

The Black Flies  
of New York State  
(Diptera: Simuliidae)

BY  
ALAN STONE  
*Entomology Research Branch  
Agricultural Research Service  
United States Department of Agriculture*

AND  
HUGO A. JAMNBACK  
*New York State Science Service*



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## INTRODUCTION

Black flies are blood-sucking Diptera of public health and economic importance. Besides being disease carriers, they are annoying to man and domestic animals because of their biting and crawling habits. Livestock may even be killed by heavy attacks of black flies. It is probable that, next to mosquitoes, black flies are the most annoying insect pests of man in New York State. The importance of the State as a vacation area makes such pests of particular importance, although their effect on the resident population and on domestic animals is likewise well worth serious consideration.

Recent taxonomic studies on the family Simuliidae in this country have greatly increased the number of known species. They have also shown that many of these species are rather difficult to distinguish unless all of the stages are known. Because of these facts, some of the early biological work, based upon erroneously determined material, is of little value. Without doubt a number of the species now known from other parts of the Northeast will be found in New York State, but we have confined this work to the 23 species actually collected in the State.

In order to develop and carry out effective control programs it is necessary to know which species are important and how they live. It is the purpose of this publication to facilitate the determination of the New York State species of black flies and to give some idea of their distribution and habits.

The economic importance and control of black flies are considered in a separate New York State Museum Bulletin by Jannback and Collins.

Figures 1-32 and 48-74 were drawn by Arthur D. Cushman, Entomology Research Branch, United States Department of Agriculture; figures 34-38, 40, 43-47, and 75-113 by the junior author; figures 33, 39, 41, and 42 by the senior author. Photographs 114-116 were taken by the junior author.

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## CHARACTERS USED IN CLASSIFICATION AND DETERMINATION

While we do not intend to present here a complete study of the anatomy of black flies, we include this section in order that the keys and descriptions can be used with understanding. More important anatomical studies include those by Krafchick (1943) and Nicholson (1945) on mouthparts, Freeman (1950) on the male genitalia, and Puri (1925) on the larvae and pupae.

### ADULTS

**Head** (fig. 1). The *eyes* of the female are separated by the *frons* which is usually narrowest just above the antennae and widened upward. The male is usually holoptic, and the larger upper facets are sharply differentiated from the smaller lower ones. The *antennae* are located in a widened area between the eyes and are usually 11-segmented, rarely 9 or 10-segmented. The first segment, or *scape* and the *second*, or *pedicel*, are usually less closely united than the usual nine segments of the *flagellum*. Below the antenna is the convex *clypeus*, and below this the tapering *labrum*, which bears teeth at the apex. The *mandibles* are broad, flat plates, usually serrate on both edges, and the *maxillae* are more slender and usually have retrorse teeth on their margins. A few species, such as *Cnephia dacotensis*, have the mandibles and maxillae unarmed. The maxillary *palpi* are five-segmented, the first two segments short, the third usually enlarged and containing a *sensory organ*, the fourth slender and rather short, and the fifth usually the *longest*. The pharyngeal structures may show some usable characters, although we have not determined this for our species.

**Thorax** (fig. 4). This is rather strongly convex above, giving the fly a hump-backed appearance, particularly in the male. The *scutum* may have a characteristic pattern of pollinosity or hairs. Frequently a pair of spots near the anterior margin, the sides and the prescutellar declivity are paler in color. The color pattern is largely structural so that the pattern varies greatly with the angle of incidence of the light. There is also a strong sexual dimorphism, in the color pattern. The males are usually much darker and more velvety in appearance, with the anterolateral scutal spots standing out in greater contrast. The *postscutellum* is the convex sclerite lying between the scutellum and the base of the abdomen. The *pleuron* is rather uniform in the family, although there may be some difference in the arrangement of fine hairs on the sclerites. The color of the *pleural tuft* (beneath the wing base) may be characteristic.

**Wings** (fig. 2). These have a characteristic venation, the thickened veins being concentrated anteriorly on the rather broad wing. The *costa* ends with the *radial sector* before the apex of the wing. The *basal vein* is short and stout and basad of the *humeral crossvein*. The color of the hairs on the basal vein and on the base of the *costa* is often diagnostic. The *subcosta* is complete, joining the *costa*, and it often has hairs on the under surface. The *radial vein* (R) extends from the end of the basal vein to the point where it divides into vein  $R_1$  and the *radial sector* ( $R_s$ ), and it is pilose above in *Twinnia*, *Prosimulium*, *Cnephia* and *Simulium* (*Eusimulium*). The *radial sector* has two branches in *Prosimulium* and *Twinnia* and rarely in *Cnephia*, and it is unbranched in *Simulium*. The anterior veins bear only fine, hairlike macrotrichia in *Twinnia* and *Prosimulium*, while in *Cnephia* and *Simulium* these are mixed with short, spinelike macrotrichia. The rest of the wing venation is as figured and shows no diagnostic characters in our genera, except in the presence or absence of the small *basal cell*.

**Legs.** Characters in the legs are both tinctorial and structural. *Twinnia*, *Prosimulium* and *Cnephia* usually have rather uniformly colored legs, while most *Simulium* have a distinct pattern of pale areas on the coxae, tibiae and tarsi. The tibiae are usually somewhat flattened and the shape of the hind tibia may be significant. The tarsus consists of a long basitarsus, and four shorter segments, the fourth segment being short and bilobed. The apex of the hind basitarsus is usually produced posteriorly as a flattened lobe, the *calcipala*, and in *Simulium* the second hind tarsal segment has a dorsal notch, the *pedisulcus*. The claws of the female are variously shaped, often with subbasal teeth or basal lobes.



**Abdomen.** The first abdominal tergite is modified as a basal scale, from which arises the usually long hairs of the *basal fringe*. In most species the sclerotized tergites are reduced on the intermediate segments, enlarging progressively posteriorly. The vestiture and pilosity of the abdomen are often of value in determination. In females, sternites 2 to 7 are usually unsclerotized. The *ninth tergite* of the female (fig. 3) is broad and narrowly attached laterally to the arms of the genital fork. The *genital fork* is a Y-shaped internal structure, with the stem heavily sclerotized and anteromedian in position, and the arms are variously shaped and irregularly sclerotized, often with dorsal or ventral projections. The *eighth sternite* is more or less sclerotized, its shape being somewhat diagnostic, and projecting posteriorly from this are the two lobes of the *ovipositor* or anterior gonapophyses. On each side of the *anus* are sclerotized *anal lobes* and posterior to these the paired *cerci*. The shape of the genital fork, ovipositor, anal lobes and cerci are of some taxonomic value. In the male the sternites are all more or less sclerotized. The male genitalia (figs. 11 and 12) provide excellent characters for specific determination, although their small size and their thickness make full utilization of the structures rather difficult. It has been customary to depend upon the dististyles and ventral plate principally for specific characters, and the drawings given in this paper of the species omit the more dorsal structures. The *parameres* and the hooks on the *parameral arms*, the *dorsal sclerite* and the *median sclerite* are also often of value, and can best be seen in cleared specimens in glycerine. The *basistyle* is usually short and stout and shows little variation. The *dististyle* has a wide variety of shapes in the different genera and species. The *ventral plate* or adminiculum is heavily sclerotized and variously shaped. It is usually concave dorsally with the apex curving ventrally, resembling the lip of a pitcher, and it may be heavily pilose or armed with teeth laterally; the basal projections of the ventral plate are variously shaped and may have lateral prongs. The parameres are a pair of sclerotized plates from each of which arises a slender arm, usually bearing teeth of various sizes.

## PUPAE

**Cephalothorax.** The surface is usually relatively smooth, although in certain species it may be distinctly rugose. There are a few sensory hairs, the *trichomes*, usually directed forward, and either simple or branched. On each side of the thorax there is a *respiratory organ*, and the shape of this structure is of great value in determining species. In most species there is a regular number of slender filaments

with characteristic arrangement, but in some these may be thickened or irregularly branched.

**Abdomen.** This is armed with recurved hooks in one or more rows on both the tergites and the sternites of some of the segments. These are of some use in group classification and possibly also in species determination. The tip of the abdomen dorsally has a pair of strong acute projections, the *terminal hooks*, in *Twinnia*, *Prosimulium* and some *Cnephia*. In other *Cnephia* and in *Simulium* these are greatly reduced or absent.

**Cocoon.** The shape of the cocoon is often very characteristic for the species. In *Prosimulium*, *Twinnia* and some *Cnephia* it is an irregular, shapeless covering over part or all of the pupa. In other *Cnephia* and in *Simulium* the cocoon is well formed and may be wall-vase-shaped (see fig. 70), the sides not connected anteroventrally below the head, or boot-shaped, with a distinct connection anteroventrally. The sides of the cocoon may be solid or may have one or more lateral apertures.

## LARVAE

(Fig. 75)

**Head.** The *head capsule* is made up of two sclerites, the dorsal *frontoclypeus* and the lateral and ventral *epicranial plate*. The frontoclypeus is uniform in color except for the *head spots*. The head spots occur at the points of attachment of muscles to the head capsule. In some species, the area around the head spots may be fulvous. Since the location of the head spots on the frontoclypeus is constant in most of the species studied, they may be divided into four categories based on their locations: the *anterior median group*, the *posterior median group*, and the paired *anterior lateral* and *posterior lateral groups* (fig. 78). In some species, the head spots are light against a dark background, in others dark against a lighter background. The epicranial plate is less uniform in color than the frontoclypeus. Often the lateral portion is somewhat darker than the ventral. There are a series of muscle attachment points along the posterolateral margin of the epicranial plate. Three spots may be visible, arranged in an irregular line on each side, extending from near the posterolateral margin anteriorly to a point below the eye. In some species there is a single lateral spot on each side of the ventral surface slightly anterior to the apex of the throat cleft.

The *throat cleft* or epicranial cleft is located on the posteroventral margin of the epicranial plate. It may vary in shape, width, and length between species (figs. 89-97).

The *suboesophageal ganglion* is located just ventrad of the digestive tract just under the epidermis in the general region of the throat cleft. It is a distinct black in some species and either white or light brown in others (figs. 93, 95).

The *submentum* bears heavily sclerotized teeth on the anterior margin. These are fused to the anteromedian margin of the epicranial plate. The shape, size and number of teeth of the submentum are slightly variable but nevertheless furnish good generic and sometimes specific characters. The degree of serration of the lateral margins of the submentum is also of some value in distinguishing species (figs. 81-88).

There are two series of *setae* which appear to originate near the lateral margins of the submentum. Actually, as was pointed out by Puri (1925), they originate on the epicranial plate just ventrad of the submentum. Earlier workers described these as submental or labial setae. These setae will be referred to as *epicranial setae* in the larval descriptions. The number of setae and the distance from the outermost tooth of the submentum to the anteriormost seta on the same side are of some taxonomic value.

The *mandibles* of many species have been well described by Puri (1925). There are a series of teeth and serrations on the distal portion of the mandible which are of some value in identifying genera, subgenera and species. Puri divided these teeth into four groups. There are three large, black *apical teeth* which are stout in most species. The basal tooth of these three is about twice as large as the upper two. Basad of the apical teeth there is a series of *small teeth* on the ventral surface of the mandible. The first three of these are similar in appearance to the apical teeth but are usually much less heavily pigmented. They project clearly beyond the inner edge of the mandible and are not overlapped by other teeth. Their relative lengths vary between species but are fairly constant within each species. Basad of these three teeth the series of small teeth is continued by less distinctly visible teeth which gradually decrease in size from anterior to posterior. This series of teeth is overlapped by a submarginal row of *bristlelike teeth* which begin just basad of the third tooth of the series of small teeth. The first tooth of this bristlelike series is usually longer than the third tooth of the small teeth series. The bristlelike teeth decrease gradually in size from anterior to posterior. Since all but the first three teeth of the small teeth series overlap the bristlelike teeth, it is difficult to determine the number and size of either of these series without clearing, staining and examining a number of specimens under oil immersion. The edge of the inner subapical margin of the mandible

may bear *serrations* (toothlike processes of Puri, 1925). These serrations are variable, even within a species, but the basic pattern usually remains recognizable.

The *antennae* are generally four-segmented. (Some authors have considered segments 1 and 2 as a single compound segment.) Segment 2 bears two small spinelike distal processes. Segment 4 is very short and pointed apically. The pigmentation and the total length of the antennae are characters of some taxonomic value. The *segment length ratios* are somewhat variable within species but have some taxonomic value (figs. 98-107).

The *cephalic fans* are complex paired structures homologous to the mouth brushes of mosquito larvae, attached to the sides of the labrum and located laterad of the antennae. The number of fan rays is variable within a species, but the average number for a species often varies from that of other species. Sommerman (1953) used the shape of the secondary fan (under the primary fan) as a taxonomic character of generic value.

The *maxillae* are rounded apically, bearing numerous setae and bristles. The *maxillary palpi* are single segmented and bear stout apical bristles.

**Thorax.** This is somewhat stouter than the first few abdominal segments. In mature specimens, the developing pupal respiratory organ can be readily seen as a histoblast just under the epidermis on each side of the prothorax. These filaments may be removed for study as an aid in identifying larvae. A single median ventral proleg arises from the prothorax (although the base appears to extend into the mesothorax as a ventral thickening). This proleg terminates distally in rows of radially arranged hooks, similar in appearance to the anal hooks. Sommerman (1953) noted that the lateral plate of the proleg is of some value in identifying species of *Prosimulium*.

**Abdomen.** This is eight-segmented. The segments usually increase gradually in diameter from anterior to posterior with segment 7 the stoutest.

The *ventral tubercles* of the abdomen are paired conical projections from the lateroventral portion of the eighth abdominal segment. These may be conspicuous as in *S. (Eusimulium) spp.*; small and indistinct as in *S. (S.) venustum*; or totally lacking as in *P. hirtipes* and most of the other species found in New York.

The *anal gill* is a projection of the ventral wall of the rectum (Headlee, 1906). When retracted it lies completely within the rectal cavity. The rectal opening is located just anterior to the anal cross-piece on the dorsum of the eighth abdominal segment. The anal gill

may consist of three simple lobes (*Prosimulium* and *Cnephia*) or be made up of three compound lobes (all *Simulium* species found in New York except *S. (E.) aureum*). *S. (N.) vittatum* is distinguished by having very small ventral accessory lobes.

The *anal hooks* are located at the posterior end of the terminal abdominal segment. These hooks are arranged in a series of radially arranged parallel rows. The number of rows and the number of hooks per row, while difficult to count, are sometimes of use in taxonomy.

The *anal cross-piece* is located just anterior to the anal hooks of the eighth abdominal segment. It consists of two sclerotized pieces. Each piece is broadly U-shaped with the arms of one directed to the right and of the other to the left. These arms are joined medially, forming an X-shaped or Y-shaped structure. The comparative lengths of the upper and lower arms and the presence or **absence** of lightly sclerotized areas adjoining or between the arms are of some value in determining species although these may vary somewhat within a species (figs. 114-16).

## GENERAL BIOLOGY

The egg-laying habits of most species of black flies are poorly known. Some species lay their eggs in **masses** on grass trailing in the water (e.g. *S. aureum*); others drop the eggs singly into **streams** (*S. arcticum*; Fredeen *et al.*, 1951); still others lay their eggs in long strings (*S. vittatum*). Comstock (1895) observed *S. pictipes* (as *S. innoxium*) laying eggs on rocks beneath a thin sheet of water. Oviposition of species observed generally took place in the late afternoon or early evening (Fredeen *et al.*, 1951; Jobbins-Pomeroy, 1916). However, Gambrell (1933) reported that oviposition of *S. pictipes* was observed between 9 and 11 a.m.

A black fly lays between 150 and 450 eggs. They are whitish to light orange when first laid, darkening as they mature, and are sub-triangular in outline, ranging in length from 0.2 to 0.4 mm. The incubation period varies from about 2.5 days to more than 7 months. The eggs of species tested by Jobbins-Pomeroy (1916), Wu (1931) and Smart (1944) were not resistant to prolonged desiccation.

Larvae are found only in running water in this country. Some species occur primarily in rivers (*C. pecuaria*<sup>1</sup>, *S. arcticum*, *S. reptans*, and *S. jenningsi*). It is interesting to note that all of these river species may be pests of economic importance at times. Some species are found in both large and small permanent **streams** (*S. venustum*, *S. tuberosum*,

<sup>1</sup> This name is here emended from *pecuarum* to conform with the proper Latin adjective in the feminine gender.



*S. gouldingi*). Other species are more catholic in their distribution, being found in large or small, permanent and temporary streams (*P. hirtipes*, *C. mutata*). Still other species are found almost exclusively below lake outlets, dams and large pools (*S. vittatum*, *S. decorum*, *S. aureum*, *C. dacotensis* and *P. magnum*). *S. pictipes* larvae are usually found in swift, permanent streams with sedimentary rock bottoms. *S. latipes* has been found only in small, shallow, semi-permanent streams.

Larvae of species studied by Puri (1925), Edwards (1920), Baranov (1935) and Cameron (1922) molt six times before pupation. Mature larvae range from 5 to 12 mm in length depending on the species and somewhat on the time of year. The duration of the larval period depends on the species, temperature of the water, season and amount of food available. DeFoliart (1951) reported a minimum larval developmental period of 12 days in the summer. *P. hirtipes*, *C. mutata* and *S. vittatum* overwinter as larvae in the Adirondacks. Most of the other species found in New York State probably overwinter in the egg stage (although overwintering eggs have not been found) and hatch in the spring or summer.

Pupae are found attached to the substrata in the same locations as the larvae. The larvae weave silken pupal cases which may be small and rudimentary (*Twinnia*), shapeless masses of silk (*Prosimulium* spp., *Cnephia dacotensis* and *C. mutata*), coarsely woven cocoons (*S. pictipes*, *S. decorum*), or closely woven cocoons of various shapes (*C. loisae*, *S. parnassum*, *S. venustum*, *S. tuberosum*, *S. (Fusimulium)* spp.). Usually the pupal case has the open end facing downstream. The length of the pupal stage ranges from two days to three weeks depending on water temperature and the species involved.

The feeding habits of the adults of most species are not known. Females of some species are known to suck blood from mammals and birds. Both males and females have been kept alive for long periods when fed sugar-water or soaked raisins. Wu (1931) kept adults of *S. vittatum* and *S. jenningsi* alive for five to six days on a diet of water and up to 18 days with sugar solutions or soaked raisins. At least two species (*C. dacotensis* and *P. alpestre*) do not feed as adults. According to Jobbins-Pomeroy (1916), *S. venustum* requires a blood meal for the development of eggs. Cameron (1922) reported that *S. arcticum* (as *S. simile*) also requires a blood meal. Wu (1931) reported that *S. venustum* apparently requires a blood meal while *S. vittatum* does not.

Because of the expense and large number of personnel required, few flight range studies of black flies have been carried out. Dalmat

(1950, 1952) and Dalmat and Gibson (1952) in Guatemala reported flight ranges of marked specimens of *S. metallicum*, *S. ochraceum*, and *S. callidum* up to 9.7 miles, although most of the specimens were collected at distances of less than four miles. Twinn (1952) reported that radioactive phosphorous ( $P^{32}$ ) is being used in studies of the dispersal and flight range of black flies in Saskatchewan.

Flight range studies based on the distance from the nearest known breeding areas are less reliable because the flies may have migrated from streams further away or from closer but unknown breeding areas. However, the flight ranges of species which pass the immature stages in large rivers can be determined fairly accurately. Cameron (1922) reported taking *S. arcticum* (as *S. simile*) in large numbers 12 to 15 miles from the nearest known breeding area. Baranov (1937) recorded *S. colombaschensis* (as *S. columbacense*) being collected 60 to 160 miles from the nearest known breeding places. Underhill (1944) reported taking *S. jenningsi* (as *S. nigroparvum*) in large numbers 10 miles from the nearest known breeding area and in smaller numbers 20 to 30 miles away. Wanson and Henrard (1945) have collected *S. damnosum* regularly 12 miles from the nearest known breeding place. Gibbins (1934) and Wanson (1950) reported collecting *S. damnosum* 30 to 50 miles from the nearest known breeding area. Rempel and Arnason (1947) reported collecting *S. arcticum* 50 miles from the breeding area, with an indicated range of 80 to 90 miles.

It is more difficult to determine the flight range of species which pass the immature stages in smaller (and usually more numerous) streams. Edwards (1920) reported taking *S. venustum* two miles and *S. ornatum* one mile from the nearest known breeding area. Jobbins-Pomeroy (1916) collected *S. johannseni* and *S. meridionale* (as *S. forbesi*) five to six miles from the nearest known breeding place.

## COLLECTING, REARING AND STUDY

The taxonomic study of black flies presents certain special problems arising from the rather specialized habitat of the immature stages, the relatively small size of the adults and the presence of species groups in which it is difficult to recognize the species unless several stages are available. The pupae of black flies, however, are usually readily distinguishable, and it is not difficult to associate pupae with both the larvae and the adults, as will be explained below.

## COLLECTING

Adults all too frequently come to the collector and can be taken by sweeping a net around the head, by putting a killing bottle over the

biting females or by capturing crawling specimens in a vial of alcohol. They may also be collected from domestic animals, particularly in the ears. Both males and females will come to light traps, and specimens can often be collected by sweeping vegetation in the vicinity of their breeding areas. The best method, however, is the rearing of adults from pupae.

Larvae and pupae are almost always found in flowing water, and usually that with a rather swift flow. Since species vary in the types of streams they inhabit, they should be searched for in everything from large rivers to tiny trickles, and at depths from half an inch to several feet. They are found attached to all sorts of objects, including sticks and branches, dead leaves, vegetation trailing in the water, and stones, from rather small pebbles to the bed rock of streams. They may occur in large masses or be very scattered. Often several species will be found mingled together in a single stream. Both larvae and pupae should be collected, if present.

