# The Mosquitoes of the Mid-Atlantic Region: An Identification Guide


**Bruce A. Harrison**
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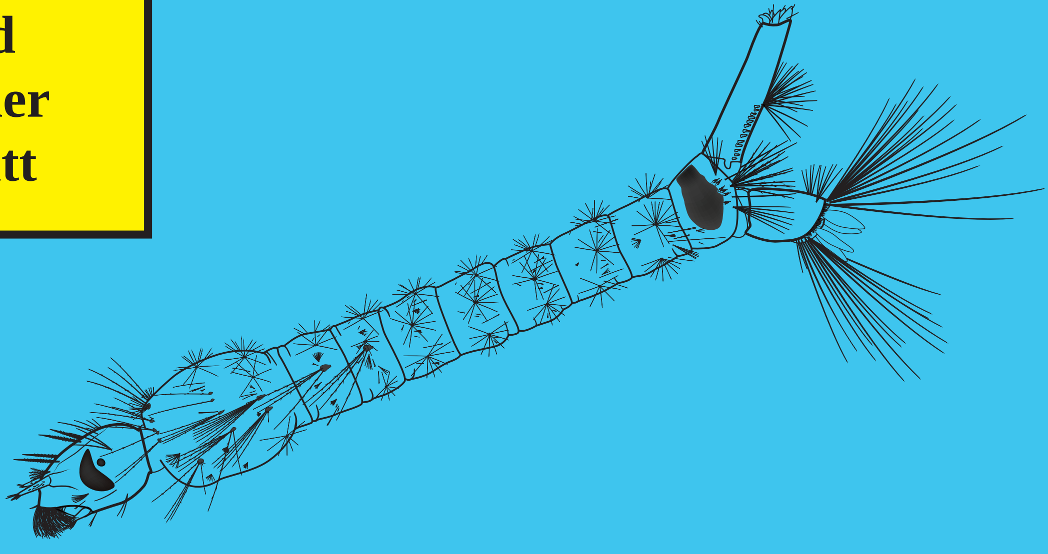

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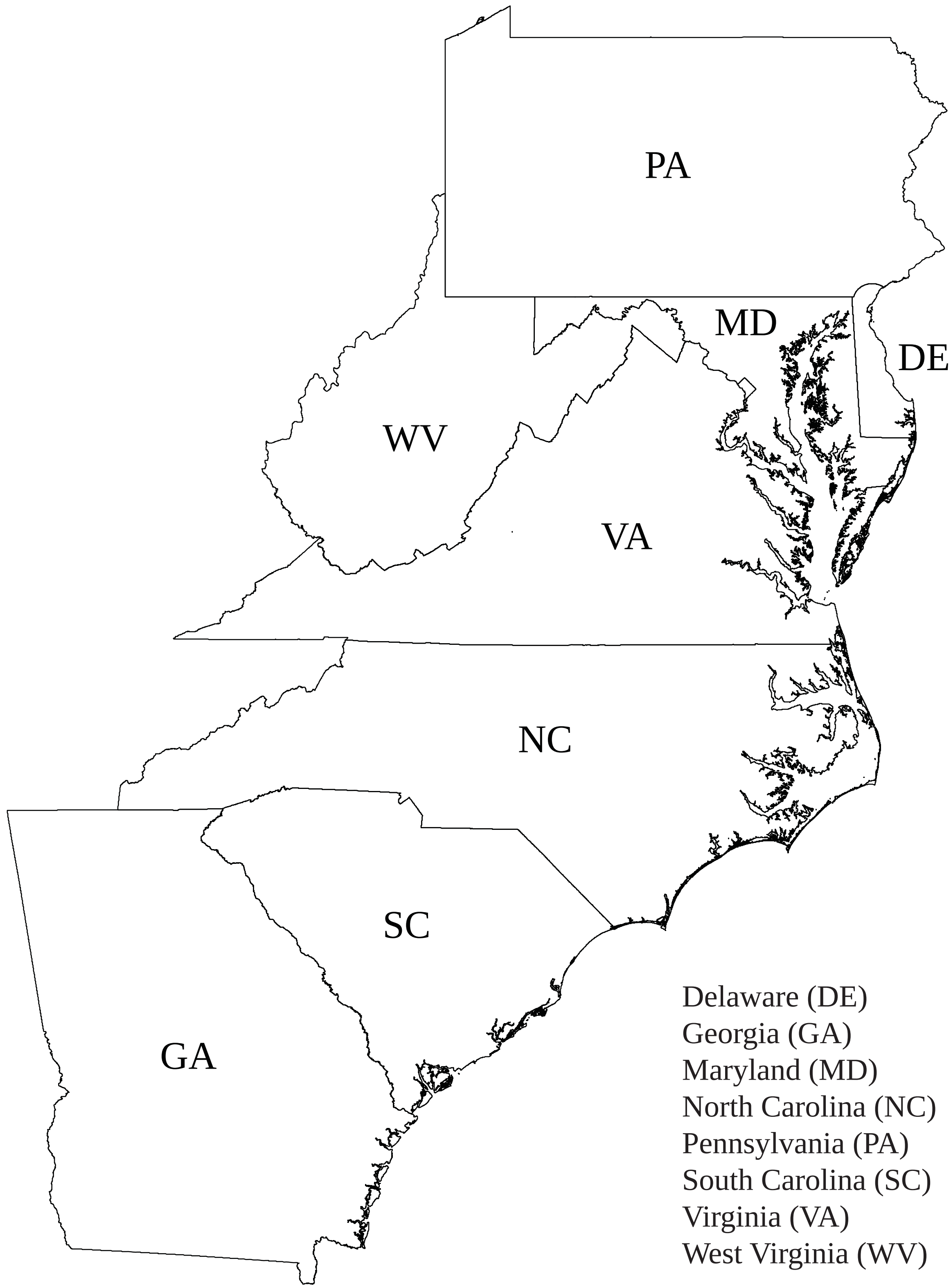
Western Carolina University | Cullowhee, North Carolina | 2016

Map of the States of the Mid-Atlantic Mosquito Control Association (excluding Tennessee)



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## DEDICATION

This work is dedicated to Dr. Charles S. Apperson, William Neal Reynolds Distinguished Professor Emeritus at North Carolina State University, whose many contributions to the discipline have greatly enhanced our knowledge of the biology of mosquito and tick vectors. For more than 35 years, Dr. Apperson has mentored graduate and postdoctoral students, junior faculty members, and countless professionals. In addition to establishing himself as an international expert in the biotic cues mediating oviposition by dengue vectors, Apperson has tirelessly worked to address state and regional problems relating to tick-borne and mosquito-borne diseases.

This book was prepared for mosquito control professionals and individuals that identify mosquitoes. Thus, we also dedicate this book to the numerous field personnel and mosquito control professionals who diligently work to protect the health of the public.

## ACKNOWLEDGEMENTS

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Regarding specimens and records, this book would not be possible without the assistance of Mosquito Control Professionals from the Mid-Atlantic Region and beyond. Special recognition and thanks go to Michael Hutchinson, for the invaluable specimens he provided from Pennsylvania. Without his contributions the broad scope of the northern *Aedes* species could not have been realized in the keys. In addition, we are grateful to Dr. Dina Fonseca for clarifying the genetics of the *Culex pipiens* complex in North Carolina. We also extend special thanks to many other professionals who contributed specimens and records to assist the authors in completing this work: Charles Abadam, Dr. Alice Anderson (deceased), Joseph Andrews, Dr. Charles Apperson, Dr. Jennifer Armistead, Tommy Bowen, Jeff Brown, Kristy Burkhalter, Robert Collins, Dr. Roxanne Connelly, Eric Dotseth, Dr. Barry Engber, Jim Ericson, Dr. Christopher Evans, Tom Floore, Andy Fox, Joe Garcia, Jim Gardner, Dr. Jerome Goddard, Dr. John Gingrich, Ryan Harrison, Dr. Carmony Hartwig, Marie Hemmen, Rick Hickman, David Jenkins, Dr. Rosmarie Kelly, Jamie Layton, Ken Manuel, Tim McGonegal, Eugene McRoy, Robert Moulis, John Neely, Dr. Nolan Newton, Keith Oates, James Pecor, Eugene Powell, Walker Rayburn Jr., Michael Riles, Jerry Robinson, Dennis Salmen, Dr. Marc Slaff, Crystal Swinger, Dreda Symonds, Dr. Ken Tennessen, Marcée Toliver, and Jason Williams.

Last, but not least, this effort would not have been possible for two of us (BAH, BDB) without the continuing love, support, encouragement, and understanding of our spouses and families.

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## I. INTRODUCTION

The Mid-Atlantic Region of the eastern United States remains poorly defined. In this publication it refers to eight states that stretch from Georgia to Pennsylvania that are members of the Mid-Atlantic Mosquito Control Association (MAMCA). This association assists the individual state associations that provide support to many mosquito control programs in the respective states. The mosquito species existing in these states occupy a variety of different ecological habitats that occur in either the boreal, temperate, or subtropical regions of the eastern United States. In the north this region is renowned for deep snows while there are rare snows in the south, and moderate to hot temperatures in the north to very hot temperatures and very humid conditions in the south. Mountains occur in seven of the states, some at elevations over 6,500 feet, including Mt. Mitchell in North Carolina, the highest peak east of the Mississippi River. Seven of the eight states are connected to the Atlantic Ocean either directly or by brackish-tidal waters in river systems near the ocean. The region is periodically exposed to the ravages of severe winter coastal storms, destructive summer-fall hurricanes, and tropical depressions. In addition to mosquito diversity, there are many species of birds, amphibians, reptiles, mammals, and plants dependent upon the latitudes from southern Georgia to northern Pennsylvania. This broad diversity of organisms has promoted many species-specific mosquito associations with certain fauna and/or flora, including parasitic and virus life cycles. Dense populations of mosquitoes and their close association with humans are of great importance to the MAMCA states because they may act as vectors of parasitic protozoa or viral pathogens that affect the health of humans, our domestic animals, and other zoonotic fauna.

This guide and the development of the keys were conceived and initiated in North Carolina in 1994. This required extensive collections of mosquito larvae, pupae, and adults that were preserved, maintained, and studied for this effort to the present. As the concepts for the book slowly expanded, specimens from other states in the Mid-Atlantic region were sought to accrue the total mosquito species composition found in the region. States finally ascribed to this book are members of the Mid-Atlantic Mosquito Control Association (MAMCA), i.e., Delaware, Georgia, Maryland, North Carolina, Pennsylvania, South Carolina, Virginia, West Virginia, and Tennessee. However, Tennessee recently joined MAMCA, and since the keys and figures in this book were completed before this occurred we decided not to modify the keys or add figures. Regardless, we think this book should be of considerable value to the Tennessee mosquito control personnel and vector biologists because the keys include all but two of the species known from Tennessee. Those two species, *Anopheles pseudopunctipennis* Theobald, and *Psorophora signipennis* (Coquillett), are mid-western in origin and have not been reported in the other MAMCA states.

The primary goals for this publication follow: (1) to prepare more accurate field-oriented female and larval pictorial keys that contain many new characters for use by mosquito control personnel, students, and mosquito specialists: (2) to provide characters that accurately separate the four larval instars of anopheline and culicine species (except *Toxorhynchites* and *Wyeomyia* species); (3) to provide easily used keys for use in detecting species distribution extensions/withdrawals during the current ongoing global climate warming event; and (4) to encourage mosquito control personnel to initiate larval surveillance, identification, and control for mosquito-borne disease prevention. This last goal is based, in part, on recent National Pollution Discharge Elimination System (NPDES) guidelines for implementing mosquito control that requires documentation of surveillance, collection records, and mosquito identifications to justify control efforts that should have the least harmful effects on the environment. A foundation of any organized mosquito control program should be larval surveillance, including species identification, and early control interventions. As such, the NPDES requirements have essentially “turned back the clock” to remind us of the need for effective larval surveillance.

There are clear reasons why many mosquito control programs have discontinued larval surveillance, identification, and control efforts. Historically, mosquito records and morphological keys to this area of the eastern United States were based primarily on morphological characters found on species collected and identified concurrently during World War II at numerous U.S. military installations and in state mosquito control programs. Many new state species records were detected during those efforts. Fortunately, military mosquito control efforts in the 1940s coincided and collaborated with the last decade of the U.S. National Malaria Eradication Program (NMEP), which relied heavily on larval surveillance, identification, and control. These efforts enhanced the aims and success of the NMEP and it was successfully completed and terminated in 1951. By then huge numbers of larvae and adults had been collected, processed, and identified for control efforts to prevent malaria transmission in the U.S., and also prevent the transmission of mosquito-borne virus pathogens causing human diseases. During this period hundreds, if not thousands, of U.S. military and U.S. Public Health and state government personnel had been trained to identify mosquito species in both the larva and adult stages. Thousands of specimens from those efforts were preserved in numerous collections and used for the publications of Carpenter and LaCasse (1955), King et al. (1960), and numerous individual state mosquito publications. The keys in Carpenter and LaCasse included all of the then known species in North America, while those in King et al. only encompassed the southeastern U. S. species. Even more recent keys for the mosquitoes north of Mexico (Darsie and Ward 1981, 2005) were based primarily on mosquito specimens collected during the 1940-1950s, and those authors basically followed the keys, in part, of the above earlier authors. With the end of WWII in 1945 and the NMEP in 1951, mosquito control personnel in the Mid-Atlantic Region were left with the comprehensive keys of Carpenter and LaCasse (1955) and later, Darsie and Ward (1981, 2005), to identify overlapping species from three different ecological zones.

In the immediate post-WWII period many military installations, government, and local mosquito control programs closed, and this was shortly followed by the termination of the National Malaria Eradication Program in 1951. These closures drastically reduced mosquito surveillance efforts over wide areas. The loss of these major surveillance efforts severely impacted mosquito taxonomic efforts over the next 30-40 years. Also, technological advances affected the decline in larval surveillance. The availability of DDT and relatively new surveillance tools like the New Jersey light trap and the CDC light trap (in 1960) greatly assisted in the monitoring and control of female mosquito populations on surviving installations and in local mosquito control programs. The easy use of permanently wired or battery operated light traps basically eliminated the perceived need for larval surveillance. Thus, in many control programs larval surveillance and control was no longer considered an essential surveillance tool, because control decisions based on the light traps could be made when captured female mosquitoes became too abundant and crossed a locally designated numerical threshold that triggered control. Over two successive human generations there was a rapid decline in entomologists and control personnel that had been well trained in mosquito larval collection, processing, identification, and control. Although the U.S. *Aedes aegypti* Eradication Program in the 1960s trained a large number of personnel to conduct larval surveillance and identify the larvae of a few species, that program was only focused on container species. Thus, an extremely important mosquito taxonomic research and control methodology nearly disappeared, i.e., the Belkin (1962) and more recently described in Reinert et al. (1997, Appendix I) link-reared specimen system, including the preservation of larval and pupal exuviae for each individual reared adult. The near absence of larval collections and link-reared specimens for many species in the United States over the last 50 years is currently reflected in the very few mosquitoes contributed to and deposited in the national mosquito collections at the National Museum of Natural History (NMNH), Smithsonian Institution. These collections are still curated, maintained, and managed by the U.S. Army Walter Reed Biosystematics Unit (WRBU) at the Smithsonian Institution, but the 1940-50s specimens are now less useful for morphological studies as they have aged, the original colors have faded, and many are rubbed or have broken parts. For this reason the submission of fresh specimens to the museum is always welcome as is the submission of questionable specimens needing confirmations or identifications.

Mosquito taxonomy started in 1758 with the development of the binomial (= genus and species) naming system by Linnaeus. Like taxonomic efforts involving other insects, birds, mammals, plants, fish, worms, etc., mosquito taxonomy has not been static, but is a vibrant discipline in which changes are constant and should be anticipated. Like every other discipline, the advent of new analytical techniques has fostered more thorough in-depth studies of mosquito taxonomy. These efforts have led to the recognition of novel species and the re-examination of previously known species as more comprehensive collections became available. Concurrently, the rules have changed about how species should be described and, on occasion, even valid species names have been changed because of the discovery of older names in older obscure literature sites that apply to that species. Taken together, we expect that these advances will continue to alter researchers' opinions of phylogenetic relations among mosquito taxa and the discipline will remain dynamic.

Some examples of how both generic and species names have changed since 1758 are given below.

> The first mosquito genus, *Culex*, was described in 1758 and many species that would later end up in other genera were described in *Culex* up until the mid -1880s.
>
> The next genera described were *Aedes* and *Anopheles* in 1818, however due to the limited dispersal and access to literature many species we now recognize as *Aedes* continued to be described in *Culex* long after that time.
>
> *Mansonia* species were assigned to a genus level name, *Taeniorhynchus* (now a synonym), until the early 1970s. This included *Coquillettidia perturbans*, which was originally described in genus *Culex*, then moved to *Taeniorhynchus*, and later *Mansonia* until the 1970s, when *Coquillettidia* was elevated to genus level and this species was transferred to that genus.
>
> The first species of *Toxorhynchites* was *haemorrhoidalis* (Fabricius), originally described in 1787 in *Culex*. In the mid-1880s known *Toxorhynchites*-like species were transferred to *Megarhinus* (now a synonym) where they remained until the 1940-50s, when they were finally transferred into genus *Toxorhynchites*.
>
> A prime example of changing species names is *Aedes aegypti*, which was described as *Culex aegypti* by Linnaeus in 1762. It remained in *Culex* for 137 years. However, it was given other species names like *argenteus, fasciatus, calopus*, and 15 other names until the 20$^{th}$ Century. In fact the species name labeled on the slides that the Walter Reed team made in the famous Yellow fever research in Cuba in the first decade of the 20$^{th}$ Century is *Stegomyia fasciatus*. Starting in

the 1920s this species (*aegypti*) was reassigned to genus *Aedes*, which lasted until Reinert et al. (2004) restored *Stegomyia* to genus level. Based on the recent Wilkerson et al. (2015) publication, the genus name has now changed back to *Aedes*.

Another example of species name changes involves *Aedes taeniorhyncus*, which was described as *Culex taeniorhynchus* by Wiedemann in 1821. From that time until the 1920s, species names like *damnosus*, *niger*, *portoricensis*, and *epinolus* were assigned to this species. *Aedes taeniorhynchus* has been used since the 1920s, until Reinert (2000) restored *Ochlerotatus* to a genus and transferred many species previously in *Aedes* to *Ochlerotatus*. This action has now been reversed with the publication of Wilkerson et al. (2015) and once again it is *Aedes taeniorhynchus*.

Taxonomic names and terminology are often confusing to the general public and some mosquito control personnel. Below are explanations of terms that you will see in the interpretations, notes and other sections in this book.

**Author names** without parentheses means the species is currently in the same genus in which it was originally described; with parentheses means the species is currently in a different genus than the genus in which it was originally described.

**Binomial name** means "Bi"= two and "nomial" = name, or two names as represented by a species name, like *Aedes aegypti*, *Culex pipiens*, and *Uranotaenia sapphirina*. Basically, nearly all species have binomial names.

**Trinomial names** means "Tri" = three and "nomial" = name, or three names as in subspecies like *Aedes canadensis mathesoni* or *Toxorhynchites rutilus septentrionalis*. Subspecies were more common in the past than now, as many subspecies are being found to be distinct species using molecular techniques. If this happened in the latter trinomial example above the new species would have a binomial name, i.e., and the "rutilus" in the middle would be deleted.

A **nominal species** is one that has been described and named according to the rules of the International Code of Zoological Nomenclature (ICZN). A nominal species can be a senior (oldest) synonym, in which case it is recognized as the current correct name for the species, or it can be a junior (younger) synonym with a different name that represents the same species as the senior synonym, in which case it will not be recognized as the current correct name, but it remains available for recognition in case the senior synonym is reinterpreted and removed or determined to be non-valid.

A **provisional species** is one that has been recognized as a distinct species by morphologic, molecular genetics, or some other technique, but it has only been designated by a letter or number like "A", "D", or "2", "3", and it has not been described with diagnostic characters that will separate it from a closely related species or been given a name according to the ICZN. Examples of this are *crucians* A, B, C, D, and E in the *Anopheles crucians* complex.

A **taxon (singular)** is a term intended for a species, genus, family, order, etc. in a singular sense. **Taxa (plural)** is used for taxonomic clusters of groups, complexes, genera, families, etc., that have more than one entity. Examples follow: "The taxon, *Aedes aegypti*, is a good vector." Or, "The current number of mosquito generic taxa in family Culicidae is conjectural."

**Species** is either singular or plural.

**Genus** is singular, meaning one genus, and **Genera** is plural, meaning two or more genera.

The term **Group** is a historical collective term that may be applied to a small number of species that morphologically appear similar, but can be identified relatively easily. Groups have no status in the ICZN rules, but are useful for sorting species in keys.

The term **Complex** is applied to small numbers of very similar species that are closely related and difficult or impossible to distinguish morphologically. Many complexes have some members that are morphologically or genetically distinct, but those provisional species have not been described according to the rules of the ICZN. There are complexes that must rely on DNA analysis to identify the included species (e.g., Crucians Complex), and other complexes are nearly resolved and can be identified, but there are still other new related species that are suspected and unstudied, so they retained the term Complex (e.g., Punctipennis Complex).

**Assemblages** is another term that is occasionally used to discuss a group or complex of species. Like "group"and "complex", "assemblage" is not an official category used in the International Code of Zoological Nomenclature.

The abbreviation "*s.s*." after a species name means "in the strict sense." That is an abbreviation for the Latin term "*sensu stricto*." Literally, this means the one and only species that bears that name. An example is *An. quadrimaculatus s.s*., which equals *An. quadrimaculatus* Say, which means that is the only species having that name in the Quadrimaculatus Complex.

The abbreviation "*s.l."* after a species name means in the "broad sense." That is an abbreviation for the Latin term "*sensu lato*." This term is used when you are not sure of the exact identity of specimens that belong to a group or complex of species you are examining. Example: you have many specimens that look like *An. quadrimaculatus*, but you are unable to identify those specimens to any of the five species in the Quadrimaculatus Complex, so you call them *An. quadrimaculatus s.l.*, or *An. quadrimaculatus* complex, which means the specimens could be any of the five species in the Quadrimaculatus Complex. Some personnel prefer using "*s.l.*" instead of "complex", but both imply "in the broad sense."

**Synonym** is a term used when addressing more than one name for a given species. The oldest published and described name has priority and is the name applied to the species according to the rules of the ICZN. The oldest recognized valid name is called the senior synonym, and younger recognized names are called junior synonyms. Some common and widely distributed species have many names that are junior synonyms.

Since 1900 there has been a remarkable increase in the discovery of new mosquito species. At that time there were no more than 200 species of mosquitoes that had been discovered, described and had valid names. Since then the numbers have increased dramatically primarily due to the recognition of the importance of mosquitoes in the transmission of human pathogens and the need for surveillance and control of important vector species. The systematic arrangement for our current classification of mosquitoes is based primarily on Edwards (1932), although modifications have been made (see below).

Numbers of valid species listed by Edwards and the numbers listed in three subsequent world catalogs/inventories are below.

1,400 = Edwards (1932)
2,401 = Stone, Knight, and Starcke (1959)
2,960 = Knight and Stone (1977)
3,549 = Mosquito Taxonomic Inventory (Nat. Hist. Mus., London; Online as of Dec. 2015)

The ~150% increase in numbers during the 83 year period between 1932 to the present should not be a surprise, because there are estimates (Harbach 2007) that less than half the mosquito species currently extant have been discovered and named. Until recently the rate of new species descriptions was approximately 25 per year. However, the advent of Bar Coding mitochondrial DNA and ITS2 sequencing will likely increase the recognition, description, and naming of new species. Those new species will still need to be described and named using morphological characters (if present) so that mosquito control personnel will be able to quickly identify them for making essential control decisions.

Since Edwards (1932) the upper taxonomic classification of mosquitoes (family Culicidae) consisted of 3 subfamilies, Anophelinae, Culicinae, and Toxorhynchitinae. There were no tribes in Anophelinae or Toxorhynchitinae, but there were 10 tribes in subfamily Culicinae (Knight and Stone 1977). Harbach and Kitching (1998) determined that there was no morphological justification for subfamily Toxorhynchitinae, and they reduced this group of taxa to a tribe and placed it in subfamily Culicinae. This change in the upper classification was corroborated by Mitchell et al. (2002). Now there are 11 tribes in subfamily Culicinae. Recently Rueda (2008) listed the upper classification (see below). He also provided a breakdown of the distributions for each subfamily/tribe and the number of genera in each zoogeographical region.

Subfamily Anophelinae

Subfamily Culicinae
- Tribe Aedeomyiini
- Tribe Aedini
- Tribe Culicini
- Tribe Culisetini
- Tribe Ficalbiini
- Tribe Hodgesiini
- Tribe Mansoniini
- Tribe Orthopodomyiini
- Tribe Sabethini
- Tribe Toxorhynchitini
- Tribe Uranotaeniini

Throughout this book we have chosen to use *Aedes* Meigen, a decision based, in part, on the recent generic level revisions published by Wilkerson et al. (2015). These authors duplicated the cladistic analyses of Reinert, Harbach, and Kitching (2004, 2006, 2008, 2009). The results of this latest study has led to the reduction of *Ochlerotatus* to a subgenus of *Aedes*. In addition, Wilkerson et al. reduced the 74 Reinert, Harbach, and Kitching (2004, 2006, 2008, 2009) genera to subgenera, species groups, or synonymy.

Although some (but not all) of us have used *Ochlerotatus* since 2000, the return to *Aedes* is welcome, because many of the additional genera published by Reinert (2000) and Reinert, Harbach, and Kitching (2004, 2006, 2008, 2009) were confusing and not well supported in cladistic analyses, not easily distinguished from the other new genera in keys, and in general not user friendly for the mosquito control personnel as well as some public health entomologists and taxonomists. The generic changes made in those publications were based strictly on cladistic analyses that were derived from morphological characters. We view visual morphological characters as only a partial representation of the vast number of molecular, genetic, biochemical, physiological, behavioral, ecological, and morphological, etc., traits and characters that initiate and differentiate species and ultimately may define generic and higher level taxonomic ranks. This is particularly evident in *Anopheles*, where there are many cryptic species in sibling species complexes that are distinguishable by karyotype, cytogenetic, crossing studies or DNA studies, and have been given provisional letter or number designations (Baimai et al. 1984, Cockburn et al. 1993, Krzywinski and Besansky 2003, Wilkerson et al. 2004, Harbach 2013). However, most provisional species are inseparable or inconsistently separable using morphological characters. Provisional species need to be named and described with characters provided to differentiate them from the other closely related species before they will be recognized as valid nominal (= named) species according to the International Code of Zoological Nomenclature (1999).

Scientific advances in the 21st Century demand that systematic studies broaching phylogenetic questions should be based on not only morphological traits but also evidence from other disciplines. At present a partial solution is to combine morphology and molecular genetics. We encourage scientists and students that work strictly in one of these disciplines to recognize the values of both disciplines and utilize both in their studies and publications. This will provide taxonomists and others more accuracy in differentiating species and subspecies taxa and also aid in the discovery of new species that do not have definitive morphological differences.

## II. TAXONOMIC INTERPRETATIONS AND SOURCES

This section provides our interpretations of certain species problems and also sources for certain important species records for the MAMCA states. In addition readers also should be aware of the 24 “Notes” (beginning on page 141) that provide additional information regarding our interpretations of species complexes with accompanying references.

***Aedes abserratus***. This northern mosquito has only been reported from three MAMCA states, i.e., Maryland, Pennsylvania, and West Virginia. **Maryland**. Bickley et al. (1971) reported this species collected in Cranberry Swamp, near Finzel, Garrett County. Schamberger (2009) listed it as rare and in the western part of the state. **Pennsylvania.** Darsie and Hutchinson (2009) presented a map of the distribution of this species, showing it only occurred in the northern half of the state. **West Virginia**. Joy et al. (1994) were the first to report this species in this state, in Logan County in the southwestern part of the state.

***Aedes albopictus***. The distribution map for this species in Delaware, Pennsylvania, Virginia, and West Virginia in Darsie and Ward (2005, Plate 90) is outdated, because *Ae. albopictus* is widely distributed in these states. Gingrich et al. (2006) provided the first report and distribution for this species in Delaware. Darsie and Hutchinson (2009, p. 124) provided a Pennsylvania map showing the wide distribution of this species, with most sites clustered in the southeastern quarter of the state. Prior to 2008 published maps showed very few records for *Ae. albopictus* in Virginia, however, this species is widely distributed in Virginia. The last published list of mosquitoes in West Virginia documented the species by counties (Joy et al. (1994), but did not include *Ae. albopictus*. Joy and Clay (2002) were the first to document its appearance and Joy and Sullivan (2005) documented its wide spread distribution in the state.

***Aedes aurifer*. North Carolina.** Rayburn et al. (2004) reported the collection of two females in a light trap set in April and May, 2002, off Tull's Creek Road in Currituck County, in the extreme northeastern portion of this state. This currently represents the most southern extension of *Ae. aurifer* along the Atlantic seaboard. **Virginia**. Harrison et al. (2002) established a new record for this species in this state based on 22 females collected at two sites in or along the western edge of the Great Dismal Swamp National Wildlife Refuge in April and May, 1998, in Suffolk. Prior to this discovery in southeastern Virginia, Maryland was the southern-most extension of this species along the Atlantic seaboard. This southern distribution was extended into northeastern North Carolina only two years later (Rayburn et al. 2004) see above.

***Aedes cantator***. **North Carolina**. This species was not found in this state until 2002 when specimens were collected at two rural sites in Perquimans County southeast of Hertford (Rayburn et al. 2004), plus at an additional rural site adjacent to the Pasquotank County line, 14 miles northeast of the other two sites. Additional specimens were collected each year following their initial discovery. The sites in North Carolina are currently the most southern in the *Ae. cantator* distribution along the Atlantic seaboard, and are separated from the nearest more northern known collection site in Virginia by about 40 miles. **Virginia**. Jason Williams, Chesapeake Mosquito Control (personal communication) identified two females of *Ae. cantator* collected in Chesapeake in 2002.

***Aedes flavescens***. **Virginia**. Darsie and Ward (1981) recorded this species in Virginia based on a short sentence in a newsletter of the Virginia Mosquito Control Association, and without confirmation of the identification. Based on previous most-southern distributions of this species in New Jersey and New York, plus known variations in abdominal pale scaling on *Ae. cantator* in North Carolina that closely approximate the description for *Ae. flavescens,* Harrison et al. (2002) deleted *Ae. flavescens* from a revised list of the Virginia mosquitoes.

***Aedes grossbecki***. **North Carolina**. Although Darsie and Ward (1981) and Slaff and Apperson (1989) included this species in the list of mosquitoes from this state, these actions were not based on previous published records or known specimens, but on published records of this species in Georgia, South Carolina, and Virginia (Harrison et al. 1998). Therefore collections of three females of this species (Rayburn et al. (2004) in Chowan (2003) and Edgecombe (2001, 2003) counties represent the first confirmed records for *Ae. grossbecki* in North Carolina. Several specimens of this species have been identified in Nash County (adjacent to Edgecombe County) since the earlier records.

***Aedes j. japonicus***. For cataloging purposes we are referencing the first records of this species in each of the MAMCA states. **Delaware**. Gingrich et al. (2006) lists the first record as Dover Air Force Base in 2001, based on information provided by the Center for Health Promotion and Preventive Medicine (CHPPM), Fort Meade, Maryland. Gingrich reconfirmed that record when he collected a specimen in Blackbird State Forest in 2002. **Georgia**. Gray et al. (2005) documented the first collections of this species in Georgia, including the first specimen collected in Fulton County in 2002, and in Lumpkin, Towns, Union, and White counties in 2003-04. Reeves and Korecki (2004) reported collections of larvae of this species in Rabun County in 2003. **Maryland**. Fonseca et al. (2001) and Sardelis and Turell (2001) established the presence of this species in Frederick County in 2000. **North Carolina**. The first specimens of this species collected in this state occurred in June, 2003 in Mecklenburg County. Additional collections in 2003 occurred in Buncombe, Cabarrus, Iredell, Macon (courtesy of Mike Womack), and McDowell counties. Since these early records this species has been found in all mountain and piedmont counties and is slowly invading the coastal plain counties from the west and north. This species has been recorded at elevations over 5,000 feet in rock holes in streams adjacent to the Blue Ridge Parkway. **Pennsylvania**. Fonseca et al. (2001) reported the first collections (as eggs) of this species in Chambersburg, Franklin County in 1999. Hutchinson et al. (2008) referenced this information, but did not provide any additional information about the location of the site. Recently, Darsie and Hutchinson (2009) provided a distribution map showing this it is now one of the most abundant species collected throughout the state. **South Carolina**. Reeves and Korecki (2004) documented the first collection of this species in Greenville County in 2003. **Virginia**. Harrison et al. (2002) reported the first collection and verification of *Ae. j. japonicus* in this state from Occoquan, Prince William County in July 2000. **West Virginia**. Joy (2004) reported that the first records for *Ae. j. japonicus* in WV were from early 2002 (James Amrine, personal communication), and that there were abundant specimens collected in 2002 during summer tire dump surveys.

***Aedes mitchellae***. The distribution of this species is not shown in most of North Carolina, or in Virginia, Maryland, Delaware, and West Virginia on the distribution map of this species in Darsie and Ward (2005), yet these states, except West Virginia, have records for this species. **Delaware**. Gingrich et al. (2006) lists this species in this state. **Maryland**. Schamberger (2009) lists this species occurring in the state, but could not locate a record for the collections site, and listed it as "accidental." However, Bickley et al. (1971) reported 1969 collections of this species in Talbot, Wicomico, and Worcester counties, Maryland. **North Carolina**. Brimley (1938) was the first to record this species from New Hanover County. Currently it is known from 22 coastal plain and piedmont counties (not in the mountains as indicated in Darsie and Ward 2005), and is most common in coastal plain counties. **Virginia**. Dorer et al. (1944) recorded the first collection of this species in this state in 1942 in the Hampton Roads area. He listed the larvae as common, but the adults were rarely collected in light traps. Harrison et al. (2002) failed to find this species among 72,638 identified specimens collected in light traps from North Carolina and Virginia in a 1998 survey around the Great Dismal Swamp.

***Aedes stimulans***. **Maryland**. Bickley (1957) reported a single female collected by C. W. McComb at Easton, in June 1956. **Virginia**. Bickley (1957) reported two females collected by C. W. McComb at Gloucester Point, Virginia in June of 1956. These represent the first records for this species in those two states, and also represent the most southern extensions for this species along the Atlantic seaboard. More southern confirmed records for *Ae. stimulans* have been published for Louisiana (Sither et al. 2014) and Mississippi (Dyar 1920, Goddard and Harrison 2005).

***Aedes tormentor***. **Georgia**. Recently Shroyer et al. (2015) identified and confirmed a species new to the United States in Florida. This species, *Aedes pertinax* Grabham, is related to and very similar to *Ae. atlanticus* and *Ae. tormentor*. *Aedes pertinax* will key to *Ae. tormentor* using the head scale characters in our female key. If the distribution of *Ae. pertinax* extends northward into southern

Georgia in the future this may present identification problems for mosquito control personnel. **North Carolina**. Advances in our ability to identify females of this species have changed our perception of this species. Prior to finding characters for identifying the females it was considered a less common species than *Ae. atlanticus* in North Carolina. However, now it is commonly identified and is often the dominant species when compared to *Ae. atlanticus*. It appears in early (April) in piedmont counties and occurs much further west than indicated (Darsie and Ward 2005), in counties at elevations over 2,000 feet and west of the Blue Ridge Parkway. **Virginia**. Although the distribution map of this species (Darsie and Ward 1981) recorded this species in the eastern half of the state, this was based on confirmed records of the species in Maryland and North Carolina, not confirmed specimens or published documentation of this species in Virginia. Powell and Harrison (2001) provided the first records of this species collected in Virginia based on five larvae collected in May and June, 1996 and 1997 near South Boston, Halifax County.

***Aedes vexans nipponii* (Theobald).** Darsie and Ward (2005) introduced a new record for this subspecies of *Ae. vexans* in the United States based on specimens supposedly reported by Reinert (1973) from Delaware, New Jersey and Ohio, and a personal communication from Andreadis in 2000 about specimens in Connecticut. However, Darsie and Ward mistakenly credited Reinert (1973) for the Delaware, New Jersey, and Ohio specimens, because Reinert credited Crans and Gandek (1968) for the nipponii-like specimens from those states. Darsie and Ward also misinterpreted what Reinert wrote about *Ae. v. vexans* and *Ae. v. nipponii* when they introduced this record.

In his 1973 revision of subgenus *Aedimorphus* Theobald of *Aedes*, Reinert examined 7,560 specimens of *Ae. v. vexans* from around the world and 350 specimens of *Ae. v. nipponii* from east Asian countries. No North American records for *Ae. v. nipponii* were included in the listed distribution for this subspecies in his revision. He considered wide spread nipponii-like specimens in North America to be rare variants of *Ae. v. vexans*, and suggested they were due to a recessive genotype. He also listed nipponii-like specimens that he examined from Georgia, Maryland, and Oregon, and discussed 26 similar specimens (out of 13,600 *Ae. v. vexans*) that were collected and identified by U. S. Army taxonomists [including BAH] from Arkansas, Louisiana, Oklahoma, and Texas during the Venezuelan equine encephalitis outbreak in the U. S. in 1971.

During this study the authors have examined nipponii-like specimens from Georgia, Maryland, Massachusetts, North Carolina, South Carolina, and Virginia and want to stress that in addition to the median longitudinal abdominal pale stripe, there are other morphological differences that will differentiate females of *Ae. v. nipponii* from *Ae. v. vexans*, and at least one larval difference. We feel strongly that such records should not be established without confirmation using morphological and molecular genetics research. Thus, we agree with Reinert's conclusions about nipponii-like specimens of *Ae. vexans* in North America, and here delete the Darsie and Ward (2005) record of *Ae. vexans nipponii* from the list of mosquito species and subspecies in the United States.

**Crucians Complex**. (See **Notes 8, 19, 20, 22, 23** for additional information). Using the name, *An. crucians*, is no longer taxonomically accurate because Wilkerson et al. (2004), using rDNA ITS2 sequencing, identified 5 distinct molecular sibling species in what was previously called "crucians". Presently, morphological characters have not been identified that will differentiate the females, males, pupae or larvae of the five sibling species, which have been designated *crucians* A, B, C, D, and E. Taxonomically, they are considered provisional species, not formally named species. The name *An.*

*crucians* should not be used because one of those five provisional species is probably the real nominal species, *An. crucians s.s.*, but no one has determined which one of the five alphabetically lettered provisional species represents the original species. Until that is accomplished, and the other four provisional sibling species are described and named, we should use Crucians Complex, or *An. crucians s.l. (=sensu lato*, meaning "in the broad sense") for the 5 provisional species. *Anopheles bradleyi* and *An. georgianus* are also members of the Crucians Complex. This concurs with the 7 species listed by Harbach (2004) in the Crucians Complex.

Wilkerson et al. (2004) documented *crucians* A, B, C, D, and E in Georgia, and *crucians* A and E in North Carolina. More recently, *crucians* D was identified from North Carolina (Wilkerson 2007, personal communication). Beside Wilkerson et al. (2004) we have not found published records for these five provisional species in the other MAMCA states.

**Punctipennis Complex**. (See **Notes 7**, **21** for additional information). We are following Bellamy (1956), who suggested the term "Complex" for *An. punctipennis* and *An. perplexens*. This is in contradiction to the use of "Punctipennis Group" of Harbach (2004, 2013). The use of complex became fully justified when Porter and Collins (1996) found that *An. punctipennis* from California (designated "W") was a distinct molecular species from *An. punctipennis* (designated "E") in the eastern USA. Porter and Collins (1996) also found that several other species probably were related to the *An. punctipennis* "Lineage" in cladograms, from which we infer that there may be more species that could be considered in the Punctipennis Complex.

**Quadrimaculatus Complex**. (See **Notes 9**, **18** for additional information). Reinert et al. (1997) revised the complex of provisional species with letter designations that were related to *An. quadrimaculatus*, and described four new species, *An. diluvialis*, *An. inundatus, An. maverlius*, and *An. smaragdinus. Anopheles quadrimaculatus* and the additional four species now represent the Quadrimaculatus Complex. However, many mosquito control programs still use *An. quadrimaculatus* as a catch-all category for all of the species in the complex. Thus, many published records for *An. quadrimaculatus* should be listed as *An. quadrimaculatus sensu lato* or "*s.l.*", meaning in the broad sense. True *An. quadrimaculatus* should be listed as *An. quadrimaculatus sensu stricto* or "*s.s.*", or with the author's name. Reinert et al. (1997) also provided county records for the species they identified in a number of states. For the MAMCA Region those counties are provided below.

**Delaware.** *Anopheles quadrimaculatus s.l.* is wide-spread; and *An. smaragdinus* was collected and confirmed from Glasgow in New Castle County in 1999 (Gingrich et al. 2006).

**Georgia.** Reinert et al. (1997) provided the following county records: *Anopheles inundatus* from Bullock, Calhoun, Chatham, Effingham, Screven; *An. maverlius* from Bullock, Camden, Chatham, Effingham, McDuffie, Screven; *An. quadrimaculatus s.s.*, was confirmed from Brooks, Bryan, Bullock, Camden, Chatham, Decatur, Effingham, Glynn, Hart, Lanier, Long, McDuffie, Screven, Seminole; and *An. smaragdinus* was confirmed from Brooks, Bullock, Camden, Chatham, Decatur, Effingham, Glynn, Hart, Lanier, Long, Screven, and Seminole.

**Maryland**. Schamberger (2009) recorded only *An. quadrimaculatus s.s.,* with a statewide distribution. Considering the presence of *An. smaragdinus*, in Westmoreland County, Virginia, just across the Potomac River from Maryland, it is likely that this species or others in Quadrimaculatus Complex occur in Maryland.

**North Carolina**. Reinert et al. (1997) provided the following county records: *Anopheles quadrimaculatus s.s.*, from McDowell and Wake; and *An. smaragdinus* from Wake. Levin et al. (2004) provided records (no counties) for *An. diluvialis* and *An. maverlius.* Levine (personal communication in 2002) provided the following county records: *An. diluvialis* from Camden and Perquimans; *An. maverlius* from Camden, Gates, Pasquotank, Robeson; *An. quadrimaculatus s.s.*, from Bladen, Brunswick, Cabarrus, Camden, Chowan, Columbus, Craven, Currituck, Duplin, Gates, Henderson, New Hanover, Pasquotank, Pender, Perquimans, Robeson, Scotland; and *An. smaragdinus* from Brunswick, Nash, New Hanover, Pender, Robeson, and Wayne.

**Pennsylvania**. Darsie and Hutchinson (2009) provided a map showing *An. quadrimaculatus s.l.*, with a statewide distribution. However, see information on page 176.

**South Carolina**. Reinert et al. (1997) provided the following county records: *An. maverlius* from McCormick; *An. quadrimaculatus s.s*., from Anderson, Calhoun, Clarendon, Jasper, McCormick, Sumter; and *An. smaragdinus* from Anderson, Calhoun, Clarendon, and McCormick.

**Virginia**. *Anopheles maverlius* was reported by Levine et al. (2004), but without county records. Strickman et al. (2000) reported *An. quadrimaculatus s.s.* and *An. smaragdinus* from Westmoreland County. *Anopheles quadrimaculatus s.l.*, has been collected from many other areas in the state.

**West Virginia**. Joy et al. (1994) reported *An. quadrimaculatus s.l.*, from Cabell, Mason, and Summers counties. We have not been able to locate any additional published information about other members of the Quadrimaculatus Complex from West Virginia.

***Culex coronator***. Currently there are confirmed records for *Cx. coronator* for three of the MAMCA states, i.e., Georgia, North Carolina, and South Carolina. Known county distributions for this species in those states follow. **Georgia.** Kelly et al. (2008) reported the first collections of this species in Dougherty, Lowndes, and Muscogee counties, and Moulis et al. (2008) reported this species in coastal Chatham County. See possible additional information about *Cx. coronator* in Georgia under *Culex tarsalis* below. **North Carolina.** This species is a new record for this state. See the North Carolina list of species in the State Records section (p. 173) for previously unpublished, but confirmed, county records of this species in Brunswick (specimens provided by J. Brown and R. Hickman) and New Hanover (specimens provided by D. Jenkins) counties. **South Carolina.** Moulis et al. (2008) reported the species in Jasper County, and Chris Evans, SCDHEC (personal communication) confirmed specimens from Beaufort and Richland counties.

***Culex pipiens and Cx. quinquefasciatus***. (See **Notes 10 and 24** for additional information.) Old records of *Cx. pipiens* and *Cx. quinquefasciatus* in some MAMCA states should be reviewed with suspicions that some or all of their records may have been incorrectly identified. Those states involve Georgia, Maryland, North Carolina, South Carolina, and Virginia. Modern molecular methods (Crabtree et al. 1995, Aspen and Savage 2003, Smith and Fonseca 2004) have provided good molecular tests for separating the members of the Pipiens Complex. Current unpublished studies have confirmed the historical concept of a large eastern zone of genetic introgression, where *Cx. pipiens* x *Cx. quinquefasciatus* hybrids occur in the Mid-Atlantic Region. This zone may be broader than that previously recognized (Fonseca, personal communication). North Carolina serves as an example for this. North Carolina has 100 counties and all specimens currently tested from the ocean to the Tennessee line, including specimens collected at over 3,300 ft elevation, are now recognized as hybrids, except for specimens at one site in the most southeastern county, Brunswick, where *Cx. quinquefasciatus* has been found. Brunswick County is on the coast just north of Myrtle Beach, South Carolina. For years coastal plain specimens in North Carolina were identified as *Cx. quinquefasciatus*, but now we know that nearly all of those were hybrids with varying percentages, based on latitude, of genetic introgression from both *Cx. pipiens* and *Cx. quinquefasciatus*. The current situation in the other MAMCA states follows. **Georgia.** Along the east coast *Cx. quinquefasciatus* occurs up to Savannah, and in the western part of the state this species extends up to just south of Atlanta. Specimens from the northern mountainous areas of the state are most likely hybrids, like those found in North Carolina north of Georgia. **Maryland.** Based on long standing records Schamberger (2009) listed *Cx. pipiens* as state wide, and *Cx. quinquefasciatus* as occurring in southern and southeastern Maryland. However, these records need to be reviewed and current specimens tested to determine their actual identity, because the northern-most *Cx. pipiens* in Maryland may be true *Cx. pipiens*, while the southern-most specimens labeled *Cx. pipiens* may be hybrids. As for *Cx. quinquefasciatus* in Maryland, the most northern currently known confirmed specimens of this species along the Atlantic coast were found in the most southeastern county (Brunswick) in North Carolina. This suggests the specimens previously labeled *Cx. quinquefasciatus* in Maryland are actually hybrids. **South Carolina**. Weathersbee and Arnold (1947) and Chris Evans (SCDHEC, unpublished list 2008) recorded both *Cx. pipiens* and *Cx. quinquefasciatus* from this state. Although most of South Carolina has *Cx. quinquefasciatus*, we suspect that the *Cx. pipiens* specimens from the northern and northwest parts of the state are hybrids like those found in most of North Carolina. **Virginia**. Harrison et al. (2002) included a revised list of mosquitoes for this state (a 1928 *Cx. tarsalis* record mistakenly left out). Based on older publications they listed both *Cx. pipiens* and *Cx. quinquefasciatus* in the state. Now it is likely that most specimens identified as *Cx. pipiens* in Virginia were actually hybrids, and that the *Cx. quinquefasciatus* records from the past are likely misidentifications and were also hybrids. Specimens collected in extreme northern and northwestern Virginia need to be tested to see if true *Cx. pipiens* occurs in Virginia.

***Culex tarsalis***. Normally records for *Cx. tarsalis* east of the Mississippi River are rare and usually based one or two specimens, at least in the more southern states. Currently this species has only been found in five of the MAMCA states, i.e., Georgia, Pennsylvania, South Carolina, Tennessee (not addressed here), and Virginia. County records for *Cx. tarsalis* in those states follow. **Georgia.** Single specimens were reported from Bibb in 1943 (Carpenter 1945, Carpenter and Chamberlain 1946), Liberty in 1943 (Carpenter and Chamberlain 1946), and from Muscogee in 1944 (Carpenter 1945). More recently, Smith and Floore (2001) recorded 27 specimens of this species collected in light traps in Calhoun, Mitchell, Terrell, and Worth counties during a four week period in June and July, 1997. Of importance, these counties are close together and nearly encircle Dougherty County, which was not collected. The large number of *Cx. tarsalis* specimens collected in this confined area is very unusual and does not follow the normal reports of isolated specimens usually found in most of the eastern states. At least two explanations may account for the larger than normal collections of this species, i.e., (1) the species has become established in this area of the Georgia, or (2) the specimens may have been misidentified. There are no surviving specimens from those collections (John Smith, personal communication). Although *Culex tarsalis* is quite distinct, it can be confused with *Culex coronator*, because both have similar characters that are used in classic keys: hindtarsomeres that have both basal and apical pale bands, including hindtarsomere 5; basal pale bands on the abdominal terga; and pale scales on the venter of the proboscis. The possibility of misidentification is further supported by the first collections of *Culex coronator* in Georgia occurring in Albany, Dougherty County in 2006 (Kelly et al. 2008), right in the center of the four counties where the 27 *Cx. tarsalis* were collected in 1997. In September, 2006 *Culex coronator* was found in 6 different sites in the Albany area, and in October it was also found in Muscogee County, northwest of Albany, and in Lowndes County, southeast of Albany. From Albany in Dougherty County to the four County Seats of the counties where *Cx. tarsalis* were collected by Smith and Floore (2001) the distances range from 15 to 29 miles. If those *Cx. tarsalis* specimens were actually *Cx. coronator*, this would significantly predate the time of the rapid northward and eastward expansion of *Cx. coronator* into northern Texas (Bolling et al. 2005), Louisiana (Debboun et al. 2005), Mississippi (Varnado et al. (2005), and Florida (Smith et al. 2006). Because the *Cx. tarsalis* collections predate the currently recognized introduction dates (Kelly et al. 2008) for *Cx. coronator* in Georgia, finding and identifying *Cx. coronator* in the 1997 collections in southern Georgia would not have been anticipated and *Cx. coronator* could have been overlooked very easily and mistakenly identified as *Cx. tarsalis*. **Pennsylvania.** Darsie and Hutchinson (2009) found one historical *Cx. tarsalis* record from this state based on a larva collected by C. G. Briet on September 2, 1970, in New Cumberland Army Depot, Cumberland County, which was reported in an article by Briet in 1970 (title unknown) in the United States Department of Agriculture, Agricultural Research Service, Cooperative Economic Insect Report Vol. 20, issue 42, p. 723. The identity of this specimen was confirmed by Dr. Alan Stone, at the Smithsonian. **South Carolina.** Carpenter (1945) and Carpenter and Chamberlain (1946) reported a single specimen from Sumter collected in 1943, and Weathersbee and Arnold (1947) reported two collections of this species in Sumter County in 1943 and Richland County in 1944. **Virginia.** Dyar (1928) reported a specimen collected on October 18, 1926 in Quantico, Prince William County. Seventy seven years later a second specimen of this species was collected in a light trap in Chesapeake, on November 5-6, 2003, and confirmed as *Cx. tarsalis* (Williams et al. 2004).

***Culiseta annulata***. This species is an accidental intruder from Europe. **Maryland**. Faran and Bailey (1980) collected a female of this species resting in an underground bunker in 1978 at Ft. McHenry, near Baltimore. The identity of the specimen was confirmed by Faran at the Smithsonian Institution. Schamberger (2009) included this species in the Maryland list of species, but called it "accidental (European)." We agree with this interpretation. In North America *Culiseta annulata* would be very distinct, with broad basal pale bands on hindtarsomeres 1-4, large dark spots on the wing, and preapical pale bands on the femora. Since additional specimens have not been collected in Maryland during the past 37 years we consider this an unsuccessful introduction. Accordingly, we have included *Cs. annulata* in the MAMCA and Maryland lists, but not in the keys.

***Culiseta impatiens***. Pagac et al. (1992) collected 56 specimens of this species during light trap collections in 1987-1988 set along the Big Patuxent River flood plain. The specimens were confirmed at the Smithsonian Institution, and represent the furthest south records for *Cs. impatiens* along the eastern U. S. seaboard.

***Culiseta melanura***. Mosquito control personnel that rely on this species as an indicator of potential eastern equine encephalomyelitis activity in their area should be aware that the primary character in Darsie and Ward (1981, 2005) and Darsie and Hutchinson (2009) for separating female *Cs. melanura* from other *Culiseta* species in the MAMCA Region is unreliable. These authors separated the females of this species on the basis of not having pale basal bands on the abdominal terga. Fortunately, Andreadis and Munstermann (1997) noted this problem and recorded and photographed females of *Cs. melanura* with pale basal bands on the abdomen. When present these bands do not appear bright white, but cloudy and opaque. These last authors found up to 20% of females from certain collection sites in Connecticut with these bands, but noted the banded specimens did not occur regularly each year. Within certain populations bands occurred when bands did not occur in other populations that usually produced females with bands. They found no evidence that banding was due to genetic or biochemical traits, and concluded the bands must be environmentally induced, and noted that banded females occurred only during the early part of the mosquito season (June to early August). In our studies, the senior author (1967 unpublished data) collected and identified females of *Cs. melanura* with opaque abdominal bands in March-June in the Pocomoke Cypress Swamp of southeastern Maryland, and periodically small numbers of females with opaque basal bands have been found during the March-June period in eastern North Carolina since 1993. As previously noted (Andreadis and Munstermann 1997), these bands seem to be restricted to adults that eclose (= emerge) from overwintering larvae and pupae during the spring and early summer months. Specimens that emerge during the hot summer and fall months lack pale basal bands on the abdomen.

***Culiseta minnesotae***. **Maryland.** Schamberger (2009) listed the collection site for this species record as "location unknown" and the abundance was listed as "accidental." However, Bickley et al. (1971) provided the following information "Rare." This species was first collected in a light trap 14 September 1967 at Grasonville, Queen Anne's County (Berry and Joseph)." Also, they provided "This species was also taken in a light trap in Chesapeake City, Cecil County 2 July 1969 and 25 July 1969, J. Myers and G. J. Tompkins (Maryland Cumulative Environmental Impact Report 19(41):781 and 19(48):854)."

***Mansonia dyari***. This species has only been recorded from two of the MAMCA states, i.e., Georgia and South Carolina. **Georgia**. Miles and Rings (1945) recorded a single female (as *Ma. indubitans* Dyar and Shannon), collected in July 1945 from Fort [as Camp] Stewart, Hinesville, Liberty County. In the same year Pratt (1945) was the first to report *Ma. indubitans* in the United States (in Florida). *Mansonia indubitans* was the name used for this species in the U. S. until 1970. Belkin et al. (1970) determined that *Ma. indubitans* was restricted to South America, and the species found in the Caribbean, Central America, and the United States that looked like *Ma. indubitans* was actually a new species, which they described and named *Mansonia dyari*. The identification of the specimen from Liberty County is suspect as its collection and identification occurred before the presence or absence of a row of spiniform setae on the posterior margin of abdominal tergum VII was recognized and published (Carpenter et al. 1946). This is an excellent diagnostic character as spiniform setae are present on *Ma. titillans* and absent on *Ma. dyari.* Before this character was discovered, identifiers used the length of the palpi and the pale scales on the proboscis to distinguish *Ma. titillans* from what was called *Ma. indubitans* at that time. These last two characters are now considered variable and unreliable for separating females of *Ma. titillans* from *Ma. dyari*. Carpenter et al. (1946) first emphasized the use of the tergum VII character, and Pratt (1945, 1953) emphasized a tergum VIII character for separating females of these two species and both characters remain diagnostic to the present. **South Carolina**. Darsie and Hager (1993) reported a single female of *Ma. dyari* collected in Beaufort County in 1992. Those authors identified the specimen as *Ma. dyari*, because spiniform setae were not present on tergum VII.

***Mansonia titillans***. Like *Ma. dyari*, this species has only been recorded from two MAMCA states, i.e., Georgia and South Carolina. **Georgia**. Prior to 2001, there were no published records (including Darsie and Ward 2005) of this species in Georgia. Smith and Floore (2001) conducted a four week surveillance trip across the southern third of Georgia in June and July of 1997. This survey consisted of light trap collections in 20 counties. They collected *Ma. titillans* in Ben Hill, Calhoun, Charlton, Tift, and Worth counties. Moulis et al. (2015) found this species at four different sites in Chatham County, three south of Savannah and one north of Savannah, and considered it an established resident species in Chatham County. **South Carolina**. Elizabeth Hager collected a single female of *Ma. titillans* in Beaufort County in 1995, and the identification was confirmed by Darsie. However, since this record was not published, Goddard and Harrison (2005) received permission from Darsie and Hager, and published the record. Burkett-Cadena (2013) has the most accurate map for the distribution of this species in the southeastern states.

***Orthopodomyia alba***. All of the MAMCA states now have records for this species. Although, the record for West Virginia was published by Heaps (1980) it was not included in Darsie and Ward (1981) or the list of mosquitoes from West Virginia that was published by Joy et al. (1994). The record was based on a male and female reared in 1979 from larvae collected from a red maple tree hole, 8.2 m above the ground, in the West Virginia University Forest, Coopers Rock State Park, Monongalia County.

***Psorophora horrida***. **North Carolina**. Prior to the early 1990s most mosquito control personnel in North Carolina that found a specimen of *Psorophora* with hindtarsomeres 4 and 5 entirely white would call that specimen *Ps. ferox*. Thus, *Ps. horrida* was considered rare and had been confirmed from only five counties. Harrison and Whitt (1996) found six characters that are very useful in separating the females of these two species, and Harrison et al. (2008) conducted a search for new diagnostic characters and prepared a key that will separate the females of all U.S. species in subgenus *Janthinosoma* of *Psorophora*. Now *Ps. horrida* has been identified in NC in many more counties and is frequently present in large eclosions of *Ps. ferox*, but in much lower numbers than the latter species. Our observations agree with those of Buren (1946), who found that the immature stages of *Ps. horrida* and *Ps. mathesoni* (see below) utilize forested river and creek bottoms that flood periodically with large amounts of debris floating on the surface, even in slowly moving water, while the immature stages of *Ps. ferox* are normally found in transient rain pools with still water in shaded forests.

***Psorophora mathesoni***. This species was previously identified in the U.S. as *Ps. varipes* (Coquillett) until Belkin and Heinemann (1975) determined that *Ps. varipes* does not occur in the U.S. and they described a new species, *Ps. mathesoni*, for U.S. specimens previously called *Ps. varipes*. Harrison and Whitt (1996), while addressing *Ps. horrida*, also found characters that will clearly identify the females of *Ps. mathesoni* and *Ps. horrida*, and Harrison et al. (2008) examined additional specimens that confirmed those characters. Finding habitats that contain immature stages of *Ps. mathesoni* is very difficult since the rate of growth of the immature stages is very rapid (4-6 days) and adult eclosion is simultaneous.

***Wyeomyia mitchellii***. **Georgia**. Darsie and Ward (1981) misinterpreted the collection records from which they established a record of this species in Georgia and (Harrison 2009) deleted that record. However, see **Note 2** after the keys for the possibility that this species may be introduced into Georgia in tank bromeliads in the future.

## III. MOSQUITO TAXA RECOGNIZED IN THE MID-ATLANTIC REGION

**Genus *Aedes* Meigen, 1818**

**Subgenus *Aedes*, 1818**

*cinereus* Meigen, 1818

**Subgenus *Aedimorphus*, Theobald, 1903**

*vexans* (Meigen, 1830)

**Subgenus *Georgecraigius*, Reinert, Harbach, and Kitching, 2006**

a*tropalpus* (Coquillett, 1902)

**Subgenus *Hulecoeteomyia*, Theobald, 1904**

*japonicus japonicus* (Theobald, 1901)

**Subgenus *Ochlerotatus* Lynch Arribázaga, 1891**

*abserratus* (Felt and Young, 1904)
*atlanticus* Dyar and Knab, 1906
*aurifer* (Coquillett, 1903)
*canadensis canadensis* (Theobald, 1901)
*canadensis mathesoni* Middlekauff, 1944
*cantator* (Coquillett, 1903)
*communis* (De Geer, 1776)
*decticus* Howard, Dyar, and Knab, 1917
*diantaeus* Howard, Dyar, and Knab, 1912 (1913)
*dorsalis* (Meigen, 1830)
*dupreei* (Coquillett, 1904)
*excrucians* (Walker, 1856)
*fitchii* (Felt and Young, 1904)
*fulvus pallens* Ross, 1943
*grossbecki* Dyar and Knab, 1906
*infirmatus* Dyar and Knab, 1906
*intrudens* Dyar, 1919
*mitchellae* (Dyar, 1905)
*punctor* (Kirby, 1837)
*sollicitans* (Walker, 1856)
*sticticus* (Meigen, 1838)
*stimulans* (Walker, 1848)
*taeniorhynchus* (Wiedemann, 1821)
*thibaulti* Dyar and Knab, 1909 (1910)

*tormentor* Dyar and Knab, 1906
*trivittatus* (Coquillett, 1902)

**Subgenus *Protomacleaya*, Theobald, 1907**

*hendersoni* Cockerell, 1918
*triseriatus* (Say, 1823)

**Subgenus *Rusticoidus*, Shevchenko and Prudkina, 1973**

*provocans* (Walker, 1848)

**Subgenus *Stegomyia* Theobald, 1901**

*aegypti* (Linnaeus, 1762)
*albopictus* (Skuse, 1894 [1895])

**Genus *Anopheles* Meigen, 1818**

**Subgenus *Anopheles* Meigen, 1818**

*atropos* Dyar and Knab, 1906
*barberi* Coquillett, 1903
*bradleyi* King, 1939
*crucians* A (provisional species of Wilkerson et al. (2004)
*crucians* B (provisional species of Wilkerson et al. (2004)
*crucians* C (provisional species of Wilkerson et al. (2004)
*crucians* D (provisional species of Wilkerson et al. (2004)
*crucians* E (provisional species of Wilkerson et al. (2004)
*diluvialis* Reinert, 1997
*earlei* Vargas, 1943
*georgianus* King, 1939
*inundatus* Reinert, 1997
*maverlius* Reinert, 1997
*perplexens* Ludlow, 1907
*punctipennis* (Say, 1823)
*quadrimaculatus* Say, 1824
*smaragdinus* Reinert, 1997
*walkeri* Theobald, 1901

**Genus *Coquillettidia* Dyar, 1905**

**Subgenus *Coquillettidia* Dyar, 1905**

*perturbans* (Walker, 1856)

**Genus *Culex* Linnaeus, 1758**

**Subgenus *Culex* Linnaeus, 1758**

*coronator* Dyar and Knab, 1906
*nigripalpus* Theobald, 1901
*pipiens* Linnaeus, 1758
*quinquefasciatus* Say, 1823
*pipiens* X *quinquefasciatus* hybrids

*restuans* Theobald, 1901
*salinarius* Coquillett, 1904
*tarsalis* Coquillett, 1896

**Subgenus *Melanoconion* Theobald, 1903**

*erraticus* (Dyar and Knab, 1906)
*peccator* Dyar and Knab, 1909
*pilosus* (Dyar and Knab, 1906)

**Subgenus *Neoculex* Dyar, 1905**

*territans* Walker, 1856

**Genus *Culiseta* Felt, 1904**

**Subgenus *Climacura* Howard, Dyar, and Knab, 1915**

*melanura* (Coquillett, 1902)

**Subgenus *Culicella* Felt, 1904**

*minnesotae* Barr, 1957
*morsitans* (Theobald, 1901)

**Subgenus *Culiseta* Felt, 1904**

*annulata* (Shrank, 1776)
*impatiens* (Walker, 1848)
*inornata* (Williston, 1893)

**Genus *Mansonia* Blanchard, 1901**

**Subgenus *Mansonia* Blanchard, 1901**

*dyari* Belkin, Heinemann, and Page, 1970
*titillans* (Walker, 1848)

**Genus *Orthopodomyia* Theobald, 1904**

*alba* Baker, 1936
*signifera* (Coquillett, 1896)

**Genus *Psorophora* Robineau-Desvoidy, 1827**

**Subgenus *Grabhamia* Theobald, 1903**

*columbiae* (Dyar and Knab, 1906)
*discolor* (Coquillett, 1903)

**Subgenus *Janthinosoma* Lynch Arribálzaga, 1891**

*cyanescens* (Coquillett, 1902)
*ferox* (von Humboldt, 1819)
*horrida* (Dyar and Knab, 1908)
*mathesoni* Belkin and Heinemann, 1975

**Subgenus *Psorophora* Robineau-Desvoidy, 1827**

*ciliata* (Fabricius, 1794)
*howardii* Coquillett, 1901

**Genus *Toxorhynchites* Theobald, 1901**

**Subgenus *Lynchiella* Lahille, 1904**

*rutilus rutilus* (Coquillett, 1896)
*rutilus septentrionalis* (Dyar and Knab, 1906)

**Genus *Uranotaenia* Lynch Arribálzaga, 1891**

**Subgenus *Uranotaenia* Lynch Arribálzaga, 1891**

*lowii* Theobald, 1901
*sapphirina* (Osten Sacken, 1868)

**Genus *Wyeomyia* Theobald, 1901**

**Subgenus *Wyeomyia* Theobald, 1901**

*smithii* (Coquillett, 1901)

## IV. BASIC MORPHOLOGY OF MOSQUITOES

The external morphology of adult female and larval mosquitoes is not as simple as one might think. The most important part of identifying mosquitoes is locating the correct structure on the specimens. Hence, studying and learning the morphology of mosquitoes is essential. It is also very important that repeated identification efforts are attempted as this is another essential part of learning mosquito identification.

While examining the morphological characters for identifying mosquitoes, your dissection microscope should possess a magnification level of at least 75-80x magnification. Many programs try to save money by buying low powered microscopes, but this is a mistake. The species-level characters on adults and larvae require higher levels of magnification than found on 40-45x microscopes. There are reasonably priced microscopes with quality optical resolution that are available and provide 50-55x magnification with 10x ocular lenses. These scopes can reach 75-80x magnification if the ocular lenses are changed to 15x magnification. Adding 1.5-2.0x magnification auxillary lenses at the bottom of the scope tube is not a good idea as this dramatically reduces the visible work space for manipulating specimens under the scope. This is particularly true when identifying larvae in spot-well depression plates in 80% ethyl alcohol.

On adults most of the exoskeleton is hardened and subject to changes in the presence or absence of setae, scales, pigmentation, and slightly different structural shapes, i.e., lengths and widths, depending on the genus or even the species. On larvae the exoskeleton is mostly membranous and often with scattered hardened plates and up to 222 different paired setae that are numbered for use in taxonomic studies and have specific sites on the body. Although true scales are not present on larvae, the other structures are subject to changes just like those that occur on adults. Most structures or characters used in the keys are provided on the morphology illustrations (Figures i-xiv). Other structures or characters used in the keys may not be labeled on those figures or on the individual illustrations used to separate the genera and species in the keys, but are probably provided in the glossary. The individual 585 illustrations in between the key couplets have been simplified by removing extraneous structures such as setae and scales that are not important for the identification of the species in that couplet. In most couplets, the characters necessary to identify the species are pointed out by arrows on the illustrations.

Proceed through the keys slowly and check the characters in top to bottom sequence, because the top (first) character is usually the best character. The characters used in the included keys have been checked on thousands of specimens of the species in the MAMCA Region and have been found reliable for separating those species at the highest possible level of authenticity, provided the characters are retained and used only in the sequence provided in these keys. Not following the key and trying to find differentiating characters on your own is usually unsuccessful and a waste of your time and efforts.

Since adult mosquitoes have bilateral symmetry, the legs, wings, and sides of the thorax are paired, thus if one side is rubbed or damaged, and a character is missing, that character should be examined on the other side. While the head, top of the thorax (scutum), and abdomen may not appear paired nearly all of the structures that occur on them are paired relevant to a longitudinal midline through the structure. The proboscis appears to be a single structure, but in reality the internal mouth parts hidden within the outer covering (labium) are paired. Although paired appendages are limited to the antennae and anal papillae on larvae the other structures (setae, plates, siphon, ventral brush) are bi-lateral or have bi-lateral characters based on a longitudinal midline starting on the head, extending posteriorly through the thorax, abdomen, siphon or spiracular apparatus, and ending with the anal papillae.

The general appearance (habitus) and other morphological characters on mosquitoes are not static and differences within a given species can often be seen among adults from one egg batch or brood. Differences also occur over time. The recognition that mosquitoes are variable organisms is essential in making correct decisions about identifications, because variations within most species are more common than generally recognized. Most keys using single character couplets generally ignore variations and thus, are less reliable. Key characters for a given species may be less variable on one species and highly variable on another species. These variations are genetic in origin and may develop in response to latitudinal or environmental pressures such as temperatures or xeric versus hygric climates. Just because a structure is paired does not mean that both will look identical. There are published examples of one wing being typical and the other wing missing certain veins or portions of veins, or of banding differences on two legs of a pair. Rare mosquito specimens can possess albinic or melanic characters and may not be identified using published keys. Other rare specimens are gynadromorphs, and express both male and female characters. These individuals can be divided into bi-polar gynanders or bi-lateral gynanders. Bi-polar means the anterior half of the body expresses one sex and the posterior half of the body expresses the other sex, while bi-lateral means the left side of the body is one sex and the right side the other sex. These facts make more thorough specimen examinations necessary during the identification process.

There are numerous large, median, to very small characters used and illustrated in these keys, hence the reason for a high magnification dissection microscope. For most species 2-4 characters are needed to achieve the most accurate identification. Those characters can be categorized into basic groups, each containing multiple morphological expressions.

**Major Morphological Characters Used to Identify Adult Female Mosquitoes**.
(See examples of Adult Morphology on pages 25-27 or the Glossary beginning on page 149)

**Scales.** Differences may be expressed in shapes, sizes, colors, stature = erect or decumbent, and presence or absence on certain locations on structures.

**Setae**. Since these serve as sensory organs, they are variously distributed over many parts of the body. On adults they are almost always simple single setae (compare with larvae). Their differences are expressed in sizes, fixed locations, single, clusters or rows, and colors.

**Color Patterns.** May be due to pigmentation of the exoskeleton or color patterns in the scales, or less frequently setae. These may be expressed in stripes (lengthwise, curved, or transverse), bands (around), patches, spots, speckled, or solid colors.

**Length Ratios**. Typically expressed as comparisons of a character on two different structures, e.g., leg segment lengths, proboscis versus forefemur lengths, antennae versus palpi lengths.

**Major Morphological Characters Used to Identify Fourth Instar Larvae.**
(See examples of Larval Morphology on pages 84-85 or the Glossary beginning on page 149)

**Setae.** These normally occur in precise locations and are expressed in a multitude of shapes (blunt, pointed, palmate, and many different types of branching), sizes (stout, thin, long, short), and are located on nearly every structure on the larvae except the anal papillae.

**Pecten.** Occur, when present, as different shaped stout or thin spines in a basal row on the venter of the siphon, and often possess small basal denticles on the posterior border.

**Anal Papillae.** Almost always expressed as two pairs of pale, membranous, short, long, blunt, attenuated, or sharp pointed structures located on segment X. Occasionally they are swollen and sausage-like or with visible internal tracheae.

**Siphon.** Shape highly variable. These are expressed as thick, inflated, very thin, long, short, tubular (width equal along length), attenuated, curved, with or without subapical spines, straight, clear, pigmented, or banded.

**Spiracular Apparatus**. Only occurs on *Anopheles*. Differences are expressed as pigmentation, lengths of setae, and number, length, and arrangements of pecten spines on the pecten plate.

*Note, there are no true scales on larvae, but there can be flattened pointed structures in the comb that are typically called "comb scales."*

## V. USING A DICHOTOMOUS KEY

This book contains dichotomous keys with illustrations between the couplets that are used to identify the adult female or 4$^{th}$ instar larvae of mosquitoes. The dichotomous keys in this guide are a series of paired statements (i.e., "couplets") that allow the reader to accurately identify an unknown mosquito at genus and species levels. Both halves of a couplet must be read to determine which choice(s) may be correct. Using a key, the reader will examine the unknown specimen using a series of descriptive choices at each couplet. After selecting the correct choice, the reader is directed to another couplet and will continue this process until they arrive at a terminal couplet that will provide the correct identity (genus or species) for the mosquito. In this guide, we have attempted to avoid single character couplets, thus two or more characters have been found for most couplets that, in many cases, will assist in identifying rubbed or otherwise damaged specimens. The couplets containing multiple characters are presented in a manner where the most valid characters have a ranked priority. In other words, the first character presented in a couplet-half will be more valid than later characters in that couplet-half.

## VI. DISTINGUISHING FEMALE FROM MALE MOSQUITOES

Before using the generic key to the adult females (page 28) the sex of the adults must be determined. The following table provides two useful characteristics that, in the absence of gynandromorphic specimens, will always distinguish the two sexes.

| Sex | Distinguishing Characteristics |
|---|---|
| **Females** | Tip of abdomen rounded or pointed, without obvious external sexual structures, except short or long cerci; Antennae with sparse short whorl setae |
| **Males** | Tip of abdomen ends in the male external genitalia, including clasping structures used during mating; Antennae almost always with many long whorl setae which provide a bushy appearance (except for *Wy. smithii*). |

Although commonly used to separate the females of certain genera, the differences in palpi lengths are not useful for distinguishing males and females of all mosquito species. Males of at least four species in the MAMCA region have short palpi identical to those on the respective females. Because of this ambiguity we use the two above characters to accurately separate the sexes.

## VII. THE ADULT KEYS

# ADULT MORPHOLOGY

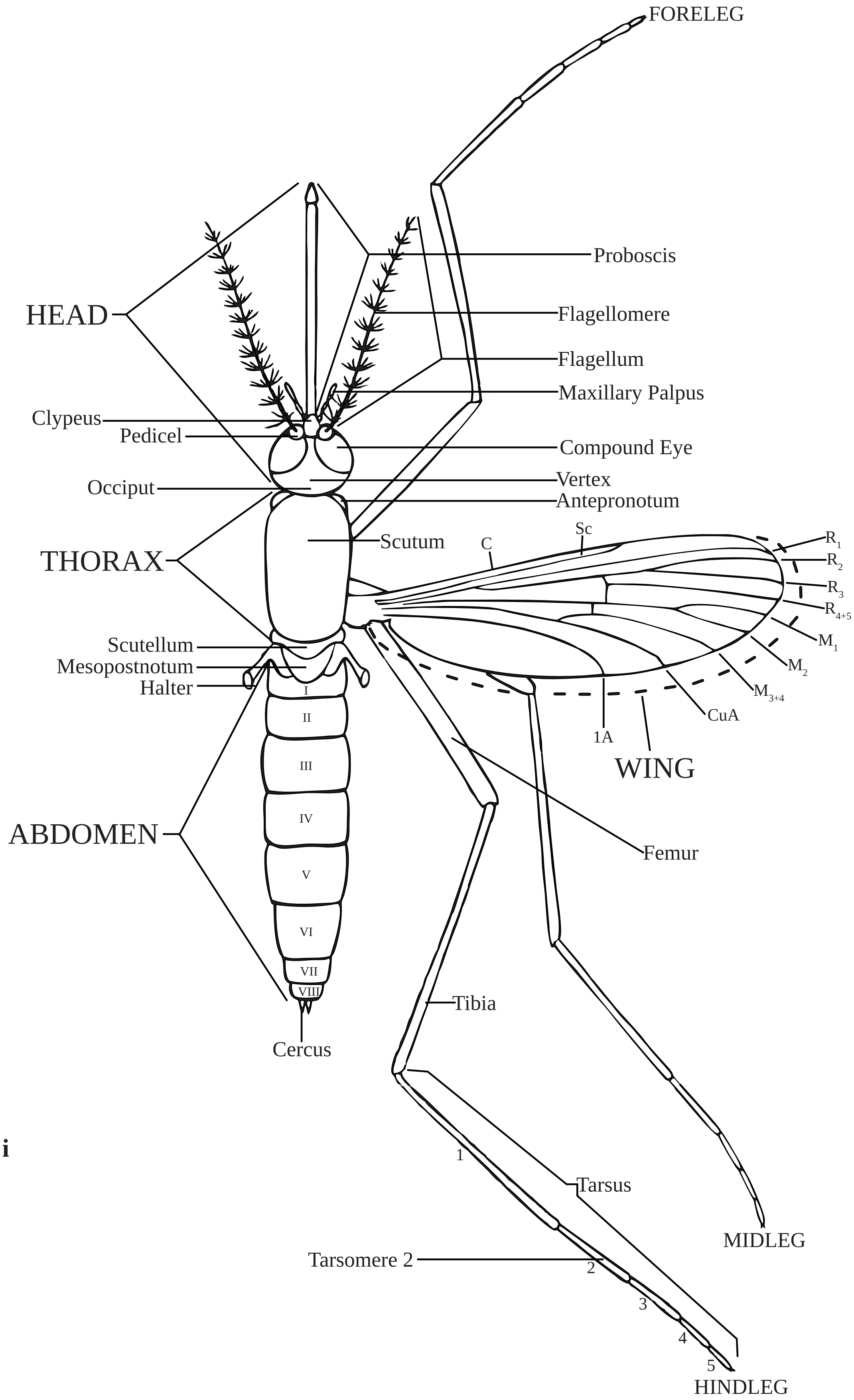



**Figure i**

## Wing - Dorsal View

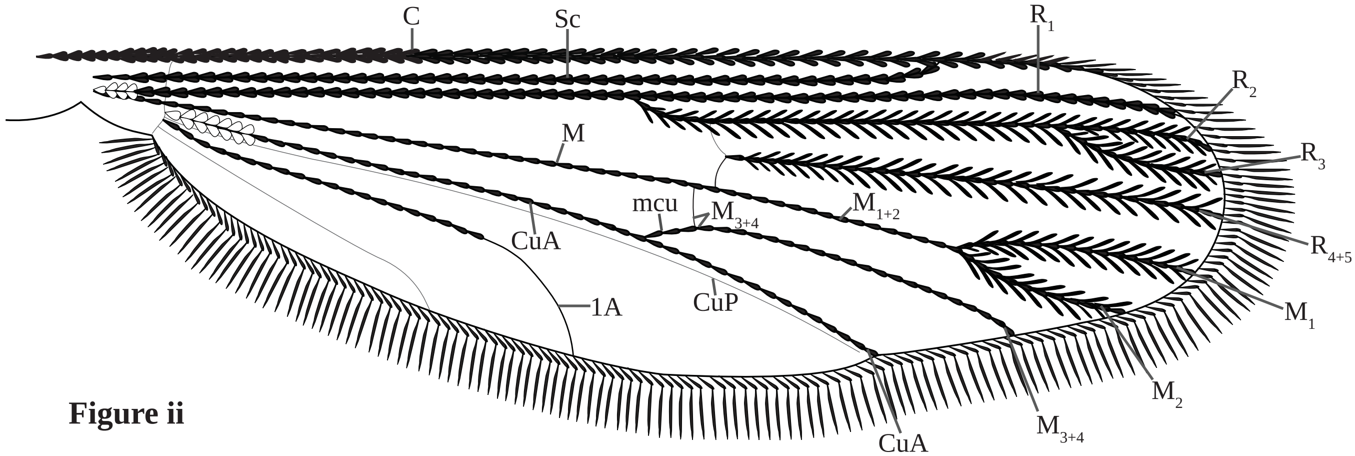
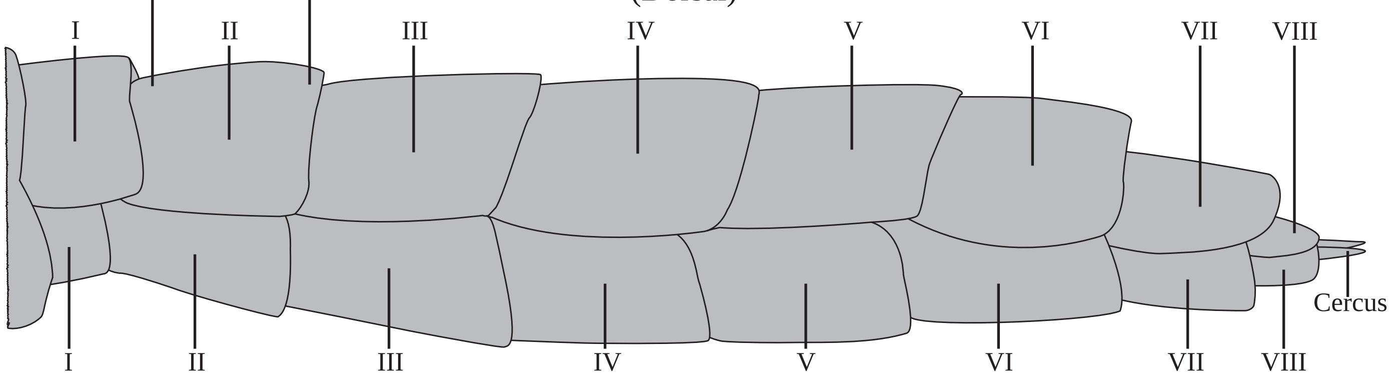



**Figure ii**

| | | | | | |
|---|---|---|---|---|---|
| 1A | - anal vein | $M_2$ | - media two | $R_{4+5}$ | - radius four plus five |
| C | - costa | $M_{3+4}$ | - media three plus four | Sc | - Subcosta |
| CuA | - cubitus anterior | mcu | - mediocubital crossvein | | |
| CuP | - cubitus posterior | $R_1$ | - radius one | | |
| M | - media | $R_2$ | - radius two | | |
| $M_1$ | - media one | $R_{2+3}$ | - radius two plus three | | |
| $M_{1+2}$ | - median one plus two | $R_3$ | - radius three | | |

## Abdominal Terga (I-VII)

(Dorsal)




## Abdominal Sterna (I-VIII)

(Ventral)

**Figure iii**

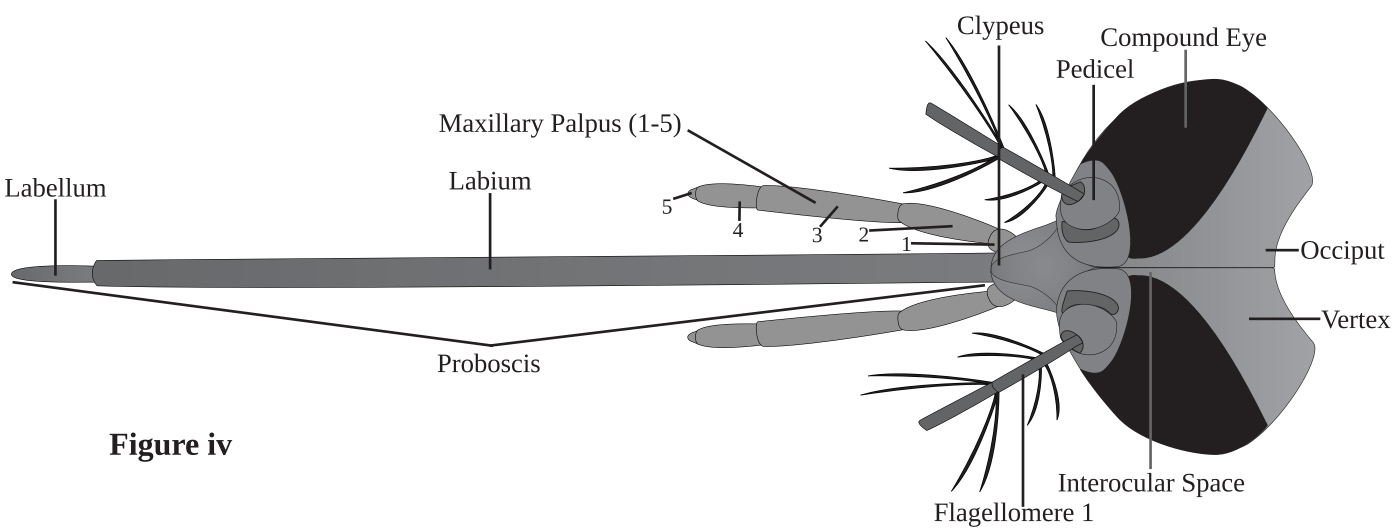



**Figure iv**

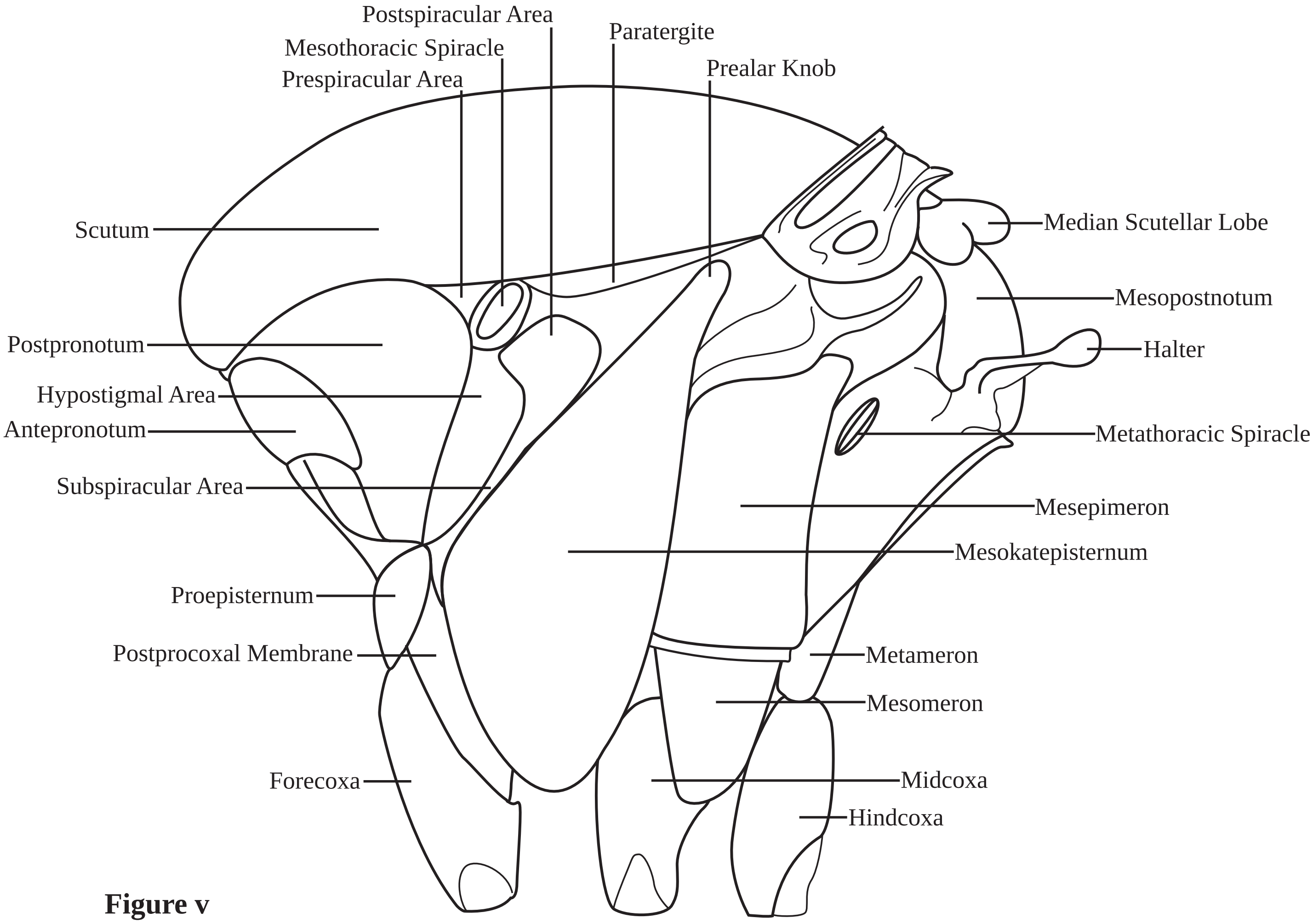



**Figure v**

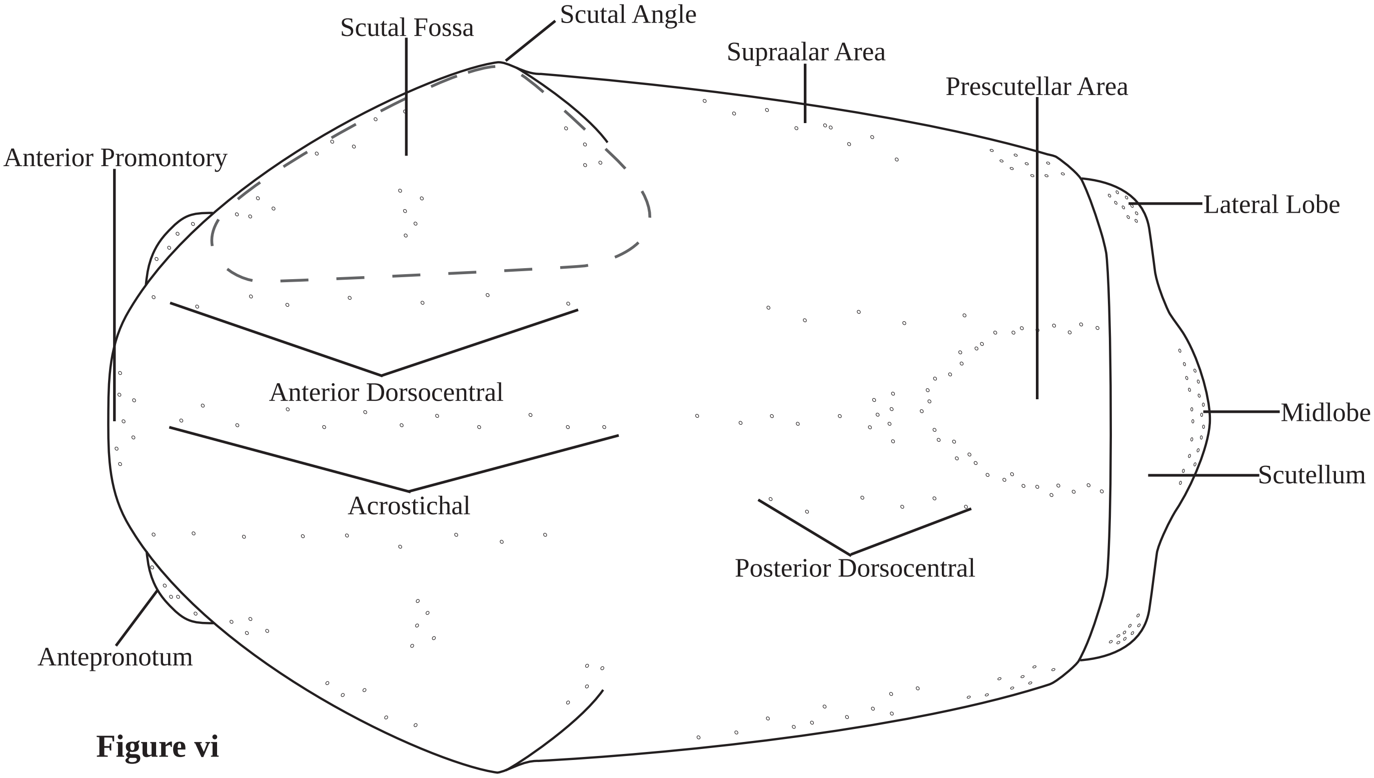



**Figure vi**

# Key to the Female Genera

1. Palpus longer than antennae (Fig. 1); scutellum evenly rounded, with continuous row of posterior setae (Fig. 2). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

   Palpus much shorter than antennae (Fig. 3); scutellum with 3 distinct lobes, long setae confined to the 3 lobes (Fig. 4). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

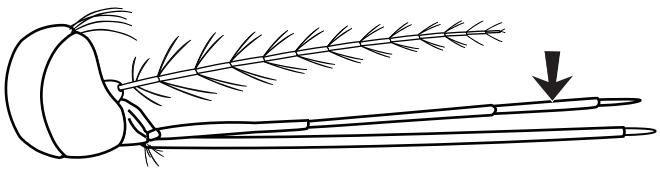


Fig. 1

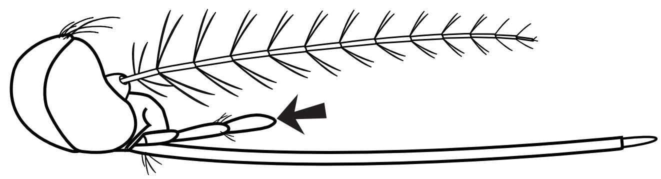


Fig. 3

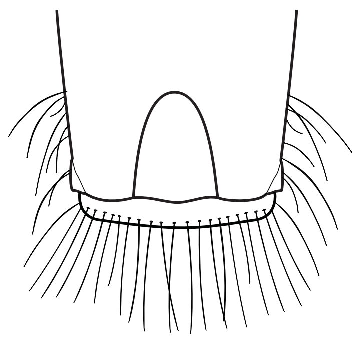


Fig. 2

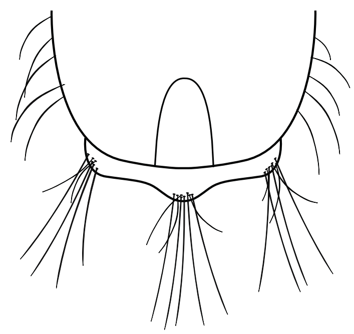


Fig. 4

2(1). Proboscis strongly bent downward, much thicker at base than at apex (Fig. 5); palpus approximately 0.5-0.6 length of proboscis (Fig. 5). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Toxorhynchites rutilus rutilus***
***Toxorhynchites rutilus septentrionalis***
(See Note 1)

