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II. The First-stage Larvae of North
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Anophelinae

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Studies on Mosquito Larvae II. The First-stage Larvae of North American Culicidae and of World Anophelinae¹

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Abstract

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First instars of 93 North American species of mosquitoes are studied and 56 are illustrated, 41 for the first time. Generic differences are well marked in this instar and nearly all species are separable.

Two keys to the 11 North American genera are presented; the first is constructed to show similarities between first and later instars. Each genus is described and keyed to species, and notes are given on each species. A supplementary key to the species of the southeastern states is designed for the use of a binocular microscope with magnification up to 60 \times .

Specific and generic differences are as well marked in the first as in the fourth instar. Identifications are as easy or as difficult in the first as in the fourth instar, though usually based on different characters.

An expanded key to the North American species of *Aedes*, incorporating those previously treated by Bohart and by Price, is attempted. The key reveals several species complexes which have not been discerned from other stages of the life cycle, namely, *Aedes canadensis*, *nigromaculis*, *punctator*, *stimulans infirmatus* and *trivittatus*.

A key to the first instars of the 37 species of the world-wide Anophelinae is presented, on the basis of published descriptions and figures of the exotic species.

Introduction

This is Part II of "Studies on Mosquito Larvae". Part I, "Later Instars of Eastern North American Species", appeared in the *Canadian Entomologist* (Dodge 1963).

Because of the role of mosquitoes as disease vectors, probably no other group is as well known in both larval and adult stages. However, in North America, the species have been recognized only in the adult stage, except for some species of *Aedes* and *Anopheles*, the larvae of which can be identified. Rearing for adults is time-consuming and often difficult, yet a collection made at any one time may contain only immature larvae, or possibly all stages of one species or even various stages of several species. The number of identifiable fourth-stage larvae or adults obtained from such a collection, without rearing, cannot indicate the percentage of each species in the collection or its density in the area being collected. The ability to recognize the species in the immature larval stage is therefore obviously of great advantage. This fact is the reason for undertaking the study of first-stage mosquito larvae. The results of this study are presented here.

Aedes flavescens Muller was the first North American species of mosquito to be examined in all its stages (Hearle 1929). Subsequently, keys have been published to four first instar *Anopheles* of the eastern United States by Hurlbut (1941), to three Puerto Rican species, to the genera of first-stage larvae of North American mosquitoes by Dodge (1946), to first-instar California *Aedes* by Bohart (1954), and to first-instar Minnesota *Aedes* by Price (1960).

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Marshall's excellent text (1938), in which keys to first and later instars of British species are given, has provided further aid and incentive for the study and identification of all larval stages. In the preparation of the present work, based largely on the fauna of the southeastern United States and particularly the state of Georgia, first instars of 39 species were collected or reared and an additional 20 species were obtained from other sources. The results of this study were the basis of the writer's doctoral thesis at Ohio State University (Dodge 1945b).

Procedure

Several means have been employed for determining the first instar. In the case of the common species the first instar has been taken many times in association with the later ones, and often individuals taken in the first have moulted into the second instar before being killed in the preservative. Fifteen species, including four of *Culex* (*Culex*), were obtained by rearing from gravid females on egg masses, and two additional ones were reared to the adult stage from field-collected first-stage larvae. In only one case (*Aedes infirmatus*) was it necessary to assign a field-collected larva to species by the process of deduction.

Larvae were examined with a stereoscopic binocular microscope with magnifications ranging from 9× to 90×. With experience, many culicines were determined in the first instar by means of the lowest powers of the microscope (the large, black maxillary spines of young *Culex erraticus* are very conspicuous as these larvae lie on their sides, for example), but it is difficult to determine first-instar *Anopheles* without the higher powers of the compound microscope.

Preparatory to making the illustrations, permanent mounts were attempted, but were not satisfactory because a specimen was seldom found to be in the correct position for drawing. Therefore, specimens were prepared for drawing by temporary mounting, in aqueous solution, on microscopic slides. A small wedge was placed under one edge of the coverslip, so that the specimen would not move and was not crushed as the fluid evaporated. The coverslip was manipulated by forceps until the larva was lightly pressed between the slide and the coverslip. A slight movement of the coverslip would cause the specimen to change its position, and when the correct position was obtained the drawing was made. All drawings were made with the aid of a camera lucida.

Procurement of first-instar specimens by rearing from females which were collected while biting gave mediocre results. Females often died before the blood meal was digested, or before the fully formed ova were laid. Sometimes this was due to lack or excess of moisture, but often there was no apparent reason for their death. They were confined in containers ranging in size from small vials to quart jars. The results with the vials were as good as those with the jars.

Aedes and *Psorophora* eggs are "dry laid"; that is to say, the eggs are laid upon the ground or duff instead of upon the open water. The term is misleading, because moisture is essential to complete the embryonic development. Eggs subjected to drying before the embryonic development is complete will collapse, and, though they become turgid again upon moistening, their viability is lost. After embryonic development is completed they are resistant to the normal desiccation which occurs in nature, and may remain viable for years. Abundant moisture is essential at first; eggs may become indented while the blotting paper upon which they laid is still moist to the touch. The author has not tried the method described by Mitchell (1907). The best results obtained for the least amount of attention were as follows. *Aedes* and *Psorophora* females were captured by slowly placing a small vial over the individual while it is engorging with blood. The vial is then thrust, mouth downward, into cool,

damp, shaded earth. After two weeks the vial may be removed from the ground with the plug of earth intact in its neck. If examination of the dead female indicates that eggs have been laid, the plug is pushed to the bottom of the vial and water is added. If a homeopathic vial is used the plug of earth is smaller than the diameter of the vial, and the emerging larvae can more readily escape to the surface. A porous, loam soil is preferred to a clay soil, as the latter often settles to the bottom and entraps most of the eggs. Storing in a refrigerator may be necessary before eggs of some species of *Aedes* will hatch.

Morphology

The morphology of the first instar is similar to that of mature larvae, with variations in detail in all the species studied. The characters by which mosquito larvae vary from other dipterous larvae apply equally well to all instars. Several excellent works have dealt in detail with the morphology and chaetotaxy of both Anopheline and Culicine larvae (Martini 1923; Hurlbut 1938; Marshall 1938; and others; more recently Belkin 1950, 1962 has published several important papers on larval chaetotaxy). The similarities and differences that exist between the first and the later instars are given after the description of the larval characters.

The *head* is a large, sclerotized, exserted capsule with a large frontoclypeal sclerite, or *frontoclypeus*, dorsally. Upon the sides of the head anteriorly are a pair of rather to extremely prominent *antennae*. Each antenna is a cylindrical, one-segmented, glabrous or spiculose *shaft* with an *antennal hair* situated along its length, usually dorsally. The apex of the antenna usually bears three spines, a shorter, articulated appendage, and a pale appendage. Two of the spines are sometimes subapical in position. The buccal cavity is usually very large, and bears, in order, a setulose median lobe (*labrum*), the *mouth brushes*, *mandibles*, *maxillae* and the hypostomium, or *mentum*. All but the first and last are paired structures. The similarity of first- and fourth-instar mouthparts is very close in most species. The mandible bears a row of hairs called the *mandibular fan*, which is preceded by a group of several stout setae. The maxillae usually have a tuft or fan of hairs at the apex, the inner margin setose, and a *maxillary spine* usually situated subapically on the outer margin. At the base, at its outer margin, is a more or less prominent *maxillary palp*. On the dorsal face of the maxilla a rod-like thickening of the sclerotin is often visible (represented by two dotted lines in Fig. 41C), which extends the length of the maxilla. This rod serves as an axis for a slight rocking motion of the maxilla during the process of feeding. The finer details of the pharyngeal structure have not been studied closely. The *gula* is the ventral sclerite of the head, extending from the buccal cavity to the posterior margin of the head, or *occipital foramen*. The gula is usually defined laterally by the *gular sutures* (maxillary sutures of Belkin 1962), from which arise a pair of tentorial pits, or *gular apodemes*. The apodemes are present when the sutures are not (genus *Uranotaenia*) and evidently are the point of attachment of the flexor muscles of the mouth brushes. The extensor muscles of the mouth brushes are attached to the *frontoclypeus* in the region of the *egg burster*. The latter is present in all first-stage larvae and appears as a transverse ridge or medianly pointed disc.

The *thorax* is enlarged, with segmentation indicated only by the arrangement of the hairs. Neither the thorax nor the abdomen bears prolegs, ambulatory setae, or other processes ventrally.

The *abdomen* consists of nine segments of which the first eight are in line with the thorax, and the ninth, or anal segment, is direct posteroventrally. The eighth segment bears the *air tube* or spiracular valves posterodorsally, and, usually,

a group of lateral scales called the *comb*. Five hairs, usually arranged in a semi-circle behind the comb, are called the *pentad hairs*. The air tube usually bears a paired row of ventrolateral spines called the *pecten*, and one or more pairs of *air tube hairs*, in line with or slightly ventrad to the pecten. Situated near the apex of the air tube is a small pair of *dorsal preapical setulae*, and the apex of the air tube bears a pair of *spiracles* surrounded by five *spiracular valves*. Two tracheal trunks (*tracheae*) extend forward from the spiracles and are often very conspicuous through the abdomen into the thorax. In the thorax they are sometimes expanded into a pair of sacs, or *vacuoles*. The anal segment bears two, rarely one, pair of *gills* surrounding the anal orifice, above which are two pairs of large *caudal hairs* ("dorsal tufts" of most American authors). Dorsally upon the anal segment is usually a sclerite called the *saddle*, which, when completely encircling the segment, is said to "ring" the segment. Posterolaterally is the *lateral hair of the anal segment*, or "saddle hair", and posteroventrally the *ventral brush* is present in the later instars of most genera, but lacking in the first instar.

The sclerotized parts of the body are the head, antennae, air tube, spiracular apparatus, saddle, bases of the larger hairs or hair groups, especially of the thorax and first two or three abdominal segments, and occasionally other sclerotized plates or platelets of the abdomen. The sclerotization is of two kinds, the "*primary sclerotization*", which develops and hardens soon after each molt, and the more unusual "*secondary sclerotization*" which develops in certain instars at a later time. Examples of the latter are the "*collar*" in the genus *Anopheles* and the "*secondary zone of sclerotization*" common on the air tube of most Culicines in the first instar. Soon after hatching, the "*primary zone of sclerotization*" becomes evident on the apical part of the air tube. The secondary zone develops later as an extension of the sclerotin towards the base of the air tube. The surface sculpture may differ on the two zones (Fig. 6A) and a more or less distinct line between them is visible under the binocular microscope. This is represented in the drawings by a dotted line.

Examples of secondary sclerotization in the fourth instar are the saddle in the genus *Anopheles*, the dorsal plates on the posterior abdominal segments in the genus *Orthopodomyia*, and perhaps the comb plate in such genera as *Uranotaenia* and *Psorophora*.

The chaetotaxy of the head and body affords many excellent characters for distinguishing genera and species. A system was proposed by Martini (1923) in which all the hairs were numbered. This system has been adopted, with minor alterations, by subsequent workers, while other systems have been proposed for designating the hairs of the head. Belkin (1950, 1962) has most recently published on the nomenclature of the head and body hairs. The more important hairs are familiarly known by names suggestive of their position, and much synonymy has resulted. The author prefers to retain the names most generally used in the North American literature, with exception of the caudal hairs. The hairs referred to in this work are listed and defined below. The numbering of the dorsal hairs of the head in Figs. 1B and 15 are according to Belkin.

Hairs of the Head

Preclypeal spine (hair 1): a pair of usually stout, spine-like hairs on the preclypeus.

Clypeal hairs (hairs 2 and 3): in *Anopheles* hair 2 is known as the *inner* clypeal hair and hair 3 the *outer* clypeal hair; these hairs are very minute in most culicines, if actually present.

Posterior clypeal hair (hair 4): situated behind the clypeal hairs; in culicines usually closely associated with the head hairs.

Frontal hairs (hairs 5, 6, and 7): in *Anopheles* these hairs are in a transverse row.

In culicine species they are arranged otherwise and designated separately, thus:

Head hairs (hairs 5 and 6): the *upper* head hair (hair 5) and *lower* head hair (hair 6) are well developed in all instars. It has been previously reported (Hearle 1929) that the position of the upper head hair in the first instar is very different from that in succeeding instars of *Aedes flavescens*. In the first instar of most species of *Aedes* studied the upper head hair is situated above or outside of the lower head hairs, in agreement with this observation.

Anteantennal hair (hair 7).

Occipital hairs (hairs 8 and 9): the *inner* (hair 8) and *outer* (hair 9) occipital hairs are located on each side of the epicranial suture, approximately between the eyes and the egg burster. The inner occipital hair is always situated anterior to the outer, and may be unusually long in the first instar.

Orbital hair (hair 10): situated opposite or approximately opposite, the eye.

Subantennal hair (hair 11): very important in taxonomy of first-instar *Anopheles*. The hairs of the antennae are numbered separately.

Hairs of the Antennae

Antennal hair (hair 1): or "shaft hair" is situated more or less dorsally on the middle third of the length of the shaft. The position and nature of this hair are very important taxonomically.

Terminal hairs or spines of the antenna (hairs 2 to 6): not all are truly hair-like, and two are sometimes subapical in position. In *Anopheles* hair 4 is important; in *Aedes* the number of long, equal spines is very important.

Hairs of the Body

Dorsal submedian prothoracic hair group (prothoracic hairs 1, 2 and 3): these hairs are labelled in Fig. 29B.

Lateral hairs of the abdomen (hairs 6 and 7, or 6 only): one or two hairs, usually very prominent on the first six abdominal segments.

Lanceolate hairs: hair 1 of the thoracic and most abdominal segments (and often several other thoracic hairs) are lanceolate in first-instar *Anopheles*.

Pentad hairs (hairs 1 to 5 of the eighth abdominal segment or, according to Martini, hairs 6, 7, 9, 11 and 13): a group of five hairs closely associated with the comb, usually arranged in a semicircle behind it. These hairs were designated by Greek symbols by Marshall (1938) and by Arabic letters by Hearle (1929). Hairs 3-5 are closely grouped in sabethines; the relative size of hair 3 is a useful character in *Aedes*.

Caudal hairs: two pairs of large hairs situated on the anal segment, above the gills. These are the "dorsal tufts" of the anal segment of most American authors; the inner (upper and outer (lower)) submedian caudal hairs of most English authors.

Lateral hair of the anal segment (the "saddle hair"): previously described.

Ventrolateral hair(s) of the air tube: previously described.

Most of the other thoracic and abdominal hairs have not been referred to in this study. This is not to imply that they do not present good specific or generic characters; a study of these hairs might indicate otherwise.

The ventral surface of some or most segments of the body of first instar often bears a transverse band of fine spicules. Each band consists of four to seven transverse rows situated in the middle of the segment. These bands have been

observed in 23 of 31 species examined, but because of difficulty of observation they may have been overlooked in the others. This is apparently strictly a first-instar character. The saddle usually bears spicules, rarely spines or scales, and the anal segment is sometimes pilose. Otherwise the body of first instar is devoid of pilosity or spicules.

As has been indicated on a previous page, the first instar is very similar morphologically to the later instars, but differences in some details occur in all species. The structure of the mouthparts changes little, except in the subgenus *Psorophora* (*Psorophora*), which changes from a herbivorous to a carnivorous diet in the second instar. There nearly always is an increase in the branches of certain hairs, but the reverse may take place. Some hairs, like the dorsolateral hair group and lateral hair 7 of the third abdominal segment of *Anopheles*, are greatly reduced in size in the later instars; other hairs may increase in size, or appear for the first time in one of the later instars.

The most constant character by which the first instar can be recognized is the presence of the egg burster, but this structure is often poorly defined when the head capsule is darkly pigmented. The ventral brush of the anal segment, present in the later instars of all genera except *Wyeomyia*, is always lacking in the first instar. The air tube is usually unsclerotized basally in the first instar and completely sclerotized in the later instars, but exceptions occur. The size of the head capsule cannot be relied upon because of the variability in size between the various species. *Uranotaenia* are much smaller insects than *Anopheles*, yet the first instar *Uranotaenia sapphiriana* head is larger than that of a second instar *Anopheles*. The number of comb scales and pecten teeth usually increases in the later instars, but the comb is absent in later instar *Anopheles* and there is no increase in the average number of comb scales in *Aedes atlanticus* or pecten teeth in *Psorophora* (*Psorophora*). Other differences of this nature will be considered in the discussion of some genera or species.

Results of Studies to Define the Genera

Six of the North American genera are also native to Europe and their generic characters in the first instar were made known by Marshall (1938) in his study of the fauna of Great Britain. The author's observations on American species of these genera entirely confirm the characters Marshall ascribed to them, with one minor exception: the antennal hair in the genus *Aedes*, described as bifid or trifid, is sometimes bifurcate or unbranched. Marshall's key, to a certain point, is nearly identical with his generic key to the later instars, as it is based upon such fundamental characters as the presence or absence of the air tube and pecten, and the number of pairs of ventrolateral hairs of the air tube.

It has been shown (Dodge 1945a) that the genera *Anopheles*, *Toxorhynchites* and *Uranotaenia* differ from other North American genera by the reduction or absence of the gular suture. This character holds for all instars, and the first instars of these genera are so nearly identical on superficial examination with their later instars that they can be recognized at once.

Of the three remaining North American genera, first-instar *Psorophora* are similar to *Aedes*, as might be expected; *Deinocerites* has a constant number of air tube hairs and similar mandibular structure in all instars; *Wyeomyia* has several characters constant in all instars, such as the presence of the ventrolateral hair of the anal segment, the shape of the foramen, the absence of the pecten, and the lateral grouping of pentad hairs 3 to 5. However, the presence of a false pecten and but one ventrolateral air tube hair are strictly first-instar characters in the latter genus.

Certain characters, constant in all instars of some genera, are found to vary in others. For example, the number of pairs of hairs of the air tube is constant, except in later instar *Wyeomyia*, some *Culiseta* and a few *Aedes*.

It is interesting to note that there is always exact correlation of morphological characters between the different genera and subgenera in both the first instar and the later instars. Genera easily defined in the fourth instar, such as *Anopheles*, *Mansonia*, *Toxorhynchites* and *Uranotaenia*, are as easily defined in the first instar. Related genera, like *Aedes* and *Psorophora*, are very similar yet distinct in both first and later instars.

Key to Suprageneric Groups

- 1. Air tube absent; clypeal hairs well developed; body dorsally with some lanceolate hairs; anal segment uniformly sparsely pilose; saddle absent ANOPHELINAE: *Anopheles*
 Air tube present; clypeal hairs rarely evident; body without lanceolate hairs; anal segment not uniformly pilose, saddle present 2
- 2. Mouth brushes reduced to about ten stout rods; abdomen with 3 pairs of lateral platelets on each of segments 1-7; thorax and segment 8 with some very stout, spinous hairs; anal segment completely ringed; comb and pecten absent TOXORHYNCHITINAE: *Toxorhynchites*
 Mouth brushes of numerous fine hairs; abdomen without 3 pairs of platelets on sides of each segment; stout spinous hairs absent on segment 8 and thorax; anal segment not completely ringed by the saddle; comb present CULICINAE 3
- 3. Dorsal submedian prothoracic hair groups wide-set, not arising from a platelet and with rather weak hairs; air tube with one pair of ventrolateral hairs beyond the middle (before middle in *Wyeomyia*) 4
 Dorsal submedian prothoracic hair groups close-set, usually arising from a platelet and usually with at least 2 large hairs, with prominent trichopores; air tube with 3 or more pairs of ventrolateral hairs or a single pair before the middle (beyond middle in *Mansonia*) 5
- 4. Ventrolateral hair present on anal segment; a false pecten present on apical half of air tube SABETHINI: *Wyeomyia*
 Ventrolateral hair absent on anal segment; true pecten present or absent on basal part of air tube AEDINI: *Aedes*, *Psorophora*, *Orthopodomyia*
- 5. Gular sutures absent; head usually elongate, with very small antennae; air tube without secondary zone of sclerotization; anal segment nearly ringed by the saddle URANOTAENIINI: *Uranotaenia*
 Gular sutures present; head rounded with antennae longer; air tube with secondary zone of sclerotization; saddle small, dorsal CULICINI: *Culex*, *Culiseta*, *Deinocerites*, *Mansonia*

Keys to the Genera

- 1. Air tube absent; body dorsally with lanceolate hairs *Anopheles*
 Air tube present; body without lanceolate hairs 2
- 2. Mouth brushes reduced to about 10 stout rods; anal segment completely ringed by the saddle; abdominal segments 1-7 each with 3 pairs of platelets laterally *Toxorhynchites*
 Mouth brushes of numerous fine hairs; anal segment and abdominal segments not as above 3
- 3. Pecten absent 4
 Pecten present 6

4. Pentad hairs 3-5 in a close-set lateral group, none ventral 5
 Pentad hairs normally spaced, in an arc nearly half encircling the comb
 *Orthopodomyia*
5. Air tube with attenuated apex; antennae much longer than the head, with
 a pair of subapical spines; ventrolateral hairs absent on air tube .. *Mansonia*
 Air tube and antennae not as above; anal segment with both lateral and
 ventrolateral hairs *Wyeomyia*
6. Dorsal submedian prothoracic hair groups close-set, with at least two
 hairs long and stout, with prominent trichopores, arising from a
 sclerotized platelet which is rarely divided or poorly defined in the
 first instar 7
 Dorsal submedian prothoracic hair groups well separated, with hairs
 rarely long or stout, rarely associated with a platelet 9
7. Head usually elongate, with stout head hairs and gular sutures absent; anal
 segment nearly ringed by the saddle *Uranotaenia*
 Head rounded or subtriangular, wider than long, with gular sutures
 present and head hairs fine; saddle small, dorsal 8
8. Air tube with at least 3 pairs of ventrolateral hairs *Culex*
 Air tube with only one pair of ventrolateral hairs *Culiseta*
9. Air tube with 3 pairs of hairs, of which two are ventrolateral; anal gills
 one pair; mandible with a setose knob on outer side near base; egg
 burster preceded by a membranous area *Deinocerites*
 Air tube with one pair of ventrolateral hairs; anal gills two pair; mandible
 not as above; egg burster nearly surrounded by a membranous ring
 or "moat", connected by a posterior strap 10
10. Egg burster a transverse, medianly pointed ridge on a pale disk; gular or
 clypeal area unsclerotized *Psorophora*
 Egg burster a median, conical point or sometimes a transverse ridge on a
 dark disk; gular and clypeal areas sclerotized *Aedes*

The above key is constructed to show the resemblance of first-instar larvae to the later instars, with the following exceptions: (1) reference to the saddle may not apply to the fourth instar; (2) most or all of the lanceolate hairs of the abdomen become palmate hairs in later instar *Anopheles*; (3) the egg burster, and separation of *Aedes* and *Psorophora* are first-instar characters.

