

# The Insects of Virginia No. 3

A SYSTEMATIC REVIEW OF  
THE GENUS *CULICOIDES* (Diptera: Ceratopogonidae) IN VIRGINIA  
WITH  
A GEOGRAPHIC CATALOG OF THE SPECIES OCCURRING IN  
THE EASTERN UNITED STATES NORTH OF FLORIDA

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# CONTENTS

Abstract .....	v
Acknowledgments .....	vi
Introduction .....	1
Methods and Materials .....	4
Procedures Used in Taxonomic Studies .....	4
Explanation of Terminology and Measurements .....	5
Format of the Present Study .....	6
The Genus <i>Culicoides</i> .....	8
Key to Females of Virginia <i>Culicoides</i> Based Primarily on Quantitative Characters .....	10
Key to Females of Virginia <i>Culicoides</i> Based Primarily on Wing Patterns ..	14
Synoptic Table of Sorting Characters for Females of Virginia <i>Culicoides</i> ....	18
Key to Virginia species of <i>Culicoides</i> Based on Male Genitalia .....	20
Description of Species .....	22
<i>Culicoides arboricola</i> Root and Hoffman .....	22
<i>Culicoides baueri</i> Hoffman .....	24
<i>Culicoides beckae</i> Wirth and Blanton .....	26
<i>Culicoides bickleyi</i> Wirth and Hubert .....	28
<i>Culicoides biguttatus</i> (Coquillett) .....	30
<i>Culicoides chiopterus</i> (Meigen) .....	32
<i>Culicoides crepuscularis</i> Malloch .....	34
<i>Culicoides debilipalpis</i> Lutz .....	36
<i>Culicoides flukei</i> Jones .....	38
<i>Culicoides footei</i> Wirth and Jones .....	41
<i>Culicoides furens</i> (Poey) .....	43
<i>Culicoides guttipennis</i> (Coquillett) .....	45
<i>Culicoides haematopotus</i> Malloch .....	47
<i>Culicoides hinmani</i> Khalaf .....	49

<i>Culicoides hollensis</i> (Melander and Brues) .....	51
<i>Culicoides loisae</i> Jamnback .....	54
<i>Culicoides melleus</i> (Coquillett) .....	56
<i>Culicoides mulrennani</i> Beck .....	58
<i>Culicoides nanus</i> Root and Hoffman .....	60
<i>Culicoides niger</i> Root and Hoffman .....	62
<i>Culicoides obsoletus</i> (Meigen) .....	64
<i>Culicoides ousairani</i> Khalaf .....	66
<i>Culicoides paraensis</i> (Goeldi) .....	68
<i>Culicoides piliferus</i> Root and Hoffman .....	70
<i>Culicoides pseudopiliferus</i> Wirth and Hubert .....	72
<i>Culicoides sanguisuga</i> (Coquillett) .....	74
<i>Culicoides scanloni</i> Wirth and Hubert .....	76
<i>Culicoides snowi</i> Wirth and Jones .....	77
<i>Culicoides spinosus</i> Root and Hoffman .....	78
<i>Culicoides stellifer</i> (Coquillett) .....	81
<i>Culicoides testudinalis</i> Wirth and Hubert .....	83
<i>Culicoides travisi</i> Vargas .....	84
<i>Culicoides variipennis variipennis</i> (Coquillett) .....	86
<i>Culicoides variipennis australis</i> Wirth and Jones .....	87
<i>Culicoides venustus</i> Hoffman .....	89
<i>Culicoides villosipennis</i> Root and Hoffman .....	91
A Geographic Catalog of the <i>Culicoides</i> of the Eastern United States	
Exclusive of Florida .....	93
Literature Cited .....	122

## ABSTRACT

Morphological descriptions, with illustrations, are given for the 35 species of *Culicoides* in Virginia, along with keys for the identification of males and females. Special emphasis is given to species occurring in southwest and central Virginia. Notes on their geographic distribution within Virginia, breeding sites, feeding habits, with seasonal distribution, are also presented. Included are 36 plates containing 175 figures. A geographic catalog of the *Culicoides* of the Eastern United States north of Florida is presented following the descriptions of species.

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# THE INSECTS OF VIRGINIA NO: 3

A Systematic Review of the Genus *Culicoides* (Diptera: Ceratopogonidae) in Virginia, With a Geographic Catalog of the Species Occurring in the Eastern United States North of Florida<sup>1</sup>

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## INTRODUCTION

Members of the genus *Culicoides* are small, nematocerous flies generally referred to as "biting midges," "gnats," "no-see-ums," or "punkies." The latter term, according to Jamnback (1965), is derived from an old Delaware Indian word which probably referred to something causing a burning sensation. Anyone who has experienced the bite of a *Culicoides* female can attest to the accuracy of the Delaware terminology.

In many cases, species of this genus (and two other genera of haematophagous Ceratopogonidae) are more of a problem than mosquitoes, because they can penetrate mosquito-proof screens. There are numerous reports of their biting so voraciously as to severely interfere with recreational activities; and, in some areas, they have become so notorious that property values have been lowered. In addition, they are known to transmit several disease organisms and parasites. However, they are not without beneficial aspects: several Ceratopogonidae (including *Culicoides* sp.) are involved in the pollination of rubber trees (Wirth, 1956).

The present study was undertaken to provide keys and illustrations for identification of Virginia *Culicoides*, particularly in the southwest and central portions of the state. In addition, a geographic catalog of the species occurring in the Eastern United States north of Florida is presented. The catalog was compiled after an extensive literature search and a review of the specimen collection at the U.S. National Museum.

The Ceratopogonidae was once considered a subfamily of the Chironomidae. It differs from the Chironomidae, however, in having the head rounded behind with complete mouthparts and having well-developed mandibles in both sexes.

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The antennal flagellum usually appears 13-segmented in both sexes. The  $M_{1+2}$  vein is branched, and the postscutellum lacks a median furrow or keel. The metathoracic legs are longest (Johannsen, 1952; Atchley, 1967).

*Culicoides* is distinguished from other genera by the presence of the r-m crossvein, a petiolate M vein, and two, more or less equal, radial cells. The claws of the female are small and equal, and there is no well-developed empodium (Macfie, 1940; Johannsen, 1952; Wirth, 1952a).

Khalaf (1954) developed a phylogenetic scheme for *Culicoides* based on male genitalia and female spermathecae, recognizing four subgenera and many species groups. Fox (1955) recognized 8 subgenera, and Vargas (1960) listed 14 subgenera for the species in the Western Hemisphere. Wirth and Hubert (1959) proposed *Trithecooides* as a new subgenus for 20 African and Asian species. Vargas (1962) classified the Russian species into subgenera. More recently, Wirth (1965) has subdivided the North American species into nine subgenera.

There are approximately 800 valid names of *Culicoides* in existence today, according to Arnaud and Wirth (1964). They published a name list of world *Culicoides* which supplements an earlier list by Arnaud (1956).

*Culicoides* has been intensively studied in many parts of Europe. Edwards (1926) monographed the British species; and Downes and Kettle (1952) revised the keys to the *C. pulicaris* and *C. obsoletus* groups. The work by Campbell and Pelham-Clinton (1960) is the most recent comprehensive treatment of British species. The French fauna was studied by Kremer (1960, 1961); Kremer and Callot (1961a, 1961b); Kremer and Deduit (1961); Kremer, Vermeil, and Callot (1961); and Callot *et al.* (1967, 1968). In addition, Kremer (1965) monographed the French species. Nielsen (1964) published taxonomic studies on 21 Danish species; Kremer, Doby, and Skierska (1965) reported 13 species from Poland. Gutsevich (1960) reviewed the Russian species.

Early works on the African fauna include those of Carter (1916, 1919) and Carter, Ingram, and Macfie (1920). Fiedler (1951) reviewed the South African species. Clastrier has published on *Culicoides* species from Algeria (1957, 1958a), French West Africa (1958b, 1959), and the Congo (1960). Clastrier and Wirth (1961) described new species from Nigeria, Gambia, and Liberia. Recent papers by Callot, Kremer, and Molet (1967) and Callot, Kremer, and Basset (1967, 1968) deal with African *Culicoides*. Callot, Kremer, and Brunhes (1968) collected five *Culicoides* species from *Anopheles coustani* in Madagascar.

Macfie (1934) described four new species from Malaya. Causey (1938) monographed Siamese *Culicoides* and described 10 new species. Lee and Reye (1953, 1955, 1962) have studied the Australian fauna. Arnaud (1956) reviewed the species from Japan, Korea, and the Ryukyu Islands. Wirth and

Hubert (1959) described 10 new species from southern and eastern Asia. Tokunaga and Murachi (1959) monographed the Micronesian *Culicoides*. Sen and Das Gupta (1959) reviewed Indian species, and Delfinado (1961) reviewed Philippine *Culicoides*. Khalaf (1961) described seven new species from Iraq, and Navaï (1970) recently published on Iranian *Culicoides*. Hubert and Wirth (1961) published a key to the *Culicoides* of Okinawa and described two new species. Wirth and Hubert (1961) recorded 18 species from Taiwan, and Tokunaga (1962) covered the New Guinea species. Cal- lot, Kremer, and Braverman (1969) reported seven species from Israel.

Neotropical *Culicoides* has received considerable recent attention. Forat- tini's (1957) treatment of the neotropical species is the most comprehensive work to date. Macfie (1938) published records of *Culicoides* from the islands of Trinidad and Grenada. Williams (1956a) constructed a key to the Bermuda fauna. Puerto Rican *Culicoides* has been treated by Fox (1949, 1952b), Fox and Kohler (1950), and Fox and Garcia-Moll (1961). Fox (1946a) reviewed Caribbean species, and Macfie (1948) published a key to females likely to be found in the Caribbean area. Wirth (1952b, 1955) published on Guatemalan *Culicoides*. The Panamanian fauna has been re- viewed by Wirth and Blanton (1959). Macfie (1935) published notes on Brazilian species. Fox (1952a) described five new species from Venezuela and one from Peru. Wirth and Lee (1967) found nine new species at high altitudes in Colombia. Clastrier (1968) described a new species from French Guiana.

Wirth (1965) lists 97 *Culicoides* species from America north of Mexico. Hoffman (1925) and Root and Hoffman (1937) monographed the North American species, but these works are now out of date. Foote and Pratt (1954) reviewed the *Culicoides* of the eastern United States. Wirth and Hubert reviewed the *C. copiosus* group (1960) and the *C. piliferus* group (1962), and Jamnback and Wirth (1963) reviewed the *C. obsoletus* group in eastern North America. Wirth and Blanton (1967) reviewed the species related to *C. guttipennis*.

The *Culicoides* fauna of only a few states has received comprehensive taxo- nomic treatment; such as, California (Wirth, 1952a), Missouri (Childers and Wingo, 1968), New Mexico (Atchley, 1967), New York (Jamnback, 1965), and Wisconsin (Jones, 1956). Downes (1958a) provides preliminary information on *Culicoides* in Canada.

Little information is available on western *Culicoides*. Curtis (1941) re- corded 8 species from British Columbia, and James (1943) found 11 in Colorado. Fox (1946b) described two new species from Utah and Montana. The papers by Knowlton and Fronk (1950) and Knowlton and Kardos (1951) listed locality records of Utah *Culicoides*. Khalaf (1952) found 14 species in the Wichita Refuge and published keys to the Oklahoma species (1957).



Sailer, Marks, and Lienk (1956) gave the distribution of six Alaskan species. Wirth and Bottimer (1956) recorded 19 species from western Texas, and Jones and Wirth (1958) gave new records from Texas. Wirth and Hubert (1959) reported several species from cacti in the Southwest. Wirth and Blanton (1969a) described five new species from the Western States and British Columbia, and reviewed the *C. pulicaris* group (1969b). Jorgensen (1969) monographed the species occurring in southeastern Washington.

The *Culicoides* fauna of the Eastern States has received more attention than that of the Western States. Johannsen (1952) published a key to the northeastern species. Coher, Wirth, and Knutson (1955) gave a locality list of the New England species, and Jamnback (1965) listed collecting sites from New York. Lewis (1959) reported 19 species from Connecticut. Burbutis and Jobbins (1964) and Das Gupta and Hansens (1965) provided distributional and taxonomic notes on the New Jersey fauna. Gazeau and Messersmith (1970b) published numerous records from Maryland.

Pratt (1907) recognized three *Culicoides* (as *Ceratopogon* sp.) from Virginia. Wirth (1951) noted eight species from the northern part of the state. Messersmith (1966) published a list of known collecting sites for species from Virginia. Hair *et al.* (1966) and Battle and Turner (1969) have published the results of breeding site surveys in Virginia.

The fauna of the Tennessee River basin was intensively collected and studied by the late W. E. Snow and co-workers (Snow, 1955; Snow and Pickard, 1953, 1954, 1958; Snow, Pickard and Moore, 1957; Pickard and Snow, 1955). In addition, Snow, Pickard, and Jones (1958) recorded four species from South Carolina.

Beck (1952, 1956, 1958) published distributional notes on Florida *Culicoides*. Hinman (1932) gave records from the Gulf Coast, and Roberts (1965) reported six species from central Mississippi. A series of papers by Khalaf (1966a, 1966b, 1967a, 1967b, 1967c, 1969) provided much taxonomic and seasonal information on Louisiana and Mississippi species.

Malloch's (1915a, 1915b) earlier works listed several *Culicoides* from Midwestern States. Adams (1940) reported only 2 species from Missouri, but Childers and Wingo (1968) listed 21 species from central Missouri and constructed a key to the females. Williams (1955b, 1955c) published on Michigan *Culicoides*, and Jones (1956) published a key to the Wisconsin species.

## METHODS AND MATERIALS

### PROCEDURES USED IN TAXONOMIC STUDIES

All measurements were made with the aid of a Tiyoda (Model No. 50254) compound microscope equipped with an ocular micrometer. Illustrations were made with the aid of a Leitz Prado microprojector. The wings were photographed through a Wilde M-5 microscope fitted with a Nikon photo attach-

ment, using a strobe flash attachment at 1/1000 second exposure. Only slide-mounted specimens were used for taxonomic study. These specimens were cleared in phenol, mounted, and dissected in a mixture of Canada balsam and phenol as described by Wirth and Marston (1968).

## EXPLANATION OF TERMINOLOGY AND MEASUREMENTS

### FEMALE CHARACTERS

*Culicoides* females possess a number of characters which, alone or in combination, may be of taxonomic value; such as, degree of eye separation, relative length of proboscis, number of mandibular teeth, the combined length of the last five flagellomeres divided by the combined length of the first eight (given as antennal ratio), sensillar pattern (location of flagellomeres possessing distal sensory tufts), relative degree of swelling of the third segment of the maxillary palp and the morphology of its sensory pit or pits, wing length (in millimeters) and patterns, coloration of legs and number of apical spines on the hind tibia, and size and shape of the spermathecae and presence or absence of a sclerotized ring about the duct. Some of the terms and measurements are defined below.

*P/H ratio*.—This is defined by Jamnback as the proboscis-to-head ratio, although the term is misdefined on page 17 of his 1965 monograph (Jamnback, 1969; personal communication). This measurement is the distance from the center of the median hair socket (located dorsally more or less between the eyes) to the tormae (small laterally oriented sclerites directly at the base of the proboscis (divided *into* the distance from the tormae to the tip of the labrum-epipharynx. Proboscis lengths are therefore short if the P/H ratio is less than 0.65, intermediate if between 0.65 and 0.75, and long if greater than 0.75. This term is used rather than the head-to-proboscis ratio of various authors, because it is felt that a P/H ratio more clearly indicates proboscis length.

*Segmentation of antenna*.—The antenna consists of three major segments: a small, indistinct scape; an enlarged pedicel (which appears to be the first antennal segment); and an elongate flagellum subdivided into 13 flagellomeres. The latter are numbered 3 through 15 in the present work (as though they are entire segments in a series with the scape and pedicel), rather than 1 through 13, in order to maintain uniformity with other monographs.

*Antennal ratio (AR)*.—The antennal ratio is the total length of the last five flagellomeres (11-15) divided by the total length of the first eight (3-10). The latter are generally subspherical in shape and shorter than the more elongate terminal flagellomeres.

*Sensillar pattern*.—This refers to the position of flagellomeres which possess distal sensory tufts. For example, a sensillar pattern of 3, 7-10 (as in *C.*

*furens*) indicates that distal sensory tufts are found on the first flagellomere (number 3) and on numbers 7 through 10, inclusive.

*Maxillary palpus*.—The third segment is considered slightly swollen if the L/W (length divided by maximum width) ratio is greater than 3.00, moderately swollen if between 2.50 and 3.00, and greatly swollen if less than 2.50. The  $P_3/P_5$  ratio (as used to distinguish *obsoletus* group females) refers to the length of the third segment divided by the length of the fifth.

*Wing*.—The wing length is the distance in millimeters from the basal arcus to the wing tip. The wing venation is shown in plate 1, figure B. The color pattern of wings provides useful characters for distinguishing species. A key based partially on wing patterns is given on page 14.

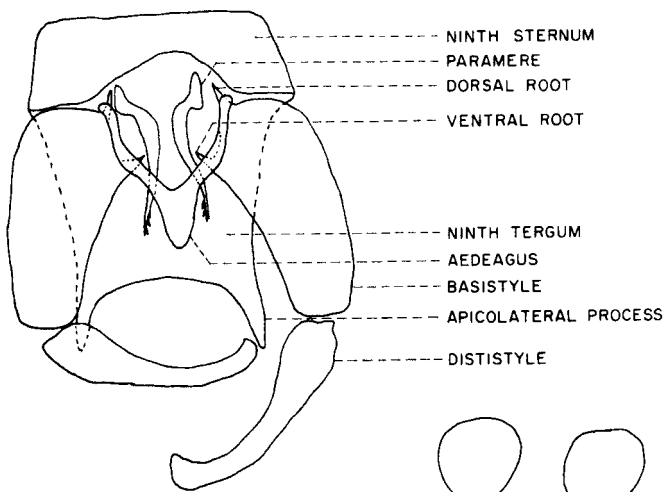
*Spermatheca*.—The spermathecal neck is that portion of the spermathecal duct (proximal to the spermatheca) which is sclerotized. Most species with two fully developed spermathecae possess an elongate, tubular rudimentary spermatheca (except *footei*). The presence of a sclerotized ring (pl. 1, fig. C) indicates a portion of the duct that is sclerotized near the junction of the bursa copulatrix and the spermathecal ducts.

#### MALE TERMINALIA

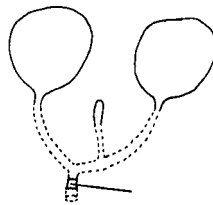
The following characters may be of taxonomic value: size and shape of the apicolateral processes (if present) on the ninth tergum, and presence or absence of a median notch on same; depth and width of the caudo-median excavation (if present) on the ninth sternum; condition of the ventral and dorsal roots of the basistyle; shape of the dististyle; and condition of the parameres (claspettes of Atchley, 1967) and aedeagus. The terminology is illustrated in plate 1, figure A.

#### FORMAT OF THE PRESENT STUDY

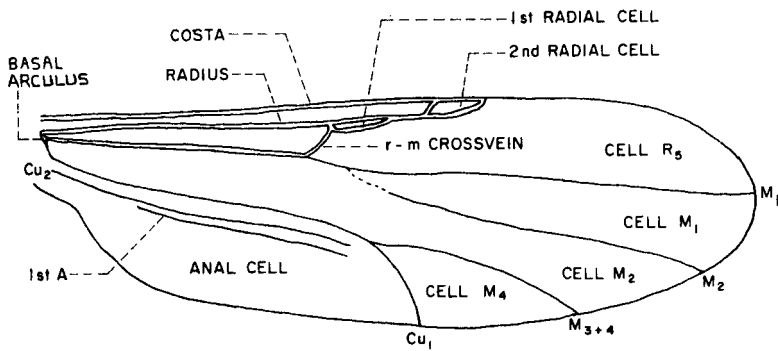
Notes on the biology of each species and its known distribution within Virginia are given following the appropriate description. The distribution includes all previously published records (with the exception of any unintended omissions), results of collecting for the present work, and all unpublished records of Virginia *Culicoides* from the U.S. National Museum. The localities are usually given as counties, with the exception of comparatively large cities which serve as political units discrete from any county. The cities so listed in this paper are Alexandria, Chesapeake, Petersburg, Richmond, and Virginia Beach. Smaller independent cities are considered to be within the geographically surrounding county; for example, Falls Church records are listed only as Fairfax County. Localities which could not be placed completely within a given county or independent city are also listed separately. Two localities were so treated: Dismal Swamp, which is shared by the City of Chesapeake and Nansemond County, and the Bull Run Mountains, located primarily on the border between Fauquier and Prince William Counties.



**A**



**C**



**B**

Plate I. - *Culicoides* general morphology

Records from near Plummer's Island are given as Fairfax County, and those from the Peaks of Otter are listed as Botetourt County (because the collectors generally indicated such).

The biological notes (breeding sites, feeding habits, and seasonal distribution) were, when possible, taken from studies conducted in Virginia. The seasonal distribution probably varies from year to year; additional collections of adults are needed before strict conclusions can be drawn.

## THE GENUS *CULICOIDES*

The keys in this study have been based on slide-mounted specimens, as have most recent works. A total of 35 species (and 2 subspecies) is now known from Virginia. These are listed by subgenera and species groups in table 1. The classification used here is adapted from that of Wirth (1965) and Jamnback (1965). A definition of the subgenera and species groups, as used in the present study follows.

### SUBGENUS AVARITIA

Obsoletus group.—Male terminalia without apicolateral processes (except in *C. chiopterus*); basistyle with long, simple roots; parameres simple and separate, with the posterior part bent ventrad and tapering to a fine point which is bare or has microscopic hairs. Female with contiguous eyes; sensillar pattern 3, 11-15; wing with apical portion of second radial cell included in pale spot; hind tibia with five spines; spermathecal neck short (varying in *C. sanguisuga*), slightly tapering.

### SUBGENUS BELTRANMYIA

Male terminalia with well-developed apicolateral processes; basistyle with ventral root minute or absent; dorsal root long, blunt; parameres separate, tapering to fine bare points. Female with only one large subelliptical spermatheca.

Biguttatus group.—Jamnback (1965) removed these species from the subgenus *Oecacta*, a seemingly justifiable move because this group appears worthy of a distinct status from others in that subgenus.

Male terminalia with well-developed apicolateral processes; basistyle with ventral and dorsal roots simple and usually long; parameres separate, tapering to single bare point (except in *C. loisae* and *C. spinosus*). Females variable, but often with reduced wing markings and the absence of a sclerotized ring about the spermathecal duct (as in *C. loisae*, *C. melleus*, *C. mulrennani*, and *C. spinosus*).

### SUBGENUS DIPHAOMYIA

Male terminalia with ventral root boat-hook shaped; dorsal root long, simple; parameres separate with long recurved tips with numerous well-developed spines; lateral arms of aedeagus with anteriorly projecting processes on either

TABLE 1—*Subgenera and species groups of Virginia Culicoides.*

Subgenus or species group	<i>Culicoides</i> species indicated
<i>Avaritia</i> Fox, 1955	
Obsoletus group	<i>chiopterus</i> , <i>obsoletus</i> , <i>sanguisuga</i>
<i>Beltranmyia</i> Vargas, 1953	<i>crepuscularis</i> , <i>hollensis</i>
Biguttatus group (after Jamnback, 1965)	<i>biguttatus</i> , <i>loisae</i> , <i>melles</i> , <i>mulrennani</i> , <i>nanus</i> , <i>niger</i> , <i>spinosus</i> , <i>travisi</i>
<i>Diphaomyia</i> Vargas, 1960	<i>baueri</i> , <i>footei</i> , <i>haematopotus</i>
<i>Drymodesmyia</i> Vargas, 1960	<i>hinmani</i>
Guttipennis group (after Wirth and Blanton, 1967)	<i>arboricola</i> , <i>beckae</i> , <i>flukei</i> , <i>guttipennis</i> , <i>ousairani</i> , <i>villosipennis</i>
<i>Hoffmania</i> Fox, 1948	<i>venustus</i>
<i>Monoculicoides</i> Khalaf, 1954	<i>variipennis</i>
<i>Oecacta</i> (Poey, 1851)	
Debilipalpis group	<i>debilipalpis</i> , <i>paraensis</i>
Furens group	<i>furens</i> , <i>stellifer</i>
Piliferus group	<i>bickleyi</i> , <i>piliferus</i> , <i>pseudopiliferus</i> , <i>scanloni</i> , <i>snowi</i> , <i>testudinalis</i>

side of median posterior process. Female with eyes narrowly separated; third segment of maxillary palp greatly swollen; wing with pale spot over r-m crossvein usually not extending well basad of vein; hind tibia with four spines; spermathecae with necks long, parallel-sided.

#### SUBGENUS DRYMODESMYIA

Male terminalia with well-developed apicolateral processes; basistyle with long, slender ventral root; dorsal root long, blunt; parameres with long, sharp tip devoid of spines. Female with eyes barely contiguous; sensillar pattern 3, 11-15; hind tibia with four spines; overall size very small.

Guttipennis group.—Male terminalia with well-developed apicolateral processes; ninth sternum with shallow caudomedian excavation; basistyle with ventral and dorsal roots simple and slender with pointed tips; paramere with short, rather broad basal knob and a sharp basal constriction on stem, the latter usually sinuate, swollen in proximal portion and tapering to simple bare tip bent or curved ventrad. Female with eyes usually narrowly separated; distal sensory tufts always present beyond flagellomere 10; wings distinctly marked; hind tibia with five spines; spermathecal neck tapering, usually short.

#### SUBGENUS HOFFMANIA

Male terminalia with apicolateral processes minute, knob-like; basistyle with ventral root absent; dorsal root more or less fingerlike; parameres with foot-

shaped base and tip ending in fine hairs; aedeagus with internal subapical  
 perg and apical papillae. Female large, wings well marked.

#### SUBGENUS MONOCULICOIDES

Male terminalia with parameres fused basally, terminating posteriorly in  
 two fine, bare tips. Female with distal sensory tufts not present beyond fla-  
 gellomere 10; wings usually well marked; hind tibia with at least five spines  
 usually six or seven; one spermatheca present, varying from straight and  
 elongate to C-shaped; overall size very large.

#### SUBGENUS OECACTA

Male terminalia with boat-hook shaped ventral root; paramere ending in  
 tip with well-developed spines; posteriorly directed processes (as in *Diphao-  
 myia*) not present on lateral arms of aedeagus. Females very diverse in many  
 characters.

Debilipalpis group.—Male terminalia with small subapical ventral lobe on  
 paramere. Female with antennal ratio 0.6-0.9; sensillar pattern 3, 8-10.

Furens group.—Male terminalia without small subapical ventral lobe on  
 paramere; paramere instead with indistinct, to prominent, swelling nearer mid-  
 length. Female with antennal ratio 1.1-1.4; sensillar pattern 3, 7-10 or 3,  
 8-10.

Piliferus group.—Male terminalia with slender paramere without swellings  
 or knobs beyond base. Females diverse, but always with distal sensory tufts  
 present beyond flagellomere 10; spermathecae oval; wing pattern, when ex-  
 pressed, with pale spots straddling veins  $M_1$  and  $M_2$ .

#### KEY TO FEMALES OF VIRGINIA CULICOIDES

##### BASED PRIMARILY ON QUANTITATIVE CHARACTERS

1. Mandibular teeth absent; pale spots on wing very obscure (pl. 17,  
     fig. C) ..... *loisae* p. 55  
     Mandibular teeth present; wing markings variable ..... 2
2. One spermatheca present; wing length at least 1.1 mm ..... 3  
     At least 2 well-developed spermathecae present (rarely 3); wing  
     length variable ..... 6
3. Spermatheca straight and elongate to C-shaped; distal sensory tufts  
     absent from flagellomeres 11-15; antennal ratio less than  
     1.0; at least 5 hind tibial spines, usually 6 or 7 ..... 4  
     Spermatheca elliptical; distal sensory tufts present on most or all  
     of flagellomeres 11-15; antennal ratio at least 1.1; 4  
     hind tibial spines ..... 5
4. Sensillar pattern 3, 8-10; mandible with 14-16 teeth .....  
     ..... *variipennis variipennis* p. 88

Sensillar pattern 3, 5-10 or 3, 6-10 (rarely 3-10); mandible with 9-15 teeth .....	<i>variipennis australis</i>	p. 88
5(3). Sensillar pattern 3-15; third segment of maxillary palp greatly swollen; eyes narrowly separated .....	<i>crepuscularis</i>	p. 35
Sensillar pattern not 3-15 because distal sensory tufts absent from flagellomeres 4-10; third segment of maxillary palp slightly swollen; eyes broadly separated; tidewater species .....	<i>hollensis</i>	p. 52
6(2). Antennal ratio 0.6-0.9; sensillar pattern 3, 8-10 .....		7
Antennal ratio at least 1.0; sensillar pattern variable .....		8
7. Wing with pale spot at tip of cell R <sub>5</sub> (pl. 24, fig. C) .....	<i>paraensis</i>	p. 69
Wing without pale spot at tip of cell R <sub>5</sub> (pl. 9, fig. C) .....	<i>debilipalpis</i>	p. 37
8(6) Spermathecal duct without sclerotized ring .....		9
Spermathecal duct with sclerotized ring (pl. 1, fig. C) present .....		11
9. Wing uniformly hyaline (pl. 18, fig. C); thorax pale yellow; third palpal segment without single well-developed sensory pit; tidewater species .....	<i>melleus</i>	p. 57
Wing with at least 2 pale spots, one over r-m crossvein and another just distad of second radial cell; thorax yellowish brown or darker; third palpal segment with well-developed sensory pit .....		10
10. Wing with only 2 distinct pale spots (pl. 19, fig. C); thorax yellowish brown .....	<i>mulrennani</i>	p. 59
Wing with additional faint pale spots (pl. 30, fig. C); thorax darker brown .....	<i>spinosus</i>	p. 79
11(8). Mandible with 10 or fewer teeth .....		12
Mandible with at least 11 teeth .....		13
12. Wing markings faint, distal half of second radial cell included in light spot (pl. 7, fig. C); superior transverse suture absent between eyes .....	<i>chiopterus</i>	p. 33
Wing markings more distinct, distal half of second radial cell dark (pl. 10, fig. C); superior transverse suture present between eyes .....	<i>flukei</i>	p. 39
13(11). Wing with transverse pale band beginning just beyond second radial cell (pl. 21, fig. C) .....	<i>niger</i>	p. 63
Wing without transverse pale band .....		14
14. Wing with 2 distinct basal pale spots in cell M <sub>2</sub> (pl. 11, fig. C); rudimentary spermatheca absent .....	<i>footei</i>	p. 42
Wing markings variable; rudimentary spermatheca present .....		15
15. Pale spot over r-m crossvein small, not extending well basad of vein .....		16



Pale spot over r-m crossvein larger, usually extending well basad of vein .....	1
16. Distal sensory tufts present beyond flagellomere 11; wing with pale spot at tip of cell $R_5$ (pl. 14, fig. C)..... <i>haematopodus</i>	p. 41
Distal sensory tufts usually not present beyond flagellomere 10, never beyond 11; cell $R_5$ with pale spot in middle (pl. 3, fig. C) .....	<i>baueri</i> p. 21
17(15). Sensillar pattern 3, 7-10 or 3, 8-10; spermathecal neck long, parallel-sided .....	18
Sensillar pattern not 3, 7-10 or 3, 8-10 because distal sensory tufts present beyond flagellomere 10; spermathecal neck absent or short, if long, then not parallel-sided .....	19
18. Antennal ratio 1.3; 4 hind tibial spines; tidewater species..... <i>furens</i>	p. 44
Antennal ratio 1.0-1.1; 5 hind tibial spines; distribution statewide .....	<i>stellifer</i> p. 82
19(17). Wing markings very distinct (pl. 35, fig. C); maxillary palp very bristly, third segment slightly to moderately swollen .....	<i>venustus</i> p. 90
Wing markings less distinct; maxillary palp much less bristly in appearance .....	20
20. Distal sensory tufts absent from flagellomeres 4-10 .....	21
Distal sensory tufts present on several of flagellomeres 4-10; rarely on just one (some <i>biguttatus</i> ) .....	24
21. Hind tibia with 4 spines .....	22
Hind tibia with 5 spines .....	23
22. Wing at least 1.0 mm long with markings as shown in plate 5, figure C; sensillar pattern 3, 13-15; spermathecal neck absent or very short, parallel-sided; eyes narrowly to moderately separated; hind tibia with second spine longest .....	<i>bickleyi</i> p. 29
Wing less than 0.8 mm long (pl. 15, fig. C); sensillar pattern 3, 11-15; spermathecal neck blunt, slightly tapering; eyes barely contiguous; hind tibia with first spine longest .....	<i>hinmani</i> p. 50
23(21). Maxillary palp with third segment greatly swollen; thorax dark brown; wing vein $M_{3+4}$ with 7-14 macrotrichia .....	<i>obsoletus</i> p. 65
Maxillary palp with third segment slightly to moderately swollen; thorax light brown; wing vein $M_{3+4}$ with 1-6 macrotrichia; an extremely common and vicious pest of man in deciduous highland forests .....	<i>sanguisuga</i> p. 75

24(20). Hind tibia with 4 spines .....	25
Hind tibia with 5 spines .....	32
25. Spermathecae heavily pigmented; neck long, stout, sharply tapering (pl. 6, fig. D) .....	<i>biguttatus</i> p. 31
Spermathecae less distinct, neck absent or short and parallel-sided.....	26
26. Sensillar pattern 3-15 .....	27
Sensillar pattern not 3-15 because distal sensory tufts absent from several flagellomeres .....	28
27. Wing length 0.9-1.1 mm with markings as shown in plate 20, figure C; P/H ratio 0.5-0.6, antennal ratio 1.2-1.3; third palpal segment with L/W ratio less than 2.0; spermathecal neck short, parallel-sided .....	<i>nanus</i> p. 61
Wing length 1.1-1.4 mm with markings as shown in plate 33, figure C; P/H ratio 0.7-0.9; antennal ratio 1.4-1.6; third palpal segment with L/W ratio at least 2.1; spermathecal neck absent .....	<i>travisi</i> p. 85
28(26). Wing markings reduced with at most 2 pale spots present, one over r-m crossvein and another just distad of second radial cell .....	29
Wing with additional (though sometimes indistinct) pale spots along outer margin .....	30
29. Sensillar pattern 3, 5, 7, 9, 11-15; spermathecal neck very short, parallel-sided .....	<i>snowi</i> p. 78
Sensillar pattern 3, 5, 7, 9, 13-15; spermathecal neck absent.....	<i>testudinalis</i> p. 83
30(28). Antennal ratio 1.1-1.2; sensillar pattern 3, 5, 7, 9, 11, 13-15 or 3, 5, 7, 9, 13-15 .....	<i>pseudopiliferus</i> p. 73
Antennal ratio 1.3-2.1; sensillar pattern usually 3, 5, 7, 9-15 .....	31
31. Antennal ratio 1.7-2.1; third palpal segment with L/W ratio 1.9-2.3; eyes narrowly separated .....	<i>piliferus</i> p. 71
Antennal ratio 1.3-1.6; third palpal segment with L/W ratio 2.1-2.5; eyes moderately separated .....	<i>scanloni</i> p. 76
32(24). Wing with apex of vein Cu <sub>1</sub> pale at wing margin (pl. 2, fig. C) .....	<i>arboricola</i> p. 23
Wing with apex of vein Cu <sub>1</sub> dark .....	33
33. Wing with pale spot over r-m crossvein large, extending caudad well past base of media (pl. 13, fig. C); mandible with 17-22 teeth .....	<i>guttipennis</i> p. 46
Wing with pale spot over r-m crossvein small, not extending caudad past base of media; mandible with 13-18 teeth .....	34

34. Eyes narrowly separated; mandible with 13-18 teeth ..... *beckae* p. 2  
 Eyes moderately to broadly separated; mandible with 13-16 teeth ..... 3
35. P/H ratio 0.9-1.0; antennal ratio 1.1-1.2; sensillar pattern 3-15  
 or 3-9, 11-15 ..... *ousairani* p. 6  
 P/H ratio 0.8-0.9; antennal ratio 1.6-1.7; sensillar pattern 3, 5,  
 7, 9, 11-15 ..... *villosipennis* p. 9

## KEY TO FEMALES OF VIRGINIA CULICOIDES

### BASED PRIMARILY ON WING PATTERNS

1. Wing (pl. 18, fig. C) uniformly hyaline, no pale spots present;  
 thorax unique pale yellow; tidewater species ..... *melleus* p. 5  
 Wing with at least 2 pale spots, often many more, present; thorax  
 not pale yellow, at least a yellowish brown, usually light  
 to dark brown ..... 4
2. Wing with small pale spot adjacent to r-m crossvein not extend-  
 ing basad of crossvein ..... 3  
 Wing with pale spot over r-m crossvein extending basad of cross-  
 vein ..... 4
3. Wing (pl. 3, fig. C) with pale spot in center of cell  $R_5$ , not at apex;  
 sensillar pattern usually 3, 6-10; occasionally 3, 5, 7-10;  
 3, 7-10; 3, 7-11; 3-10; or 3-11 ..... *baueri*<sup>1</sup> p. 25  
 Wing (pl. 14, fig. C) with pale spot at apex of cell  $R_5$ , not in  
 center; sensillar pattern 3-15; 3, 5-15; 3, 5, 7-15; or  
 3, 5, 7, 9-15 ..... *haematopodus* p. 48
- 4(2). Wing (pls. 7 and 22, figs. C) with distal half of 2nd radial  
 cell included in pale spot; superior transverse suture  
 absent between eyes (Obsoletus group) ..... 5  
 Wing (pls. 6 and 35, figs. C) with entire 2nd radial cell dark;  
 superior transverse suture usually present between eyes  
 (absent in *venustus*) ..... 7
5. Wing (pl. 7, fig. C) faintly marked; mandible with 7-10 teeth;  
 proboscis short, P/H ratio 0.54-0.63 ..... *chiopterus* p. 33  
 Wing more distinctly marked; mandible with 12-16 teeth; proboscis  
 long, P/H ratio 0.76-0.96 ..... 6
6. Wing vein  $M_{3+4}$  with 7-14 macrotrichia; thorax dark brown .....  
 ..... *obsoletus* p. 65

<sup>1</sup> Occasionally one encounters specimens of *C. baueri* in which the pale spot over the r-m crossvein appears to extend slightly basad of the crossvein. However, most *baueri* females will probably key out to couplet 3 rather than couplet 10.