## REARING

Rearing from eggs or larvae requires special equipment and flowing water, and is not usually practicable under field conditions. Emergence traps have been used for collecting adults from streams. Positive association of the adults with the immature stages, however, is not possible by this method. Rearing from isolated pupae is not at all difficult. The pupa to be reared should be carefully removed from the stream, if possible without taking it from the surface to which it is attached, and placed on damp blotting paper, paper toweling, Cellucotton, or absorbent cotton, in a vial. It is important that this is kept damp, but it should not be wet. If older, darker pupae are selected, emergence should occur within a few days. The adult should be allowed to harden several hours; then it can be preserved in alcohol with the associated pupal skin or it can be killed dry and mounted.

## STUDY

The value of the pupa in the taxonomic study of black flies lies in the relative ease of associating this stage with both the larva and the adult. It is often possible to dissect out fully developed adults of either sex. It is also possible to see in fully grown larvae the developing respiratory organs (histoblasts) of the pupa. It is often necessary to dissect out this pupal histoblast from the side of the larva. Frequently one also finds in the anterior part of the cocoon the shed head capsule of the larva, which again provides a tie between larval and pupal

characters. This makes possible the utilization of a much larger number of specific characters than can be found in one stage alone.

For studying the adults, both pinned dry specimens and those preserved in alcohol are useful, for different reasons, although if only one can be obtained, the specimen preserved in alcohol is preferable. It does not show the often distinctive color pattern as well as do dry specimens, but it is much easier to observe the structural characters. It is often necessary to make slide mounts of mouthparts, genitalia, tarsal claws and larval head structures. Both male and female genitalia can often be more clearly understood in cleared, whole preparations, preserved in glycerine, since the relationship of the parts is easier to observe in them. However, in order to see the minute, but often significant, details, dissection of the parts and mounting them on slides is necessary.

## TAXONOMY

The generic classification of the Simuliidae is still unsettled, because little work has been done on a world-wide scale and there is still a great deal to be learned about the immature stages and life histories. We have adopted the rather conservative course of recognizing for New York State only four genera and six subgenera. These are *Twinnia* (a new genus); *Prosimulium*; *Cnephia* with the subgenera *Cnephia*, *Ectemnia* and *Mallochianella*; and *Simulium*, with the subgenera *Simulium*, *Neosimulium* and *Eusimulium*. The new genus is related to both *Prosimulium* and *Gymnopais*, but appears to be sufficiently different from both to warrant generic rank. There is some difference of opinion about *Eusimulium*, some workers considering it as a full genus, at least for *aureum* and its relatives, and this may be justified, but until all of its presently included species can be more thoroughly studied we prefer to leave it in the genus *Simulium*. The genus *Cnephia* is even less homogeneous than *Simulium*, and the three New York State species are quite divergent. *Cnephia dacotensis* appears to be closely related to *C. pecuaria*, the genotype, although differing in mouthparts and habits; the other two species satisfactorily key to *Cnephia* in current keys to the adults, but diverge rather widely in the immature stages.

## KEYS TO GENERA

### Adults

- 1 Macrotrichia of anterior wing veins all hairlike, not intermingled with spiniform ones; radial sector forked (*Prosimuliinae*)..... 2
- Macrotrichia of anterior wing veins mixed, hairlike and spiniform; radial sector rarely forked (*Simuliinae*)..... 3

- 2 Antenna 9-segmented; ovipositor short, not extending beneath anal lobes  
*Twinnia*, n. gen.
- Antenna 11-segmented; ovipositor longer, extending beneath anal lobes  
*Prosimulium* Roubaud
- 3 Second hind tarsal segment with a deep pedisulcus; vein R with or without setae dorsally; basal cell absent.....*Simulium* Latreille
- Second hind tarsal segment without pedisulcus, or this represented by a shallow depression only; vein R with setae on dorsal surface; basal cell present.....*Cnephia* Enderlein

### Pupae

- 1 Cocoon irregular, closely appressed to pupa, without any clearly defined anterior margin; abdomen with strong terminal hooks..... 2
- Cocoon well developed, variously shaped, usually with a clearly defined anterior margin; abdomen without large terminal hooks..... 5
- 2 Tergites 6 to 8, at least, each with an anterior row of fine hooklets..... 3
- Tergites 6 to 8 without an anterior row of fine hooklets.....*Twinnia*, n. gen.
- 3 Respiratory filaments arising from a rounded knob on a short petiole  
*Cnephia* (*Cnephia*) Enderlein
- Respiratory filaments not arising from a rounded knob on a short petiole.. 4
- 4 Respiratory filaments less than 14, arising from two main trunks  
*Cnephia* (*Mallochianella*) Enderlein
- Respiratory filaments usually more than 14, if less, not arising from two main trunks.....*Prosimulium* Roubaud
- 5 Cocoon stalked; anterior margin not clearly defined  
*Cnephia* (*Ectemnia*) Enderlein
- Cocoon not stalked; anterior margin clearly defined.....*Simulium* Latreille

### Larvae

- 1 Head capsule with strongly convex lateral margins; mouth brush present, but inconspicuous, with fan rays shorter than antenna; teeth of submentum and mandible rounded; anal cross-piece Y-shaped.....*Twinnia*, n. gen.
- Head capsule with slightly convex lateral margin; mouth brush conspicuous, with fan rays longer than antenna; teeth of submentum and mandible pointed; anal cross-piece X-shaped or absent..... 2
- 2 Antenna with segments 1 and 2 colorless, segments 3 and 4 dark brown to black; throat cleft a subrectangular notch, two to three times as wide as long; median tooth of submentum trifid; anal gill with three simple lobes.....*Prosimulium* Roubaud
- Antenna with segments 1 and 2 yellow to brown, segments 3 and 4 rarely dark brown; throat cleft neither a subrectangular notch nor two to three times as wide as long; median tooth of submentum single; anal gill with either three simple or three compound lobes..... 3
- 3 Submentum with large and subequal outer and median teeth and three smaller subequal intermediate teeth on each side; anal gill with three compound lobes (except *S. aureum*).....*Simulium* Latreille
- Submentum not as above; anal gill with three simple lobes.. *Cnephia* Enderlein



## SUBFAMILY PROSIMULIINAE

## TWINNIA, NEW GENUS

**Generic characters. Adults.** Antenna 9-segmented; frons and occiput of female broad, the eyes being somewhat reduced; a protuberance behind eye of female; male holoptic, the dorsoanterior facets enlarged. Thorax with fine hairs, no bristles. Wing venation as in *Prosimulium*; radial sector forked; all macrotrichia of anterior wing veins hairlike; fold between veins M and Cu forked; anal vein broadly curved twice; basal cell present. **Legs** uniformly colored; no calcipala; no pedisulcus; hind tibia of male distinctly clavate; hind basitarsus of male considerably broadened. Ovipositor short, not reaching anal lobes. Ventral plate of male genitalia broad; dististyle with a single tooth.

**Pupa.** Respiratory organ multibranched; dorsal hooklets of abdomen greatly reduced; no row of fine hooklets on anterior margins of tergites 6 to 8; sternal hooklets strong; terminal hooks large. Cocoon very thin, shapeless, closely appressed to body.

**Larva.** Head capsule with strongly convex lateral margins; mouth brush very inconspicuous, with fan rays shorter than antenna; teeth of submentum and mandible rounded; mandible lacking teeth on outer subapical margin; anal cross-piece Y-shaped.

**Genotype.** *Twinnia tibblesi*, new species.

**Included species.** *Twinnia nova* (Dyar & Shannon) (= *Prosimulium novum* Dyar and Shannon, 1927:5). New combination.

This genus obviously belongs to the Prosimuliinae. The adult appears to be more closely related to *Prosimulium*, but the larva resembles *Gymnopaïs*. The 9-segmented antenna, protuberance behind eye, and reduced ovipositor of the adult, the reduction of hooklets on the dorsum of the abdomen of the pupa, and the head shape, reduced mouth brush, and the Y-shaped anal cross-piece of the larva, all clearly separate the genus from *Prosimulium*. The absence of stout setae on the thorax of the adult, the character of the respiratory organ of the pupa, and the presence of mouth brushes, even though reduced, in the larva, distinguish it from *Gymnopaïs*. When the larva was first discovered it was thought to be a *Gymnopaïs*, but the discovery of the pupae with head capsules of the larvae within the cocoons settled the matter. Only the female of *T. nova* is known, but it agrees very well with the generic characters we have given except that the protuberance behind the eye is less developed.

We take great pleasure in dedicating this genus to Dr C. R. Twinn, whose work on the species of eastern Canada is one of the outstanding contributions to our knowledge of the black flies of this continent. The work that led to the discovery of the pupae and adults of the type of this genus was directed by Doctor Twinn.

**Twinnia tibblesi, new species**

(Figs. 17, 33, 55, 76, 79, 81, 89, 98, 115)

**Female.** Length 2.5-4 mm. General color blackish brown. Wing length 3.25-3.75 mm. Head gray with pale yellowish hair; width of frons about as great as length of first two antennal segments, widened above. First three antennal segments about 0.8 length of last six. Palpus dark; ratio of last three segments 2-2-3. Mouthparts very short; margin of mandibles not serrate; maxilla without teeth. Scutum brownish black, clothed with recumbent yellow hair. Scutellum with dense, erect yellow hair. Postscutellum velvety dark gray. Pleuron reddish brown to black; pleural tuft rather large, yellowish. Wing with hair of stem vein yellow; hair of rest of wing brownish yellow. Halter yellowish brown. Legs yellowish brown to blackish, with mostly pale yellowish hair. Claws simple. Abdomen brownish black, with yellow hair. Tergites rather large, only slightly narrower on segments 2 and 3; sternites 2 to 7 unsclerotized; sternite 8 V-shaped, with apex anterior. Anal lobe subtriangular, the anterior angle broad, the ventral angle rounded and short; cercus not much wider than long, rounded posteriorly; ovipositor short, each half a short flap with inner margin concave, distal margin rounded, not reaching base of anal lobes. Genital fork rather short and stout, the stem expanding at base and apex, the arms sclerotized, each with a weak ventral projection.

**Male.** Color and vestiture as in female, but basal fringe of abdomen much longer and darker. Mouthparts extremely reduced. All tergites large. Sternites 4 to 8 sclerotized. Basistyle subconical, about as long as basal width; dististyle flattened distally, about three times as long as broad, curved and tapering to a single tooth; ventral plate about as broad as long, rounded and slightly notched distally, finely pilose, with short basal arms; parameres rather small, without parameral hooks; median sclerite subrectangular, with two short, truncate, distal arms; dorsal sclerite a narrow transverse band.

**Pupa.** Length about 4 mm. Respiratory organ about as long as cephalothorax to apex of wing pads, consisting of 16 filaments arranged as follows: from a short base three stout branches diverge; from the dorsal of these four pairs of filaments arise at varying levels; from

the lateral and ventral branches four filaments each, one pair on a short stalk, one pair sessile. Trichomes of cephalothorax very small, slender. Tergites 3 and 4 each with eight very fine hooklets near posterior margin; sternite 5 with four larger hooklets; sternites 6 and 7 each with two, even larger. Terminal hooks dark, curved. Cocoon thin, irregular.

**Larva.** Mature specimens 8 mm long. Head capsule with distinct dark brown to black head spots; fulvous area around head spots lacking; median posterior group of head spots present; just anterior to these, paired mediolateral spots are present on each side; two pairs of antero-lateral spots present; single anteromedian spot visible just distad of anterolateral spots; epicranial plate with dark posterolateral spots; suborbital series and single lateroventral spot present on each side. Throat cleft absent; posteroventral margin of head capsule irregular. Submentum with median trifid tooth and outermost teeth shorter than intermediate teeth; lateral margin of submentum serrate. Two long epicranial setae present on each side, appearing to arise from near lateral margins of submentum. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than distance between outermost teeth. Mandible with teeth not differentiated as in *Prosimulium*, *Cnephia* or *Simulium*; with eight apical and subapical blunt teeth followed by six bristlelike teeth; inner subapical margin with three small serrations. Antenna relatively short, about one-third as long as distance from base to posterior margin of head capsule; segment length ratios base to apex, 2.4-6.4-5-1; segments 1 and 2 clear, 3 and 4 dark brown. Each cephalic fan with about 36 rays. Length of maxillary palpus slightly more than twice width at base. Pupal respiratory histoblast with 16 filaments arising from three main branches. Abdomen of preserved specimens dark mottled brown, widening posteriorly, with greatest width between segments 5 and 6. Anal cross-piece well sclerotized, lacking lightly sclerotized areas between arms; with ventral arms fused and dorsal arms separate, forming Y; dorsal arms slightly shorter than ventral arms. Anal hooks about 10 to a row in 54 rows.

**Holotype.** Female, Goose Bay, Labrador, August 30, 1950. J. J. Tibbles (on slide). Paratypes, 8 females, 8 males, 10 pupae, larvae, Goose Bay, Labrador, June 20 to September 6, 1950. Holotype and paratypes, Canadian National Collection; paratypes, U. S. National Museum. There is no direct association of emerged adults with pupal exuviae, but adults dissected from pupal skins agreed with the emerged adults. Larval head capsules found within the cocoons are also preserved, and these agree with the larvae collected at the type locality.

Larvae of apparently the same species have been collected at Brooktondale, Tompkins co., N. Y. April 8th and 24th, and in northern Vermont.

### PROSIMULIUM ROUBAUD

*Pro-Simulium* Roubaud, 1906:521. Genotype *Simulium hirtipes* Fries

*Prosimulium* Roubaud: Smart, 1945:480-82

**Generic characters.** Antenna usually 11-segmented. Radial sector forked. Macrotrichia of anterior wing veins all hairlike, not mixed with spiniform ones. Anterior branch of radial sector a concave vein, bare above; posterior branch a convex vein with triple row of macrotrichia above; vein R with macrotrichia on upper side; basal cell present;  $Cu_2$  sinuous. No calypala, no pedisulcus. Ovipositor well developed. Respiratory organ of pupa usually with 16 or more filaments, these sometimes arising from one or more swollen structures; terminal hooks well developed. Cocoon lacking a definite shape or clearly defined anterior margin. Antenna of larva with segments 1 and 2 colorless, 3 and 4 dark brown to black; throat cleft a subrectangular notch two to three times as wide as long; median tooth of submentum trifid; inner subapical margin of submentum with 8 to 17 serrations, distalmost largest; anal cross-piece X-shaped, with ventral arms subequal to or distinctly shorter than dorsal arms; ventral tubercles lacking.

This genus is difficult to study because of the scarcity of good characters to separate a number of the species. The true identity of *Prosimulium hirtipes* is rather uncertain, but we have here applied the name to a common North American species that seems to agree with the *hirtipes* of Europe as defined by Puri, Smart and Rubzov, and as recognized in this country by Twinn. It may never be possible to determine what Fries had, but it seems best to continue the name, as it has been redefined, for this well-known species. In the references cited we have not included those of Johannsen 1903, Malloch 1914, or Dyar and Shannon 1927, since it is quite certain that they were dealing with two or more species under the name. The pupa described as having "upwards of 60 filaments" may have been *P. magnum*, although this is an excessive number for that species. It is also possible that the larva described by Puri is not the same species as the pupa he described.

It is quite possible that *P. multidentatum* Twinn occurs in New York, although we have seen no specimens we could definitely call that species. The pupa is very close to *magnum* while the female looks very much like *hirtipes* or any other of the local species except *magnum*. Positive determination can only be made if males are present in the series.

## Key to Females

- 1 First flagellar segment distinctly longer than pedicel (fig. 7); wing usually more than 4 mm long.....*magnum* Dyar & Shannon
- First flagellar segment not conspicuously longer than pedicel; wing usually less than 4 mm long.....*hirtipes* (Fries)  
*rhizophorum*, new species  
*saltus*, new species

## Key to Males

- 1 First flagellar segment much longer than pedicel, the scape, pedicel, and first flagellar segment about half total length of antenna (fig. 6).....*magnum* Dyar & Shannon
- First flagellar segment shorter than or a little longer than pedicel; scape, pedicel and first flagellar segments combined less than half total length of antenna.....*hirtipes* (Fries)  
*rhizophorum*, new species  
*saltus*, new species

## Key to Pupae

- 1 Respiratory organ consisting of one or three stout tubes or irregularly swollen structures from which arise slender filaments..... 2
- Respiratory organ consisting entirely of slender filaments arising near a common base..... 3
- 2 Respiratory organ consisting of one irregularly swollen club from which arise smaller swollen structures bearing one or more filaments (fig. 56).....*rhizophorum*, new species
- Respiratory organ consisting of three strongly divergent and decidedly swollen trunks from which arise much more slender filaments (fig. 57).....*saltus*, new species
- 3 Respiratory filaments usually 16 (fig. 64).....*hirtipes* (Fries)
- Respiratory filaments at least 20 (fig. 62).....*magnum* Dyar & Shannon

## Key to Larvae

- 1 Antenna about one-third as long as distance from base to posterior margin of head capsule; teeth of submentum gradually decreasing in length from median to lateral teeth; inner subapical margin of mandible with about eight serrations, mostly large; length of maxillary palpus twice width at base.....*magnum* Dyar & Shannon
- Antenna about one-half as long as distance from base to posterior margin of head capsule; teeth of submentum not gradually decreasing in length from median to lateral teeth; inner subapical margin of mandible with 12 or more serrations, mostly small; length of maxillary palpus three times width at base..... 2
- 2 Head capsule with distinct dark brown anterolateral head spots; submentum with trifid tooth shorter than all others; intermediate teeth subequal in length to outer teeth; pupal histoblast with 16 filaments arising from three main branches; inner subapical margin of mandible with about 12 serrations.....*hirtipes* (Fries)
- Head capsule with distinct yellow anterolateral head spots; submentum with median trifid tooth larger than all other teeth; intermediate teeth shorter than outer teeth; pupal histoblast with 16 setiform filaments arising from a stumplike base; inner subapical margin of mandible with usually about 17 serrations.....*rhizophorum*, new species



**Prosimulium hirtipes (Fries)**

(Figs. 2, 15, 34, 64, 90, 99, 108, 116)

*Simulia hirtipes* Fries, 1824:17-18, figs. 1, 2 (female, male)*Melusina hirtipes* (Fries) : Lundstroem, 1911:19-20, fig. 19 (female, male)*Simulium hirtipes* Fries : Puri, 1925:350-362, fig. 20A-H (pupa, larva)*Simulium* (*Prosimulium*) *hirtipes* Fries : Twinn, 1936:103-6, fig. 1A (female, male, pupa) ; Smart, 1944:32, 43, 44, 48, 50, figs. 3, 8, 11a (female, male, pupa, larva)*Prosimulium hirtipes* (Fries) : Rubzov, 1940:261-64, figs. 4, O, S.; 16B, 66J, 75B (female, pupa, larva) ; Davies, 1949:18-19 (female, male, pupa) ; Nicholson and Mickel, 1950:20-21, fig. 16A-E. (female, male, pupa) ; Sommerman, 1953:265, 268, fig. 16 (larva) ; Grenier, 1953:83-86, figs. 13, 18, 30, 38, 50, 86, 87, 118, 137, 138, 149, 152, 185 (male, female, larva, pupa)

**Female.** General color blackish brown. Wing length 3-3.75 mm. Head gray, with pale yellowish hair; frons about as wide as length of first two antennal segments, widened above. Antenna dark brown, the first two segments yellowish brown or reddish brown; first flagellar segment and pedicel about equal in size. Palpus dark, with pale yellowish hair. Mandible serrate; maxilla with retrorse teeth. Scutum brownish black, clothed with recumbent yellow hair. Scutellum with dense, erect yellow hair. Postscutellum velvety dark gray. Pleuron reddish brown to black, with some thin gray pollinosity; pleural tuft yellowish. Wing with hairs at base of costa, on stem vein, and some on under surface of subcosta, pale yellow; rest of hairs yellowish brown. Halter yellowish brown. Legs blackish brown to yellowish red; hairs yellowish except, on tarsi, brownish. Each claw with a very minute basal tooth. Abdomen brownish black, with dense yellowish hair, including the basal fringe. Tergites rather large, narrowest on segment 3; sternites 2 to 6 unsclerotized. Anal lobe J-shaped, the postero-ventral arm extending slightly beyond apex of cercus, which is about twice as wide as long and set at nearly right angles to axis of body; ventral margin of anal lobe evenly rounded; ovipositor elongate, each half tapering posteriorly, with inner margins heavily sclerotized, not reaching apex of anal lobes. Arms of genital fork each with a weakly sclerotized ventral expansion.

**Male.** General color as in female, but scutum and abdomen slightly darker. First flagellar segment slightly longer than pedicel. Hairs at base of costa and on stem vein dark. Halter dark. Basal fringe of abdomen long, dark brown. All tergites large, sclerotized; sternites 1, and 3 to 8 sclerotized. Basistyle stout, tapering distally, about as broad as long; dististyle about two-thirds length of basistyle, curved inward, the apex compressed, usually with three teeth, the subapical one detached from the two nearer the apex; ventral plate broad, with stout basal arms and the apex thickened and curved downward.

**Pupa.** Length 4.5-5.5 mm. Respiratory organ about length of dorsum of cephalothorax, usually with 16 filaments in three somewhat divergent groups; dorsal group with eight filaments arranged 3-2-3; lateral and ventral groups of four filaments each, branching dichotomously. Dorsum of cephalothorax nearly smooth; trichomes single. Tergites 4 to 8 with a single row of fine, closely set hooklets anteriorly; tergites 2 to 4 with about eight larger hooklets in a single row posteriorly, those on tergite 2 inconspicuous. Terminal hooks somewhat divergent with a short seta at base of each anteriorly. Sternite 4 with two posterior hooklets; sternites 5 to 7 each with four hooklets posteriorly, with lateral ones on sternite 5 more ventral than on sternites 6 and 7. Cocoon usually covering most of pupa.

**Larva.** Mature specimens 6-8 mm long. **Head capsule** with distinct dark brown anterolateral head spots. Throat cleft three times as broad as long. Submentum with **outermost** teeth slightly longer than median trifid tooth, with three intermediate teeth between median and outer on each side, subequal in length to **outer teeth, and with innermost** of these slightly smaller than others; lateral margins of submentum wavy but not serrate distally. Usually two long and two short epicranial setae present on each side. Mandible with small **teeth** having relative lengths 2-1-3 from distalmost **basal**; inner subapical margin of mandible with about 12 serrations, mostly small. Antenna relatively short, slightly more than half as long as distance from base to **posterior** margin of head capsule; segment length ratios, base to apex 6.6-9.2-9.4-1, width of first two segments approximately 0.16 their combined length. Each cephalic fan with 30 to 40 rays. Length of maxillary palpus about three times width at base. Pupal respiratory histoblast with 16 filaments arising from three main branches. Anal cross-piece well sclerotized, dorsal arms longer than ventral arms. Anal hooks 9 to 14 to a row in about 77 rows.

