AN EVALUATION OF THE EFFECT OF LARVICIDING OPERATIONS IN RURAL AREAS NEAR ABADAN, IRAN*

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ABSTRACT

Anti-Larval measures were carried out in and around the city of Abadan in conjunction with residual spraying against the only malaria vector of the area, *A. stephensi*, which has developed resistance to both DDT and dieldrin.

There is evidence that larviciding is a valuable measure for reducing the *A. stephensi* population when used as a supplement to Malathion, which has a relatively short residual effect.

INTRODUCTION

Anti-larval measures have been carried out in and around the city of Abadan since 1934, in conjunction with residual spraying since 1947. The only malaria vector of the area, *A. stephensi*, developed resistance to both DDT and dieldrin in the period 1957-1959 (Mofidi, 1962). This means that, for the protection of this area of Iran, so important to the economy of the country, it has been necessary to rely more and more on the efficacy of anti-larval measures. These factors have been chronicled in some detail elsewhere (N.I.O.C., 1968), but the purpose of the present paper is to demonstrate quantitatively to what extent the application of larvicides has had an effect on the anopheline density and malaria incidence of the area.

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MATERIAL AND METHOD

All of the rural areas of southern Khuzestan were treated with DDT, two rounds of residual spraying per year, 2 g/m^2, until 1967, when malathion at 2 g/m^2 was used for the second round. Therefore, it has not been possible to make any comparison with unsprayed areas, and the areas compared in this study are area under combined spraying and larviciding and areas under residual spraying only. All of these areas have been covered by active case detection for several years. The map attached as Annex 1 shows the geographic location of the places (towns and group of villages) referred to in this paper.

For comparsion on parasitological grounds, entire dehestans were taken, 4 of which had no village protected by larviciding. For entomological studies, the results of total catch collections made fortnightly in 5 villages in the first group of villages, and in 4 villages in the second group, were compared.

In each village, 8 rooms which had been known at one time to harbour mosquitoes were selected. The periods during which larviciding and rounds of residual spraying were carried out are indicated on the graph, From 1967, the second round of residual spraying was carried out with malathion (dosage 2 g/m^2) rather than with DDT as used in previous years.

Although, as far as possible, the areas selected for comparison are comparable, in that, breeding places, climatic conditions, agricultural activities and, to a large extent, ethnic groups are similar, there are, none the less, some inevitable differences between the two areas which must ve borne in mind. The following factors may affect the comparison to a greater or lesser extent :

a. Larviciding is considered economically feasible only in areas close to cities and therefore, in areas of higher population density.
b. Many people from these areas adjacent to cities are employed in the cities on non-rural activities; thus they constitute to some degree a dormitory population.
c. All of these rural areas depend largely on date cultivation and they attract a considerable number of migrant workers at certain times of the year, many coming from malarious areas. The concentration of these workers may not be uniform in all groups of villages. It has not been possible to separate the imported cases of malaria from the totals because epidemiological investigations of positive cases were not carried out owing to the large number of malaria cases in the province.
d. In general, because of a greater degree of sophistication in villages nearer to the cities, the percentage of unsprayed houses has been higher in the areas under larviciding than in the more remote areas.
e. In some villages or groups of villages where high parasite incidence was detected, mass drug distribution was introduced at various intervals and this will undoubtedly have affected the parasite incidence

in a localized area.

However, despite all these possible sources of error, it is felt that the comparison may be of interest.

RESULTS

As a basis for the study, the period from April 1965 (the beginning of the Iranian year 1344) to the end of 1968 was taken.

Annex II shows graphically the meteorological data collected from Abadan for this period. Since, during one day, the temperature and humidity vary so greatly, it was thought better to plot the monthly averages of daily maxima and minima rather than of daily average in order to give a clearer picture of the weather conditions. Rainfall is seen to be irregular, the month of maximum intensity not being the same each year. The seven-year average rainfall for Abadan is about 101 mm, falling in 20 days, but, in fact, rainfall plays a limited role in *A. stephensi* breeding in this particular area, as the most favorable breeding places for larvae are in the branches of date palm irrigation channels which are subject to tidal action and in adjacent depressions or excavations. A greater influence is the level of the Arvand River, which is affected by the rainfall in Turkey, Syria and Iraq.