The following alternate key is presented to show other differences and similarities:

1. Anal segment with a small dorsal saddle; gular sutures entire; comb and
 air tube present 3
 Saddle not as above; gular sutures short or absent; egg burster a poorly
 defined, transverse ridge 2
2. Gular sutures absent; comb, pecten and air tube present; saddle nearly
 encircles anal segment *Uranotaenia*
 Gular sutures and air tube present; comb and pecten absent; saddle com-
 pletely rings the anal segment *Toxorhynchites*
 Gular sutures, comb and pecten present; air tube absent; saddle absent ...
 *Anopheles*
3. Egg burster nearly surrounded by a membranous ring or "moat" 4
 Egg burster not surrounded by a ring, but may be preceded by an
 unsclerotized area 5
4. Egg burster a dark disk with median, usually conical point; head without
 unpigmented gular or clypeal areas *Aedes*

- Egg burster a pale disk with a dark, transverse, medianly pointed ridge; gular or clypeal area unpigmented *Psorophora*
5. Pecten absent; air tube with a single pair of hairs 6
Pecten present 8
6. Air tube attenuated apically, adapted for piercing; antenna much longer than head, with a pair of subapical spines *Mansonia*
Air tube not attenuated apically; antennae much shorter than head 7
7. Air tube and lateral hair of anal segment branched; ventrolateral hair of anal segment absent; head capsule without a deep cleft behind each eye *Orthopodomyia*
Air tube hair and lateral hair of anal segment simple; ventrolateral hair of anal segment present; head capsule with a deep cleft of the occipital foramen behind each eye *Wyeomyia*
8. Air tube with 3 or more pairs of hairs 9
Air tube with a single pair of hairs; antennal hair simple; comb scales in a row or patch *Culiseta*
9. Antenna glabrous, with simple hair; head hairs multifid; air tube with 2 ventrolateral and 1 lateral hair *Deinocerites*
Antenna spinulose, with branched hair; head hairs simple; air tube with 3-8 ventrolateral and perhaps lateral hairs *Culex*

Notes on the Genera and Species

Aedes Meigen

Figs. 1-14, 54

Head rounded or subtriangular, wider than long, width 0.22-0.36 mm. Clypeal hairs vestigial; head hairs simple. Egg burster a dark disk with a median, conical point, set in a membranous ring and joined to the surrounding sclerotin by a narrow posterior strap (Fig. 9 K). Antenna of variable length, usually spinulose, the spinules rarely arranged in short, transverse rows; antennal hair dorsal, situated before middle of length of shaft, simple to trifid. Antenna with 5 terminal spines, of which 1 to 3 are long but never half as long as the shaft. Mouthparts of the normal culicine type, with mouth brushes and other vestiture rather short. Gula triangular, with sutures entire.

Dorsal submedian prothoracic hair group of three simple hairs, not arising from a platelet nor with prominent trichopores. One hair may be rather large and another may be somewhat isolated from the other two.

Abdomen with 2 pairs of lateral hairs on the first six segments. These hairs are simple, but with sparse lateral branchlets and decrease regularly in length from the first to the sixth segment; the lower hair is smaller than the upper. Eighth segment with comb of 3-10 scales and pentad hairs usually simple. Air tube with pecten of 3-11 spines; ventrolateral hair usually simple, situated beyond or sometimes within the pecten; sclerotization confined to apical half or less, consisting of a primary and a secondary zone. Anal segment longer than its diameter, with a small, dorsal saddle, lateral hair usually unbranched and gills of variable length.

First-instar *Aedes* may be immediately recognized by the prominent, dark, disk-like egg burster set within a membranous ring. Hearle (1929), Abdel-Malik (1949) and Breland (1951) have each described one species in all instars. Marshall (1938) presents a key to 11 of the 14 British species; Bohart (1954) keys and describes 15 California species and Price (1960) similarly treats 18 Minnesota species; Lake (1963) has described and illustrated two salt marsh species from Delaware. The author included 18 species in his dissertation, and presents here a key to all the North American species whose first-instar larvae are known.

Key to the Species of *Aedes*

- 1.(a) Antennae glabrous, spinules absent 2
- (b) Antennae with spinules present, arranged in short, transverse rows ... 5
- (c) Antennae with spinules scattered, not arranged in transverse rows
 (sometimes the ventral spinules are in longitudinal or oblique
 rows) 9
2. Lateral hair of anal segment and pentad hairs 1 and 5 bifid or trifid;
 antennal hair simple 3
- Lateral hair of anal segment and pentad hairs simple 4
3. Air tube hair bifid or trifid *Aedes triseriatus*
- Air tube hair simple *Ae. zoosophus*
4. Pecten teeth not or slightly spirally arranged; antennal hair bifid
 *Ae. sierrensis*
- Pecten teeth rather spirally arranged *Ae. mediiovittatus*
5. Air tube of much smaller diameter than anal segment; gills very long;
 thorax strongly transverse *Ae. dupreei*
- Not as above, the air tube subequal in diameter to anal segment 6
6. Gills of equal length; antennal hair bifid or trifid, rather fine 7
- Gills unequal, the lower shorter; antennal hair stout, bifurcate or
 simple 8
7. Head hairs in nearly vertical alignment (Illinois) *Ae. trivittatus*
- Lower head hairs more approximate than the upper *Ae. infirmatus*
8. Pecten teeth 4-7, none beyond air tube hair *Ae. atlanticus*
- Pecten teeth 8-12, the apical 1-3 beyond the hair *Ae. tormentor*
- 9.(a) Antennae with one long terminal spine, and 2 progressively shorter .. 10
- (b) Antennae with two long equal, and a shorter terminal spine 14
- (c) Antennae with three long, equal, terminal spines 26
- 10.(a) Primary zone of sclerotization about 2.5:1 *Ae. fitchii*
- (b) Primary zone of sclerotization about 1:1 (Calif.) *Ae. species*
- (c) Primary zone of sclerotization less than 1:1, more than 0.5:1 11
- (d) Primary zone of sclerotization less than 0.5:1 12
11. Dorsal preapical setule at basal 0.15 of length of primary zone of
 sclerotization (Colo.) *Ae. nigromaculis*
- Dorsal preapical setule beyond middle of length of primary zone
 *Ae. taeniorhynchus*
- 12.(a) Dorsal preapical setule *before* the primary zone (Calif.) .. *Ae. nigromaculis*
- (b) Dorsal preapical setule at mid length of primary zone 13
- (c) Dorsal preapical setule beyond middle of primary zone (Minn.)
 *Ae. trivittatus*
13. Outer occipital hair bifid *Ae. aegypti*
- Outer occipital hair simple *Ae. atropalpus*
- 14.(a) Primary zone of sclerotization about 0.5:1, half as long as diameter ... 15
- (b) Primary zone about 0.67:1 (Minn.) *Ae. communis*
- (c) Primary zone about 1:1 (0.8:1 to 1.2:1) 16
15. Head hairs and postclypeal hairs in a nearly straight transverse line ...
 *Ae. sticticus*
- These hairs not in a transverse line (Colo.) *Ae. trivittatus*
16. Pecten extending beyond the air tube hair 17
- Distal pecten tooth at or before the air tube hair 19
17. One pecten tooth beyond the hair *Ae. intrudens*
- Three to 5 pecten teeth beyond the hair 18

18. Pentad hair 3 subequal to the others; dorsal preapical setule at about apical third of primary zone of sclerotization *Ae. cataphylla*
 Pentad hair 3 about twice as long as the others; dorsal preapical setule subapical in position *Ae. trichurus*
- 19.(a) Dorsal preapical setule at basal 0.2 of length of primary zone of sclerotization *Ae. mitchellae*
 (b) Dorsal preapical setule at basal third of length 20
 (c) Dorsal preapical setule at about middle of length (0.45 to 0.55) 21
 (d) Dorsal preapical setule at apical third (0.66 to 0.85) of length 24
20. Primary zone of sclerotization more than 1:1; comb scales 9-10; pecten teeth 7-8 (Calif.) *Ae. communis*
 Primary zone shorter than 1:1; comb scales and pecten teeth 3 or 4 to 6 in number *Ae. sollicitans*
21. Pentad hair 3 subequal to the others 22
 Pentad hair 3 much larger than the others 23
22. Comb scale with stout terminal spine and weak lateral fringe
 *Ae. implicatus*
 Comb scale subequally fringed apically, the spine weak ... *Ae. increpitus*
23. Primary zone of sclerotization about 1:1 (Minn.) *Ae. punctor*
 Primary zone longer, about 1.2:1 *Ae. hexodontus*
24. Head hairs and anteantennal hair very stout, frayed .. (Alaska) *Ae. punctor*
 Head hairs finer, simple 25
25. Comb scale with strong terminal spine; gills long *Ae. ventrovittis*
 Terminal spine weakly differentiated; gills short, bud-like
 *Ae. squamiger*
26. Air tube hair bifid or trifid (sometimes simple on one side), small 27
 Air tube hair simple, usually longer than diameter of tube 28
27. Postclypeal hair above lower head hair; first denticle of distal pecten tooth reaches halfway to apex; anteantennal hair bifid or trifid ...
 *Ae. cinereus*
 Postclypeal hair below lower head hair; first denticle of distal pecten tooth shorter; anteantennal hair simple *Ae. vexans*
- 28.(a) Primary zone of sclerotization short, 0.33:1 29
 (b) Primary zone about 1:1 31
 (c) Primary zone about 1.5:1 *Ae. barri*
 (d) Primary zone about 2:1 *Ae. excrucians*
29. Apical 1 or 2 pecten teeth beyond the hair; gills long
 (Minn.) *Ae. nigromaculis*
 Pecten not surpassing the air tube hair; gills short, bud-like 30
30. Air tube about 2:1, with hair reaching apex of tube *Ae. dorsalis*
 Air tube longer, with hair not reaching the apex *Ae. melanimon*
31. Dorsal preapical spine on apical third of length of primary zone of sclerotization; distal pecten tooth beyond the hair 32
 Dorsal preapical setule on or before middle third; pecten not surpassing the air tube hair 33
32. Comb scales and pecten teeth 4 or 5; usually 1 pecten tooth beyond the hair *Ae. bicristatus*
 Comb scales 6-9, pecten teeth 7-11, usually 2 beyond the hair
 (Europe) *Ae. rusticus*

33. Comb scale with well-marked terminal thorn; dorsal preapical setule
at apical third of length of primary zone 34
Comb scale with apical fringe, not thorned 35
34. Antennae 0.75 as long as head, or longer *Ae. diantaeus*
Antennae less than 0.5 as long as head *Ae. flavescens*
35. Dorsal preapical setule at about basal third of primary zone; head
capsule black *Ae. canadensis*
Dorsal preapical setule at about apical third; head grey 36
36. Head hairs longer than antennae *Ae. thibaulti*
Head hairs shorter than antennae (Minn.) *Ae. stimulans*

Notes on the Species

The included species of *Aedes* are listed alphabetically below, without regard to their subgeneric position. All are of the subgenus *Ochlerotatus* unless otherwise indicated. The treatment of the various species is not uniform. Species included in my 1945 thesis are usually described as in that work, without subsequent amplification. Species described by Bohart (1954) and Price (1960), if described, are described following those authors, sometimes with additional notes based on examination of specimens loaned by them. It has been found, on comparison of specimens from different localities, that each of several species must be keyed out several times. This may indicate species complexes, which may not be surprising in view of the complex synonymy of some of the species. However, when quite distinct species like *nigromaculis* and *trivittatus* must be run out several times some doubt may be entertained about the constancy of the key characters selected.

Aedes (Stegomyia) aegypti (Linnaeus)

Figs. 2A and B

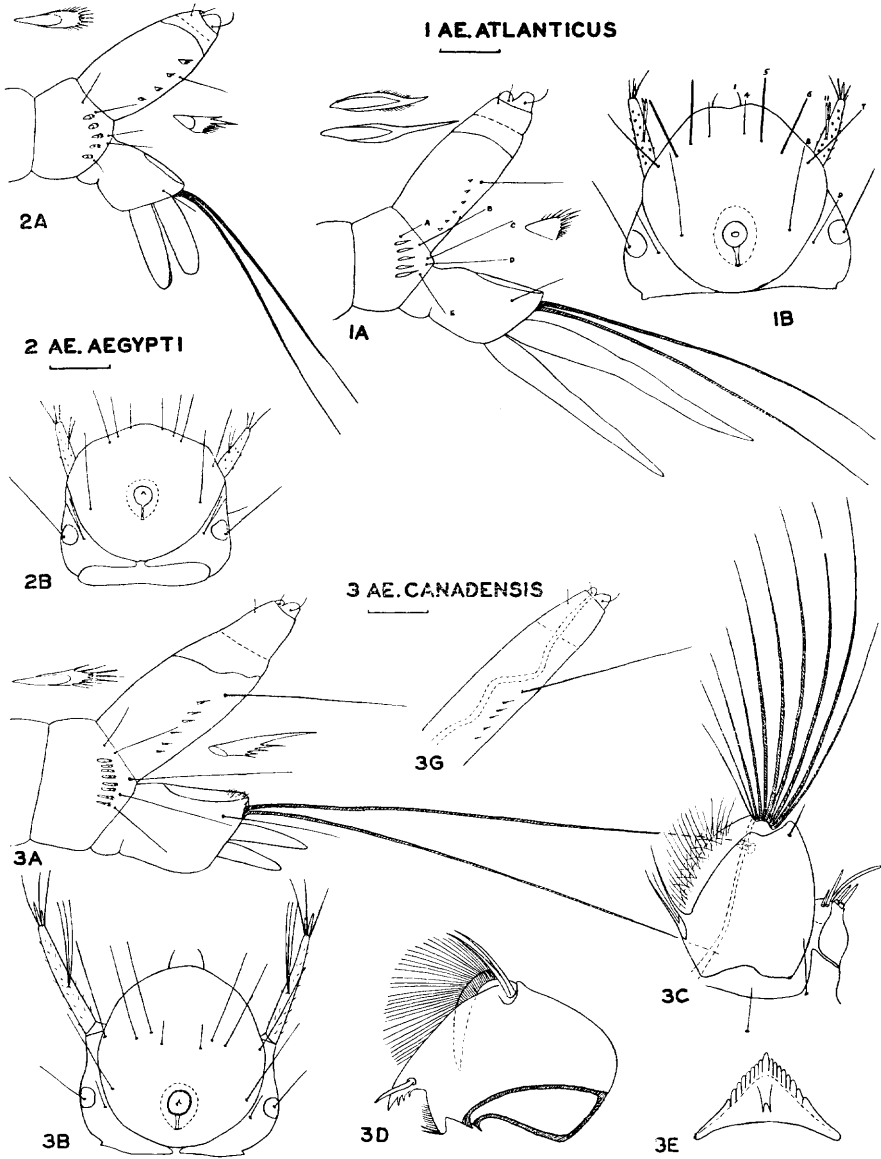
This species, and *atropalpus*, are distinguished from the other species by the antennae with scattered spicules, with one long terminal spine, primary zone of sclerotization of air tube short, with dorsal preapical setule at about middle of its length. Both have the comb scales fringed apically and the air tube hair within the pecten. In both these respects *aegypti* differs from its fourth-instar larvae. Intermediate instars and rarely the fourth instar may have the tuft within the pecten. *Aedes aegypti* has only one pecten tooth beyond the air tube hair, and both comb scales and pecten spines fewer in number than in *atropalpus*. In a small series studied, the comb scales and pecten spines were 4-5 in number, not crowded.

Aedes atlanticus Dyar and Knab

Figs. 1A and B

Characterized by the antennal spinules in short, transverse rows, the air tube subequal in diameter to the anal segment, and the gills unequal, the lower shorter. In all these respects it is similar to *tormentor*, and both have the antennal hair stout and usually bifurcate, sometimes simple, the comb scales elongate, with a rather stout or short terminal spine. It differs from *tormentor* only in the pecten teeth 5-7 in number, with none beyond the air tube hair. The head capsule of both species is quite pale in the first instar, becoming dark in the fourth instar. Comb scales 4-6; pecten teeth 5-7.

Aedes atlanticus, *tormentor*, *dupreei* and *infirmatus* form a distinct group of species, characterized by the arrangement of the antennal spinules in short, transverse rows. This is a first-instar character only, and in this respect they are much like *Psorophora*, from which they differ by generic characters. The adults of



Figs. 1-3. Fig. 1 A, B, *Aedes atlanticus* Dyar and Knab, Statesboro, Georgia, July 1943 (W. A. Hodges). Fig. 2 A, B, *Aedes aegypti* (Linnaeus), reared in laboratory, Macon, Georgia, July 1943 (H. R. Dodge). Fig. 3 A-E, G, *Aedes canadensis* (Theobald), Savannah, Georgia, December 1943.

these four species are characterized by silvery vestiture of the pronotum. Specimens of *trivittatus* from Illinois also have this antennal character, unlike other *trivittatus* studied.

***Aedes (Finlaya) atropalpus* (Coquillett)**

Figs. 54A and B

The larva of this species has the air tube hair small, exceeded by the pecten. Superficially it resembles *aegypti*, from which it differs by the more numerous, crowded comb scales and pecten spines, the air tube hair exceeded by 2-3 pecten

spines, the simple outer occipital hair, and the shape of the egg burster. The apical pecten spines may be situated in the secondary zone of sclerotization. Comb scales 5-9; pecten teeth 5-8.

***Aedes barri* Rueger**

Aedes barri, Price, 1960, p. 530, fig. 3.

Head hairs simple, together with the postclypeal hairs in a straight, nearly transverse line. Antennae half as long as head, heavily spinulose, with shaft hair usually bifid and 3 equal terminal spines. Comb scales 6-9, each with distinct terminal spine, the spines short in the middle of the row and long on the upper and lower scales, thus the hind margin of the comb is concave. Pentad hair 3 slightly longer than the others. Air tube 5:1, with 7-10 pecten teeth; air tube hair simple, opposite or slightly before the apical pecten tooth.

***Aedes bicristatus* Thurman and Winkler**

Aedes bicristatus, Bohart, 1954, p. 358, fig. 6.

Antenna with 3 long, equal terminal spines, antennal hair usually trifold, shaft spinulose. Comb scales thorn-shaped, 4-5; pecten teeth 4-5. Apical pecten tooth usually beyond air tube hair. Dorsal preapical spine as long as apical pecten tooth and situated very near the apex of the tube; primary zone of sclerotization longer than its diameter at base. Air tube hair long, simple. Pentad hairs and lateral hair of anal segment simple. The two additional air tube hairs of the later instars are not present in the first instar.

Known only from California. Description based on Bohart (1954).

***Aedes canadensis* (Theobald)**

Figs. 3A-E, G

Aedes canadensis, Price, 1960, p. 550, fig. 4.

In the Southeastern States this species, together with *thibaulti*, is characterized by the antennae at least half as long as the head, with 3 subequal terminal spines, and the comb scales fringed apically, without a well-differentiated terminal spine. It is separable from that species by the shorter antennae and shorter, coarser head hairs, and is especially distinct from all other *Aedes* by the black head capsule. In this respect it resembles *Culiseta inornata*, which has shorter antennae and a very different egg burster. Smith (1904) also refers to the dark head capsule of young *canadensis*. Comb scales 4-9; pecten teeth 4-7.

Price's description is in general agreement, but apparently his larvae had the head capsule lighter, the apical spine of the comb scale better differentiated and the dorsal preapical setule somewhat differently placed.

***Aedes cantator* (Coquillett)**

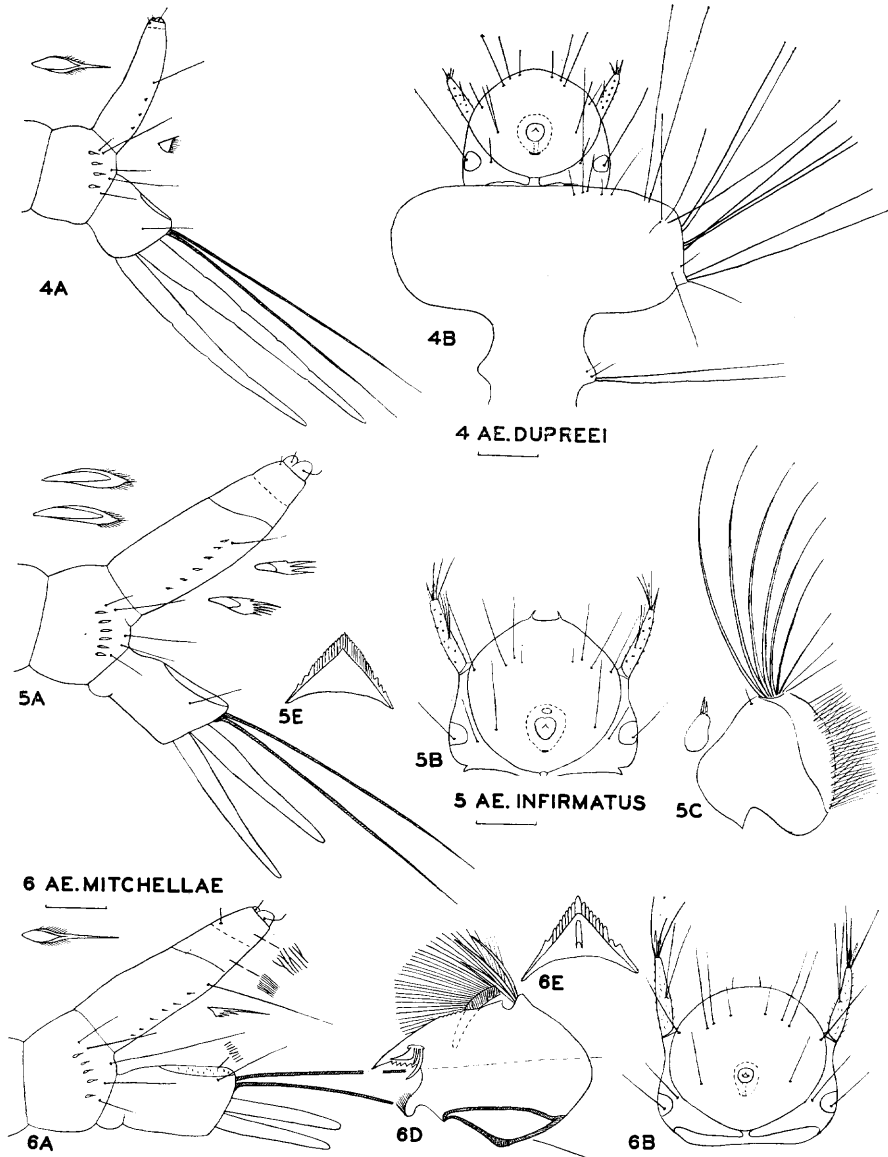
Aedes cantator, Lake, 1963, pp. 254-256, fig. 1.