   Proboscis nearly straight, approximately as wide at apex as at base (Fig. 6); palpus approximately equal to length of proboscis (Fig. 6). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Anopheles* (p. 55)**

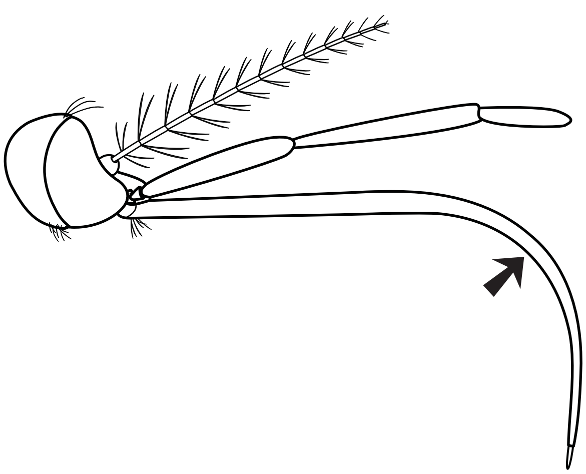


Fig. 5

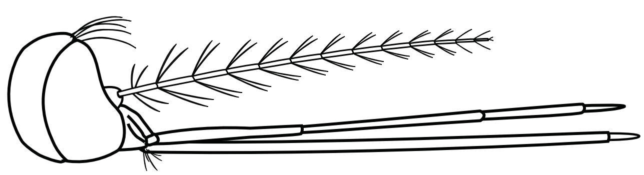


Fig. 6

3(1). Scutum and scutellum with setae and small scales, but integument clearly visible; mesopostnotum without setae or scales (Fig. 7). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

Scutum and scutellum covered with round flat scales; mesopostnotum with small patch of setae (Fig. 8); small species found in pitcher plants . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Wyeomyia smithii***
(See Note 2)

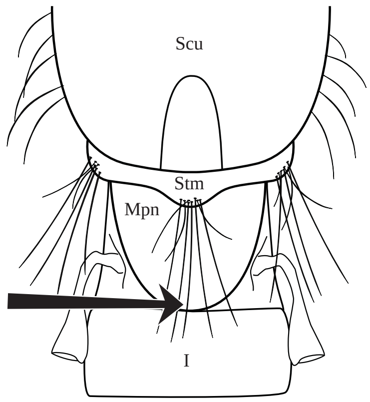


Fig. 7

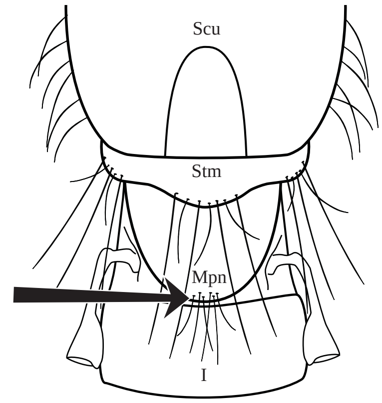


Fig. 8

4(3). Postspiracular setae present (Fig. 9). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5

Postspiracular setae absent (Fig. 10). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

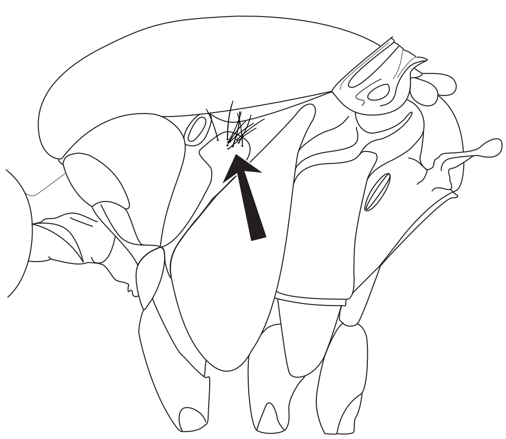


Fig. 9

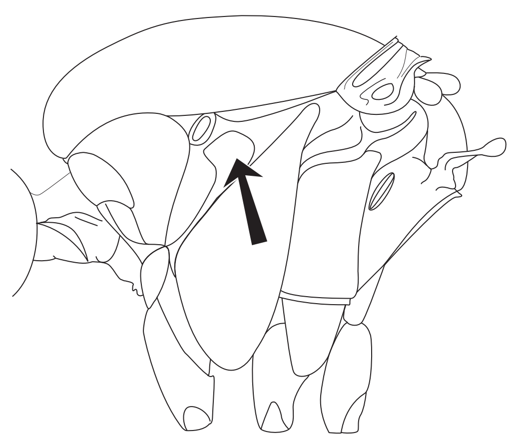


Fig. 10

5(4). Tip of abdomen blunt or rounded from dorsal view (Fig. 11); abdominal segment VII much wider than long (Fig. 11). . . . . . . . . . . . . . . . . . . . . .(Currently in GA and SC). . . . . . . . . . . . . . . . . . . . ***Mansonia* (p. 69)**

Tip of abdomen sharply pointed from dorsal view (Fig. 12); if appearing blunt, then abdominal segment VII will be narrower than long (Fig. 12). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6

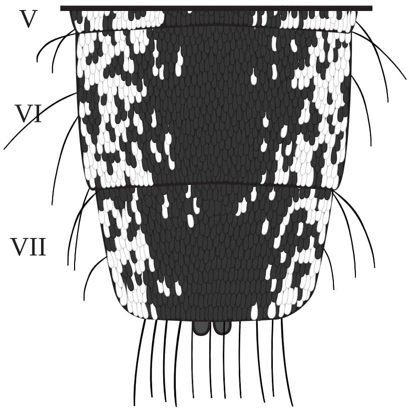



Fig. 11

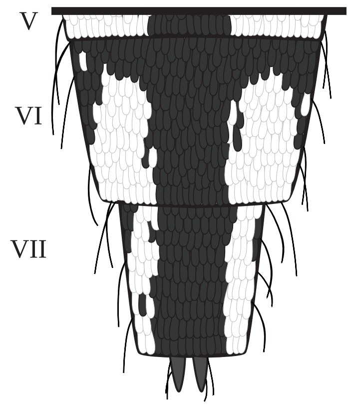



Fig. 12

6(5). Prespiracular setae present (Fig. 13); abdominal segments with apical pale bands or lateral patches (Fig. 14). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Psorophora* (p. 71)**

Prespiracular setae absent (Fig. 15); abdominal segments with basal pale bands and/or lateral patches (Fig. 16). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Aedes* (p. 33)**

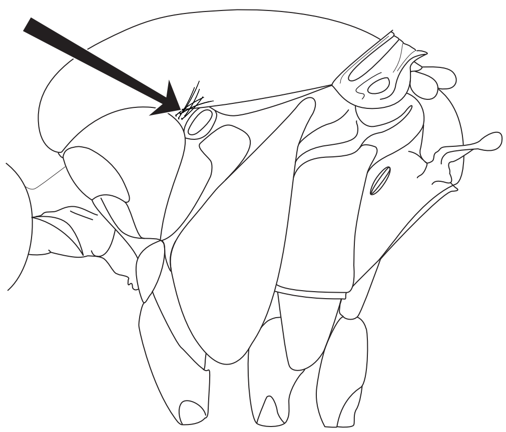


Fig. 13

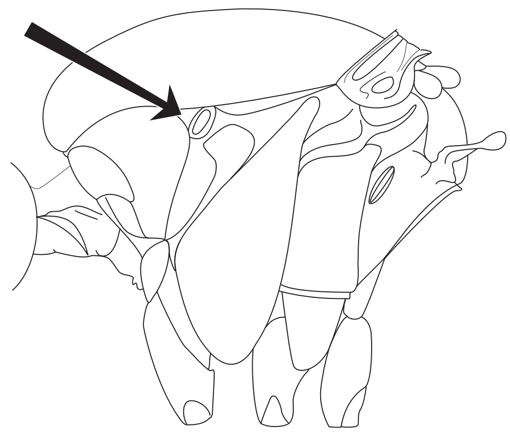


Fig. 15

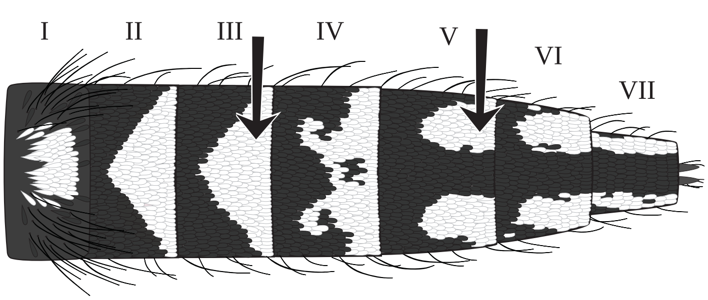



Fig. 14

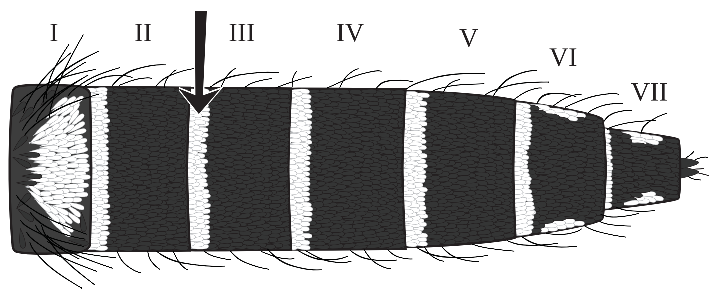



Fig. 16

7(4). Head, thorax, and wings with rows of metallic blue scales; wing with tip of vein 1A reaching wing margin before a perpendicular line drawn from front margin through vein CuA-mcu fork (Fig. 17); very small species . . . . .. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Uranotaenia* (p. 76)**
(See Note 3)

Head, thorax, and wings without rows of metallic blue scales; wing with tip of vein 1A reaching wing margin beyond a perpendicular line drawn through CuA-mcu fork (Fig. 18); . . . . . . . . . . . . . . . . . . . . 8

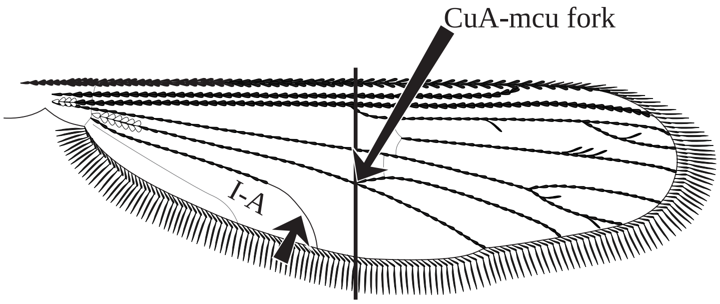



Fig. 17

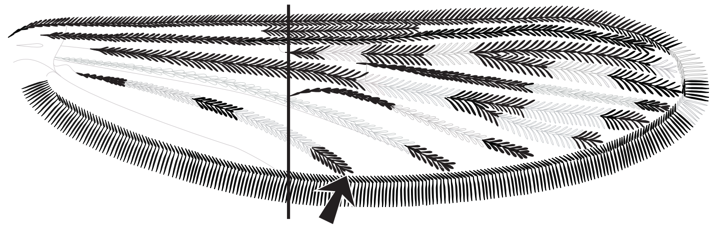


Fig. 18

8(7). Base of subcostal vein on underside of wing without small patch of setae (Fig. 19); prespiracular setae absent (Fig. 20). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

Base of subcostal vein on underside of wing with patch of short fine setae (Fig. 21); prespiracular setae present (Fig. 22) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Culiseta*** **(p. 66)**

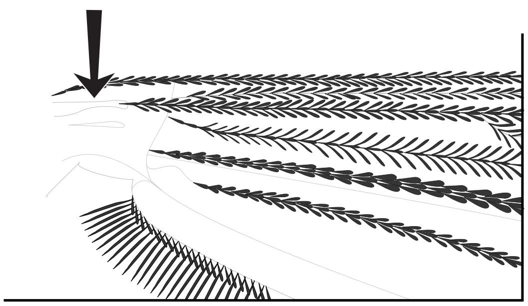


Fig. 19

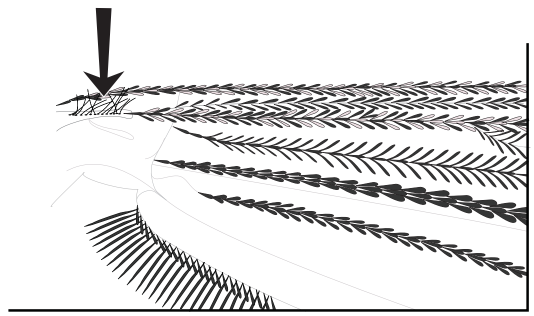


Fig. 21

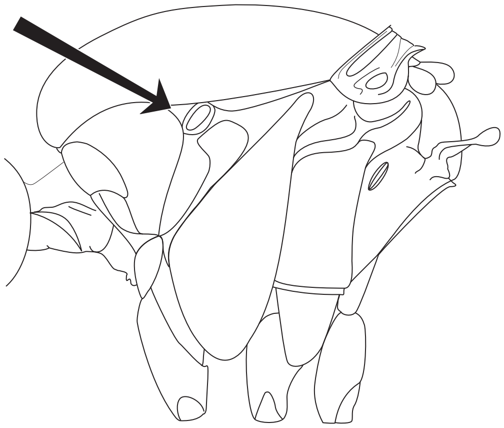


Fig. 20

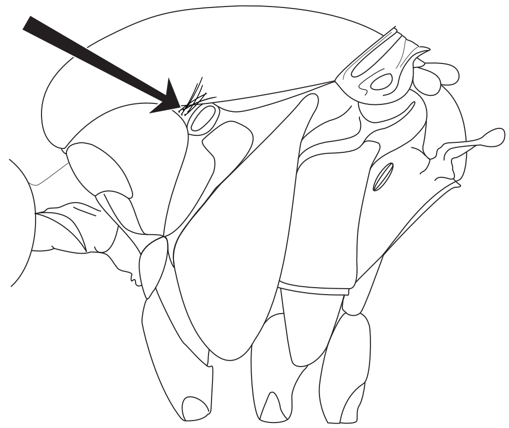


Fig. 22

9(8). Wing scales narrow and usually all dark (Fig. 23); hindtarsomeres entirely dark (except *Cx. tarsalis* & *Cx. coronator*). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Culex*** **(p. 61)**

Wing scales broad, pale and dark, in speckled pattern (Fig. 24), or wing with distinct white spots on some areas; hindtarsomeres with broad pale bands (Fig. 25). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

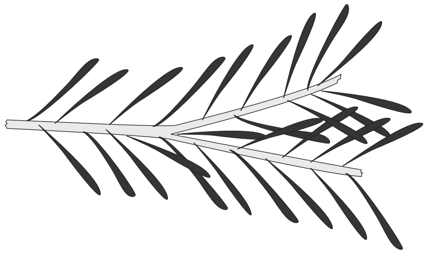


Fig. 23

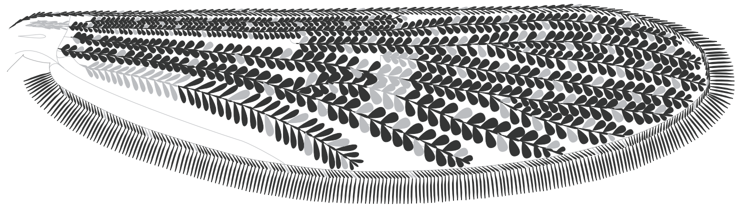


Fig. 24

Fig. 25

10(9). Scutum with mixed brown and yellow scales, not forming a distinct, well-defined pattern (Fig. 26); hindtibia with broad preapical pale band (Fig. 27); pale bands on hindtarsomeres basal except for median pale on hindtarsomere 1 (Fig. 27) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Coquillettidia perturbans***

Scutum black with distinct narrow longitudinal lines of white scales (Fig. 28); hindtibia speckled, without preapical pale band, but with apical pale band; pale bands on hindtarsomeres both basal and apical (Fig. 29). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Orthopodomyia* (p. 70)**

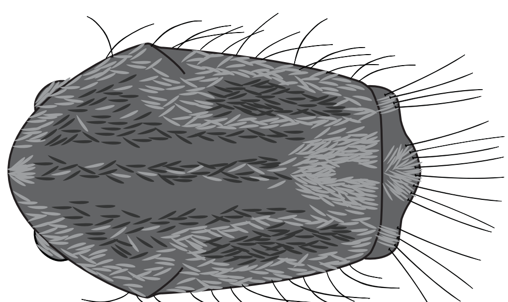


Fig. 26

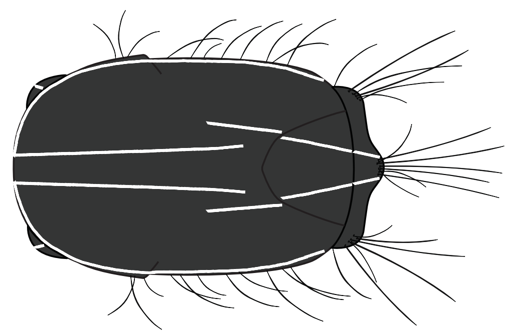


Fig. 28

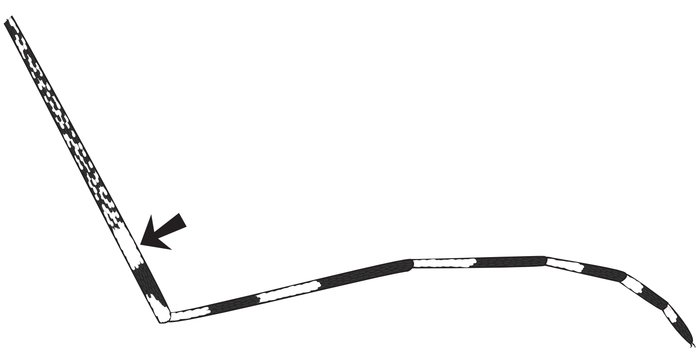


Fig. 27

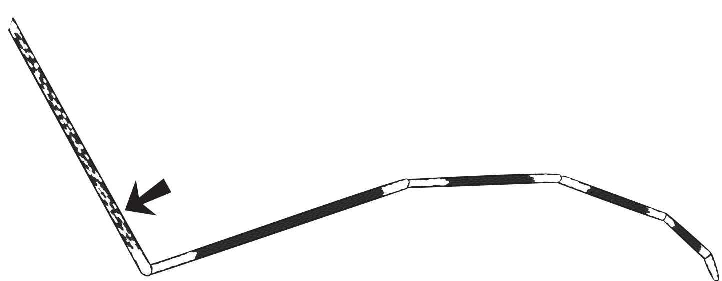


Fig. 29

# Key to Female *Aedes* (= *Ae.*)

1. Large golden-orange mosquito; with two large posterolateral black spots (Fig. 30). . . . ***Ae. fulvus pallens***

   Large to small species, variously ornamented but not golden-orange; scutum without large posterolateral black spots (Figs. 31, 32, 33) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

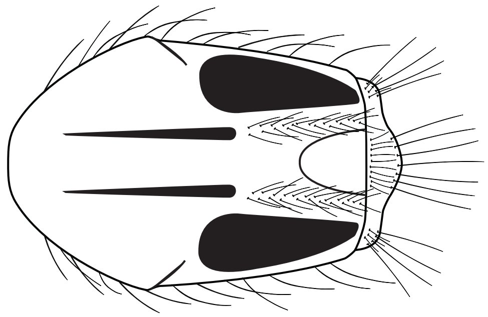


Fig. 30

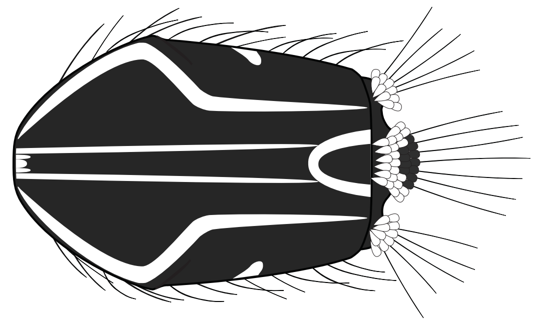


Fig. 32

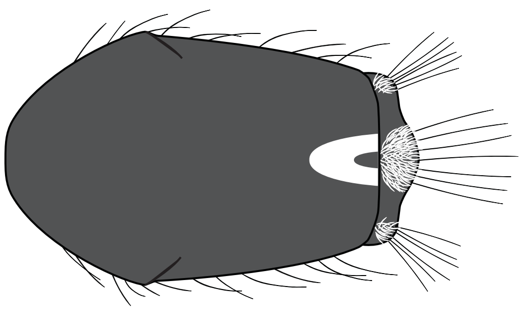


Fig. 31

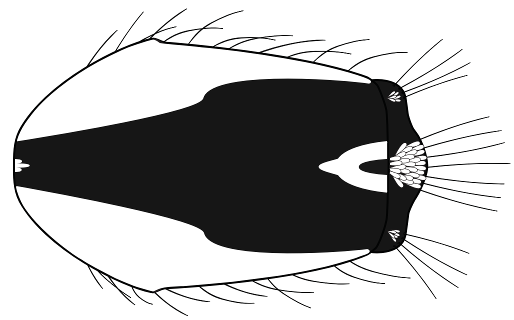


Fig. 33

2(1). Hindtarsi with basal pale or basal and apical pale bands (Fig. 34, 35). . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

   Hindtarsi without pale bands (Figs. 36). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 18

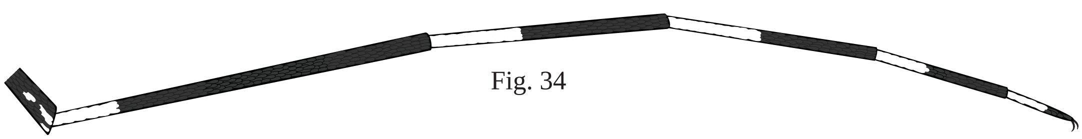


Fig. 34

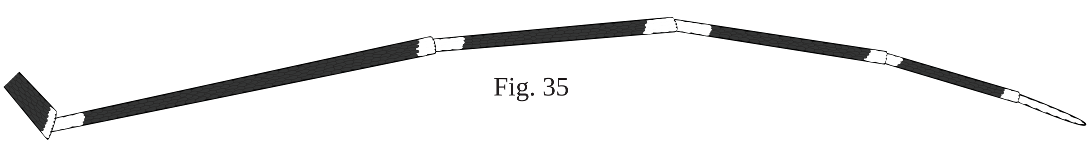


Fig. 35

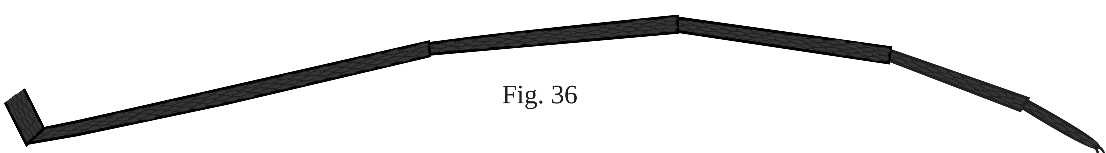


Fig. 36

3(2). Proboscis with distinct median pale band (Fig. 37). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .4

Proboscis either dark scaled, with scattered pale scales, or with ventral pale area, but no complete pale band (Figs. 38, 39). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

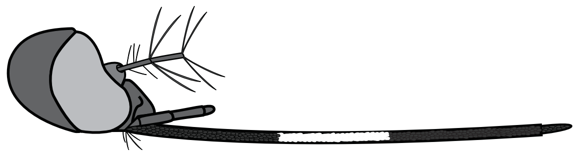


Fig. 37

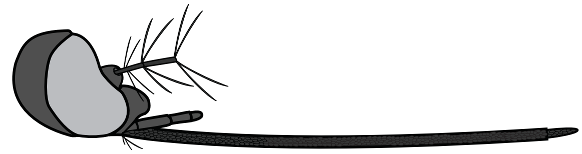


Fig. 38

Fig. 39

4(3). Wing speckled with dark and pale scales (Fig. 40); postprocoxal membrane with white scales (Fig. 41); hindtarsomere 1 with median pale band (Fig. 42). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. sollicitans***

Wing scales all dark (Fig. 43); postprocoxal membrane without scales (Fig. 44); hindtarsomere 1 without median pale band (Fig. 45). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .5

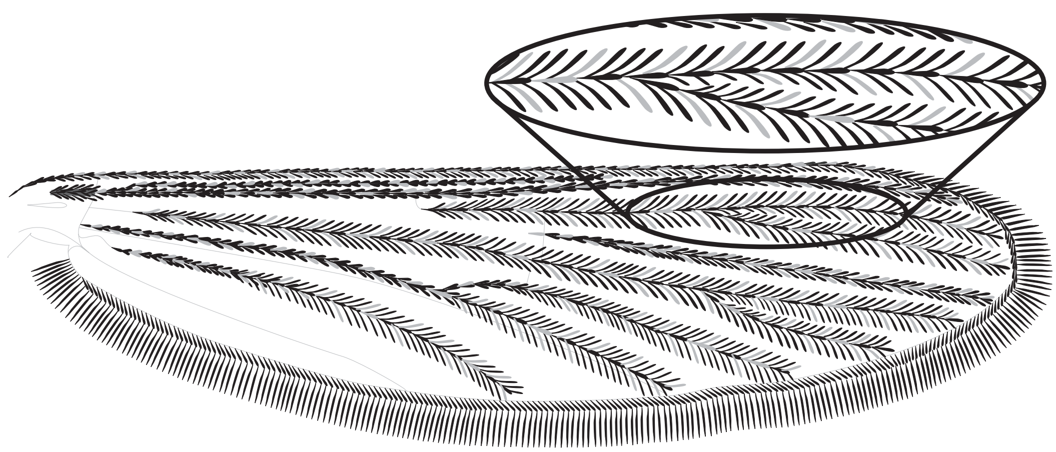


Fig. 40

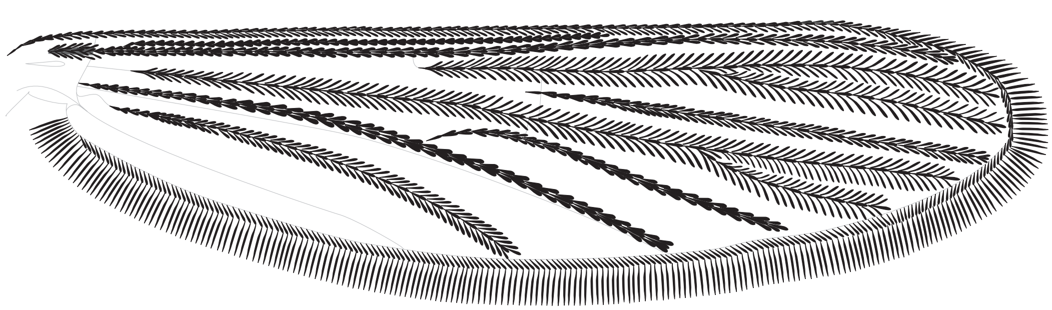


Fig. 43

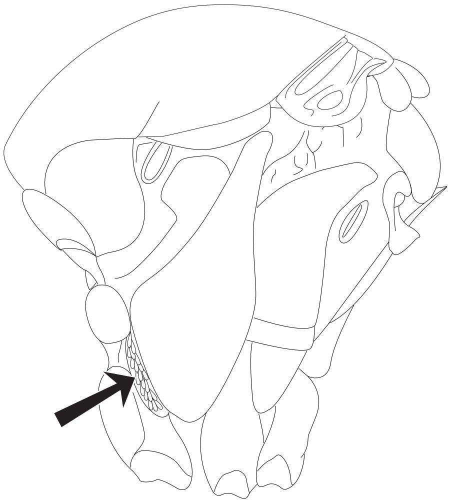


Fig. 41

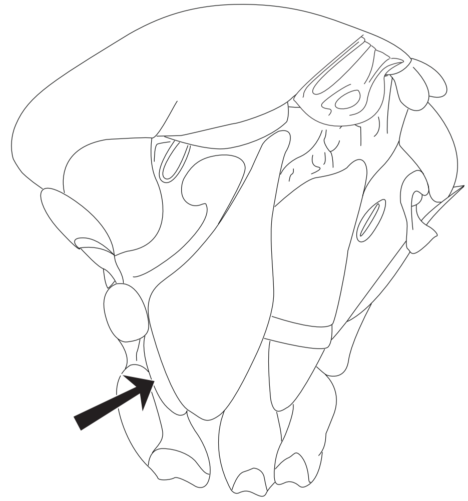


Fig. 44

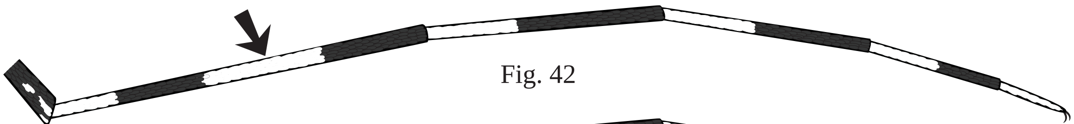


Fig. 42

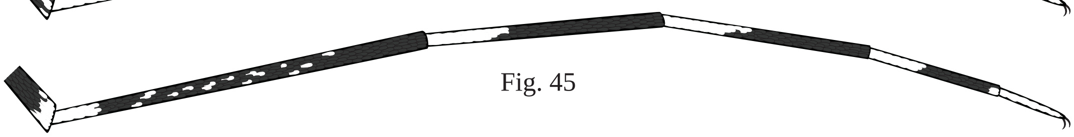


Fig. 45

5(4). Abdominal terga with narrow basal pale bands, and central pale spots or median-longitudinal pale stripe (Fig. 46); forefemur and tibia speckled with white scales (Fig. 47). . . . . . . . . . . . . . . . . . . . ***Ae. mitchellae***

Abdominal terga with basal pale bands, lacking central pale spots or median-longitudinal pale stripe (Fig. 48); forefemur and tibia black, not speckled with white scales (Fig. 49). . . . . . .***Ae. taeniorhynchus***
(See Note 4)

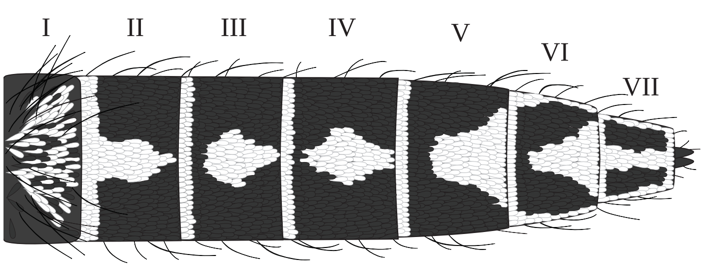



Fig. 46

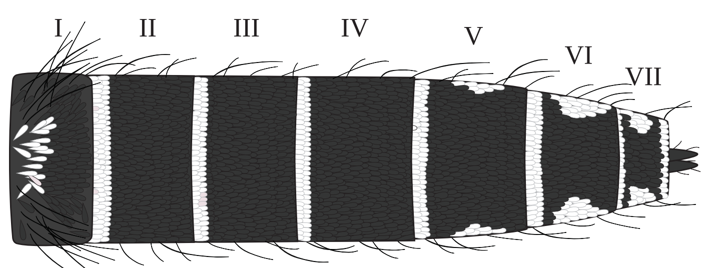



Fig. 48

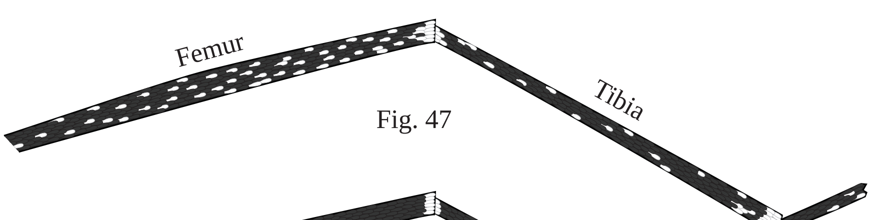



Fig. 47

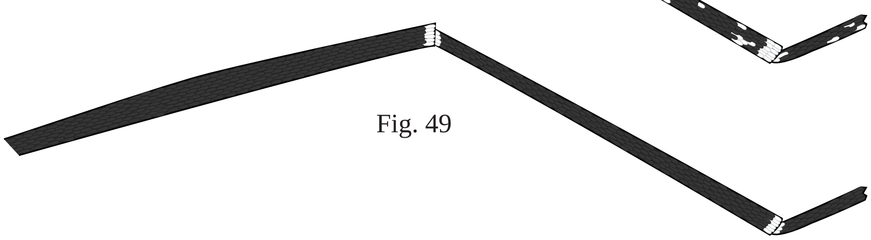


Fig. 49

6(3). Hindtarsomeres with basal and apical bands (i.e., bands crossing the joints) (Fig. 50). . . . . . . . . . . . . . . 7

Hindtarsomeres with only basal pale bands (Fig. 51). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

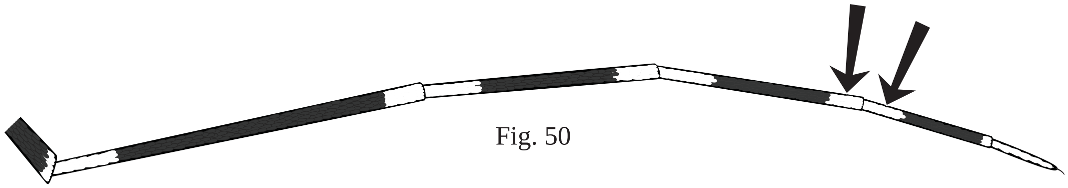


Fig. 50

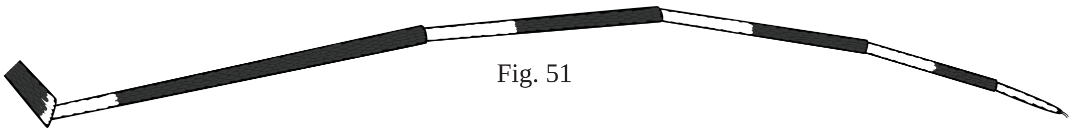


Fig. 51

7(6). Wing and abdomen nearly covered with white scales (Figs. 52, 53); wing with distinct white areas and speckled with black scales on other areas (Fig. 52); white hypostigmal and postprocoxal scales present (Fig. 54). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. dorsalis***

Wing and abdomen mostly dark scaled (Figs. 55, 56); hypostigmal and postprocoxal scales absent (Fig. 57). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8

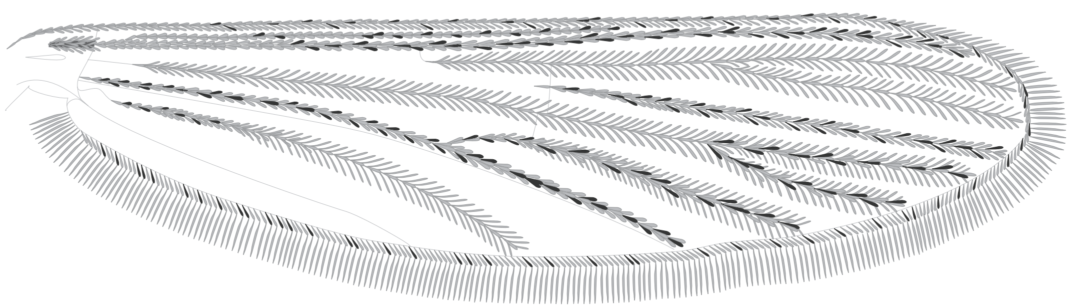


Fig. 52

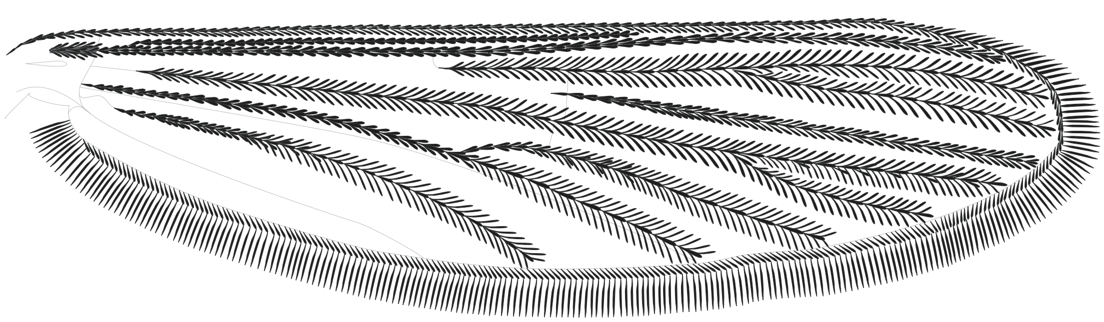


Fig. 55

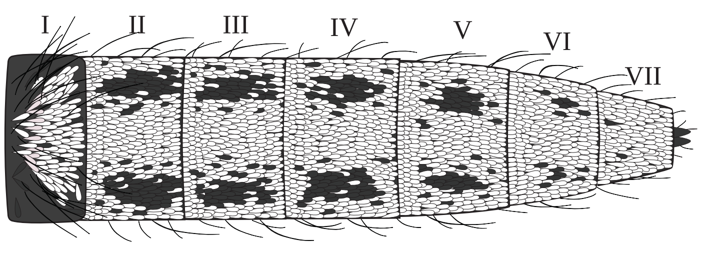



Fig. 53

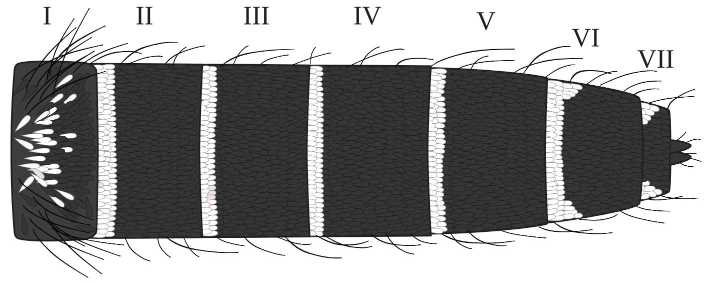



Fig. 56

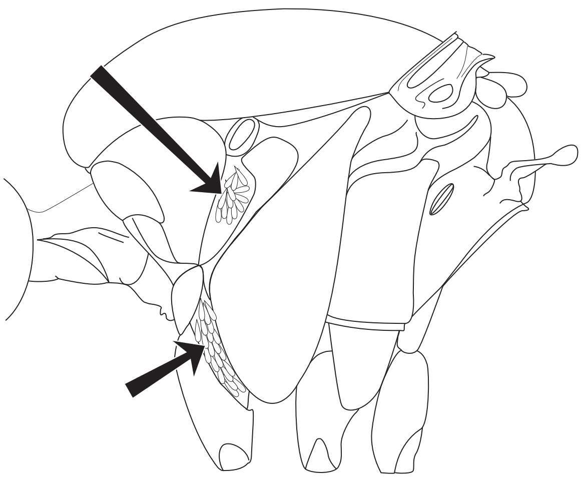


Fig. 54

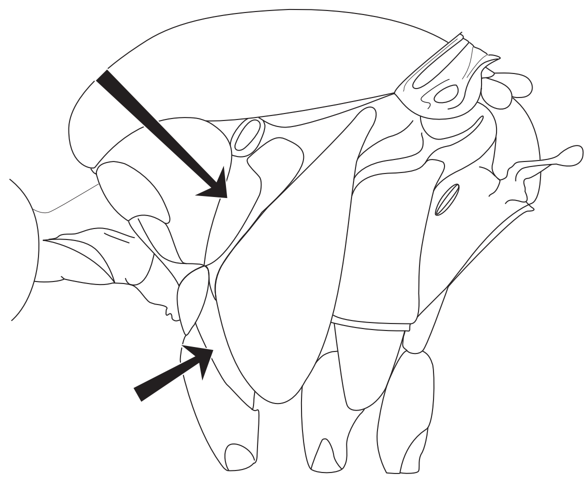


Fig. 57

8(7). Base of costa with small white patch (Fig. 58); scutum with median area of dark brown scales and large anterior lateral patches of pale scales (Fig. 59); palpus black scaled (Fig. 60). . . . . . . . . . . ***Ae. atropalpus***

Base of costa entirely dark (Fig. 61); scutum covered with brown scales (Fig. 62); palpus with scattered pale scales and white-scaled apex (Fig. 63). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .9

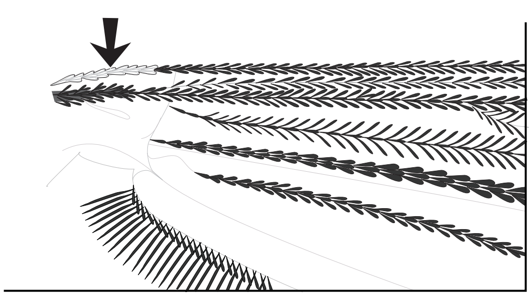


Fig. 58

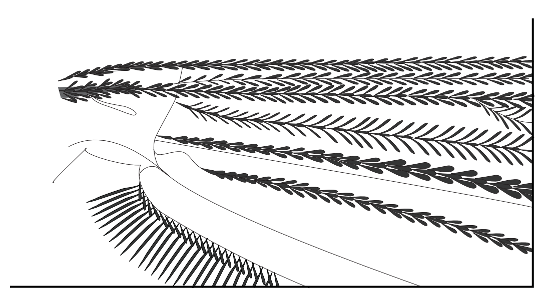


Fig. 61

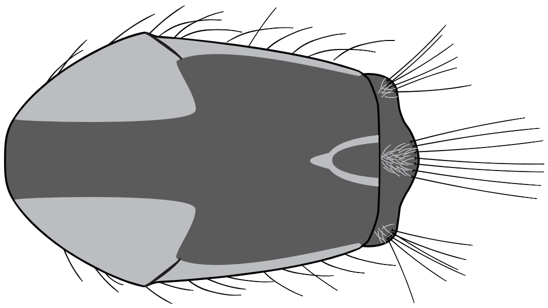


Fig. 59

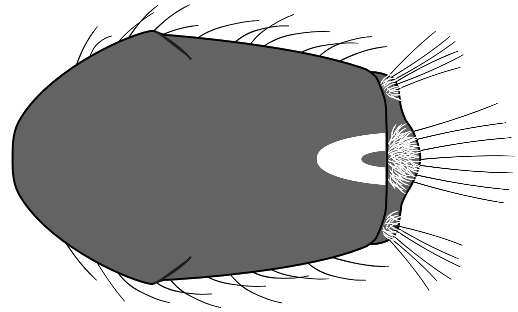


Fig. 62

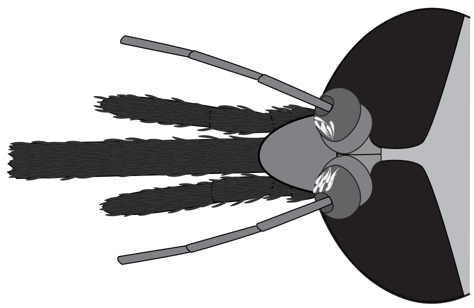


Fig. 60

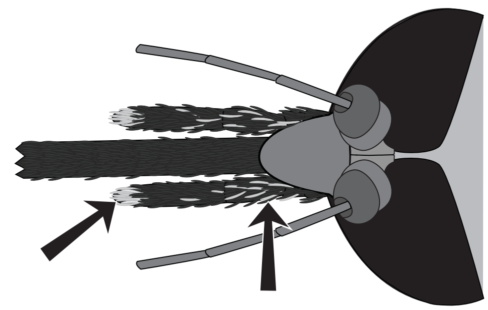


Fig. 63

9(8). Hindtarsomeres 1-4 with broad apical and basal bands (i.e., crossing the joints); hindtarsomere 5 entirely white (Fig. 64). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. c. canadensis***

Hindtarsomeres 1-2 with apical and basal pale bands; hindtarsomere 3 with narrow basal pale band and tip black; hindtarsomeres 4-5 entirely dark (Fig. 65). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. c. mathesoni***

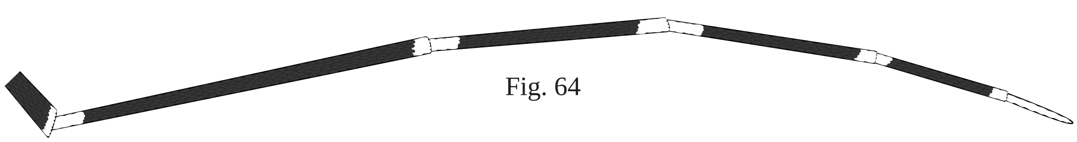


Fig. 64

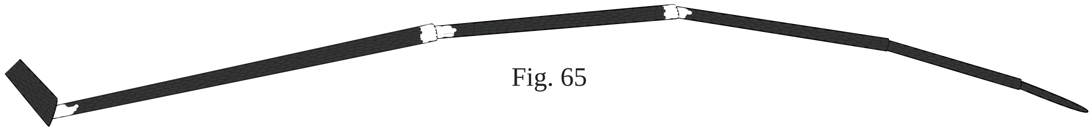


Fig. 65

10(6). Scutum with conspicuous silver or golden lyre-shaped stripes and submedian stripes or a single median longitudinal stripe (Fig. 66); or without lyre-shaped stripes, but with a single median longitudinal white stripe (Fig. 67); hindtarsomeres with broad basal pale bands on some tarsomeres (Fig. 68). . . . . . . . . . 11

Scutum colored otherwise, without lyre-shaped silver or gold stripes or a single narrow median longitudinal pale stripe (Figs. 69, 70); hindtarsomeres with narrow basal pale bands (Fig. 71). . . . . . . .13

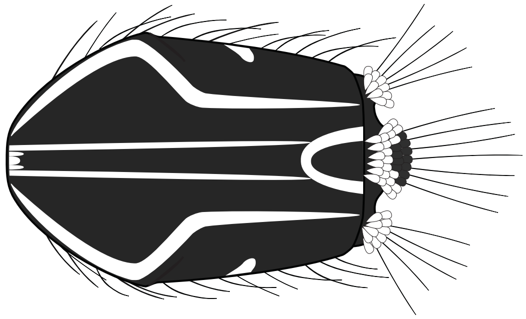


Fig. 66

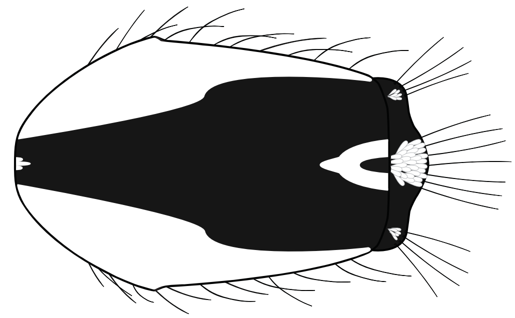


Fig. 69

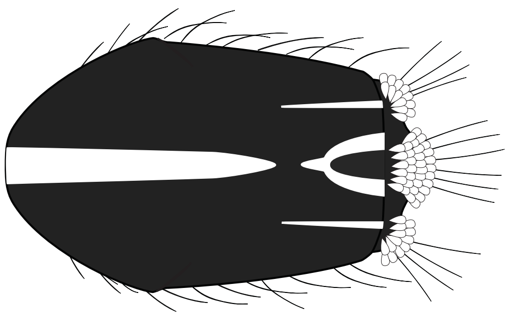


Fig. 67

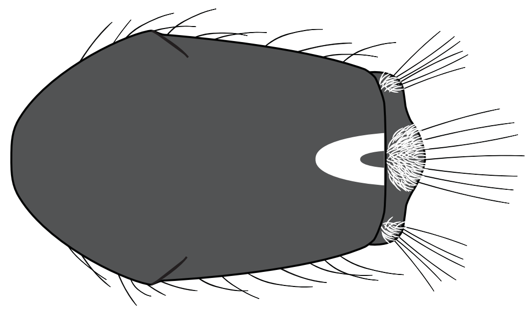


Fig. 70

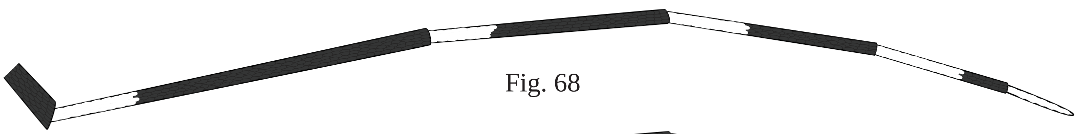


Fig. 68

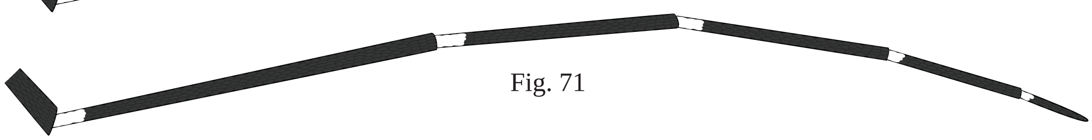


Fig. 71

11(10). Scutum with golden stripes, including a gold median longitudinal stripe (Fig. 72); scales on lobes of scutellum long and narrow (Fig. 72); palpus with black scales (Fig. 73); hindtarsomeres 1-3 with broad basal white bands, 4 black, rarely with small dorsobasal pale spot, 5 entirely black (Fig. 74). . . . . . . .***Ae. j. japonicus***

Scutum with white or silver stripes, with or without a median longitudinal stripe (Fig. 75); scales on lobes of scutellum short, broad, and silver (Fig. 75); palpus with white scales apically (Fig. 76); hindtarsomeres 1-4 with broad basal white bands, 5 entirely pale or pale dorsally (Fig. 77). . . . . . . . . . . . . . . . . . . . . . 12

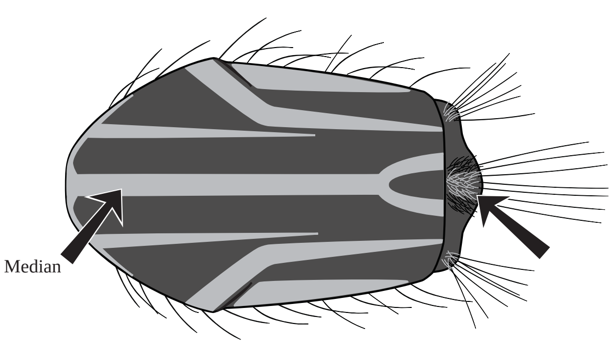



Fig. 72

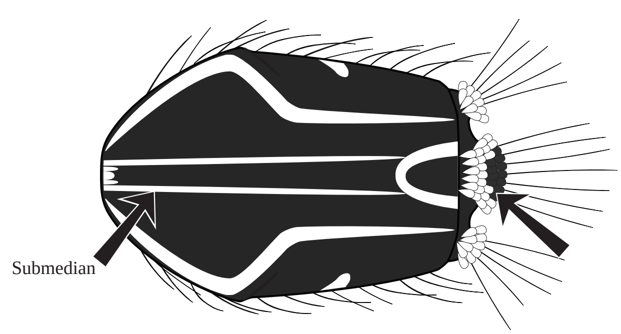



Fig. 75

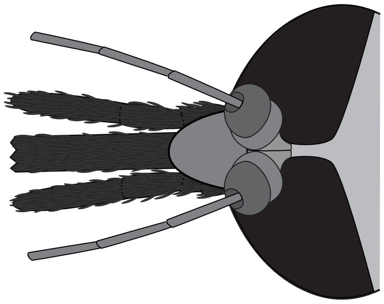


Fig. 73

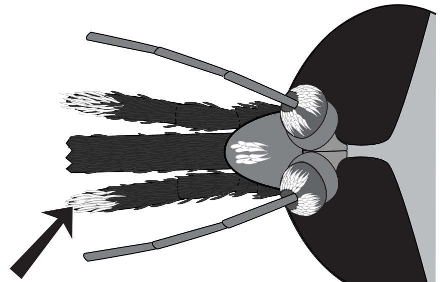


Fig. 76

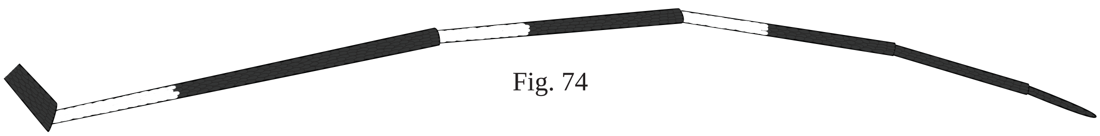


Fig. 74

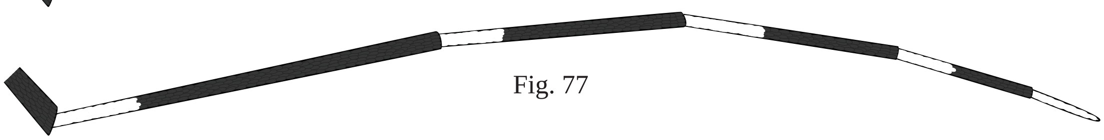


Fig. 77

12(11). Scutum with narrow white median longitudinal stripe (Fig. 78); clypeus without silver scales (Fig. 79); midfemur without anterior longitudinal white stripe (Fig. 80). . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. albopictus***

Scutum with lyre-shaped silver stripes and narrow submedian longitudinal white stripes (Fig. 81); clypeus with silver scales (Fig. 82); midfemur with anterior longitudinal white stripe (Fig. 83). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. aegypti***
(See Note 5)

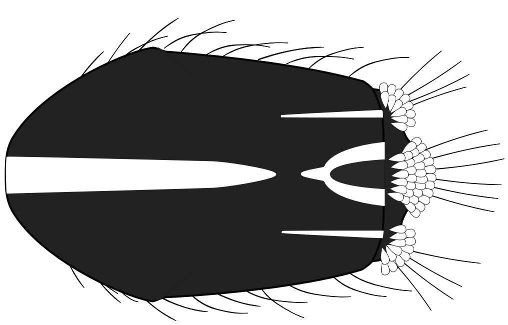


Fig. 78

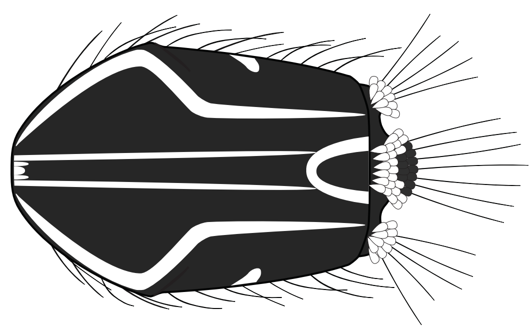


Fig. 81

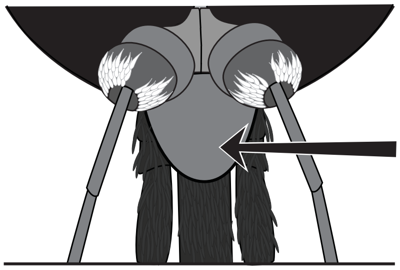


Fig. 79

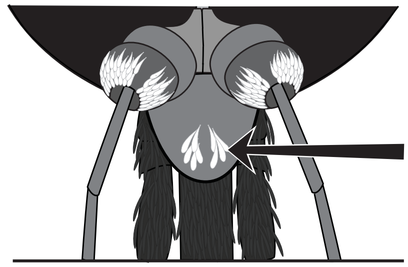


Fig. 82

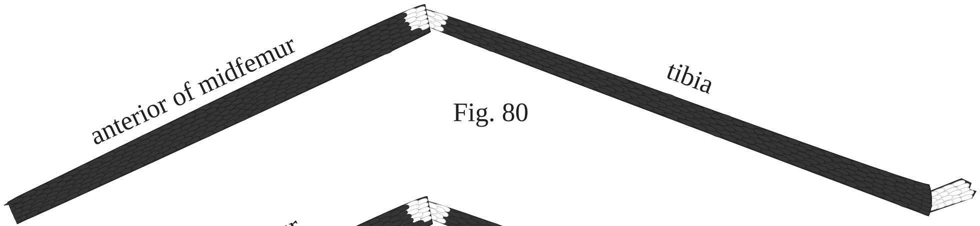


Fig. 80

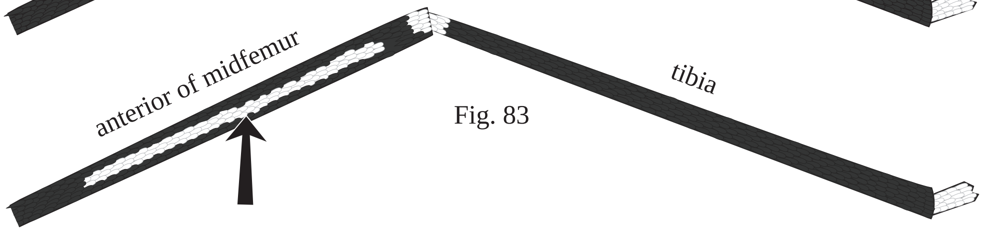


Fig. 83

13(10). Hindtarsomeres with narrow basal pale bands, band length rarely more than 2 times diameter of tarsomere (Fig. 84); scutum with uniform brown scales (Fig. 85) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 14

Hindtarsomeres with broad basal pale bands, band length at least 3 times diameter of tarsomere (Fig. 86); scutum with dark and pale scales or different shades of brown (Fig. 87) . . . . . . . . . . . . . . . . . . . . . . . . 15

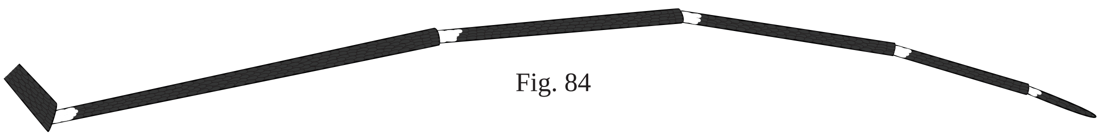


Fig. 84

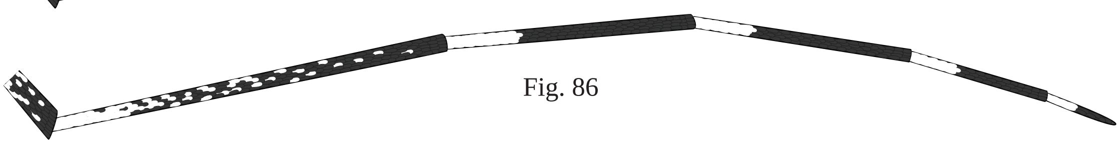


Fig. 86

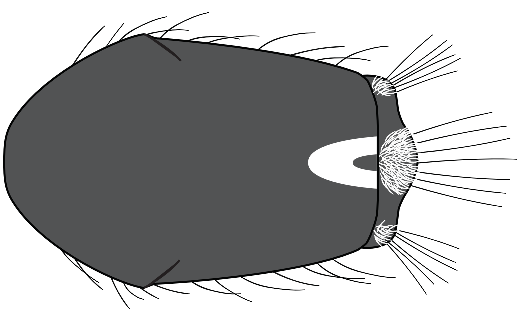


Fig. 85

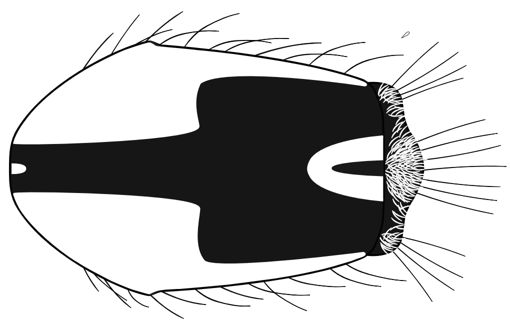


Fig. 87

14(13). Basal abdominal pale bands with median notch, dorsum of abdominal segments VI-VII mostly dark (Fig. 88); metameron without pale scales (Fig. 89). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. vexans***

Basal abdominal pale bands without median notch, dorsum of abdominal segments VI-VII entirely pale (Fig. 90); metameron with pale scales (Fig. 91). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. cantator***

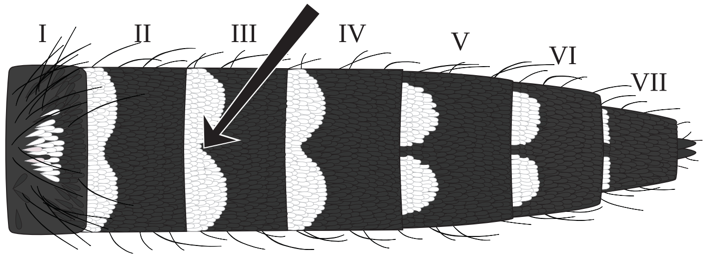


Fig. 88

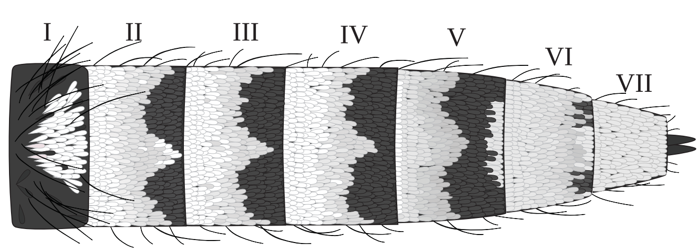


Fig. 90

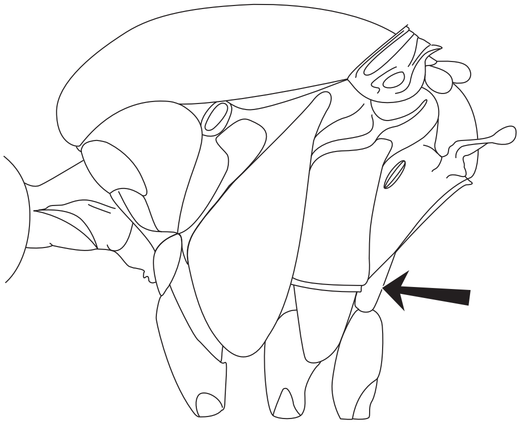


Fig. 89

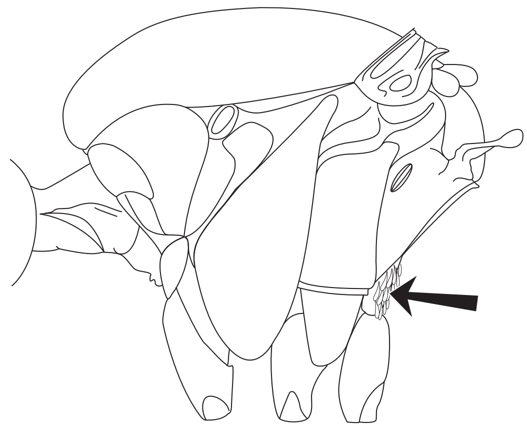


Fig. 91

15(13). Scutum with distinct dark brown median longitudinal area and prominent lateral white scales (Fig. 92); wing scales very broad, truncate, with mixed dark and pale scales (Fig. 93). . . . . . . . . . . . ***Ae. grossbecki***

Scutum mostly brown scaled, median area may be slightly darker, but without lateral white scales (Fig. 94): wing scales long, slender, mixed dark and pale with rounded tips (Fig. 95). .(northern species). . . 16

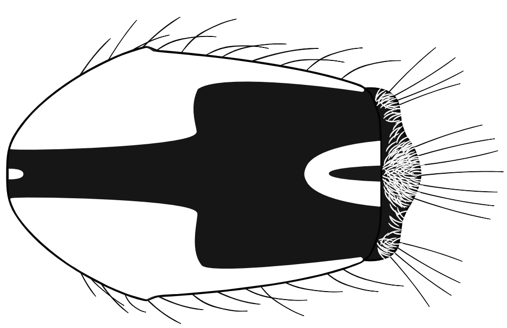


Fig. 92

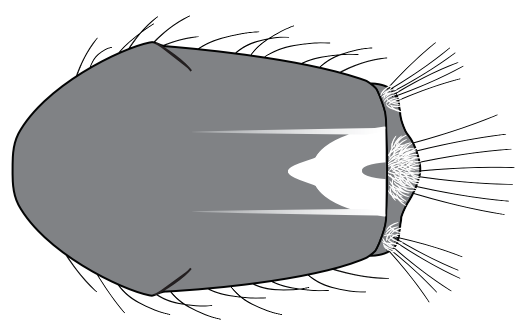


Fig. 94

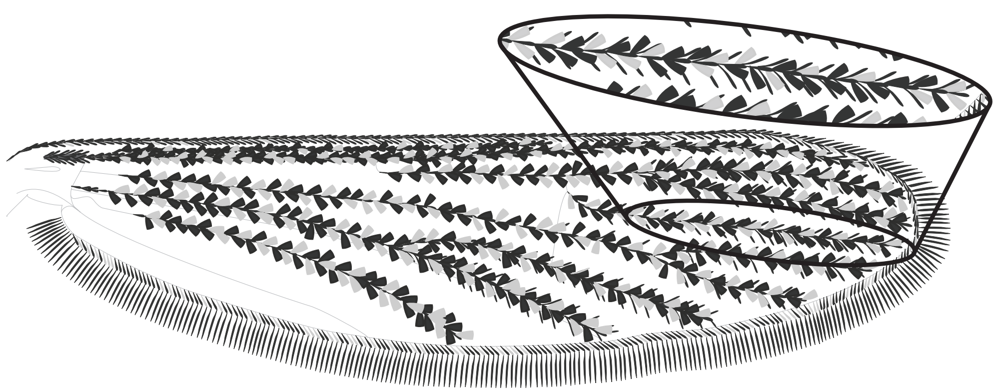


Fig. 93

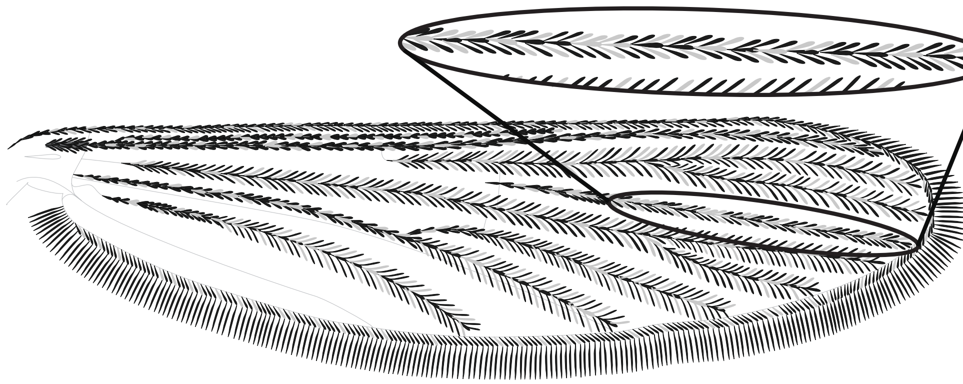


Fig. 95

16(15). Accessory tooth of foretarsus claw long, nearly parallel to long claw (Fig. 96); antennal pedicel nearly covered with white scales (Fig. 97). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. excrucians***

Short accessory tooth of foretarsus claw divergent from claw (Fig. 98); antennal pedicel with median patch of black or white scales (Fig. 99). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 17

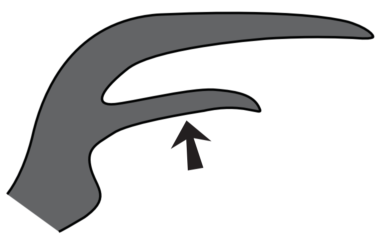


Fig. 96

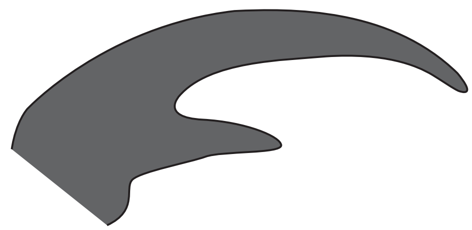


Fig. 98

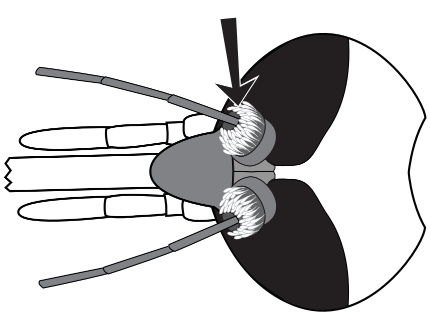


Fig. 97

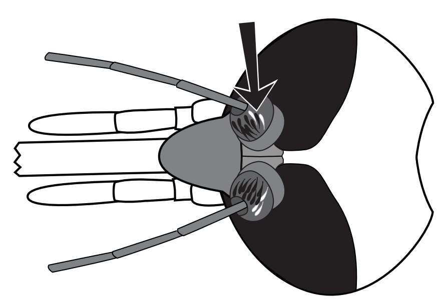


Fig. 99

17(16). Wing vein $R_{4+5}$ and other posterior veins heavily speckled with pale and dark scales (Fig. 100); antennal pedicel with large dorsomedian patch of cream-colored scales (Fig. 101). . . . . . . . . . . . . . . . . . . ***Ae. fitchii***

Wing vein $R_{4+5}$ and other posterior veins lightly speckled or entirely dark scaled (Fig. 102); pedicel with median patch of dark scales (Fig. 103). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. stimulans***

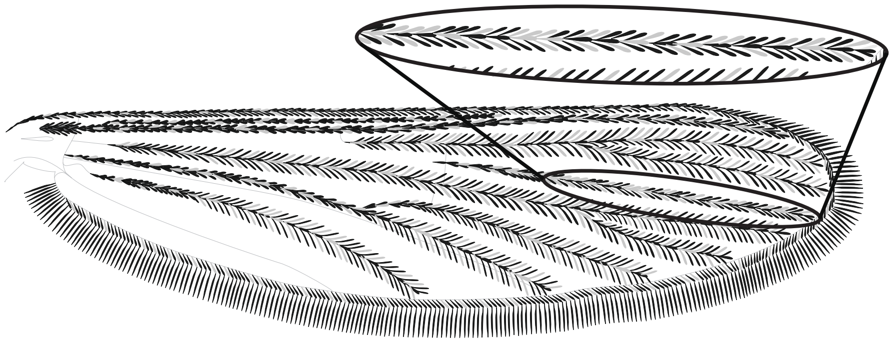


Fig. 100

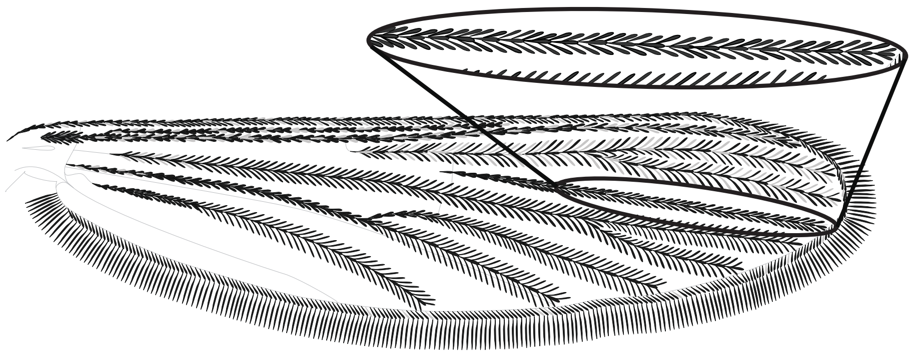


Fig. 102

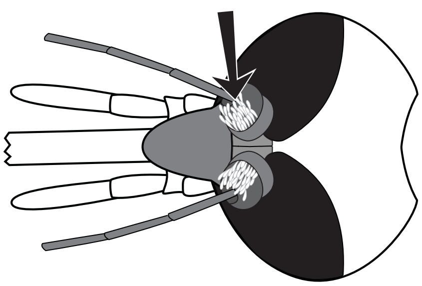


Fig. 101

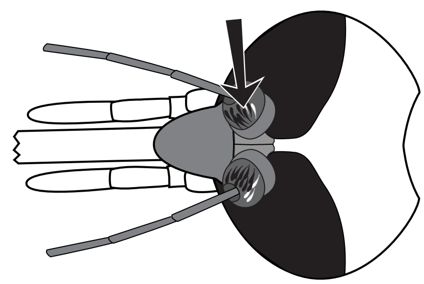


Fig. 103

18(2). Postprocoxal membrane without patch of scales (Fig. 104). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 19

Postprocoxal membrane with patch of scales (Fig. 105). . . . . . . . . (northern species). . . . . . . . . . . . . . 33

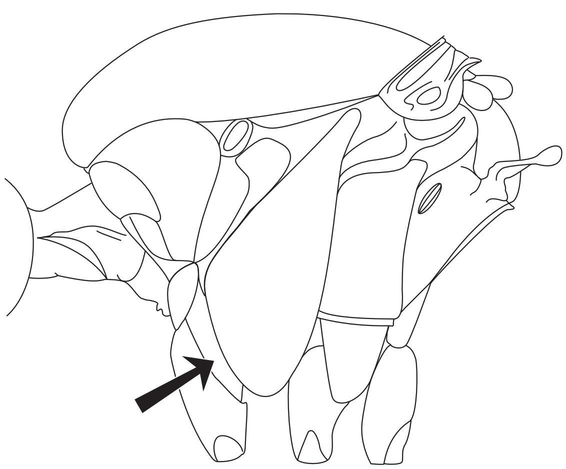


Fig. 104

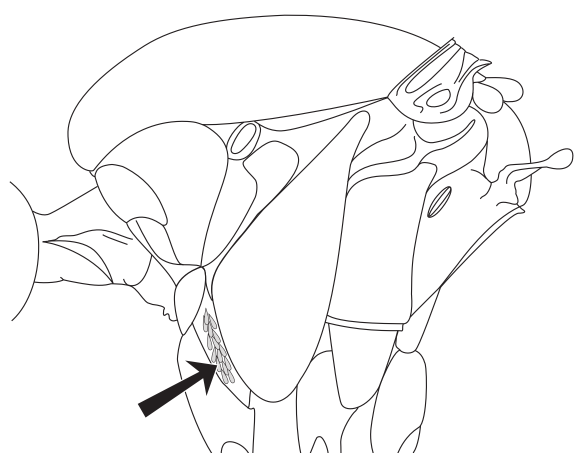


Fig. 105

19(18). Paratergite without scales (Fig. 106); scutum with median longitudinal white stripe or broad anterior white or yellow area (Fig. 107), or with submedian longitudinal pale stripes separated by median longitudinal brown stripe (Fig. 108). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 20

Paratergite with pale scales (Fig. 109); scutal scales one color, either dark red-brown or light tan (Fig. 110), or with broad median (Fig. 111) or submedian longitudinal brown stripes with lateral pale scales. . . . . .24

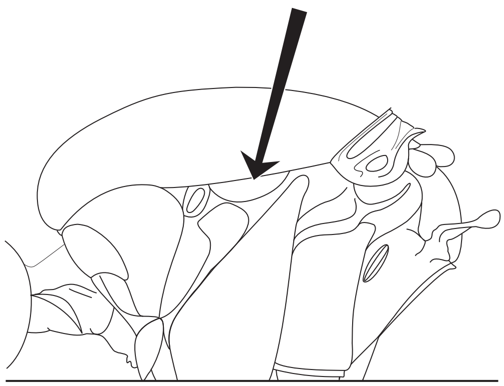


Fig. 106

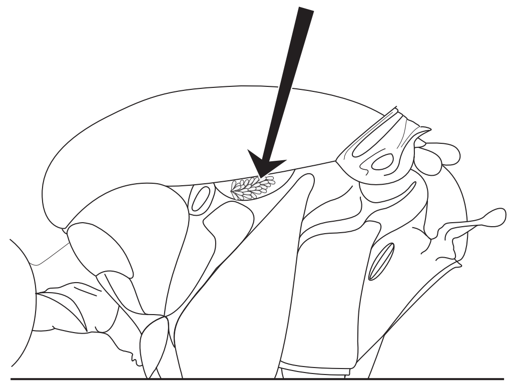


Fig. 109

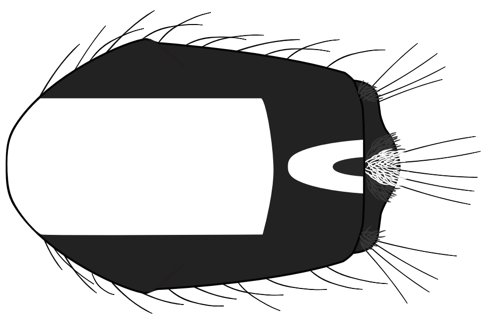


Fig. 107

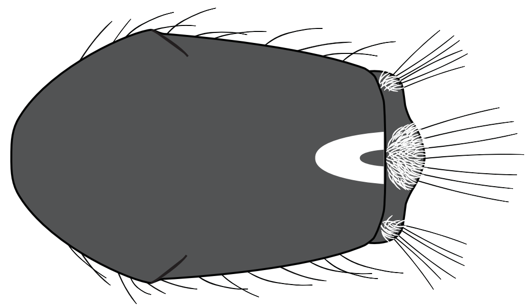


Fig. 110

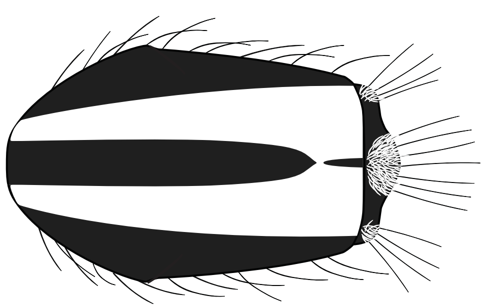


Fig. 108

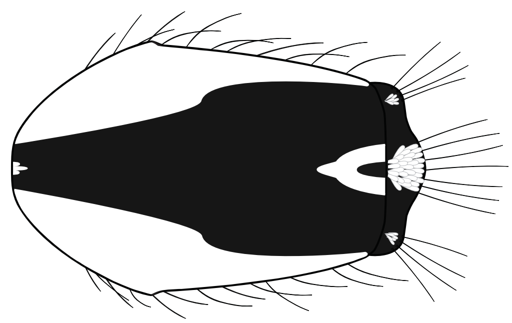


Fig. 111

20(19). Scutum with submedian longitudinal white stripes separated by narrow median longitudinal brown stripe (Fig. 112); antepronotum and postspiracular areas with pale scales (Fig. 113). . . . . . ***Ae. trivittatus***

Scutum with median longitudinal pale stripe or wide anterior area (Fig. 114); antepronotum and postspiracular areas without pale scales (Fig. 115). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .21

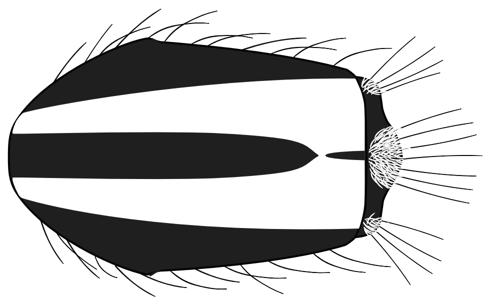


Fig. 112

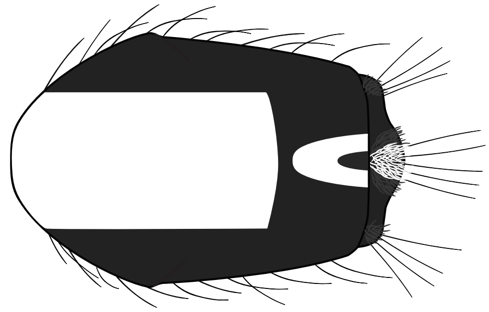


Fig. 114

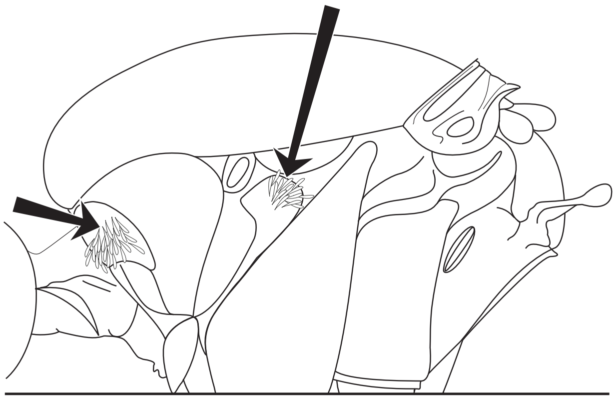


Fig. 113

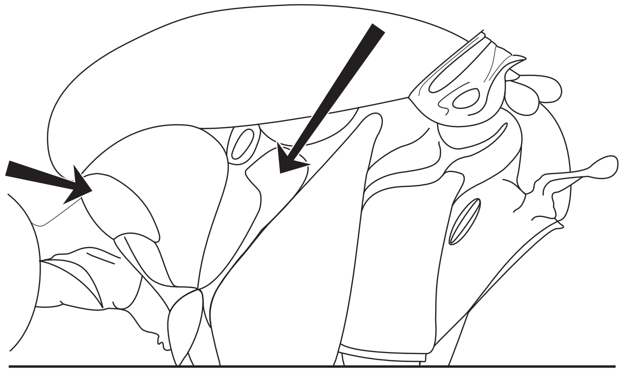


Fig. 115

21(20). Scutum with wide median white or yellow area on anterior half (Fig. 116); subspiracular area with pale scales (Fig. 117). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. infirmatus***

Scutum with median longitudinal white stripe from head to scutellum (Fig. 118); subspiracular area without scales (Fig. 119). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 22

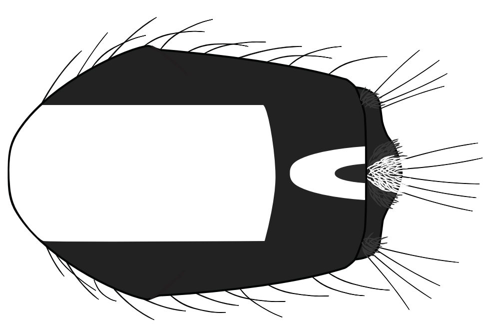


Fig. 116

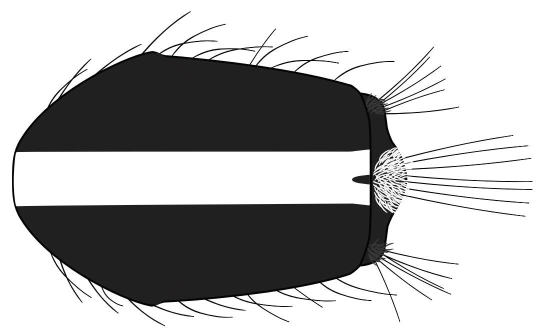


Fig. 118

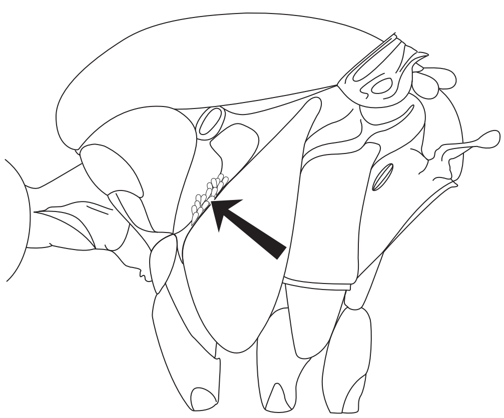


Fig. 117

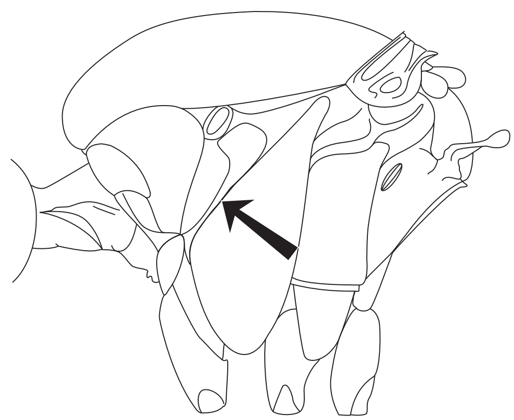


Fig. 119

22(21). Scutum with median longitudinal white stripe usually wider than brown lateral areas on either side (Fig. 120); vertex usually with lateral gray scale patches (Fig. 121); specimens always small . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. dupreei***
(See Note 6)

Scutum with median longitudinal white stripe usually narrower than brown areas on either side (Fig. 122); vertex with lateral black scale patches (Fig. 123); specimen size variable. . . . . . . . . . . . . . . . . . . . . . . . .23

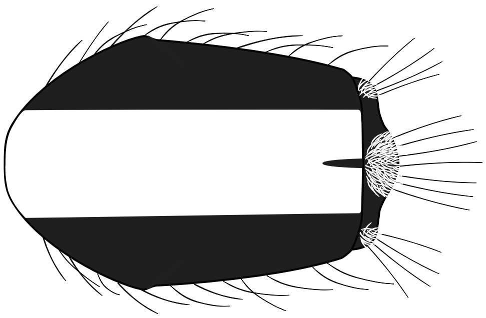


Fig. 120

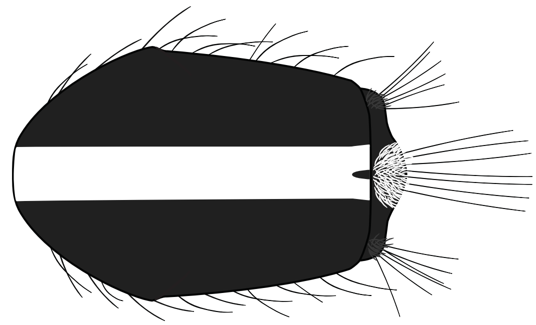


Fig. 122

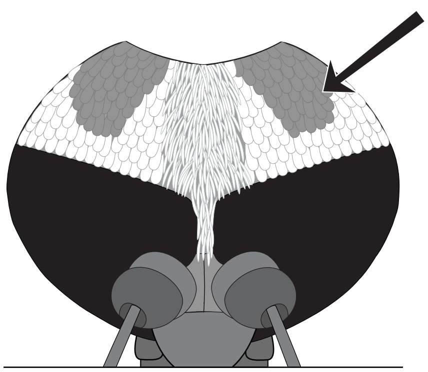


Fig. 121

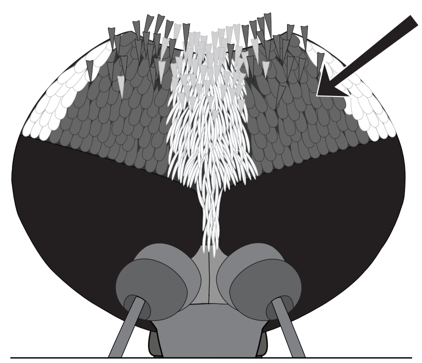


Fig. 123

23(22). Black lateral scale patches on head extend forward to reach the eyes (Fig. 124); scutum with median longitudinal pale stripes of equal width on anterior and posterior ends (Fig. 125). . . . . . . . ***Ae. atlanticus***

Black lateral scale patches on head do not reach the eyes because of 2-3 rows of narrow white scales bordering the eyes (Fig. 126); scutum with median longitudinal pale stripe clearly narrower at posterior end (Fig. 127). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. tormentor***

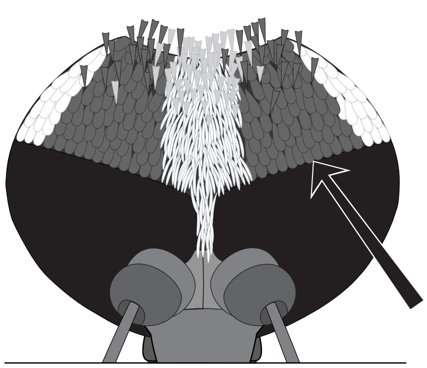


Fig. 124

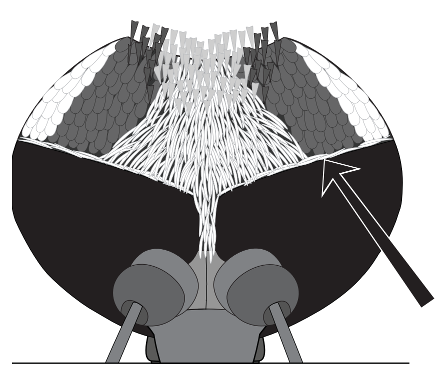


Fig. 126

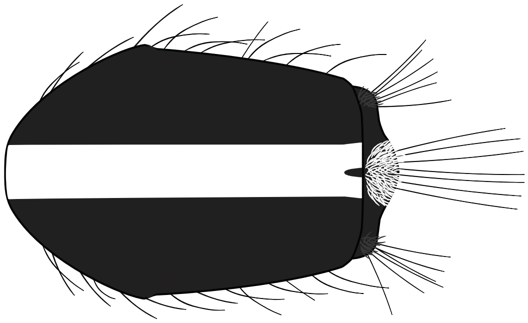


Fig. 125

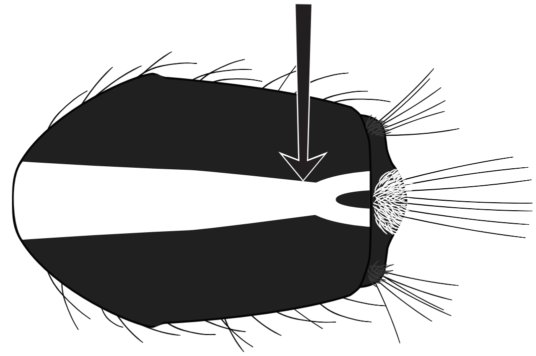


Fig. 127

24(19). Scutal scales one color, either red-brown or light tan (Fig. 128). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 25

Scutal scales with several shades of brown and cream, usually with darker brown median stripe or submedian longitudinal stripes (Fig. 129). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26

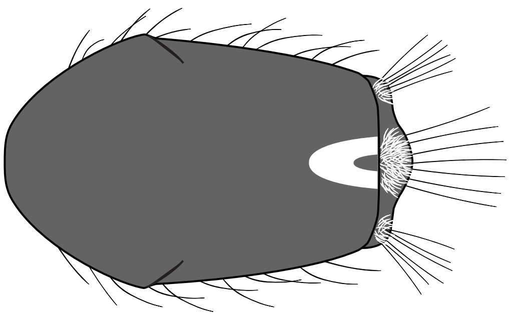


Fig. 128

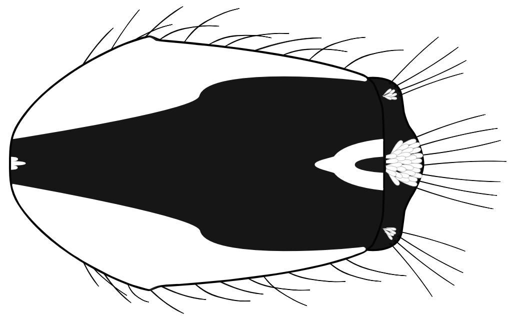


Fig. 129

25(24). Scutum with red-brown (cinnamon) scales (Fig. 130); side of thorax without subspiracular and metameral scales (Fig. 131); forecoxa with patch of dark scales (Fig. 132) . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. cinereus***

Scutum with light tan scales (Fig. 133); side of thorax with subspiracular and metameral scales (Fig.134); forecoxa almost entirely pale scaled (Fig. 135). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. intrudens***

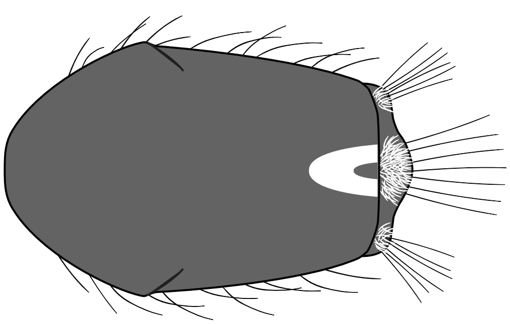


Fig. 130

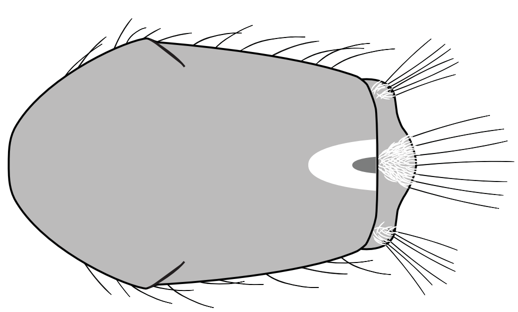


Fig. 133

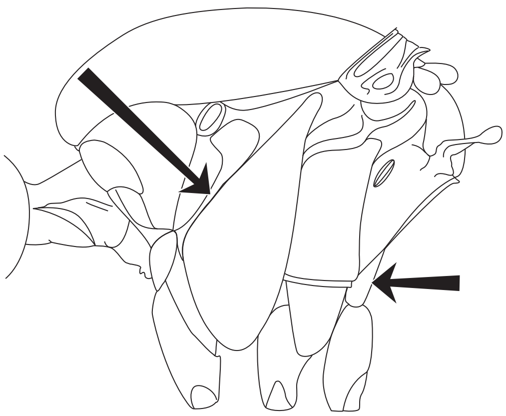


Fig. 131

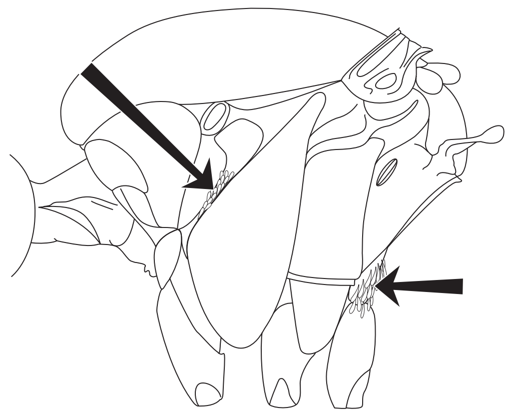


Fig. 134

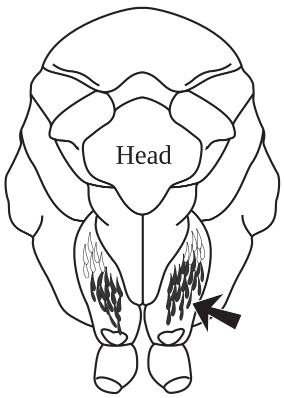



Fig. 132

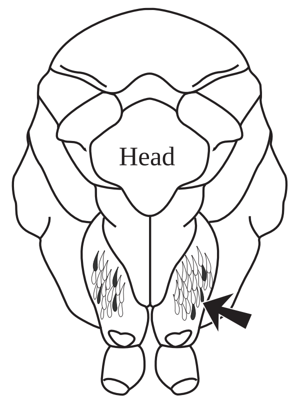



Fig. 135

26(24). Abdominal terga II-IV with distinct narrow to wide basal bands (Fig. 136); scutum with pale cream colored scales laterally (Fig. 137). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 27

