

EXPERIENCES WITH SUSCEPTIBILITY EXPERIMENTS¹

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Susceptibility experiments on malaria vectors have been carried out in Bihar beginning in 1951. The experiments are undertaken with the help of WHO test kits and recommendations.

The insecticidal spray history, area of spray operation with frequency and dosage of spraying in Bihar has been described by Bose and Sinha (1964) and Sinha and Mishra (1966). Presently 2 rounds of DDT residual spray (1 g/m² per round) are applied from May to September each year in the endemic areas.

Results of 19 susceptibility trials for the period 1961 to 1964 revealed low density of *Anopheles culicifacies* and *An. fluviatilis* in all areas where spraying was withdrawn under National Malaria Eradication Program from 1962 onward. Both species were susceptible to DDT, and corrected mortality ranged between 83.9% and 94.7% in 4% DDT with 1 hr exposure (Bose and Sinha 1964). Susceptibility trials in 1965 under the same conditions showed mortality varying between 71.1% and 92.6% (Sinha and Mishra 1966). This confirmed the earlier finding that low population densities of all species of mosquitoes existed where there was continuing insecticidal pressure.

In the year 1967 further lowering in susceptibility status was recorded, and in 1968 a resistant strain was recorded among *An. culicifacies* with 1 hr exposure to 4% DDT, the corrected mortality ranged between 24.4% and 47.3% in the areas with insecticidal pressure (Sinha 1975).

During July 1968 simultaneous susceptibility trials were made with *An. culicifacies* collected from a village with:

(1) houses and cattle sheds sprayed 10 days before the trial with DDT (1 g/m²);

(2) houses and cattle sheds sprayed with DDT (1 g/m²) 2 months earlier and left unsprayed for the present trial; and (3) houses and cattle sheds from a village 6 km away from where DDT spray had been withdrawn 3 years before. On the analysis of the data collected in this study it was observed that with 1 hr exposure to DDT among *An. culicifacies* (a) 100% mortality was recorded in 2 and 4% DDT as well as in the control among *An. culicifacies* collected from houses sprayed 10 days earlier. (b) corrected mortality of 45.7% in 2% and 60.7% in 4% DDT was noted in unsprayed houses of the sprayed village whereas, (c) in the unsprayed village 59.6% and 92.6% corrected mortality was noted in 2 and 4% DDT impregnated papers respectively.

The resistance level went on progressively increasing among *An. culicifacies* and *An. annularis*, and in 1975 the corrected mortality to 4% DDT impregnated paper came to 16.6% in *An. culicifacies* and 10.0% in *An. annularis*.

During the years 1976 and 1977 several susceptibility tests have been carried out with varying exposure periods and the data of the tests have been summarized in Table 1.

According to the data in Table 1 an increase in exposure time resulted in increased mortality among *An. culicifacies*, *An. annularis* and *An. subpictus*. In 1 hr exposure to 4% DDT, all the 3 species tested were resistant, whereas in 2 and 4 hr exposures to 4% DDT the same species collected from the same environment are partially susceptible. Mortality in 2 and 4 hr exposures make marginal differences in the mortality rate.

Experiments on nocturnal and diurnal activities of *An. culicifacies*, *An. annularis* and *An. subpictus* have revealed that these species begin to enter cattle sheds and human dwellings with sunset, and the maximum population density is reached

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Table 1. Corrected mortality to DDT 4% impregnated paper at different exposure periods in areas with insecticidal pressure from 1955.

| Name of species | Name of village (in parenthesis district) | Exposure period and corrected mortality percent | | |
|-------------------------|---|---|----------|----------|
| | | 60 min. | 120 min. | 240 min. |
| <i>An. annularis</i> | Sharda (Singhbhum) | 10.0 | 70.0 | 73.3 |
| " | Rithora (Ranchi) | 26.6 | 73.3 | N.D.* |
| " | Byhathu (Singhbhum) | 30.0 | 75.0 | 72.3 |
| " | " | 26.6 | 70.0 | 77.7 |
| " | Khairadih (Singhbhum) | N.D. | 40.0 | N.D. |
| <i>An. culicifacies</i> | Khatanga (Ranchi) | 25.0 | 62.5 | N.D. |
| " | Goratoli (Ranchi) | 26.6 | 64.3 | 69.2 |
| <i>An. subpictus</i> | Khatanga (Ranchi) | 19.7 | 46.5 | N.D. |
| " | " | 25.8 | 50.5 | N.D. |