From the description and figure: Inner occipital hair elongate, larger than the head hairs; postclypeal hairs in line between the lower head hairs; antenna about half of head, spiculose, with 2 long, equal and a shorter terminal spine; comb scales 5-7, with a slightly differentiated terminal spine; pecten teeth 3-5; air tube 2.5:1 to 4:1 (!), with air tube hair very long, single; primary zone of sclerotization about 1:1, with small dorsal preapical setule beyond its mid length.

***Aedes cataphylla* Dyar**

Aedes cataphylla, Bohart, 1954, p. 358, figs. 1-5.

Antennae spinulose, slightly less than half as long as the head, with two long terminal spines and shaft hair bifid. Head hairs and anteantennal hair simple. Comb scales 4-6, each with a terminal thorn shorter than the base. Pentad hairs



Figs. 4-6. Fig. 4 A, B, *Aedes dupreei* (Coquillett), Statesboro, Georgia, August 1943 (W. A. Hodges). Fig. 5 A-C, E, *Aedes infirmatus* Dyar and Knab, Valdosta, Georgia, 17 February 1944 (Leighton Golden). Fig. 6 A, B, D, E, *Aedes mitchellae* Dyar, Douglas, Georgia, 17 December 1943 (Glenn Tanner).

and lateral hair of anal segment simple; gills less than half as long as anal segment. Air tube about 4:1, with a very long hair; pecten with 2-5 (usually 3) teeth beyond the hair. Primary zone of sclerotization about 1.25:1, with a large dorsal preapical setule at about its apical third. Description based on Bohart's California specimens.

***Aedes (Aedes) cinereus* Meigen**

Aedes cinereus, Price, 1960, p. 531, fig. 5.

This species was placed in my 1945 key by the number of comb scales ascribed to it by Marshall (1938). That author stated that the air tube is 3:1 in *cinereus*

and 2:1 in *vexans*, but numerous North American *vexans* have the air tube about 3:1, never 2:1. His description of *vexans* was based upon a cast skin.

Price had specimens reared from females, and found that the postclypeal hair, upper head hair and anteantennal hairs were in a straight transverse line, with the lower head hair anteriorly displaced to this line. Antennae spinulose, antennal hair 2-3 branched; 3 equal terminal spines. Comb scales 5-7, each with a prominent terminal spine; all pentad hairs simple, equal. Air tube 4:1 to 5:1, with 5-9 pecten teeth, and a simple or bifid hair beyond the pecten. Price concluded that the arrangement of the head hairs and the distal pecten tooth with first denticle strong, reaching over half way to apex, were the best ways to distinguish *cinereus* from *vexans*.

Aedes communis (De Geer)

Aedes communis, Price, 1960, p. 552, fig. 6.

After Price: Head hairs simple, the upper and lower head hair and postclypeal hair on each side being in a straight, slightly diagonal line. Antennae spinulose, half as long as head, with hair bifid or trifid and two long, equal terminal spines. Comb scales 6-9, each sole-shaped, with a slight terminal spine. Pentad hair 3 twice as long as the others. Air tube 3-4:1; pecten teeth 7-9; air tube hair simple, beyond pecten; primary zone of sclerotization about 0.7:1 (shorter than its basal diameter).

Bohart's *communis* (1954, p. 360, fig. 8) will not key out with Price's specimens. Two specimens are before me; the primary zone of sclerotization is longer than its basal diameter, with dorsal preapical setule slightly before the middle of its length; comb scale fringed apically; pentad hair 3 very large, exceeding the anal segment.

Aedes diantaeus Howard, Dyar and Knab

Aedes diantaeus, Price, 1960, p. 552, fig. 7.

After Price: Head hairs simple, postclypeal hair in line between the upper head hairs. Antennae at least 0.75 of head length, with 3 equal terminal spines. Comb scales 6-8, each with a very stout terminal spine and one shorter on each side. Pentad hairs simple, equal. Air tube 4-5:1, with pecten teeth 5-7 and a simple hair beyond the pecten.

Aedes dorsalis (Meigen)

Aedes dorsalis, Bohart, 1954, p. 360, fig. 13.

Aedes dorsalis, Price, 1960, p. 554, fig. 10.

Price's Minnesota specimens are quite in agreement with Bohart's description and figure of California specimens. From Price: Head hairs simple, with upper, lower and postclypeal on each side in a straight, nearly transverse line. Antennae half as long as head, with 3 equal terminal spines. Comb scales 4-6, each with a weak terminal spine; pentad hair 3 slightly larger than the others. Air tube 2:1, with 3-5 pecten teeth, hair simple, beyond or opposite last pecten tooth. Primary zone short, with dorsal preapical setule subapical. Gills short.

Aedes dupreei (Coquillett)

Figs. 4A and B

Only a few field-collected specimens were available for study. The thorax is strongly transverse and the air tube of small diameter in all instars. Comb scales 3-4; pecten teeth 4-5.

***Aedes excrucians* (Walker)**

Aedes excrucians, Price, 1960, p. 548, fig. 1.

This species is well described by Price. Distinguished by the elongate air tube and 3 equal terminal spines of antennae. Pentad hair 3 exceeds the anal segment. Comb of this species and *fitchii* as described for *barri*.

***Aedes fitchii* (Felt and Young)**

Aedes fitchii, Bohart, 1954, p. 360, fig. 10.

Aedes fitchii, Price, 1960, p. 552, fig. 8.

Price's figure and description was based on two of Bohart's specimens. He found it nearly identical with *excrucians*, except that the antennae had three equal terminal spines in the latter species whereas *excrucians* had one long and two progressively shorter.

***Aedes flavescens* (Müller)**

Hearle (1929) gave a good illustration and description of the first-instar larva of this species, but as he did not describe or show the primary zone of sclerotization, everyone since then has speculated on its position in their keys. I have borrowed four slides of Hearle's material, all collected at Indian Head, Saskatchewan, in April 1927. The antennae are about half as long as the head, with 3 equal terminal spines. The egg burster is perfectly conical, the disk fringed with strong spicules. Comb scales thorn-like, very minutely fringed, the thorns in the center of the comb shorter than at the extremities, so that the hind margin of the comb is concave, as Price describes for *barri* and several others. Pentad hairs small. Pecten of 5-6 teeth, ending before the hair; air tube hair 1.5 as long as diameter of the tube. Primary zone of sclerotization 1:1, with dorsal preapical setulae at basal 0.3 of its length.

***Aedes hexodontus* Dyar**

Aedes hexodontus, Bohart, 1954, p. 362, fig. 7.

From Bohart: Antenna with 2 long terminal spines; comb of 5-7 scales, each with strong terminal spine; pecten of 4-7 teeth, none beyond the hair; primary zone of sclerotization 1.2:1, with setule at about middle of its length.

Three larvae from Dr. Bohart (Ebbet's Pass, Alpine Co., Calif.) agree well with his figure, except that pentad hair 3 is somewhat longer, reaching to middle of the saddle and the saddle hair is subequal to it. A fourth specimen, from Sonora Pass, Tuolumne County, on a slide with all the later instars of *hexodontus*, may be misassociated; it differs by pentad hair 3 reaching nearly to apex of saddle and saddle hair small, equal to pentads 4 and 5. The dorsal preapical setule is before the middle of the primary zone (much before the middle on one side). Bohart states that the dorsal preapical setule is at the apical two-fifths or three-fifths (0.6 to 0.4 from base, by my expression) — at any rate it is on the mid third of the length of the primary zone.

***Aedes implicatus* Vockeroth**

This species has not been described or figured. A Minnesota specimen sent by Dr. Price has the antennae with two long and a shorter terminal spines, the primary zone of sclerotization about as long as its basal diameter, with setule at its middle, pentad hair 3 only slightly larger than the others and comb scale with stout thorn and very weak lateral fringe. Comb scales 6; pecten teeth 5-6; pecten not exceeding the air tube hair.

***Aedes increpitus* Dyar**

Aedes increpitus, Bohart, 1954, p. 362, fig. 11.

Twelve larvae from Lake Tahoe, California, loaned by Dr. Bohart, check well with his figure, but the third terminal spine of the antenna is nearly equal to the other two in several specimens. Bohart has already noted that occasionally the last pecten tooth is beyond the hair; such specimens would run to *intrudens*.

***Aedes infirmatus* Dyar and Knab**

Figs. 5A-C, E

To this species is referred a single field-collected larvae from Georgia, on the basis of the antennal spinules in short, transverse rows (see discussion under *atlanticus*) and the fact that there is no other species of *Aedes* from its locality with first instar unknown, with exception of the rarer *fulvus pallens* Ross. The larva of the latter is probably larger, with pecten exceeding the air tube hair. *Infirmatus* is distinguished from other members of the *atlanticus* group by the longer antennae, with shaft hair bifid or trifid, the median spine of the comb scale hardly differentiated, the equal gills, and the egg burster preceded by a smaller, transversely oval sclerite situated in the ring. Comb scales and pecten teeth six.

One larva from a female, Palmetto, Texas, loaned by Dr. Breland, differs from my figure in several respects. The comb scales have a definite, small thorn and very scanty fringe; the sclerite before the egg burster is lacking; antennae with sparse spinules and two long terminal spines.

***Aedes intrudens* Dyar**

Aedes intrudens, Price, 1960, p. 554, fig. 9.

This species has been well characterized by Price.

***Aedes mediovittatus* (Coquillett)**

A collection of all instars from Salinas, Puerto Rico (C. E. Kohler, coll.) was studied. The spiral twisting of the pecten and the blade-like pecten teeth and comb scales characterize all instars; the lower head hair is strongly displaced forward, ahead of the postclypeal hair. Certain hairs of the head are very stout and simple or bifid in the first instar—these hairs become stellate, with 3-6 branches in the fourth instar.

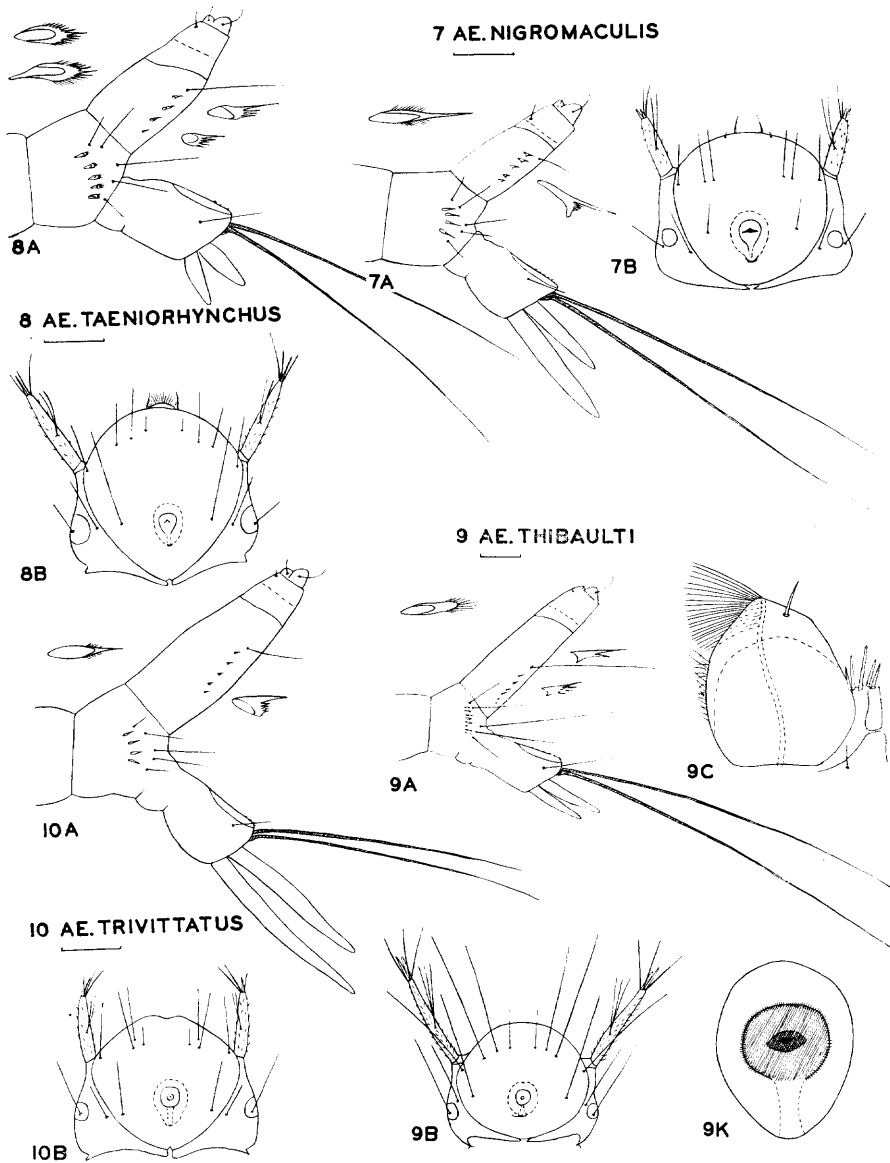
***Aedes melanimon* Dyar**

Eighteen larvae on one slide, Silverville, Yolo County, California, were loaned by Dr. Bohart. They are very similar to *dorsalis*, as may be expected, the only differences noted being the slightly longer air tube, with the hair not quite reaching the apex of the tube. Comb scales 5-7; pecten teeth 5-6; gills half as long as the anal segment.

***Aedes mitchellae* Dyar**

Figs. 6 A, B, D and E, and p. 389 Figs. 6 D, F

This species is recognized by the long air tube hair, antennae half as long as head, median spine of comb scale as long as the basal portion, dorsal preapical setule long, situated near the base of the primary zone of sclerotization. The antennal hair is usually bifid, sometimes trifid or simple. The surface sculpture of the primary and secondary zones of sclerotization is shown in Fig. 6A. Comb scales 3-6; pecten teeth 4-5; very rarely the distal tooth is opposite the air tube hair.



Figs. 7-10. Fig. 7 A, B, *Aedes nigromaculis* (Ludlow), reared from gravid female, Denver, Colorado, September 1945 (W. R. Lasky). Fig. 8 A, B, *Aedes taeniorhynchus* (Wiedemann), reared by author from gravid female, Brunswick, Georgia, July 1944 (R. C. Ball). Fig. 9 A-C, K, *Aedes thibaulti* Dyar and Knab, Macon, Georgia, 6 March 1945, ground pool under gum tree (H. R. Dodge). Fig. 10 A, B, *Aedes trivittatus* (Coquillett), reared from gravid female, Denver, Colorado, July 1945 (W. R. Lasky).

***Aedes nigromaculis* (Ludlow)**

Figs. 7 A and B

Aedes nigromaculis, Bohart, 1954, p. 364, fig. 16.

Aedes nigromaculis, Price, 1960, p. 556, fig. 11

Price redescribed this species on the basis of two of Bohart's California specimens, and their figures are in agreement, showing two long terminal spines of the antennae and the dorsal preapical setule situated slightly before the primary zone

of sclerotization. A specimen sent me by Bohart from Silverville, California, shows only one long terminal spine of the antenna. Two Minnesota specimens loaned by Dr. Price have *three* equal long terminal spines, so on the basis of these findings I have run this species out three times in the key. To further complicate the picture, Colorado specimens originally studied and figured in my thesis are still different by the dorsal preapical setule situated on the base of the primary ring (not before the ring) and the postclypeal hair strongly displaced forward, as well as by the unequal gills. My description of the Colorado specimen (comparing it to southeastern species) is as follows:

"This species is distinguished by the small air tube, with small air tube hair and large, displaced dorsal preapical setule, the thorn-shaped comb scales and the small antennae. These gills are unequal in length, the upper shorter. A pair of minute hairs near the clypeal spines probably represents the postclypeal hairs, because no hairs can be found in the usual position of those hairs. The point of the egg burster is hardly conical, but quite transverse. Comb scales 3-4; pecten teeth 4-5."

It is possible that *nigromaculis* is a previously unrecognized species complex or are these first-instar differences intraspecific?

Aedes punctor (Kirby)

Aedes punctor, Price, 1960, p. 556, fig. 12.

Specimens from Umiat, Alaska, referred to this species by Dr. K. L. Knight, are somewhat different from Minnesota specimens. The head hairs and anteantennal hair are very stout, as stout as any thoracic hair, and finely frayed. The primary zone of sclerotization is 1.2:1, with dorsal preapical setule at apical 0.65 to 0.75 of its length. Comb scales and pecten teeth 6-9. The egg burster has a conical point, the sides and front margin extremely spinulose.

Aedes rusticus (Rossi)

This European species was described by Marshall (1938) and Bohart (1954, p. 358) commented briefly on specimens he had examined. Other European species described by Marshall cannot be keyed out because the descriptions and figures are inadequate.

Aedes (Finlaya) sierrensis (Ludlow)

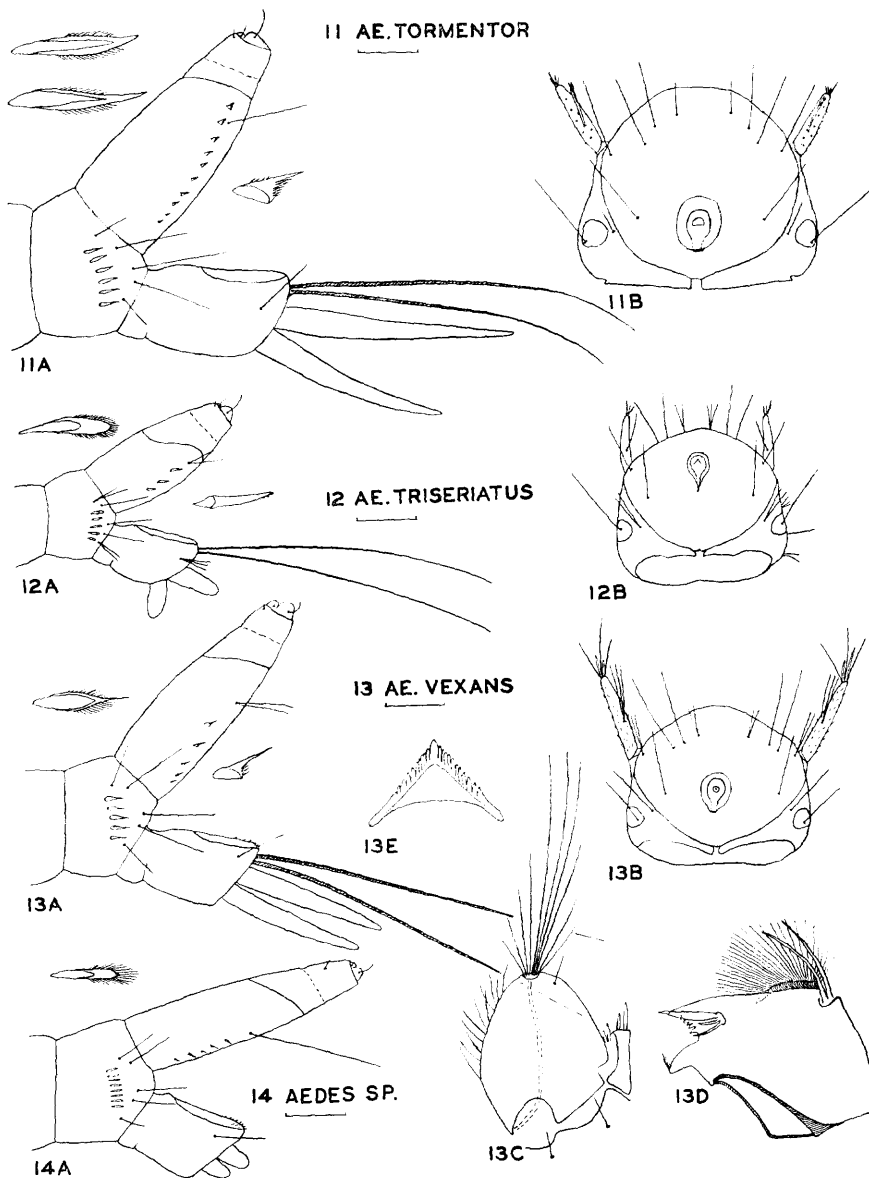
Aedes varipalpus, Bohart, 1954, p. 365, fig. 12.

Distinguishable from the eastern tree hole species by the simple air tube hair.

Aedes sollicitans (Walker)

Specimens from Vero Beach, Florida, were sent by Dr. Maurice Provost. Head hairs simple, rather close-set, not in vertical or horizontal alignment, postclypeal hair slightly before the lower head hair, anteantennal hair long, simple. Antenna about half of head, with scattered spinules, with bifid hair and two long terminal spines. Egg burster oval, with strong conical point on a transverse ridge, posterior strap well developed. Comb scales 5-6, thorn-shaped; pentad hairs simple, rather short; saddle hair as long as saddle. Air tube less than 3:1, with 5-6 pecten teeth followed by an elongate hair. Primary zone of sclerotization about 1:1, dorsal preapical setule at or before basal 0.3 of its length.