**Distribution.** Holarctic. In the Nearctic region in the Hudsonian, Canadian and Transition zones from Alaska and Labrador to California and Georgia.

### New York Distribution

A common species found throughout the State.

**Biology.** Smart (1936, 1944) noted that the oviposition habits of *P. hirtipes* are not known but that negative information indicates that they do not lay their eggs in masses.

The appearance of larvae of this species in the fall in streams which do not flow during the summer is rather puzzling. It has been suggested

that the females drop their eggs into streams one at a time as do the females of *S. arcticum*. Since the bottoms of these streams usually remain damp throughout the summer, it is conceivable that eggs deposited in this way would remain viable. The well-developed ovipositor suggests that the eggs might be imbedded in vegetation or soil. With these points in mind, the vegetation and bottoms of Adirondack streams where *P. hirtipes* was known to be abundant were examined for eggs, but with no success.

In Amherst, Mass., on May 9, 1953, gravid females of *P. hirtipes* were collected crawling in and around a network of partially exposed fine roots which were moistened by spray from water flowing over a dam. The roots were imbedded in loose soil at the edge of a stream. Twelve days after these observations were made, the roots were pulled up and examined. Large numbers of typical black fly eggs were found loosely attached to them. These eggs averaged 0.36 mm in length and 0.159 mm in width at the widest point. The evidence that these were *P. hirtipes* eggs is as follows: Large numbers of gravid *P. hirtipes* females were collected crawling over the roots 12 days before the eggs were collected; *P. hirtipes* larvae, the only larvae collected there, were extremely numerous in this stream earlier in the season; no other black flies are known to lay their eggs in similar situations.

This species overwinters in the larval stage, usually appearing in streams in late October or November (Strickland, 1911; O'Kane, 1926; DeFoliart, 1951). *P. hirtipes* larvae collected in November and December in the Adirondacks ranged from 1 to 7 mm in length, with a modal length of about 4 mm. During the winter and early spring they make up about 80 per cent of the larval population. The number of *P. hirtipes* larvae declines rapidly during the spring. By June only a few can be found, although some may be present as late as July.

Data collected in the Adirondacks in 1950 and 1951 indicated that there might be a partial second generation of *P. hirtipes* each year. To determine the number of generations a year, all larvae of this species collected from November 1951 to July 1952 were measured. Small larvae (1-2 mm) were found as late as June 5th. There was no apparent second generation, however, as would be indicated by a sudden large increase in the number of small larvae. It seems probable that the small larvae found in April, May and June emerged from late hatching eggs laid the previous summer. This information is important to consider when planning a control program. Fall treatments made after the appearance of some *P. hirtipes* larvae would not be so effective as spring treatments because in the fall many of the black flies would be in the highly resistant egg stage. By treating the streams in the

spring after most of the eggs have hatched, a more effective control can be obtained.

In the Adirondacks *P. hirtipes* larvae pupate, for the most part, between late April and the first week in June, depending on the temperature of the stream. The peak period of adult emergence was between May 15 and May 30 in 1950, 1951 and 1952.

A comparison of data obtained by Dimond and Hart (1953) in Rhode Island with data collected in the Adirondacks also indicates that larvae pupate earlier and adults emerge sooner in warm areas than in cooler ones. Similarly, in the Adirondacks, there was a very noticeable difference in the time of pupation of *P. hirtipes* in the Old Forge area and the warmer, less elevated Forestport area.

The duration of adult life and the habits of adults, except for annoying humans, are little known. They do not begin biting for about a week after they first appear. Judging from the seasonal population changes of the different stages, the adults probably live for about three weeks.

*P. hirtipes* has been reported attacking man, cattle, a pony and other animals (Bromley, 1952; Davies, 1950; DeFoliart, 1951; Dimond and Hart, 1953; Dyar and Shannon, 1927; Edwards, 1915; Edwards *et al.*, 1939; Frost, 1949; Hocking and Richards, 1952; Jamnback, 1952; Jenkins, 1948; Johannsen, 1934; Malloch, 1914; Sailer, 1953; Smart, 1936, 1944; and Twinn, 1936).

### **Prosimulium magnum Dyar and Shannon**

(Figs. 4, 6, 7, 35, 62, 83, 100, 110)

*Prosimulium magnum* Dyar and Shannon, 1927:6-7, figs. 1, 2, 22, 23 (female, male, pupa)

*Eusimulium frisoni* Dyar and Shannon, 1927:18, Pl. 1, E (female) (New synonymy)

**Female.** Agreeing with *P. hirtipes* (p. 23) with the following exceptions: Slightly larger, the wing length 3.25-4.5 mm. First flagellar segment of antenna decidedly larger than pedicel both in length and thickness. Tarsal claw lacking a minute basal tooth. Anal lobe L-shaped, the posterior arm curving below and beyond base of cercus, and with ventral margin evenly rounded; cercus set at an angle, with its width about three times its length; ovipositor elongate, just reaching posterior end of anal lobes; arms of genital fork with a subquadrate dorsal expansion.

**Male.** Agreeing with the male of *P. hirtipes* (p. 23) except as follows: First flagellar segment of antenna large and long, much longer than pedicel, so that first three antennal segments comprise

about half length of antenna. Hairs of stem vein mixed pale and dark. Basal fringe of abdomen long, dark basally, pale yellow apically.

**Pupa.** Agreeing with pupa of *P. hirtipes* (p. 24) except as follows: Length about 7 mm. Respiratory organ with 25 to 30 filaments, branching irregularly. Six slender hooklets on sternite 3, and four larger ones on sternite 4, in addition to those on sternites 5 to 7. Cocoon very loose and irregular, often not covering entire pupa.

**Larva.** Agreeing with larva of *P. hirtipes* (p. 24) except: Throat cleft about two and one-half times as wide as long. Submentum with median trifid tooth longer than all others; other teeth gradually decreasing in length from median to outermost teeth; lateral margins of submentum serrate distally. Inner subapical margin of mandible with about eight serrations, mostly large. Antenna short, about one-third as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 5-7.5-8-1; width of first two segments approximately 0.19 their combined length. Each cephalic fan with about 45 fan rays. Length of maxillary palpus slightly more than twice width at base. Pupal respiratory histoblast with about 25 to 30 filaments. Abdomen with median ventral bulge often present on segment 7. Anal cross-piece well sclerotized, dorsal arms subequal in length to ventral arms. Anal hooks 15 to 16 to a row in about 92 rows.

**Distribution.** Transition and Upper Austral zones from Illinois and Oklahoma to Massachusetts and Georgia.

### New York State Records

Fulton co.—Caroga lake (adult) May 6th (larva)

Hamilton co.—Long lake (Eaton Pond outlet), May 6th-24th (larvae and pupae)

Putnam co.—Brewster, April 24th-May 15th (adults)

Schuyler co.—Mecklenburg, June 1; Cayuta lake, April 21st (larvae), May 1st-June 1st (adults)

Tompkins co.—Ithaca, April 8th (larvae), May 22d (adults); Ringwood, May 30th (adults)

Ulster co.—Spring Glen, May 8th (adults)

Warren co.—Pack Forest Lake outlet, Warrensburg, May 8th (larvae)

Westchester co.—Armonk, May 11th; Tarrytown, May 7th (adults)

**Biology.** There is one generation a year of *P. magnum* in the Adirondacks. Larvae and pupae were collected at Eaton Pond outlet on May 6, 1952. Larvae were collected from a stream near the junc-

tions of Route 13 and Eastlawn Road in Ithaca, April 8, 1952, and from Pack Forest Lake outlet, Warrensburg, May 8, 1952. This species is not present in large enough numbers to be annoying in the Adirondacks. It is probably more plentiful in the lowlands.

***Prosimulium rhizophorum*, new species**

(Figs. 56, 82, 109)

*Prosimulium* sp. O'Kane, 1926:21, fig. 1 (pupa)

**Female.** General color yellowish brown. Wing length 3.5 mm. Head dark gray, with pale yellowish hair; frons distinctly widened above. Antenna dark brown, with scape and pedicel reddish brown; first flagellar segment scarcely longer than pedicel. Palpus yellowish brown, with pale hair. Mandible serrate; maxilla with retrorse teeth. Scutum dark brown, with recumbent pale yellow hair. Scutellum with erect yellow hair. Postscutellum reddish brown. Pleuron reddish brown; pleural tuft pale yellowish. Hairs at base of costa and on stem vein pale yellow. Halter pale yellowish. Legs yellow, the tarsi somewhat darkened. Each claw with a very minute basal tooth. Abdomen yellowish brown, with dense, pale yellowish hair; sclerotized tergites large, especially posteriorly; sternites 1 to 6 unsclerotized; sternite 7 a plate slightly wider than long, rounded anteriorly; sternite 8 larger. Anal lobe L-shaped, with dorsal arm at right angles to axis of body, and ventral arm broader, reaching nearly to apex of cercus; cercus subrectangular, about twice as wide as long; ovipositor elongate, each half with inner margin heavily sclerotized, tapering, not quite reaching apex of anal lobe; genital fork scarcely expanded anteriorly; each lateral arm with a blunt dorsal lobe.

**Male.** General color darker than female. Wing length 2.75 mm. Antenna dark, the first flagellar segment slightly larger than pedicel. Humerus paler than rest of scutum. Hind basitarsus about four times as long as greatest width. Sternites sclerotized. Dististyle about two-thirds length of basistyle, broad basally, flattened distally, with two distal teeth. Ventral plate broad with a median ventral lobe.

**Pupa.** Length 3.75-4.5 mm. Respiratory organ about one-third length of pupa, with 16 slender filaments arising from an irregularly swollen base, as shown in figure 56; four filaments arise from a basal ventral lobe, four from a more distal lateral swelling, and eight from four distal projections. Thorax smooth, with trichomes hairlike, pointing forward. Terminal hooks dark, long, slender, subparallel, without accessory hooks. Cocoon a shapeless mass.

**Larva.** Agreeing with the larva of *P. hirtipes* except: Head capsule with distinct, light yellow, anterolateral head spots. Submentum with median trifold tooth longer than others; with outer lateral teeth nearly as long as median; with two intermediate teeth between median and outer teeth on each side, distinctly shorter than outermost and innermost teeth; third intermediate tooth much smaller. Usually three long and one or two short epicranial setae present on each side. Inner subapical margin of mandible generally with about 17 serrations, mostly small. Antennal segment length ratios, base to apex, 8.3-11.5-10.5-1. Each cephalic fan with about 37 fan rays. Pupal respiratory histoblast with 16 short, setiform filaments arising from a stumplike base.

**Holotype.** Male, with pupal skin and cocoon, Waterfalls, Bear Creek Township, Luzerne co., Pennsylvania, May 13, 1948 (Goulding). **Paratypes.** CONNECTICUT: Morris, Litchfield co., April 10, 1953 (Stone), 2 pupae. ILLINOIS: Gibbins creek, Herod, May 15, 1941 (Mohr & Burks), 2 pupae; April 29, 1941 (Mohr & Burks), 1 pupal skin. MAINE: Livermore Falls, May 22, 1952 (Kusche), 1 pupa. NEW YORK: Caroga lake, April 27, 1952, 16 larvae; May 6, 1952, 2 reared males with pupal skins, 1 pupa; May 15, 1952, 6 females with pupal skins, 2 pupae (Jamnback); Brooktondale, Six Mile Creek inlet, April 24, 1952 (Jamnback), 2 pupae, and April 24, 1954 (Stone), 1 larva, 3 pupae; 11 miles N. of Lake Placid, April 24, 1954, (Jamnback), larvae and pupae. RHODE ISLAND: Kingston, May 8, 1952 (Dimond), 10 larvae, 10 pupae.

Holotype and paratypes, U. S. National Museum No. 62358. Paratypes, Illinois Natural History Survey, New York State Museum, and University of Rhode Island.

**Biology.** The larvae of this species are found primarily in small, temporary, rapid streams in forested areas in New York. They are often present in large numbers but the distribution is spotty. They are found with *Prosimulium hirtipes*, and *Cnephia mutata* larvae.

### ***Prosimulium saltus*, new species**

(Fig. 57)

**Female.** No characters found to distinguish this from *P. hirtipes*.

**Male.** No satisfactory characters found to separate this from *hirtipes*, although there may be slight differences in the male genitalia. The ventral plate appears slightly broader in proportion to its width, and the median hirsute lobe is narrower; the dististyle is truncate, with two teeth, represented only by sockets in the single, teneral specimen.

**Pupa.** Length about 4.5 mm. Respiratory filaments 14 to 16 arising from three stout, divergent trunks; these trunks nearly as long as filaments; the dorsal trunk expanding distally with six to eight filaments arising from cones of varying thickness; the middle trunk, pointing forward, divides into two parts at about half its length, and each half bears two filaments; the ventral trunk divides near the apex, and each half bears two filaments, one from a stout cone and one from a slender one. Dorsum of cephalothorax nearly smooth; trichomes single. Tergites 5 to 8 each with a single row of fine, closely set hooklets anteriorly, those on tergite 5 very small; tergites 3 and 4 each with eight hooklets posteriorly. Terminal hooks somewhat divergent, with a short seta at base of each anteriorly. Sternites 4 to 7 each with four hooklets posteriorly, those on sternite 4 smaller and in two pairs, on sternites 5 to 7 larger and more evenly spaced. Cocoon small and irregular.

**Larva.** Unknown.

**Holotype.** Female with associated pupal skin, near outlet of Cayuta lake, Schuyler co., N. Y. Paratypes, one male with associated pupal skin and larval head capsule, two pupae. Holotype and one pupa collected May 17, 1950, and male and one pupa, April 24, 1954, all by the senior author from a small cascade flowing into the outlet of Cayuta lake about one mile from the lake on the east side, U. S. National Museum No. 62359. The specific name is the genitive of *saltus*, a dale, ravine or glade.

**Biology.** This species has been collected in one restricted locality only, at the foot of a small, temporary cascade falling off a shale cliff. The pupae were on small stones in the stream.

## SUBFAMILY SIMULIINAE

### CNEPHIA ENDERLEIN

*Cnephia* Enderlein, 1921a:199. Genotype *Simulium pecunarium* Riley Smart, 1945: 483-85

**Generic characters.** Antenna 11-segmented. Male holoptic. Subcosta, radius, and radial sector all close together;  $R_1$  joining costa well beyond middle of latter's length; radial sector usually an unbranched convex vein, with a single row of hairs on upper side; vein R with macrotrichia on upper side; macrotrichia of anterior wing veins mixed hairlike and spiniform; basal cell present; submedian fold forked;  $Cu_2$  sinuous. Legs not contrasting dark and light; fore tarsus not particularly flattened; cacipala usually small or absent; pedisulcus absent or represented by a weak constriction. Ventral plate of male



genitalia broad; dististyle more or less curved, tapering, with one or two terminal teeth.

Pupa with 8 to 30 terminal filaments in respiratory organ, often arising from a swollen knob on a short stem. Abdominal tergites 6 to 8 each with an anterior row of small spines; terminal hooks present or absent. Cocoon variable, usually irregular and poorly defined, but sometimes boot-shaped or otherwise constructed.

The larvae all have simple anal gills but are otherwise quite dissimilar.

We consider the New York State species to represent three separate subgenera, separable primarily on characters of the immature stages. These subgenera are:

*Cnephia* Enderlein 1921a:100. Tarsal claws of female each with a distinct tooth; calcipala small; dististyle of male with a single tooth. Respiratory filaments of pupa numerous and arising from a distinct knob on a short petiole; terminal hooks of pupa well developed; cocoon loosely woven, shapeless. Submentum of larva with small subequal teeth on each side of a slightly larger median tooth, anterior margin of submentum nearly straight; inner subapical margin of mandible with a long, thin, pointed process followed by one to three small projections and a small cleft; anal cross-piece X-shaped, with ventral arms longer than dorsal arms; ventral tubercles absent.

*Ectemnia* Enderlein, 1930:88. Genotype, *Cnetha taeniatifrons* Enderlein. Tarsal claws of female each with a distinct tooth; calcipala absent; a shallow pedisulcus often present; dististyle of male with two teeth. Respiratory filaments of pupa rather stout, simple, curving toward a common point; terminal hooks present; cocoon rather closely woven with the front margin ragged, attached by a woven stalk to the substratum. Submentum of larva with a deeply concave anterior margin which bears a few very small teeth; inner subapical margin of mandible smooth except for a single small serration; anal cross-piece absent; ventral tubercles present. Through the kindness of Dr Fritz Peus, the type female of *Cnetha taeniatifrons* Enderlein was sent to the senior author. Although Enderlein described *Ectemnia*, the genus that he later erected for *taeniatifrons*, as having a pedisulcus, this is shallow in the type, and not sufficiently developed to consider it as belonging to the genus *Simulium*. A considerable number of specimens in the U. S. National Museum show it to be often more weakly developed than in the type. The relationship of *C. taeniatifrons* to *C. loisae* is particularly evident in the pupal stage.

*Mallochianella* Vargas and Diaz, 1948a:67. Genotype, *Mallochella sibirica* Enderlein. Tarsal claws of female lacking teeth; calcipala well developed; dististyle of male with two teeth. Respiratory filaments

of pupa slender, branching irregularly; terminal hooks present; cocoon loosely woven, irregular. Submentum of larva with two broad, large, lateral teeth with a deep cleft between them from which arises a long, thin, median tooth and one or two small intermediate teeth on each side; inner subapical margin of mandible with 7 to 12 serrations, the distalmost largest; anal cross-piece as in the subgenus *Cnephia*; ventral tubercles absent. The authors of this subgenus placed it in the genus *Gigantodax* Enderlein, but we follow Rubzov, who placed both the genotype and *mutata* in the genus *Cnephia*, although in the subgenus *Stegopterna*. Both species differ from *Stegopterna* in having the tarsal claw untoothed. Following Smart's (1945) classification of the family, the two species would fall into *Cnephia* rather than *Gigantodax*.

### Keys to Species of *Cnephia*

#### Females

- 1 Tarsal claw simple (*Mallochianella*).....*mutata* (Malloch)
- Tarsal claw with a small, distinct tooth or strong basal projection..... 2
- 2 Ninth tergite with a distinctly projecting posterior lobe with a thickened edge; claw long, the basal tooth short (*Cnephia*)  
*dacotensis* (Dyar & Shannon)
- Ninth tergite normal, without a prominent posterior lobe; claw shorter, the basal tooth prominent (*Ectemnia*).....*loisae*, n. sp.

#### Males

- 1 Dististyle with only one apical tooth.....*dacotensis* (Dyar & Shannon)
- Dististyle with two apical teeth..... 2
- 2 Hind basitarsus with a distinct calcipala.....*mutata* (Malloch)
- Hind basitarsus without a calcipala.....*loisae*, n. sp.

#### Pupae

- 1 Respiratory filaments more than 20.....*dacotensis* (Dyar & Shannon)
- Respiratory filaments less than 15..... 2
- 2 Respiratory filaments about 12, slender, branching irregularly from two main trunks.....*mutata* (Malloch)
- Respiratory filaments 8, stout, all arising from the base and curving toward a common point.....*loisae*, n. sp.

#### Larvae

- 1 Abdominal segment 5 projecting ventrally far beyond segment 4; head spots light; paired ventral tubercles present; throat cleft U-shaped, rounded anteriorly; submentum with concave anterior margin, with teeth very small (fig. 85).....*loisae*, n. sp.
- Abdominal segment 5 not projecting ventrally far beyond segment 4; head spots dark; paired ventral tubercles absent; throat cleft usually not rounded anteriorly; submentum not as above..... 2

- 2 Throat cleft a shallow, V-shaped notch (fig. 91); submentum with large lateral teeth, long slender median tooth, apical margin not smoothly concave (fig. 84); antenna long, nearly as long as distance from base to posterior margin of head capsule (fig. 101).....*mutata* (Malloch)
- Throat cleft U-shaped with flattened apex; submentum with small teeth, median largest anterior margin smoothly concave (fig. 86); antenna short, slightly less than half as long as distance from base to posterior margin of head capsule (fig. 103).....*dacotensis* (Dyar & Shannon)

### **Cnephia (Cnephia) dacotensis (Dyar and Shannon)**

(Figs. 9, 14, 38, 63, 86, 103)

*Eusimulium dacotense* Dyar and Shannon, 1927:20-21, figs. 48-51 (male, female); Stains and Knowlton, 1943:268, figs. 30, 38, 39, 49, 50 (male, female); Nicholson, 1945:281-96, figs. 1-6, 9, 10, 13, 17, 18, 21, 23, 25 (mouthparts)

*Cnephia dacotense* (Dyar and Shannon): Nicholson and Mickel, 1950:22-24, figs. 17 A-E. (male, female, pupa)

*Simulium (Eusimulium) lascivum* Twinn, 1936:127-30, Pl. 1, fig. 4, textfig. 8D (male, female, pupa)

*Eusimulium lascivum* (Twinn): Krafchick, 1943:426-34, Pl. I, figs. A-E, Pl. II, figs. A-E (mouthparts)

*Cnephia lascivum* (Twinn): Davies, 1949:19 (female, male)

**Female.** General color brownish black. Wing length 2.75-3.2 mm. Frons and occiput brownish black, with dark hair, the occipital area rather broad and frons distinctly diverging above. Clypeus slightly more reddish. Antenna nearly black, with scape and pedicel slightly reddened. Palpus dark. Mandible not serrate; maxilla without retrorse teeth. Scutum dark brown, subshining, with short brownish hair and three narrow paler brown lines. Scutellum usually somewhat reddened, with erect dark brown hair. Postscutellum dark, subshining. Pleuron reddish brown to nearly black; pleural tuft brown. Wing smoky, with veins yellowish brown, with all hairs brownish; subcosta and  $R_s$  with abundant hairs beneath. Halter pale yellowish. Legs almost uniformly yellowish brown, with concolorous hair; fore tibia flattened; hind basitarsus nearly six times as long as wide; calcipala very small; no distinct pedisulcus; claw rather slender, with basal swelling and small tooth. Abdomen dark brown, with basal fringe rather short, fine, yellowish to brown; ninth tergite narrowed and convex above, projecting rooflike over genitalia; sternites weakly sclerotized. Anal lobe rather elongate, the ventral margin straight, slightly produced posteriorly below, with elongate narrow projection above and concave posterior margin; cercus twice as broad as long; ovipositor small with each half triangular; arms of genital fork broad, sclerotized, each with a small dorsal tooth.