* N.D. Not done due to paucity of species.

at about midnight. The gravid mosquitoes begin to leave houses and cattle sheds at dawn and exiting is completed by sunrise. The fully-fed, half-fed, gravid and half-gravid mosquitoes have been observed to continue to rest in dark and humid parts of the dwellings. These mosquitoes leave houses earliest on the next morning.

The lessons learned are: 1) the time lag between susceptibility test and insecticidal spray should be at least a month. This will reduce residual contact dosage of the insecticides on the mosquitoes; 2) increase in exposure time to insecticides increases the mortality of mosquitoes; 3) susceptibility studies should not be undertaken in isolation. The total picture of the susceptibility status of a particular species at particular time and of particular area will only emerge when the following biography of the mosquitoes is also taken into consideration along with directions already prescribed in the 17th report, Insecticide Resistance and Vector Control (WHO 1970) and Resistance to Vectors and Reservoirs of disease to Pesticides (WHO 1976).

(a) The population density pattern of the mosquitoes in the sprayed and unsprayed villages/houses should be studied; b) the night and day resting behavior in the study area should also be undertaken; c) mortality patterns should be studied in

control and exposure tubes in between the trials; and d) susceptible, partially susceptible and resistant are definitions based on dosage-mortality relationship, whereas experience shows that these phenomena are dependent on several factors. The exposure time, resting design, dosage of insecticides, and mortality pattern have analogy with the death rate of the species. The declaration of resistant strain in any insect or parasite has great national importance involving both technical and administrative complications. The term "hyper-resistant" may be included before declaring any species "total resistant" which should only be announced after careful and thorough investigation.

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THE SECOND BLOOD MEAL OF THE NORTHERN HOUSE MOSQUITO: BIRD VS. HUMAN BLOOD^{1, 2}

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ABSTRACT. A comparison of host feeding behavior on chickens and humans was conducted with a Bladensburg, Maryland strain of *Culex pipiens* L. during 1977 and 1978. Three thousand female *Cx. pipiens* were tested for multiple feeding potential on chickens while 3200 *Cx. pipiens* were used for comparing multiple feeding preferences on chickens and hu-

mans. Data showed "opportunistic" feeding tendencies; 7.2% took the 2nd blood meal from a chicken; 4.0% from a man. It is suggested that this strain of *Cx. pipiens* has good vector potential for St. Louis encephalitis since, after taking bird blood, the second blood meal sometimes consisted of human blood.

INTRODUCTION

An important factor governing the vector capability of a mosquito is its propensity toward taking a 2nd blood meal. It appears that little is known about the 2nd blood meal of mosquitoes in general and *Culex pipiens* L. in particular.

Among the reports on the feeding behavior of *Cx. pipiens*, the northern house mosquito, are those of Tate and Vincent (1936), Reeves and Hammon (1944),

Tempelis and Reeves (1964), Murphey et al. (1967), Tempelis et al. (1967), Means (1968), Kokernot et al. (1969), Hess and Hayes (1970), Ekis (1971), Spielman (1971), Tempelis (1975), and Magnarelli (1977). Most of these studies used precipitin tests to detect blood sources. All of them provided evidence that *Cx. pipiens* is primarily a bird feeder.

Edman and Downe (1964) found that *Cx. pipiens* "complex" females in Kansas fed on mammals more often than on birds. In their study 5 of 24 single feedings consisted of human blood with the remainder beef and hog. Tempelis and Reeves (1964) reported some feeding on man in Colorado and Illinois. In Delaware Murphey et al. (1967) found that *Cx. pipiens* fed on 7 species of small mammals. In the Mississippi River Basin Kokernot et al. (1969) found that 4 of 813 specimens tested had fed on man. Spielman (1971) sampled 194 specimens in Massachusetts and found 4 human feedings. Reeves and Hammon (1944) in Washington State

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