Lake (1963) has figured and described this species, with air tube 2:1 to 3:1; pecten teeth 3-6 (usually 4-5) and comb scales 4-6. He shows two nearly equal terminal spines of antennae and dorsal preapical setule before the middle of the length of the primary zone; his specimens should fit my key, although if the terminal spines of the antennae are interpreted as one long plus two shorter, *sollicitans* would then run to couplet 11, where it separates from *taeniorhynchus*



Figs. 11-14. Fig. 11 A, B, *Aedes tormentor* Dyar and Knab, Macon, Georgia, July 1942 (C. M. Crutchfield). Fig. 12 A, B, *Aedes triseriatus* (Coquillett), Augusta, Georgia, August 1943 (W. Ivey). Fig. 13 A-E, *Aedes vexans* (Meigen), Douglas, Georgia, December 1943 (Glenn Tanner). Fig. 14 A, *Aedes* species, Tulare Co., California, January 1943 (John T. Medler).

on the position of the dorsal preapical setule, as well as by the better differentiated terminal spine of the comb scales.

Aedes squamiger (Coquillett)

Aedes squamiger, Bohart, 1954, p. 364, fig. 14.

Three specimens loaned by Dr. Bohart show the head hairs in nearly transverse alignment, the saddle hair long and set very close to the saddle. Comb scales 5-8; pecten teeth 3-5.

***Aedes sticticus* (Meigen)**

Aedes sticticus, Bohart, 1954, p. 364, fig. 17.

Aedes sticticus, Price, 1960, p. 557, fig. 13.

Bohart and Price are in close agreement in their descriptions of this species.

***Aedes stimulans* (Walker)**

Aedes stimulans, Price, 1960, p. 557, fig. 14.

Price described this species from a single specimen and noted that its separation from *intrudens* was questionable. Two specimens which he kindly provided have three, not two, long terminal spines of the antennae and so run out with *thibaulti* in my key.

***Aedes taeniorhynchus* (Lynch-Arribalzaga)**

Figs. 8 A and B

Aedes taeniorhynchus, Bohart, 1954, p. 365, fig. 15.

Bohart's figures agree quite closely with mine, except that he shows a rather strong thorn on the comb scale, whereas my specimens had the thorn weak or absent. The primary zone of sclerotization is about half as long as wide.

***Aedes thibaulti* Dyar and Knab**

Figs. 9 A, B, C and K

Two first-instar larvae and a cast skin were collected from a cavity under a gum tree, in association with later instars of this species. The head hairs, ante-antennal hair and inner occipital hair are extremely long and fine. It differs further from *canadensis* by the longer antennae and grey head capsule. Comb scales 8-9, evenly fringed; pecten teeth 5-6, followed by the long air tube hair. Other characters as illustrated.

***Aedes tormentor* Dyar and Knab**

Figs. 12 A and B

Field-collected larvae were reared to the second instar, thus ensuring identification. In all instars the pecten exceeds the air tube hair and has more numerous teeth than *atlanticus*. Otherwise very similar to *atlanticus*. Comb scales 5-7; pecten teeth 8-12.

***Aedes trichurus* Dyar**

Aedes trichurus, Price, 1960, p. 557, fig. 15.

Antennae half as long as head, with two long equal terminal spines and one shorter; comb scales 6-9, each with a very long, stout thorn; pentad hair 3 twice as long as the others; pecten of 7-13 teeth, 4-5 beyond the hair and 1-2 on the primary zone of sclerotization.

***Aedes* (Finlaya) *triseriatus* (Say)**

Figs. 12 A and B

A common eastern tree hole breeder with glabrous antennae, and ninth lateral hair of the anal segment, air tube hair and pentad hairs 1 and 5 bifid or trifid. It is most frequently associated with *O. signifera*, which also has glabrous antennae but lacks the pecten. Specimens hatch readily when tree holes are flooded in spring or summer, but in the late fall few eggs hatch. Material from a hollow log yielded 130 and 47 larvae the first two times it was flooded, but none thereafter.

***Aedes trivittatus* (Coquillett)**

Figs. 13 A and D

Aedes trivittatus, Price, 1960, p. 558, fig. 17.

This is another species where larvae from various sources do not agree with each other, so it is placed in the key three times. The Colorado specimens

originally studied by me were described as follows: "Larvae reared from a female are distinguished from other species studied by the following combination of characters: comb scales thorn-shaped, with long median spine and lateral fringes; antennae less than half as long as head, with scattered spinules; dorsal preapical setule small, extremely apical in position; comb scales 4-6; pecten teeth 4-6."

Price found his Minnesota larvae to be essentially in agreement with mine, but he showed one (not two equal) long terminal spine of the antenna and the postclypeal hair farther forward, between the lower head hairs.

Dr. Horsfall has submitted Illinois larvae of all instars, and it is most perplexing to find that they have the antennal spinules in transverse rows and thus will run out with *infirmatus* in the key. The larvae are otherwise much like Minnesota specimens: one long terminal spine of antenna, lower head hair almost directly below the upper; air tube hair small, simple, primary zone of sclerotization about half as long as its basal diameter; comb scales 6; pecten teeth 4.

***Aedes ventrovittis* Dyar**

Aedes ventrovittis, Bohart, 1954, p. 365, fig. 9.

Antenna with two equal terminal spines; pentad hairs and air tube hair short; primary zone of sclerotization nearly as long as its diameter, with dorsal preapical setule very apical in position; comb scales 5-6, each with long thorn; pecten teeth 3-6, not reaching the hair.

***Aedes (Aedimorphus) vexans* Meigen**

Figs. 13 A-E

Aedes vexans, Bohart, 1954, p. 365, fig. 18.

Aedes vexans, Price, 1960, p. 560, fig. 18.

This is the only common *Aedes* inhabiting temporary ground pools in the Southeastern States, which has the air tube hair branched. Specimens match Marshall's (1938) description very well and have antennae with 3 long equal terminal spines; air tube hair small, bifid or trifid; primary zone of sclerotization about half as long as wide; comb scales 4-7, each with small thorn and well-developed fringe; pecten spines 4-7; pentad hairs small.

Bohart's and Price's larvae are in agreement.

The separation of this species from *cinereus* is discussed under that species, in regard to the apical pecten tooth. *Vexans* furthermore has the postclypeal hair slightly below the lower head hair, whereas in *cinereus* it is in line between the upper head hairs.

***Aedes zoosophus* Dyar and Knab**

One field-collected larva from Austin, Texas, received through Dr. Breland, may pertain to this species. It differs from *triseriatus* by the antennal hair simple and comb scales shorter, four in number. Pecten teeth three.

Aedes species

Fig. 14 A

A series of Californian larvae of all instars were sent under the name of *dorsalis* and the mature larvae keyed to that species in the keys then available. However the air tube is too elongate in all instars for that species. It was thought that they may be *melanimon* but after recently studying that species they are seen to differ by the more elongate air tube and the comb scales evenly fringed apically. My figure does not match anything illustrated by Bohart.

***Anopheles* Meigen**

Figs. 15-25, 56

Head longer than wide, width 0.16 to 0.18 mm. Clypeal hairs simple, the inner clypeal hairs usually widely separated; frontal hairs (the head hairs and ante-antennal hair forming a transverse row across the front) usually branched but simple in some species; egg burster a transverse ridge, slightly pointed medianly, set in an oval, poorly defined depression which is sclerotized. Antenna with spinules sparse or none; antennal hair situated very close to the base of the shaft; apical armature of two stout spines or sabres, between which is placed the terminal hair and a short appendage (Fig. 23F, p. 389). Subantennal hair variable and very important taxonomically. Mouthparts (Fig. 18J) and gula very similar to those of the later instars, but the maxillary palpus is shorter. Head scarcely constricted behind, with a broad, sclerotized collar which is absent at eclosion, but develops during the instar.

Thorax dorsally with a maximum of five pairs of lanceolate hairs, two on the prothorax, one on the mesothorax and two on the metathorax. The mesothorax bears a dorsolateral group of long, strong hairs arising from a platelet.

Abdomen with a pair of lanceolate hairs dorsally on some or all of the first seven segments; these are hair no. 1, and correspond to the palmate hair of the later instars. Segments 1-3 each with two pairs of long, strong, equal lateral hairs. Air tube absent, the spiracles sessile. Pecten a row of 7-12 spines on a sclerotized plate, the spines about equal except that the lower spines become shorter and broader. Comb present, consisting of 4-7 elongate scales, each usually with sparse, fine lateral fringes. Anal segment pilose, with saddle absent; gills 2 pair, short; posteroventrally the anal segment bears a group of stiff, usually short spines, in the position of the ventral brush of the later instars.

First-instar *Anopheles* may be distinguished readily by the absence of the air tube. Several structural peculiarities distinguish them from the later instar larvae. Later instars have the dorsolateral mesothoracic hair group and the lower lateral hair of the third abdominal segment very small, lack the comb, and have median tergal platelets on the abdominal segments. Hurlbut (1938) has made a careful study of the chaetotaxy of all instars of *A. walkeri*.

Two keys have been published for first-instar American *Anopheles* larvae; one by Hurlbut (1941) separates four eastern species, and the other by Pratt (1943) separates the three Puerto Rican species. The following key and descriptions are offered to separate the North American species.

Key to North American Species of *Anopheles*

- | | | |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| 1.(a) | Subantennal hair minute, unbranched; clypeal and frontals likewise | |
| | | <i>A. barberi</i> |
| (b) | Subantennal hair large, bifid | 2 |
| (c) | Subantennal hair pectinate or unequally pinnate, with branches few or none on inner side | 3 |
| (d) | Subantennal hair equally pinnate, with branches on each side to near base | 9 |
| 2. | Lanceolate hairs on abdominal segments 1-6; terminal hair of antenna usually bifurcate | <i>albimanus</i> |
| | Lanceolate hairs slender, on segments 3-6; terminal hair of antenna short, simple; postclypeal hair longer than the inner and outer clypeal hairs | <i>pseudopunctipennis</i> |

- 3. Subantennal hair with 12 or more branches, the apical ones fine and numerous 4
- Subantennal hair with less than 12 branches 5
- 4. Lanceolate hairs on segments 1-7; subantennal hair with extremely long basal branches *walkeri*
- Lanceolate hairs on segments 2-7; subantennal hair with basal branches shorter, not as long as the shaft of the hair *aztecus*
- 5. Frontal hairs usually unbranched 6
- Frontal hairs usually branched 8
- 6. Inner clypeal hairs more widely spaced than the inner frontals *earlei*
- Inner clypeals not more widely spaced 7
- 7. Outer clypeal hairs subequal in length to the inner clypeals *grabhamii*
- Outer clypeal hairs less than half of inner clypeals *atropos*
- 8.(a) Subantennal hair 7-11-branched; outer frontal 2-4-branched ... *freebornii*
- (b) Subantennal hair 5-9-branched; outer frontal usually simple *perplexens* and *punctipennis*
- (c) Subantennal hair 4-8-branched; outer frontal usually simple ... *occidentalis*
- 9. Lanceolate hairs on abdominal segments 1-7 *quadrifasciatus*
- Lanceolate hairs on abdominal segments 2-6 10
- 10. Subantennal hair with stout shaft; antennal hair long *vestitipennis*
- Subantennal hair with usual shaft; antennal hair short 11
- 11.(a) Frontal hairs with 2-6 branches; occipitals simple *crucians*
- (b) Frontal hairs with more (4-9) branches *georgianus*
- (c) Occipital hairs tend to be smaller and branched *bradleyi*

***Anopheles albimanus* Wiedemann**

Fig. 15

This and *pseudopunctipennis* are the only North American species with the subantennal hair long and bifid; the branches are incurved apically. A number of Old World species have this type of hair. *Albimanus* is easily distinguished from *pseudopunctipennis* by the normal ventral bristles of the anal segment, not forming a basket, and the postclypeal hair not longer than the clypeals. Pratt (1943) states that the three Puerto Rican species (including this species) have the palmate hairs of segments 3-7 represented by lanceolate hairs in the first instar. Specimens from Puerto Rico, Jamaica and Texas all have lanceolate hairs on segments 1-6 only.

***Anopheles atropos* Dyar and Knab**

Fig. 17

This species has the subantennal hair as in *punctipennis*, but differs by the unbranched frontal hairs. Only one bifurcated frontal hair was found in 14 larvae. Its separation from the West Indian *grabhamii* is more difficult, the most reliable character being the short outer frontal hairs. In this species these hairs are less than half as long as the inner clypeal hairs.

***Anopheles aztecus* Hoffman**

Fig. 17

This species is much like *walkeri* except that the basal branches of the subantennal hair are shorter than the shaft of that hair, and the first abdominal segment does not possess a pair of lanceolate hairs. The frontal hairs have 3-5 branches, the outer frontals rarely with two. The subantennal hair has 13-21 branches, of which 3-8 are on the inner side of the shaft. The basalmost inner

branch is preceded by 1-5 outer branches. This species occurs in the higher altitudes of Mexico; larvae examined were from Ixmaquilpan (Luis Vargas) and Texcaltenco (Alfonso Dampf).

***Anopheles barberi* Coquillett**

Figs. 18 and 18J

A remarkably distinct species in all instars because of the minute head hairs and glabrous, small antennae. No other species except *pseudopunctipennis* has lanceolate hairs on segments 3-6 only, and lanceolate thoracic hairs cannot be discerned. The frontal hairs, especially the inner frontal hairs, are posterior to the position of these hairs in the other species.

***Anopheles bradleyi* King**

***Anopheles crucians* Wiedemann**

***Anopheles georgianus* King**

Fig. 19

These three species are well defined only upon characters of the fourth-instar larvae. *Crucians* is common and widespread, whereas the other two are confined, respectively, to coastal brackish waters and seepage waters about the heads of streams in the South Atlantic and Gulf States. The writer has presumed *bradleyi* and *georgianus* larvae from each of these habitats, and many typical *crucians* larvae from sites that do not produce the other two. All have lanceolate hairs on abdominal segments 2-6, five pairs of lanceolate hairs on the thorax, the frontal hairs branched and the subantennal hair pinnate, with branches on both sides to near its base.

In the probable *bradleyi* larvae the frontal hairs had 2-6 (av. 4.11) branches and the occipital hairs sometimes smaller than usual and branched (see Fig. 19, left side of head). One specimen had both outer occipitals 3-branched, and another had one 4-branched hair.

In the probable *georgianus* larvae the frontal hairs had 4-7 (av. 5.84) branches with exception of one specimen which had 5-9 (av. 8) branches. The occipital hairs are simple.

Typical *crucians* larvae have 2-6 (av. 4.4) branches of the frontal hairs and the occipital hairs simple.

***Anopheles freeborni* Aitken**

Fig. 20

Specimens from a laboratory culture are very similar to *punctipennis* in all instars. The only difference in the first-instar larvae is a tendency for certain hairs to have more branches, as is indicated in the key. In addition, the inner occipital hair is frequently bifurcate in *freeborni*, but simple in *punctipennis*. *Freeborni* has the subantennal hair with 7-11 branches, of which 0-4 are on the inner side of the shaft.

***Anopheles grabhamii* Theobald**

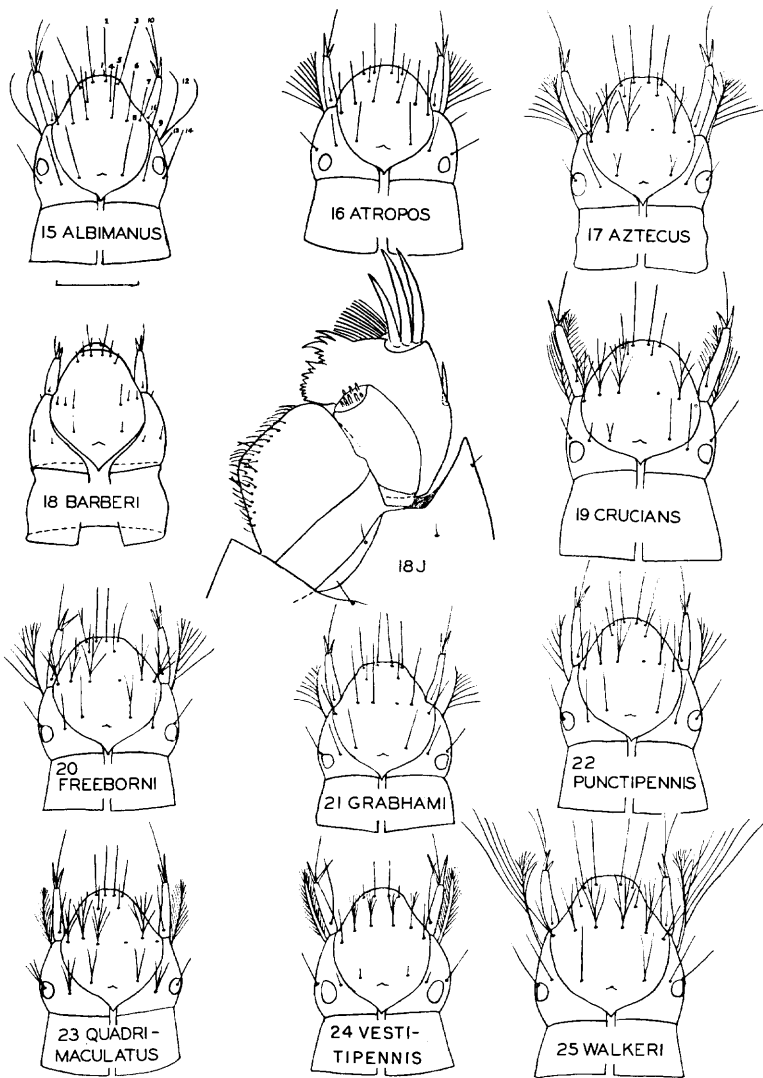
Fig. 21

A West Indian species with first-instar larva very similar to *atropos* and *earlei* except that the outer clypeal hairs are subequal in length to, not shorter than, the inner clypeal hairs. Lanceolate hairs are present on abdominal segments 2-7.

***Anopheles pseudopunctipennis* Theobald**

Fig. 56

A very distinct species, similar to *albimanus* by the bifid subantennal hair and simple frontal hairs, but differing from all other North American species by the



Figs. 15-25. Heads of various species of *Anopheles*, dorsal view. Fig. 15, *Anopheles albimanus* Weidemann, Jamaica, September 1944 (G. A. Thompson, Jr.). Fig. 16, *Anopheles atropos* Dyar and Knab, Fort George, Florida, August 1945 (A. Earl Pritchard). Fig. 17, *Anopheles aztecus* Hoffman, Texcaltenco, Mexico, 4 May 1940 (Alfonso Dampf). Figs. 18, 18 J, *Anopheles barberi* Coquillett, Macon, Georgia, September 1944, field-collected larva reared to adult (H. R. Dodge). Fig. 19, *Anopheles crucians* Wiedemann, Albany, Georgia, February 1943. The left occipital hairs show a variation which may be *bradleyi*; Savannah, Georgia, October 1945. Fig. 20, *Anopheles freeborni* Aitken, Columbia, South Carolina, from a laboratory colony, through the courtesy of Dr. Martin D. Young, February 1943. Fig. 21, *Anopheles grabhamii* Theobald, Guraba, Puerto Rico, July 1945 (H. D. Pratt). Fig. 22, *Anopheles punctipennis* (Say), reared from gravid female, Macon, Georgia, August 1945 (H. R. Dodge). Fig. 23, *Anopheles quadrimaculatus* (Say), reared from gravid female, Macon, Georgia, July 1944 (H. R. Dodge). Fig. 24, *Anopheles vestitipennis* Dyar and Knab, redrawn from Pratt (1943). Fig. 25, *Anopheles walkeri* Theobald, Rome, Georgia, May 1944 (Michael Gold).

postclypeal hair longer than the clypeal hairs, the lateral hair of the anal segment with 2-4 dorsal branchlets on its basal half, and especially by the ventral bristles of the anal segment "basket-shaped", forming a transverse row of 12-15 very long, curved, subequal elements preceded by a group of smaller bristles. The lanceolate hairs are more slender than in the other species, and present as one pair on the prothorax and on abdominal segments 3-6. The antennal sabres are nearly two-thirds as long as the terminal hair of the antenna, which is unbranched. The occipital and orbital hairs are usually bifid, sometimes simple.

Specimens of the California subspecies *pseudopunctipennis franciscanus* do not differ perceptibly from typical specimens from Texas and Mexico City, except possibly as shown in the following key.

***Anopheles punctipennis* (Say)**

Fig. 22

This species is quite similar to four other species (*grabhamii*, *atropos*, *earlei* and *freeborni*) by the subantennal hair of less than 12 branches, of which all or nearly all are on the outer side of the shaft, and lanceolate hairs on abdominal segments 2-7. The first three of the others have the frontal hairs simple (rarely one or more is bifurcate), whereas the last has all of these hairs with 2-4 branches. In *punctipennis* the outer frontal hair is usually simple, the middle and inner frontal hairs usually branched; rarely both outer frontals are branched on the same specimen, and one larva had all but two of the frontal hairs unbranched.

Two larvae from St. Helena, California (J. T. Medler), agree with larvae from Georgia. However, a series from Ixmiquilpan, Hidalgo, Mexico (Luis Vargas) have characters intermediate between *punctipennis* and *freeborni*.

Two probable larvae of the dark-winged species *perplexans* Ludlow have been studied. They appear identical with *punctipennis*.

***Anopheles quadrimaculatus* (Say)**

Fig. 23, and on p. 389 Fig. 23F

This species, with the members of the *crucians* complex, is distinguished by the subantennal hair with a moderately slender shaft, branched on both sides to near its base. The branches are more or less in a vertical plane, whereas the branches in species with "unequally pinnate" hair lie nearly in a horizontal plane. It is distinct from the *crucians* complex by the presence of lanceolate hairs on segments 1 and 7, the longer antennal hair (Fig. 23F, on p. 389), and the occipital and orbital hairs usually branched. In addition, Hurlbut (1941) found that hair 5 of abdominal segments 6-7 is normally bifurcate in this species, normally simple in *crucians*. *Walkerii* is the only other species studied which has lanceolate hairs on all of the first seven abdominal segments.