**Male.** Color, size and most of anatomy as in female. Hind basitarsus about four times as long as greatest width. Sternites 3 to 7

large, sclerotized. Basistyle stout, about as long as basal width, somewhat narrowed distally; dististyle about two-thirds length of basistyle, somewhat flattened, curved upward and mesally, and narrowing to apex, which bears a single short spine; ventral plate broad, rounded distally, with broad, low mesal keel ventrally, with stout, slightly converging basal arms; paramere rather small and membranous, the parameral hooks small.

**Pupa.** Length 4-6 mm. Respiratory organ of 30 to 40 filaments in 6 to 7 branches from a swollen base, with some further branching close to base, and additional branching more distally; total length of organ about length of thorax. Dorsum of thorax with slight transverse wrinkling; trichomes small, simple, pointing posteriorly. Terminal hooks well developed, divergent, with darkened tips. Cocoon loosely woven, shapeless.

**Larva.** Mature specimens 11 mm long. Head capsule with distinct brown head spots surrounded by dark fulvous area; median row which consists of about 11 irregularly placed spots without distinct isthmus between anterior and posterior groups. Throat cleft extending slightly more than one-fourth distance from posterior margin of head capsule to anterior margin of submentum; with anterior margin variable, flattened to slightly arched; widest at posterior margin. Suboesophageal ganglion colorless to light brown, never black. Submentum with six small teeth on each side of a slightly larger median tooth; with anterior margin, at most, slightly concave, lateral margins serrate distally. Usually two long and one short epicranial seta present on each side. Distance from apex of outermost tooth to anteriormost seta on same side slightly less than distance between outermost teeth. Mandible with small teeth having relative lengths 15-11-17 from distalmost basad; inner subapical margin with long thin toothlike serrations followed by one to three smaller serrations which are followed by a small cleft. Antenna short, slightly less than half as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex 3.8-9-8.5-1; general color light yellow, uniform. Each cephalic fan with 41 to 49 rays. Length of maxillary palpus about two and one-half times width at base. Pupal respiratory histoblast with 30 to 40 filaments. Abdomen of preserved specimens mottled brown with light intersegmental areas; with maximum thickness at posterior margin of segment 7. Ventral tubercles lacking. Anal cross-piece well sclerotized, the area between dorsal arms lightly sclerotized; dorsal arms slightly shorter than ventral arms. Anal hooks 11 to 17 to a row in about 61 rows.

**Distribution.** Transition and Upper Austral zones from South Dakota and Iowa to Ontario, Rhode Island and Pennsylvania. Also one series of specimens from the Hudsonian zone at Churchill, Manitoba.

### New York State Records

Herkimer co.—Lily Pad Pond outlet, May 14th (larva)

Lewis co.—Big Otter Lake outlet, May 29th (pupa), May 9th, May 29th, June 5th (larva)

Rensselaer co.—Taborton, May 9th (pupae)

Rockland co.—Bear mountain, June 1st (adult)

Schuyler co.—Cayuta Lake outlet, April 24th (larvae), May 1st-21st (adult, larva, pupa)

Tompkins co.—Ithaca, May 28th (adult)

**Biology.** *Cnephia dacotensis* is found only rarely in the Adirondacks. Larvae and pupae are present only in warm pond or lake outlets such as Lily Pad Pond outlet and Big Otter Lake outlet. It is found only in May and June in the larval or pupal stage, probably overwintering in the egg stage. The senior author has seen huge congregations of this species at Cayuta lake and in Pennsylvania, the adults emerging and crawling all over the stones and vegetation above water, and on one's person if he wades in among them. At the same time there may be great quantities of larvae and pupae under the surface of the water. Nicholson and Mickel (1950) reported that in Minnesota larvae are found in April and adults emerge in May, and that the species spends most of the summer and winter in the egg stage. Davies (1950) reported that the adults emerge in June in Ontario.

According to Nicholson and Mickel (1950), the pupae require about eight days to complete development. Large and apparently well-developed eggs are present in the mature pupae of the females and copulation takes place immediately after emergence. The females do not feed as adults (Krafchick, 1942; Nicholson, 1945).

### *Cnephia (Ectemnia) loisae*, new species

(Figs. 22, 39, 65, 72, 85, 102, 111)

**Female.** General color dark grayish brown. Wing length 4 mm. Frons dark brown, narrow, at narrowest near middle slightly less than width of first flagellar segment, widening above and below. Clypeus gray, with pale yellow hair, about four times as wide as frons and slightly longer than wide. Antenna entirely dark brown. Mandible serrate; maxilla with retrorse teeth on both margins. Scutum dark

brown, with fine, recumbent, yellowish hairs; integument **paler behind** each humerus and before the prescutellar declivity, **these areas connected** by a slender line on each side; **from the posterior** paler area a very slender median line runs forward, tapering and not reaching anterior margin of scutum. Scutellum dark brown, with rather short, erect, yellowish hair. Postscutellum dark brown with **grayish** pollen. Pleuron brown, the upper portions somewhat reddish, the lower portion darker; pleural tuft yellowish. Wing veins dark brown; hairs of stem vein yellow brown; subcosta with hairs **beneath**; basal cell very small. Halter pale yellow, with stem darker. **Legs** almost uniformly dark brown; hind basitarsus about 5 times as long as wide; calceola absent; no pedisulcus; each claw strongly curved, with a strong basal projection nearly two-thirds length of claw. Abdomen dark brown, the membranous areas paler; tergites large, **narrowest on segments 4 and 5**; subshining, with pale yellow hair; **basal fringe pale yellow**; sternites 2 to 7 unsclerotized; sternite 8 rather large, **rounded** anteriorly. Anal lobe subquadrate, the anteroventral portion paler, with a very short ventral projection at corner; cercus slightly longer than **broad, rounded** and slightly tapering posteriorly; ninth sternite **broad, heavily** sclerotized; ovipositor with inner margins of the two halves **parallel, basally** sclerotized and apically pale, rounded, little produced; **genital fork** not expanded at base; arms short, broadly expanded apically, each with a broad ventral lobe and a short, acute, subapical dorsal projection.

**Male.** Slightly darker than female. Wing length 3.5 mm. Hairs of clypeus brownish. First flagellar segment about 1.6 times as long as second flagellar segment. Mandible apparently without serrations; maxilla reduced, without teeth. Hairs of thorax mixed pale yellow and brownish. Hairs of stem vein brown; subcosta without hairs beneath. Halter slightly darker than in female. Hind basitarsus about 3.4 times as long as wide. Basal fringe and most abdominal hairs dark brown; sternites 3 to 8 sclerotized. Basistyle subquadrate; dististyle about 4.5 times as long as basistyle, curved and apically **compressed**; apex with two small teeth; ventral plate more than twice as broad as long, the basal arms flattened and divergent, the center with a rather narrow, ventrally curved lip; hairs on ventral plate short and inconspicuous; median sclerite about as wide at base as lip of ventral plate, **slightly** narrowed distally and dividing into a pair of slightly divergent prongs; paramere of moderate size, the arm without hooks.

**Pupa.** Length about 4 mm. Respiratory organ about one-third length of pupa, of eight moderately stout, slightly tapering filaments, all arising near the base, curving and converging to a common point

on an extension of the median axis of the body. Dorsum of cephalothorax nearly smooth, the trichomes moderately developed, straight, single. Tergite 2 with six posterior hooklets, the two lateral ones on each side close together; tergites 3 and 4 each with eight hooklets posteriorly; tergite 5 with six posterior hooklets; tergites 7 and 8 each with an anterior row of fine, closely set hooklets. Terminal hooks small, divergent. Sternites 6 to 8 each with four hooklets posteriorly. Cocoon consisting of a slender woven cylinder filled with debris and attached to the substratum by a slightly enlarged base, on which, about half way out, is a closely woven, wall-vase-shaped container for the pupa, with the anterior margin ragged.

**Larva.** Mature specimens 7.5 mm long. Head capsule with distinct yellow to white head spots, with dark fulvous area around head spots; anterior median group separated from posterior median group by wide dark brown isthmus; posterolateral spots obscure. Throat cleft U-shaped, rounded apically, slightly narrowed posteriorly, extending about one-third distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion light except near anterior margin where tinged with black. Submentum with deeply concave anterior margin, with small median tooth, two small intermediate teeth and a single large outer tooth on each side; lateral margins wavy but not serrate distally. Usually three long epicranial setae on each side. Distance from apex of outermost tooth of submentum to anteriormost seta on same side one-fourth distance between outermost teeth. Mandible with small teeth broader and more heavily pigmented than in other species, having relative lengths 13-11-9; inner subapical margin smooth except for single small serration. Antenna long, almost as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 11.4-16.8-3.6-1; segment 1 clear ventrally, pigmented yellow dorsally, segment 2 mostly clear, yellow dorsally near base, segments 3 and 4 light yellow. Each cephalic fan with 68 rays. Length of maxillary palpus slightly less than four times width at base. Pupal respiratory histoblast with eight filaments. Abdomen of preserved specimens mottled brown with light intersegmental areas; segment 5 projecting abruptly ventrally about one-fourth width of preceding segment; following segments tapering posteriorly. Ventral tubercles present, directed posteriorly anal cross-piece absent or not sclerotized. Anal hooks 7 to 8 to a row in about 69 rows.

**Holotype.** Male, Pine creek, Forestport, N. Y., April 10, 1952 (H. A. Jamnback). Paratypes, 1952, same locality, April 4th, male, 2 pupal skins, 8 pupae; April 10th, 3 females, 2 pupal skins; April 17th,

male with pupal skin; Gulf creek, May 1st, female; 1954; White Lake outlet, Bear creek, March 31st, larvae; Pine creek, April 7th, pupae; Long Lake outlet, April 20th, pupae; Little Woodhull R., April 24th, in car, female (all Jannback). Holotype, U. S. Nat. Mus. No. 62360; Paratypes, U. S. National Museum and New York State Museum.

**Biology.** This species has only been found in the vicinity of Forestport, N. Y. Larvae and pupae were found in late March and early April. It has been collected only in streams 20 to 30 feet wide where the bottom is sandy and large rocks are present. The larvae and pupae have been found almost exclusively on the large rocks at depths of one to two feet. *C. loisae* probably overwinters in the larval stage with adults emerging in the early spring. There is apparently only one generation a year.

The name *Simulium invenustum* Walker has been associated with both *Cnephia pecuaria* (Riley) and *Cnephia taeniatifrons* (Enderlein). Notes on the types of *invenustum* provided by Paul Freeman of the British Museum rather clearly indicate that neither *pecuaria* nor *taeniatifrons* is *invenustum*, and the type locality (St Martin's Falls, Albany river, Hudson's bay) is also against such synonymy. There is the possibility that what we here describe as new is *Cnephia invenusta*, but we prefer not to so determine it without further evidence.

We take pleasure in dedicating this species to the wife of the junior author.

### ***Cnephia (Mallochianella) mutata* (Malloch)**

(Figs. 5, 16, 36, 54, 80, 84, 91, 101)

*Prosimulium mutatum* Malloch, 1914:20-21, pl. 2, fig. 18 (female)

*Eusimulium mutatum* (Malloch): Dyar and Shannon, 1927:17, figs. 34, 35 (female)

*Mallochella mutata* (Malloch): Enderlein, 1930:91

*Simulium (Eusimulium) mutatum* (Malloch): Twinn, 1936:125-27, fig. 8C (female, male, pupa, larva)

*Cnephia mutatum* (Malloch): Davies, 1949:19 (pupa); Nicholson and Mickel, 1950:25-26, fig. 18A-E (female, male, pupa)

*Eusimulium mutatum permutatum* Dyar and Shannon, 1927:17-18, fig. 36 (female)  
Undescribed species No. 2, Ritcher, 1931:243-45, pl. 6, figs. 1-6 (pupa, larva)

**Female.** General color grayish black. Wing length 3-3.5 mm. Frons dark grayish, pollinose, divergent above, at narrowest slightly narrower than concolorous clypeus; both with yellowish hairs. Antenna entirely blackish, with pale pubescence. Palpus blackish; sensory organ of third segment about one-third length of segment. Mandible serrate; maxilla with retrorse teeth. Scutum dark brownish gray, subshining, clothed with short, pale yellow, recumbent hairs. Humerus often more or less reddened. Scutellum concolorous with scutum, with erect dark



and more recumbent pale hairs. Postscutellum velvety gray. Pleuron grayish black, with portion posterior to sternopleuron usually reddish or yellowish brown; pleural tuft pale yellow. Wing veins yellow to yellow brown, with hairs and spinules black to dark brown, a few at base of costa yellowish; hairs of subcosta and radial sector on under surface abundant. Halter yellow to brownish. Legs almost uniformly yellow-brown with yellow hair; fore tibia flattened; hind basitarsus about 6-7.5 times as long as wide, nearly parallel-sided; calcipala broadly rounded, extending about one-third length of second tarsal segment; no distinct pedisulcus; claws simple. Abdomen brown, the basal fringe long, yellow; sternites not sclerotized. Anal lobe narrow dorsally, expanded ventrally, extending under cercus, expanded portion notched posteriorly; cercus twice as long as broad, subquadrate with rounded posterior angles; ovipositor with each half rounded posteriorly, not produced; arms of genital fork broadly flattened distally, pale.

**Male.** Somewhat darker than female. Scutum dark, in some lights showing a pair of black submedian stripes, in others a **very slender** median pale stripe and a pair of pale comma-shaped marks from inner angles of humeri. Pleural tuft, halter, and hairs of abdomen darker than in female. Legs darker, the hind basitarsus distinctly broader than in female, about three times as long as broad; calcipala **less produced**. Hind margins of tergites narrowly paler; sternites **large**, sclerotized. Basistyle small, subquadrate; dististyle short, about two-thirds length of basistyle, triangular, the apex with two small teeth; ventral plate broad, with short, flattened, slightly divergent basal arms; distal portion with a broad rounded lip; paramere **very small**, arm with fine hairs but no distinct hooks; median sclerite Y-shaped, the **base** slender, the arms nearly as long as base.

**Pupa.** Length 3-4 mm. Respiratory organ subequal in length to pupa; normally with 12 filaments; the main trunk divides near **base** into two main branches; the upper branch divides again, one subbranch with four divisions, the other with three; the lower main branch divides into two subbranches, one with three divisions, the other with two. Dorsum of thorax smooth, the trichomes rather large. Terminal hooks of abdomen large. Cocoon poorly defined, of loosely woven silk.

**Larva.** Mature specimens 6 mm long. Head capsule with distinct dark brown head spots, lacking dark fulvous area around head spots; with about five anterior and four posterior median head spots, these groups widely separated by a yellow isthmus; with single lateral spot on each side of ventral surface of head capsule slightly anterior

to anterior margin of throat cleft. Throat cleft a small, V-shaped notch extending less than one-fifth distance from posterior margin of head capsule to tip of longest submental tooth. Suboesophageal ganglion never a distinct black, but occasionally brownish. Submentum with nine teeth (excluding processes beyond two large lateral teeth); the outermost teeth large and broad, with small tooth on inner slope of each side, one or two additional small teeth present on each side of long narrow median tooth, which is shorter than large lateral teeth; lateral margins medially wavy, with distal serrations. Two to three long epicranial setae and a variable number of short setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost seta on same side slightly greater than distance between outermost teeth. Mandible with small teeth having relative lengths 8-5-15 from distalmost basad, with teeth 1 and 2 almost obscured by apical teeth; inner subapical margin with 7 to 12 serrations, distal ones larger than basal. Antenna long, slightly longer than distance from base to posterior margin of head capsule; segment length ratios, base to apex 10.4-9.6-8-1, yellowish with pigmentation somewhat heavier on dorsal surface, with segments 3 and 4 darker than segments 1 and 2. Each cephalic fan with about 54 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with 12 filaments arising from two main branches. Abdomen of preserved specimens with brownish and yellowish areas, with light intersegmental areas; median ventral bulge on segment 8. Anal cross-piece well sclerotized, area between arms not sclerotized; ventral arms longer than dorsal arms. Anal hooks 11 to 13 per row in about 60 rows.

**Distribution.** Canadian, Transition and Upper Austral zones from Alaska and Labrador to California, Wyoming, Arkansas and Alabama.

### New York State Distribution

Moderately abundant throughout State. An early spring species.

**Biology.** The larvae of *C. mutata* are found in temporary or permanent streams. They are most numerous in streams with sandy bottoms, with few rocks and pebbles, and with abundant trailing grass. This species overwinters in the larval stage in the Adirondacks and probably in the rest of New York State. In November and December it makes up about 20 per cent of the total larval population. This percentage remains relatively constant until about March, when it begins to decline owing to pupation and appearance of larvae of other species. Larvae may be found until late May or early June. Adults have been

collected from rocks or grass on stream edges in May. Data collected in the Adirondacks support Davies' (1950) statement that there is one generation per year. The adults are usually not anthropophilic, at least in the central Adirondacks. They have been caught in collections of annoying adults in the Forestport area and by the Bozenkill near Delanson, Davies (1950), Hocking and Richards (1952), and Frohne and Sleeper (1951) report that this species is rarely annoying to man.

### SIMULIUM LATREILLE

*Simulium* Latreille, 1802:426. Type *Rhagio colombaschensis* Fabricius.

**Generic characters.** Radial sector unbranched; macrotrichia of anterior wing veins mixed hairlike and spiniform; vein R usually without macrotrichia on upper side; basal cell absent;  $Cu_2$  sinuous; calcipala usually well developed; pedisulcus well developed; antenna with 11 segments; ovipositor not greatly produced. Abdomen of pupa with terminal hooks very small or absent; cocoon well developed with a distinct anterior margin, but not on a stalk. Larval submentum with nine teeth, with the outermost and median largest and usually subequal, the three intermediate teeth on each side much smaller, the outermost of these slightly larger than the others; anal cross-piece X-shaped, with well sclerotized ventral arms, subequal to or distinctly longer than dorsal arms.

We recognize, in the New York State fauna, three of the subgenera of this genus. These are:

*Eusimulium* Roubaud, 1906:521. Genotype, *Simulium aureum* Fries. Vein R with hairs above. Respiratory organ of pupa with three to ten filaments; cocoon simple, wall-vase-shaped, with or without a median anterior projection. Larva of *aureum* with mandibles having the inner subapical margin with a double or two single toothlike processes, with the anterior portion twice as long as posterior; other species with a single large toothlike process projecting at right angles from margin, followed by two to four small, anteriorly pointing projections; anal gill of all except *aureum*, compound with well-developed accessory lobes; ventral tubercles well developed.