Wing vein $M_{3+4}$ with 1-6 macrotrichia; thorax light brown; extremely common in deciduous forests in Eastern North America .....	<i>sanguisuga</i>	p. 75
7(4). Wing with vein $M_{3+4}$ ending in distinct pale area at wing margin (figs. 12C, 13C); pale spots on wing numerous .....		8
Wing with vein $M_{3+4}$ dark at wing margin (pls. 6 and 31, figs. C); pale spots on wing often, though not always, reduced .....		15
8. Wing with vein $Cu_1$ ending in distinct pale area at wing margin.....		9
Wing with vein $Cu_1$ ending in dark area at wing margin .....		11
9. Wing (fig. 35C) with unique pale spot recurved above 2nd radial cell; superior transverse suture absent between eyes (pl. 35, fig. A) .....	<i>venustus</i>	p. 90
Wing (pls. 2 and 3, fig. C) without corresponding pale spot recurved above 2nd radial cell; superior transverse suture present between eyes (pl. 2, fig. A) .....		10
10. Wing with pale spot over r-m crossvein very large, extending well basad and distad beyond crossvein (pl. 2, fig. C); proboscis long, P/H ratio 0.93-1.10 .....	<i>arboricola</i>	p. 23
Wing with pale spot over r-m crossvein much smaller; extending little beyond crossvein in either direction (pl. 3, fig. C); proboscis short to intermediate, P/H ratio 0.58-0.76 .....	<i>baueri</i> <sup>1</sup>	p. 25
11(8). Wing with pale spot over r-m crossvein extending caudad of vein $M_{1+2}$ (pls. 12 and 13, fig. C) .....		12
Wing with pale spot over r-m crossvein not extending caudad of vein $M_{1+2}$ (pls. 4 and 36, fig. C) .....		13
12. Wing with 3 distinct pale spots (fig. 12C) in cell $R_5$ ; wing length 0.92-1.06 mm; mandible with 12-16 teeth; tidewater species .....	<i>furens</i>	p. 44
Wing with 2 distinct pale spots (pl. 13, fig. C) in cell $R_5$ ; wing length 1.20-1.51 mm; mandible with 17-22 teeth .....	<i>guttipennis</i>	p. 46
13(11). Halter knob dark .....	<i>beckae</i>	p. 27
Halter knob pale .....		14
14. Antennal ratio 1.10-1.20; P/H ratio 0.87-1.03; sensillar pattern 3-15, with sensoria absent from flagellomere 10 in about half the specimens .....	<i>ousairani</i>	p. 67
Antennal ratio 1.56-1.72; P/H ratio 0.75-0.88; sensillar pattern 3, 5, 7, 9, 11-15 .....	<i>villosipennis</i>	p. 92
15(7). One spermatheca present .....		16
Two spermathecae present (rarely 3) .....		19

16.	Numerous pale spots present in centers of wing cells (pl. 8, fig. C); spermatheca oval; sensillar pattern 3-15 <i>crepuscularis</i>	p. 35
	Wing with pale spots numerous (pl. 34, fig. F) or restricted (pl. 16, fig. C), but located more towards the apex of cells; spermatheca subspherical to C-shaped; sensoria absent from about half of the flagellomeres	17
17.	Wing with faint markings (pl. 16, fig. C); spermatheca subspherical; sensillar pattern 3, 13-15; 3, 11-15; 3, 11, 13-15; or 3, 11, 13, 14; tidewater species <i>hollensis</i>	p. 52
	Wing with very distinct markings (pl. 34, fig. F); spermatheca straight, elongate to C-shaped; sensillar pattern 3-10; 3, 5-10; 3, 6-10; or 3, 8-10	18
18.	Sensillar pattern 3, 5-10 or 3, 6-10 (rarely 3-10); mandible with 9-15 teeth <i>variipennis australis</i>	p. 88
	Sensillar pattern 3, 8-10; mandible with 14-16 teeth <i>variipennis variipennis</i>	p. 88
19(15).	Spermathecal duct without sclerotized ring; sensillar pattern 3, 11-15; wing spots reduced	20
	Spermathecal duct with sclerotized ring present; if sensillar pattern 3, 11-15, then wing spots numerous (pls. 10 and 15, fig. C)	22
20.	Mandibular teeth absent <i>loisae</i>	p. 55
	Mandibular teeth present	21
21.	Wing with only 2 distinct pale spots (pl. 19, fig. C); thorax yellowish brown <i>mulrennani</i>	p. 59
	Wing with additional pale spots, though often very faint, along outer margin (pl. 30, fig. C); thorax dark brown <i>spinosus</i>	p. 79
22(19).	Wing with transverse pale band beginning just beyond second radial cell (pl. 21, fig. C); wing without distal pale spots <i>niger</i>	p. 63
	Wing without transverse pale band; distal pale spots present or absent	23
23.	Wing with discal pale spots very faint or absent (pls. 6, 32, and 33; fig. C)	24
	Wing with distinct discal pale spots (pls. 9, 11, and 25; fig. C)	28
24.	Wing with pale spots (though often very faint) located along the outer wing margin (pls. 20 and 33, fig. C); sensillar pattern 3-15	25
	Wing with only 2 distinct pale spots, one over the r-m crossvein and the other just distad of the 2nd radial cell (pls. 6, 29, and 32; fig. C); sensillar pattern never 3-15	26

25. Proboscis very short, P/H ratio 0.50-0.55; spermathecal neck short, parallel-sided .....	<i>nanus</i>	p. 61
Proboscis long, P/H ratio 0.74-0.85; spermathecal neck absent ....	<i>travisi</i>	p. 85
26(24). Spermathecal neck long, stout, and tapering .....	<i>biguttatus</i>	p. 31
Spermathecal neck very short and parallel-sided or absent .....		27
27. Wing (pl. 29, fig. C) almost uniformly whitish; halter pale; spermathecal neck very short, parallel-sided; sensillar pattern 3, 5, 7, 9, 11-15 .....	<i>snowi</i>	p. 78
Wing (pl. 32, fig. C) appearing more coarse; halter dark; spermathecal neck absent; sensillar pattern 3, 5, 7, 9, 13-15 .....	<i>testudinalis</i>	p. 83
28(23). Wing with elongate pale spot filling distal portion of cell $R_5$ (pls. 5, 10, and 28, fig. C) ; pale spots present over midportions of veins $M_1$ and $M_2$ .....		29
Wing without elongate pale spot filling distal portion of cell $R_5$ (pls. 9, 11, and 31, fig. C) ; pale spots absent from midportions of veins $M_1$ and $M_2$ .....		33
29. Mandible with 7 teeth; hind tibia with 5 spines; sensillar pattern 3, 11-15 .....	<i>flukei</i>	p. 39
Mandible with 11-17 teeth; hind tibia with 4 spines; sensillar pattern never 3, 11-15 .....		30
30. Antennal ratio 1.29-2.11; sensillar pattern usually 3, 5, 7, 9-15 .....		31
Antennal ratio 1.07-1.25; sensillar pattern 3, 13-15; 3, 5, 7, 9, 11, 13-15 .....		32
31. Antennal ratio 1.68-2.11; eyes narrowly separated .....	<i>piliferus</i>	p. 71
Antennal ratio 1.29-1.56; eyes moderately separated .....	<i>scanloni</i>	p. 76
32(30). Sensillar pattern 3, 13-15; P/H ratio 0.55-0.66; mandible with 11-13 teeth .....	<i>bicklei</i>	p. 29
Sensillar pattern 3, 5, 7, 9, 13-15 or 3, 5, 7, 9, 11, 13-15; P/H ratio 0.63-0.82; mandible with 12-17 teeth .....	<i>pseudopiliferus</i>	p. 73
33(28). Wing (fig. 11C) cells $R_5$ , $M_1$ , and $M_2$ without distinct pale spots; rudimentary spermatheca absent; sensillar pattern 3-10; third segment (pl. 11, fig. B) of maxillary palp greatly swollen, L/W ratio 1.65-2.05 .....	<i>footei</i>	p. 42
Wing cells $R_5$ , $M_1$ , and $M_2$ with numerous distinct pale spots; rudimentary spermatheca present; sensillar pattern never 3-10; third segment of maxillary palp with L/W ratio 2.00-2.81 .....		34
34. Wing with pale spot at apex of cell $R_5$ (pls. 24 and 31, fig. C) .....		35
Wing without pale spot at apex of cell $R_5$ (pls. 9 and 15, fig. C) .....		36

35. Wing with 2 small pale spots just distad of 2nd radial cell (pl. 24, fig. C); antennal ratio 0.62-0.81 ..... *paraensis* p. 69  
 Wing with one larger pale spot just distad of 2nd radial cell (pl. 31, fig. C); antennal ratio 1.06-1.09 ..... *stellifer* p. 82  
 36(34). Antennal ratio 0.74-0.90; sensillar pattern 3, 8-10...*debilipalpis* p. 37  
 Antennal ratio 1.22-1.41; sensillar pattern 3, 11-15...*hinmani* p. 50

# SYNOPTIC TABLE OF SORTING CHARACTERS FOR FEMALES OF VIRGINIA CULICOIDES

1. Mandibular teeth:
  - a. Absent — *loisae*.
  - b. 10 or less—some *chiopterus*, *flukei*, some *melleus*, some *variipennis australis*.
  - c. 10-20 — many species.
  - d. More than 20 — some *guttipennis*.
2. Proboscis length:
  - a. Short (P/H ratio less than 0.65) — some *baueri*, *bickleyi*, *chiopterus*, *flukei*, some *footei*, *loisae*, some *melleus*, *nanus*, some *pseudopiliferus*.
  - b. Intermediate (P/H ratio 0.65-0.75) — some *baueri*, some *footei*, some *furens*, some *haematopotus*, some *hinmani*, some *melleus*, some *pili-ferus*, some *pseudopiliferus*, some *spinosus*, some *stellifer*, some *testudi-nalis*.
  - c. Long (P/H ratio 0.75+) — many species.
  - d. P/H ratio 1.00+ — some *arboricola*, some *guttipennis*, some *hollensis*, some *ousairani*, some *paraensis*.
3. Antennal ratio:
  - a. Less than 1.00 — *debilipalpis*, some *niger* (rare), *paraenis*, *variipen-nis* (both ssp.).
  - b. 1.00-1.50 — many species.
  - c. 1.50-2.00 — *arboricola*, *beckae*, some *crepuscularis*, some *footei* (rare), *guttipennis*, *haematopotus*, some *piliferus*, some *scanloni*, some *travisi*, *villosipennis*.
  - d. Greater than 2.00 — some *piliferus*.
4. Sensillar pattern:
  - a. 3-15 — some *beckae*, *crepuscularis*, some *haematopotus*, *nanus*, some *niger*, *ousairani* (sensoria absent from flagellomere 10 about 50% of the time), *travisi*.
  - b. 3-11 — some *baueri* (rare).
  - c. 3-10 — some *baueri*, *footei*, some *variipennis australis* (rare).

- d. 3, 5-10; 3, 6-10; or 3, 8-10 — most *baueri*, *debilipalpis*, *furens*, *paraensis*, *stellifer*, most *variipennis australis*, *variipennis variipennis*.
  - e. 3, 13-15 — *bickleyi*, some *hollensis*.
  - f. 3, 10-14 — *melleus*.
  - g. 3, 11-15 — *chiopterus*, *flukei*, *hinmani*, some *hollensis*, *loisae*, *mulrennani*, *obsoletus*, *sanguisuga*, *spinosus*, some *venustus*.
  - h. 3, 5-15 or 3, 7-15 — some *biguttatus*, some *haematopotus*, some *niger*.
  - i. 3, 5, 7, 9-15; 3, 5, 7, 9, 11-15; or 3, 5, 7, 9, 11, 13-15 — *arboricola*, some *beckae*, *guttipennis*, some *haematopotus*, *piliferus*, *pseudopiliferus*, *scanloni*, *snowi*, *testudinalis*, *villosipennis*.
  - j. 3, 5, 7-15; 3, 7, 11-15; 3, 7, 9-15; 3, 9, 11-15; or 3, 7, 9, 11-15 — most *biguttatus*, some *haematopotus*, some *piliferus* (rare), some *venustus*.
  - k. 3, 11, 13, 14 or 3, 11, 13-15 — some *hollensis*.
5. L/W ratio of 3rd palpal segment:
    - a. Less than 2.00 — some *baueri*, *chiopterus*, *flukei*, most *footei*, some *loisae*, *nanus*, some *niger*, some *piliferus*.
    - b. 2.00-3.00 — many species.
    - c. Greater than 3.00 — some *furens*, some *guttipennis*, *hollensis*, some *sanguisuga*, some *variipennis* (both ssp.), some *venustus*.
  6. Superior transverse suture absent between eyes: — *chiopterus*, *obsoletus*, *sanguisuga*, *venustus*.
  7. Wings:
    - a. Patterns diagnostic for species — *arboricola*, *baueri*, *crepuscularis*, *footei*, *furens*, *guttipennis*, *haematopotus*, *melleus*, *niger*, *paraensis*, *stellifer*, *variipennis*, *venustus*.
    - b. Wing length less than 0.8 mm — some *debilipalpis*, few *footei*, *hinmani*, few *loisae*, some *paraensis*, few *scanloni*.
    - c. Wing length 0.8-1.4 mm — many species.
    - d. Wing length greater than 1.4 mm — few *arboricola*, few *beckae*, few *crepuscularis*, some *guttipennis*, some *hollensis*, few *travisi*, most *variipennis australis*, *variipennis variipennis*, some *venustus*, some *villosipennis*.
  8. Spermathecae:
    - a. Only one present — *crepuscularis*, *hollensis*, *variipennis* (both ssp.)
    - b. Rudimentary spermatheca absent — *footei*.
    - c. Sclerotized ring absent when 2 fully-developed spermathecae present — *loisae*, *melleus*, *mulrennani*, *spinosus*.



# KEY TO VIRGINIA SPECIES OF CULICOIDES

## BASED ON MALE GENITALIA

1. Parameres fused basally, terminating distally in 2 fine bare tips  
(pl. 34, fig. H) ..... *variipennis* p. 88  
Parameres separate, not fused ..... 2
2. Posteriorly directed processes present on lateral arms near base of  
median process ..... 3  
Posteriorly directed processes absent ..... 5
3. Paramere without subapical knob (pl. 3, fig. E) ..... *baueri* p. 25  
Paramere with subapical knob ..... 4
4. Ninth sternum with deep, very narrow V-shaped caudomedian ex-  
cavation (pl. 11, fig. E) ..... *footei* p. 42  
Ninth sternum with broad, shallow caudomedian excavation (pl.  
14, fig. E) ..... *haematopotus* p. 48
- 5(2). Ventral root with distinct "boat-hook" shape ..... 6  
Ventral root absent or simple, not boat-hook shaped ..... 9
6. Paramere slender, without swellings or knobs beyond base .....  
..... Piliferus group<sup>1</sup> p. 71  
Paramere with at least a small swelling or knob distal to base ..... 7
7. Paramere with large prominent swelling just distad of midlength  
..... *furens* p. 44  
Paramere without large prominent swellings ..... 8
8. Paramere with small, distinct subapical knob.....Debilipalpis group<sup>2</sup> p. 37  
Paramere with slight, often indistinct swelling just distad of mid-  
length (pl. 31, fig. E) ..... *stellifer* p. 82
- 9(5). Ninth tergum with apicolateral processes absent or minute ..... 10  
Apicolateral processes well-developed, long and relatively slender  
or short, stout ..... 12
10. Ventral root vestigial; apicolateral processes minute, knob-like;  
lateral arms connected at base forming large triangular  
aedeagus; ninth sternum with very broad caudomedian  
excavation (pl. 35, fig. E) ..... *venustus* p. 90  
Ventral root very long; apicolateral processes absent; lateral arms  
of aedeagus not connected at base; ninth sternum with  
very narrow caudomedian excavation ..... 11
11. Caudomedian excavation narrowed posteriorly; paramere with  
microscopic hairs at tip (pl. 22, fig. E) ..... *obsoletus* p. 65

<sup>1</sup> Males of the Piliferus group cannot be reliably distinguished from one another.

<sup>2</sup> The genitalia of *debilipalpis* and *paraensis* males are nearly identical; however, the males may be separated on the basis of wing patterns (see couplet 7, key to Virginia females based primarily on quantitative characters).

Caudomedian excavation open posteriorly, narrowed anteriorly; paramere with bare tip (pl. 27, fig. E) .....	<i>sanguisuga</i>	p. 75
12(9). Aedeagus with median process with blunt tip appearing minutely serrate (pl. 15, fig. E) .....	<i>hinmani</i>	p. 50
Aedeagus with median process pointed or rounded at tip, if blunt then not minutely serrate .....		13
13. Paramere with fine spines at tip .....		14
Paramere bare at tip .....		15
14. Apicolateral processes long, would touch if directed mesally; ninth tergum with broad posterior excavation (pl. 30, fig. E) .....	<i>spinusus</i>	p. 79
Apicolateral processes shorter, would not touch if directed mesally; ninth tergum without broad posterior excavation (pl. 17, fig. E) .....	<i>loisae</i>	p. 55
15(13). Paramere with broad, blunt tip; aedeagus with median process short, parallel-sided, ending in unique cap-like structure (pl. 18, fig. E) .....	<i>melleus</i>	p. 57
Paramere with fine tip; median process tapering at least slightly ....		16
16. Paramere with prominent swelling at midlength .....		17
Paramere with little or no swelling at midlength .....		19
17. Aedeagus with very fine, parallel-sided, rounded tip (pl. 23, fig. E) .....	<i>ousairani</i>	p. 67
Aedeagus with broadly rounded or distinctly tapering tip .....		18
18. Ventral root minute; aedeagus with finely rounded tip (pl. 10, fig. E) .....	<i>flukei</i>	p. 39
Ventral root long, slender; aedeagus with broadly rounded tip (pl. 21, fig. E) .....	<i>niger</i>	p. 63
19(16). Aedeagus with 4 subapical filaments giving appearance of 5-pronged tip (pl. 36, fig. E) .....	<i>villosipennis</i>	p. 92
Aedeagus without subapical filaments, apparently ending in a single tip .....		20
20. Ventral root minute or absent .....		21
Ventral root at least moderate in length .....		23
21. Aedeagus with median process rounded at tip (pl. 8, fig. E) .....	<i>crepuscularis</i>	p. 35
Aedeagus with blunt tip .....		22
22. Ninth tergum without median notch; apicolateral processes very long, slender, widely divergent at tip; probably state-wide in distribution (pl. 19, fig. E) .....	<i>mulrennani</i>	p. 59
Ninth tergum with median notch V-shaped; apicolateral processes not as widely divergent at tip; tidewater species (pl. 16, fig. E) .....	<i>holiensis</i>	p. 52

- 23(20). Aedeagal arms joined at midlength by transverse sclerotized membrane; ventral roots very long, almost touching (pl. 7, fig. E.) ..... *chiapterus* p. 35  
 Aedeagal arms not joined at midlength; ventral roots usually long, but not almost touching ..... 25  
 24. Aedeagus ending in long, slender process ..... 25  
 Aedeagus ending in stout process ..... 26  
 25. Aedeagus tapering little to fine, somewhat blunt tip (pl. 33, fig. E) ..... *travisi* p. 85  
 Aedeagus tapering rapidly to slender, finely rounded, almost pointed tip (pls. 2 and 4, fig. E) ..... *arboricola* p. 23; *beckae*<sup>3</sup> p. 25  
 26(24). Median notch shallow or indistinct ..... 25  
 Median notch deep, prominent (pl. 6, fig. E) ..... *biguttatus* p. 35  
 27. Aedeagus with median process long, slightly swollen mesally, ending in somewhat truncate tip with cap-like structure (pl. 13, fig. E) ..... *guttipennis* p. 40  
 Aedeagus with median process relatively short, tapering to slightly rounded tip ..... *nanus* p. 61

## DESCRIPTION OF SPECIES

### *Culicoides arboricola* ROOT AND HOFFMAN

(Plate 2)

*Culicoides arboricola* Root & Hoffman, 1937: 166-167; Foote and Pratt, 1954: 15-16 figs. 30, 56, 77, 123 (male, female); Jamnback, 1965: 40-42, figs. 1, 28, 67, 104, 140 (male, female); Wirth and Blanton, 1967: 210-213, figs. 1-8 (male, female).

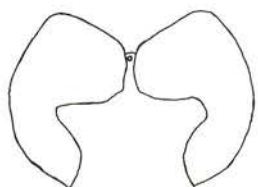
#### DESCRIPTION

*Female*.—Eyes narrowly separated (fig. A). Proboscis long, P/H ratio 1.01 (0.93-1.10). Mandible with 16 (15-17) teeth. Flagellomere length ratio: 22:17:18:18:20:18:20:19:43:43:44:46:66, AR = 1.59 (1.49 — 1.64); sensillar pattern 3, 5, 7, 9, 11-15; two specimens from Ottobine, Virginia without distal sensory tuft on segment 5. Third segment of maxillary palp moderately swollen (fig. B), L/W ratio 2.78 (2.38 — 3.00) but usually greater than 2.75.

Wing length 1.21 (1.14 — 1.39) mm with pale spots distinct as shown in figure C; halter pale. Legs with knees dark, distinct pale bands at apex of femur and base of tibia; hind tibia with five spines, 1 and 2 subequal and longer than 3-5.

Spermathecae (fig. D) with maximum widths 41(37 — 43) and 46 (43 — 47) microns, respectively; neck short, tapering.

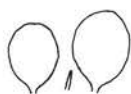
<sup>3</sup> Males of *arboricola* and *beckae* could not be consistently separated in Virginia material; Wirth and Blanton (1967) found the parameres of *beckae* to be more slender distally than those of *arboricola*.



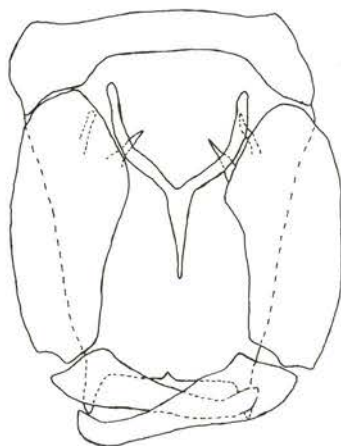
A



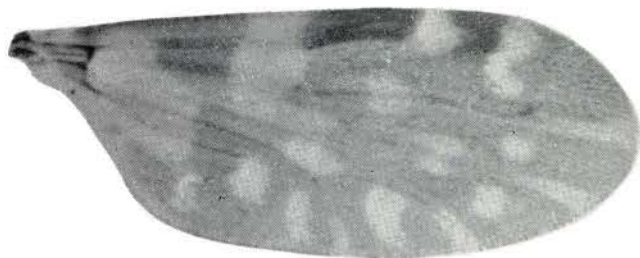
B



D



E



C

Plate 2. - *C. arboricola* Root & Hoffman

*Male terminalia* (fig. E).—Ninth tergum with prominent, fairly stout apico-lateral processes; ninth sternum with broad, shallow caudomedian excavation. Basistyle with ventral root long and slender, tapering to sharp point; dorsal root less tapered, blunt distally.

Paramere with large basal knob, slightly swollen median portion, and strongly curved tip ending in fine, bare point. Aedeagus with long, slender basal arms, high basal arch, and long, slender median posterior process tapering to pointed tip.

*Notes.*—Females of this species differ from other members of the *C. guttipennis* group in Virginia in having vein  $Cu_1$  ending in a pale spot at wing margin, and by having a subapical pale band on the hind femur. No consistent difference was seen between the males of this species and those of *C. beckae*. Wirth and Blanton (1967) found the parameres of *C. beckae* to be more slender distally.

#### DISTRIBUTION IN VIRGINIA

Alexandria, Augusta, Bedford, Craig, Franklin, Giles, Montgomery, Nansemond, Rockbridge, Rockingham, and Wythe counties.

#### BIOLOGY

*Breeding sites.*—Wet tree-holes, wet wood debris, water and moist woody debris (Hair *et al.*, 1966).

*Feeding habits.*—Hair and Turner (1968) reported 14 females collected from birds and 4 from man. Humphreys (1969) reported this species from rabbits. Nonetheless *C. arboricola* is apparently primarily ornithophilic.

*Seasonal distribution.*—Messersmith (1966) has collected adults in Virginia from July 2 to September 26, and reported a numerical peak in August. This species probably breeds continually in warm weather in the south (Jamnback, 1965).

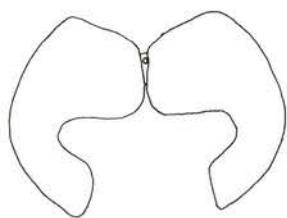
### *Culicoides baueri* HOFFMAN

(Plate 3)

*Culicoides baueri* Hoffman, 1925: 297-298; Foote and Pratt, 1954: 16, figs. 23, 46, 89, 104 (male, female); Jamnback, 1965: 42-44, figs. 2, 29, 68, 105, 142 (male, female); Atchley, 1967: 985-987, figs. 55-59 (male, female).

#### DESCRIPTION

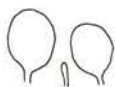
*Female.*—Eyes very narrowly separated (fig. A). Proboscis short to moderately long, P/H ratio 0.64 (0.58 — 0.76,  $n = 11$ ). Mandible with 12 (11 — 13,  $n = 11$ ) minute teeth. Flagellomere length ratios 21:14:14:15:15:15:15:16:23:25:26:27:39, AR = 1.12 (1.01 — 1.20); sensillar pattern 3, 6-10 in half the specimens; other patterns seen were 3, 5, 7-10; 3, 7-10; 3, 7-11; 3-10; and 3-11, all about equal in frequency. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.02 (1.87 — 2.13),  $n = 12$ ; sensory pit deep with large opening.



A



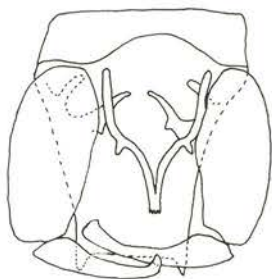
B



D



E



C

Plate 3. - *C. baueri* Hoffman

Wing length 1.03 (0.96 — 1.20) mm with markings as shown in figure C. Legs with distinct pale bands on either side of dark knees; hind tibia with 4 spines, the 1st longest.

Spermathecae (fig. D) with maximum widths 34.6 (31 — 45,  $n = 9$ ) and 39.9 (35 — 51,  $n = 9$ ) microns, respectively; neck long, parallel-sided; sclerotized ring elongate.

*Male terminalia* (fig. E).—Ninth tergum with short, stout apicolateral processes; median notch shallow, indistinct, or absent; ninth sternum with broad, shallow caudomedian excavation. Basistyle with “boat-hook” shaped ventral root; dorsal root fairly long, parallel-sided.

Paramere swollen at base, tapering slightly to recurved tips with several spines on each. Aedeagus with long, arcuate lateral arms without flange at base; lateral posteriorly directed processes present as in *C. footei* and *C. haematopotus*; aedeagus with median process slightly tapering to minutely serrate or ridged tip.

*Notes*.—Females of *baueri* differ from *haematopotus* in having a pale spot in the center of cell  $R_5$ , not at wing margin. Both branches of the medio-cubital fork end in pale areas at the wing margin, not in dark areas as in *C. stellifer*. *Culicoides baueri* males may be distinguished from *C. footei* and *C. haematopotus* by the absence of a subapical knob on the parameres.

#### DISTRIBUTION IN VIRGINIA

The city of Alexandria, Accomac, Augusta, Botetourt, Mecklenburg, Montgomery, Rockbridge, Rockingham, and York Counties.

#### BIOLOGY

*Breeding sites*.—This species has been reared from many stream margins during the present study. Similar data were obtained by Jamnback (1965).

*Feeding habits*.—Probably ornithophilic (Jamnback, 1965).

*Seasonal distribution*.—Messersmith (1966) collected adults from May through September, with a peak in June. Other studies indicate this species to be most abundant in May and June.

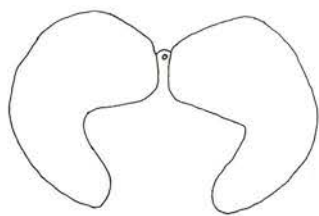
### *Culicoides beckae* WIRTH AND BLANTON

(Plate 4)

*Culicoides beckae* Wirth and Blanton, 1967: 213-215, figs. 9-16 (male, female).

#### DESCRIPTION

*Female*.—Eyes narrowly separated (fig. A). Proboscis long, P/H ratio 0.86 (0.76 — 0.94). Mandible with 15 (13 — 18,  $n = 4$ ) teeth. Flagellomere length ratios 25:15:17:18:20:19:20:20:43:42:43:45:60, AR = 1.51 (1.48 — 1.61,  $n = 4$ ); sensillar pattern, 3, 5, 7, 9, 11-15; 3, 5, 7, 9, 13-15; and 3-15 in 3 paratypes from Ferrum (Franklin Co., Va.). Third segment of maxillary palp (fig. B) moderately to greatly swollen, L/W ratio 2.60 (2.21 — 3.00).



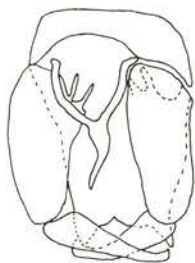
A



B



D



E



C

Plate 4. - *C. beckae* Wirth & Blanton  
(27)



Wing length 1.17 (1.04 — 1.34) mm with numerous pale spots present as shown in figure C; halter dark. Legs dark brown, knees dark with pale bands on either side; hind tibia with subapical pale bands and 5 spines, the 1st longest.

Spermathecae (fig. D) with maximum widths 38.3 (20 — 47,  $n = 3$ ) and 40.7 (33 — 49,  $n = 3$ ), microns, respectively; neck short, slightly tapering.

*Male Terminalia* (fig. E).—Ninth tergum with stout, triangular apico-lateral processes; median notch shallow; ninth sternum with broad, shallow caudomedian excavation. Basistyle with long, slender, pointed ventral root; dorsal root slightly longer.

Paramere with prominent basal lobe with anterior and posterior projections, swollen near base and tapering gradually to fine bare tip. Aedegal arms long, arcuate with distinct flange at base; median posterior process very long, tapering rapidly to finely rounded tip.

*Notes.*—Females of this species show considerable variation in several characters tending to intergrade towards other members of the *C. guttipennis* group. Wirth and Blanton separated *C. beckae* females on the basis of dark halter knobs and a shallow palpal pit; both characters were noted in the present study. They also listed the gray pruinose pattern of the scutum and the sensillar pattern as diagnostic. The scutal pattern could not be studied in this treatment because only slide mounted specimens of *C. beckae* were observed; the sensillar pattern was found to be quite variable. Males closely resemble *C. arboricola* (see notes for that species).

#### DISTRIBUTION IN VIRGINIA

Franklin County.

#### BIOLOGY

*Breeding sites.*—Moist or wet tree holes.

*Feeding habits.*—Probably ornithophilic; species with an abundance of sensorial pits on the flagellum generally prefer birds to mammals.

*Seasonal distribution.*—Unknown. The known range of collection dates of adults at present is June (Alabama) through September (Florida). The Virginia series was collected by Messersmith in July and August.

#### *Culicoides bickleyi* WIRTH AND HUBERT

(Plate 5)

*Culicoides bickleyi* Wirth and Hubert, 1962: 188-189, figs. 4a-g, 13 (male, female); Jamnback, 1955: 46-48, figs. 31, 70, 107, 144, 177 (female).

#### DESCRIPTION

*Female.*—Eyes narrowly separated (fig. A). Proboscis short, P/H ratio 0.61 (0.55 — 0.66,  $n = 6$ ). Mandible with 12 (11 — 13,  $n = 4$ ) teeth. Flagellomere length ratios 19:13:13:14:14:14:14:15:22:23:26:28:41, AR = 1.21 (1.15 — 1.24); sensillar pattern 3, 13-15. Third segment of maxillary

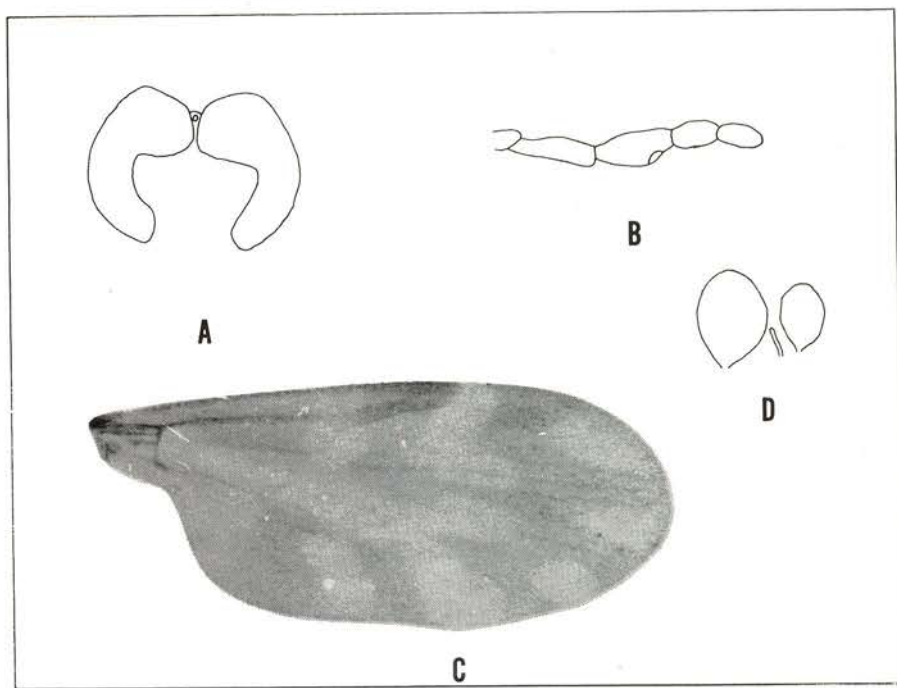


Plate 5. - *C. bickleyi* Wirth & Hubert

palp (fig. B) short, moderately to greatly swollen, L/W ratio 2.27 (2.00 — 2.67,  $n = 6$ ).

Wing length 1.08 (1.04 — 1.12) mm, markings shown in figure S. Tibiae with faint subbasal pale bands; hind tibia with 4 spines, the 2nd longest.

Spermathecae oval (fig. D) with maximum widths 34.8 (30 — 39,  $n = 6$ ) and 49 (41 — 57,  $n = 6$ ) microns, respectively; neck absent or very short and parallel-sided.

*Male Terminalia*.—The males of the *C. piliferus* group so closely resemble one another that only the *piliferus* male will be described and illustrated in the present study.

*Notes*.—May be separated from other *C. piliferus* group females by the unusual sensillar pattern of 3, 13-15.

#### DISTRIBUTION IN VIRGINIA

Craig, Fairfax, and Montgomery Counties.

#### BIOLOGY

*Breeding sites*.—Mud, sphagnum, or decaying organic matter near streams or springs (Jamnback, 1965).

*Feeding habits*.—Wirth and Hubert (1962) reported *C. bickleyi* biting man in Massachusetts and West Virginia. Humphreys (1969) collected 39 from

goats and 1 from a turkey. The reduced sensillar pattern indicates a preference for mammals.

*Seasonal distribution.*—An early spring species according to Jamnback (1965). Only inadequate data are available from Virginia.

*Culicoides biguttatus* (COQUILLET)

(Plate 6)

*Culicoides biguttatus* (Coquillett), 1901: 604; Foote and Pratt, 1954: 16-17, figs. 7, 42, 72, 118 (male, female); Jamnback, 1965: 48-50, figs. 3, 32, 71, 108, 145, 178 (male, female).

DESCRIPTION

*Female.*—Eyes very narrowly separated (fig. A). Proboscis long, P/H ratio 0.81 (0.77 — 0.85,  $n = 7$ ). Mandible with 16 (15 — 17,  $n = 6$ ) teeth. Flagellomere length ratios 20:14:15:17:18:17:17:18:27:27:29:30:46, AR = 1.16 (1.04 — 1.25); sensillar pattern variable, specimens seen with patterns of 3, 7-15; 3, 5, 7-15; 3, 7, 11-15; 3, 7, 9-15; 3, 9, 11-15; and 3, 7, 9, 11-15, respectively ( $n = 7$ ). Third segment of maxillary palp moderately swollen (fig. B), L/W ratio 2.73 (2.50 — 3.00,  $n = 6$ ); sensory pit shallow with a small opening.

Wing length 1.13 (0.92 — 1.32,  $n = 6$ ) mm, with two pale spots, one over the r-m crossvein and one just distad of the second radial cell (fig. C). Legs usually with faint pale bands; hind tibia with four spines, the second longest.

Spermathecae ovoid (fig. D) with maximum widths 41.7 (37 — 47,  $n = 6$ ) and 45.3 (39 — 51,  $n = 6$ ) microns, respectively; neck long, stout, and distinctly tapering; sclerotized ring small.

*Male Terminalia* (fig. E).—Ninth tergum with stout, widely divergent apicolateral processes; median notch broad, deep; ninth sternum with deep caudomedian excavation. Basistyle with long, slender ventral root, slightly longer than blunt dorsal root.

Paramere with basal arms abruptly bent laterad, slightly tapering to slender, fairly blunt recurved tip. Aedeagus with short lateral arms with an indistinct flange at base; median posterior process strongly tapering, appearing truncate at tip.

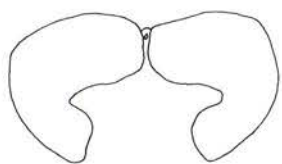
*Notes.*—*Culicoides biguttatus* females may be distinguished from species with similar wing markings by the strongly tapering spermathecal neck, presence of a sclerotized ring, sensillar pattern (though quite variable), large size, and the dark gray wing with uniform coarse macrotrichia.

DISTRIBUTION IN VIRGINIA

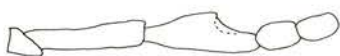
Augusta, Bedford, Craig, Fairfax, Giles, Gloucester, Montgomery, Rockbridge, and Rockingham Counties, and the city of Petersburg.

BIOLOGY

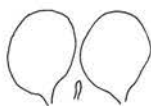
*Breeding sites.*—Mud, wet leaves, and decaying organic matter in extremely moist and shaded sites (Hair *et al.*, 1966).



A



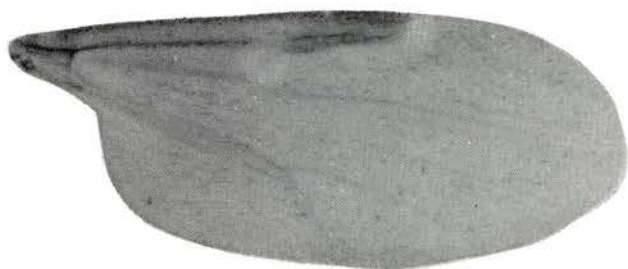
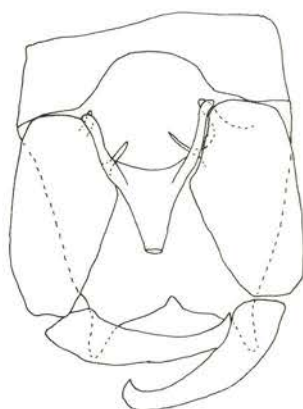
B



D



E



C

Plate 6. - *C. biguttatus* (Coquillett)  
(31)

*Feeding habits.*—Readily feeds on mammals or birds, but is rarely a serious pest of man. Hair and Turner (1968) collected 13 from man, 59 from other mammals, and 46 from birds. Humphreys (1969) reported about twice as many from mammals as from turkeys.

*Seasonal distribution.*—Messersmith (1966) collected adults between April 18 and July 22, and found a population peak in June. Jamnback (1965) reported adult collections from May 26 to October 5 in New York, with the species most common from early June through August.

*Culicoides chiopterus* (MEIGEN)

(Plate 7)

*Culicoides chiopterus* (Meigen), 1830: 263; Jamnback and Wirth, 1963: 187-188, figs. 5, 8, 12, 16, 20, 24, 28 (male, female); Jamnback, 1965: 50-52, figs. 4, 33, 72, 109, 146 (male, female).

DESCRIPTION

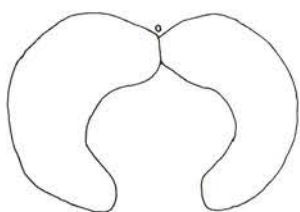
*Female.*—Eyes (fig. A) contiguous; angle of separation at interocular seta 90 degrees or more; superior transverse suture absent. Proboscis short, P/H ratio 0.60 (0.54 — 0.63,  $n = 4$ ). Mandible with 9 (7 — 10,  $n = 2$ ) teeth. Flagellomere length ratios 19:12:12:13:13:14:14:15:21:22:24:24:37, AR = 1.14 (1.06 — 1.19,  $n = 4$ ); sensillar pattern 3, 11-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 1.90 (1.85 — 2.00,  $n = 4$ ); sensory pit shallow with small round opening;  $P_3/P_5$  ratio 1.25 (1.10 — 1.40,  $n = 4$ ).

Wing length 0.96 (0.82 — 1.05,  $n = 4$ ) mm, with markings (fig. C) very indistinct, wing appearing almost uniformly hyaline; macrotrichia few, those present confined mostly to apex of wing; macrotrichia less dense at costal margin than in *C. obsoletus* and *C. sanguisuga*; vein  $M_{3+4}$  with 2 (0 — 6,  $n = 4$ ) macrotrichia, cell  $M_4$  usually without them except at margin. Thorax a very dark brown. Legs without distinct pale bands; hind tibia with 5 spines, the first longest.

Spermathecae (fig. D) with maximum widths 34.0 (31 — 37,  $n = 4$ ) and 37.5 (35 — 39,  $n = 4$ ) microns, respectively; neck short, slightly tapering; rudimentary spermatheca long, tubular.

*Male Terminalia* (fig. E).—Ninth tergum with short, stout, apically rounded apicolateral processes; median notch broad, shallow, barely visible; ninth sternum with broad, relatively shallow caudomedian excavation. Basistyle with ventral roots very long, slender, almost touching mesally; dorsal root shorter, stouter, but also tapering.

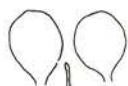
Paramere with elongate base gradually tapering to fine, bare point. Aedeagal arms with slight flange at base, joined in midlength by a transverse sclerotized membrane; median posterior process slightly tapering and rounded at tip.