Abdominal terga II-IV without complete basal pale bands, but with basolateral pale patches (Fig. 138); scutum with silver-white, yellow, or tan-bronze scales laterally (Fig. 139). . . . . . . . . . . . . . . . . . . . . . . 28

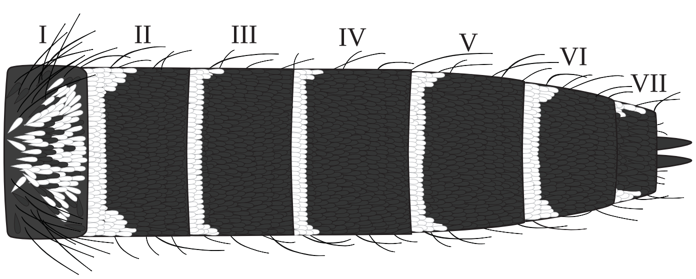



Fig. 136

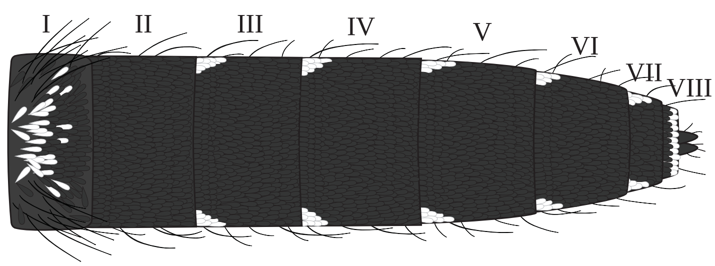



Fig. 138

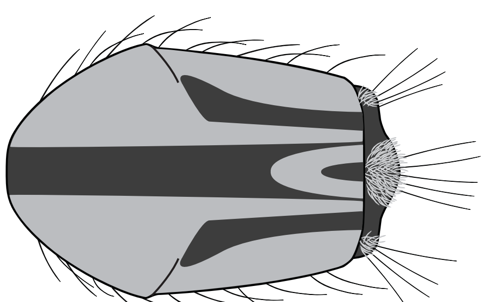


Fig. 137

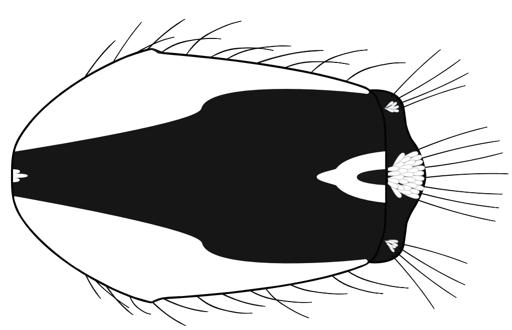


Fig. 139

27(26). Upper postpronotal scales narrow and red-brown (Fig. 140); mesepimeron with scales extending downward only 0.5-0.6 of distance toward bottom (Fig. 140); tergum VII with very narrow basal pale band, almost obscure at midline (Fig. 141) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. sticticus***

Upper postpronotal scales more stout and yellow-tan (Fig. 142); mesepimeron with scales extending downward to bottom (Fig. 142) tergum VII with broad basal pale band, nearly half length of segment (Fig. 143). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. communis***

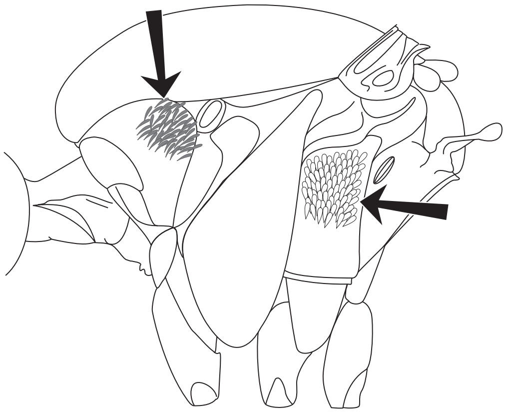


Fig. 140

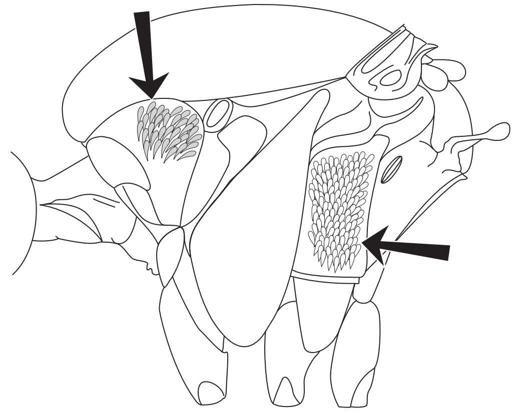


Fig. 142

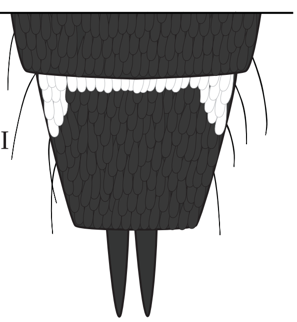



Fig. 141

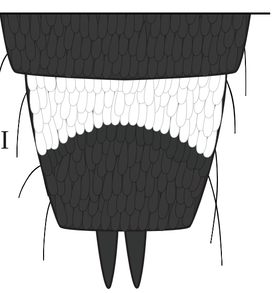



Fig. 143

28(26). Scutum with broad dark brown median longitudinal stripe, much broader posteriorly (Fig. 144). . . . . .29

Scutum with two narrow dark submedian longitudinal stripes separated by narrow median stripe of yellow scales, if the two dark stripes are joined then dark area not broader posteriorly (Fig. 145) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(northern species). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 32

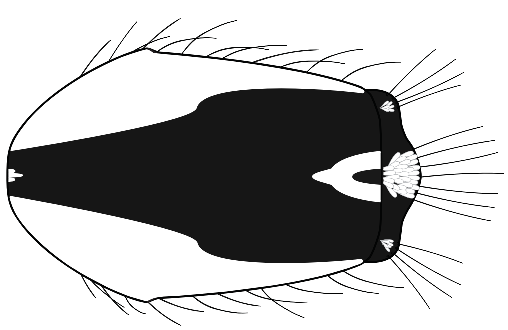


Fig. 144

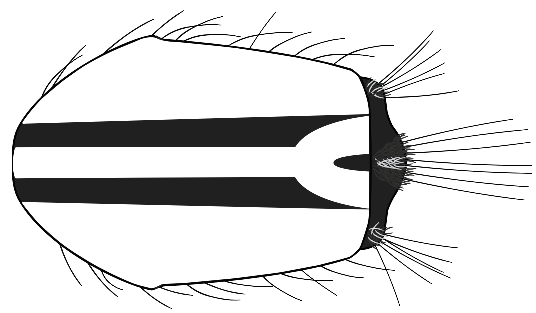


Fig. 145

29(28). Abdominal segments VII-VIII flattened laterally like a flea from dorsal view (Fig. 146); tip of abdomen rounded from side view (Fig. 147); scutum with silver-white lateral areas (Fig. 148); head scales entirely white or cream colored, including long erect forked scales (Fig. 149). . . . . . . . . . . . . . . . . . . . . . . . . . . 30

Abdominal segments VII-VIII not flattened laterally from dorsal view (Fig. 150); tip of abdomen pointed from side view (Fig. 151); scutum with lateral pale areas yellow or bronze colored (Fig. 152); head with submedian or lateral dark scale patches and with pale or dark erect forked scales (Fig. 153). . . . . . . . . 31

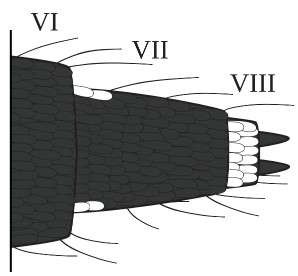


Fig. 146

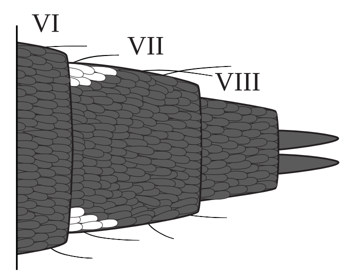


Fig. 150

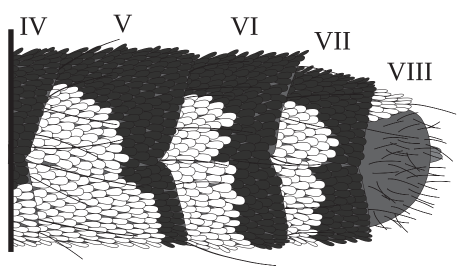


Fig. 147

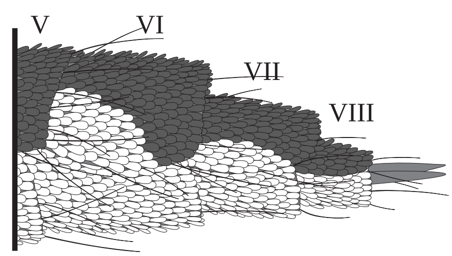


Fig. 151

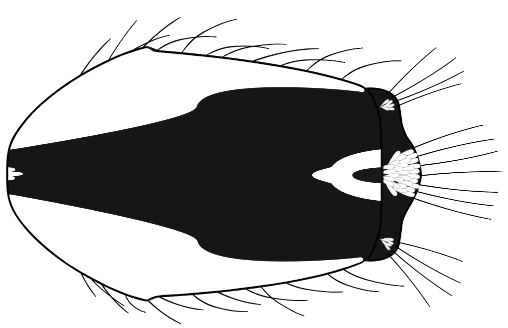


Fig. 148

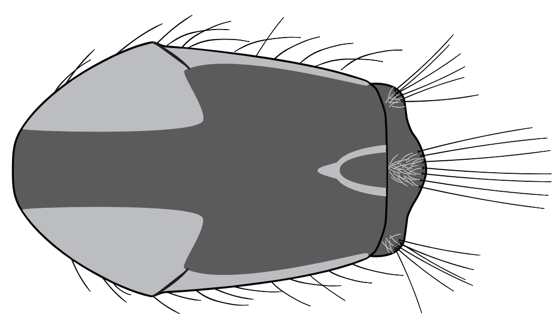


Fig. 152

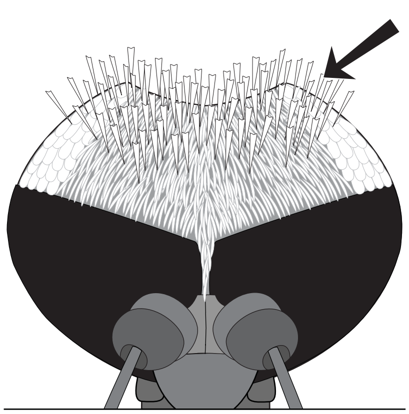


Fig. 149

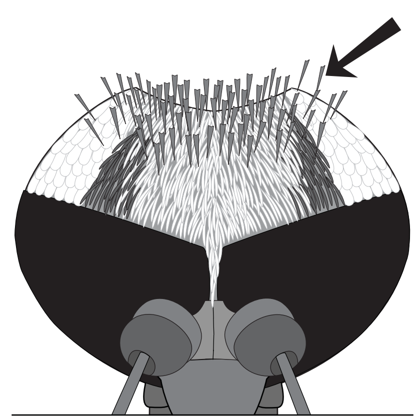


Fig. 153

30(29). Scutum with anterior half of median dark stripe broad, reaching laterally to dorsocentral setal rows (Fig. 154); scutal fossa with 1-4 weakly developed setae (Fig. 154); base of costal vein black scaled (Fig. 155). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. triseriatus***

Scutum with anterior half of median dark stripe narrow, not reaching laterally to dorsocentral setal rows (Fig. 156); scutal fossa with numerous well developed setae (Fig. 156); extreme base of costal vein with small patch of pale scales (Fig. 157). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. hendersoni***

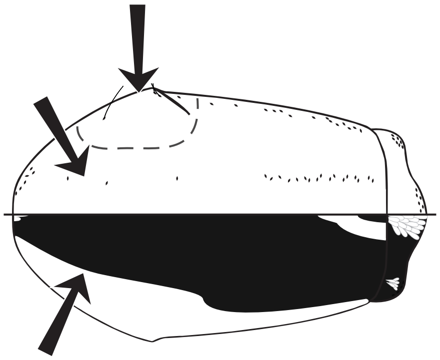


Fig. 154

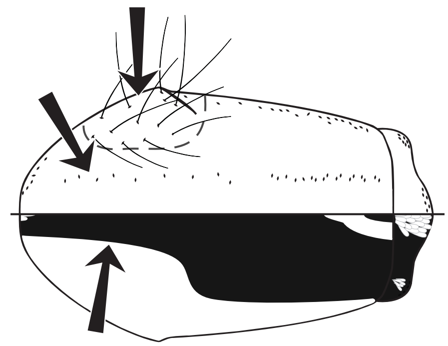


Fig. 156

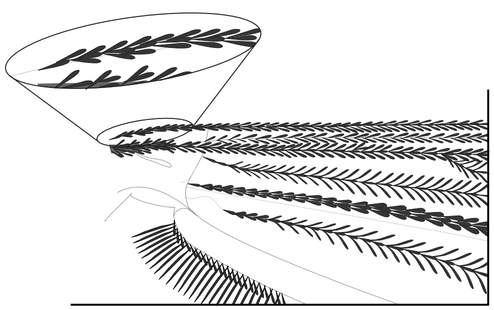


Fig. 155

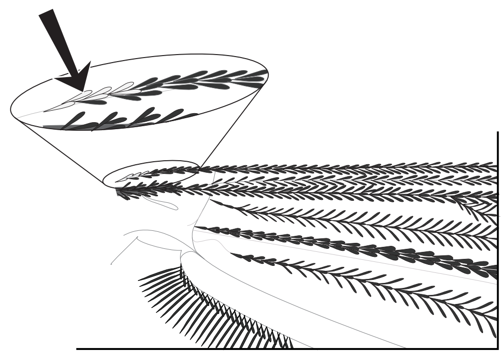


Fig. 157

31(29). Head with erect black forked scales on occiput (Fig. 158); abdominal sterna entirely pale scaled (Fig. 159) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. aurifer***

Head with erect yellow forked scales on occiput (Fig. 160); abdominal sterna with apical black bands, at least on distal segments (Fig. 161). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. thibaulti***

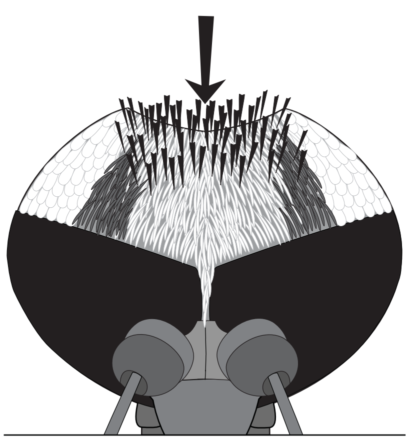


Fig. 158

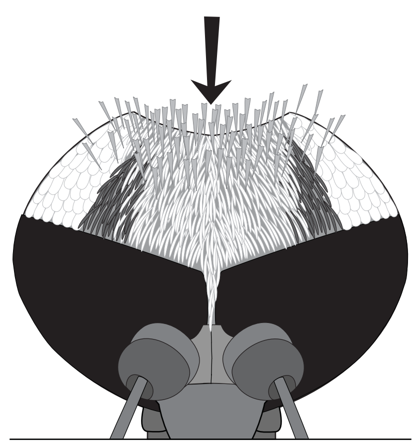


Fig. 160

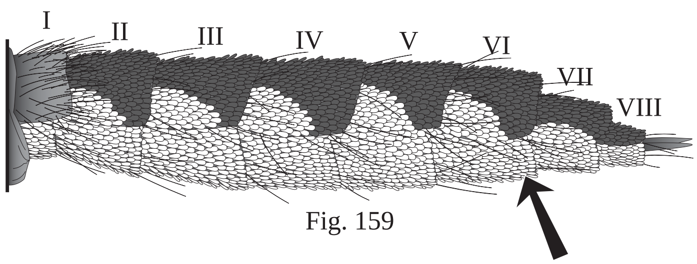


Fig. 159

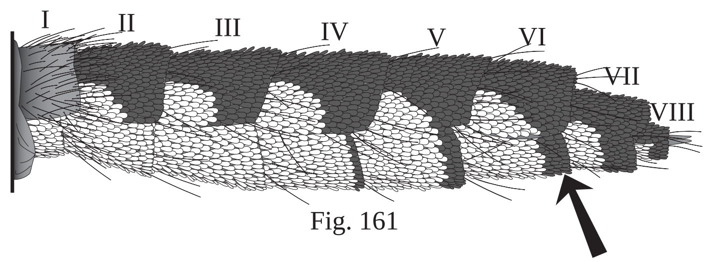


Fig. 161

32(28). Vertex scales entirely yellow (Fig. 162); metameron with several pale scales (Fig. 163); mesokatepisternum with 12-20 setae (Fig. 163). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. diantaeus***

Vertex scales yellow except for two lateral dark spots (Fig. 164); metameron without scales (Fig. 165); mesokatepisternum with 10 or less setae (Fig. 165). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. decticus***

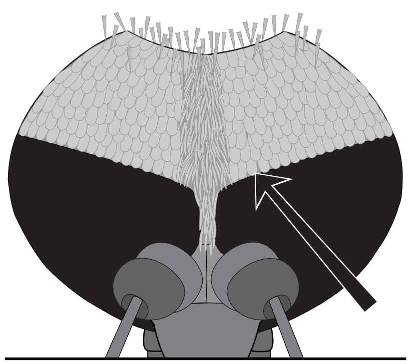


Fig. 162

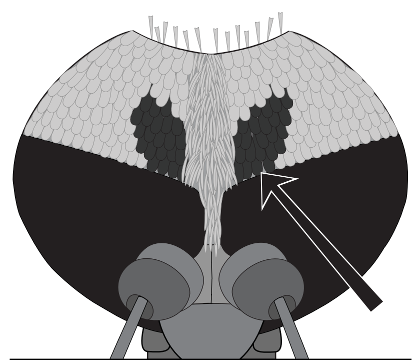


Fig. 164

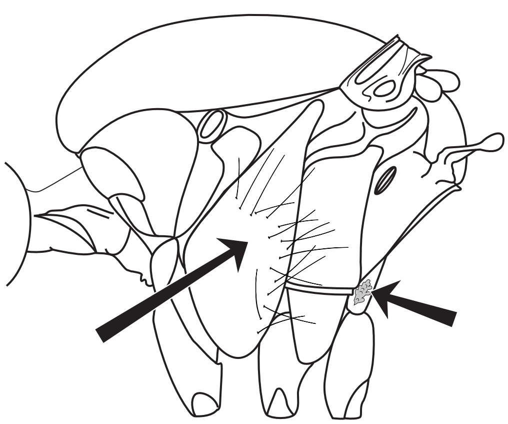


Fig. 163

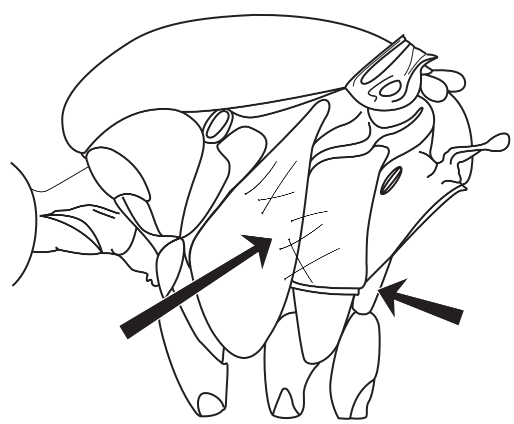


Fig. 165

33(18). Hypostigmal scales present just below mesothoracic spiracle (Fig. 166); wing with large pale spot on base of costa (Fig. 167); intersegmental membrane connecting tergum I and sternum I with white scales (Fig. 168). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. provocans***

Hypostigmal scales absent (Fig. 169); wing with base of costa black (Fig. 170); intersegmental membrane connecting tergum I and sternum I without scales (Fig. 171). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 34

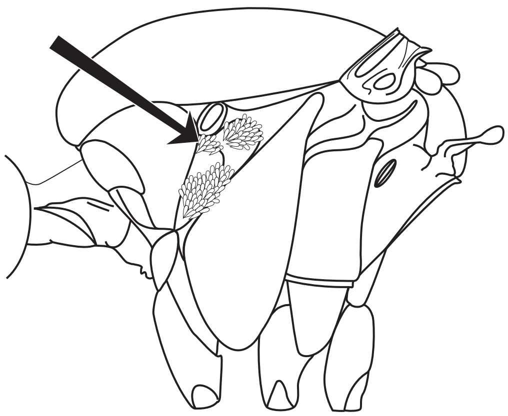


Fig. 166

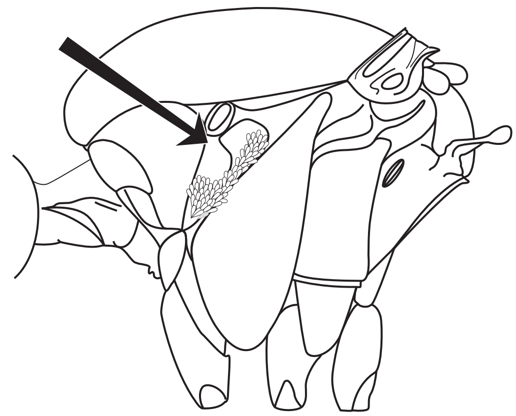


Fig. 169

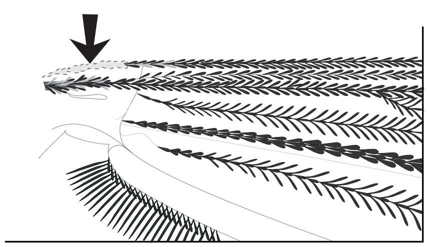


Fig. 167

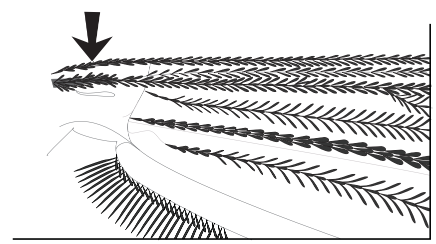


Fig. 170

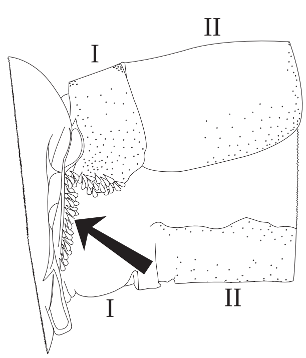


Fig. 168

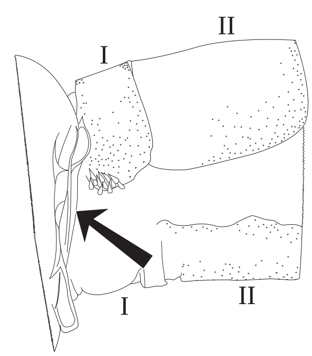


Fig. 171

34(33). Postpronotum with red-brown scales dorsally and white or cream scales ventrally (Fig. 172); proepisternum with many scattered white scales (Fig. 173); occiput with few erect black scales that are thin, relatively short, and notched at the tip (Fig. 174). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. abserratus***

Postpronotum with yellow scales dorsally and white or cream scales ventrally (Fig. 175); proepisternum without scattered white scales, infrequently several may occur dorsally (Fig. 176); occiput erect scales yellow (Fig. 177). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. punctor***

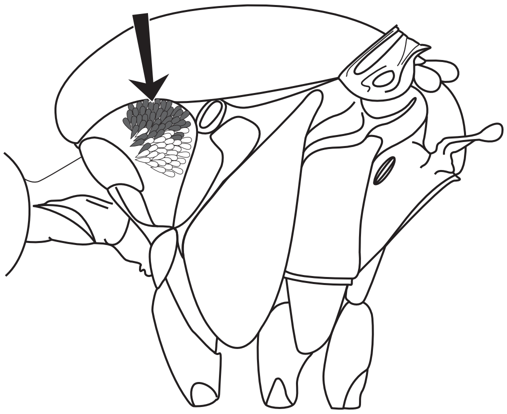


Fig. 172

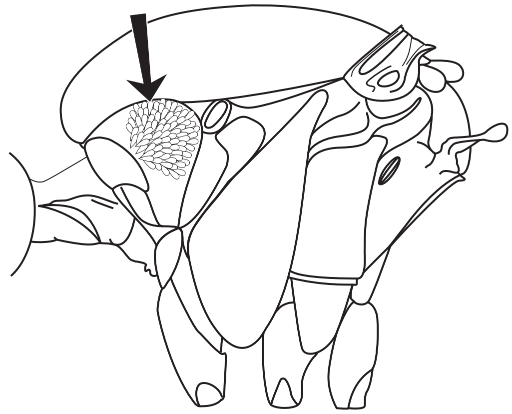


Fig. 175

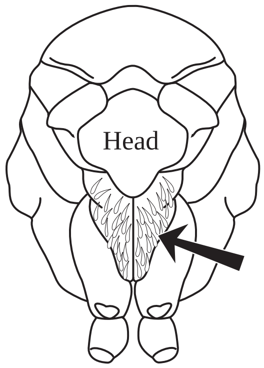



Fig. 173

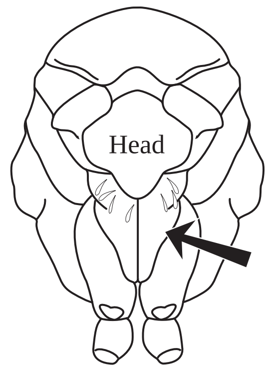



Fig. 176

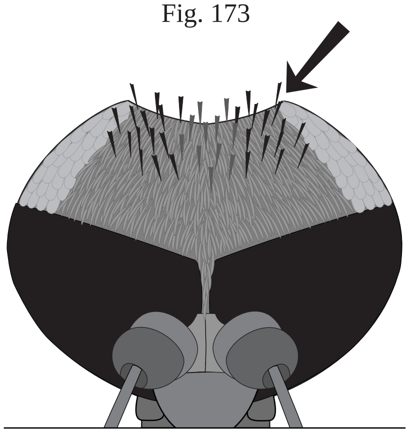


Fig. 174

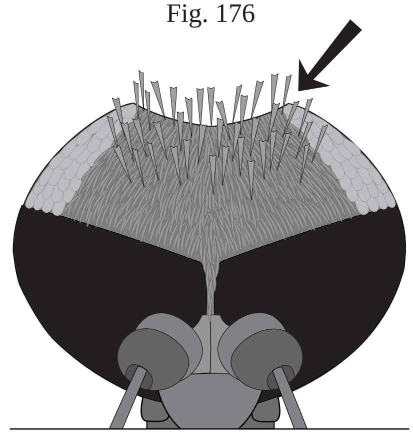


Fig. 177

## Key to Female *Anopheles* (= *An.*)

1. Wings with patches of white or yellow scales (Fig. 178); vein 1A with dark and pale patches of scales (Fig. 178). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

   Wing scales entirely brown, with or without dark spots due to dense clumps of scales (Fig. 179); tip of wing may have copper colored apical fringe spot (Fig. 179); vein 1A entirely dark scaled. . . . . . . . . . . .3

Fig. 178

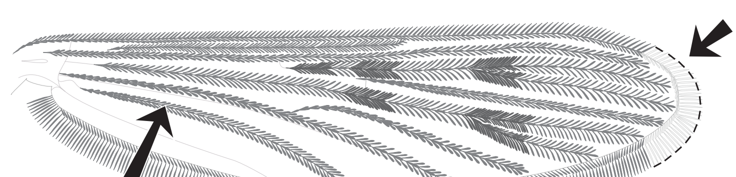


Fig. 179

2(1). Palpus entirely dark scaled (Fig. 180); wing with small to large yellow subcostal pale spot on anterior margin of wing (Fig. 181); vein 1A with 2 dark spots (basal and apical) (Fig. 181). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. punctipennis s.l.***

**(Includes *An. punctipennis* E and *An. perplexens*)**

(See Note 7)

Palpus with pale bands (Fig. 182); wing with small apical pale spot, but no subcostal spot (Fig. 183); vein 1A with 3 dark spots (Fig. 183). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. crucians s.l.***

**(Includes *An. bradleyi*, *An. georgianus*, *crucians* A, B, C, D, E)**

(See Note 8)

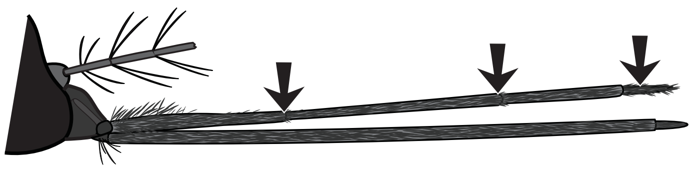


Fig. 180

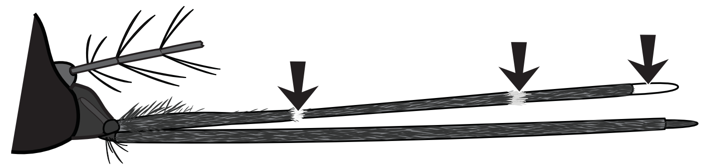


Fig. 182

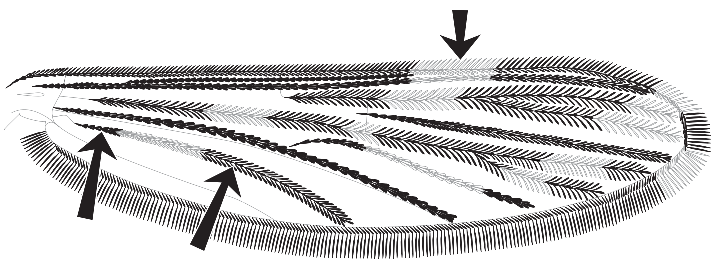


Fig. 181

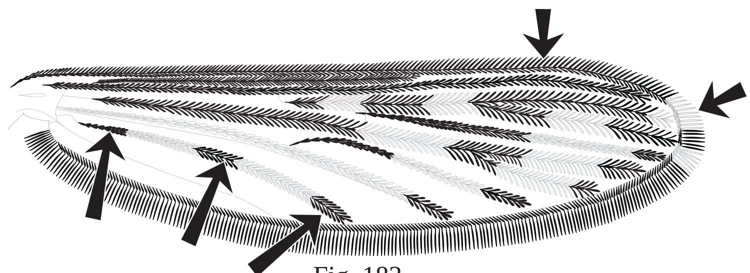


Fig. 183

3(1). Tip of wing with copper colored apical fringe spot (Fig. 184); wing with dense clumps of brown scales forming dark spots. . . . . . . . . . . . . . . . . . . .(Pennsylvania). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. earlei***

Tip of wing without apical fringe spot, all scales brown; wing with or without dense clumps of scales forming dark spots (Fig. 185). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

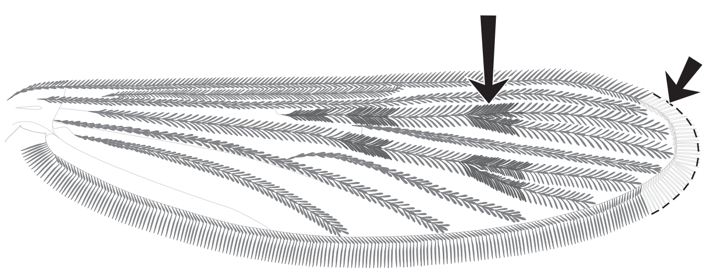


Fig. 184

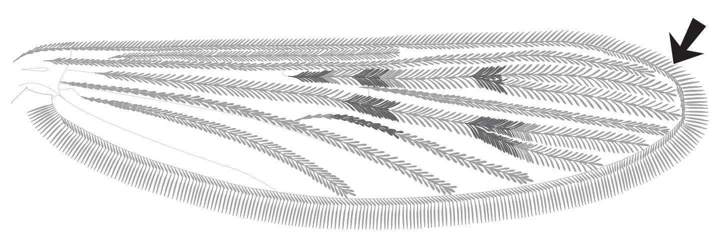


Fig. 185

4(3). Palpus with distinct narrow apical pale bands (Fig. 186); halter capitellum pale scaled (Fig. 187). . . . . . . . .(capitellum scales on extreme northern specimens may be brown). . . . . . . . . . . . . . . . . . . ***An. walkeri***

Palpus entirely dark scaled or with very faint pale tips on some segments, if faint pale tips present then top of head entirely dark scaled; halter capitellum with dark scales (Fig. 188). . . . . . . . . . . . . . . . . . . . . 5

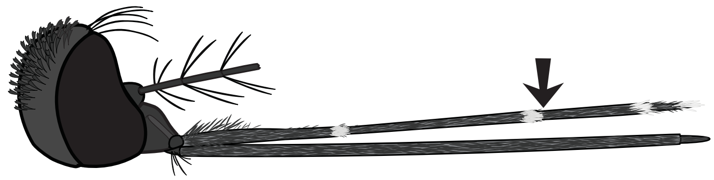


Fig. 186

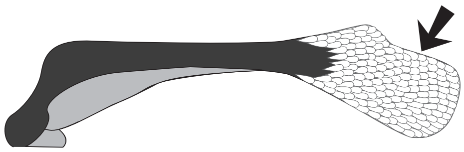


Fig. 187

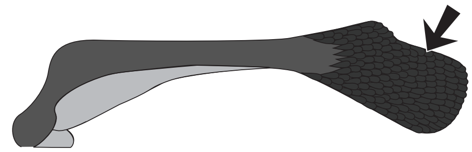


Fig. 188

5(4). Vertex and frontal tuft of head without pale scales (Fig. 189); forecoxa with large patch of black scales (Fig. 190). . . . . . . . . . . . . . . . . . . . . (brackish water species). . . . . . . . . . . . . . . . . . . . . . . . . . ***An. atropos***

Vertex and frontal tuft with pale scales (Fig. 191); forecoxa without black scales or rarely with 1-2 (Fig. 192). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6

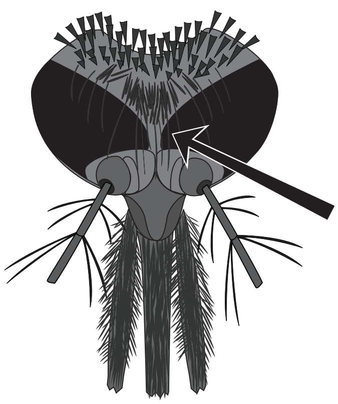


Fig. 189

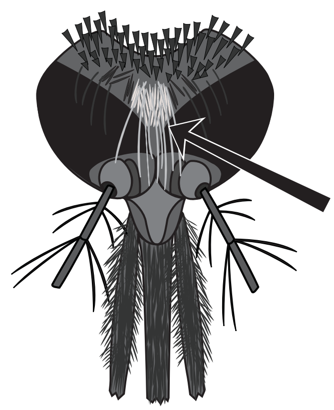


Fig. 191

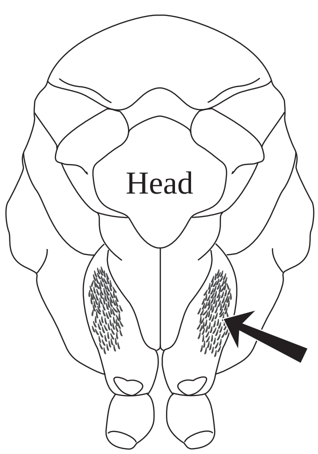



Fig. 190

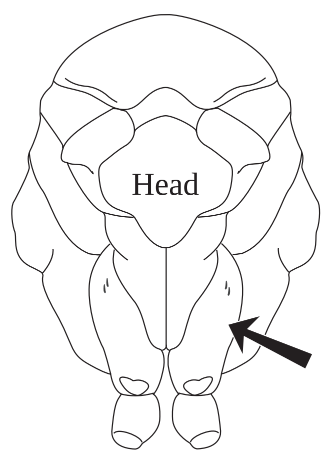



Fig. 192

6(5). Large species; wings with 4 distinct clumps of dark scales (Fig. 193); frontal tuft pale, with pale setae and long pale scales (See previous Fig. 191); length of black scutal setae much less than 0.5 width of scutum (Fig. 194). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . **(*An. quadrimaculatus s.l.*)**. . . . . . 7
(See Note 9)

Small species; wings without distinct clumps of dark scales (Fig. 195); frontal tuft typically dark, usually only setae (See previous Fig. 189); length of most black setae on scutum long, at least 0.4-0.5 width of scutum (Fig. 196). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. barberi***

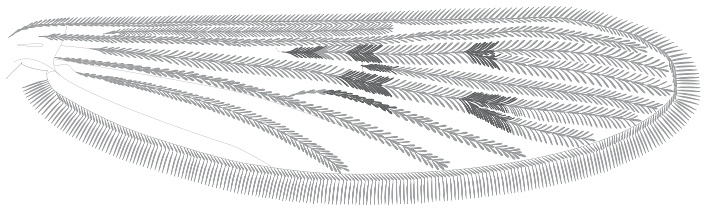


Fig. 193

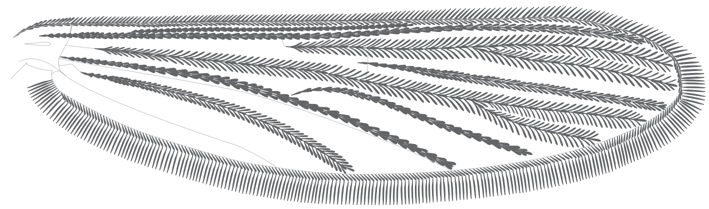


Fig. 195

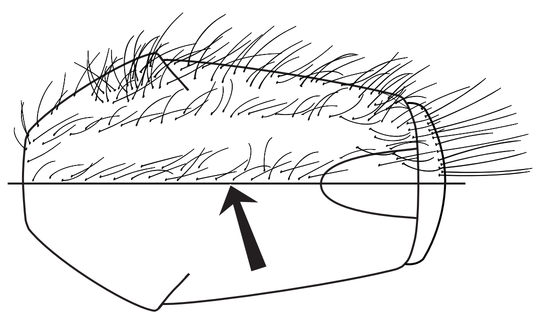


Fig. 194

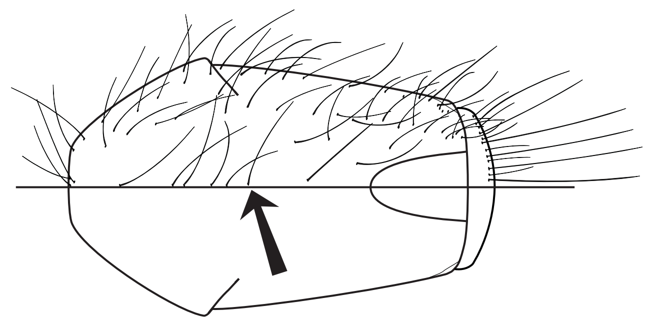


Fig. 196

7(6). Upper proepisternum usually with 2-6 setae (Fig. 197); mid- and usually foretibia with pale scales at apex (Fig. 198). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .8

Upper proepisternum usually with 7-26 setae (Fig. 199); mid- and foretibia without pale scales at apex (Fig. 200). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

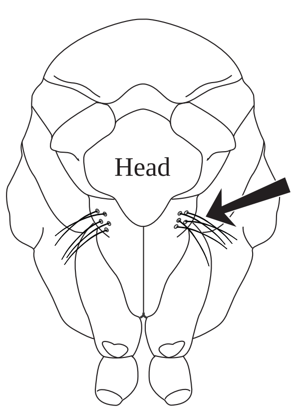


Fig. 197

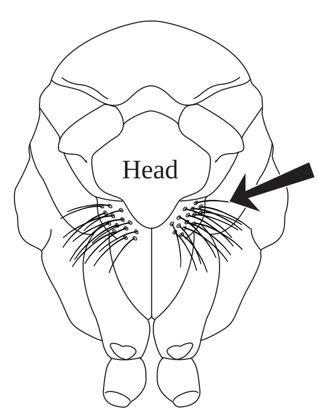


Fig. 199

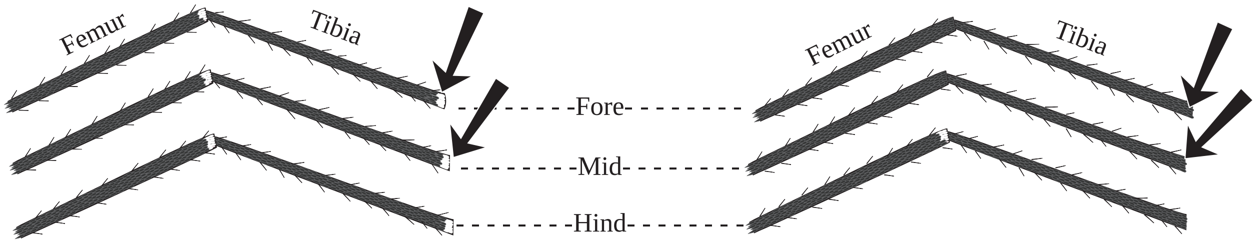



Fig. 198

Fig. 200

8(7). Scutal fossa on one side usually with 21-45 setae (Fig. 201); prealar knob usually with 6-12 setae (Fig. 202); interocular area with 7-12 setae (Fig. 203). . . . . . . . . . . . . . . . . . . . . . . . . . ***An. quadrimaculatus s.s.***

Scutal fossa on one side usually with 8-20 setae (Fig. 204); prealar knob usually with 1-5 setae (Fig. 205); interocular area with 4-6 setae (Fig. 206). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. smaragdinus***

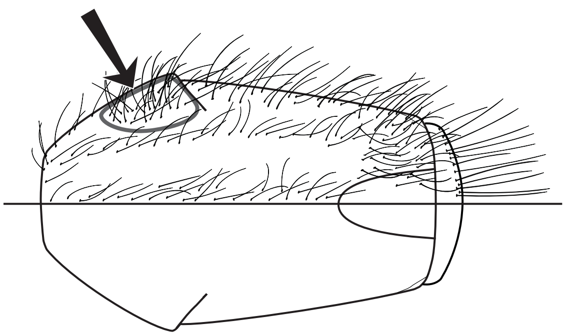


Fig. 201

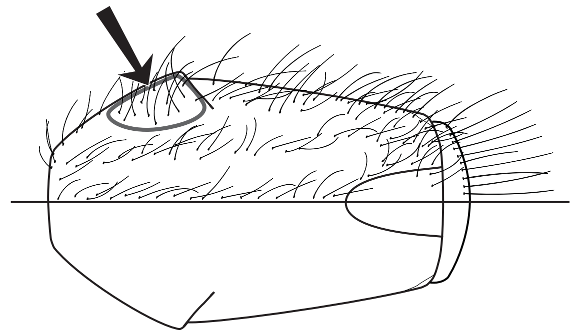


Fig. 204

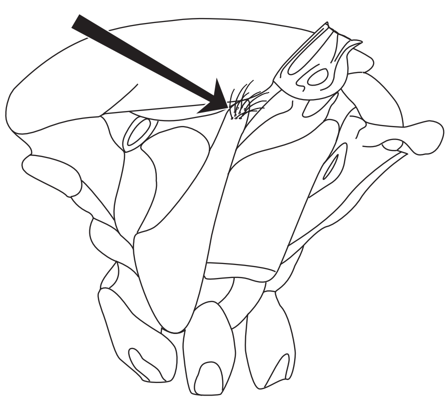


Fig. 202

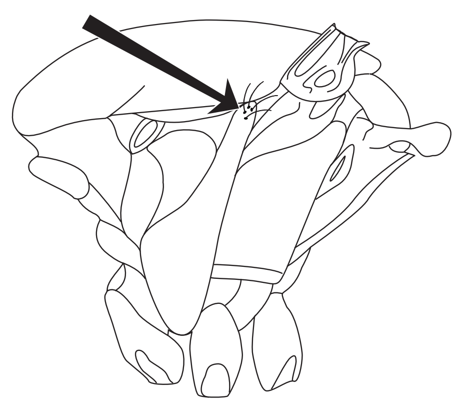


Fig. 205

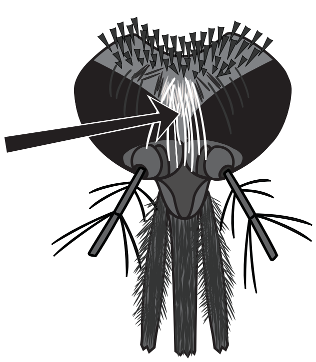


Fig. 203

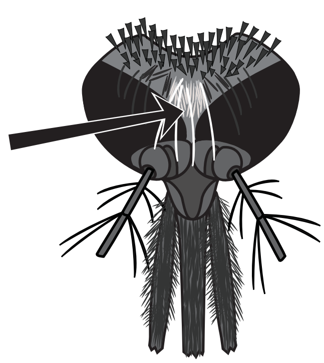


Fig. 206

9(7). Dorsocentral area usually without golden piliform scales on anterior margin (Fig. 207). . . . ***An. diluvialis***

Dorsocentral area with few or several golden piliform scales on anterior margin (Fig. 208). . . . . . . . . .10

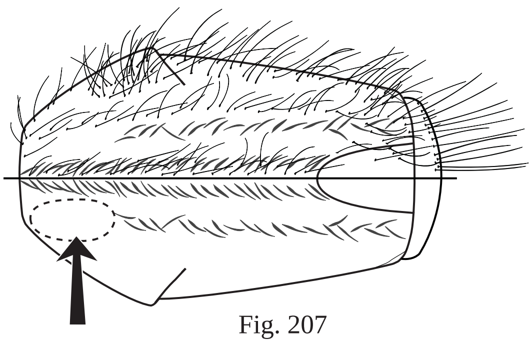


Fig. 207

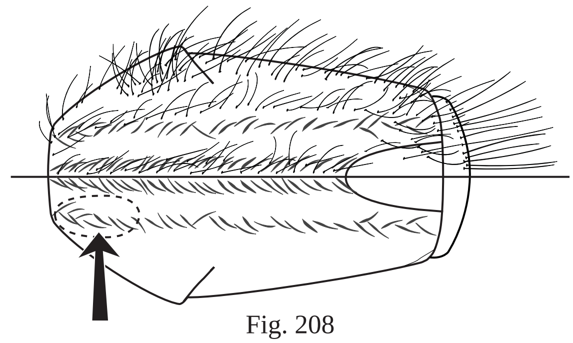


Fig. 208

10(9). Fore- and midfemur usually with apical pale scales (Fig. 209); palpus often shorter than proboscis (Fig. 210); interocular area usually with 3-5 setae (Fig. 211). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. maverlius***

Forefemur without and midfemur usually without apical pale scales (Fig. 212); palpus equal to or longer than proboscis (Fig. 213); interocular area usually with 6-9 setae (Fig. 214). . . . . . . . . . . . ***An. inundatus***

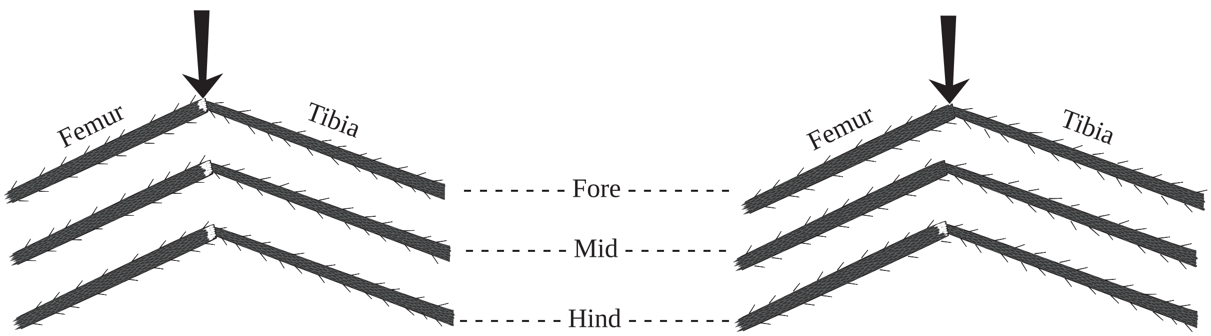



Fig. 209

Fig. 212

Fig. 210

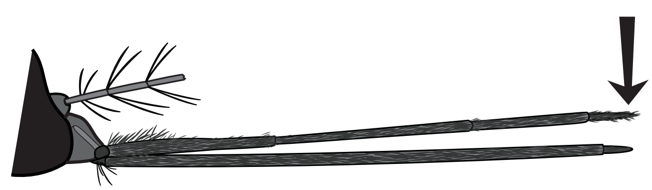


Fig. 213

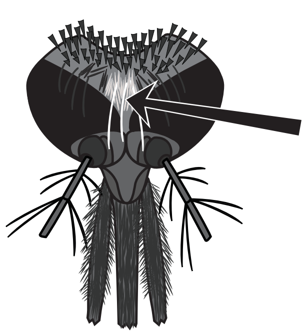


Fig. 211

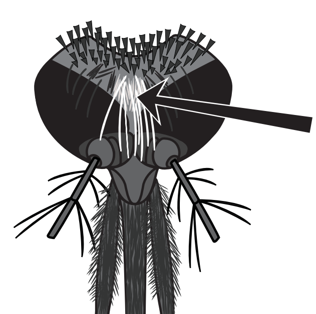


Fig. 214

# Key to Female *Culex* (= *Cx.*)

1. Hindtarsomeres 1-5 with narrow apical and basal pale bands (Fig. 215); proboscis with pale band or distinct median pale ventral patch (Figs. 216, 217). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .2

Hindtarsomeres 1-5 dark scaled (Fig. 218); proboscis dark scaled, rarely with small pale ventral area (Fig. 219). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .3

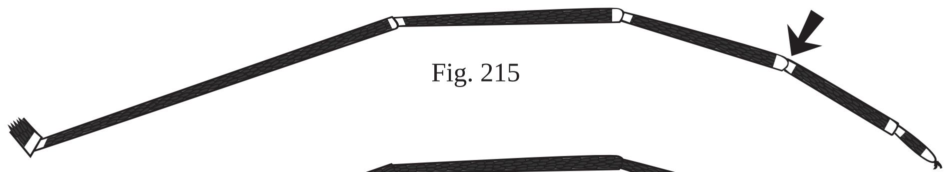


Fig. 215

Fig. 218

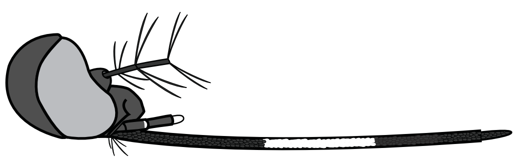


Fig. 216

Fig. 217

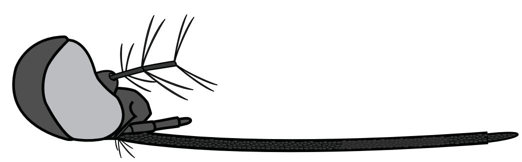


Fig. 219

2(1). Proboscis with distinct pale band (Fig. 220); palpus with pale scales; costal and subcostal veins on wing with some pale scales (Fig. 221). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. tarsalis***

Proboscis dark dorsally, with ventral median pale area (Fig. 222); palpus without pale scales; costal and subcostal veins on wing dark scaled (Fig. 223). . . . . . . . . .(GA, SC, and NC). . . . . . . .***Cx. coronator***

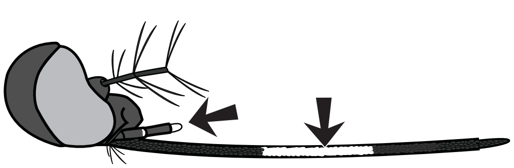


Fig. 220

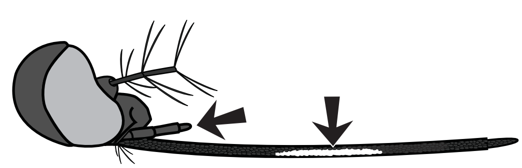


Fig. 222

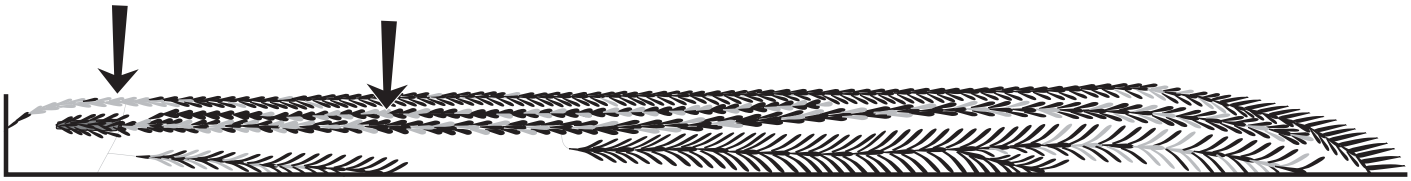


Fig. 221

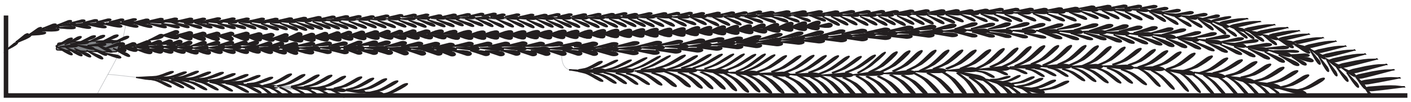


Fig. 223

3(1). Vertex of head with narrow curved scales and long erect forked scales (Fig. 224); scutum with median longitudinal row of acrostichal setae (Fig. 225). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .4

Vertex of head with broad round scales and long erect forked scales, or if with several rows of broad round scales immediately behind eyes then with more posterior small narrow curved scales and erect forked scales (Fig. 226); scutum without median longitudinal row of acrostichal setae (Fig. 227). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8

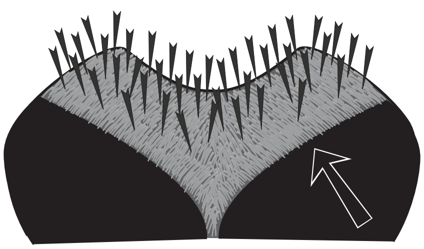


Fig. 224

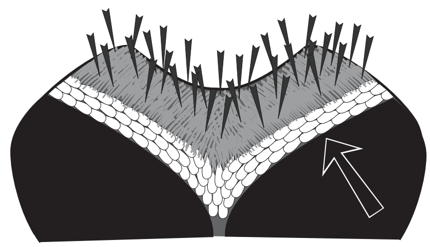


Fig. 226

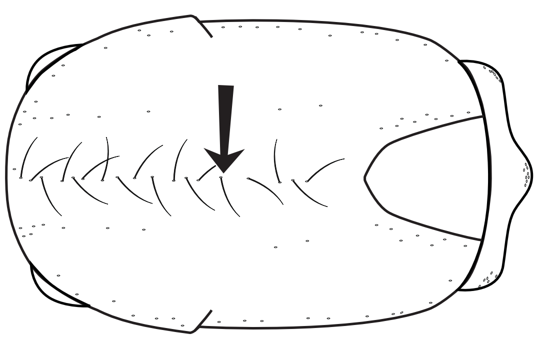


Fig. 225

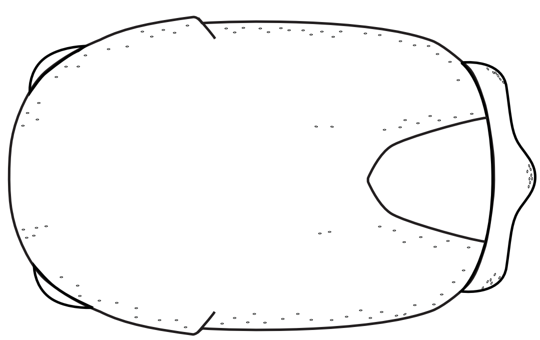


Fig. 227

4(3). Abdominal terga with pale apical lateral patches or pale apical bands (Figs. 228, 229). . . . .***Cx. territans***

Abdominal terga with basal pale bands and/or basal lateral patches (Fig. 230). . . . . . . . . . . . . . . . . . . . . 5

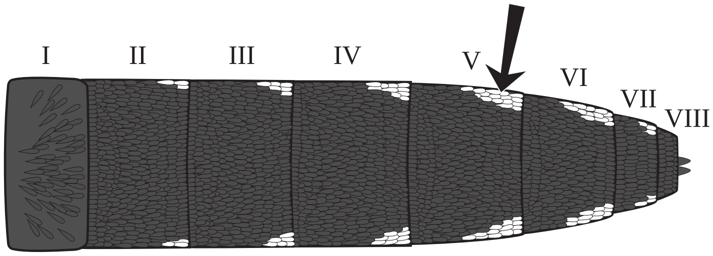


Fig. 228

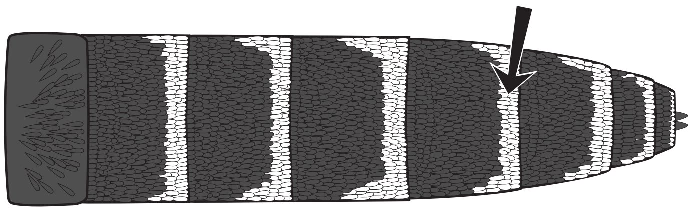


Fig. 229

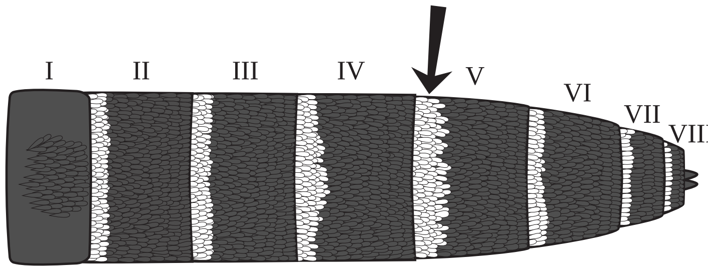


Fig. 230

5(4). Abdominal terga with basal pale bands indistinct or very narrow on segments II-III (Fig. 231); mid-lobe of scutellum with basal patch of fine dark brown scales (Fig. 232). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

Abdominal terga with basal pale bands distinct and broad from segments II-VII, infrequently with only median spots on segment II (Figs. 233, 234); mid-lobe of scutellum with basal patch of white or cream-colored scales (Fig. 235). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .7

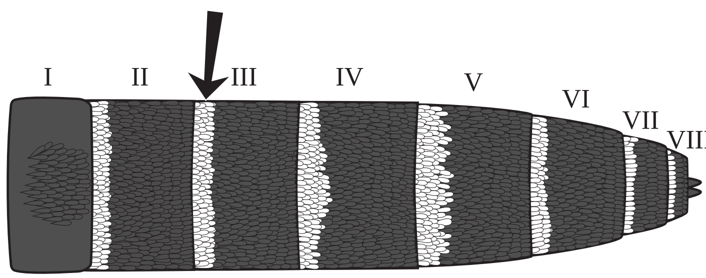


Fig. 233

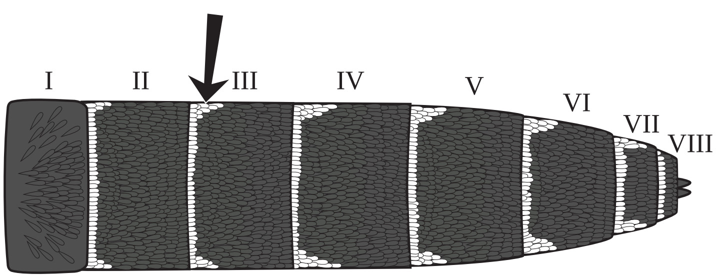


Fig. 231

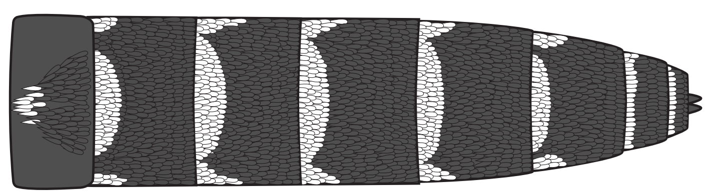


Fig. 234

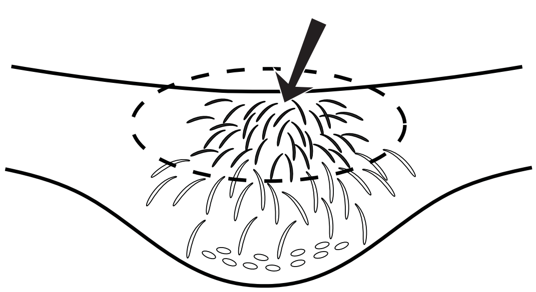


Fig. 232

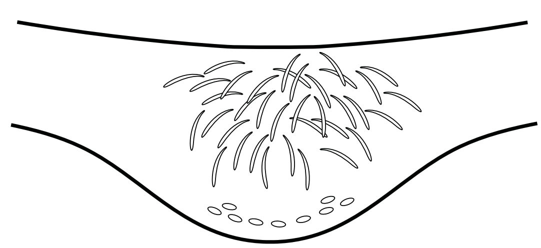


Fig. 235

6(5). Abdominal segments VII-VIII nearly covered with copper-colored scales (Fig. 236); mesepimeron with distinct middle patch of white scales (Fig. 237). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. salinarius***

Abdominal segment VII mostly dark, with large lateral patches of white scales, VII-VIII may have narrow basal white band (Fig. 238); mesepimeron without middle patch of white scales (Fig. 239). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. nigripalpus***

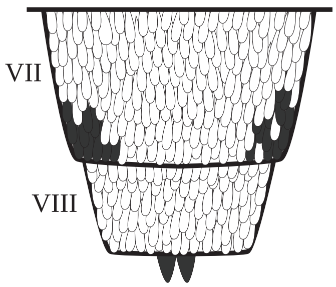


Fig. 236

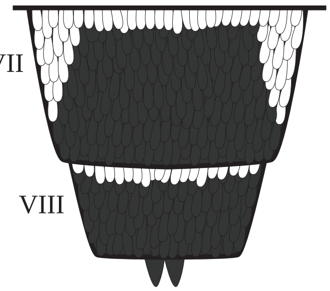


Fig. 238

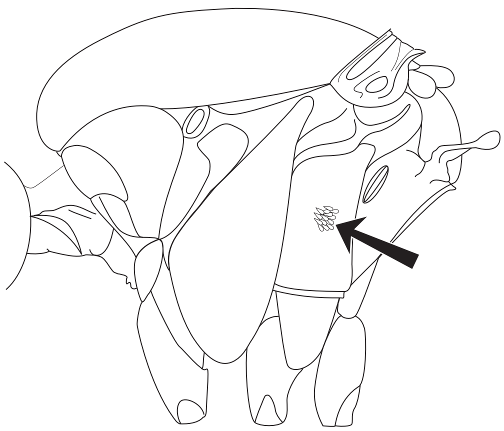


Fig. 237

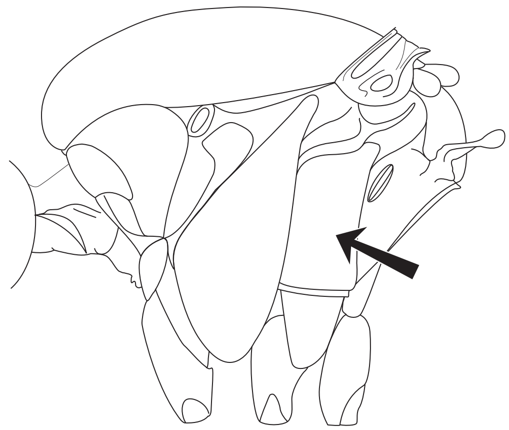


Fig. 239

7(5). Top of head with erect forked scales on vertex and occiput black (Fig. 240); scutum with fine dark brown scales and usually 2 small round white spots (Fig. 241); abdominal segments II and III with continuous white basal bands with straight or nearly straight margins. (Fig. 242) . . . . . . . . . . . . . . . . . . ***Cx. restuans***

Top of head with several light tan or pale erect forked scales on median area of vertex and/or occiput, lateral erect forked scales dark brown (Fig. 243); scutum with coarse light tan scales, without small pale spots (Fig. 244); abdominal segments II and III usually with enlarged cream or light yellow central spot that is narrowly attached (or not attached) to white lateral basal spots (Fig. 245) . . . . . . . . . . .***Cx. pipiens***
***Cx. quinquefasciatus***
***Cx. pipiens* X *quinquefasciatus***
(See Note 10)

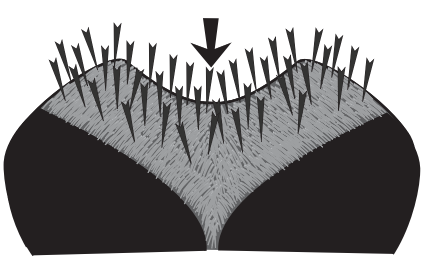


Fig. 240

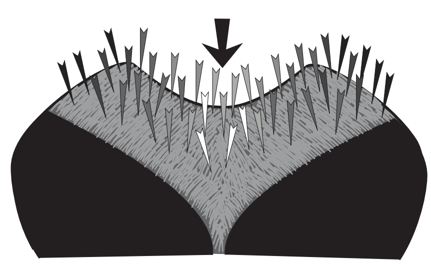


Fig. 243

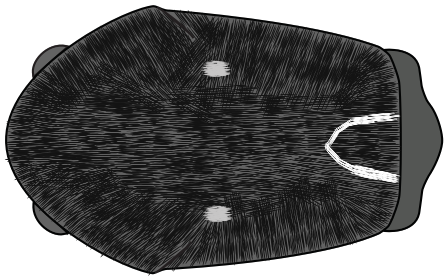


Fig. 241

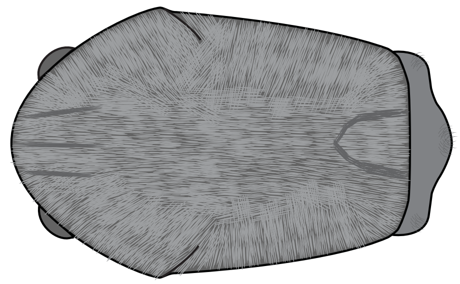


Fig. 244

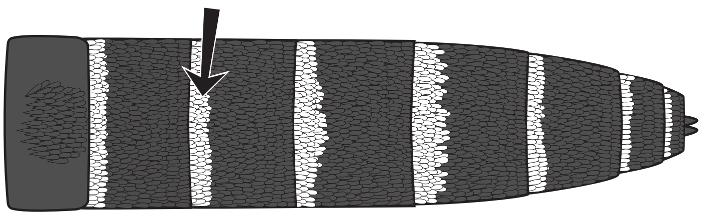


Fig. 242

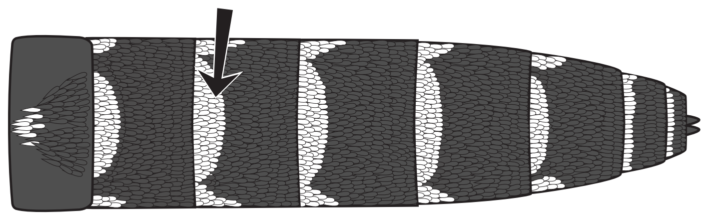


Fig. 245

8(3). Vertex with several rows of broad round scales immediately behind eyes, and more posterior narrow curved scales and erect forked scales (Fig. 246); mesepimeron with distinct middle patch of white scales (Fig. 247). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. erraticus***

Vertex covered with broad round scales and erect forked scales (Fig. 248); mesepimeron without middle patch of scales, but with color pattern (Fig. 249). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

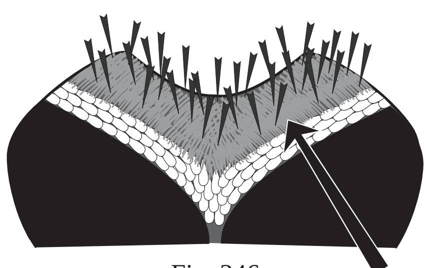


Fig. 246

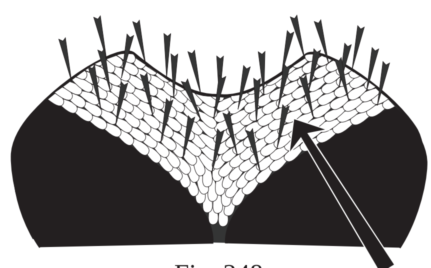


Fig. 248

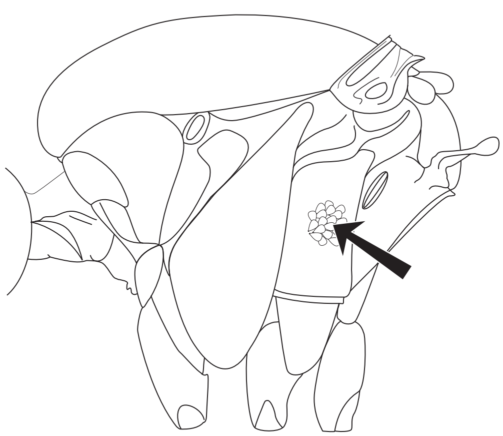


Fig. 247

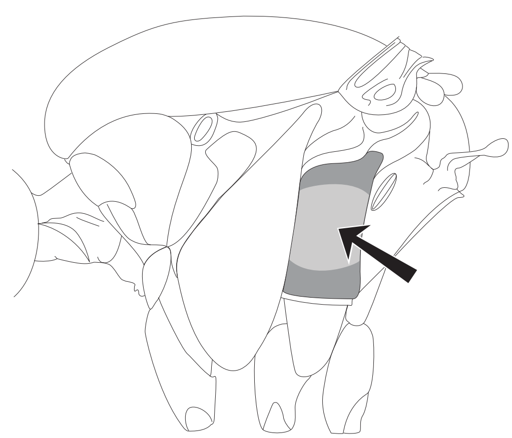


Fig. 249

9(8). Mesokatepisternum with upper patch of 5 or more broad white scales (Fig. 250); dark angulate ventral integument on mesepimeron with posterior-dorsal tip adjacent to metathoracic spiracle (Fig. 250). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. peccator***

Mesokatepisternum with no more than 2-3 broad white scales in upper patch (Fig. 251); dark ventral integument on mesepimeron with dorsal margin reaching posterior border well below level of metathoracic spiracle (Fig. 251). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. pilosus***

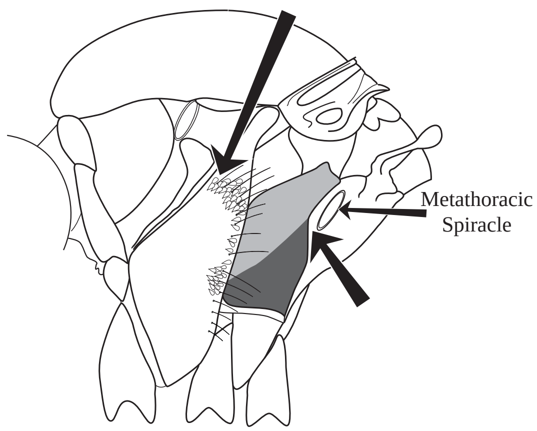


Fig. 250

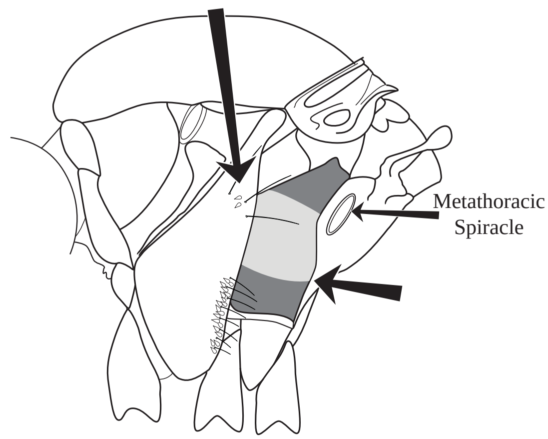


Fig. 251

## Key to Female *Culiseta* (= *Cs.*)

1. Paratergite and postspiracular areas with pale scales (Fig. 252). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .2

Paratergite without scales, postspiracular area usually without scales (Fig. 253). . . . . . . . . . . . . . . . . . . .3

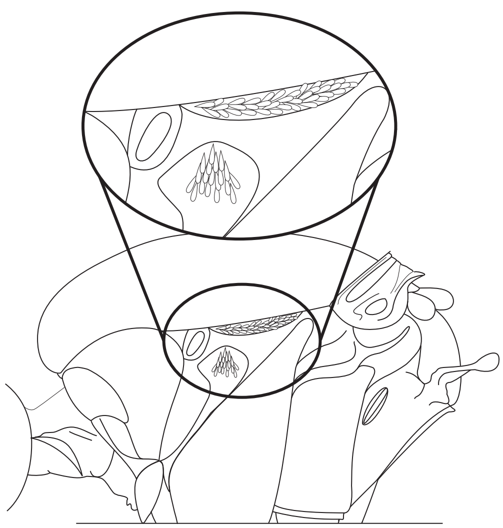


Fig. 252

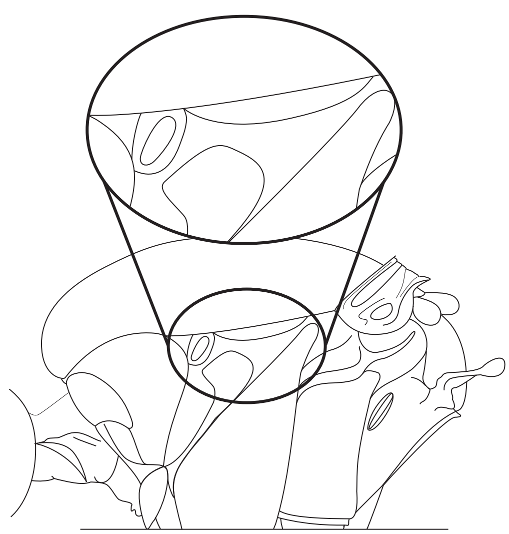


Fig. 253

2(1). Wing with speckled brown and white scales on three anterior veins (costa, subcosta, and radius) (Fig. 254); hind femur, tibia, and tarsomere 1 heavily speckled with cream-colored scales (Fig. 255). . .***Cs. inornata***

Wing scales all dark (Fig. 256); hind femur, tibia, and tarsomere 1 dark scaled (Fig. 257). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (Maryland and Pennsylvania). . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cs. impatiens***

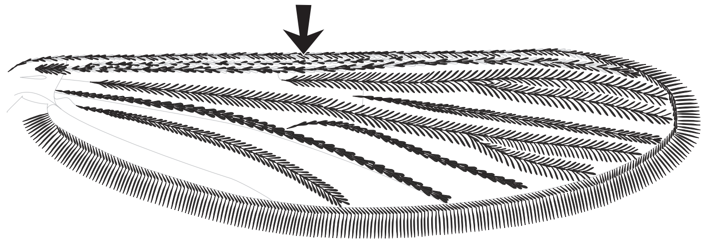


Fig. 254

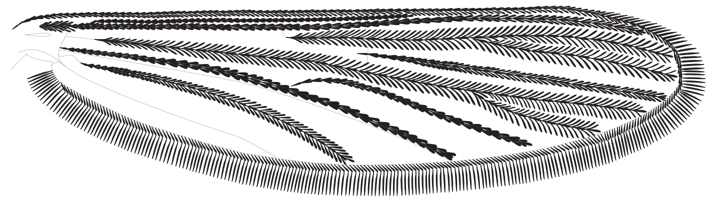


Fig. 256

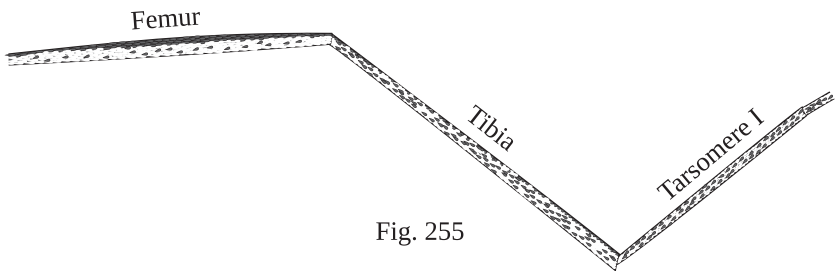



Fig. 255

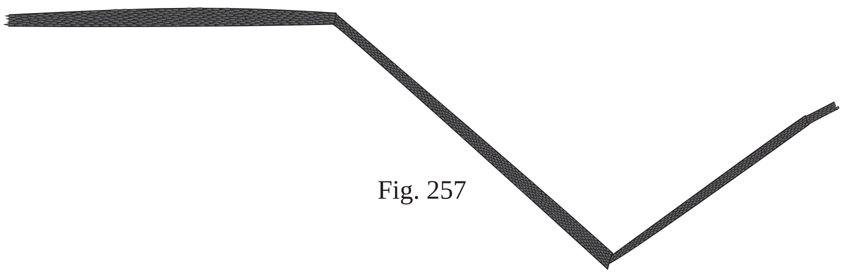


Fig. 257

3(1). Hindtarsi dark, without pale bands (Fig. 258); 1-5 prespiracular setae, usually 1-3; lower area of paratergite with 1-6 fine setae (Fig. 259). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cs. melanura***

Hindtarsi with narrow basal and apical pale bands (Fig. 260); 5 or more prespiracular setae; lower area of paratergite bare (Fig. 261). . . . . . . . . . . . . (northern species) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .4

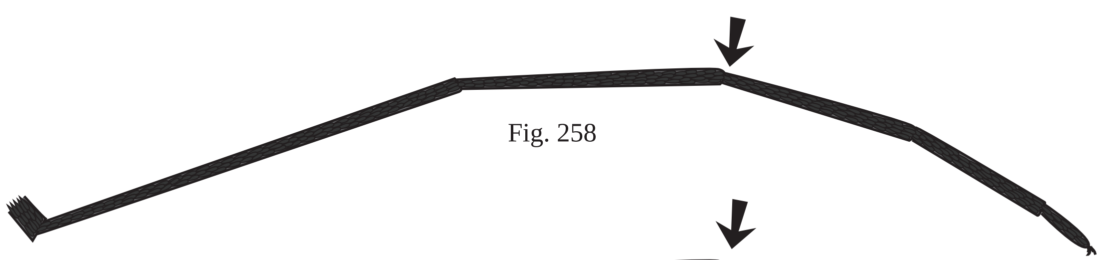


Fig. 258

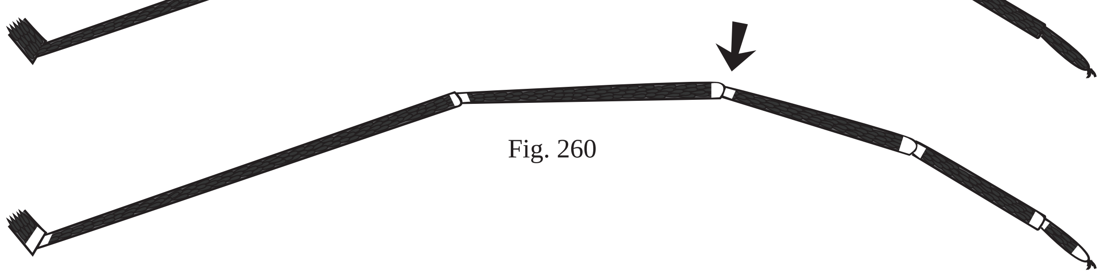


Fig. 260

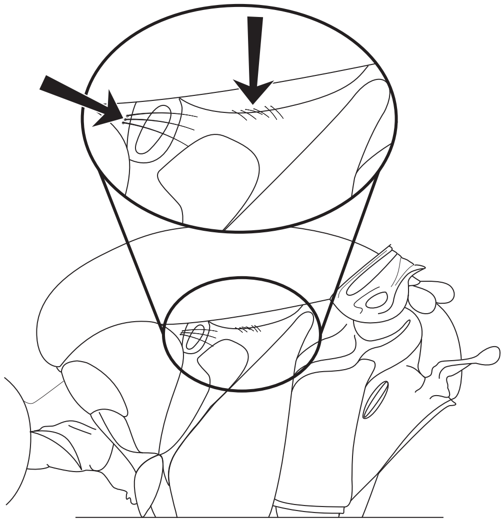


Fig. 259

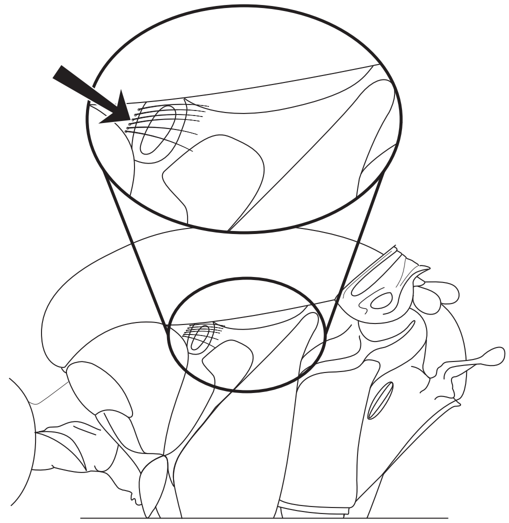


Fig. 261

4(3). Abdominal terga with narrow basal pale bands (Fig. 262); forecoxal scales primarily pale, with few dark scales (Fig. 263) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cs. morsitans***

Abdominal terga with basal and apical pale bands (Fig. 264); forecoxal scales entirely dark (Fig. 265). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cs. minnesotae***

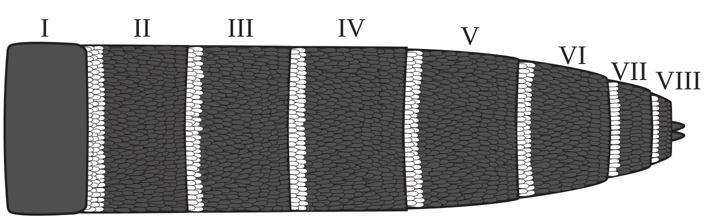



Fig. 262

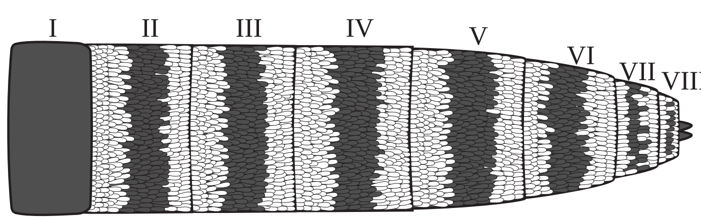



Fig. 264

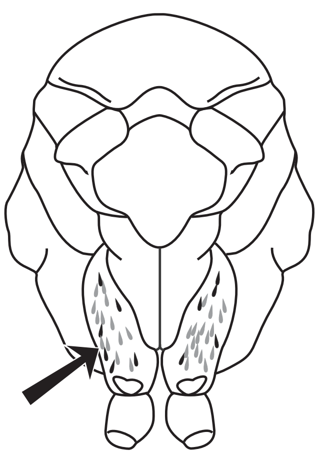


Fig. 263

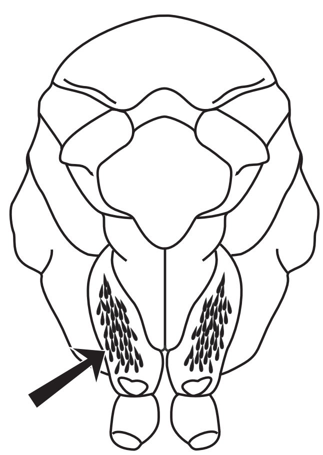


Fig. 265

# Key to Female *Mansonia* (= *Ma.*)

1. Antennal flagellomere 1 with median patch of broad black scales (Fig. 266); abdominal tergum VII with long transverse row of short black spiniform setae beneath the scales on posterior margin (Fig. 267); palpus 0.33 or slightly more length of proboscis (Fig. 268) . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ma. titillans***

   Antennal flagellomere 1 without median patch of broad black scales (compare to Fig. 266); abdominal tergum VII without spiniform setae on posterior margin (Fig. 269); palpus shorter, approximately 0.25 length proboscis (Fig. 270). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ma. dyari***

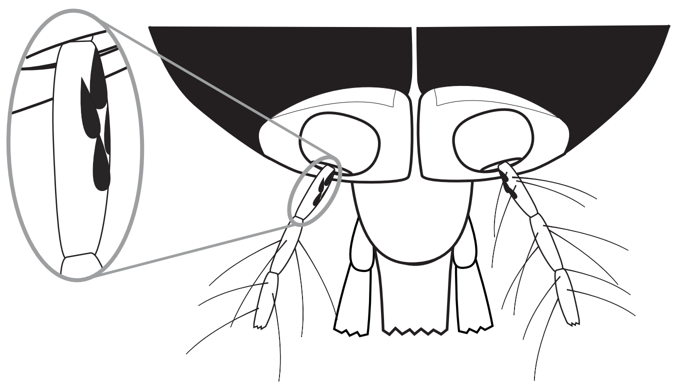


Fig. 266

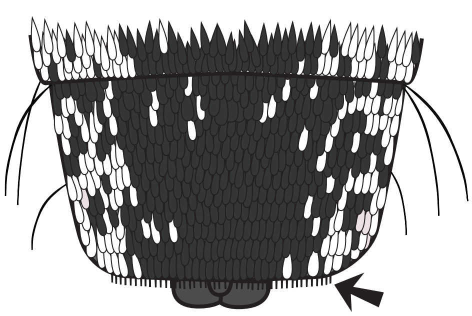


Fig. 267

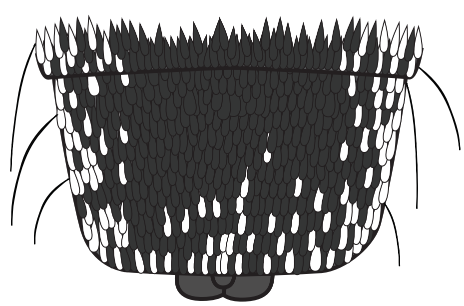


Fig. 269

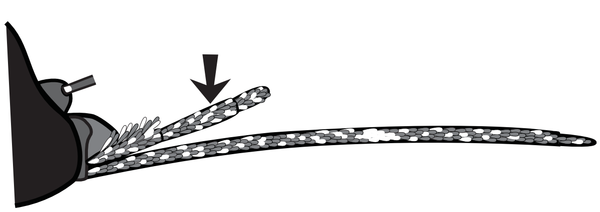


Fig. 268

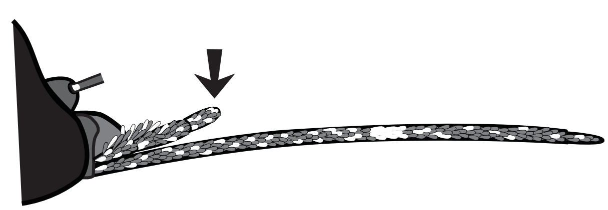


Fig. 270

# Key to Female *Orthopodomyia* (= *Or.*)

1. Lower mesokatepisternal setae 4-10 (Fig. 271); base of vein $R_{4+5}$ usually with patch of pale scales (Fig. 272); scutellum usually with white scales on lateral lobes (Fig. 273). . . . . . . . . . . . . . . . . . . . . . . . .***Or. signifera***

   Lower mesokatepisternal setae 0-3 (Fig. 274); base of vein $R_{4+5}$ usually dark scaled (Fig. 275); scutellum usually without white scales on lateral lobes (Fig. 276). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Or. alba***

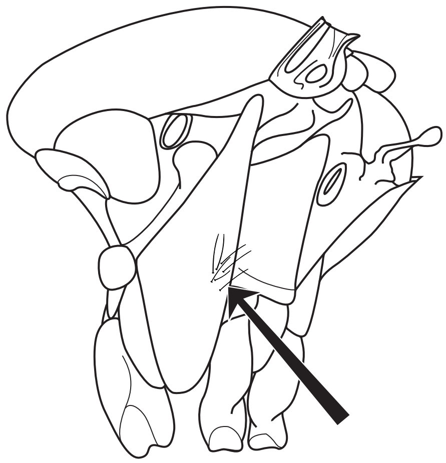


Fig. 271

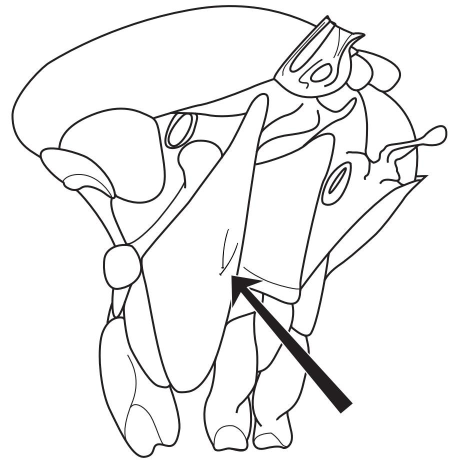


Fig. 274

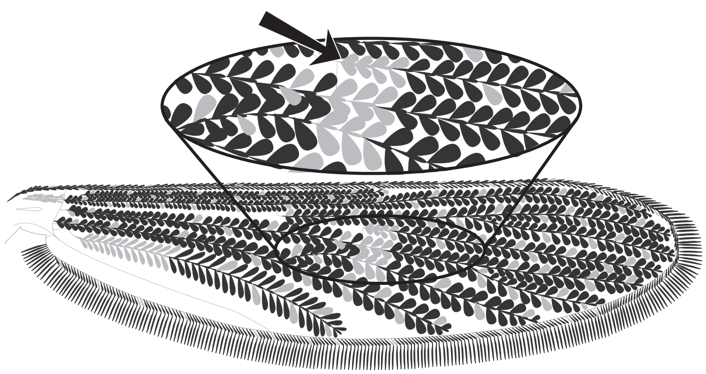


Fig. 272

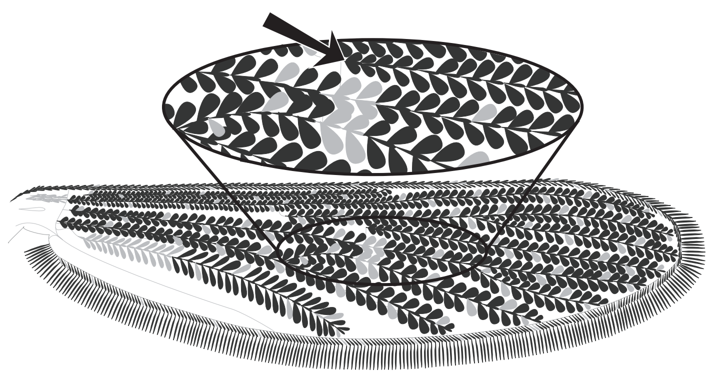


Fig. 275

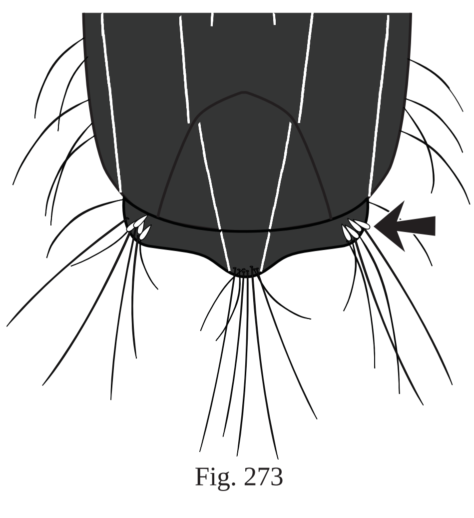


Fig. 273

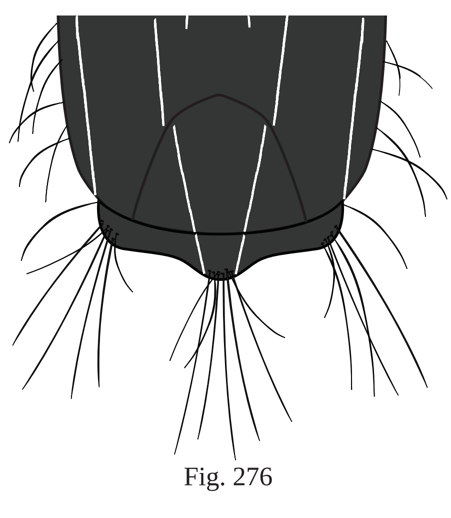


Fig. 276

# Key to Female *Psorophora* (= *Ps.*)

1. Dorsal surface of wing with black (or brown) and white scales scattered on most veins (Fig. 277); hindfemur with narrow preapical white band (Fig. 278); tarsal claws long, simple, without basal tooth (Fig. 279) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .Subgenus *Grabhamia*. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