*Neosimulium* Rubzov 1940:116, 124, 130. Genotype, *Simulium vittatum* Zetterstedt. Legs markedly bicolored; calcipala small; pedisulcus near middle of second hind tarsal segment; abdomen of female with a distinct pattern of black and light gray; male dististyle with two to four terminal teeth. Respiratory organ of pupa with 10 to 24 filaments; trichomes of cephalothorax well developed; abdominal sternites 6 and 7 with four spines each; cocoon simple, wall-vase-



- 2 Postcutellum with appressed yellow scales; ventral plate and dististyle as in figure 30.....*aurum* Fries
- Postcutellum without scales; ventral plate and dististyle quite different.....*gouldingi* Stone  
*latipes* (Meigen)  
*pugelense* Dyar & Shannon
- 3 Dististyle short and stout with three or more teeth (*Neosimulium*)  
.....*vittatum* Zetterstedt
- Dististyle longer, with only one or two teeth, or no teeth (*Simulium*)..... 4
- 4 Dististyle with a distinct basal, internal tubercle bearing stout spines  
.....*tuberosum* (Lundstroem)
- Dististyle without a distinct tubercle at base..... 5
- 5 Ventral plate more or less compressed, with denticles on margin..... 6
- Ventral plate triangular or broadly rounded, without denticles on margin.. 11
- 6 Basal arm of ventral plate without lateral projections; posterior fourth or less of scutum shiny, clothed with strong erect hairs..... 7
- Basal arms of ventral plate with distinct lateral projections; posterior third of scutum shiny and with hairs indistinct..... 10
- 7 Ventral plate very compressed, in the shape of an inverted Y; with ventral process or keel..... 8
- Ventral plate broader, tooth-shaped, without ventral process, or this not very prominent ..... 9
- 8 Ventral keel of ventral plate setose, forming an angle before apex of median portion of ventral plate.....*decorum* Walker
- Ventral keel of ventral plate concave in profile, the angle being at apex  
.....*corbis* Twinn
- 9 Toothed lateral margins of ventral plate flaring outward, when viewed on end appearing somewhat trilobed, the two lateral lobes with teeth  
.....*venustum* Say
- Toothed lateral margins turned inward toward each other concealing the central region and the distoventral lobe narrower.....*verecundum*, n. sp.
- 10 Velvety black area of mesoscutum less extensive, the distance separating the apex of the iridescent anterior spot from the prescutal shiny area much less than the distance from the hind margin of the black area to the scutellum; white spot at base of hind tibia about one-third length of tibia  
.....*fibrinflatum* Twinn
- Velvety black area more extensive, the distances described above subequal; white of hind tibia about one-fifth length of tibia.....*jenningsi* Malloch
- 11 Ventral plate with a broad median notch nearly dividing it into two parts  
.....*pictipes* Hagen
- Ventral plate without a broad median notch.....*parnassum* Malloch

### Key to Pupae

- 1 Respiratory filaments 4, or if more, the anterior margin of cocoon with a long median projection (*Eusimulium*)..... 2
- Respiratory filaments 6 or more; anterior margin of cocoon without a long median projection ..... 6
- 2 Respiratory filaments 4 ..... 3
- Respiratory filaments 6 or 8 (anterior margin of cocoon with long median projection) ..... 5



- 4 Throat cleft narrowly V-shaped, extending one-third distance from posterior margin of head capsule to teeth of submentum... *parnassum* Malloch
- Throat cleft bulbous, width and depth near middle subequal, extending one-half distance from posterior margin of head capsule to teeth of submentum ..... 5
- 5 Abdomen light to yellowish brown; suboesophageal ganglion light; pupal histoblast with 10 slender filaments..... *jenningsi* Malloch
- Abdomen blackish brown; suboesophageal ganglion faintly dark; pupal histoblast with 6 stout filaments..... *fibrinflatum* Twinn
- 6 Infuscation around head spots not extending beyond inner edge of antero-lateral spots; light yellow area present just anterior to apex of throat cleft on epicranial plate; anal cross-piece narrowly fused medially; mature specimens 8-10 mm long..... *decorum* Walker
- Infuscation around head spots extending to outer edge of anterolateral spots; light yellow area absent on epicranial plate just anterior to apex of throat cleft; anal cross-piece broadly fused medially; mature specimens 6-7 mm long..... *venustum* Say  
*verecundum*, n. sp.
- 7 Throat cleft a bowed-V; mature larvae 5.5-7 mm long; anal hooks 11 to 15 per row..... 8
- Throat cleft not as above; antenna with light spot on venter of second segment (on distal half); mature larvae 9-11 mm long; anal hooks 18 to 27 per row..... 9
- 8 Mature larvae 7 mm long; throat cleft extending two-thirds distance from posterior margin of head capsule to teeth of submentum, with narrow apical extension; suboesophageal ganglion light, epidermis in throat cleft black..... *corbis* Twinn
- Mature larvae 5.5 mm long; throat cleft extending less than one-half distance from posterior margin of head capsule to teeth of submentum, lacking narrow apical extension (fig. 93); suboesophageal ganglion distinctly black, epidermis in throat cleft usually light. *tuberosum* (Lundström)
- 9 Submentum with large median tooth extending far beyond lateral teeth; second antennal segment with bilobed ventral light spot; anal gill with three lobes bearing numerous large ventral accessory lobes; throat cleft extending half way from posterior margin of head capsule to apex of submentum; anal hooks in 127 to 135 rows..... *pictipes* Hagen
- Submentum not with large median tooth extending far beyond lateral teeth; second antennal segment with single lobed ventral light spot; anal gill with three lobes; small ventral accessory lobes usually visible; throat cleft extending slightly more than one-fourth distance from posterior margin to apex of submentum; and hooks in 67 to 88 rows  
..... *vittatum* Zetterstedt
- 10 Throat cleft more or less flattened on anterior margin; anal gill with three simple lobes; inner subapical margin of mandible with two serrations, anterior one twice as long as posterior; respiratory histoblast with four filaments..... *aureum* Fries
- Throat cleft rounded on anterior margin; anal gill made up of three compound lobes; inner subapical margin of mandible with five serrations typically; large anterior serration more or less flat on anterior margin and forming an angle of about 90° with margin, followed by two to four small, anteriorly pointing serrations; respiratory histoblast with four or six filaments ..... 11
- 11 Second antennal segment slightly longer than third segment; respiratory histoblast with six filaments..... *gouldingi* Stone
- Second antennal segment more than twice as long as third segment; respiratory histoblast with four filaments..... 12

- 12 Larvae present in streams in early spring (March in Adirondacks); four long and one to two short epicranial setae on each side.....*pugetense* Dyar & Shannon
- Larvae present in streams in late spring and summer (May and June in Adirondacks); one to three long and one to two short epicranial setae on each side.....*latipes* (Meigen)

### ***Simulium (Eusimulium) aureum* Fries**

(Figs. 30, 45, 66, 96)

*Simulia aurca* Fries, 1824:16 (male, female)

*Melusina aurca* (Fries): Lundstroem, 1911:22, figs. 3, 23, 24 (male)

*Simulium aureum* Fries: Edwards, 1915:39-40 (female only); Edwards, 1920:242-44, figs. 1k, 4m (pupa, larva); Puri, 1925:354-56, fig. 17 (pupa, larva); Nicholson and Mickel, 1950:37-40, fig. 25 (male, female, pupa); Grenier, 1953:108-9, figs. 33, 67, 77, 106, 176 (female, male, pupa, larva)

*Nevermannia auroa* (Fries): Enderlein, 1921a:199

*Cnetha auroa* (Fries): Enderleiu, 1922:69 (misspelling)

*Eusimulium aurcum* (Fries): Dyar and Shannon, 1927:14, fig. 44 (female); Hearle, 1932:9 (female, pupa); Stains and Knowlton, 1943:266, figs. 31-33, 60, 61 (male, female)

*Simulium (Eusimulium) aurcum* Fries: Twinn, 1936:115-17, fig. 6A (male, female, pupa); Smart, 1944:36, 43, figs. 11g, 13m, 17k (male, pupa, larva); Vargas, Martinez and Diaz, 1946:166; Sommerman, 1953:271, 273, fig. 34 (larva)

*Simulium bracteatum* Coquillett, 1898:69 (male, female); Johanssen, 1903:358-59, pl. 38, figs. 13, 15 (female, male); Strickland, 1913:45-46, pl. 1, figs. 1-9 (pupa, larva); Malloch, 1914:38-39 (female, male); Jobbins-Pomeroy, 1916:5, text figs. 3, 4, 6, pl. 2, fig. 4, pl. 3, fig. 7, pl. 4, fig. 7, pl. 5, fig. 3 (male, pupa, larva)

*Eusimulium aurcum bracteatum* (Coquillett): Dyar and Shannon, 1927:14, figs. 24-26 (female, male)

*Eusimulium bracteatum* (Coquillett): Johanssen, 1934:60 (larva)

*Simulium angustipes* Edwards, 1915:40, figs. 1j, k, l, 4h (male); Friederichs, 1921:55, fig. 21c (female, male)

?*Simulium obtusum* Dyar and Shannon, 1927:15 (lectoparatype male: see Stone, 1949:138)

*Eusimulium pilosum* Knowlton and Rowe, 1934a:580, figs. 1-2 (female)

*Simulium (Eusimulium) pilosum* Knowlton and Rowe: Twinn, 1938:49 (female)

*Eusimulium utahense* Knowlton and Rowe, 1934a:582, figs. 5-6 (female)

*Simulium (Eusimulium) donovani* Vargas, 1943:359-60, pl. 5, figs. 34-36 (female)

*Simulium diazi* De Leon, 1945:5, fig. 7 (pupa)

**Female.** Generally dark grayish brown, covered with glistening, pale to golden yellow, fine hairs. Wing length 2.75-3 mm. Frons gray, with recumbent hairs; width at narrowest about half width of clypeus, strongly divergent above; clypeus about as long as wide, gray, with nearly white hairs. Antennal scape and pedicel yellowish, the flagellum darker. Palpus dark brown. Scutum brown, rather uniformly covered with recumbent yellow hairs. Humerus yellow. Scutellum with abundant pale yellow hairs, both erect and recumbent. Postscutellum reddish to dark brown, centrally with a single or divided patch of appressed yellow hairs. Pleuron grayish brown, the pleural tuft dense, yellow. Wing veins yellow brown, the long hairs at base of costa and



on stem vein pale yellow, the other hairs and spinules darker; vein R with short hairs above; subcosta with hairs beneath. Halter pale yellow, with base darker. Legs yellow, with pale yellow hair except for dark brown at apices of femora, tibiae and entire tarsi except for most of hind basitarsus; outer surface of fore tibia distinctly white; fore basitarsus nearly cylindrical; calcipala and pedisulcus distinct; hind basitarsus about five times as long as greatest width; claws each with stout basal tooth. Abdomen dark brown with pale yellow to silvery white hairs, the tergites small, gradually widening posteriorly, subshining; sternites not sclerotized. Anal lobe subtriangular, narrow above, widened anteriorly and posteriorly below, with anterior and posterior margins concave, anterior portion not extending as far ventrally as posteriorly; cercus twice as broad as long, rounded subquadrate; ovipositor short, with apices of the two lobes slightly divergent; arms of genital rod acute distally, with a slender sclerotized dorsal tooth and a broader, less sclerotized ventral lobe.

**Male.** Darker than female, with pale hairs more golden. Slightly smaller. Scutum dark brown, with golden-yellow hairs dense obliquely behind humeri, laterally and posteriorly, with hairs centrally orange brown, somewhat shorter. Scutellum with yellow or brownish erect and recumbent hairs. Appressed golden hairs on postscutellum as in female. Pleural tuft yellow. Hairs at base of costa and on stem vein mostly dark brown. Halter yellow. Dark of legs considerably more extensive; fore tibia mostly white on outer surface; hind tibia pale on basal third; hind tarsus about as in female. Abdomen velvety black to reddish brown; hairs usually dark brown, sometimes mixed with golden hairs in the basal fringe and laterally on the posterior segments; tergites larger than in female; sternites sclerotized. Basistyle about as long as broad, somewhat conical; dististyle very short, about one-third length of basistyle, with outer margin convex, the inner margin nearly straight, with strong tooth at apex; ventral plate with a narrow triangular central portion and widely divergent basal arms, their apices broad, truncate; each paramere with a single hook.

**Pupa.** Length about 4 mm. Respiratory organ about three-fourths length of pupa, of four slender filaments; upper pair with a short petiole and the two filaments widely divergent; lower pair with almost no petiole and less divergent. Dorsum of thorax smooth; trichomes distinct, curved. Terminal hooks very short. Cocoon simple, wall-vase-shaped, tightly woven, the anterior margin oblique with a distinctly thickened rim and no anterior projection.

**Larva.** Mature specimens 7 mm long. Head capsule with dark head spots; fulvous area very light or absent; isthmus narrow between anterior and posterior median groups; epicranial plate fumeous brown, lacking ventrolateral spots. Throat cleft U-shaped; width and length subequal; apex flat or slightly upcurved medially; lateral margins subparallel, diverging slightly from posterior to anterior. Suboesophageal ganglion never distinctly black. Submentum typical; lateral margins serrate distally, with distalmost serration large and pigmented. Usually three long and one to two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side subequal to distance between outermost teeth. Mandible with small teeth having relative lengths of 14-11-13 from distalmost basad; inner subapical margin with two simple teeth, anterior tooth one to two times as long as posterior. Antenna about three-fourths as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex: 10.3-11.7-6.5-1; uniformly yellow except segment 1 slightly darker than others. Each cephalic fan with about 45 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with four filaments. Abdomen of preserved specimens mottled brown, with light intersegmental areas. Ventral tubercles conspicuous. Anal gill made up of three simple lobes. Anal cross-piece well sclerotized, areas between arms lightly sclerotized; ventral arms slightly longer than dorsal arms. Anal hooks about 11 to a row, in about 60 rows.

**Distribution.** Holarctic; in the Nearctic region from Alaska and Maine to Guatemala.

### New York State Records

Franklin co.—Tupper Lake, May 29th (larva)

Hamilton co.—Salmon river, July 31st, August 25th (larva)

Herkimer co.—Bald Mountain Pond outlet, June 16th-August 19th (pupa); same, June 16th-August 23d (larva)

Oneida co.—Forestport area, June 16th-August 20th (larva)

Tompkins co.—Brooktondale, April 24th (larva); Ithaca, May 12th, June (adult)

**Biology.** The eggs of *S. aureum* are 0.21-0.26 mm in length (DeFoliart, 1951). They are laid on trailing grass or leaves and deposited in a compact mass, one layer deep, all the eggs standing on end and covered by a thick layer of gelatinous material (DeFoliart, 1951).

The incubation period of the eggs is 8 to 12 days, according to Malloch (1914). The larval period is said to be 4 to 5 weeks (Puri, 1925). The larvae are found in warm streams in the Adirondacks, especially at lake outlets such as Bald Mountain Pond outlet near Old Forge. They are somewhat more generally distributed in the warm meadow streams in the less elevated Forestport area. Jenkins (1948) reported that this species is found in warm, slow-moving lake outlets in Alaska. Jobbins-Pomeroy reported five to six generations a year in South Carolina. Pacaud (1942) in Europe, Edwards (1920) in the British Isles, Davies (1950) in Ontario, and Forbes (1912) in Illinois, all reported two generations a year, and this appears to be the case in New York State.

This species is not a pest in the Adirondacks. Edwards (1920) and Caneron (1922, as *bracteatum*) reported that there is no evidence of blood-sucking in this species. It has been reported attacking goslings (Smart 1944; Bequaert 1938). Hocking and Richards (1952) state that this species is rarely annoying.

### **Simulium (Eusimulium) croxtoni Nicholson and Mickel**

(Fig. 50)

*Simulium croxtoni* Nicholson and Mickel, 1950:41-42, fig. 20, A, B

*Eusimulium croxtoni* (Nicholson and Mickel): Hocking and Richards, 1952:240

Since we have only a single female dissected from a pupa, and two additional pupal skins and cocoons, we here reproduce the original description.

"Female. Length about 2 millimeters. Vertex as broad as the clypeus, narrow above the antennae, light gray pollinose, moderate to densely covered with white hair-like setae. Clypeus bluish-gray pollinose, longer than broad, moderately white setose. Antennae 11-segmented, dark brown with the basal two segments very slightly paler on some specimens. Palpi dark brown. Mesonotum dark brown to black, somewhat gray pollinose; moderately covered by hair-like setae, those on the margins white, while those on the disk are brassy yellow. (On paratype specimens the pile is entirely white.) Scutellum dark brown with upright and recumbent pale setae. Postnotum dark brown, shining pollinose. Pleural area bluish-gray pollinose; membranous areas brown; tuft white. Halteres pale; bases dusky, setose. Wings clear; hair-like setae on the costa between the humeral cross vein and the base of the wing white ventrally and dark dorsally; those on the vein long and rusty brown in color; setae on other veins dark; subcosta with a row of setae ventrally; radius setose dorsally on its entire length. Legs mostly brown; front coxae gray pollinose, coxae, femora and tibiae densely covered by white setae; tarsi black, dark setose; calcipala and pedisulcus present; claws with large basal and sub-basal teeth, the sub-basal tooth being the longer. Abdomen with the basal scale pale dorsally; fringe long and white; remaining seg-

ments dark brown, subopaque; pilosity hair-like, most dense laterally and terminally; white except on the terminal segments where a few dark setae may be found.

"Genitalia: Ovipositor valves short and membranous, darkened at the inner margins. Anal lobe broader than long, narrow dorsally, expanded mesally; the antero-ventral margin produced as a broad lobe; the postero-ventral margin indented; setose on the posterior half. Cercus broadly rounded. Stem of the genital rod sclerotized; crotch with an indentation caused by mesal expansions of the bases of the arms; arms membranous, gradually expanded at the tips, the ventral margins sclerotized narrowly; a small tooth present about midway from the crotch to the tip of the arms."

**Male.** Unknown.

"Pupa. Respiratory filaments of about equal length and thickness, and approximately five-eighths the length of the pupa. Each tuft with eight filaments arising from a short trunk as follows: a pair of filaments arising from a short-stemmed dorsal branch; a shorter stalked lateral branch which produces a single filament ventrally near its base and a relatively long-stemmed dorsal pair; and a ventral branch which divides into a single dorsal filament and a short-stemmed ventral pair. The stem of the main lateral branch is about one-half the length of that of the main dorsal branch which is, in turn, about one-half the length of the stem of the main ventral branch.

"The cocoon is of the wall vase type and is rather loosely woven. The anterior margin is thickened and protruded dorso-medially as a short, flat projection similar to that which occurs on the cocoons of *S. latipes* Meigen."

**Larva.** Unknown.

**Distribution.** Hudsonian and Canadian zones from Labrador to northern Minnesota and New York.

### New York State Records

Oneida co.—Cassville, May 28, 1952 (pupal skin and cocoon); Forestport, June 16, 1952 (pupa)

### *Simulium (Eusimulium) gouldingi* Stone

(Figs. 60, 75, 106)

*Simulium (Eusimulium) gouldingi* Stone, 1952:90-91 (female, male, pupa); Sommerman, 1953:271, 272, fig. 30 (larva)

**Female.** General color grayish brown, with yellow brown to gray hairs. Wing length 2.75 mm. Frons and clypeus gray, with fine, recumbent gray hairs; width of frons at narrowest about half width of clypeus, strongly divergent above. Antenna with scape and pedicel reddish brown, flagellum dark, with fine gray pubescence. Palpus nearly black. Scutum brown, with a covering of fine yellow brown,

recumbent hairs, both integument and hairs grayer around the entire margin. Humerus reddish. Scutellum reddish brown, with both erect and recumbent yellow brown hairs. Postscutellum dark, velvety gray. Pleuron grayish brown, pleural tuft yellowish gray. Wing veins brown, the long hairs at base of costa pale yellow, those on stem vein brownish black; subcosta with hairs beneath. Halter pale yellow. **Legs** mostly yellow brown, coxae and apices of femora and tibiae, and tarsi except most of hind basitarsus darkened; outer surface of fore tibia rather distinctly whitened; fore basitarsus nearly cylindrical; calcipala and pedisulcus distinct; hind basitarsus slightly more than five times as long as greatest width; claw with a stout basal tooth. Abdomen reddish brown, with pale yellow hairs, the tergites gradually widening posteriorly, subshining; sternites not sclerotized. Anal lobe somewhat widened below, the ventral margin not produced; cercus slightly wider than long, tapering slightly posteriorly; ovipositor short, blunt, pale posteriorly; arms of genital fork irregularly widened, weakly sclerotized.

**Male.** Darker than female, with pale hairs entirely golden yellow. Wing length 2.25-2.6 mm. Scutum dark brown, with hairs golden, somewhat darker on disk. Humerus and scutellum paler, the latter with erect brown and recumbent golden hairs. Pleuron mostly reddish black; pleural tuft nearly black. Hairs of wing all black. Halter yellowish brown, the stem darker. Legs blackish brown, the fore coxae, femora, and tibiae yellowish, with yellow hair; hairs elsewhere mostly dark; hind tibia slightly swollen, about 4.75 times as long as greatest width. Abdomen velvety brownish black, with dark hair; tergites broad; sternites small and weakly sclerotized. Basistyle subquadrate; dististyle about as long as basistyle, the end with a depressed shiny area, the inner angle of which bears a small tooth; ventral plate broad, rounded distally, the arms short, slightly expanded distally, and without lateral projections.

**Pupa.** Length 2-3 mm. Respiratory organ about two-thirds length of pupa, of six filaments arising from a short petiole; dorsal pair of filaments diverging strongly upward from the other two pairs, the petiole about three times as long as broad; petiole of median pair slightly shorter and directed somewhat laterad; petiole of third pair directed somewhat mediad, and with the petiole about as long as in first pair. Trichomes three or four on each side, slender, rather long. Terminal hooks small, blunt. Cocoon wall-vase-shaped, well formed but rather loosely woven, with a tapering anterior median projection.

**Larva.** Mature specimens 6.5 mm long. Head capsule with dark head spots; fulvous area very light or absent; isthmus wide between

anterior and posterior median groups; epicranial plate fumeous with ventrolateral spots present, one on each side of the epicranial plate at about level of the apex of throat cleft. Throat cleft U-shaped, slightly narrowed posteriorly and rounded apically; about as wide as long; extending about one-third distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion never distinctly black. Submentum typical for genus; lateral margins serrate distally with distalmost serrations large and pigmented. Usually two to three long and one to two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anterior-most epicranial seta on same side subequal to distance between outermost teeth. Mandible with small teeth having relative lengths 12-7-10 from distalmost basad; inner subapical margin with a large anterior serration which is more or less flat on the anterior margin and forms an angle of about 90° with the margin, followed by two to four small, anteriorly pointing serrations. Antenna almost as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex, 7-6-5-1; uniformly yellow except for slightly darkened third segment. Each cephalic fan with about 53 rays. Length of maxillary palpus three times basal width. Pupal respiratory histoblast with six filaments. Abdomen of preserved specimens mottled brown with light intersegmental areas. Anal gill consisting of three compound lobes. Anal cross-piece well sclerotized, areas between arms lightly sclerotized; ventral arms slightly longer than dorsal arms. Anal hooks about 10 to a row in 50 to 60 rows.

**Distribution.** Hudsonian to Transition zones in Alaska, New York and Pennsylvania.

### New York State Records

Hamilton co.—Inlet vicinity, June 10th-July 1st (pupa); May 28th-July 2d (larva)

**Biology.** Larvae of *S. gouldingi* have been found only in a few permanent streams flowing through heavily wooded areas in the Adirondacks, in May, June and July. In June 1952 about 8 per cent of the black fly larvae collected were of this species. The senior author found the species in Pennsylvania, in a small stream flowing from a blueberry-sphagnum bog, and again in a small stream, about six feet wide and three inches deep, flowing over rocks through sphagnum and royal fern, the pupae being found on the under sides of the rocks. There is probably only one generation a year. DeFoliart (1951) concurs in this opinion.

Little is known of the egg-laying or adult-feeding habits of this species. Adults were not taken in collections of annoying black flies.