A



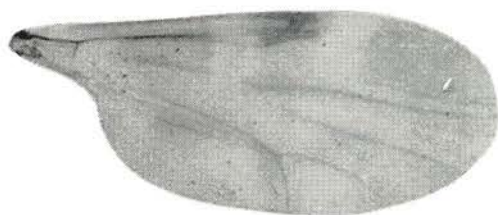
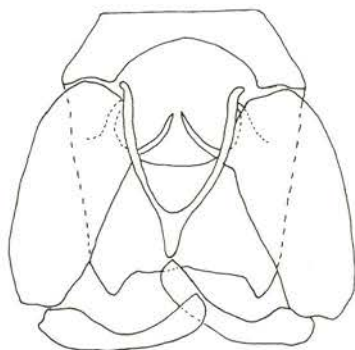
B



D



E



C

Plate 7. - *C. chiopterus* (Meigen)

*Notes*.—This is the only Virginia species with a faintly marked wing, dark brown thorax, and fewer than 10 mandibular teeth (there are no teeth in *C. loisae*). The third palpal segment is much shorter than in *C. obsoletus* and *C. sanguisuga*, and *C. chiopterus* is a smaller species than those two. See notes for *C. obsoletus* males.

#### DISTRIBUTION IN VIRGINIA

Fairfax, Franklin, Montgomery, Rockbridge, Rockingham, and Wythe Counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites*.—Jamnback (1965) reared this species from moist straw and moist polluted soil mixed with chicken manure.

*Feeding habits*.—Humphreys (1969) collected 2 gnats from galliform birds. Messersmith (1965a) collected 8 females in poultry houses with light traps.

*Seasonal distribution*.—Messersmith (1966) trapped adults from May 24 to September 2, and noted a peak in July.

### *Culicoides crepuscularis* MALLOCH

(Plate 8)

*Culicoides crepuscularis* Malloch, 1915a: 303; Foote and Pratt, 1954: 19-20, figs. 14, 47, 64, 73, 98 (male, female); Jamnback, 1965: 52-56, figs. 5, 34, 65, 73, 110, 147 (male, female); Atchley, 1967: 972-974, figs. 28-33 (male, female).

#### DESCRIPTION

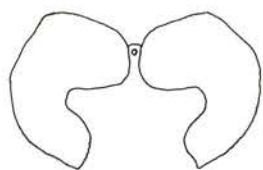
*Female*.—Eyes narrowly separated (fig. A). Proboscis long, P/H ratio 0.86 (0.81 — 0.90,  $n = 20$ ). Mandible with 14 (13 — 16,  $n = 20$ ). Flagellomere length ratios 22:14:13:14:14:14:15:16:31:32:35:34:51, AR = 1.48 (1.42 — 1.61); sensillar pattern 3 — 15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.15 (2.00 — 2.42,  $n = 20$ ); sensory pit large, deep.

Wing length 1.27 (1.10 — 1.37,  $n = 20$ ) mm with extensive oval pale spots centering in cells as shown in figure C. Legs without distinct pale bands; 4 hind tibial spines with the first longest.

One large oval spermatheca (fig. D) with maximum width 63 (57 — 69,  $n = 10$ ) microns; neck short, parallel-sided, rarely absent.

*Male Terminalia* (fig. E).—Ninth tergum with slender apicolateral processes; ninth sternum with broad, shallow caudomedian excavation. Basistyle with vestigial ventral root, represented only by a slight protuberance; dorsal root long, slender.

Paramere with prominent anteriorly projecting accessory process at base, slightly swollen at midlength, and tapering to fine, twisted bare point. Aedeagus with long lateral arms with flange at base; median process, short, conical, slightly rounded at tip.



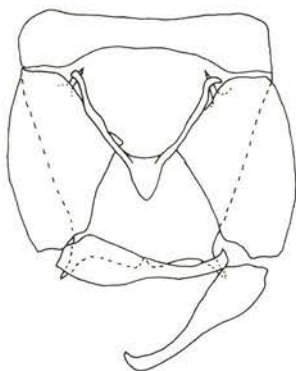
**A**



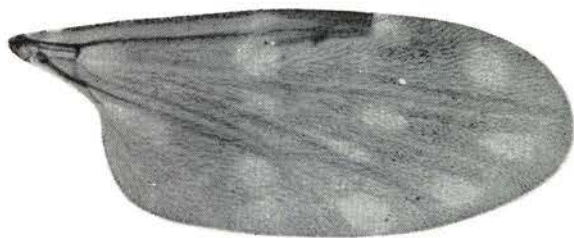
**B**



**D**



**E**



**C**

Plate 8. - *C. crepuscularis* Malloch



*Notes.*—*Culicoides crepuscularis*, *C. hollensis*, and *C. variipennis* are the only species in the state with one spermatheca; the remainder have two fully developed spermathecae. The former can be easily distinguished from the other two species by its sensillar pattern and wing markings.

Males closely resemble *C. hollensis*, but the aedeagus ends in a more rounded tip in *C. crepuscularis*.

#### DISTRIBUTION IN VIRGINIA

Amherst, Augusta, Buchanan, Buckingham, Campbell, Craig, Fairfax, Franklin, Gloucester, King George, Mecklenburg, Montgomery, Pittsylvania, Roanoke, Rockbridge, Rockingham, Smyth, Spotsylvania, Tazewell, Wythe, and York Counties.

#### BIOLOGY

*Breeding sites.*—This species breeds in almost any moist terrestrial habitat — mud or sand at pond and stream margins, water tank overflows, drainage ditches, marshy meadows, etc. It is one of the most common species in this type habitat, and is frequently reared in large numbers from breeding site samples, aprticularly those taken from pastureland streams and ponds that consist of open sunny, grassy sites.

*Feeding habits.*—Ornithophilic (Jamnback, 1965). Hair and Turner (1968) collected 52 from birds, 8 from man, and 11 from other mammals in Virginia. Although a common and widespread species, it rarely attacks man. However, Edmunds and Keener (1954) reported *C. crepuscularis* severely annoying people in Nebraska's North Platte Valley.

*Seasonal distribution.*—Messersmith (1966) collected adults in Virginia from April through September with a population peak in August. Jamnback (1965) suggested that *C. crepuscularis* produces more than one generation per year in New York with adult populations highest in mid to late summer.

### *Culicoides debilipalpis* LUTZ

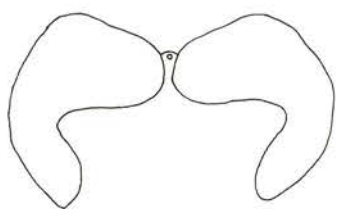
(Plate 9)

*Culicoides debilipalpis* Lutz, 1913: 60; Wirth and Blanton, 1959: 442-446, figs. 79a-g (male, female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) moderately separated. Proboscis long, P/H ratio 0.86 (0.81 — 0.88,  $n = 7$ ). Mandible with 15 (15 — 16,  $n = 6$ ) teeth. Flagellomere length ratios 18:16:17:19:18:19:19:19:19:21:20:35, AR = 0.79 (0.74 — 0.90); sensillar pattern 3, 8-10. Third segment of maxillary palp (fig. B) moderately swollen, L/W ratio 2.50 (2.42 — 2.63); sensory pit deep.

Wing length 0.85 (0.70 — 0.96,  $n = 7$ ) mm; markings shown in figure C. Legs with pale bands on either side of dark knees; tibia with faint distal



A



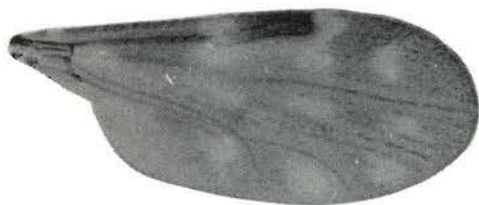
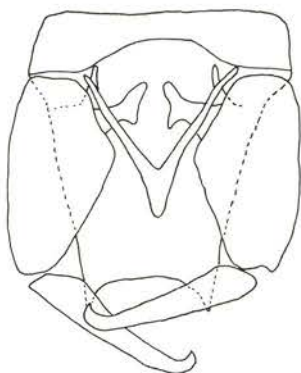
B



D



E



C

Plate 9. - *C. debilipalpis* Lutz

pale bands not always visible; hind tibia with four or five spines; 1 and 2 subequal, or 2 longest.

Spermathecae (fig. D) with maximum width 33.8 (30 — 37,  $n = 4$ ) and 37.2 (34 — 41,  $n = 4$ ) microns, respectively; neck very long, parallel-sided.

*Male Terminalia* (fig. E).—Ninth tergum with short, triangular apico-lateral processes; ninth sternum with broad, shallow caudomedian excavation. Basistyle with massive foot-shaped ventral root; dorsal root long, slender, slightly tapering to blunt tip.

Paramere with slight basal swelling, tapering little to slight ventral knob just basad of long, fine spinose tip. Aedeagal arms long, straight with distinct flange at base; median posterior process tapering gradually to rounded tip.

*Notes.*—The pale spot just distad of the second radial cell is more constricted at its center than in *C. stellifer* and *C. furens*, and generally takes the form of two separate spots in the Debilipalpis group. *Culicoides debilipalpis* is similar to *C. paraensis* but may be distinguished by the absence of a pale spot at the tip of wing cell  $R_5$ . These two species along with *C. variipennis* are the only Virginia *Culicoides* with antennal ratios less than 0.90, but *C. variipennis* is much larger and has distinctly different wing patterns. The male genitalia so closely resemble *C. paraensis* that accurate determinations must be made on the basis of wing markings. Khalaf (1969) is of the opinion that this species is synonymous with *C. paraensis*, but Wirth (1970, personal communication) disagrees.

#### DISTRIBUTION IN VIRGINIA

Dismal Swamp; Fairfax, Franklin, Montgomery, and Rockingham Counties.  
BIOLOGY

*Breeding sites.*—Messersmith (1964) reared one male from wet bits of wood and leaves from the bottom of a white oak (*Quercus alba*) stump hole near Mt. Crawford, Virginia. Smith (1965) reared this species from tree-holes in Florida.

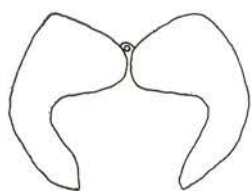
*Feeding habits.*—Messersmith (1965a) reported three engorged females from Virginia poultry houses. Lutz (1913) recorded *C. debilipalpis* feeding on man and horses in Brazil.

*Seasonal distribution.*—Khalaf (1967a) collected adults in light traps in southern Louisiana from late April through October. He noted a population peak in the first half of May. Messersmith (1966) recorded a numerical peak in July in Virginia.

#### *Culicoides flukei* JONES

(Plate 10)

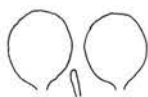
*Culicoides flukei* Jones, 1956: 30; Jamnback, 1965: 61-63, figs. 6, 38, 77, 114, 151 (male, female); Wirth and Blanton, 1967: 218-220, figs. 34-39, 41-42 (male, female).



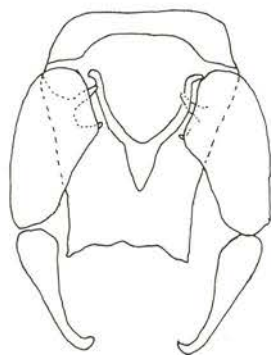
A



B



D



E



C

Plate 10. - *C. flukei* Jones

## DESCRIPTION

*Female*.—Only two specimens seen. Eyes (fig. A) contiguous or very narrowly separated. Proboscis very short, P/H ratio 0.48 (0.46 — 0.50,  $n = 2$ ). Mandible with 7 (7 — 7,  $n = 2$ ) teeth. Flagellomere length ratios 22:16:17:17:17:17:17:24:24:26:32:47, AR = 1.09 ( $n = 1$ ); sensillar pattern 3, 11-15. Third segment of maxillary palp short (fig. B) and greatly swollen, L/W ratio 1.62 (1.54 — 1.70,  $n = 2$ ); sensory pit shallow with small opening.

Wing length 0.95 (0.92 — 0.98,  $n = 2$ ) mm. Wing with pale spot (fig. C) in cell  $R_5$  elongate, filling distal portion of cell. Legs with pale bands located subapically on femora and subbasally on tibiae; hind tibiae also have subapical pale bands so that only the middle third is dark; hind tibia with five spines, the first two longest.

Spermathecae (fig. D) with maximum widths 33 ( $n = 1$ ) and 34 (33 — 35,  $n = 2$ ) microns, respectively; neck very short, slightly tapering.

*Male Terminalia* (fig. E).—Ninth tergum with short, stout apicolateral processes with small knob at each tip; median notch shallow; ninth sternum with broad, caudomedian excavation. Basistyle with undeveloped ventral root; dorsal root moderately long, slender.

Paramere with prominent basal lobe with anterior and posterior projections, swollen at midlength, and tapering to long, fine, bare tip. Aedeagal arms long, curved with distinct flange at base; median posterior process tapering slightly to rounded tip.

*Notes*.—This species can be separated from other Virginia species by the reduced mandibular dentition, sensillar pattern, and distinct wing markings with numerous pale spots (*C. chiopterus* has pale wings). Other members of the *guttipennis* group have more mandibular teeth and lack the enlarged pale spot in the distal portion of cell  $R_5$ . The genitalia of *C. flukei* are similar to *C. niger*; see notes on that species for distinguishing characters.

## DISTRIBUTION IN VIRGINIA

Augusta County.

## BIOLOGY

*Breeding sites*.—Tree holes and pitcher plants (Wirth and Blanton, 1967).

*Feeding habits*.—Unknown. This species may not suck blood because of the reduced mandibular teeth.

*Seasonal distribution*.—Additional collections are needed to draw any conclusions here. Records of *C. flukei* are extremely scarce throughout its range.

*Culicoides footei* Wirth and Jones, 1956: 162-163, figs. 1a-f (male, female).

#### DESCRIPTION

*Female*.—Eyes (fig. A) narrowly separated. Proboscis short to intermediate, P/H ratio 0.68 (0.59 — 0.75,  $n = 8$ ). Mandible with 15 (15 — 15,  $n = 4$ ) very minute teeth. Flagellomere length ratios 16:11:12:12:12:12:15:25:25:26:25:42, AR = 1.45 (1.35 — 1.52); sensillar pattern 3-10. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 1.84 (1.65 — 2.05,  $n = 7$ ), sensory pit with small, very deep pore.

Wing length 0.93 (0.78 — 1.04,  $n = 7$ ) mm, with pale spots as shown in figure C. Legs with inconspicuous pale bands, knees dark; four hind tibial spines with first longest.

Spermathecae (fig. D) with maximum widths of 33.5 (33 — 35,  $n = 4$ ) and 41.0 (35 — 45,  $n = 4$ ) microns, respectively: neck moderate to long and parallel-sided; rudimentary spermatheca usually absent, although what may have been one was seen in a single specimen.

*Male Terminalia* (fig. E).—Ninth tergum strongly tapered with moderately prominent apicolateral processes; ninth sternum with very narrow, deep caudo-median excavation. Basistyle with well-developed boat-hook shaped ventral root; dorsal root long, blunt.

Paramere with slight subbasal swelling and prominent knob just below recurved, spiny tip. Aedeagus with long lateral arms strongly bent mesally; median process long, parallel-sided with distinct posteriorly directed processes near base and serrate at tip.

*Notes*.—Females of this species may be distinguished by the absence of distal wing spots, presence of two distinct basal pale spots in cell  $M_2$ , sensillar pattern, greatly swollen palp with small deep pit, and the absence of a rudimentary spermatheca. Male terminalia very near *C. baueri* and *C. haematopotus*; separated by the subapical knob on the parameres and the narrow caudomedian excavation.

#### DISTRIBUTION IN VIRGINIA

Augusta, Bedford, Fairfax, Giles, and Rockbridge Counties, and the City of Alexandria.

#### BIOLOGY

*Breeding sites*.—Oak, maple, and buckeye tree holes (Hair *et al.*, 1966).

*Feeding habits*.—Unknown.

*Seasonal distribution*.—Unknown.

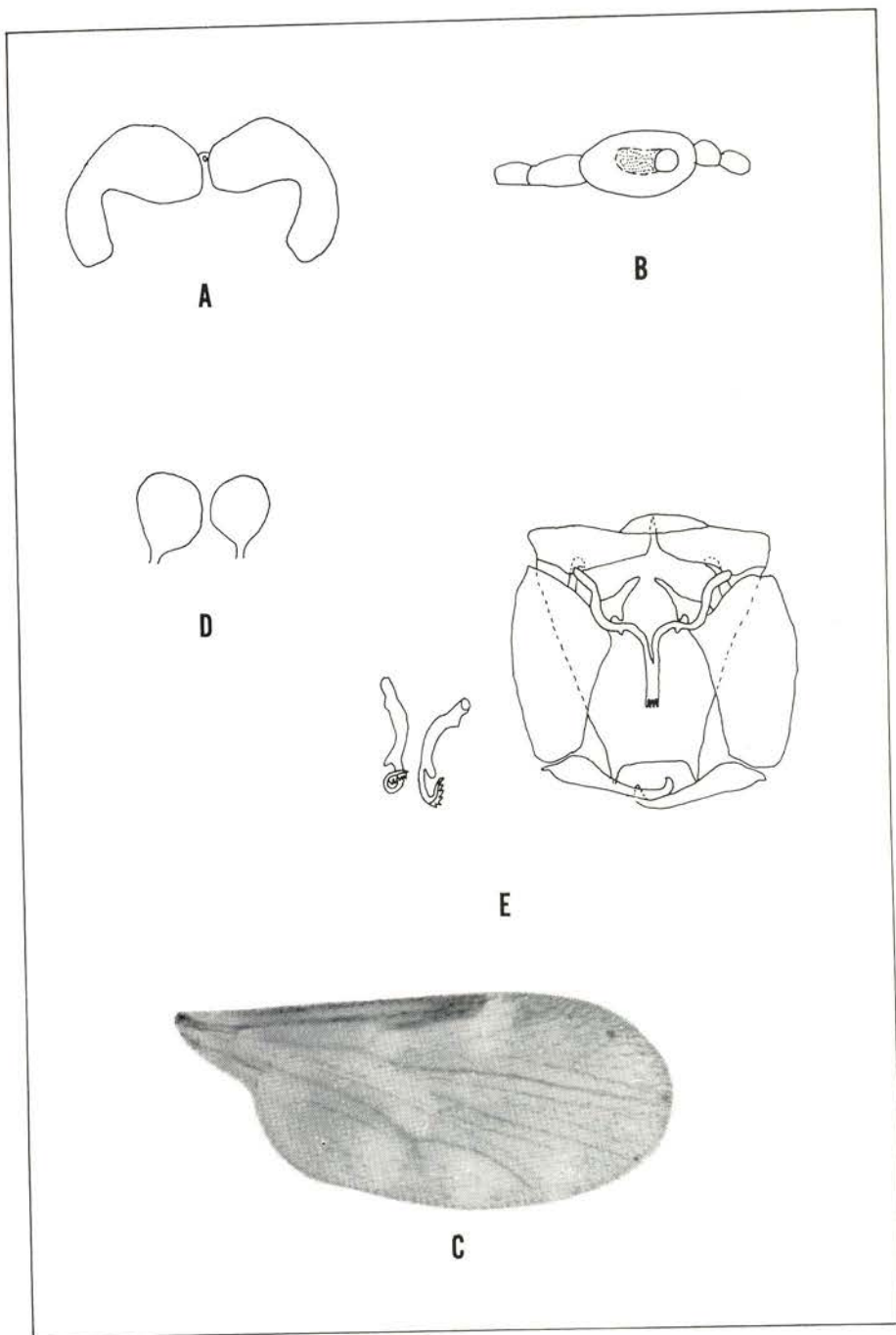


Plate II. - *C. footei* Wirth & Jones  
(42)

*Culicoides furens* (POEY)

(Plate 12)

*Culicoides furens* (Poey), 1851: 238; Foote and Pratt, 1954: 21-22, figs. 20, 58, 69, 105 (male, female); Wirth and Blanton, 1956: 159-161, figs. 1a-h (male, female); Wirth and Blanton, 1959: 404-407, figs. 62a-h (male, female); Jamnback, 1965: 63-66, figs. 7, 39, 78, 115, 152, 179 (male, female).

DESCRIPTION

*Female*.—Eyes (fig. A) narrowly separated. Proboscis long, P/H ratio 0.82 (0.73 — 0.91,  $n = 20$ ). Mandible with 14 (12 — 16,  $n = 20$ ) teeth. Flagellomere length ratios 17:14:14:14:15:14:13:13:24:25:25:30:45, AR=1.32 (1.31 — 1.34); sensillar pattern 3, 7 — 10. Third segment of maxillary palp (fig. B) usually moderately swollen, L/W ratio 2.72 (2.21 — 3.14,  $n = 20$ ); sensory pit shallow to moderately deep.

Wing length 0.98 (0.92 — 1.06,  $n = 20$ ); pale spots (fig. C) numerous, particularly in cell  $R_5$ . Legs with distinct pale bands at apex of femur and base of tibia, knees dark; four hind tibial spines, with the first longest.

Spermathecae (fig. D) with maximum widths of 32 (31 — 35,  $n = 20$ ) and 35 (31 — 37,  $n = 20$ ) microns, respectively; neck long, parallel-sided.

*Male Terminalia* (fig. E).—Ninth tergum strongly tapering with long apico-lateral processes which would touch if directed mesally; median notch deep, V-shaped; ninth sternum with deep, narrow caudomedian excavation.

Basistyle with well-developed boat-hook shaped ventral root; dorsal root long, slender.

Paramere with slightly swollen basal knob, large prominent ventral swelling just distad of midlength, and fine tip with several lateral spines. Aedeagus with moderately long lateral arms; median process long, slightly tapered, appearing serrate apically.

*Notes*.—*Culicoides furens* closely resembles *C. stellifer*, but has fewer hind tibial spines and different wing markings (an additional pale spot in the center of cell  $R_5$  in *C. furens*).

The shape of the ventral root and the swollen ventral lobes on the parameres distinguish *C. furens* from other Virginia *Culicoides*. The parameres of *C. footei* and *C. haematopotus* have much longer subapical spines, and *furens* lacks the posteriorly directed processes on the lateral arms.

DISTRIBUTION IN VIRGINIA

*Tidewater species*.—Dismal Swamp and Virginia Beach; Accomack, Gloucester, Middlesex, and Northumberland Counties.

BIOLOGY

*Breeding sites*.—Salt marshes, drainage ditches, edges of streams near the coast.

*Feeding habits*.—This is one of the most annoying coastal species in the eastern states, and there are numerous reports in the literature of it biting



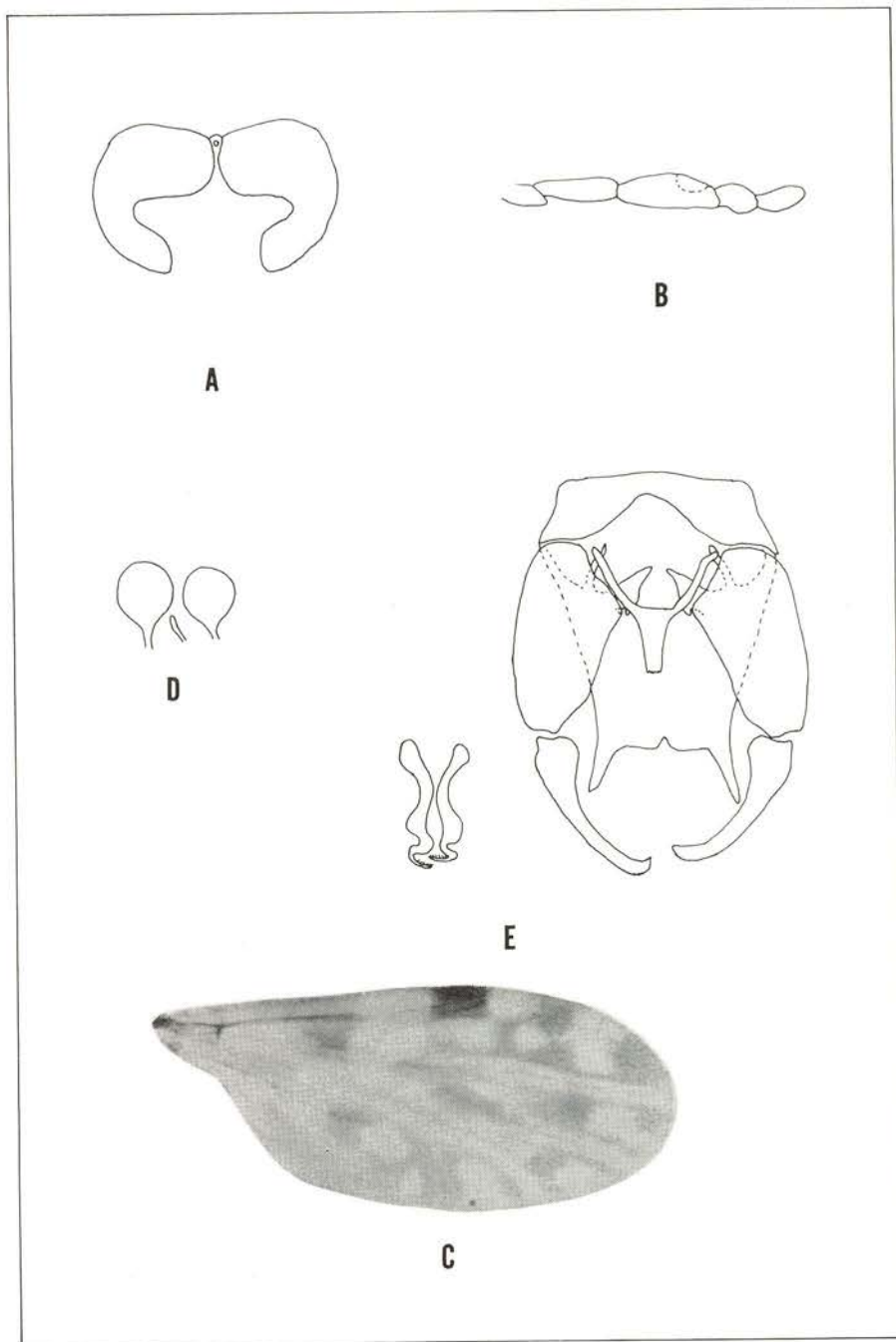


Plate 12. - *C. furens* (Poey)

man. Hair and Turner (1968) collected 26 from birds, 70 from man, and 52 from other mammals. This species is apparently a general feeder with a slight preference for mammals, particularly man.

*Seasonal distribution.*—Jamnback (1965) found the largest numbers present in New York during July. This species occurs in enormous numbers in Florida swamps throughout most of the year, but is important only during the summer months in the north (Hall, 1932). No information is available on seasonable fluctuations in Virginia.

*Culicoides guttipennis* (COQUILLET)

(Plate 13)

*Culicoides guttipennis* (Coquillett), 1901: 603; Foote and Pratt, 1954: 22-23, figs. 29, 55, 80, 108 (male, female); Jamnback, 1965: 67-70, figs. 9, 41, 80, 117, 154 (male, female); Wirth and Blanton, 1967: 220-223, figs. 43-48, 50-51 (male, female).

DESCRIPTION

*Female.*—Eyes (fig. A) narrowly separated. Proboscis long, P/H ratio 0.98 (0.86 — 1.06  $n = 20$ ). Mandible with 20 (17 — 22,  $n = 21$ ) teeth. Flagellomere length ratios 24:19:21:20:22:22:22:22:48:47:51:54:67, AR = 1.55 (1.49 — 1.63); sensillar pattern 3, 5, 7, 9, 11-15. Third segment of maxillary palp (fig. B) slightly to moderately swollen, L/W ratio 2.77 (2.45 — 3.33,  $n = 20$ ); sensory pit deep with large opening.

Wing length 1.39 (1.20 — 1.51,  $n = 22$ ) mm with markings distinct as shown in figure 13C. Legs with distinct pale bands; five hind tibial spines with 1 and 2 subequal and longest.

Spermathecae (fig. D) with maximum widths 47 (45 — 51,  $n = 15$ ) and 51 (47 — 54,  $n = 15$ ) microns, respectively; necks long, parallel-sided; sclerotized ring massive.

*Male Terminalia* (fig. E).—Ninth tergum with stout, prominent apico-lateral processes; median notch very indistinct; ninth sternum with broad, deep caudomedian excavation. Basistyle with roots strongly tapered; dististyle hooked at midlength.

Paramere with prominent basal lobe, slightly tapered from swelling near base to slender, blunt, bare tip; paramere curved at tip in semicircle so that tips are directed mesally. Aedeagus with lateral arms slightly tapered to distinct flange at base; median process long, slightly swollen mesally, ending in somewhat truncate tip with cap-like apical process.

*Notes.*—This species can be separated from other members of the *Guttipennis* group in Virginia by the wing pattern (apex of vein  $Cu_1$  dark, pale spot over r-m crossvein massive) and number of mandibular teeth. Males may be distinguished from others in this group by the tip of the aedeagus, bent dististyles, and massive size. Also see notes on *C. nanus*.

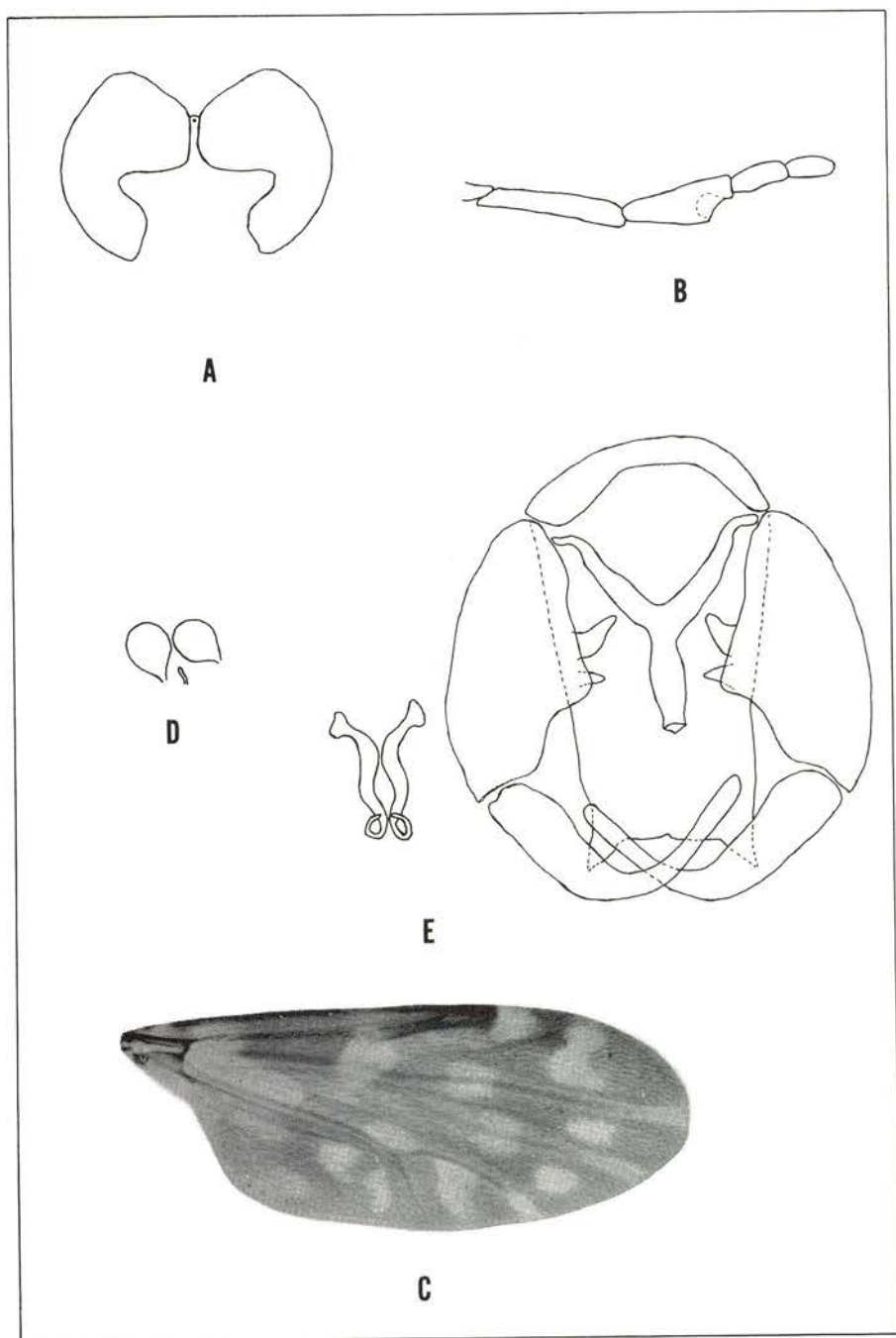


Plate 13. - *C. guttipennis* (Coquillett)

## DISTRIBUTION IN VIRGINIA

Augusta, Bedford, Botetourt, Craig, Fairfax, Fauquier, Franklin, Giles, Greensville, Loudoun, Montgomery, Page, Rockbridge, Rockingham, Shenandoah, and Wythe Counties, and the city of Alexandria.

## BIOLOGY

*Breedings sites.*—Tree and stump holes (Hair *et al.*, 1966 reared one specimen from wet leaves on the edge of a wildlife watering pond in Craig County, Virginia).

*Feeding habits.*—This species has often been reported biting man. Studies by Hair and Turner (1968) and Humphreys (1969) indicate a preference for mammals, although Humphreys also collected engorged females from avian hosts.

*Seasonal distribution.*—Messersmith (1966) collected adults in Virginia from late April to mid-September, and recorded a peak in August. Murray (1957) recorded a population peak from late June to mid-July at Mt. Solon in Augusta County.

## *Culicoides haematopodus* MALLOCH

(Plate 14)

*Culicoides haematopodus* Malloch, 1915a: 302-303; Foote and Pratt, 1954: 23-24, figs. 26, 53, 70, 103 (male, female); Jamnback, 1965: 70-73, figs. 10, 42, 81, 118, 155 (male, female); Atchley, 1967: 987-989, figs. 60-65 (male, female).

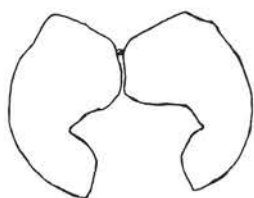
## DESCRIPTION

*Female.*—Eyes (fig. A) narrowly to moderately separated. Proboscis intermediate to long, P/H ratio 0.76 (0.67 — 0.86,  $n = 51$ ). Mandible with 13 (11 — 15,  $n = 49$ ) teeth. Flagellomere length ratios 19:11:11:11:11:11:12:13:29:30:32:34:43, AR = 1.71 (1.62 — 1.89); sensillar pattern variable, specimens seen with 3-15; 3, 5-15; 3, 5, 7-15; and 3, 5, 7, 9-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.13 (2.00 — 2.38,  $n = 44$ ); sensory pit shallow with large opening.

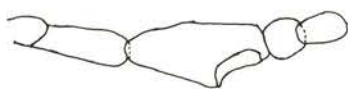
Wing length 0.99 (0.86 — 1.16,  $n = 57$ ) mm with pale spots as shown in figure C; pale spot over r-m crossvein not extending basad of vein. Legs with distinct pale bands on either side of dark knees; hind tibia usually with distal pale band, the middle third dark; 4 hind tibial spines with the first longest.

Spermathecae (fig. D) with maximum widths 33.1 (31 — 39,  $n = 30$ ) and 38.3 (35 — 45,  $n = 30$ ) microns, respectively; neck long, parallel-sided; sclerotized ring massive.

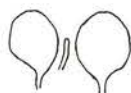
*Male Terminalia* (fig. E).—Ninth tergum with moderately slender, short apicolateral processes; median notch often absent; ninth sternum with broad, shallow caudomedian excavation. Basistyle with boat-hook shaped ventral root; dorsal root long, stout.



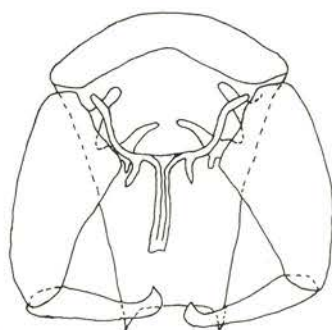
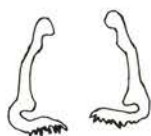
A



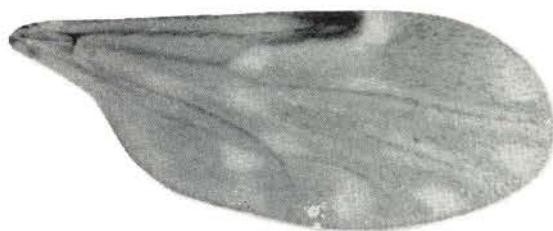
B



D



E



C

Plate 14. - *C. haematopodus* Malloch

Paramere with slight basal swelling; prominent lobed swelling on outer surface just below broad tip which ends in row of well-developed spines. Aedeagus with lateral arms strongly curved with indistinct flange at base; posteriorly projecting processes present just lateral to base of long, parallel-sided median process which ends in more or less truncate tip.

*Notes.*—*Culicoides haematopodus* can be separated from *C. baueri* by the presence of a pale spot at the wing margin in cell  $R_5$  and by the sensillar pattern. *Culicoides haematopodus* is one of three Virginia species in this genus with posteriorly projecting processes located on the aedeagal arms just laterad to the base of the median process. It differs from *C. baueri* in having a prominent lobed swelling just below the tip of the paramere. It is distinguished from *C. footei* by the shape of the caudomedian excavation on the ninth sternum: broad, shallow in the former and deep, narrow, and V-shaped in the latter

#### DISTRIBUTION IN VIRGINIA

Accomack, Albemarle, Amherst, Augusta, Bedford, Bland, Botetourt, Buchanan, Buckingham, Campbell, Craig, Cumberland, Dickenson, Fairfax, Franklin, Giles, Gloucester, Halifax, Henry, King George, Lee, Lunenburg, Mecklenburg, Montgomery, Nelson, Northumberland, Nottoway, Pittsylvania, Prince Edward, Pulaski, Rockbridge, Scott, Spotsylvania, Stafford, Tazewell, Wise, and York counties; the cities of Alexandria and Chesapeake.

#### BIOLOGY

*Breeding sites.*—Mud and organic matter adjacent to streams, ponds, etc. This species is more frequently found in conditions of little or no pollution, whereas *C. crepuscularis* is seldom found breeding in the absence of at least a small amount of animal excrement.

*Feeding habits.*—Ornithophilic (Jamnback, 1965). Hair and Turner (1968) collected 89 from birds, 39 from man, and 51 from other mammals in Virginia.

*Seasonal distribution.*—Population peaks have been noted in late May or June in New York (Jamnback, 1965) and in June in Virginia (Messersmith, 1966).

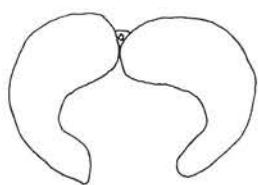
#### *Culicoides hinmani* KHALAF

(Plate 15)

*Culicoides hinmani* Khalaf, 1952: 353-354, figs. 4a-d (male, female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) barely contiguous. Proboscis intermediate to long, P/H ratio 0.74 (0.70 — 0.79,  $n = 9$ ). Mandible with 13 (11 — 13,  $n = 7$ ) teeth. Flagellomere length ratios 17:11:12:12:12:12:12:12:21:22:23:26:38, AR = 1.32 (1.22 = 1.41); sensillar pattern 3, 11-15. Third segment of



A



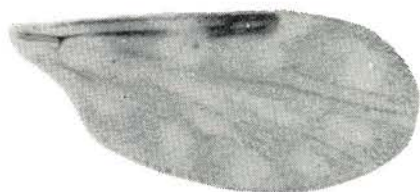
B



D



E



C

Plate 15. - *C. hinmani* Khalaf  
(50)

maxillary palp (fig. B) greatly swollen, LW ratio 2.23 (2.00 — 2.35,  $n = 8$ ).

Wing (fig. 15C) length 0.74 (0.70 — 0.76),  $n = 7$ ) mm. Legs with distinct pale bands; four hind tibial spines with the first longest.

Spermathecae (fig. D) with maximum widths 26.5 (25 — 27,  $n = 4$ ) and 28.5 (27 — 29,  $n = 4$ ) microns, respectively; neck blunt, slightly tapering.

*Male Terminalia* (fig. E).—Ninth tergum with long, slender apicolateral processes; ninth sternum with broad, shallow caudomedian excavation. Basistyle with long, slender ventral root; dorsal root long, blunt.

Paramere with rounded basal knob, swollen mesally and tapering little to relatively blunt, bare tip. Aedeagus with short, slightly curved lateral arms, basal arch low; median process strongly tapered, tip truncate and slightly serrate apically.

*Notes.*—Only two other very small species (*C. debilipalpis* and *C. paraensis*) have distinct (several pale spots) wing markings. *Culicoides hinmani* has only two distinct pale spots in cell  $M_1$ , whereas the above species have three or four such spots in cell  $M_1$ . In addition, *C. hinmani* has a sensillar pattern of 3, 11-15 as opposed to 3, 8-10 in the *C. debilipalpis* group.