   Dorsal surface of wing with all scales dark, or with scattered pale scales on costa and subcosta (Fig. 280); hindfemur without preapical white band (Fig. 281); tarsal claws with prominent basal tooth (Fig. 282). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

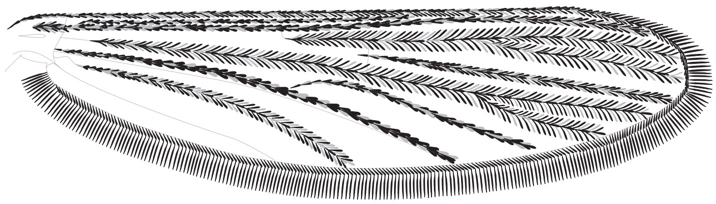


Fig. 277

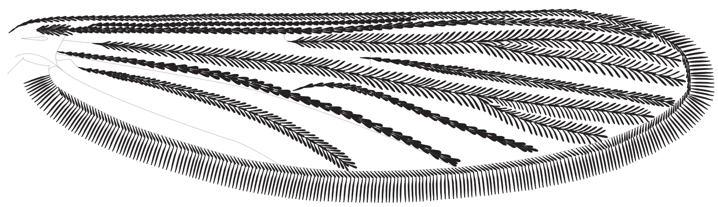


Fig. 280

Fig. 278

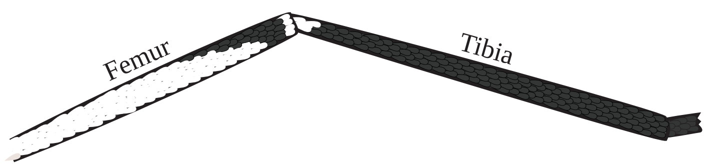


Fig. 281


Fig. 279

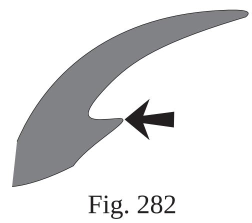


Fig. 282

2(1). Black and white scales on wing veins randomly scattered (Fig. 283); vein 1A with speckled black and white scales along entire length (Fig. 283); hindtarsomere 1 with basal and median pale bands (Fig. 284) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. columbiae***

   Brown and white scales on wing not randomly scattered on some veins (Fig. 285); vein 1A with basal 70-75% pale scaled, and apex dark scaled (Fig. 285); hindtarsomere 1 pale on basal 80-90%, without median pale band (Fig. 286). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ps. discolor***

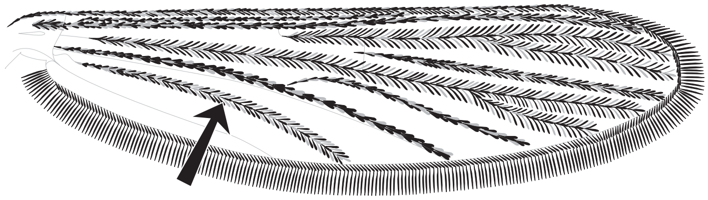
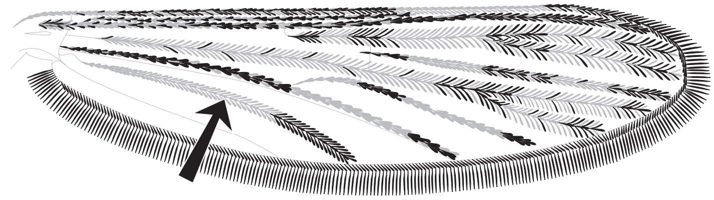


Fig. 283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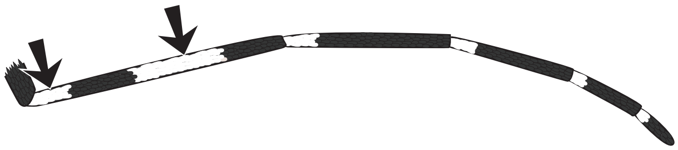
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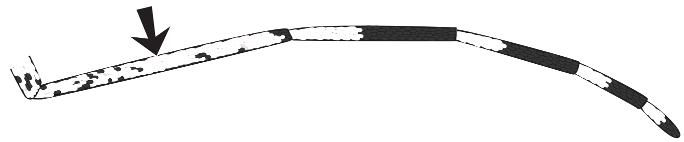


Fig. 286

3(1). Proepisternum bare, without pale scales (Fig. 287); erect scales on occiput seta-like, not flattened and wide at apex, but with small notch at tip (Fig. 288); mesepimeron with 5-11 lower setae (Fig. 289); exceptionally large species with erect black scale tufts on apex on hindfemur (Fig. 290). . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . . . . . . . Subgenus *Psorophora*. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .4

Proepisternum with pale scales (Fig. 291); erect scales on occiput with apex flattened, wide, and with deep fork (Fig. 292); mesepimeron with 1-2 lower setae (Fig. 293); hindfemur without tufts of erect black scales on apex (Fig. 294). . . . .Subgenus *Janthinosoma*. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5

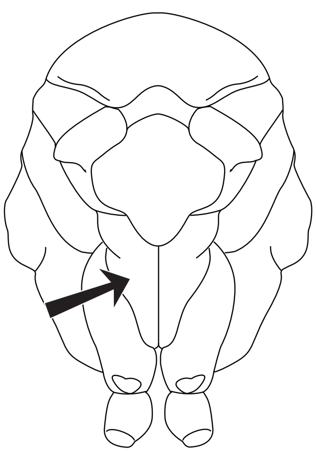
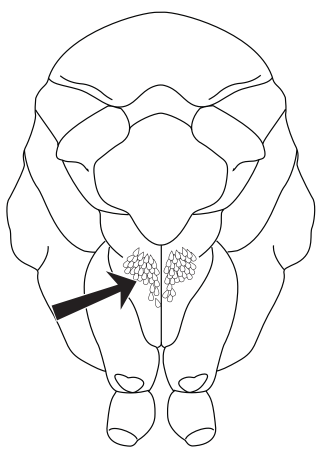


Fig. 287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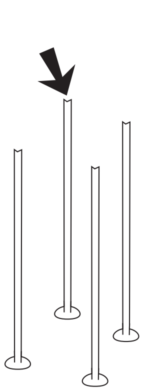
Fig. 288

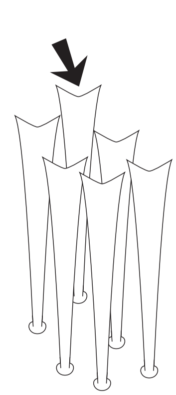
Fig. 292

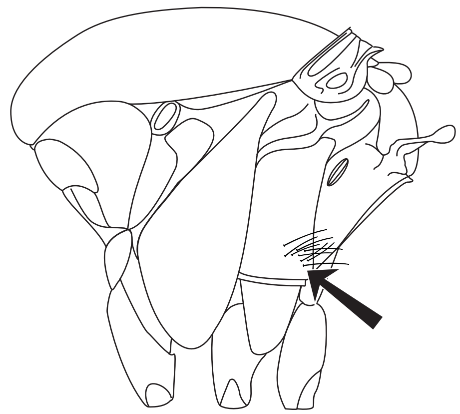

Fig. 289

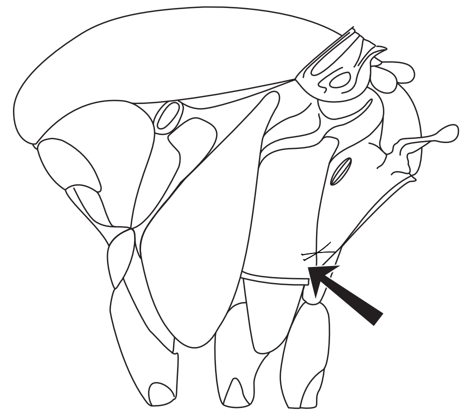

Fig. 293

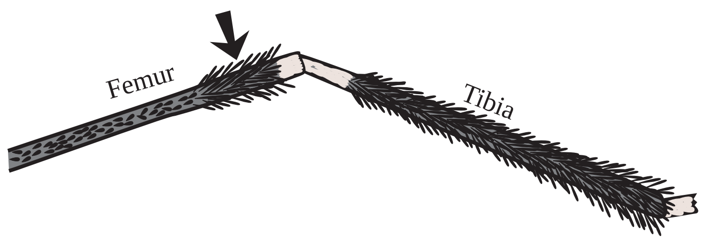


Fig. 290


Fig. 294

4(3). Scutum with median-longitudinal stripe of golden-brown scales extending across prescutellum almost to scutellum (Fig. 295); proboscis with golden scales on distal half, tip dark (Fig. 296); postprocoxal membrane with white scale patch (Fig. 297). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. ciliata***

Scutum with median-longitudinal stripe of black scales ending at prescutellar area, with white scales on prescutellum (Fig. 298); proboscis dark scaled (Fig. 299); postprocoxal membrane without scales (Fig. 300). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. howardii***

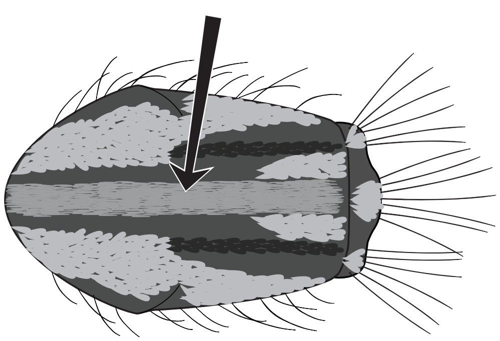

Fig. 295

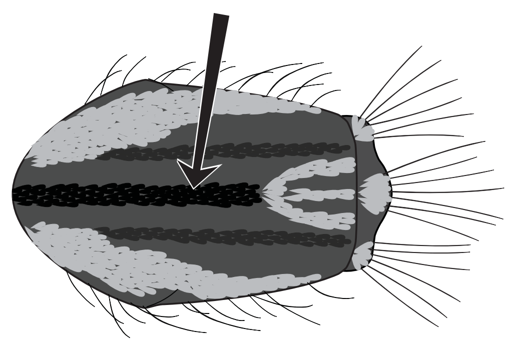

Fig. 298

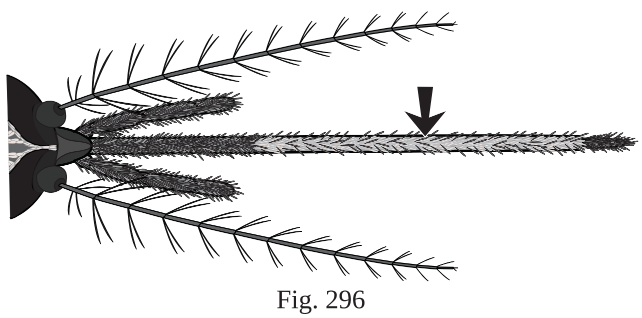

Fig. 296

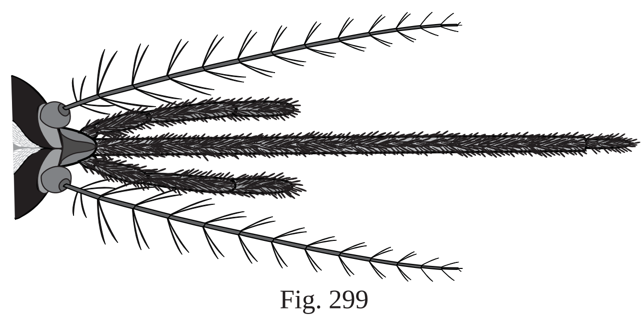

Fig. 299

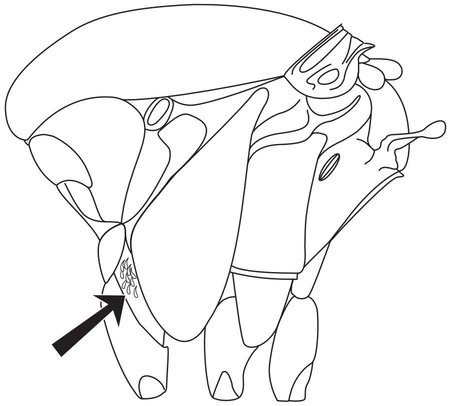

Fig. 297

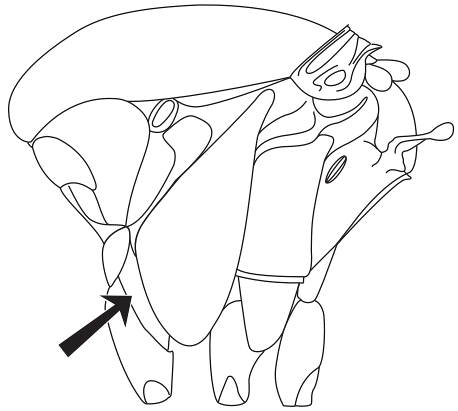

Fig. 300

5(3). Hindtarsomeres dark scaled (Fig. 301); abdominal tergum II with distinct apical pale band and terga III-VI usually with submedian pale apical patches (Fig. 302); longest antennal whorl setae exceptionally short, less than half palpus length (Fig. 303). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ps. cyanescens***

At least one of hindtarsomeres 3-5 with pale scales (Fig. 304); terga II-VI purple, with small apicolateral patches of white scales (Fig. 305); longest antennal whorl setae distinctly more than half length of palpus (Fig. 306). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

Fig. 301

Fig. 304

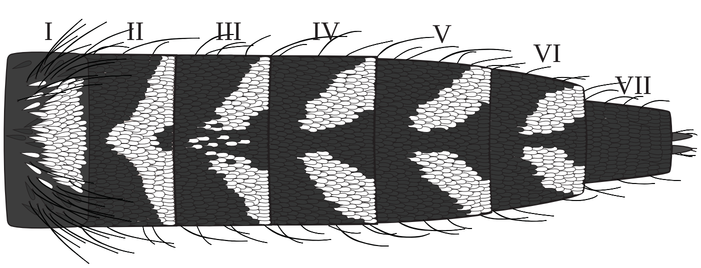


Fig. 302

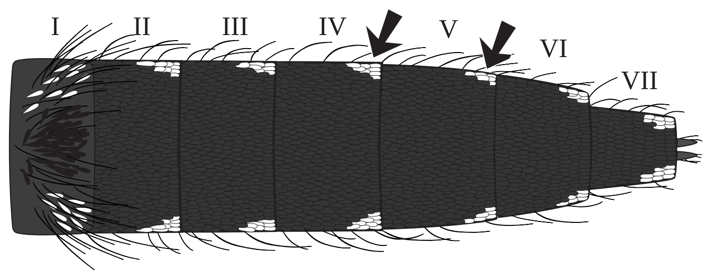


Fig. 305

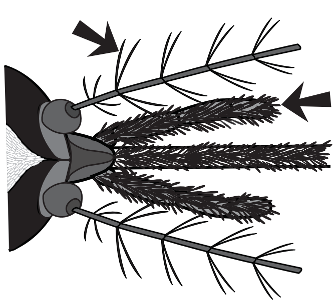

Fig. 303

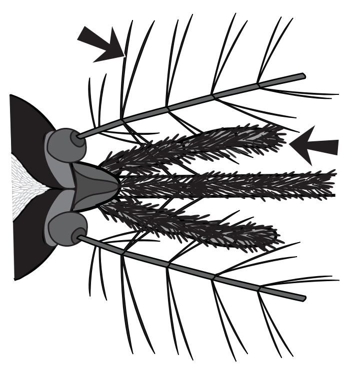

Fig. 306

6(5). Scutum without distinct color pattern, with scattered and mixed pale and brown scales (Fig. 307); base of proboscis and base of palpus with golden-orange tint from side view; erect forked scales on occiput golden-orange; tergum I with median patch of purple scales (Fig. 308); hindtarsomere 3 with white scales on apex, and 4-5 entirely white (Fig. 309); subspiracular area with white scales (Fig. 310). . . . . ***Ps. ferox***

Scutum with distinct color pattern, median-longitudinal third with dark brown scales, lateral thirds with white or yellow scales (Fig. 311); base of proboscis and palpus with dark purple scales; erect forked scales on occiput very pale yellow or white; tergum I primarily with median patch of creamy white scales (Fig. 312); hindtarsomere 3 usually without white scales on apex, and at least tarsomere 4 entirely or partially white (Fig. 313); subspiracular area normally without scales (Fig. 314). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

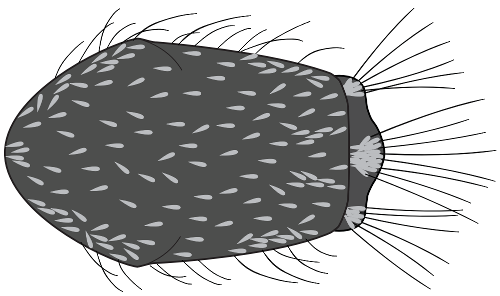
Fig. 307

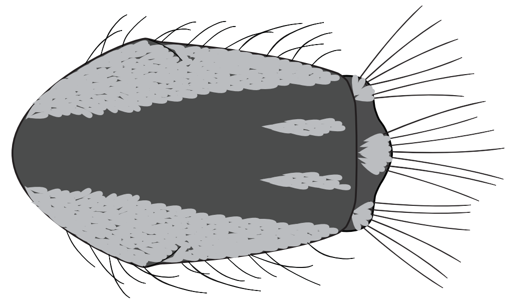
Fig. 311

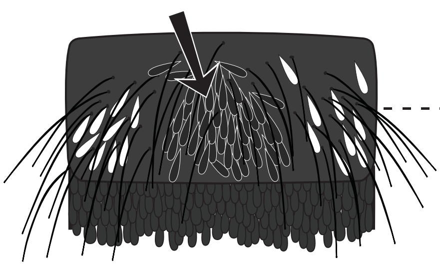
Fig. 308

- - - - -abdominal tergum I- - - - -

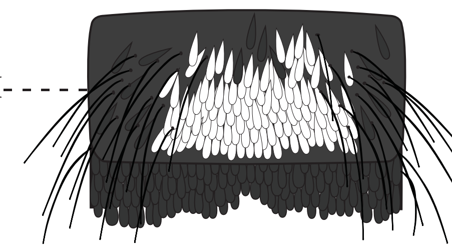
Fig. 312


Fig. 309


Fig. 313

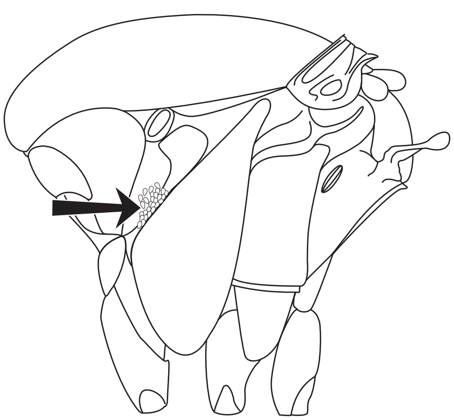
Fig. 310

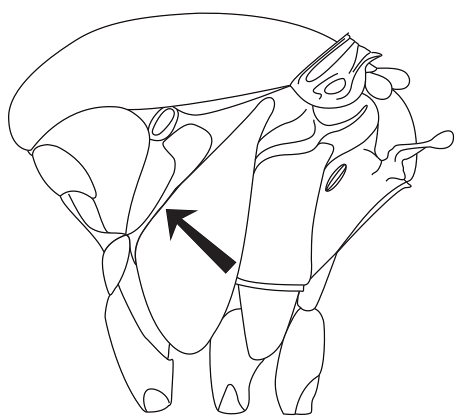
Fig. 314

7(6). Postspiracular area with 7-12 setae and abundant pale scales (Fig. 315); hindtarsomere 5 white (Fig. 316); medium to large species. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. horrida***

Postspiracular area normally with 3-7 setae and without scales, or with 1-4 pale scales (Fig. 317); hindtarsomere 5 dark scaled (Fig. 318); small species. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. mathesoni***

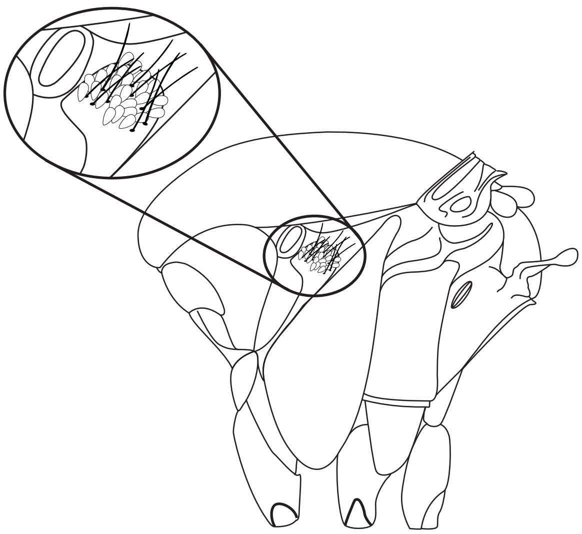

Fig. 315

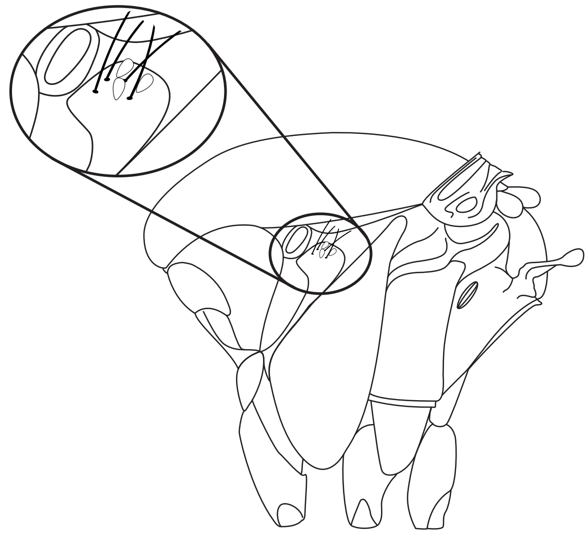

Fig. 317

Fig. 316

Fig. 318

## Key to Female *Uranotaenia* (= *Ur.*)

1. Scutum with median longitudinal row of shiny iridescent blue scales (Fig. 319); hindtarsomeres entirely dark scaled (Fig. 320); iridescent blue scales cover at least 50% of vein CuA before CuA-mcu fork (Fig. 321). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ur. sapphirina***

Scutum without median longitudinal row of iridescent scales (Fig. 322); hindlegs with tarsomeres 4 and 5 entirely pale and tarsomere 3 pale apically (Fig. 323); iridescent blue scales cover 30% or less of vein CuA before CuA-mcu fork (Fig. 324). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ur. lowii***

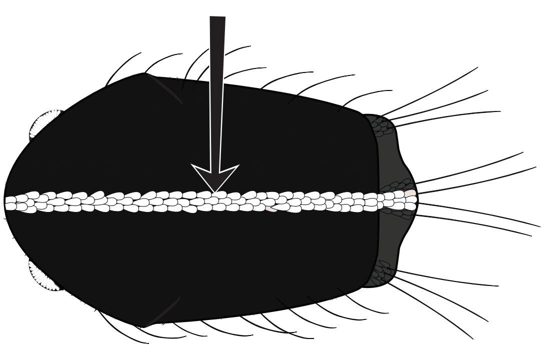

Fig. 319

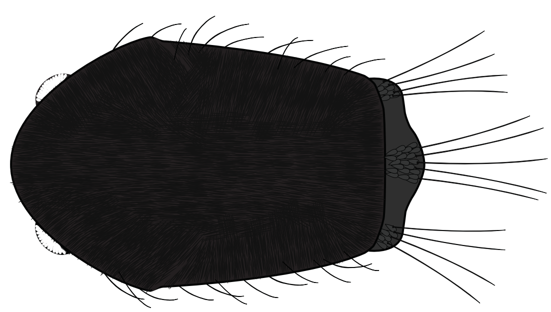

Fig. 322

Fig. 320

Fig. 323

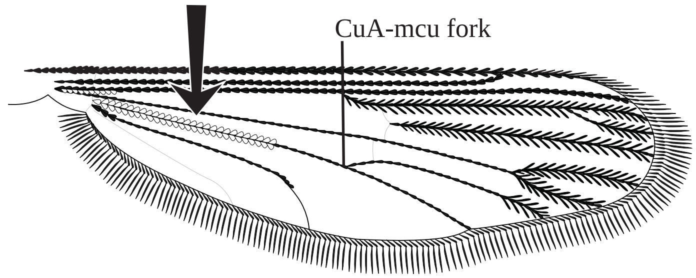


Fig. 321

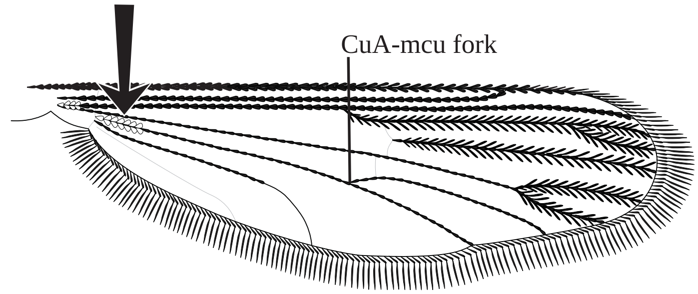


Fig. 324

## VIII. THE IMPORTANCE OF IDENTIFYING LARVAL INSTARS

Surveillance for and control of mosquito larvae can provide major cost-saving and disease prevention impacts that significantly boost the overall effectiveness of mosquito control programs. For this to happen, the collected larvae must be identified and problem pest and/or vector species and their larval habitats need to be targeted before control measures are attempted. However, not just any larva should be identified. Upon hatching from the egg the development of each larval specimen involves four growth periods (small to large) called larval instars, with each of these periods terminated by the shedding of the larval skin (exuviae). Upon shedding the fourth larval exuviae the specimen becomes a pupa. <u>Only larvae in the fourth instar should be identified</u>. But, determining those specimens in the fourth instar can present problems. Major advantages for determining specimens in the fourth instar are they have reached the maximum size for their species, they have acquired all of the species specific characters, and they can be identified by binocular dissection microscopes, while specimens in earlier instar periods are smaller, have not acquired all of their characters and they need to be examined using compound microscopes. Adult mosquitoes come in various sizes due to differences in abundance of larval food and the differing sizes of species. Thus, larval specimens also vary in size and size alone cannot be used to determine which specimens are in the fourth instar.

With experience mosquito control personnel develop a "sense" for the size of the larvae in the four larval instar periods for the most common species they collect. However, this practice is an educated guess at best, because specimens in the late third instar can be nearly identical to specimens in the early fourth instar. This is because growth continues and changes occur within a given instar, as well as by shedding the exuviae between the instar periods.

To help alleviate these identification problems we are providing a Table (page 80) and illustrations (Figs. 326-337) of the four larval instars of *Aedes aegypti* that demonstrate the sequential acquisition of certain characters that accurately identify the four larval instar periods of culicine and anopheline mosquitoes. Of major importance in the recognition of these characters are Macfie (1917), Hurlbut (1938), Baisas (1947), Belkin (1962), Belkin and McDonald (1956), Bohart and Washino (1957), Dodge (1964), Knight (1964), MacKenzie (1971), Harrison and Rattanarithikul (1973), and Savignac and Maire (1981). The characters are identified by their absence or presence, or incomplete or complete sclerotization of a structure. Other workers have used linear or biometric methods for separating the instars, but those methods are more prone to human errors in linear measurements and imperfect slide preparations that may alter measurements. The characters presented in the following Table are less tedious and highly accurate.

Not every specimen or every field collection needs to be conclusively identified with regard to instar number. However, like academic research efforts, many control programs conduct specialized targeted studies, e.g., length of larval development periods for certain species, testing larvae for pesticide resistance levels, and testing the efficacy of liquid and granular biological pesticides, which requires larvae in the first, second, and third instar periods, because larvae in the last half of the fourth instar stop feeding and should not be targeted for control using these methods.

<u>Two characters define the first instar</u>: (1) the presence of a spine on top of the head that is used to rupture the egg during hatching called an Egg Burster (EBu), and (2) the lack of a ventral brush (seta 4-X) on the ventral portion of the tenth segment. <u>Three characters define the second instar</u>: (1) the

presence of seta 7-P on the prothorax, (2) the absence of seta 8-M on the mesothorax, and (3) the absence of seta 7-T on the metathorax. Four characters define the third instar: (1) the presence of 8-M on the mesothorax, (2) the presence of 7-T on the metathorax, (3) incomplete sclerotization on the siphon, and (4) incomplete sclerotization on the saddle. Two characters define the fourth instar: (1) complete sclerotization of the siphon, and (2) complete sclerotization of the saddle. Collectors targeting the largest larvae and using the last two characters will quickly learn to recognize specimens in the fourth instar.

There are a couple of additions/exceptions to these defining characters. First, larvae of the first to third instars may have a broad collar (Harbach and Knight 1980) or a cervical collar (Christophers 1960) on the back of the head, while larvae in the fourth instar have a very narrow sclerotized collar. This is particularly obvious in *Anopheles* larvae. Second, the only sabethine mosquito in our region, *Wyeomyia smithii*, has a larval ventral brush with only one pair of simple setae 4-X, while seta 4-X on larvae in the second to fourth instars of all the other species in the Mid-Atlantic Region have multiple pairs of simple or branched setae.

## IX. ACQUISITION OF CHARACTERS TO SEPARATE THE LARVAL INSTARS

| | Instars | | | |
|---|---|---|---|---|
| Characters | **1st** | **2nd** | **3rd** | **4th** |
| Egg Burster | + | 0 | 0 | 0 |
| Ventral Brush (Seta 4-X) | 0 | + | + | + |
| Seta 7-P | 0 | + | + | + |
| Seta 8-M | 0 | 0 | + | + |
| Seta 7-T | 0 | 0 | + | + |
| Siphon Sclerotization | i | i | i | c |
| Saddle Sclerotization | i | i | i | c |

0 = absent
+ = present
c = complete
i = incomplete

**Figures:**

**1st Instar**: 325-328 **3rd Instar**: 332-334
**2nd Instar**: 329-331 **4th Instar**: 335-337

Note: This section includes a table (above) and labeled illustrations of the four larval instars of *Aedes aegypti* that demonstrate the sequential acquisition of certain characters that accurately identify the four larval instar periods of culicine and anopheline mosquitoes.

The acquisition sequence of these characters apply to all the species identified in this key with the exception of *Toxorhynchites* and *Wyeomyia*.

A distinguishing character found only on 1st instar larvae is the egg burster (EBu). This specialized area is found on the dorsum of the head and consists of a dark central cone-like structure that is thought to aid in opening the egg during hatching (Fig. 325).

**1st Instar with EBu**

Fig. 325

## First Instar

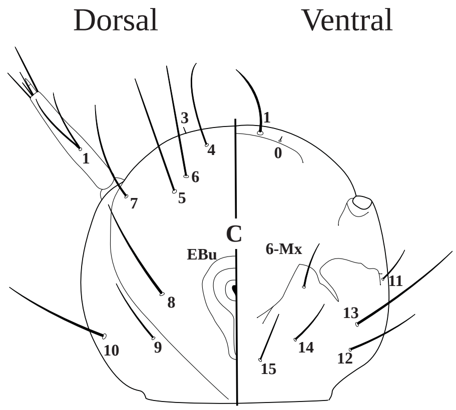


Fig. 326

## Second Instar

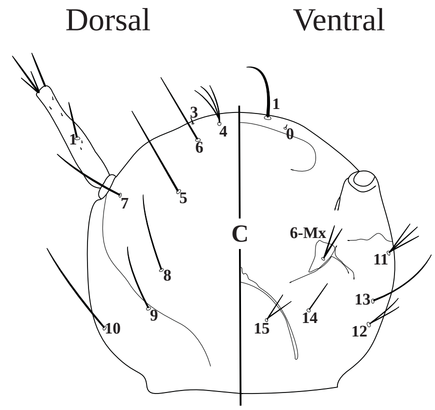


Fig. 329

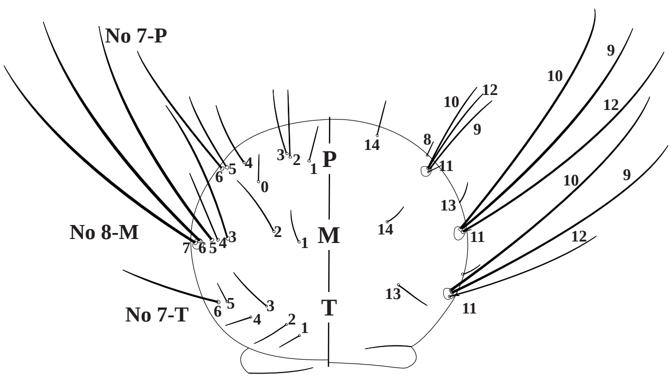


Fig. 327

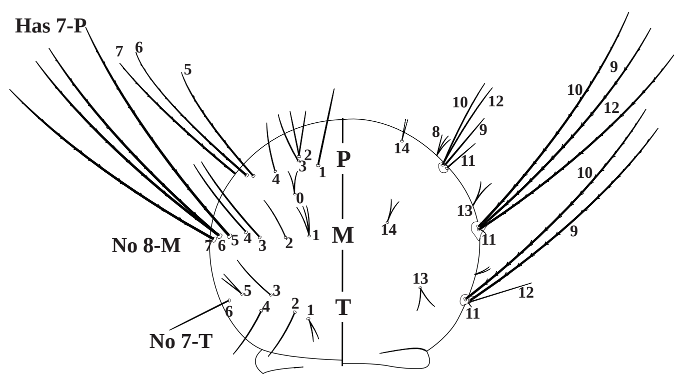


Fig. 330

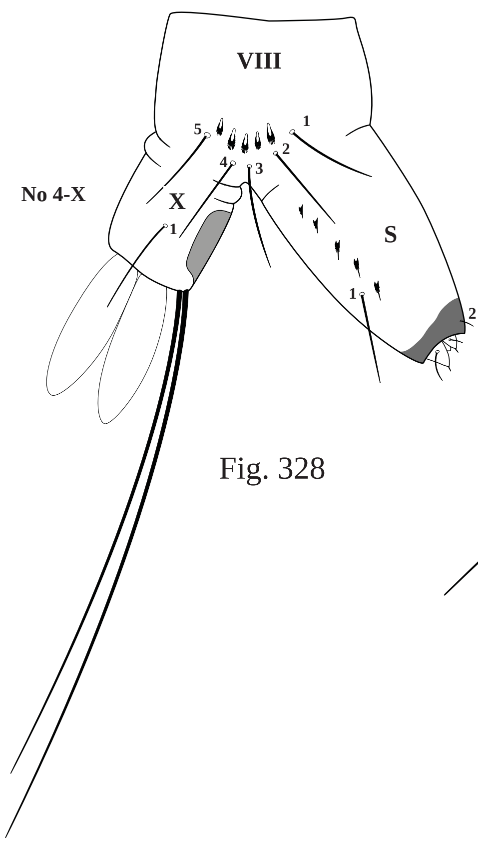


Fig. 328

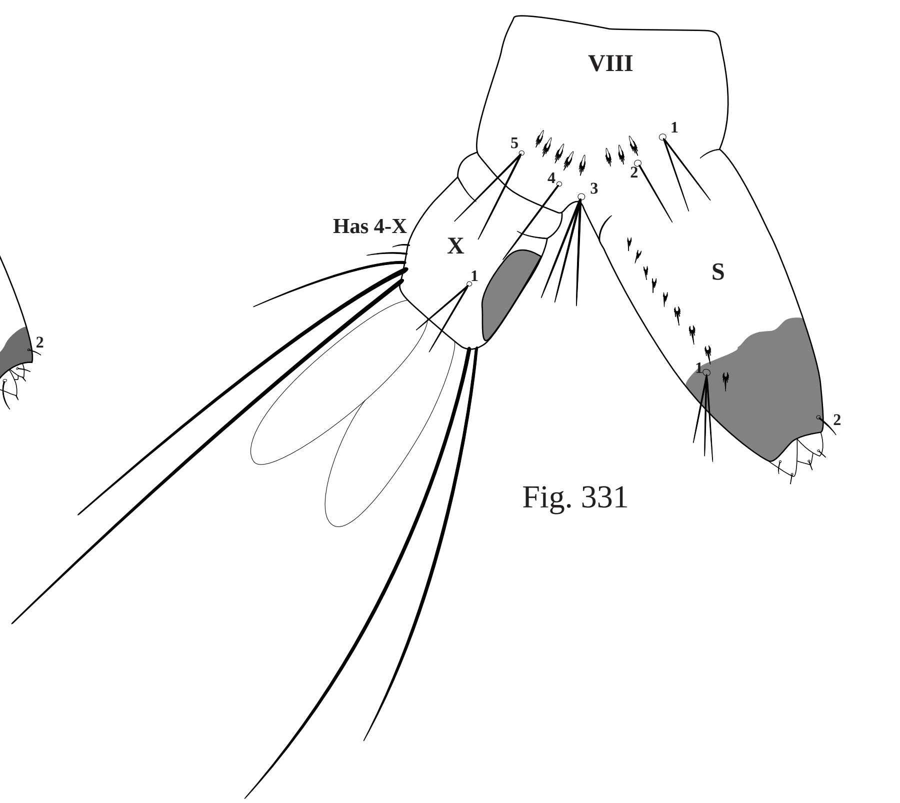


Fig. 331

# Third Instar

# Fourth Instar

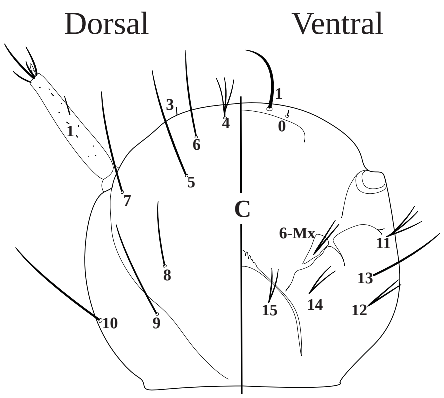


Fig. 332

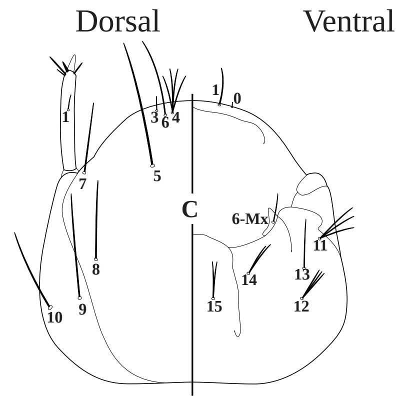


Fig. 335

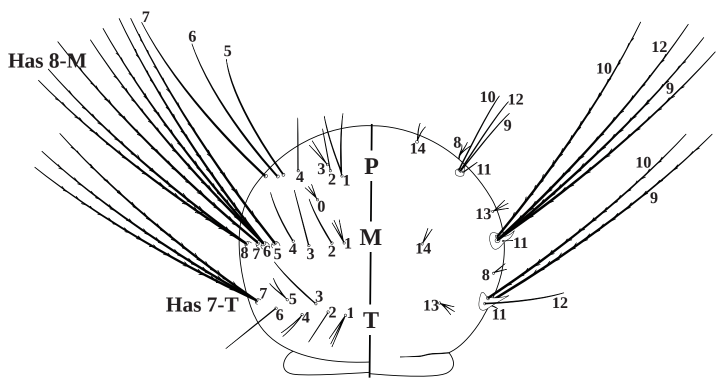


Figure 333

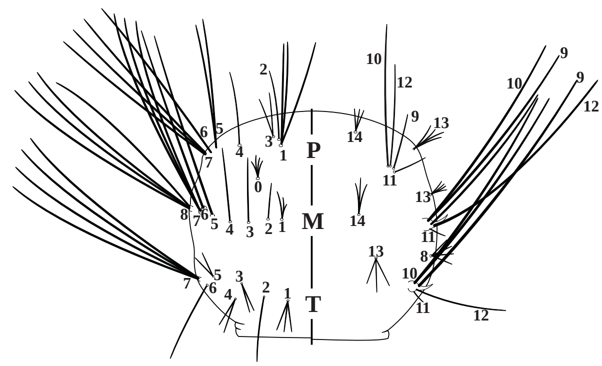


Fig. 336

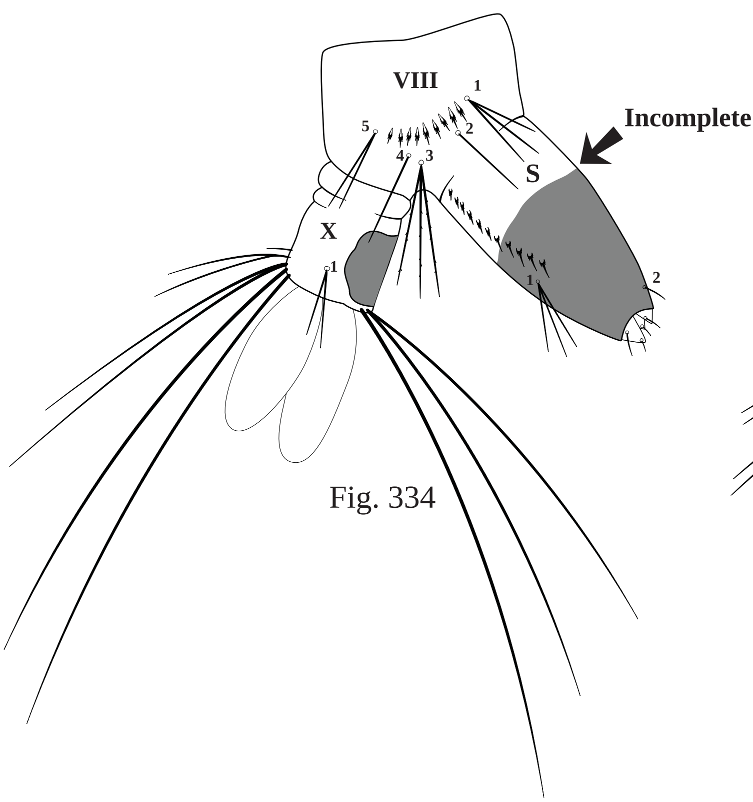


Fig. 334

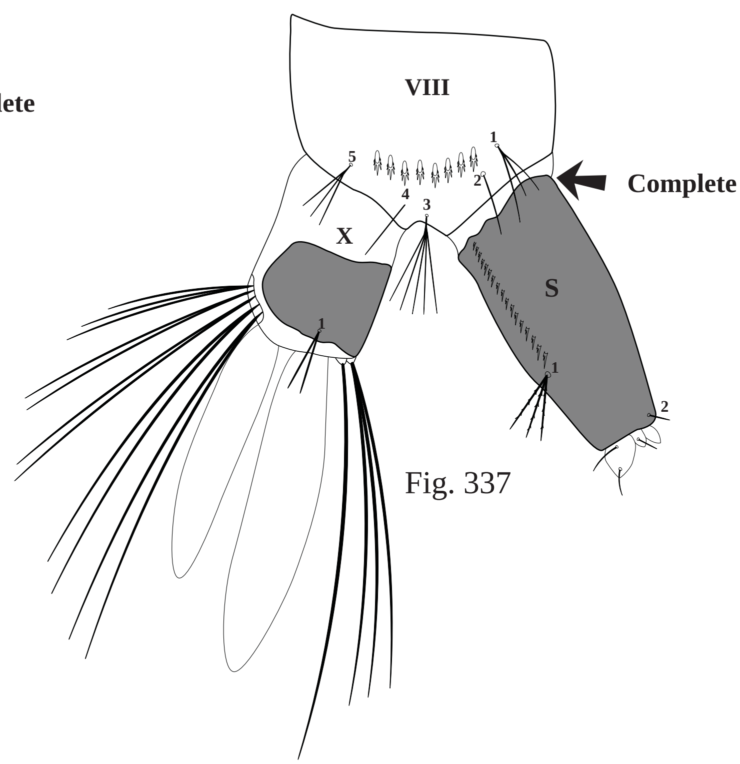


Fig. 337

# X. THE FOURTH INSTAR LARVAL KEYS

# LARVAL MORPHOLOGY

**Fourth Instar *Anopheles* Larva**

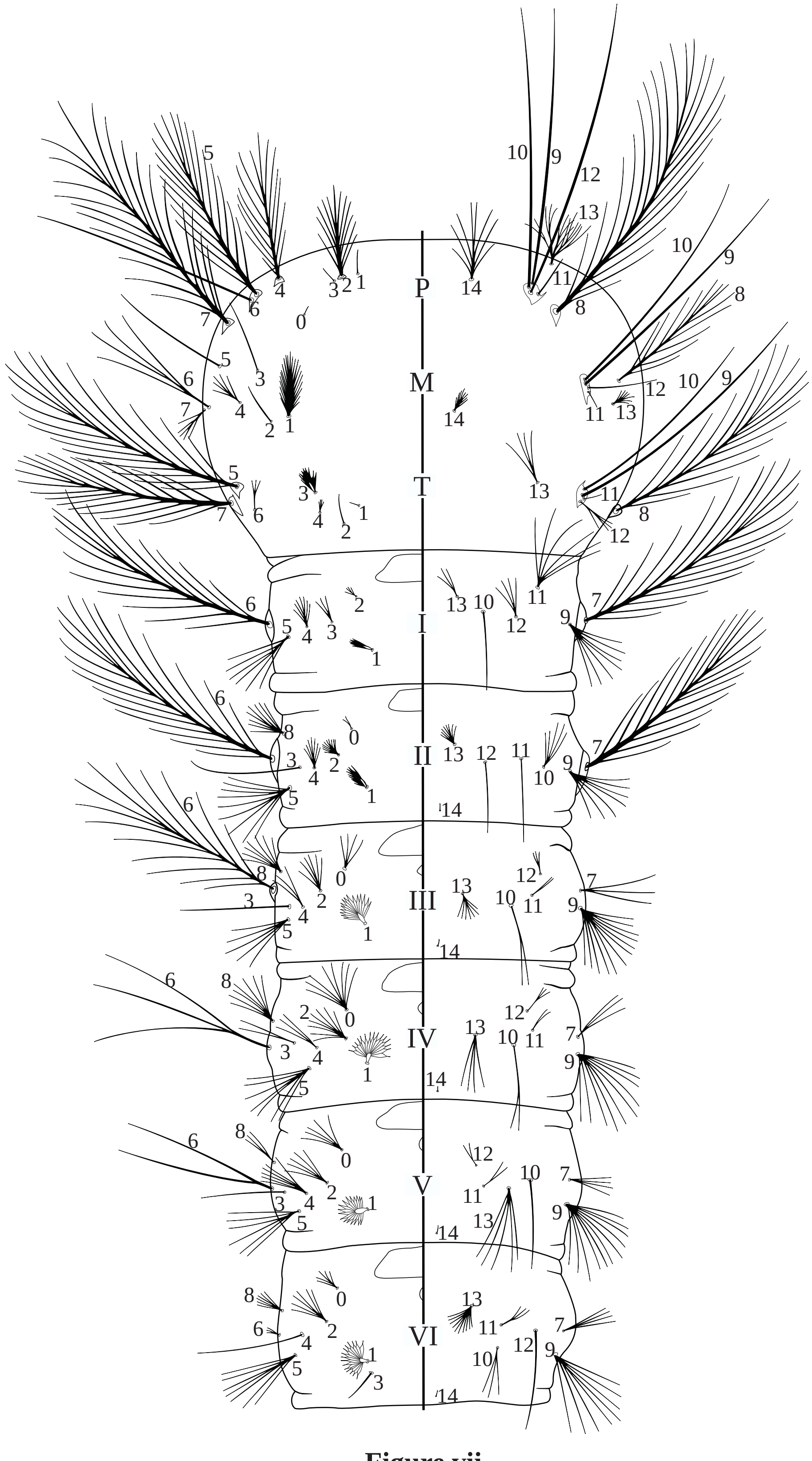


**Figure vii**

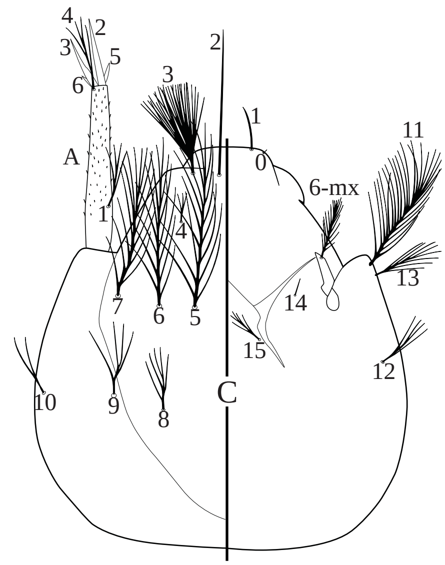


**Figure viii**

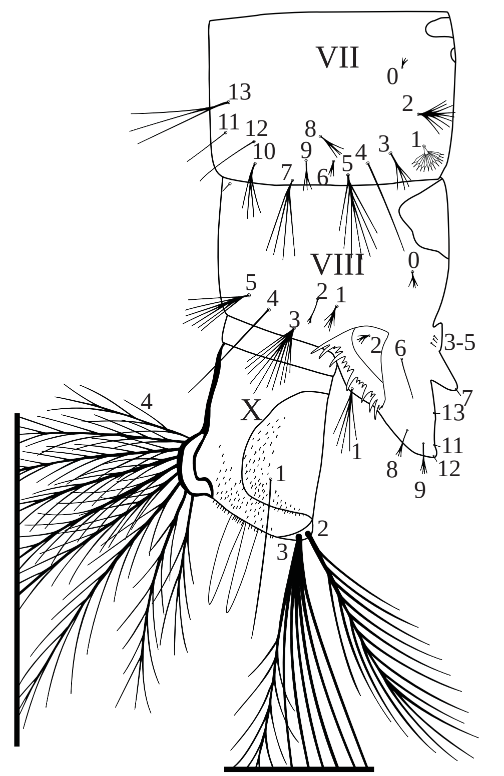


**Figure vix**

***Anopheles crucians s.l.***

## Fourth Instar *Culex* Larva

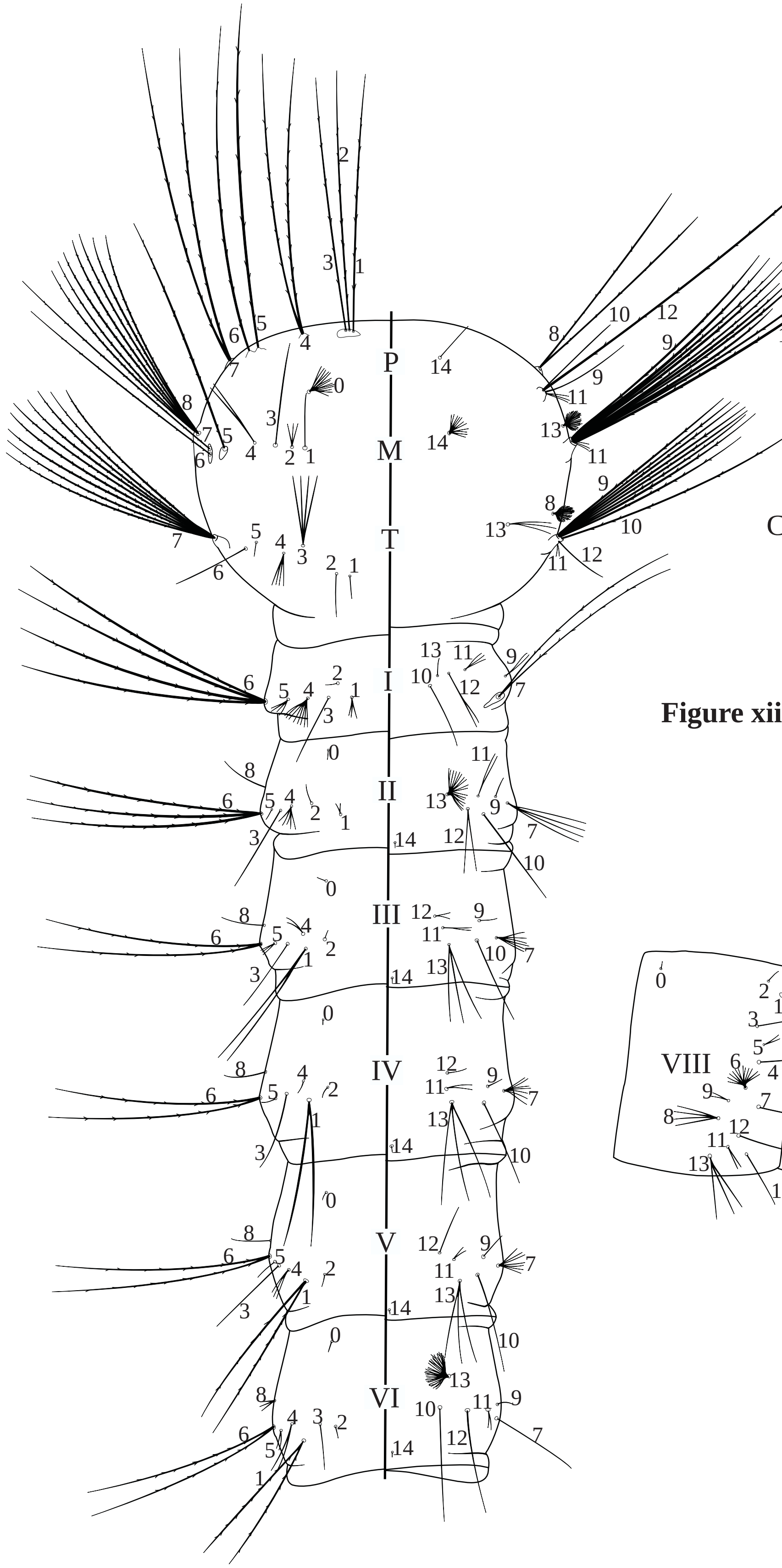


**Figure x**

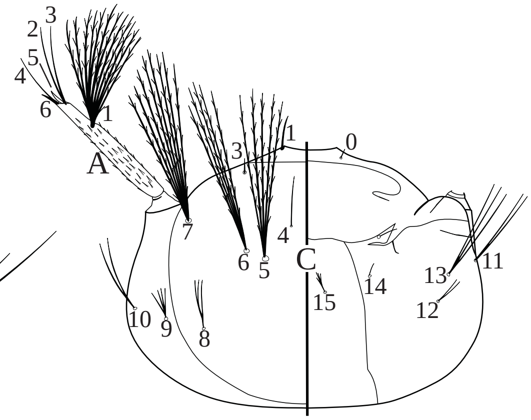


**Figure xi**

Pecten Spine

**Figure xii**

Comb Scale

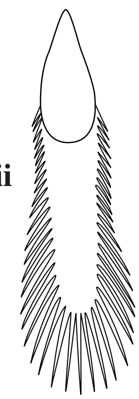

**Figure xiii**

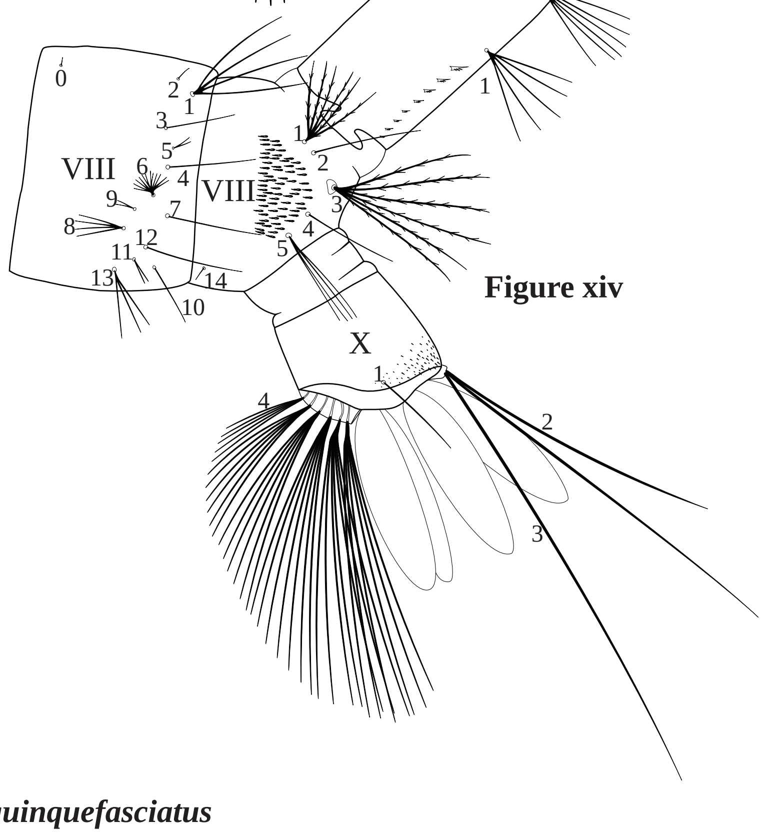


**Figure xiv**

*Culex quinquefasciatus*

# Key to Genera of Fourth Instar Larvae

1. Abdominal segment VIII without siphon (Fig. 338); with palmate setae on some segments (Fig. 339) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . **Genus *Anopheles* (p. 114)**

   Segment VIII with long or short siphon (Fig. 340); without palmate setae on abdominal segments (Fig. 341). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

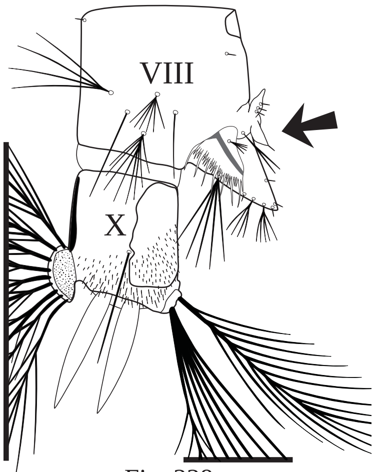

Fig. 338

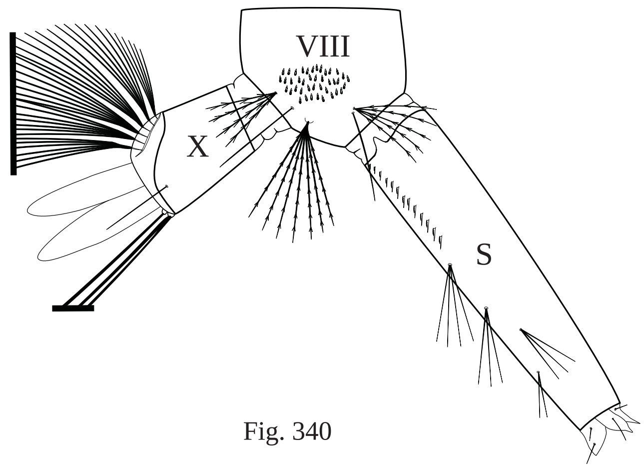

Fig. 340

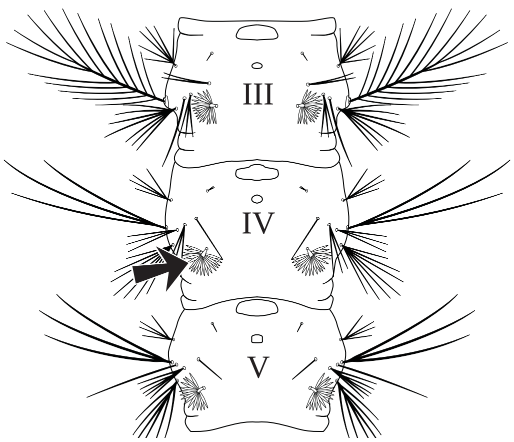

Fig. 339

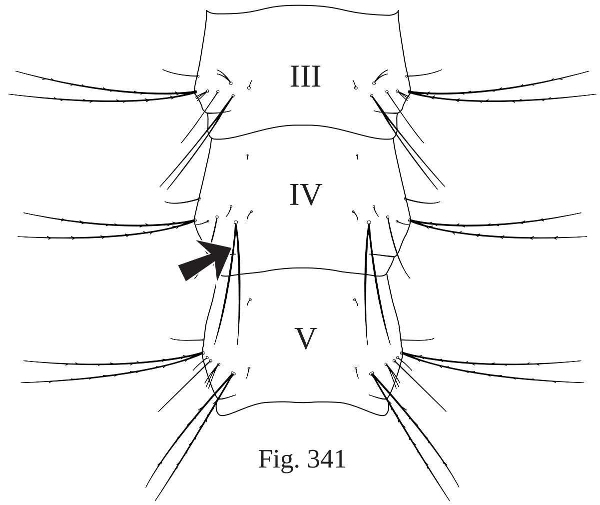

Fig. 341

2(1). Pecten spines present (at least 2-3 pairs) on siphon (Fig. 342). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

   Pecten spines absent (Fig. 343). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

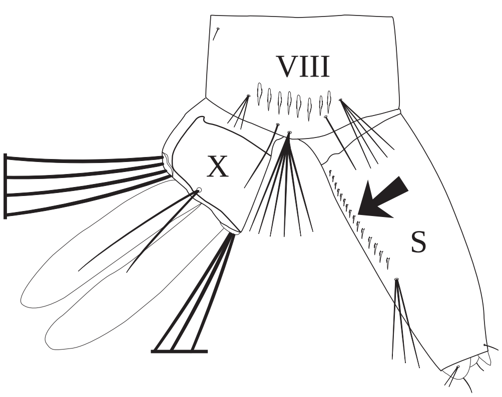

Fig. 342

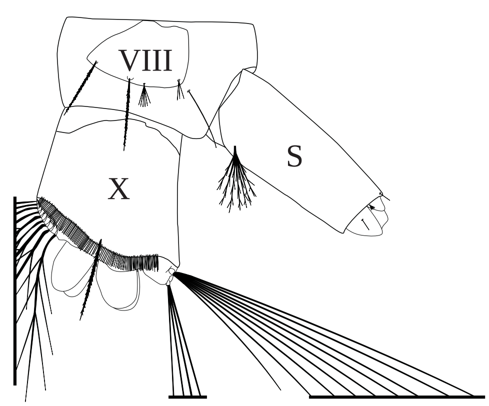

Fig. 343

3(2). Siphon with multiple pairs of seta 1-S (Fig. 344). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

Siphon with one ventral or subventral pair of seta 1-S (Fig. 345), except *Aedes provocans*, a northern species that has ventral, subventral and dorsal pairs of seta 1-S and some widely separated pecten spines (see Fig. 366).. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .5

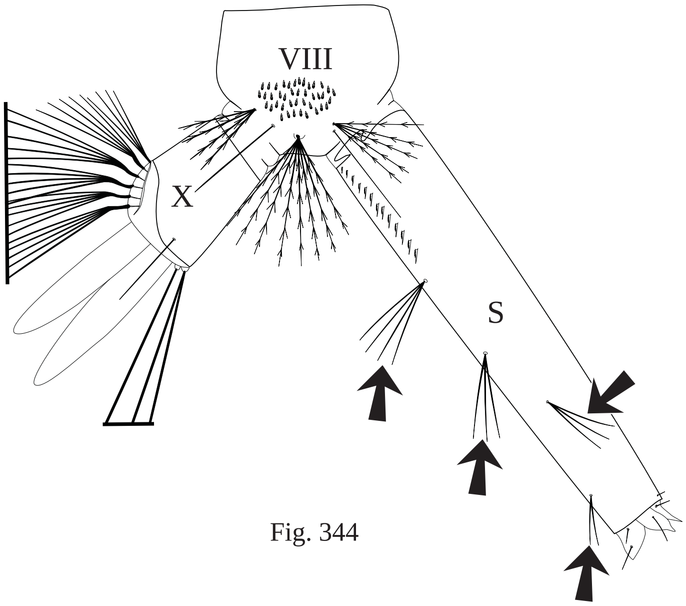


Fig. 344

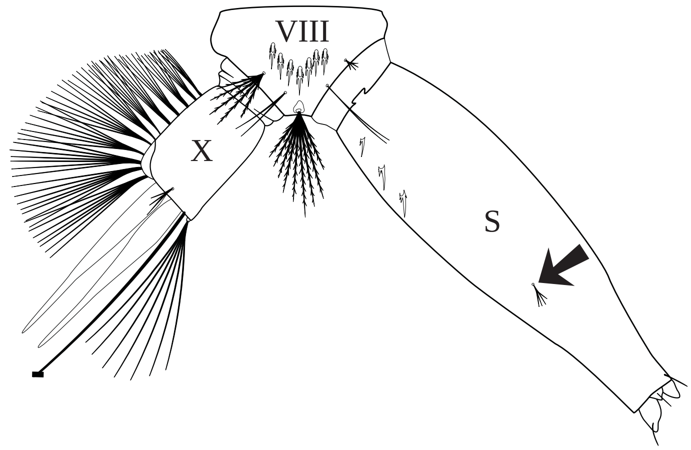


Fig. 345

4(3). Siphon without pair of seta 1-S at extreme base of pecten (Fig. 346). . . . . . . . . . . . . . . . . .***Culex*** **(p. 123)**

Siphon with pair of setae 1-S at or near base of pecten (Fig. 347). . . . . . . . . . . . . . . . . . .***Culiseta*** **(p. 130)**

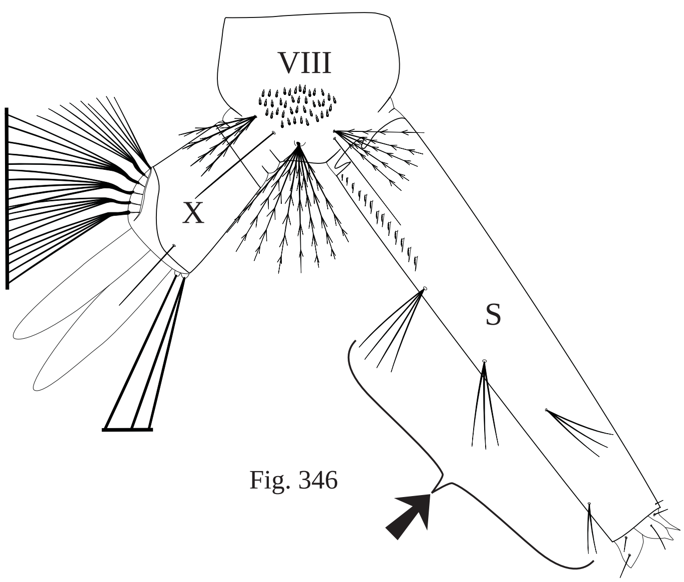


Fig. 346

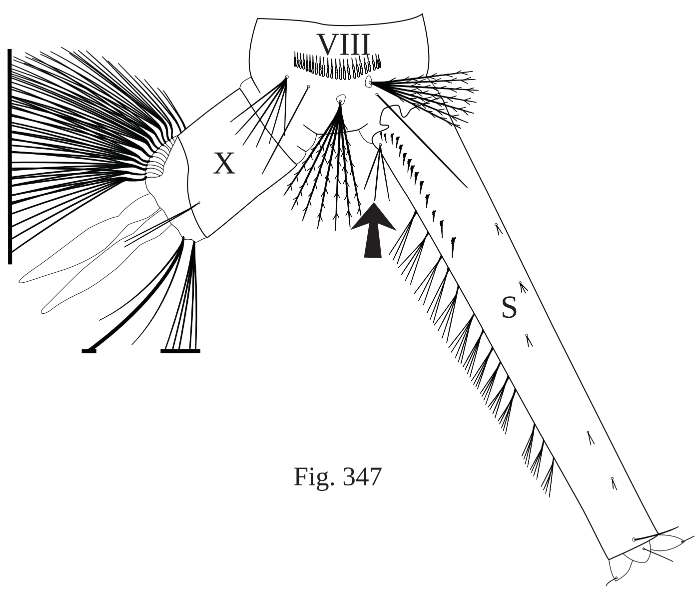


Fig. 347

5(3). Head longer than wide, with setae 5,6-C stout and spiny (Fig. 348); abdominal segment VIII with large lateral plate containing 6-10 stout comb scales on posterior margin (Fig. 349). . . . . . ***Uranotaenia*** **(p. 140)**

Head wider than long, without stout spines (Fig. 350); segment VIII without large lateral plate, or rarely comb scales on small plate (Fig. 351). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

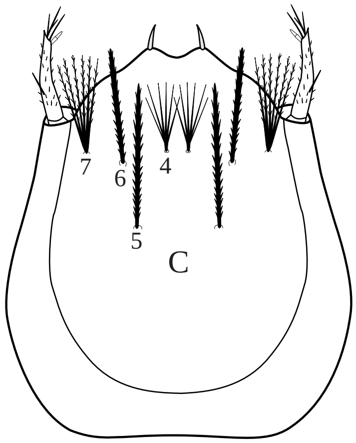


Fig. 348

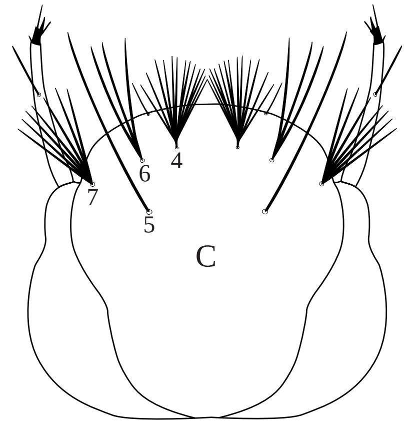


Fig. 350

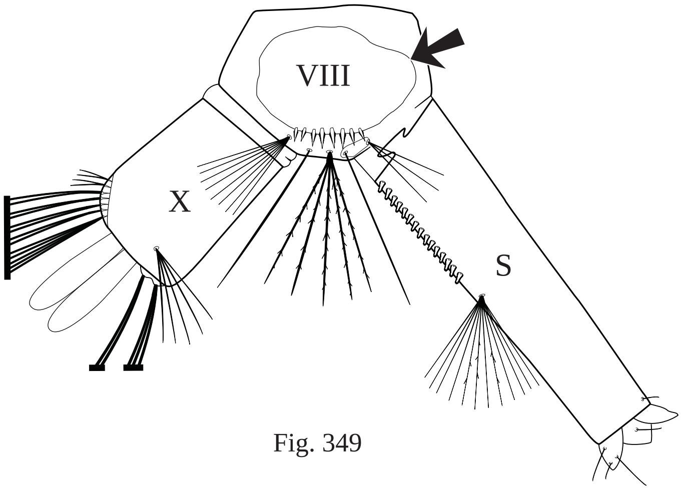


Fig. 349

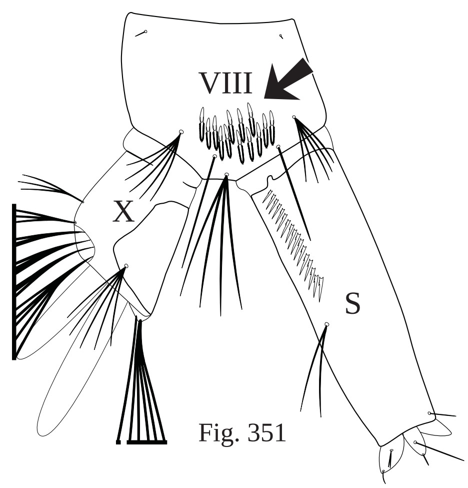


Fig. 351

6(5). Saddle on segment X incomplete, not encircling segment (Fig. 352); or if complete, ventral brush (seta 4-X) confined to grid posterior to and not piercing saddle (Fig. 352). . . . . . . . . . . . . . . . . . . . . . . . . ***Aedes* (p. 92)**

Saddle on segment X complete (Fig. 353); with most anterior pairs of seta 4-X piercing saddle (Fig. 353) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Psorophora* (p. 135)**

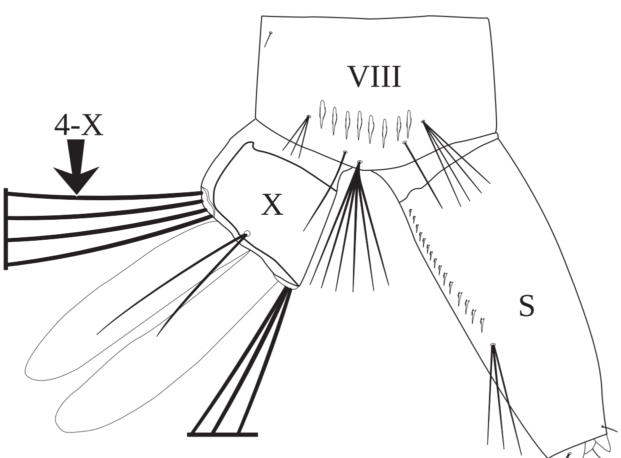


Fig. 352

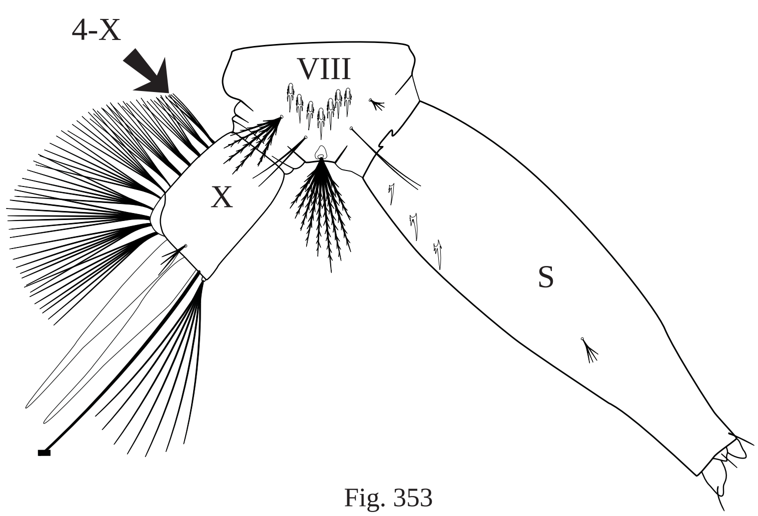


Fig. 353

7(2). Siphon tubular, without very sharp tip with saw-like projections (Fig. 354). . . . . . . . . . . . . . . . . . . . . . . 8

Siphon very short, base very broad, tip sharply attenuated with dorsal saw-like projections (Fig. 355) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

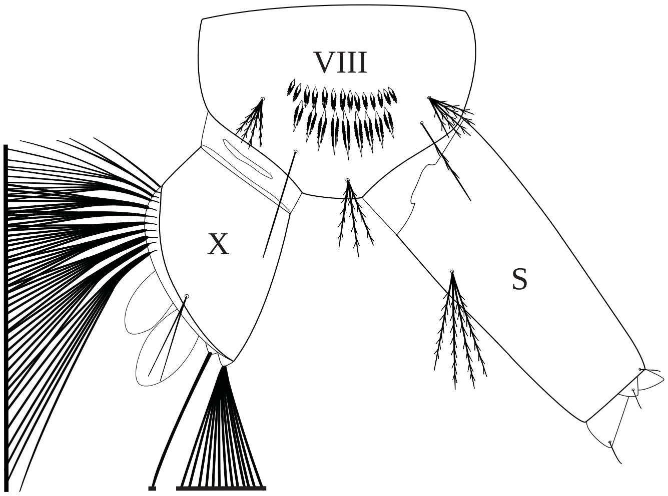

Fig. 354

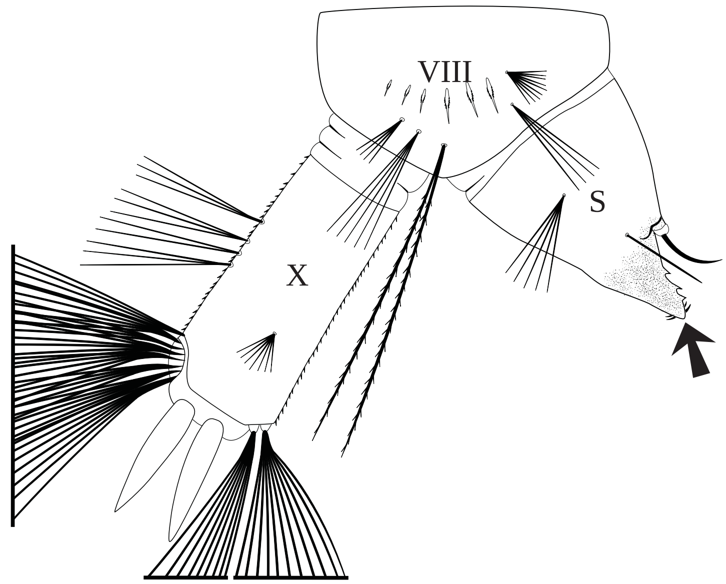

Fig. 355

8(7). Siphon with numerous setae ventrally, laterally, and dorsally (Fig. 356); saddle incomplete (Fig. 356). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Wyeomyia smithii***

Siphon with one pair of ventral or subventral setae (Fig. 357); saddle complete (infrequent *Or. alba* are not quite complete) (Fig. 357). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

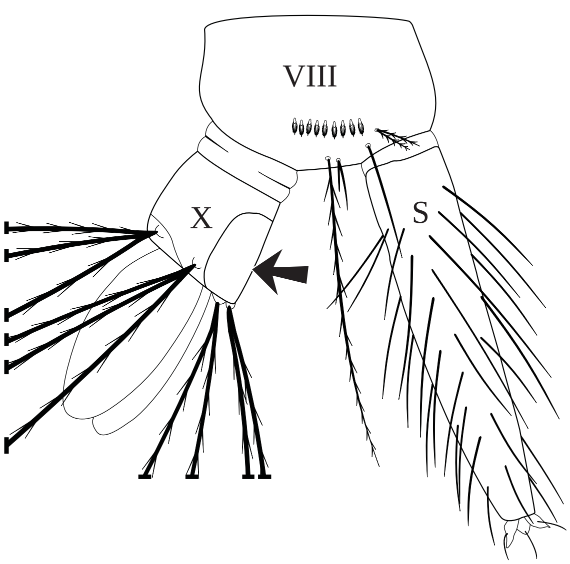

Fig. 356

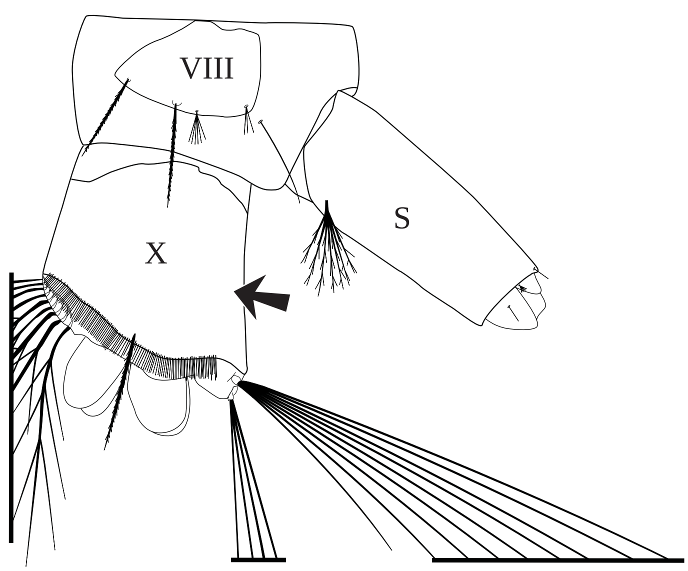

Fig. 357

9(8). Thorax and abdomen without stout spines or prominent plates (Fig. 358); segment VIII with two rows of comb scales (Fig. 359); small to medium size. . . . . . . . . . . . . . . . . . . . . . . . . . .***Orthopodomyia* (p. 134)**

Thorax and abdomen with numerous stout spines and prominent plates (Fig. 360); segment VIII without comb scales (Fig. 361); very large. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Toxorhynchites rutilus rutilus***
***Toxorhynchites rutilus septentrionalis***
(See Note 1)

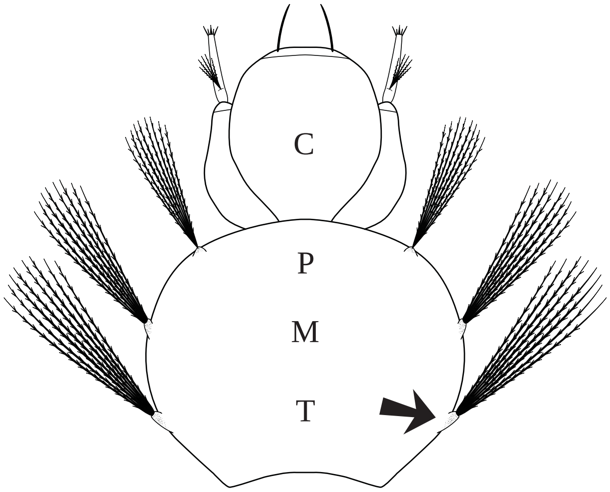

Fig. 358

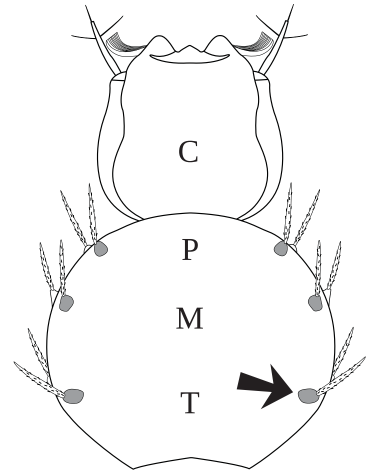

Fig. 360

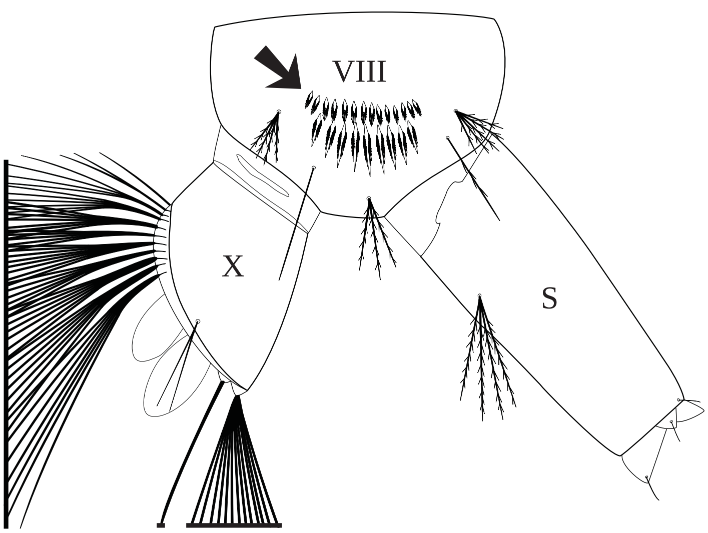

Fig. 359

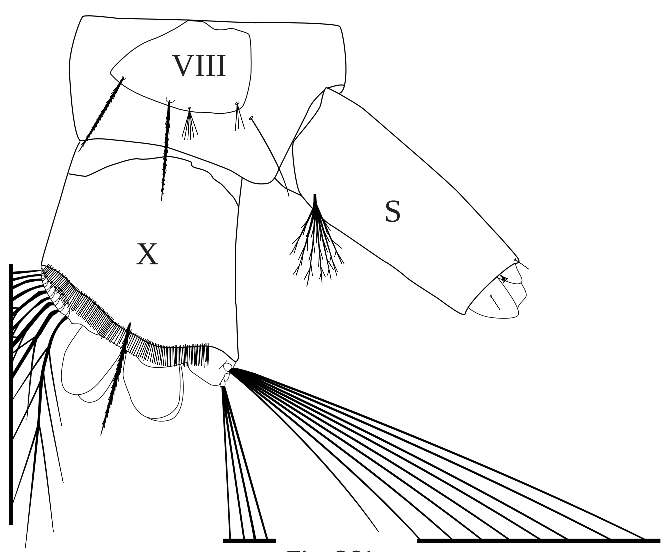

Fig. 361

10(7). Antenna exceptionally long, with two very short setae distal to antennal seta 1-A (Fig. 362); venter of saddle with or without 1-2 tiny setae on apex of saddle (Fig. 363); setae 1-VIII and 1-X long with multiple branches (Fig. 363). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Coquillettidia perturbans***

Antenna long, with two very long setae equal length of antennal flagellomere distal to seta 1-A (Fig. 364); venter of saddle with 4-5 large precratal setae piercing middle of saddle (Fig. 365); setae 1-VIII and 1-X short with multiple branches (Fig. 365). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Mansonia* (p. 133)**

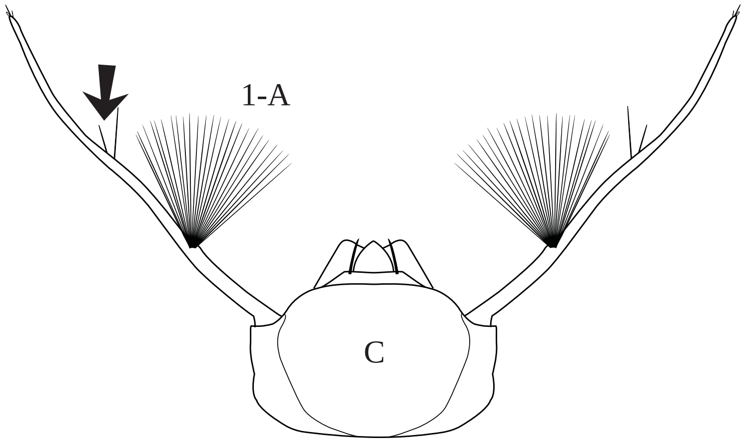

Fig. 362

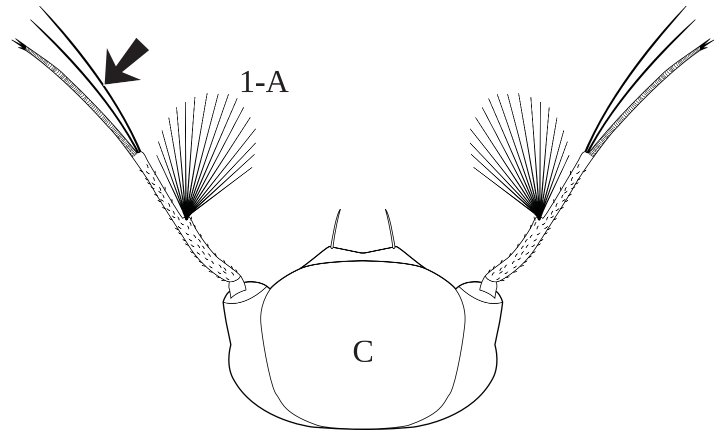

Fig. 364

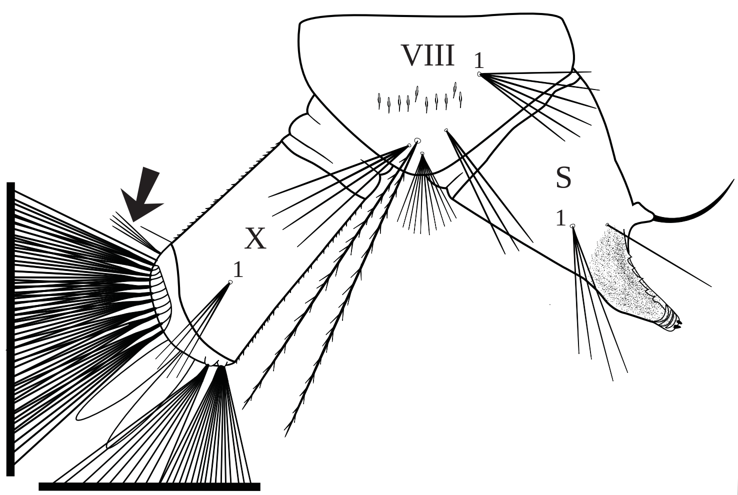

Fig. 363

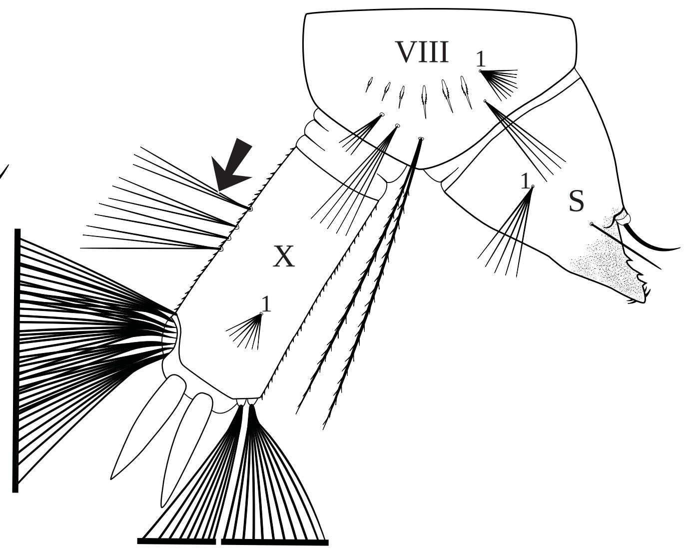

Fig. 365

# Key to Species of Fourth Instar Larvae of *Aedes* (=*Ae.*)

1. Siphon with large multiple lateral and subdorsal setae in addition to setae 1-S and 2-S (Fig. 366). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (northern species). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. provocans***

Siphon without obvious setae other than setae 1-S and 2-S (Figs. 367, 368) . . . . . . . . . . . . . . . . . . . . . . . .2
(See Note 11)

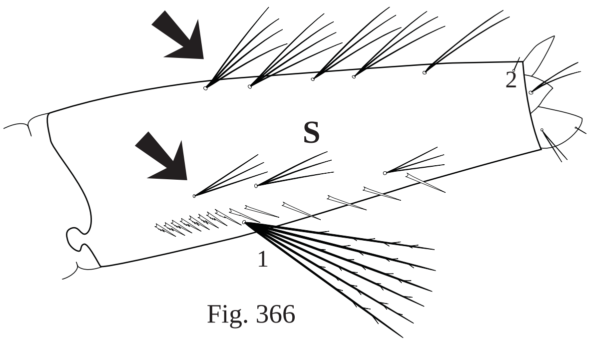

Fig. 366

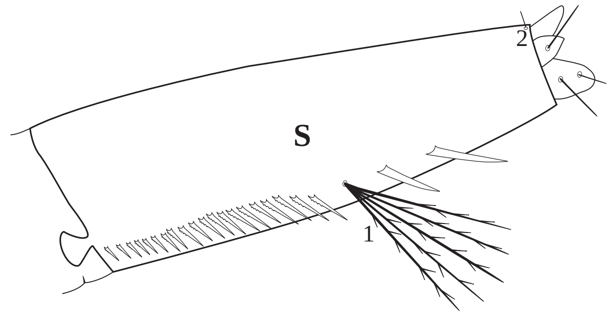

Fig. 367

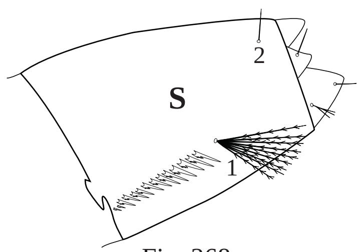

Fig. 368

2(1). Saddle completely encircling abdominal segment X (Fig. 369). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

Saddle incomplete, not encircling segment X (Fig. 370). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .13

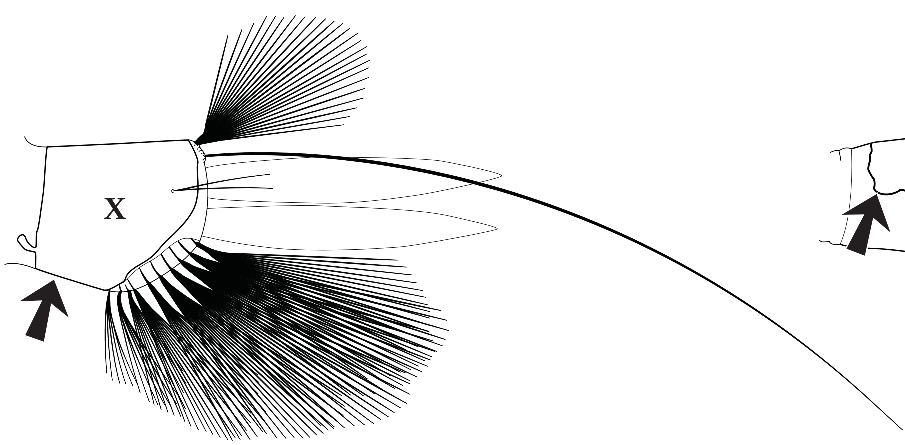

Fig. 369

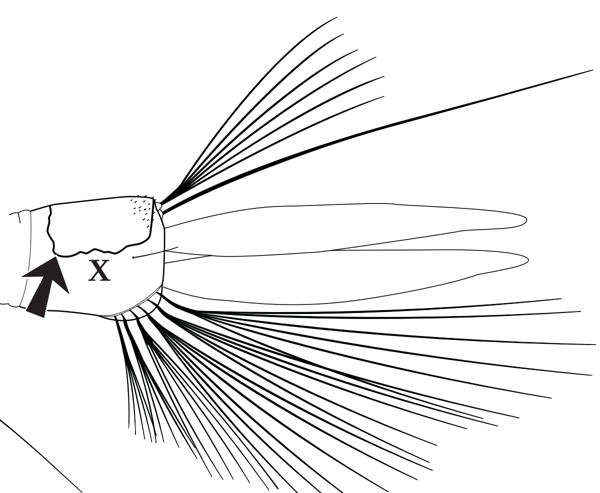

Fig. 370

3(2). Abdominal seta 2-X single and long, approximately same length as seta 3-X (Fig. 371); head setae 5,6-C single and stout with uniform diameter their entire length (Fig. 372). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (northern species). . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. abserratus***

