in 1977, which are clearly expressed in Fig. 2, this sector is hyperendemic. Owing to the presence of favourable environment, mosquito vectors were found to be distributed throughout the area. Malaria infection, in the Southern Region, reaches a maximum rate during the period from October to February (mostly during Winter season).

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Table 1. Summary of Malaria incidence in the Eastern Region, Saudi Arabia, during 1965–1977

Year	No. of blood smears		Positive with species of				% Incidence
	Examined	Positive	<i>P. falcip.</i>	<i>P. vivax</i>	<i>P. mal.</i>	Mixed	
1965	22341	932	818	104	10	0	4.1
1966	13242	691	554	132	5	0	5.2
1967	10672	381	248	125	8	0	3.5
1968	8529	224	99	122	3	0	2.6
1969	17743	483	238	242	3	0	2.7
1970	12408	468	236	231	1	0	3.5
1971	18626	329	171	158	0	0	1.7
1972	18160	254	126	127	1	0	1.3
1973	18329	49	25	24	0	0	0.2
1974	11760	77	41	36	0	0	0.6
1975	10227	142	69	71	2	0	1.3
1976	6821	154	74	78	2	0	2.2
1977	7912	179	—	170	9	0	2.2

Table 2. Malaria incidence in the Western Region, Saudi Arabia, during 1968–1977

Year	No. of blood smears		Positive with species of				% Incidence
	Examined	Positive	<i>P. falcip.</i>	<i>P. vivax</i>	<i>P. mal.</i>	Mixed	
1968	1049	178	124	54	0	0	17
1969	3825	2000	1.15	974	2	9	52.3
1970	4542	1012	451	550	7	4	22.3
1971	4844	444	196	231	17	0	9.2
1972	10064	980	598	343	33	6	9.7
1973	16785	2281	1819	424	26	12	13.6
1974	11463	1375	880	474	16	5	11.9
1975	12400	1302	702	520	65	15	10.5
1976	15200	1854	1054	740	50	10	12.2
1977	4325	456	343	107	2	3	10.5

Table 3. Malaria incidence in the Southern Region, Saudi Arabia, during 1974–1977

Year	No. of blood smears		% Incidence	Positive with species of			
	Examined	Positive		<i>P. falcip.</i>	<i>P. vivax</i>	<i>P. mal.</i>	Mixed
1974	10617	1900	17.8	1200	180	500	20
1975	13400	3030	22.6	2500	230	220	80
1976	18755	3520	18.7	2800	510	170	40
1977	20500	4810	23.4	4110	605	80	15

Table 4. Incidence of Malaria in the Northern Region, Saudi Arabia, during 1974–1977

Year	No. of blood smears		% Incidence	Positive with species of			
	Examined	Positive		<i>P. falcip.</i>	<i>P. vivax</i>	<i>P. mal.</i>	Mixed
1974	7531	5	0.07	2	3	0	0
1975	15062	15	0.09	6	8	1	0
1976	13609	137	1.01	30	100	7	0
1977	7280	40	0.54	20	0	20	0