The presence or absence of adult mosquitoes is conditioned to a large extent by the humidity. This varies greatly depending on whether the wind is blowing off the Persian Gulf, when it is charged with moisture, or whether it is a northerly wind off the desert, which is very dry. However, conditions change from day to day, and monthly averages do not show these considerable fluctuations in humidity levels, although there is always a possibility that mosquito densities on the days of collection might be affected by a few days of low humidity.

Annex III, plotted on a logarithmic scale and on a monthly basis, shows the indoor resting densities of *A. stephensi* from the regular fortnightly collections made in 9 test villages selected as being typical of the areas and used as capture stations.

Tables 1 and 2 show, month by month, the number of positive cases detected in the two groups of villages, together with the parasite incidence per thousand population. These incidences are somewhat imprecise, as the population is not a constant one, being subject to considerable migratory influence particularly at the time of date harvesting which coincides with the peak transmission season in August and September. As already mentioned, no attempt has been made to isolate imported cases. The progression of these monthly incidences is shown in Annex IV, which is drawn on the same horizontal time scale as Annexes II and III so that the graphs can be superimposed.

DISCUSSION

Comparison of the meteorological data with the recorded mosquito densities shows that more mosquitoes are to be found in the warmer months of the year, even when the average daily minimum relative humidity is of the order of 10-15%. This is clearly compensated for by the fact that the average daily maximum humidity in this season does not drop much below 50%, while the minimum temperature is about 25°.

Without any unsprayed control areas, it is not possible to know what effect DDT has had on the population of *A. stephensi*. This vector has persistently shown high levels of resistance to DDT in this area (Javadian, 1969) and, in fact, the build-up of indoor resting densities is not noticeably affected by the spring rounds of DDT spraying, according to the graphs in Annex III. The situation was changed by the introduction of malathion spraying in the late summer of 1967, which brought about a rapid decrease in anopheline densities and apparently had the effect of delaying the build-up of high densities in 1968. The spraying of malathion in 1968, at a date one month earlier than in 1967, likewise had an apparent immediate effect, but the reappearance of a few mosquitoes in sprayed houses in October and November points to its short residual effect. This was shown by bioassy tests in the area to be about 4 weeks on permeable mud surfaces and 10-12 weeks on impermeable surfaces.

During the 4 years under study, there were only 2 months when mosquito densities were found to be higher in the areas under larviciding than in those without it, and these were both in 1966 at the beginning and end of the season. Generally, larviciding appears to have had an important effect in keeping the densities low, and this was particularly noticeable in 1968, when at no time did the indoor resting density in larvicided areas exceed 0.1 mosquitoes per room per day, and when only 3 months of the year gave no catches at all. In 1968, in the villages not protected by larviciding, anopheline mosquitoes were found during 7 months of the year, and the density went as high as 4.0 mosquitoes per room per day.

This picture is repeated in Annex IV, showing the monthly malaria parasite incidence over this period. Generally, the areas under larviciding have significantly lower incidences than those treated only with residual spraying. The inclusion of imported cases in the totals may confuse the issue. In fact, of the 20 cases detected in September, 1968, in the larvicided zones, 17 are understood to have come from one group of immigrant date packers in Kutsheikh dehestan and are most certainly not all local infections. However, there is no doubt that some local transmission takes place and, superimposing the curves of parasite incidence and resting densities, it is possible to see that the peak malaria incidences follow, generally speaking, the peak anopheline densities with a time-lag of one or two months as is to be expected.

CONCLUSION

While the diverse factors already referred to prevent a more precise mathematical comparison of the two areas under study, it is felt that the data presented here does show, from a quantitative standpoint, the effectiveness of the larviciding program carried out in this area. There is evidence that larviciding is a valuable measure for reducing *A. stephensi* densities, supplementary to the use of malathion which has a relatively short residual effect. There is also some indication that the adoption of new larviciding techniques and the co-ordination of the program of the Malaria Eradication Organization and the National Iranian Oil Company in 1968 have been beneficial and have succeeded in reducing anopheline densities to a very low level.