Abdominal seta 2-X with 2 or more branches and much shorter than seta 3-X (Fig. 373); head setae 5,6-C single or branched, but diameter gradually tapering from base (Fig 374). . . . . . . . . . . . . . . . . . . . . . . . . . 4

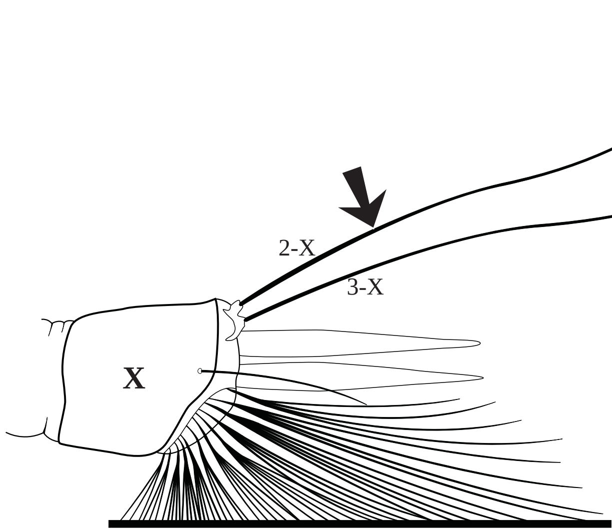


Fig. 371

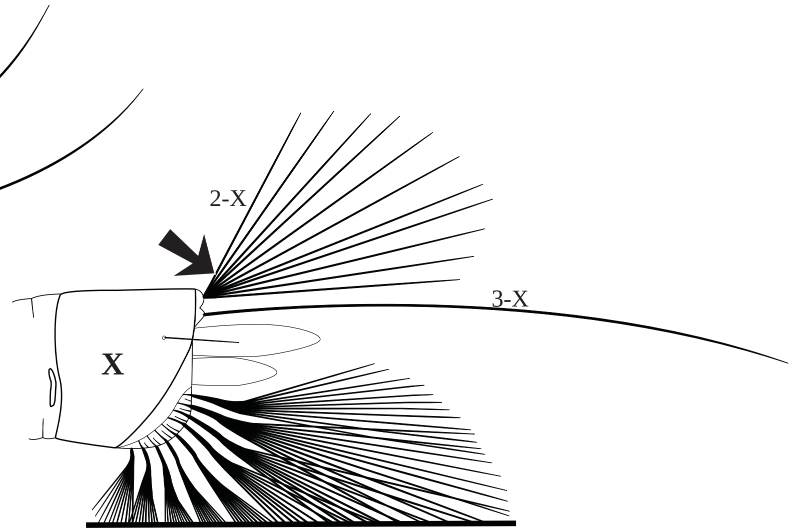


Fig. 373

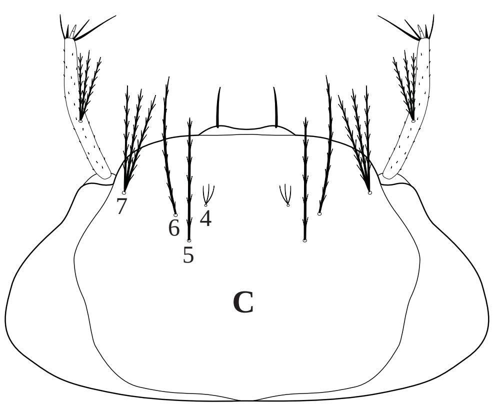


Fig. 372

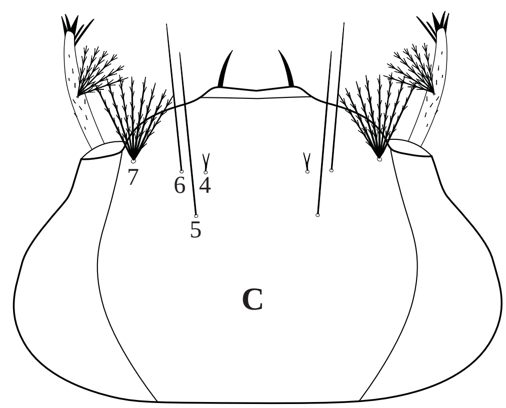


Fig. 374

4(3). Siphon seta 1-S inserted within pecten, before the end of the row of pecten spines (Fig. 375). . . . . . . . . 5

Siphon seta 1-S inserted distally beyond pecten, or uncommonly beside most distal pecten spine (Fig. 376) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6

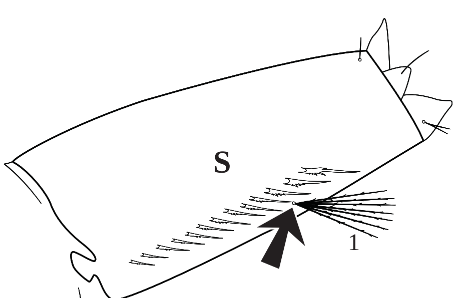


Fig. 375

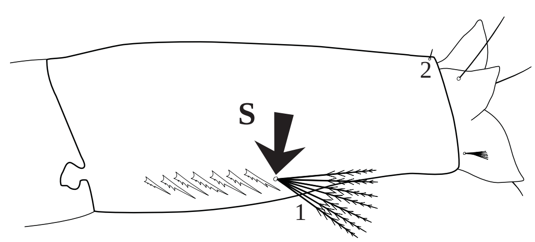


Fig. 376

5(4). Siphon pecten spines evenly spaced (Fig. 377); abdominal segment VIII with 9-13 comb scales in single row, each with a very long sharp median spine (Fig. 377). . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. tormentor***

Siphon pecten spines with one or more distal spines widely spaced (Fig. 378); segment VIII with more than 25 comb scales in patch, scales rounded apically (Fig. 378). . . . . . . . . . . . . . . . . . . . . . .***Ae. fulvus pallens***

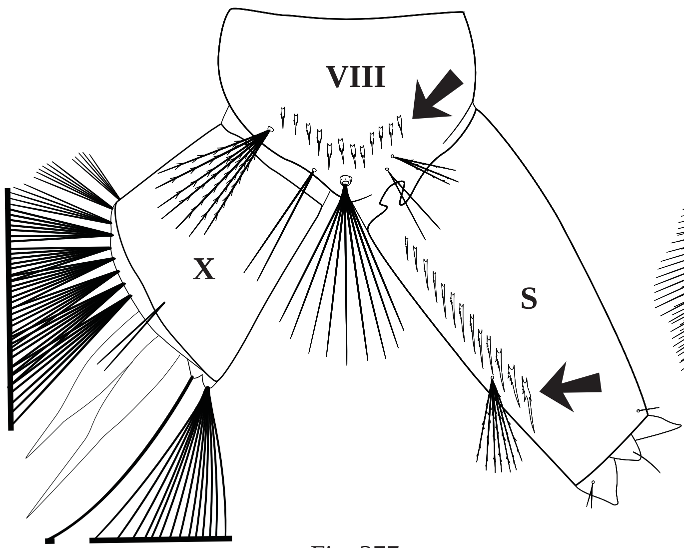

Fig. 377

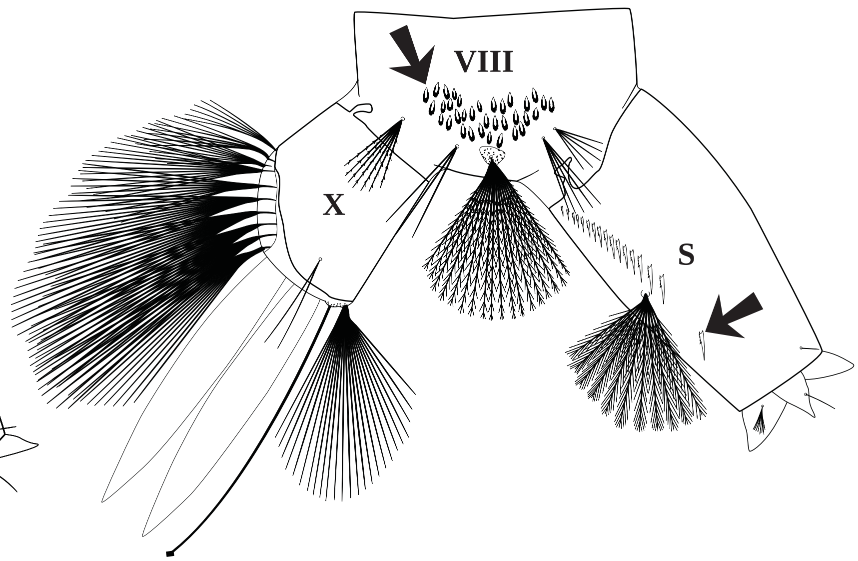

Fig. 378

6(4). Siphon much narrower than width of segment X (Fig. 379); anal papillae extremely long, at least 8 times length of saddle, with dark pigmented tracheae internally (Fig. 379); seta 2-X with 2-3 short weak branches (Fig. 379). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. dupreei***

Siphon width approximately equal to segment X width (Fig. 380); anal papillae shorter, less than 5 times length of saddle, without internal tracheae (Fig. 380); seta 2-X with 6 or more strong branches (Fig. 380). .7

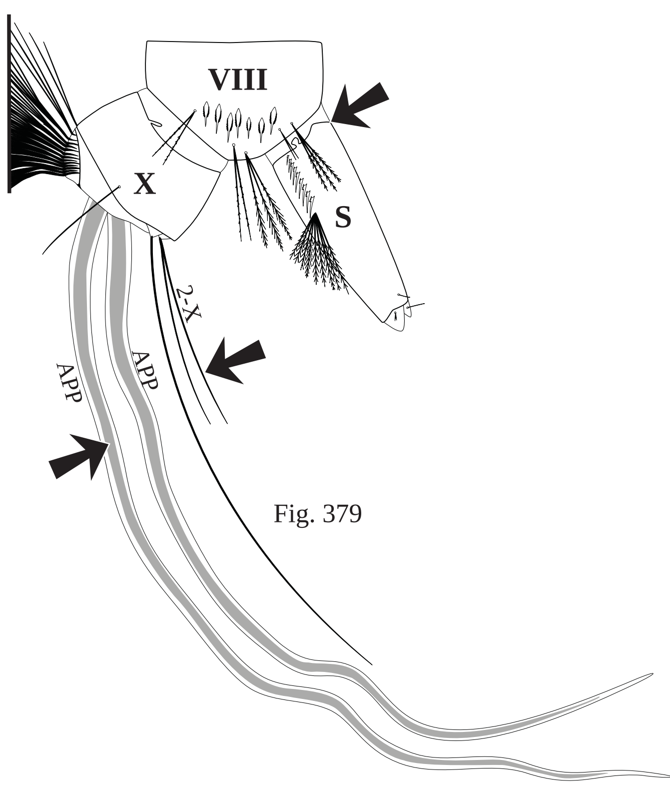

Fig. 379

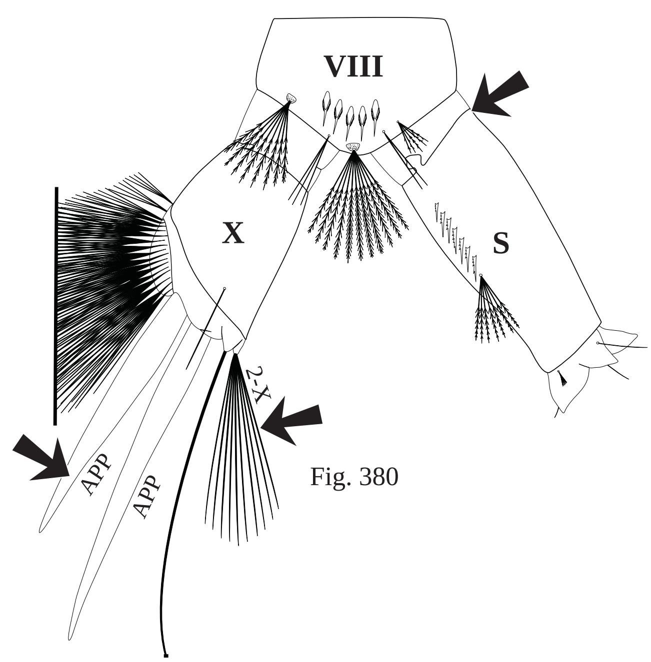

Fig. 380

7(6). Comb scales (4-19) in curved single or irregular double rows (Fig. 381). . . . . . . (See Note 12). . . . . . . .8

Comb scales (11-28) in irregular patch, not in rows (Fig. 382). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .9

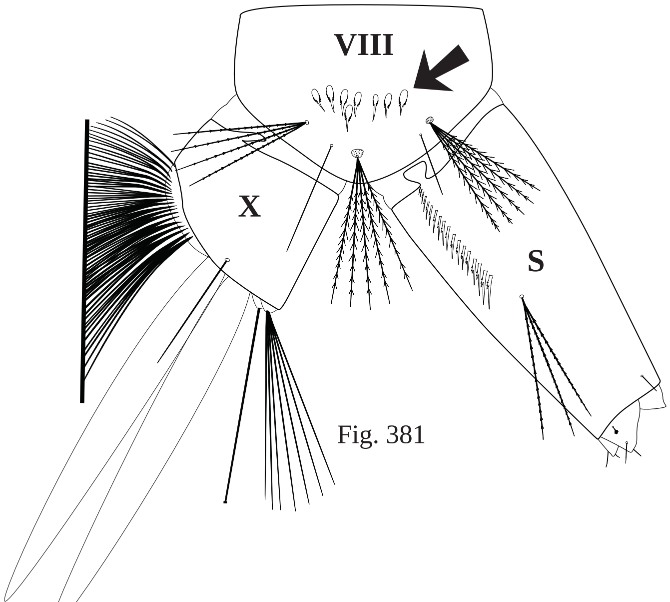

Fig. 381

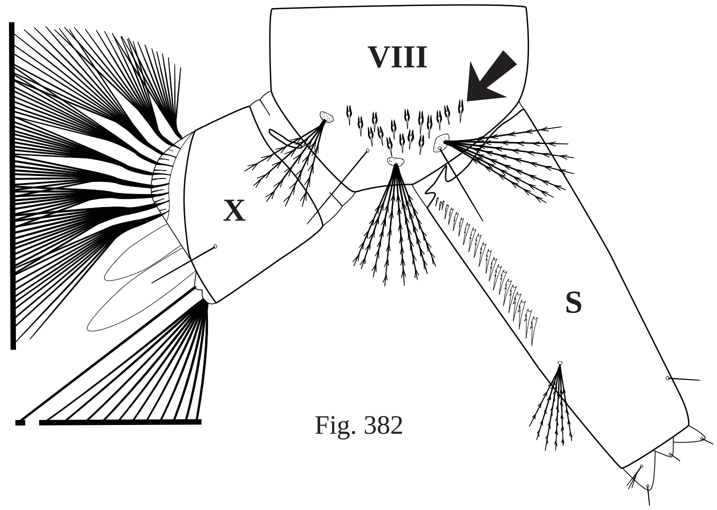

Fig. 382

8(7). Siphon length approximately 2.0-2.5 times width at base (Fig. 383); abdominal segment VIII with 4-6 comb scales (Fig. 383); head seta 8-C long, reaching forward to base of seta 5-C (Fig. 384). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. atlanticus***

Siphon length 3.0-3.5 times width at base (Fig. 385); segment VIII with 10-19 comb scales (Fig. 385); head seta 8-C very short, not reaching forward half the distance to base of seta 5-C (Fig. 386). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(northern species). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. punctor***
(See Note 12)

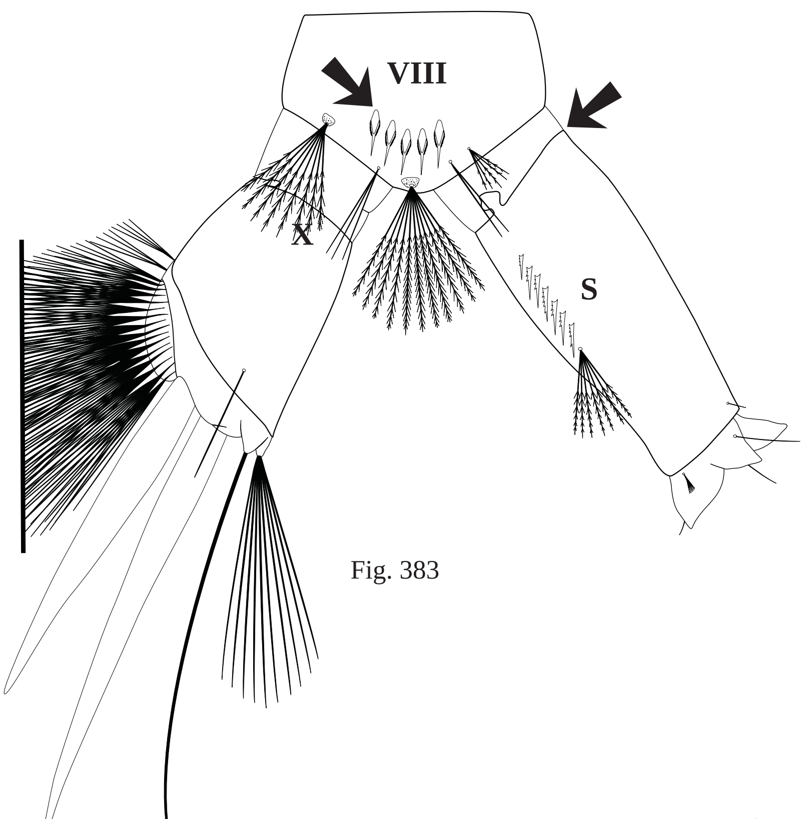

Fig. 383

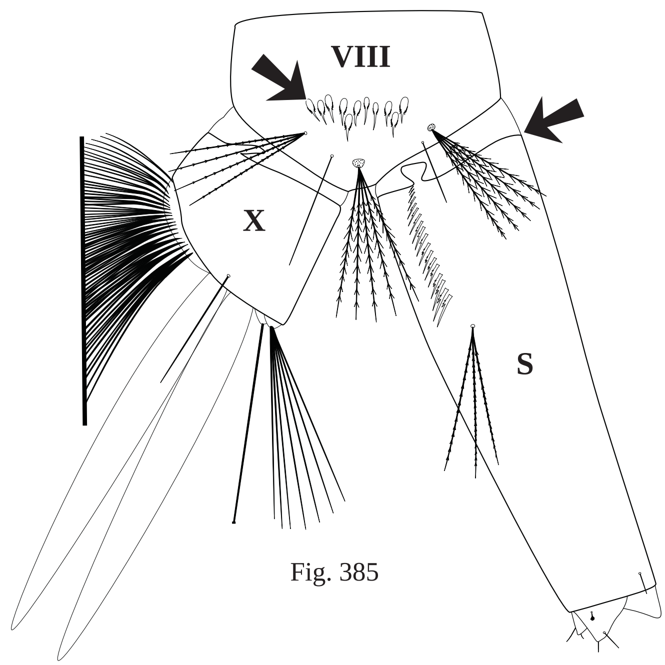

Fig. 385

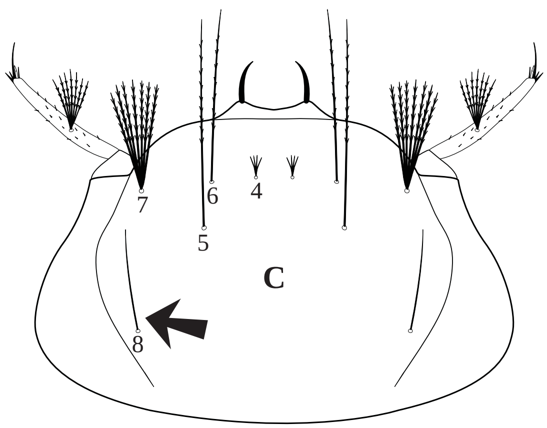


Fig. 384

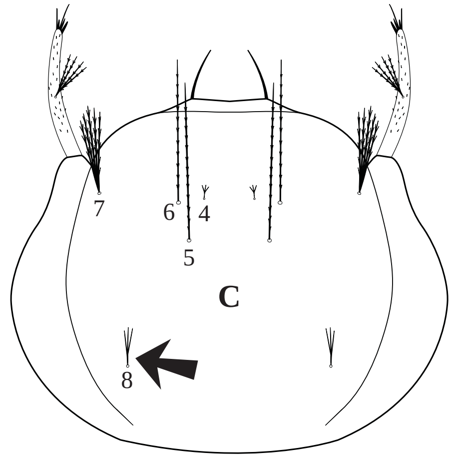


Fig. 386

9(7). Comb scales rounded apically, with subequal median and submedian spines (Fig. 387); abdominal seta 1-VIII long, more than half siphon length (Fig. 387); siphon length less than 2.0 times width at base; posterior margin of saddle with many spicules (Fig. 387). . . . . (brackish water) . . . . . . . . . . . ***Ae. taeniorhynchus***

Comb scales sharply pointed, with median spine longer than submedian spines (Fig. 388); seta 1-VIII short, less than half siphon length (Fig. 388); posterior margin of saddle smooth, without spicules (Fig. 388). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

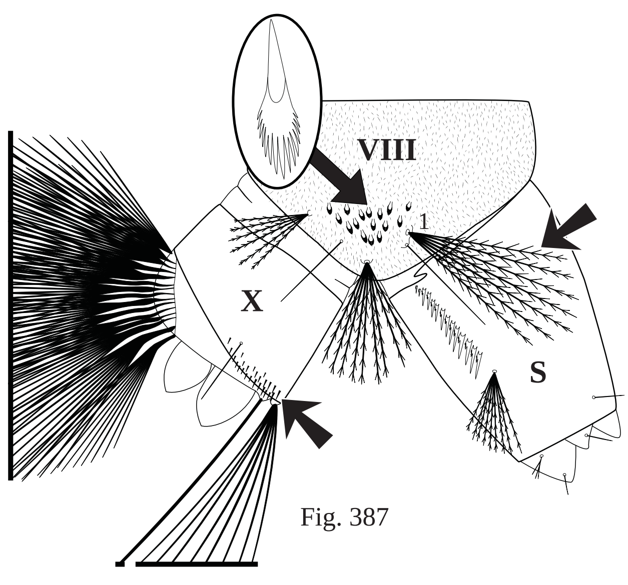


Fig. 387

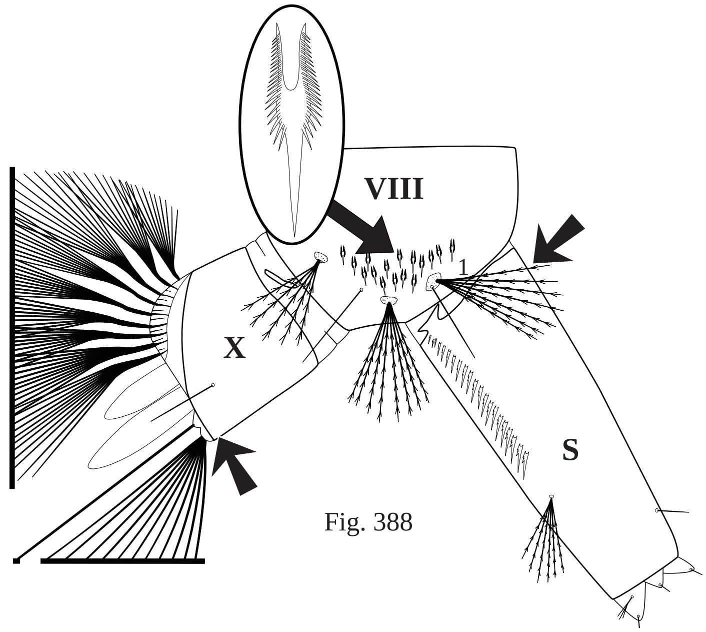


Fig. 388

10(9). Siphon dorsal preapical seta 2-S stout, long, removed from tip of siphon (Fig. 389); comb scales with median spine 10 times or more length of tiny lateral spines (Fig. 389). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 11

Siphon dorsal preapical seta 2-S tiny, adjacent to tip of siphon (Fig. 390); comb scales with median spine 1.3-2.5 times length of adjacent lateral spines (Fig. 390). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12

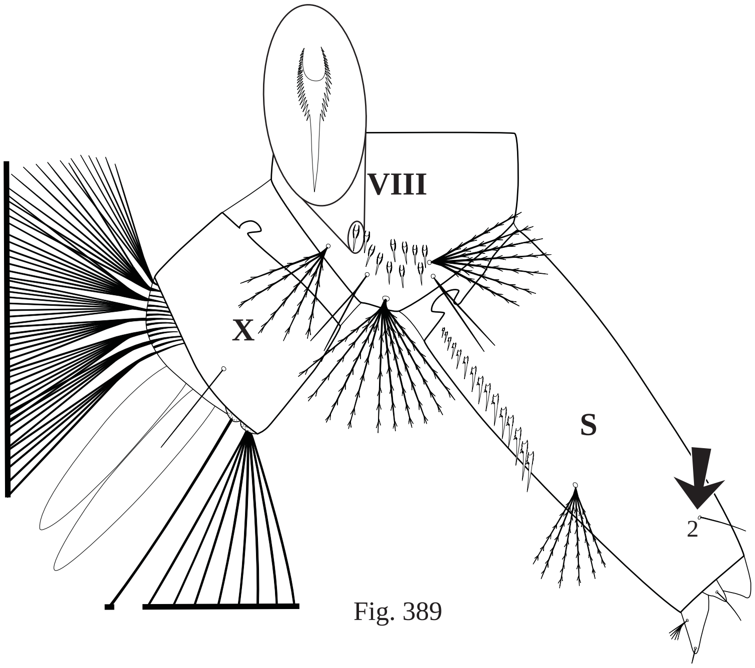


Fig. 389

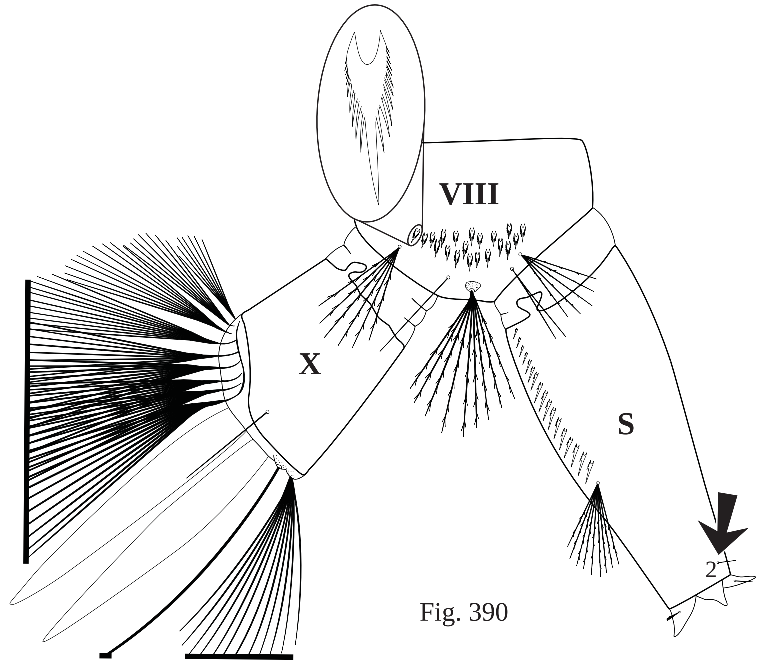


Fig. 390

11(10). Siphon short, length 2.0-2.5 times width at base (Fig. 391); antennal seta 1-A long, reaching tip of antenna (Fig. 392); anal papillae shorter than dorsal length of saddle (Fig. 391). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(brackish water) . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. sollicitans***

Siphon length 3.0-3.5 times width at base (Fig. 393); antennal seta 1-A short, not reaching tip of antenna (Fig. 394) dorsal pair of anal papillae approximately 1.5 times dorsal length of saddle (Fig. 393). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(fresh water). . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. mitchellae***

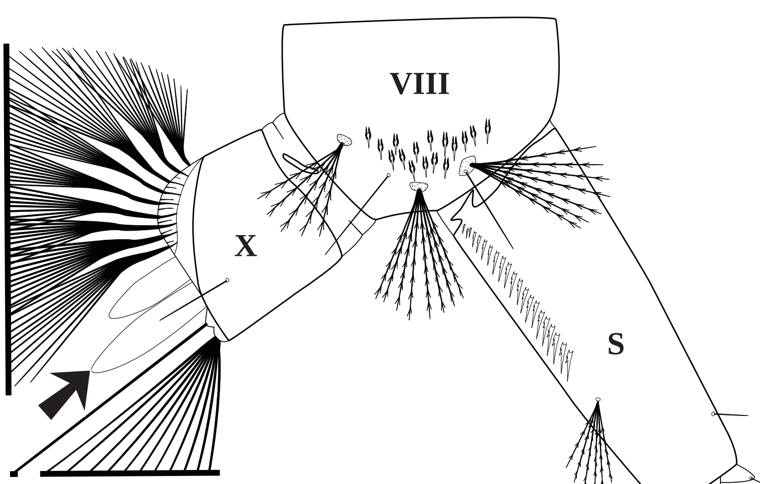


Fig. 391

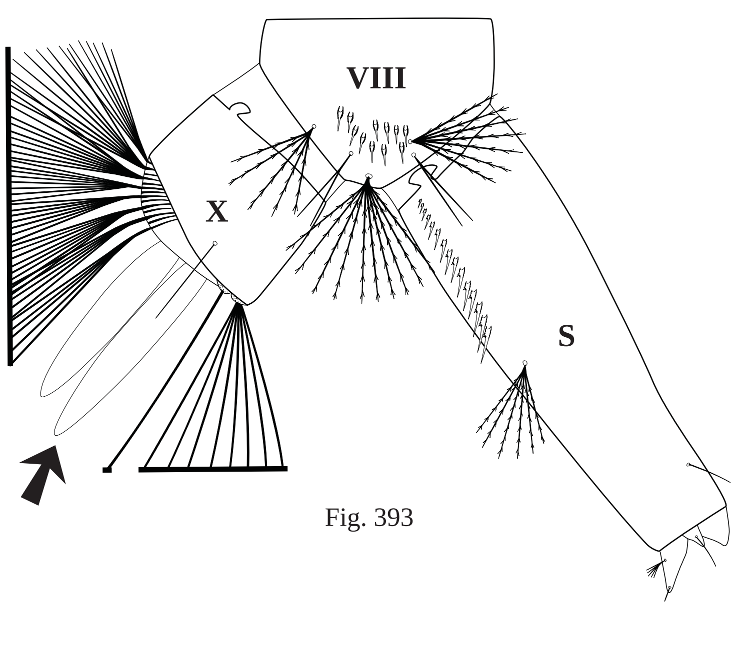


Fig. 393

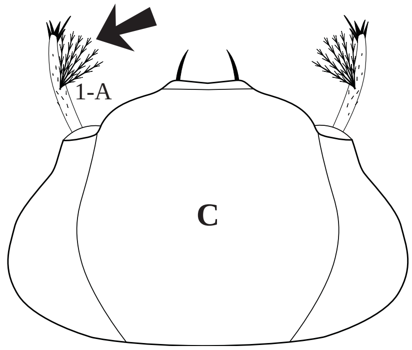


Fig. 392

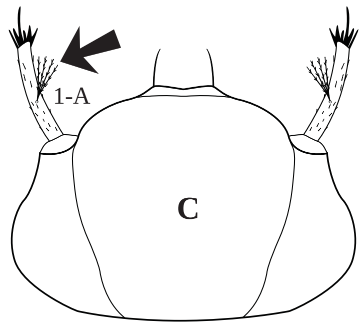


Fig. 394

12(10). Abdominal seta 2-VIII with 2-3 branches, equal in length to seta 1-VIII (Fig. 395); median spine on comb scales 2.0-2.5 times length of adjacent lateral spines (Fig. 395); prothorax seta 1-P slightly longer than seta 4-P (Fig. 396). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. infirmatus***

Abdominal seta 2-VIII single, much longer than seta 1-VIII (Fig. 397); median spine on comb scales less than 2.0 times length of adjacent lateral spines (Fig. 397); prothorax seta 1-P more than 2 times length of short weak seta 4-P (Fig. 398) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. trivittatus***

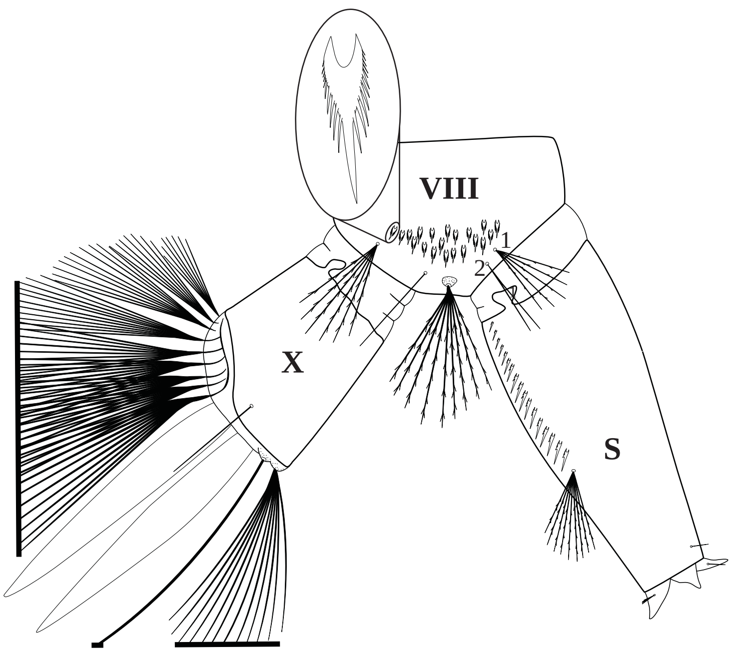


Fig. 395

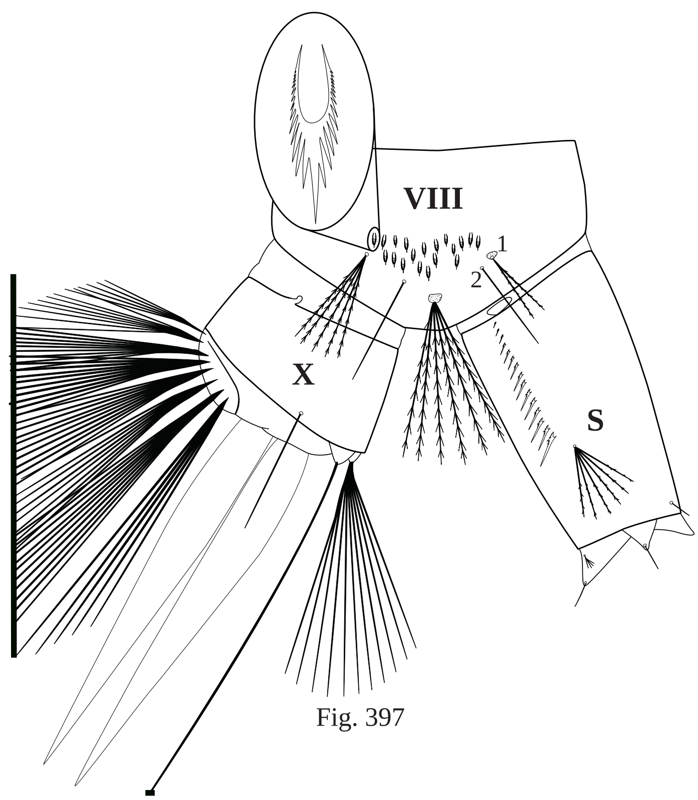


Fig. 397

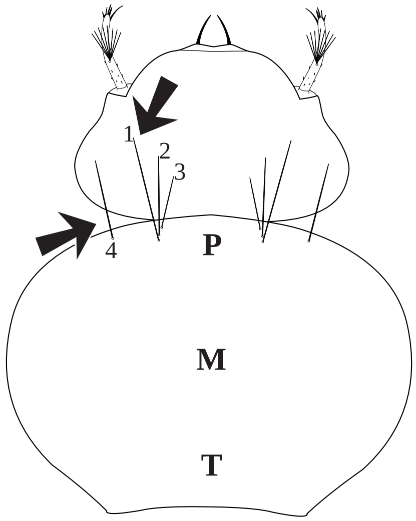

Fig. 396

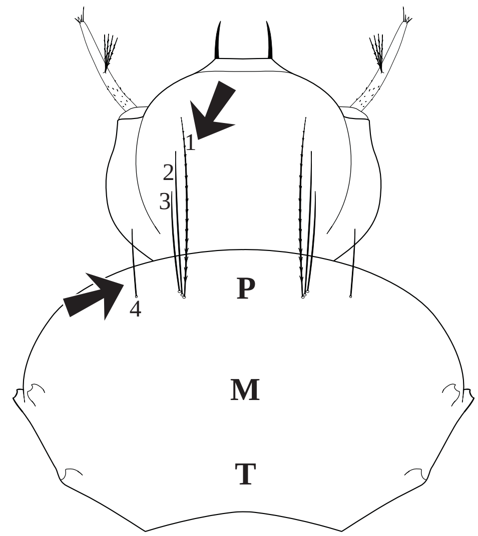

Fig. 398

13(2). Siphon pecten spines evenly spaced (Fig. 399). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .14

Siphon pecten spines with one or more apical spines more widely spaced than basal spines (Fig. 400). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26

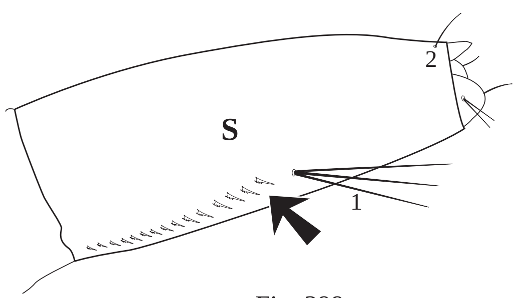

Fig. 399

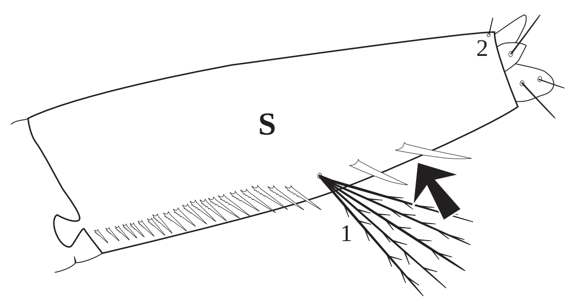

Fig. 400

14(13). Antenna seta 1-A single and very small (Fig. 401); segment VIII comb scales (8-12) in neat curved single row (Fig. 402). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15

Antenna seta 1-A single and long, or branched (Figs. 403, 404); segment VIII comb scales in irregular single or double row with some scales out of line, or in a patch (Fig. 405). . . . . . . . . . . . . . . . . . . . . . . .16

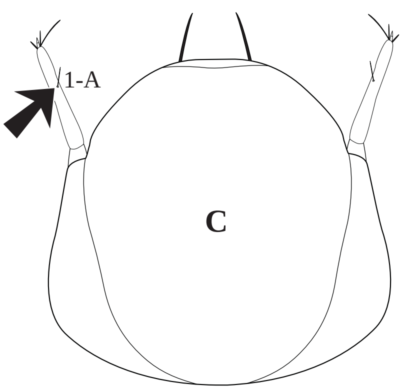

Fig. 401

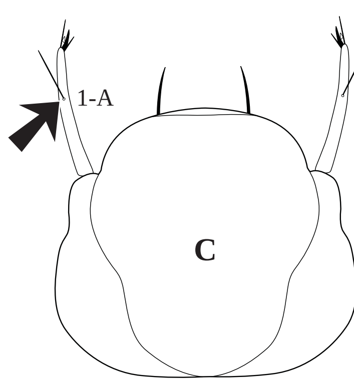

Fig. 403

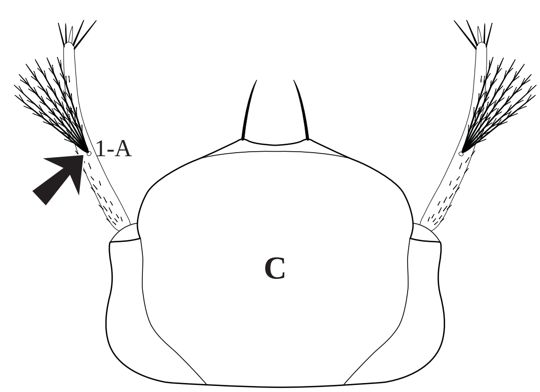

Fig. 404

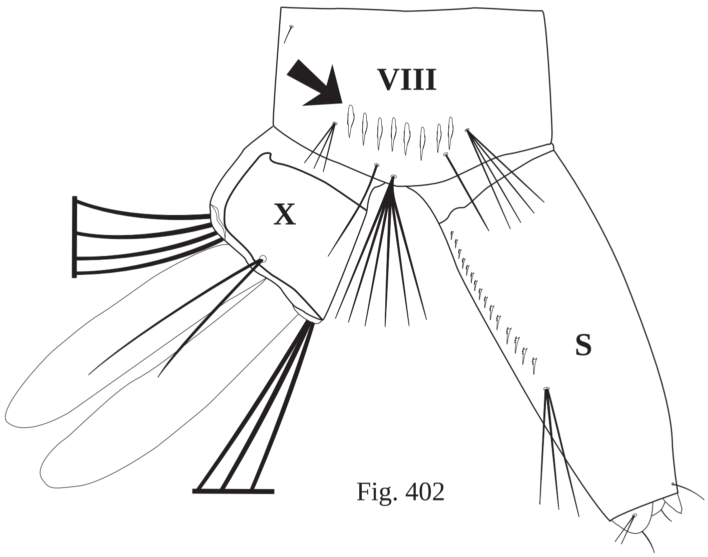

Fig. 402

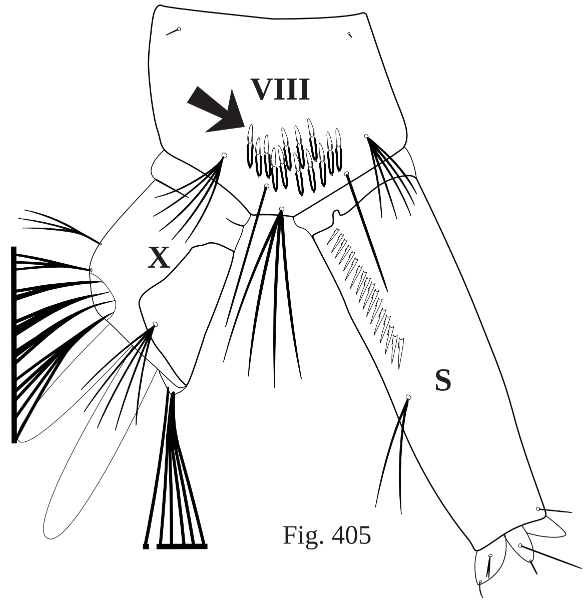

Fig. 405

15(14). Comb scale median spine very long and sharp, length more than 10 times length of tiny lateral spines on base of scale (Fig. 406); preantennal seta 7-C with 2 (rarely 3) branches (Fig. 407); lateral setal support plates on meso- and metathorax with small spines (Fig. 407). . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. albopictus***

Comb scale median spine no more than 2.0-2.5 times length of strong submedian spines (Fig. 408); preantennal seta 7-C single (Fig. 409); lateral support plates on meso- and metathorax with large curved spines (Fig. 409). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. aegypti***

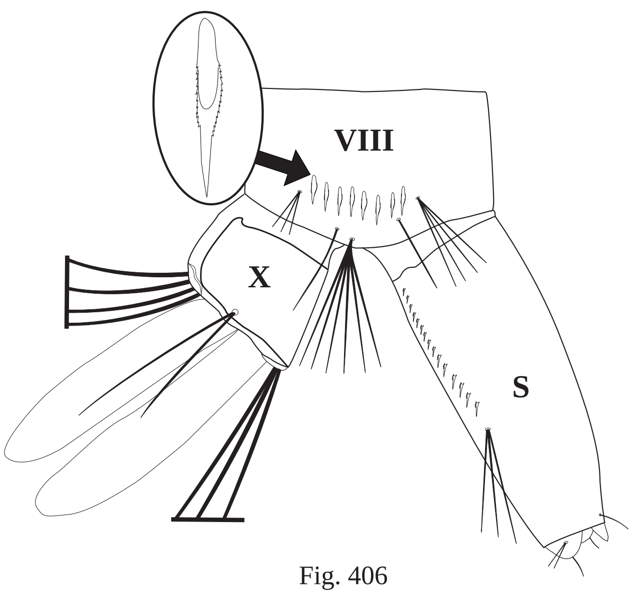

Fig. 406

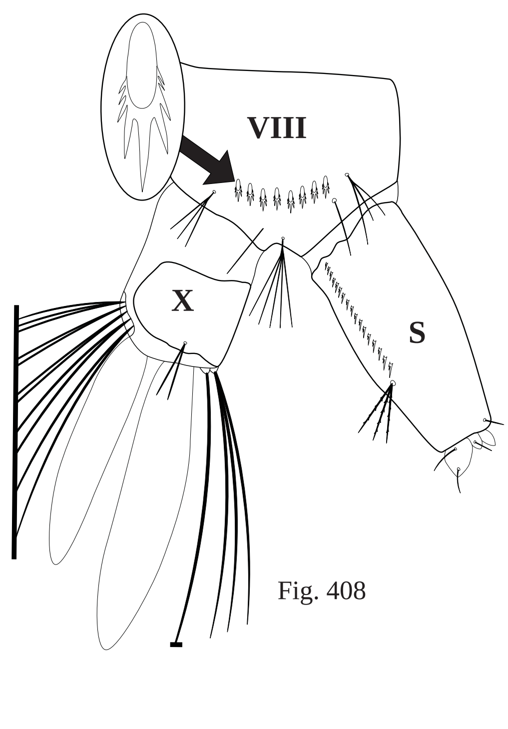

Fig. 408

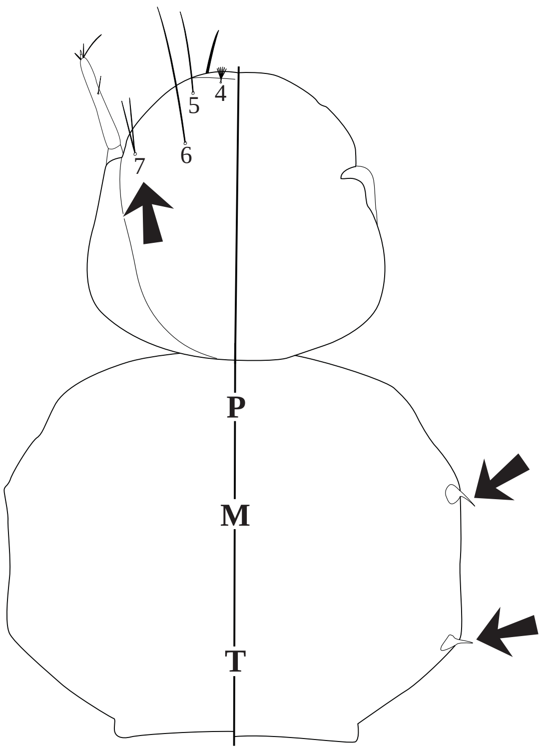

Fig. 407

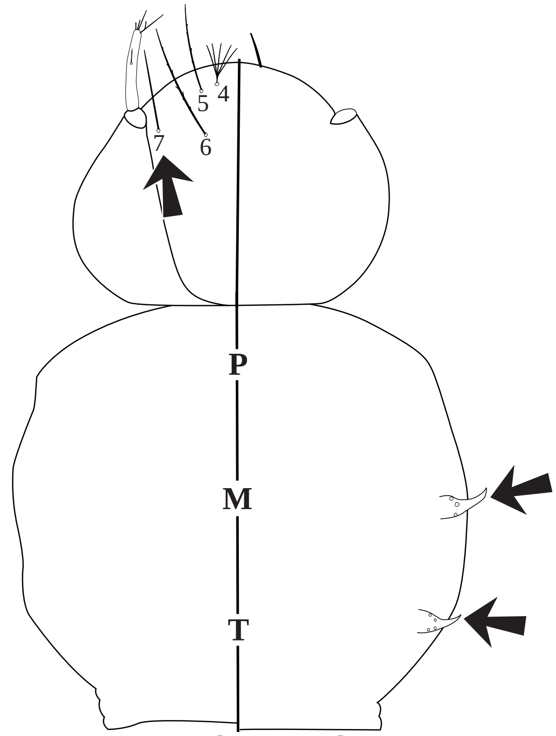

Fig. 409

16(14). Antenna seta 1-A single, long, nearly reaching tip of antenna (Fig. 410); comb scales long spine-like with slightly rounded tip, with frill of tiny spinules around apical 70% (Fig. 411). . . . . . . . . . . . . . . . . . . . . . 17

Antenna seta 1-A branched, reaching or not reaching tip of antenna (Fig. 412); comb scales rounded at tip or with long median spine, but without frill of tiny spinules around apex (fig. 413). . . . . . . . . . . . . . .18

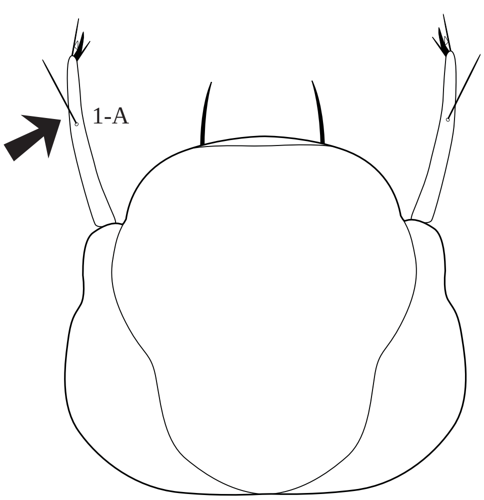

Fig. 410

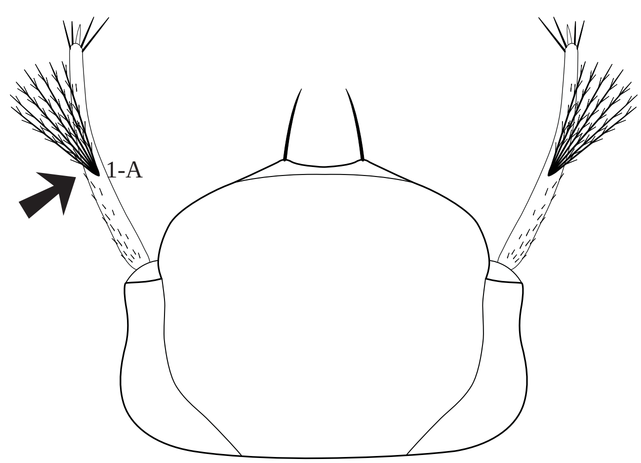

Fig. 412

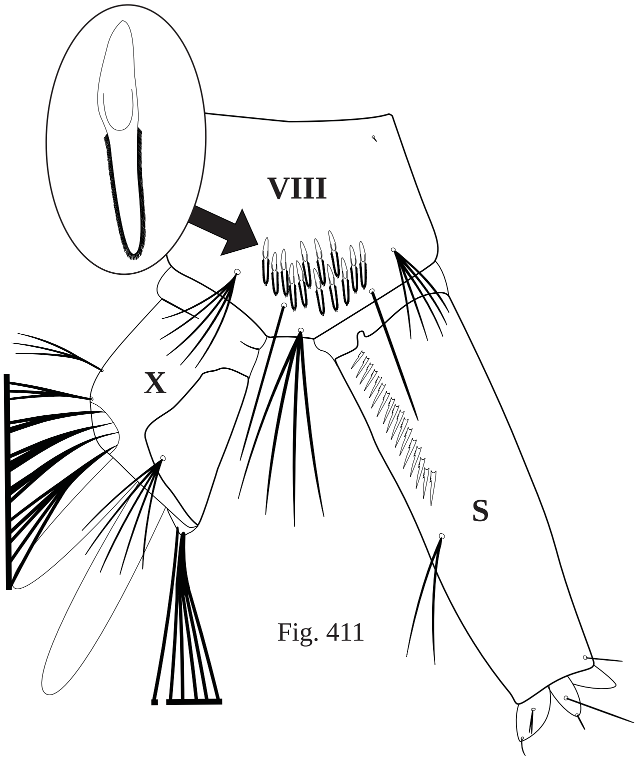


Fig. 411

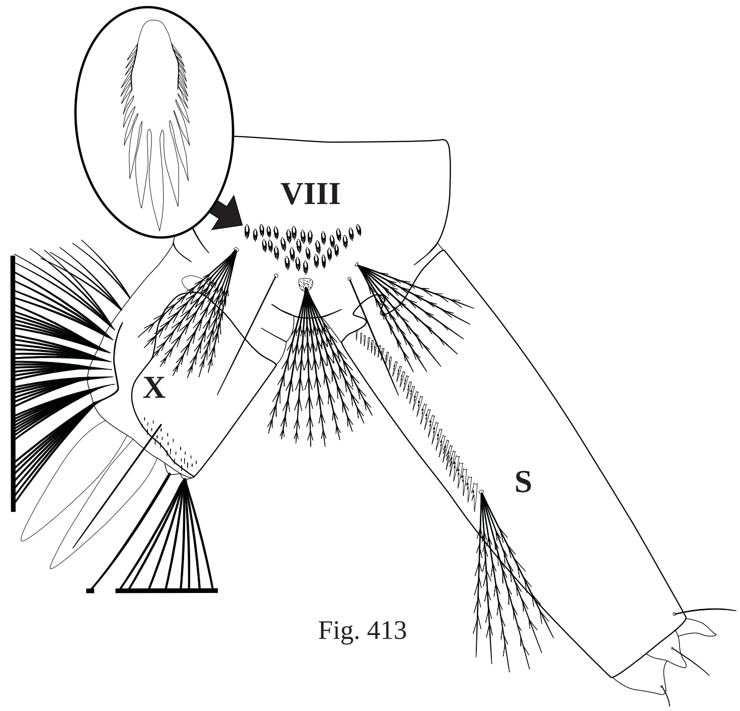


Fig. 413

17(16). Saddle seta 1-X with 4-8 short branches of even length and spread out like a fan (Fig. 414); length of seta 1-X less than dorsal length of saddle (Fig. 414); dorsal pair of anal papillae clearly longer than ventral pair and tapering at apex (Fig. 414); ventral brush on segment X with 6 pairs of setae 4-X (Fig. 414). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. triseriatus***
(See Note 13)

Saddle seta 1-X with 2-3 stout branches, when 3 branches one shorter than others (Fig. 415); length of seta1-X greater than dorsal length of saddle (Fig. 415); both pairs of anal papillae equal length and rounded at apex (Fig. 415); ventral brush with 5 pairs of seta 4-X (Fig. 415). . . . . . . . . . . . . . . . . . . ***Ae. hendersoni***
(See Note 13)

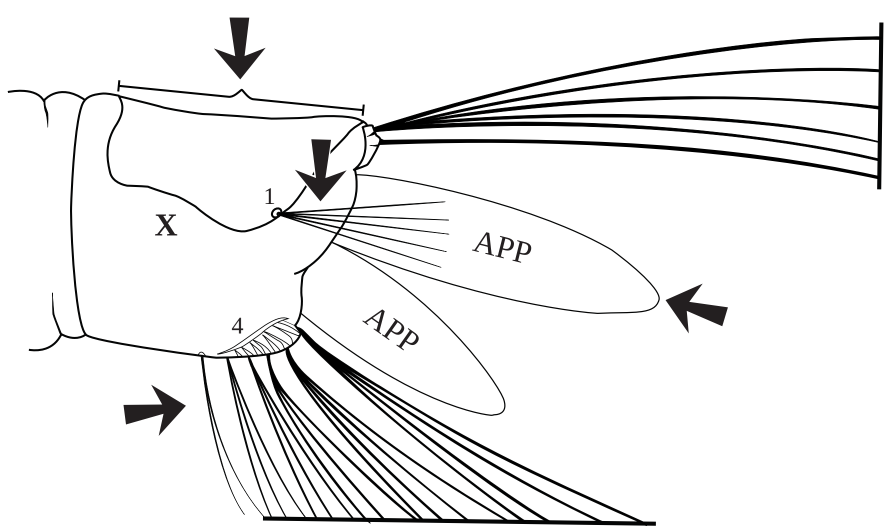


Fig. 414

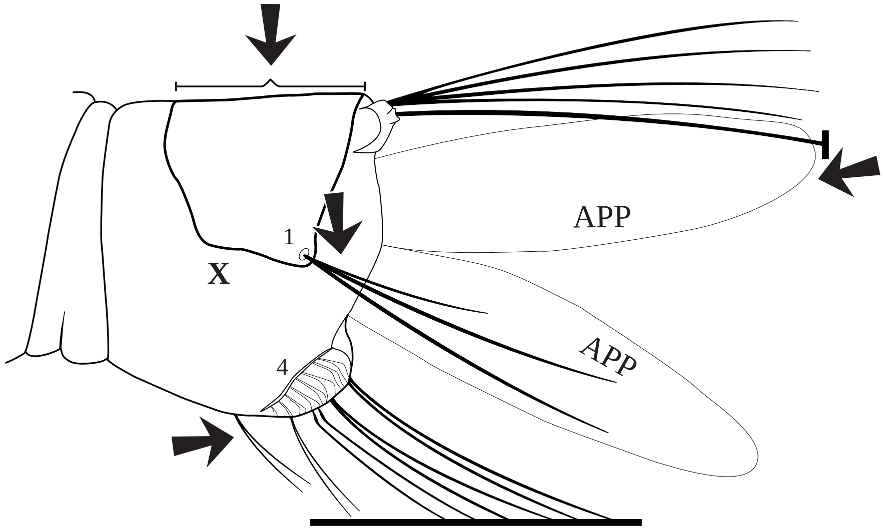


Fig. 415

18(16). Head seta 5-C with 4-10 branches (rarely less); seta 6-C with 3-8 branches (rarely less) (Fig. 416). . . .19

Head seta 5-C and 6-C usually single or 2-4 branches (Fig. 417). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .21

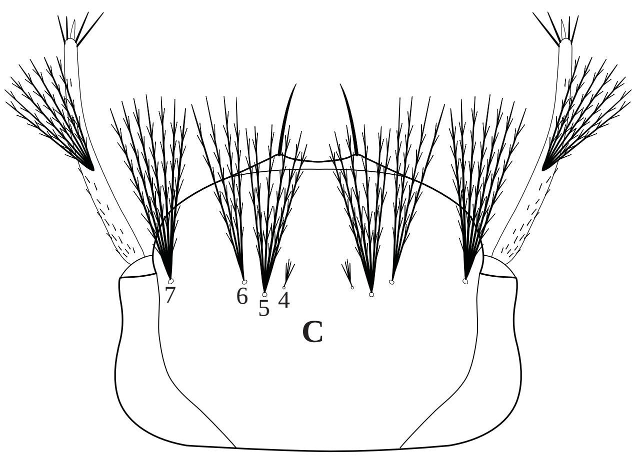


Fig. 416

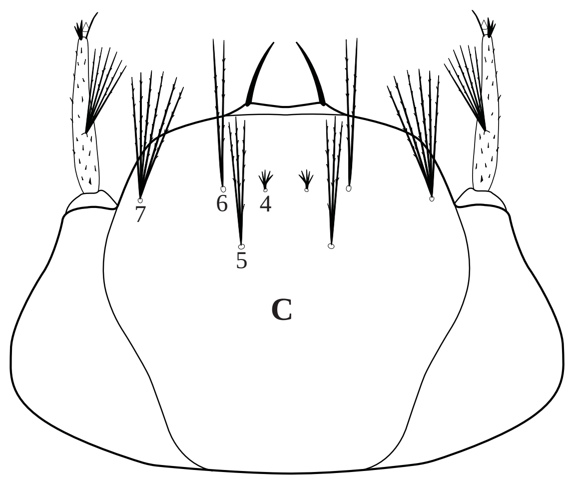


Fig. 417

19(18). Siphon length 4.5-5.0 times width at base (Fig. 418); antenna length, long nearly equal head length on midline (Fig. 419); head setae 5-7-C nearly inserted in straight line (Fig. 419). . . . . . . . . . . ***Ae. thibaulti***

Siphon length short, 2.5-4.0 times width at base (except *Ae. fitchii*) (Fig.420); antenna length short, approximately half head length (Fig. 421); head setae 5-7-C not in straight line, 6-C far forward of 5-C (Fig. 421). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 20

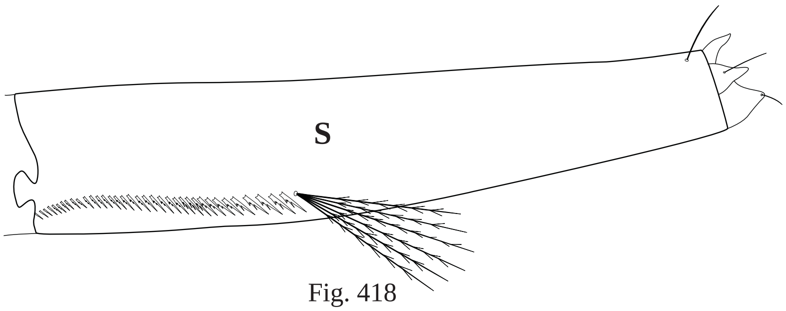


Fig. 418

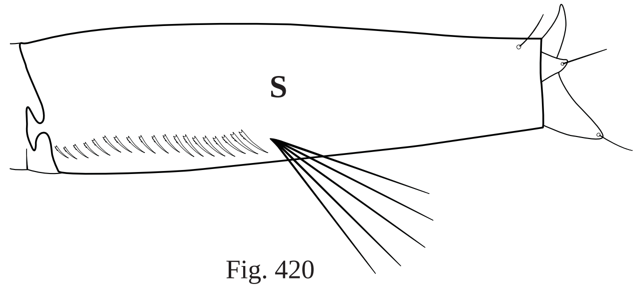


Fig. 420

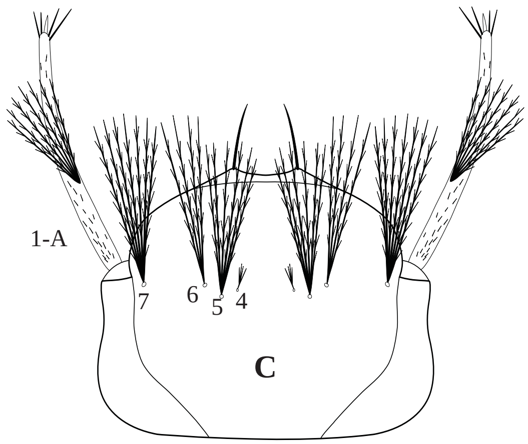


Fig. 419

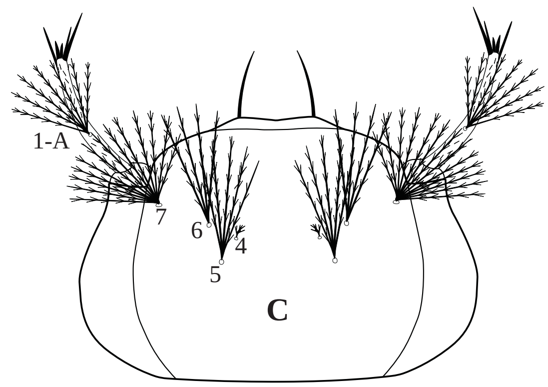


Fig. 421

20(19). Mesothorax seta 1-M long, extending forward beyond thorax (Fig. 422); anal papillae very short and bud-like (Fig. 423); brackish water species along coast of northern half of study area. . . . . . ***Ae. cantator***

Mesothorax seta 1-M small and short, not reaching bases of prothorax setae (Fig. 424); anal papillae equal or longer than length of saddle (Fig. 425); early season fresh water species. . . . . . . . . . ***Ae. c. canadensis***
***Ae. c. mathesoni***
(See Note 14)

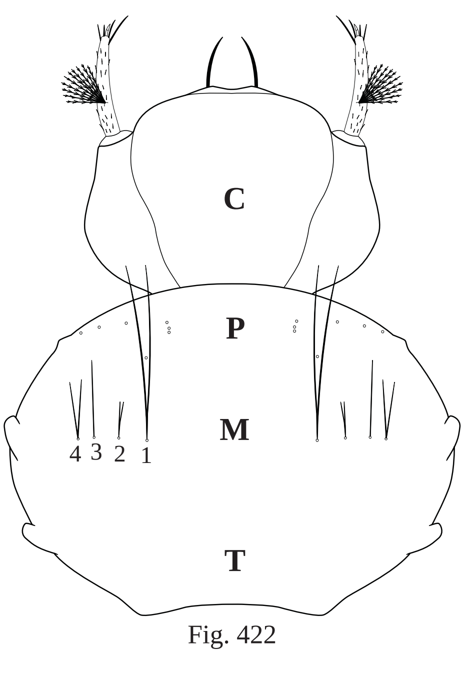


Fig. 422

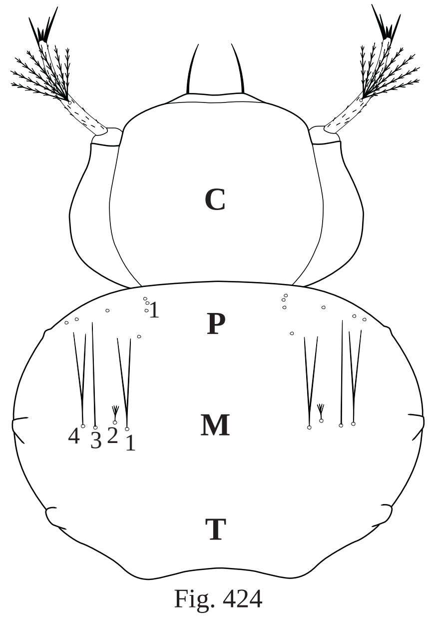


Fig. 424

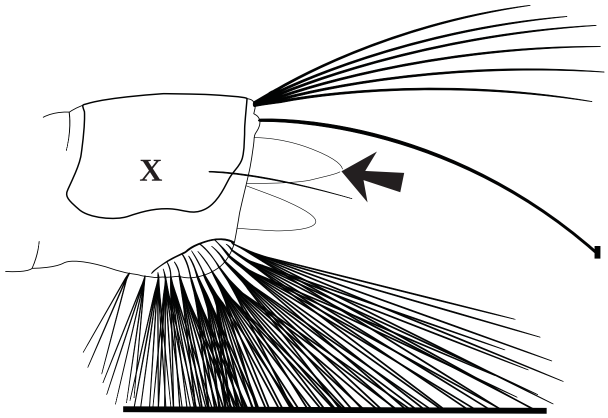


Fig. 423

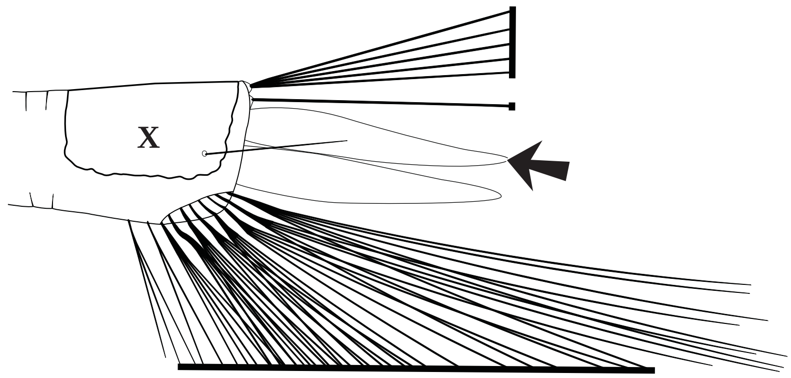


Fig. 425

21(18). Siphon length 4.0-5.0 times width at base and much narrower on apical half (Fig. 426); seta 9-S on ventral lobe beyond tip of siphon stout and hooked (Fig. 426); saddle seta 1-X much longer than saddle (Fig. 426) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. fitchii***

Siphon length less than 4 times width at base (Fig. 427); siphon seta 9-S small and straight (Fig. 427); saddle seta 1-X short, less than length of saddle (Fig. 427). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 22

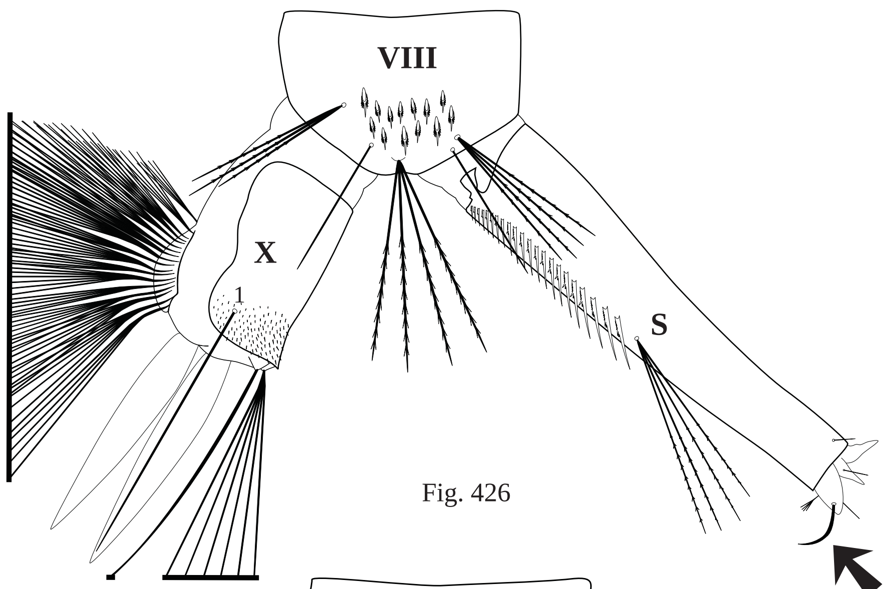


Fig. 426

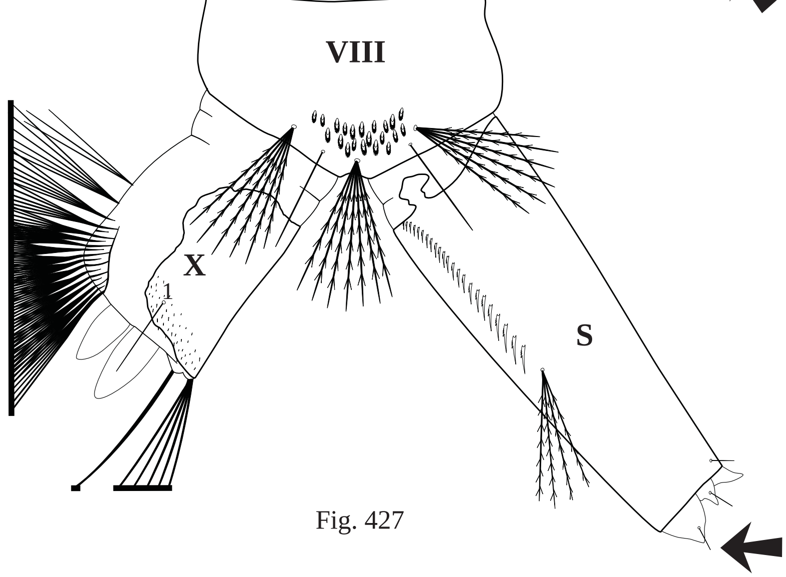


Fig. 427

22(21). Comb scales on segment VIII with apex pointed, with median apical spine 1.5-2.75 times length of adjacent lateral spines (Fig. 428). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .23

Comb scales with apex round, median spine approximately equal length of adjacent lateral spines (Fig. 429) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (northern species). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .25

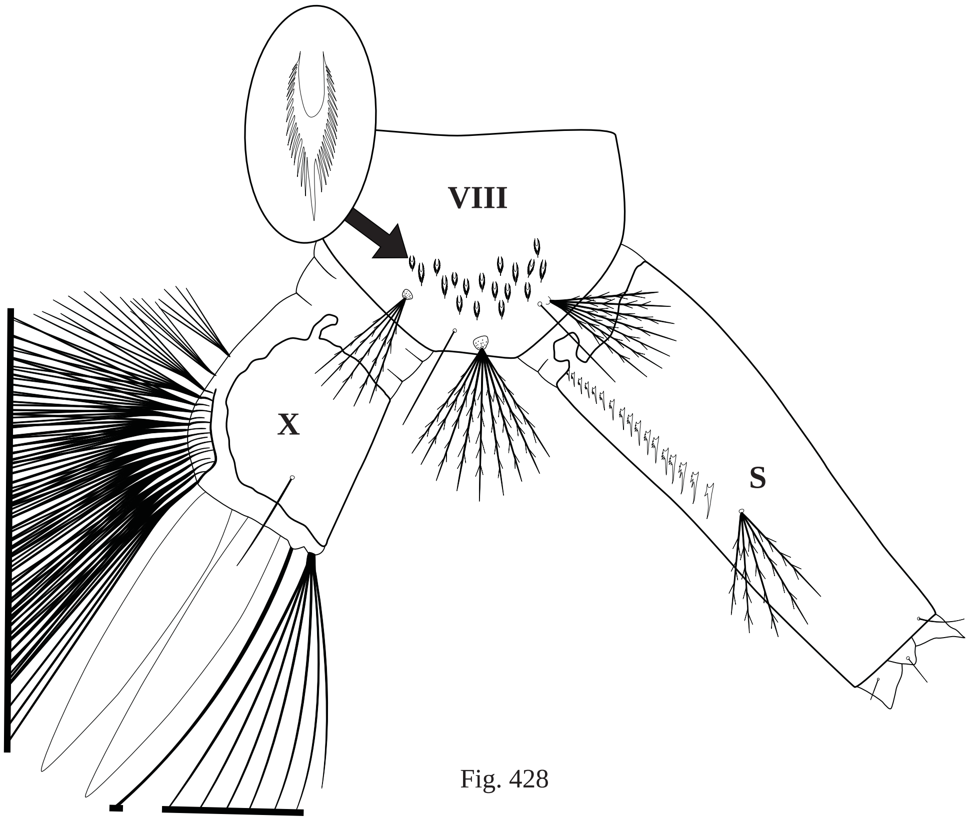


Fig. 428

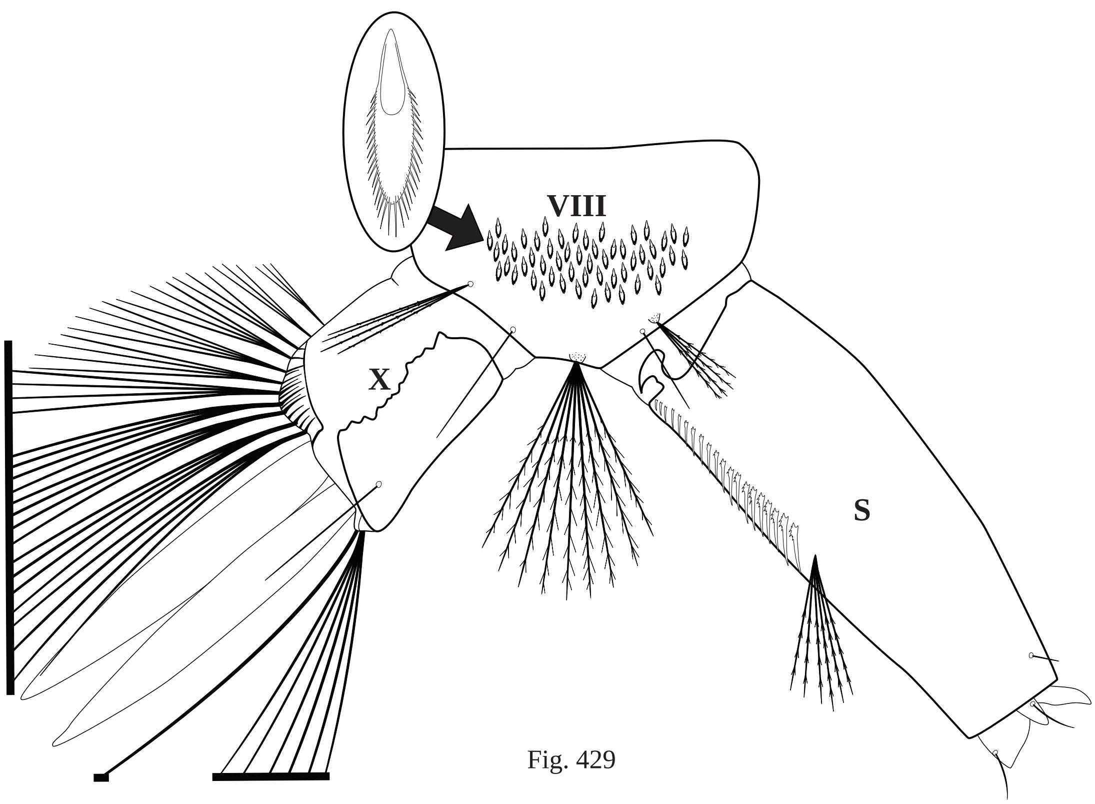


Fig. 429

23(22). Saddle on segment X approximately 90-95% complete, nearly encircling segment and may appear complete from dorso-lateral view (Fig. 430); siphon seta 1-S small, length half or shorter than width of siphon at point of insertion (Fig. 430). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .*Ae. sticticus*

Saddle only 60-70% complete from lateral view (Fig. 431); siphon seta 1-S long, length equal to or more than width of siphon at point of insertion (Fig. 431). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .24

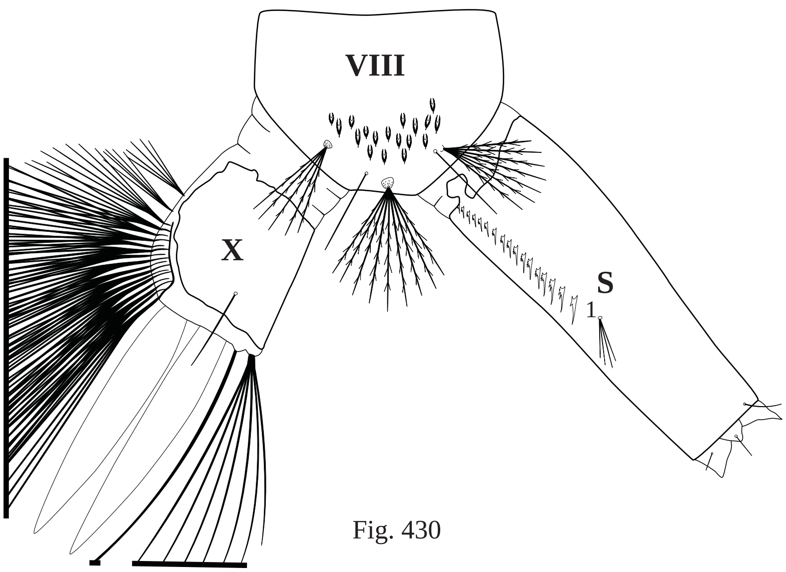

Fig. 430

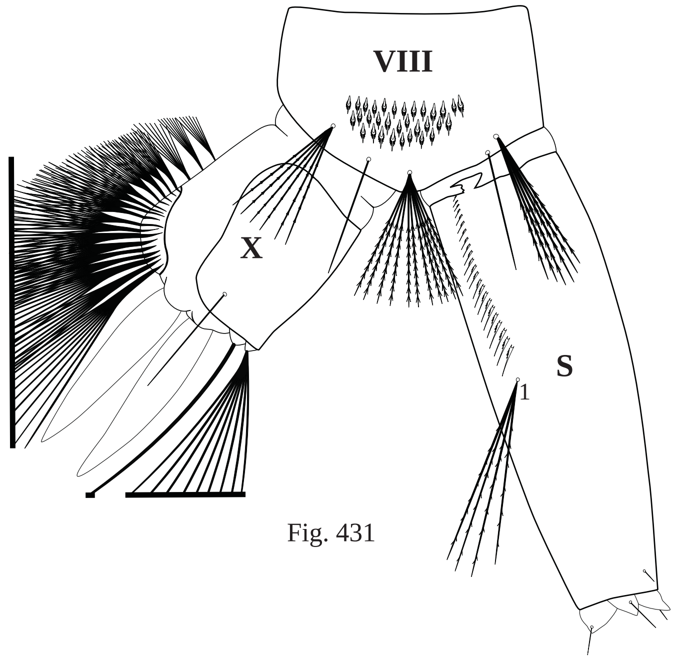

Fig. 431

24(23). Mesothoracic seta 1-M reaching anteriorly to base of seta 1-P (Fig. 432); total branches on combined head setae 5,6-C, 8 or more (Fig. 432); prothoracic seta 1-P more than 2 times length of seta 4-P (Fig. 432). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Ae. grossbecki*

Mesothoracic seta 1-M not reaching anteriorly to base of seta 1-P (Fig. 433); total branches on combined head setae 5,6-C, 7 or less (Fig. 433); prothoracic seta 1-P less than 2 times length of seta 4-P (Fig. 433). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(northern species) . . . . . . . . . . . . . . . . . . . . . . . . . *Ae. stimulans*

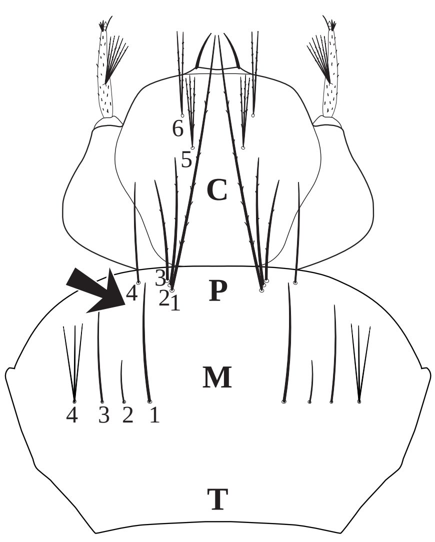

Fig. 432

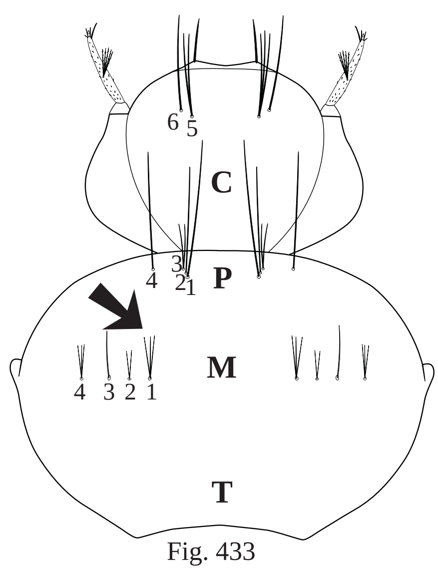

Fig. 433

25(22). Mesothoracic seta 1-M reaching forward to bases of prothorax setae (Fig. 434); anal papillae usually small, no longer than saddle (Fig. 435). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. dorsalis***

Mesothoracic seta 1-M short, not reaching half way to bases of prothorax setae (Fig. 436); anal papillae usually 2.0-2.5 times length of saddle (Fig. 437). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. communis***

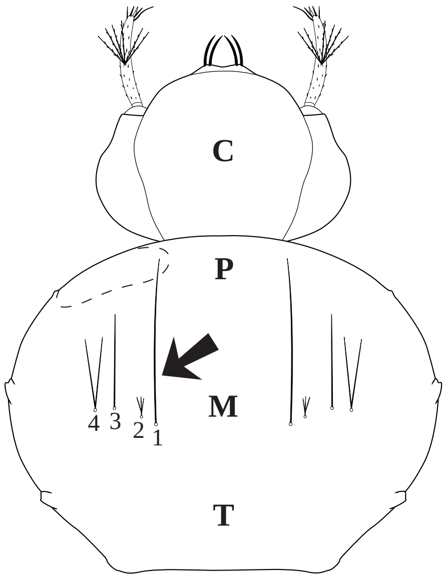

Fig. 434

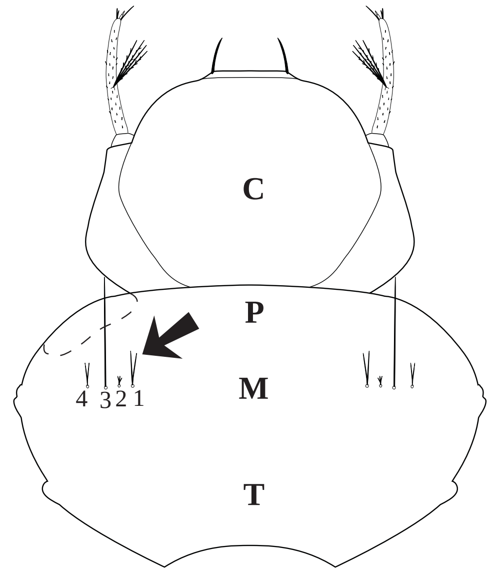

Fig. 436

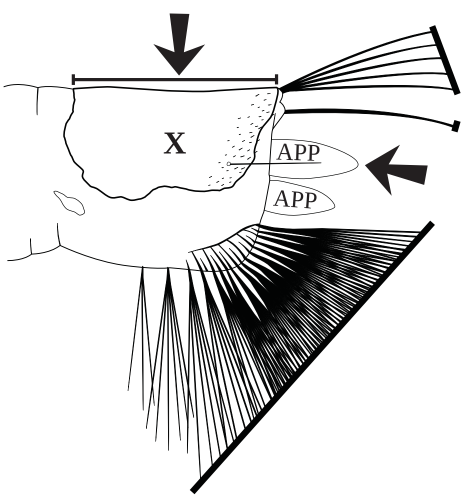

Fig. 435

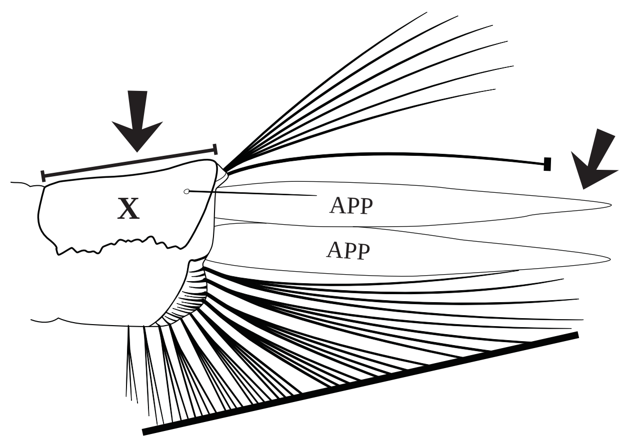

Fig. 437

26(13). Siphon seta 1-S inserted within the pecten spines (Fig. 438); ventral brush (seta 4-X) without basal precratal tufts, all setal pairs inserted on grid (Fig. 438). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .27

Siphon seta 1-S inserted distal to pecten spines or beside most apical pecten spine (Fig. 439); ventral brush (seta 4-X) with at least 1-2 pairs of precratal setae (Fig. 439). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 28

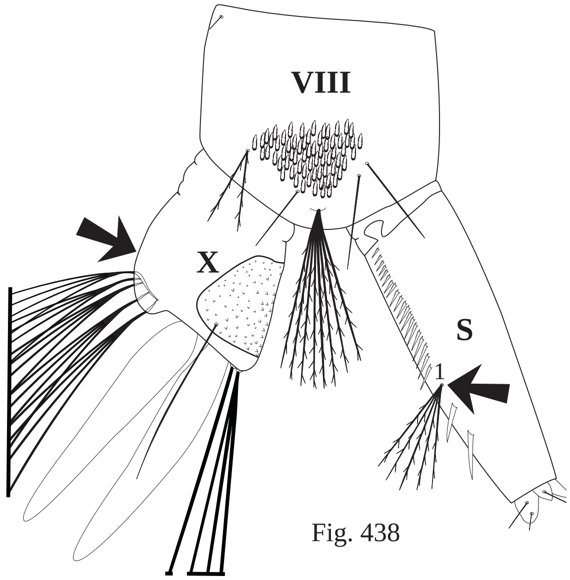

Fig. 438

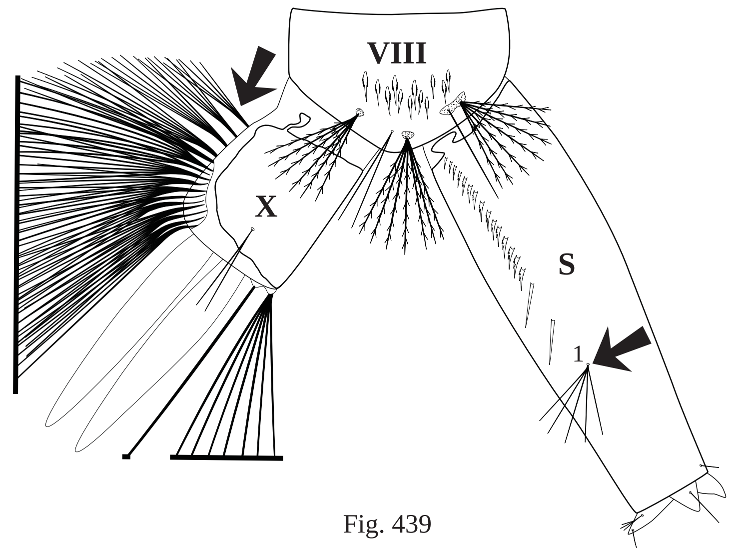

Fig. 439

27(26). Head setae 5,6-C branched and inserted near anterior edge of head, with 5-C mesal to 6-C (Fig. 440); saddle seta 1-X inserted on saddle near posterior margin (Fig. 441). . . . . . . . . . . . . . . . . . ***Ae. j. japonicus***

Head setae 5,6-C single, not inserted near anterior edge of head, 5-C inserted posterior to 6-C, 6-C inserted approximately level with antennal base and seta 7-C (Fig. 442); saddle seta 1-X inserted below saddle on non-sclerotized membrane (Fig. 443). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. atropalpus***

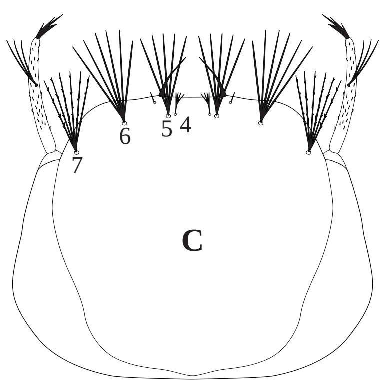

Fig. 440

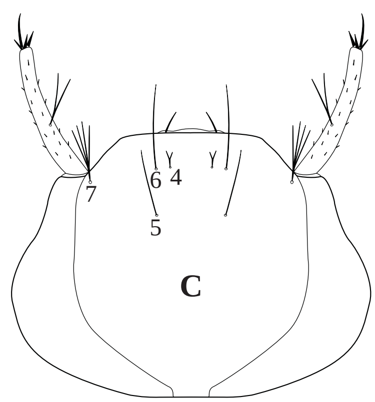

Fig. 442

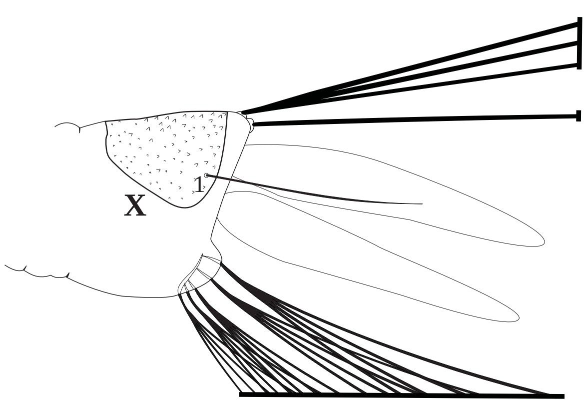

Fig. 441

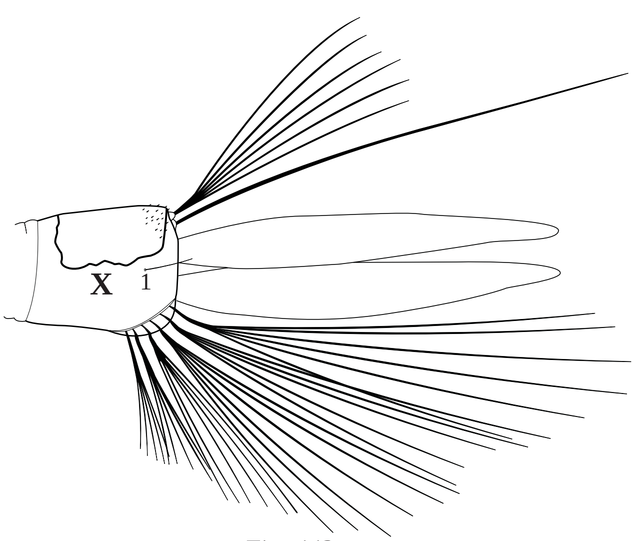

Fig. 443

28(26). Siphon long and sharply tapered distally, length nearly 5.0 times width at base; siphon seta 9-S on ventral lobe beyond tip of siphon, stout and hook-shaped (Fig. 444). . . (northern species). . . . . . . . . . ***Ae. excrucians***

