STUDIES ON THE RESISTANCE OF *ANOPHELES STEPHENSI* TO MALATHION IN BANDAR ABBAS, IRAN[1]

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ABSTRACT. The Bandar Abbas area has been treated with malathion at the rate of 2gm^2, 2–3 cycles per year, since 1964. Susceptibility tests carried out in this area showed that after almost 12 years of malathion application the LT50 with 3.2% malathion has increased 6.4 times that of a susceptible strain of this species.

INTRODUCTION. The chief vector of malaria in southern Iran is *An. stephensi* Liston. This species was recorded as resistant to DDT and dieldrin in Iran (Mofidi et al. 1958, 1960) and elsewhere (Brown and Pal 1971).

The Bandar Abbas area has been treated with malathion at the rate of 2g/m^2, w.p., 2–3 rounds per year (Manouchehri et al., 1972, 1974) and up to the present time (February 1976) 26 rounds of spraying inside houses have been completed.

Resistance to organophosphorus and carbamate compounds has been reported in *An. albimanus* in Central America (Georghiou 1973, Pal and Brown 1974).

In the laboratory, at the School of Public Health and Institute of Public Health Research, Teheran University, an attempt was made to select resistance to malathion in *An. stephensi*. After 5 generations the LT_{50} with 3.2% malathion increased to 5 times that of the wild-caught parents from Mamasani, Kazeroun (Manouchehri et al. 1975). Suspecting similar happenings in nature we conducted a series of susceptibility tests in Minab, Bandar Abbas. In this paper we present the changes that

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have taken place in the susceptibility of field populations of *An. stephensi* in 1975.

MATERIALS AND METHODS. The method used in testing is that developed by the World Health Organization for evaluating the susceptibility of a field population of adult anophelines (WHO, 1970) to organophosphorus compounds. Papers impregnated with malathion were provided by WHO. For the controls, paper impregnated with olive oil alone was used. The exposure times to the impregnated papers were 0.5, 1.0, 1.5 and 4 hr. After a 24-hour recovery period a mortality count was made. For each test, as well as the control, 6 replicates were made, and for each replicate 20–25 freshly fed female *An. stephensi* were tested. During the holding period, the mosquitoes were held in paper cups and a pad of wet cotton wool was placed on the top of each cup. All observed mortalities were corrected by Abbott's formula when necessary (Abbott 1925). LT50's were estimated by plotting the percentage mortality against time.

The mosquitoes used were blood-fed *An. stephensi* which had been collected from animal shelters at Chelow, Rorknabad and Zahouky villages, Minab.

RESULTS. The base-line data collected just prior to starting malathion spraying (October, 1964) for the control of *An. stephensi* in Minab Shahrestan (county) showed that the discriminating concentration that killed 100% of this species was 3.2% malathion, 1 hr exposure, 24 hr recovery (Manouchehri et al. 1966).

From October 1964 up to the present time (February 1976), the area has been treated with malathion at the rate of 2g/m^2 2–3 rounds per year and 26 rounds of spraying with this insecticide inside houses have already been completed. During 1964–1974, this species remained susceptible to malathion, and the mortality rate was 100% after 1 hr exposure to 3.2% of malathion, 24 hr recovery (Manouchehri et al. 1974).

By April–May 1975, the mortality rate with 3.2% malathion, 1 hr exposure, 24 hr recovery, decreased to 75% in Chelow, Zahouky and Rorknabad villages (Manouchehri et al. 1976).

However, the area was retreated with malathion at the rate of 2g/m^2, wp in April and August 1975. The susceptibility tests carried out in winter 1976 with 3.2% malathion, 1 hr exposure, 24 hr recovery, show that the mortality is decreasing and has been shown to be between 12% and 35%. When exposure was increased to 1.5, 2 and 4 hr the mortalities were 49, 82 and 100% respectively.

The present tests carried out with 5.0% malathion at 1.0, 1.5, 2 and 4 hr exposure, 24 hr recovery, show 43–83, 77–90, 97–100 and 100% mortality respectively and, whereas previously it was found that the susceptible strain of *An. stephensi* had an LT50 of 14 minutes with 3.2% malathion (Manouchehri et al. 1975), the present studies showed that the LT50 had increased to 90 minutes, a 6.4 fold increase.

The three villages were checked every 2 weeks for adults and larvae of anophelines in 1975. After malathion application the density of *An. stephensi* decreased sharply, and it was less than 10 per shelter during the transmission season (April–November, 1975). Although the LT_{50} has increased 6.4 fold, malathion is still partially effective against *An. stephensi* in the field. It is worthwhile to mention that during 1964–1965 after each malathion spraying the indoor density of *An. stephensi* used to be zero for about 3–4 months (Manouchehri et al. 1972), but in 1975–1976 we caught this species in all catches.

DISCUSSION. Susceptibility tests carried out at 3 villages, where only malathion is used for controlling adult *An. stephensi* in houses and where there is no record of the use of organophosphorus insecticide for agricultural pest control, showed that after almost 12 years of malathion application at the rate of 2g/m^2, wp, 2–3 rounds per year, the LT50 with 3.2% malathion has increased 6.4 fold. Although malathion is still partially effective against *An. stephensi*, there is a possibility that in the future this species will become fully re-

sistant to malathion, as did *An. albimanus* in Central America (Georghiou 1973).

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