### **Simulium (Eusimulium) latipes (Meigen)**

(Figs. 46, 68, 74, 97, 112)

*Atractocera latipes* Meigen, 1804:96

*Simulia latipes* (Meigen) : Meigen, 1818:297

*Melusina latipes* (Meigen) : Lundstroem, 1911:11, 16-17, figs. 2, 13

*Simulium latipes* (Meigen) : Edwards, 1915:38-39, figs. 1m, 4f, 5a; Edwards, 1920:239-41, figs. 1j, 2e, 3d, 4l (female, pupa, larva); Friederichs, 1921:52, 59, 66, figs. 15h, 16c, 20c, d, 21b; Puri, 1925:352-54, fig. 16 A-H (pupa, larva); Freeman, 1950:147-50, figs. 6-8 (male); Nicholson and Mickel, 1950:40-41, figs. 26 A-E (male, female, pupa); Grenier, 1953:105-6, figs. 19, 21, 35, 60, 97, 98, 104, 172, 181, 192 (female, male, pupa, larva)

*Cnetha latipes* (Meigen) : Enderlein, 1921a:199

*Simulium (Eusimulium) latipes* (Meigen) : Twinn, 1936:121 (pupa); Sommerman, 1953:271, 272, fig. 31 (larva)

**Female.** General color dark grayish brown. Wing length 2.5-3 mm. Frons pale gray with concolorous hair, at narrowest slightly less than half width of clypeus, widened above; clypeus gray with gray hair. Antenna uniformly dark brown to black; palpus dark. Mandible serrate, maxilla with retrorse teeth. Scutum dark brown with fine recumbent yellow hair, paler and grayer along the anterior margin and sides where there is also a dusting of grayish white. Scutellum yellowish brown, with dense, erect and recumbent yellow hair. Post-scutellum dark, without recumbent scales. Pleuron grayish to brown; pleural tuft whitish. Wing with hairs at base of costa mostly pale, those on stem vein dark; subcosta with scattered hairs beneath. Halter pale yellow; the stem darkened. Legs mostly dark brown; each tibia with whitish pollen and hairs on anterior surface, most extensive on fore tibia, less so on others; hind basitarsus five to seven times as long as broad, nearly parallel-sided; calcipala short and broad; pedisulcus deep; basal projection of claw slightly more than half as long as claw, ovate. Abdomen dark brownish; basal fringe pale yellow; tergite 2 broad, rounded behind; tergites 3 to 7 narrow, the seventh widest; tergite 8 very broad; sternite 8 broad. Anal lobe subquadrate, often with a distinct notch ventroposteriorly; cercus about as broad as long, longer dorsally than ventrally; ovipositor short, rounded; stem of genital fork rather stout, not expanded at base; arms expanded, dorsally sclerotized and weakly serrate.

**Male.** Darker than female, with pale hairs entirely golden yellow. Wing length 2.3-2.7 mm. Scutum dark brown, with hairs golden yellow; humeri and scutellum paler, the latter with erect brown, and recumbent golden hairs. Pleuron reddish black with thin gray

pruinosity; pleural tuft blackish brown. Hairs of wing all dark. Halter mostly brown, the distal margin paler. Legs blackish brown, the femora with some yellowish hair, the fore tibia distinctly whitish polli-nose and pilose anteriorly; hairs elsewhere mostly dark; hind tibia slightly swollen, widest at distal fourth, about five times as long as greatest width; hind basitarsus four times as long as wide. Abdomen velvety dark reddish brown, with dark hair; basal fringe long; tergites broad; sternites rather narrow, sclerotized. Basistyle subquadrate; dististyle about two-thirds length basistyle, the end obliquely truncate, triangular, the inner angle with a small tooth; ventral plate broad, rounded distally, the arms short, tapering, without lateral projections; median sclerite Y-shaped; dorsal sclerite broad.

**Pupa.** Length 2.5-3 mm. Respiratory organ about as long as pupa, of four slender filaments from a short petiole; dorsal pair of filaments on a very short petiole; petiole of ventral pair of filaments slightly longer. Dorsum of thorax smooth, the trichomes very slender, rather long. Terminal hooks very short, blunt. Cocoon wall vase-shaped, rather broad anteriorly, with a long, usually tapering median projection from the anterior margin.

**Larva.** Mature specimens 6.5 mm long. Head capsule with dark brown head spots; no fulvous area on frontoclypeal plate around head spots; anterior and posterior median groups separated by moderately broad isthmus; epicranial plate fumeous brown with ventrolateral spots present. Throat cleft U-shaped, slightly narrowed posteriorly and rounded apically (somewhat flattened on some specimens); about as wide as long and extending about one-third distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion never distinctly black. Submentum typical for genus; lateral margins serrate distally with distalmost serrations large and pigmented. Usually one to three long and one to two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly more than distance between outermost teeth. Mandible with small teeth having relative lengths of 10-6-8; inner subapical margin with a large anterior serration which is more or less flat on the anterior margin, followed by two to four small anteriorly pointing serrations. Antenna almost as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex 8-10.3-4.8-1; uniformly yellow except for lightened ventral portion of segment 1. Each cephalic fan with about 45 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with four filaments. Abdomen of preserved specimens mottled



light brown with light intersegmental areas. Anal gill made up of three compound lobes. Anal cross-piece well sclerotized, areas between arms lightly sclerotized; ventral arms slightly longer than dorsal arms. Anal hooks about 10 to a row in about 80 rows.

**Distribution.** Holarctic. In the Nearctic region, Hudsonian and Canadian zones from Alaska and Maine to California and Connecticut.

### New York State Records

Franklin co.—Tupper Lake, May 29th (pupae)

Herkimer co.—inlets to South Inlet, Old Forge area, June 8th (adult); May 29th-June 10th (pupa); May 9th-June 24th (larva)

**Biology.** *S. latipes* is not a common species in the Adirondacks. Larvae were found only in temporary streams which continue to flow until at least mid-May or June. Edwards (1920) reported that this species overwinters in the larval stage. In the Adirondacks larvae were not found until May 1952, although frequent collections were made in these streams earlier in the season. In the Adirondacks this species probably overwinters in the egg stage. Larvae are first found in May and the major portion of pupation takes place in June. Since *S. latipes* larvae closely resemble those of *S. pugetense*, and to a lesser degree *S. gouldingi* and *S. aureum*, caution should be taken in determining this species. Edwards (1920) stated that there is probably one generation a year. This agrees with observations made in the Adirondacks.

Although Edwards reported in 1915 that *S. latipes* was not a pest species, in 1920 he reported instances of its being annoying to man. Smart (1944) reported this species to be a pest. Hocking and Richards (1952) reported that this species is not a pest in Labrador. *S. latipes* is not a pest in the Adirondacks, but then, it is not present in large numbers. A few females of the subgenus *Eusimulium* which may be *S. latipes* were collected along with other species of annoying adults.

### *Simulium (Eusimulium) pugetense* (Dyar and Shannon)

(Figs. 31, 107)

*Eusimulium pugetense* Dyar and Shannon, 1927:23, figs. 121-23; Stains and Knowlton, 1943:271, figs. 28, 36 (female, male)

*Simulium (Eusimulium) pugetense* (Dyar and Shannon): Stone, 1952:92; Sommerman, 1953:271, 273, fig. 33 (larva)

*Simulium (Eusimulium) quebecense* Twinn, 1936:117-18, fig. 6B (female, male, pupa)

**Female and Male.** No reliable character has been found for distinguishing them from *latipes*.

**Pupa.** Agreeing with the description of *latipes* except that the respiratory filaments are somewhat less widely divergent, the dorsal pair is slightly thicker than the ventral pair, and the cocoon is simple with a thickened anterior rim but with no anterior median projection.

**Larva.** Mature specimens 7 mm long. Head capsule with dark brown head spot; fumeous area absent on frontoclypeus; isthmus wide between anterior and posterior median groups; epicranial plate fumeous with ventrolateral spots present, one on each side of the epicranial plate at about the level of the apex of the throat cleft. Throat cleft U-shaped, slightly narrowed posteriorly and rounded to slightly pointed apically; about as wide as long; extending about one-third distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion never distinctly black. Submentum typical for genus except: lateral margins serrate distally with distalmost serrations large and pigmented. Usually four long and one to two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than the distance between outermost teeth. Mandibles with small teeth having relative lengths 12-9-11 from distalmost basad; inner subapical margin with large anterior serration which is more or less flat on anterior margin and forms angle of about 90 degrees with margin, followed by two to four small anteriorly pointing serrations. Antenna almost as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 9.4-12.4-5.8-1; uniformly yellow except for lightened ventral portion of segment 1. Each cephalic fan with about 37 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with four filaments. Abdomen of preserved specimens mottled brown with light intersegmented areas. Anal gill of three compound lobes. Anal cross-piece well sclerotized; ventral arms slightly longer than dorsal arms. Anal hooks 11 to 13 to a row in about 77 rows.

**Distribution.** Canadian zone from Alaska, Ontario and Maine, to California, Utah and West Virginia.

#### New York State Record

Oneida co.—Crystal brook, Forestport, April 10th, 12th, 15th (pupa, larva)

**Biology.** *S. pugetense* is very rare in the Adirondacks. It was found only in the Forestport area in Crystal brook. This is a small spring-fed stream with a bottom of fine sand, dead leaves, twigs and some grass.

Larvae and pupae were collected during the first two weeks in April but were not found thereafter.

Jenkins (1948) reported that the larvae are found in cold waterfalls and mountain streams in Alaska. Hocking and Richards (1952), reported that this species is found in small forest streams and in rather larger streams while in flood. They stated that this species apparently overwinters in the larval stage. Well-grown larvae can be found early in May in Labrador, according to these authors. There is probably only one generation a year. Davies (1950) recorded two generations a year for the species under the name of *S. costatum*.

Davies (1950) recorded this as a severe blood sucker. Hocking and Richards (1952) noted that it was rarely annoying.

### ***Simulium (Neosimulium) vittatum* Zetterstedt**

(Figs. 1, 3, 13, 29, 47, 67, 70, 77, 95, 105, 113)

*Simulia vittata* Zetterstedt, 1838:803; Bequaert, 1945:115

*Simulium vittatum* Zetterstedt: Coquillett, 1898:69 (female); Johannsen, 1903:383-86, pl. 35, figs. 1-3 (female, pupa, larva); Forbes, 1912:47-48, figs. 23-25 (female, larva); Emery, 1913:324-48, pls. XXXVIII-XI.11 (female, male, pupa, larva); Malloch, 1914:53-55, pl. 2, fig. 9, pl. 4, fig. 4, pl. 5, fig. 2 (female, male, pupa, larva); Hungerford, 1914:368-369, 374-381, pls. XI.III-XI.V (anatomy); Jobbins-Pomeroy, 1916, pl. II, fig. 5, pl. IV, fig. 2, pl. V, fig. 1, text figs. 11, 13 (male, pupa, larva); Dyar & Shannon, 1927:28-30, figs. 74, 75, 106-8 (male, female); Hearle, 1932:12, fig. B; Knowlton and Rowe, 1934a:582, figs. 3, 4 (female); 1934b:fig. 1 (female); Stains and Knowlton, 1943:274, figs. 73, 74, 92-94 (female, male); Davies, 1949:20 (male, pupa); Nicholson and Mickel, 1950:42-46, fig. 28 A-E (female, male, pupa)

*Wilhelmia vittata* (Zetterstedt): Enderlein, 1921c:46

*Simulium (Simulium) vittatum* Zetterstedt: Twinn, 1936:132-34, pl. 1, figs. 1, 3, 6, text fig. 10 (female, male, pupa)

*Simulium (Neosimulium) vittatum* Zetterstedt: Rubzov, 1940:116, 130; Sommerman, 1953:267, 268, fig. 21 (larva)

*Simulium tribulatum* Lugger, 1896:179-81, figs. 147-51 (female, male, pupa)

*Simulium glaucum* Coquillett, 1902:97 (male)

*Simulium venustoides* Hart, in Forbes, 1912:42-44, figs. 13-15 (female, male) (Lectotype male designated by Frison, 1927)

*Simulium decorum* Walker: Dyar and Shannon, 1927:30, figs. 133, 134 (male only)

**Female.** General color ashy gray with brownish markings on thorax and black markings on abdomen. Wing length 3-3.5 mm. Frons opaque gray, with white hair, at narrowest about five-eighths width of clypeus, widened above; clypeus gray, with white hair, about as broad as long. Antenna with scape and pedicel dark reddish, the flagellum black with pale pubescence. Palpus black, the last segment longer than the first three, slender. Scutum gray, clothed with short, recumbent gray hair and with a blackish brown pattern as in figure 13. Scutellum dark gray with erect white hair. Postscutellum velvety

black, with gray reflections. Pleuron gray, with a narrow blackish band across the upper sternopleuron; pleural tuft white. Wing veins yellowish; hairs at base of costa and on stem vein white; subcosta bare. Halter nearly white, with extreme base darkened. Coxae, femora, and tibiae mostly dark gray, with white hair; trochanters reddened; fore tibia flattened, the basal three-fourths white; approximately basal halves of mid and hind tibiae white; fore tarsus cylindrical, black; other tarsi black except for white on basal half of mid-basitarsus and basal two-thirds of hind basitarsus; hind basitarsus about 7.5 times as long as wide, nearly parallel-sided; calcipala very short; pedisulcus deep; claw simple. Abdomen gray with velvety black pattern, extensive basally and dividing into three tapering stripes posteriorly; sides with transverse black spots on segments 3 to 6; basal fringe white. Sternites 1 to 7 not sclerotized. Anal lobe narrow, expanding ventrally and then narrowed to a blunt point; lower half usually less pigmented; cercus subquadrate, rounded behind, nearly twice as wide as long; ovipositor short, with halves broadly rounded, diverging, with strong setae on margin; genital rod with a swollen knob at base; arms divergent and each with a narrow ventral lobe and just beyond a broader, blunt, dorsal lobe.

**Male.** Wing length 2.25-3 mm. Scutum velvety brownish black, with appressed yellow hair, and in certain lights a pair of grayish stripes from anterior margin, tapering rapidly and reaching middle of scutum; sides and posterior declivity usually gray in reflected light. Scutellum dark, with erect pale hair. Pleuron mostly dark grayish; pleural tuft white to brownish. Wing veins yellow brown; hairs at base of costa and on stem vein dark brown; subcosta bare. Halter white, the stem dark. Legs dark brown, with white markings as follows: a patch on fore tibia anteriorly, extending to two-thirds of outer margin, one-third of inner margin; basal halves or less of mid and hind tibiae, basal two-thirds of hind basitarsus, and base of hind second tarsus. Abdomen mostly velvety black; basal fringe dark; sides of tergites 5 and 6 externally silvery gray, with some pale hair; sternites 3 to 8 sclerotized. Basistyle short, stout, nearly as broad as long; dististyle about two-thirds length of basistyle, flattened, curved inward, with three or four teeth on outer margin distally; ventral plate broader than long, the center somewhat curved ventrally; basal arms short, stout; paramere narrow, the arm with several strong teeth.

**Pupa.** Length 3-3.5 mm. Respiratory organ about two-thirds length of pupa, usually consisting of 16 filaments in eight pairs arising at varying distances from the base. Dorsum of thorax smooth, the trichomes short, slender. Terminal hooks very short. Cocoon wall-vase-

shaped, rather loosely woven, the anterior margin sloping backward, somewhat thickened.

**Larva.** Mature specimens 9 mm long. Head capsule with dark brown head spots; narrowly infuscated around median row, antero-lateral and posterolateral head spots; with narrow isthmus between anterior and posterior median groups; degree of pigmentation quite variable; epicranial plate fumeous brown. Throat cleft widest at posterior margin, apex varying from a blunt point to nearly flattened; twice as wide as long; extending slightly more than one-fourth distance from posterior margin of head capsule to teeth of submentum. Sub-oesophageal ganglion distinctly black. Submentum typical for genus; lateral margins serrate. Usually four to five long and one to two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly more than one-half distance between outermost teeth. Mandibles with small teeth having relative lengths 20-14-17 from distalmost base; inner subapical margin with large double tooth, anterior portion twice as long as posterior. Antenna slightly more than one-half as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 6.2-9.2-8-1; segment 1 brown except for basal ventral light spot, segment 2 brown except for distinctive single lobed light area on ventral portion extending 0.5 to 0.7 distance from base to apex, segments 3 and 4 uniformly brown. Each cephalic fan with about 50 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with 16 filaments. Abdomen of preserved specimens mottled black with light intersegmental areas. Anal gill consisting of three compound lobes (small ventral auxiliary lobes not always visible). Anal cross-piece well sclerotized, areas between arms lightly sclerotized; ventral arms subequal or slightly longer than dorsal arms. Anal hooks 18 to 24 to a row in 67 to 88 rows.

**Distribution.** Hudsonian, Canadian, Transition and Upper Austral zones from Alaska and Greenland to Southern California and Georgia.

### New York State Distribution

Common and widespread species, with the adults present from April to November.

**Biology.** The biology of *S. vittatum* has been fairly completely studied, probably owing to the ease with which large numbers of eggs, larvae or pupae can be collected from readily accessible areas. The

eggs are said to be between 0.27 and 0.3 mm in length (DeFoliart, 1951): 0.25 (Wu, 1931). Malloch (1914) reported that eggs take nine to 15 days to hatch while Wu (1931) reported that they require only four to five days. These eggs are not resistant to desiccation according to Wu (1931). Larvae of this species are found on dam faces, below lake outlets, and below large pools. The species overwinters in the larval stage. DeFoliart (1951) noted that the duration of the larval stage is influenced by the amount of food available. Pupation, however, may occur even during the winter, although this is quite rare. The senior author collected larvae and pupae near Washington, D. C., on February 12th, and an adult emerged from one of the pupae before getting it home. During the summer the pupal period lasts three to four days (DeFoliart, 1951). Adults have been collected flying about on warm days when there was still ice on the lakes and snow on the ground.

*S. vittatum* lays its eggs in characteristic strings joined by a gelatinous substance. Dead females are often found partially buried in the egg masses. Apparently numerous females lay their eggs in the same spot. The larvae are often so numerous that they appear like a black mossy covering on the dam face. At least three generations a year have been observed in the Adirondacks during the course of a summer. From field observation, it seems probable that there are at least four generations a year, DeFoliart (1951) reported three or more generations a year in the Adirondacks. Davies (1950) stated that there are probably two generations a year in Ontario, while Jenkins (1948) stated that there are two to three generations a year in Central Alaska. The females probably lay about 300 eggs each (300-320 according to Wu, 1931). The pupal period lasts about four days (Wu, 1931).

*S. vittatum* is rarely annoying to man in the Adirondacks although larvae can be found in large numbers below dams, at lake outlets and below large pools. It has, however, been reported attacking man, horses, domestic animals and "mammals" (Cameron, 1922; Davies, 1950; Dyar and Shannon, 1927; Emery, 1913; Frost, 1949; Hocking and Richards, 1952; Jobbins-Pomeroy, 1916; Knowlton, 1935; Knowlton and Maddock, 1944; Longstaff, 1932; Lugger, 1896; Malloch, 1914; Sailer, 1953; Twinn, 1936).

### **Simulium (*Simulium*) *corbis* Twinn**

(Figs. 10, 18, 42, 51, 73)

*Simulium* sp. O'Kane, 1926:21-22, figs. 2-6 (pupa, larva)

*Simulium* (*Simulium*) *corbis* Twinn, 1936:147-48, fig. 15B (female, male, pupa); Stone, 1952:92, fig. 4 (pupa); Sommerman, 1953:269-70, fig. 24 (larva)

*Simulium corbis* Twinn, Nicholson and Mickel, 1950:58-60, fig. 32 A-E (male, female)

?*Simulium* (s. str.) *relictum* Rubzov, 1940:425-28, 516-17, figs. 5F, 15E, 92A-K (female, male, pupa, larva)

**Female.** General color grayish black. Wing length 3-3.5 mm. Frons shining black, divergent above; clypeus dark, covered with a gray pruinosity. Antenna black, scape rarely yellowish. Palpus nearly black. Scutum dark brown, in certain lights lateral thirds and posterior third gray pruinose; a patch at either side of center at anterior margin either black or pale gray depending on light angle; fine hairs of scutum pale yellow; humerus reddish. Scutellum dark brown, with yellowish brown hair curving toward median line. Postscutellum velvety dark brown. Pleuron dark brown with gray pruinosity; pleural tuft yellow. Wing veins pale, with hairs and spinules mostly darker; hairs at extreme base of costa and on stem vein yellow; subcosta with hairs beneath. Halter pale yellow, the stem darker. Fore coxa yellow; femora light to dark brown, usually paler basally; all tibiae white on basal two-thirds; tarsi black except for base of mid basitarsus and most of hind basitarsus; fore basitarsus somewhat flattened; hind basitarsus nearly six times as long as wide, with parallel sides; claw small, curved, with a distinct short tooth near base. Abdomen dark brown, with tergites 6 to 9 subshining; basal fringe pale yellow. Anal lobe quadrate, rounded anteriorly, with very short projections dorsally and ventrally; cercus with anterior margin nearly straight, posterior margin angularly rounded, twice as broad as long; ovipositor short, each half broadly rounded distally; arnus of genital rod with a lateral angle near base, a somewhat expanded, sclerotized apex and a sharp sclerotized preapical tooth.

**Male.** Wing 2.75-3.25 mm. Scutum velvety black except for a pair of oblique spots extending back from humeri, the lateral margins, and the prescutellar declivity, which are gray pruinose in certain lights; hairs of scutum pale yellow. Scutellum dark brown with erect brown and recumbent golden hairs. Postscutellum velvety, nearly black. Pleuron black to reddish; pleural tuft dark brown; hairs at base of costa and on stem vein black; subcosta bare. Halter as in female. Fore coxa yellow; fore tibia with a long silvery white area on anterior surface; dorsal surface of basal half of mid tibia white; hind tibia very narrowly white at base; hind basitarsus with approximately basal half white; rest of legs dark brown to black; flattened area at apex of hind tibia dark brown, hairs surrounding it dark. Abdomen velvety dark brown with brown hairs; grayish pollinose spots on sides of tergites 2, 5 and 6; sternites sclerotized. Basistyle short, two-thirds to five-sixths as long as wide; dististyle about three times as long

as the greatest width, the base swollen but without a basal lobe, somewhat constricted centrally, and with the apex rounded and with only a very small tooth, if any; ventral plate with the central portion strongly compressed so that the two serrate margins are almost in contact; ventroapical angle distinctly produced beyond serrate portion; basal arms divergent, with no lateral projections; parameral hooks gradually lengthening toward center.