Siphon length less than 4.5 times width at base; siphon seta 9-S weakly developed, not hook-shaped (Fig. 445) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 29

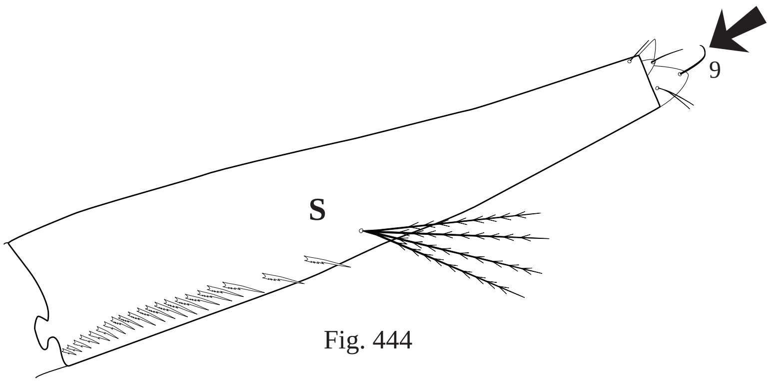

Fig. 444

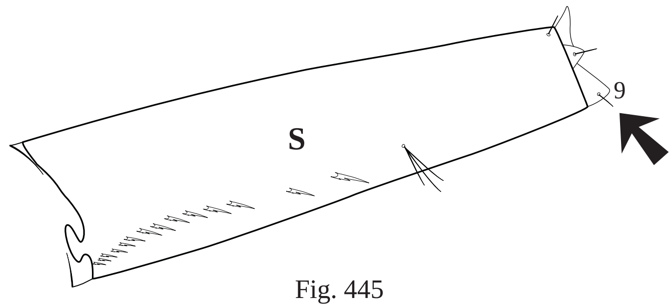

Fig. 445

29(28). Siphon seta 1-S small, length less than width of siphon at point of insertion (Fig. 446). . . . . . . . . . . . . . 30

Siphon seta 1-S large, length equal or greater than width of siphon at point of insertion (Fig. 447). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (northern species). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .31

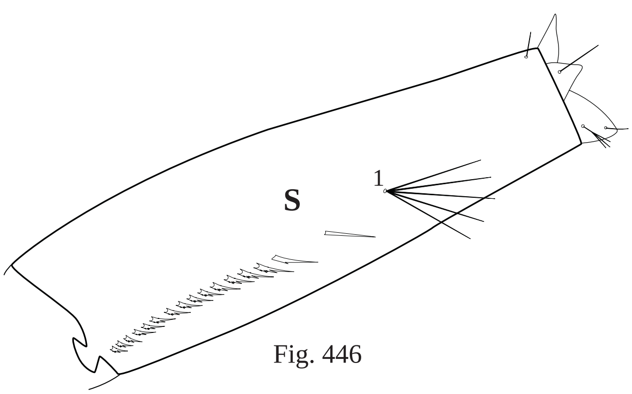

Fig. 446

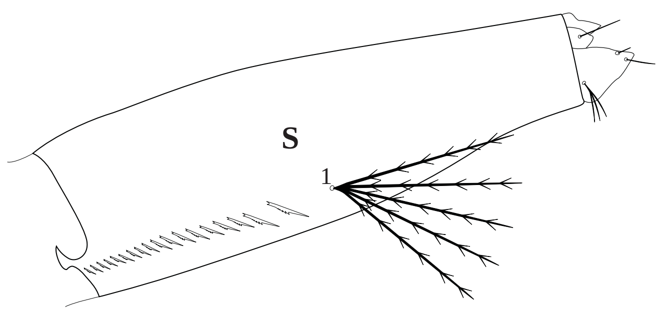

Fig. 447

30(29). Head setae 5,6,7-C inserted in straight row (Fig. 448); saddle clearly incomplete, encircling about 70% of segment X (Fig. 449). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. cinereus***

Head setae 5,6,7-C not in straight row, 6-C clearly anterior of line between insertion sites of seta 5-C and 7-C (Fig. 450); saddle nearly complete, encircling about 90-95% of segment X (Fig. 451). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. vexans***

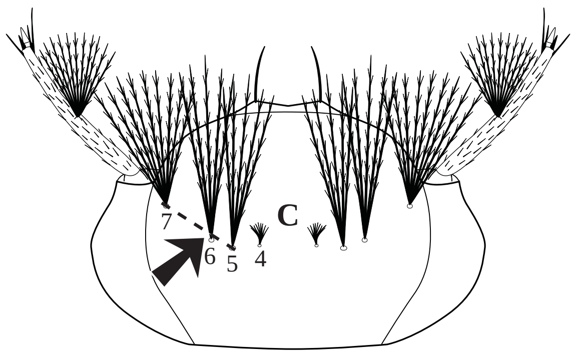

Fig. 448

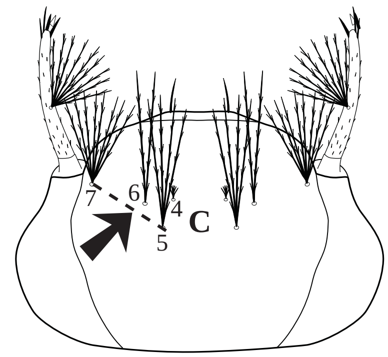

Fig. 450

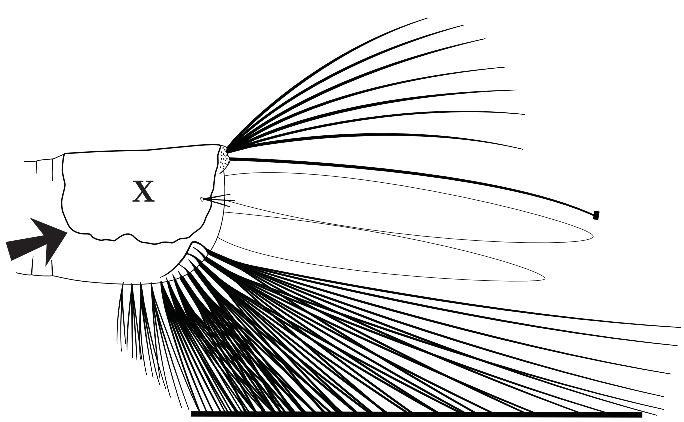

Fig. 449

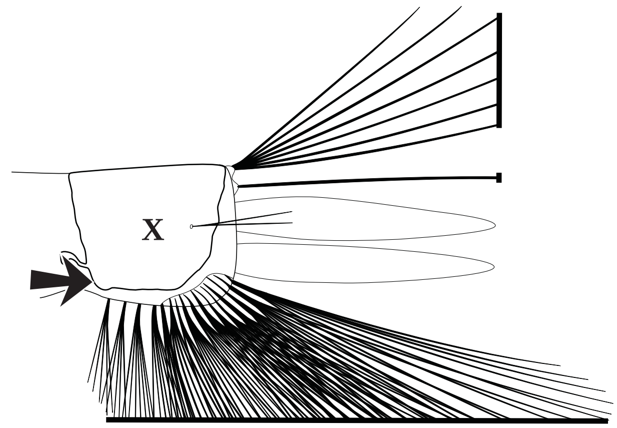

Fig. 451

31(29). Antenna long, approximately equal or longer than head measured on midline (Fig. 452). . . . . . . . . . . . .32

Antenna shorter, 0.5-0.75 length of head measured on midline (Fig. 453). . . . . . . . . . . . . . . . . . . . . . . . . .33

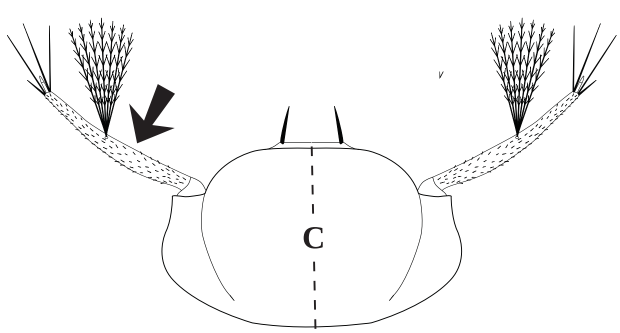

Fig. 452

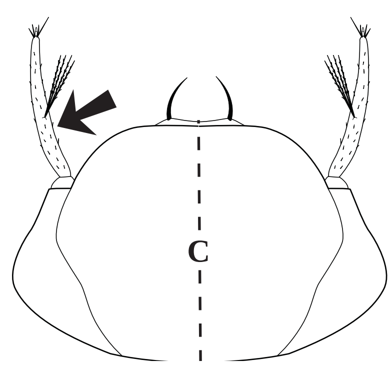

Fig. 453

32(31). Antenna approximately equal to head length with apex black (Fig. 454); head setae 5,6,7-C inserted in straight row (Fig. 454); segment VIII with comb scales (15-32) in patch (Fig. 455). . . . . . .***Ae. aurifer***

Antenna longer than head length measured on midline, antenna pale (Fig. 456); head setae 5,6,7-C inserted nearly in straight row, but seta 6-C slightly anterior to line between insertion sites of 5,7-C (Fig. 456); comb scales (6-14) in single uneven curved row (Fig. 457). . . . . . . . . . . . . . . . . . . . . . . . . .***Ae. diantaeus***

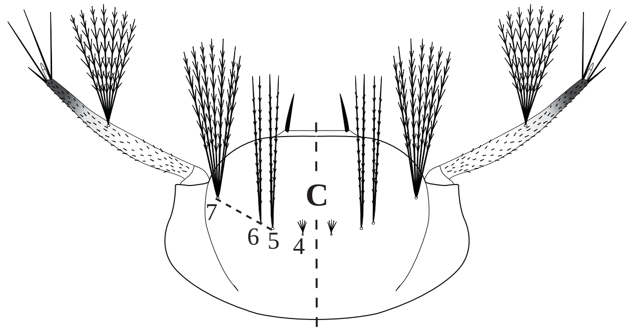


Fig. 454

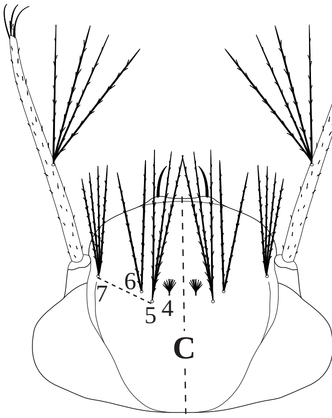


Fig. 456

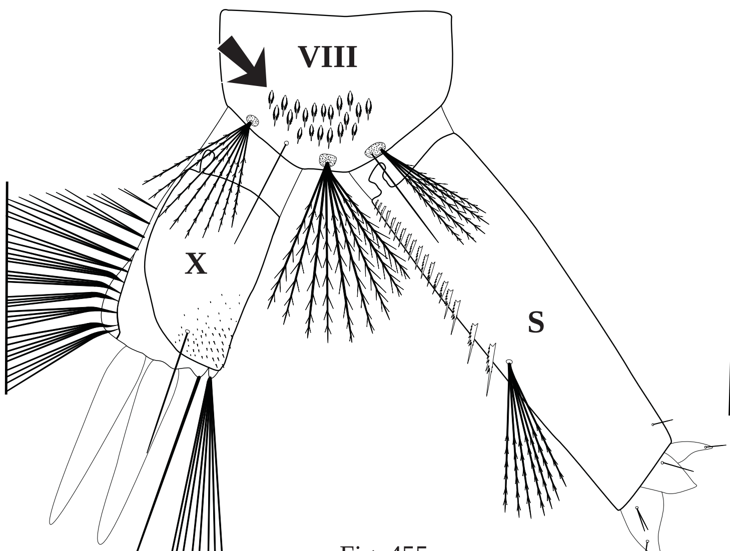


Fig. 455

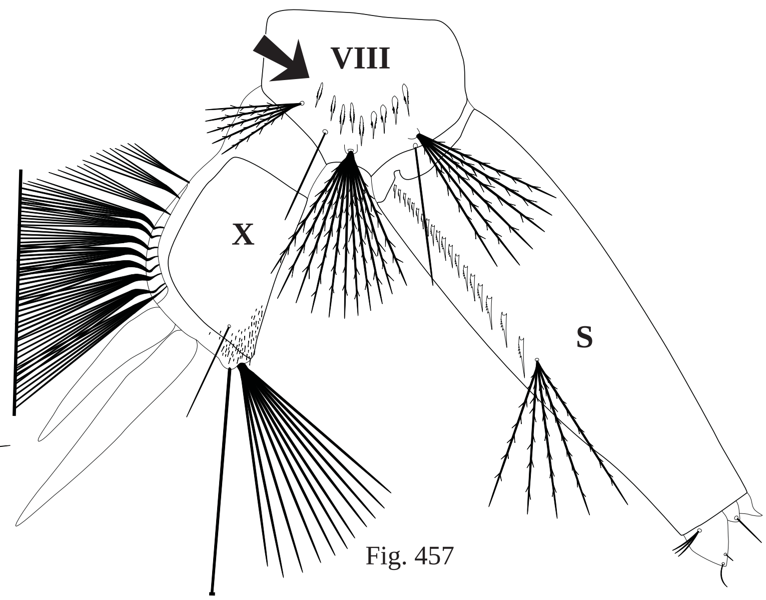


Fig. 457

33(31). Preantennal seta 7-C with 3-8 attenuated branches (Fig. 458); comb on segment VIII with 11-18 sharp scales in irregular double row (Fig. 459); saddle with distinct notch on ventral margin (Fig. 459). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. intrudens***

Preantennal seta 7-C with 2-4 stout branches of uniform diameter for entire length (Fig. 460); comb on segment VIII with 5-7 sharp scales in a single row (Fig. 461); saddle without notch on ventral margin (Fig. 461). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ae. decticus***

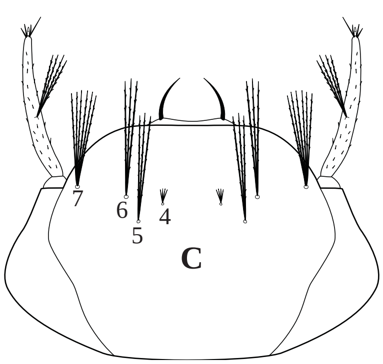


Fig. 458

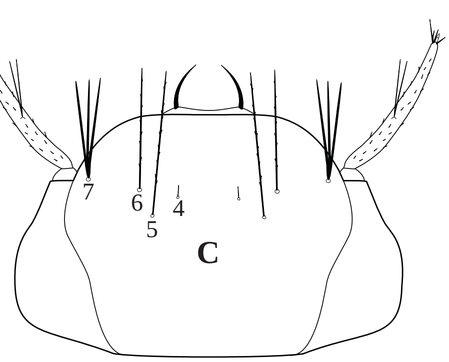


Fig. 460

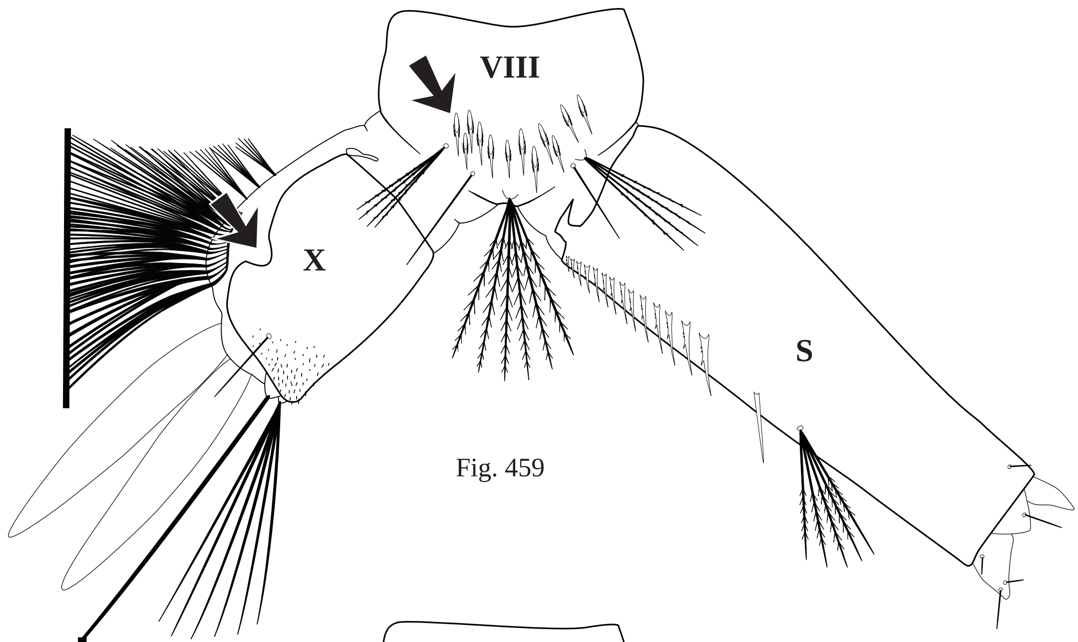


Fig. 459

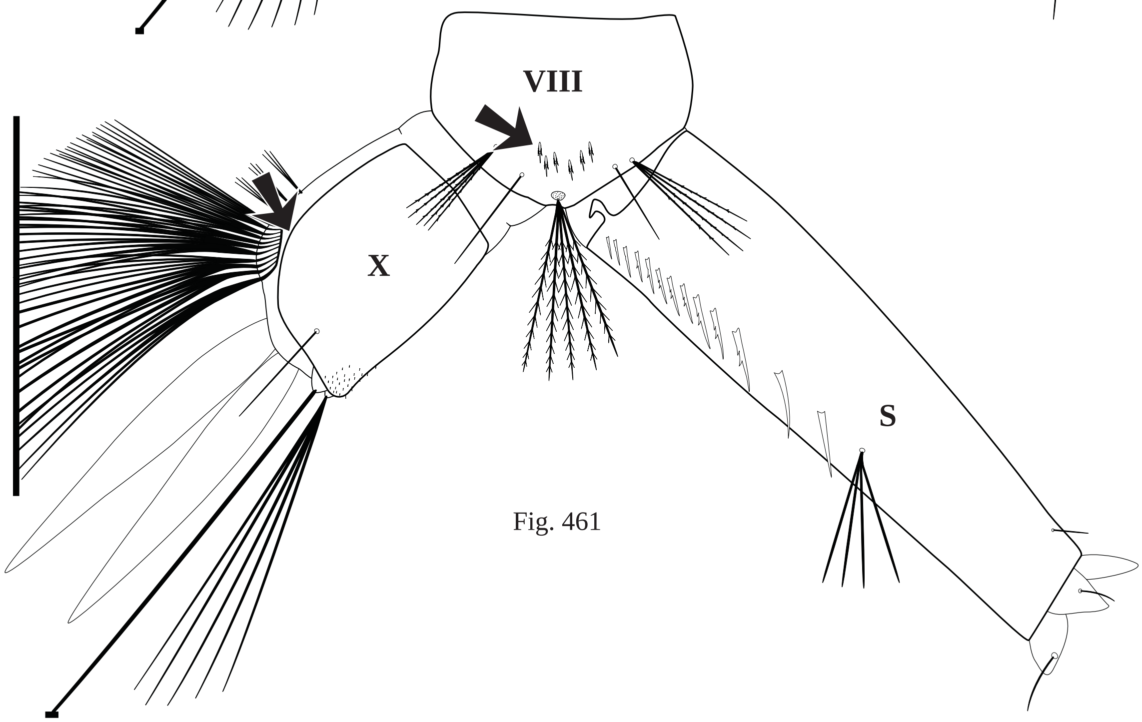


Fig. 461

# Key to Species of Fourth Instar Larvae of *Anopheles* (=*An.*)

1. Abdominal seta 6-VI long and plumose (Fig. 462); head seta 4-C near anterior margin of head and lateral to setae 2,3-C, 4-C longer than 3-C (Fig. 463); antennal seta 1-A short, single, and inserted at midpoint of antenna (Fig. 463). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. barberi***
(See Note 15)

   Abdominal seta 6-VI tiny, branched, hard to see (Fig. 464); head seta 4-C inserted posterior to 2,3-C (Fig. 465); antennal seta 1-A branched and inserted on basal 0.25 - 0.50 of antenna (Fig. 465). . . . . . . . .2

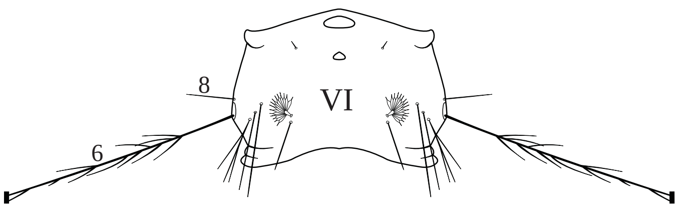

Fig. 462

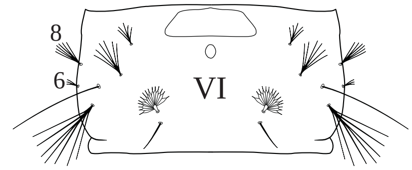

Fig. 464

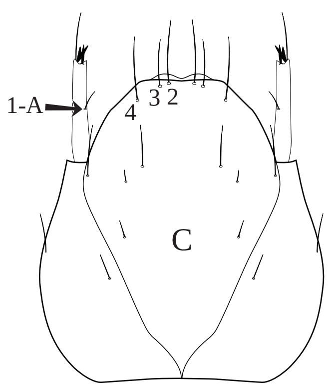

Fig. 463

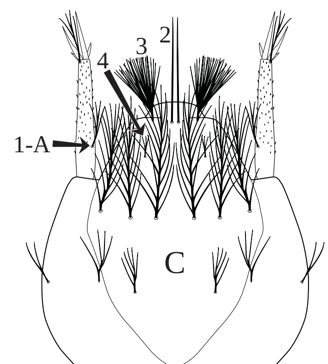

Fig. 465

2(1). Head seta 3-C with 5-10 branches on apical 0.5, much shorter than seta 2-C (Fig. 466); seta 2-C simple or with few fine aciculae near tip (Fig. 466). . . . . . . . . . . . .(brackish water) . . . . . . . . . . . . . ***An. atropos***

   Head seta 3-C with 15 - 40+ branches, usually branching on basal 0.50 of seta (Fig. 467); seta 2-C with or without fine aciculae or branches (Fig. 467). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .3

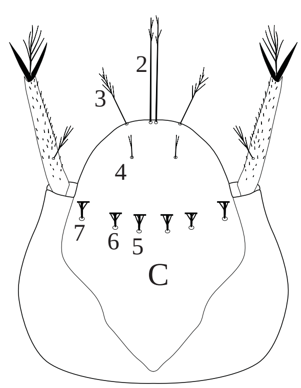

Fig. 466

**Setae 5,6,7-C have been shortened to show front part of head**

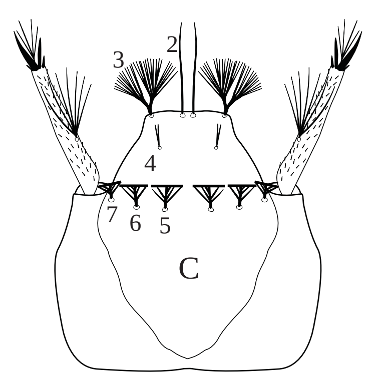

Fig. 467

3(2). Head seta 2-C with fine aciculae or 2-5 strong branches on apical half (Fig. 468). . . . . . . . . . . . . . . . . . . .4

Head seta 2-C simple, without branches (Figs. 469). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5
(See Note 16)

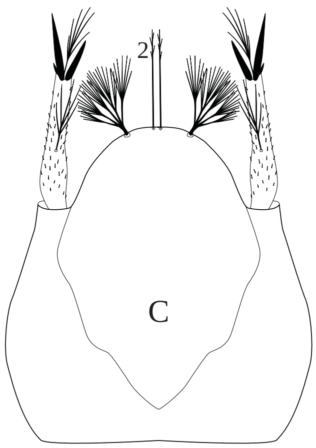

Fig. 468

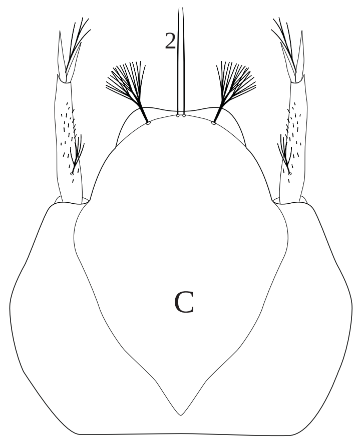

Fig. 469

4(3). Head seta 2-C with sparse fine aciculae near tip (Fig. 470); prothoracic seta 1-P with 3-5 branches from base (Fig. 471); abdominal seta 0-IV,V small with 3-7 branches (Fig. 472). . . . . . . . . . . . . . . . . . . ***An. walkeri***
(See Note 17)

Head seta 2-C with 2-5 strong apical branches, at least on one side of head (Fig. 473); prothoracic seta 1-P single (Fig. 474); abdominal seta 0-IV,V absent or simple (Fig. 475). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .(northern species) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. earlei***

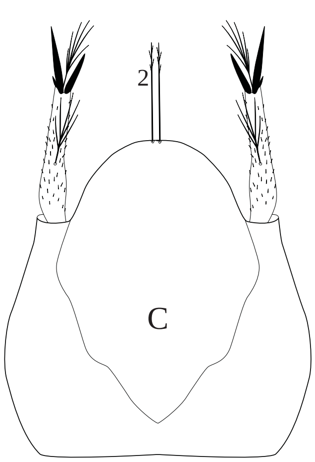

Fig. 470

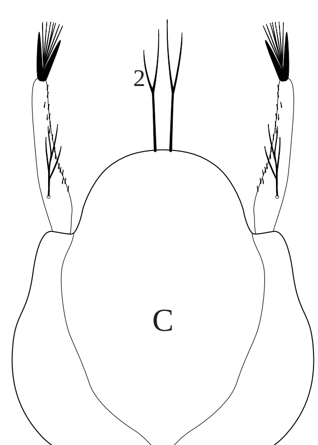

Fig. 473

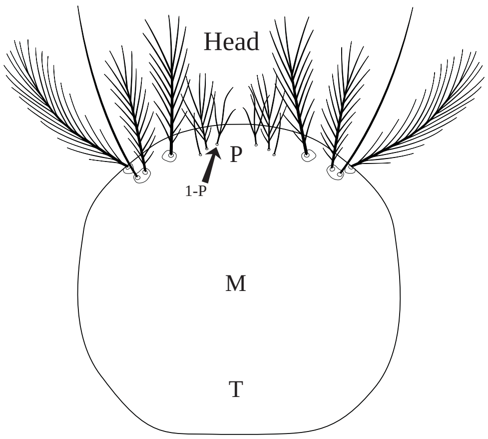


Fig. 471

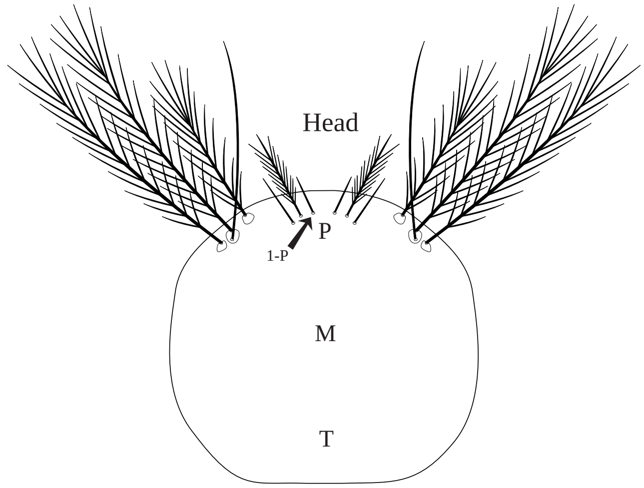


Fig. 474

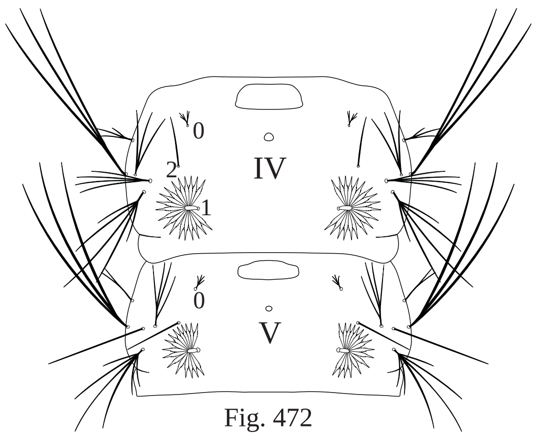


Fig. 472

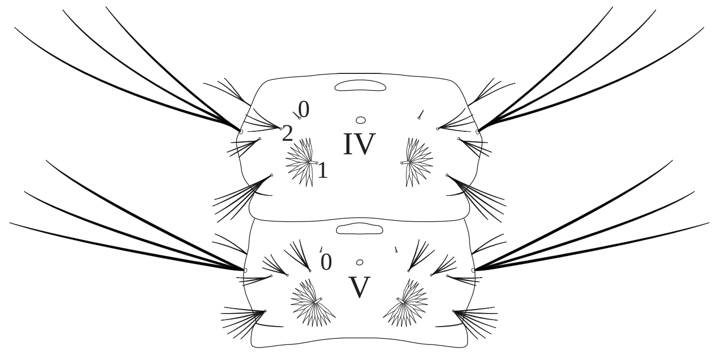


Fig. 475

5(3). Alveoli of head setae 2-C separated by width of one alveolus or more (Fig. 476); abdominal segment II with seta 1-II usually partially developed into functional palmate seta (Fig. 477). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (***An. quadrimaculatus s.l.***). . . . . . . . . . . . . .6
(See Note 18)

Alveoli of head setae 2-C close together, separated by less than width of one alveolus (Fig. 478); abdominal seta 1-II usually rudimentary and non-functional as palmate seta (Fig. 479). . . . . . . . . . . . . . . . . . . . . . 10

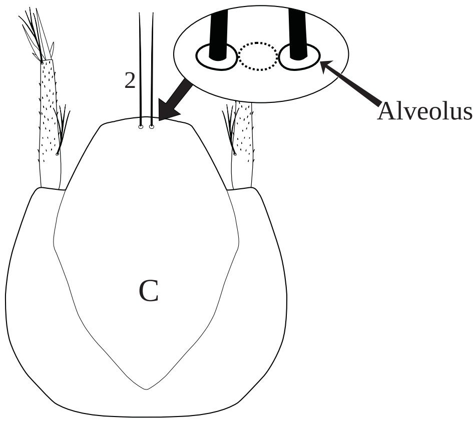


Fig. 476

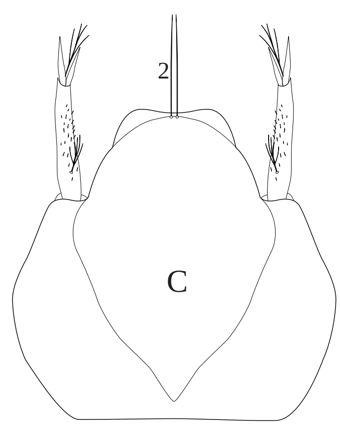


Fig. 478

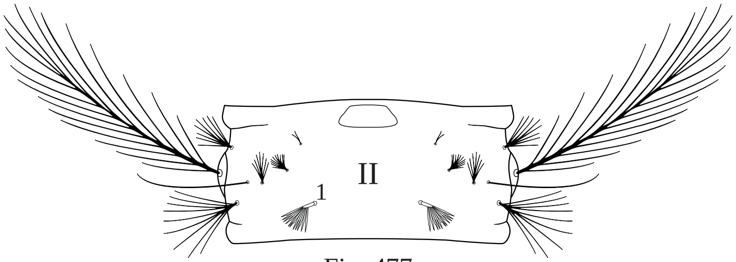


Fig. 477

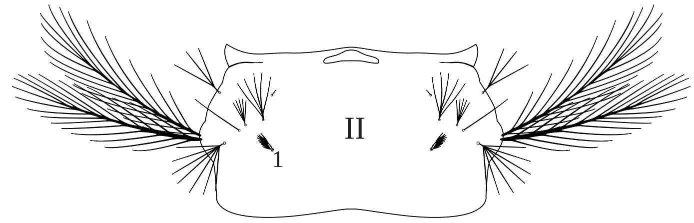


Fig. 479

6(5). Sum of both setae 1-A usually 18-29 branches (Fig. 480); sum of both setae 8-III plus setae 8-VI usually 19 or more branches (Fig. 481); head seta 2-C short, only 1.29 or less length of seta 3-C (Fig. 480). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. maverlius***

Sum of both setae 1-A usually 5-17 or fewer branches (Fig. 482); sum of setae 8-III plus setae 8-VI usually 18 or fewer branches (Fig. 483); head seta 2-C longer, 1.30 or more length of 3-C (Fig. 482) . . . . . . . . .7

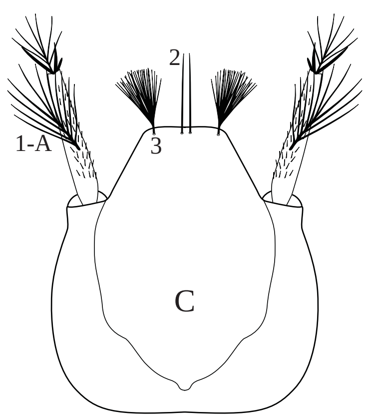


Fig. 480

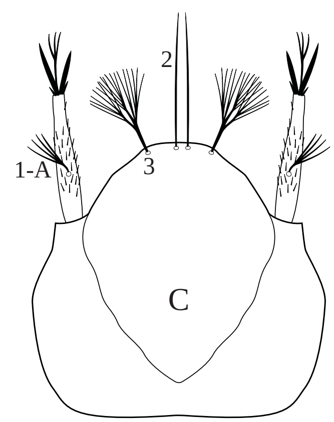


Fig. 482

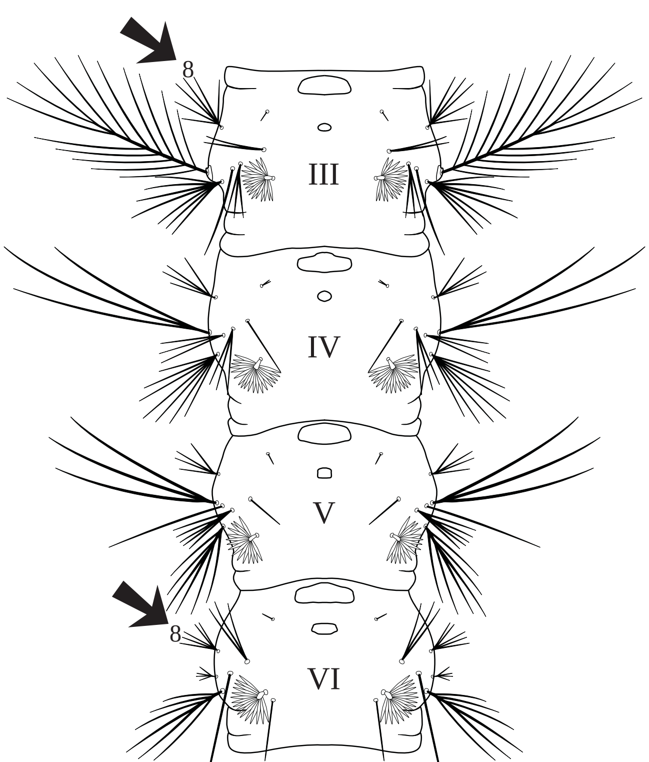


Fig. 481

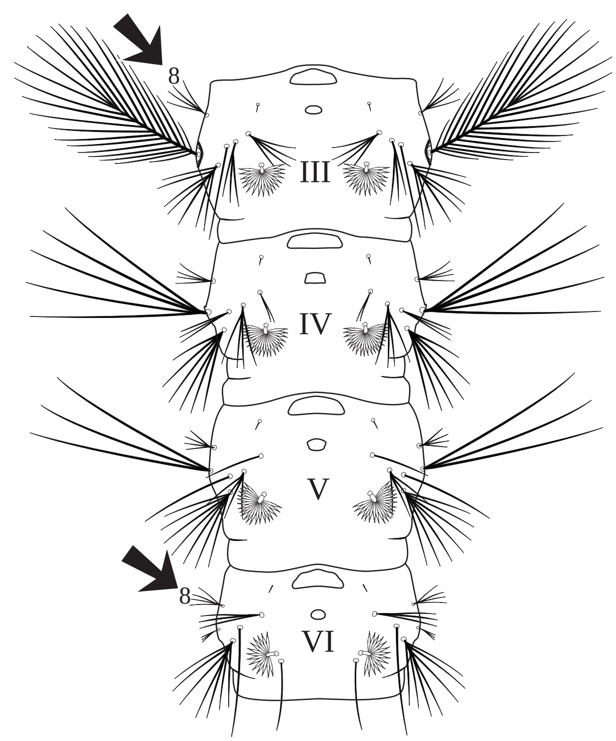


Fig. 483

7(6). Pecten plates each with 6-8 long spines (Fig. 484); antennal seta 1-A inserted 0.31 or more from antennal base (Fig. 485). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .8

One or both pecten plates with 9-11 long spines (Fig. 486); antennal seta 1-A usually inserted 0.30 or less from antennal base (Fig. 487). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .9

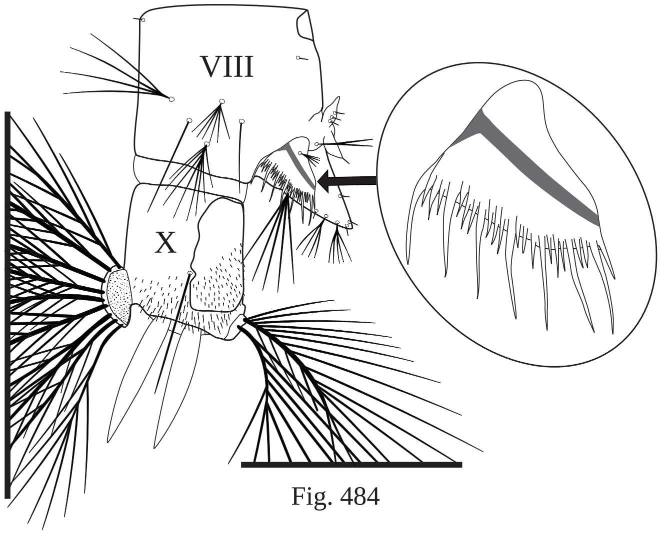

Fig. 484

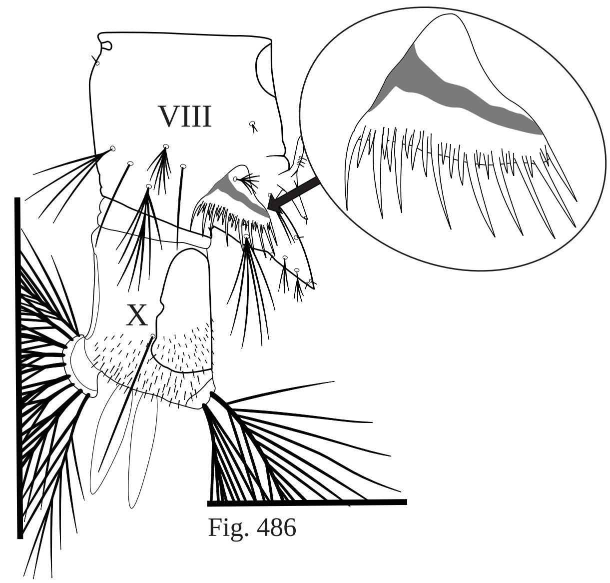

Fig. 486

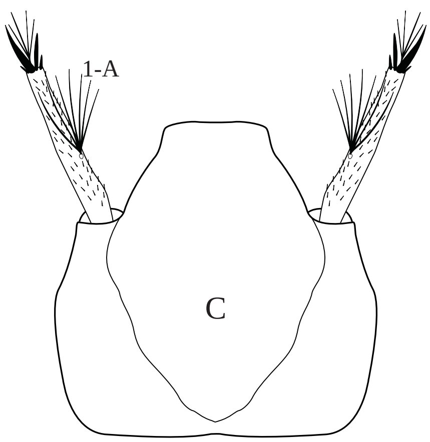

Fig. 485

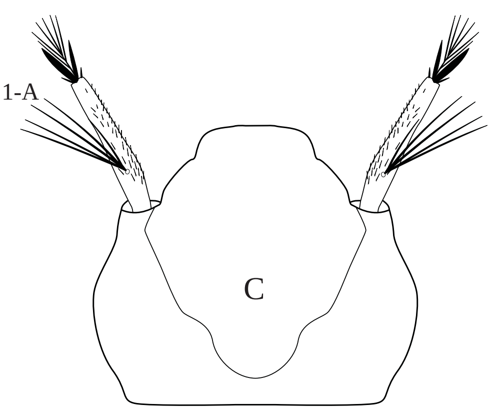

Fig. 487

8(7). Sum of both setae 3-C with 25-63 branches (Fig. 488); sum of both setae 8-V usually 7-10 branches (Fig. 489); segment VIII with small bi-lobed plate on anteroventral midline (Fig. 490). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. quadrimaculatus s.s.***

Sum of both setae 3-C usually 64 or more branches (Fig. 491); sum of both setae 8-V usually 6 or fewer branches (Fig. 492); segment VIII usually without bi-lobed plate on anteroventral midline (Fig. 493). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. smaragdinus***

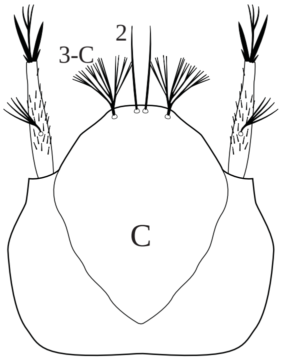


Fig. 488

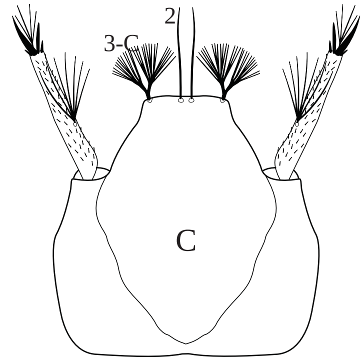


Fig. 491

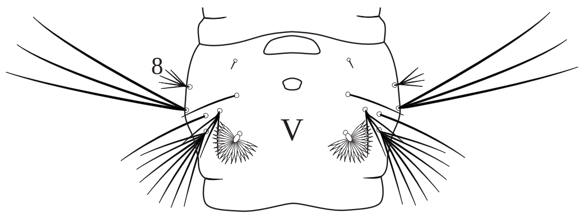


Fig. 489

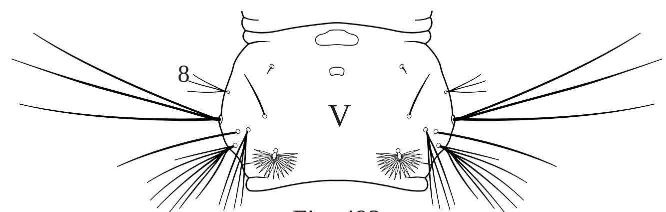


Fig. 492

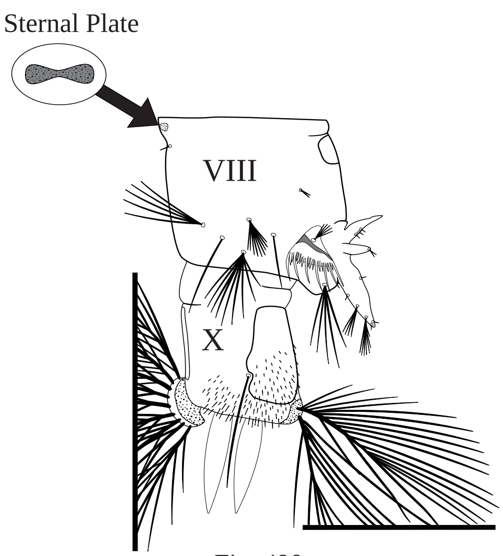


Fig. 490

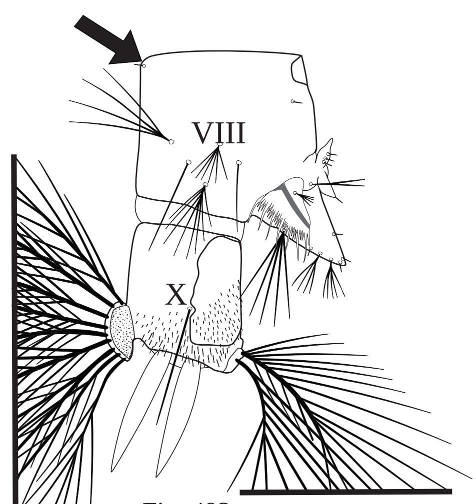


Fig. 493

9(7). Sum of both setae 8-II and 9-II usually 18-25 branches (Fig. 494); sum of both setae 2-I and 9-I, 16-24 branches (Fig. 494); sum of both setae 14-P often with 17-27 branches (Fig. 495). . . . . . . . ***An. diluvialis***

Sum of both setae 8-II and 9-II usually 26-40 branches (Fig. 496); sum of both setae 2-I and 9-I, 25-35 or more branches (Fig. 496); sum of both setae 14-P usually with 8-16 branches (Fig. 497) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. inundatus***

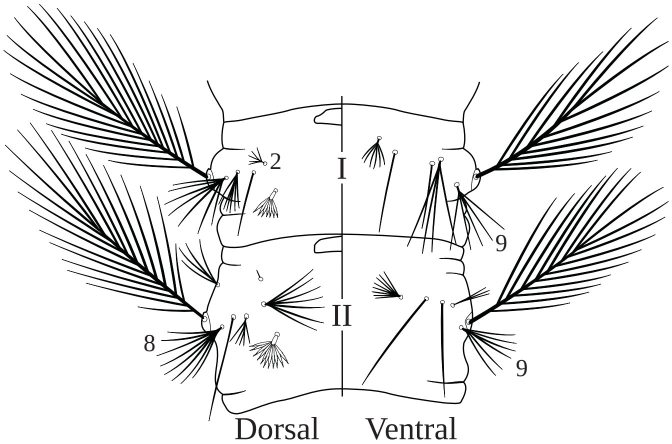


Fig. 494

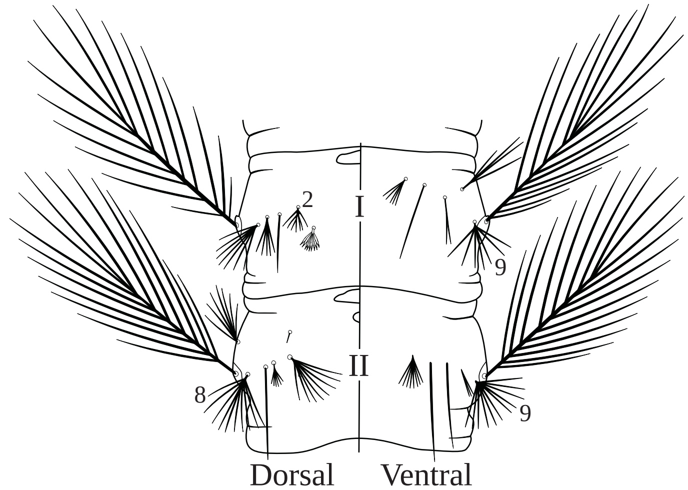


Fig. 496

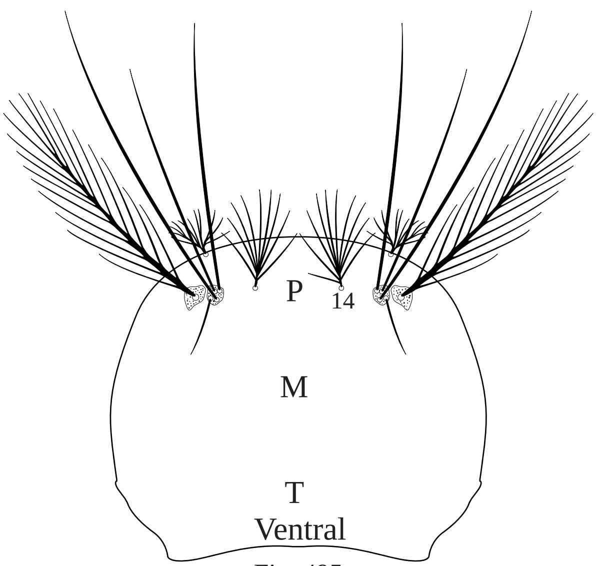


Fig. 495

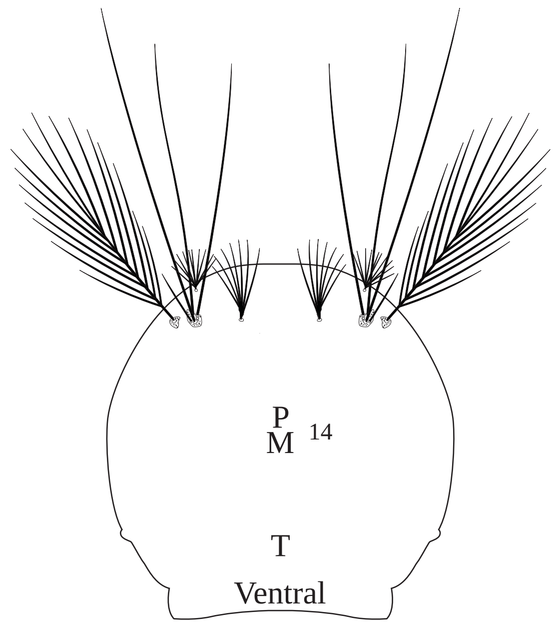


Fig. 497

10(5). Abdominal seta 0 on segment IV-V large, with 4-13 branches, approximately equal size seta 2 on IV-V (Fig. 498) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. crucians s.l.***

**(Includes *crucians* A, B, C, D, E)**

(See Note 19)

Abdominal seta 0 on segment IV-V tiny, single or with 2-3 branches, or absent; when seta 0 is present it is much smaller than seta 2 on IV-V (Fig. 499). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .11

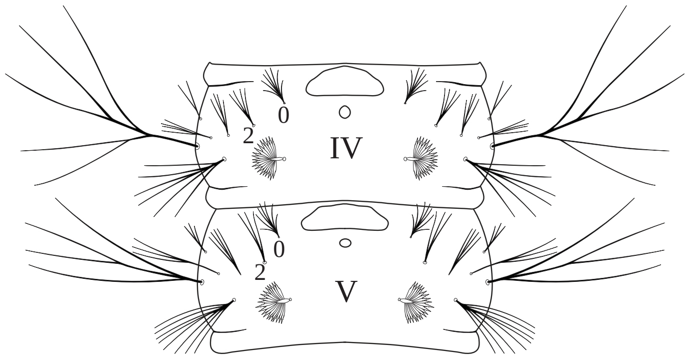


Fig. 498

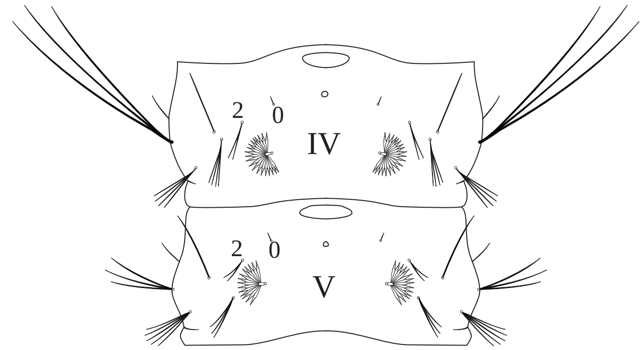


Fig. 499

11(10). Palmate seta 1 on segments IV-VI well developed, much larger than less developed seta 1 on III and VII (Fig. 500); segment II without tiny accessory tergal plate posterior to anterior tergal plate (Fig. 500). . . . . .12
(See Note 20)

Palmate seta 1 on segments III-VII well developed and nearly the same size (Fig. 501); segment II with tiny accessory tergal plate on midline just posterior to anterior tergal plate (Fig. 501). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . **(*An. punctipennis s.l.*)**. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .13
(See Note 21)

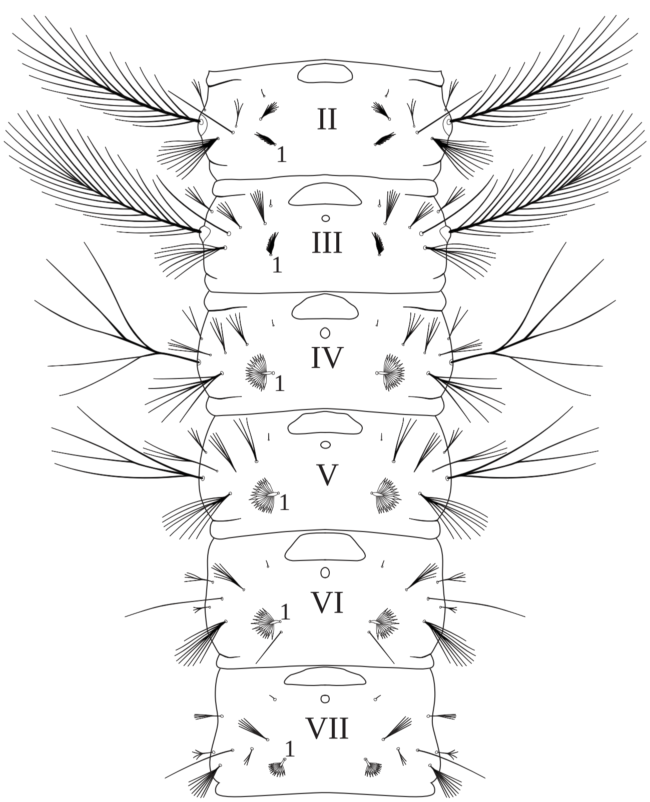


Fig. 500

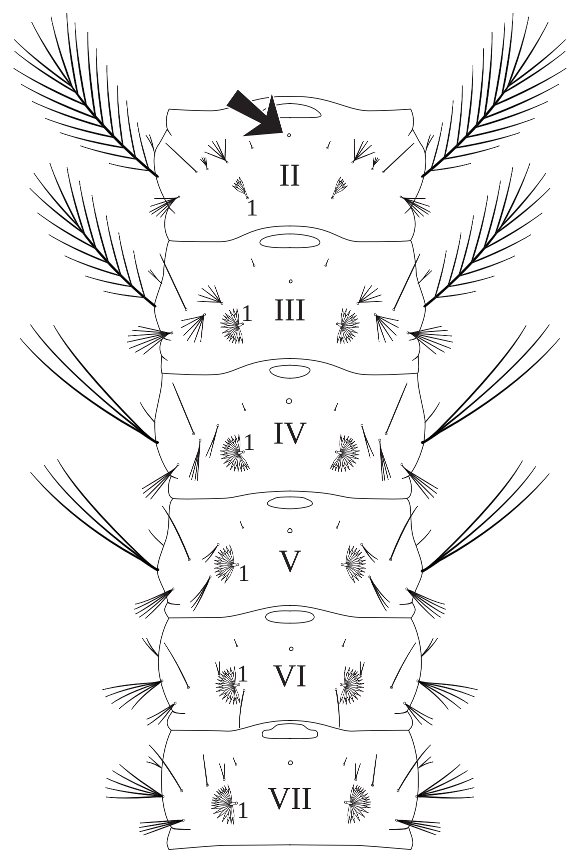


Fig. 501

12(11). Palmate seta 1 on segment III more like seta 1 on IV than seta 1 on II (Fig. 502); seta 5 on II with 5-9 (usually 5-6) branches (Fig. 502); seta 11 on segment I with 4-6 branches (Fig. 502); antenna entirely black-brown (Fig. 503); brackish water . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. bradleyi***
(See Note 22)

Palmate seta 1 on segment III very small and appearing more like seta 1 on II, than seta 1 on IV (Fig. 504); seta 5 on segment II with 7-14 branches (Fig. 504); seta 11 on 1 with 6-10 branches (Fig. 504); antenna not deeply pigmented (Fig. 505); fresh seepage water. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. georgianus***
(See Note 23)

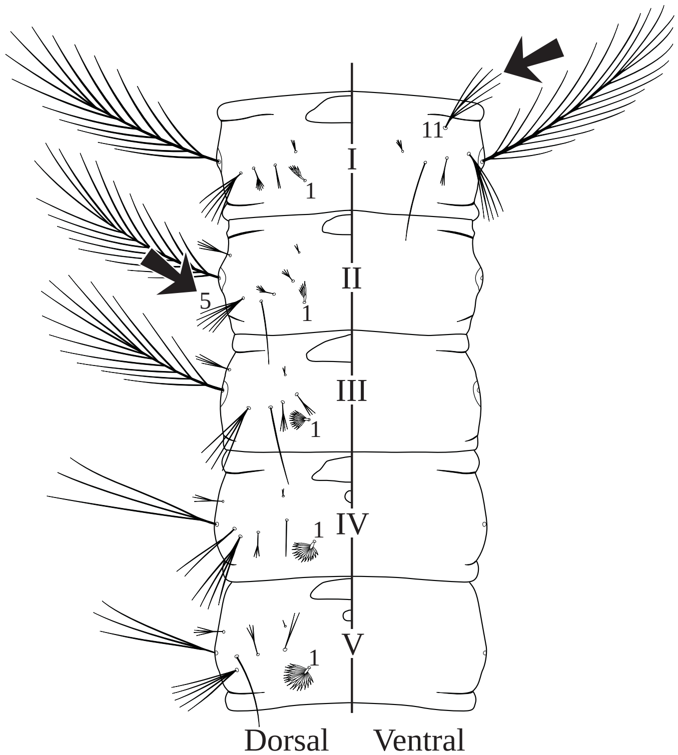


Fig. 502

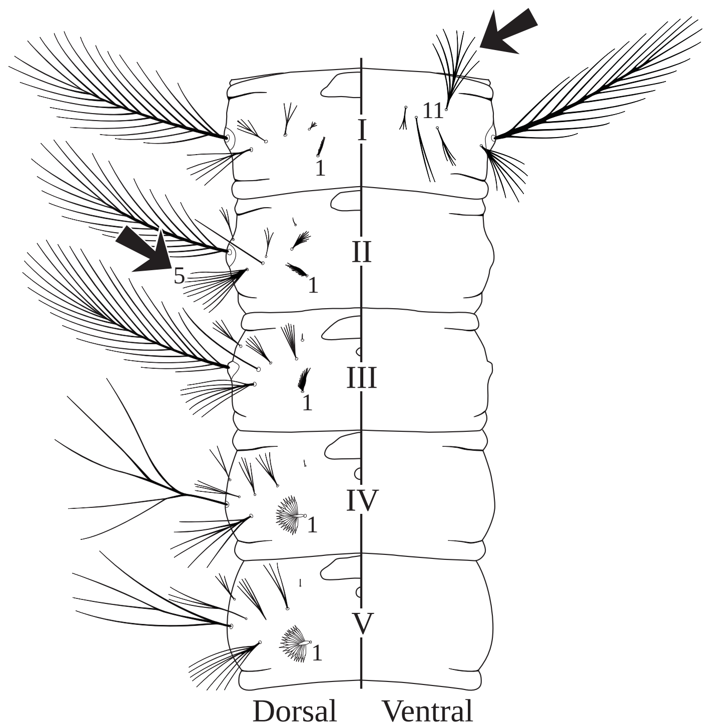


Fig. 504

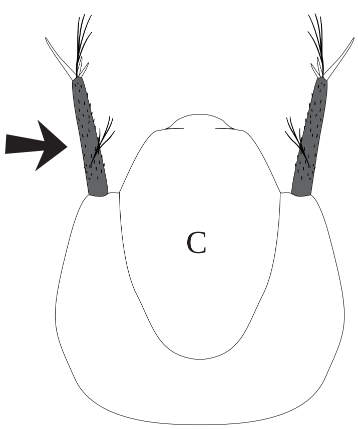


Fig. 503

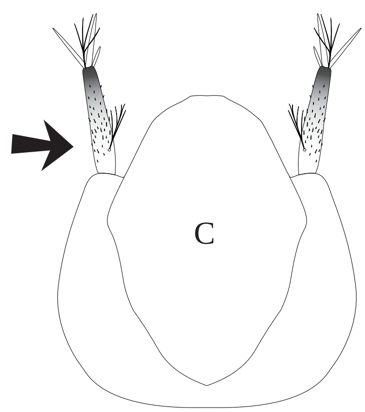


Fig. 505

13(11). Setae 2 on segments IV-V usually with 2-4 branches from base, these setae rarely single or double (Fig. 506) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***An. punctipennis*** (E= eastern U.S.)
(See Note 21)

Setae 2 on segments IV-V all single, or with no more than two with 2 branches from base (Fig. 507). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***An. perplexens*** (*auctorum*)*
(See Note 21)

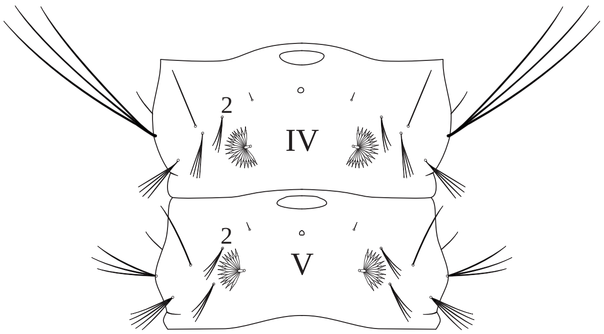


Fig. 506

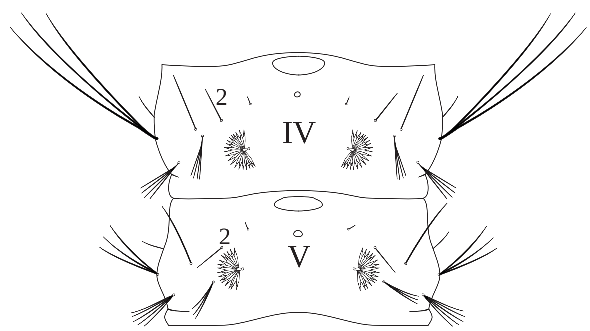


Fig. 507

*auctorum* means "of authors"

## Key to Species of Fourth Instar Larvae of *Culex* (= *Cx.*)

1. Head setae 5,6,7-C with 3 or more main branches, each with small aciculate branches (Fig. 508); prothoracic seta 3-P at least two thirds length of seta 1-P (Fig. 509). . . . . . . . . .Subgenus *Culex* . . . . . . . . . . . . . . . .2

   Head seta 7-C multibranched, 6-C single or double, 5-C smaller, single to multibranched (Fig. 510); prothoracic seta 3-P one-third or less length of seta 1-P (Fig. 511). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .7

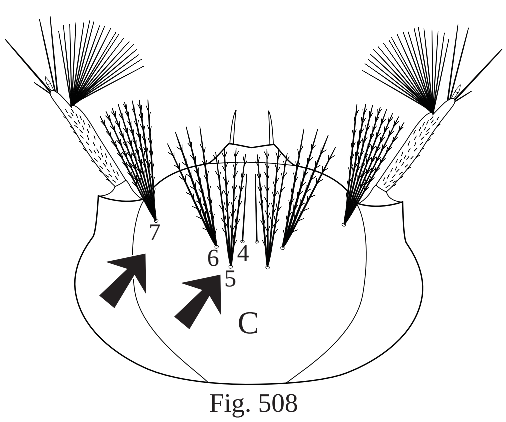


Fig. 508

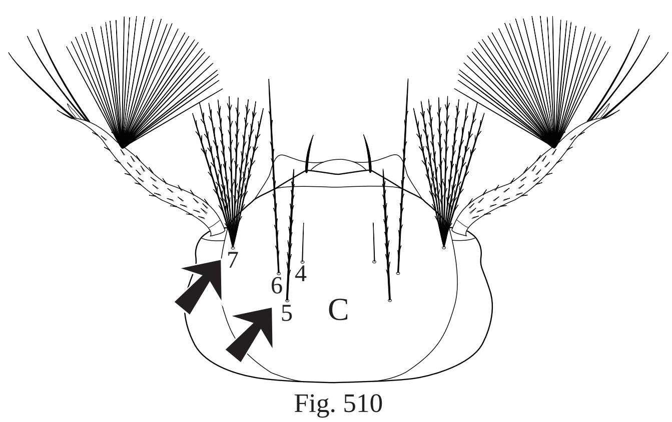


Fig. 510

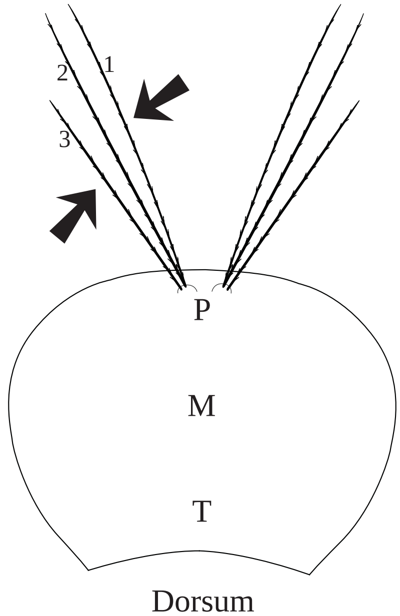

Fig. 509

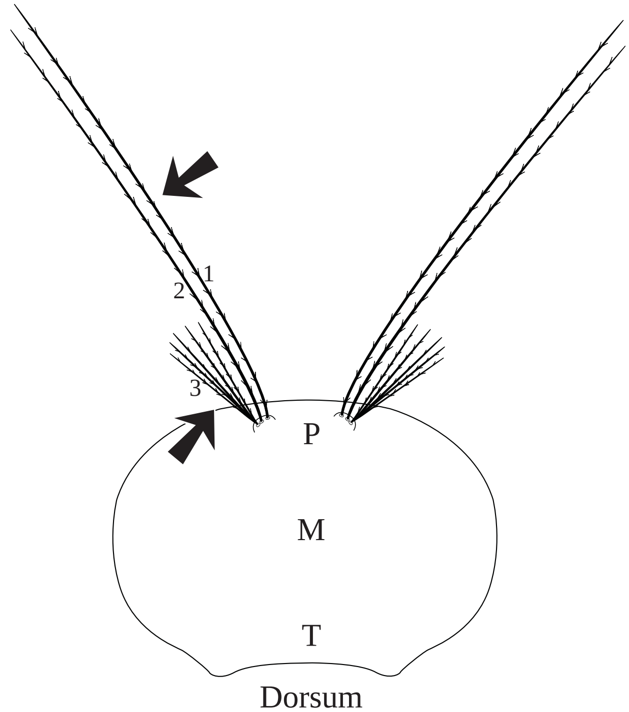

Fig. 511

2(1). Siphon length 7-9 times width at base, with few to many short spines just before the tip (Fig. 512). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. coronator***

Siphon length 3.5-9.0 times width at base, without small spines near apex (Fig. 513). . . . . . . . . . . . . . . . .3

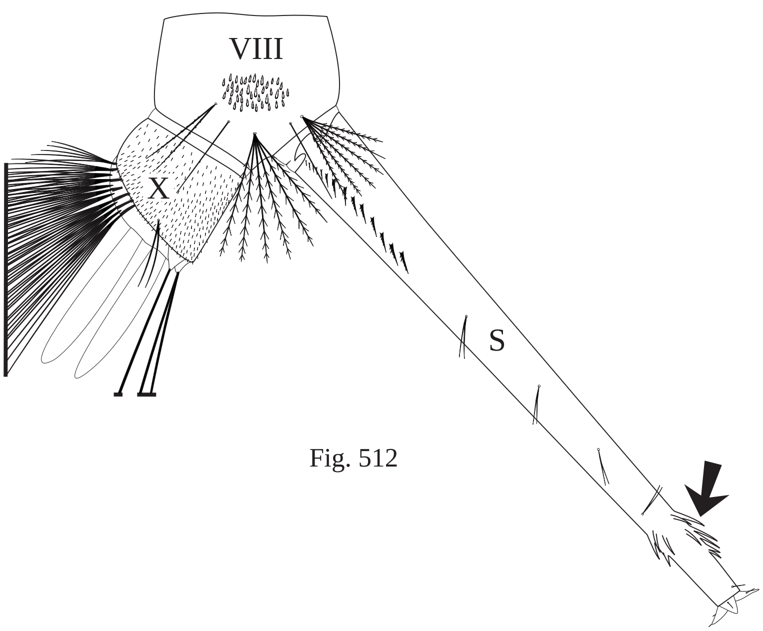

Fig. 512

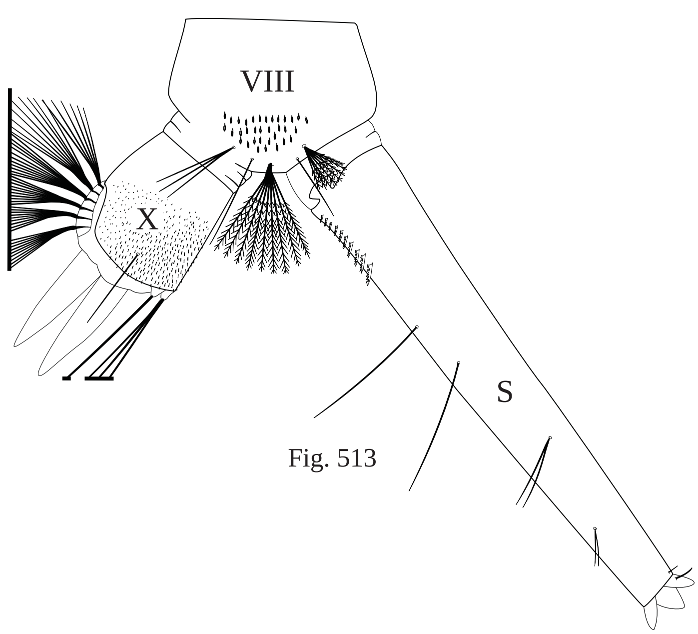

Fig. 513

3(2). Antennal seta 1-A inserted at midpoint on antenna (Fig. 514); seta 2-X single, equal in length to 3-X (Fig. 515). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. restuans***

Antennal seta 1-A large, inserted beyond midpoint on apical third (Fig. 516); seta 2-X with 2-3 branches and shorter than 3-X (Fig. 517). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

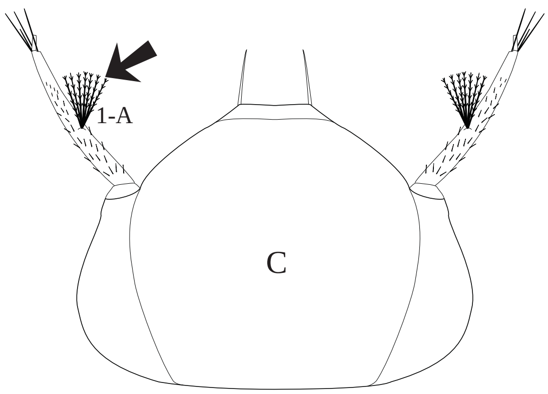

Fig. 514

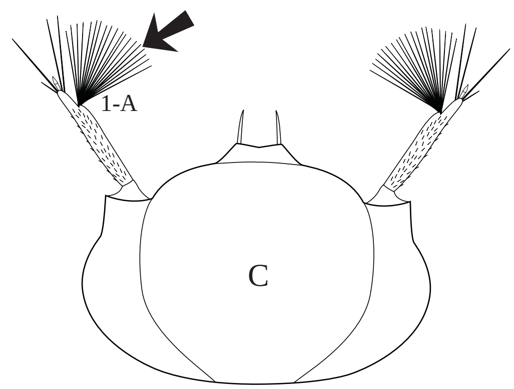

Fig. 516

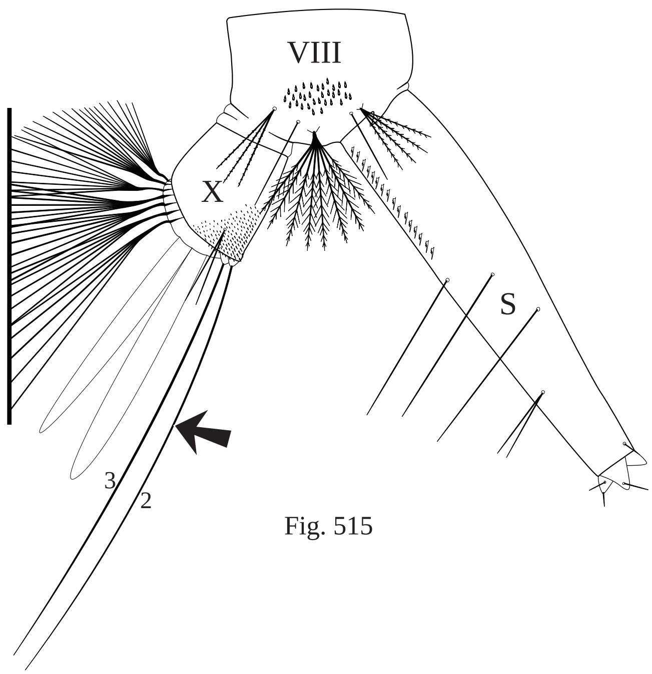

Fig. 515

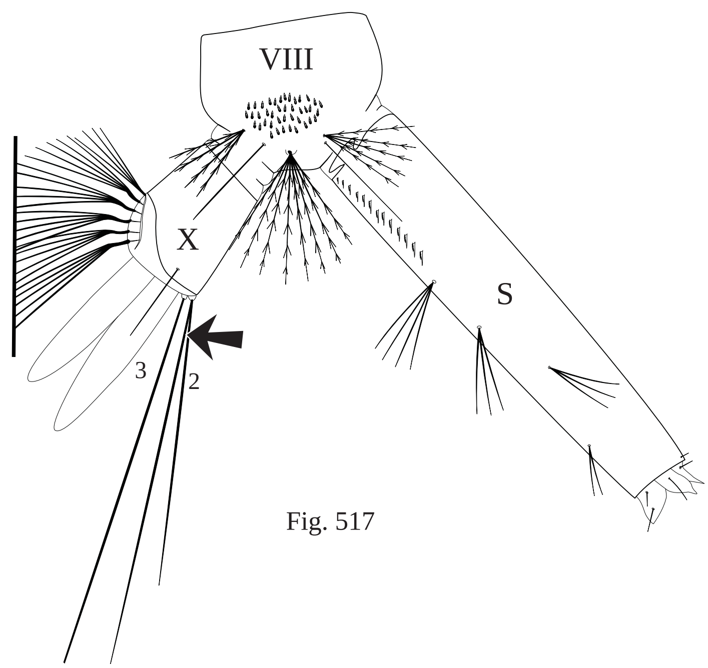

Fig. 517

4(3). Seta 1-S tufts on siphon all ventral and inserted in a straight row (Fig. 518). . . . . . . . . . . . . . .***Cx. tarsalis***

Seta 1-S tufts inserted ventrally and laterally, not in a straight row (Fig. 519). . . . . . . . . . . . . . . . . . . . . .5

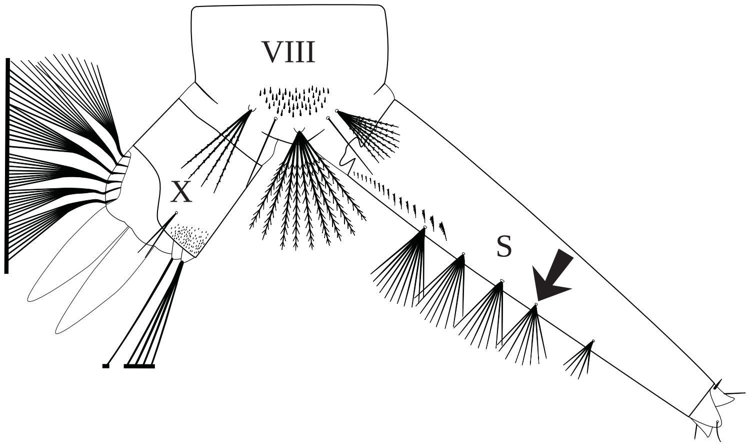


Fig. 518

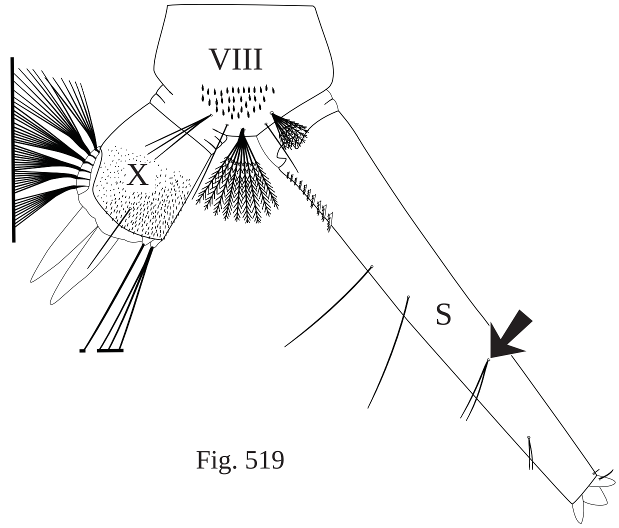


Fig. 519

5(4). Siphon length 3.5 to 5.5 (rarely 6.0) times width at base (Fig. 520); head setae 5,6-C with 5 or more branches (Fig. 521); seta 2-X with 2 branches (Fig. 520). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. pipiens***
***Cx. quinquefasciatus***
***Cx. pipiens X quinquefasciatus***
(See Note 24)

Siphon length 6-7 (infrequently 8) times width at base (Fig. 522); head seta 5,6-C with 3 - 4 branches (Fig. 523); seta 2-X with 3 branches (Fig. 522). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

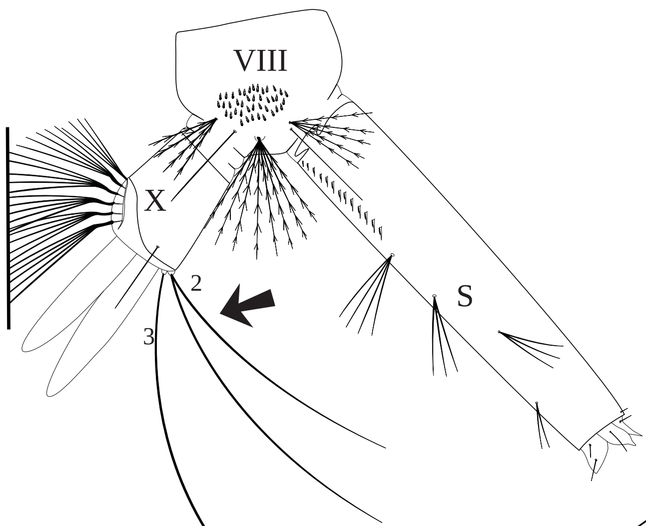


Fig. 520

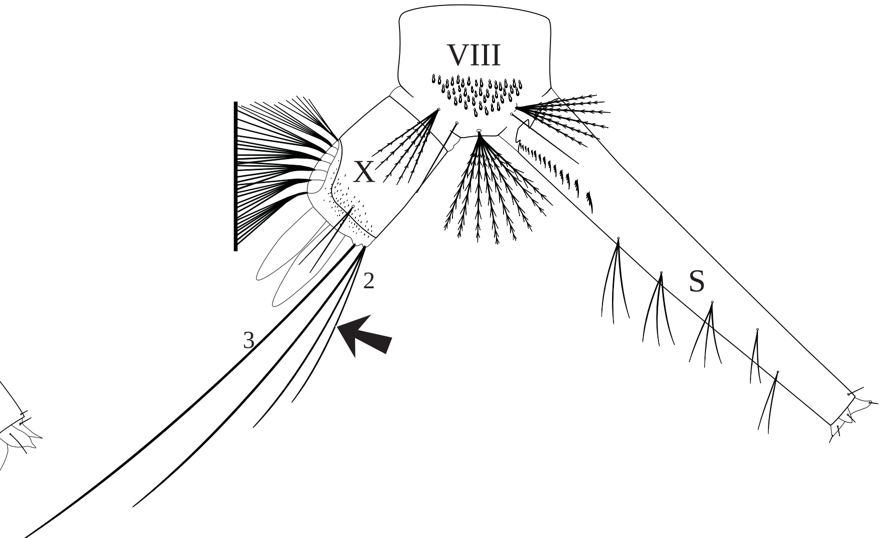


Fig. 522

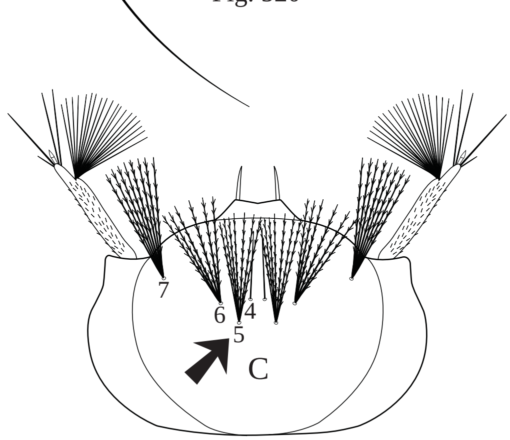


Fig. 521

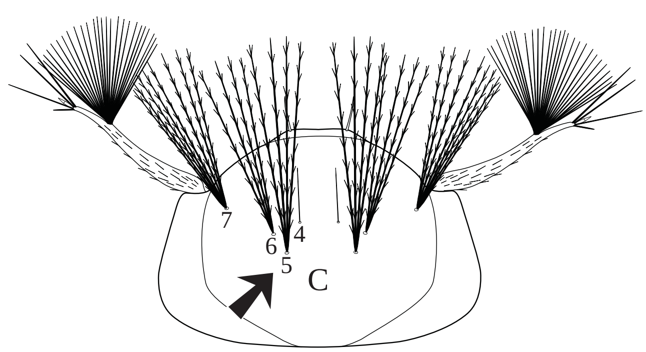


Fig. 523

6(5). Mesothoracic seta 1-M long, 2 - 3 branched, much longer than tiny 2-M (Fig. 524); thorax smooth, without tiny aculeae (= spicules) (Fig. 524); basal tuft of siphon 1-S only slightly longer than width of siphon at point of insertion, with 2-3 branches (Fig. 525). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. salinarius***

Mesothoracic seta 1-M tiny, equal length of 2-M (Fig. 526); thorax with tiny aculeae (Fig. 526); basal tuft of siphon seta 1-S length nearly twice width of siphon at point of insertion, usually single (Fig. 527). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. nigripalpus***

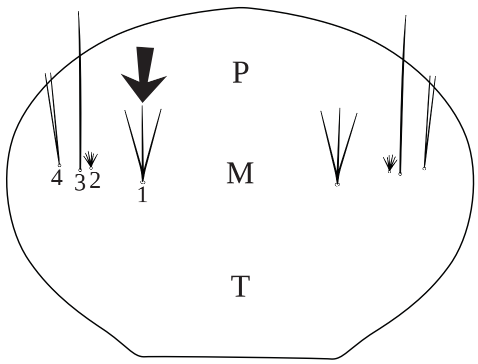

Fig. 524

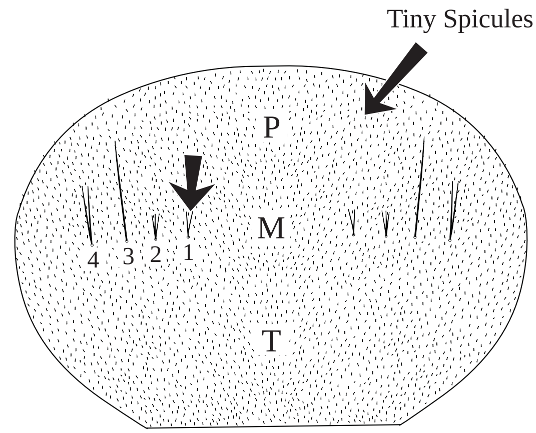

Fig. 526

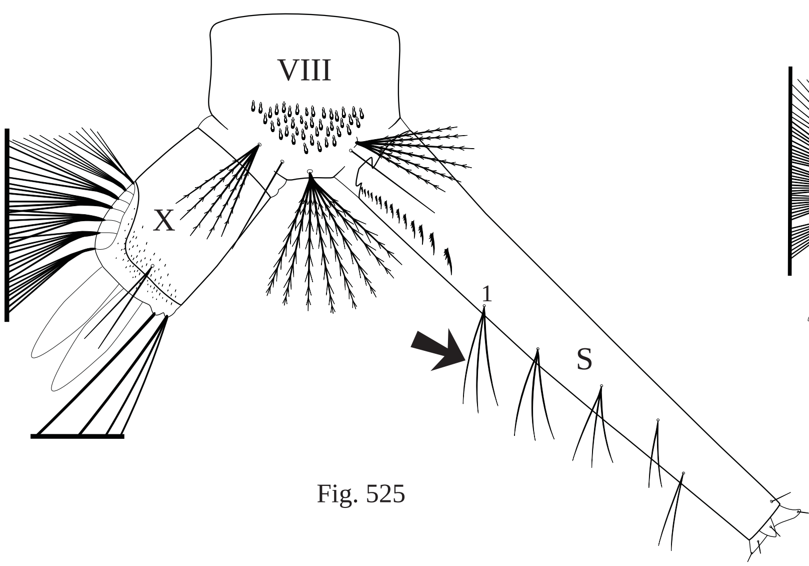

Fig. 525

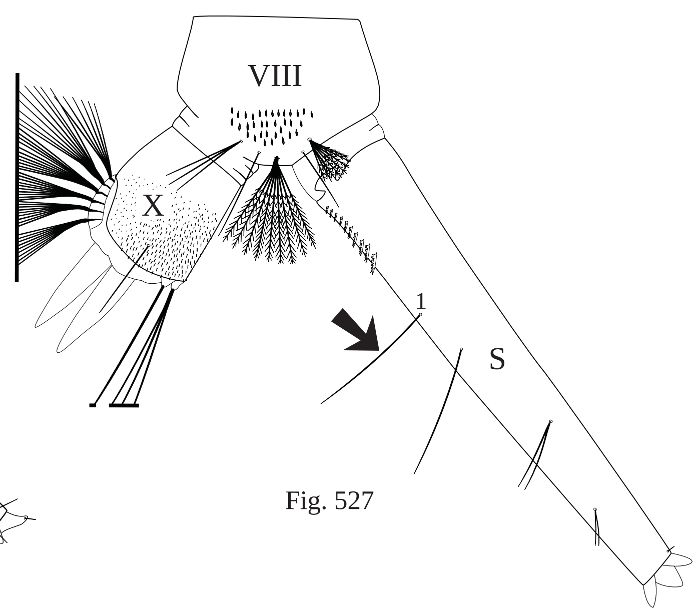

Fig. 527

7(1). Siphon long, without subdorsal seta 1-S tufts, most apical 1-S tuft lateral (Fig. 528); small dorsoapical seta 2-S on siphon straight (Fig. 528); pecten spines with 1-6 large teeth on one side (Fig. 528); saddle with 2 - 3 ventral precratal tufts of seta 4-X (Fig. 528); seta 2-X with 4-5 branches (Fig. 528). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .Subgenus *Neoculex* . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. territans***

Siphon long or short, with lateral or subdorsal seta 1-S tufts (Fig. 529); dorsoapical seta 2-S curved and hook-like (Fig. 529); pecten spines with 10 or more small teeth on one side (Fig. 529); saddle without precratal tufts (Fig. 529); seta 2-X with 2-3 branches (Fig. 529). . . .Subgenus *Melanoconion*. . . . . . . . . .8

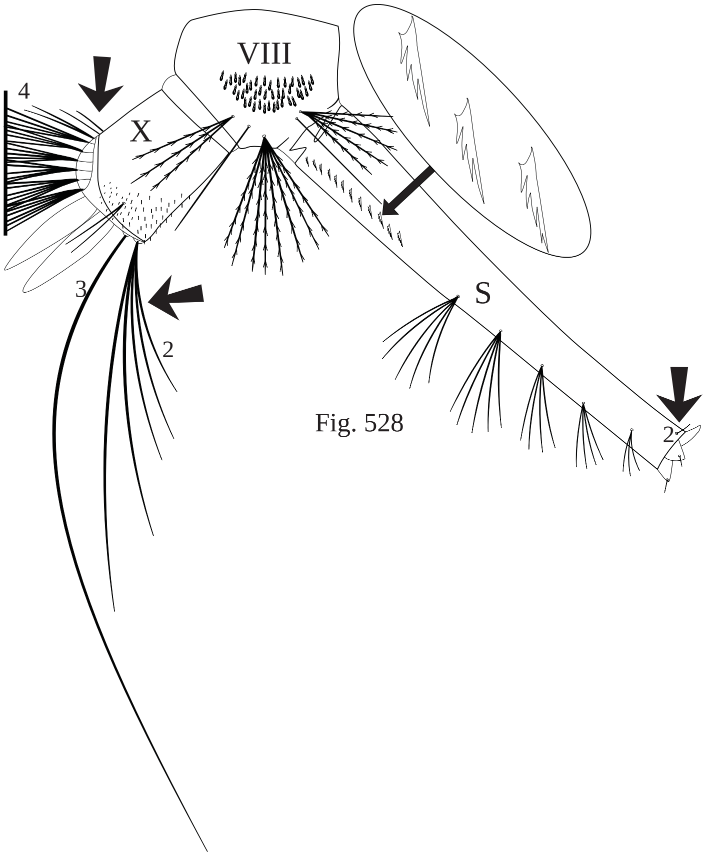

Fig. 528

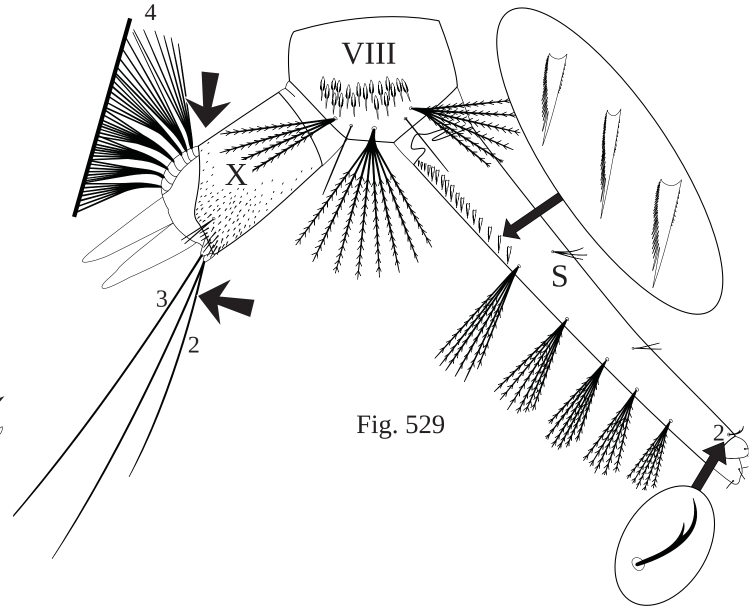

Fig. 529

8(7). Siphon with small light to dark pigmented band just beyond midpoint (Fig. 530); comb scales in large patch, each scale rounded apically with subequal lateral spines (Fig. 530). . . . . . . . . . . . . . . ***Cx. peccator***

Siphon without dark median band (Fig. 531); comb scales in single or irregular double row, each scale thorn-like with long central spine (Fig. 531). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .9

