THE MOSQUITOES OF COSTA RICA

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In Costa Rica sharp contrasts in climate occur within quite short distances. The Atlantic railway ascends from sea level to an altitude of 5,000 feet in a journey of less than 95 miles, while several of the nearby volcanoes are more than 10,000 feet high. The linear distance from the Atlantic to the Pacific Oceans varies from 160 miles in the north to only 75 miles near the Panaman border. Undoubtedly the great variations in climate account for the diversity of the mosquito fauna.

The backbone of the American continent, which stretches from the Canadian Rockies to the Chilean Andes, is not so lofty in Costa Rica as at its northern and southern extremities. Nevertheless this ridge of high mountains divides quite effectively the Atlantic and Pacific Zones. It also encloses a large upland plateau known as the "Meseta Central," most of which is 2,000 to 4,000 feet above sea level.

The climatic differences between the Atlantic and Pacific sides of this Republic are well illustrated by the figures for the average monthly rainfall. Through the courtesy of the United Fruit Company and certain other interested persons we were permitted to copy rainfall data from four representative localities on the Atlantic slope, which covered a total of 47 years of observations. We also obtained monthly rainfall tabulations for the city of San José extending over a 65-year period, and for the past 11 years from Puerto Jimenez on the Golfo Dulce. Both

1 The studies and observations on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation, the United States Public Health Service, The Gorgas Memorial Laboratory, and the Secretaría de Salubridad Pública y Protección Social of the Government of Costa Rica.
of the latter are on the Pacific slope. Table 1 shows the average monthly rainfall on the Atlantic and Pacific sides of Costa Rica.

The total annual rainfall is decidedly greater on the Atlantic coast than on the Pacific. The peak months on the Caribbean littoral are November and December, whereas the maximum rainfall on the Pacific side occurs in September and October. The figures in table 1 are shown in graph 1. The curve for the Pacific slope brings out clearly the long dry season lasting for four or five months in the beginning of each year, followed by

<table>
<thead>
<tr>
<th>MONTHS</th>
<th>AVERAGE RAINFALL PER MONTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Atlantic side</td>
</tr>
<tr>
<td>January</td>
<td>10.4</td>
</tr>
<tr>
<td>February</td>
<td>5.2</td>
</tr>
<tr>
<td>March</td>
<td>6.1</td>
</tr>
<tr>
<td>April</td>
<td>7.5</td>
</tr>
<tr>
<td>May</td>
<td>10.2</td>
</tr>
<tr>
<td>June</td>
<td>11.6</td>
</tr>
<tr>
<td>July</td>
<td>13.6</td>
</tr>
<tr>
<td>August</td>
<td>11.2</td>
</tr>
<tr>
<td>September</td>
<td>10.3</td>
</tr>
<tr>
<td>October</td>
<td>11.6</td>
</tr>
<tr>
<td>November</td>
<td>15.5</td>
</tr>
<tr>
<td>December</td>
<td>18.2</td>
</tr>
</tbody>
</table>

| Totals    | 131.4         | 83.8         |

rain in May and June, and then a short dry season in July, before the heaviest rains in September and October.

Some of the earliest studies of the mosquito fauna of Costa Rica were made by Knab (1) in 1905, followed 16 years later by Alfaro (2) and Serre (3). Alfaro (4) reported no less than 73 different species from this country. Some of these later proved to be synonyms of one another, but the majority were valid.

The mosquito survey of Costa Rica on which the present report is based was conducted as a part of a malaria survey of the Republic. Accordingly more attention was paid to the Anopheles than to any of the other genera. Indeed, most of the
collections of non-anophelines were made merely incidentally to the main study. It is likely, therefore, that our knowledge of the anophelines is fairly complete, while undoubtedly many more culicine and sabethine species exist in this country than

![Graph 1]

those we have encountered. Dyar (5) mentions the following 14 species, which we have not found as yet.

- Sabethes tarsopus
- Wycomeyia bromeliarum
- Wycomeyia hemisagnosta
- Wycomeyia pseudopecten
- Psorophora citipes
- Haemagogus equinus
- Uranotaenia orthodoza
- Culex derivator
- Culex educator
- Culex elevator
- Culex inflectus
- Culex latisquama
- Culex metempsytus
- Culex restrictor
From the first 1,000 collections which were made between December 1937 and July 1939, 24,704 mosquitoes were examined. Of these, 14,961 had been taken as adults and 9,743 as larvae or pupae. Among them we found 93 different species, of which 16 were Anopheles, 12 were Aedes, and at least 20 belonged to the genus Culex.

**TABLE 2**

9,000 anophelines collected as adults classified by species and mode of capture

<table>
<thead>
<tr>
<th>SPECIES OF ANOPHELES</th>
<th>CAUGHT INSIDE HOUSES</th>
<th>CAUGHT IN STABLE-TYPE MOSQUITO TRAPS</th>
<th>CAUGHT WITH A HORSE AS BAIT AT SUNSET</th>
<th>OTHER MODES OF CAPTURE*</th>
<th>TOTALS</th>
<th>PER CENT OF ALL ANOPHELINES CAUGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anopheles albimanus</td>
<td>2,848</td>
<td>4,673</td>
<td>514</td>
<td>34</td>
<td>8,069</td>
<td>89.7</td>
</tr>
<tr>
<td>Anopheles apicimacula</td>
<td>1</td>
<td>57</td>
<td>79</td>
<td>43</td>
<td>180</td>
<td>2.0</td>
</tr>
<tr>
<td>Anopheles argyritarsis</td>
<td>1</td>
<td>9</td>
<td>25</td>
<td>21</td>
<td>35</td>
<td>0.4</td>
</tr>
<tr>
<td>Anopheles eisenti</td>
<td></td>
<td></td>
<td>1</td>
<td>22</td>
<td>22</td>
<td>0.2</td>
</tr>
<tr>
<td>Anopheles neivai</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>Anopheles neomaculipalpus</td>
<td>3</td>
<td>31</td>
<td>6</td>
<td>40</td>
<td>40</td>
<td>0.4</td>
</tr>
<tr>
<td>Anopheles pseudopunctipennis</td>
<td>31</td>
<td>132</td>
<td>95</td>
<td>20</td>
<td>278</td>
<td>3.1</td>
</tr>
<tr>
<td>Anopheles punctimacula</td>
<td>4</td>
<td>53</td>
<td>52</td>
<td>14</td>
<td>123</td>
<td>1.4</td>
</tr>
<tr>
<td>Anopheles strodei</td>
<td>4</td>
<td>52</td>
<td>47</td>
<td>103</td>
<td>103</td>
<td>1.1</td>
</tr>
<tr>
<td>Anopheles tarsimaculatus</td>
<td>1</td>
<td>7</td>
<td>71</td>
<td>72</td>
<td>72</td>
<td>0.8</td>
</tr>
<tr>
<td>Anopheles vestitipennis</td>
<td>62</td>
<td></td>
<td>7</td>
<td>69</td>
<td>69</td>
<td>0.8</td>
</tr>
<tr>
<td>Chagasia balthanus</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>7</td>
<td>0.1</td>
</tr>
<tr>
<td>Totals</td>
<td>2,955</td>
<td>5,007</td>
<td>906</td>
<td>132</td>
<td>9,000</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Other modes of capture include catches in hollow trees, outhouses, under bridges, in holes in the ground, and with human bait in the forests in the daytime.

**RELATIVE PREVALENCE OF THE DIFFERENT ANOPHELINES**

Anopheles albimanus accounted for 89.7 per cent of the first 9,000 Anopheles captured as adults, and A. pseudopunctipennis for only 3.1 per cent. We feel that this result has considerable significance in any consideration of the relative importance of those two species as vectors of malaria in Costa Rica. From an examination of table 2 it is evident that 96.4 per cent of the anophelines caught in houses and 93.3 per cent of those taken in stable-type mosquito traps were A. albimanus. But of the 906 mosquitoes of this genus caught with a horse or mule as bait at sunset, only slightly more than half were A. albimanus.
Adult catches with animal bait at nightfall yielded a greater diversity of anopheline species than did any of the other methods used.

In table 3 we have arranged the 7,548 anophelines which were taken in their immature stages, by species and by type of breed-

**TABLE 3**

*7,548 anophelines collected as larvae or pupae, classified by species and type of breeding place*

<table>
<thead>
<tr>
<th>SPECIES OF ANOPHELES</th>
<th>TYPE OF BREEDING PLACE</th>
<th>PER CENT OF ALL ANOPHELENS MARRIAT COLLECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Running streams and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ponds</td>
<td></td>
</tr>
<tr>
<td>Anopheles albimanus</td>
<td>5</td>
<td>160</td>
</tr>
<tr>
<td>Anopheles albitarsis</td>
<td>23</td>
<td>2,174</td>
</tr>
<tr>
<td>Anopheles anomalophyllus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Anopheles apicimaculata</td>
<td>18</td>
<td>44</td>
</tr>
<tr>
<td>Anopheles argyritarsis</td>
<td>27</td>
<td>227</td>
</tr>
<tr>
<td>Anopheles bachmanni</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Anopheles chiriquiensis</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Anopheles eiseni</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Anopheles neivai</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Anopheles neomaculipalpus</td>
<td>7</td>
<td>220</td>
</tr>
<tr>
<td>Anopheles pseudopunctipennis</td>
<td>38</td>
<td>934</td>
</tr>
<tr>
<td>Anopheles punctimacula</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Anopheles strodei</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Anopheles tarsimaculatus</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Anopheles vestitipennis</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Chagasia bithanus</td>
<td>64</td>
<td>18</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>160</strong></td>
<td><strong>1,496</strong></td>
</tr>
</tbody>
</table>

ing place. Striking differences are shown in tables 2 and 3 between the percentages of anophelines taken as adults and as larvae. This difference is particularly notable in the case of *A. argyritarsis*. Table 3 shows that 21.2 per cent of the anopheline larvae captured were *A. argyritarsis*, whereas only 0.4 per cent of the adults listed in table 2 belong to that species.
Evidently *A. argyritarsis* feeds but rarely on either animals or humans, though it breeds freely in many places and under diverse conditions. It is hard to conceive how *A. argyritarsis* could ever be of much importance as a vector of any human disease in Costa Rica. (See table 3.)

