HYDROGEN ION CONCENTRATION (pH) AS RELATED TO
THE OCCURRENCE AND ABUNDANCE OF TREE-HEL
DWELLING CULICOIDES SPP., (DIPTERA:
CERATOPOGONIDAE) IN NORTHERN
FLORIDA 1

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INTRODUCTION. The species of Culicoeides which complete their immature stages in tree-holes or stump-holes constitute an important part of the pestiferous insect fauna in wooded areas where rainfall supplies sufficient moisture. Although most species presumably feed on birds by choice, C. parvus (Goeldi) and C. kinhmani Khalaf (borequeni of authors) avidly bite man during daylight hours in Tennessee forests (Snow, 1955) and C. gustipennis (Coquillett) also feeds on man during the crepuscular hours. We have been bitten diurnally by specimens of C. arboricola Root and Hoffman which escaped in the laboratory. Wirth and Hubert's report of C. snowi Wirth and Jones biting man is the only host record known by the authors for this species. C. debilipalpis Lutz, C. osairani Khalaf and C. villosipennis Root and Hoffman recorded from northern Florida are believed to be feeders on birds primarily as blood-engorged specimens were trapped in chicken houses (Messersmith, 1965).

The biting habits of C. nanus Root and

1 This research supported in part by NIH Grant No. GM 12322-03 Florida Agricultural Experiment Stations Journal Series No. 2709.


Hoffman, probably the most abundant tree-hole species in northern Florida, are unknown. This species was rarely captured in light traps and chicken houses, and no blood-engorged specimens were encountered. Antennal sensory pits on segments 3 through 14 (Varnell, 1967) indicate it may feed on birds, based on Jamback's suggestion (1965) that species with pits on most antennal segments prefer to feed on birds rather than on large mammals. One specimen of C. pusillus Lutz was taken from a tree-hole sample in this study. Its biting habits are unknown and it may not be a true tree-hole species. C. osairani was also reared from two samples obtained after this study had been concluded.

No species has been incriminated as a disease vector, but the tendencies of certain species to bite both birds and humans indicate the possible transmission of commonly shared viral diseases by some tree-hole Culicoeides.

METHODS AND MATERIALS. Collections of tree-hole and stump-hole debris and water samples were made in Alachua County, Florida from September, 1964 through September, 1966, examinations of samples continuing until January, 1967.
Studies of selected positive samples from these collections constitute the data reported below.

Four hammock areas in Alachua County were routinely sampled at monthly intervals and additional samples were obtained from seven other areas throughout the county in August and September, 1966. A 50-ml cooking baster was used to extract some of the water and bottom debris from wet tree- and stump-holes. Distilled water was added to samples scooped with a spoon from dry tree- or stump-holes. All samples were placed in 1-pint Mason jars with the disc of the two-piece lid replaced by a disc of ordandy supported by a plastic screen disc. The material's volume varied from one-fourth to three-fourths of a pint according to the amount of water and debris present in the hole sampled. Samples were stored in the laboratory at 72 to 74°F. for 3 to 6 months, or until adult Culicoides ceased to emerge. Each was examined weekly and all adults were identified, counted and recorded according to sex.

The pH of the selected samples was determined initially in the field with a portable Beckman Model N meter and subsequently checked weekly in the laboratory. The pH did not change appreciably (+0.2) in the jars from the original field determinations if water of approximately the same pH was added when necessary to prevent desiccation. Consequently, samples taken during the latter part of the study received only one pH determination when brought in from the field, after which water of near that pH was added as needed during the weekly inspections.

**Results and Discussion.** There was little relationship between pH and tree species having tree- or stump-holes. In sweet gum (*Liquidambar styraciflua* L.) and magnolia (*Magnolia grandiflora* L.) tree-holes, the pH ranged from 6.3 to 9.4. In the oaks *Quercus virginiana* Mill., *Q. nigra* L., and *Q. imbricaria* Mich., the range was wider, 4.1 to 9.1, the lowest value having been obtained from a live oak tree-hole; pH values above 9.0 occurred in magnolias and water oaks only.

Table 1 summarizes the occurrence of each species as related to pH.

A chi square test of dependency between species abundance and pH was applied to the original data from which Table 1 was derived. *C. snowi* and *C. villosipennis* being excluded because of insufficient information on their abundance. A very significant chi square ($X^2=44.56; .005=66.77$) indicated a very high degree of dependency but the factors involved are unknown. Successful completion of development at a particular pH range is more reasonably assumed than female choice for oviposition of tree-holes with a specific pH range.