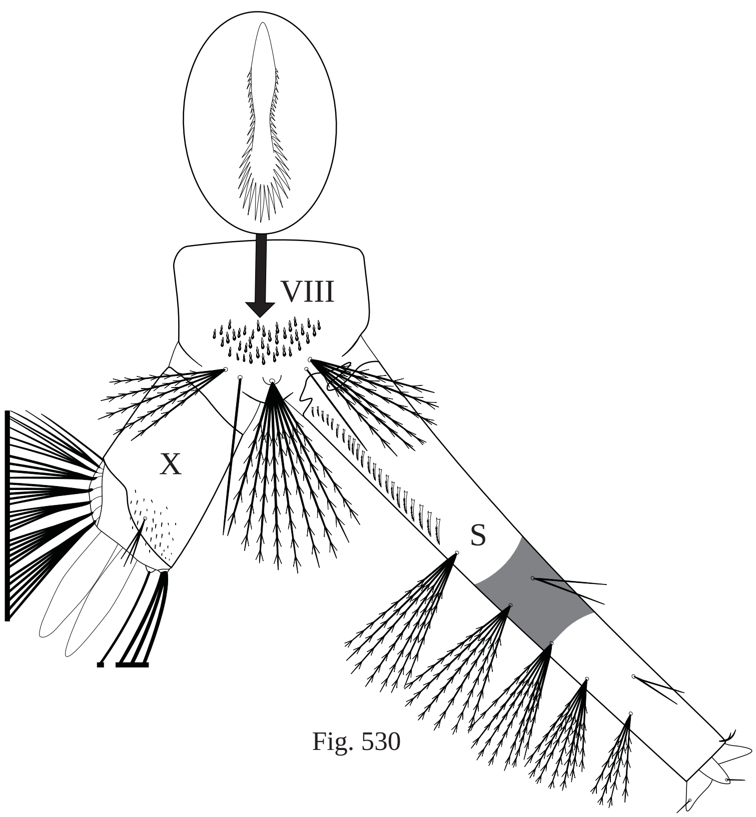

Fig. 530

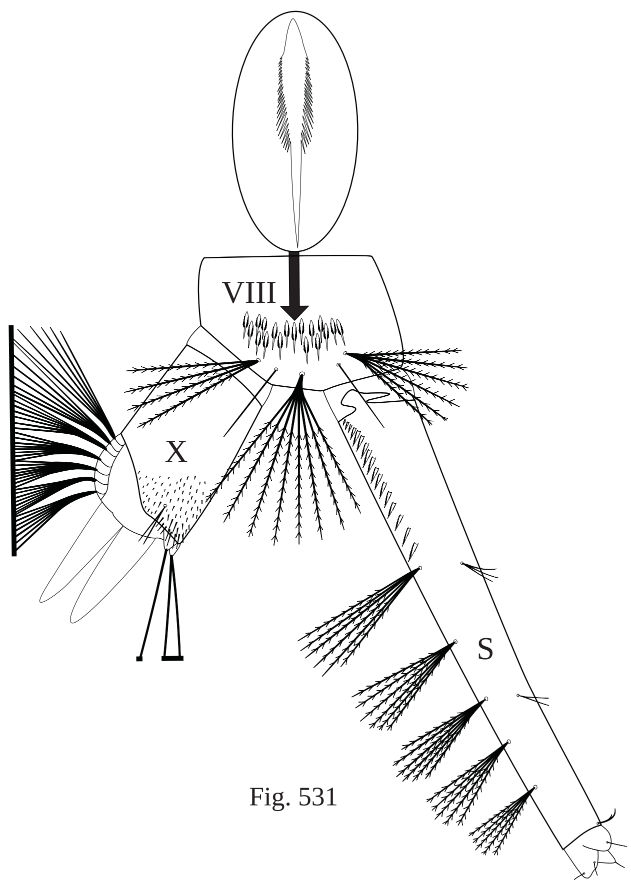

Fig. 531

9(8). Siphon length 6-7 times width at base, with dorsal and ventral margins slightly curved upward (Fig. 532); siphon seta 1-S with 5 ventral tufts and 2 small subdorsal tufts (Fig. 532); head seta 5-C very small, with 4-8 branches (Fig. 533). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cx. erraticus***

Siphon length short, 3-4 times width at base, with dorsal margin straight and ventral margin curved upward (Fig. 534); siphon seta 1-S with 8 very long ventral tufts, the basal-most tufts inserted within pecten (Fig. 534); head seta 5-C short, single or double (Fig. 535). . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Cx. pilosus***

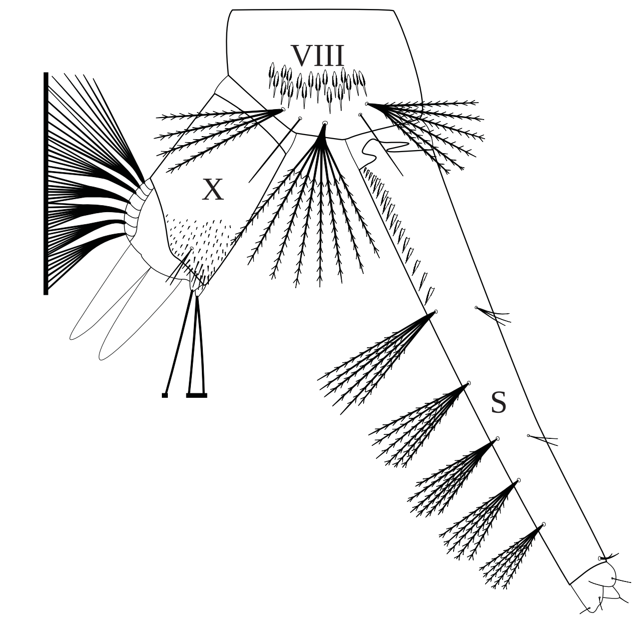


Fig. 532

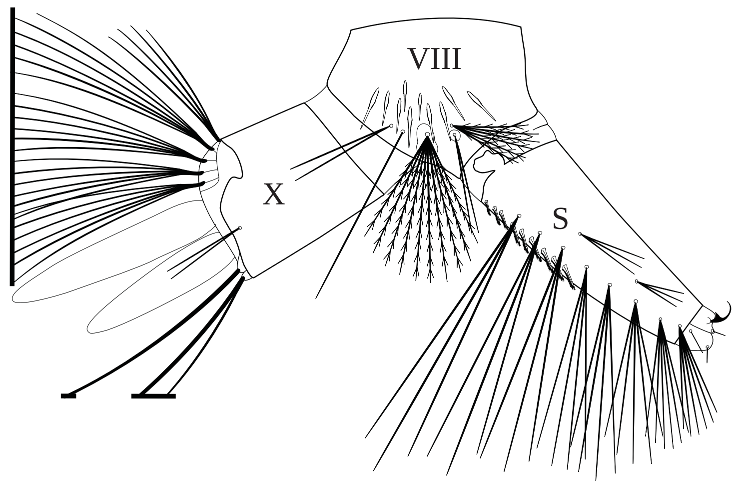


Fig. 534

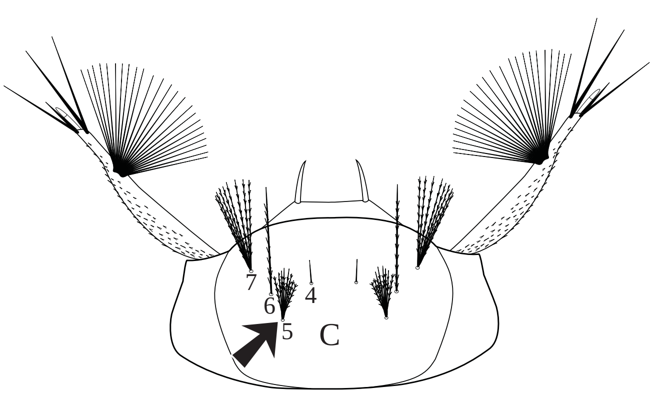


Fig. 533

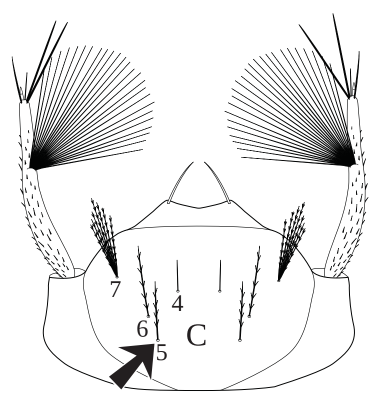


Fig. 535

# Key to Species of Fourth Instar Larvae of *Culiseta* (= *Cs.*)

1. Antenna as long as or longer than head (Fig. 536); seta 1-A inserted on distal third of antenna (Fig. 536); siphon length 6 or more times width at base (Fig. 537). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .2

   Antenna shorter than head (Fig. 538); seta 1-A inserted near mid-point on antenna (Fig. 538); siphon length no more than 4 times width at base (Fig. 539). . . . . . . . . . . . . . . .Subgenus *Culiseta*. . . . . . . . . . . . . . . . .4

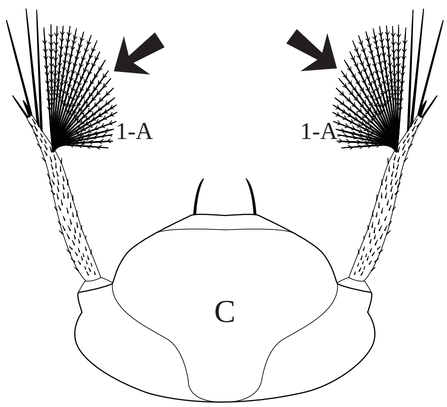

Fig. 536

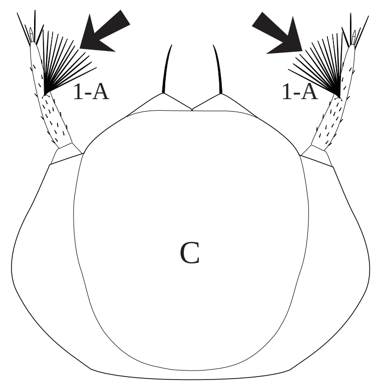

Fig. 538

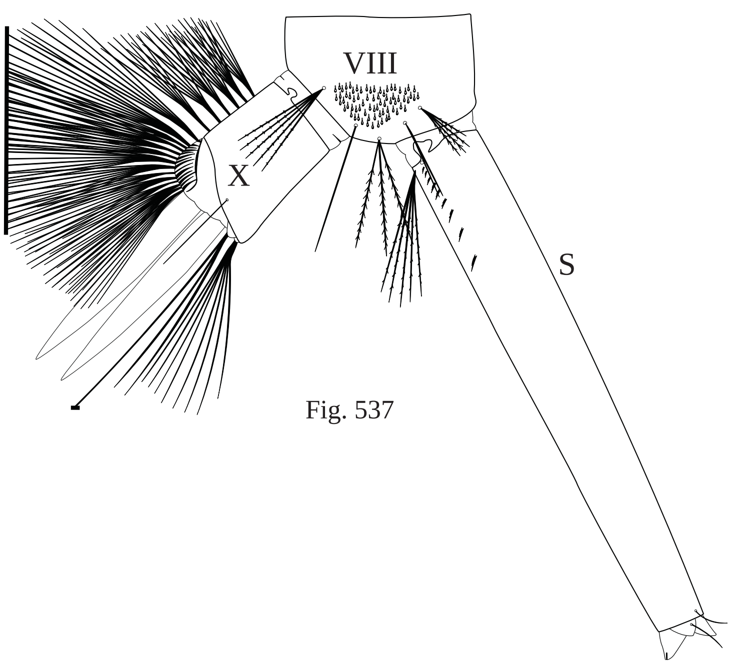

Fig. 537

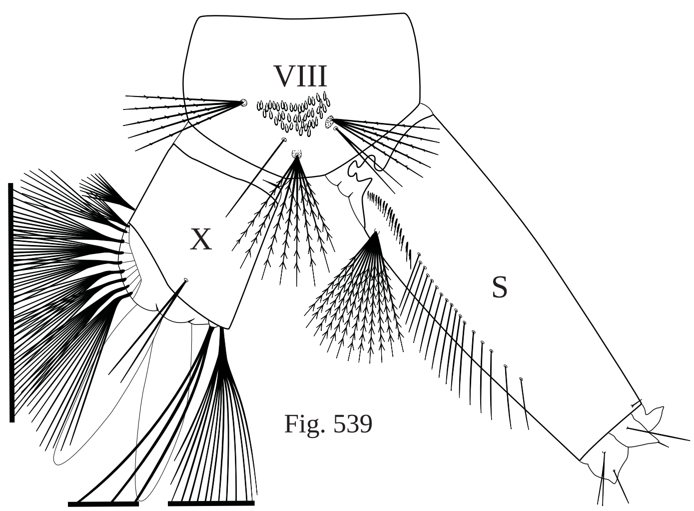

Fig. 539

2(1). Siphon with 8-16 small branched setal tufts inserted in line along mid-ventral area, starting within pecten and ending near tip of siphon (Fig. 540); comb scales exceptionally long, arranged in a neat bar-like single row (Fig. 540). . . . . . . . . . . . . . . . . . . .Subgenus *Climacura*. . . . . . . . . . . . . . . . . . . . . . . . .***Cs. melanura***

   Siphon without mid-ventral row of setal tufts (Fig. 541); comb scales short and in a large irregular patch (Fig. 541). . . . . . . . . . . . . . . . . . . . . . Subgenus *Culicella*. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

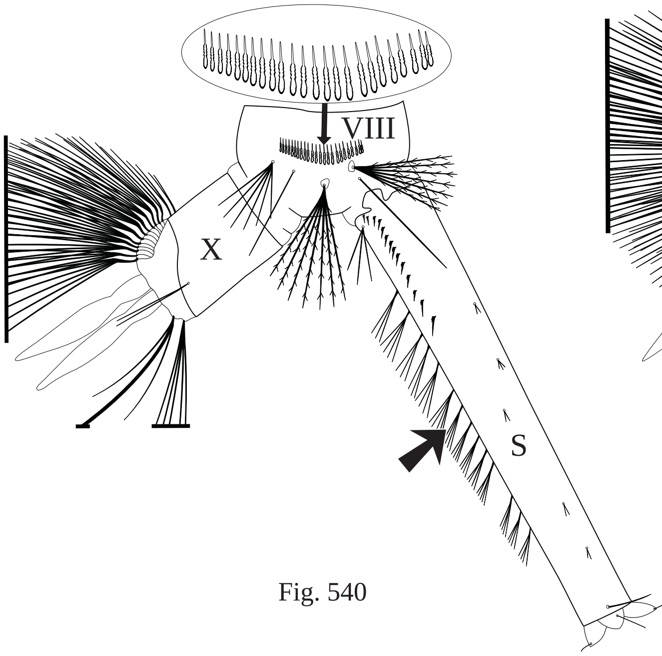


Fig. 540

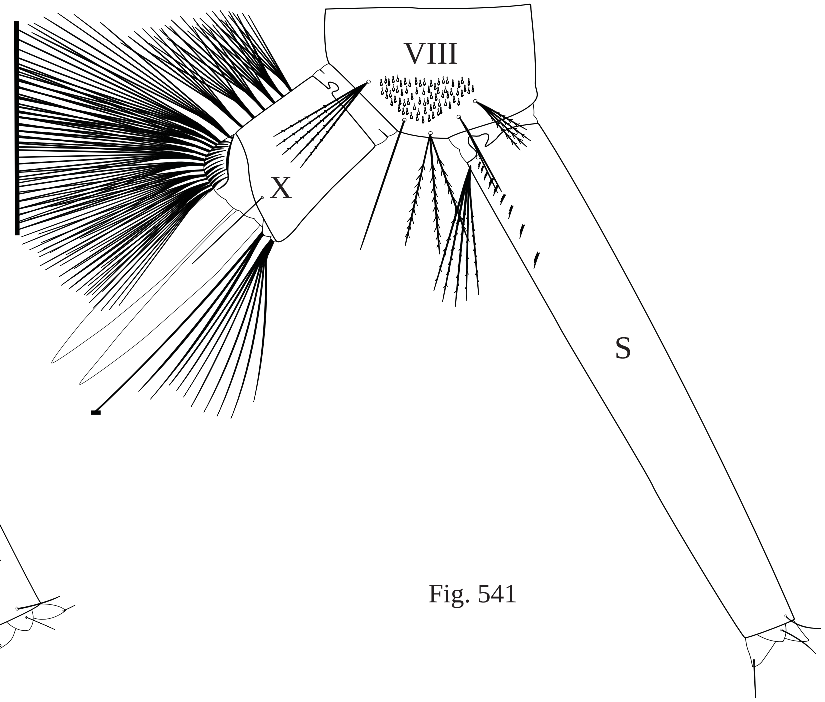


Fig. 541

3(2). Head seta 5-C with 3-7 branches, 7-C with 5-9 branches (Fig. 542); seta 1-X 0.75 length of dorsum of saddle (Fig. 543). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cs. morsitans***

Head seta 5-C with 6-11 branches, 7-C with 8-14 branches (Fig. 544); seta 1-X approximately equal to length of dorsum of saddle (Fig. 545). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cs. minnesotae***

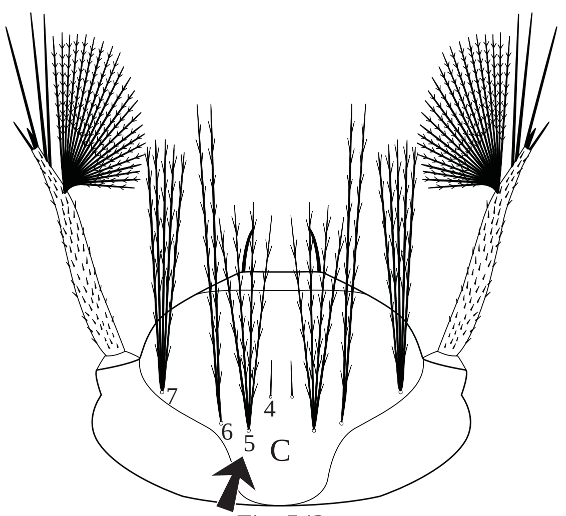


Fig. 542

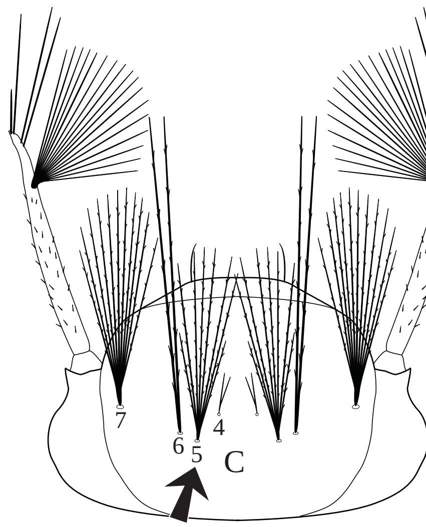


Fig. 544

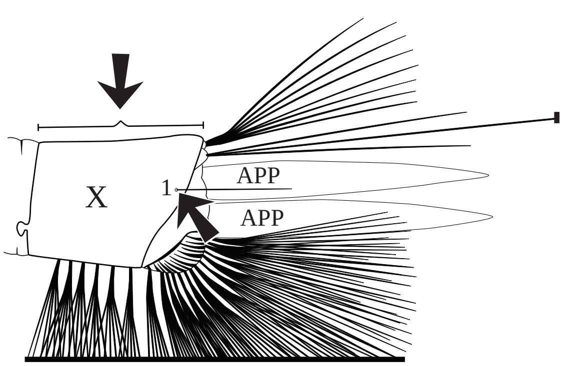


Fig. 543

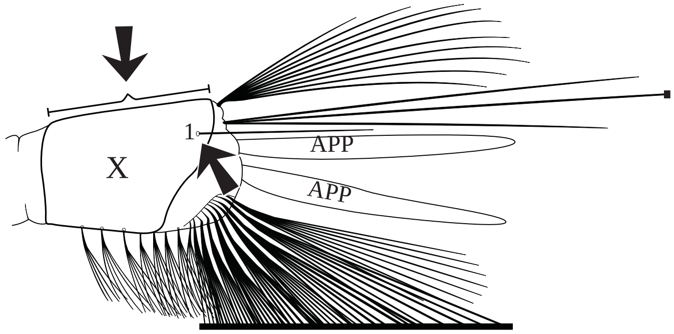


Fig. 545

4(1). Head seta 6-C noticeably longer than 5-C and 7-C (Fig. 546); head seta 4-C with 3-5 branches (Fig. 546); abdominal setae 1-VI,VII as long as seta 1-V (Fig. 547). . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Cs. inornata***

Head seta 6-C approximately equal in length to 5-C and 7-C (Fig. 548); head seta 4-C single or double (Fig. 548); abdominal setae 1-VI,VII tiny, much shorter than seta 1-V (Fig. 549). . . . . . . . .***Cs. impatiens***

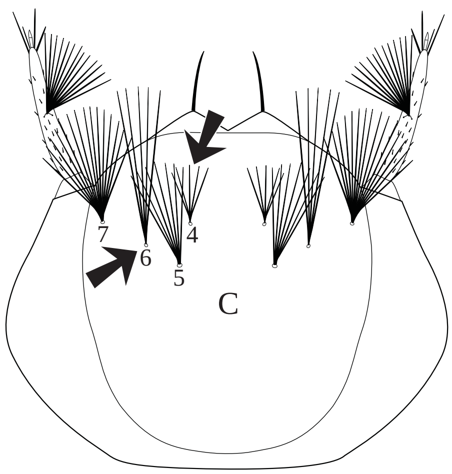

Fig. 546

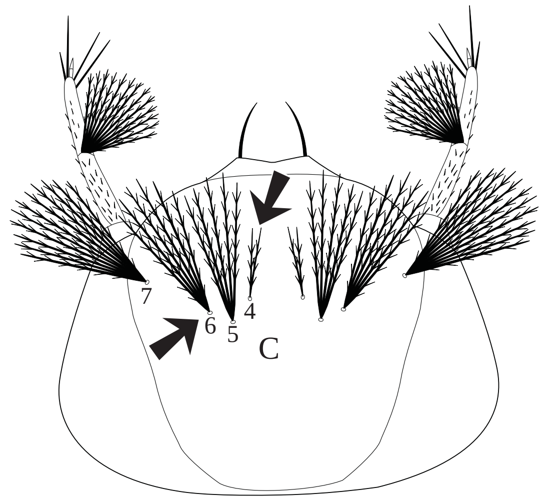

Fig. 548

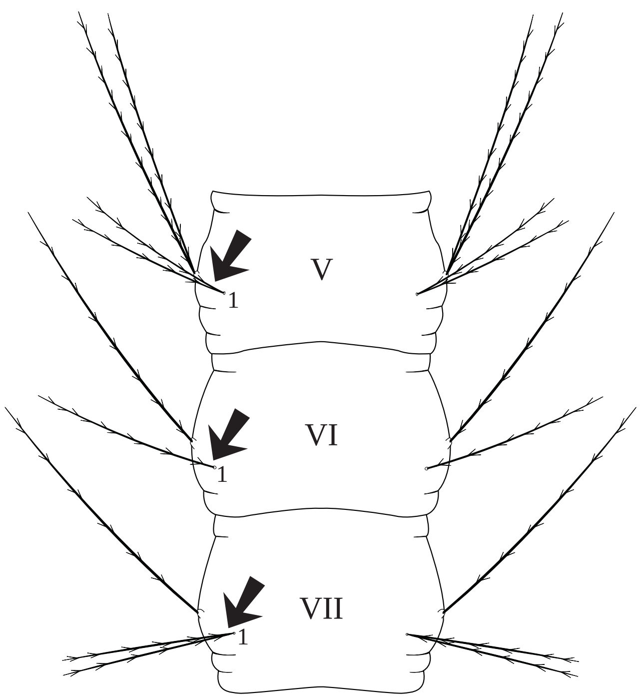

Fig. 547

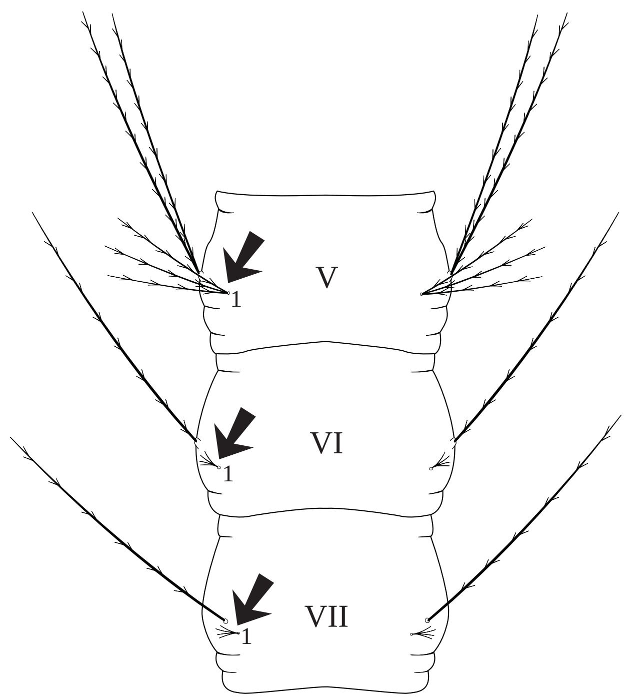

Fig. 549

## Key to Species of Fourth Instar Larvae of *Mansonia* (= *Ma.*)

1. Comb scales on abdominal segment VIII slender, with long central spine much longer than short lateral spines at base (Fig. 550) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Ma. titillans***

   Comb scales on abdominal segment VIII wide, with several lateral spines nearly as long as central spine (Fig. 551) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ma. dyari***

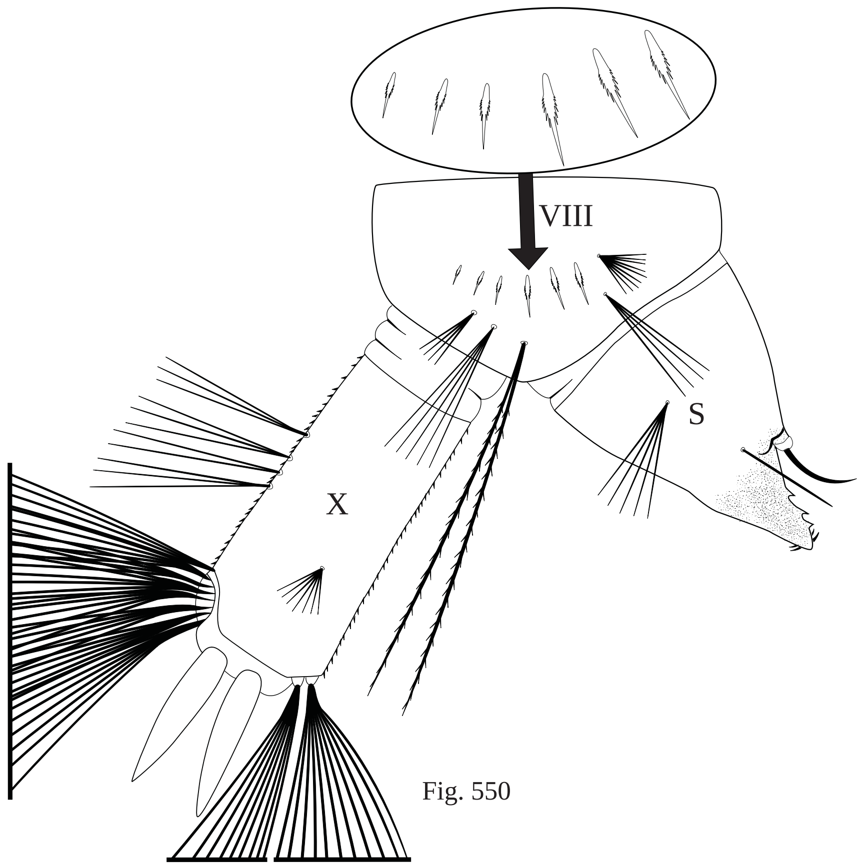


Fig. 550

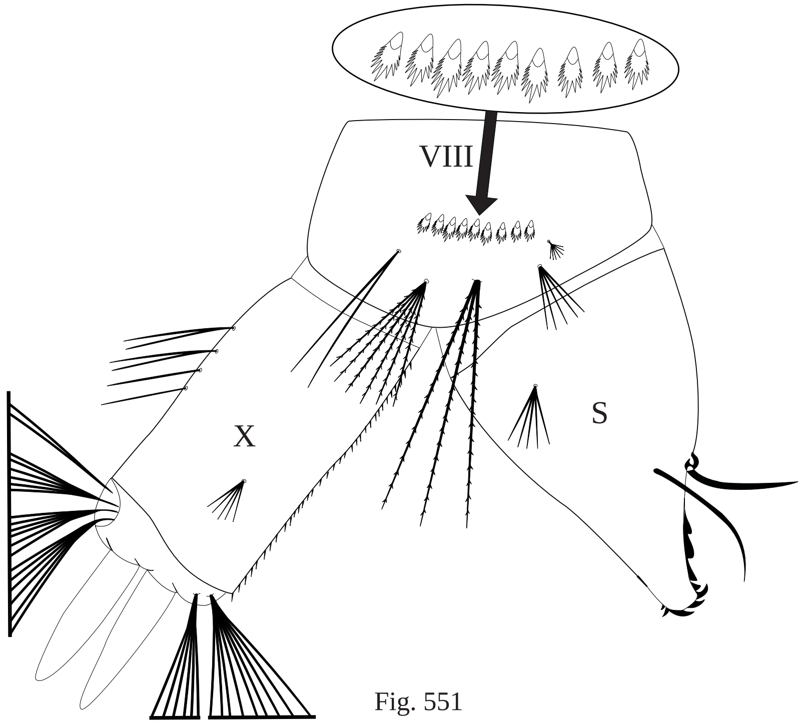


Fig. 551

# Key to Species of Fourth Instar Larvae of *Orthopodomyia* (= *Or.*)

1. Abdominal segment VIII (and often VI and VII) with large saddle-like plate (Fig. 552); siphon seta 1-S with more than 4 branches (Fig. 552); seta 3-VIII very large (Fig. 552); abdomen usually red or orange. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .***Or. signifera***

   Abdominal segments VI-VIII without large plates (Fig. 553); seta 1-S short with 2-4 branches (Fig. 553); seta 3-VIII small (Fig. 553); abdomen usually pale creamy white . . . . . . . . . . . . . . . . . . . . . . . . ***Or. alba***

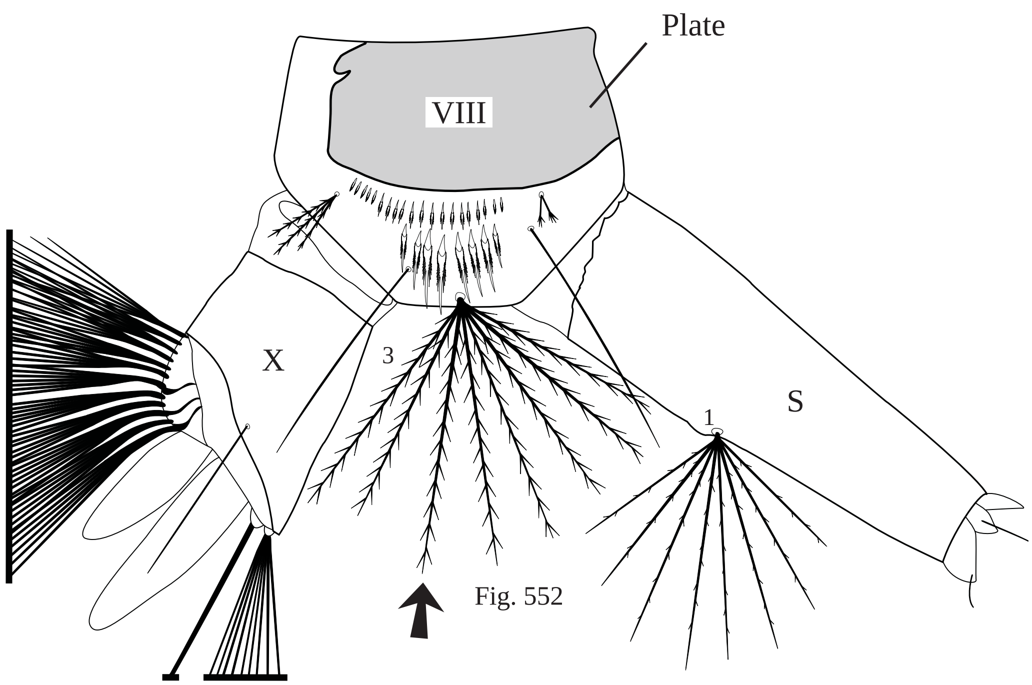

Fig. 552

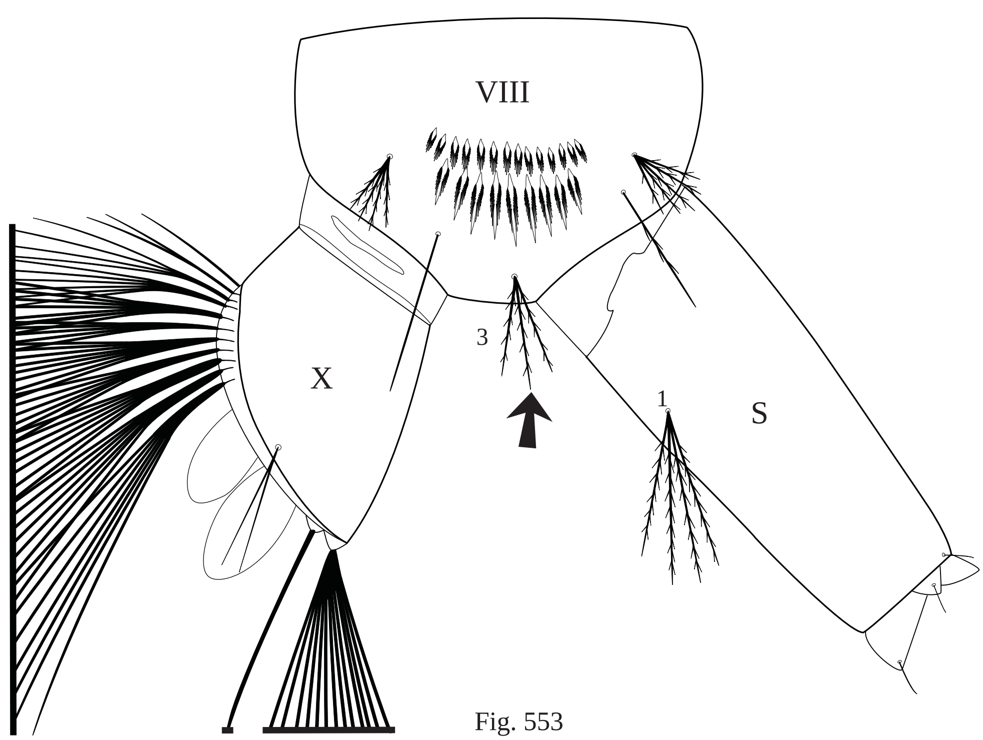

Fig. 553

# Key to Species of Fourth Instar Larvae of *Psorophora* (= *Ps.*)

1. Larva very large, more than 0.5 inches long; front of head truncate, with antenna short, not reaching or barely reaching front of head (Fig. 554); pecten spines very long, 15 or more (Fig. 555). . . . . . . . . . . . . . .2

   Larva length 0.5 inches or less; head rounded in front, with antenna long and reaching well beyond front of head (Fig. 556); pecten spines small, 8 or less (Fig. 557). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .3

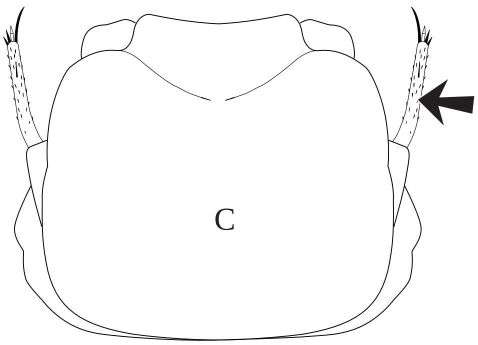

Fig. 554

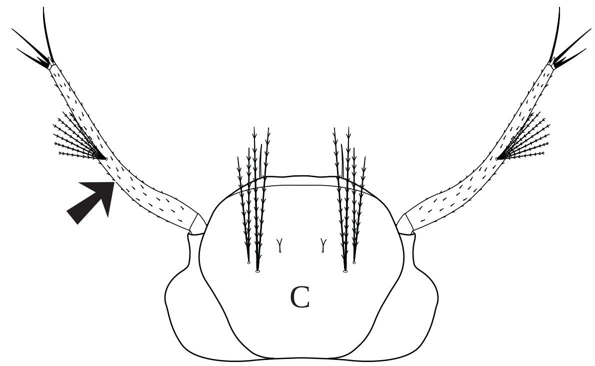

Fig. 556

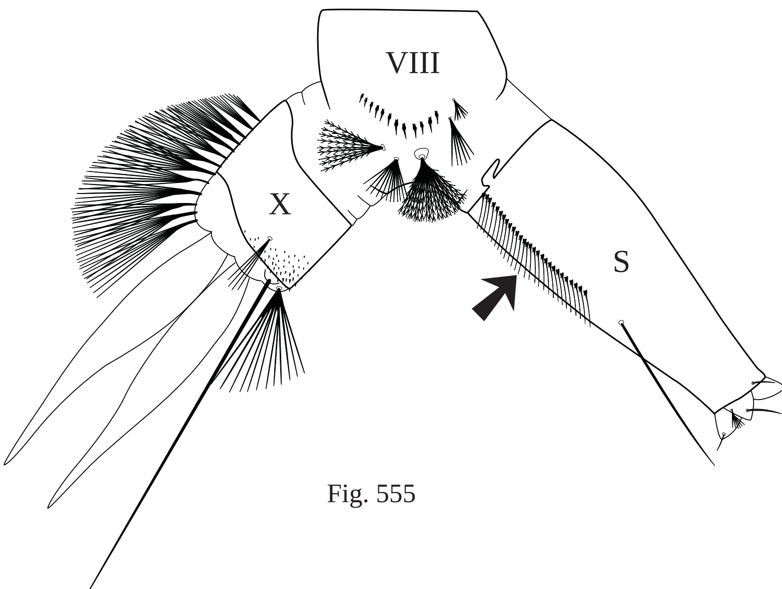

Fig. 555

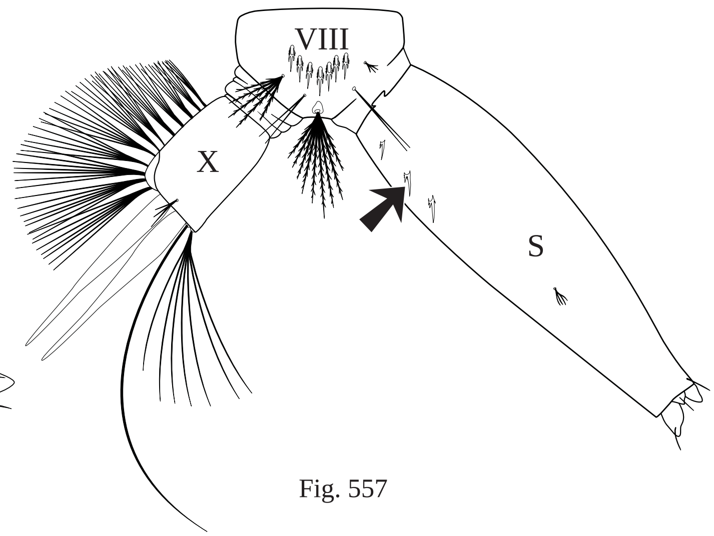

Fig. 557

2(1). Seta 1-X on saddle short with 3-4 branches originating from base (Fig. 558). . . . . . . . . . . . . . . ***Ps. ciliata***

   Seta 1-X on saddle single or forked well beyond mid-length (Fig. 559). . . . . . . . . . . . . . . . . ***Ps. howardii***

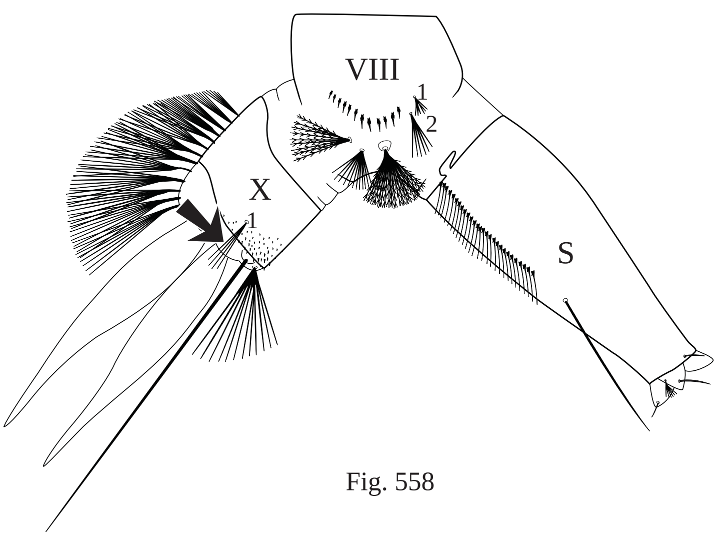

Fig. 558

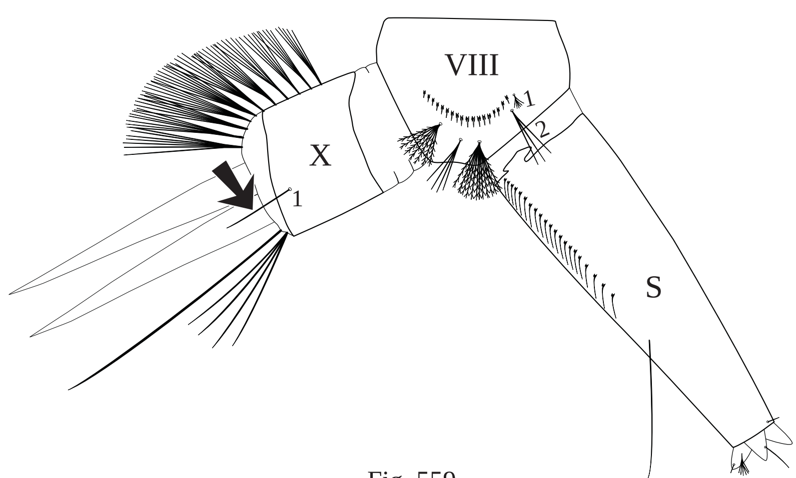

Fig. 559

3(1). Siphon with near parallel sides, not swollen in middle (Fig. 560); seta 1-S stout with many branches, as long as siphon (Fig. 560); antenna very long, sinuous, appearing swollen or flattened (Fig. 561); siphon with dorsal preapical seta 2-S very stout, long and curved (Fig. 560). . . . . . . . . . . . . . . . . . . . . . . . ***Ps. discolor***

Siphon swollen in middle (Fig. 562); seta 1-S small or tiny with 3 or more branches (Fig. 562); antenna long or short, not swollen, flattened, or sinuous (Fig. 563); siphon with seta 2-S small, weak, and straight (Fig. 562). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

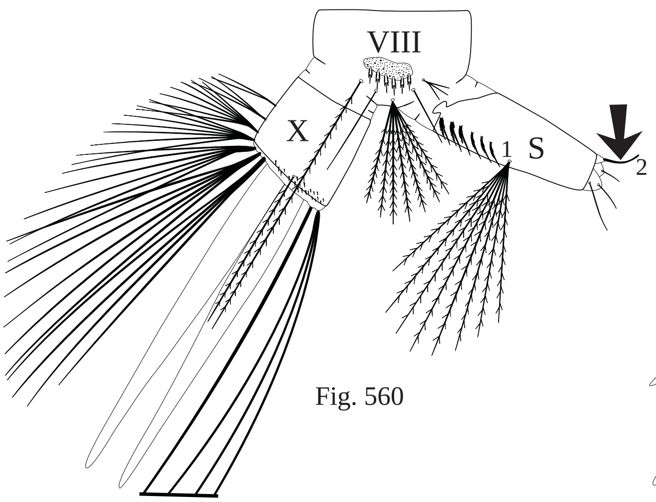

Fig. 560

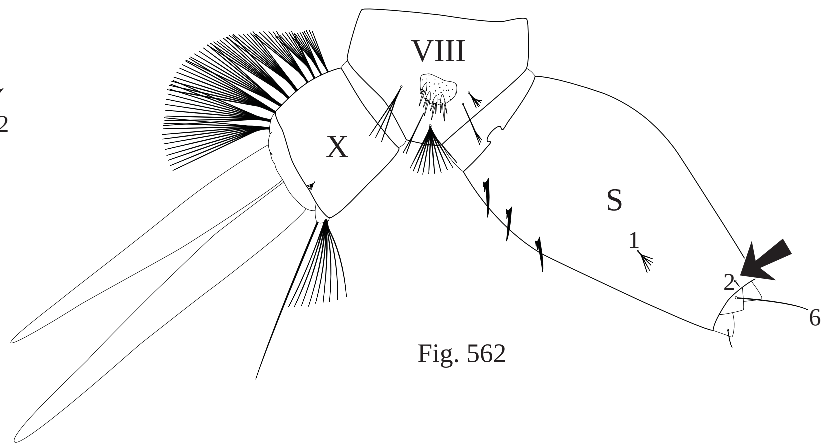

Fig. 562

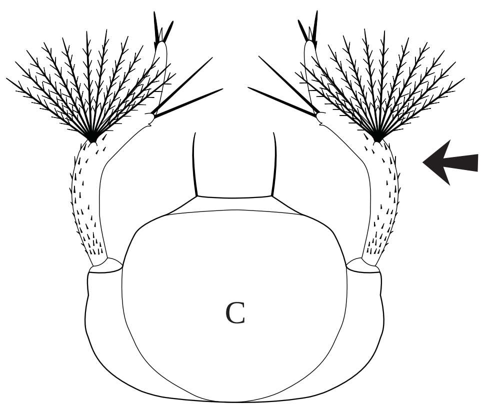

Fig. 561

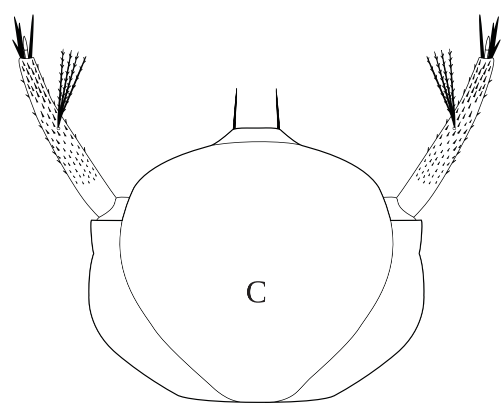

Fig. 563

4(3). Head setae 5,6-C with 4 or more branches (Fig. 564); abdominal seta 5-VIII single or 2-3 branches (Fig. 565); abdominal segment VIII with 5-6 comb scales, usually on posterior edge of small, weakly sclerotized plate (Fig. 565). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. columbiae***

Head setae 5,6-C single or with 2-3 branches originating from base (Fig. 566); abdominal seta 5-VIII with 5-7 branches (except 2 branches on *Ps. cyanescens*) (Fig. 567); abdominal segment VIII with 4-9 comb scales and lacking plate (Fig. 567). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .5

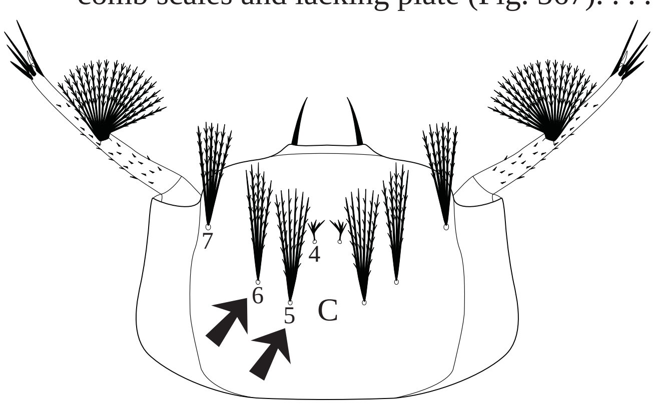

Fig. 564

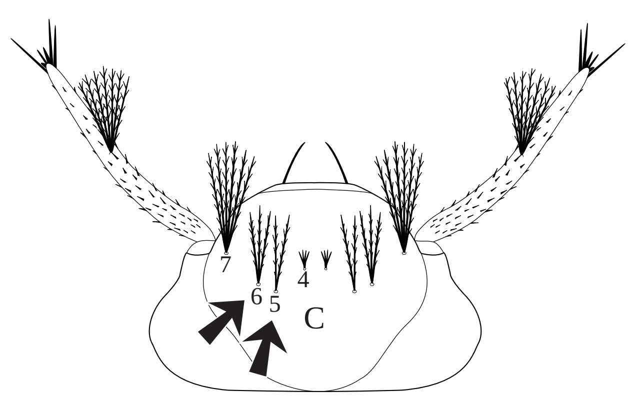

Fig. 566

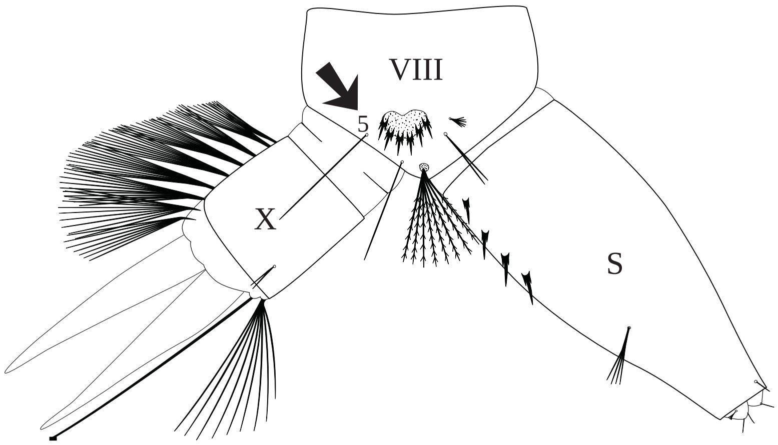


Fig. 565

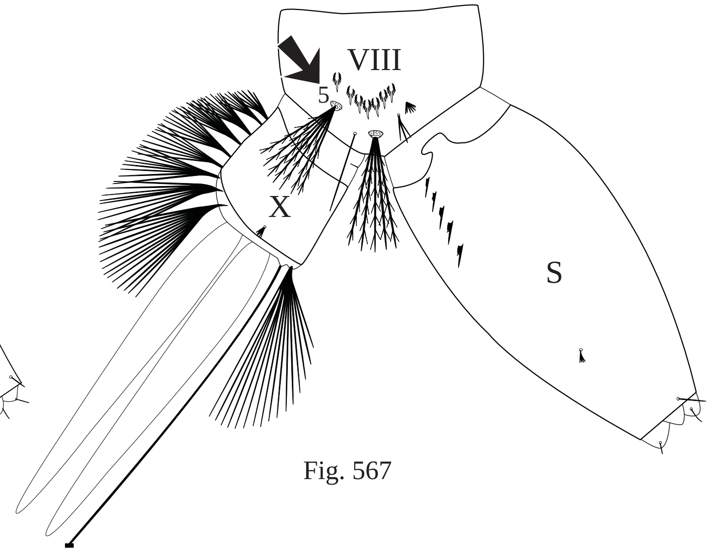


Fig. 567

5(4). Head seta 7-C with 2-3 branches, setae 5,6-C single (Fig. 568); anal papillae very long, much longer than setae 2,3-X (Fig. 569); seta 6-S on lateral valve at tip of siphon very long (Fig. 569). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .*Ps. cyanescens*

Head seta 7-C with 5 or more branches, setae 5,6-C usually double (rarely triple) (Fig. 570); anal papillae shorter or equal length of seta 3-X (Fig. 571); seta 6-S on lateral valve at tip of siphon very short and hard to see (Fig. 571). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .6

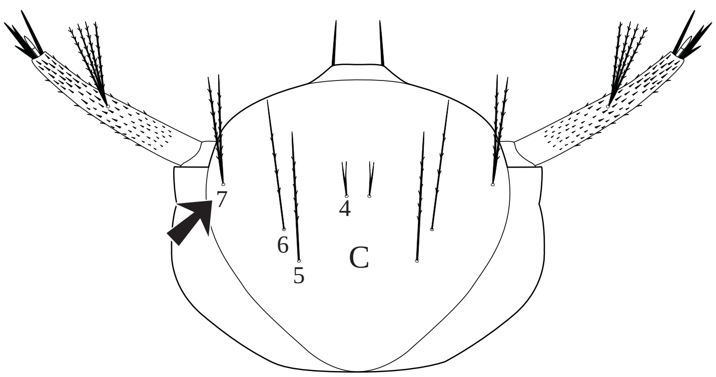


Fig. 568

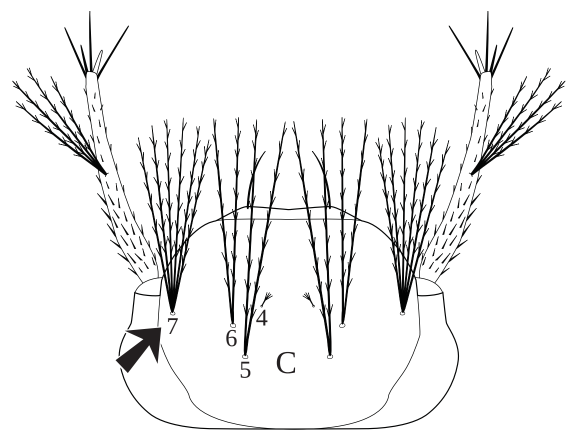


Fig. 570

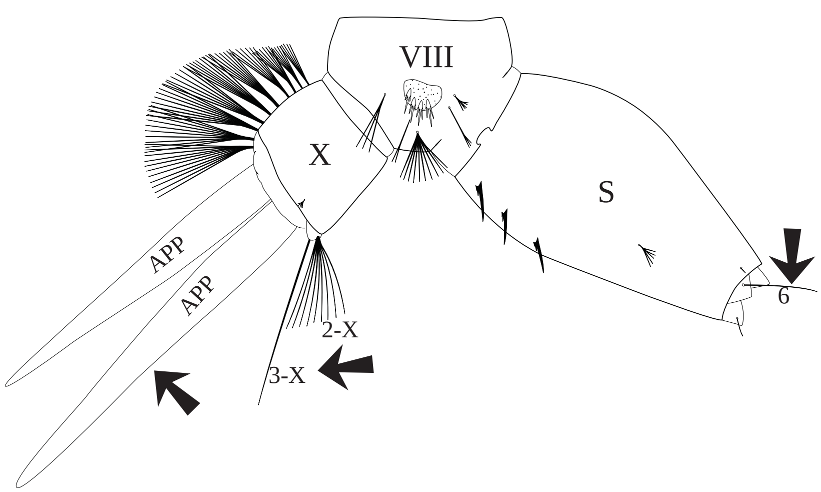


Fig. 569

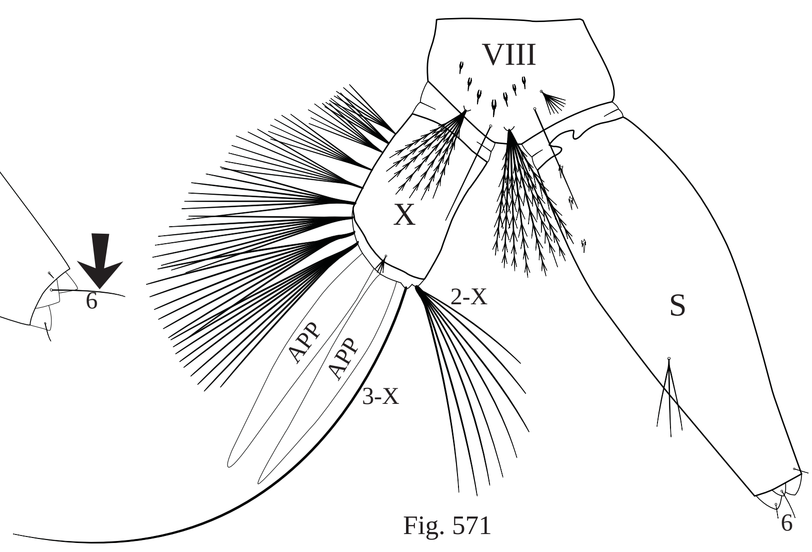


Fig. 571

6(5). Head setae 5,6-C shorter than seta 7-C, not reaching front margin of head (Fig. 572); abdominal setae 6-IV-VI double or triple, shorter than length of the abdominal segment of origin (Fig. 573); setae 1,2-VIII small, branched (Fig. 574). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. horrida***

Head setae 5, 6-C longer than seta 7-C, reaching to or beyond front margin of head (Fig. 575); abdominal setae 6-IV-VI single or double, longer than the abdominal segment of origin (Fig. 576); seta 1-VIII tiny and multibranched, seta 2-VIII much longer than 1-VIII, single to 3 branched (Fig. 577). . . . . . . . . . . . .7

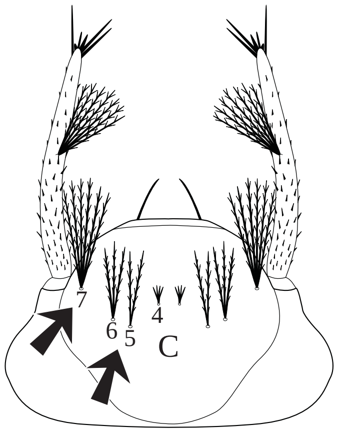

Fig. 572

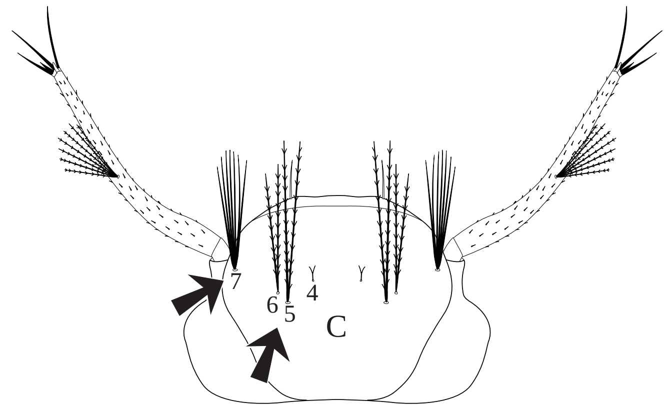

Fig. 575

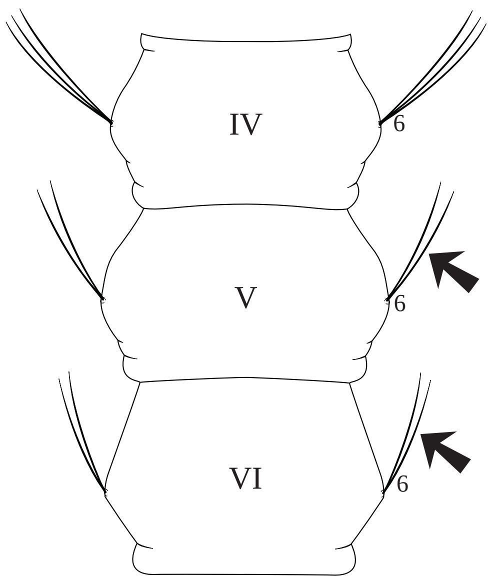

Fig. 573

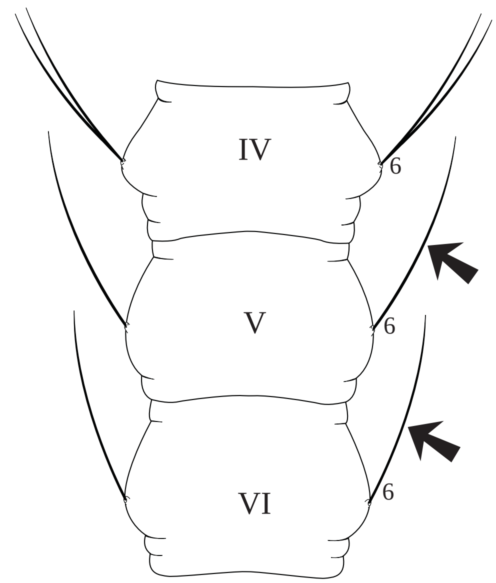

Fig. 576

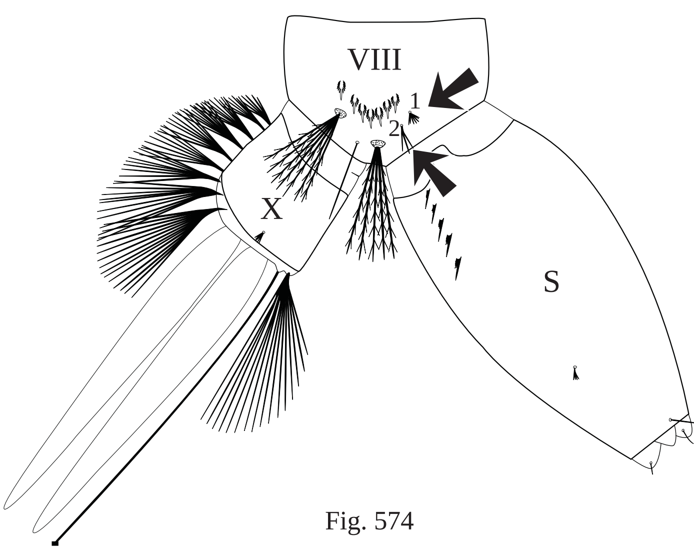

Fig. 574

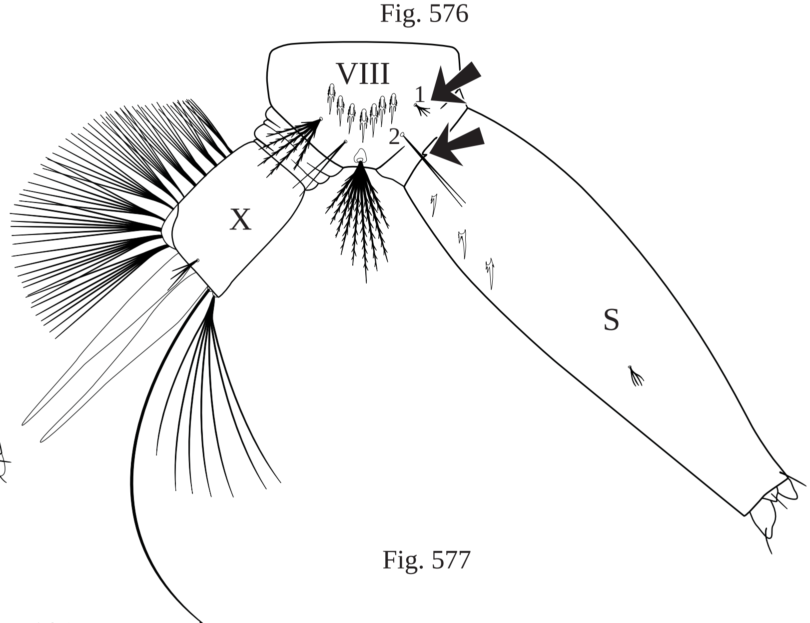

Fig. 577

7(6). Antenna very long, length approximately 1.5 times head length at midline (Fig. 578); lateral seta 1-S on siphon tiny, branched, approximately same length as preapical dorsal seta 2-S (Fig. 579); comb scales 6-8, often originating on posterior border of small weak lateral plate on abdominal segment VIII (Fig. 579). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. ferox***

Antenna approximately equal head length at midline (Fig. 580); siphon seta 1-S branched, much longer than seta 2-S (Fig. 581); comb scales 6-7 in "v shaped" row and not originating on plate (Fig. 581). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ps. mathesoni***

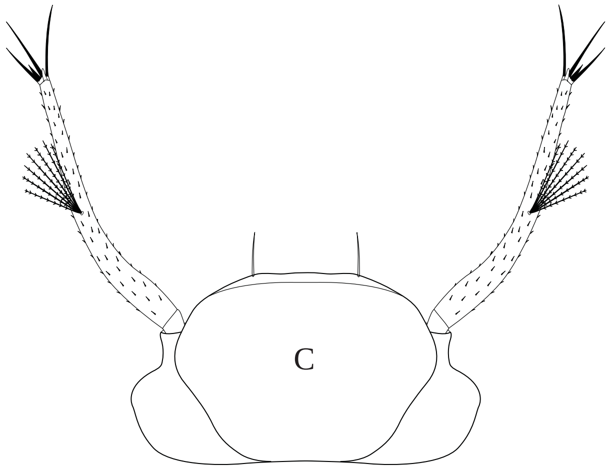


Fig. 578

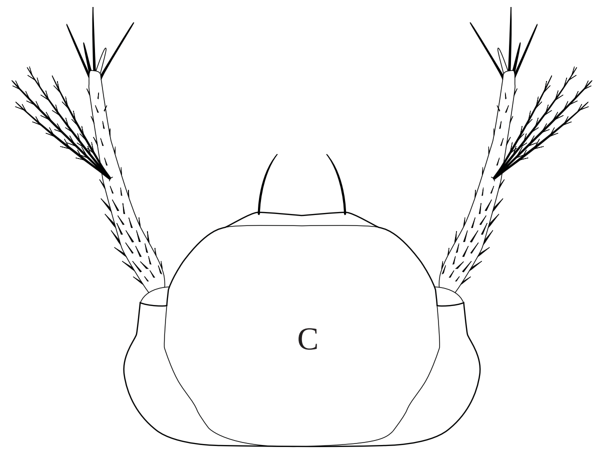


Fig. 580

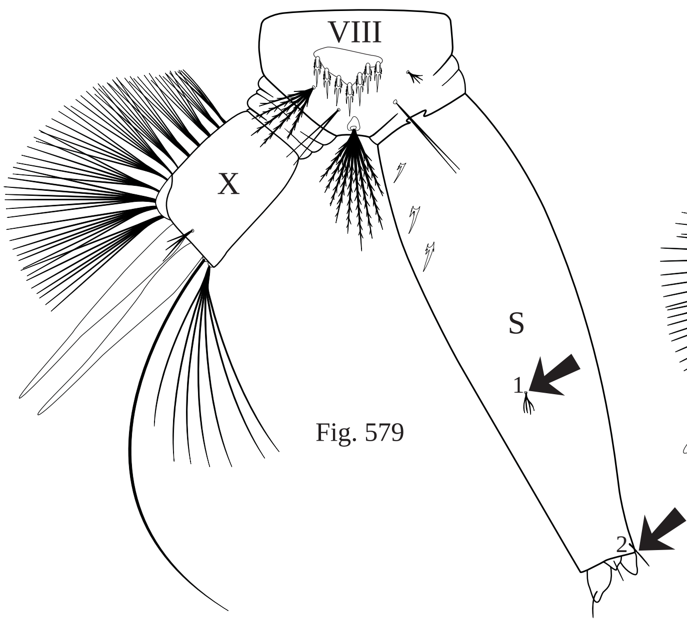


Fig. 579

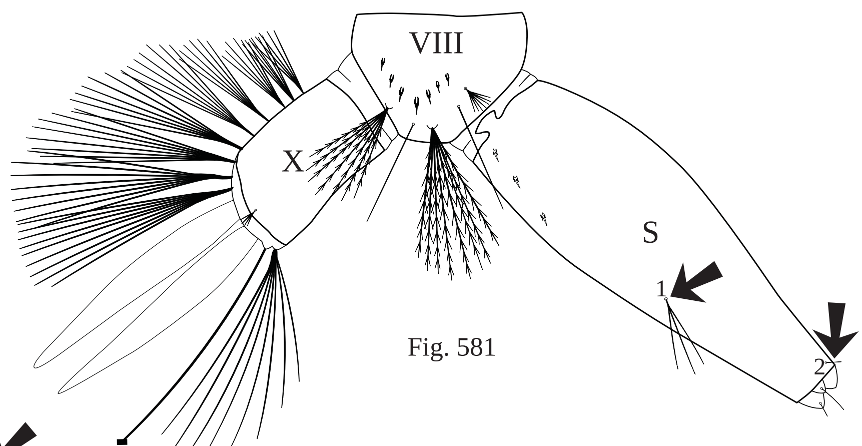


Fig. 581

# Key to Species of Fourth Instar Larvae of *Uranotaenia* (= *Ur.*)

1. Ventral prothoracic seta 14-P multibranched (Fig. 582); dorsal prothoracic seta 3-P much less than 0.5 length of seta 1-P (Fig. 582); anal papillae sharply pointed (Fig. 583). . . . . . . . . . . . . . . . . ***Ur. sapphirina***

   Seta 14-P single (Fig. 584); seta 3-P more than 0.5 length of seta 1-P (Fig. 584); anal papillae rounded (Fig. 585) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ur. lowii***

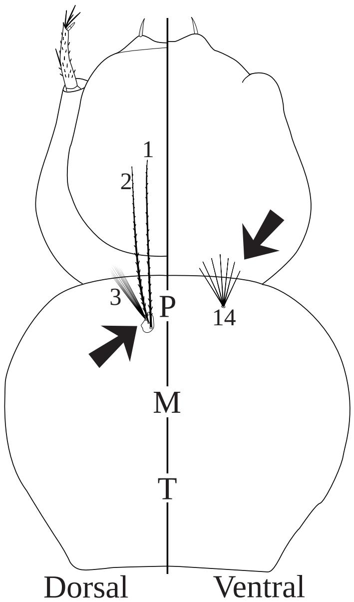

Fig. 582

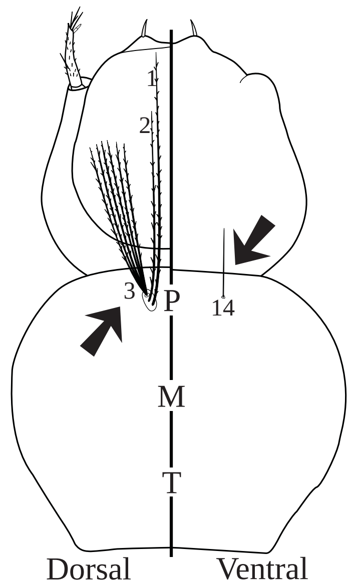

Fig. 584

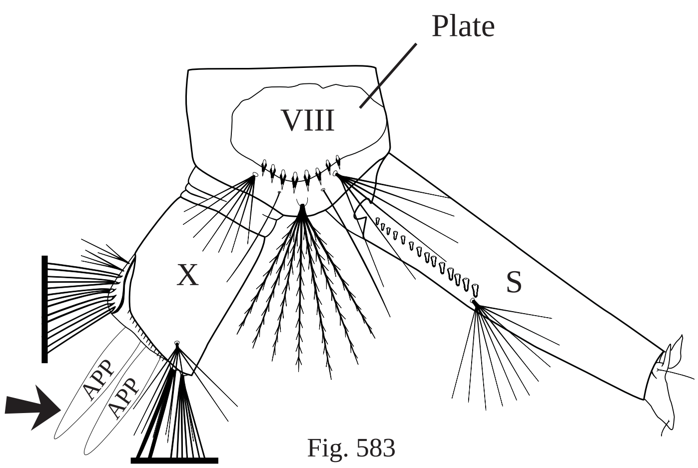

Fig. 583

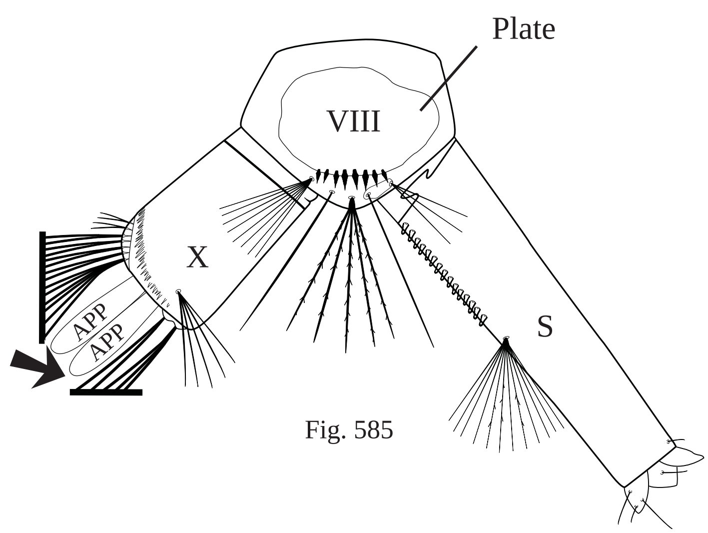

Fig. 585

## XI. NOTES

**Note 1.** *Toxorhynchites rutilus* includes two subspecies in the MAMCA states, i.e., *Tx. rutilus rutilus* in Florida, Georgia, North Carolina, and South Carolina, plus *Tx. rutilus septentrionalis* in all eight MAMCA states. The above North Carolina record represents the first records for *Tx. rutilus rutilus* collected in this state (see NC list of taxa in the State Records section). Females, pupae, larvae, and male genitalia of both subspecies are currently indistinguishable. However, males exhibit fore-, mid-, and hindtarsal banding differences that will normally distinguish both subspecies, although intermediates are widely distributed and not uncommon.

- *Tx. rutilus rutilus* has foretarsomere 2 ($FT_2$) and the basal part of foretarsomere 3 ($FT_3$) white scaled; midtarsormere 2 ($MT_2$) and basal part of midtarsomere 3 ($MT_3$) white scaled; and hindtarsomere 5 ($HT_5$) is entirely white scaled.
- *Tx. rutilus septentrionalis* has foretarsomere 2 and 3 entirely dark scaled; midtarsomere 2 and midtarsomere 3 entirely dark scaled; and hindtarsomere 5 entirely dark scaled.
- Male specimens that do not conform precisely to the above characters should be considered intermediates.

**Note 2.** Three species of *Wyeomyia,* i.e., *Wy. haynei* Dodge, *Wy. mitchellii* (Theobald), and *Wy. smithii* were recorded from MAMCA states in the past, but that has changed. Harrison (2009) deleted the record of *Wy. mitchellii* in Georgia after determining that the Darsie and Ward (1981) record for *Wy. mitchellii* in Georgia was a misinterpretation of the original collection records published by Newhouse et al. (1966). However, George O'Meara (personal communication) has observed *Wy. mitchellii* larvae in purchased domestic bromeliads in northern Florida and suspects that the same could be true in southern Georgia. Bradshaw and Lounibos (1977) carried out cross-mating studies utilizing 31 populations of *Wy. haynei* and *Wy. smithii* from both high and low elevations in southern states, and *Wy. smithii* from northern states and Canadian provinces, and determined that *Wy. smithii* is a polytypic species with three geographic "races". In the past the term "race" was equated with subspecies, but is no longer used in zoological nomenclature. Those "races" included *Wy. smithii*, the southeastern taxon previously named *Wy. haynei*, and a newly recognized southern taxon in the Gulf Coast states of Alabama, Florida, and Mississippi. Also, they did not provide a name for the southern taxon. Although these authors did not specifically say they synonymized *Wy. haynei* as a junior synonym under *Wy. smithii*, the breadth and results of their study clearly demonstrated that *Wy. haynei* is a southeastern variant of *Wy. smithii* and does not warrant species status. Darsie and Morris (2000) sunk *Wy. haynei* as a junior synonym of *Wy. smithii*. For more information regarding these changes and biological notes for *Wy.smithii* see Goddard et al. (2007). Presently, *Wy. smithii* is the only recognized *Wyeomyia* species recorded from the MAMCA states.

**Note 3.** For years mosquito identifiers in the U.S. have used the long length of wing vein $R_{2+3}$ compared to the short length of wing cell 2 to identify genus *Uranotaenia* from other genera (Carpenter and LaCasse 1955). However, there is another wing character on *Uranotaenia* species in the eastern U.S that is easier to see than the above character and does not require measuring. This involves drawing an "imaginary" line from the Mcu fork on the cubital vein straight back to the hind margin of the wing. On both eastern *Uranotaenia* species the anal vein curves sharply down to the hind margin of the wing before the "imaginary" line reaches the hind margin. All the other species and genera in the MAMCA Region have the anal vein reaching the wing margin beyond the "imaginary" line.

**Note 4.** Gargan and Linthicum (1986) found 10 (1.9%) of 533 females of *Aedes taeniorhynchus* collected in Chincoteague National Wildlife Refuge, Assateague Island, VA, lacking a pale band on the proboscis. We have also noted this variation on rare specimens of *Ae. taeniorhynchus* along the North Carolina coast. Identifiers that may encounter this rare trait should remember that if it looks like *Ae. taeniorhynchus*, even without the proboscis band it is probably that species. This is particularly true when large numbers of this species eclose simultaneously.

**Note 5.** Historically, *Aedes aegypti* was present in most MAMCA states. For example, in North Carolina it was still commonly found in piedmont and coastal plain counties until the mid-1990s, particularly in used tire piles. *Aedes albopictus* arrived in NC in 1989 and by the early 1990s was spreading rapidly across the state. This coincided with a NC Department of Environment and Natural Resources program to rapidly remove used tire piles. By 1994-95, *Ae. aegypti* was very hard to find in NC, and thereafter it disappeared from the state, except for two collections, one in Swain County in 2002 (Reeves et al. 2004), and the other in Harnett County in 2004 (Eugene Powell, specimens shipped to/confirmed by BAH). Focal infestations can still be found in southern Georgia and South Carolina. Further north, specimens or small temporary infestations have been reported (electronically) in recent years in The District of Columbia, Maryland, Pennsylvania, and Virginia.

**Note 6**. Two commonly used characters to identify *Ae. dupreei* have been found variable and definitely make identification of females of this species ambiguous. (1) The first character is "occiput with few or no dark scales laterally", which technically are lateral vertex scales. Since 1981 it has been illustrated with no dark lateral decumbent scales and used as a primary character in most published keys. Examination of specimens, some reared with associated larval exuviae from North Carolina and Florida, has revealed this represents a minority of *Ae. dupreei* females in those states. In fact, the scale colors on the vertex range from a minority pattern of all white, to the dominant pattern of median white scales with two small somewhat oval patches of lateral gray scales on the vertex (Figure 121), and to another minority pattern of median white scales with two large dark gray to black lateral patches of scales on the vertex. Regardless of the vertex pattern there are always lateral erect dark forked scales on the occiput. Carpenter and LaCasse (1955), King et al. (1960), and Bickley (1980) recognized and described the lateral patches of decumbent scales, but called them brown scales. Why later authors did not utilize these descriptions is unknown. (2) The second character is "width of the median white longitudinal stripe on the scutum." as depicted in Figure 120, this stripe is wider than those found on *Ae. atlanticus* and *Ae. tormentor*, and usually has nearly parallel sides. However, we have found that a minority of specimens have that stripe widening on the posterior half of the scutum. A few specimens had that portion of the stripe at least 50 % wider than the width of the stripe on the anterior half. This might occasionally cause problems in separating *Ae. dupreei* from *Ae. infirmatus*. The two characters discussed above are clearly seen in the photos of female *Ae. dupreei* in Burkett-Cadena (2013). The male of *Ae. dupreei* is easily recognized because it has the scutum entirely covered with long slender silvery-white scales.

In addition to the two variable characters defined above, *Ae. dupreei* can be easily identified by its size, i.e., it is a very small species compared to *Ae. atlanticus*, *Ae. tormentor,* and *Ae. infirmatus*, and by the length and shape of the white scales in the scutal stripe. Those scales are silvery-white (not cream colored), slender and almost wire-like, slightly curved, and much longer that those on the above three species that have median pale stripes on the scutum.

**Note 7.** Although Harbach (2004, 2013) retained *An. punctipennis* and *An. perplexens* in the Punctipennis Group, we prefer the name for this group as the Punctipennis Complex, which was first used by Bellamy (1956). The Punctipennis Complex was expanded to three species by Porter and Collins (1996), with the discovery of *An. punctipennis* W (=West) in California, and may include more species considering the *An. punctipennis* "Lineage" discussed by Porter and Collins. We are only dealing with females of *An. punctipennis* E (=East) and *An. perplexens*, which we will not separate in the adult key. The SCP ratio wing character used in other keys may be more reliable in Florida and southern Georgia, but the reliability of this character elsewhere is suspect based on the wide range of sizes in the subcostal pale wing spot on both *An. punctipennis* E and W. This decision is based on the following information.

Bellamy (1956) elevated *An. perplexens* Ludlow, a junior synonym of *An. punctipennis,* to species level based primarily on egg and larval differences. He also noted that in Florida and Georgia females could usually be distinguished from each other by a ratio in size differences in the subcostal pale spot compared to the preapical dark (PD) wing spot on the front margin of the wing. Since then, *Anopheles* keys used in the eastern U. S. (King et al. 1960; Darsie and Ward 1981, 2005; Darsie and Morris 2000; Darsie and Hutchinson 2009; Burkett-Cadena 2013) have used the less reliable SCP ratio on the wing to separate females of these two species, while use of the more reliable egg character described by Bellamy has not been mentioned. Fortunately, Linley and Kaiser (1994) described and provided scanning electron microscope (SEM) photomicrographs of the easily seen egg differences for the two species.

Ross (1947) discussed wing spot variations on *An. punctipennis* and determined that of all wing spots on this species the SCP spot is "subject to the most conspicuous variations". Fritz et al. (1991) followed up on this statement and studied four populations of *An. punctipennis*, three from California and one from Illinois, and determined from SCP ratios that most of their study specimens had intermediate ratios that could only provide ambiguous identifications. Also, 12-23% of field collected females in California had SCP ratios corresponding to *An. perplexens*, but extensive larval and egg collections revealed no evidence of *An. perplexens* in California. These authors concluded that the SCP ratio, by itself, is not a useful character for differentiating the females of these two species. We, however, think that character may be more useful in Florida and Georgia than in other areas of the U.S. In North Carolina the senior author reared progeny from individual females having wide SCP spots indicative of *An. punctipennis,* and found that female offspring within a single egg brood could exhibit variations from wide SCP spots, intermediate SCP spots, to a few females with SCP spots that were narrow and indicative of *An. perplexens*. These results are similar to those found in California and Illinois by Fritz et al. (1991). These combined results clearly indicate the need for more extensive morphological and molecular studies of the Punctipennis Complex.

Based on the above we believe the wing SCP ratio is unreliable for differentiating *An. punctipennis* and *An. perplexens* females in most of the MAMCA region. We urge identifiers in the region to use the egg characters of Bellamy (1956) and Linley and Kaiser (1994) whenever possible to confirm specimens coming to their collection sites. In the absence of confirmation of their specimens they should use "Punctipennis Complex."

**Note 8.** Before the 1990s three species*, An. crucians*, *An. bradleyi,* and *An. georgianus*, were included in the North American Crucians Subgroup (Floore et al. 1976). Cockburn et al. (1993) determined that four, not three, species were present in a "crucians complex." Reinert (unpublished) was able to sort five species morphologically in the complex (*An. bradleyi/*sp C, sp. A, sp. B, sp. D, sp. E), but he was unable to associate *An. crucians* and *An. georgianus* with any of the lettered provisional (A, B, D, and E) species. To help clarify this situation, he sent representatives of his five species to the Smithsonian Institution for molecular analysis. Wilkerson et al. (2004), utilizing internal transcribed spacer 2 (ITS2) sequences, determined that *An. bradleyi* and species C were separate and distinct species and that there were actually six named and provisional species. But again, *An. crucians* and *An. georgianus* could not be associated with any of the five lettered provisional species (*crucians* A, B, C, D, and E).

Currently, there are five provisionally lettered species (*crucians* A, B, C, D, and E) that cannot be separated by morphology, but are distinct species genetically. The nominal species, *An. crucians*, cannot be identified by morphological characters, and has not been designated as any one of the five provisional lettered species. The other two nominal (= named) species, *An. bradleyi* and *An. georgianus*, can be identified morphologically in at least the larval stage (Floore et al. 1976). *Anopheles bradleyi* can also be identified by ITS2 sequencing, but the rare species, *An. georgianus*, has not been identified by DNA sequencing and females are inseparable from the 5 "crucians" lettered provisional species. Thus, collected females of all seven of these nominal and provisional species should be called "Crucians Complex."

**Note 9.** Reinert et al. (1997) revised the group of *Anopheles* species in the Quadrimaculatus Complex and described five species including *An. quadrimaculatus sensu stricto,* and four new species, *An. diluvialis*, *An. inundatus*, *An. maverlius*, and *An. smaragdinus*. In order to find good differentiating morphological characters to separate females of these species it was necessary for those authors to use near perfect specimens, which they obtained by rearing each female individually from a fourth instar larva and saving both the larval and pupal exuviae of that specimen. That way they could double check the validity of prospective adult characters by referring to the ID of the two immature stages and also molecular identifications. They found good characters to separate the females, but these characters required high magnification (>60x) and in some cases counting large numbers of setae on the scutum. Requiring near perfect specimens and use of high magnification dissecting microscopes is essential for taxonomic studies. However, personnel working in surveillance and control programs may not have high magnification dissecting microscopes, and they rarely find near perfect specimens because they are collected in surveillance traps and are either rubbed or otherwise damaged. For this reason we have provided the term "Quadrimaculatus Complex" for use by control personnel that routinely and rapidly identify large numbers of specimens for quick control decisions. For others that want to try to identify the females of this complex continuing on to couplet 7 will allow species identification of the five species in the Quadrimaculatus Complex at a 90-95% level.

**Note 10.** In this publication we consider the entities related to the Pipiens Complex to include: *Culex pipiens*, *Culex quinquefasciatus*, hybrids of parental *Cx. pipiens* and *Cx. quinquefasciatus*, and an autogenous physiological strain of *Cx. pipiens* called "molestus" that does not warrant a formal taxonomic name (Harbach et al. 1984, Bourguet et al. 1998, Smith and Fonseca 2004, Harbach 2012). Other authors, particularly in the United States, consider the first two taxa as subspecies of *Cx. pipiens* with a broad zone of hybridization ($36^{o}$ to $39^{o}$ North Latitude) proposed by Barr (1957). This zone is real and based on recent genetic introgression studies (Fonseca, *in litt.*), it may need to be broadened.

Turell (2012) provided virus susceptibility evidence that suggests *Cx. pipiens* and *Cx. quinquefasciatus* are distinct species.

Regardless of your use of species or subspecies, females of the two parental taxa and their hybrids are very difficult to separate morphologically. Obviously, if you live above the northern boundary of the hybrid zone you can consider your specimens *Cx. pipiens*, and if you live south of the southern boundary of the hybrid zone you can call your specimens *Cx. quinquefasciatus*. For the rest of us in the mid-part of the MAMCA region, i.e., extreme northern GA and SC, all of NC except for one extreme southeastern county, all of VA except for the northern hump adjacent to Maryland, and the southern part of WV, it is best to use the term "Pipiens complex." Even specimens taken at over 3,000 ft. elevation in the mountains of NC are hybrids (Savage, unpublished).

**Note 11.** The word "obvious" in the second half of couplet 1 in the *Aedes* larval key was used because on rare *Ae. cinereus* specimens, besides setae 1-S and 2-S, there can be two pairs of extremely tiny subdorsal setae on the siphon. Normally, these tiny setae cannot be seen using dissecting microscopes (with 40-60X magnification) that are commonly used in mosquito control. 80X or higher magnification is needed to clearly see them. These tiny subdorsal setae have been illustrated by Bohart & Washino (1978) under the name *Ae. hemiteleus*, a western mosquito that is currently considered a synonym of *Ae. cinereus* (Bickley 1980). Because a vast majority of *Ae. cinereus* larvae in the eastern United States and Canada do not have those tiny subdorsal setae we decided this species should not come out with *Ae. provocans* in couplet 1.

**Note 12.** On *Ae. punctor* larvae the shape of the comb scale rows can be variable and may present problems in separating this species from *Ae. trivittatus*. However, *Ae. punctor* has: seta 1-VIII longer than seta 2-VIII; (2) siphon seta 1-S long, length approximately equal the width of the siphon; (3) comb scales with the central spine length 5 or more times the length of the very small basolateral spines; and (4) prothoracic setae 1-3-P very long and nearly equal length. *Aedes trivittatus* has: (1) seta 1-VIII much shorter than 2-VIII; (2) siphon seta 1-S short, length approximately only half the width of the siphon; (3) comb scales with central spine length no more than 2 times the length of the basolateral spines; and (4) prothoracic seta 1-P long, but setae 2,3-P are much shorter than 1-P. Also, keying larvae of these two species only presents a problem in Pennsylvania, because *Ae. punctor* only occurs in the northern half of Pennsylvania.

**Note 13**. The characters used in the larval keys are based strictly on fourth instar larvae. The number of branches and shape of setae on third instar larvae of *Ae. triseriatus* can be very misleading and similar to *Ae. hendersoni*. Thus, we have provided a table and illustrations for characters that will separate the instars of Culicine and Anopheline mosquitoes. The user should refer to that table and make sure that the larva they are examining is a fourth instar, particularly when it appears the identity of the larva will be one of these two species or a hybrid. Although *Ae. triseriatus* and *Ae. hendersoni* are very closely related species, hybrids between these species are rarely reported. Several papers (Truman and Craig 1968, Lunt 1977, Grimstad et al. 1974) have addressed this situation. Those authors point out the difficulties in identifying adult F1 hybrids and fourth instar larvae that are hybrids. Thus, suspected hybrid adults should not be identified unless there are associated fourth instar larval skins available for confirmation. Our key provides validated characters that clearly separate these two species.

**Note 14**. The two subspecies of *Ae. canadensis* are separated in the adult female key, but are not separated in the larval key. Those subspecies, *Ae. canadensis canadensis* and *Ae. canadensis mathesoni*, represent a real taxonomic puzzle that begs to be resolved with more study and the use of modern techniques. Initially, subspecies *Ae. c. mathesoni* was described as a species from Florida by Middlekauff (1944) based on adult characters. Later, Rings and Hill (1946, 1948) described the larva from the same area and sunk the species to a subspecies. Subsequently, there has been skepticism about the validity of this name being worthy of subspecies level. Carpenter and LaCasse (1955) considered this taxon "A melanistic subspecies or geographical variation of *A. canadensis"* that has been found in southern Alabama, Florida, Georgia, and South Carolina." Later, Pickavance et al. (1970) collected a female specimen in Newfoundland, Canada. Wood et al. (1979) commented on this disjunct distribution saying, "From such widely separated localities it is hardly likely to be a subspecies, but could represent anything from a rare recessive allele to another species." We agree with this statement, but consider an environmental stimulus or a genetic variation as the most likely cause for the morphological differences.

**Note 15**. The small single or double setae 5-7-C on the head of *An. barberi* larvae are classical characters in the eastern U.S. for identifying this species. However, these characters are very difficult to see due to their small size and the normally black background integument of the head, even on slide mounted larvae. We decided to use more lateral characters on the specimens in the key that are easier to see for surveillance personnel identifying larvae using dissecting microscopes.

**Note 16**. A number of Mid-Atlantic *Anopheles* species besides *An. walkeri* and *An. earlei* may have branching on setae 2-C, but these instances are uncommon or rare. The "norm" (= 90+ %) for 2-C on all of these "other" species is for both setae 2-C to be single and simple, i.e., without apical aciculae or branches. On those specimens that do have variations they may appear as one 2-C single and the other 2-C bifid or trifid, or even less commonly both 2-C bifid or trifid. Such specimens can cause identification problems, particularly where *An. earlei* may occur. In some instances one 2-C may be missing (no alveolus), or more than one 2-C may appear on one side. Roth (1945) examined variations (particularly 2-C and 3-C) occurring on over 10,000 larvae of *Anopheles bradleyi*, *georgianus*, *crucians*, *punctipennis* and *quadrimaculatus* and found a very wide range of variations for which he tabulated numbers and prepared illustrations. Now these species are known to be sibling species complexes, i.e., the Crucians Complex, Punctipennis Complex and the Quadrimaculatus Complex. More recently (Reinert 1999) described similar 2-C and 3-C variations on all five of the sibling species in the Quadrimaculatus Complex.

**Note 17**. The aciculae on seta 2-C of *An. walkeri* are difficult to see because they are very short, thin, and fragile and only occur near the apex of the seta. Personnel trying to see this character should use dissecting microscopes with at least 55x magnification. Lower magnification levels (30-45x) on standard dissecting scopes will not work. Historically, *An. walkeri* has been recorded from nearly every state covered in these keys. However, it is now uncommon or rare in nearly all of these states due to habitat loss, e.g., there are no preserved specimens or published records of this species in North Carolina since 1950. Classic oviposition sites for females of this species were in ponds, lakes, and swamps with heavy submerged, floating, and emergent vegetation in open sunlight. Such habitats are now very uncommon due to "weed" control efforts and modifications to beautify ponds and lakes for fishing, boating, and swimming.

**Note 18**. The larval key for *Anopheles* identifies most of the separate species and the five species in the Quadrimaculatus Complex. Review Note 9 for a better understanding of this complex and the difficulties involved in identifying the five included species. In fact, identifying the fourth instar larvae of these species is particularly difficult. If you want to identify larvae we strongly suggest that you do not use whole larvae and a dissecting microscope. Larvae of *Anopheles* species are best identified using the shed associated fourth instar exuviae (skin) of a reared adult that has been mounted on a slide under a coverslip, and using a compound microscope. Saving and mounting the pupal and larval exuviae of the eclosed (emerged) pinned adult provides three stages of one specimen on which to base your identification. If this requires too much man-power and time for surveillance and control personnel we recommend using the term “Quadrimaculatus Complex.”

**Note 19**. Please review Note 8 to understand the status of the *Anopheles* species in the Crucians Complex. Although adult females of this complex are mostly inseparable based on morphological characters, there are larval characters that will separate the two groups of species that key out in couplets 10 and 12 that make up the Crucians Complex. The least known group consists of five lettered provisional species that are associated with the nominal (named) species, *An. crucians*, and are keyed out in couplet 10 as *crucians* A, B, C, D, and E. Actually, in the future one of those lettered species will become the real *An. crucians* and the other four remaining lettered provisional names will need to be named and described as new species. For larvae that key out in couplet 10 to the *crucians* A, B, C, D, and E, they should be called “Crucians Complex.”

**Note 20**. The other two species in the Crucians Complex key out in couplet 12 and consists of two nominal species, *An. bradleyi* and *An. georgianus*. The former utilizes brackish water for oviposition sites and occurs down the eastern coast and along the Gulf Coast to Texas, while *An. georgianus* is a rare species restricted to a small inland southeastern distribution and oviposits in fresh seepage water. While adults of these two species are best identified as Crucians Complex, the larvae and pupae are separable from each other, and the five lettered provisional species, using the keys of Floore et al. (1976).