The three commoner anophelines taken as larvae or pupae were *A. albimanus*, *A. argyritarsis* and *A. pseudopunctipennis*.

**TABLE 4**

*Larval collections of Anopheles albimanus, A. argyritarsis and A. pseudopunctipennis classified by the number of occasions on which each species was found in the various types of breeding places*

<table>
<thead>
<tr>
<th>TYPE OF BREEDING PLACE</th>
<th>A. ALBIMANUS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>A. PSEUDO-PUNCTIPENNIS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
<td>Per cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of times</td>
<td>of total</td>
<td>of times</td>
<td>of total</td>
<td>of times</td>
<td>of total</td>
<td>of times</td>
<td>of total</td>
<td></td>
</tr>
<tr>
<td>Running streams</td>
<td>2</td>
<td>0.9</td>
<td>4</td>
<td>1.7</td>
<td>2</td>
<td>1.3</td>
<td>6</td>
<td>28.7</td>
<td></td>
</tr>
<tr>
<td>Pooled streams</td>
<td>20</td>
<td>9.1</td>
<td>31</td>
<td>13.4</td>
<td>45</td>
<td>28.7</td>
<td>6</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Lakes and ponds</td>
<td>6</td>
<td>2.7</td>
<td>9</td>
<td>3.8</td>
<td>5</td>
<td>3.2</td>
<td>2</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Ground pools, ditches or borrow pits</td>
<td>147</td>
<td>66.5</td>
<td>123</td>
<td>53.0</td>
<td>67</td>
<td>42.7</td>
<td>8</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Wells, springs or small seepage areas</td>
<td>2</td>
<td>0.9</td>
<td>15</td>
<td>6.5</td>
<td>8</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoof prints of cattle</td>
<td>21</td>
<td>9.5</td>
<td>28</td>
<td>12.1</td>
<td>15</td>
<td>9.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh water swamps</td>
<td>12</td>
<td>5.4</td>
<td>20</td>
<td>8.6</td>
<td>12</td>
<td>7.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brackish water swamps</td>
<td>10</td>
<td>4.5</td>
<td>2</td>
<td>0.9</td>
<td>3</td>
<td>1.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rock holes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artificial containers</td>
<td>1</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>221</td>
<td>100.0</td>
<td>232</td>
<td>100.0</td>
<td>157</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These accounted for 87.8 per cent of the 7548 anophelines caught in their immature stages. An analysis of the type of breeding place preferred by the three commoner anophelines was made by tabulating the number of occasions on which each species was found in each type of breeding place. Table 4 shows that *A. albimanus* usually selected ground pools. At least two-thirds of the collections were obtained in breeding places included in that category. The ten occasions on which *A. albimanus* were secured in partly brackish water are of interest, as well as the
one time that species was discovered in an iron drum full of rain water.

While half of the collections of *A. argyritarsis* were made in ground pools, certain other classes of breeding places also were frequently utilized by this species. *A. argyritarsis* was found in wells, springs and small seepage areas much more often than *A. albimanus*. The same statement applies to pooled and running streams. But the commonest of the three species to

**TABLE 5**

*Effect of sunlight on the occurrence of various species of Anopheles taken as larvae in Costa Rica*

<table>
<thead>
<tr>
<th>SPECIES OF ANOPHELES</th>
<th>NUMBER OF TIMES FOUND IN SUNLIGHT</th>
<th>NUMBER OF TIMES FOUND IN SHADE</th>
<th>TOTAL NUMBER OF LARVAL COLLECTIONS MADE</th>
<th>PER CENT OF OCCURRENCES IN SUNLIGHT</th>
<th>COLLECTIONS WITHOUT DATA AS TO SUNLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anopheles albimanus</em></td>
<td>199</td>
<td>5</td>
<td>204</td>
<td>97.5</td>
<td>17</td>
</tr>
<tr>
<td><em>Anopheles albitarsis</em></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles anomalophyllus</em></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles apicimacula</em></td>
<td>31</td>
<td>16</td>
<td>47</td>
<td>66.0</td>
<td>3</td>
</tr>
<tr>
<td><em>Anopheles argyritarsis</em></td>
<td>194</td>
<td>16</td>
<td>210</td>
<td>92.4</td>
<td>22</td>
</tr>
<tr>
<td><em>Anopheles baccmanni</em></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles chiriquiensis</em></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles eiseni</em></td>
<td>6</td>
<td>8</td>
<td>14</td>
<td>42.9</td>
<td>1</td>
</tr>
<tr>
<td><em>Anopheles neivai</em></td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles neomaculipalpus</em></td>
<td>36</td>
<td>3</td>
<td>39</td>
<td>92.3</td>
<td>8</td>
</tr>
<tr>
<td><em>Anopheles pseudopunctipennis</em></td>
<td>143</td>
<td>4</td>
<td>147</td>
<td>97.3</td>
<td>10</td>
</tr>
<tr>
<td><em>Anopheles punctimacula</em></td>
<td>9</td>
<td>5</td>
<td>14</td>
<td>64.3</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles strodei</em></td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>100.0</td>
<td>2</td>
</tr>
<tr>
<td><em>Anopheles tarsimaculatus</em></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><em>Anopheles vestitipennis</em></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>31.3</td>
<td></td>
</tr>
<tr>
<td><em>Chagasia bathanus</em></td>
<td>5</td>
<td>11</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

be met with in pooled streams was *A. pseudopunctipennis*. This type of breeding place accounted for three times as many of the *A. pseudopunctipennis* larvae as it did for *A. albimanus*—28.7 as compared to 9.1 per cent.

A factor of considerable importance in anopheline ecology is sunlight. Of the 16 species which we have found in Costa Rica, some have shown a marked preference for light, while others have appeared to select shade and the remainder have failed to exhibit a well-marked tropism either way. *Anopheles albimanus*,
A. argyritarsis, A. neomaculipalpus and A. pseudopunctipennis constitute the group which has consistently chosen breeding places well exposed to the sunshine. On the other hand Chagasia bathanus has seemed definitely to prefer shade, while A. apicimacula, A. punctimacula and A. eiseni have been met with in sunny as well as shady places. In a few collections we omitted to record data as to light or shade, so the percentages in table 5 have been calculated from collections with complete data only.

### TABLE 6

Relative prevalence of 5,338 culicine mosquitoes captured as adults inside houses, in traps, or with a horse as bait at sunset

<table>
<thead>
<tr>
<th>SPECIES OF MOSQUITO</th>
<th>CAUGHT INSIDE HOUSES</th>
<th>CAUGHT IN STABLE-TYPE MOSQUITO TRAPS</th>
<th>CAUGHT WITH A HORSE AS BAIT AT SUNSET</th>
<th>TOTALS</th>
<th>PER CENT OF ALL MOSQUITOES CAUGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psorophora cingulata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psorophora feroz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psorophora howardi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psorophora lutzii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psorophora tolleca</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psorophora varipes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes aegypti</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes angustivittatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes cuplocamurus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes taeniorynchus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Aedes and Haemagogus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mansonia fasciolata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mansonia titillans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deinocerites epitedens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deinocerites pseudes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex chrysonotum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex corniger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex declarator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex fatigans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culex sp.?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sabethines, Megarhinus, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>1,485</td>
<td>1,773</td>
<td>2,080</td>
<td>5,338</td>
<td>100.0</td>
</tr>
</tbody>
</table>

RELATIVE PREVALENCE OF THE VARIOUS CULICINES AND SABETHINES

The culicine mosquitoes most frequently taken as adults inside houses, in stable-type mosquito traps, or with a horse as
bait at sunset, were *Culex fatigans*, *Mansonina titillans* and *Aedes angustivittatus*. Table 6 analyses the relative prevalence of 32 species among 5338 culicine mosquitoes caught as adults. Only the commoner species are mentioned in Table 6 by name, while the rarer ones have been grouped.

2,195 non-anophelines representing some 60 species were collected as larvae or pupae and were later bred out and identified.