***Anopheles vestitipennis* Dyar and Knab**

Fig. 24

A West Indian species recognized by the stout subantennal hair and the antennal hair as long as the shaft. The frontal hairs are usually 2-3 branched beyond the middle; occasionally one or two are simple. The outer and posterior clypeal hairs are small, the latter could not be recognized at all. Specimens examined are from Ft. Buchanan, P.R. (H. D. Pratt) and San Juan, P.R. (W. A. Hoffman).

***Anopheles walkeri* Theobald**

Fig. 25

This species is very distinct by the extremely long basal branches of the subantennal hair. The chaetotaxy in all instars is minutely described by Hurlbut

(1938). A single field-collected first-instar larva agrees with Hurlbut's description.

Anophelines of the World

The world species are very poorly known in the first instar, and the following key is offered to summarize the diagnostic characters of the species which have been described or figured. Sometimes certain details are omitted in the descriptions or illustrations, and some illustrations may be inaccurate because careful comparative studies were not made. The figure of the subantennal hair of *maculipennis* in Marshall (1938) is especially misleading, and that author has kindly furnished me with photographs and notes on some of the British species, so that they may be more accurately placed in this key. No discussion in text of the various species seems warranted at this time. Some recent contributions to the literature may have been overlooked and one, to various Asiatic species, cannot be recalled, though it was published prior to 1948. Most recently Belkin and Hogue (1962) have illustrated six species from the South Pacific region.

- 1. Frontal hairs simple (rarely one or two are bifurcate) 2
 Frontal hairs with 2-9 branches, sometimes one or more is simple
 (subantennal hair pinnate) 19
- 2. Subantennal and frontal hairs short, inconspicuous (tree hole species) .. 3
 Subantennal and frontal hairs long 5
- 3. Inner and outer clypeal hairs branched apically; subantennal hair
 bifid; lanceolate hairs on segments 3-7, none on thorax (Europe)
 *plumbeus*
 Clypeal and subantennal hairs simple; lanceolate hairs on segments
 3-6 4
- 4. Thorax with a single pair of lanceolate hairs on the prothorax (India)
 *barianensis*
 Thorax without lanceolate hairs (North America) *barberi*
- 5. Subantennal hair bifid or (in some Indian species) tripartite 6
 Subantennal hair pectinate or pinnate, with all or most branches on
 outer side of shaft; lanceolate hairs on segments 2-7 16
- 6. Posterior clypeal hair as long or longer than inner clypeal hair 7
 Posterior clypeal hair shorter than inner clypeal hair (presumably so
 in 4 of the 7 Indomalayan species) 9
- 7. Ventral bristles of anal segment of 12-15 very long, curved elements
 in a transverse row, forming a "basket"; lanceolate hairs on
 abdominal segments 3-6 (America) 8
 Ventral bristles short, straight, apparently in a longitudinal row as is
 the rule; frontal hairs shorter than the clypeal; lanceolates on seg-
 ments 2-7 (Africa) *gambiae*
- 8. Long ventral bristles preceded by a tuft of shorter bristles
 *pseudopunctipennis*
 Ventral basket preceded by 1-2 shorter bristles *pseudo. franciscanus*
- 9.(a) Lanceolate hairs on segments 1-7; antennal hair attains apex of shaft
 (South Pacific) *Bironella hollandi*
 (b) Lanceolate hairs on segments 1-6; terminal hair of antenna usually
 bifurcate (Neotropical) *albimanus*
 (c) Lanceolate hairs on segments 2-7; terminal hair simple as far as known 10
 (d) Lanceolate hairs on segments 3-7 15
 (e) Lanceolates on segments 3-6; terminal antennal hair simple (South
 Pacific) *lungae*

- (f) Lanceolates long and narrow, on segments 4-6; thoracic lanceolates none (India) *turkhudi*
- (g) Lanceolate abdominal hairs not mentioned; subantennal hair about half as long as the antenna (India) *maculatus* var. *willmori*
- 10.(a) European species 11
- (b) Asiatic species 12
- (c) South Pacific species 13
11. Subantennal hair longer than the antenna; frontal hairs, especially the inner frontal hair, elongate *algeriensis*
 Subantennal hair only slightly longer than the antenna; inner frontal hair not very long (Europe) *claviger*
 (The probable larva of the African *demeiloni* is cited and partly figured by Evans (1938), and probably keys to this couplet. This species has the longer ventral spines of the anal segment barbed, which character might prove true for *gambiae* or other members of subgenus *Myzomyia*).
12. Inner clypeal hair subpinnate; outer clypeal about 0.25 its length (Malaya) *kochi*
 Inner clypeal hair smooth; length of outer clypeals undescribed *culicifacies* and *subpictus*
13. (Ventral spines of anal segment in a short, transverse row)
 Thoracic lanceolate hairs 2-1-1 (four in all) *solomonis*
 Thoracic lanceolates 2-1-2 14
14. Mesothoracic hair 2 simple *punctulatus*
 Mesothoracic hair 2 with lateral branchlets *farauti* and *koliensis*
15. Outer clypeal hair only 0.16 as long as the inner (Malaya) *tessellatus*
 Outer clypeal hair probably longer but undescribed (India) *lindesaii*
16. Subantennal hair with about 3 well-developed branches on inner side of shaft (Europe) *maculipennis* var. *messeae*
 Subantennal hair with no inner branches 17
17. Outer frontal (anteantennal) hair strongly displaced posteriorly (Neotropical) *grabhamii*
 Frontal hairs in a straight or slightly curved transverse row 18
18. Inner clypeal hairs more widely spaced than the inner frontals and less than twice as long as outer clypeals (North America) *earlei*
 and probably *maculipennis atroparvus*
 Inner clypeal hairs less widely spaced than the inner frontals and more than twice as long as the outer clypeal hairs (North America) *atropos*
19. Subantennal hair equally pinnate, with branches on both sides to near base 20
 Subantennal hair unequally pinnate, with branches few or none on inner side 22
20. Antennal hair long, nearly reaching or exceeding the apex of antenna 21
 Antennal hair much shorter; lanceolate hairs on segments 2-6 (North America) *crucians* complex
21. Subantennal hair with stout shaft; lanceolates on segments 2-6 (Neotropical) *vestitipennis*
 Shaft more slender; lanceolates on segments 1-7 (North America) *quadrinaculatus*
22. Subantennal hair with more than 12 branches, the apical ones fine and numerous, arising from both sides of the shaft 23

- Subantennal hair with less than 12 branches, with few or none on inner side of shaft; lanceolates on segments 2-7 24
23. Subantennal hair with basal branches longer than the shaft; lanceolate hairs on abdominal segments 1-7 *walkeri*
Subantennal hair with basal branches shorter than the shaft; lanceolate hairs on segments 2-7 *aztecus*
24. Subantennal hair with 7-11 branches; outer frontal hair usually with 2-4 branches *freeborni*
Subantennal hair with 5-9 branches; outer frontal hair usually unbranched *perplexens* and *punctipennis*

***Culex* Linnaeus**

Figs. 26-35, and on p. 389 Fig. 31D

Head rounded, broader than long, width 0.26-0.30 mm. Clypeal hairs vestigial; frontal and occipital hairs usually simple; egg burster a transverse, medianly pointed ridge usually entirely surrounded by sclerotin but sometimes preceded by an oval, membranous area. Antennae nearly as long as the head or shorter, with numerous, slender spinules, which are reduced or absent on the inner margin; antennal hair bifid to 6-branched, situated dorsally on about the middle of the shaft; antennal apex with three spines, usually long and dark, and two shorter processes. Mouthparts of the usual culicine type, with long setae in most species. Gular sutures entire.

Dorsal submedian prothoracic hair group of two long and one small, or three long hairs, arising from a sclerotized platelet which may be poorly defined or divided. Many of the other thoracic hairs are large.

Abdomen with two pairs of long lateral hairs on segments 1-6, the upper hair longer than the lower, and the hairs slightly decreasing in length from the second segment posteriorly. Comb scales 3-15, often very irregular in size, usually elongate, with apex usually evenly fringed with spinules; pentad hairs usually simple and normally spaced. Air tube 3:1 to 7:1, with 3-8 pairs of ventrolateral hairs and pecten of 2-7 spines; sclerotization consisting of a primary and usually a secondary zone, which latter often extends nearly to the base of the tube. Anal segment longer than broad, with small dorsal saddle, simple lateral hair and gills moderately long or short.

First-instar *Culex* may be recognized by the presence of 3 or more pairs of ventrolateral hairs on the air tube. The branching of the antennal hair is characteristic (Fig. 34F); the hair is bifid, with one branch curving toward the apex of the antenna and bearing usually 1-4 branches on its convex side.

Larvae of 13 of the North American species and subspecies have been studied.

Key to the Subgenera and Species of *Culex*

1. Air tube with two pairs of small lateral hairs in addition to the ventrolateral hairs; maxilla with large spine situated at middle of length upon the ventral surface (Fig. 27C); prothoracic hair 3 small 3
Air tube without lateral hairs; maxillary spine small, situated subapically upon the outer margin 2
2. Air tube with primary zone of sclerotization comprising less than half its length; prothoracic hair 3 subequal to hairs 1-2 (*Culex*) 6
Air tube with primary zone of sclerotization comprising over half its length; prothoracic hair 3 is 0.66 of hairs 1-2 (*Neoculex*) *territans*
3. Air tube with 8 pairs of ventrolateral hairs; head with a pair of gills below the antennae; terminal spines shorter than the shaft of antenna (*Mochlostyrax*) *pilosus*

- Air tube with 4-5 pairs of ventrolateral hairs; head without gills; terminal spines as long as shaft of antenna (*Melanoconion*) 4
4. Comb scale with long apical thorn; hair 1 tufted (stellate) on mesothorax to 7th abdominal segment; outer occipital hair tufted; body yellow *erraticus*
- Comb scales fringed apically; body dorsally without tufted hairs; occipital hairs simple; body color grey 5
5. Upper head hair (outer frontal hair) above the lower; apical spines of antenna very sparsely feathered; air tube less than 5:1 *peccator*
- Upper head hair *below* the lower; terminal spines of antenna distinctly feathered when viewed by compound microscope; air tube 5:1 or longer (Jamaica) *atratus*
6. Head hairs in a straight, transverse row, antennal hair 2-3-branched 7
- Head hairs not in a transverse row; egg burster not usually preceded by a pale area; antennal hair multibranched 8
7. Egg burster preceded by an oval pale area; antennal hair usually bifid ..
..... *restuans*
- Egg burster not preceded by a pale area; antennal hair bifid *declarator*
- 8.(a) Terminal spines of antenna much shorter than shaft; air tube about 3:1, with secondary zone of sclerotization extending less than 0.66 to base *pipiens pipiens* and *p. quinquefasciatus*
- (b) Terminal spines subequal in length to the shaft of antenna; sclerotization of the air tube variable 9
- (c) Terminal spines slightly longer than the length of the shaft; air tube over 4:1, with primary sclerotization about 0.4 its length and secondary ring nearly reaching the base of tube *salimarius*
9. Head hairs shorter than the antennae; air tube about 3:1, with primary ring on about the apical 0.4 *tarsalis*
- Head hairs longer than antenna; air tube over 4:1, with primary ring on apical third and secondary ring extending nearly to base
..... *nigripalpus* and *thriambus*

***Culex (Neoculex) territans* Walker**

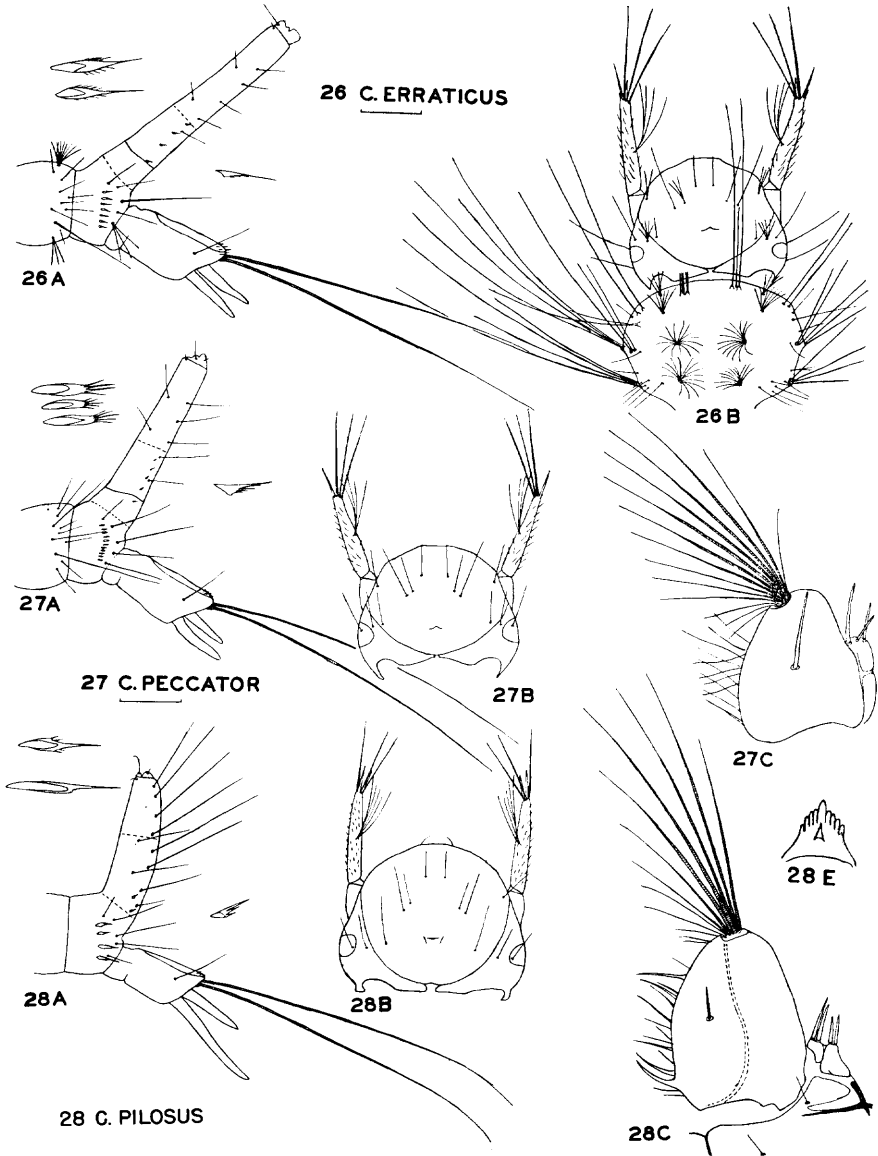
Figs. 29 A, B and E

A very common species with elongate air tube, bearing 4-6 pairs of ventrolateral hairs. Like the long-tubed *Melanoconions*, the primary zone of sclerotization extends for over half the length of the air tube, but it is easily recognized by the subgeneric characters given in the key. Larvae in all instars are taken throughout the year in Georgia, and it is often the only species of Culicine found in permanent pools. The eggs are said to be laid at the water's edge, not upon the water. Comb scales 9-12; pecten teeth 3-5.

***Culex (Melanoconion) atratus* Theobald**

Figs. 30 A, B, D, E and G

This species shows several characters not found in the other species, namely the placement of the head hairs and the feathering of the terminal spines of the antenna. The maxillary spine is smaller than usual for the subgenus. Comb scales 12-13; pecten teeth 4-5; lateral hairs of air tube 2-3. Larvae from Jamaica and Puerto Rico have been examined.



Figs. 26-28. Fig. 26 A, B, *Culex erraticus* (Dyar and Knab), Americus, Georgia, June 1943 (J. C. Dudley). Fig. 27 A, B, C, *Culex peccator* Dyar, Statesboro, Georgia, September 1943 (W. A. Hodges). Fig. 28 A, B, C, *Culex pilosus* (Dyar and Knab), Statesboro, Georgia, September 1943 (W. A. Hodges).

***Culex (Melanoconion) erraticus* (Dyar and Knab)**

Figs. 26 A and B

This species is readily distinguished by the subdorsal tufted hairs of the thorax and first seven abdominal segments, and by the yellow body color. In the later instars the corresponding hairs have fewer branches. Comb scales about 7; pecten teeth 3-5. The maxillary spine is unusually large in all instars and can easily be seen in lateral view of unmounted larvae, since it projects from the maxilla at a strong angle and is black in colour.

***Culex (Melanoconion) peccator* Dyar and Knab**

Figs. 27 A, B and C

First-instar larvae have been taken infrequently in association with the later instars. They resemble *territans* closely, from which they may be separated by the subgeneric characters mentioned in the key. Comb scales 9–12; pecten teeth 3–5.

***Culex (Mochlostyrax) pilosus* (Dyar and Knab)**

Figs. 28 A, B, C and E

Readily distinguished from all other larvae by the small, slightly curved air tube with eight pairs of long ventrolateral hairs and by the presence of gills under the antennae. The basal two pairs of air tube hairs are quite small in the first instar; in the later instars these hairs are the longest. The secondary zone of sclerotization is not evident in the few specimens examined. Comb scales 3–6; pecten teeth 2–3; antennal hair of 3–6 branches.

***Culex (Culex) declarator* Dyar and Knab**

One specimen from Texas (Dr. Breland) appears separable from the other species by the characters mentioned in the key. The terminal spines of the antennae are slightly shorter than in *thriambus* and the lower head hairs are directly in line between the upper head hairs.

***Culex (Culex) nigripalpus* Theobald**

Figs. 30 A, B, D, E, G

This species is characterized by the elongate air tube with a short primary zone of sclerotization and the terminal spines of the antenna shorter than the shaft. Otherwise it is very similar to *salinarius*. Larvae have been reared from females. Comb scales 8–11; pecten teeth 3–5.

***Culex (Culex) pipiens pipiens* Linnaeus**

Larvae from a laboratory colony of an autogenous race were sent by Dr. A. Glenn Richards, and larvae reared from field-collected egg rafts sent by W. R. Lasky, from Denver, Colorado. No differences have been found between this species and its subspecies, *quinquefasciatus*.

***Culex (Culex) pipiens quinquefasciatus* Say**

Figs. 32 A, B

This subspecies, with typical *pipiens*, is distinguished by the shortness of the terminal spines of the antenna and the air tube about 3:1. The secondary sclerotization of the air tube does not extend upon the basal third of the tube. This is one of the most common mosquitoes in the South, breeding by preference in foul water. Comb scales 8–13; pecten teeth 3–5.

***Culex (Culex) restuans* Theobald**

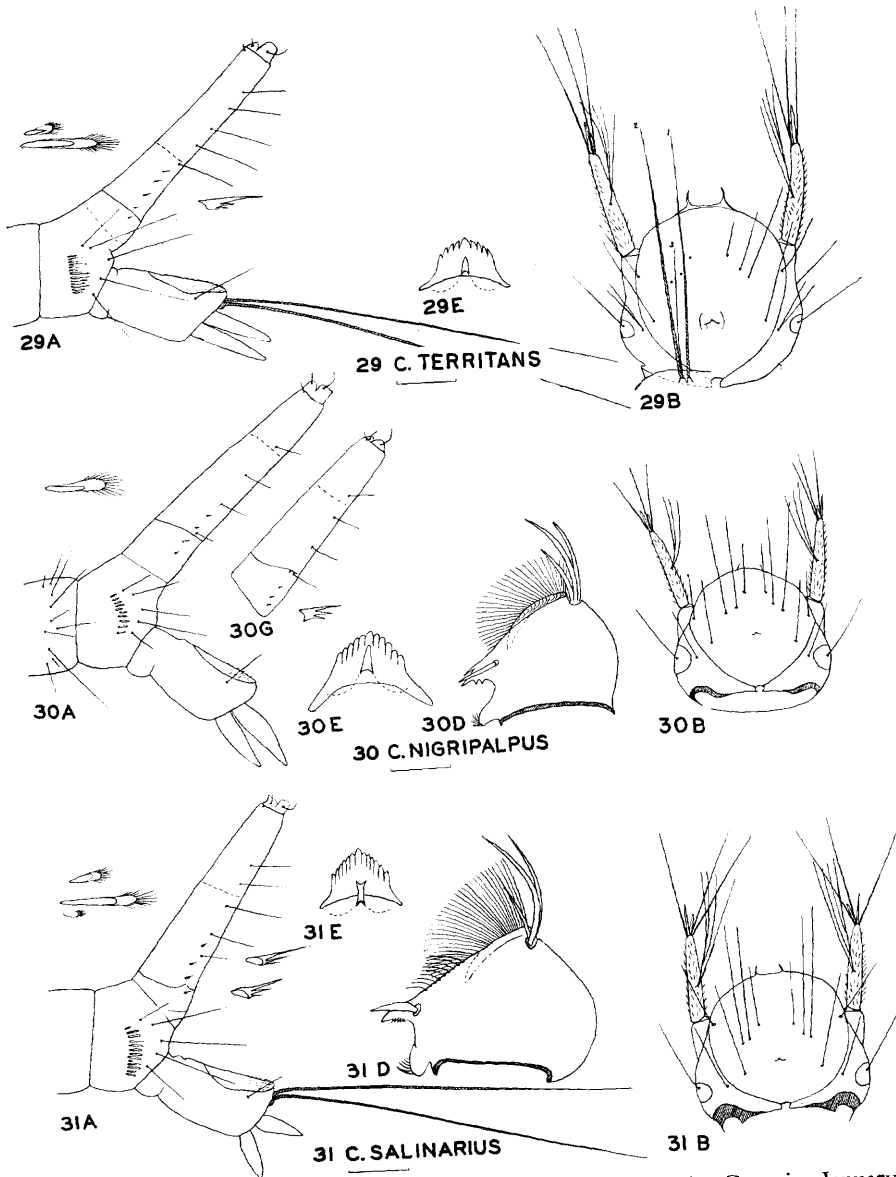
Figs. 33 A–E

This species is distinguished from all other species studied by the presence of an oval, membranous area before the egg burster and the head hairs in a strictly transverse row. *C. restuans* was first determined by association with the later instar larvae and later verified by rearing adults from field-collected egg rafts. Comb scales 7–13; pecten teeth 3–8.