**Pupa.** Length 4-5 mm. Respiratory organ about one-fourth length of pupa, of ten slender filaments on two short stalks, upper one with six filaments, lower with four; upper group consists of two pairs, each with a third filament from the stem; the lower group is of two pairs. Dorsum of thorax smooth, trichomes small. No terminal hooks. Cocoon with a broad anteroventral connection, so that it is boot-shaped; anterior margin with three or four slender loops on each side, making an open basket, the respiratory organ extending little beyond this; main part of cocoon tightly woven.

**Larva.** Mature specimens 7 mm long. Head capsule with distinct brown head spots; anterior median group separated from posterior median group by wide isthmus; posterolateral head spots less distinct; anterior and median portion of frontoclypeus light yellow, posterior portion with dark fulvous area around head spots. Throat cleft bowed V-shaped, with blunt apical point, widest about one-fourth distance from posterior margin to apex; extending two-thirds distance from posterior margin of head capsule to tip of submentum, with narrow apical extension. Suboesophageal ganglion light, epidermis in throat cleft black. Submentum typical for genus; lateral margin serrate distally. Usually with three long and two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than the distance between teeth. Mandible with small teeth having relative lengths of 16-12-13 from distalmost basad. Antenna long, about three-fourths as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex 11-12-6-1; segment 1 with light basal area; segments 1 and 2 light below, yellow above; segments 3 and 4 yellow. Each cephalic fan with about 50 rays. Length of maxillary palpus 3.6 times width at base. Pupal respiratory histoblast with 10 filaments. Abdomen of preserved specimens black with broad white intersegmental areas; segments 7 and 8 lightened ventrally. Anal cross-piece well sclerotized, with areas between arms moderately sclerotized; ventral arms longer than dorsal arms. Anal hooks about 14 to a row in about 94 rows.



**Distribution.** Hudsonian and Canadian zones from Alaska and Quebec to Minnesota and Maine.

### New York State Records

Clinton co.—West Chazy, June 17, 1952 (pupae)

Hamilton co.—Long Lake, May 31, 1950 (pupal pelts and cocoons)

St Lawrence co.—South Colton, June 16, 1952 (pupae)

The synonymizing of *relictum* Rubzov under *corbis* Twinn by Stone (1952) was perhaps rather rash since the claw of *relictum* is figured and described as being without a tooth. This might have been overlooked by Rubzov since it is rather small. Until specimens of *relictum* from Siberia can be studied it would seem best to question the synonymy.

**Biology.** Twinn (1936) found pupae of *S. corbis* May 22d on the submerged stems of dogwood growing close to the bank of a river in the rapids a short distance below a waterfall. The river was flowing swiftly over a stony bottom; the temperature of the water was 53° F. Pupae of *venustum* and *pugctense* occurred on stones nearby. Nicholson and Mickel (1950) found the immature stages in Minnesota in cold streams associated with *latipes*. Sailer (1953) reported *S. arcticum* and/or *S. corbis* biting man in Alaska. This species is apparently quite rare in New York.

### *Simulium (Simulium) decorum* Walker

(Figs. 23, 24, 43, 61, 114)

*Simulium decorum* Walker, 1848:112; Dyar and Shannon, 1927:30-31, figs. 69, 70 (female only); Stains and Knowlton, 1943:275, figs. 76, 77 (female); Nicholson and Mickel, 1950:55-58, fig. 31 (female, male, pupa); Grenier, 1953:122-24, figs. 25, 27-29, 31, 40, 65, 71, 117, 169, 188, 205, 206 (female, male, pupa, larva)

*Simulium (Neosimulium) decorum* Walker: Rubzov, 1940:130

*Simulium (Simulium) decorum* Walker: Sommerman, 1953:269, 272, fig. 28 (larva)

*Simulium piscicidium* Riley, 1870:367, fig. 143 (female, male, pupa, larva); Osborn, 1896:56, fig. 20; Malloch, 1914:45-46, pl. 6, fig. 5 (female, male, pupa); Johannsen, 1934:63

*Simulium venustum* var. *piscicidium* Riley: Johannsen, 1903:381-83, pl. 37, figs. 2, 5, 7, pl. 38, figs. 1-3 (female, male, larva, pupa)

*Simulium venustoides* Hart, in Forbes, 1912:43-44, fig. 13 (female only, not the male lectotype)

*Simulium nölteri* Friedrichs, 1920:567; 1921:46-47, fig. 19a, (male, larva); Puri, 1925:303-33, text figs. 1-6, pls. VIII-IX (pupa, larva)

*Simulium subornatum* Edwards, 1920:227-28, figs. 1c, 2b, 3b, 4d, 5b (female, male, pupa, larva); Rubzov, 1940:428-29, figs. 1E, 5G, 60, 8A, B, 16Z, 21I, 58K, 62I), 65B, C, Q, S, 72E (female, male, pupa, larva)

*Simulium tenuimanus* Enderlein, 1921b:222

*Simulium decorum katmai* Dyar and Shannon, 1927:31, figs. 56-57 (female); Hearle, 1932:13

*Simulium (Simulium) ottawaense* Twinn, 1936:146-47, fig. 15A (female, male, pupa); Davies, 1949:20 (male, pupa)

*Simulium nölleri* Friederichs: Smart, 1944:figs. 11o, 13d, 15b, 17c (male, pupa, larva)

**Female.** General color grayish black, subopaque. Wing length 3-3.5 mm. Frons black, thinly dusted with gray, divergent above; clypeus more distinctly gray, with fine whitish hairs. Antenna dark brown, the scape, pedicel and base of first flagellar segment orange brown. Palpus nearly black. Scutum distinctly convex in lateral view, blackish brown, thinly covered with gray pollen, particularly laterally and posteriorly, sparsely covered with fine white or yellowish, recumbent hairs. Humerus usually somewhat reddened. Scutellum nearly black, with erect black hairs and recumbent fine pale hairs. Post-scutellum velvety gray. Pleuron velvety grayish black, the pleural membrane more reddish; pleural tuft pale. Wing veins pale brown, the hairs and spinules mostly darker; hairs at base of costa and on stem vein pale yellow; subcosta with fine hairs beneath. Halter pale yellow, with stem slightly darker. Fore coxa yellow, with whitish pruinosity; fore femur slightly darker; fore tibia yellow brown, with apex darkened, dorsal surface mostly white; fore tarsus black, the first segment somewhat flattened; mid and hind coxae somewhat darkened; rest of mid and hind legs yellowish except for the considerable whitening of tibiae and black at apices of basitarsi, with rest of tarsi black except base of second hind tarsus; claw simple. First and second abdominal segments dark brown, with basal fringe yellowish; third segment silvery whitish; tergites 4 to 5 opaque brownish black; tergites 6 to 9 subshining black with a thin dusting of gray; sternites 1 to 7 not sclerotized; anal lobe in lateral aspect narrow above, broadened and rounded below with a short posteroventral projection; cercus subquadrate, with rounded posterior margin; ovipositor short, each half with inner margin sclerotized, slightly concave; arms of genital rod tapering, each with a rather broad, blunt, dorsal, subapical tooth.

**Male.** General color dark brown, legs paler. Clypeus with gray pruinosity. Scutum strongly convex dorsally in lateral view, dark brown, with abundant fine yellow hairs; anterior, to either side of central portion, posterior declivity and narrow marginal portion on sides gray by reflected light. Scutellum brown, with erect dark hairs, and a few fine, recumbent, yellow hairs. Pleuron mostly reddish brown with a thin grayish pruinosity. Wing veins yellowish brown; subcosta without hairs. Halter yellow, the base darkened. Legs mostly yellowish brown, with tarsi darker; tips of femora darkened; fore tibia with large white patch anteriorly, and bases of other tibiae whitened; fore basitarsus flattened. Abdomen dark brown; basal fringe brown; whitish pru-

inosity on sides of tergites 2, 5 and 6; sternites 3 to 7 sclerotized. Basistyle subquadrate; dististyle about three times as long as broad, twice as long as basistyle, somewhat flattened, apically rounded, with a distinct subapical tooth; ventral plate narrow medially with a hairy angular ventral keel; basal arms diverging, without lateral projections; paramere subtriangular, the arm with a number of hooks.

**Pupa.** Length 3.5-4.5 mm. Respiratory organ about 0.4 length of pupa, with eight filaments consisting of a dorsal pair with a short petiole, a second transverse pair without petiole arising just below dorsal pair, this with inner filament slightly larger than the outer one, and two more ventral pairs on short petioles, that of the ventral pair longer. Dorsum of thorax smooth; trichomes short, simple; abdomen with very short, acute terminal hooks. Cocoon wall-vase-shaped, consisting of woven strands, slender and more tightly woven posteriorly, thicker and more loosely woven anteriorly.

**Larva.** Mature specimens 8 mm long. Head capsule with light head spots; dark fulvous area around median row forming H-shaped dark area on posterior two-thirds of frontoclypeus with horizontal line formed by moderately wide isthmus between anterior and posterior median groups; medium posterior fulvous area also present; fulvous area not extending laterad beyond inner edge of anterolateral group; anterolateral and posterolateral head spots obscurely pale; epicranial plate fumeous brown with light yellow area just anterior to apex of throat cleft, widening gradually anteriorly, extending to anteroventral margin of head capsule. Throat cleft bulbous; slightly longer than basal width; pointed apically; widest about one-third distance from posterior margin to apex; extending about one-half of distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion light, never distinctly black. Submentum typical for genus. Usually three or four long and one or two short epicranial setae present on each side; lateral margin serrate distally. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than distance between outermost teeth. Mandible with small teeth having relative lengths 20-13-14 from distal-most basad. Antenna slightly more than one-half as long as distance from base to posterior margin of head capsule; segment length ratios, base to apex, 8-11.2-9.4-1; uniformly yellow except for light basal area on first segment beneath. Each cephalic fan with about 50 rays. Length of maxillary palpus about two and one-half times width at base. Pupal respiratory histoblast with eight filaments. Abdomen of preserved specimens dirty gray to brown with light intersegmental areas. Anal cross-piece well sclerotized, areas between arms not sclero-

tized; ventral arms longer than dorsal arms. Anal hooks 9 to 16 to a row in about 74 rows.

**Distribution.** Holarctic. In the Nearctic region, Hudsonian, Canadian, Transition and Upper Austral zones from Alaska and Maine to Iowa and Georgia.

### New York State Distribution

Common and widely distributed, the adults present from the middle of May to October.

**Biology.** The eggs of *S. decorum* are laid in large masses, more than one female often being found imbedded in a single mass. According to DeFoliart (1951), the eggs require from less than four to seven days to hatch at 70° F.

Larvae of this species are found almost invariably on dams, at lake outlets, or below large pools. Larvae were found in the Adirondacks in large numbers during the latter part of the summer, especially after the first two weeks in June. Sometimes they entirely cover parts of the face of a concrete dam or the twigs of a beaver dam. DeFoliart (1951) reported that the larval stage lasts 12-16 days during warm weather. Puri (1925) stated that pupae of *S. decorum* (as *S. noelleri*) required five days at 16° C. or 13-15 days at 3.8° C. for maturation. DeFoliart (1951) reported that the pupal stage lasted three to four days at summer temperatures.

Davies (1950) reported that there appear to be two generations of *S. decorum* a year in Ontario.

This species is apparently of little importance as a pest of man, although there are a few records of it annoying man and cows (DeFoliart, 1951; Dyar and Shannon, 1927; Hocking and Richards, 1952; Lugger, 1896; Nicholson and Mickel, 1950).

### *Simulium (Simulium) fibrinflatum* Twinn

(Figs. 32, 48)

*Simulium (Simulium) fibrinflatum* Twinn, 1936:141-42, fig. 13a (female, male, pupa)

**Female.** General color glossy blackish brown. Wing length 2-2.5 mm. Frons shiny dark brown, about equal in width to clypeus, divergent above; clypeus subshiny, with thin gray pollen. Antenna with scape and pedicel yellow, flagellum dark brown with pale pubescence. Palpus nearly black. Scutum shiny brownish black, with short decumbent yellowish brown hair and, particularly anteriorly and laterally, thin gray pollinosity; humerus yellowish brown. Scutellum dark red-

dish brown, with erect dark hair. Postscutellum velvety brown. Pleuron blackish brown with grayish pollinosity; pleural tuft dark brown. Wing veins yellowish, hairs, including those of stem vein, dark brown; subcosta bare. Halter pale yellow, with extreme base slightly darker. Legs mostly yellowish brown; most of fore tibia anteriorly, basal half of mid and hind tibiae externally, and most of hind basitarsus glistening white; fore tarsus, most of hind tibia, and distal segments of hind tarsus dark brown; fore basitarsus slightly flattened; claw simple. First abdominal segment dark brown, the basal fringe yellowish; second segment mostly silvery gray; tergites 4 and 5 velvety blackish brown; tergites 6 to 9 shining black or brownish; sternites 1 to 7 not sclerotized. Anal lobe triangular, the ventral angle rounded, with the anterior angle slightly notched; cercus rounded quadrate, slightly wider than long; ovipositor with halves short, wider than long, the blunt tips remote; arnus of genital rod rather narrowed distally, with a slender, dark, dorsal tooth.

**Male.** Wing length 2-2.25 mm. Scutum velvety black with fine brown hair except for a brilliant white patch on each side, with iridescent reflections, one arm of which runs obliquely inward from behind the humerus and the other along the side of the scutum to join with the bluish gray, shiny, prescutellar area. These shiny areas confine the velvety black area to a median stripe widening anteriorly and extending back about three-fifths the length of the scutum, where it is rather broadly joined to a pair of sublateral spots. Scutellum reddish brown with erect dark hairs, no decumbent hairs. Postscutellum velvety brown. Pleuron yellowish to dark brown with some shiny gray areas; pleural tuft dark. Hairs at base of costa and on stem vein black; subcosta bare. Halter pale yellow, with stem dark. Legs dark brown except for yellow fore coxa, some yellowing at bases of all femora, a long white spot on fore tibia, a white spot at base of each mid and hind tibia on outer side approximately one-third length of tibia, and yellow on most of hind basitarsus. Abdomen velvety black with dark brown hair; iridescent spots on sides of tergites 2, 6 and 7; sternites 3 to 7 sclerotized. Basistyle short, about three-fifths as broad as long; dististyle about three times as long as greatest width, flattened, slightly constricted medially, apex rounded, with a small spine, the base with no strong protuberance or spine; ventral plate with central portion a narrow trough, slightly narrowed at base, truncate apically, a few teeth on margin laterally; basal arms, divergent, each with a strong lateral projection; paramere subtriangular, the arm with mixed large and small hooks.

**Pupa.** Length 2.5-3 mm. Respiratory organ less than one-third length of pupa, with six swollen, blunt filaments all arising close to the base. Dorsum of thorax smooth, the trichomes very small. No terminal hooks. Cocoon short and stout, narrowly joined anteroventrally to produce a short collar; anterior margin obliquely rounded, the side with a large oval aperture; respiratory organ scarcely projecting beyond anterior margin of cocoon.

**Larva.** Mature specimens 5 mm long. Head capsule with distinct brown head spots; anterior median group separated from posterior median group by wide isthmus; posterolateral and mediolateral head spots distinct, posterior portion of frontoclypeus with light fulvous area. Throat cleft broadly bowed U-shaped, as long as width at base; pointed apically, extending slightly less than one-half distance to teeth of submentum. Suboesophageal ganglion not distinctly black, but tinged with faint black. Submentum typical for genus. Usually three long and one short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than distance between outermost teeth. Mandible with small teeth having relative lengths of 11-10-9 from distalmost basad. Antenna long, length subequal to distance from base to posterior margin of head capsule; segment length ratios, base to apex 10-11-5-1; segments 1 and 2 yellow above, light below; segments 3 and 4 yellow. Each cephalic fan with about 43 rays. Length of maxillary palpus about 3.5 times width at base. Pupal respiratory histoblast with six stout filaments. Abdomen of preserved specimens blackish brown with light intersegmental areas. Anal cross-piece well sclerotized, with areas between arms moderately sclerotized; ventral arms longer than dorsal arms. Anal hooks 13 to 18 to a row in about 81 rows.

Distribution. Alleghanian from Ontario and Maine to Virginia.

### New York State Records

Clinton co.—Altona, June 17th; Peru, June 22d (pupae).

**Biology.** Since this species has been collected infrequently, not much can be said of its biology. The larvae and pupae have been found in rushing water of rivers, and also in small permanent streams. They have been found on moss at several localities, but may also occur on other vegetation and on twigs. There are probably several generations a year, at least in the South, since the senior author collected pupae both in late May and in the second week of September in Virginia.

**Simulium (Simulium) jenningsi Malloch**

(Figs. 11, 12, 21, 40, 53, 69)

*Simulium venustum* var. a, Johanssen, 1903:381, pl. 37, figs. 8-14; pl. 38, figs. 4-6 (female, male, pupa, larva); 1934:64 (pupa, larva)

*Simulium jenningsi* Malloch, 1914:41-43, pl. III, fig. 1, pl. V., fig. 12 (female, male, pupa, larva)

*Simulium jenningsi jenningsi* Malloch: Nicholson and Mickel, 1950:52-54, fig. 29 A-F. (female, male, pupa)

*Simulium (Simulium) nigroparvum* Twinn, 1936:142-44, fig. 13b (female, male, pupa); Cox, 1938:443-47, pl. 1-3 (female anatomy); Underhill, 1944:3-12, figs. 2-5 (female, male, pupa, larva)

**Female.** General color glossy black. Wing length 2-2.3 mm. Frons shiny black, divergent above, at narrowest narrower than clypeus, which is slightly longer than wide, grayish pollinose, subshining, with sparse dark brown hairs. Antenna with scape and pedicel reddish brown, flagellum blackish brown with pale pubescence. Palpus dark brown. Scutum shiny brownish black, clothed with short, yellowish brown, decumbent hairs, with anterior portion laterally back to wing base with thin grayish pollinosity with pink and greenish reflections. Scutellum velvety brownish black with a border of long erect black hairs, but no fine recumbent hairs. Postscutellum velvety dark brown with yellowish reflections anteriorly. Pleuron shiny black with grayish pollinosity; pleural tuft brown. Wing veins pale brown, the hairs and spinules slightly darker; hairs at base of costa light brown; those of stem vein dark brown to black; subcosta bare; radius bare to shortly beyond base of radial sector, followed by a single row of rather stout, short hairs dorsally; radial sector with slender hairs beneath. Halter pale yellow, the stem dark brown. Fore coxa and femur light yellow with concolorous hair, or femur somewhat darkened; fore tibia flattened, dark, the anterior surface with a large patch of silvery white pollen; fore tarsus black, with dark hair, basitarsus flattened; mid and hind coxae dark; mid leg mostly yellowish to brownish yellow, tip of tarsus darker; some whitish pollen on external surface of tibia basally; hind femur and tibia somewhat darkened, the basal half of hind tibia with white pollen externally; hind basitarsus about six times as long as wide, parallel-sided, yellow except at apex; claw simple. First and second abdominal segments dark brown, the basal fringe yellowish; third segment mostly silvery whitish; tergites 4 and 5 velvety black, that on 4 tapering laterally, that on 5 smaller; tergites 6 to 8 shining brown; sternites 1 to 7 not sclerotized. Anal lobe subtriangular, with blunt apex pointing anteriorly and small subapical spur; dorsal and ventral margins concave, posterodorsal and posteroventral produced; cercus with posterior margin rounded; anterior margin nearly straight, twice as broad as long, with hairs scattered

over entire surface; each half of ovipositor broadly rounded distally; arms of genital rod sclerotized, roundly expanded distally, each with slender dark dorsal tooth and a broad, weakly sclerotized ventral lobe.

**Male.** Wing length 1.75-2 mm. Scutum velvety black except for brilliant white stripes with iridescent reflections running back and somewhat in from humeral angles about one-third length of scutum, the shiny posterior third, and a silvery gray spot on the side just before wing base; fine hairs of scutum dark brown. Scutellum dark brown with erect black hairs, no decumbent hairs. Postscutellum velvety brown. Pleuron yellowish to dark brown with some shiny gray areas; pleural tuft brown. Hairs at base of costa and on stem vein black; subcosta bare. Halter as in female. Legs dark brown except for yellow fore coxa, some yellowing at bases of all femora, a long white spot on fore tibia, a small white spot at base of each mid and hind tibia, and yellow on most of hind basitarsus. Abdomen velvety black, with dark brown hair; iridescent spots on sides of tergites 2, 6 and 7; sternites 3 to 7 sclerotized. Basistyle short, about two-thirds as long as broad; dististyle about 2.8 times as long as greatest width, flattened, slightly constricted medially, the apex rounded with a small spine, the base with no strong protuberance or spine; ventral plate with central portion a narrow trough, slightly narrowed at base, truncate apically, a few teeth on margins laterally; basal arms divergent, each with a strong lateral projection; paramere subtriangular, the arm with about eight large hooks and many smaller ones.

**Pupa.** Length 2.5 mm. Respiratory organ about one-third length of pupa with 10 slender filaments arranged in four groups from dorsal to ventral as 2-2-3-3. Dorsum of thorax smooth, the trichomes rather long and slender. No terminal hooks. Cocoon short and stout, closely woven, usually joined anteroventrally to produce a short collar; anterior margin oblique, each side with a large aperture; respiratory organ projecting little beyond anterior margin of cocoon.

**Larva.** Mature specimens 5-5.5 mm long. Head capsule with distinct dark head spots; wide isthmus between anterior and posterior median groups. Throat cleft bulbous; slightly longer than width at base; pointed apically; widest about one-half distance from posterior margin to apex; extending slightly less than one-half distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion never distinctly black. Submentum typical for genus; lateral margins serrate distally. Usually three long and one short epicranial setae present, forming an irregular line on each side, appearing to arise from near lateral margins of submentum. Distance from



apex of outer tooth of submentum to anteriormost epicranial seta on same side slightly more than one-half distance between outermost teeth. Mandibles with small teeth having relative lengths 7-6-4 from distalmost basad. Antennal segment length ratios 10.3-12-3.8-1; from base to apex uniformly pale yellow. Each cephalic fan with 38 to 42 rays. Length of maxillary palpus slightly more than three times width at base. Pupal respiratory histoblast with ten filaments. Abdomen light to moderately yellowish brown, often with a slight green and sometimes red tinge. Anal cross-piece well sclerotized, the areas between arms lightly sclerotized; ventral arms longer than dorsal arms. Anal hooks 12 to 14 to a row in 68 to 70 rows.