**Map 1**

Of these, the most numerous were *Culex stigmatosoma* and *Uranotaenia geometrica*. The latter were found in three times as many localities as the former. The geographical distribution of the various anophelines obtained in Costa Rica has been discussed in a paper by Kumm and Ruiz (6). Similarly, the distribution of four of the commoner non-anophelines, namely *Culex fatigans*, *Mansonina titillans*, *Aedes angustivittatus* and *Uranotaenia geometrica* is shown in the following map. It is evident that *Mansonina titillans* is confined in its distribution to
<table>
<thead>
<tr>
<th>SPECIES OF MOSQUITOES</th>
<th>CAUGHT IN DAYTIME CAPTURES IN FOREST</th>
<th>OTHER MODES OF CAPTURE*</th>
<th>TOTALS</th>
<th>PER CENT OF ALL MOSQUITOES CAUGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psorophora ferox</td>
<td>64</td>
<td>3</td>
<td>106</td>
<td>17.0</td>
</tr>
<tr>
<td>Psorophora lutzi</td>
<td>33</td>
<td>2</td>
<td>106</td>
<td>17.0</td>
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<tr>
<td>Other species of Psorophora</td>
<td>6</td>
<td>6</td>
<td>248</td>
<td>39.8</td>
</tr>
<tr>
<td>Haemagogus species</td>
<td>10</td>
<td>1</td>
<td>11</td>
<td>1.8</td>
</tr>
<tr>
<td>Aedes angustivittatus</td>
<td>42</td>
<td>2</td>
<td>44</td>
<td>44.0</td>
</tr>
<tr>
<td>Aedes nubilus</td>
<td>67</td>
<td>6</td>
<td>67</td>
<td>9.0</td>
</tr>
<tr>
<td>Aedes serratus</td>
<td>127</td>
<td>4</td>
<td>131</td>
<td>21.2</td>
</tr>
<tr>
<td>Other species of Aedes</td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>2.6</td>
</tr>
<tr>
<td>Mansonia arribalzage</td>
<td>16</td>
<td>1</td>
<td>17</td>
<td>2.6</td>
</tr>
<tr>
<td>Mansonia fasciolata</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>1.0</td>
</tr>
<tr>
<td>Mansonia titillans</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>11.6</td>
</tr>
<tr>
<td>Lutzia allostigma</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Culex nigripalpus</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.8</td>
</tr>
<tr>
<td>Other species of Culex</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>2.2</td>
</tr>
<tr>
<td>Sabethoides chloropterus</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>1.3</td>
</tr>
<tr>
<td>Limatus species</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Wyomyia melanoccephala</td>
<td>19</td>
<td>19</td>
<td>38</td>
<td>6.1</td>
</tr>
<tr>
<td>Wyomyia scotinomus</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>2.2</td>
</tr>
<tr>
<td>Other species of Wyomyia</td>
<td>24</td>
<td>24</td>
<td>48</td>
<td>7.7</td>
</tr>
<tr>
<td>Goeldia species</td>
<td>11</td>
<td>11</td>
<td>22</td>
<td>3.5</td>
</tr>
<tr>
<td>Trichoprosopon digitatus</td>
<td>19</td>
<td>19</td>
<td>38</td>
<td>6.1</td>
</tr>
<tr>
<td>Orthopodomyia fascipes</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Megarhinus moctezuma</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>472</td>
<td>151</td>
<td>623</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Other modes of capture include catches in hollow trees, outhouses, under bridges and in holes in the ground.
localities at or near sea level, whereas the other three species have been found in the highlands as well as the lowlands.

In addition to the 5338 culicine mosquitoes caught as adults inside houses, in stable-type mosquito traps or with a horse as bait at sunset, 623 other non-anophelines were taken in the forests in the daytime, or in various other ways. Because of the proximity of Costa Rica to some of the endemic regions of jungle yellow fever, it seemed worthwhile to study the day-biting mosquitoes of the Costa Rican forests. Accordingly, we occasionally made daytime catches of adult mosquitoes in the dense forest, when time permitted and conditions were suitable. Such catches have been made with human bait in the manner often employed in Brazil. The 472 mosquitoes thus obtained are listed in the second column of table 7. This shows that the most prevalent mosquitoes in the Costa Rican forests included certain wild species of Psorophora, Aedes and Mansonia.

During the course of the mosquito survey of Costa Rica we discovered new species of Haemagogus, Orthopodomyia and Aedes. A new species of Haemagogus, *H. mesodontatus*, was described by Komp and Kumm (7), and the new species of Orthopodomyia from Orosi will be named by Dr. F. W. Edwards. A new Aedes belonging to the subgenus *Howardina* was found breeding in arboreal bromeliads on the slopes of the Irazú and Poás volcanoes and will be described at a later date.

**GEOGRAPHICAL DISTRIBUTION RECORDS WITH NOTES ON PREFERRED TYPES OF BREEDING PLACES FOR EACH SPECIES**

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Province</th>
<th>Localities</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Sabethoides chloropterus</em> Humboldt</td>
<td>Alajuela</td>
<td>Coyolar</td>
</tr>
<tr>
<td></td>
<td>Guanacaste</td>
<td>Santa Cruz</td>
</tr>
<tr>
<td></td>
<td>Puntarenas</td>
<td>Esparta, Puntarenas</td>
</tr>
</tbody>
</table>

Adults of this species were captured during the daytime with human bait in the forests.

*Limatus asulleptus* Theobald | Alajuela | Orotina |
|                            | Limón    | Beverley |

In Orotina this species was found breeding in some ornamental sea shells which had been employed to decorate an open air altar in the garden of the local church.
**Limatus durhamii** Theobald
Alajuela
Guanacaste
Puntarenas

**Orotina**
Cañas
Esparta, Golfito

*L. durhamii* was obtained from the same ornamental sea shells in the church at Orotina as *L. asulleptus*. It was also found in holes in bamboos which were full of rain water.

**Wyeomyia aporonoma** Dyar and Knab
Cartago
Guanacaste
Limón
Puntarenas

**Oroso**
Santa Cruz
Barra del Parismina,
Liverpool, Margarita,
Siquiress
Golfito, Pozo

Larvae of this species were usually encountered in rain water in tree holes and coconut shells, but on one occasion they were also found in the holy-water font of the church in Santa Cruz.

**Wyeomyia complosa** Dyar
Limón

**Barra del Parismina**

Larvae of *W. complosa* were aspirated from the interstices of the pink flowers of certain large Heliconias which were found in the forest behind the cemetery at Parra del Parismina.

? **Wyeomyia guatemala** Dyar and Knab
Cartago
Limón
Guanacaste

**Oroso**
Bananito, Barra del Parismina, Cairo, Liverpool
Cañas

The larvae live in the water which collects in the leaf bases of arboreal bromeliads.

**Wyeomyia intonca** Dyar and Knab
Cartago
Limón

**Turrialba**
Bananito, Beverley, Liverpool and Siquiress

Larvae were aspirated from rain water in the leaf bases of certain arboreal bromeliads.

**Wyeomyia melanocephala** Dyar and Knab
Limón

**Barra del Parismina, Liverpool**

Adults of *W. melanocephala* were captured with human bait in the forests in the daytime.

? **Wyeomyia melanopus** Dyar
Cartago
Limón

**Oroso**
Liverpool

Larvae of this species were secured by sucking up water from the leaf bases of certain arboreal and terrestrial bromeliads and on one occasion from a tree hole.
*Wyeomyia sc otinomus* Dyar and Knab

Knab

Cartago

Limón

Orosi

Laguna de Jaloba, Liverpool

Larvae were encountered in the rain water which collects in the leaf bases of certain arboreal bromeliads.

*Goeldia leucopus* Dyar and Knab

Limón

Liverpool

Adults were taken in daytime captures in the forests.

*Goeldia longipes* Fabricius

Limón

Barra del Parísmina, Siquirres

A day-biting sylvan species.

*Goeldia magna* Theobald

Limón

Laguna de Jaloba.

A single adult specimen of *G. magna* was obtained in the dense forest shortly after midday.

*Trichoprosopon digitatus* Rondani

Limón

Bananito, Beverley, Liverpool, Margarita, Siquirres

Puntarenas

Esparta

This is the cocoa-pod mosquito. Dyar (5) says that the adults do not bite, but we have been bitten by this species in the States of Bahia and Para, Brazil, as well as in Costa Rica.

? *Psorophora champerico* Dyar and Knab

Limón

Siquirres

This species was caught in the daytime in the forest.

*Psorophora cingulata* Fabricius

Alajuela

Cartago

Limón

Pital

Canada

Barra del Parísmina, Siquirres

Adults only were obtained, and they were secured either with a horse as bait at sunset, or else in the dense forests in the daytime.

*Psorophora ferox* Humboldt

Cartago

Guanacaste

Limón

Chitarría

Filadelfía, Liberia, Las Cañas, Santa Cruz

Barra del Parísmina, Beverley Chase, Cahuita, Laguna de Jaloba, Liverpool, Margarita, Siquirres

Puntarenas

Pozo, Puntarenas
We encountered larvae of this species in ground pools exposed to the sun, and on two occasions in semistagnant pools at the edge of slowly running streams.

*Psorophora howardii* Coquillett  
Guanacaste  
Puntarenas  
Belen, Liberia, Santa Cruz  
Puntarenas

*P. howardii* breeds in ground pools and in the water which has collected in the hoof prints of cattle, in the sunshine.

?*Psorophora jamaicensis* Theobald  
Cartago  
Guanacaste  
Turrialba  
Belen, Cañas, Las Juntaes, Pozo de Agua, Santa Barbara, Santa Cruz

Limón  
Barra del Colorado, Cairo, Cieneguita, Puerto Viejo

Puntarenas  
Barranca, Jicaral, Paquera

This species was found breeding in sunny pools and depressions on the ground.

*Psorophora lutzii* Theobald  
Limón  
Bananito, Barra del Colorado, Beverley, Field, Liverpool, Margarita, Siquirres, Suerre

No larvae were taken, but adults were caught with a horse as bait at sunset, and in the forests in the daytime.