#### DISTRIBUTION IN VIRGINIA

Craig, Fairfax, Franklin, Giles, Montgomery, and Rockbridge Counties and the city of Alexandria.

#### BIOLOGY

*Breeding sites.*—Moist or dry tree holes (Snow *et al.*, 1957; Hair *et al.*, 1966).

*Feeding habits.*—There are several reports in the literature of this species feeding on man. Hair and Turner (1968) collected 27 from man, 26 from other mammals, and none from birds.

*Seasonal distribution.*—Khalaf (1966a) collected small numbers of adults from late April through November in Louisiana. Messersmith (1966) reported a peak in August in Virginia. This species is seldom encountered in great numbers in any region.

#### *Culicoides hollensis* (MELANDER AND BRUES)

(Plate 16)

*Culicoides hollensis* (Melander and Brues), 1903: 13; Wirth, 1963: 68; Jamnback, 1965: 73-75, figs. 11, 43, 82, 119, 156 (male, female). *Culicoides canithorax* Hoffman, 1925: 284-285; Foote and Pratt, 1954: 17-18, figs. 13, 35, 66, 79, 97, 99 (male, female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) broadly separated. Proboscis long, P/H ratio 1.00 (0.93 — 1.07,  $n = 7$ ). Mandible with 14 (12 — 16,  $n = 7$ ) teeth. Flagellomere length ratios 26:17:18:18:19:18:19:18:30:31:37:40:51, AR =



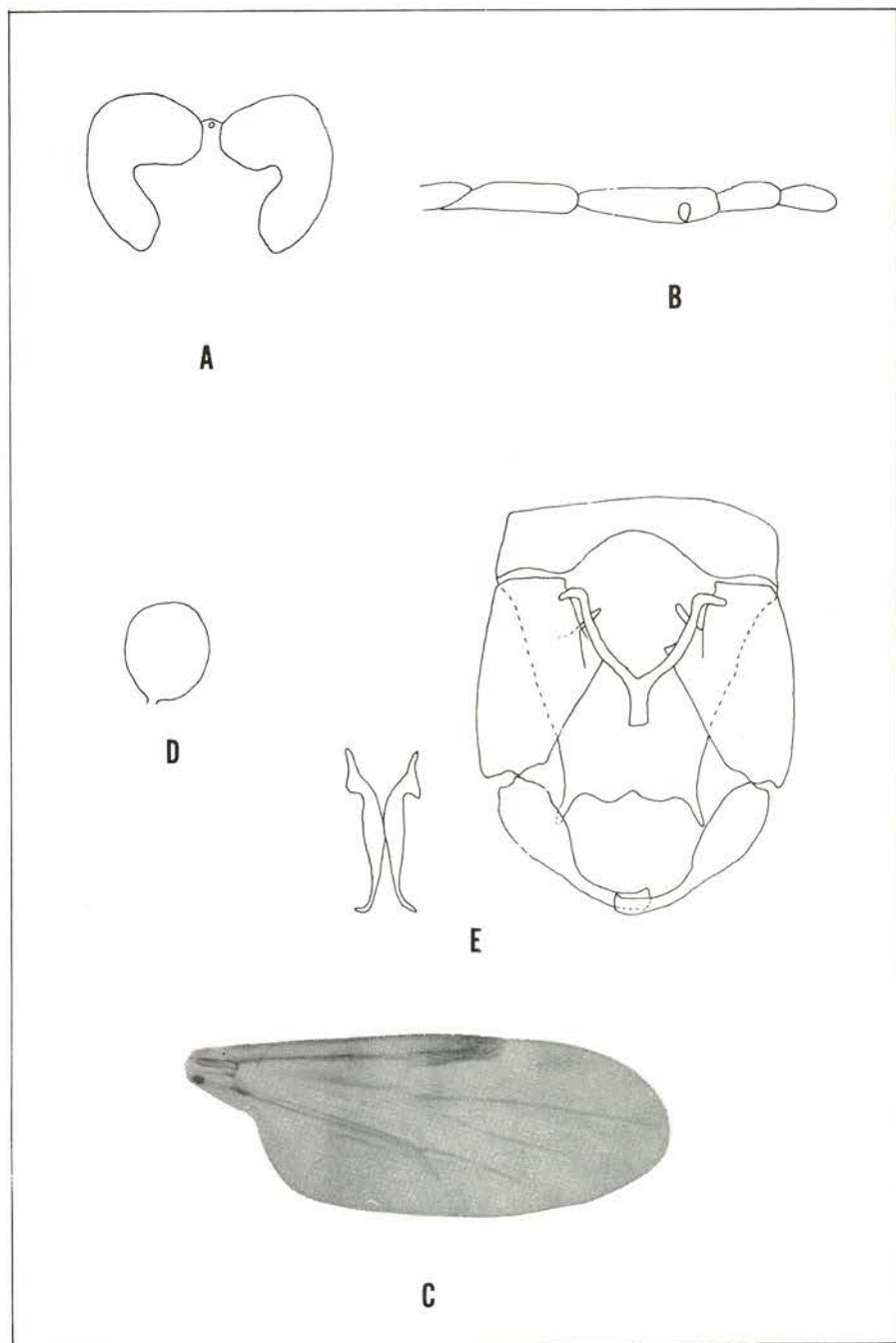


Plate 16. - *C. hollensis* (Melander & Brues)  
(52)

1.24 (1.17 — 1.33); sensillar pattern variable, specimens seen with 3, 11-15; 3, 11, 13-15; and 3, 13-15. Third segment of maxillary palp (fig. B) slightly swollen, L/W ratio 3.35 (3.00 — 3.72,  $n = 7$ ); sensory pit shallow with small opening.

Wing length 1.45 (1.34 — 1.54,  $n = 7$ ) mm with markings as shown in figure 16C. Thorax dark yellowish-brown. Legs without distinct pale bands; hind tibia with four spines, 1 and 2 subequal and longest.

One large spermatheca (fig. D) present, maximum width 88 (84 — 90) microns; neck absent or very short and parallel-sided.

*Male Terminalia* (fig. E).—Ninth tergum with long, tapering apicolateral processes; median notch V-shaped. Ninth sternum with broad, shallow caudo-median excavation. Basistyle with undeveloped ventral root; dorsal root long, blunt.

Paramere with prominent basal lobe composed of posteriorly projecting knob and long anterior process, slightly swollen in basal half, and tapering gradually to fine, bare tip. Aedeagal arms long, arcuate with very prominent flange at base; median posterior process tapering little to blunt tip.

*Notes.*—*Culicoides crepuscularis*, *C. hollensis*, and *C. variipennis* are the only Virginia *Culicoides* with only one fully developed spermatheca. *Culicoides hollensis* is easily separated from the other two species by the sensillar pattern, wing markings, spermathecal shape (usually C-shaped in *C. variipennis*), antennal ratio, etc., *hollensis* has distinctly fewer pale spots on the wing than the aforementioned species, and is much larger than other coastal species (i.e., *C. furens* and *C. melleus*). Males closely resemble *C. crepuscularis*, but the aedeagus ends in a blunter tip in *C. hollensis*. There are numerous pale spots centering in cells in the wing of *C. crepuscularis* males, whereas *C. hollensis* males have faintly marked wings.

#### DISTRIBUTION IN VIRGINIA

*Coastal species.*—Gloucester and Middlesex counties, Virginia Beach.

#### BIOLOGY

*Breeding sites.*—Salt marshes, drainage ditches, etc. near coast.

*Feeding habits.*—A very noxious pest of man in coastal regions of much of the eastern U. S.; no records are available of *C. hollensis* feeding on other hosts (Jamnback, 1965; Hair and Turner, 1968).

*Seasonal distribution.*—Jamnback (1965) found adults most abundant in early and late summer with relatively few present from late June through early August (New York). No data available on seasonal population fluctuations in Virginia.

*Culicoides loisae* JAMNBACH

(Plate 17)

*Culicoides loisae* Jamnback, 1965: 77-79, figs. 12, 45, 84, 121, 158, 180 (male, female).

DESCRIPTION

*Female*.—Eyes (fig. A) contiguous or narrowly separated. Proboscis short, P/H ratio 0.48 (0.45 — 0.50,  $n = 3$ ). Mandibular teeth absent. Flagellomere length ratios 17:13:13:13:14:14:14:15:21:22:25:26:36, AR = 1.25 (1.12 — 1.22); sensillar pattern 3, 11-5. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 1.92 (1.67 — 2.10,  $n = 3$ ); sensory pit shallow with small, round opening.

Wing length 0.87 (0.78 — 0.98,  $n = 4$ ) with pale spots very indistinct as shown in figure C. Legs without distinct pale bands; four hind tibial spines with the first or second longest.

Spermathecae (fig. D) with maximum widths 35 and 37 ( $n = 1$ ) microns, respectively; neck long, slightly tapering; sclerotized ring on spermathecal duct absent.

*Male Terminalia* (fig. E).—Ninth tergum with short, slender apicolateral processes; median notch very shallow, sometimes indistinct; ninth sternum with broad, deep caudomedian excavation. Basistyle with short pointed ventral root; dorsal root longer and blunter.

Paramere with well-developed basal lobe with anterior and posterior extensions, slightly swollen subbasally and gradually tapering to blunt tip with several small spines. Aedeagal arms long, arcuate with slight flange at base; median posterior process tapering rapidly to rounded tip.

*Notes*.—This is the only Virginia species without mandibular teeth. There are four species in the state with two fully developed spermathecae and no sclerotized ring: *C. loisae*, *C. melleus*, *C. mulrennani*, and *C. spinosus*. For male see notes on *C. spinosus*.

DISTRIBUTION IN VIRGINIA

Fairfax, Giles, Halifax, and Montgomery Counties.

BIOLOGY

*Breeding sites*.—Stream margins and sand bars with substrates varying from clay to sandy mud (Jamnback, 1965).

*Feeding habits*.—This species is non-haematophagous, with a very short proboscis and no mandibular teeth.

*Seasonal distribution*.—Most of the adults collected in New York by Jamnback (1965) were captured in May and June. He noted a few as late as September.

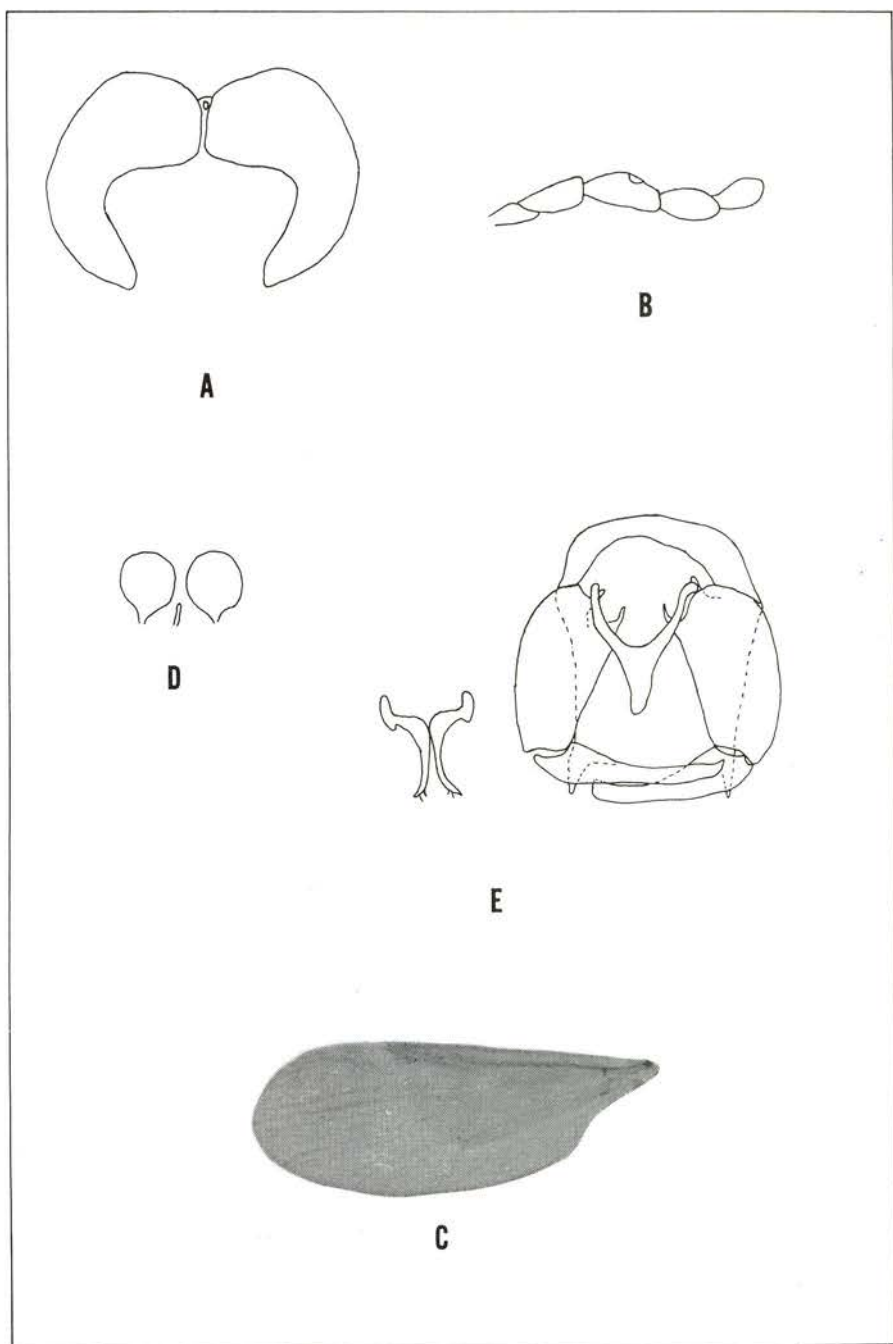


Plate 17. - *C. loisae* Jamnback  
(55)

*Culicoides melleus* (COQUILLET)

(Plate 18)

*Culicoides melleus* (Coquillett), 1901: 604; Foote and Pratt, 1954: 27, figs. 2, 33, 88, 113 (male, female); Jamnback, 1965: 79-82, figs. 13, 46, 85, 122, 159 (male, female).

DESCRIPTION

*Female*.—Eyes (fig. A) narrowly to moderately separated. Proboscis variable, usually intermediate in length; P/H ratio 0.67 (0.59 — 0.79,  $n = 20$ ). Mandible with 11 (9 — 12,  $n = 20$ ) teeth. Flagellomere length ratios 20:12:12:12:13:13:13:13:19:20:21:23:33, AR = 1.07 (1.01 — 1.11); sensillar pattern 3, 10-14, distal sensory tuft absent from flagellomere 10 in one specimen. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.29 (2.00 — 2.54,  $n = 20$ ); numerous small pits cover surface of third segment, no single well-developed sensory pit present.

Wing length 0.97 (0.84 — 1.10,  $n = 20$ ); wing completely pale (fig. C). Thorax colored a distinctive pale yellow. Legs without distinct pale bands; hind tibia with four spines, the second longest or subequal to the first.

Spermathecae (fig. D) with maximum widths 49 (41 — 53,  $n = 20$ ) and 51 (45 — 59,  $n = 20$ ) microns, respectively; neck short, slightly tapered; sclerotized ring absent. One specimen from Bluffton, South Carolina with one fully developed and two rudimentary spermathecae.

*Male Terminalia* (fig. E).—Ninth tergum with long, well-developed apicolateral processes; median notch shallow, V-shaped; ninth sternum with broad, shallow caudomedian excavation. Basistyle with long, slender ventral root; dorsal root stouter.

Paramere stout, with well-developed basal lobe and stout accessory process; paramere tapering suddenly to relatively blunt, bare tip. Aedeagus with long lateral arms, base without distinct flange; median posterior process very short, broad, and parallel-sided, terminating in slightly concave cap-like structure.

*Notes*.—This species has a number of distinctive characters which facilitate identification: a small number of mandibular teeth, an unusual sensillar pattern, the absence of a single well-developed sensory pit on the third palpal segment, the absence of any wing markings, the unique pale yellow thorax, and the absence of a sclerotized ring around the spermathecal duct. The genitalia of *C. melleus* are quite unique among Virginia *Culicoides*; the wide concave cap on the aedeagal tip is diagnostic for this species.

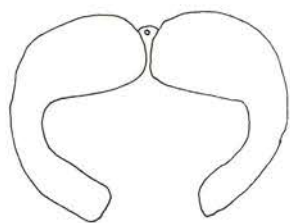
DISTRIBUTION IN VIRGINIA

*Coastal species*.—Virginia Beach; Middlesex County.

BIOLOGY

*Breeding sites*.—Intertidal sand.

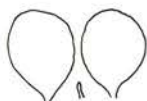
*Feeding habits*.—*Culicoides melleus* readily bites man, and is a serious pest along much of the east coast, particularly in the north (Jamnback, 1965). Hair and Turner (1968) collected 6 from birds, 200 from man, and 19 from



A



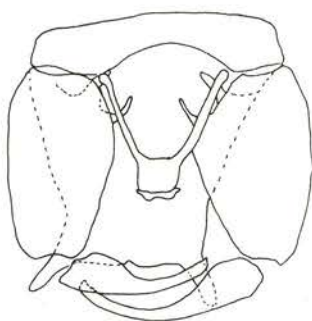
B



D



E



C

Plate 18. - *C. melleus* (Coquillett)  
(57)

other mammals. Hair and Turner concluded that man is the preferred host.

*Seasonal distribution.*—No data available from Virginia. Jamnback (1965) found that *C. melleus* reaches peak numbers in mid-summer in New York.

*Culicoides mulrennani* BECK

(Plate 19)

*Culicoides mulrennani* Beck, 1957: 103-104, figs. 1a-b (male).

DESCRIPTION

*Female.*—Eyes (fig. A) narrowly separated. Proboscis long, P/H ratio 0.76 (0.74 — 0.81,  $n = 4$ ). Mandible with 13 (11 — 14,  $n = 7$ ) teeth. Flagellomere length ratios 19:13:14:14:15:15:15:15:23:23:24:27:39, AR = 1.13 (1.09 — 1.28); sensillar pattern 3, 11-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.35 (2.00 — 2.55).

Wing (fig. C) length 1.01 (0.90 — 1.14,  $n = 6$ ) mm. Hind femur dark at apex; hind tibia with basal pale band and four apical spines, the second longest.

Spermathecae (fig. D) with maximum widths 39.7 (37 — 43,  $n = 3$ ) and 44.3 (41 — 49,  $n = 3$ ) microns, respectively; neck long, tapering; sclerotized ring absent.

*Male Terminalia* (fig. E, redrawn from Beck, 1957 by permission of the author).—Not seen; the males of *C. mulrennani* very closely resemble *C. loisae* and *C. spinosus* but Beck (1957, fig. 1b) shows the paramere of *C. mulrennani* ending in a bare tip. The parameres of *C. spinosus* and *C. loisae* end in a slender tip with several subapical to apical spines.

*Notes.*—This species closely resembles *C. spinosus*, but has pale spots only over the r-m crossvein and in the poststigmatic area, whereas *spinosus* has several faint pale areas in the middle of cell M, and the distal portions of M<sub>2</sub>, M<sub>4</sub>, and the anal cell (Wirth, W. W., 1969; personal communication). In addition, the thorax of *C. mulrennani* appears to be a lighter yellowish-brown than *C. spinosus*. They are both distinguished from *C. loisae* by the presence of mandibular teeth.

DISTRIBUTION IN VIRGINIA

Fairfax, Montgomery, and Rockbridge Counties.

*Notes.*—This species was previously known only from Florida until Gazeau and Messersmith (1970b) reported it from Maryland. An examination of the collection at the U.S. National Museum revealed the following unpublished records:

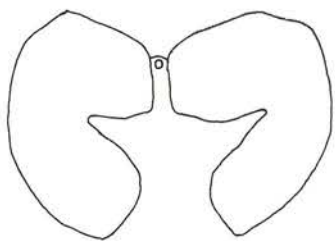
MARYLAND: Beltsville.

MASSACHUSETTS: Centerville.

MISSISSIPPI: Washington County.

NEW JERSEY: Jocky Hollow.

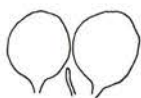
VIRGINIA: Blacksburg, Falls Church, Vesuvius.



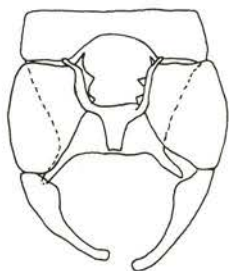
A



B



D



E



C

Plate 19. - *C. mulrennani* Beck



## BIOLOGY

*Breeding sites.*—Probably similar or identical to those of *spinosus*.

*Feeding habits.*—Wirth (1969, personal communication) indicates that *C. mulrennani* is a pest at Cranberry Glades, W. Va.

*Seasonal distribution.*—Not known.

### *Culicoides nanus* ROOT AND HOFFMAN

(Plate 20)

*Culicoides nanus* Root and Hoffman, 1937: 165; Foote and Pratt, 1954: 28, figs. 9, 43, 68, 124 (male, female); Jamnback, 1965: fig. 47 (female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) narrowly separated. Proboscis short, P/H ratio 0.51 (0.50 — 0.55,  $n = 4$ ). Mandible with 12 (11 — 13,  $n = 4$ ) teeth. Flagellomere length ratios 20:14:15:15:16:16:16:17:29:28:31:33:44, AR = 1.26 (1.17 — 1.32,  $n = 6$ ); sensillar pattern 3-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 1.67 (1.58 — 1.76); sensory pit deep with large opening.

Wing length 1.00 (0.92 — 1.10,  $n = 7$ ) mm, with markings as shown in figure C. Prothoracic and mesothoracic legs with pale bands on either side of dark knees, pale band absent from hind femora; hind tibia with four spines, the first longest.

Spermathecae (fig. D) with maximum widths 35.7 (35 — 37,  $n = 3$ ) and 43.7 (42 — 46,  $n = 3$ ) microns, respectively; neck short, parallel-sided. One specimen from Broad Run Game Reserve (Craig Co.) with three fully developed spermathecae, maximum widths 33, 35, and 41 microns, respectively.

*Male Terminalia* (fig. E).—Ninth tergum with long, relatively slender apicolateral processes; median notch shallow, V-shaped; ninth sternum with shallow caudomedian excavation. Basistyle with ventral root long, strongly tapering to rather blunt point; dorsal root somewhat shorter and blunter.

Paramere with rounded basal knob, slightly swollen mesally, and tapering to long, fine, sharply curved tip without spines. Aedeagal arms slightly curved with indistinct flange at base; median process fairly short, strongly tapering to rounded, almost blunt tip.

*Notes.*—This is the only Virginia species with a sensillar pattern of 3-15 and a P/H ratio less than 0.55. The wing resembles that of *C. travisi* in having several pale spots around the margin and none in the center, but the legs are more distinctly banded in *C. nanus* and the proboscis is much shorter. The male *C. nanus* differs from *C. guttipennis* in having the aedeagus more tapered and ending in a somewhat rounded tip. The massive aedeagus of *C. guttipennis* is somewhat swollen mesally and ends in a more or less truncate tip with a terminal cap-like structure.

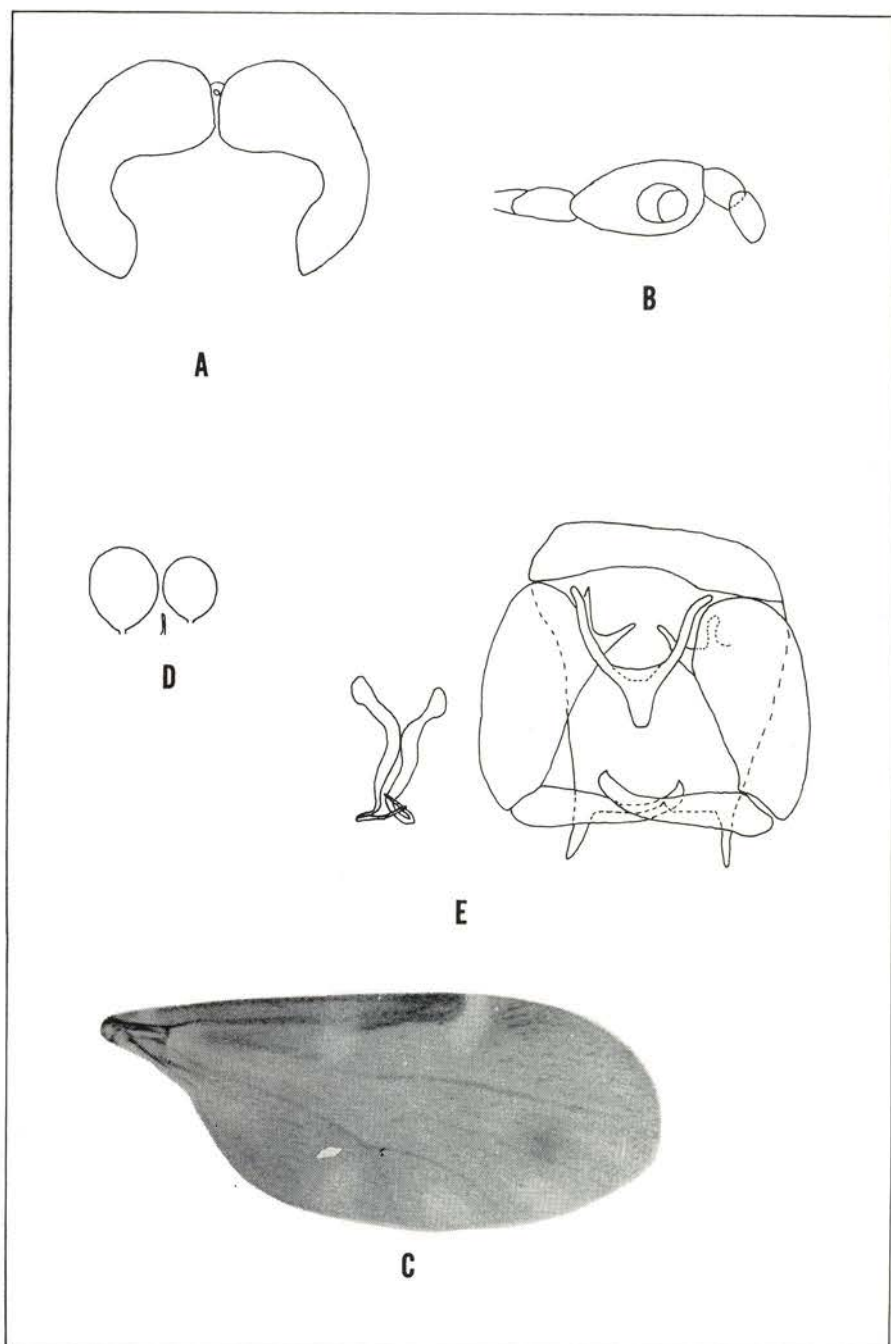


Plate 20. - *C. nanus* Root & Hoffman

## DISTRIBUTION IN VIRGINIA

Augusta, Craig, Fairfax, Franklin, Montgomery, Rockbridge, and Rockingham Counties, and the city of Alexandria.

## BIOLOGY

*Breeding sites.*—Tree holes (Hair *et al.*, 1966).

*Feeding habits.*—Not known; probably ornithophilic.

*Seasonal distribution.*—Messersmith (1966) collected adults from July 2 through September 1 in Virginia, and reported a population peak in July.

## *Culicoides niger* ROOT AND HOFFMAN

(Plate 21)

*Culicoides niger* Root and Hoffman, 1937: 168-169; Foote and Pratt, 1954: 28-29, figs. 22, 40, 90, 122 (male, female); Jamnback, 1965: 82-84, figs. 14, 48, 86, 123, 160 (male, female).

## DESCRIPTION

*Female.*—Eyes (fig. A) narrowly to moderately separated. Proboscis long, P/H ratio 0.84 (0.78 — 0.92). Mandible with 17.7 (16 — 17) teeth. Flagellomere length ratios 19:12:13:14:14:14:14:15:22:24:26:26:34, AR = 1.15 (0.99 — 1.23); sensillar pattern 3-15 in specimens from Massachusetts, New Jersey, and Bay Shore, Maryland; a series of five females from Patuxent Wildlife Refuge, Maryland contained four with sensillar patterns 3, 7-15 and one with a pattern of 3, 5-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.03 (1.65 — 2.39); sensory pit shallow with very large opening.

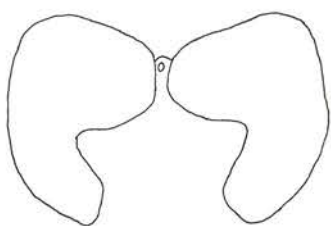
Wing (fig. C) length 1.06 (0.90 — 1.20,  $n = 8$ ) mm, with unique pale band extending transversely across wing from just beyond the second radial cell. Thorax a very dark brown. Femora with very indistinct subbasal pale band; four hind tibial spines, with the second longest.

The spermathecae were crumpled in the specimens examined; hence, no measurements nor illustrations were made.

*Male Terminalia* (fig. D).—Ninth tergum with long, slender apicolateral processes; median notch shallow, V-shaped; ninth sternum with broad, deep caudomedian excavation. Basistyle with ventral root long, slender, dorsal root parallel-sided, tip fairly blunt.

Paramere with basal anterior extension, greatly swollen at midlength, tapering gradually to fine, bare, outwardly curved tip. Aedeagal arms long, arcuate, without distinct flange at base; median posterior process tapering slightly to rounded tip.

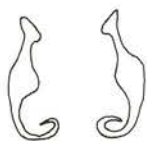
*Notes.*—This species is distinguished by the unique pale band on the wing, the deep sensory pit on the palp, and the very dark coloration of the thorax. Males closely resemble *C. flukei*, but the ventral root is longer and the aedeagus has a blunter tip in *C. niger*.



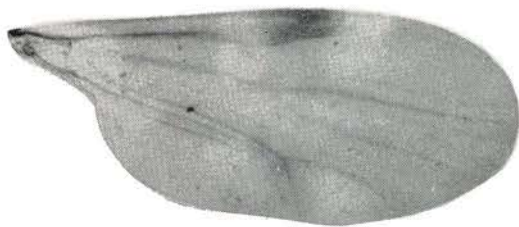
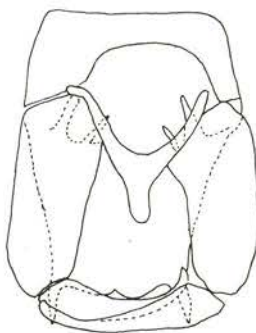
A



B



D



C

Plate 21. - *C. niger* Root & Hoffman

## DISTRIBUTION IN VIRGINIA

Fairfax County.

## BIOLOGY

*Breeding sites.*—The type material was reared from pupae collected in a cattail marsh containing fresh and brackish water (Jamnback, 1965).

*Feeding habits.*—Unknown.

*Seasonal distribution.*—Only inadequate data available.

### *Culicoides obsoletus* (MEIGEN)

(Plate 22)

*Culicoides obsoletus* (Meigen), 1818: 76; Jamnback and Wirth, 1963: 188-189, figs. 2, 7, 9, 15, 19, 23, 27 (male, female); Jamnback, 1965: 84-86, figs. 15, 49, 124, 161 (male, female).

## DESCRIPTION

*Female.*—Eyes (fig. A) contiguous; dorsal angle of eye separation acute, not obtuse as in *C. chiopterus*; superior transverse suture absent. Proboscis long, P/H ratio 0.82 (0.76 — 0.96,  $n = 7$ ). Mandible with 14.1 (12 — 15,  $n = 7$ ). Flagellomere length ratios 20:13:13:14:14:14:15:16:23:23:25:26:43, AR = 1.16 (1.10 — 1.25); sensillar pattern 3, 11-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.33 (2.27 — 2.50,  $n = 7$ ); sensory pit shallow with small opening;  $P_3/P_5$  ratio 1.8 (1.7 — 1.9,  $n = 6$ ).

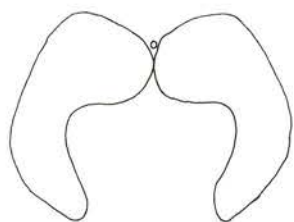
Wing (fig. C) length 1.03 (0.94 — 1.14,  $n = 7$ ) mm, with markings usually more distinct than in *C. chiopterus* and *C. sanguisuga*; vein  $M_{3+4}$  with 10.4 (7 — 14,  $n = 7$ ) macrotrichia. Legs without distinct pale bands; hind tibia with five spines, the first longest.

Spermathecae (fig. D) with maximum widths 32.3 (31 — 35,  $n = 6$ ) and 34.5 (31 — 39,  $n = 6$ ) microns, respectively; neck short, slightly tapering; rudimentary spermatheca long, tubular.

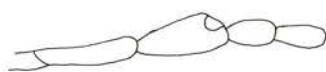
*Male Terminalia* (fig. E).—Ninth tergum without apicolateral processes; median notch absent; ninth sternum with fairly deep, extremely narrow caudo-median excavation that is narrowed posteriorly. Basistyle with ventral roots very long, tapering slightly to fine tip and almost touching mesally; dorsal roots shorter, stout, and rapidly tapering to blunt tip.

Paramere with large, lateral foot-shaped extension at base, tapering to fine point with microscopic hairs. Aedeagal arms long, arcuate with flange at base; aedeagal arch higher than in *C. sanguisuga*; median process rounded apically.

*Notes.*—This species is easily distinguished from *C. chiopterus* by the fairly distinct wing markings and overall size. It differs from *C. sanguisuga* in having the third segment of the maxillary palp greatly swollen, the thorax a dark brown, and wing vein  $M_{3+4}$  with seven or more macrotrichia. The male *Culicoides obsoletus* has the caudomedian excavation narrowed posteriorly



A



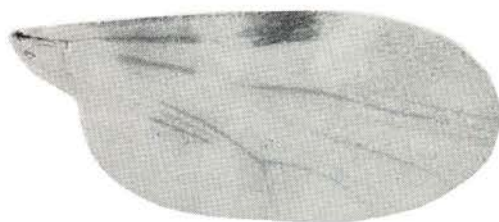
B



D



E



C

Plate 22. - *C. obsoletus* (Meigen)

and the paramere with fine hairs at the tip. The caudomedian excavation is narrowed anteriorly in *C. sanguisuga* and the paramere is bare at the tip. *Culicoides chiopterus* is easily distinguished from both of these species by the presence of apicolateral processes on the ninth tergum.

#### DISTRIBUTION IN VIRGINIA

Many early records of *C. obsoletus* are actually misidentifications of *C. sanguisuga*, hence only post-1963 (the date of Jamnback and Wirth's revision of the *Obsoletus* group) records are given here: Augusta, Bedford, Craig, Fairfax, Franklin, Montgomery, Roanoke, Rockbridge, Rockingham, and Wythe Counties.

#### BIOLOGY

*Breeding sites.*—Moist straw, needles, twigs etc. that are mixed with animal excrement.

*Feeding habits.*—This species has been recorded feeding on horses, cattle, and man (Jamnback, 1965).

*Seasonal distribution.*—Messersmith (1966) noted a peak population in August in Virginia.

#### *Culicoides ousairani* KHALAF

(Plate 23)

*Culicoides ousairani* Khalaf, 1952: 354-355, figs. 5a-d (male, female); Wirth and Blanton, 1967: 225-228, figs. 60-67 (male, female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) moderately to broadly separated. Proboscis long, P/H ratio 0.97 (0.87 — 1.03,  $n = 28$ ). Mandible with 15 (13 — 16,  $n = 25$ ) teeth. Flagellomere length ratios 26:20:21:21:22:22:22:23:34:34:39:40:53, AR = 1.13 (1.10 — 1.20); sensillar pattern 3-15, with distal sensory tufts often (50%) absent from segment 10, giving a pattern of 3-9, 11-15. Third segment of maxillary palp (fig. B) usually moderately swollen, L/W ratio 2.60 (2.36 — 2.80,  $n = 29$ ); sensory pit very deep with small opening.

Wing length 1.12 (0.98 — 1.26,  $n = 29$ ) mm with markings shown in figure C. Thorax a very dark brown; halter pale. Knees dark; prothoracic and mesothoracic legs with apical pale bands on the femora and subbasal pale bands on the tibiae; hind tibia with both apical and subbasal pale bands and with five apical spines, the first two longest.

Spermathecae (fig. D) with maximum widths 32.5 (29 — 35,  $n = 25$ ) and 40.2 (35 — 45,  $n = 25$ ) microns, respectively; neck short, slightly tapering.

*Male Terminalia* (fig. E). Ninth tergum with long, slender apicolateral processes which would touch if bent mesally; median notch shallow, V-shaped; ninth sternum with broad, shallow caudomedian excavation. Basistyle with long, strongly tapered ventral root; dorsal root long, parallel-sided, and blunt at tip.

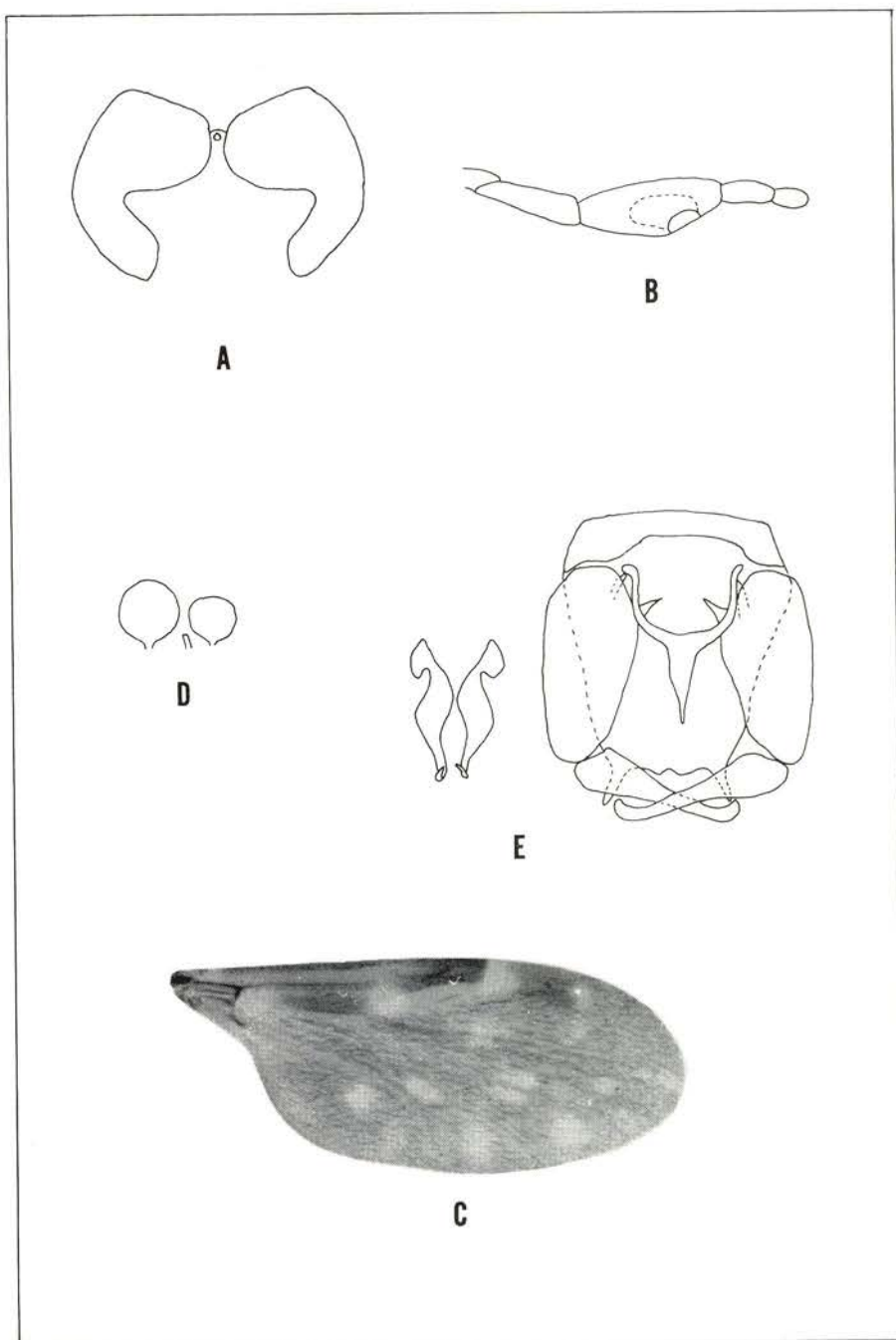


Plate 23. - *C. ousairani* Khalaf  
(67)



Paramere with prominent basal knob projecting both anteriorly and posteriorly; paramere swollen mesally and tapering gradually to fine, bare tip. Aedeagal arms long, arcuate with distinct flange at base; median posterior process long, tapering, with apical one-fourth parallel-sided and tip finely rounded.