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Table 1

Number of positive malaria cases detected and parasite incidence by month

4 dehestans without larviciding

Year	1965		1966		1967		1968	
Population*	40 794		41 514		46 226		46 757	
Month	+	0%	+	0%	+	0%	+	0%
January			3	0.07	6	0.13	5	0.11
February			6	0.14	0	–	3	0.06
March			0	–	0	–	1	0.02
April	3	0.07	2	0.05	0	–	5	0.11
May	3	0.07	7	0.17	5	0.11	4	0.08
June	48	1.18	26	0.63	28	0.61	15	0.32
July	143	3.50	80	1.92	57	1.24	24	0.51
August	208	.09	181	4.35	86	1.85	27	0.58
September	79	1.94	179	4.30	107	2.31	44	0.94
October	97	2.38	397	9.55	67	1.45	14	0.30
November	203	4.96	11	0.26	14	0.30	5	0.11
December	39	0.95	13	0.31	2	0.04	8	0.17
Total	823+	20.15+	905	21.75	372	8.05	155	3.31

4 dehestans with larviciding

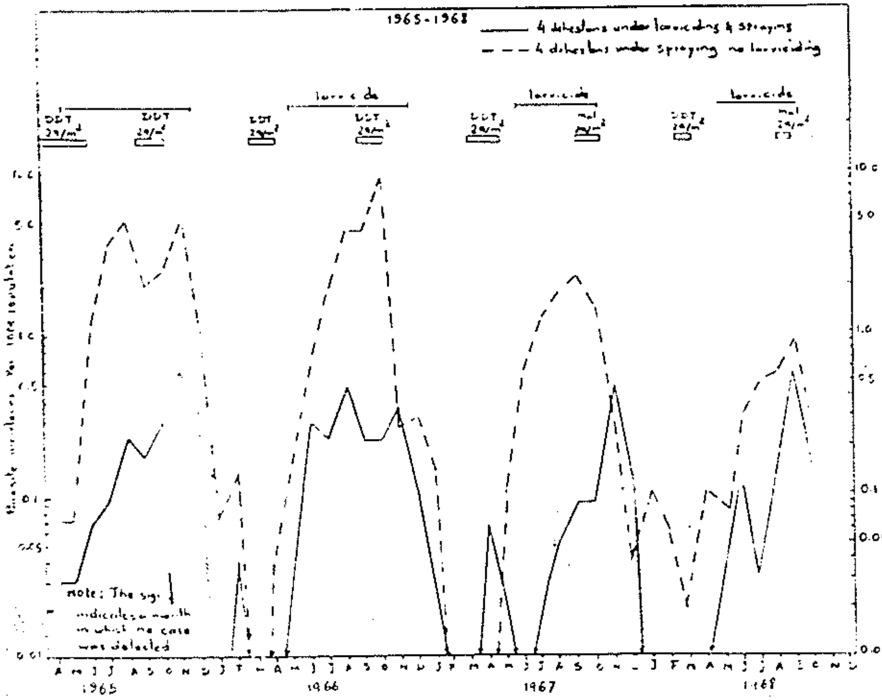
Table 2

Year	1965		1966		1967		1968	
Population*	28 999		27 445		43 663		32 649	
Month	+	0%	+	0%	+	0%	+	0%
January			0	–	1	0.02	0	–
February			1	0.04	0	–	0	–
March			0	–	0	–	0	–
April	1	0.03	0	–	3	0.07	0	–
May	1	0.03	1	0.04	1	0.02	1	0.03
June	2	0.07	8	0.29	0	–	4	0.12
July	3	0.10	6	0.22	1	0.02	1	0.03
August	7	0.24	13	0.47	2	0.05	4	0.12
September	5	0.17	6	0.22	4	0.09	20	0.61
October	8	0.28	6	0.22	4	0.09	5	0.15
November	17	0.59	10	0.36	21	0.48	2	0.06
December	10	0.34	3	0.11	6	0.14	1	0.03
Total	54+	1.85+	54	1.97	43	0.98	38	1.15

* Population variation is due partly to demographic increase, but, in the case of Table 2, is due to the relocation of boundaries, eliminating certain groups of population from the active case detection and residual spraying operations.