*Psorophora varipes* Coquillett  
Limón  
Chase, Field, Margarita

Adults only were obtained and they were captured with a horse as bait at sunset, or else with human bait in the forests in the daytime.

*Haemagogus anastasionis* Dyar  
Guanacaste  
Santa Cruz

Larvae of this species were collected in a holy-water font in the church at Santa Cruz, and were described by Komp and Kumm (7).

*Haemagogus chalcospilans* Dyar  
Puntarenas  
Golfito, Puerto Jimenez, Puntarenas

*H. chalcospilans* was found breeding in tree holes and coconut shells full of clean rain water.

*Haemagogus iridicolor* Dyar  
Limón  
Puntarenas  
Barra del Parismina  
Pozo
Adults were caught with human bait in the dense forests in the daytime, while larvae were aspirated from rain water in tree holes.

**Haemagogus lucifer** Howard, Dyar and Knab

Limón

Guapiles

This species breeds in tree holes.

**Haemagogus mesodentatus** Komp and Kumm

San José

San José

A tree-hole breeder found in the Parque Bolivar, San José, and described by Komp and Kumm (7).

**Aedes aegypti** Linnaeus

Alajuela

Orotina

Cieneguita, Liverpool, Siquirres, Zent, Puerto Viejo

Puntarenas

Esparta, Puntarenas

Stegomyia larvae were encountered in artificial containers, and also in some ornamental sea shells that were being utilized to decorate an open air altar in the garden of the church at Orotina.

**Aedes angustivittatus** Dyar and Knab

Alajuela

Cerrillos, Coyolar, Muelle, Pital, Santa Clara, Cascajal

Cartago

Canada, Chitaria, Orosi, Peralta, Sanatorio Duran, Turrialba

Guanacaste

Bolsón, Cañas, Filadelfia, Liberia, Santa Barbara, Santa Cruz, Sardinal

Limón

Bananito, Barra del Colorado, Barra del Parismina, Cairo, Castilla, Chase, Cieneguita, Liverpool, Margarita, Puerto Viejo, Siquirres, Suerre

Puntarenas

Barranca, Paquera, Pozo, Puntarenas, Sierpe, Volcan

This is the commonest of the Aedes which we have taken in Costa Rica, both as regards the actual number of adults and larvae obtained and in the number of different localities where this species has been met with. It breeds in ground pools, hoof prints of animals, pooled streams and sometimes in fresh water swamps.
**Aedes cuplocamus** Dyar and Knab

Guanacaste
Heredia
Limón
Puntarenas

Liberia
Heredia
Bananito, Puerto Viejo, Siquirres
Barranca, Paquera

This species breeds in ground pools in the sun.

**Aedes hastatus** Dyar

Puntarenas

Pozo

Larvae of *A. hastatus* were found in ground pools beside a slowly running stream in the sunlight.

**Aedes lithoeceter** Dyar and Knab

Cartago
Guanacaste

Peralta, Turrialba
Las Juntas

A rock-hole breeder by preference, which occasionally appears in ground pools as well.

**Aedes nubilus** Theobald

Limón

Barra del Parismina, Beverley, Field, Laguna de Jaloba, Liverpool, Margarita, Siquirres

No larvae were secured, but adult *A. nubilus* were captured in the forests with human bait.

**Aedes atropalpus** Coquillet

Guanacaste

Liberia

Larvae of this species were observed in urns and flower vases half full of rain water in the cemetery at Liberia.

**Aedes terrens** Walker

Alajuela
Cartago
Guanacaste
Limón
San José

Orotina, Rio Segundo, San Mateo
Orosi
Liberia, Santa Cruz
Chase
San José, Santa Ana

This is a tree-hole breeder and has been obtained nowhere else.

**Aedes quadrivittatus** Coquillet

Alajuela

Poás Volcano

This species breeds in the leaf bases of arboreal bromeliads on the slopes of Poás Volcano.

**Aedes n. sp.**

Alajuela
Cartago

Poás Volcano
Cipreses

A bromeliad breeder which was taken on the slopes of the Irazú and Poás volcanos.
**Aedes serratus** Theobald  
Guanacaste  
Limón  
Puntarenas  
Filadelfia  
Bananito, Barra del Parismina, Field, Laguna de Jaloba, Liverpool, Siquirres  
Pozo  

A day-biting sylvan species. No larvae were seen.

**Aedes taeniorynchus** Wiedemann  
Guanacaste  
Limón  
Puntarenas  
Bolsón, Cañas, Filadelfia, Huacas, Pozo de Agua, Santa Barbára, Santa Cruz, Sardinal Cieneguita, Puerto Viejo Barranca, Bonilla, Caldera, Jicaral, Puntarenas, San Lucas Island  

Usually a brackish water breeder, but occasionally found in pools of fresh water also, near the sea.

**Theobaldia maccrackenae** Dyar and Knab  
Cartago  
San José  
Sanatorio Duran  
San Isidro de Coronado  

The larvae of this species were found in ground pools in the high mountains. It is also known from the Chiriquí Volcano region in Panamá.

**Mansoninae arribálzaga** Theobald  
Limón  
Barra del Parismina, Laguna de Jaloba, Liverpool  

A day-biting sylvan species of which we obtained no larvae.

**Mansoninae fasciolata** Lynch—Arribálzaga  
Alajuela  
Cartago  
Limón  
Puntarenas  
Muelle, Pital  
Canada, Chitaría, Orosi, Peralta  
Barra del Colorado, Barra del Parismina, Cairo, Chase, Cieneguita, Liverpool, Margarita, Siquirres, Suerre  
Barranca, Bonilla, Pozo  

No larvae were seen, but numerous adults were captured inside houses, in traps, with a horse as bait at sunset, and even in the dense forests in the daytime.

**Mansoninae titillans** Walker  
Alajuela  
Cartago  
Muelle  
Chitaría
This species breeds in ground pools and ponds, especially in the presence of *Pistia stratiotes*. It is very abundant in the coastal lowlands.

*Deinocerites epiteleus* Knab

In Costa Rica this species has been caught on the Atlantic coast only.

*Deinocerites pseudes* Dyar and Knab

A crab-hole breeder which has been found, so far, on the Pacific coast only.

*Culex (Lutzia) allostigma* Howard, Dyar and Knab

No larvae have been seen, but adults were captured resting inside a water tank.

*Culex aikenii* Aiken

This species was secured in a pond, whose surface was largely overgrown with floating *Pistia stratiotes*.

*Culex bastagarius* Dyar and Knab

Larvae were obtained in a stagnant pool in a slowly running stream among plenty of horizontal and vertical vegetation.

*Culex chrysonotum* Dyar and Knab

Pital

Barra del Colorado, Chase, Estrada, Puerto Viejo, Siquirres

Pozo
C. chrysonotum breeds in ground pools and ponds in the sunshine and was found on one occasion in partly brackish water with Anopheles tarsimaculatus and Aedes taeniorhynchus.

_Culex conservator_ Dyar and Knab  
Puntarenas  
Golfito

An adult of this species was taken in a hollow tree in the forest at Golfito.

_Culex conspirator_ Dyar and Knab  
Guanacaste  
Limón  
Cañas, Santa Cruz  
Liverpool

Larvae were encountered in pot holes and rocky pools at the edge of streams and rivers among floating leaves and other debris.

_Culex corniger_ Theobald  
Alajuela  
Cartago  
Limón  
San José  
Mastate, San Rafael Sur, Alajuela  
Orosi  
Liverpool  
Santa Ana

Larvae of this species were found in ground pools, tree holes, and even coconut shells full of rain water.

_Culex coronator_ Dyar and Knab  
Cartago  
Limón  
Peralta  
Estrada

Specimens of this species were taken in ground pools and depressions along the edges of streams as well as in seepage areas in the sunshine.

_Culex daumastocampa_ Dyar and Knab  
Limón  
Cairo

The larvae live in the water that collects in the leaf bases of arboreal bromeliads.

_Culex declarator_ Dyar and Knab  
Alajuela  
Cartago  
Guanacaste  
Limón  
Puntarenas  
Cascajal, Mastate  
Orosi  
Cañas, Liberia, Santa Cruz  
Cieneguita, Siquirres  
Barranca, Pozo

This is generally a ground-pool breeder though it has been found in pot holes among rocks in the beds of intermittent streams, but always in the sunlight.

_Culex fatigans_ Wiedemann  
Alajuela  
Cartago  
Guanacaste  
Orotina, Rio Segundo, San Antonio de Tejar  
Canada, Capellades, Orosi  
Arenal, Cañas, Huacas, Liberia, Nicoya, Que-
brada Honda, Rio Seco, Santa Barbára, Santa Cruz, Santa Rosa, Sardinal, Tempate

Limón Cairo, Cieneguita, Guapiles, Siquirres

Puntarenas Barranca, Esparta, Puntarenas

San José Parrita, San José

Breeds in abundance in artificial containers, ground pools, seepage areas, and indeed in any place with dirty water. It is the commonest Culex in Costa Rica.

*Culex hesitator* Dyar and Knab Cartago Orosi, Peralta

Larvae were found in hoof prints, neglected ditches and pools in the ground exposed to the sun.

*Culex inhibitor* Dyar and Knab Puntarenas Bonilla

This species breeds in sunny ponds which are covered with floating lilies’ *Pistia stratiotes*, water hyacinth and other horizontal vegetation.

*Culex jenningsi* Dyar and Knab Cartago Orosi, Turrialba.