*Notes.*—The wing pattern of *C. ousairani* is very similar to that of *C. beckae* and *C. villosipennis*. This species can be separated from *C. beckae* by the pale halteres and from *C. villosipennis* by the antennal ratio and sensillar pattern. Male *Culicoides ousairani* and *C. flukei* differ from other members of the Virginia Guttipennis group in having parameres with prominent mesal swellings; however, these two species are easily separated on the basis of the aedeagal apex (much finer in *C. ousairani*) and the ventral root, which is much longer in *C. ousairani*.

#### DISTRIBUTION IN VIRGINIA

Fairfax, Franklin, and Rockingham Counties.

#### BIOLOGY

*Breeding sites.*—Tree holes (Wirth and Blanton, 1967).

*Feeding habits.*—Messersmith (1965a) collected seven engorged females in Virginia poultry houses. This species is probably ornithophilic.

*Seasonal distribution.*—Messersmith (1966) recorded adults from July 2 through August 20, with a peak in July.

#### *Culicoides paraensis* (GOELDI)

(Plate 24)

*Culicoides paraensis* (Goeldi), 1905: 137; Wirth and Blanton, 1959: 440-442, figs. 78a-g (male, female).

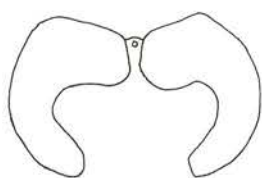
#### DESCRIPTION

*Female.*—Eyes (fig. A) narrowly to moderately separated. Proboscis long, P/H ratio 0.92 (0.84 — 1.06,  $n = 18$ ). Mandible with 16 (15 — 18,  $n = 20$ ) teeth. Flagellomere length ratios 17:14:16:19:18:18:18:19:17:17:19:18:29, AR = 0.72 (0.62 — 0.81,  $n = 6$ ); sensillar pattern 3, 8-10. Third segment of maxillary palp (fig. B) moderately to greatly swollen, L/W ratio 2.46 (2.30 — 2.70,  $n = 16$ ); sensory pit fairly deep with small, circular opening.

Wing length 0.77 (0.68 — 0.88,  $n = 22$ ) with markings shown in figure 24C. Legs with distinct pale bands; knees dark; four hind tibial spines with one and two longest.

Spermathecae (fig. D) with maximum widths 28.2 (25 — 33,  $n = 14$ ) and 32.0 (27 — 39,  $n = 14$ ) microns, respectively; neck very long and parallel-sided.

*Male Terminalia* (fig. E).—*Culicoides paraensis* males could be distinguished from *C. debilipalpis* only on the basis of wing markings in material examined in the present study (see *C. debilipalpis*).



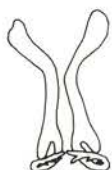
A



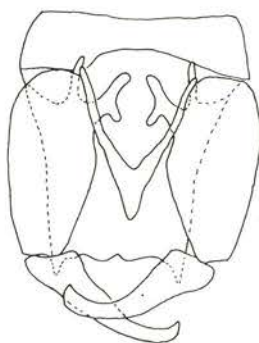
B



D



E



C

Plate 24. - *C. paraensis* (Goeldi)

*Notes.*—See notes on *C. debilipalpis*.

#### DISTRIBUTION IN VIRGINIA

Bedford, Craig, Fairfax, Franklin, Giles, Montgomery, and Rockbridge Counties.

#### BIOLOGY

*Breeding sites.*—Tree holes (Snow *et al.*, 1957; Breeland, 1960).

*Feeding habits.*—This species will feed on man (Snow, 1955; Hair and Turner, 1968). Messersmith (1965a) reported 3 unengorged females from poultry houses, and Humphreys (1969) collected 5 gnats from rabbits and 13 from galliform birds.

*Seasonal distribution.*—Khalaf (1966a) found this species to be rare in light trap collections from southern Louisiana, but noted the presence of adults from late April to November. Messersmith (1966) found adults present in Virginia from July 15 to August 17, with a population peak in July.

#### *Culicoides piliferus* ROOT AND HOFFMAN

(Plate 25)

*Culicoides piliferus* Root and Hoffman, 1937: 163-164; Wirth and Hubert, 1962: 185-186, figs. 1a-g, 11 (male, female); Jamnback, 1965: 86-89, figs. 16, 50, 88, 125, 162, 181 (male, female).

#### DESCRIPTION

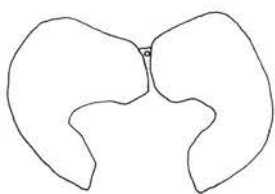
*Female.*—Eyes (fig. A) narrowly separated. Proboscis intermediate to long, PH ratio 0.71 (0.66 — 0.84,  $n = 31$ ). Mandible with 14 (12 — 16,  $n = 35$ ) teeth. Flagellomere length ratios 17:11:11:11:11:12:12:31:32:33:34:52, AR = 1.91 (1.68 — 2.11,  $n = 33$ ); sensillar pattern usually 3, 5, 7, 9-15; patterns of 3, 5-7, 9-15; 3, 5, 7-15; and 3-7, 9-15 rarely seen. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.11 (1.87 — 2.33,  $n = 34$ ); sensory pit shallow with large opening.

Wing (fig. C) length 1.06 (0.94 — 1.18,  $n = 35$ ) mm; markings typical of *C. piliferus* group. Knees dark; tibiae with subbasal pale bands; hind tibia with four spines, the second longest.

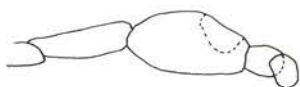
*Spermathecae* (fig. D) with maximum widths 34 (31 — 37,  $n = 17$ ) and 41 (39 — 47,  $n = 17$ ) microns, respectively; neck absent or very short and parallel-sided.

*Male Terminalia* (fig. E).—Ninth tergum with fairly long, slender apicolateral processes; median notch very shallow, V-shaped; ninth sternum with deep, narrow caudomedian excavation. Basistyle with boat-hook shaped ventral root; dorsal root long and slender.

Paramere tapering gradually from base to long, curved tip with approximately six spines. Aedeagal arms long, arcuate with slight flange at base; median process long, parallel-sided; tip appearing truncate.



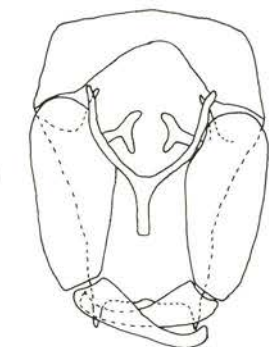
A



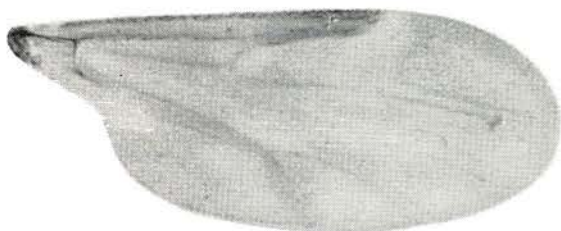
B



D



E



C

Plate 25. - *C. piliferus* Root & Hoffman

*Notes.*—*Culicoides piliferus* can be distinguished from other Virginia members of this group by the numerous pale spots on the wing (pale spots reduced in *C. snowi* and *C. testudinalis*), the presence of distal sensory tufts on 10 or more flagellomeres (sensory tufts found on only 4 flagellomeres in *C. bicklei*), and an antennal ratio of 1.7-2.1 ( $AR = 1.1-1.2$  in *C. pseudopiliferus* and 1.3-1.6 in *C. scanloni*). Males of this species are distinguished by the absence of posteriorly directed processes on the aedeagal arms (as present in subgenus *Diphaomyia*), the presence of a boat-hook shaped ventral root, and the absence of swellings or knobs on the paramere beyond the base (as present in *C. debilipalpis*, *C. furens*, *C. paraensis*, and *C. stellifer*).

Wirth and Hubert (1962) noted that males of the *Piliferus* group could not be distinguished from one another by morphological characters alone, hence the males of the other species in this group (*C. bicklei*, *C. pseudopiliferus*, *C. scanloni*, *C. snowi*, and *C. testudinalis*) will not be described nor illustrated in this paper.

#### DISTRIBUTION IN VIRGINIA

Prior to 1962 (the date of Wirth and Hubert's comprehensive review of this group) these species were all identified as "*Culicoides piliferus*," with the exception of *C. snowi* (described in 1956). For this reason, only post-1962 records of *C. piliferus* are given here: Augusta, Bedford, Botetourt, Craig, Fairfax, Franklin, Giles, Montgomery, Roanoke, Rockbridge, Rockingham, Stafford, and Wythe counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites.*—Soft mud or silt near streams, marshes, or bogs (Jamnback, 1965; Hair *et al.*, 1966).

*Feeding habits.*—Wirth and Hubert (1962) reported two females as collected while biting man at Cape Cod, Massachusetts. Humphreys (1969) recorded two taken from goats, one from a rabbit, and three from turkeys.

*Seasonal distribution.* Messersmith (1966) noted the greatest Virginia populations in July, with adults present from April through September.

#### *Culicoides pseudopiliferus* WIRTH AND HUBERT

(Plate 26)

*Culicoides pseudopiliferus* Wirth and Hubert, 1962: 189-190, figs. 5a-g (male, female); Jamnback, 1965: 89-91, figs. 51, 89, 126, 163 (female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) narrowly to broadly separated. Proboscis variable, usually intermediate in length, P/H ratio 0.71 (0.63 — 0.82). Mandible with 14 (12 — 17,  $n = 6$ ) teeth. Flagellomere length ratios 20:13:13:14:14:14:14:22:23:25:27:39,  $AR = 1.20$  (1.07 — 1.25,  $n = 4$ ); sensillar pattern usually 3, 5, 7, 9, 11, 13-15, less frequently (33%) 3, 5, 7, 9, 13-15. Third segment of maxillary palp (fig. B) moderately to greatly swollen, L/W ratio 2.36 (2.00 — 2.67,  $n = 6$ ).

Wing (fig. C) length 1.13 (1.04 — 1.20,  $n = 6$ ) mm, with markings closely resembling *C. piliferus*. Tibia with pale subbasal band; hind tibia with four spines, the second longest.

Spermathecae (fig. D) with maximum widths 39.0 (37 — 41,  $n = 3$ ) and 49.7 (47 — 53,  $n = 3$ ) microns, respectively; neck parallel-sided, ranging in length from very short to moderately long, usually very short.

*Male Terminalia*.—See *C. piliferus*.

*Notes*.—The degree of eye separation and length of spermathecal neck were found to be quite variable in this species. It closely resembles *C. piliferus* but can be distinguished by the antennal ratio and sensillar pattern (see notes for *C. piliferus*).

#### DISTRIBUTION IN VIRGINIA

Fairfax County and the city of Alexandria.

#### BIOLOGY

*Breeding sites*.—Muddy habitats (Jamnback, 1965).

*Feeding habits*.—Unknown.

*Seasonal distribution*.—No data available from Virginia; Jamnback (1965) indicates that it is a spring and early summer species.

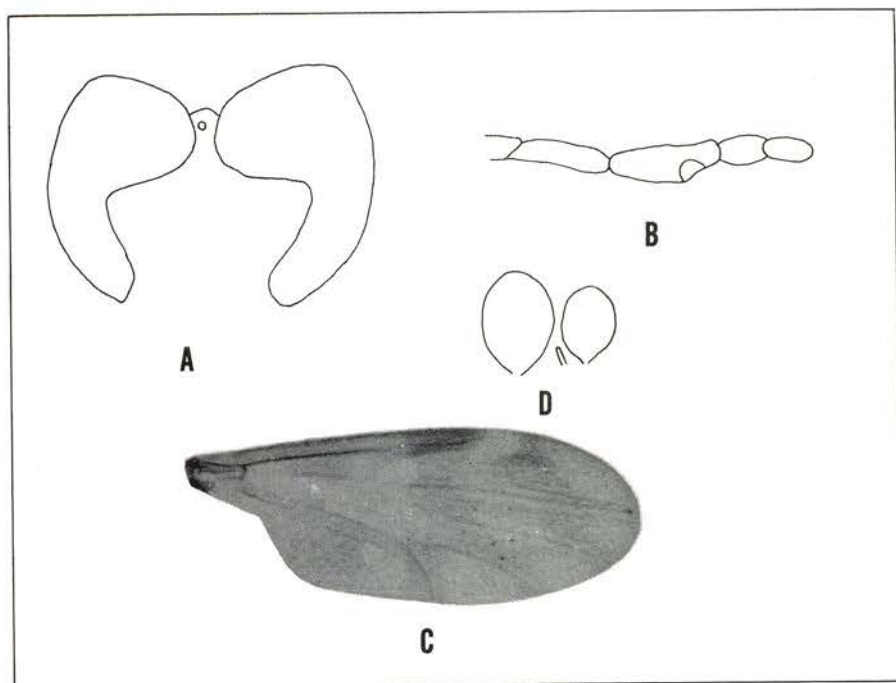


Plate 26. - *C. pseudopiliferus* Wirth & Hubert

*Culicoides sanguisuga* (COQUILLET)

(Plate 27)

*Culicoides sanguisuga* (Coquillett), 1901: 604; Jamnback and Wirth, 1963: 189-191, figs. 3, 4, 6, 10, 11, 13, 14, 18, 22, 26 (male, female); Jamnback, 1965: 91-93, figs. 17, 52, 90, 127, 164 (male, female).

DESCRIPTION

*Female*.—Eyes (fig. A) contiguous; dorsal angle of eye separation acute as in *C. obsoletus*; superior transverse suture absent. Proboscis long, P/H ratio 0.92 (0.88 — 0.96,  $n = 6$ ). Mandible with 16 (15 — 16) teeth. Flagellomere length ratios 20:12:12:13:13:13:13:15:22:22:23:23:39, AR = 1.15 (1.14 — 1.17); sensillar pattern 3, 11-15. Third segment of maxillary palp (fig. B) slightly to moderately swollen, L/W ratio 3.07 (2.88 — 3.29,  $n = 6$ ); sensory pit shallow with small opening;  $P_3/P_5$  ratio 1.8 (1.6 — 2.0).

Wing length 0.94 (0.88 — 1.07,  $n = 6$ ) mm with markings as shown in figure C; vein  $M_{3+4}$  with 2.2 (1 — 6,  $n = 6$ ) macrotrichia. Thorax a light yellowish brown. Legs without distinct pale bands; hind tibia with five spines, the first longest.

Spermathecae (fig. D) with maximum widths 35.7 (33 — 39,  $n = 6$ ) and 39.0 (35 — 41,  $n = 6$ ) microns, respectively; neck variable in length and slightly tapering; rudimentary spermatheca long, tubular.

*Male Terminalia* (fig. E).—Ninth tergum without apicolateral processes; median notch absent; ninth sternum with narrow, deep, somewhat V-shaped caudomedian excavation. Basistyle with ventral roots very long, slightly tapering to fine tip and almost touching mesally; dorsal roots much shorter and stouter.

Paramere with large, lateral foot-shaped extension at base, tapering to fine, bare tip. Aedeagal arms short with slight flange at base; slightly concave tip and subparallel sides.

*Notes*.—See notes on *C. obsoletus* for distinguishing characters. For males see notes on *C. obsoletus*.

DISTRIBUTION IN VIRGINIA

Augusta, Bedford, Botetourt, Craig, Fairfax, Franklin, Giles, Montgomery, Page, Reanoke, Rockbridge, Rockingham, and Wythe counties, Bull Run Mountains and the city of Alexandria.

BIOLOGY

*Breeding sites*.—Accumulations of dead leaves (commonly beech) containing a little moisture (Jamnback, 1965).

*Feeding habits*.—*C. sanguisuga* is an extremely noxious pest of man in deciduous woodlands in eastern North America; it is apparently of diminishing importance further southeast. This species is very bothersome in the high-

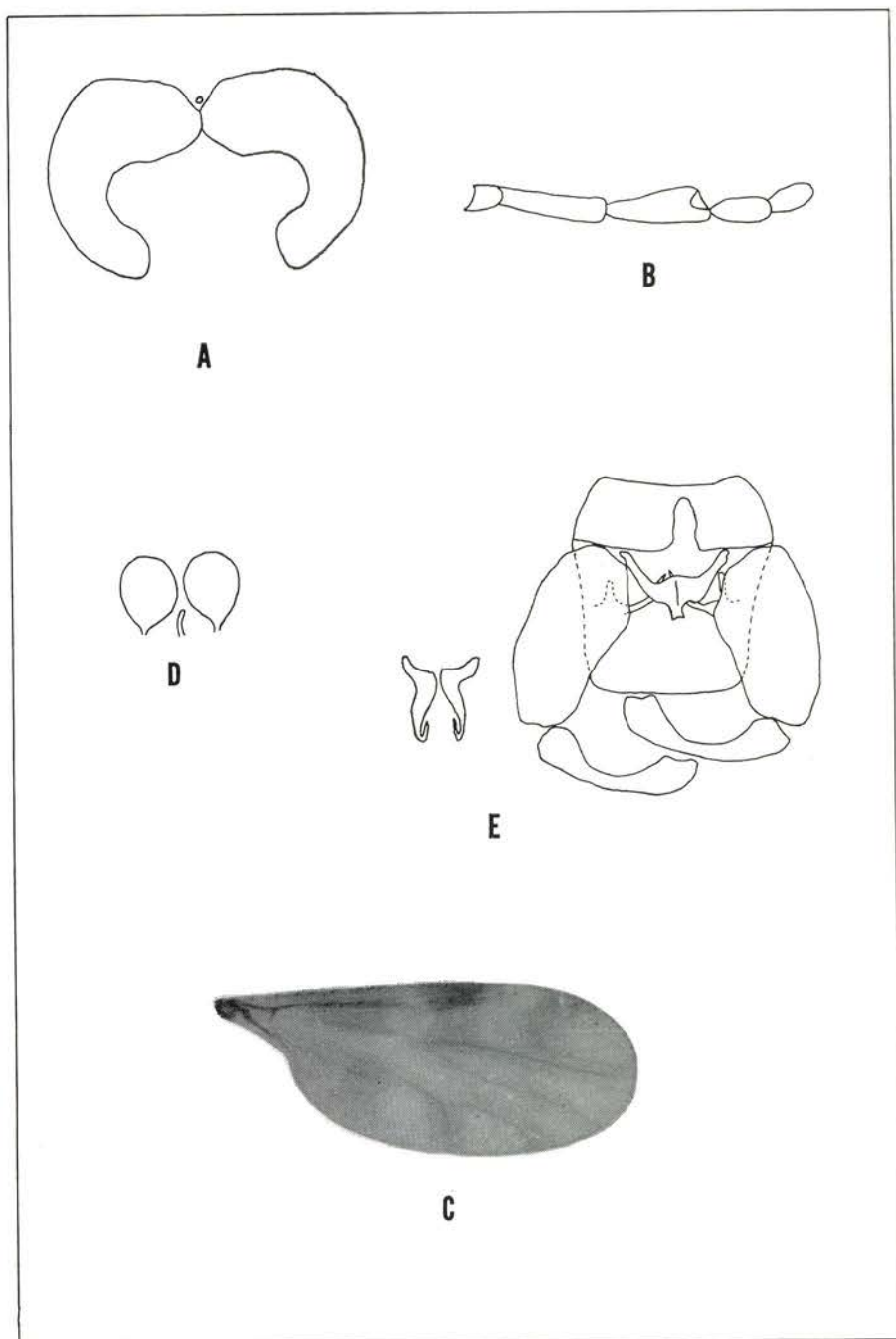


Plate 27. - *C. sanguisuga* (Coquillett)



lands of southwestern Virginia, and will feed on birds and other mammals in addition to man (Humpreys, 1969).

*Seasonal distribution.*—Adult populations of this pest are greatest in late June and July (Jamnback, 1965; Messersmith, 1966).

*Culicoides scanloni* WIRTH AND HUBERT

(Plate 28)

*Culicoides scanloni* Wirth and Hubert, 1962: 187-188, figs. 3a-g, 12 (male, female); Jamnback, 1965: 94, figs. 53, 91, 128, 165 (female).

DESCRIPTION

*Female.*—Eyes (fig. A) moderately separated. Proboscis long, P/H ratio 0.78 (0.76 — 0.80,  $n = 4$ ). Mandible with 14 (13 — 15,  $n = 7$ ) teeth. Flagellomere length ratios 17:11:11:11:11:11:12:12:23:23:26:26:38, AR = 1.44 (1.29 — 1.56,  $n = 8$ ); sensillar pattern 3, 5, 7, 9-15. Third segment of maxillary palp (fig. 28B) greatly swollen, L/W ratio 2.28 (2.09 — 2.50,  $n = 8$ ); sensory pit shallow with large opening.

Wing (fig. C) length 0.86 (0.78 — 0.98,  $n = 8$ ) mm, with typical *C. piliferus* group markings. Knees dark with faint pale bands on either side; four hind tibial spines, the second longest.

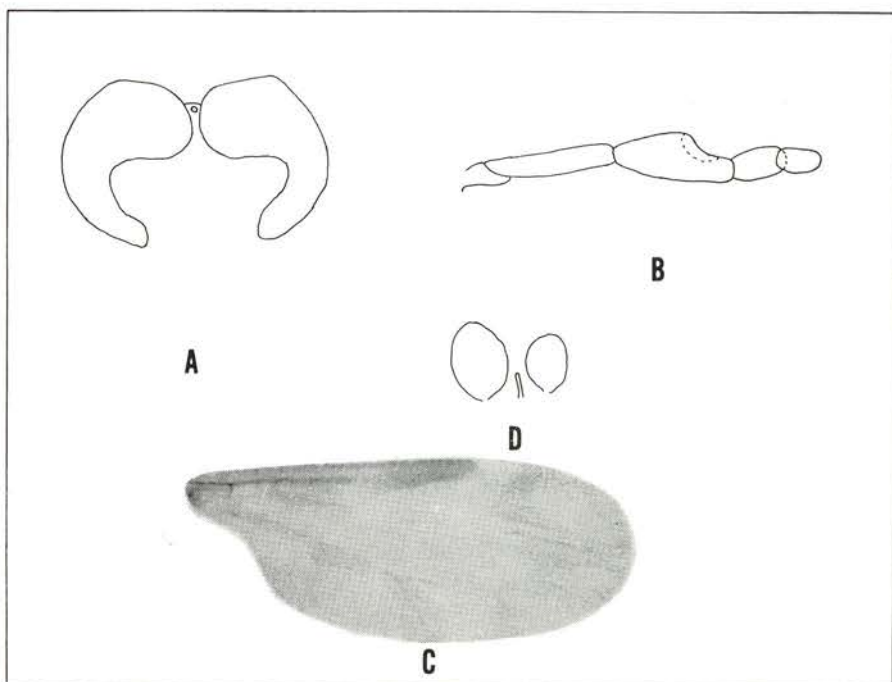


Plate 28. - *C. scanloni* Wirth & Hubert

Spermathecae (fig. D) with maximum widths 28.3 (25 — 31,  $n = 6$ ) and 33.8 (30 — 39,  $n = 6$ ) microns, respectively; neck absent (one specimen seen with neck very short and parallel-sided).

*Male Terminalia*.—See *C. piliferus*.

*Notes*.—The antennal ratio, third palpal segment, and degree of eye separation separate this species from *C. piliferus* (see notes for that species). *Culicoides scanloni* differs from *C. pseudopiliferus* in having a sensillar pattern of 3, 5, 7, 9-15 (usually 3, 5, 7, 9, 11, 13-15 in the latter).

#### DISTRIBUTION IN VIRGINIA

Fairfax, Franklin, Rockbridge, and Rockingham counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites*.—Wirth reared four males and five females from an *Osmunda* fernbog at Falls Church (Wirth and Hubert, 1962).

*Feeding habits*.—Probably ornithophilic (Jamnback, 1965).

*Seasonal distribution*.—This is probably an early spring species (Jamnback, 1965), although Messersmith (1966) collected adults in Virginia only in July.

#### *Culicoides snowi* WIRTH AND JONES

(Plate 29)

*Culicoides snowi* Wirth and Jones, 1956: 163-166, figs. 2a-f (male, female); Wirth and Hubert, 1962: 192-193, figs. 9a-g, 17 (male, female).

#### DESCRIPTION

*Female*.—Eyes (fig. A) moderately to broadly separated. Proboscis long, P/H ratio 0.82 (0.75 — 0.88,  $n = 7$ ). Mandible with 17 (15 — 19,  $n = 7$ ) teeth. Flagellomere length ratios 19:13:13:13:14:14:14:15:24:25:27:27:33, AR = 1.18 (1.13 — 1.32); sensillar pattern 3, 5, 7, 9, 11-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.15 (2.00 — 2.31,  $n = 7$ ).

Wing length 0.98 (0.88 — 1.08,  $n = 7$ ) mm with pale spots reduced as shown in figure 29C. Tibia with subbasal and apical pale bands; hind tibia with four spines, the second longest.

Spermathecae (fig. D) with maximum widths 31.0 (29 — 35) and 33.8 (29 — 39) microns, respectively; neck very short, parallel-sided.

*Male Terminalia*.—See *C. piliferus*.

*Notes*.—*Culicoides snowi* and *C. testudinalis* have faintly marked wings and are easily distinguished from other Virginia *Culicoides* of the *Piliferus* group, but may be confused with other species which have the pale spots on the wing greatly reduced (*biguttatus*, *mulrennani*, etc.). However, *snowi* and *testudinalis* can be identified as belonging to the *Piliferus* group by their sensillar patterns (3, 5, 7, 9, 11-15 in *C. snowi* and 3, 5, 7, 9, 13-15, in *C. testudinalis*)

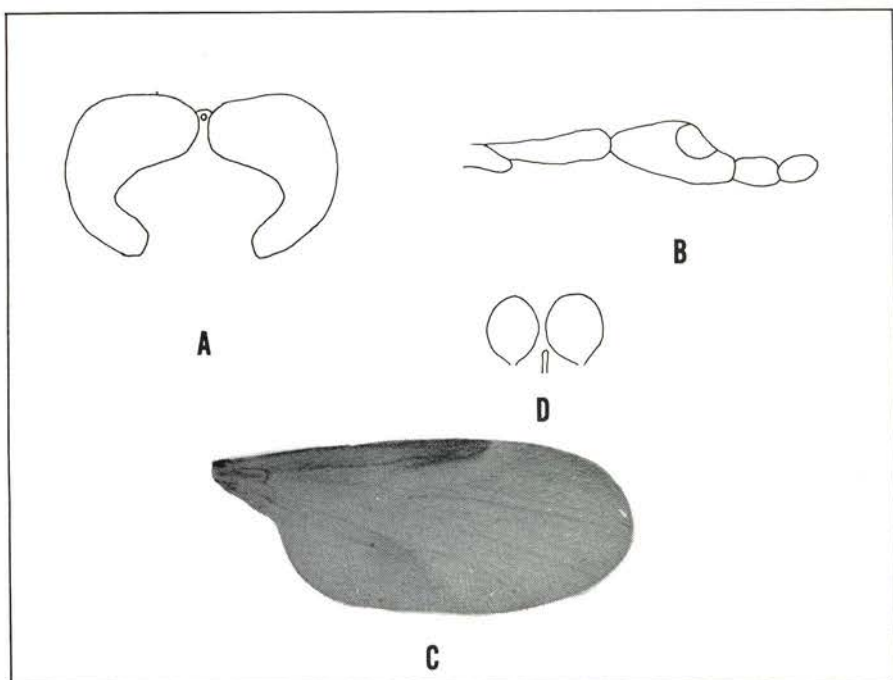


Plate 29. - *C. snowi* Wirth & Jones

and by their spermathecae (neck very short, parallel-sided in *C. snowi* and absent in *C. testudinalis*).

#### DISTRIBUTION IN VIRGINIA

Fairfax and Rockingham counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites.*—Tree holes (Wirth and Hubert, 1962).

*Feeding habits.*—This species has been collected while biting man in Alabama, Virginia, and West Virginia (Wirth and Hubert, 1962).

*Seasonal distribution.*—Probably an early spring species. Most adult collections of *snowi* have been made in May or earlier.

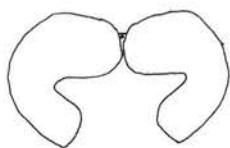
#### *Culicoides spinosus* ROOT AND HOFFMAN

(Plate 30)

*Culicoides spinosus* Root and Hoffman, 1937: 172; Foote and Pratt, 1954: 31-32, figs. 16, 111 (male, female); Jamnback, 1965: 96-99, figs. 19, 55, 93, 130, 167 (male, female).

#### DESCRIPTION

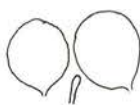
*Female.*—Eyes (fig. A) narrowly to moderately separated. Proboscis intermediate to long, P/H ratio 0.80 (0.65 — 0.88,  $n = 8$ ). Mandible with 14



A



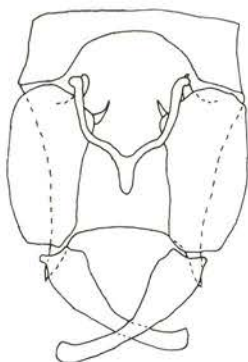
B



D



E



C

Plate 30. - *C. spinosus* Root & Hoffman  
(79)

(11 — 16)  $n = 8$ ) teeth. Flagellomere length ratios 20:15:15:16:17:17:17:18:26:26:30:32:45,  $AR = 1.18$  (1.16 — 1.19); sensillar pattern 3, 11-15. Third segment of maxillary palp (fig. B) usually moderately swollen, L/W ratio 2.56 (2.33 — 2.70,  $n = 8$ ); sensory pit shallow with large opening.

Wing length 1.14 (0.98 — 1.32,  $n = 8$ ) mm, markings shown in figure C. Hind tibia with subbasal pale band and four spines, the second longest.

Spermathecae (fig. 30D) with maximum widths 45.8 (43 — 49),  $n = 7$ ) and 49.6 (45 — 53,  $n = 7$ ) microns, respectively; neck moderate to long and slightly tapering; sclerotized ring absent.

*Male Terminalia* (fig. E).—Ninth tergum with long, prominent apicolateral processes; median notch absent; ninth sternum with deep, broad caudomedian excavation. Basistyle with ventral and dorsal roots fairly long, tapering; dorsal root blunter.

Paramere with well developed accessory processes, tapering rapidly from base into slender tip with approximately four spines. Aedeagal arms strongly arcuate, distinct flange at base; median process fairly short, slightly tapered, and rounded apically.

*Notes*.—Closely resembles *C. biguttatus*, *C. loisae*, *C. mulrennani*, and *C. travisi*. *Culicoides spinosus* may be separated from the first and last of those species by the absence of a sclerotized ring on the spermathecal duct and by the sensillar pattern; it differs from *C. loisae* in having mandibular teeth and from *C. mulrennani* in having more pale spots on the wing (see notes on *C. mulrennani*). Males closely resemble *C. loisae* and *C. mulrennani*. *Culicoides spinosus* has no distinct median notch, but the ninth tergum has a broad, deep posterior emargination that is not evident in *C. loisae*; the apicolateral processes hence appear longer in *C. spinosus*. The paramere of *C. mulrennani* ends in a bare tip, whereas the tip in *C. spinosus* (and *C. loisae*) has several small spines.

#### DISTRIBUTION IN VIRGINIA

Albemarle, Augusta, Craig, Fairfax, Franklin, Gloucester, Highland, Lancaster, Mecklenburg, Montgomery, Rockbridge, Rockingham, and York counties, and the cities of Alexandria and Chesapeake.

#### BIOLOGY

*Breeding habits*.—Stream margins, mud flats, bogs, etc.

*Feeding habits*.—This species has been recorded biting man (Jamnback, 1965). Humphreys (1969) collected 116 from goats, 9 from rabbits, and 46 from galliform birds.

*Seasonal distribution*.—Messersmith (1966) collected adults from April through August and recorded a peak in June.

*Culicoides stellifer* (COQUILLET)

(Plate 31)

*Culicoides stellifer* (Coquillett), 1901: 603-604; Foote and Pratt, 1954: 32-33, figs. 25, 52, 85, 107 (male, female); Jamnback, 1965: 99-102, figs. 20, 56, 94, 131, 168 (male, female).

DESCRIPTION

*Female*.—Eyes (fig. A) narrowly separated. Proboscis usually long, P/H ratio 0.80 (0.71 — 0.93,  $n = 54$ ). Mandible with 14 (12 — 16,  $n = 64$ ) teeth. Flagellomere length ratios 19:14:15:15:16:16:15:16:21:22:25:26:41, AR = 1.07 (1.06 — 1.09); sensillar pattern 3, 8-10; rarely 3, 7-10. Third segment of maxillary palp (fig. B) moderately to greatly swollen, L/W ratio 2.53 (2.23 — 2.81,  $n = 56$ ); sensory pit shallow with large opening.

Wing length 0.97 (0.86 — 1.08,  $n = 65$ ) mm with markings as shown in figure 31C. Legs with distinct pale bands; hind tibia with five spines, the second usually slightly longer than the first.

Spermathecae (fig. D) with maximum widths 33 (27 — 39,  $n = 35$ ) and 36 (31 — 43,  $n = 35$ ) microns, respectively; neck tapering, varying in length.

*Male Terminalia* (fig. E).—Ninth tergum with very long, slender apico-lateral processes; median notch broad, shallow; ninth sternum with deep caudomedian excavation. Basistyle with ventral root boat-hook shaped; dorsal root extremely long, slender, and parallel-sided.

Paramere tapering very little from base to broad tip with prominent spines. Aedeagal arms very long, arcuate, with distinct flange at base; median process short, truncate, appearing slightly serrate or ridged at apex.

*Notes*.—This species closely resembles *C. baueri* and *C. furens* but has one more hind tibial spine and slightly different wing markings, particularly in cell R<sub>5</sub> (see notes on *C. baueri*, *C. debilipalpis*, and *C. furens*). Male terminalia very near *C. debilipalpis*, but *C. stellifer* lacks the small, distinct sub-apical knob on the paramere.

DISTRIBUTION IN VIRGINIA

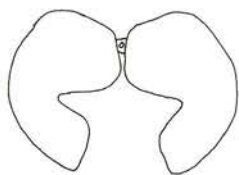
Albemarle, Augusta, Bedford, Craig, Fairfax, Franklin, Giles, Gloucester, King George, Lancaster, Mecklenburg, Montgomery, Northumberland, Page, Patrick, Rockbridge, Rockingham, Smyth, Spotsylvania, Stafford, Wythe, and York counties, Dismal Swamp, and the city of Alexandria.

BIOLOGY

*Breeding sites*.—Mud and sand along the margins of streams and ponds. Hair *et al.* (1966) reared *C. stellifer* from a dry cavity in a buckeye tree (*Aesculus octandra*).

*Feeding habits*.—Hair and Turner (1968) collected 4 from birds, 3 from man, and 18 from other mammals. This species is probably mammalophilic.

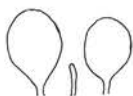
*Seasonal distribution*.—Jamnback (1965) stated that adults are most commonly collected in early July in New York. Messersmith (1966) found adults



A



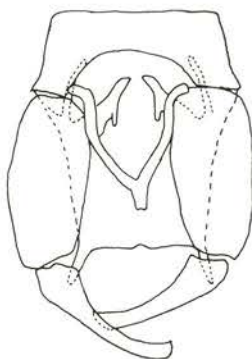
B



D



E



C

Plate 31. - *C. stellifer* (Coquillett)

present from April through early September in Virginia and recorded a population peak in June.

*Culicoides testudinalis* WIRTH AND HUBERT

(Plate 32)

*Culicoides testudinalis* Wirth and Hubert, 1962: 191-192, figs. 7a-d, 15 (female); Jamnback, 1965: 105-106, figs. 58, 96, 133, 1970 (female).

DESCRIPTION

*Female*.—Eyes (fig. A) moderately to broadly separated. Proboscis intermediate to long, P/H ratio 0.75 (0.74 — 0.76,  $n=4$ ). Mandible with 18 (17 — 19,  $n=4$ ) teeth. Flagellomere length ratios 21:13:14:14:14:14:14:26:26:27:29:44, AR = 1.28 (1.26 — 1.29),  $n=4$ ; sensillar pattern 3, 5, 7, 9, 13-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.31 (2.15 — 2.45,  $n=4$ ); sensory pit shallow with round opening.

Wing length 1.00 (0.98 — 1.06,  $n=4$ ) mm with pale spots reduced as shown in figure C. Tibiae with faint pale bands; hind tibia with four spines, the second longest.

Spermathecae (fig. D) with maximum widths 39 ( $n=1$ ) and 57 ( $n=1$ ) microns, respectively; neck absent.

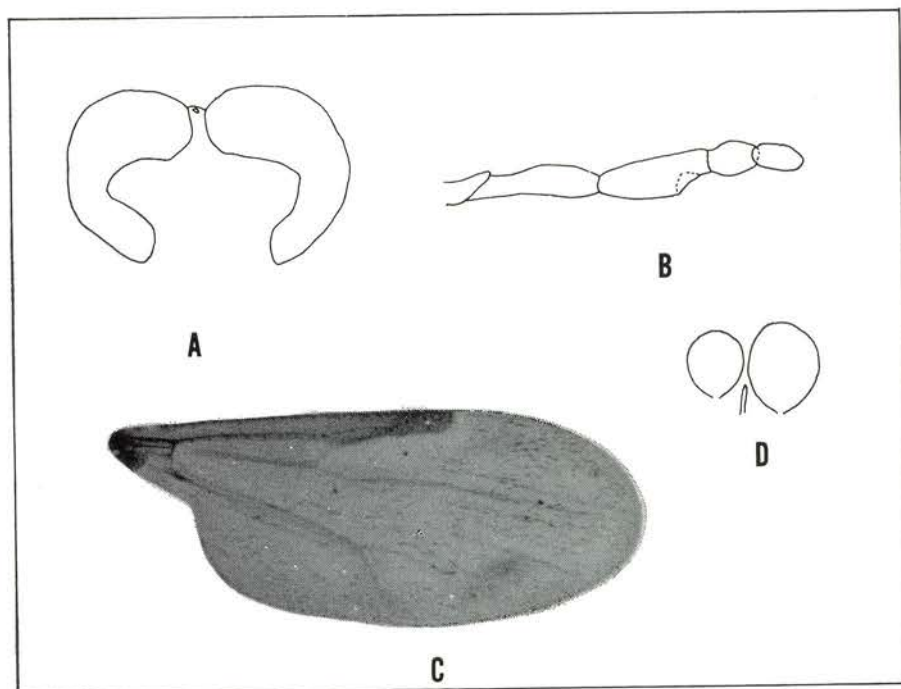


Plate 32. - *C. testudinalis* Wirth & Hubert



*Male Terminalia*.—See *C. piliferus*.

*Notes*.—See notes on *C. snowi*.

#### DISTRIBUTION IN VIRGINIA

Fairfax, Montgomery, and Rockbridge counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites*.—Wirth reared 11 females from an *Osmunda fernbog* in Alexandria (Wirth and Hubert, 1962).

*Feeding habits*.—Wirth and Hubert (1962) cite several records of this species feeding on turtles.

*Seasonal distribution*.—Messersmith (1966) collected adults only in July from Virginia. Jamnback (1965) indicates this species is most common in May and June.

#### *Culicoides travisi* VARGAS

(Plate 33)

*Culicoides travisi* Vargas, 1949: 233; Foote and Pratt, 1954: 33-34, figs. 8, 34, 83, 114 (male, female); Jamnback, 1965: 106-108, figs. 22, 59, 97, 134, 171 (male, female).

*Culicoides simulans* Root and Hoffman, 1937: 167-168, figs. 21, 33 (male, female).

*Culicoides horneae* Foote and Pratt, 1954: 25, figs. 27, 37, 121 (male).

#### DESCRIPTION

*Female*.—Eyes (fig. A) narrowly separated. Proboscis long, P/H ratio 0.80 (0.74 — 0.85,  $n = 7$ ). Mandible with 15 (13 — 16,  $n = 8$ ) teeth. Flagellomere length ratios 24:15:16:16:17:17:17:17:38:38:40:41:52, AR = 1.49 (1.39 — 1.61); sensillar pattern 3-15. Third segment of maxillary palp (fig. 33B) usually greatly swollen, L/W ratio 2.31 (2.09 — 2.70,  $n = 8$ ); sensory pit moderately shallow with very large opening.

Wing (fig. C) length 1.24 (1.12 — 1.39,  $n = 7$ ) mm with two distinct pale spots, one over the r-m crossvein and one just beyond the second radial cell; additional pale spots rarely present along margin. Legs with faint pale bands; hind tibia with four spines, the second usually longest.