***Culex (Culex) salinarius* Coquillett**

Figs. 31 A, B, D, E

This is the only species of its subgenus which has the terminal spines of the antenna longer than the shaft, in this respect resembling certain *Melanoconion*.



Figs. 29-31. Fig. 29 A, B, E, *Culex territans* Walker, Moultrie, Georgia, January 1944. Fig. 30A, B, D, E, G, *Culex nigripalpus* Theobald, Statesboro, Georgia, July 1943 (W. A. Hodges). Fig. 31 A, B, D, E, *Culex salinarius* Coquillett, Brunswick, Georgia, March 1944.

It has been reared from field-collected egg rafts, thus confirming previous identification through association with older larvae. Comb scales 10-15; pecten teeth 3-5.

***Culex (Culex) tarsalis* Coquillett**

Figs. 35 A, B

A species much like *nigripalpus*, except for the shorter air tube and shorter head hairs. Reared larvae from Denver, Colorado, are on hand. No secondary zone of sclerotization of the air tube is evident, but this may be due to immaturity. Comb scales 5-10; pecten teeth 3-5.

***Culex (Culex) thriambus* Dyar**

One specimen from Palmetto State Park, Texas (O. P. Breland), seems indistinguishable from *nigripalpus*.

***Culiseta* Felt**

Figs. 36–38, and on p. 389 Figs. 36 D, 38 F

Head rounded, wider than long, width 0.30–0.33 mm. Clypeal hairs vestigial; all dorsal hairs of the head simple. Egg burster a transverse ridge, pointed at the middle, completely sclerotized or preceded by a large, oval, membranous area. Antennae of variable length, with numerous long spinules except along the inner margin beyond the hair and ventrally; antennal hair simple, situated at about the middle of the length of the shaft; antennal apex with three long terminal spines and two shorter processes. Mouthparts and gula variable, according to the subgenus.

Dorsal submedian hair group of two long and a shorter hair, arising from a sclerotized platelet.

Abdomen with lateral hairs as in *Culex*; eighth segment with a comb of 7–13 regular or irregular scales or (*Culicella*) a patch of 17–24 scales; pentad hairs simple, normally spaced. Air tube of various proportions, according to the subgenus; pecten of 2–8 teeth; air tube hair simple, situated within the pecten but not basal in position as in the later instars; sclerotization of tube extends for half its length or more, composed of a primary and a secondary zone. Anal segment longer than broad, saddle present; gills shorter than the segment.

First-instar *Culiseta* is much like *Culex* except that the antennal hair is simple and the air tube has but one pair of ventrolateral hairs. From later instar *Culiseta* they differ by the air tube hair situated at about the basal 0.33 of the tube, not at its base.

Key to the Subgenera and Species of *Culiseta*

1. Air tube elongate, over 4:1 2
Air tube stout, less than 3:1 (*Culiseta*) 3
2. Comb a patch of 17–24 scales (Europe) or a row of 13–17 irregular scales (Minnesota) (*Culicella*) *morsitans*
Comb a row of 8–13 scales of nearly equal size (*Climacura*) *melamura*
3. Comb scales of irregular size, more or less fused together basally; lateral hair of anal segment arising from the edge of the saddle; anal gills of equal length *inornata*
Comb scales irregular but not fused together basally; lateral hair of anal segment slightly detached from the margin of the saddle; ventral gills longer than the dorsal *particeps*

***Culiseta (Culiseta) inornata* (Williston)**

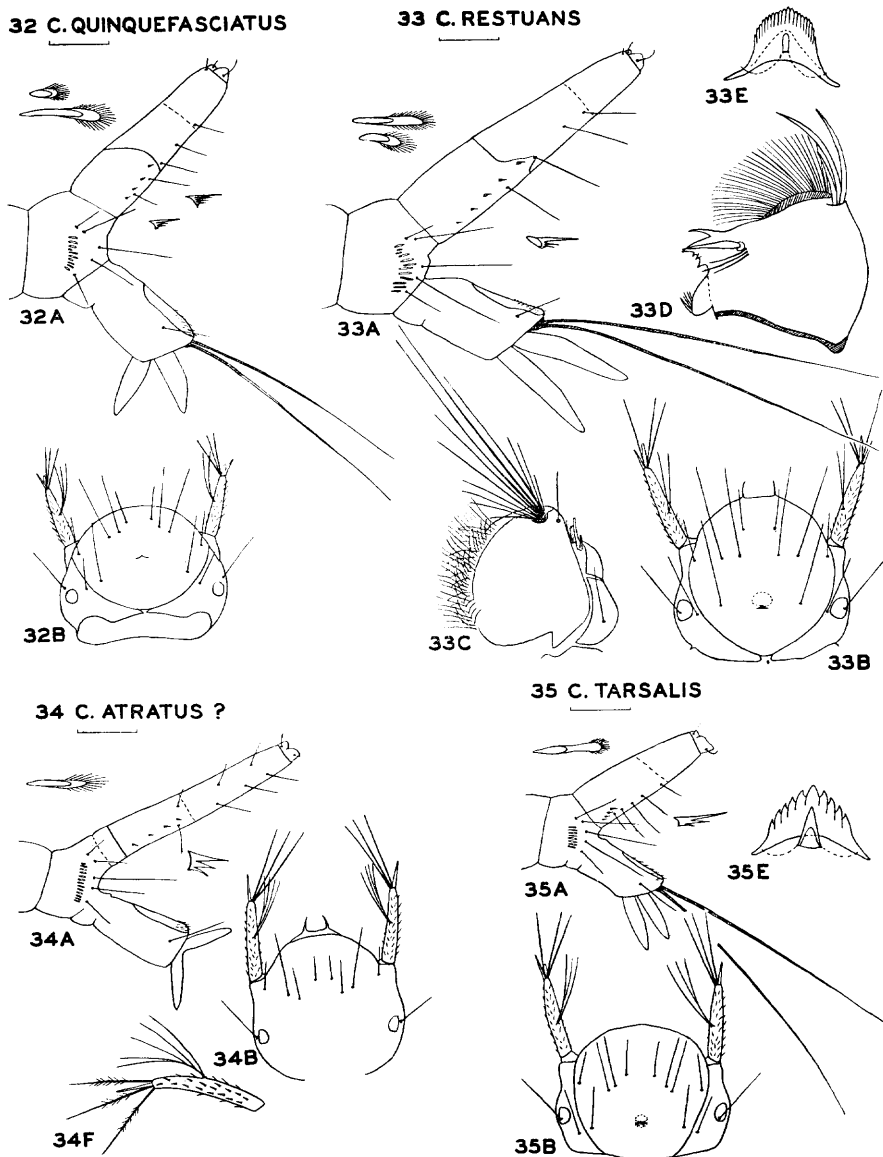
Figs. 36 A, B

This species breeds during the winter months in Georgia, and first-instar larvae have been taken each season, associated with the later instars. The head and apex of the air tube are black; in this respect it resembles *Aedes canadensis*, but differs by the shorter antennae and completely sclerotized egg burster. This species is unusual in that the lateral hair of the anal segment arises from the margin of the saddle and the comb scales are more or less fused together basally. Comb of 6–10 large scales plus smaller ones; pecten spines 2–6.

***Culiseta (Culiseta) particeps* (Adams)**

Figs. 37 A, B

California larvae of all instars have the upper gills slightly shorter than the lower, and all mature larvae were *particeps*. First-instar larvae differ from



Figs. 32-35. Fig. 32 A, B, *Culex quinquefasciatus* Say, Macon, Georgia, July 1944 (George S. Collins, Jr.). Fig. 33 A-E, *Culex restuans* Theobald, Thomasville, Georgia, January 1944. Fig. 34 A, B, F, *Culex atratus* Theobald, Jamaica, September 1944 (G. A. Thompson, Jr.). Fig. 35 A, B, E, *Culex tarsalis* Coquillett, Denver, Colorado, July 1945, reared from eggs (W. R. Lasky).

inornata by the comb scales not fused basally and the finer body hairs. Comb scales 7-13; pecten teeth 4-8.

***Culiseta (Climacura) melanura* (Dyar)**

Figs. 38 A, B

This species has been submitted in all instars several times, and progeny from one egg raft were reared to the third instar. The first-instar larva is like a long-tubed *Culex* with only one pair of air tube hairs; these hairs are much smaller and more basal in position in the later instars. Like *Culex restuans*, the egg burster is preceded by an oval, membranous area. Comb scales 8-13; pecten teeth 2-5.

***Culiseta (Culicella) morsitans* Theobald**

Marshall (1938) figured the first-instar larvae, and described the comb as a patch of 17–24 scales. Two Minnesota larvae loaned by Dr. Price show fewer scales in a row, suggesting a specific difference. The Minnesota larvae are described as follows:

Antenna 0.6 as long as head, finely spinulose, with 3 equal terminal spines, shaft hair simple, as long as the shaft and situated 0.4 to 0.5 from the base. Head hairs simple; egg burster transverse, in a large oval modified area; prothoracic hairs 1–3 long, simple, with *no platelet*. Pentad hairs equal, simple; comb scales 13–17 in an irregular row, some small ones interspersed with the long ones, each minutely fringed apically. Air tube about 5:1, sclerotized 0.8 to base, the two zones of sclerotin of equal length; dorsal preapical setule small and very apical in position. Pecten teeth 4–6; pecten reaches to the air tube hair, which is simple and just before the sclerotized portion. The air tube hair is much longer in this species than in *melanura*.

Four other European species of *Culiseta* are known from the first instar; for details consult Marshall (1938).

***Deinocerites* Theobald**

Figs. 39 A, B, J and on p. 389 Fig. 39 F

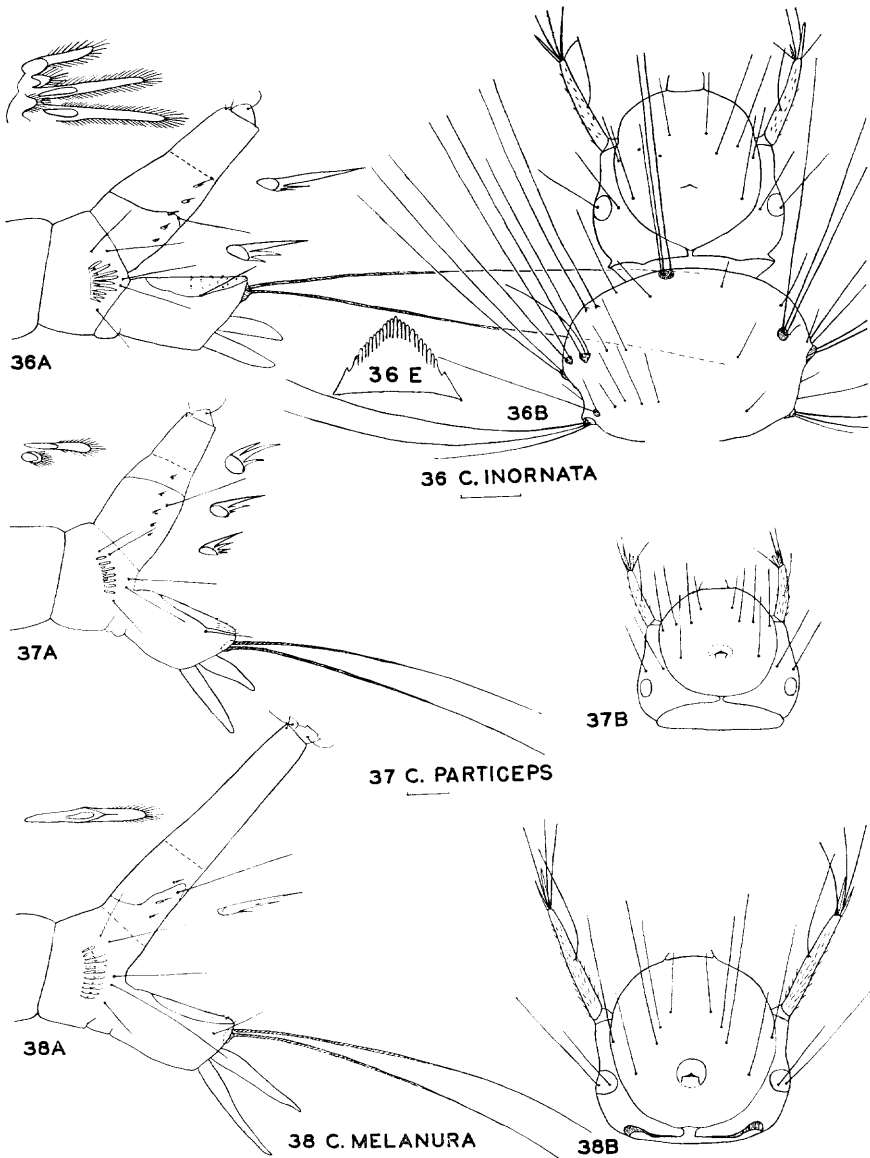
Head rounded, slightly longer than wide, width 0.29 mm. Clypeal hairs vestigial; frontal and accessory head hairs multifid or bifid; occipital hairs simple. Egg burster a transverse, medianly pointed ridge, preceded by an oval, membranous area. Antennae rather short and stout, glabrous, with a simple hair situated dorsally, beyond the middle of the length of the shaft; apex of antenna with three slender spines and two shorter processes. Mandible with a slightly raised, setose area on outer aspect near its base; maxillae nearly cleft into dorsal and ventral sclerotized halves, with long, slender maxillary spine ventrally and a tuft of setae apically; maxillary palpus rather small, globular, with three stout spines. Figure 39 J is not drawn in a strictly ventral view, but rather antero-ventrally. Therefore the setose knob near the base of the mandible appears to be laterally situated.

Dorsal submedian prothoracic hair group of three small hairs, not arising from a platelet. The thoracic vestiture is rather fine.

Lateral hairs of abdomen as described for *Aedes*. Comb a patch or irregular row of 25–30 elongate scales, each with a fine apical fringe. Pentad hairs small, simple, hair 5 well separated from the others. Air tube 3:1, sclerotized on the apical third, without evident secondary sclerotization; pecten of 2–4 teeth, each fringed on posterior margin on apical half; air tube bears two pairs of ventrolateral and one pair of lateral hairs. Anal segment longer than wide, with the lateral hair simple, saddle small, dorsal, with numerous scales dorsoapically. A pilose area is situated on ventral apical part of the anal segment. Gills one pair, very short and broad.

This genus is easily recognized by the three pair of air tube hairs, the glabrous antennae, multifid frontal hairs, and the single pair of anal gills. In the later instars the antennae are more elongate, the pecten teeth bifid, and a membranous lobe is present at the base of each mandible. The latter evidently functions as a gill. The renowned lateral pouches of the head capsule are merely an artifact, caused by crushing the rather soft head capsule with the coverslip.

Deinocerites is a small Neotropical genus breeding in crab holes. Two species are available for study.



Figs. 36-38. Fig. 36 A, B, E, *Culiseta inornata* (Williston), Thomasville, Georgia, February 1944. Fig. 37 A, B, *Culiseta particeps* (Adams), Tulare Co., California, January 1943 (John T. Medler). Fig. 38 A, B, *Culiseta melanura* (Dyar), Macon, Georgia, July 1943, in tree hole (H. R. Dodge).

Key to *Deinocerites*

- 1. Comb a patch of 25-30 scales, those in the basal row shorter; anal segment with a ventral apical patch of pile *cancer*
- Comb an irregular single row of 10-16 scales; pilose patch of anal segment absent *mathesoni*

***Deinocerites cancer* Theobald**

Figs. 39 A, B, J and on p. 389 Fig. 39 F

The above generic description was based upon this species; the comb scales in a patch are unusual in first-instar larvae. The species is common in crab holes in southern Florida.

***Deinocerites mathesoni* Belkin and Hogue**

Specimens from Brownsville, Texas (C. R. Joyce), differ from *cancer* in the first instar by having fewer comb scales, arranged in a somewhat irregular row, the ventral pile of the anal segment absent and the saddle scales very poorly developed. The anal gills are multinucleate and the anal segment somewhat excavated laterally to receive them.

***Mansonia* Blanchard**

Figs. 40 and 41, A-C; and on p. 389 Fig. 40 F

Head rounded, about as long as wide, width 0.32 mm. Clypeal hairs vestigial; all dorsal hairs of head simple, the inner occipital hair unusually long and the post-clypeal hair well developed. Egg burster a transverse, pointed ridge set in the base of, or preceded by an oval membranous area. Antennae spinulose or not, much longer than the head, with two apical and two subapical spines; antennal hair at the basal third of the shaft, simple or not. Mouthparts of the usual culicine type, the maxillary spine apical, large, simple or serrate. Gula subtriangular, with sides rounded and suture rather poorly defined.

Dorsal submedian prothoracic hair group of three simple, medium-sized hairs, not arising from a platelet.

Abdomen with two pairs of lateral hairs on the first six segments, long on the first three, thence shorter, especially the lower hair. Comb of 5-8 scales; pentad hairs simple, unusually placed, hairs 3-5 closely grouped laterally. Air tube sclerotized nearly to the base, tapering apically to a slender rod with apical serrations and a pair of dorsal subapical hooks; pecten absent; air tube with a single pair of large ventrolateral hairs. Anal segment twice as long as its diameter, with a small dorsal saddle, simple lateral hair, and gills shorter than the length of the segment.

The most distinctive feature of this genus is the attenuated air tube, adapted for piercing plant tissues. The very long antennae, with a pair of subapical spines, are also unusual. In these respects the first instar resembles the later instars. Two subgenera are represented in the North American fauna, with one species of each available for study. The general nature of the pentad hairs, antennal spines, maxillary spine and air tube is maintained in all instars.

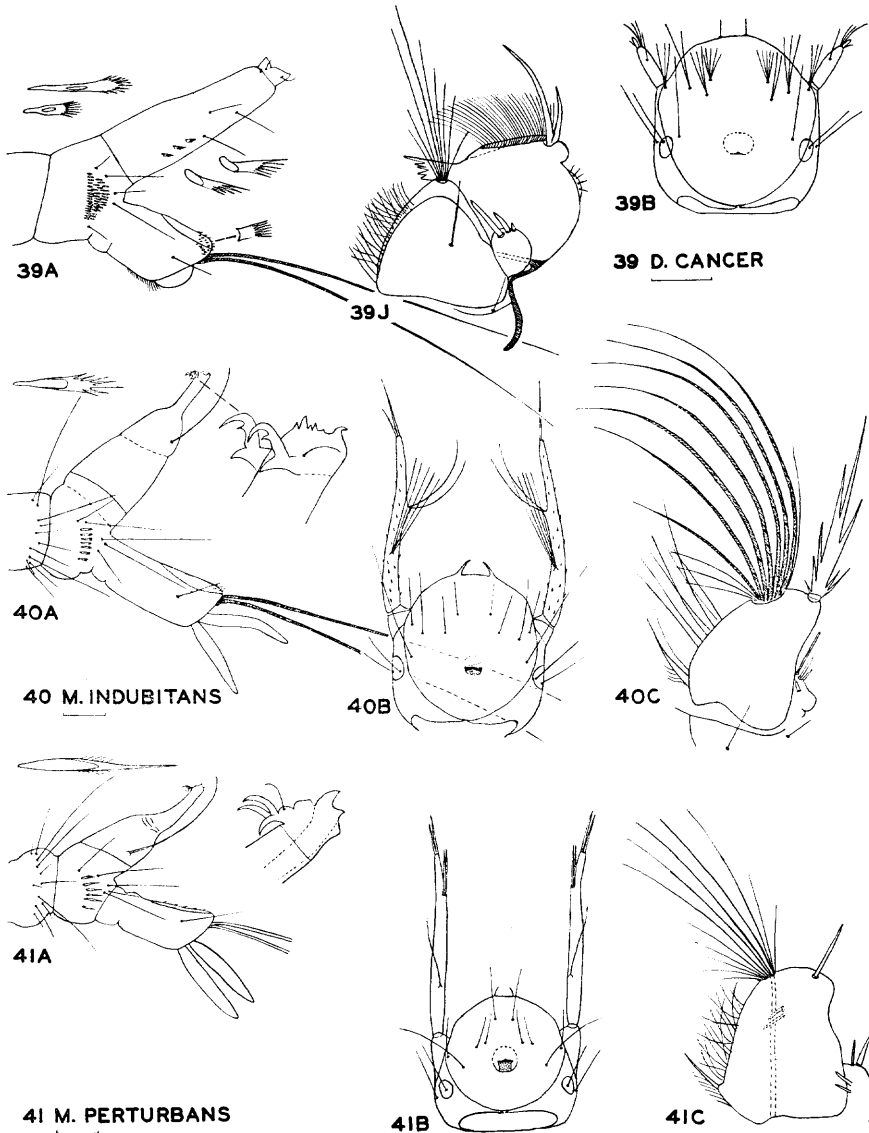
Key to the Species of *Mansonia*

1. Maxillary spine cylindrical, smooth; antennae glabrous, with hair simple, separated from the subapical spines by half the length of the antenna; air tube hair on basal half, not preceded by a constriction; comb scale thorn-shaped *perturbans*
- Maxillary spine flattened, with coarse serrations on both sides; antennae spinulose, with multifid hair separated from the subapical spines by a third the length of antenna; air tube with hair on apical half, preceded by a constriction; comb scale with apex fringed with equal rays ... *indubitans*

***Mansonia (Mansonia) indubitans* Dyar and Shannon**

Figs. 40 A-C; and on p. 389 Fig. 40 F

Besides the characters given in the key, this species is further distinguished by an internal tooth on the dorsal subapical hooks of the air tube, and the subapical antennal spines are longer, diverging from the shaft. In the later instars the antennae undergo only a slight change in proportions. Field-collected larvae were associated with the later instars of this species, on *Pistia*. Comb scales 7-8.



Figs. 39-41. Fig. 39 A, B, J, *Deinocerites cancer* Theobald, Boca Raton Field, Florida, April 1945 (E. L. Seabrook). Fig. 40 A-C, *Mansonia indubitans* Dyar and Shannon, Boca Raton Field, Florida, July 1944, on *Pistia* (D. G. Denning). Fig. 41 A-C, *Mansonia perturbans* (Walker), reared by author from gravid female, Valdosta, Georgia, May 1943 (G. A. Thompson, Jr.).

