This flood-water mosquito is difficult to control in the larval stage, since only 4 or 5 days may be required for larval development during the summer months; thus, a limited amount of time is available for larviciding from inundation of the eggs to adult emergence.

The permanent-water-breeding Anopheles, Culex and Mansonia constituted over 60 percent of the mosquitoes taken, exclusive of the Uranotaenia, indicating the need for permanent control measures such as drainage and aquatic vegetation suppression.

The appreciable number of Culex quinquefasciatus taken was indicative of large populations of this mosquito, since the light trap has generally been found to be comparatively ineffective in attracting this species. In addition to being extremely pestiferous, C. quinquefasciatus is believed to be the principal vector of St. Louis encephalitis in the southern portion of the state. Larval development is heaviest in waters with high organic content, frequently produced in connection with municipal or individual disposal of sewage or other wastes. Breeding is usually concentrated and the larvae vulnerable to relatively simple and inexpensive control procedures. This common house mosquito should receive primary consideration in formulating and applying control measures. In areas of St. Louis endemicity, it is advisable that cities or counties with inadequate budgets institute species control measures against C. quinquefasciatus. Since it invades dwellings and attacks man freely, it is a major pest species, as well as a disease vector.

Summary. Three light traps were operated in the County of Orange, Texas, from May 1 to September 10, 1958. A total of 18,076 mosquitoes were taken in 148 trap nights. Less than 10 percent of the mammal-biting species were Aedes sollicitans and A. taeniorhynchus.

DDT-Resistant Adults of Anopheles Subpictus in The Lahore District of West Pakistan

J. Maldonado-Capriles 1 and A. S. Nasir 2

Susceptibility tests were performed by the authors with wild caught adults of Anopheles subpictus Grassi in two DDT-sprayed villages near Lahore, West Pakistan. The data collected, although somewhat meager, show a definite resistance to DDT by this species in this locality. Pronounced DDT-resistance in this species was found in 1956 at Jawalaheri and Nanglishidar, Uttar Pradesh, India, by Sharma and Krishnamurthy (1, 5) and recently by Pant (2) in Nepal. The species, as detailed below, has been reported to be relatively susceptible in Java by various authors (3).

Anopheles subpictus, for reasons still unknown, is not a vector of malaria in West Pakistan. However, it is a vector in some areas of Indonesia. In West Pakistan this species is extremely abundant after the monsoon rains, i.e., usually during the months of July and August. Larvae are found in great numbers in temporary and permanent pools. The adults freely enter buildings and are collected with great ease at any time during the day.

The susceptibility tests discussed herein were performed with the kit once provided.
by the International Cooperation Admin-
istration (4). The DDT-saturated papers
used were those provided and obtainable
from WHO-Geneva. An interesting fact is
that the DDT-papers were 17 months
old at the time of the tests. The papers
were impregnated on 22-29 March 1957
and the tests performed in August 1958.
Test performed by the Communicable
Disease Center's Technical Development
Laboratories at Savannah, Georgia, USA,
showed that the DDT-papers were fully
potent at the time of usage. Using
Anopheles quadrimaculatus Say as the test
insect, at an exposure of one hour the
average mortality from three replicates
with 1, 2, and 4 percent DDT-papers were
3 and 5 percent, 64 and 64 percent, and
96 and 99 percent. The first figure of these
percentages refer to the papers used in
Pakistan and the second to papers im-
pregnated in January 1958.

The tests performed in West Pakistan
were made with DDT concentrations of
0.25, 0.5, 1.0, 2.0, and 4.0 percent. The
exposure times used were 1, 2, and 4 hours.
At one hour exposure the highest kill with
4 percent papers was 20.0 percent. For
comparison it can be mentioned that in
tests performed in Java with the same
species and with specimens from four
localities, with 4 percent papers and one
hour exposure, mortalities of 95, 82, 89,
and 100 percent were obtained (2). At two
hours exposure the highest kill with 4
percent papers was 56.2 percent. At 4
hours exposure (in a second village) the
highest kill was 70.0 percent. A summary
of the results is tabulated below.