Spermathecae (fig. D) with maximum widths 35.8 (33 — 43,  $n = 7$ ) and 41.3 (35 — 47,  $n = 7$ ) microns, respectively; neck absent, sclerotized ring present.

*Male Terminalia* (fig. E).—Ninth tergum with long, stout apicolateral processes; median notch deep, V-shaped; ninth sternum with broad, moderately deep caudomedian excavation. Basistyle with ventral root long, slightly tapering; dorsal root stouter, tapering very little to rounded tip.

Paramere with very prominent accessory process; paramere swollen near base, gradually tapering to fine, bare tip. Aedeagal arms short, nearly straight with distinct flange at base; median process long, tapering very little to somewhat blunt tip.

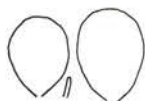
*Notes*.—See notes on *C. nanus*. Occasionally specimens with poorly marked wings may be confused with *C. biguttatus* or *C. spinosus*. However, *C. travisi*



A



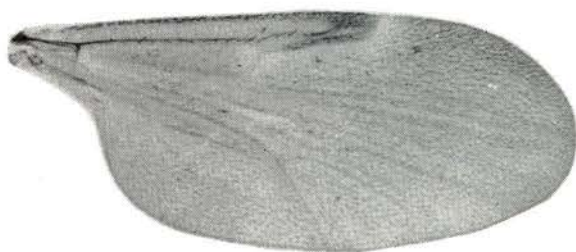
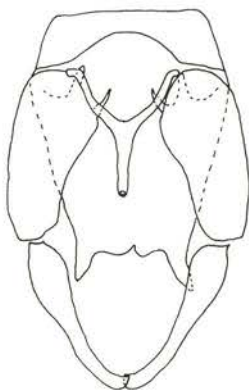
B



D



E



C

Plate 33. - *C. travisi* Vargas  
(85)

lacks a spermathecal neck (a strongly tapering one is present in *C. biguttatus*) and possesses a sclerotized ring on the spermathecal duct (absent in *C. spinosus*, *C. loisae*, and *C. mulrennani*). Males of this species are fairly distinct among Virginia *Culicoides*. They might be confused with *C. arboricola* or *C. beckae*, but the median posterior process is much less tapered in *C. travisi*.

#### DISTRIBUTION IN VIRGINIA

Augusta, Bedford, Craig, Fairfax, Franklin, Giles, Montgomery, Rockbridge, Rockingham, and Wythe counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites*.—Margins of streams and ponds, mud bars, etc. (Hair *et al.*, 1966).

*Feeding habits*.—This species is probably ornithophilic although there are reports of it feeding on man and other mammals (Jamnback, 1965). Hair and Turner (1968) collected 35 from birds, 3 from man, and 13 from other mammals.

*Seasonal distribution*.—Peak populations apparently occur in most areas in late springtime. Messersmith (1966) noted a numerical peak in June, in Virginia.

#### *Culicoides variipennis variipennis* (COQUILLET)

(Plate 34 in part)

*Culicoides variipennis variipennis* (Coquillett), 1901: 602; Wirth and Jones, 1957: 12-15, figs. 2 (in part), 8a (male, female); Jamnback, 1965: 110-113, figs. 23, 61, 99, 136, 173, 182 (male, female).

#### DESCRIPTION

*Female*.—Eyes (fig. D) broadly separated. Proboscis long, P/H ratio 0.86 (0.78 — 0.91,  $n = 10$ ). Mandible with 15 (14 — 16,  $n = 13$ ) teeth, Flagellomere length ratios 28:18:19:20:20:20:20:23:25:25:27:41, AR = 0.86 (0.78 — 0.91); sensillar pattern 3, 8-10. Third segment of maxillary palp (fig. 34E) bristly and usually slightly swollen, L/W ratio 3.14 (2.77 — 3.38,  $n = 10$ ); sensory pit sometimes subdivided.

Wing (fig. F) length 1.59 (1.40 — 2.02,  $n = 13$ ) mm. Legs with distinct pale bands; hind tibia with six or seven spines, the second longest.

One usually kidney-shaped spermatheca (fig. G) present, shape varying from types I and II (*sensu* Wirth and Jones, 1957) to type X.

*Male Terminalia* (fig. H).—Ninth tergum with short, subconical apico-lateral processes; median notch minute or absent; ninth sternum without caudo-median excavation. Ventral root vestigial; dorsal root long, somewhat arcuate, and tapering very slightly to relatively blunt tip.

Parameres fused at base, tapering to slender, fine bare tips. Aedeagal arms with distinct flange at base; basal arch extending to about one-quarter total length of aedeagus; median process divided on midline near apex, each half

ending in what appears to be two separate, fine, bare tips (the four separate tips not always visible, sometimes appearing as two tips).

*Notes.*—The wing markings alone are very unique for the Virginia species. In addition, only two other species (*C. crepuscularis* and *C. hollensis*) have just one spermatheca, but their wing patterns are drastically different from *C. variipennis* (compare pls. 8 and 16, fig. C, with pl. 34, fig. F.). The male is the only Virginia species with the parameres fused basally (subgenus *Monoculicoides*).

*Culicoides variipennis australis* WIRTH AND JONES

(Plate 34 in part)

*Culicoides variipennis australis* Wirth and Jones, 1957: 15-17, figs. 2 (in part), 8b (female).

DESCRIPTION

*Female.*—Eyes (fig. A) broadly separated. Proboscis long, P/H ratio 0.84 (0.79 — 0.86). Mandible with 12 (9 — 15,  $n=9$ ) teeth. Flagellomere length ratios 25:20:20:20:21:21:21:20:23:25:26:28:43, AR = 0.86 (0.82 — 0.88); sensillar pattern 3, 5-10; patterns of 3, 6-10 and 3-10 rarely seen. Third segment of maxillary palp (fig. B) slightly to moderately swollen, L/W ratio 2.85 (2.59 — 3.24,  $n=9$ ); sensory pit sometimes subdivided.

Wing length 1.51 (1.36 — 1.80,  $n=9$ ) mm. Legs with distinct pale bands; hind tibia with six or seven spines, the second longest.

Only one spermatheca (fig. C) present; usually more or less kidney-shaped (Wirth and Jones' 1957 types I and II most common, although shape ranging all the way to type X).

*Male Terminalia.*—See *C. variipennis variipennis*.

DISTRIBUTION IN VIRGINIA

The *australis* is known only from Saltville (Smyth County); *variipennis* is known in Augusta, Hanover, Mecklenburg, Montgomery, and Smyth Counties. *Subspecies* not given: Augusta, Bedford, Franklin, Montgomery, Prince Edward, Pulaski, Rockbridge, Spotsylvania, and Wythe counties, and the city of Richmond.

BIOLOGY

*Breeding sites.*—*C. australis* breeds in mud and algal mats with high salinity, whereas *variipennis* breeds in wet mud usually high in animal excrement.

*Feeding habits.*—This species probably prefers to feed on large mammals (Jamnback, 1965).

*Seasonal distribution.*—Messersmith (1966) recorded a population peak in Virginia in June.

*Notes.*—See discussion after *C. variipennis australis*.

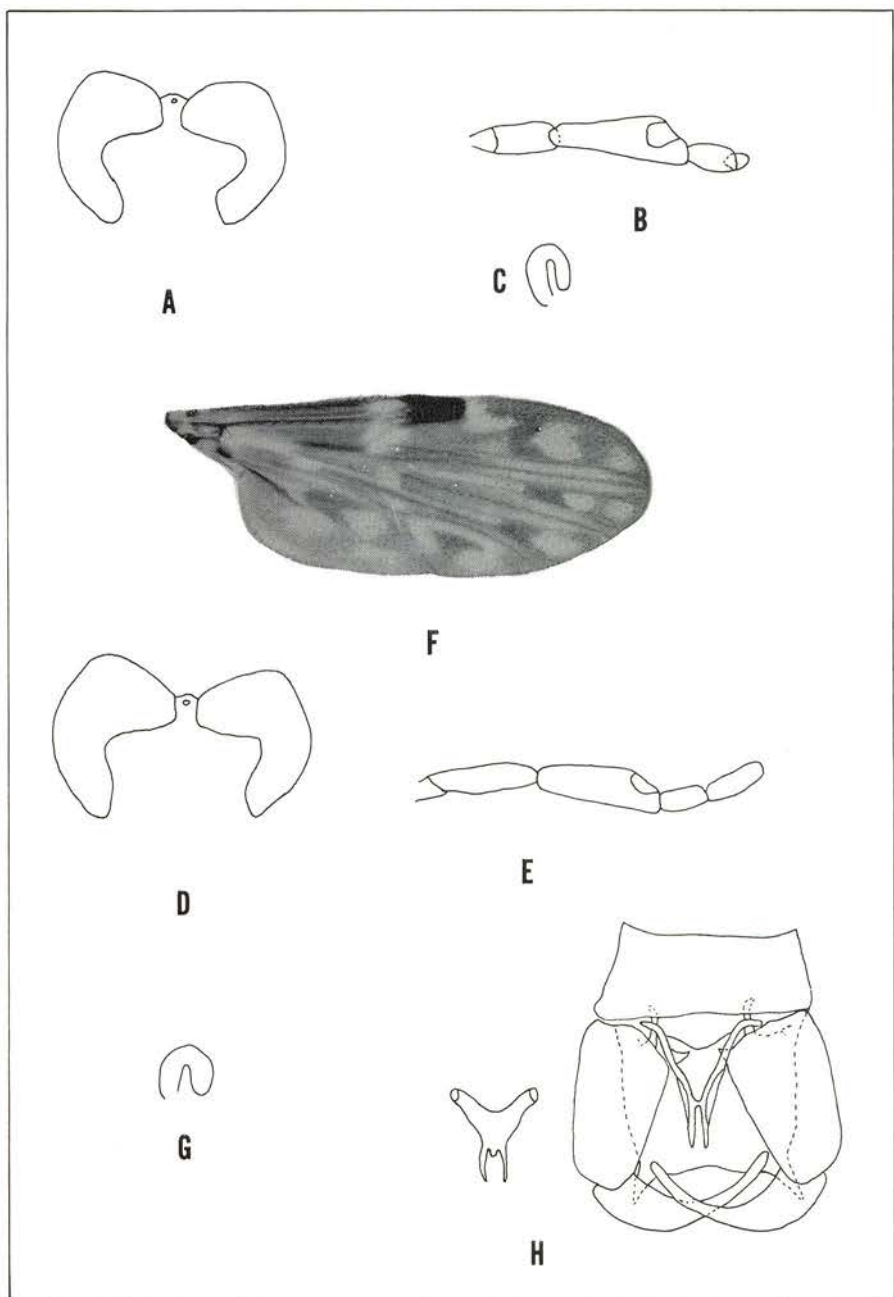


Plate 34. - *C. variipennis australis* Wirth & Jones  
*C. variipennis variipennis* (Coquillett)

## DISCUSSION

Wirth and Jones (1957) list four characters which, alone or in combination, could reliably separate most females of the five subspecies of *variipennis*. These characters are as follows: (1) the L/W ratio of the third palpal segment, (2) wing length, (3) sensillar pattern, and (4) the number of mandibular teeth. Characters (3) and (4) were found, in the present study, to be of use in distinguishing the two subspecies which occur in Virginia. Characters (1) and (2) were found to be variable and hence unreliable in identifications. No consistent differences in wing markings or "spermathecal types" (*sensu* Wirth and Jones, 1967) were seen between the two subspecies.

No differences in male genitalia were observed. The aedeagus of *australis* is bare, as is that of *variipennis*, not spinose as in *C. variipennis sonorensis* which according to Atchley (1967) is synonymous with *australis*. It would appear that *australis* (*sonorensis*, *sensu* Atchley) is definitely a different subspecies from *variipennis*, based on Virginia material. Only reared adults were studied, hence, the two groups were represented by appropriately ecologically isolated populations with respect to breeding sites.

### *Culicoides venustus* HOFFMAN

(Plate 35)

*Culicoides venustus* Hoffman, 1925: 290-291; Foote and Pratt, 1954: 35-36, figs. 10, 50, 84, 93 (male, female); Jamnback, 1965: 113-116, figs. 24, 62, 100, 137, 174 (male, female).

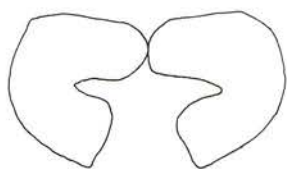
## DESCRIPTION

*Female*.—Eyes (fig. A) contiguous; superior transverse suture absent. Proboscis long, P/H ratio 0.89 (0.86 — 0.94). Mandible with 15 (14 — 15) teeth. Flagellomere length ratios 29:23:23:24:25:24:25:26:33:34:38:43:64, AR = 1.07 (1.05 — 1.11); sensillar pattern variable, specimens seen with patterns of 3, 11-15; 3, 9, 11-15; and 3, 6-9, 11-15. Maxillary palp very bristly, third segment (fig. B) slightly to moderately swollen, L/W ratio 3.06 (2.88 — 3.42); sensory pit shallow with small opening.

Wing length 1.43 (1.25 — 1.53) mm with characteristic markings as shown in figure C. Legs with distinct pale bands; hind tibia with five spines, the second longest.

Spermathecae (fig. D) with maximum widths 43.0 (41 — 45) and 46.6 (43 — 51) microns, respectively; neck broad, tapering, and varying in length from short to moderately long.

*Male Terminalia* (fig. E).—Ninth tergum strongly tapering posteriorly with minute, knob-like apicolateral processes; ninth sternum with shallow caudo-median excavation. Basistyle with vestigial ventral root; dorsal root moderately long, strongly tapering.



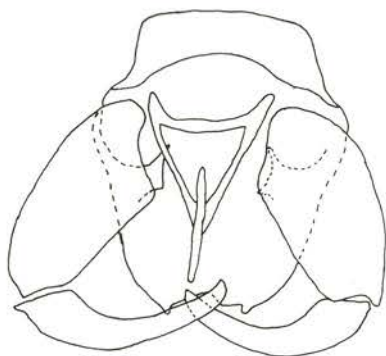
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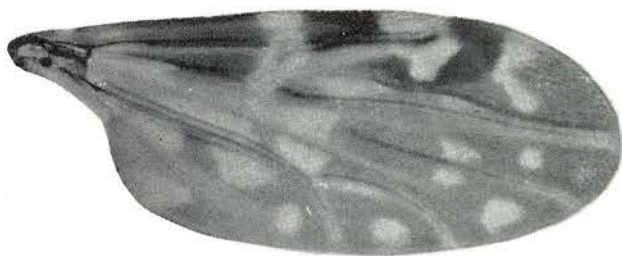
B



D



E



C

Plate 35. - *C. venustus* Hoffman  
(90)

Paramere with foot-shaped accessory process; base strongly swollen to near midlength, then tapering rapidly toward fine tip with minute hairs. Aedeagal arms long, straight, connected near base by transverse sclerotized bar; median process long, parallel-sided, apparently extending anteriorly a short distance beyond basal arch and ending posteriorly in slightly rounded tip.

*Notes.*—The unique wing markings and bristly palp separate *C. venustus* from other Virginia species. It might possibly be confused with *C. variipennis*, but veins  $M_{3+4}$  and  $Cu_1$  end in pale areas at the wing margin in *C. venustus*, and there is a small distal pale spot in cell  $R_5$  in *C. variipennis*. The aedeagus and apicolateral processes make *C. venustus* male fairly easy to recognize among Virginia *Culicoides*.

#### DISTRIBUTION IN VIRGINIA

Accomack, Augusta, Bedford, Fairfax, Franklin, Grayson, Lee, Montgomery, Northumberland, Roanoke, Rockbridge, Rockingham, Scott, Tazewell, and Wythe counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites.*—Stream margins and other similar moist terrestrial habitats.

*Feeding habits.*—Unknown.

*Seasonal distribution.*—Messersmith (1966) collected adults from April to September, and recorded a peak in May. Snow *et al.* (1957) noted a peak in mid-June in collections from Humphreys County, Tennessee.

#### *Culicoides villosipennis* ROOT AND HOFFMAN

(Plate 36)

*Culicoides villosipennis* Root and Hoffman, 1937: 165-166; Foote and Pratt, 1954: 36, figs. 28, 54, 71, 116 (male, female); Jamnback, 1965: 116-118, figs. 25, 63, 101, 138, 175 (male, female); Wirth and Blanton, 1967: 229-232, figs. 76-82 (male, female).

#### DESCRIPTION

*Female.*—Eyes (fig. A) narrowly to moderately separated. Proboscis long, P/H ratio 0.82 (0.75 — 0.88). Mandible with 13 (13 — 14) teeth. Flagellomere length ratios 25:20:22:22:22:23:23:23:56:55:54:54:74, AR = 1.63 (1.56 — 1.72); sensillar pattern 3, 5, 7, 9, 11-15. Third segment of maxillary palp (fig. B) greatly swollen, L/W ratio 2.25 (2.05 — 2.55); sensory pit deep with large opening.

Wing length 1.36 (1.31 — 1.47) mm, with distinct markings as shown in figure C. Legs with distinct pale bands on either side of dark knees; hind tibia with five spines, the second longest.

Spermathecae (fig. D) with maximum widths 37.8 (33 — 41) and 41.4 (37 — 45) microns, respectively; neck short, tapering.

*Male Terminalia* (fig. E).—Ninth tergum with long, stout apicolateral processes; median notch narrow, V-shaped; ninth sternum with broad, shal-



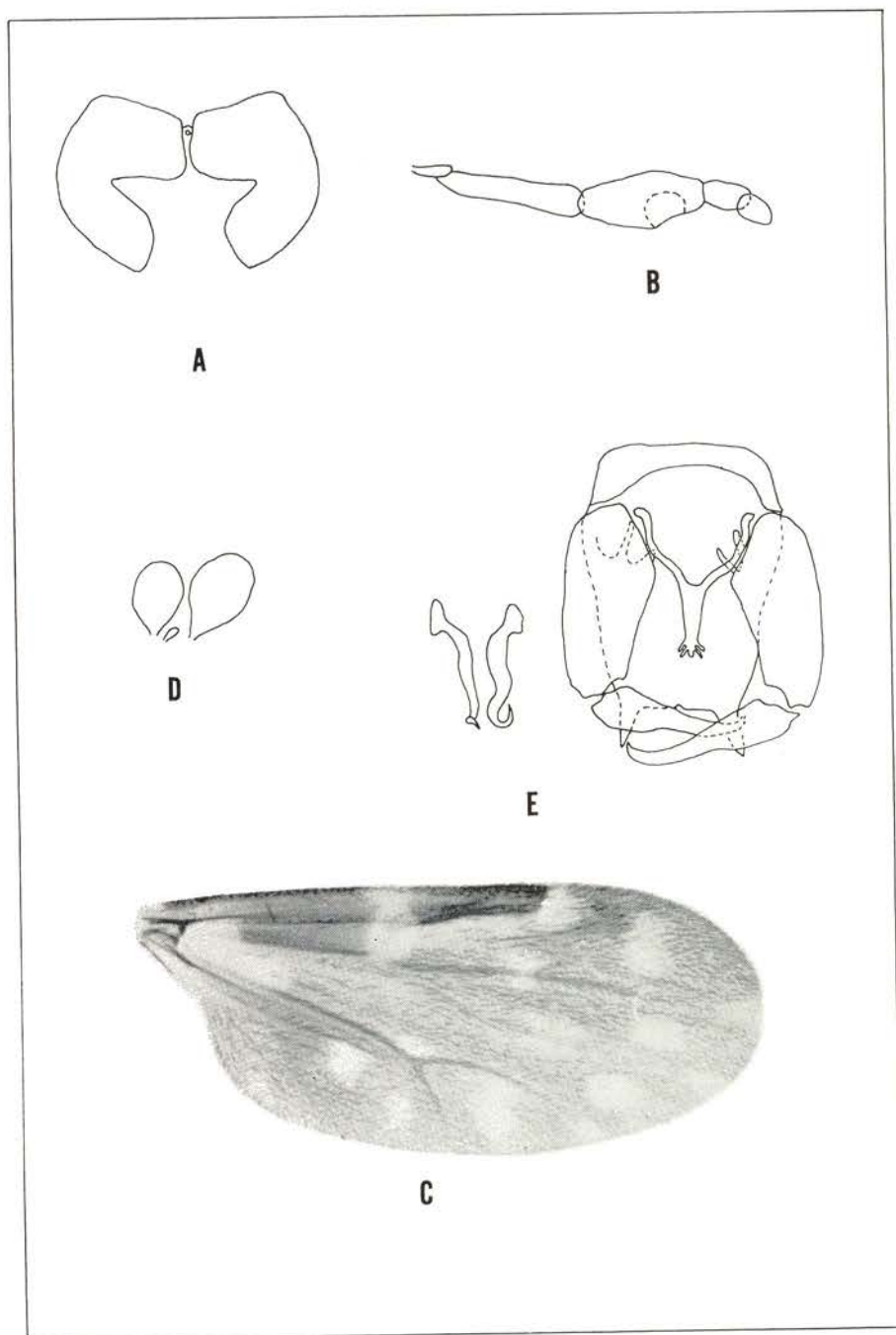


Plate 36. - *C. villosipennis* Root & Hoffman  
(92)

low caudomedian excavation. Basistyle with ventral root slender, relatively long, slightly tapered; dorsal root longer, more blunt.

Paramere with elliptical accessory process projecting both anteriorly and posteriorly; paramere tapering gradually to strongly curved, fine bare tip. Aedeagal arms strongly arcuate with flange at base; median process long, tapering, ending in slightly rounded tip with two fine subapical filaments on either side.

*Notes.*—See notes for *C. ousairani*. The aedeagal tip of *C. villosipennis* male appears five-pronged, due to the subapical filaments, and is easily recognized.

#### DISTRIBUTION IN VIRGINIA

Augusta, Bedford, Craig, Fairfax, Franklin, Montgomery, Rockbridge, Rockingham, and Wythe counties, and the city of Alexandria.

#### BIOLOGY

*Breeding sites.*—Tree and stump holes (Wirth and Blanton, 1967). Gazeau and Messersmith (1970a) reared one male from decaying vegetable matter and mud from a swampy area in Howard County, Maryland.

*Feeding habits.*—This species is probably ornithophilic (Jamnback, 1965). Messersmith (1965a) collected 79 engorged females in Virginia poultry houses.

*Seasonal distribution.*—Messersmith (1966) recorded a population peak in July in Virginia.

### A GEOGRAPHIC CATALOG OF THE *CULICOIDES* OF THE EASTERN UNITED STATES EXCLUSIVE OF FLORIDA

A list of all reported collecting sites for the *Culicoides* of the eastern United States north of Florida has been compiled. This list consists of all known published records, plus unpublished records from the U. S. National Museum of Natural History (indicated as NMNH) and other sources. The area covered by the present listing is composed of Minnesota, Iowa, Missouri, Arkansas, and Louisiana, and all states east of these with the exception of Florida (a review of the Florida species is currently in preparation by Wirth and Blanton). Distribution of Virginia *Culicoides* is given in the previous section of this bulletin.

Reported collecting sites are given by state for each species. Since the papers by Wirth and Hubert (1962) and Jamnback and Wirth (1963) altered our concepts of *C. piliferus* and *C. obsoletus*, early records of these species are given only as "*obsoletus* group" or "*piliferus* group".

The following is a geographical listing of the papers which supplied most of the records given in the present study: *Gulf Coast*—Hinman (1932), Khalaf (1966a, 1966b, 1967a, 1967b, 1967c, 1969). *Illinois*—Malloch (1915a, 1915b). *Iowa*—Kardatzke and Rowley (1971). *Maryland*—Gazeau and Messersmith

(1970b). *Michigan*—Williams (1955b, 1955c). *Miscellaneous Southeastern States*—Hall (1932), Williams (1955a), Snow *et al.* (1958), Roberts (1965), Wirth and Blanton (1966). *Missouri*—Adams (1940), Childers and Wingo (1968). *New England*—Coher *et al.* (1955), Lewis (1959), Shaw (1959), Wall and Doane (1960). *New Jersey*—Burbutis and Jobbins (1964), Das Gupta and Hansens (1965). *New York*—Jamnback (1965). *North Carolina*—Battle and Turner (1970a). *Tennessee River Basin*—Snow (1955), Snow and Pickard (1953, 1954, 1958), Snow *et al.* (1957), Pickard and Snow (1955). *Virginia*—Pratt (1907), Wirth (1951), Wirth and Jones (1956), Murray (1957), Hair *et al.* (1966), Messersmith (1966), Battle and Turner (1969). *West Virginia*—Battle and Turner (1970b). *Wisconsin*—Jones (1956, 1961a). *Papers with general coverage*—Coquillett (1901), Hoffman (1925), Root and Hoffman (1937), Barbosa (1947), Foote and Pratt (1954), Fox (1955), Wirth and Jones (1957), Wirth and Hubert (1962), Jamnback and Wirth (1963), Wirth and Blanton (1967).

*Culicoides alexanderi* Wirth and Hubert

CONNECTICUT: Oxford (Lake Nor), Storrs.

KENTUCKY: Methany Branch.

MARYLAND: Bittering 4-H Camp, Patuxent Wildlife Refuge, Swallow Falls State Park.

MASSACHUSETTS: Merrimacport.

MICHIGAN: Cheboygan Co., Clare Co.

NEW YORK: Cattaraugus Co., Chautauqua Co., St. Lawrence Co., Tompkins Co., Wyoming Co.

TENNESSEE: Chestuee Creek.

*Culicoides arboricola* Root and Hoffman

ALABAMA: Atmore, Cherokee, Florence, Town Creek, Waterloo, Wilson Dam.

CONNECTICUT: Storrs.

GEORGIA: Atlanta, Baker Co., DeKalb Co., Isle of Hope (near Savannah), Macon, Savannah.

ILLINOIS: Grafton, Lyons, Scottfield.

LOUISIANA: Arabi, Avery Marsh, Baton Rouge, Belle Chasse, Carlisle, Covington, Crown Point, Estelle, Grand Isle, Hwy. 90 and 190, Indian Camp, Kilbourne, Lafayette, Lafitte, Maplewood, New Orleans area, Weeks Island, Welsh, West Bay, West Lake, West Pointe a la Hache.

MARYLAND: Baltimore (Gwynn Falls and Roland Parks), Cooksville, Fairland, Forest Glen, Patuxent Wildlife Refuge, Snow Hill.

MINNESOTA: Burnside.

MISSISSIPPI: Greenwood, Hancock Co., Harrison Co., Jackson Co., Pearl River Co., Washington Co.

MISSOURI: Boone Co., Morgan Co.

NEW JERSEY: Salem Co.

NEW YORK: Albany Co.

PENNSYLVANIA: York.

TENNESSEE: Chestuee Creek, Hustburg, Jasper, Maynardville, Newport,  
Sugar Tree.

WISCONSIN: Dane Co., no location given by Anderson *et al.* (1961).

*Previously unpublished records:*

KENTUCKY: Golden Pond (NMNH).

*Culicoides baueri* Hoffman

ALABAMA: Florence.

CONNECTICUT: Storrs.

GEORGIA: Baker Co.

LOUISIANA: Covington, Hwy. 90 and 190, Indian Camp.

MARYLAND: Baltimore, Forest Glen, Snow Hill, Thurmont.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

MISSOURI: Boone Co., Morgan Co.

NEW JERSEY: Jockey Hollow.

NEW YORK: Cattaraugus Co., Chautauqua Co., Schuyler Co., Tompkins Co.

NORTH CAROLINA: Granville Co.

TENNESSEE: Chestuee Creek, Hustburg, Johnson City.

WEST VIRGINIA: Monroe Co.

WISCONSIN: Richland Co.

*Previously unpublished records:*

ALABAMA: Greenbrier (NMNH); Talladega Co. (F. V. Battle).

WISCONSIN: Dane Co. (NMNH).

*Culicoides beckae* Wirth and Blanton

ALABAMA: Atmore.

MARYLAND: Forest Glen.

*Culicoides bermudensis* Williams

LOUISIANA: Alliance, Avery Marsh, Calcasieu Lock, Cypremort Point, Erath,  
Estelle, Haymark Terminal (Lake Charles), Homeplace, Hopedale, Hwy.  
90 and 190, Indian Camp, Intracoastal Canal, Lake Hermitage, Maple-  
wood, Micheaud, New Orleans area, Oak Grove, Pointe a la Hache,  
Vincent Landing, Weeks Island, West Lake, West Pointe a la Hache.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co.

NEW YORK: Suffolk Co.

*Previously unpublished records:*

GEORGIA: Savannah (NMNH).

LOUISIANA: Cheniere Caminada (NMNH).

*Culicoides bickleyi* Wirth and Hubert

CONNECTICUT: Norwich, Storrs.

LOUISIANA: Baton Rouge, Covington, Crown Point, Des Allemands, Hwy. 90 and 190, Indian Camp, New Orleans area, West Pointe a la Hache.

MARYLAND: Fairland, Garrett Co., Patuxent Refuge, Snow Hill.

MASSACHUSETTS: Buzzards Bay, Centerville, Truro.

MICHIGAN: Cheboygan Co.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

NEW YORK: Albany Co., Hamilton Co., Lewis Co., Suffolk Co., Tompkins Co., Washington Co.

SOUTH CAROLINA: Hampton Co.

WEST VIRGINIA: Cranberry Glades (Pocahontas Co.).

WISCONSIN: Dane Co., Grant Co., Washburn Co.

*Culicoides biguttatus* (Coquillett)

ALABAMA: Collbran, Florence, Greenbrier, Moulton, Sheffield, Triana, Wil-son Dam.

CONNECTICUT: East Haddam, Madison, New Haven, South Norwalk, Storrs.

DISTRICT OF COLUMBIA.

GEORGIA: Atlanta, Baker Co., Macon, Savannah.

ILLINOIS: Lyons, Urbana.

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

LOUISIANA: Baton Rouge, Belle Chasse, Braithwaite, Branch, Carlisle, Che-niere Caminada, Covington, Crown Point, Des Allemands, Grand Isle, Hopedale, Hwy. 90 and 190, Indian Camp, Lafitte, Maplewood, New Iberia, New Orleans area, Weeks Island, Welsh, West Lake, West Pointe a la Hache.

MAINE: Ashland, Dennistown, Greenville, Moosehorn, Oxbow, Square Lake, Vasselboro.

MARYLAND: Centreville, Cranesville Pine Swamp, Cunningham Falls State Park, Fairland, Forest Glen, Glenwood, Patuxent Wildlife Refuge, Plummer's Island, Queenstown, Roland Park (Baltimore), Snow Hill, Sparrows Point, Thurmont.

MASSACHUSETTS: Amherst, Merrimacport, Sunderland, Westhampton, Wilm-ington.

MICHIGAN: Cheboygan Co.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co., Washington Co.

MISSOURI: Boone Co., Morgan Co.

NEW JERSEY: Dover, Jockey Hollow, Salem Co.

NEW YORK: Albany Co., Cattaraugus Co., Essex Co., Genesee Co., Hamilton Co., Lewis Co., Livingston Co., Nassau Co., Niagara Co., Orleans Co., Seneca Co., Steuben Co., Suffolk Co., Tompkins Co., Ulster Co., Washington Co.

NORTH CAROLINA: Rowan Co.

OHIO: Deerfield.

PENNSYLVANIA: Coatesville, Fayetteville.

RHODE ISLAND: No location given (Jamnback, 1965).

SOUTH CAROLINA: Jasper Co.

TENNESSEE: Chalhoun, Camden, Chestuee Creek, Dandridge, Dayton, Hales Bar Reservoir, Hollow Rock, Hustburg, Jasper, Kentucky, Reservoir, Lenoir City, Newport, Perryville, Seven Mile Island (Pickwick Reservoir), Sugar Tree.

VERMONT: Laurel Lake, Middlebury.

WEST VIRGINIA: Cranberry Glades.

WISCONSIN: No location given (Anderson *et al.*, 1961), Wisconsin and Black River drainages (DeFoliart *et al.*, 1967)

*Previously unpublished records:*

ARKANSAS: St. Francis Co. (NMNH).

CONNECTICUT: Norwich (NMNH).

DELAWARE: Stanton (NMNH).

GEORGIA: Statesboro (NMNH).

ILLINOIS: Macomb (NMNH).

LOUISIANA: Kilbourne, Mer Rouge (NMNH).

MAINE: Old Town (NMNH).

MARYLAND: Green Spring Valley (NMNH).

MASSACHUSETTS: Fall River, Wayland (NMNH).

MICHIGAN: Nottawa (NMNH).

MISSISSIPPI: Tallahatchie Co. (NMNH).

NEW JERSEY: New Brunswick (NMNH).

PENNSYLVANIA: York (NMNH).

TENNESSEE: Dover (NMNH).

WISCONSIN: Washburn Co. (NMNH).

*Culicoides canadensis* Wirth and Blanton

MAINE: Mt. Desert Island.

MINNESOTA: Itasca State Park.

WISCONSIN: Dane Co.

*Culicoides chiopterus* (Meigen)

CONNECTICUT: Storrs.

LOUISIANA: Baton Rouge, Covington.

MARYLAND: Baltimore, Fairland, Forest Glen, Patuxent Wildlife Refuge, Snow Hill

MICHIGAN: Cheboygan Co.

MISSISSIPPI: Harrison Co., Jackson Co., Pearl River Co.

NEW YORK: Essex Co., Hamilton Co.

*Previously unpublished records:*

MICHIGAN: Brevort (Mackinac Co.—NMNH).

NEW HAMPSHIRE: Bethlehem (NMNH).

*Culicoides crepuscularis* Malloch

ALABAMA: Florence, Tuscaloosa, Wilson Dam.

CONNECTICUT: Madison, Storrs.

GEORGIA: Atlanta, Baker Co., Macon.

ILLINOIS: Dubois, Lyons, St. Joseph, Urbana.

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

LOUISIANA: Alliance, Baton Rouge, Branch, Calcasieu Lock, Carlisle, Cote Blanche, Covington, Crown Point, Cypremort Point, Des Allemands, Estelle, Grand Lake, Hackberry, Haymark Terminal, Hwy. 90 and 190, Indian Camp, Intracoastal Canal, Lafayette, Lafitte, Lydia, Maplewood, New Iberia, New Orleans area, Rockefeller Refuge, Vincent Landing, Weeks Island, Welsh, West Lake.

MAINE: Augusta, Moosehorn, Oxbow.

MARYLAND: Annapolis, Baltimore area, Centreville, Fairland, Patuxent Wildlife Refuge, Queenstown.

MASSACHUSETTS: Amherst, Boston, Martha's Vineyard, Merrimacport North Shore, Sunderland.

MICHIGAN: Cheboygan Co., Muskegon, South Haven.

MINNESOTA: No location given (Wirth, 1952a).

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co., Washington Co.

MISSOURI: Atherton, Boone Co., Morgan Co.

NEW JERSEY: Dias Creek, Jockey Hollow, Madison, Pittstown, Salem Co.

NEW YORK: Albany Co., Chautauqua Co., Genesee Co., Hamilton Co., Jefferson Co., Lewis Co., St. Lawrence Co., Seneca Co., Suffolk Co., Tompkins Co., Wyoming Co.

NORTH CAROLINA: Camden Co., Granville Co., Murphy (Cherokee Co.), Person Co., Warren Co.

OHIO: Knox Co.

RHODE ISLAND: No location given (Jamnback, 1965).

TENNESSEE: Charleston, Chestuee Creek, Dayton, Hustburg, Newport, Paris, Reelfot Lake, Reelfoot Lake Biol. Station, Samburg, Sugar Tree.

VERMONT: Laurel Lake.

WEST VIRGINIA: Monroe Co.

WISCONSIN: Dane Co., no location given (Anderson *et al.*, 1961), Outagamie Co., Richland Co., Rusk Co., Shawano Co., Vernon Co.

*Previously unpublished records:*

CONNECTICUT: Norwich (NMNH).

DELAWARE: Stanton (NMNH).

GEORGIA: Sapelo Island, Savannah (NMNH).

IOWA: Council Bluffs, Sioux City (NMNH).

LOUISIANA: Kilbourne (NMNH).

MASSACHUSETTS: Lexington (NMNH).

MINNESOTA: Burnside, Detroit Lakes (NMNH), Dakota Co. (E. J. Robinson).

TENNESSEE: Douglas Reservoir (NMNH).

WISCONSIN: Shullsburg (Lafayette Co.), Washburn Co. (NMNH).

*Culicoides debilipalpis* Lutz

GEORGIA: Baker Co. (this record is given as *debilipalpis* group by Williams, 1955a, and may refer to *paraensis*).

LOUISIANA: Baton Rouge, Hwy. 90 and 190, Indian Camp, New Orleans area.

MARYLAND: Queenstown, Snow Hill.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

TENNESSEE: Chestuee Creek (this record is given as *debilipalpis* group by Snow and Pickard, 1953).

*Previously unpublished records:*

KENTUCKY: Golden Pond (NMNH).

SOUTH CAROLINA: Batesburg, Myrtle Beach (NMNH).

TENNESSEE: Beaver Dam Creek, Chestuee Creek, Morgan Creek (NMNH).

*Culicoides denticulatus* Wirth and Hubert

CONNECTICUT: Norwich, Storrs.

MARYLAND: Fairland, Queenstown, Snow Hill.

MASSACHUSETTS: Centerville, Truro.

MICHIGAN: Midland.

MINNESOTA: Itasca State Park.

NEW YORK: Cattaraugus Co., Hamilton Co., Lewis Co., Monroe Co., Tompkins Co.

WISCONSIN: Dane Co., Grant Co., Rusk Co., Washburn Co.

*Previously unpublished records:*

MICHIGAN: E. S. George Reserve (Livingston Co. — NMNH).

MINNESOTA: Nine Mile Creek (Hennepin Co. — NMNH). The NMNH specimens from Michigan and Minnesota were labeled as *C. unicolor* but are probably *C. denticulatus*. Jones' (1956, 1961a) species reported as *unicolor* from Wisconsin is actually *denticulatus* (W. W. Wirth, personal communication); whereas, *unicolor* is a western species.



MARYLAND: Baltimore, Fairland, Forest Glen, Patuxent Wildlife Refuge, Snow Hill.

*Culicoides dickei* Jones

NEW YORK: Lewis Co.

WEST VIRGINIA: Cranberry Glades.

WISCONSIN: Washburn Co.

*Culicoides downesi* Wirth and Hubert

MICHIGAN: Cheboygan Co.

NEW YORK: Albany Co., Essex Co., Hamilton Co., Tompkins Co.

*Previously unpublished records:*

MAINE: Big Black River (Aroostook Co. — NMNH).

*Culicoides flukeyi* Jones

NEW YORK: Albany Co., Essex Co., Tompkins Co.

WISCONSIN: Dane Co.

*Culicoides footei* Wirth and Jones

KENTUCKY: No location given (Wirth, 1965).

MARYLAND: Forest Glen, Patuxent Wildlife Refuge.

MISSISSIPPI: Tishomingo.

TENNESSEE: Camden, Morgan Creek, Sugar Tree.

*Previously unpublished records:*

MARYLAND: Snow Hill (NMNH).

*Culicoides furens* (Poey)

CONNECTICUT: Madison.

GEORGIA: Brunswick, Savannah.

LOUISIANA: Alliance, Avery Marsh, Baton Rouge, Belle Chasse, Braithwaite, Buras, Carlisle, Cheniere Caminada, Cote Blanche, Crown Point, Cypressmort Point, Des Allemands, Erath, Estelle, Fort Livingston, Grand Bayou, Grand Isle, Haymark Terminal, Homeplace, Hopedale, Hwy. 90 and 190, Indian Camp, Intracoastal Canal, Intracoastal City, Lafitte, Lake Hermitage, Micheaud, New Orleans area, Oak Grove, Pointe a la Hache, Rockefeller Refuge, Tidewater, Weeks Island, West Pointe a la Hache.

MARYLAND: Centreville, Crisfield, Kent Island, Patuxent Wildlife Refuge, Queenstown.

MASSACHUSETTS: Cape Cod, Cataumet, Martha's Vineyard.

MISSISSIPPI: Hancock Co., Harrison Co., Horn Island, Jackson Co., Pearl River Co.

NEW JERSEY: Cape May, Dias Creek, Estelle Manor, Salem Co.  
NEW YORK: Nassau Co., Suffolk Co.  
NORTH CAROLINA: Brunswick Co., no location given (Hall, 1932).  
RHODE ISLAND: Peacedale.  
SOUTH CAROLINA: Charleston, Jasper Co.