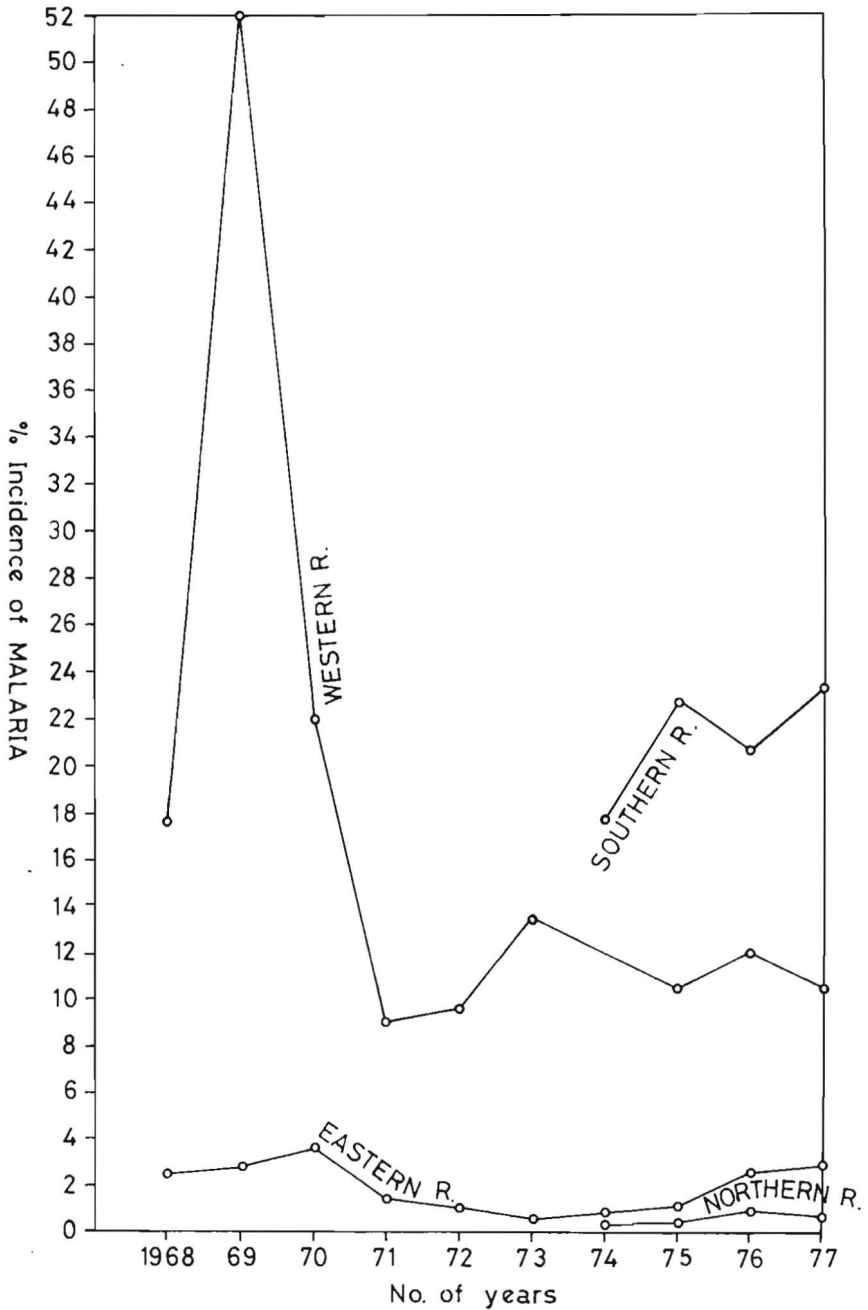


Fig. 1. Rate of parasitic infections in Eastern, Western, Northern and Southern Regions of Saudi Arabia.

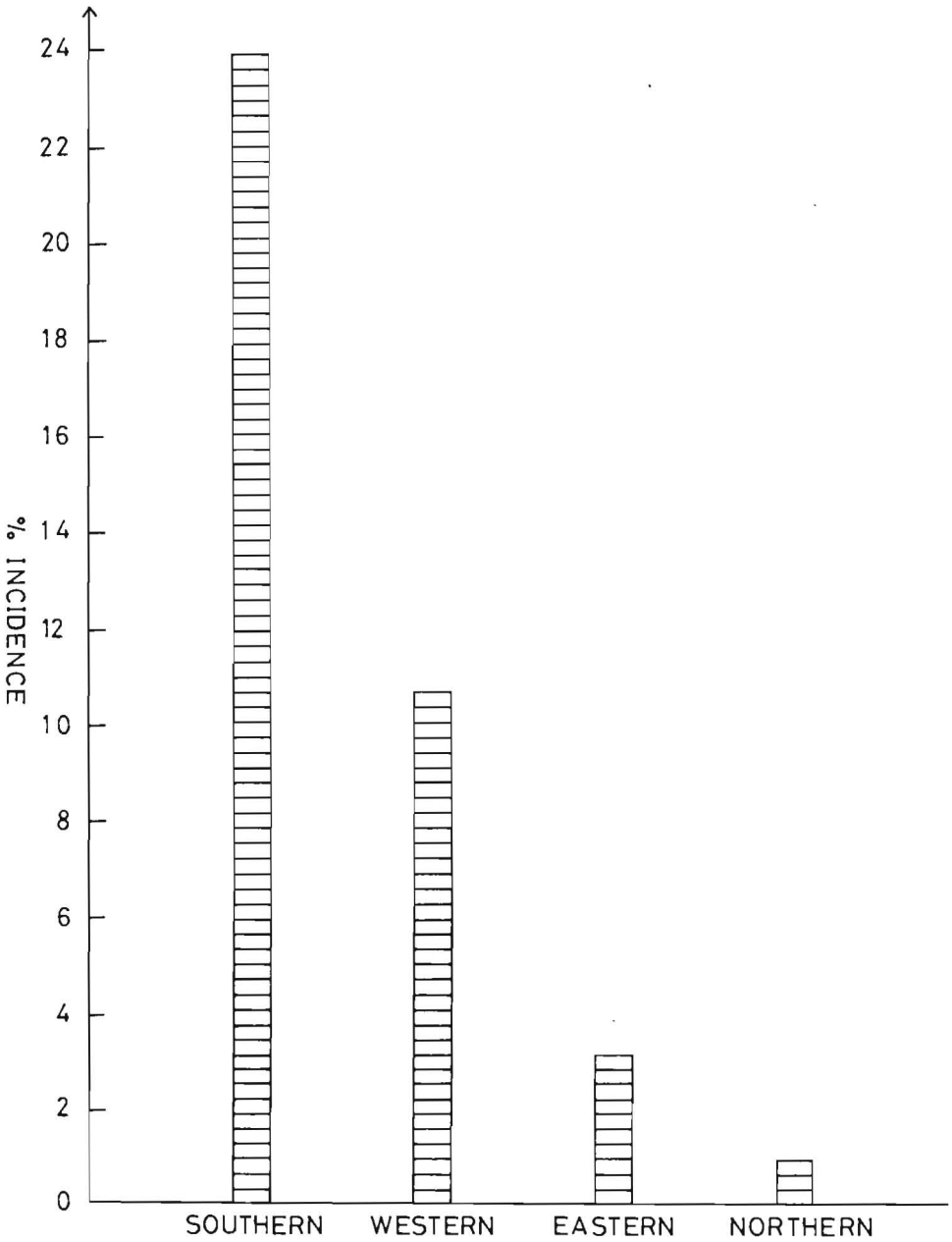


Fig. 2. Histogram showing the average percentage incidence of malaria during the year 1977. Regions of Saudi Arabia.