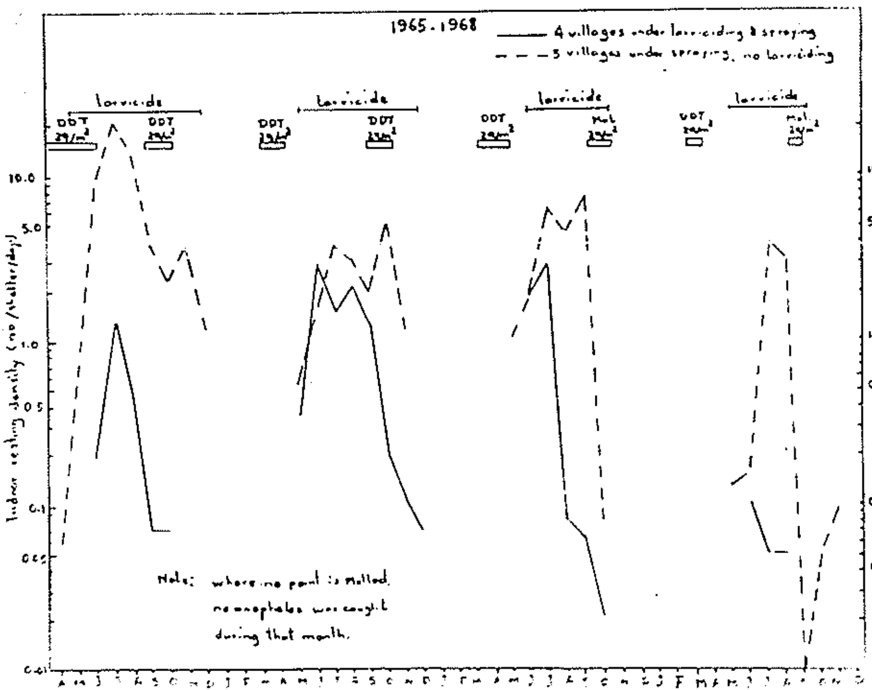
ANNEX IV

ABADAN RURAL AREAS MONTHLY PARASITE INCIDENCE (CASES FROM ALL SOURCES)

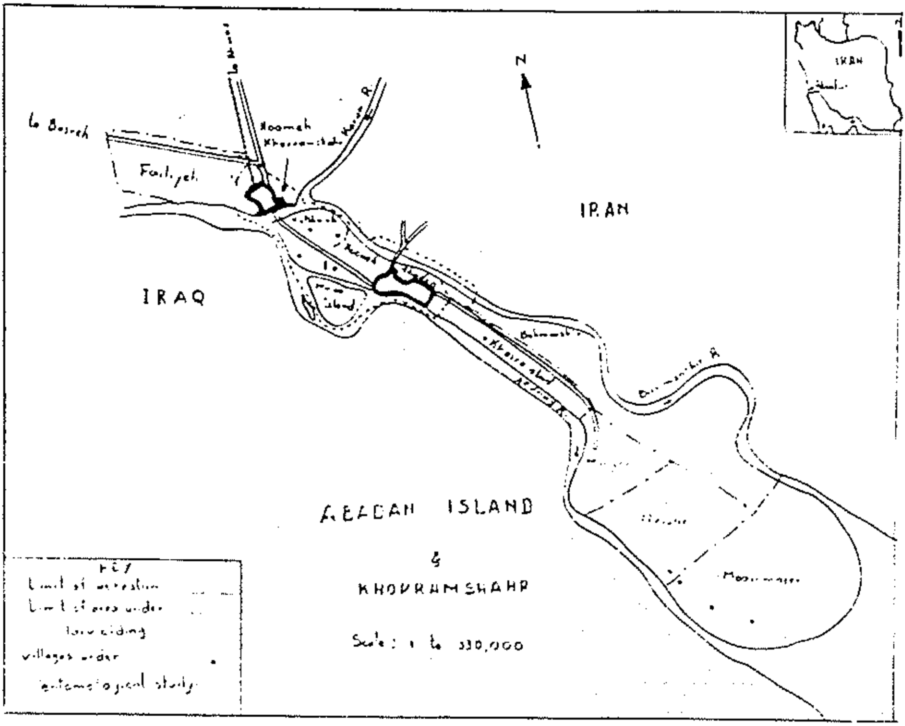


ANNEX III

ABADAN RURAL AREAS INDOOR RESTING DENSITIES OF A STEPHENSI



ANNEX I



ANNEX II METEOROLOGICAL DATA FOR ABADAN, IRAN