*Previously unpublished records:*

GEORGIA: Sapelo Island (NMNH).  
MARYLAND: Snow Hill (NMNH).  
NEW JERSEY: Cape May Court House (NMNH).  
SOUTH CAROLINA: Bluffton (Beaufort Co. — E. C. Turner, Jr).

*Culicoides furensoides* Williams

MICHIGAN: Cheboygan Co.  
NEW YORK: Monroe Co.

*Culicoides guttipennis* (Coquillett)

ALABAMA: Florence, Greenbrier, Town Creek, Waterloo.  
CONNECTICUT: East Haddam, Storrs.  
GEORGIA: Atlanta, Baker Co., Fort Mtn. (Murray Co.), Macon, Savannah.  
ILLINOIS: Dubois, Grafton, Urbana, White Heath.  
IOWA: Ames.  
KENTUCKY: Golden Pond (Trigg Co.).  
LOUISIANA: Avery Marsh, Baton Rouge, Carlisle, Covington, Houma, Hwy.  
90 and 190, Indian Camp, Kilbourne, New Orleans area, Weeks Island,  
Welsh, West Bay.  
MARYLAND: Baltimore, Centreville, College Park, Cooksville, Fairland, Forest  
City, Forest Glen, Green Spring Valley, Patuxent Wildlife Refuge,  
Plummer's Island.  
MASSACHUSETTS: Boxford, Scituate.  
MICHIGAN: Cheboygan Co., Detroit.  
MINNESOTA: Hennepin Co.  
MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.,  
Pickwick Reservoir, Washington Co.  
MISSOURI: Boone Co., Independence, Morgan Co., Webster Groves.  
NEW JERSEY: Jockey Hollow, Pittstown.  
NEW YORK: Albany Co., Cattaraugus Co., Essex Co., Hamilton Co., St.  
Lawrence Co., Suffolk Co., Tompkins Co., Washington Co.  
OHIO: Ashland Co., Medina.  
PENNSYLVANIA: York.  
TENNESSEE: Bristol, Calhoun, Camden, Chestuee Creek, Dayton, Edgemoor,  
Hustburg, Newport, Perryville, Reelfoot Lake, Reelfoot Lake Biol. Sta-  
tion, Samburg, Sugar Tree.

VERMONT: Laurel Lake.

WISCONSIN: Dane Co., no location given (Anderson *et al.*, 1961), Washburn Co.

*Previously unpublished records:*

ALABAMA: Decatur (NMNH).

ILLINOIS: Scottfield (NMNH).

LOUISIANA: Anthony Ferry (NMNH).

MARYLAND: Snow Hill, Sparrows Point (NMNH).

MISSISSIPPI: Tallahatchie Co. (NMNH).

OHIO: Knox Co. (E. J. Robinson, Jr.).

*Culicoides haematopotus* Malloch

ALABAMA: Florence, Waterloo.

CONNECTICUT: Madison, Storrs.

DISTRICT OF COLUMBIA.

GEORGIA: Atlanta, Baker Co., Macon, Savannah, Thomasville.

ILLINOIS: Lyons, Muncie, Urbana.

LOUISIANA: Avery Marsh, Baton Rouge, Belle Chasse, Berwick, Branch, Carlisle, Cote Blanche, Covington, Crown Point, Des Allemands, Estelle, Hackberry, Haymark Terminal, Hwy. 90 and 190, Indian Camp, Lafayette, Lafitte, Logansport, Lydia, Maplewood, New Iberia, New Orleans area, Vincent Landing, Weeks Island, Welsh, West Lake.

IOWA: Central Iowa (Kardatze and Rowley, 1971).

MAINE: Moosehorn.

MARYLAND: Baltimore, Catoctin State Park, Centreville, Cunningham Falls State Park, Fairland, Forest Glen, Green Spring Valley, Patuxent Wildlife Refuge, Plummer's Island, Queenstown, Thurmont.

MASSACHUSETTS: No location given (Gazeau and Messersmith, 1970b).

MICHIGAN: East Lansing.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

MISSOURI: Boone Co., Morgan Co.

NEW YORK: Cattaraugus Co., Chautauqua Co., Genesee Co., Hamilton Co., Lewis Co., Livingston Co., Monroe Co., St. Lawrence Co., Suffolk Co., Tompkins Co.

NORTH CAROLINA: Camden Co., Caswell Co., Granville Co., Halifax Co., Person Co., Rockingham Co., Warren Co.

OHIO: Deerfield.

PENNSYLVANIA: Coatesville.

SOUTH CAROLINA: Jasper Co.

TENNESSEE: Chestuee Creek, Dayton, Hustburg, Kingsport, Newport, Paris, Reelfoot Lake, Reelfoot Lake Biol. Station, Samburg.

WEST VIRGINIA: Greenbrier Co., Monroe Co.

WISCONSIN: No location given (Anderson *et al.*, 1961), Richland Co., Rusk Co., Shawano Co.

*Previously unpublished records:*

ALABAMA: Talladega Co. (F. V. Battle).

ILLINOIS: Macomb (NMNH).

LOUISIANA: Kilbourne (NMNH).

MARYLAND: Snow Hill (NMNH).

MICHIGAN: Cheboygan Co. (NMNH).

MINNESOTA: Dakota Co. (E. J. Robinson, Jr.).

MISSOURI: Independence (NMNH).

OHIO: Knox Co. (E. J. Robinson, Jr.).

PENNSYLVANIA: Davidsburg (NMNH).

WISCONSIN: Dane Co. (NMNH).

*Culicoides hieroglyphicus* Malloch

The reports of this species from Hot Springs, Arkansas, by Root and Hoffman (1937) and Foote and Pratt (1954) are incorrect, and actually refer to a locality in Arizona by the same name (W. W. Wirth, personal communication).

*Culicoides hinmani* Khalaf

ALABAMA: Sheffield.

LOUISIANA: Baton Rouge, Covington, Crown Point, Estelle, Indian Camp, Lafayette, Lafitte, New Orleans area, Tidewater.

MARYLAND: Forest Glen, Patuxent Wildlife Refuge.

MISSISSIPPI: Hancock Co., Harrison Co.

MISSOURI: Columbia.

NORTH CAROLINA: Cherokee Village, Valley River (Hiwassee Reservoir).

OHIO: No location given (Wirth, 1965).

TENNESSEE: Bluff City, Camden, Maynardville, Perryville, Reelfoot Lake, Samburg, Sugar Tree.

*Previously unpublished records:*

ALABAMA: Decatur, Greenbrier (NMNH).

GEORGIA: Athens (NMNH).

LOUISIANA: Shreveport, Verm River (NMNH).

MINNESOTA: Burnside (NMNH), Dakota Co. (E. J. Robinson, Jr.).

*Culicoides hollensis* (Melandar and Brues)

CONNECTICUT: Madison, Storrs.

DELAWARE: Delaware City, Denkyntville, Odessa.

GEORGIA: Brunswick, Savannah.

LOUISIANA: Alliance, Avery Marsh, Belle Chasse, Berwick, Braithwaite,

Buras, Carlisle, Chalmette, Chef Menteur, Cheniere Caminada, Cote Blanche, Crown Point, Cypremort Point, Des Allemands, Erath, Fort Livingston, Fort Pike, Gentilly, Grand Bayou, Grand Isle, Homeplace, Hopedale, Hwy. 90 and 190, Indian Camp, Intracoastal City, Lafitte, Lake Hermitage, Lydia, Micheaud, New Orleans area, Pointe a la Hache, Rigolets, Shell Beach, Tidewater, Weeks Island, West Pointe a la Hache.

MAINE: Mt. Desert Island, South Harpswell.

MARYLAND: Centreville, Chapel Point, Deal Beach, Kent Island, Ocean City, Queenstown, St. Leonard.

MASSACHUSETTS: Cape Cod, Cataumet, Cranberry Bog, Essex Co., Groton, Hyannisport, Mystic (East Sandwich), Woods Hole.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Ocean Springs, Pass Christian, Pearlinton, Ship Island.

NEW JERSEY: Atlantic City, Salem Co.

NEW YORK: Nassau Co., Suffolk Co.

NORTH CAROLINA: Camp Lejeune (Onslow Co.), Wrightsville (New Hanover Co.).

RHODE ISLAND: Peacedale.

SOUTH CAROLINA: Charleston and vicinity, Ridgeland (Jasper Co.).

*Previously unpublished records:*

CONNECTICUT: Westport (NMNH).

DELAWARE: Dona Landing (NMNH).

GEORGIA: Sapelo Island (NMNH).

MARYLAND: Snow Hill (NMNH).

NEW JERSEY: Dennis, Nixon (Middlesex Co.), Oceanville, Waterwich (NMNH).

SOUTH CAROLINA: Bennett's Point (Colleton Co.), Hunting Island, Lady's Island, Parris Island (NMNH).

*Culicoides jamnbacki* Wirth and Hubert

MICHIGAN: Cheboygan Co.

NEW YORK: Albany Co., Cattaraugus Co., Essex Co., Hamilton Co., Lewis Co., Suffolk Co., Tompkins Co.

*Previously unpublished records:*

MASSACHUSETTS: Merrimacport (NMNH).

*Culicoides loisae* Jamnback

MARYLAND: Patuxent Wildlife Refuge.

NEW YORK: Cattaraugus Co., Hamilton Co., Tompkins Co.

NORTH CAROLINA: Halifax Co., Highlands (Macon Co.).

WEST VIRGINIA: Cranberry River.

*Culicoides melleus* (Coquillett)

CONNECTICUT: Madison.

DELAWARE: No location given (Jamnback, 1965).

GEORGIA: Savannah.

LOUISIANA: No location given (Jamnback, 1965).

MAINE: Mt. Desert Island.

MARYLAND: Centreville, Plummer's Island, Queenstown, South River.

MASSACHUSETTS: Cape Cod, Cataumet, Fall River.

MISSISSIPPI: Hancock Co., Harrison Co., Horn Island, Jackson Co., Pascagoula, Pass Christian, Ship Island.

NEW JERSEY: Jockey Hollow, Salem Co.

NEW YORK: Suffolk Co.

NORTH CAROLINA: Long Beach.

RHODE ISLAND: Kingston, Peacedale.

SOUTH CAROLINA: Charleston and vicinity.

*Previously unpublished records:*

GEORGIA: Sapelo Island (NMNH).

SOUTH CAROLINA: Bluffton (E. C. Turner, Jr.).

*Culicoides mississippiensis* Hoffman

This species is considered synonymous with *C. hollensis* by Fox (1955), but not by Wirth (1965). It is listed separately here pending resolution of the problem.

LOUISIANA: Buras, Chef Menteur, Fort Pike, Gentilly, Grand Bayou, Rigollets, Shell Beach.

MISSISSIPPI: Pass Christian.

*Previously unpublished records:*

ALABAMA: Gulf State Park (NMNH).

LOUISIANA: Lake Hermitage, New Orleans, Pointe a la Hache, West Pointe a la Hache (NMNH).

MISSISSIPPI: Ocean Springs (NMNH).

*Culicoides mulrennani* Beck

MARYLAND: Forest Glen, Snow Hill.

WEST VIRGINIA: Cranberry Glades.

*Previously unpublished records:*

MARYLAND: Beltsville (NMNH).

MASSACHUSETTS: Centerville (NMNH).

MISSISSIPPI: Washington Co. (NMNH).

NEW JERSEY: Jockey Hollow (NMNH).

*Culicoides multipunctatus* Malloch

ALABAMA: Florence.

ILLINOIS: Urbana.

MISSOURI: Columbia.

TENNESSEE: Hustburg, Newport, Reelfoot Lake Biol. Station, Samburg.

*Culicoides nanus* Root and Hoffman

ALABAMA: Florence, Waterloo.

CONNECTICUT: Madison.

GEORGIA: Atlanta, Baker Co., Savannah.

LOUISIANA: Baton Rouge, Covington, Hwy. 90 and 190, Indian Camp, Lafitte, New Orleans area, Weeks Island, Welsh.

MARYLAND: Gwynns Falls Park (Baltimore), Forest Glen.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

MISSOURI: Boone Co., Morgan Co.

SOUTH CAROLINA: Charleston.

TENNESSEE: Paris, Sugar Tree.

WEST VIRGINIA: No location given (Gazeau and Messersmith, 1970b).

WISCONSIN: Dane Co.

*Previously unpublished records:*

ALABAMA: LaPlace near Tuskegee (NMNH).

ILLINOIS: Grafton (NMNH).

KENTUCKY: Morgan Creek (NMNH). This label is probably erroneous; there are numerous records of *Culicoides* from Morgan Creek, Tennessee (which is very near Sugar Tree, one of the collecting sites for this species — see Tennessee above).

LOUISIANA: Kilbourne, Lake Charles (NMNH).

MARYLAND: Snow Hill (NMNH).

*Culicoides niger* Root and Hoffman

CONNECTICUT: Madison.

LOUISIANA: Baton Rouge, Covington, Haymark Terminal, Hwy. 90 and 190, Lafitte, Marrero, Weeks Island.

MARYLAND: Bay Shore near Baltimore, Centreville, Patuxent Wildlife Refuge, Queenstown, Snow Hill.

MASSACHUSETTS: No location given (Wirth, 1965).

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

NEW YORK: Suffolk Co.

SOUTH CAROLINA: Ridgeland (Jasper Co.).

*Previously unpublished records:*

ALABAMA: Gulf State Park (NMNH).

MASSACHUSETTS: Cape Cod (NMNH).

NEW JERSEY: Great Swamp (Morris Co. — NMNH).

*Culicoides obsoletus* group

The records of *obsoletus* given below were taken from papers published before Jamnback and Wirth (1963) revised the *obsoletus* group. Most of the records listed below are probably misidentifications of *sanguisuga*.

ALABAMA: Florence.

DISTRICT OF COLUMBIA.

GEORGIA: Atlanta, Baker Co., Macon.

ILLINOIS: Lyons.

MAINE: Aziscoos Lake, Dennysville, Grand Lake Stream, Greenville, Kellyland, Moosehead Lake, Moosehorn, Mt. Desert Island, Oquossoc, Rangeley Lake, Square Lake.

MARYLAND: Marlboro.

MASSACHUSETTS: Arlington, Berkshire area, Brookline, Cape Cod area, Chester, Goshen, Merrimacport, Montague, North Adams, North Shore, Sherborn, Sturbridge, Westhampton.

MISSOURI: St. Louis.

NEW HAMPSHIRE: Bear River at Hwy. 26, Bethlehem, Bretton Woods, Dixville Notch, Dolly Copp Camp (White Mtns.), First and Third Connecticut Lakes, Franconia, Glen House, Jaffrey, Pike, Warren, West Milan.

NEW JERSEY: Dover.

NEW YORK: Batavia, Bethlehem, Cranberry Lake, Lake George, Sabbath Day, Wilmington Notch.

NORTH CAROLINA: Cherokee, Fontana Village, Murphy.

OHIO: Deerfield, Mechanicsville.

PENNSYLVANIA: Fayetteville, Stone Valley.

SOUTH CAROLINA: Charleston.

TENNESSEE: Athens, Bristol, Chattanooga, Dayton, Gatlinburg, Hustburg, Jasper, Lobelville, Newport, Paris, Parksville, Samburg, Sugar Tree.

VERMONT: Downer State Forest, Groton State Park, Laurel Lake, Maidstone State Park, Moscow, Mt. Holly, North Troy, Pittsfield-Sherbourne, South Troy, Starksboro, Warren.

*Culicoides obsoletus* (Meigen)

The following are records of *C. obsoletus* sensu Jamnback and Wirth, 1963:

CONNECTICUT: Storrs.

INDIANA: Knox Co., Lafayette.

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

MAINE: Ashland, Dennistown, Greenville.



MARYLAND: Baltimore, Centerville, Fairland, Forest Glen, Green Spring Valley, Patuxent Wildlife Refuge, Plummer's Island, Queenstown, Swallow Falls State Park, Woodside.  
 MASSACHUSETTS: Amherst, Centerville.  
 MICHIGAN: Cheboygan Co.  
 MISSOURI: Boone Co., Morgan Co.  
 NEW JERSEY: Jockey Hollow, Pittstown.  
 NEW YORK: Albany Co., Cattaraugus Co., Chautauqua Co., Erie Co., Essex Co., Franklin Co., Genesee Co., Hamilton Co., Herkimer Co., Lewis Co., Livingston Co., St. Lawrence Co., Tompkins Co., Washington Co.  
 NORTH CAROLINA: Lake Junaluska (Haywood Co.).  
 OHIO: Lockwood.  
 PENNSYLVANIA: Coatesville, York.  
 TENNESSEE: Chestuee Creek, Knoxville.  
 WEST VIRGINIA: Cranberry Glades.  
 WISCONSIN: Dane Co., Miss. River floodplain (DeFoliart *et al.*, 1967), Washburn Co.

*Previously unpublished records:*

MAINE: Old Town (NMNH).  
 MARYLAND: Snow Hill (NMNH).  
 OHIO: Knox Co. (E. J. Robinson, Jr.).  
 PENNSYLVANIA: Davidsburg (NMNH).

*Culicoides oklahomensis* Khalaf

LOUISIANA: Baton Rouge, Covington.  
 MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.  
 MISSOURI: Morgan Co.

*Culicoides ousairani* Khalaf

ALABAMA: Atmore, Florence.  
 LOUISIANA: Baton Rouge, Covington, Cypremort Point, Erath, Estelle, Hwy. 90 and 190, Indian Camp, Lafayette, Lafitte, Lake Charles, New Orleans area, Verm River, Vincent Landing, Weeks Island, Welsh.  
 MARYLAND: Centerville, Fairland, Patuxent Wildlife Refuge, Queenstown.  
 MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.  
 PENNSYLVANIA: York.  
 TENNESSEE: Hustburg.

*Previously unpublished records:*

MARYLAND: Forest Glen (NMNH).

*Culicoides paraensis* (Goeldi)

- ALABAMA: Florence, Greenbrier, Moulton, Muscle Shoals, Rogersville, Sheffield, Tuscumbia, Wilson Dam.  
LOUISIANA: Baton Rouge, Belle Chasse, Carlisle, Covington, Crown Point, Hwy. 90 and 190, Indian Camp, Lafitte, Maplewood, New Orleans area, Welsh.  
MARYLAND: Bethesda, Colesville, Forest Glen, Plummer's Island, Silver Spring.  
MISSISSIPPI: Hancock Co., Jackson Co., Pearl River Co., Washington Co.  
MISSOURI: Boone Co.  
NORTH CAROLINA: South Mills.  
OHIO: No location given (Wirth, 1965).  
PENNSYLVANIA: No location given (Wirth, 1965).  
SOUTH CAROLINA: Jasper Co.  
TENNESSEE: Bristol, Camden, Chattanooga, Gatlinburg, Jasper, Maynardville, Perryville, Reelfoot Lake, Samburg, Sugar Tree.  
WEST VIRGINIA: Capon Springs.

*Previously unpublished records:*

- ALABAMA: Cypress Creek, Lookout Mtn. (DeKalb Co.), Red Bay (NMNH).  
MISSISSIPPI: Pickwick Reservoir near Iuka (NMNH).  
PENNSYLVANIA: Davidsburg, York (NMNH).

*Culicoides piliferus* group

The records given below were taken from papers published before Wirth and Hubert (1962) described eight new species from what had previously been known as *C. piliferus* Root and Hoffman.

- ALABAMA: Florence.  
CONNECTICUT: Madison.  
GEORGIA: Atlanta, Baker Co., Macon.  
MAINE: Three Mile Pond.  
MASSACHUSETTS: Amherst.  
NEW YORK: Batavia (Genesee Co.).  
SOUTH CAROLINA: Ridgeland (Jasper Co.).  
TENNESSEE: Big Sandy, Chestuee Creek, Dayton, Hustburg, Washington.

*Culicoides piliferus* Root and Hoffman

- The following are records of *C. piliferus* sensu Wirth and Hubert, 1962:  
CONNECTICUT: Storrs.  
MARYLAND: Fairland, Glenwood, Green Spring Valley, Patuxent Wildlife Refuge, Queenstown, Roland Park (Baltimore), Snow Hill, Thurmont.  
MASSACHUSETTS: Buzzards Bay, Centerville, Falmouth, Merrimacport, Seacoast Shores.

MICHIGAN: Cheboygan Co.

MISSOURI: Boone Co.

NEW JERSEY: Salem Co.

NEW YORK: Albany Co., Cattaraugus Co., Essex Co., Hamilton Co., Livingston Co., Suffolk Co., Tompkins Co., Washington Co.

WEST VIRGINIA: Cranberry Glades.

WISCONSIN: Dane Co., Rusk Co., Washburn Co.

*Previously unpublished records:*

ALABAMA: Atmore (NMNH).

CONNECTICUT: Oxford (NMNH).

IOWA: Preparation Canyon State Park (NMNH).

MASSACHUSETTS: Wayland (NMNH).

*Culicoides pseudopiliferus* Wirth and Hubert

ALABAMA: Florence.

CONNECTICUT: Storrs.

MARYLAND: Bittinger 4-H Club Camp (Garrett Co.), Patuxent Wildlife Refuge, Roland Park (Baltimore), Swallow Falls State Park.

MASSACHUSETTS: Centerville.

MICHIGAN: Roscommon Co.

NEW YORK: Cattaraugus Co., Chautauqua Co., Lewis Co., Schuyler Co., Suffolk Co., Wyoming Co.

SOUTH CAROLINA: Hampton Co., Ridgeland (Jasper Co.).

WISCONSIN: Dane Co., Grant Co., Rusk Co., Washburn Co.

*Previously unpublished records:*

KENTUCKY: Golden Pond (NMNH).

*Culicoides sanguisuga* (Coquillett)

CONNECTICUT: Norwich, Storrs.

DISTRICT OF COLUMBIA.

GEORGIA: Atlanta.

ILLINOIS: Carbondale, Dubois, Grand Tower, St. Joseph, Urbana, White Heath.

INDIANA: Lafayette.

MAINE: Dennistown, Rangeley Lakes, Ship Harbor (Mt. Desert Island), Square Lake, Suerette.

MARYLAND: Baltimore, Catoctin State Park, Fairland, Forest Glen, Green Spring Valley, Marlboro, Plummer's Island, Woodside.

MASSACHUSETTS: Centerville, Merrimacport, Monterey, Sturbridge, Wayland.

MICHIGAN: Cheboygan Co., Clare Co.

MISSOURI: Boone Co., Morgan Co.

NEW HAMPSHIRE: Bear River (Old Spec Mtn.), Dixville Notch, Franconia, Melvin (Clarks Landing), Zealand Camp.  
NEW JERSEY: Jockey Hollow, Pittstown, Salem Co.  
NEW YORK: Albany Co., Cattaraugus Co., Clinton Co., Essex Co., Hamilton Co., Herkimer Co., Jefferson Co., Lewis Co., Livingston Co., Orleans Co., St. Lawrence Co., Tompkins Co., Warren Co., Washington Co.  
NORTH CAROLINA: Balsam (Jackson Co.), Highlands (Macon Co.), Rowan Co.  
OHIO: Mechanicsville.  
PENNSYLVANIA: Davidsburg, Stone Valley, York.  
TENNESSEE: Athens, Chattanooga, Chestuee Creek, Gatlinburg, Overton Co.  
VERMONT: Downer State Forest, Laurel Lake, Maidstone State Park.  
WEST VIRGINIA: Allegheny Mtns., Cranberry Glades, Lost River State Park, Monroe Co.  
WISCONSIN: Shullsburg (Lafayette Co.).

*Previously unpublished records:*

GEORGIA: Rabun (NMNH).  
IOWA: Boone (NMNH).  
MAINE: Ashland, Big Black River (Aroostock Co.), Old Town, Orono (NMNH).  
MICHIGAN: Leelanau Co. (NMNH).  
MISSISSIPPI: Washington Co. (NMNH).  
TENNESSEE: Smoky Mountains National Park (NMNH).

*Culicoides scanloni* Wirth and Hubert

ALABAMA: Greenbrier.  
CONNECTICUT: Storrs.  
MARYLAND: Fairland, Patuxent Wildlife Refuge.  
MASSACHUSETTS: Centerville.  
MISSOURI: Morgan Co.  
NEW YORK: Suffolk Co.  
SOUTH CAROLINA: Ridgeland (Jasper Co.).

*Previously unpublished records:*

ALABAMA: Atmore (NMNH).  
MICHIGAN: Cheboygan Co. (NMNH).

*Culicoides snowi* Wirth and Jones

ALABAMA: Blackwell Swamp, Greenbrier.  
GEORGIA: Isle of Hope near Savannah.  
ILLINOIS: Grafton.  
MARYLAND: College Park, Plummer's Island, Snow Hill.  
MISSISSIPPI: Tishomingo.

TENNESSEE: Carter's Mill (Knoxville), Morgan Creek.

WEST VIRGINIA: Lost River State Park.

*Previously unpublished records:*

TENNESSEE: Chestuee Creek (NMNH).

*Culicoides sphagnumensis* Williams

MICHIGAN: Cheboygan Co.

NEW YORK: Essex Co., Hamilton Co., Suffolk Co.

WISCONSIN: No location given (Wirth, 1965).

*Previously unpublished records:*

MINNESOTA: Burnside (NMNH).

WISCONSIN: Washburn Co. (NMNH).

*Culicoides spinosus* Root and Hoffman

ALABAMA: Florence, Moulton, Wilson Dam.

CONNECTICUT: No location given (Lewis, 1959).

DELAWARE: No location given (Gazeau and Messersmith, 1970b).

GEORGIA: No location given (Gazeau and Messersmith, 1970b).

ILLINOIS: No location given (Gazeau and Messersmith, 1970b).

LOUISIANA: Alliance, Avery Marsh, Baton Rouge, Calcasieu Lock, Covington, Crown Point, Haymark Terminal, Hwy. 90 and 190, Indian Camp, Intracoastal Canal, Maplewood, New Orleans area, Vincent Landing, Welsh, West Lake.

MARYLAND: Centreville, Fairland, Patuxent Wildlife Refuge, Plummer's Island, Queenstown, Roland Park (Baltimore), Snow Hill, Thurmont.

MASSACHUSETTS: Merrimacport.

MICHIGAN: No location given (Gazeau and Messersmith, 1970b).

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

MISSOURI: Boone Co., Morgan Co.

NEW JERSEY: Jockey Hollow.

NEW YORK: Cattaraugus Co., Chautauqua Co., Genesee Co., Hamilton Co., Jefferson Co., Lewis Co., Livingston Co., Monroe Co., Orleans Co., Schuyler Co., Tompkins Co.

NORTH CAROLINA: Andrews (Cherokee Co.), Granville Co., Person Co., Warren Co.

OHIO: No location given (Gazeau and Messersmith, 1970b).

PENNSYLVANIA: No location given (Gazeau and Messersmith, 1970b).

SOUTH CAROLINA: Near Grays (Jasper Co.).

TENNESSEE: Camden, Hollow Rock, Hustburg, Kentucky Reservoir, Reelfoot Lake, Samburg, Sugar Tree.

WEST VIRGINIA: Cranberry Glades (Pocahontas Co.), Summers Co.

WISCONSIN: Richland Co., Shawano Co., Vernon Co.

*Previously unpublished records:*

ALABAMA: Decatur, Greenbrier, Gulf State Park (NMNH).  
CONNECTICUT: Norwich, Storrs (NMNH).  
MASSACHUSETTS: Amherst, Centerville, Wayland (NMNH).  
MICHIGAN: Mackinac (NMNH).  
MISSISSIPPI: Washington Co. (NMNH).  
PENNSYLVANIA: Davidsburg (NMNH).  
TENNESSEE: Chestuee Creek (NMNH).  
WISCONSIN: Dane Co. (NMNH).

*Guilcoides stellifer* (Coquillett)

ALABAMA: Florence, Tuscaloosa, Wright (Lauderdale Co.).  
CONNECTICUT: East Haddam, Madison, Storrs.  
DELAWARE: Port Penn.  
DISTRICT OF COLUMBIA.  
GEORGIA: Atlanta, Baker Co., Hancock Co., Macon, Savannah, Thomasville.  
IOWA: Central Iowa (Kardatzke and Rowley, 1971).  
ILLINOIS: Lyons, Urbana, White Heath.  
KENTUCKY: McCarr.  
LOUISIANA: Avery Marsh, Baton Rouge, Branch, Carlisle, Covington, Crown Point, Des Allemands, Estelle, Grand Lake, Hopedale, Hwy. 90 and 190, Indian Camp, Lafayette, New Orleans area, Vincent Landing, Weeks Island, Welsh, West Lake.  
MARYLAND: Baltimore, Beltsville, Centreville, Cranesville Pine Swamp, Fairland, Forest Glen, Glenwood, Green Spring Valley, Herrington Manor, Patuxent Wildlife Refuge, Plummer's Island, Queenstown, Snow Hill.  
MASSACHUSETTS: Amherst, Merrimacport.  
MICHIGAN: Cheboygan Co., South Haven.  
MISSISSIPPI: Corinth (Alcorn Co.), Hancock Co., Harrison Co., Jackson Co., Pearl River Co.  
MISSOURI: Boone Co., Morgan Co.  
NEW JERSEY: Jockey Hollow, Pittstown, Salem Co.  
NEW YORK: Albany Co., Genesee Co., Hamilton Co., Lewis Co., Schuyler Co., Suffolk Co., Tompkins Co., Washington Co.  
NORTH CAROLINA: Camden Co., Halifax Co., Murphy (Cherokee Co.), Person Co., Vance Co., Warren Co.  
OHIO: Deerfield, Zanesville.  
PENNSYLVANIA: Fayetteville, Philipsburg.  
SOUTH CAROLINA: Eutawville, Jasper Co.  
TENNESSEE: Athens, Chestuee Creek, Clarksville, Dayton, Hustburg, Lobelville, Newport, Norris.  
WEST VIRGINIA: Monroe Co.

WISCONSIN: No location given (Anderson *et al.*, 1961), Richland Co., Vernon Co.

*Previously unpublished records:*

ALABAMA: Atmore, Wilson Lake (NMNH).

CONNECTICUT: Norwich (NMNH).

LOUISIANA: Grand Isle, Kilbourne (NMNH).

MARYLAND: Middle River (NMNH).

MASSACHUSETTS: Centerville, Lexington, Wayland (NMNH).

MISSISSIPPI: Washington Co. (NMNH).

NEW JERSEY: New Brunswick (NMNH).

OHIO: Knox Co. (E. J. Robinson, Jr.), South Zanesville (NMNH).

PENNSYLVANIA: York (NMNH).

WISCONSIN: Dane Co., Washburn Co. (NMNH).

*Culicoides stilobezzioides* Foote and Pratt

MINNESOTA: Itasca State Park.

NEW YORK: Essex Co., Lewis Co., St. Lawrence Co., Tompkins Co.

WISCONSIN: Dane Co.

*Previously unpublished records:*

MINNESOTA: Burnside (NMNH).

*Culicoides testudinalis* Wirth and Hubert

CONNECTICUT: Madison, Norwich, Storrs.

MARYLAND: Fairland, Patuxent Wildlife Refuge.

MASSACHUSETTS: Amherst, Centerville, Merrimacport.

NEW JERSEY: Pittstown.

NEW YORK: Tompkins Co.

PENNSYLVANIA: Coburn (Centre Co.), Conewago Creek (13 mi. west of York).

WISCONSIN: Grant Co., Rusk Co., Washburn Co.

*Previously unpublished records:*

KENTUCKY: Golden Pond (NMNH).

MARYLAND: Snow Hill (NMNH).

MICHIGAN: Cheboygan Co. (NMNH).

*Culicoides tissoti* Wirth and Blanton

MARYLAND: Snow Hill.

SOUTH CAROLINA: Gillisonville (Jasper Co.).

*Culicoides travisi* Vargas

ALABAMA: Florence, Greenbrier, Sheffield Wilson Dam.

CONNECTICUT: No location given (Lewis, 1959).

GEORGIA: Atlanta, Baker Co., Macon.  
 IOWA: Central Iowa (Kardatzke and Rowley, 1971).  
 LOUISIANA: Baton Rouge, Branch, Carlisle, Covington, Hwy. 90 and 190,  
 Indian Camp, Lafitte, Lydia, New Iberia, New Orleans area, Weeks  
 Island, Welsh.  
 MARYLAND: Centreville, College Park, Forest Glen, Green Spring Valley,  
 Patuxent Wildlife Refuge, Queenstown, Roland Park (Baltimore).  
 MASSACHUSETTS: Merrimacport.  
 MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.,  
 Washington Co.  
 MISSOURI: Boone Co., Morgan Co.  
 NEW YORK: Albany Co., Cattaraugus Co., Genesee Co., Lewis Co., Livingston  
 Co., Monroe Co., Orleans Co., Seneca Co., Steuben Co., Tompkins Co.,  
 Washington Co.  
 OHIO: Deerfield.  
 PENNSYLVANIA: Fayetteville.  
 SOUTH CAROLINA: No location given (Wirth, 1965).  
 TENNESSEE: Camden, Chestuee Creek, Dayton, Hustburg, Kentucky Res-  
 ervoir, Newport, Paris, Reelfoot Lake, Reelfoot Lake Biol. Station, Sam-  
 burg, Springville, Sugar Tree.  
 WEST VIRGINIA: Cranberry River, Monroe Co.  
 WISCONSIN: Richland Co.

*Previously unpublished records:*

ALABAMA: Decatur (NMNH).  
 ARKANSAS: St. Francis Co. (NMNH).  
 ILLINOIS: Macomb (NMNH).  
 KENTUCKY: Golden Pond (NMNH).  
 LOUISIANA: Kilbourne (NMNH).  
 MARYLAND: Snow Hill (NMNH).  
 MASSACHUSETTS: Centerville (NMNH).  
 MICHIGAN: Cheboygan Co., Wayne Co. (NMNH).  
 MINNESOTA: Burnside (NMNH), Dakota Co. (E. J. Robinson, Jr.).  
 MISSISSIPPI: State College (NMNH).  
 OHIO: Knox Co. (E. J. Robinson, Jr.).  
 PENNSYLVANIA: Conewago Creek, Davidsburg (NMNH).  
 SOUTH CAROLINA: Ridgeland (NMNH).  
 TENNESSEE: Birdsong Creek, Dover, Nashville (NMNH).  
 WISCONSIN: Dane Co., Grant Co. (NMNH).

*Culicoides unicolor* (Coquillett)

See *C. denticulatus* Wirth and Hubert.



*Culicoides utowana* Jamnback

NEW YORK: Hamilton Co.

*Culicoides variipennis australis* Wirth and Jones

LOUISIANA: Baton Rouge.

MISSOURI: Petersburg (Howard Co.).

SOUTH CAROLINA: Charleston.

*Previously unpublished records:*

GEORGIA: Savannah (NMNH).

*Culicoides variipennis sonorensis* Wirth and Jones

MISSOURI: Boone Co.

TENNESSEE: Paris.

*Culicoides variipennis variipennis* (Coquillett)

ALABAMA: Flatwood (Wilcox Co.).

DELAWARE: Dona Landing.

GEORGIA: Macon, Savannah.

ILLINOIS: Dubois.

INDIANA: Lafayette.

LOUISIANA: Kilbourne.

MARYLAND: Beltsville, Brinklow.

MICHIGAN: No location given (Wirth and Jones, 1957).

MINNESOTA: No location given (Wirth and Jones, 1957).

MISSISSIPPI: No location given (Wirth and Jones, 1957).

MISSOURI: Boone Co., Kirkwood, Morgan Co.

NEW HAMPSHIRE: No location given (Jamnback, 1965).

NEW JERSEY: New Brunswick, Salem Co.

NEW YORK: Essex Co., Hamilton Co., Suffolk Co., Tompkins Co.

OHIO: Lockwood.

TENNESSEE: Hustburg.

WISCONSIN: Dane Co., Grant Co., Richland Co., Rusk Co., Washburn Co.

*Previously unpublished records:*

GEORGIA: Atlanta (NMNH).

ILLINOIS: Urbana (NMNH).

IOWA: Ames (NMNH).

MARYLAND: Baltimore, Forest Glen (NMNH).

MISSISSIPPI: Washington Co. (NMNH).

MISSOURI: Atherton (NMNH).

NEW JERSEY: Westville (NMNH).

OHIO: Wooster (NMNH).

SOUTH CAROLINA: Charleston (NMNH).

WISCONSIN: Shullsburg (Lafayette Co.—NMNH).

*Culicoides variipennis* (Coquillett), *subspecies not known*

These records were taken either from papers published prior to the Wirth and Jones, 1957, study of the *variipennis* complex, or from publications in which the author(s) did not report the subspecies. When a particular subspecies is known from a given location, that location is not listed again below.

ALABAMA: Florence.

ARKANSAS: Hot Springs.

CONNECTICUT: Madison.

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

ILLINOIS: Ashley, Carmi, Centralia, Cuba, Manchester, Normal, St. Joseph.

LOUISIANA: Alliance, Avery Marsh, Berwick, Braithwaite, Branch, Cheniere Caminada, Covington, Crown Point, Cypremort Point, Erath, Fort Livingston, Grand Lake, Hackberry, Hopedale, Hwy. 90 and 190, Indian Camp, Intracoastal City, Lydia, New Iberia, New Orleans area, Weeks Island, Welsh, West Lake.

MARYLAND: Centreville, Downsville, Fairland, Patuxent Wildlife Refuge, Queenstown.

MASSACHUSETTS: Truro.

MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

NEW HAMPSHIRE: Franconia.

OHIO: Deerfield.

TENNESSEE: Charleston, Chattanooga, Chestuee Creek, Dayton, Perryville.

WEST VIRGINIA: Monroe Co.

*Culicoides venustus* Hoffman

ALABAMA: Florence, Tuscaloosa.

CONNECTICUT: East Haddam, no location given (Lewis, 1959).

DELAWARE: Odessa.

GEORGIA: Atlanta, Baker Co., Hiawasse, Macon, Thomasville.

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

LOUISIANA: Alliance, Avery, Marsh, Baton Rouge, Covington, Homeplace, Hwy. 90 and 190, Indian Camp, New Orleans area, Welsh.

MARYLAND: Baltimore, Beltsville, Centreville, Fairland, Green Spring Valley, Patuxent Wildlife Refuge, Queenstown, Snow Hill.

MASSACHUSETTS: Cascade (North Adams), Merrimacport.

MICHIGAN: Cheboygan Co.

MISSISSIPPI: Charleston (Tallahatchie Co.), Hancock Co., Harrison Co., Jackson Co., Pearl River Co.

MISSOURI: Boone Co., Morgan Co.  
 NEW JERSEY: Jockey Hollow, Pittstown Salem Co.  
 NEW YORK: Albany Co., Cattaraugus Co., Chautauqua Co., Lewis Co.,  
 Rensselaer Co., St. Lawrence Co., Schuyler Co., Tompkins Co., Wash-  
 ington Co.  
 NORTH CAROLINA: Camp Davis, Murphy.  
 OHIO: Deerfield, Lockwood.  
 PENNSYLVANIA: Coatesville.  
 SOUTH CAROLINA: Near Grays (Jasper Co.).  
 TENNESSEE: Chestuee Creek, Dayton, Hustburg, Knoxville, Newport, Reel-  
 foot Lake Biol. Station, Samburg.  
 VERMONT: Laurel Lake.  
 WISCONSIN: No location given (Anderson *et al.*, 1961), Richland Co.

*Previously unpublished records:*

CONNECTICUT: Norwich (NMNH).  
 ILLINOIS: Macomb (NMNH).  
 INDIANA: Lafayette (NMNH).  
 LOUISIANA: Kilbourne (NMNH).  
 MISSOURI: Charleston (Mississippi Co.—NMNH).  
 OHIO: Knox Co. (E. J. Robinson, Jr.).  
 SOUTH CAROLINA: Ridgeland (Jasper Co.—NMNH).  
 WISCONSIN: Dane Co., Shullsburg (Lafayette Co.—NMNH).

*Culicoides villosipennis* Root and Hoffman

ALABAMA: Cherokee, Florence, Greenbrier.  
 CONNECTICUT: Madison, Storrs.  
 GEORGIA: Atlanta, Baker Co., DeKalb Co., Jonesboro, Macon, Thomasville.  
 IOWA: Ames.  
 KENTUCKY: Fulton, Golden Pond.  
 LOUISIANA: Baton Rouge, Covington, Hwy. 90 and 190, Indian Camps,  
 Kilbourne, Lafayette, Lake Charles, New Orleans area, Verm River, Weeks  
 Island, Welsh.  
 MAINE: Sebago Lake State Park.  
 MARYLAND: Baltimore, Centreville, Cooksville, Fairland, Forest Glen, Glen-  
 wood, Green Spring Valley, Patuxent Refuge, Plummer's Island, Queens-  
 town, Sparrows Point.  
 MASSACHUSETTS: Amherst, Centerville, Martha's Vineyard.  
 MICHIGAN: Cheboygan Co.  
 MISSISSIPPI: Hancock Co., Harrison Co., Jackson Co., Pearl River Co.  
 MISSOURI: Boone Co., Morgan Co.  
 NEW JERSEY: Jocky Hollow, Pittstown, Salem Co.  
 NEW YORK: Albany Co., Essex Co., Hamilton Co., Suffolk Co.