**Note 21**. As previously explained in Note 7, there are currently at least three sibling species that make up the Punctipennis Complex, i.e., *An. perplexens*, *An. punctipennis* E [= East], and *An. punctipennis* W [= West]. The third species was discovered based on differences found in rDNA (Porter & Collins 1996). Here we only deal with the first two species. The larvae of this complex have the five pairs of setae 1-III to VII enlarged and fully functional, but seta 1-II is small and non-functional. The seta branching characters in couplet 13 that are used to separate the larvae of *An. punctipennis* E and *An. perplexens* are poor at best because of branching variations of setae 2-IV,V on *An. punctipennis* which overlap with the character set described for *An. perplexens*. Although, we provided a couplet using these larval characters for Georgia and Florida specimens, the only really good characters to separate these two species are on the eggs (Bellemy 1956; Linley and Kaiser 1994). Female and larval specimens that appear to be *An. perplexens* based on the previously used wing characters (Darsie and Ward 2005; Darsie & Hutchinson 2009; Burkett-Cadena 2013) or the larval characters in couplet 13, should not be used to establish new records unless they have been confirmed as *An. perplexens* using the egg characters mentioned above.

**Note 22**. Surveillance personnel should not try to identify larvae of *An. bradleyi* using only the black antennae because there is another member of the Crucians Complex, *crucians* D, which has a black antenna. The latter provisional species is found in black-water creeks, rivers, and ponds in coastal plain areas, but not in brackish water. Since *An. bradleyi* can be found in very weak brackish water along coastal margins, creeks, and rivers near where *crucians* D may occur, the black antenna used in couplet 12 is only valid when separating *An. bradleyi* from *An. georgianus*. Larval and pupal characters that distinguish *An. bradleyi*, and illustrations of the female, male, pupa, and all four of the larval instars are in Floore et al. (1976).

**Note 23**. *Anopheles georgianus* is a rare species that apparently has a very specialized oviposition behavior, i.e., ovipositing in clear water in very shallow slowly moving seepage areas. Although many collectors in southeastern states collected and recorded this species during World War II and the National Malaria Eradication Program in the U.S., there have been no confirmed and published records of this species since 1951. The adult female looks just like the five provisional species, *crucians* A, B, C, D, and E, but the larvae of *georgianus* can be recognized by having only three functional pairs of palmate setae, 1 pair each on segments IV-VI. This is a most unusual character in *Anopheles*. The partially light antenna illustrated in couplet 12 can be used to assist in separating *An. georgianus* from *An. bradleyi* and *crucians* D. Previously, large numbers of specimens of this species were examined and compared with what was then called *An. crucians* and *An. bradleyi* and characters for separating the larvae and pupae of *An. georgianus* were found (Floore et al. 1976). That publication includes keys and illustrations of the female, male, pupa and all four instars of the larvae of *An. georgianus*.

**Note 24.** All members of the Pipiens Complex in the eastern USA come out in couplet 5 of the *Culex* larval key (review Note 10 for additional information). This is because over 50 % of the Mid-Atlantic Region covered in this book is a zone of genetic introgression involving *Cx. pipiens* x *Cx. quinquefasciatus* hybrids. Our current interpretation of this hybrid zone stretches from the Potomac River in the north to a line in the south across northern SC and northern GA, where we suggest using "Pipiens Complex." Collectors in southern and mid-GA, and southern and mid-SC can call their specimens *Culex quinquefasciatus*. Collectors in MD, DE, PA and northern WV can call their specimens *Culex pipiens*, although there could be a small (unconfirmed) level of genetic introgression occurring in southern MD and on the eastern shore of MD. Measurement differences in certain larval characters among the two species and even intermediates have been evaluated and described (Brogdon 1981, 1984a, 1984b), but since his studies were in the Memphis area they may not apply to the MAMCA states (except for Tennessee). Also, certain books have illustrated differences in the siphon shape and length for the two species, e.g., Harbach (1988), but those illustrations were not based on specimens from the Western Hemisphere. The average length of the siphon on *Cx. pipiens* is longer than that of *Cx. quinquefasciatus*, but the differences are slight. For example, *Cx. pipiens* can have siphon lengths of >4 to 6 times the width, while that of *Cx. quinquefasciatus* is < 4 to <5.5 times the siphon width. Both species normally have 4 pairs of seta 1-S on the siphon, but *Cx. pipiens* larvae can have a $5^{th}$ pair, and *Cx. quinquefasciatu*s can have only 3 pairs of seta 1-S on the siphon (Rey et al. 2006). Anyone wanting to investigate morphological characters for separating the two parental species, *Cx. pipiens* and *Cx. quinquefasciatus*, must select specimens from outside the zone of hybridization and should confirm their morphological findings by using molecular genetics techniques because characters on hybrid specimens will confuse and cause ambiguous results.

## XII. GLOSSARY

This list is based primarily on the Mosquito Taxonomic Inventory, Museum Natural History, London, Harbach and Knight (1980), and Torre-Bueno (1985), with slight alterations to the terminology and positions of certain structures and definitions. The word "plural" is abbreviated as "pl." with the pleural word in parentheses or as "(s)" after the singular word. Abbreviations are indicated in parenthesis as "(abv. - )." The life stage or stages to which a definition applies is shown in brackets. The reader should compare the definitions, when applicable, with the included basic female illustrations (Figures i-vi), and larval illustrations (Figures vii-xiv).

**-A-**

**Abdomen –** [Female & Larva]. The third or most posterior major division of the body. Ten segments are recognized in adults, and nine in larvae (segments I-VIII and X, IX is not apparent externally). The segments are typically numbered with Roman numerals.

**Abdominal Segment –** [Female & Larva]. One of the subdivisions of the insect abdomen. These segments are rounded or oval, with dorsal and ventral sclerotized plates and membranes separating those plates on each segment. On the adults the plates have setae and/or scales of taxonomic importance, but generally those on the dorsal plates do not match those on the ventral plates. On larvae the integument of the segments is primarily membranous and possesses various types of setae, and may have small sclerotized plates.

**Accessory Tergal Plate –** [Larva]. One or more small median or submedian plates behind the dorso-median tergal plate on certain abdominal segments of some anophelines.

**Acicula (pl. Aciculae) –** [Larva]. A small, slender, rigid, needle- or thorn-like spicule (see spicule); often seen in a fringe on the posterior margin of the larval saddle called a "saddle fringe." Those on individual setae may appear more slender and frail.

**Acrostichal Area –** [Female]. The median longitudinal area straddling the midline of the scutum from the anterior promontory to the prescutellar area; usually bearing paired acrostichal setae and/or scales. Certain genera and subgenera can be identified by not possessing acrostichal setae/scales.

**Aculea (pl. Aculeae) –** [Females]. Very tiny sharp pointed spicules that create a covering (see Tormentum) over the cuticula (outer surface of the exoskeleton) of a female mosquito, except when present on the wing membranes where they are called microtrichium. Aculeae are uncommon on larvae.

**Adult –** A fully developed sexually mature female or male; the final stage in the arthropod life cycle.

**Alveolus (pl. Alveoli) –** [Female & Larva]. A cup-like sensory structure in the integument that serves as a socket for an associated seta (of various types); this structure can be used to confirm the past presence of a seta if a specimen is damaged and the seta has been rubbed of.

**Anal Papilla (pl. Papillae) –** [Larva]. One of the soft, clear, and elongate "sausage-like" processes extending posteriorly from abdominal segment X. There are usually 2 pairs of these, a dorsal pair and a ventral pair. They function as excretory organs, eliminating toxic byproducts that accumulate in the body of the larva. They also may function in some species in the collection of oxygen from the water.

**Anal Vein –** [Female]. From a dorsal view, the most posterior vein on the wing that also extends distally to join the hind margin of the wing. Scale colors and spots on this wing vein are very important in identifying *Anopheles*.

**Antenna (pl. Antennae) –** [Female & Larva]. One of the bilateral paired anterior organs projecting from the head, originating between the eyes on females and anterior to the eyes on larvae. On adult mosquitoes, consisting of a very narrow ring-like basal segment (scape) that is underneath the second segment (pedicel) which is globular and tire-shaped, and a third segment (flagellum) comprised of a series of 13-14 flagellomeres bearing whorls of sensory setae. On the head of larval mosquitoes, inserted anterolaterally and consisting of a narrow ring-like scape which is united with a large distal tubular part, the fused pedicel and flagellum.

**Antepronotum –** [Female]. One of the paired anterior divisions of the pronotum, the first part of the thorax; visible as an anterolateral lobe beneath the anterior promontory area on the scutum, bearing setae and occasional scales, and laterally situated just above the dorsal extension of the proepisternum.

**Anterior –** [Female & Larva]. A directional clue pointing to some point near or on the head. Examples: the head is anterior to the abdomen; the anterior end of an abdominal segment is actually the basal (attachment-wise) part of that segment, and the posterior end of that segment is most distal from the head; and segments on the legs have anterior aspects.

**Anterior Dorsocentral Area –** [Female]. A pair of submedian longitudinal rows of setae and/or scales that are near, but lateral to the acrostichal (median) row on the scutum; divided into two regions, the Anterior Dorsocentral Area and the Posterior Dorsocentral Area with setae and/or scales which occur lateral and just before the beginning of the prescutellar area.

**Anterior Promontory Area –** [Female]. The broad median area of the mesonotum at the anterior end of the acrostichal area which projects, more or less, cephalad over the cervix. (Used on morphology plate, not in the key)

**Apex –** [Female & Larva]. The furthest or most distal point on a structure from the base.

**Apical –** [Female & larva]. A directional relationship to the apex of a structure; typically something beyond the midpoint on a lengthy structure, e.g., like a preapical pale band on a leg segment, or apical pale bands (SEE BAND) on the abdominal segments, or apical bands on hindtarsomeres.

**Attenuated –** [Female & Larva]. The gradual loss of diameter (width) towards the apex of a structure (e.g., a sharp spine).

**-B-**

**Band –** [Female & Larva]. A complete circular ring that encompasses the entire circumference of a structure; typically used in describing a band on the proboscis, leg, or on a siphon. However, the reader should take note that while we continue to use the term "bands" on the abdominal segments (because of general usage) in our keys and discussion, the apical and basal "bands" on those segments do not completely encircle the segments and they are actually apical and basal transverse stripes.

**Basal –** [Female & Larva]. A directional relationship to something closer to the base than the midpoint on a lengthy structure; typically used in describing structures, e.g., basal pale bands on the hindtarsomeres, basal transverse stripes on the abdominal segments, or a basal row of pecten spines on the venter of a siphon.

**Basal Tooth –** [Larva]. Typically used for a small basoventral sharp projection on the "claws" (= ungues) on some adult mosquitoes; its length and shape in relation to the main "claw" can be important in identifying species, e.g., *Aedes stimulans*.

**Base –** [Female & Larva]. The most proximal point of a structure, e.g., base of a wing, antenna, or siphon.

**Broad Scales –** [Female]. Scales that are broadly rounded or triangular distally; refer to "Scale" for more information.

**-C-**

**Capitellum –** [Female]. The apical part of the halter, which is knob-like and has scales. These structures represent the modified second pair of wings on the metathorax. (SEE HALTER)

**Central Spine of a Comb Scale –** [Larva]. The median spine and typically the largest spine on a larval comb "scale" (actually misnomer as they are spicules).

**Cercus (pl. Cerci) –** [Female]. A pair of appendages at the apex of the abdomen beyond tergum IX that is used in assisting in the oviposition of eggs. These may be short and circular (e.g., *Culex*) or long, slender, and rounded or flattened (e.g., *Aedes*).

**Clypeus –** [Female & Larva]. A large sclerotized facial structure on the head below and anterior to the antennal pedicels and above the base of the maxillary palpi; also occurs on larvae, but not used here. Scales on the female clypeus are uncommon, but when present are valuable identification tools, e.g., *Aedes aegypti*.

**Comb –** [Larva]. A small or large patch or row(s) of spicules on the posterolateral part of the abdominal segment VIII. The types and arrangement of spicules can be highly variable and very valuable in identification; based on the number of spicules in the comb, it may be linear (curved or straight), comb-like, in several rows, or randomly scattered.

**Comb Plate –** [Larva]. A small or large lateral sclerite on abdominal segment VIII bearing the comb spicules, which occurs on certain culicine larvae; sometimes the paired lateral sclerites are joined dorsally. Not homologous with the tergal plate of anopheline larvae.

**Comb Scale –** [Larva]. A generalized name for spicules that occur in the comb on abdominal segment VIII. Each spicule is non-articulated and joined continuously with the integumental membrane or a comb plate, and may have lateral and apical spinules or denticles. Those with apical spinules often have a "central spine of a comb scale" (see definition above). Some comb scales lack spinules or denticles and appear lanceolate or sharp pointed "claw-like." Comb scales are absent on *Toxorhynchites*, and occur on *Anopheles* only during the first larval instar.

**Compound Eye(s) –** [Female]. Light perception organs consisting of an aggregation of optic elements (ommatidia), generally located on each side of the head of adult mosquitoes; convex, kidney shaped, and occupying much of the dorsal and lateral surface of the head. These organs are very adept at detecting shades of colors and movement and aid the adults in avoiding predators, and in finding food (blood and/or carbohydrates), and in finding oviposition habitats.

**Costa (abv. C) –** [Female]. The anterior-most (= Front) longitudinal vein on the wing, normally extending from the base of the wing to the wing apex. Typically possessing many scales that may be unicolored or multicolored. Pale scaled spots on the costa are very important in separating *Anopheles* species.

**Coxa (pl. Coxae) –** [Female]. The basal-most sclerotized segment of a leg, articulated by a membrane with the thorax.

**Cubitus (abv. Cu) –** [Female]. The fifth longitudinal vein on the wing, with two main branches cubitus anterior (CuA) and the cubitus posterior (CuP). The CuA is located dorsally on the wing and has scales, while the CuP is posterior to the CuA, is projected ventrally thus most easily seen on the venter of the wing, and is long, slender, and without scales.

**-D-**

**Decumbent Scales –** [Female]. Scales that lay flat or appressed on the surface of origin, e.g., top of the head, abdomen, legs, or wing veins.

**Diameter –** [Female & Larva]. A straight line across a circular structure that extends from one side of the circle over the midpoint to the other side of the circle. On females this is normally used in discussing the width across a proboscis and leg segments, and on larvae in measuring the width across the siphon.

**Distal –** [Female & Larva]. Located away from the center of the body or center of a structure or point of attachment. Often used in terms like "most-distal" or beyond the midpoint of a structure toward the apex, e.g., a preapical band on the tibia is distal to the mid-point (length-wise) on the tibia. On larvae it is most often used in discussing forks occurring on setae, or distal aciculate branches on a seta.

**Dorsal –** [Female & Larva). Relating to the dorsum of an organism or body structure, e.g., the dorsum (or dorsal aspect) of a leg segment, wing, proboscis, thorax, head, abdomen, etc.

**Dorsum –** [Female & Larva]. The upper part of an organism or structure.

**-E-**

**Egg Burster (abv. EBu) –** [Larva]. A specialized structure of the embryonic or first instar larva head cuticle thought to aid in opening the egg chorion during hatching. A specialized median oval area on top of the head that consists of a pale peripheral area and a dark hardened central spine. (SEE FIGURES 325-326)

**Erect Forked Scale –** [Female]. Typically long, narrow, stalked scales that are erect and stand vertically from the top of the head, which have a slightly widened and blunt apex with a median notch (depth varying per species). These occur on the vertex and occiput of adult mosquitoes. (SEE SCALE)

**Exuviae (does not exist in the singular) –** [Larva]. The entire outer covering (= skin) of a larva (also a pupa), including the membranous and sclerotized parts. Typically exuviae are shed between the four larval instars and while the adult is eclosing from the pupa. These "skins" are very important to taxonomists identifying adults to species when there is more than one species with the adult habitus extremely similar or identical. (SEE HABITUS)

**-F-**

**Flagellomere(s) –** [Female]. An individual unit of the antennal flagellum. Typically there is a whorl of long thin setae around the base of each flagellomere.

**Flagellum –** [Female]. The distal third segment of the antenna. In adult mosquitoes comprised of 13-14 smaller flagellomeres.

**Forecoxa (pl. Forecoxae) –** [Female]. The basal most sclerotized segment of a foreleg.

**Foreleg(s) –** [Female]. The front pair of legs that are attached to the prothorax.

**Foretarsus (pl. Foretarsi) –** [Female]. The tarsus of one of the forelegs. The most distal section of a front leg, consisiting of five segments called tarsomeres.

**Frontal Tuft –** [Female]. A grouping of erect elongate simple setae and/or fusiform scales arising from the interocular space and the immediately adjacent portion of the vertex of the head; used in identifying anophelines.

**-G-**

**Genus (pl. Genera) –** [Female & Larva]. The first part of the scientific binomial name of a species, or trinomial name of a subspecies, with Greek or Latin gender endings; always with the first letter capitalized and the name set apart from the normal font by italics or less commonly by bold.

**Grid –** [Larva]. The ventral area of sclerotized ridges on abdominal segment X that bear the cratal setae (pairs of Seta 4-X) of the ventral brush. Smaller, more anterior paired (precratal) setae of the ventral brush that are attached ventrally to the saddle or membrane of segment X, may occur on larvae of certain species.

## -H-

**Habitus –** [Female & Larva]. The characteristic form and appearance of an organism, species, subspecies. This is typically used in discussing the outward appearance of members of a species complex where all of the females basically look identical, e.g., *Anopheles crucians* complex.

**Halter(s) –** [Female]. The paired drumstick-shaped structures on the metathorax below and behind the wing, consisting of a slender stem-like pedicel and an expanded distal part, the capitellum. The halters represent a second pair of wings in the order Diptera (true flies) that are supposedly used in balance during flight.

**Head –** [Female & Larva]. The most anterior major section of the insect body, bearing compound eyes, antennae, and mouthparts, separated from the thorax by the cervix.

**Hindcoxa (pl. Hindcoxae) –** [Female]. The most basal sclerotized segment on the hindleg that is attached to the metathorax.

**Hindleg(s) –** [Female]. The metathoracic legs; the most posterior pair of legs.

**Hindtarsus (pl. Hindtarsi) –** [Female]. The five-segmented tarsus of the most posterior leg that is attached to the metathorax.

**Hindtibia (pl. Hindtibiae) –** [Female]. The tibia of one of the hindlegs.

**Hypostigmal Area –** [Female]. A weakly sclerotized or membranous area immediately below the mesothoracic spiracle and just above the subspiracular area. This area is usually bare of scales, but when scales are present they are of taxonomic significance in identifying species.

## -I-

**Instar(s) –** [Larva]. A term used to denote a particular larval developmental period. Mosquito larvae go through four of these periods, shedding the exuviae between each period. After the $4^{th}$ period is completed the larva sheds the $4^{th}$ instar exuviae and changes to a pupa. The periods are usually denoted as $1^{st}$, $2^{nd}$, $3^{rd}$, and $4^{th}$ instars. For this definition we are following Torre-Bueno (1985, $6^{th}$ Edition).

**Integument –** [Female & Larva]. The outer surface of the body, comprised of membranes and sclerites.

**Interocular Space –** [Female]. The narrow part of the vertex on the head, between the compound eyes and above the margins of the antennal pedicels. Setae and scales can occur in this area and can be used for identification, particularly in the anophelines.

**Intersegmental Membranes –** [Female & Larva]. On females the membranes that connect the segments of the body (head, thorax, abdomen) and the appendages (antennae, palpi, wings, legs, and genitalia). On larva, most of the body integument is membranous but the intersegmental membranes connect the head to the thorax, the thorax to the abdomen, the 9 abdominal segments, and the siphon to segment VIII (except for *Anopheles*).

**Iridescence –** [Female]. Having an appearance of "rainbow-like" colors; appears to change colors when light strikes it from different directions. Iridescence on female mosquitoes is associated with scales whose internal structure reflects refractive light, not from scales with permanent pigmentation. These colors are most often shades of red, pink, orange, yellow, green, blue, and purple, e.g., *Toxorhynchites*.

**-L-**

**Labellum –** [Female]. A short partially bilobed structure on the apex of the labium on the proboscis.

**Labium –** [Female]. The elongate sheath-like covering of the proboscis, which covers and protects the internal mouth parts that are involved in detecting and sucking blood or other fluids.

**Larva (pl. Larvae) –** An immature specimen in the second stage of a holometabolous (complete) life cycle of an insect. In mosquitoes a very active, feeding, and wiggling specimen that is always found in water, has four developmental periods called instars, and precedes the pupal stage, which is also aquatic. Mosquito larvae can be found in just about any soil or container habitat that will hold water for 10 days, depending on ambient temperatures.

**Lateral –** [Female & Larva]. A directional term used in referring to the "side" (in respect to the mid-line) of an organism or structure.

**Lateral Scutellar Lobe –** [Female]. One of two lateral lobes on the scutellum of a culicine mosquito. Typically culicine mosquitoes (except genus *Toxorhynchites*) have three posterior lobes on the scutellum, one median lobe on the mid-line, and two lateral lobes. There is one genus of anophelines, *Chagasia*, that has three lobes on the scutellum, the other anophelines have the posterior of the scutellum rounded.

**Lateral Spines –** [Larva]. These are present on the comb scales on abdominal segment VIII. They occur as lateral pointed projections on the distal portion of comb scales of some species. Although we use "spine", a general word used in most keys, technically these projections are either spinules or denticles. (SEE COMB SCALE)

**Leg(s) –** [Female]. One of six paired appendages originating on the venter of the thorax that is used for support and locomotion. The legs are comprised of segments labeled coxa, trochanter, femur, tibia, and tarsus. The three pairs of legs are denoted by the prefixes fore-, mid-, and hind-, as appropriate. The forelegs are articulated with the prothorax, midlegs articulated with the mesothorax, and hindlegs articulated with the metathorax.

**Lower Mesokatepisternal Setae –** [Female]. Setae that occur in a more or less vertical line along the posterior margin of the mesokatepisternum approximately at the level of the top of the mesomeron; sometimes continuous with the upper mesokatepisternal setae.

## -M-

**Maxillary Palpus (pl. Maxillary Palpi) –** [Female]. A paired sensory structure inserted on the head immediately below the clypeus and lateral to the base of the proboscis; varies widely in length and form according to genus and sex; primitively consisting of 5 segments called palpomeres.

**Media (abv. M) –** [Female]. The fourth principal longitudinal vein on the wing; with two areas of branching, beyond the wing cross veins M changes to $M_{1+2}$ and more distally splits into two separate veins, $M_1$ and $M_2$, that extend to the wing margin just posterior to the wing apex, also at the cross veins a more posterior branch, $M_{3+4}$, extends to the hind margin of the wing before vein CuA.

**Median Scutellar Lobe –** [Female]. The posterior lobe on the midline of the scutellum; the medial lobe. Present on culicine mosquitoes, except genus *Toxorhynchites*, and on anopheline mosquitoes in genus *Chagasia*.

**Mesepimeron –** [Female]. The large lateral thoracic sclerite immediately posterior to the mesokatepisternum, below the wing base, and above the mesomeron; divided on mosquitoes into a very large upper portion, the mesanepimeron, and a very narrow horizontal meskatepimeron, just below the upper part. Scales and setae often occur on the upper part and are referred to as mesepimeral scales or setae.

**Mesokatepisternum –** [Female]. A very large, diagonally projecting, lateral thoracic sclerite in between the postspiracular area and the mesepimeron; the lower part is broad and projects downward between the fore- and midcoxae, while the upper part joins with the small narrow posterior mesanepisternum sclerite that narrows to a rounded point called the prealar knob just in front of the wing base. Scales and setae on the mesokatepisternum are of taxonomic significance.

**Mesomeron –** [Female]. A lateral thoracic sclerite below the mesepimeron that projects downward between the bases of the mid- and hindcoxae.

**Mesopostnotum –** [Female]. A large dorsomesal lobe of the mesothorax that projects posteriorly from under the scutellar lobes to join with the dorsum of the abdomen; setae and/or scales in a posterior patch on the midline are highly significant, i.e., they help identify members of the tribe sabethini, e.g., *Wyeomyia smithii*. Such setae or scales are uncommon on members of the tribe culicini.

**Mesothoracic Spiracle –** [Female]. A large opening on the side of the mesothorax that can be opened or closed voluntarily, and is involved in breathing (intake of air) to supply oxygen throughout the body by means of tracheal tubes; located just below the scutum, just behind the postpronotum and prespiracular area, and just in front of the large posterior portion of the postspiracular sclerite.

**Mesothorax –** [Female & Larva]. The second or middle portion of the thorax that is larger than the prothorax and metathorax on adults; it has the scutum dorsally and a majority of the large lateral thoracic sclerites, and bears the mesothoracic spiracle, the wings and the midlegs. On larvae the middle part (M) of the fused thorax, bearing 14 pairs of numbered setae starting near the dorsal midline that extend laterally and ventrally to near the ventral midline.

**Metameron –** [Female]. A small narrow sclerite located above the base of the hindcoxa, posterior to the mesepimeron and mesomeron, and beneath the metathorax; usually bare, but of taxonomic significance when scales are present, e.g., *Aedes cantator*.

**Metathoracic Spiracle –** [Female]. A medium sized opening on the metathorax that can be opened or closed voluntarily and involved in breathing (intake of air) to help supply oxygen throughout the body by means of tracheal tubes; located just posterior to the upper part of the mesepimeron; not in the keys, but used to locate nearby structures.

**Metathorax –** [Female & Larva]. On females the third most posterior part of the thorax; located below the wing and just behind mesepimeron and mesomeron, and bearing the metathoracic spiracle, hind pair of legs, and the paired lateral halters (= second pair of wings) that are used in orientation and balance. On larvae the most posterior third (T) of the fused thorax, bearing 13 pairs of numbered setae starting near the dorsal midline that extend laterally and ventrally to near the ventral midline.

**Midcoxa (pl. Midcoxae) –** [Female]. The most basal sclerotized segment (= coxa) of the midleg that articulates with the mesothorax.

**Midleg(s) –** [Female]. One of the pair of legs that articulate with the mesothorax.

**-N-**

**Notch, Notches, or Notched –** [Female & Larva]. The presence of a "V" shaped median indentation(s) on the posterior margins of basal pale bands on the abdominal terga, or a notch(es) on the apex of extremely narrow stalked erect head scales on females. On larvae a notch in the ventral or posterior margin of the dorsal plate (= saddle) on segment X.

**-O-**

**Occiput –** [Female]. The extreme posterior portion of the top of the head adjacent to the postocciput and cervix, usually bearing a single row of long dark or pale erect forked scales. Its boundaries with the vertex and postgena are not easily differentiated.

**-P-**

**Palmate seta (pl. Palmate setae) –** [Larva]. A seta with flattened, movable, and usually horizontal branches that radiate from a common point on a short basal stem; when spread out resembling a fully extended collapsible hand fan. Palmate setae are commonly found on *Anopheles* larvae, e.g., seta 1, on a variable number of abdominal segments.

**Palpus (pl. Palpi) –** [Female]. See maxillary palpus.

**Paratergite –** [Female]. A narrow lateral sclerite of the mesonotum (= mostly the scutum and scutellum) that is separated by a suture from the scutum and positioned immediately below the scutum just before the wing root. On some species it is immediately posterior to the mesothoracic spiracle and on other species it is clearly separated from that spiracle. Scales and/or setae on this structure are valuable in identifying certain species.

**Pecten –** [Larva]. On culicine larvae a comb-like row of variously developed posterolateral spicules that occur on each side of the siphon and most commonly extend distally from the base of the siphon; on each side of anopheline larvae, occurring on the posteroventral margin of the pecten plate, which is lateral and below the spiracular apparatus on abdominal segment VIII.

**Pecten Plate –** [Larva]. A lateral plate on both sides of an *Anopheles* larva below the spiracular apparatus on abdominal segment VIII; posteroventrally the plate bears long sharp pointed spicules of various shapes and sizes that resemble a comb. This structure is thought to assist the anopheline larva in cleaning the mouth brushes.

**Pecten Spine(s) –** [Larva]. Spicules of various shapes and lengths that make up the pecten on culicine larvae, and posteroventrally on anopheline pecten plates.

**Pigmented Color(s) –** [Female & Larva]. Colors that occur from different pigments found in scales and various parts of the exoskeleton; colors that do not change when light strikes it from different directions. These colors will fade when the specimen is exposed to light, heat or direct sunlight for long periods. (See Refractive Color)

**Piliform Scale(s) –** [Female]. Scales that resemble hair; referring to very fine scales that are circular or elliptical in diameter, and normally narrow, curved and pointed like a setae. They can still be identified as scales by having longitudinal ridges. They often occur on the scutum of anopheline mosquitoes.

**Plumose Seta (pl. Plumose Setae) –** [Larva]. Referring to a seta that is long with many regularly arranged, or alternating, branches on each side of the main stem and is similar to a plume or feather. The branching plume can be wide spread or narrow.

**Posterior –** [Female & Larva]. A direction opposite to the direction of the anterior end, which is the head on mosquitoes. However, leg segments and many structures can have posterior sides or margins, as well as anterior, dorsal and ventral sides/margins. <u>Warning:</u> to assign these directions on leg segments the identifier must make sure the legs or other structures are positioned naturally on the specimen when examined.

**Postprocoxal Membrane –** [Female]. The membrane between the forecoxa and the mesokatepisternum on the side of the thorax. Scales on this membrane are valuable in identifying species, e.g., *Aedes sollicitans*.

**Postpronotum –** [Female]. A large lateral thoracic sclerite below the scutum in front of the scutal angle and mesothoracic spiracle, and immediately posterior to the antepronotum, with a narrow ventral extension that meets the upper part of the proepisternum; often covered with a large patch of scales of various colors.

**Postspiracular Area –** [Female]. A small lateral thoracic scleritized area slightly ventral and posterior to the mesothoracic spiracle, that often has setae and/or scales of importance in the identification of genera.

**Postspiracular Scales –** [Female]. Scales that are found attached to the postspiracular sclerite.

**Postspiracular Setae –** [Female]. Setae that are found attached to the postspiracular sclerite.

**Posterior Mesanepisternum –** [Female]. A small dorsally extending sclerite that joins ventrally with the upper portion of the mesokatepisternum by a barely visible suture and ends in the prealar knob.

**Prealar Knob –** [Female]. A lateral thoracic part of the posterior mesanepisternum that is below the paratergite and projects dorsally and ends in a knob just in front of the wing base; often bearing setae and/or scales.

**Preapical –** [Female & Larva]. A directional term used for a scale band or seta that is found near, but not at the apex of a structure. Examples: preapical pale band on the hind femur or tibia, preapical seta 2-S that is dorsal and just before the apex of the siphon, larval antennal seta 1-A that is inserted just before the apex of the tubular antenna.

**Precratal Seta (pl. Precratal Setae) –** [Larva]. Paired setae on the venter of a complete saddle or membranous area on segment X that are just anterior to the ventral brush, which is composed of paired setae of seta 4-X.

**Prescutellar Area –** [Female]. The median posterior area of the scutum between the posterior acrostichal area and the scutellum; frequently devoid of scales and setae.

**Prespiracular Area –** [Female]. The smaller triangular shaped membranous area just anterior to the mesothoracic spiracle; set off from the postpronotum by a prominent ridge, and occasionally bearing setae and/or scales.

**Proboscis –** [Female]. A generalized word for the greatly elongated sheath-like labium and the enclosed mouth parts on the adult head.

**Proepisternum –** [Female]. An anterolateral sclerite on each side of the thorax that extends from the base of the antepronotum down to the base of the forecoxa, and further anteriorly around the coxa under the cervix to join together on the midline; normally bearing setae on posterolateral part, and occasionally bearing scales on the anteromedian part.

**Prothorax –** [Female & Larva]. The most anterior internal and external division of the thorax. On adult thorax, including the sclerites just behind the head and cervix, including the antepronotum, postpronotum, proepisternum, postprocoxal membrane, forecoxa, and remainder of the foreleg. On larvae, it is just behind the head, is the most anterior part of the fused thorax, and it bears 14 pairs of numbered, dorsal and ventral setae on each side of the midline.

**-R-**

**Radius (abv. R) –** [Female]. The third major longitudinal wing vein posterior to the anterior margin of the wing bearing four branches: Radius one ($R_1$) extends from the base of the wing to the distal wing margin just anterior to the apex of the wing; $R_{2+3}$ branches from $R_1$ behind and approximately midway along $R_1$, and divides into $R_2$ and $R_3$ on the apical third of the wing with both reaching the wing margin near the wing apex; and $R_{4+5}$ arising posterior to $R_{2+3}$ just beyond the midpoint on the wing, and extending to the apex of the wing.

**Refractory Color(s) –** [Females]. Colors that change depending on the direction from which light strikes a structure that reflects the light.

**Refractory Scale(s) –** [Female]. Scales having an internal structure that reflects different colors when the light strikes them from different directions.

**Round Scale(s) –** [Female]. Scales that have a circular (round) appearance.

**-S-**

**Saddle –** [Larva]. The large dorsal sclerite (plate) covering most of the dorsal and lateral surfaces of Segment X; can be completely circling segment X like a broad band, and bearing seta 1-X and often tiny non-articulating spicules.

**Saddle Length –** [Larva]. The mid-dorsal length of the saddle measured along a straight line parallel to the longitudinal axis of abdominal segment X.

**Saw-like Projection(s) –** [Larva]. The "saw" is a modified serrated structure of the anterior serrated plate on the siphon of *Mansonia* and *Coquillettidia* larvae, which is used to assist in the insertion and attachment of the siphon into aquatic plant roots.

**Scale(s) –** [Female]. A modified seta that is comprised of a slender stalk (= pedicel) and an expanded and/or flattened or rounded distal part (= squama, pl. = squame); all scales have longitudinal ridges that separate them from hairs, and they originate from a sensory socket (= aveolus).

**Sclerite(s) –** [Female & Larva]. A term for the hardened portions (= plates) that make up the majority of the exoskeleton of an insect. On female mosquitoes dorsal sclerites on the abdominal segments are called tergites, ventral sclerites on the abdominal segments are called sternites, and lateral sclerites of the side of the thorax are called pleurites (not commonly used). On larvae most sclerites, when present, occur on abdominal segments VI-VIII, and X (= plates), but *Anopheles* usually have one or more dorsal sclerites on most of the abdominal segments.

**Scutal Angle –** [Female]. The more or less distinct acute angular projection on the lateral margins of the scutum just anterior or dorsal to the prespiracular area on the side of the thorax.

**Scutal Fossa –** [Female]. A slightly concave anterolateral area on the scutum extending posteriorly to the level of the scutal angle and from the dorsocentral row to the edge of the scutum. The number of setae in this area can be very useful in separating certain species. (SEE FIGURE VI, DASHED AREA)

**Scutellum –** [Female]. A transverse dorsal area on the top of the thorax that is immediately behind the scutum. On adult mosquitoes it bears setae and often scales; on anopheline mosquitoes (except genus *Chagasia*) and culicine genus *Toxorhynchites* the posterior margin is rounded, while the posterior margin on all the other culicine species is tri-lobed.

**Scutum –** [Female]. The principal dorsal area of the thorax belonging to the mesothorax that extends posteriorly from the anterior promontory to the scutellum. Scutal setae and scales are usually present in highly variable and taxonomically important patterns.

**Segment(s) –** [Female & Larva]. Typically a generalized term denoting the abdominal segments of females and larvae, but can also be used in reference to parts of the antennae, legs, and maxillary palpi on females. On some of the latter structures the "segments" actually may be false structural segments, but they are generally referred to as segments. The female and larval abdominal segments are identified by Roman numerals starting at the anterior end of the abdomen and extending to cerci on segment XI on females and to segment X on larvae.

**Seta (pl. Setae) –** [Female & Larva]. Latin for "bristle", in reference to structures on arthopods that may appear similar to hairs. In mosquitoes they are found on the larva, pupa, and the adult stages; appearing in many different shapes and forms, and all serving as sensory structures that originate in pit-like holes called 'alveoli" in sclerites and/membranes of the exoskeleton.

**Siphon –** [Larva]. In mosquitoes, the siphon is only present on culicine larvae and is dorsally located on abdominal segment VIII; a tubular structure containing the respiratory trachea used for oxygen transfer when the tip of the siphon is attached to the surface. Siphons can be very short to very long, differing diameters, swollen, pigmented, bearing setae, may possess pecten, and may have specialized denticles and other structures at the tip for penetrating the roots of aquatic plants (*Mansonia* and *Coquillettidia*).

**Siphon Index (pl. Siphon Indices) –** [Larva]. The ratio of the siphon length to the width of the siphon at the base.

**Siphon Length –** [Larva]. The dorsal length of the siphon measured in a straight line from the base to the apex.

**Siphon Width –** [Larva]. The width at the base of the siphon measured at a right angle to the longitudinal axis. Certain *Psorophora* species with swollen siphons have narrow bases and basal measurements do not correctly reflect the actual width of the siphons, so a measurement across the widest part of the siphon may be more important.

**Species (singular and pleural) –** [Female & Larva]. A genetically distinct organism (= mosquito species) maintained by reproduction and usually infertile in crosses with other species. Certain species may not be recognized using morphology, but can be recognized using other methods or disciplines (cytogenetics, environmental, behavior, biochemical, DNA, etc.). Thus, we suggest that morphology data (to satisfy the ICZN Code) and molecular genetic (DNA) methods be used as the primary (Key) means for confirming species.

**Spicule(s) –** [Female & Larva]. Minute, non-articulating spine-like structures that can occur in dense patches on sclerotized and membranous parts of adults and larvae.

**Spine(s) –** [Larva]. A very large, sturdy, immovable spicule, with a sharp or narrowly rounded tip.

**Spiniform(s) –** [Female]. A thick, spine-like, and usually not markedly attenuated or sharply pointed seta. Used for a closely packed row of blunt spine-like setae on the posterior margin of tergum VII on *Mansonia titillans* females.

**Spinule(s) –** [Larva]. A minute spine-like spicule; always stiff; commonly occurring in short rows on the saddle and siphon.

**Spiracular Apparatus –** [Larva]. A five-lobed valvular structure encompassing the postabdominal respiratory tracheal spiracles on the dorsum of abdominal segment VIII that are obvious on anopheline larvae. On culicine larvae they are the membranous lobes on the tip of the siphon, and they are highly modified in *Mansonia* and *Coquillettidia* larvae for piercing plant tissue.

**Stage(s) –** [Female & Larva]. In mosquitoes, they are one or more of the four major developmental stages of an individual specimen (egg, larva, pupa, and adult); representing the four life stages of a holometabolous (complete) life cycle in dipterous insects (two winged flies).
This definition follows that of Torre-Bueno (1985).

**Sternite** – [Female & Larva]. A subdivision of a sternum; often incorrectly applied to an entire sternum, i.e., the venter of a structure or the body.

**Sternum (pl. Sterna) –** [Female]. A ventral sclerotized part of the exoskeleton; usually used in reference to the sterna on the ventral parts of the abdominal segments on adults. Sterna can possess setae and scales in different patterns that are of taxonomic importance.

**Subcosta** – [Female]. The second primary longitudinal vein on the wing; a single vein immediately behind the costa that extends lengthwise towards the apex of the wing in front of radius one ($R_1$), but joins the costa before the wing apex. The base of the subcostal on the venter of the wing can have a small patch of setae which identifies genus *Culiseta*.

**Subgenus (pl. Subgenera) –** [Female & Larva]. A division within a genus that is a higher subjective category than the species; technically a category that is not actually part of the binomial name, i.e., Genus and species.

**Subspiracular Area –** [Female]. An area just above the dorsoanterior extension of the meso-katepisternum, and just below the hypostigmal area and mesothoracic spiracle. A narrow row or patch of scales in this area is of taxonomic significance.

**Supraalar Area –** [Female]. A small lateral area of the scutum just above and in front of the wing. A line of setae in this area may extend anterior to the posterior end of the paratergite, and a line of scales in this area is sometimes continuous laterally to the front of the scutum.

**-T-**

**Tapered –** [Female & Larva]. To be diminished or reduced in thickness (diameter) towards an end of a structure; usually refers to the diameter apically, but can also be used basally. On females this could be used in addressing the tapered tip of the abdomen on *Aedes* and *Psorophora* species. On larvae there can be many setae that are tapered to a sharp point, or a tapered siphon can be discussed on some species.

**Tarsal Claw(s) –** [Female]. The generally used terminology for the "unguis" (pl. ungues) on the "posttarsus" (= the fifth and most distal tarsal segment); references may be made about the fore, mid, and hind tarsal claws, some of which may have a short, basal, ventrally projecting "tooth." (SEE BASAL TOOTH).

**Tarsomere(s) –** [Female]. An individual subsegment of a tarsus, which is the most distal major portion of a leg. Each tarsomere is numbered (1 to 5) following an abbreviation of the tarsus, i.e., foretarsus one (= FT1) or MT1, or HT1.

**Tarsus (pl. Tarsi) –** [Female]. In mosquitoes the fifth and last leg segment distad to the tibia. Each tarsus is composed of five subsegments called tarsomeres, with the last and most distal tarsomere being called the posttarsus.

**Tergal Plate(s) –** [Larva]. A small to large anteromesal sclerite occurring on abdominal segments I-VIII on *Anopheles* larvae; the dorsomesal sclerite on segment X in anopheline and culicine larvae typically covers nearly all of the dorsal surface of segment X and is called the saddle as it extends laterally and on some species, and on other species it extends completely around the segment. On *Orthopodomyia signifera* plates similar to incomplete "saddles" may occur on abdominal segments VI-VIII.

**Tergite(s) –** [Female]. A subdivision of a tergum, typically small paired plates associated with tergum X of females; often incorrectly applied to an entire tergum.

**Tergum (pl. Terga) –** [Female & Larva]. The dorsal sclerotization of a body segment; called the notum on the thorax, but usually used in referring to the dorsal sclerites on the abdominal segments. Such plates are much less common on larvae. (SEE TERGAL PLATE)

**Thorax (pl. Thoraces) –** [Female & Larva]. The second or intermediate division (= tagma) of an insect body; bearing the true legs and wings; comprised of pro-, meso-, and metathoracic segments.

**Tibia (pl. Tibiae) –** [Female]. In insects the usual fourth segment of the leg that is just distal to the femur; referred to as fore-, mid-, and hindtibia as appropriate.

**Trachea (pl. Tracheae) –** [Female & Larva]. The air conveying tubes present in the respiratory system throughout the adult and larval bodies; the mesothoracic and metathoracic spiracles are the openings for the tracheae of those two segments of the thorax on adults, and on larvae the siphon is the tubular structure housing the primary tracheae.

**Truncate –** Abruptly ending as if it was cut off at the base or apex.

**Tubular –** [Larva]. Short to long, round, and tube-like structures, that are best illustrated by the short to long siphons on larvae.

**Tuft –** A collection of numerous setae that are long and tightly clustered together.

**-V-**

**Vein(s) –** [Female]. One of the narrow tubular thickenings of a wing that often contain hemolymph, tracheae, and nerves. The principal longitudinal veins of mosquitoes are the anal vein, costa, cubitus, media, radius, and subcosta.

**Vein 1A** - [Female]. Refer to Anal Vein.

**Vein C –** [Female]. Refer to Costa.

**Vein CuA and Vein CuP –** [Female]. Refer to Cubitus.

**Vein M, Vein $M_1$, Vein $M_2$, and Vein $M_{3+4}$ –** [Female]. Refer to Media.

**Vein $R_1$, Vein $R_2$, Vein $R_3$, and Vein $R_{4+5}$ –** [Female]. Refer to Radius.

**Vein Sc –** [Female]. Refer to Subcosta.

**Venter –** [Female & Larva]. This term refers to the ventral area of an organism or structure. It could refer to the venter of the head, proboscis, palpus, leg, an abdominal segment, wing, etc., on adults, and to the venter of the head, thorax, an abdominal segment, the siphon, saddle, seta 4-X, etc., on larvae.

**Ventral –** Of or relating to the underside of an organism or structure.

**Ventral Brush –** [Larva]. Technically known as seta 4-X and usually projecting as a more or less linear series of irregularly or regularly paired setae borne posteroventrally on the ventral midline of segment X, but can appear as 1-2 pairs of setae on certain species. The longer more posterior setae in a brush usually originate on a grid or boss, and anterior preboss (= precratal) setae, if present, are usually weaker, shorter and known as precratal setae. All but one species in genus *Psorophora* have precatal setae that puncture the venter of a complete saddle.

**Vertex –** [Female]. This is the area on the dorsal and lateral surfaces of the head just behind the compound eyes and interocular space, and in front of the occiput. Decumbent and/or long erect forked scales in this area are of taxonomic significance.

**-W-**

**Whorl Seta (pl. Whorl Setae) –** [Female]. A ring of long curved setae originating from the flagellomeres on the antennae; also referred to as a "flagellar whorl."

**Wing –** [Female]. In most insects this refers to one of the paired structures used in flight that occur on the mesothoracic and metathoracic segments of the thorax. In mosquitoes (Order Diptera) the metathoracic pair of wings has been reduced to a pair of halters that are used in maintaining balance.

**Wing Fringe –** [Female]. Incorrectly seen as a single row of long scales projecting from the wing tip and hind margin of the wing. Actually this "row" is composed of 4 rows of scales, one of long fringe scales, one of medium length secondary scales, and two rows of short tertiary scales. The presence or absence of one or more of these rows, plus color differences in parts of the rows can be used as taxonomic characters, particularly in genus *Anopheles*.

**Wing Margin –** [Female]. The edge of the structural wing (not including fringe scales) that consists of a very narrow vein extending around the edge of the wing, which is attached to and supports the wing membrane.

**Wing Scale(s) –** [Female]. One of the various types and shapes of scales that are borne on the wing veins and crossveins.

## XIII. STATE RECORDS

### Named or Provisional Species, Subspecies, and One Hybrid.

Currently there are 89 taxa in the Mid-Atlantic Mosquito Control Association (MAMCA) Region, including named species and subspecies, provisional species, and one hybrid. Nearly all of these taxa are listed in the state lists by their officially recognized scientific names, i.e., genus, species (and subspecies if present), and the author's name. The subgenera in which they occur and the years they were described and published were not included in the state lists, but can be found in Section III (p. 17). New state records for three taxa are provided in the North Carolina list of taxa.

Provisional species are the confirmed genetically distinct species in the *Anopheles crucians* complex that have not been described and named, but are designated by letters (e.g., *An. crucians* A to E). The hybrid taxon is represented by specimens having introgressed genetic material from both *Culex pipiens* and *Culex quinquefasciatus*. Hybrids currently do not have official status according to the International Code of Zoological Nomenclature. Previously, the Code considered they were a good indication of different subspecies within a species. However several molecular studies have demonstrated that is not always true and different distinct species can hybridize when distributional and environmental circumstances place them in close contact (Truman and Craig 1968; Zavorink 1968, Grimstad et al. 1974; Byrd et al. 2009, 2012). Some hybrids can vector pathogens and can be distributed over large areas, as demonstrated by *Cx. pipiens* x *Cx. quinquefasciatus* hybrids in the MAMCA Region.

One official entry, *Culiseta annulata* (Shrank) of European origin, is an accidental intruder in the USA that was collected (one specimen) in Maryland (Faran and Bailey 1980). Subsequently, no additional specimens of this species have been collected in this state. Accordingly, this species is counted in the MAMCA and Maryland lists, but it has not been included in the keys. Characters have been provided to ID this species under "*Culiseta annulata*" in Section II (p. 7).

Three other unofficial entries in the keys may also be included in certain state lists, i.e., *An. crucians sensu lato* (abbreviated *s.l.*), *An. punctipennis s.l.*, or *An. quadrimaculatus s.l.* The Latin term, i.e., *sensu lato,* is defined in the glossary. These entries are intended to provide identification conveniences for mosquito control personnel to speed up timely identifications for control decisions, or to record old or new records for which precise species identifications cannot be determined. The three entries represent *Anopheles* sibling species complexes where the habitus (outward appearance) of the adult females are very similar and very difficult to identify, or cannot be identified.

**Delaware – named or provisional mosquito species and subspecies**

Currently this state has confirmed records for 57 named taxa. Included in the count are the entries *An. crucians s.l.* and *An. quadrimaculatus s.l.*, because genetic analyses have not been attempted on all of the Delaware species in those two complexes. These entries indicate that at least one cryptic species from each of those complexes, other than *An. smaragdinus* in the Quadrimaculatus Complex, has been collected in the state. Our list agrees with Gingrich et al. (2006) except the authors of *An. crucians s.s.* and *An. quadrimaculatus s.s.* are not included, because those species need molecular confirmation.

*Aedes albopictus* (Skuse)
*Ae. atlanticus* Dyar and Knab
*Ae. atropalpus* (Coquillett)
*Ae. aurifer* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cantator* (Coquillett)
*Ae. cinereus* Meigen
*Ae. dorsalis* (Meigen)
*Ae. dupreei* (Coquillett)
*Ae. excrucians* (Walker)
*Ae. fitchii* (Felt and Young)
*Ae. fulvus pallens* Ross
*Ae. grossbecki* Dyar and Knab
*Ae. hendersoni* Cockerell
*Ae. infirmatus* Dyar and Knab
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. stimulans* (Walker)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* Dyar and Knab
*Ae. tormentor* Dyar and Knab
*Ae. triseriatus* (Say)
*Ae. vexans* (Meigen)
*Anopheles barberi* Coquillett
*An. bradleyi* King
*An. crucians s.l.*
*An. punctipennis* (Say)
*An. quadrimaculatus s.l.*
*An. smaragdinus* Reinert
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex erraticus* (Dyar and Knab)
*Cx. pipiens* Linnaeus
*Cx. restuans* Theobald

*Cx. salinarius* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Cs. melanura* (Coquillett)
*Cs. minnesotae* Barr
*Cs. morsitans* (Theobald)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* Coquillett
*Ps. mathesoni* Belkin and Heinemann
*Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

## Georgia - named or provisional mosquito species, subspecies, and one hybrid

Currently this state has confirmed records for 68 named taxa. *Aedes canadensis* and *Toxorhynchites rutilus* each have two subspecies recorded in the state. The single unofficial taxon (= *Cx. pipiens* x *Cx. quinquefasciatus* hybrids) occurs in the northern part of the state adjoining northern Alabama and South Carolina and southwestern North Carolina and southeastern Tennessee. How far south the hybrids occur in Georgia needs to be clarified.

*Aedes aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. canadensis mathesoni* (Middlekauff)
*Ae. cinereus* Meigen
*Ae. dupreei* (Coquillett)
*Ae. fulvus pallens* Ross
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* (Dyar and Knab)
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* (Dyar and Knab)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles atropos* Dyar and Knab
*An. barberi* Coquillett
*An. bradleyi* King
*An. crucians* A (provisional species of Wilkerson et al. 2004)
*An. crucians* B (provisional species of Wilkerson et al. 2004)
*An. crucians* C (provisional species of Wilkerson et al. 2004)
*An. crucians* D (provisional species of Wilkerson et al. 2004)
*An. crucians* E (provisional species of Wilkerson et al. 2004)
*An. georgianus* King
*An. inundatus* Reinert
*An. maverlius* Reinert
*An. perplexens* Ludlow
*An. punctipennis* (Say)
*An. quadrimaculatus* Say
*An. smaragdinus* Reinert
*An. walkeri* Theobald

*Coquillettidia perturbans* (Walker)
*Culex coronator* Dyar and Knab
*Cx. erraticus* (Dyar and Knab)
*Cx. nigripalpus* Theobald
*Cx. peccator* Dyar and Knab
*Cx. pilosus* (Dyar and Knab)
*Cx. pipiens* x *Cx. quinquefasciatus* hybrids
*Cx. quinquefasciatus* Say
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. tarsalis* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Cs. melanura* (Coquillett)
*Mansonia dyari* Belkin, Heinemann and Page
*Ma. titillans* (Walker)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Ps. mathesoni* Belkin and Heinemann
*Toxorhynchites rutilus rutilus* (Coquillett)
*Tx. rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia lowii* Theobald
*Ur. sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

**Maryland – named or provisional mosquito species, subspecies, two unidentified sibling species, and one hybrid**

We are recognizing 60 named or provisional species, subspecies, two unidentified sibling species, and one hybrid in Maryland. Schamberger (2009) listed 60 mosquito species in Maryland, but we disagree with his records of *Culex quinquefasciatus* in this state. Here we are transferring the record for *Cx. quinquefasciatus* over to *Cx. pipiens* x *Cx. quinquefasciatus* hybrids based on those records coming primarily from the southeastern part (outer shore) of MD, and on DNA evidence (Fonseca, unpublished) that the most northern representatives of true *Cx. quinquefasciatus* along the Atlantic coast occur in the extreme southeastern corner of North Carolina, just north of Myrtle Beach, South Carolina. This agrees with our recognition of *Cx. pipiens* x *Cx. quinquefasciatus* hybrids on the adjoining outer shore of Virginia. The entries, *An. crucians s.l.* and *An. quadrimaculatus s.l.* were counted in our list because at least one unidentified species in each of those sibling species complexes has been collected in MD.

*Aedes abserratus* (Felt and Young)
*Ae. aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. aurifer* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cantator* (Coquillett)
*Ae. cinereus* Meigen
*Ae. dorsalis* (Meigen)
*Ae. excrucians* (Walker)
*Ae. fitchii* (Felt and Young)
*Ae. fulvus pallens* Ross
*Ae. grossbecki* (Dyar and Knab)
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* (Dyar and Knab)
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. stimulans* (Walker)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* (Dyar and Knab)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles atropos* Dyar and Knab
*An. barberi* Coquillett
*An. bradleyi* King
*An. crucians s.l.*

*An. punctipennis* (Say)
*An. quadrimaculatus s.l.*
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex erraticus* (Dyar and Knab)
*Cx. pipiens* Linnaeus
*Cx. pipiens* x *Cx. quinquefasciatus* hybrids
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. territans* Walker
*Culiseta annulata* (Shrank) (Accidental Intruder)
*Cs. impatiens* (Walker)
*Cs. inornata* (Williston)
*Cs. melanura* (Coquillett)
*Cs. minnesotae* Barr
*Cs. morsitans* (Theobald)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Ps. mathesoni* Belkin and Heinemann
*Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

## North Carolina – named, provisional mosquito species, subspecies, and one hybrid

Currently this state has confirmed records for 66 named, provisional species, subspecies, and one hybrid taxa. The single unofficial taxon is the hybrid, *Cx. pipiens* x *Cx. quinquefasciatus*. We are reporting *An. crucians* D, *Cx. coronator* and *Tx. rutilus rutilus* as new records for North Carolina.

**New Records.** ***Anopheles crucians* D-** larvae were discovered and reared from darkly stained tannic water in small streams in Scotland County in 2007, and adults were collected in Perquimans County shortly thereafter. These adults were confirmed as *An. crucians* D by rDNA ITS2 assays (R. Wilkerson, unpublished). ***Culex coronator-*** The first collections (all females) occurred on 29 September and again on 3 October 2008 at three widely separated sites, one on the southwestern side of the county in Wilmington, one in the northeast corner of the county, and one in the southeastern corner of New Hanover County. In October 2008 a female was collected near Belville in northern Brunswick County across the Cape Fear River from New Hanover County. Both of these counties are in the southeastern corner of the state. Several additional specimens were collected in both counties in 2009, including a male in Brunswick County. Since 2009, only 2-3 specimens have been collected, with the last, a female, collected in October in 2012 in New Hanover County. All of the specimens were collected in either CDC light traps with $CO_2$ and no larvae have been found in the state. Whether this species is permanently established or just an infrequent intruder into NC is unknown. ***Toxoryhnchites rutilus rutilus-*** Two males of *Tx. rutilus rutilus* collected in NC are new records for North Carolina. The two subspecies of this species can only be separated by characters on the males (see Note 1 for the Mid-Atlantic Keys). The first male was reared from a larva collected in a used tire. The collection data follow: Guilford Co., Greensboro, tire disposal pile, reared from larva, 2 June 1993, B.A. Harrison & J. Trammel. The second male was also reared from a larva. The collection data follow: Nash Co., Rocky Mount, 934 Lindsey St., reared from a larva collected in a large garbage cart, 30 September 2014, Robert F. Collins & John R. Faulkner. When the record for *Tx. rutilus rutilus* was established in South Carolina from a single tree hole in Myrtle Beach that treehole contained males of both subspecies (Carpenter and Jenkins 1945). We suggest these data indicate a single species that genetically expresses polymorphic characters in males that are likely expressed in a latitudinal cline in the southeastern USA. However, a much more concerted molecular effort is needed to resolve the correct taxonomic status of these two *Tx. rutilus* subspecies.

*Aedes aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. aurifer* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cantator* (Coquillett)
*Ae. cinereus* Meigen
*Ae. dupreei* (Coquillett)
*Ae. fulvus pallens* Ross
*Ae. grossbecki* (Dyar and Knab)
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* (Dyar and Knab)
*Ae. japonicus japonicus* (Theobald)

*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* (Dyar and Knab)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles atropos* Dyar and Knab
*An. barberi* Coquillett
*An. bradleyi* King
*An. crucians* A (provisional species of Wilkerson et al. 2004)
*An. crucians* D (provisional species of Wilkerson et al. 2004)
*An. crucians* E (provisional species of Wilkerson et al. 2004)
*An. diluvialis* Reinert
*An. georgianus* King
*An. maverlius* Reinert
*An. perplexens* Ludlow
*An. punctipennis* (Say)
*An. quadrimaculatus* Say
*An. smaragdinus* Reinert
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex coronator* Dyar and Knab
*Cx. erraticus* (Dyar and Knab)
*Cx. nigripalpus* Theobald
*Cx. peccator* Dyar and Knab
*Cx. pilosus* (Dyar and Knab)
*Cx. pipiens* x *Cx. quinquefasciatus* hybrids
*Cx. quinquefasciatus* Say
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Cs. melanura* (Coquillett)
*Orthopodomyia* alba Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Ps. mathesoni* Belkin and Heinemann

*Toxorhynchites rutilus rutilus* (Coquillett)
*Tx. rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia lowii* Theobald
*Ur. sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

**Pennsylvania – named or provisional mosquito species and subspecies**

Currently this state has confirmed records for 62 named or provisional taxa, which includes one entry listed as *An. crucians s.l.* This entry is counted in our list because the specimens identified as *An. crucians*-like represent at least one of the 6 sibling species known in the Crucians Complex. Our count agrees with the counts listed in Hutchinson et al. (2008) and Darsie and Hutchinson (2009). In 2014, a state-wide survey for *An. quadrimaculatus s.l.* specimens was conducted and over 900 specimens were tested to determine the genetic identities of those specimens. All of the specimens were identified by DNA as *An. quadrimaculatus* Say. None of the other four species of the Quadrimaculatus Complex were detected. This confirms the presence of the eastern U.S. malaria vector throughout the state. This contribution to our book is greatly appreciated and is here credited to Michael Hutchinson, Pennsylvania Department of Environmental Protection and David Lampe, Duquesne University, who should be credited for this work in future references.

*Aedes abserratus* (Felt and Young)
*Ae. aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. aurifer* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cantator* (Coquillett)
*Ae. cinereus* Meigen
*Ae. communis* (De Geer)
*Ae. decticus* Howard, Dyar, and Knab
*Ae. diantaeus* Howard, Dyar, and Knab
*Ae. dorsalis* (Meigen)
*Ae. dupreei* (Coquillett)
*Ae. excrucians* (Walker)
*Ae. fitchii* (Felt and Young)
*Ae. grossbecki* Dyar and Knab
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* Dyar and Knab
*Ae. intrudens* Dyar
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. provocans* (Walker)
*Ae. punctor* (Kirby)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. stimulans* (Walker)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* Dyar and Knab
*Ae. tormentor* Dyar and Knab
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)

*Ae. vexans* (Meigen)
*Anopheles barberi* Coquillett
*An. crucians s.l.*
*An. earlei* Vargas
*An. perplexens* Ludlow
*An. punctipennis* (Say)
*An. quadrimaculatus* Say
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex erraticus* (Dyar and Knab)
*Cx. pipiens* Linnaeus
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. tarsalis* Coquillett
*Cx. territans* Walker
*Culiseta impatiens* (Walker)
*Cs. inornata* (Williston)
*Cs. melanura* (Coquillett)
*Cs. minnesotae* Barr
*Cs. morsitans* (Theobald)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

**South Carolina – named or provisional mosquito species, and one hybrid**

Currently this state has confirmed records for 63 named or provisional mosquito taxa, including a positive unofficial entry for *An. crucians s.l.* We included this unofficial entry because we are unaware of any genetic assays attempted on SC members of the *An. crucians* sibling species complex, and specimens identified as *An. crucians* are very common in parts of SC. Thus, at least one member of that complex occurs in SC. Also included is one hybrid. A 2008 list of mosquitoes for SC (Chris Evans, SCDHEC, unpublished) includes *Cx. pipiens*. However we suspect that like the situation in North Carolina where *Cx. pipiens* was previously recorded, we now know those collections were hybrids. Thus, we have transferred the 2008 entry for the SC records of *Cx. pipiens* that are found primarily in the northern part of the state, to the entry, *Cx. pipiens* x *Cx. quinquefaciatus* hybrids. Most of the state is occupied by *Cx. quinquefasciatus*, with the more northern part being a part of a zone that is occupied by genetically introgressed hybrids, *Cx. pipiens* x *Cx. quinquefasciatus.* True *Cx. pipiens* is not found until you reach West Virginia, northern Virginia, and Maryland. *Aedes canadensis* and *Tx. rutilus* each have two subspecies recorded in this state.

*Aedes aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. canadensis mathesoni* (Middlekauff)
*Ae. cinereus* (Meigen)
*Ae. dupreei* (Coquillett)
*Ae. fulvus pallens* Ross
*Ae. grossbecki* (Dyar and Knab)
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* (Dyar and Knab)
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* (Dyar and Knab)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles atropos* Dyar and Knab, 1906
*An. barberi* Coquillett
*An. bradleyi* King
*An. crucians s.l.*
*An. georgianus* King
*An. maverlius* Reinert
*An. punctipennis* (Say)
*An. quadrimaculatus* Say

*An. smaragdinus* Reinert
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex coronator* Dyar and Knab
*Cx. erraticus* (Dyar and Knab)
*Cx. nigripalpus* Theobald
*Cx. peccator* Dyar and Knab
*Cx. pilosus* (Dyar and Knab)
*Cx. pipiens* x *Cx. quinquefasciatus* hybrids
*Cx. quinquefasciatus* Say
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. tarsalis* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Cs. melanura* (Coquillett)
*Mansonia dyari* Belkin, Heinemann, and Page
*Ma. titillans* (Walker)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Ps. mathesoni* Belkin and Heinemann
*Toxorhynchites rutilus rutilus* (Coquillett)
*Tx. rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia lowii* Theobald
*Ur. sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

**Virginia – named or provisional mosquito species, subspecies, and one hybrid**

Virginia has a long history of published lists documenting mosquito species in the state (Dyar 1928, Dorer et al. 1944, Bickley 1957, Gladney and Turner 1969, Harrison et al. 2002). Currently this state has confirmed records for 56 named taxa, including one hybrid and one unidentified provisional species entry in the *An. crucians* complex. That entry, *An. crucians s.l.,* is counted because we are unaware of any molecular attempts to analyze the species in this complex in Virginia, but specimens of this complex have been collected and identified in VA. We are changing the VA listing of *Cx. quinquefasciatus* to the hybrid, *Cx. pipiens* x *Cx. quinquefasciatus*, because the most northern confirmed record of *Cx. quinquefasciatus* along the Atlantic Coast is a site in the most southeastern county in North Carolina (Fonseca, unpublished). Actually we also consider most of the specimens of *Cx. pipiens* reported in Virginia to be *Cx. pipiens* x *Cx. quinquefasciatus* hybrids. However, since true *Cx. pipiens* may occur in extreme northern and northwestern VA, but need molecular confirmation, we have included *Cx. pipiens* in the list of nominal species in VA. The numbers reported here increase the number (55) reported in Harrison et al. (2002) to 56, because *Cx. tarsalis* was inadvertently left out of that list (David Gaines, personal communication).

*Aedes aegypti* (Linnaeus)
*Ae. albopictus* (Skuse)
*Ae. atlanticus* (Dyar and Knab)
*Ae. atropalpus* (Coquillett)
*Ae. aurifer* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cantator* (Coquillett)
*Ae. cinereus* Meigen
*Ae. dupreei* (Coquillett)
*Ae. fulvus pallens* Ross
*Ae. grossbecki* Dyar and Knab
*Ae. hendersoni* (Cockerell)
*Ae. infirmatus* (Dyar and Knab)
*Ae. japonicus japonicus* (Theobald)
*Ae. mitchellae* (Dyar)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. stimulans* (Walker)
*Ae. taeniorhynchus* (Wiedemann)
*Ae. thibaulti* (Dyar and Knab)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles atropos* Dyar and Knab
*An. barberi* Coquillett
*An. bradleyi* King
*An. crucians s.l.*
*An. punctipennis* (Say)

*An. quadrimaculatus* Say
*An. smaragdinus* Reinert
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex erraticus* (Dyar and Knab)
*Cx. peccator* Dyar and Knab
*Cx. pipiens* Linnaeus
*Cx. pipiens* x *Cx. quinquefasciatus* hybrids
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. tarsalis* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Cs. melanura* (Coquillett)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)
*Ps. cyanescens* (Coquillett)
*Ps. discolor* (Coquillett)
*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Ps. mathesoni* Belkin and Heinemann
*Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia sapphirina* (Osten Sacken)
*Wyeomyia smithii* (Coquillett)

**West Virginia – named or provisional mosquito species, subspecies, and two unidentified entries for cryptic species**

Currently this state has confirmed records for 34 named or provisional species, including two entries for unidentified cryptic species in the *An. crucians* complex and the *An. quadrimaculatus* complex. These entries are listed as *An. crucians s.l.* and *An. quadrimaculatus s.l.*, because molecular work has not been attempted on these two complexes in West Virginia, but at least one unidentified species in each of these complexes has been collected in the state. This list also includes the record of *Orthopodomyia alba* by Heaps (1980), which was not in the WV list of species of Joy et al. (1994) and not in the list of species for WV in Darsie and Ward (2005). However, the last two authors included *Or. alba* in WV on map 34b, but failed to reference WV in the caption for that Figure, and they also included Heaps (1980) in the references. Additional records for *Ae. dorsalis*, *Ae. tormentor*, *An. walkeri*, *Ps. horrida*, and *Ps. howardii* are included in this list. These five species and the *An. crucians s.l.* entry represent new West Virginia records that were collected and kindly provided by Eric Dotseth, West Virginia Department of Health and Human Services. Eric Dotseth should be credited with their discovery when referencing these new records for West Virginia.

*Aedes abserratus* (Felt and Young)
*Ae. albopictus* (Skuse)
*Ae. atropalpus* (Coquillett)
*Ae. canadensis canadensis* (Theobald)
*Ae. cinereus* Meigen
*Ae. hendersoni* (Cockerell)
*Ae. japonicus japonicus* (Theobald)
*Ae. sollicitans* (Walker)
*Ae. sticticus* (Meigen)
*Ae. tormentor* (Dyar and Knab)
*Ae. triseriatus* (Say)
*Ae. trivittatus* (Coquillett)
*Ae. vexans* (Meigen)
*Anopheles barberi* Coquillett
*An. crucians s.l.*
*An. punctipennis* (Say)
*An. quadrimaculatus s.l.*
*An. walkeri* Theobald
*Coquillettidia perturbans* (Walker)
*Culex erraticus* (Dyar and Knab)
*Cx. pipiens* Linnaeus
*Cx. restuans* Theobald
*Cx. salinarius* Coquillett
*Cx. territans* Walker
*Culiseta inornata* (Williston)
*Orthopodomyia alba* Baker
*Or. signifera* (Coquillett)
*Psorophora ciliata* (Fabricius)
*Ps. columbiae* (Dyar and Knab)

*Ps. ferox* (von Humboldt)
*Ps. horrida* (Dyar and Knab)
*Ps. howardii* (Coquillett)
*Toxorhynchites rutilus septentrionalis* (Dyar and Knab)
*Uranotaenia sapphirina* (Osten Sacken)

## XIV. TABLE OF TAXONOMIC ACTIONS AND NEW RECORDS

| **Actions or New Records** | **Pages** |
|---|---|
| *Ae. vexans nipponii* (Theobald) record deleted from list of U.S. species and subspecies | 8 |
| *Cx. coronator*, new record for North Carolina | 10,173 |
| *An. crucians*-D, new record for North Carolina | 148,173,174 |
| *Tx. rutilus rutilus*, new record for North Carolina | 28,141,173 |
| *An. quadrimaculatus s.s.*, new record for Pennsylvania credited to Michael Hutchinson | 176,177 |
| *Ae. dorsalis*, new record for West Virginia credited to Eric Dotseth | 182 |
| *Ae. tormentor*, new record for West Virginia credited to Eric Dotseth | 182 |
| *An. crucians s.l.*, new record for West Virginia credited to Eric Dotseth | 182 |
| *An. walkeri*, new record for West Virginia credited to Eric Dotseth | 182 |
| *Ps. horrida*, new record for West Virginia credited to Eric Dotseth | 183 |
| *Ps. howardii*, new record for West Virginia credited to Eric Dotseth | 183 |

Mosquito control personnel in Maryland, and Virginia, and in 99 of 100 counties in North Carolina should be aware that we have changed their records of *Cx. quinquefasciatus* to *Cx. pipiens* x *Cx. quinquefasciatus* hybrids. One county in North Carolina, Brunswick, is the only county in the state to have true *Cx. quinquefasciatus* (Fonseca, personal communication) and that record represents the most northern record for *Cx. quinquefasciatus* along the Atlantic seaboard.

Mosquito control personnel in northern Georgia and South Carolina should be aware that we have changed their records of *Cx. pipiens* to *Cx. pipiens x quinquefasciatus* hybrids. This action was done because 99 counties in North Carolina just north of these two states are considered positive for hybrids, not true *Cx. pipiens*, which occurs much further north in northern Virginia, northern Maryland, Delaware, West Virginia and Pennsylvania.

A potential earlier record than the Kelly et al. (2008) record for *Cx. coronator* in Georgia is discussed under *Cx. tarsalis* on pages 11-12.

## XV. SPECIES COUPLET SEQUENCES

In the following table, we are providing the couple sequences for each species identified in the key. These couplet sequences may be useful for both teaching and training purposes. When teaching courses, we highly recommend that the student write down the couple sequence as they progress thorugh the key. Thus, if a student fails to reach the correct identification, we can review which step (i.e, couplet choice) the initial error was made. The student may then return to the appropriate couplet and address the problem instead of starting again from the beginning of the key.

| | Adult Couplet Sequence | Larval Couplet Sequence |
|---|---|---|
| ***Aedes*** | | |
| *Ae. abserratus* | 1, 2, 18, 33, 34 | 1, 2, 3 |
| *Ae. aegypti* | 1, 2, 3, 6, 10, 11, 12 | 1, 2, 13, 14, 15 |
| *Ae. albopictus* | 1, 2, 3, 6, 10, 11, 12 | 1, 2, 13, 14, 15 |
| *Ae. atlanticus* | 1, 2, 18, 19, 20, 21, 22, 23 | 1, 2, 3, 4, 6, 7, 8 |
| *Ae. atropalpus* | 1, 2, 3, 6, 7, 8 | 1, 2, 13, 26, 27 |
| *Ae. aurifer* | 1, 2, 18, 19, 24, 26, 28, 29, 31 | 1, 2, 13, 26, 28, 29, 31, 32 |
| *Ae. canadensis canadensis* | 1, 2, 3, 6, 7, 8, 9 | 1, 2, 13, 14, 16, 18, 19, 20 |
| *Ae. canadensis mathesoni* | 1, 2, 3, 6, 7, 8, 9 | 1, 2, 13, 14, 16, 18, 19, 20 |
| *Ae. cantator* | 1, 2, 3, 6, 10, 13, 14 | 1, 2, 13, 14, 16, 18, 19, 20 |
| *Ae. cinereus* | 1, 2, 18, 19, 24, 25 | 1, 2, 13, 26, 28, 29, 30 |
| *Ae. communis* | 1, 2, 18, 19, 24, 26, 27 | 1, 2, 13, 14, 16, 18, 21, 22, 25 |
| *Ae. decticus* | 1, 2, 18, 19, 24, 26, 28, 32 | 1, 2, 13, 26, 28, 29, 31, 33 |
| *Ae. diantaeus* | 1, 2, 18, 19, 24, 26, 28, 32 | 1, 2, 13, 26, 28, 29, 31, 32 |
| *Ae. dorsalis* | 1, 2, 3, 6, 7 | 1, 2, 13, 14, 16, 18, 21, 22, 25 |
| *Ae. dupreei* | 1, 2, 18, 19, 20, 21, 22 | 1, 2, 3, 4, 6 |
| *Ae. excrucians* | 1, 2, 3, 6, 10, 13, 15, 16 | 1, 2, 13, 26, 28 |
| *Ae. fitchii* | 1, 2, 3, 6, 10, 13, 15, 16, 17 | 1, 2, 13, 14, 16, 18, 21 |
| *Ae. fulvus pallens* | 1 | 1, 2, 3, 4, 5 |
| *Ae. grossbecki* | 1, 2, 3, 6, 10, 13, 15 | 1, 2, 13, 14, 16, 18, 21, 22, 23, 24 |
| *Ae. hendersoni* | 1, 2, 18, 19, 24, 26, 28, 29, 30 | 1, 2, 13, 14, 16, 17 |
| *Ae. infirmatus* | 1, 2, 18, 19, 20, 21 | 1, 2, 3, 4, 6, 7, 9, 10, 12 |
| *Ae. intrudens* | 1, 2, 18, 19, 24, 25 | 1, 2, 13, 26, 28, 29, 31, 33 |
| *Ae. japonicus japonicus* | 1, 2, 3, 6, 10, 11 | 1, 2, 13, 26, 27 |
| *Ae. mitchellae* | 1, 2, 3, 4, 5 | 1, 2, 3, 4, 6, 7, 9, 10, 11 |
| *Ae. provocans* | 1, 2, 18, 33 | 1 |
| *Ae. punctor* | 1, 2, 18, 33, 34 | 1, 2, 3, 4, 6, 7, 8 |
| *Ae. sollicitans* | 1, 2, 3, 4 | 1, 2, 3, 4, 6, 7, 9, 10, 11 |
| *Ae. sticticus* | 1, 2, 18, 19, 24, 26, 27 | 1, 2, 13, 14, 16, 18, 21, 22, 23 |
| *Ae. stimulans* | 1, 2, 3, 6, 10, 13, 15, 16, 17 | 1, 2, 13, 14, 16, 18, 21, 22, 23, 24 |
| *Ae. taeniorhynchus* | 1, 2, 3, 4, 5 | 1, 2, 3, 4, 6, 7, 9 |
| *Ae. thibaulti* | 1, 2, 18, 19, 24, 26, 28, 29, 31 | 1, 2, 13, 14, 16, 18, 19 |
| *Ae. tormentor* | 1, 2, 18, 19, 20, 21, 22, 23 | 1, 2, 3, 4, 5 |

| | | |
|---|---|---|
| *Ae. triseriatus* | 1, 2, 18, 19, 24, 26, 28, 29, 30 | 1, 2, 13, 14, 16, 17 |
| *Ae. trivittatus* | 1, 2, 18, 19, 20 | 1, 2, 3, 4, 6, 7, 9, 10, 12 |
| *Ae. vexans* | 1, 2, 3, 6, 10, 13, 14 | 1, 2, 13, 26, 28, 29, 30 |
| ***Anopheles*** | | |
| *An. atropos* | 1, 3, 4, 5 | 1, 2 |
| *An. barberi* | 1, 3, 4, 5, 6 | 1 |
| *An. bradleyi* | 1, 2 | 1, 2, 3, 5, 10, 11, 12 |
| *An. crucians* A | 1, 2 | 1, 2, 3, 5, 10 |
| *An. crucians* B | 1, 2 | 1, 2, 3, 5, 10 |
| *An. crucians* C | 1, 2 | 1, 2, 3, 5, 10 |
| *An. crucians* D | 1, 2 | 1, 2, 3, 5, 10 |
| *An. crucians* E | 1, 2 | 1, 2, 3, 5, 10 |
| *An. crucians s.l.* | 1, 2 | 1, 2, 3, 5, 10 |
| *An. diluvialis* | 1, 3, 4, 5, 6, 7, 9 | 1, 2, 3, 5, 6, 7, 9 |
| *An. earlei* | 1, 3 | 1, 2, 3, 4 |
| *An. georgianus* | 1, 2 | 1, 2, 3, 5, 10, 11, 12 |
| *An. inundatus* | 1, 3, 4, 5, 6, 7, 9, 10 | 1, 2, 3, 5, 6, 7, 9 |
| *An. maverlius* | 1, 3, 4, 5, 6, 7, 9, 10 | 1, 2, 3, 5, 6 |
| *An. perplexens* | 1, 2 | 1, 2, 3, 5, 10, 11, 13 |
| *An. punctipennis* (East) | 1, 2 | 1, 2, 3, 5, 10, 11, 13 |
| *An. punctipennis s.l.* | 1, 2 | 1, 2, 3, 5, 10, 11 |
| *An. quadrimaculatus s.l.* | 1, 3, 4, 5, 6 | 1, 2, 3, 5 |
| *An. quadrimaculatus s.s.* | 1, 3, 4, 5, 6, 7, 8 | 1, 2, 3, 5, 6, 7, 8 |
| *An. smaragdinus* | 1, 3, 4, 5, 6, 7, 8 | 1, 2, 3, 5, 6, 7, 8 |
| *An. walkeri* | 1, 3, 4 | 1, 2, 3, 4 |
| ***Coquillettidia*** Generic Key | | |
| *Cq. perturbans* | 1, 3, 4, 7, 8, 9, 10 | 1, 2, 7, 10 |
| ***Culex*** | | |
| *Cx. coronator* | 1, 2 | 1, 2 |
| *Cx. erraticus* | 1, 3, 8 | 1, 7, 8, 9 |
| *Cx. nigripalpus* | 1, 3, 4, 5, 6 | 1, 2, 3, 4, 5, 6 |
| *Cx. peccator* | 1, 3, 8, 9 | 1, 7, 8 |
| *Cx. pilosus* | 1, 3, 8, 9 | 1, 7, 8, 9 |
| *Cx. pipiens* | 1, 3, 4, 5, 7 | 1, 2, 3, 4, 5 |
| *Cx. pipiens X quinquefasciatus* | 1, 3, 4, 5, 7 | 1, 2, 3, 4, 5 |
| *Cx. quinquefasciatus* | 1, 3, 4, 5, 7 | 1, 2, 3, 4, 5 |
| *Cx. restuans* | 1, 3, 4, 5, 7 | 1, 2, 3 |
| *Cx. salinarius* | 1, 3, 4, 5, 6 | 1, 2, 3, 4, 5, 6 |
| *Cx. tarsalis* | 1, 2 | 1, 2, 3, 4 |
| *Cx. territans* | 1, 3, 4 | 1, 7 |
| ***Culiseta*** | | |
| *Cs. impatiens* | 1, 2 | 1, 4 |
| *Cs. inornata* | 1, 2 | 1, 4 |

| | | |
|---|---|---|
| *Cs. melanura* | 1, 3 | 1, 2 |
| *Cs. minnesotae* | 1, 3, 4 | 1, 2, 3 |
| *Cs. morsitans* | 1, 3, 4 | 1, 2, 3 |
| ***Mansonia*** | | |
| *Ma. dyari* | 1 | 1 |
| *Ma. titillans* | 1 | 1 |
| ***Orthopodomyia*** | | |
| *Or. alba* | 1 | 1 |
| *Or. signifera* | 1 | 1 |
| ***Psorophora*** | | |
| *Ps. ciliata* | 1, 3, 4 | 1, 2 |
| *Ps. columbiae* | 1, 2 | 1, 3, 4 |
| *Ps. cyanescens* | 1, 3, 5 | 1, 3, 4, 5 |
| *Ps. discolor* | 1, 2 | 1, 3 |
| *Ps. ferox* | 1, 3, 5, 6 | 1, 3, 4, 5, 6, 7 |
| *Ps. horrida* | 1, 3, 5, 6, 7 | 1, 3, 4, 5, 6 |
| *Ps. howardii* | 1, 3, 4 | 1, 2 |
| *Ps. mathesoni* | 1, 3, 5, 6, 7 | 1, 3, 4, 5, 6, 7 |
| ***Toxorhynchites*** Generic Key | | |
| *Tx. rutilus rutilus* | 1, 2 | 1, 2, 7, 8, 9 |
| *Tx. rutilus septentrionalis* | 1, 2 | 1, 2, 7, 8, 9 |
| ***Uranotaenia*** | | |
| *Ur. lowii* | 1 | 1 |
| *Ur. sapphirina* | 1 | 1 |
| ***Wyeomyia*** Generic Key | | |
| *Wy. smithii* | 1, 3 | 1, 2, 7, 8 |

## XVI. ILLUSTRATION INDEX (TERMINAL COUPLETS)

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|---|---|---|
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| *Ae. aegypti* | 81, 82, 83 | 408, 409 |
| *Ae. albopictus* | 78, 79, 80 | 406, 407 |
| *Ae. atlanticus* | 124, 125 | 383, 384 |
| *Ae. atropalpus* | 58, 59, 60 | 442, 443 |
| *Ae. aurifer* | 158, 159 | 454, 455 |
| *Ae. canadensis canadensis* | 64 | 424, 425 |
| *Ae. canadensis mathesoni* | 65 | 424, 425 |
| *Ae. cantator* | 90, 91 | 422, 423 |
| *Ae. cinereus* | 130, 131, 132 | 448, 449 |
| *Ae. communis* | 142, 143 | 436, 437 |
| *Ae. decticus* | 164, 165 | 460, 461 |
| *Ae. diantaeus* | 162, 163 | 456, 457 |
| *Ae. dorsalis* | 52, 53, 54 | 434, 435 |
| *Ae. dupreei* | 120, 121 | 379 |
| *Ae. excrucians* | 96, 97 | 444 |
| *Ae. fitchii* | 100, 101 | 426 |
| *Ae. fulvus pallens* | 30 | 378 |
| *Ae. grossbecki* | 92, 93 | 432 |
| *Ae. hendersoni* | 156, 157 | 415 |
| *Ae. infirmatus* | 116, 117 | 395, 396 |
| *Ae. intrudens* | 133, 134, 135 | 458, 459 |
| *Ae. japonicus japonicus* | 72, 73, 74 | 440, 441 |
| *Ae. mitchellae* | 46, 47 | 393, 394 |
| *Ae. provocans* | 166, 167, 168 | 366 |
| *Ae. punctor* | 175, 176, 177 | 385, 386 |
| *Ae. sollicitans* | 40, 41, 42 | 391, 392 |
| *Ae. sticticus* | 140, 141 | 430 |
| *Ae. stimulans* | 102, 103 | 433 |
| *Ae. taeniorhynchus* | 48, 49 | 387 |
| *Ae. thibaulti* | 160, 161 | 418, 419 |
| *Ae. tormentor* | 126, 127 | 377 |
| *Ae. triseriatus* | 154, 155 | 414 |
| *Ae. trivittatus* | 112, 113 | 397, 398 |
| *Ae. vexans* | 88, 89 | 450, 451 |
| ***Anopheles*** | | |
| *An. atropos* | 189, 190 | 466 |
| *An. barberi* | 195, 196 | 462, 463 |
| *An. bradleyi* | 182, 183 | 502, 503 |

| | | |
|---|---|---|
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| *An. crucians* B | 182, 183 | 498 |
| *An. crucians* C | 182, 183 | 498 |
| *An. crucians* D | 182, 183 | 498 |
| *An. crucians* E | 182, 183 | 498 |
| *An. crucians s.l.* | 182, 183 | 498 |
| *An. diluvialis* | 207 | 494, 495 |
| *An. earlei* | 184 | 473, 474, 475 |
| *An. georgianus* | 182, 183 | 504, 505 |
| *An. inundatus* | 212, 213, 214 | 496, 497 |
| *An. maverlius* | 209, 210, 211 | 480, 481 |
| *An. perplexens* | 180, 181 | 507 |
| *An. punctipennis* (East) | 180, 181 | 506 |
| *An. punctipennis s.l.* | 180, 181 | 501 |
| *An. quadrimaculatus s.l.* | 191, 193, 194 | 476, 477 |
| *An. quadrimaculatus s.s.* | 201, 202, 203 | 488, 489, 490 |
| *An. smaragdinus* | 204, 205, 206 | 491, 492, 493 |
| *An. walkeri* | 186, 187 | 470, 471, 472 |
| ***Coquillettidia*** | | |
| *Cq. perturbans* | 26, 27 | 362, 363 |
| ***Culex*** | | |
| *Cx. coronator* | 222, 223 | 512 |
| *Cx. erraticus* | 246, 247 | 532, 533 |
| *Cx. nigripalpus* | 238, 239 | 526, 527 |
| *Cx. peccator* | 250 | 530 |
| *Cx. pilosus* | 251 | 534, 535 |
| *Cx. pipiens* | 243, 244, 245 | 520, 521 |
| *Cx. pipiens X quinquefasciatus* | 243, 244, 245 | 520, 521 |
| *Cx. quinquefasciatus* | 243, 244, 245 | 520, 521 |
| *Cx. restuans* | 240, 241, 242 | 514, 515 |
| *Cx. salinarius* | 236, 237 | 524, 525 |
| *Cx. tarsalis* | 220, 221 | 518 |
| *Cx. territans* | 228, 229 | 528 |
| ***Culiseta*** | | |
| *Cs. impatiens* | 256, 257 | 548, 549 |
| *Cs. inornata* | 254, 255 | 546, 547 |
| *Cs. melanura* | 258, 259 | 540 |
| *Cs. minnesotae* | 264, 265 | 544, 545 |
| *Cs. morsitans* | 262, 263 | 542, 543 |
| ***Mansonia*** | | |
| *Ma. dyari* | 269, 270 | 551 |
| *Ma. titillans* | 266, 267, 268 | 550 |
| ***Orthopodomyia*** | | |

| | | |
|---|---|---|
| *Or. alba* | 274, 275, 276 | 553 |
| *Or. signifera* | 271, 272, 273 | 552 |
| ***Psorophora*** | | |
| *Ps. ciliata* | 295, 296, 297 | 558 |
| *Ps. columbiae* | 283, 284 | 564, 565 |
| *Ps. cyanescens* | 301, 302, 303 | 568, 569 |
| *Ps. discolor* | 285, 286 | 560, 561 |
| *Ps. ferox* | 307, 308, 309, 310 | 578, 579 |
| *Ps. horrida* | 315, 316 | 572, 573, 574 |
| *Ps. howardii* | 298, 299, 300 | 559 |
| *Ps. mathesoni* | 317, 318 | 580, 581 |
| ***Toxorhynchites*** | | |
| *Tx. rutilus rutilus* | 5 (Note 1) | 360, 361 |
| *Tx. rutilus septentrionalis* | 5 (Note 1) | 360, 361 |
| ***Uranotaenia*** | | |
| *Ur. lowii* | 322, 323, 324 | 584, 585 |
| *Ur. sapphirina* | 319, 320, 321 | 582, 583 |
| ***Wyeomyia*** | | |
| *Wy. smithii* | 8 (Note 2) | 356 |

## XVII. VECTOR GRAPHICS AND ILLUSTRATION SOURCES

The Adobe Creative Suites 6 (Adobe Systems Inc., San Jose, CA) was used to create vector graphic illustrations (Adobe Illustrator) and the layout of the keys (Adobe InDesign). Vector graphics use points, lines, curves, and polygons to represent two dimensional images in computer graphics through the use of mathematical expressions. Vector graphic illustrations also possess certain advantages over traditional hand drawn illustrations. Those advantages include easy editing and creation, little digital pixelation, higher electronic image resolution, image scaling, and smaller file size. From a practical perspective, using vector graphics during the creation of these keys allowed the authors to make multiple corrections and additions to the drawings and templates.  Furthermore, the more than 600 novel Adobe Illustrator files presented in this guide remain available for additional volumes and teaching purposes.

The illustrations presented in this key were developed principally by making free-hand computer images by the illustrator (CBS) based on multiple printed references and preserved specimens as guides.  Great care was taken to accurately represent the character state(s) referenced in the couplets and the general morphological traits of the species.  However, readers should be cautioned against using these illustrations as a definitive reference for characters not presented in the key couplets.

Primary reference material used in the development of the key illustrations include: Carpenter and LaCasse (1955), Belkin et al. (1970), Tanaka et al. (1979), and Darsie and Ward (1981).

## XVIII. REFERENCES


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## XIV. BIOGRAPHICAL SKETCHES

**Bruce Arthur Harrison** is a taxonomist and Public Health research entomologist that has studied and conducted research on mosquitoes and mosquito-borne diseases for 50 years. His B.Sc. degree (North Carolina State College) was in Wildlife and Fisheries (1960), and his M.A. degree (University of Kansas) was in Entomology (1964). He received a Ph.D. from North Carolina State University in 1979 in Entomology. From 1967 to 1990 he served in the U.S. Army, mostly assigned to the Walter Reed Army Institute of Washington, D.C., and retired as a Lieutenant Colonel. During that period his research focused on malaria vectors and malaria control, working and living nine years in Southeast Asia, with a total of overseas work over ten years in 16 countries, and in the U.S. for 11 years in the Walter Reed Biosystematics Unit at the Smithsonian Institution, which he managed from 1982 to 1987. In 1990, he retired from the Army and worked 2.5 years as a Senior Program Officer at the National Research Council, National Academy of Sciences, Washington, D.C., monitoring and assisting developing country scientists with their projects funded by the U.S. Agency of International Development. In 1993 he moved to a position in the Public Health Pest Management Section, North Carolina Department of Environment and Natural Resources, where he worked for 19.5 years assisting the public and county health departments, teaching and conducting field research, and retired in 2011. During this period he taught 40 mosquito and tick identification and surveillance courses to over 800 participants from the Mid-Atlantic Region. Currently he is an Affiliate Professor at Western Carolina University. He has published 118 scientific peer-reviewed papers and books. His research has resulted in the discovery and description of 11 new species and one new subgenus of mosquitoes. He also has one subgenus and four species named after him. He is currently an active member in the Entomological Society of America, the American Mosquito Control Association, the Society of Vector Ecology, the Mid-Atlantic Mosquito Control Association, and the state mosquito control associations of North Carolina, South Carolina, and Virginia. Civilian awards/positions include the American Mosquito Control Association John N. Belkin Award, the Mid-Atlantic Mosquito Control Association (MAMCA) R.E. Dorer Award, the Virginia Mosquito Control Association (VMCA) R.E Dorer

Award, Outstanding Service Award, and Honorary Membership Award, the North Carolina Mosquito and Vector Control Association (NCMVCA) Hamilton W. Stevens Award, and Life-Time Membership Award, and the Entomological Society of North Carolina Award of Excellence. He served two terms as Mid-Atlantic Regional Director for the American Mosquito Control Association, and served as President for the NCMVCA.

**Brian David Byrd** is an Associate Professor in the Environmental Health Sciences program, College of Health and Human Sciences, Western Carolina University. He received his B.A. degree (Biology) from the University of North Carolina at Asheville, his M.S.P.H. (Parasitology) and his Doctorate (Ph.D., Parasitology/Vector Biology) from the Tulane University School of Public Health and Tropical Medicine in New Orleans, Louisiana. During his studies at Tulane he was a pre-doctoral fellow in a CDC funded training program in vector-borne infectious diseases. His research focuses on molecular methods to identify medically important vectors, the impact of invasive mosquito species, and surveillance methods for vectors of domestic mosquito-borne diseases, specifically La Crosse encephalitis. He also maintains an active undergraduate research program where his students have been nationally recognized. He has authored or co-authored peer reviewed manuscripts in discipline related journals and is an active member of a number of professional organizations including the American Mosquito Control Association and The Society for Vector Ecology.

**Charlie Benedict Sither** graduated from Western Carolina University (WCU) with a B.S. in Environmental Health. His post-baccalaureate work has ranged from disease surveillance for mosquito control programs to research ranging from pesticide efficacy to molecular assays for mosquito identification. Currently, he is enrolled in the M.S. program (Biology) at WCU.

**Parker Brian Whitt** has studied the mosquitoes of North Carolina and the Mid-Atlantic States for 28 years, and the ticks of North Carolina for the past 15 years. He has been employed by the state of North Carolina for the past 28 years and currently is working for the North Carolina Department of Agriculture and Consumer Services. He has a M.A. in Zoology from Appalachian State University. Parker worked on surveillance, identification, and pooling mosquitoes for virus isolation studies for 18 years, including after natural disasters in North Carolina and Kansas. He taught adult and larval mosquito identification courses in the Mid-Atlantic States for the past 20 years. He has published 10 scientific papers, with an emphasis on vector identification and detecting mosquito- and tick-borne pathogens causing human diseases. He is an active member of the Mid-Atlantic Mosquito Control Association, the North Carolina Mosquito and Vector Control Association (past Hamilton Stevens award winner and Past President), and the North Carolina Herpetological Association.

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