*C. jenningsi* breeds in the water that collects between the leaf bases of arboreal bromeliads.

*Culex mollis* Dyar and Knab Limón Orosi, Turrialba

San José Santa Ana

In Costa Rica this is a tree-hole breeder.

*Culex mutator* Dyar and Knab Cartago Peralta

Larvae were found in holes in rocks exposed to the sun beside the Reventazón River.

*Culex nigripalpus* Theobald Guanacaste Santa Cruz

Adults of this species were caught resting on leaves in the shade in a banana plantation, but no larvae were found.

*Culex pilosus* Dyar and Knab Limón Estrada

Larvae were secured in stagnant collections of water in the hoof prints of cattle in the sunshine.

*Culex stenolepis* Dyar and Knab Cartago Cipreses, Orosi

This is a bromeliad breeder and has been seen nowhere else.
Culex stigmatosoma Dyar
  Alajuela  Alajuela
  Cartago  Cartago, Orosi, Palomo,
          Paso Ancho, Paraiso,
          Sanatorio Duran,
          Tapanti
  San José  Santa Ana

This is a common species on the central plateau where it breeds in pools beside
streams, ponds, ditches, seepage areas, swamps and the hoof prints of animals,
but always in the sunshine.

Culex trisulcus Dyar
  San José  Santa Ana

Larvae were found in sunny pools along the edge of a stream among Spirogyra
and considerable debris.

? Culex sp. ?
  Cartago  Cipreses

This highland species breeds in the leaf bases of arboreal bromeliads.

Aedomyia squamipennis Lynch—
  Arribálzaga

Puntarenas  Barranca

Aedomyia larvae were obtained in a sunny swamp whose surface was largely
evered with Pistia stratiotes.

Orthopodomyia fascipes Coquillet
  Limón  Bananito, Cairo

No larvae of this species were seen, but adults were occasionally encountered
in hollow trees in the forest or other well-shaded places.

Orthopodomyia phyllozoa Dyar and Knab
  Cartago  Orosi

The larvae live in the water which collects in the leaf bases of arboreal bromeliads.

Orthopodomyia n. sp.
  Cartago  Orosi

On one occasion larvae of this species were secured in large numbers from an
abandoned tank or cesspool full of clear rain water in the village of Orosi.

Megarhinus moctezuma Dyar and Knab
  Alajuela  Orotina
           Puntarenas
           Barranca, Esparta, Jesus
           Maria, San Lucas Island
           San José

A tree-hole breeder. Adults were occasionally caught in houses, in hollow
trees, or in well-shaded places, such as under bridges.

Megarhinus superbus Dyar and Knab
  Cartago  Orosi
This species breeds only in epiphytic bromeliads.

_Uranotaenia coatzacoalcos_ Dyar and Knab

<table>
<thead>
<tr>
<th>Location</th>
<th>Districts</th>
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<tbody>
<tr>
<td>Alajuela</td>
<td>Ceiba, Turrucares</td>
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<tr>
<td>Cartago</td>
<td>Orosi</td>
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<td>Guanacaste</td>
<td>Cañas</td>
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<td>San José</td>
<td>San Isidro de Coronado</td>
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</tbody>
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Larvae have been found in running as well as pooled streams, in ditches, ground pools and fresh water swamps, in both light and shade.

_Uranotaenia geometrica_ Theobald

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<th>Location</th>
<th>Districts</th>
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<tbody>
<tr>
<td>Alajuela</td>
<td>Alajuela, Atenas, Cascajal, Higuito, San An-</td>
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<tr>
<td>Cartago</td>
<td>tonio de Tejar</td>
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<tr>
<td>Guanacaste</td>
<td>Canada, Chitaría, El Alto, Orosi, Palomo,</td>
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<td>Limón</td>
<td>Peralta, Turrialba</td>
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<td>Puntarenas</td>
<td>Caja, Cañas, Liberia, Veinteisiete de Abril</td>
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<tr>
<td>San José</td>
<td>Cairo, Chase, Limón, Siquirres</td>
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<td>Arancibia, Barranca, Miramar, Pozo</td>
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<td>Aserri, San Isidro de Coronado, Santa Ana</td>
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</table>

A very common species which has been observed in pooled streams, ponds, seepage areas, ditches, swamps, the hoof prints of animals and indeed ground pools of all kinds. It shows a decided tropism for breeding among green _Spirogyra_; at least three quarters of all our collections of this species having been found in the presence of green algae in the sunlight.

_Uranotaenia lowii_ Theobald

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<thead>
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<tbody>
<tr>
<td>Guanacaste</td>
<td>Liberia</td>
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<tr>
<td>Puntarenas</td>
<td>Arancibia, Kilometro 99</td>
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<tr>
<td>San José</td>
<td>Parrita</td>
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</table>

Rather a rare species, it breeds in rocky pools beside rivers, borrow pits, the hoof prints of animals, and other types of ground pools in the sunshine.

_Uranotaenia pulcherrima_ Lynch—Arribálzaga

A single larva of this species was taken in a pond full of water lettuce.

_Uranotaenia sapphirina_ Osten—Sacken

A rare highland species which has been encountered in semistagnant pools in slowly running streams, with plenty of vegetation and exposed to the sun.

_Anopheles albimanus_ Wiedemann

<table>
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<th>Location</th>
<th>Districts</th>
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<tbody>
<tr>
<td>Alajuela</td>
<td>Cascajal, Ceiba, Ciruelas, Hidalgo, Muelle,</td>
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</table>
Cartago

Pital, Santa Clara, Coyolar

Cartago

Canada, Chitaría, Peralta, Turrialba, Ujarras

Guanacaste

Arenal, Bebedero, Belen, Bolsón, Buena Vista, Caballito, Cañas, Copal, Corralillo, Filadelfia, Huacas, Laguna, Liberia, Matapalo, Montano, Moravia, Nandayure, Niquoy, Ortega, Paso Tempisque, Pozo Azul, Pozo de Agua, Quebrada Honda, Rio Seco, Roblar, San Juan (Abangares), San Juan (Santa Cruz), San Lazaro, Santa Barbara, Santa Cruz, Santa Rosa, Sardinal, Tempate, Vigia, Veinteisiete de Abril, Zapote

Limón

Barra del Colorado, Barra del Parismina, Bonifacio, Cahuita, Cairo, Chase, Cieneguita, Estrada, Guacimo, Guapiles, Jimenez, Limón, Liverpool, Margarita, Matina, Pacuarito, Penshurst, Pocora, Puerto Viejo, Siquirres, Suerre, Westfalia, Zent

Puntarenas

Aranceibia, Barranca, Bonilla, Caldera, Chomes, Corozal, Esparta, Golfito, Jesus Maria, Jicaral, Kilometro 99, Lepanto, Palmar, Paquera, Pozo, Puerto Jimenez, Puntarenas, Salinas, Tarcoles, San Lucas Island
The commonest anopheline in Costa Rica. It breeds principally in sunny ground pools about half of the collections having been obtained in the presence of *Spirogyra*.

**Anopheles albitarsis** Lynch—Puntarenas

Arribálzaga

Larvae of *A. albitarsis* were obtained in a sunny pond among algae, vertical and horizontal vegetation.

**Anopheles anomalophyllus** Komp—Cartago

Canada

A very rare species which has been taken only once in a pool in a slowly running stream.

**Anopheles apicimacula** Dyar and Knab—Alajuela

Alajuela, Atenas, Ciruelas, Coyolar, Escobal, Palmares, Pital, Quebrada Azul, San Antonio de Tejar, San Ramón, Santa Clara

Canada, Chitaria, Orosi

Arado, Cañas, Higuera, La Sierra, Las Juntas, Liberia, Nambi, Nicoya, Pozo Azul, Santa Cruz, Santa Rosa, Sardinal, Tilarán

Barra del Colorado, Cairo, Cimarrones, Guacimo, Guapiles, Jimenez, Laguna de Jaloba, Liverpool, Siquirres

**Puntarenas**

Barranca, Esparta, Jicra, Palmar, Paquera, Pavones, Pozo, Puerto Jimenez, Puntarenas, Volcan

**San José**

Escasu, Villa Colon

The breeding places selected by *A. apicimacula* were similar to those chosen by *A. argyritarsis* except that at least one third of the former were in the shade. In only 28.6 per cent was *Spirogyra* noted.

**Anopheles argyritarsis** Robineau—Desvoidy—Alajuela

Aguas Zarcas, Alajuela, Atenas, Balsa, Carrillo, Cascajal, Cerrillos, Ciruelas, Concepción, Coyolar, Escobal, Flo-
rencia, Grecia, Hacienda Vieja, Higuito, La Guacima, Mastate, Muelle, Naranjo, Ojo de Agua, Orotina, Palmare, Quebrada Azul, Rio Segundo, San Antonio de Tejar, San Mateo, San Rafael Norte, San Rafael Sur, San Ramón, Santa Clara, Turrucares, Villa Quesada

Cartago
Atirro, Cachi, Capellades, Cartago, Chitaria, El Alto, El Hoyo, Florencia, Las Mesas, Orosi, Palomo, Paraíso Pejivalle, Platanillo, Tapanti, Tres Ríos, Tucurriqui, Turrialba, Tuis, Ujarra

Guanacaste
Cañas, La Cruz, Las Juntas, Los Angeles, Liberia, Pozo Azul, Sabana Grande, San Antonio, San Juan (Abangares), San Juan (Santa Cruz), Santa Cruz, Tempate, Tilarán, Veinteisiete de Abril

Heredia
Barreal, Heredia, San Antonio de Belen, Santo Domingo

Limón
Cairo, Guapiles, Limón, Pacuarito, Siguirres, Waldeck

Puntarenas
Araneibia, Baron, Barranca, Boruca, Buenos Aires, Esparia, Jesus Maria, Miramar, Rio Seco, San Isidro, San Rafael, Volcan

San José
Alajuelita, Aserrí, Coronado, Curridabat, Desamparados, Escasu, San Juan de Tibas,
San José, San Marcos
de Tarazu, Santa Ana,
Villa Colon

A very abundant species which was encountered somewhat more often in
running streams, pooled streams and seepage areas than *A. albimanus*. In only
31.5 per cent of the collections which yielded this species, did we note the presence
of green algae. Larvae of *A. argyritarsis* have been identified from collections
made in rock pools in the dry bed of a stream more than a mile away from the
nearest human habitation.