PENNSYLVANIA: York.

TENNESSEE: Athens, Chestuee Creek, Dayton, Dover, Hustburg, Newport, Sugar Tree.

WISCONSIN: No location given (Anderson *et al.*, 1961), Sauk Co., Washburn Co.

*Previously unpublished records:*

CONNECTICUT: Manchester (NMNH).

OHIO: Wooster (NMNH).

*Culicoides wisconsinensis* Jones

IOWA: Central Iowa (Kardatzke and Rowley, 1971).

MICHIGAN: No location given (Wirth, 1965).

NEW YORK: Onondaga Co., Seneca Co.

WISCONSIN: Dane Co.

*Previously unpublished records:*

WISCONSIN: Washburn Co. (NMNH).

*Culicoides yukonensis* Hoffman

Jones' (1956) report of this species from Wisconsin actually refers to *C. canadensis* Wirth and Blanton; *yukonensis* is considered by Wirth and Blanton (1969b) to be limited to Alaska and northwest Canada.

SUMMARY: The following is a list of the *Culicoides* species and species groups reported from each state (and the District of Columbia) in the present paper.

ALABAMA: *arboricola*, *baueri*, *beckae*, *biguttatus*, *crepuscularis*, *guttipennis*, *haematopotus*, *hinmani*, *mississippiensis*, *multipunctatus*, *nanus*, *niger*, *obsoletus* group, *ousairani*, *paraensis*, Piliferus group, *piliferus*, *pseudopiliferus*, *scanloni*, *snowi*, *spinosus*, *stellifer*, *travisi*, *variipennis* *variipennis*, (ssp. not given), *venustus*, *villosipennis*.

ARKANSAS: *biguttatus*, *travisi*, *variipennis* (ssp. not given).

CONNECTICUT: *alexanderi*, *arboricola*, *baueri*, *bickleyi*, *biguttatus*, *chiopterus*, *crepuscularis*, *denticulatus*, *furens*, *guttipennis*, *haematopotus*, *hollensis*, *melleus*, *nanus*, *niger*, *obsoletus*, Piliferus group, *piliferus*, *pseudopiliferus*, *sanguisuga*, *scanloni*, *spinosus*, *stellifer*, *testudinalis*, *travisi*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.

DELAWARE: *biguttatus*, *crepuscularis*, *hollensis*, *melleus*, *spinosus*, *stellifer*, *variipennis* *variipennis*, *venustus*.

DISTRICT OF COLUMBIA: *biguttatus*, *haematopotus*, *Obsoletus* group, *sanguisuga*, *stellifer*.

GEORGIA: *arboricola*, *baueri*, *bermudensis*, *biguttatus*, *crepuscularis*, *Debilipalpis* group, *furens*, *guttipennis*, *haematopotus*, *hinmani*, *hollensis*, *melleus*, *nanus*, *Obsoletus* group, Piliferus group, *sanguisuga*, *snowi*, *spinosus*, *stel-*

- lifer, travisi, variipennis australis, variipennis variipennis, variipennis* (ssp. not given), *venustus, villosipennis*.
- IOWA: *biguttatus, crepuscularis, guttipennis, haematopotus, obsoletus, piliferus, sanguisuga, stellifer, travisi, variipennis variipennis, variipennis* (ssp. not given), *venustus, villosipennis, wisconsinensis*.
- ILLINOIS: *arboricola, biguttatus, crepuscularis, guttipennis, haematopotus, multipunctatus, nanus, Obsoletus group, sanguisuga, snowi, spinosus, stellifer, travisi, variipennis variipennis, variipennis* (ssp. not given), *venustus*.
- INDIANA: *obsoletus, sanguisuga, variipennis variipennis, variipennis* (ssp. not given), *venustus*.
- IOWA: *crepuscularis, guttipennis, piliferus, sanguisuga, variipennis variipennis, villosipennis*.
- KENTUCKY: *alexanderi, arboricola, debilipalpis, footei, guttipennis, pseudopiliferus, stellifer, testudinalis, travisi, villosipennis*.
- LOUISIANA: *arboricola, baueri, bermudensis, bickleyi, biguttatus, chiopterus, crepuscularis, debilipalpis, furens, guttipennis, haematopotus, hinmani, hollensis, melleus, mississippiensis, nanus, niger, oklahomensis, ousairani, paraensis, spinosus, stellifer, travisi, variipennis australis, variipennis variipennis, variipennis* (ssp. not given), *venustus, villosipennis*.
- MAINE: *biguttatus, canadensis, crepuscularis, downesi, haematopotus, hollensis, melleus, Obsoletus group, obsoletus, piliferus group, sanguisuga, villosipennis*.
- MARYLAND: *alexanderi, arboricola, baueri, beckae, bickleyi, biguttatus, chiopterus, crepuscularis, debilipalpis, denticulatus, footei, furens, guttipennis, haematopotus, hinmani, hollensis, loisae, melleus, mulrennani, nanus, niger, Obsoletus group, obsoletus, ousairani, paraensis, piliferus, pseudopiliferus, sanguisuga, scanloni, snowi, spinosus, stellifer, testudinalis, tissoti, travisi, variipennis variipennis, variipennis* (ssp. not given), *venustus, villosipennis*.
- MASSACHUSETTS: *alexanderi, bickleyi, biguttatus, crepuscularis, denticulatus, furens, guttipennis, haematopotus, hollensis, jamnbacki, melleus, mulrennani, niger, Obsoletus group, obsoletus, piliferus group, piliferus, pseudopiliferus, sanguisuga, scanloni, spinosus, stellifer, testudinalis, travisi, venustus, villosipennis*.
- MICHIGAN: *alexanderi, bickleyi, biguttatus, chiopterus, crepuscularis, denticulatus, downesi, furensoides, guttipennis, haematopotus, jamnbacki, obsoletus, piliferus, pseudopiliferus, sanguisuga, scanloni, sphagnumensis, spinosus, stellifer, testudinalis, travisi, variipennis variipennis, venustus, villosipennis, wisconsinensis*.
- MINNESOTA: *arboricola, canadensis, crepuscularis, denticulatus, guttipennis, haematopotus, hinmani, sphagnumensis, stilobezzioides, travisi, variipennis variipennis*.

- MISSISSIPPI: *arboricola*, *baueri*, *bermudensis*, *bickleyi*, *biguttatus*, *chiopterus*, *crepuscularis*, *debilipalpis*, *footei*, *furens*, *guttipennis*, *haematopotus*, *hinmani*, *hollensis*, *melleus*, *mississippiensis*, *mulrennani*, *nanus*, *niger*, *oklahomensis*, *ousairani*, *paraensis*, *sanguisuga*, *snorwi*, *spinosus*, *stellifer*, *travisi*, *variipennis variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.
- MISSOURI: *arboricola*, *baueri*, *biguttatus*, *crepuscularis*, *guttipennis*, *haematopotus*, *hinmani*, *multipunctatus*, *nanus*, *obsoletus* group, *obsoletus*, *oklahomensis*, *paraensis*, *piliferus*, *sanguisuga*, *scanloni*, *spinosus*, *stellifer*, *travisi*, *variipennis australis*, *variipennis sonorensis*, *variipennis variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.
- NEW HAMPSHIRE: *chiopterus*, *Obsoletus* group, *sanguisuga*, *variipennis variipennis*, *variipennis* (ssp. not given).
- NEW JERSEY: *arboricola*, *baueri*, *biguttatus*, *crepuscularis*, *furens*, *guttipennis*, *hollensis*, *melleus*, *mulrennani*, *niger*, *Obsoletus* group, *obsoletus*, *piliferus*, *sanguisuga*, *spinosus*, *stellifer*, *testudinalis*, *variipennis variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.
- NEW YORK: *alexanderi*, *arboricola*, *baueri*, *bermudensis*, *bickleyi*, *biguttatus*, *chiopterus*, *crepuscularis*, *denticulatus*, *dickei*, *downesi*, *flukei*, *furens*, *furensoides*, *guttipennis*, *haematopotus*, *hollensis*, *jamnbacki*, *loisae*, *melleus*, *niger*, *Obsoletus* group, *obsoletus*, *Piliferus* group, *piliferus*, *pseudopiliferus*, *sanguisuga*, *scanloni*, *sphagnumensis*, *spinosus*, *stellifer*, *stilobezzioides*, *testudinalis*, *travisi*, *utowana*, *variipennis variipennis*, *venustus*, *villosipennis*, *wisconsinensis*.
- NORTH CAROLINA: *baueri*, *biguttatus*, *crepuscularis*, *furens*, *haematopotus*, *hinmani*, *hollensis*, *loisae*, *melleus*, *Obsoletus* group, *obsoletus*, *paraensis*, *sanguisuga*, *spinosus*, *stellifer*, *venustus*.
- OHIO: *biguttatus*, *crepuscularis*, *guttipennis*, *haematopotus*, *hinmani*, *obsoletus* group, *obsoletus*, *paraensis*, *sanguisuga*, *spinosus*, *stellifer*, *travisi*, *variipennis variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.
- PENNSYLVANIA: *arboricola*, *biguttatus*, *guttipennis*, *haematopotus*, *obsoletus* group, *obsoletus*, *ousairani*, *paraensis*, *sanguisuga*, *spinosus*, *stellifer*, *testudinalis*, *travisi*, *venustus*, *villosipennis*.
- RHODE ISLAND: *biguttatus*, *crepuscularis*, *furens*, *hollensis*, *melleus*.
- SOUTH CAROLINA: *bickleyi*, *biguttatus*, *debilipalpis*, *furens*, *haematopotus*, *hollensis*, *melleus*, *nanus*, *niger*, *obsoletus* group, *paraensis*, *Piliferus* group, *pseudopiliferus*, *scanloni*, *spinosus*, *stellifer*, *tissoti*, *travisi*, *variipennis australis*, *variipennis variipennis*, *venustus*.
- TENNESSEE: *alexanderi*, *arboricola*, *baueri*, *biguttatus*, *crepuscularis*, *Debilipalpis* group, *debilipalpis*, *footei*, *guttipennis*, *haematopotus*, *hinmani*, *multipunctatus*, *nanus*, *Obsoletus* group, *obsoletus*, *ousairani*, *paraensis*, *piliferus* group, *sanguisuga*, *snowi*, *spinosus*, *stellifer*, *travisi*, *variipennis sonorensis*, *variipennis variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*.

- VERMONT: *biguttatus*, *crepuscularis*, *guttipennis*, *obsoletus* group, *sanguisuga*, *venustus*.
- VIRGINIA: See text.
- WEST VIRGINIA: *baueri*, *bickleyi*, *biguttatus*, *crepuscularis*, *dickei*, *haematopodus*, *loisae*, *mulrennani*, *nanus*, *obsoletus*, *paraensis*, *piliferus*, *sanguisuga*, *snowi*, *spinosus*, *stellifer*, *travisi*, *variipennis* (ssp. not given).
- WISCONSIN: *arboricola*, *baueri*, *bickleyi*, *biguttatus*, *canadensis*, *crepuscularis*, *denticulatus*, *dickei*, *flukei*, *guttipennis*, *haematopodus*, *nanus*, *obsoletus*, *piliferus*, *pseudopiliferus*, *sanguisuga*, *sphagnumensis*, *spinosus*, *stellifer*, *stilobezzioides*, *testudinalis*, *travisi*, *variipennis* *variipennis*, *variipennis* (ssp. not given), *venustus*, *villosipennis*, *wisconsinensis*.

## LITERATURE CITED

- ADAMS, C. F. 1940. A preliminary list of the Chironomidae (midges) of Missouri. Proc. Mo. Acad. Sci. 5: 124-127.
- ANDERSON, J. R., et al. 1961. Isolation of eastern encephalitis virus from Diptera in Wisconsin. Mosq. News 21: 244-248.
- ARNAUD, P. H. JR. 1956. The heleid genus *Culicoides* in Japan, Korea, and Ryukyu Islands (Insecta: Diptera). Microentomol. 21: 84-207.
- ..... and W. W. WIRTH. 1964. A name list of world *Culicoides*, 1956-1962. Proc. Entomol. Soc. Wash. 66: 19-32.
- ATCHLEY, W. R. 1967. The *Culicoides* of New Mexico (Diptera: Ceratopogonidae). Univ. Kan. Sci. Bull. 46: 937-1022.
- BATTLE, F. V., and E. C. TURNER, JR. 1969. New records of Virginia *Culicoides* (Diptera: Ceratopogonidae). Va. J. Sci. 20: 44-46.
- ..... 1970a. *Culicoides* (Diptera: Ceratopogonidae) reared from breeding site collections in North Carolina with a summary of the species occurring in that state. Mosq. News 30(3): 425-427.
- ..... 1970b. A synopsis of the *Culicoides* (Diptera: Ceratopogonidae) of West Virginia with new state records. Va. J. Sci. 21: 57-58.
- BECK, E. C. 1952. Notes on the distribution of *Culicoides* in Florida (Diptera: Ceratopogonidae). Fla. Entomol. 35: 101-107.
- ..... 1956. A new species of *Culicoides* from Florida with additional distribution data for the genus (Diptera: Heleidae). Fla. Entomol. 39: 133-138.
- ..... 1957. Two new species of *Culicoides* from Florida (Diptera: Heleidae). Fla. Entomol. 40: 103-105.
- ..... 1958. A population study of the *Culicoides* of Florida (Diptera: Heleidae). Mosq. News 18: 6-11.
- BREELAND, S. G. 1960. Observations on the breeding habitats of some *Culicoides* and other Heleidae in the Panama Canal Zone (Diptera). Mosq. News 20: 161-167.
- BURBUTIS, P. P., and D. M. JOBBINS. 1964. Notes on the *Culicoides* of New Jersey. Mosq. News 24: 447-448.
- CALLOT, J., M. KREMER, and M. BASSETT. 1967. Note faunistique sur les *Culicoides* (Dipteres: Ceratopogonides) de la Republique du Senegal. Ann. Parasitol. Hum. Comp. 42: 545-546.

- ..... 1968. *Culicoides marclei* n. sp. et nouvelles localisations de *Culicoides* (Dipteres: Ceratopogonides) de la region Mediterraneenne et particulierement d'Algerie. Bull. Soc. Pathol. Exot. 61: 271-282.
- ....., M. KREMER, and Y. BRAVERMAN. 1969. Note sur des *Culicoides* recoltes en Israel (Diptera: Ceratopogonidae). Bull. Soc. Pathol. Exot. 62: 118-123.
- ....., M. KREMER, and J. BRUNHES. 1968. Etude de *Styloconops spinosifrons* et de *Culicoides* entomophages (Dipteres: Ceratopogonides) dont certains sont nouveaux pour la faune de Madagascar. Cah. O. R. S. T. O. M., ser. Ent. Med. 6: 103-112.
- ....., M. KREMER, and B. MOLET. 1967. Ceratopogonides (Dipteres) de la Region Ethiopienne et particulierement d'Angola. Pub. Cult. Co. Diam. Angola. P. 37-44.
- CAMPBELL, J. A., and E. C. PELHAM-CLINTON. 1960. A taxonomic review of the British species of *Culicoides* Latreille (Diptera: Ceratopogonidae). Proc. Roy. Soc. Edinburgh 67(B): 181-302.
- CARPENTER, S. J. 1951. Studies of *Culicoides* in the Panama Canal Zone (Diptera: Heleidae). Mosq. News 11: 202-208.
- CARTER, H. F. 1916. On three new African midges. Ann. Trop. Med. Parasitol. 10: 131-138.
- ..... 1919. New West African Ceratopogoninae. Ann. Trop. Med. Parasitol. 12: 289-302.
- ....., A. INGRAM, and J. W. S. MACFIE. 1920. Observations on the Ceratopogonine midges of the Gold Coast with descriptions of new species. I-II. Ann. Trop. Med. Parasitol. 14: 187-274.
- CAUSEY, O. R. 1938. *Culicoides* of Siam with descriptions of new species. Amer. J. Hyg. 27: 399-416.
- CHILDERS, C. C., and C. W. WINGO. 1968. Genus *Culicoides* (Diptera: Ceratopogonidae) in central Missouri. Mo. Agr. Exp. Sta. Res. Bull. 934: 32 p.
- CLASTRIER, J. 1957. Notes sur les Ceratopogonides. II. Quelques *Culicoides* d'Algerie a ailes tachetees. Arch. Inst. Pasteur d'Algerie 35: 404-444.
- ..... 1958a. Notes sur les Ceratopogonides. III. *Culicoides semimaculatus* n. sp., d'Algerie. Arch. Inst. Pasteur d'Algerie 36: 55-60.
- ..... 1958b. Notes sur les Ceratopogonides. IV. Ceratopogonides d'Afrique Occidentale Francaise. Arch. Inst. Pasteur d'Algerie 36: 192-258.
- ..... 1959. Notes sur les Ceratopogonides. VI. Ceratopogonides d'Afrique Occidentale Francaise. Arch. Inst. Pasteur d'Algerie 37: 167-197.
- ..... 1960. Notes sur les Ceratopogonides. IX. Ceratopogonides de la Republique du Congo. Arch. Inst. Pasteur d'Algerie 38: 79-105.
- ..... 1968. Deux Ceratopogonides nouveaux de la Guyane Francaise (Diptera: Ceratopogonidae). Arch. Inst. Pasteur de la Guyane Francaise et de l'Inni 21: 85-92.
- ....., and W. W. WIRTH. 1961. Notes sur les Ceratopogonides. XIV. Ceratopogonides de la Region Ethiopienne (2). Arch. Inst. Pasteur d'Algerie 39: 302-337.
- COHER, E. I., W. W. WIRTH, and H. KNUTSON. 1955. *Culicoides* of New England (Diptera: Heleidae). Mosq. News 15: 153-155.
- COQUILLETT, D. W. 1901. New Diptera in the U. S. National Museum. Proc. U. S. Nat. Mus. 23: 593-618.
- CURTIS, L. C. 1941. A preliminary list of the species of *Culicoides* in western Canada (Diptera: Ceratopogonidae). Proc. Entomol. Soc. B. C. 37: 18-19.
- DAS GUPTA, S. K., and E. J. HANSENS. 1965. *Culicoides* (Diptera: Ceratopogonidae) from Salem County, New Jersey. J. N. Y. Entomol. Soc. 73: 156-162.



- DEFOLIART, G. R., M. R. RAO, and C. D. MORRIS. 1967. Seasonal succession of blood-sucking Diptera in Wisconsin during 1965. *J. Med. Entomol.* 4: 363-373.
- DELFINADO, M. D. 1961. The Philippine biting midges of the genus *Culicoides* (Diptera: Ceratopogonidae). *Fieldiana (Zool.)* 33: 629-675.
- DOWNES, J. A. 1958a. The genus *Culicoides* (Diptera: Ceratopogonidae) in Canada; an introductory review. *Proc. Tenth Int. Cong. Entomol.* 3: 801-808.
- ....., and D. S. KETTLE. 1952. Descriptions of three species of *Culicoides* Latreille (Diptera: Ceratopogonidae) new to science, together with notes on, and a revised key to the British species of the *pulicaris* and *obsoletus* groups. *Proc. Roy. Entomol. Soc. Lond. (B)* 21:61-78.
- EDMUNDS, L. R., and G. G. KENNER, JR. 1954. Observations on the biting habits of *Culicoides crepuscularis* Malloch in western Nebraska, with notes on other species collected in light traps (Diptera: Heleidae). *Mosq. News* 48:82-83.
- EDWARDS, F. W. 1926. On the British biting midges (Diptera: Ceratopogonidae). *Trans. Roy. Entomol. Soc. Lond.* 74:389-426.
- FIEDLER, O. G. H. 1951. The South African biting midges of the genus *Culicoides* (Ceratopogonidae: Diptera). *Onderstepoort J. Vet. Res.* 25:3-33.
- FOOTE, R. H., and H. D. PRATT. 1954. The *Culicoides* of the eastern United States (Diptera: Heleidae). *Pub. Hlth. Monogr.* 18:53 p.
- FORATTINI, O. P. 1957. *Culicoides* da regiao neotropical (Diptera: Ceratopogonidae). *Arq. Facul. Hig. e Saude Pub. da Univ. de Sao Paulo, Brasil* 2:161-526.
- FOX, I. 1946a. A review of the species of biting midges or *Culicoides* from the Caribbean region (Diptera: Ceratopogonidae). *Ann. Entomol. Soc. Amer.* 39:248-258.
- ..... 1946b. Two new biting midges or *Culicoides* from western United States (Diptera: Ceratopogonidae). *Proc. Entomol. Soc. Wash.* 48:244-246.
- ..... 1949. Notes on Puerto Rican biting midges or *Culicoides* (Diptera: Ceratopogonidae). *Bull. Brooklyn Entomol. Soc.* 44:29-34.
- ..... 1952a. Six new Neotropical species of *Culicoides*. *Ann. Entomol. Soc. Amer.* 45:364-368.
- ..... 1952b. Light trap studies on *Culicoides* in Puerto Rico. *J. Econ. Entomol.* 45:888-889.
- ..... 1955. A catalogue of the bloodsucking midges of the Americas (*Culicoides*, *Leptoconops*, and *Lashiohelca*) with keys to the subgenera and Nearctic species, a geographical index, and bibliography. *J. Agr. Univ. P. R.* 39:214-285.
- ....., and I. GARCIA-MOLL. 1961. The *Culicoides* of the international airport, Isla Verde, Puerto Rico, as shown by light traps. *Mosq. News* 21:120-132.
- ....., and C. E. KOHLER. 1950. Distribution and relative abundance of the species of biting midges or *Culicoides* in eastern Puerto Rico, as shown by light traps. *R. R. J. Pub. Hlth. and Trop. Med.* 25:342-349.
- GAZEAU, L. J., and D. H. MESSERSMITH. 1970a. Rearing and distribution of Maryland *Culicoides* (Diptera: Ceratopogonidae). *Mosq. News* 30:30-34.
- ..... 1970b. A synopsis of Maryland *Culicoides* (Diptera: Ceratopogonidae). *Mosq. News* 30:34-38.
- GOELDI, E. 1905. Os Mosquitos Para. *Mem. Mus. Goeldi* 4:1-154.
- GUTSEVICH, A. V. 1960. Bloodsucking sandflies (Diptera: Heleidae) of the fauna of the U.S.S.R. (In Russian). *Akad. Nauk Zool. Inst.* 72:130 p.
- HAIR, J. A. 1966. Bionomics of *Culicoides* (Diptera: Ceratopogonidae) in Virginia. Ph.D. dissertation, Virginia Polytechnic Institute, Blacksburg, 123 p.
- ....., and E. C. TURNER, JR. 1966. Laboratory colonization and mass-production procedures for *Culicoides guttipennis*. *Mosq. News* 26:429-433.

- ..... 1968. Preliminary host preference studies on Virginia *Culicoides* (Diptera:Ceratopogonidae). Mosq. News 28:103-107.
- ....., and D. H. MESSERSMITH. 1966. Larval habitats of some Virginia *Culicoides* (Diptera:Ceratopogonidae). Mosq. News 26:195-204.
- HALL, D. G. 1932. A new biting *Culicoides* from saltmarshes in the southeastern states. Proc. Entomol. Soc. Wash. 34:88-89.
- HINMAN, E. H. 1932. Notes on Louisiana *Culicoides* (Diptera:Ceratopogonidae). Amer. J. Hyg. 15:773-776.
- HOFFMAN, W. A. 1925. A review of the species of *Culicoides* of North and Central America and the West Indies. Amer. J. Hyg. 5:274-301.
- HUBERT, A. A., and W. W. WIRTH. 1961. Key to the *Culicoides* of Okinawa and the description of two new species (Diptera:Ceratopogonidae). Proc. Entomol. Soc. Wash. 63:235-239.
- HUMPHREYS, J. G. 1969. Factors affecting feeding activity in adult *Culicoides* spp. (Diptera:Ceratopogonidae). Ph.D. dissertation, Virginia Polytechnic Institute, Blacksburg, 52 p.
- JAMES, M. T. 1943. The genus *Culicoides* in northern Colorado (Diptera:Ceratopogonidae). Pan-Pacif. Entomol. 19:148-153.
- JAMNBACK, H. A. 1965. The *Culicoides* of New York State (Diptera:Ceratopogonidae). N. Y. St. Mus., Sci. Serv. Bull. 399:154 p.
- JAMNBACK, H. A., and W. W. WIRTH. 1963. The species of *Culicoides* related to *obsoletus* in eastern North America. Ann. Entomol. Soc. Amer. 56:185-198.
- JOHANSEN, O. A. 1952. Guide to the insects of Connecticut. Part VI. The Diptera or true flies. Fifth fasc.: midges and gnats. Family Heleidae (=Ceratopogonidae). Conn. St. Geol. Nat. Hist. Surv. Bull. No. 80:149-175.
- JONES, R. H. 1956. New species of *Culicoides* from Wisconsin (Diptera:Heleidae). Proc. Entomol. Soc. Wash. 58:25-33.
- ..... 1961a. Observations on the larval habitats of some North American species of *Culicoides* (Diptera:Ceratopogonidae). Ann. Entomol. Soc. Amer. 54: 702-710.
- ....., and W. W. WIRTH. 1958. New records, synonyme and species of Texas *Culicoides* (Diptera:Heleidae). J. Kan. Entomol. Soc. 31:81-91.
- JORGENSEN, N. M. 1969. The systematics, occurrence, and host preference of *Culicoides* (Diptera:Ceratopogonidae) in southeastern Washington. Melanderia 3:1-47.
- KARDATZKE, J. T., and W. A. ROWLEY. 1971. Comparison of *Culicoides* larval habitats and populations in central Iowa. Ann. Entomol. Soc. Amer. 64:215-218.
- KHALAF, K. T. 1952. The *Culicoides* of the Wichita Refuge, Oklahoma. Taxonomy and seasonal incidence (Diptera:Heleidae). Ann. Entomol. Soc. Amer. 45:348-358.
- ..... 1954. The speciation of the genus *Culicoides* (Diptera:Heleidae). Ann. Entomol. Soc. Amer. 47:34-51.
- ..... 1957. Light trap survey of the *Culicoides* of Oklahoma. Amer. Mid. Nat. 58:182-221.
- ..... 1961. More *Culicoides* from Iraq (Diptera:Heleidae). Beitr. zur Entomol. 11:450-470.
- ..... 1966a. The seasonal incidence of *Culicoides* in southern Louisiana (Diptera:Ceratopogonidae). Ann. Entomol. Soc. Amer. 59:881-883.
- ..... 1966b. Notes on the taxonomy of *Culicoides* from Louisiana (Diptera: Ceratopogonidae). J. Kan. Entomol. Soc. 39:227-231.
- ..... 1967a. The seasonal fluctuation of the inland *Culicoides* of southern Louisiana (Diptera:Ceratopogonidae). Fla. Entomol. 50:151-155.

- ..... 1967b. Seasonal incidence and population densities of *Culicoides* in the coastal areas of Louisiana (Diptera: Ceratopogonidae). J. Kan. Entomol. Soc. 40: 472-477.
- ..... 1967c. The *Culicoides* of New Orleans, Louisiana (Diptera: Ceratopogonidae). Proc. La. Acad. Sci. 30:49-54.
- ..... 1969. Distribution and phenology of *Culicoides* (Diptera: Ceratopogonidae) along the Gulf of Mexico. Ann. Entomol. Soc. Amer. 62:1153-1161.
- KNOWLTON, G. F., and L. E. FRONK. 1950. Some locality records of Utah Heleidae. J. Kan. Entomol. Soc. 23:113.
- ..... and E. H. KARDOS. 1951. Utah Heleidae. J. Kan. Entomol. Soc. 24:163.
- KREMER, M. 1960. Deux Ceratopogonidae nouveaux pour la France: *Culicoides semimaculatus* Clastrier and *Culicoides truncorum* Edwards. Ann. Parasitol. Hum. Comp. 35:744-746.
- ..... 1961. Un ceratopogonide nouveau pour la faune Francaise: *Culicoides bequeti* Clastrier appartenant au groupe "*fascipennis*" sensu lato, et essai de classification de ce groupe. Ann. Parasitol. Hum. Comp. 36:143-153.
- ..... 1965. Contribution a l'etude du genre *Culicoides* Latreille particulierement en France. Doctoral thesis, Strasbourg Faculty of Medicine, 299 p.
- ..... and J. CALLOT. 1961a. Contribution a l'etude du genre *Culicoides* (Diptera: Heleidae) dans le bas-rhin. Bull. Assoc. Philomath. d'Alsace et Lorraine 11:8-15.
- ..... 1961b. *Culicoides musilator* n. sp. et especes du groupe *odibilis* nouvelles pour la faune Francaise (Diptera: Ceratopogonidae). Ann. Parasitol. Hum. Comp. 36:689-699.
- ..... and Y. DEDUIT. 1961. Sur quelques *Culicoides* (Diptera: Ceratopogonidae) de Normandie. Description de *Culicoides picturatus* n. sp. Ann. Parasitol. Hum. Comp. 36:700-705.
- ....., J. M. DOBY, and B. SKIERSKA. 1965. Captures de *Culicoides* (Dipteres nematoceres Ceratopogonides) dans le nord et l'est de la Pologne. Acta Parasitol. Polonica 13:109-116.
- ....., C. VERMEIL, and J. CALLOT. 1961. Sur quelques nematoceres vulnerants des eaux saalees continentales de l'est de la France. Bull. Assoc. Philomath. d'Alsace et Lorraine 11:1-8.
- LATREILLE, P. A. 1809. Genera crustaceorum et insectorum secundum ordinem naturalem in familias disposita, iconibus exemplisque plurimis explicata. Vol. 4, 399 pp., 4 pls. Parisiis et Argentorat (=Paris and Strasbourg).
- LEE, D. J., and E. J. REYE. 1953. Australasian Ceratopogonidae (Diptera: Nematocera). Part VI. Australasian species of *Culicoides*. Proc. Linn. Soc. N. S. W. 77:369-394.
- ..... 1955. Australasian Ceratopogonidae (Diptera: Nematocera). Part VII. Notes on the genera *Alluaudomyia*, *Ceratopogon*, *Culicoides*, and *Lasiohelea*. Proc. Linn. Soc. N. S. W. 79:233-246.
- ..... 1962. Australasian Ceratopogonidae (Diptera: Nematocera). Part X. Additional Australian species of *Culicoides*. Proc. Linn. Soc. N. S. W. 87:352-363.
- LEWIS, F. B. 1959. Abundance and seasonal distribution of the common species of Ceratopogonidae (Diptera) occurring in the state of Connecticut. Can. Entomol. 91:15-28.
- LUTZ, A. 1913. Contribucao para o estudo das Ceratopogoninas hematofagas do Brazil. Mem. Inst. Oswaldo Cruz 5:45-73.
- MACFIE, J. W. S. 1934. Report on a collection of Ceratopogonidae from Malaya. Ann. Trop. Med. Parasitol. 28:177-194.
- ..... 1935. Notes on Ceratopogonidae (Diptera) from the River Amazon. Stylops 4:49-56.

- ..... 1948. Some species of *Culicoides* (Diptera:Ceratopogonidae) from the state of Chiapas, Mexico. Ann. Trop. Med. Parasitol. 42:67-87.
- MALLOCH, J. R. 1915a. The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. Bull. Ill. St. Lab. Nat. Hist. 10:275-543.
- ..... 1915b. Some additional records of Chironomidae for Illinois and notes on other Illinois Diptera. Bull. Ill. St. Lab. Nat. Hist. 11:305-363.
- MEIGEN, J. W. 1818. Systematische Beschreibung der bekannten europaischen zweifluegeligen Insekten, 1:1-259.
- ..... 1830. Systematische Beschreibung der bekannten europaischen zweifluegeligen Insekten, 6:1-401.
- MELANDER, A. L., and C. T. BRUES. 1903. Guests and parasites of the burrowing bee *Halictus*. Biol. Bull. 5:13-14.
- MESSERSMITH, D. H. 1964. The breeding site of *Culicoides debilipalpis* Lutz (Diptera: Ceratopogonidae). Mosq. News 24:339.
- ..... 1965a. *Culicoides* (Diptera:Ceratopogonidae) associated with poultry in Virginia. Mosq. News 25:321-324.
- ..... 1966. Report of a collection of *Culicoides* (Diptera:Ceratopogonidae) from western Virginia. Va. J. Sci. 17:83-104.
- MURRAY, W. S. 1957. Investigations on the bionomics of *Culicoides obsoletus* (Meigen) and other biting midges at Mount Solon, Virginia. Mosq. News 17:77-82.
- NAVAL, S. 1970. Ceratopogonidae (Diptera) of Iran V. *Culicoides* from Mazandaran. Mosq. News 30:6-8.
- NIELSEN, B. O. 1964. Studies on the Danish biting midges, *Culicoides* Latreille (Diptera:Ceratopogonidae). Entomol. Meddelelser 32:261-276.
- PICKARD, E., and W. E. SNOW. 1955. Light trap collections of punkies (Family Heleidae, genus *Culicoides*) McMinn County, Tennessee, April-September, 1952. J. Tenn. Acad. Sci. 30:15-18.
- POEY, R. 1851. El jejen, *Oecacta furens* Poey. Mem. Sobre la Hist. Nat. Isla de Cuba 1:236-243.
- PRATT, F. C. 1907. Notes on punkies. U. S. Dep. Agr. Bur. Entomol. Bull. 64:23-28.
- ROBERTS, R. H. 1965. A steer-baited trap for sampling insects affecting cattle. Mosq. News 25:281-285.
- ROOT, F. M., and W. A. HOFFMAN. 1937. The North American species of *Culicoides*. Amer. J. Hyg. 25:150-176.
- SAILER, R. I., E. P. MARKS, and S. LIENK. 1956. Notes on *Culicoides* in Alaska (Diptera:Heleidae). Mosq. News 16:270-278.
- SEN, P., and S. K. DAS GUPTA. 1959. Studies on Indian *Culicoides* (Ceratopogonidae: Diptera). Ann. Entomol. Soc. Amer. 52:617-630.
- SHAW, F. R. 1959. New records and distributions of the biting flies of Mt. Desert Island, Maine. Mosq. News 19:189-191.
- SMITH, W. W. 1965. Additional new records of treehole *Culicoides* (Diptera:Ceratopogonidae) in northern Florida. Mosq. News 25:485.
- SNOW, W. E. 1955. Feeding activities of some blood-sucking Diptera with reference to vertical distribution in bottomland forest. Ann. Entomol. Soc. Amer. 48:512-521.

- ....., and E. PICKARD. 1953. A survey of arthropods of public health significance in the Chestuee Creek watershed. TVA, Wilson Dam, Ala.: 52 p.
- ..... 1954. Observations on the seasonal activity of some night-biting Diptera. J. Tenn. Acad. Sci. 28:17-22.
- ..... 1958. Additional records of Heleidae collected in the Tennessee Valley during 1956. J. Tenn. Acad. Sci. 33:3-5.
- ..... and C. M. JONES. 1958. Observations on the activity of *Culicoides* and other Diptera in Jasper County, South Carolina. Mosq. News 18:18-21.
- ..... and J. B. MOORE. 1957. The Heleidae of the Tennessee River Basin. J. Tenn. Acad. Sci. 32:18-36.
- TOKUNAGA, M. 1962. Biting midges of the genus *Culicoides* from New Guinea (Diptera:Ceratopogonidae). Pacif. Insects 4:457-516.
- ....., and E. K. MURACHI. 1959. Diptera:Ceratopogonidae. Insects of Micronesia 12:103-434.
- VARGAS, L. 1949. *Culicoides travisi* Vargas, n.n. Rev. Inst. Salub. Enferm. Trop. 10: 233-234.
- ..... 1960. The subgenera of *Culicoides* of the Americas. Rev. Biol. Trop. 8:35-47.
- ..... 1962. Los subgeneros de *Culicoides* de la U.R.S.S. (Diptera:Heleidae). Med. Rev. Mex. 42:45-47.
- WALL, W. J., JR., and O. W. DOANE, JR. 1960. A preliminary study of the blood-sucking Diptera on Cape Cod Massachusetts. Mosq. News 20:39-44.
- WILLIAMS R. W. 1955a. Studies on the *Culicoides* of Baker County, Georgia (Diptera: Heleidae). I. Preliminary survey and observations. Ann. Entomol. Soc. Amer. 48: 30-34.
- ..... 1955b. Observations on the bionomics of some *Culicoides* of Cheboygan County, Michigan (Diptera:Heleidae). Bull. Brooklyn Entomol. Soc. 50:113-120.
- ..... 1955c. Two new species of *Culicoides* from Cheboygan County, Michigan. Proc. Entomol. Soc. Wash. 57:269-274.
- ..... 1956a. The biting midges of the genus *Culicoides* found in the Bermuda Islands (Diptera:Heleidae). I. A description of *C. bermudensis* n. sp. with a key to the local fauna. J. Parasitol. 42:297-300.
- WIRTH, W. W. 1951. New species and records of Virginia Heleidae (Diptera). Proc. Entomol. Soc. Wash. 53:313-326.
- ..... 1952a. The Heleidae of California. Univ. Calif. Pub. Entomol. 9:95-266.
- ..... 1952b. Two new species of anthropophilic *Culicoides* from Guatemala (Diptera:Heleidae). J. Parasitol. 38:245-247.
- ..... 1955. Report on a collection of biting midges on the genus *Culicoides* from Guatemala (Diptera:Heleidae). Proc. Entomol. Soc. Wash. 57:109-117.
- ..... 1956. The heleid midges involved in the pollination of rubber trees in America (Diptera:Heleidae). Proc. Entomol. Soc. Wash. 58:241-250.
- ..... 1963. New synonyms in American *Culicoides* (Diptera:Ceratopogonidae). Proc. Entomol. Soc. Wash. 65:68.
- ..... 1965. Family Ceratopogonidae. In Stone *et al*, A. Catalog of the Diptera of American North of Mexico, pp. 121-142. U.S.D.A., U.S. Gov. Print. Office, Washington.
- ....., and F. S. BLANTON. 1956. A new species of salt-marsh sand fly from Florida, the Bahamas, Panama, and Ecuador: Its distribution and taxonomic differentiation from *Culicoides furens* (Poey) (Diptera:Heleidae). Fla. Entomol. 39: 157-162.

- ..... 1967. The North American *Culicoides* of the *guttipennis* group (Diptera: Ceratopogonidae). Fla. Entomol. 50:207-232.
- ..... 1969a. New species and records of *Culicoides* from western North America (Diptera:Ceratopogonidae). Proc. Entomol. Soc. Wash. 71:556-567.
- ..... 1969b. North American *Culicoides* of the *pulicaris* group (Diptera:Ceratopogonidae). Fla. Entomol. 52:207-243.
- WIRTH, W. W., and L. J. BOTTIMER. 1956. A population study of the *Culicoides* midges of the Edwards Plateau region of Texas. Mosq. News 16:256-266.
- ....., and A. A. HUBERT. 1959. *Trithecoides*, a new subgenus of *Culicoides* (Diptera:Ceratopogonidae). Pacif. Insects 1:1-38.
- ..... 1960. Ceratopogonidae (Diptera) reared from cacti, with a review of the *copiosus* group of *Culicoides*. Ann. Entomol. Soc. Amer. 53:639-658.
- ..... 1961. New species and records of Taiwan *Culicoides* (Diptera:Ceratopogonidae). Pacif. Insects 3:11-26.
- ..... 1962. The species of *Culicoides* related to *piliferus* Root and Hoffman in eastern North America (Diptera:Ceratopogonidae). Ann. Entomol. Soc. Amer. 55:182-195.
- ....., and R. H. JONES. 1956. Three new North American species of tree-hole *Culicoides* (Diptera:Heleidae). Proc. Entomol. Soc. Wash. 58:161-168.
- ..... 1957. The North American subspecies of *Culicoides variipennis* (Diptera:Heleidae). U.S.D.A. Tech. Bull. 1170:35 p.
- ....., and V. H. LEE. 1967. New species of *Culicoides* from high altitudes in the Colombian Andes (Diptera:Ceratopogonidae). Proc. U.S. Nat. Mus. 124:1-22.
- ....., and N. MARSTON. 1968. A method for mounting small insects on microscope slides in Canada balsam. Ann. Entomol. Soc. Amer. 61:783-784.