**SUMMARY.** 1. Preliminary tests done

**TABLE 1.** DDT resistance studies with adults of Anopheles subpictus in West Pakistan, August 1958

<table>
<thead>
<tr>
<th>Concentration of DDT</th>
<th>No. of replicates</th>
<th>Total No. of adults</th>
<th>Total No. dead at 24 hrs</th>
<th>Percent dead</th>
<th>Temperatures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6</td>
<td>139</td>
<td>0</td>
<td>0.0</td>
<td>92 Max.</td>
</tr>
<tr>
<td>0.25</td>
<td>6</td>
<td>157</td>
<td>1</td>
<td>0.6</td>
<td>84 Min.</td>
</tr>
<tr>
<td>0.50</td>
<td>6</td>
<td>150</td>
<td>0</td>
<td>0.0</td>
<td>83 Wet</td>
</tr>
<tr>
<td>1.0</td>
<td>6</td>
<td>154</td>
<td>2</td>
<td>1.3</td>
<td>87 Dry</td>
</tr>
<tr>
<td>2.0</td>
<td>3</td>
<td>71</td>
<td>3</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>3</td>
<td>73</td>
<td>8</td>
<td>10.9</td>
<td></td>
</tr>
</tbody>
</table>

Tests 4, 5; August 9, 1958. Two hours exposure.

<table>
<thead>
<tr>
<th>Concentration of DDT</th>
<th>No. of replicates</th>
<th>Total No. of adults</th>
<th>Total No. dead at 24 hrs</th>
<th>Percent dead</th>
<th>Temperatures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2</td>
<td>49</td>
<td>0</td>
<td>0.0</td>
<td>89 Max.</td>
</tr>
<tr>
<td>0.25</td>
<td>2</td>
<td>42</td>
<td>0</td>
<td>0.0</td>
<td>81 Min.</td>
</tr>
<tr>
<td>0.50</td>
<td>4</td>
<td>57</td>
<td>2</td>
<td>3.5</td>
<td>83 Wet</td>
</tr>
<tr>
<td>1.0</td>
<td>4</td>
<td>87</td>
<td>5</td>
<td>5.7</td>
<td>91 Dry</td>
</tr>
<tr>
<td>2.0</td>
<td>4</td>
<td>92</td>
<td>15</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>4</td>
<td>81</td>
<td>40</td>
<td>49.3</td>
<td></td>
</tr>
</tbody>
</table>

B. Cattle-shed on eastern end of military cantonment, east from Lahore; area sprayed an unknown number of times.

Test 6; August 26, 1958. Four hours exposure.

<table>
<thead>
<tr>
<th>Concentration of DDT</th>
<th>No. of replicates</th>
<th>Total No. of adults</th>
<th>Total No. dead at 24 hrs</th>
<th>Percent dead</th>
<th>Temperatures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1</td>
<td>21</td>
<td>1</td>
<td>4.7</td>
<td>94 Max.</td>
</tr>
<tr>
<td>0.5</td>
<td>3</td>
<td>65</td>
<td>7</td>
<td>10.7</td>
<td>80 Min.</td>
</tr>
<tr>
<td>1.0</td>
<td>3</td>
<td>65</td>
<td>16</td>
<td>24.6</td>
<td>79 Wet</td>
</tr>
<tr>
<td>4.0</td>
<td>3</td>
<td>52</td>
<td>28</td>
<td>53.8</td>
<td>83 Dry</td>
</tr>
</tbody>
</table>

*Highest and lowest of 3 and 2 sets of readings for 1- and 2-hour exposure tests respectively.
with a standard susceptibility kit showed that *Anopheles subpictus* Grassi exhibits a definite resistance to DDT in the Lahore District of West Pakistan.

2. The DDT-impregnated papers used in these tests although 17 months old were found to be fully potent.

References


2. Anonymous. Summary of occurrences of insecticide resistance in anopheline mosquitoes (all regions) and of results of susceptibility tests by the WHO method in the Americas. WHO/Mal/224, WHO/Insect/05. 1 May 1959.


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