*Anopheles backmanni* Petrocchi

Larvae of this species were obtained in a pooled stream between the floating
leaves of water lettuce.

*Anopheles chiriiquiensis* Komp

The larvae of this rare highland species were found in pools in a slowly running
stream, some in the shade and some in the sunlight.

*Anopheles eiseni* Coquillet

While not a particularly common species in Costa Rica *A. eiseni* has been
obtained in its larval stages under a great variety of conditions, including pools
in stream beds, ditches, seepage areas, hoof prints of cattle, tree holes, coconut
shells full of rain water, and even bromeliads. More than half of these were in the
shade, and in only 14.3 per cent of the collections did we observe *Spirogyra*.

*Anopheles neivai* Howard, Dyar

This species breeds in the rain water which collects between the leaf bases of
arboreal bromeliads.

*Anopheles neomaculipalpus* Curry

Cañas, Higueron, Lagu-
nilla Liberia, Mata-
palo, Santa Cruz

Chase, Guacimo, Si-
quirres

Barranca, Pozo
A relatively abundant species during the rainy season, the larvae of which were observed in ground pools, ditches, hoof prints of cattle and small ponds, almost always in the sunshine. In about a quarter of the breeding places we noticed green algae.

<table>
<thead>
<tr>
<th>Anopheles pseudopunctipennis</th>
<th>Alajuela</th>
<th>Atenas, Cascajal, Ceiba, Cerrillos, Ciruelas, Coyolar, Escobal, Higuito, La Guacima, Muñoz, Ojo de Agua, San Antonio de Tejar, San Rafael Sur, Santa Clara</th>
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<td>Heredia</td>
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<td>Puntarenas</td>
<td>Arancibia, Barranca, Caldera, Canjel, Corozal, Esparta, Jesus Maria, Kilometro 99, Pavones, Pozo, Salinas Tarecoles, Volcan</td>
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<td>San José</td>
<td>Coronado, Santa Ana</td>
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Numerous larvae of this species were taken in ground pools, ditches, hoof prints of cattle and seepage areas. It was also frequently found in pooled streams and sometimes at the very edge of slowly running rivers, particularly in the sunlight and where green algae was flourishing. Among 31 collections in which a record was made as to the presence or absence of Spirogyra, algae were noted as present in 22 or 70.1 per cent.

| Anopheles punctimacula | Dyar Guanacaste | Cañas, Huacas, Rio Seco, Santa Cruz | and Knab |
A. punctimacula breeds in semistagnant pools and at the edges of slowly running streams, in ditches, borrow pits, hoof prints of animals, and small ponds. More than a third of the collections of this species were obtained in the shade and Spirogyra was noted in only 25 per cent.

Anopheles strolei Root

Alajuela
Guanacaste
Limón
Puntarenas

Cascajal, Muelle
Cañas, Liberia, Quebrada Honda
Cairo, Chase, Margarita, Pocora, Siquirres, Suerre
Barranca, Bonilla, Jicaral, Kilometro 99, Pozo Volcan

A ground pool breeder which has also been observed in small ponds, the hoof prints of cattle, and in slowly running streams in the sunshine.

Anopheles tarsimaculatus Goeldi

Limón
Barra del Colorado, Cahuita, Cieneguita, Puerto Viejo

This is the brackish water Anopheles. It was obtained in addition on one occasion in a fresh-water stream about fifty yards from the sea.

Anopheles vestitipennis Dyar and Knab

Limón
Barra del Colorado, Cahuita, Suerre

Larvae of A. vestitipennis were found in a slowly running stream with much vegetation and algae, as well as in an overgrown shaded pool.

Chagasia bathanus Dyar

Alajuela
Guanacaste
Limón
Puntarenas

Pital, Quebrada Azul, Santa Clara
Arado, Cañas, Higueron, La Sierra, Lagunilla, Las Juntas, Rio Seco, Santa Barbára, Santa Cruz, Santa Rosa
Barra del Colorado, Cairo, Guapiles, Puerto Viejo
Jicaral, Paquera, Pozo, Puerto Jimenez
Chagasia bathanus shows a marked tropism for shady pools in running streams. If there are trees along the bank the Chagia larvae will be found wherever any exposed tree roots enter the water of the stream. At other times they may be secreted among grass growing at the edge of the water, but hardly ever if Spirogyra is present.

**KEYS TO THE CULICIDAE OF COSTA RICA, ENCOUNTERED IN THE PRESENT SURVEY**

Species representing all of the five tribes recognized by Dyar were encountered. A brief key to these five tribes is given below as well as generic keys for the tribes Anophelini and Culicini. In addition species keys for the identification of adult females of the genera Psorophora, Aedes, Orthopodomyia, Mansonia, Uranotaenia and Anopheles have been prepared. In the genera Haemagogus and Culex identification is based on the characters of the male terminalia, the female adults being indistinguishable in many cases; keys to the male terminalia of those genera are beyond the scope of this paper.

**KEYS TO TRIBES OF COSTA RICAN MOSQUITOES (DYAR, NEC EDWARDS)**

1. Base of hind coxa in line with upper margin of meron. No mesonotal setae. Postnotal setae always present. Apex of 7th segment of female abdomen surrounded by a fringe of stiff bristles. Hind margin of abdominal tergites without setae. **Sabethini**
   - Base of hind coxa below upper margin of meron (except in Megarhinus); mesonotal setae always present. Postnotal setae usually absent (present in some Haemagogus, Deinocerites, and Carrollia). Hind margin of abdominal tergites with setae. **2**

2. Palpi of female nearly as long as proboscis, which is straight. First abdominal tergite without scales. Scutellum crescent-shaped, without lobes (except in genus Chagasia). Coloration never metallic. **Anophelini**
   - Not as above. **3**

3. Large species, covered with metallic scales. Proboscis thinner and curved downwards on apical half. Posterior margin of scutellum straight. Clypeus much broader than long. **Megarhinini**
   - Smaller species, usually without metallic scaling (see Haemagogus). Proboscis straight, uniform, or slightly swollen at tip. Posterior margin of scutellum trilobed. **4**

4. Small species, with spots or lines of metallic blue scales on thorax, base of wing, and/or pleura. Proboscis long, straight, directed backwards, the tip swollen. Anal vein ending at or slightly before, the fork in the fifth vein. **Uranotaeniini**
   - Small to large species, usually without metallic blue spots. Proboscis straight, not directed backwards, tip not usually enlarged. Anal vein ending beyond the fork in the fifth vein. **Culicini**
KEY TO THE GENERA AND SUBGENERA OF TRIBE ANOPHELINI OF COSTA RICA
(AFTER EDWARDS)

Generic characterization; Palpi straight, as long as the proboscis; scutellum without lobes, crescent-shaped (except in genus Chagasia); first abdominal tergite without scales............................................. Tribe Anophelelini

In a recent personal communication, Dr. F. W. Edwards of the British Museum accepts the suggestion of the second author (W. H. W. K.) that Kerteszia be raised to the rank of a subgenus co-equal with Nyssorhynchus, instead of being considered a “group” under the subgenus Nyssorhynchus. With the exception of this emendation, the classification is that of Edwards (Genera Insectorum, Diptera, Fam. Culicidae, Fasc. 194, 1932).

1. Scutellum trilobed; sides of mesonotum with erect scales; first hind tarsal segment twice as long as hind tibia; resting-attitude Mansonia-like (one species, bathanus)............................................... Chagasia

Scutellum not trilobed; sides of mesonotum without erect scales; first hind tarsal segment slightly longer than hind tibia; resting-attitude with proboscis, thorax, and abdomen in straight line at angle to resting surface (genus Anopheles).................................................................................. 2

2. A small slender black species, with unmarked wings; mesonotum with a narrow white longitudinal line in integument; body without scales; legs very long and slender (one species, kompi, not yet found in Costa Rica but probably present).................................................... subgenus Stethomyia

Larger species, with spotted wings; mesonotum without narrow central white line; body with scales.................................................................................. 3

3. Hind tarsi with last three segments all white, or with a narrow black basal ring on fifth segment.................................................... subgenus Nyssorhynchus

Hind tarsi otherwise marked............................................................................. 4

4. Hind tarsi all dark, unmarked (3 species, chiriquiensis, pseudopunctipennis and eiseni).......................................................... series Anopheles of subgenus Anopheles

Hind tarsi otherwise marked............................................................................. 5

5. Hind tarsi speckled and banded with white and black; wings with broad black, white, or yellow scales; mesonotum without parallel black lines; costa of wing marked with spots irregular in size................................................................. 6

Hind tarsi with all segments white apically, black basally; mesonotum with 4 bare black longitudinal lines; wings with 4 subequal costal white spots (one species, neivai).................................................... subgenus Kerteszia

6. Hind tarsi mostly dark; narrow light bands encircling both ends of second, third and fourth segments (one species, vestitipennis)

series Cycloleptpperon of group Anopheles

Hind tarsi speckled with black and white, not disposed in bands surrounding the articulations ........................................... (three species, apicimacula, punctimacula and neomaculipalpus)............................. group Arribalzagia of subgenus Anopheles

KEY TO GENERA OF TRIBE CULICINI (DIAR, NEC EDWARDS)

1. Base of hind coxa in line with upper margin of meron; setae absent on dorsum of mesonotum; postnotum with setae in several species; spiracular setae
absent; postspiracular setae present in several species, but usually absent; dorsum of thorax and abdomen clothed with purple, blue, or green metallic scales, sides with silvery white scales.  