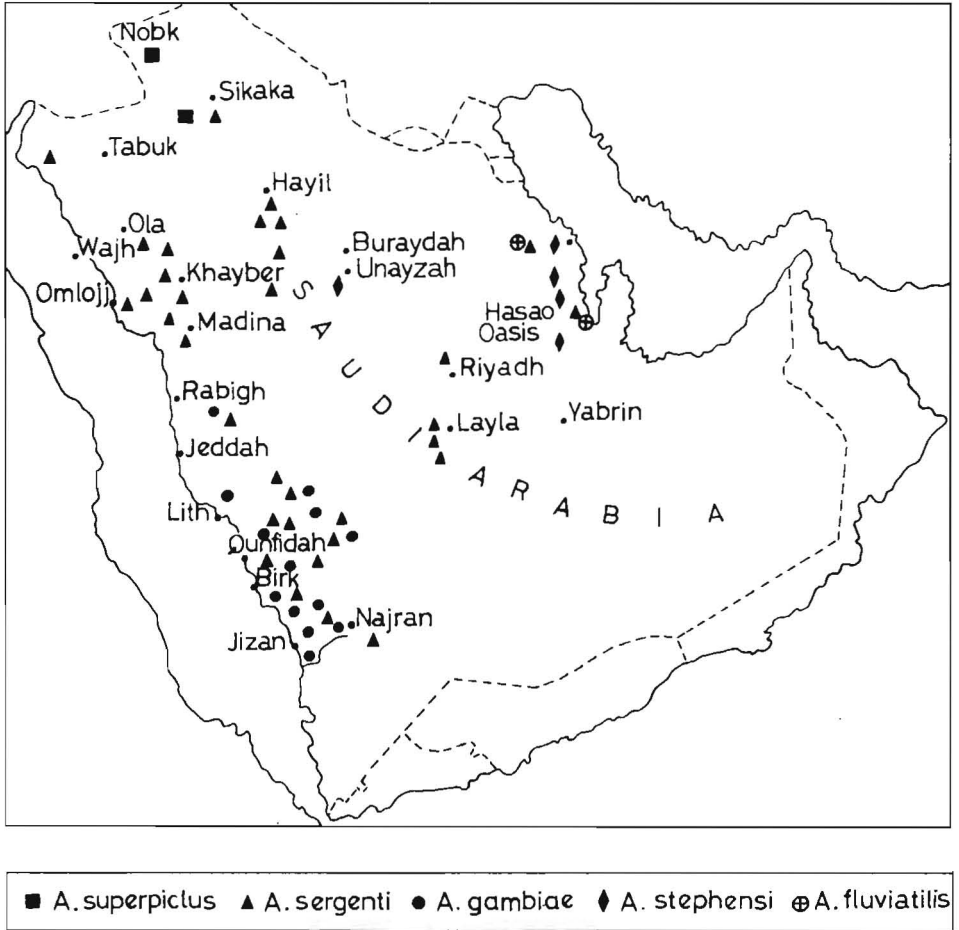


Fig. 3. Sketch map showing the distribution of anopheline vectors in Saudi Arabia.



Fig. 4. Sketch map of Saudi Arabia showing areas endemic for malaria.

بعض مظاهر وباء الملاريا في المملكة العربية السعودية

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أوضحت نتائج الدراسات التي أجريت في المناطق المختلفة من المملكة أن كثافة الملاريا تختلف من منطقة إلى أخرى . أعلى نسبة من الإصابات قد لوحظت في أنحاء جيزان بالمنطقة الجنوبية تليها المنطقة الغربية ثم الشرقية فالشمالية ، أما المنطقة الوسطى فخالية من الإصابات نظراً لعدم تواجد البعوض الناقل والذي ينتشر في المناطق الأخرى . بالرغم من صلاحية بيئة الإقليم الشرقي لتوالد البعوض بكميات كبيرة ، فإن نسبة المصابين خلال عام ١٩٧٧ كانت منخفضة ، وهذا في تقديرونا راجع إلى توفر العناية العلاجية والوقائية ، والتي أدت إلى الحد من انتشار هذا الداء الخطير في هذه المنطقة .

تعتبر معظم أجزاء المنطقة الجنوبية (خاصة جيزان وتهامه) ، حسب النتائج التي تحصلنا عليها ، منطقة موبوءة ، حيث أن متوسط نسبة الإصابة فيها قد وصل إلى حوالي ٢٣٪ . وقد تعرفنا على خمسة أنواع من البعوض الناقل ، منها ثلاثة أنواع واسعة الانتشار في المنطقة الجنوبية .