The six most abundant species emerged as adults from samples within the entire pH range encountered (4.1-9.4). How-

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**Table 1. Numbers of Culicoides that emerged from tree- or stump-hole samples within certain pH ranges, Alachua County, Florida: Sept. 1964-Dec. 1966.**

<table>
<thead>
<tr>
<th>No. Samples</th>
<th>pH Range</th>
<th>nanus</th>
<th>arboricola</th>
<th>debilipalpis</th>
<th>paraenesis</th>
<th>guttiperennis</th>
<th>hinnemi</th>
<th>snowi</th>
<th>villosipennis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>δ</td>
<td>Ψ</td>
<td>δ</td>
<td>Ψ</td>
<td>δ</td>
<td>Ψ</td>
<td>δ</td>
<td>Ψ</td>
</tr>
<tr>
<td>2</td>
<td>4.1-5.7</td>
<td>0-2</td>
<td>22-19</td>
<td>29-22</td>
<td>1-0</td>
<td>0-3</td>
<td>0-0</td>
<td>0-0</td>
<td>0-0</td>
</tr>
<tr>
<td>11</td>
<td>5.8-6.7</td>
<td>4-5</td>
<td>434-395</td>
<td>124-233</td>
<td>7-12</td>
<td>34-43</td>
<td>32-41</td>
<td>0-0</td>
<td>0-0</td>
</tr>
<tr>
<td>15</td>
<td>6.8-7.7</td>
<td>3-9</td>
<td>165-150</td>
<td>16-26</td>
<td>4-5</td>
<td>50-40</td>
<td>4-14</td>
<td>0-0</td>
<td>0-0</td>
</tr>
<tr>
<td>12</td>
<td>7.8-8.7</td>
<td>47-57</td>
<td>174-188</td>
<td>16-6</td>
<td>35-46</td>
<td>21-26</td>
<td>6-9</td>
<td>9-2</td>
<td>0-0</td>
</tr>
<tr>
<td>10</td>
<td>8.8-9.4</td>
<td>62-1248</td>
<td>15-9</td>
<td>2-4</td>
<td>94-117</td>
<td>0-0</td>
<td>41-53</td>
<td>3-16</td>
<td>0-0</td>
</tr>
</tbody>
</table>

**Sex Totals**: 680-1321 | 810-761 | 187-291 | 141-180 | 105-112 | 83-117 | 12-18 | 0-3

**Totals**: 2,001 | 1,571 | 478 | 321 | 217 | 200 | 30 | 3
ever, C. nanus, C. paraensis and C. hinni-
mami emerged in greater numbers from
samples with a pH range above 8.7.
Greater numbers of C. arboricola, C. gutti-
pennis, and C. debilitalis were obtained
from samples having pH’s less than 8.7.

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and Hoffman in eastern North America (Diptera,

AEHA CARTRIDGE-TYPE ASPIRATORS

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Collecting adult mosquitoes for virus isolations, malaria studies and insecticidal
resistance determinations has long been accomplished by many different types
of aspirators, depending largely upon the particular investigator and under what
conditions he might be collecting. The two designs discussed herein resulted from
a requirement for a small, lightweight, unbreakable aspirator to be used by U. S.
Forces in South East Asia while conducting epidemiological investigations of mos-
quitos diseases. The aspirators which evolved have been field-tested upon many
species of mosquitoes while making landing rate and diurnal resting place collec-
tions and have demonstrated their efficiency and adaptability to all who have
used them.

The majority of mouth-operated aspira-
tors in common use consist of a straight
glass or plastic tube to which a flexible
rubber or plastic tube mouthpiece is at-
tached. A retaining screen is affixed be-
tween the rigid tube and the flexible
mouthpiece to trap the mosquitoes. The
small diameter of most such aspirators
damage specimens as they are aspirated,
particularly when several specimens ac-
cumulate during a collection. Such dam-
aged mosquitoes tend to yield invalid
results when used in insecticidal resistance
tests using the WHO test kits.

The cartridge-type aspirators offer a
rapid, easy method to collect adult mos-
quitos, blackflies and other biting Diptera
without undue damage to specimens.
Specimens may be collected for virus pool
isolations, oocyst or sporozoite counts and
routine identifications with a minimum
amount of handling. The cartridges may
be used for a number of purposes, i.e.,
collecting eggs from gravid females, hold-
ing cages for malaria studies and for in-
secticide resistance determinations. WHO
test papers may be cut to fit any size
cartridge desired and mosquitoes are
readily aspirated directly into the lined
vials, exposed for one hour and held in
clean vials for 24-hour mortality counts.
Results obtained in small vials are com-
parable to those obtained using standard