*Haemagogus*

Base of hind coxa below upper margin of meron; setae present on dorsum of mesonotum; postnotum without setae (except in 1 *Deinocerites* and some *Carrollia*); spiracular setae present or absent; postspiracular setae present or absent; mesonotal scales not purple metallic.  

2. Abdomen pointed.  

Abdomen rounded and blunt at tip.  

3. Eighth segment of abdomen completely retractile; cerci usually long; spiracular setae present; postspiracular setae present.  

*Psorophora*

Eighth segment of abdomen somewhat retracted; cerci long, exserted (see subgenus *Howardina*, in which abdomen is not notably pointed, with terminal segments projecting ventrally); spiracular setae absent; postspiracular setae present.  

4. Large species, with spotted wings; lower side of base of first vein pilose; spiracular setae present, postspiracular setae absent (one Costa Rican species, found at high altitudes).  

*Theobaldia*

Smaller species, usually with unspotted wings; lower side of base of first vein bare, or with scales only; spiracular setae absent; postspiracular setae usually absent (present only in *Mansonia*).  

5. Wing-scales broad, especially on sixth vein; wings usually spotted and legs speckled; tarsal claws without pulvilli.  

Wing-scales narrow, especially on sixth vein; wings not spotted (except in *Lutzia*), legs not speckled; tarsal claws with pulvilli.  

6. Clypeus with white scales; tufts of outstanding scales on spines of middle and hind femora; wings nearly completely covered with broad brown and yellow scales; small species with banded legs.  

*Aedomyia*

Clypeus bare; no outstanding tufts on middle and hind femora; wings and legs variously spotted.  

7. Postspiracular setae absent; fourth and fifth fore tarsal segments shorter than third; thorax marked with lines of silver or golden scales.  

*Orthopodomia*

Postspiracular setae present; fourth and fifth fore tarsal segments longer than third; thorax with irregular scale pattern.  

8. Large yellowish species with banded legs; costa of wing with black and yellow areas; many lower mesepimeral setae.  

*Lutzia*

Smaller species, with wing-scales all dark; lower mesepimeral setae but few.  

9. Antennae normal, not longer than proboscis; postnotum bare (except in some *Carrollia*); abdomen rounded, cerci not prominent.  

*Culex*

Antennae slender, much longer than proboscis; first flagellar segment always very long; postnotum usually bare (with setae in *epiteudes*); abdomen rather pointed, cerci prominent.  

*Deinocerites*

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**KEY TO THE SPECIES OF PSOROPHORA IN COSTA RICA**

Seven species of the genus *Psorophora* occur in Costa Rica. One of them, *howardii*, belongs to the subgenus *Psorophora*; four species, *feroz*, *champerico*, *lutzii* and *varipes* are included in the subgenus *Janthinosoma*; and the remaining two namely *cingulata* and *jamaicensis* fall in the subgenus *Grabhamia*. The
classification of the species in the two subgenera Janthinosoma and Grabhamia is in an unsatisfactory condition, which will not be improved until further studies are made with fresh material. Dyar separated the Grabhamia species on the number of filaments on the clasper, but Martini showed that these characters are variable.

1. Mesonotum with smooth nude longitudinal areas; claws toothed; a large bluish-black species with raised scales on hind legs; tarsi with white rings at bases of 1st and 2nd segments. \textit{Howardii}

Mesonotum uniformly scaled, sometimes sparsely; claws toothed (\textit{Janthinosoma}) or simple (\textit{Grabhamia}). \textbf{2}

2. Dark species with dark-scaled wings; tarsal segments all dark, except the fifth hind tarsal segment (and sometimes the fourth), which is white; tarsal claws toothed (\textit{Janthinosoma}). \textbf{3}

Grayish or brownish species; wings usually with bicolored scales; tarsal segments white-ringed basally; tarsal claws simple (\textit{Grabhamia}). \textbf{6}

3. Hind tarsi with last segment dark; fourth segment black basally, white apically; mesonotum with dark scales centrally, sides with whitish scales; hind femur with apical white mark. \textit{Varipes}

Hind tarsi with last segment all white. \textbf{4}

4. Mesonotum with sparse golden scales only, on black integument; hind legs with erect scales. \textit{Ferox}

Mesonotum dark-scaled centrally, white-scaled on sides. \textbf{5}

5. Scutellum dark-scaled. \textit{Lutzii}

Scutellum with yellowish scales. \textit{Champerico}

6. Large brownish species, with wing-scales all dark; no mesial white ring on first tarsal segment; abdominal segments with silvery white apical bands, broadening on sides. \textit{Cingulata}

Smaller grayish species, with wing-scales black and white; a mesial white ring on first tarsal segment; abdominal segments with white posterior bands, broadening centrally. \textit{Jamaicensis}

KEY TO THE SPECIES OF Aedes in COSTA RICA

Twelve species of the genus \textit{Aedes} occur in Costa Rica, representing five of the eight subgenera of this genus.

In naming the species we have made two necessary changes in the usual nomenclature. What has been formerly called \textit{pericarces} we call \textit{atropalpus}, following Edwards, and in accordance with our own comparison of adults and larvae of this species from the United States, Costa Rica, and Panama; we agree with Shannon and Edwards that \textit{thoronti}, \textit{podographicus} and \textit{terren} are but one polymorphic species, which shows variation in numbers of larval head-hairs and in mesonotal scaling, but no correlation between these larval characters and the adults.

1. Proboscis white-ringed. \textit{Taeniorhynchus}

Proboscis without a white ring. \textbf{2}

2. Clypeus with white scales; a lyre-shaped silvery white mark on mesonotum; legs black, with silvery white tarsal bands. \textit{Aegypti}
Clypeus bare; mesonotum otherwise marked; legs either black or with tarsi variously marked. .................................................. 3
3. Tarsal segments all black. .......................................................... 4
All or some of the tarsal segments white-banded. .............................. 8
4. Mesonotum dark brown, uniform, without white scales (male with central white line on mesonotum) .......................... Nubilus
Mesonotum with white or yellow scales, either in a central line, or in an anterior patch. .................................................. 5
5. Mesonotum dark, with two narrow parallel lines of white or yellowish scales dorsally (markings variable, sometimes broad, sometimes narrow, sometimes fused across). Angustivittatus
Mesonotum otherwise marked. .................................................. 6
6. Mesonotum with a single median line of white scales. ................. 7
Mesonotum with anterior half (except extreme sides) covered with silvery scales. ............................................. Euplocochus
7. Small species, with narrow median line of white scales on mesonotum. Hostatus
Large, robust species, with broad median line of silvery white scales on mesonotum. ............................................. Serratius
8. Claws toothed on tarsi of front and middle legs; mesonotum with silvery or yellowish silvery scales in patches, not in distinct lines. ... 9
Claws simple; mesonotum with distinct lines of golden scales. .......... 11
9. Mid and hind tarsi with broad white band, formed by white rings at apex of second segment and base of third; mesonotum either entirely silvered across anteriorly, or with narrow black median band (markings variable; tree-hole breeding species). Terrens
Mid and hind tarsi not so marked; the second and third tarsal segments on these legs ringed basally only, or only very narrowly white on preceding segments. .................................................. 10
10. Mesonotum variable, usually with dark median band, the sides silvery, sometimes forming a curved lateral silvery mark, sometimes almost entirely silvered across; abdomen without median white line. Atropalpus
Mesonotum variable, usually with anterior area of pale golden or silvery scales, sometimes with 2 darker longitudinal lines; sides dark; abdomen with median white line. ............................................. Lithoeetor
11. Mesonotum brown, with six parallel narrow golden lines, four on dorsum, two on lateral margins; these lateral lines straight, not curving dorsally and not merging with subdorsal lines before reaching anterior margin of mesonotum. ............................................. Quairivittatus
Mesonotum brown, six narrow golden lines, the four dorsal lines parallel, the two on lateral margins curving inward and joining the subdorsal lines before reaching anterior margin of mesonotum. Alloteconon n.sp.

KEY TO THE SPECIES OF ORTHOPODOMYIA IN COSTA RICA

Only three species of the genus Orthopodomyia are known to occur in Costa Rica. Two of them, phyllozoa and a new species to be described, have narrow silvery markings on the mesonotum; fascipes lacks these silvery lines. The wing-scales are all broad, and no mid-mesepimeral setae are present; the fourth fore tarsal segment is very short.
1. Mesonotum without narrow silvery lines. ... \textit{Fascipes}
Mesonotum with narrow silvery lines. \hspace{1cm} 2

2. Wings with yellow spots involving costa. \hspace{1cm} \textit{Phylozoa}
Wings without yellow spots; wing-scales all dark except for a long white streak at base of first vein. \hspace{1cm} n.sp.