***Mansonia (Coquillettia) perturbans* (Walker)**

Figs. 41 A-C

Besides the characters mentioned in the key, this species is characterized by small subapical spines, closely appressed to the shaft of the antenna, and the post-clypeal hair longer than the head hairs. In the later instars the antennae become sparsely spinulose on the basal portion, with the hair multifid, and the distal portion of the shaft, beyond the subapical spines, greatly attenuated. Comb scales 5-7.

***Orthopodomyia* Theobald**

Figs. 43-44

Head rounded, hardly wider than long, width 0.27 mm. Head hairs variable in the species; postclypeal hair bifid; antennal, anteantennal and occipital hairs simple; outer occipital and orbitals very close-set. Egg burster situated far forward, consisting of a transverse ridge set in an oval, sclerotized area; extending back towards the occiput from the egg burster is a strip of paler chitin, which gives the appearance that the egg burster has been pushed forward from its normal position, leaving a "wake" behind. Antenna glabrous, with hair at about the middle, unbranched; apical appendages two sharp spines of medium length and three blunt processes, one nearly as long as the shortest spine, the others much shorter. Mouthparts as in *Aedes*, with rather short vestiture. Gular sutures entire. On the dorsal margin of the occipital foramen is a dark lateral band which develops during the instar.

Dorsal submedian prothoracic hair group of three fine hairs, not arising from a platelet; hair 1 well separated from the others.

Abdomen with lateral hairs as in *Aedes*. Pentad hairs subequal in size and well separated, except hairs 3 and 4 close-set; hairs 1 and 5 bifid or trifid, the others simple. Comb of about 10 scales in a uniform row, each scale fringed apically and with an elongate basal portion. Air tube small, not larger than the anal segment, with the lateral hair bifid or trifid. Anal segment longer than its diameter, with a rather broad, glabrous saddle; lateral hair 2- to 4-fid; anal gills short and broad, the ventral pair somewhat shorter.

First-instar *Orthopodomyia* most closely resemble *Aedes*, from which they differ by the peculiar egg burster, the lack of a pecten and the more numerous comb scales. Three species are known; Breland (1959) has treated two of them.

Key to the Species of *Orthopodomyia*

1. Pentad hairs simple; saddle spiculose (Europe) *pulchripalpus*
 Pentad hairs 1 and 5 bifid; saddle glabrous 2
2. Head yellow; head hairs usually bifid; antennal hair, head hairs and saddle
 hair feathered *alba*
 Head brown; head hairs simple; antennal hair, head hairs and saddle hair
 not feathered *signifera*

***Orthopodomyia alba* Baker**

Figs. 43 A, B, F

A rare species widely distributed in the eastern States. The first instar differs from *signifera* by the head hairs usually bifid and frontal and antennal hair feathered along the middle of their length. These hairs are also heavier than in *signifera*. The air tube, as in the later instars, is shorter than in the corresponding instar of *signifera*. The pigmentation of the head capsule is pale, hence it is hardly possible to see the peculiar wake behind the egg burster. No secondary zone of sclerotization is evident on the air tube and the gills, though short and stout, are pointed at the apex. Comb scales 8-11.

***Orthopodomyia signifera* (Coquillett)**

Figs. 44 A, B

A fairly common tree-hole breeder in eastern North America. Larvae of all instars have been collected each summer, and eggs were hatched from a gravid female collected in August. The eyes are exceptionally large in this species. Comb scales 10-13.

Orthopodomyia pulchripalpus

This European species has been figured by Marshall (1938). It apparently differs from Nearctic species by the pentad hairs all simple and the saddle spiculose.

Psorophora Robineau-Desvoidy

Figs. 45-47, and on p. 389 Fig. 45 F

Head slightly wider than long, rounded or subtriangular, width 0.30-0.52 mm. Clypeal hairs vestigial except in the subgenus *Psorophora*; dorsal vestiture of head all of fine, simple hairs, the inner occipital hair longest. Egg burster similar to *Aedes* with exception that the disk is pale, with a dark, transverse, medianly pointed ridge. Antennae variable in size, with numerous spinules arranged in short, transverse rows; antennal hair simple, rarely bifurcate, situated dorsally upon the middle third of the length of the shaft; apex of antenna with three long spines and two shorter, thicker processes. Mouthparts of the usual culicine type.

Dorsal submedian prothoracic hair group of three fine, simple hairs, not arising from a platelet; similar in this respect to *Aedes*. The thoracic vestiture is finer than usual.

Abdomen with lateral hairs as in *Aedes*. Eighth segment with comb of usually 3-4 scales, or about 8 in the typical subgenus, each scales with a large apical thorn and a few coarse lateral spinules. Pentad hairs small, simple. Air tube about twice the length of the anal segment, slender, becoming swollen late in the instar with the development of the second-instar tracheal system (Fig. 48 A); sclerotization of narrow primary and secondary zones, usually not extending for more than the apical sixth of the tube; pecten a row of 3-6 moderately stout spines, or (typical subgenus) over 20 minute ones; ventrolateral hair small, bifid or trifid, rarely simple, situated at or beyond the middle of the tube. Anal segment as long as wide or longer, with small saddle and simple lateral hair; anal gills often longer than the caudal hairs.

This genus is closely allied to *Aedes*, from which it is poorly separated by the nature of the egg burster; the unsclerotized clypeal or gular areas are not found in any other genus. The typical subgenus is very distinct; larvae of subgenera *Janthinosoma* and *Grabhamia* have better specific than subgeneric characters, as is the case with mature larvae. Seven species were included in the original study, and several more have been described by Hedeon (1959); a tenth species was made available through the courtesy of Dr. Breland.

Key to the Species of *Psorophora*

1. Pecten teeth 21-29, minute; comb scales 7-9; gula membranous; antennal hair situated beyond the middle (*Psorophora*) 2
 Pecten teeth and comb scales usually 3-5; clypeus with oval membranous area; antennal hair near or before middle 3
2. Pentad hair 5 short, stout *ciliata*
 Pentad hair 5 normal *howardii*
3. Air tube hair longer than diameter of tube, 1-3-branched *discolor*
 Air tube hair small, shorter than diameter of tube 4
4. Antenna large, stout, with a bi- or tri-furcate hair before the middle of its length; mentum with many fine serrations *cyanescens*
 Antenna variable in length, rather slender, with simple hair 5
5. Antenna subequal to or slightly longer than the head *ferox*
 Antenna 0.67 of head, or shorter 6
6. Antennal hair at about the middle of the length of the shaft *confinnis*
 Antennal hair situated before the middle of length of shaft 7

7. Antennal hair exceeds the apex of the shaft; dorsal preapical setule does not attain the apex of the air tube 8
 Antennal hair does not reach apex of the shaft; dorsal preapical setule longer 9
8. Dorsal preapical setule slightly before the primary zone of sclerotization *varipes*
 Dorsal preapical setule situated on the base of the primary zone *longipalpis*
9. Dorsal preapical setule as long as its distance from the apex of the air tube *horrida*
 Dorsal preapical setule apparently exceeds the apex of the tube *signipennis*

Psorophora (Psorophora) ciliata (Fabricius)

Figs. 45 A, B, D, E, and on p. 389 Fig. 45 F

A large species, head about 0.5 mm. wide; comb scales 7-9; pecten spines 21-29, very small. Head subtriangular (rounded in the other subgenera), with gula unpigmented. The air tube hair is bifid or trifid, or rarely bifurcate. The mouthparts are normal and the gut of field-collected larvae has been found packed with green matter; in the later instars the larvae are predatory, with very different mouthparts and the head subquadrate. Hedeén (1959) mistakenly attributed the subquadrate head to the first-instar larva.

This subgenus is unusual in several respects. The preclypeal spines are very wide-set, and posterior to them are two pairs of hairs in a diagonal row, which may represent the clypeal hairs, or one of them may be the postclypeal. The egg burster is nearly circular, with a short posterior strap and enclosed in a very narrow moat. Other characters peculiar to the subgenus are mentioned in couplet 1 of the key.

The only apparent difference between this species and *howardii* is in pentad hair 5; the difference is not so striking in reared larvae submitted by Dr. Horsfall. Certainly the larvae of the two species are remarkably similar in all instars, despite profound differences in the adults.

Psorophora (Psorophora) howardii Coquillett

See the preceding discussion of *ciliata*.

Psorophora (Grabhamia) confinnis (Lynch-Arribalzaga)

Figs. 47 A, B, D, E

A commonly collected species with first-instar larva quite like *varipes* and *horrida*, which latter species have very obscure larval habitats. Antennae about 0.6 of head length, with a simple hair slightly before the middle and terminal spines about half as long as the shaft. Comb scales 2-4, usually 3; pecten teeth 3-6, usually 4-5; air tube hair bifid or trifid.

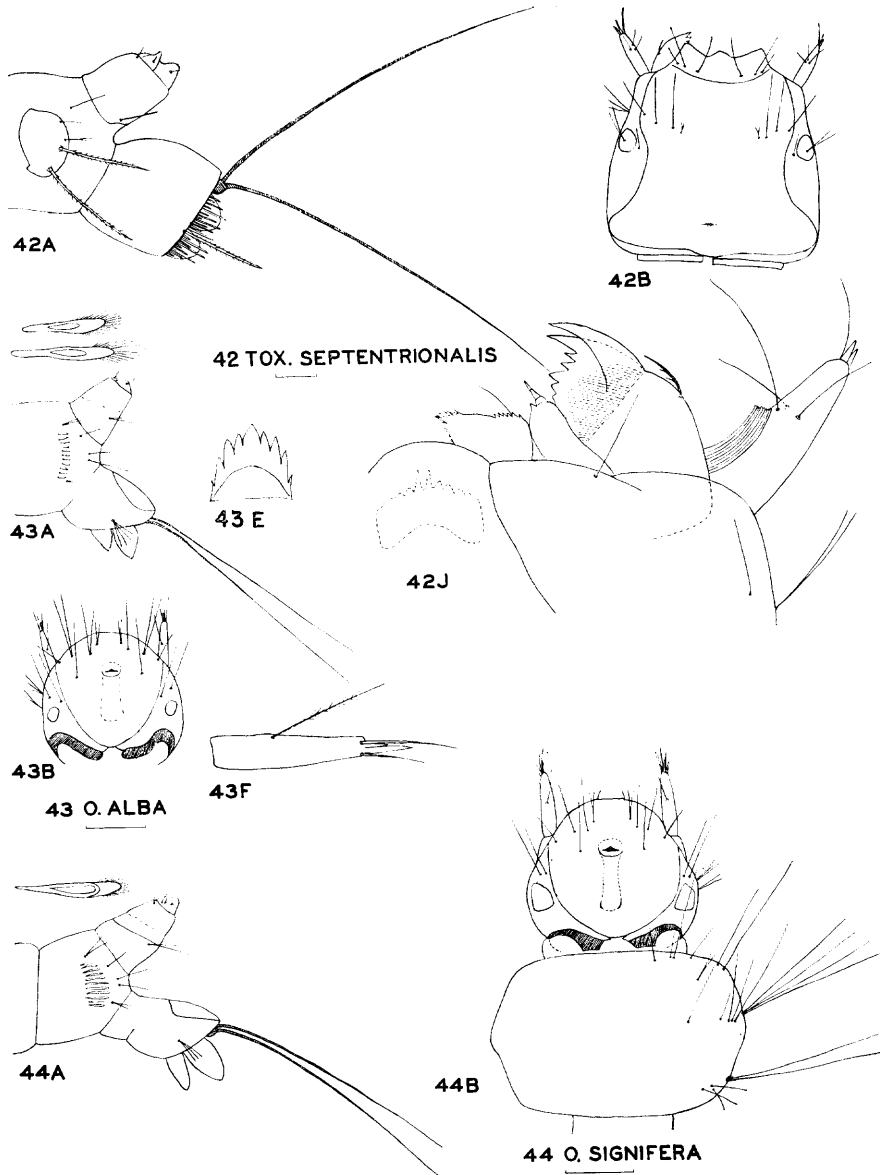
Psorophora (Grabhamia) cyanescens (Coquillett)

Figs. 47 A, B, D, E

A rare species in Georgia. Three specimens are referred to this species without doubt because *cyanescens* was previously collected from the same pool. The stout antennae, numerous denticles on the mentum, and shape of the second-instar air tube already forming are distinctive. Comb scales 4; pecten teeth 3-4; antennal hair bifurcate or trifurcate; air tube hair bifid. The clypeal membranous area is smaller than in the other species, and the postclypeal hairs are close-set.

Psorophora (Grabhamia) discolor Coquillett

The first instar of this species is included in a key to three species of *Grabhamia* by Hedeén (1959), and one larva from Lufkin, Texas (O. P. Breland), has been examined by me. The distinctive feature of this species is the ventro-



Figs. 42-44. Fig. 42 A, B, J, *Toxorhynchites rutilus septentrionalis* Dyar and Knab, Macon, Georgia, 28 July 1943, in tree hole (H. R. Dodge); male adult reared from this specimen. Fig. 43 A, B, E, F, *Orthopodomyia alba* Baker, New Orleans, Louisiana, August 1945 (P. H. Harden). Fig. 44 A, B, *Orthopodomyia signifera* (Coquillett), Macon, Georgia, July 1943, in tree hole (H. R. Dodge).

lateral hair of the air tube longer than the diameter of the tube; in later instars this hair becomes much larger. The antennae, so distinctively swollen and S-curved in the fourth instar, become progressively shorter, straighter and less swollen to the second instar, and in the first instar are not at all remarkable. Antenna straight, 0.64 of head, with three strong terminal spines, antennal hair small, at middle of length; shaft weakly spinulose. Air tube hair simple to 3-branched; gills about twice the anal segment.

***Psorophora (Janthinosoma) ferox* (Wiedemann)**

Figs. 48 A-E

Larvae were both field-collected and reared from a female. Antenna as long as the head; comb scales 3-4; pecten teeth 2-3; air tube hair bifid.

***Psorophora (Janthinosoma) horrida* (Dyar and Knab)**

Figs. 49 A, B

Specimens reared from females are very similar to *varipes*, the only differences being the shorter antennal hair, the longer dorsal preapical setule of the air tube, and the antennal spinules more sparse. Comb scales 3-5; pecten teeth 2-4, usually 3; air tube hair bifid or trifid.

***Psorophora (Janthinosoma) longipalpis* Randolph and O'Neill**

One larva from Luling, Texas (O. P. Breland), was examined. The antennae are moderately stout, with a simple hair slightly before the middle and three equal terminal spines. Comb scales 4; pecten teeth 3-4. Larva reared from a female.

***Psorophora (Grabhamia) signipennis* (Coquillett)**

The first-instar larva of this species is keyed and figured by Hedeem (1959). The head hairs and antennal hair are simple; comb scales and pecten teeth 3 each. The antennal hair situated before the middle and large dorsal preapical setule apparently distinguish this species.

***Psorophora (Janthinosoma) varipes* (Coquillett)**

Fig. 50 A

Several larvae reared from eggs were originally studied and compared with *horrida*, but the addition of several more species to the key has made the identification of this species more difficult. Evidently it will run out with *longipalpis* but has the dorsal preapical setule on the secondary zone of sclerotization, just before the base of the primary zone, whereas *longipalpis* has the setule on the base of the primary zone. In a larger series of specimens this distinction may not hold. Comb scales 4-5; pecten teeth 2-3; air tube hair bifid.

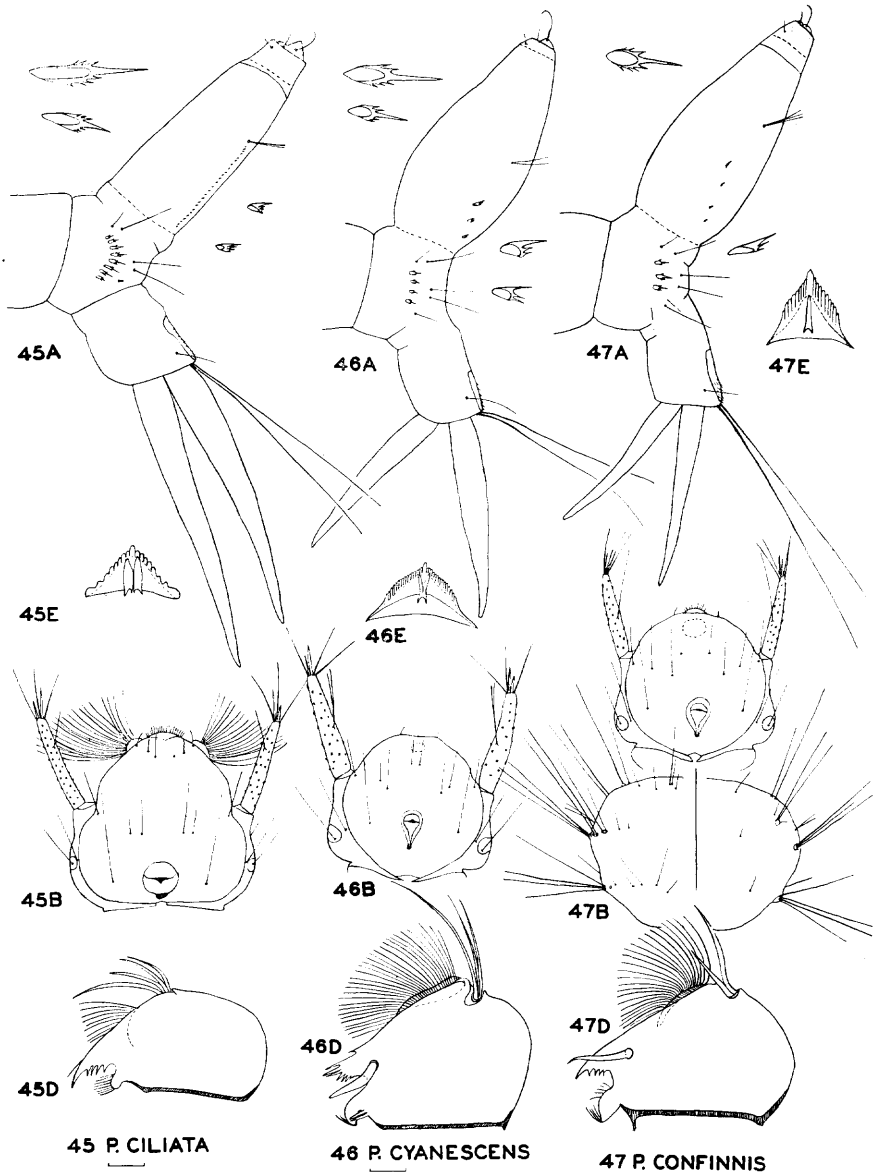
***Toxorhynchites* Theobald**

Figs. 42 A, B, J

Head subquadrate, width 0.48-0.52 mm.; eyes and setae of head set far forward. Frontoclypeus of unusual shape, with sides sinuate and anterior margin trilobed. A transverse suture divides the frontoclypeus into a small anterior part and a large posterior part, each bearing four pairs of hairs in a nearly transverse row, the outermost pair of the front row very minute. The egg burster is a completely sclerotized, small transverse ridge, situated far back on the head. Antennae small, glabrous, bearing three simple hairs, two on the inner margin and one ventrally, situated beyond the middle of the length; apex with a simple hair and two shorter, stout processes. Mouthparts adapted for predacity, the mouth brushes reduced to 10 stout rods; mandibles with two large and five smaller teeth; maxilla small, slightly larger than the maxillary palpus.

The thorax and abdomen laterally bear sclerotized platelets, usually three per segment, the eighth segment with but one large plate. Superficially the first-instar larva is much like the mature larva with respect to the platelets and vestiture, but some details differ in each instar. The very stout hairs of the thorax and eighth segment are distinctive of this genus.

The eighth abdominal segment lacks the comb, but the pentad hairs are present, four of them (the lowermost two stout) arising from the plate. Air tube small, as long as its diameter, much smaller than the anal segment, bearing a basal



Figs. 45-47. Fig. 45 A, B, D, E, *Psorophora ciliata* (Fabricius), Statesboro, Georgia, September 1943 (W. A. Hodges). Fig. 46 A, B, D, E, *Psorophora cyanescens* (Coquillett), Macon, Georgia, July 1943 (George S. Collins, Jr.). Fig. 47 A, B, D, E, *Psorophora confinnis* (Lynch-Arribalzaga), Statesboro, Georgia, September 1943 (W. A. Hodges).

pair of ventrolateral hairs; pecten absent. Anal segment as long as its diameter, with sides convex in lateral view; the posterior margin laterally bears the lateral hair and a marginal row of spines; anal gills very short and bud-like. Both the air tube and anal segment are completely ringed by sclerotin; there is no zone of secondary sclerotization on the air tube.

Toxorhynchites is easily separated from the other genera by many characters in all instars. The complete sclerotization of the air tube and anal segment in the first instar is unusual. Two species were available for study.

Key to the Species of *Toxorhynchites*

1. The marginal spines adjacent to the lateral hair of the anal segment remarkably irregular in length *rutilus septentrionalis*
 These spines nearly regular in length *portoricensis*

***Toxorhynchites rutilus septentrionalis* (Dyar and Knab)**

Figs. 42 A, B, J

The characters of the genus are described from this species. Typical *rutilus* was not available for comparison. Males have been reared from field-collected eggs.

***Toxorhynchites portoricensis* (Röder)**

One larva from Salinas, Puerto Rico, 27 October 1948 (C. E. Kohler), was available for study, and appeared to differ from *septentrionalis* only by the regular length of the spines on the hind margin of the anal segment.

Uranotaenia Lynch-Arrizabaga

Figs. 51, 52, and on p. 389 Fig. 52 F

Head usually ovoid, longer than wide, width 0.20–0.26 mm. Head hairs and anteantennal hair usually stout, subpinnate; other dorsal hairs of head fine, simple, with exception of the usually bifid occipital hairs. Egg burster a transverse ridge in a shallow, completely sclerotized depression. Antennae short, sparsely spinulose, with a small, simple antennal hair situated ventrolaterally at the basal third of the length of the shaft (Fig. 52F); apex of antenna with three spines and two shorter, stouter processes. Mouthparts small and of unusual shape, situated far forward; gula long, with sutures absent.