**KEY TO THE SPECIES OF \textsc{MASSONIA}**

1. Wing-scales distinctly inflated, broad, black and yellow; femur without subapical white ring; tarsi dark with white rings at bases of segments, broadest on hind legs. \hspace{1cm} \textit{Tithiianus}
Wing-scales narrow, elliptical, all black; femur with narrow white subapical ring. \hspace{1cm} 2

2. Tibiae all dark; mesonotum reddish, with two white spots on shoulders
\hspace{1cm} \textit{Arribalsagae}
Tibiae with yellowish speckles; mesonotum without white spots, but with brown and yellow scales in lines. \hspace{1cm} \textit{Fasciolata}

**KEY TO THE SPECIES OF \textsc{URANOTAEANIA}**

1. Tarsi all dark, without white markings; mesonotum with median blue line \hspace{1cm} \textit{Sapphirina}
Tarsi with white markings, especially on the hind legs. \hspace{1cm} 2

2. All tarsal segments marked with white at base and apex; mesonotum with median blue marks. \hspace{1cm} 3
Terminal hind tarsal segments white; apices of hind tarsal segments white; mesonotum without median blue marks. \hspace{1cm} 4

3. Fourth and fifth segments of hind tarsi all white; abdomen with apical triangular spots on tergites; a large species. \hspace{1cm} \textit{Geometrica}
Fifth segment of hind tarsi all white; fourth segment white apically, dark basally; abdomen with apical white bands on two segments; a much smaller species. \hspace{1cm} \textit{Pulcherrima}

4. Mesonotum with a metallic blue line from base of wing half way to anterior margin of mesonotum. \hspace{1cm} \textit{Coatzacoalcos}
Mesonotum without such a line, but with a black spot at wing-base, with a central area of metallic blue scales; a very small mosquito. \hspace{1cm} \textit{Lowii}

**KEY TO ADULT ANOPHELES OF COSTA RICA**

Extreme caution should be exercised in using the following key for the separation of the females of species of the subgenus \textit{Nyssorhynchus}. This subgenus contains many exceedingly variable species, in which all criteria for separation, based on wing markings, the amount of black and white on the second hind tarsal segment and on the palpi, have been found to be of little value. This is particularly true of the species which have a black ring on the fifth hind tarsal segment. The only sure way of knowing whether a species of this subgenus occurs in any given territory is to obtain larvae and males, which have excellent characters for the separation of the species.

1. Scutellum trilobed; a medium-sized shaggy brown species, with dark shaggy palpi; mesonotum with erect black scales before wing-bases; wings heavily
clothed with broad ovate scales, mixed dark and light, not forming definite spots; second to fifth hind tarsal segments broadly white basally, black apically, with a narrow black ring near base of each segment (*Chagasia*)

_Bathanus_

Scutellum not trilobed; mesonotum without erect scales before wing-bases; legs not marked as above .............................................. 2

2. Slender black species, without scales on body; mesonotum dark brown, with a narrow median white line in integument; wing-scales all black; legs very long and slender, all black (subgenus *Stethomygia* not yet found in Costa Rica) .............................................. *Kompi*

Body with scales; mesonotum without median white line .............................................. 3

3. Hind tarsi all dark; mesonotum with broad gray central stripe (*Anopheles*). 4

Hind tarsi with terminal segments white, or variously speckled or banded .............................................. 6

4. Hind tibia with broad white apical band; wing-scales dark except for a white spot at apex and another on base of first vein .............................................. *Eiseni*

Hind tibia all dark; wing with black and white costal markings .............................................. 5

5. Costa of wing dark, with two white spots, one at junction of subcosta, the other at tip; first vein with three white spots, first spot basal, third spot opposite first white spot on costa; fifth vein basally white, apically black. Thorax broadly gray centrally, clothed with sparse narrow white scales

_Pseudopunctipennis_

Costa of wing with five white spots, the first spot basal, second spot beyond humeral cross-vein, third spot between this and large spot at junction of subcosta, fourth spot at tip; base of first vein white; fifth vein white, with a black spot beyond middle and one at tip; thorax broadly gray centrally, clothed with long pale hairs only (specimens from Guatemala have darker wings, with base of first vein all dark, and a small black spot at extreme base of sixth vein) .............................................. *Chiriquirensis*

6. Hind tarsi with apical portion of second segment white, all of third, fourth and fifth segments white, with or without a narrow basal black ring on fifth segment (*Nyssorkynchus*). .............................................. 7

Hind tarsi not so marked .............................................. 12

7. Hind tarsi with narrow black ring on fifth segment .............................................. 8

Hind tarsi with fifth segment all white .............................................. 11

8. Last two segments of palpi white .............................................. 9

Terminal segment of palpi white; preceding segment more black than white. 10

9. Second segment of hind tarsi half black, half white (salt-water)

_Tarsimaculatus_

Second segment of hind tarsi more white than black (fresh-water)

_Strodei anomalophyllus_

10. Large species, the white spots on costa of wing usually broad .............................................. *Albimanus*

Smaller species, the white spots on costa of wing reduced; spot B 2 (the second costal white spot from base) usually smaller than the preceding dark spot .............................................. *Bachmanni*

11. First abdominal sternite with two parallel lines of white scales; mid tarsal segments with white rings; second hind tarsal segment nearly half black, half white .............................................. *Albitarsis*
First abdominal sternite bare, without scales; mid tarsal segments without white rings; second hind tarsal segment about one-third black. *Argyrirtarsis*

12. Mesonotum gray, with four bare black lines; costa of wing with four or five alternating subequal black and white spots; hind tarsal segments narrowly black basally, broadly white apically; abdomen without scales (*Kertesszia*) *Neivai*

Mesonotum, wings, and legs not as above .......................... 13

13. Hind tarsi brownish black, with very narrow yellowish rings at both ends of segments 3 and 4; wings large, without a bend on costa at junction with subcosta, clothed with small narrow brown scales which form three or four small spots on costa .......................... *Vestitipennis*

Hind tarsi irregularly speckled with black and white; wings with a prominent bend or “kink” on costa at junction with subcosta, with large broad black, white, or yellow scales, forming large black spots on costa (*Arribalzargia*) .......................... 14

14. Grayish species, with only two large dark spots on costa of wing; pale scales of wing all white; black spot at apex of wing usually large, distinct

*Neomaculipalpus*

Brownish or blackish species, with three large black spots on costa of wing; pale scales of wing either white or yellow .................................................. 15

15. Brownish species; wings with black, white and yellow scales; fifth vein speckled with dark and pale scales; black spot at apex of wing diffuse, about the same size as the dark spot between it and the third large costal spot

*Punctimacula*

Blackish species; wings with black and white scales only; fifth vein black at the base and on upper fork; black spot at apex of wing prominent, larger than the black spot between it and the third large black costal spot

*Apicimacula*

**OTHER BLOOD SUCKING INSECTS IDENTIFIED INCIDENTALLY**

Dr. F. W. Edwards of the British Museum (Natural History) identified *Simulium metallicum* Bellardi and *Simulium quadrivittatum* Say from Orosi. And Dr. J. W. S. Macfie of the same Museum named for us specimens of *Culicoides diabolicus* Hoffmann from Siquirres. A *Triatoma dimidiata* taken in the baptismal font of the Orosi Church was examined by Dr. H. S. Barbour of the United States National Museum.

Dr. C. B. Philip of the Rocky Mountain Laboratory identified the following eight species of *Tabanidae*:

*Chrysops tanyceras* O. S.  
*Chrysops variegatus* De G.  
*Dickelacera analis* Hine  
*Dickelacera coloptera* Hine  
*Tabanus mexicanus* Linnaeus  
*Tabanus appendiculatus* Hine  
*Phaeotabanus magnificus* Krober  
*Lepidoselaga crassipes* Fabricius
And Mr. R. A. Cooley, also of the Rocky Mountain Laboratory named for us specimens of two ticks and one species of flea namely Amblyomma cajennense, Amblyomma ovale and Pulex irritens.

SUMMARY

In a mosquito survey of the Republic of Costa Rica 14,961 adult mosquitoes and 9,743 larvae were examined, representing 93 different species. Greater attention was paid to the Anopheles than to any other group. Tables were drawn up to show the relative prevalence of the various anophelines and culicines, when caught as adults or when taken in their immature stages. In addition, we have listed the distribution records of all the species found during this survey, together with notes on the types of breeding places preferred by them. Keys for the adult females of many of the Costa Rican mosquitoes have been included, as well as the names of certain other biting insects which we have been able to identify from this country.

It is a pleasure to acknowledge the help received from Dr. F. W. Edwards of the British Museum, London, who verified our identifications of 70 of the species of mosquitoes taken in this Republic. We are also much indebted to a number of the sanitary inspectors attached to the Costa Rican Health Department who sent us collections of adults and larvae from a great many places. Among these we would like to mention by name Sr. Moises Cortes, Sr. Luis Villalobos, Sr. Abel Gutierrez, Sr. Manuel Martinez and Sr. Alejandro Perez Rivas. Finally we would like to express our sincere appreciation of the courtesies extended to us on repeated occasions by the officers and employees of the United Fruit Company.

REFERENCES