Dorsal submedian prothoracic hair group of two long, coarse hairs and a small, fine hair arising from a platelet. Thoracic hairs rather coarse.

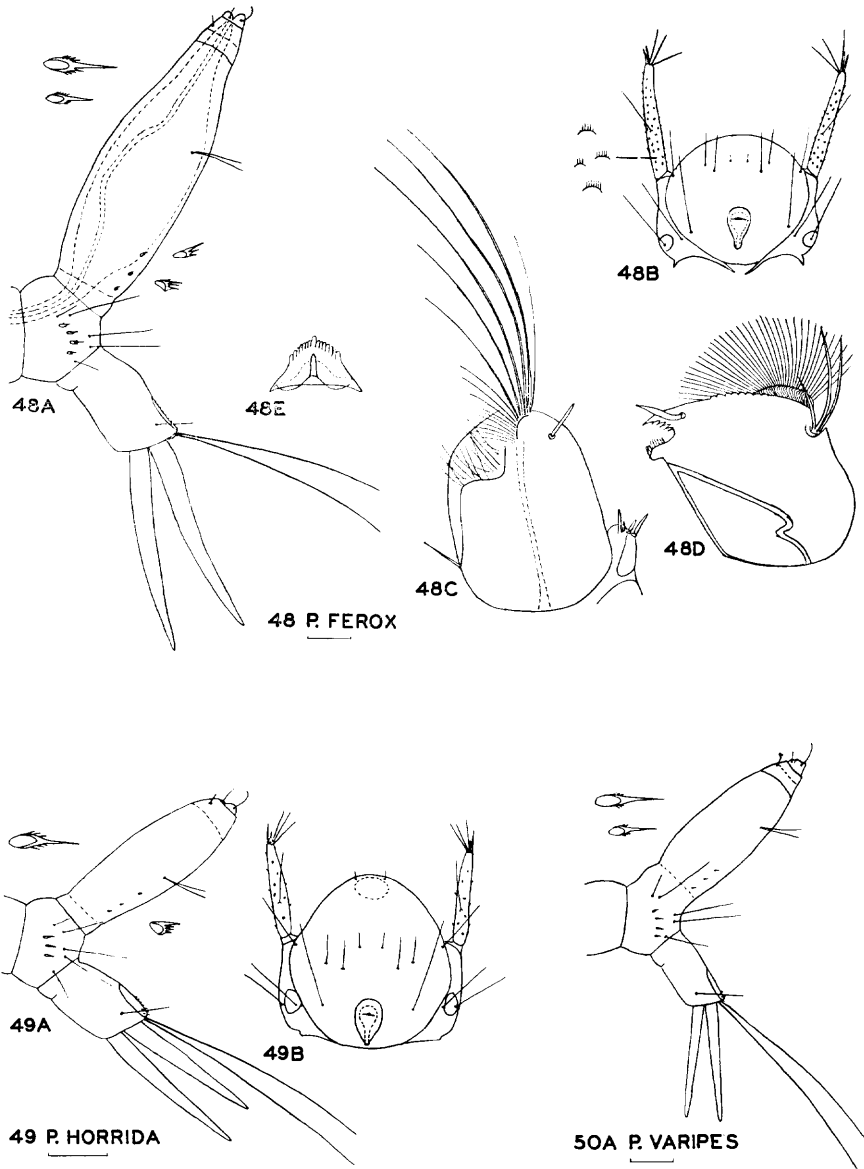
Abdomen with lateral hairs as described for *Culex*; air tube sclerotized for the greater part of its length, with no secondary zone of sclerotization. Comb a row of 6–10 scales; pecten teeth 3–7; both the comb scales and pecten teeth are broad, thin, fringed. The pentad hairs are unusual in that hairs 1, 3 and 5 are usually bifid or trifid and hairs 2 and 4 are commonly bifurcated apically. Anal segment longer than wide, with stout lateral hair; the saddle nearly encircles the segment, and on its posterior margin bears groups of spines laterally.

The surface sculpture of the head and saddle consists of rather coarse, slightly curved, unconnected transverse ridges.

Three species were available for study. The species *sapphirina* and *lowii* are more strikingly different in the first instar than in the later instars. With the molt to the second instar, the lateral hairs of segments 3 to 6 become minute and the saddle hair and anteantennal hair become fine, not stout.

Key to the Species of *Uranotaenia*

1. Head with a small, circular occipital foramen; air tube sclerotized nearly to base *sapphirina*
 Head with a relatively large, broad occipital foramen, laterally produced into a lobe behind each eye 2
2. Head longer than wide, with stout head hairs; air tube with sclerotization confined to the part beyond the hair *lowii*
 Head no longer than wide, with head hairs only slightly thickened; air tube sclerotized on apical 0.75 *anhydor syntheta*



Figs. 48-50. Fig. 48 A-E, *Psorophora ferox* (Wiedemann), Statesboro, Georgia, August 1943 (W. A. Hodges). Fig. 49 A, B, *Psorophora horrida* (Dyar and Knab), Fort Benning, Georgia, reared from female, September 1944 (L. M. Roch). Fig. 50 A, *Psorophora varipes* (Coquillett), Macon, Georgia, July 1945, reared from female (H. R. Dodge).

***Uranotaenia anhydor syntheta* Dyar**

A single larva of this species from Luling, Texas, collected by Klaus Kajihiro, was given to me by Dr. Breland. The head is shorter than in the other species, as wide as long, with head hairs only slightly thickened, antantennal hair less thickened; antennal hair simple, dorsal in position, at basal 0.4 of shaft and not surpassing the apex; outer occipital hair trifid; occipital foramen as in *lowii*; comb scales 6-7; pecten teeth 4-5; air tube hair trifid, at basal 0.4 of tube; air tube 3:1, sclerotized on apical 0.75. Anal segment with saddle smaller than in the other

species, lateral hair coarse and frayed, gills equal to the segment. Antenna 0.28 of head length; postclypeal hair in line between the lower head hairs. Similar to the detailed figure of *anhydor* by Belkin and McDonald (1956).

***Uranotaenia lowii* Theobald**

Figs. 52 A, B, H, and on p. 389 Fig. 52 F

This species is relatively rare in the South Atlantic and Gulf States, but has been collected in all instars in the absence of *sapphirina* several times. The first-instar larvae differ from *sapphirina* in structural characters, smaller size and paler head capsule; the occipital foramen (Fig. 52 H) is broadened by lateral lobes in the first instar but circular in the later instars. Comb scales 7-10; pecten teeth 3-7.

***Uranotaenia sapphirina* (Osten-Sacken)**

Figs. 51 A-C, H

A common species in eastern United States; the larvae have been frequently collected in all instars. The air tube hair usually is simple in this species, but occasionally one or both hairs are bifid, as is always the case with *lowii*. Occipital foramen circular; comb scales 7-10; pecten teeth 4-7.

***Wyeomyia* Theobald**

Figs. 53 and 54

Head elongate or subtriangular, longer or shorter than wide, width 0.22 to 0.28 mm. All hairs on dorsal surface of head fine and simple. Antennae small, glabrous, with simple hair and inconspicuous apical spines and processes. Egg burster a simple, transverse ridge. Occipital foramen with a deep cleft on each side which extends forward to the eye.

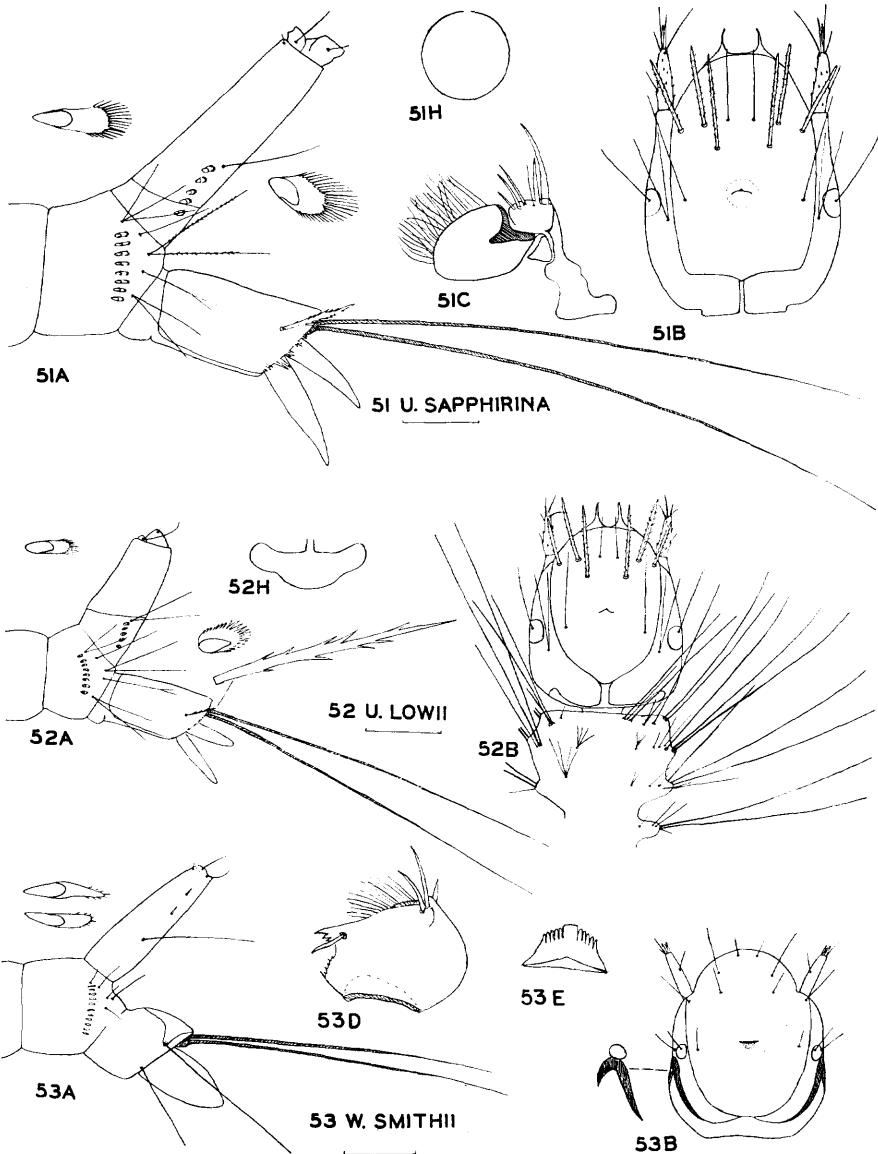
Dorsal submedian hair group of fine, simple hairs not arising from a platelet. Thoracic and abdominal vestiture not studied.

Comb of eighth abdominal segment of 8-12 elongate scales in a row, each sparsely minutely fringed or apparently nude apically. Pentad hairs unusual in position, hairs 3, 4 and 5 in a close-set lateral group, none ventral. Air tube with sclerotin and spiracular valves poorly defined; a single pair of large ventrolateral hairs before the middle of the length is followed by 2-3 pairs of pale, appressed spines. Anal segment glabrous, with dorsal saddle extending to the lateral hair; lateral hair very long; ventrolateral hair present, shorter; gills variable with the species.

Several peculiarities characterize all instars of the three species studied. The ventrolateral hairs of the anal segment, usually considered to be homologous to the ventral brush in the later instars of the other genera, are present in the first instar; the head capsule is deeply cleft basally on each side by a lateral extension of the occipital foramen; pentad hairs 3-5 form a close, lateral group. The air tube, which has numerous hairs and no pecten in the later instars, has a single pair of ventrolateral hairs plus 2-3 pairs of spines in the first instar. These spines form a row beyond the air tube hair, and appear to be homologous with neither the pecten nor any of the hairs of the later instars. It is significant to observe that some Neotropical Sabethini, to which tribe *Wyeomyia* belongs, have such a row of spines in the mature larvae. This is called a "false pecten" by Dyar (1928).

Key to the Species of *Wyeomyia*

1. Anal gills of equal length (Florida, in Bromeliads) *vanduzeei*
- Upper gills reduced or absent (in *Sarracenia purpuracea*) 2



Figs. 51-53. Fig. 51 A, B, C, H, *Uranotaenia sapphirina* (Osten-Sacken), Americus, Georgia, October 1943 (J. C. Dudley). Fig. 52 A, B, H, *Uranotaenia lowii* Theobald, Valdosta, Georgia, September 1943 (Leighton Golden). Fig. 53 A, B, D, E, *Wyeomyia smithii* (Coquillett), Plattsburg, New York, August 1945, in *Sarracenia purpuraea* (R. C. Barnes).

2. Upper gills absent; head elongate, the sides nearly parallel; postocular lobe of occipital foramen deeply pigmented; lower head hairs in line before the upper; inner occipital hair and egg burster in line between the eyes ... *smithii*
- Upper gills less than half as large as the lower; head subtriangularly rounded; postocular lobe not pigmented; lower head hairs more widely set; inner occipital hair and egg burster set well behind the eyes *haynei*

***Wyeomyia smithii* (Coquillett)**

Figs. 53A, B and on p. 389 Fig. 53 F

This species occurs in the pitcher plant, *Sarracenia purpurea*, in eastern North America. It is characterized in all instars by the presence of only one pair of anal gills. First-instar larvae have the head longer than wide, with the post-ocular cleft deeply pigmented.

***Wyeomyia haynei* Dodge**

Figs. 54 A, B

A closely related species occurring in the same host plant in South Carolina is distinguished from *smithii* in all instars by the presence of small dorsal gills, about a third as large as the lower. The head in this species is subtriangular, broadened at the base and without the deep pigmentation of the postocular cleft.

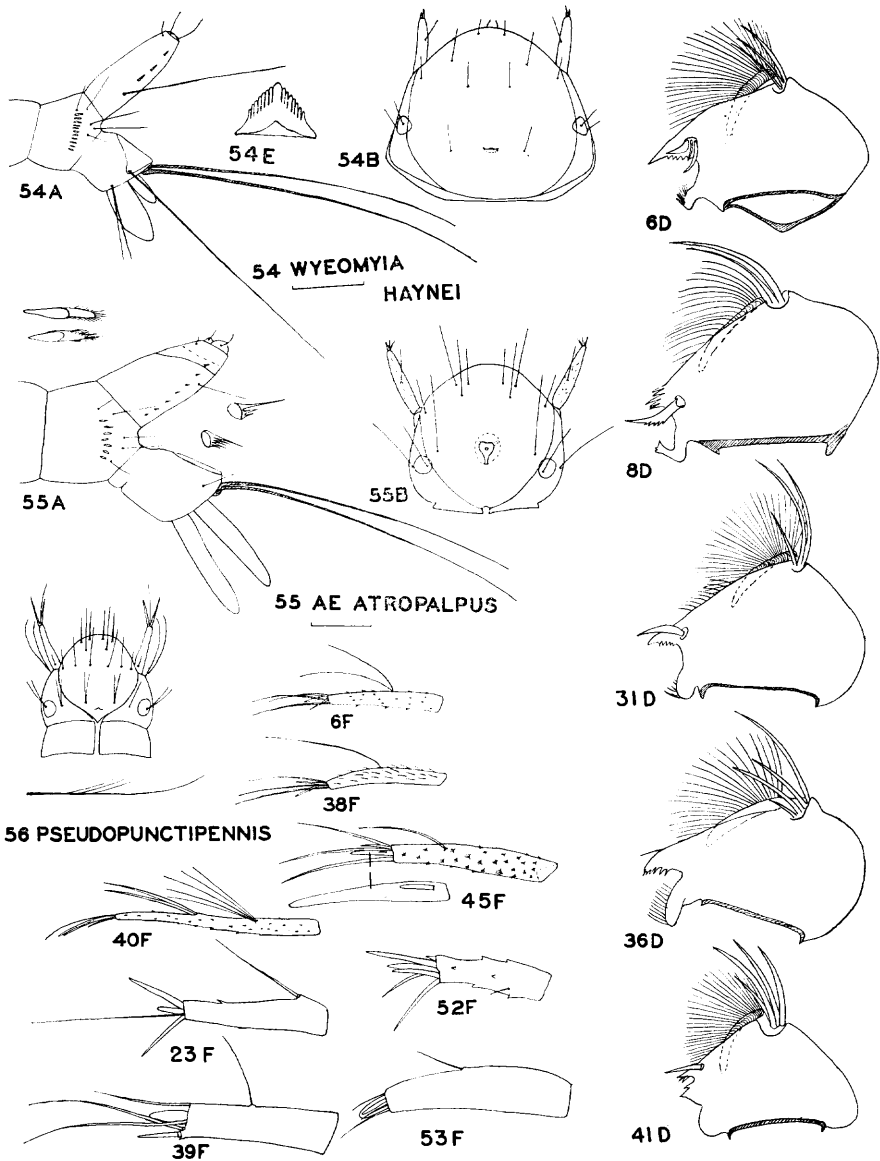
***Wyeomyia vanduzeei* Dyar and Knab**

Larvae from Vero Beach, Florida, were sent by Dr. Maurice Provost. The anal gills in this species are of equal length.

Alternate Key to First-instar Larvae, Primarily of the Southeastern States

The following key is based upon characters visible at 9× to 54× magnification by the binocular microscope, and may be more convenient for the identification of species of the Southeastern States than the preceding keys to the genera and species.

- | | | |
|-------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 1.(a) | Air tube absent | 2 |
| (b) | Air tube present, less than 2:1, shorter than the anal segment | 8 |
| (c) | Air tube longer than the anal segment but less than 4:1 | 11 |
| (d) | Air tube elongate, at least 4:1 | 40 |
| 2.(a) | Subantennal hair and all other hairs of head minute; head apparently glabrous | <i>Anopheles barberi</i> |
| (b) | Subantennal hair long, bifid | 3 |
| (c) | Subantennal hair long, equally pinnate, with branches on both sides to near base of shaft | 4 |
| (d) | Subantennal hair long, unequally pinnate or pectinate, with all or most branches on the outer side of shaft | 5 |
| 3. | Ventral bristles of anal segment forming a large, transverse basket | <i>An. pseudopunctipennis</i> |
| | Ventral bristles of anal segment small, not as above | <i>An. albimanus</i> |
| 4. | Subantennal hair with stout shaft (Jamaica) | <i>An. vestitipennis</i> |
| | Subantennal hair with slender shaft | <i>An. quadrimaculatus, crucians, georgianus, bradleyi</i> |
| 5. | Subantennal hair with less than 12 branches, with few or none on inner side of shaft | 6 |
| | Subantennal hair with more than 12 branches, apical branches fine | 7 |
| 6. | Frontal hairs simple | <i>An. atropos, grabhamii</i> |
| | Frontal hairs branched | <i>An. punctipennis, freeborni</i> |
| 7. | Subantennal hair with basal branches longer than shaft | <i>An. walkeri</i> |
| | Subantennal hair with basal branches shorter than shaft | <i>An. aztecus</i> |
| 8. | Head subquadrate; abdomen with 3 pairs lateral platelets on segments 1-7 | 9 |
| | Head rounded, abdomen without well-developed lateral platelets | 10 |
| 9. | Saddle spines (posterior margin) irregular in length | <i>Toxorhynchites rutilus septentrionalis</i> |
| | Saddle spines nearly regular in length | <i>T. portoricensis</i> |



Figs. 54-56. Fig. 54 A, B, E, *Wyeomyia haynei* Dodge, Columbia, South Carolina, 1945 (H. R. Dodge). Fig. 55 A, B, *Aedes atropalpus* (Coquillett), Washington, D.C., November 1945, from laboratory colony (Helen L. Trembley). Fig. 56, *Anopheles p. pseudopunctipennis* Theobald, head, dorsal view and lateral hair of anal segment, Mexico City, Mexico, April 1943 (Luis Vargas).

Antennae of various genera, lateral view: Fig. 40 F, *Mansonia indubitans* Dyar and Shannon. Fig. 23 F, *Anopheles quadrimaculatus* (Say). Fig. 39 F, *Deinocerites cancer* Theobald. Fig. 6 F, *Aedes mitchellae* Dyar. Fig. 38 F, *Culiseta melanura* Dyar. Fig. 45 F, *Psorophora ciliata* (Fabricius). Fig. 52 F, *Uranotaenia lowii* Theobald. Fig. 53 F, *Wyeomyia smithii* (Coquillett).

Mandibles of various species, ventral view: Fig. 6 D, *Aedes mitchellae* Dyar. Fig. 8 D, *Aedes taeniorhynchus* (Wiedemann). Fig. 31 D, *Culex salinarius* Coquillett. Fig. 36 D, *Culiseta inornata* (Williston). Fig. 41 D, *Mansonia perturbans* (Walker).

45. Head hairs in a horizontal row; egg burster preceded by an oval, pale area; basal third of air tube not sclerotized *C. restuans*
 Head hairs not in horizontal row; egg burster not preceded by a pale area; secondary sclerotin extends nearly to base of tube
 *C. nigripalpus*
46. Comb a patch of scales, or irregular row *Culiseta morsitans*
 Comb a row of equal scales *C. melamura*

Explanation of the Figures

All drawings were made with the use of a compound microscope and camera lucida. The head and posterior segments were drawn with the aid of the 16-mm. objective. The scale for each species, reproduced under the species name, represents 0.1 mm. Enlarged views of the comb scales, pecten teeth, surface sculpture and mentum were drawn with the aid of the 4-mm. objective and are approximately four times as large as the scale. Drawings of the maxillae, mandibles, antennae and other structures are usually drawn to an intermediate scale.

A. Posterior segments of the abdomen, lateral view. Enlarged comb scale above, pecten teeth behind. Sometimes with indicated enlarged details of other structures.

B. Head, or head and thorax, dorsal view (except usually a ventral view of half of the thorax).

C. Maxilla, ventral view.

D. Mandible, ventral view.

E. Mentum, ventral view.

F. Antenna, lateral view.

G. Air tube, lateral view.

H. Occipital foramen, posterior view.

J. Maxilla and mandible, ventral view.

K. Egg burster, dorsal view.

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