**Distribution.** Eastern Austral region from Manitoba and Maine to Texas and Florida.

### New York State Distribution

Found throughout the State where suitable streams are encountered.

**Biology.** The distribution of this species in New York is apparently spotty. Larvae are found chiefly in large creeks and rivers. It is annoying to humans in the Adirondacks, but has not been taken biting. It is a late-summer pest, being found in July and August. Underhill (1944) reported that, in Virginia, no larvae are present in streams during the winter but that they are abundant in the summer, being first found in March. He further reported that there are three generations a year and that the life cycle lasts about six weeks. Nicholson and Mickel (1950) stated that the pupal stage of *S. jenningsi* (as *jenningsi luggeri*) is completed in two to four days at about 25° C. under laboratory conditions.

Underhill (1944) reported that *S. jenningsi* (as *S. nigroparvum*) adults have been collected 20 to 30 miles from the known breeding places and were present in large numbers ten miles from the nearest known breeding areas. Johnson *et al.* (1938) stated that adults have been taken five to six miles from the nearest known breeding place.

This species is recorded attacking turkeys, horses, mules, cattle and "mammals" (Jobbins-Pomeroy, 1916; Johnson *et al.*, 1938; Malloch, 1914; Nicholson and Mickel, 1950; and Underhill, 1940, 1944).

### *Simulium (Simulium) parnassum* Malloch

(Figs. 8, 28, 37, 52, 94)

*Simulium parnassum* Malloch, 1914:36-37, pl. 2, fig. 8, pl. 5, fig. 11 (female);

Dyar and Shannon, 1927:41-42, figs. 65, 66 (female only)

*Odagmia parnassa* (Malloch): Enderlein, 1925:208

*Simulium hydatationis* Dyar and Shannon, 1927:28 (male). (New synonymy)

*Simulium* (*Ncosimulium*) *hydatationis* Dyar and Shannon: Rubzov, 1940:130

**Female.** A shiny black species. Wing length 2.5-3.25 mm. Frons nearly as wide as clypeus, distinctly widened above, entirely shiny black, with very few black hairs; clypeus black, with a thin gray pruinosity and black hairs. Antenna with scape and pedicel reddish brown, flagellum black. Palpus black, with sensory organ of third segment about one-third length of segment. Scutum entirely black, shiny or weakly grayish pruinose, depending upon the angle of incidence of the light, with short, fine black hairs. Scutellum black, with erect black hair. Postscutellum black, with grayish pruinosity. Pleuron black, with grayish pruinosity, the pleural membrane brown; pleural tuft black. Wing veins yellow brown; hairs at base of costa and on stem vein black; subcosta with hairs beneath. Halter pale yellow, with base dark. Legs mostly blackish, with dark hairs; fore coxa yellow, with yellow hair; fore and mid tibiae anteriorly and hind tibia posteriorly more or less covered by gray pruinosity; apex of hind tibia posteriorly with a flattened area covered with golden yellow hair; fore basitarsus flattened; approximately half of mid basitarsus yellow; approximately two-thirds of hind basitarsus yellow, the posterior surface of the latter with dense yellow hair; calipala rather narrow; claw long, with a short sharp tooth near base. Abdomen velvety brown, the first segment yellowish brown with basal fringe pale yellow; tergites 6 to 8 shiny; anal lobe subtriangular, narrow dorsally, expanding ventrally, with anterior margin concave, posterior margin nearly straight; cercus rounded subquadrate, about three times as broad as long; ovipositor small, blunt; arm of genital rod expanded and truncate at end, with a short, heavily sclerotized tooth before apex.

**Male.** Antenna entirely black. Scutum velvety black, with a broad spot on either side of anterior third, with sides, and posterior third, shiny gray-white in certain lights, tinged with pinkish. Scutellum and pleuron as in female. Hairs at base of costa and on stem vein black; no hairs on under side of subcosta. Halter orange yellow, with base dark. Legs black, a small white spot at base of each mid and hind tibia, and the hind basitarsus yellow on basal half posteriorly. Abdomen black, with silvery spot on each side of second segment; basal fringe black; sternites 2 to 7 sclerotized. Basistyle subquadrate, short, slightly broader than long; dististyle slender, about three times as long as basistyle, strongly bent outward just before middle, and then slightly curved inward; ventral plate triangular, the basal arms rather short, without lateral projections; paramere large, triangular, the arm with rather small parameral hooks.

**Pupa.** Length 3-4 mm. Respiratory organ about one-third length of pupa with six slender filaments arranged in three pairs on short petioles. Dorsum of head and thorax anteriorly strongly reticulate-rugose; trichomes short. No terminal hooks. Cocoon simple, wall-vase-shaped, rather broad, often narrowly closed anteroventrally, the dorsal and anterior profiles each slightly concave.

**Larva.** Mature specimens 6-7 mm long. Head capsule with indistinct brown head spots; no fulvous area around head spots; epicranial plate funeous. Throat cleft a long V-shaped notch with straight, anteriorly converging margins, extending about one-third distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion light, never distinctly black. Submentum typical for genus; lateral margins serrate distally. Usually three or four long and one or two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side slightly less than distance between outermost teeth. Mandibles with small teeth having relative lengths of 20-12-9 from distalmost basad; inner subapical margin quite variable with large double tooth or two single teeth. Antenna almost as long as distance from base to posterior margin of head capsule; segment length ratios 11.8-14-8.2-1; uniformly yellow except for light areas beneath on segments 1 and 2. Each cephalic fan with about 32 rays. Length of maxillary palpus slightly less than three times basal width. Pupal respiratory histoblast with six filaments. Abdomen of preserved specimens mottled brown with faint white intersegmental lines. Anal gill made up of three compound lobes. Anal cross-piece well sclerotized, area between arms not sclerotized; ventral arms longer than dorsal arms. Anal hooks about 13 to a row in about 77 rows.

**Distribution.** Alleghanian from Ontario and Maine to Georgia.

#### New York State Records

Cattaraugus co.—Allegany State Park, July 20th (adult)

Clinton co.—Plattsburg, August 18th; Saranac, July 17th (adult)

Erie co.—South Wales, July 9th (adult)

Essex co.—Keene Valley, August 16th (adult)

Greene co.—Catskill mountains, August 5th (adult); Kaaterskill Falls, June 18th (larva, pupa)

Hamilton co.—Wheeler creek, July 17th; Bear Brook, July 6th-16th (adult); June 28th (pupa); June 5th, July 17th (larva)

Herkimer co.—Old Forge area; June 2d-August 10th (larva);  
July 11th-24th (pupa)

Steuben co.—North Cohocton, July 26th (adult)

Tompkins co.—Ithaca, June (adult)

Warren co.—North River, August 6th-16th (adult)

**Biology.** Larvae of this species are found in only a few cool, permanent streams in heavily forested areas in the Adirondacks. When they are present, they are often quite numerous. There is apparently only one generation a year in the Adirondacks.

The adults of *S. parnassum* are annoying to humans in the Adirondacks, but have not been collected biting there. Dyar and Shannon (1927) and Hocking and Richards (1952) have stated that this species attacks man. Fuller (1940) found it biting a recently shot woodchuck in Massachusetts.

### ***Simulium (Simulium) pictipes* Hagen**

(Figs. 20, 44, 58, 71, 88, 104)

*Simulium pictipes* Hagen, 1880:306-7 (female, male, pupa) 1881:150-51; Howard, 1901:121-23, Johannsen, 1903:374-76, pl. 36, figs. 1-8, pl. 38, figs. 8, 17, 20 (male, female, pupa, larva); Headlee, 1906:876-83, figs. 1-4 (larva); Malloch, 1914:55-57, pl. 2, fig. 10, pl. 3, figs. 2, 4, 5, pl. 4, fig. 2 (female, pupa, larva); Jobbins-Pomeroy, 1916, text figs. 10, 14, pl. 2, fig. 1, pl. 4, figs. 1, 8, pl. 5, fig. 5 (male, pupa, larva); Dyar and Shannon, 1927:27-28, figs. 60, 61, 100-2 (male, female); Johannsen, 1934:62-63, figs. 208, 210, 214-216 (pupa, larva); Smart, 1934:62-65, figs. 1-4; Nicholson and Mickel, 1950:46-47, figs. 27 A-F (male, female, pupa)

*Wilhelmia pictipes* (Hagen): Enderlein, 1925:207

*Simulium (Simulium) pictipes* Hagen: Twinn, 1936:134-36, fig. 11A (male, female, pupa)

*Simulium (Neosimulium) pictipes* Hagen: Rubzov, 1940:130

*Simulium innoxium* Comstock, 1895:452-53, figs. 535, 536 (pupa, larva)

**Female.** General color grayish black. Wing length 3.5-4 mm. Frons slightly divergent above, at narrowest about three-fourths width of clypeus, grayish pollinose, with black hairs near eyes, paler hairs centrally; clypeus gray pollinose, with pale hairs. Antenna with scape and pedicel reddish brown, flagellum darker, with pale pubescence. Palpus dark brown. Scutum, when viewed from front, rather pale gray with three dark stripes and a dark spot in front of wing base; each lateral stripe expands anteriorly and is curved; a brownish tinge above lateral dark spot and laterad of lateral stripe; in other lights a pair of white spots on anterior margin, and spots before the wing bases white; scutum clothed with short, fine, pale yellow, recumbent hairs. Humerus pale, with a dark area across middle. Scutellum dark brownish, with erect brownish hair and somewhat more recumbent yellow hairs. Postscutellum velvety brown with a central dark spot

usually present. Pleuron blackish, with gray pollinosity; pleural tuft pale yellow. Wing veins yellow brown, with hairs and spinules darker; hairs at base of costa pale yellow; those of stem vein mixed dark brown to black and white; subcosta with a few hairs beneath; radius bare to base of radial sector except for possibly one or two hairs, followed by more fine hairs and spinules; radial sector with many fine hairs beneath. Halter pale yellow, with stem darkened basally. Legs mostly dark brown to grayish black, with fine, pale yellow hair, although teneral specimens are often caught with the femora and tibiae extensively yellow; fore tibia flattened, with grayish pollinosity; fore basitarsus somewhat flattened; hind basitarsus nearly seven times as long as greatest width, parallel-sided, yellow except for dark apical fourth; calcipala rather short; claw simple. Abdomen dark grayish, with pale yellow and brown hairs. Anal lobe rounded quadrate, with narrow dorsal projection posteriorly, broadly conical ventrally, externally shiny yellow to brown, margined with short yellow hairs; cercus twice as wide as long, with posterior margin rounded, anterior margin nearly straight, covered with dark brown hair; halves of ovipositor small, well separated, the apex of each somewhat acute and curved outward; arms of genital rod sclerotized, the apical expanded portion with a single dorsal tooth.

**Male.** Generally darker than female. Wing length 3-3.3 mm. The scutum may show three narrow dark lines with the anterior enlarged portion of the lateral line bright white in certain lights, as in female, but usually this pattern is obscured by the generally velvety black color; in reflected light there is a broad band of velvety gray on each side and in front of the scutellum, and a rather large triangular spot extending back and inward from each humerus; fine hairs of mesoscutum pale as in female. Hairs of scutellum erect, entirely black. Postscutellum, pleuron and pleural tufts as in female. Hairs at base of costa black. Halter as in female. Legs almost entirely dark brown to black, with fine, pale yellow hair; grayish pollen of flattened fore tibia scarcely evident; hind basitarsus broader than in female, the basal half usually yellowish brown; calcipala rather short. Abdomen velvety black; basal fringe yellow to brown depending upon light; sternites 3 to 8 sclerotized, that on 8 small. Basistyle subquadrate, about three-fourths as long as dististyle, with ventrolateral angle produced beyond point of attachment of dististyle; dististyle rather long and narrow, slightly constricted about midway, flattened distally, the apex rounded, with no spine; ventral plate broad, finely hirsute with a deep median notch, short, pointed, ventral lip, and short, stout basal arms; paramere very broad basally, the arm with about three hooks.

**Pupa.** Length about 4.5 mm. Respiratory organ of nine rather short, smooth filaments, somewhat swollen basally, and curving laterally and anteriorly from the center; these are arranged as four pairs, each with a very short base, and a single filament. Two pairs extending ventrally, two dorsally, and the single placed externally and extending ventrally. Dorsum of thorax smooth, the trichomes rather small. Terminal hooks short, curved backward. Cocoon a firm, boot-shaped, rather loosely woven basket, with the respiratory organ entirely surrounded by the anterodorsal extension of the cocoon.

**Larva.** Mature specimens 11 mm long. Head capsule dark brown with indistinct dark head spots; median row gradually increasing in width giving appearance of an elongate triangle, isthmus narrow. Throat cleft with subparallel sides for about one-half distance to apex, distinctly more convergent beyond, ending in an apical point; extending about one-third distance from posterior margin of head capsule to tip of submentum; about as broad as long. Suboesophageal ganglion distinctly black. Submentum typical for genus except median tooth much larger than outer teeth; lateral margins serrate distally. Usually with six to seven long and three to four short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side is slightly less than the distance between outermost teeth. Mandible with small teeth having relative lengths 35-34-30 from distalmost basad. Antenna slightly less than half as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 6.6-10.6-5.4-1; segment 1 dark brown, segment 2 dark brown except for distinctive light area beneath, extending from 0.4-0.8 distance from base of segment to apex, segments 3 and 4 dark brown. Each cephalic fan with about 59 rays. Length of maxillary palpus slightly less than four times width at base. Pupal respiratory histoblast with nine filaments. Abdomen of preserved specimens mottled black with some light areas, indistinct light intersegmental lines present; segments 6 and 7 with median ventral bulge. Anal cross-piece well sclerotized, areas between arms not sclerotized; ventral arms longer than dorsal arms. Anal hooks 18 to 27 to a row in 127 to 135 rows.

**Distribution.** Canadian and Upper Austral from Minnesota and Quebec to Oklahoma and Georgia.

#### New York State Records

Clinton co.—Ausable river (type locality) (adult); Schuyler Falls, July 1st (pupa, larva)

Erie co.—Colden, August 9th (adult)

Lewis co.—Black River canal between Boonville and Port Leyden,  
June 27th; Fall brook near Porter, June 15th (pupa, larva)

Schuyler co.—Cayuta lake, May 5th-8th (pupa, larva)

Tompkins co.—Enfield falls, June 29th; Ithaca, May 23d—September 16th; Taughannoek falls, April 26th (pupa, larva)

**Biology.** The larvae and pupae of *S. pictipes* are characteristically found on flat sedimentary rocks where the water is swift and shallow above small falls. It is particularly abundant in the gorges of the Finger Lakes region. Smart (1934) reported on studies of the biology of this species in and around Ithaca. The larvae are unusual in often being found in "colonies" which look like black moss. These "colonies" are often only a few inches in diameter, appearing to be larvae hatched from a single egg mass.

Smart (1934) reported that the egg is ovoid but without the marked triangulate shape usually associated with black fly eggs. The eggs average  $0.37 \times 0.22 \times 0.20$  mm. Oviposition was effected through a thin film of water, or the eggs were laid where the surface was wet with spray. The incubation period of the eggs is 2.5 to 5 days at  $25^{\circ}$  C. Desiccation kills the eggs. The larvae require four to six weeks to mature and pupate, but the period can be prolonged by reducing the food supply. The pupae require 4.5 days to mature at  $25^{\circ}$  C. The adults copulate immediately after emergence, and the females lay eggs about a week later. There are at least four and probably five generations per year, the species overwintering in the larval stage.

Gambrell (1933) noted that oviposition took place between 9 and 11 a.m. as a general rule. However, one swarm was detected ovipositing at about 9 p.m. It was also noted that a single female laid between 150 and 200 eggs.

*S. pictipes* has been reported attacking horses, mules and moose (Jobbins-Pomeroy, 1916; Malloch, 1914; Nicholson and Mickel, 1950). It has not been reported attacking humans.

### The *Simulium venustum* complex

The three species *Simulium tuberosum* (Lundstr.), *S. venustum* Say, and *S. verecundum*, n. sp. form a very closely related group, scarcely distinguishable in the pupa, female or the male except for the genitalia. *S. tuberosum* has been recognized as a valid species under several different names for some time. The other two have not been separated up to now, although Nicholson and Mickel (1950) refer to two forms of *venustum* based on the male genitalia. The junior author noted,

in the Adirondacks, that there are at least three and possibly four generations of what was formerly considered to be *S. venustum* between late April and October of each year. However, *S. venustum* is annoying only between late May and early July in this area. This annoyance period coincides well with the emergence of what appeared to be the first generation adults. From this it would appear that either only the first generation is anthrophilic, or that there are two separate species involved.

In 1953 it was observed that fresh specimens of the earlier *S. venustum* larvae had a distinctly reddish tinge on the abdomen, but that the later ones were entirely white. Adults were reared from pupae collected early in May and June from streams with nearly pure cultures of the red larvae and compared with adults reared from pupae collected in July and August from streams with nearly pure cultures of white larvae. There appear to be distinct morphological differences in the male genitalia corresponding to the two forms recognized by Nicholson and Mickel. Both forms are widespread in this country. It therefore is probable that there are two distinct species or that the first-generation *S. venustum* differs both in morphology and habits from the subsequent generations. For the present we consider that these two morphologically and biologically distinct forms represent two distinct, though closely related species. We retain *S. venustum* as the name of the early, annoying species, since Say in the original description remarked that "Its bite is pungent," and it is probable that he collected it between May 5th and June 9th. Because of the difficulty of separating anything but males or fresh larvae, biological data based on females, pupae, or preserved larvae are of little value.

### *Simulium (Simulium) tuberosum* (Lundstroem)

(Figs. 19, 49, 93)

*Melusina tuberosa* Lundstroem, 1911:14-15, fig. 10 (male)

*Simulium tuberosum* (Lundstroem): Edwards, 1915:33-34, figs. 1e, 2d, 4b (male, female); Edwards, 1920:234, fig. 4j (pupa, larva); Puri, 1925:346-47, fig. 12 (pupa, larva)

*Simulium (S.) tuberosum* (Lundstroem): Sommerman, 1953:269, 272, fig. 26 (larva); Grenier, 1953:130-34, figs. 69, 78, 116, 197, 198, 202-4 (female, male, larva, pupa)

*Simulium perissum* Dyar and Shannon, 1927:43-44, figs. 84, 85, 119, 120 (female, male)

*Simulium (S.) perissum* Twinn, 1936:138-39, fig. 11c (female, male, pupa)

*Simulium vandalicum* Dyar and Shannon, 1927:44, figs. 111, 112 (male)

*Simulium (S.) twinnale* Twinn, 1938:51, fig. 4 (male)

*Simulium (S.) twinni* Stains & Knowlton, 1940:77, figs. C, D, F, I (male)

**Female.** General color black, subshiny. Wing length 2.5-3 mm. Frons shiny, black, divergent above; clypeus black, with thin gray



pruinosity. Antenna with scape and pedicel reddish brown, flagellum blackish brown with pale pubescence. Palpus dark brown. Scutum brownish black, subshiny, clothed with short yellow decumbent hairs; humeri, areas on scutum surrounding each of them, the sides and the prescutellar area, grayish in certain lights. Scutellum brownish black, with a border of long, erect black hairs, and usually a few recumbent yellow hairs. Postscutellum velvety brownish black. Pleuron brownish black, with thin gray pollinosity; pleural tuft yellowish brown to black. Wing veins pale brown, the hairs and spinules slightly darker; hairs at base of costa, and on stem vein usually black; subcosta with fine hairs beneath; radius with hairs dorsally beyond base of radial sector; radial sector with fine hairs beneath. Halter nearly white. Fore coxa pale yellow, mid and hind coxae dark; all femora mostly dark brown, the fore femur with some yellowish brown basally; fore tibia flattened, the outer surface with a large patch of white; mid and hind tibiae dark brown, with white on basal half of outer surface; tarsi dark brown to black, the mid and hind basitarsi whitened on basal half or more; fore basitarsus somewhat flattened; calceipala rather small; claw simple. Abdomen blackish; basal fringe yellow; tergites 2 to 5 velvety black; tergites 6 to 8 broader, shiny black or dark brown, with short brown hairs; sternites 1 to 7 not sclerotized. Anal lobe narrowly subtriangular, narrow above, somewhat widened below, and rounded; cercus with nearly straight anterior margin, rounded posteriorly, two-thirds as broad as anal lobe and about twice as broad as long; ovipositor with each half broadly rounded distally; arms of genital rod tapering distally, and with a broad, blunt dorsal tooth.

**Male.** Wing length 2.3-2.6 mm. Scutum velvety black, clothed with dark brown, fine, recumbent hairs. An oblique patch behind each humerus, the sides narrowly, and a transverse band in front of scutellum subshiny, silvery gray in certain lights. Scutellum reddish brown to nearly black, with erect or suberect, brownish to black hairs. Postscutellum velvety brown. Pleuron dark brown to black, with gray pruinosity; pleural tuft dark brown. Hairs at base of costa and on stem vein black; subcosta bare. Halter and leg coloration as in female. Abdomen velvety black, with silvery gray spots on sides of segments 2, 6 and 7; sternites sclerotized. Basistyle subquadrate, about two-thirds length of dististyle, which is nearly three times as long as broad, flattened on distal half; at base dorsally a distinct rounded lobe bearing short, stout spines; apex of dististyle rounded with a subapical internal spine. Ventral plate about as broad as long, finely pilose, with apex truncate, very weakly dentate laterally, with a broad ventral lip; arms

subparallel, with no lateral projections; **parameral** arm with numerous hooks.

**Pupa.** Length about 3 mm. Respiratory organ about one-third to one-half length of pupa, with six slender filaments in three pairs, on short petioles, those of the upper pair not diverging more than the others. Dorsum of thorax smooth; trichomes simple, of moderate size. No terminal hooks. Cocoon simple, wall-vase-shaped with no lateral windows, the anterior margin thickened, slightly concave in profile.

**Larva.** Mature specimens 5.5 mm long. **Head capsule** with obscure dark head spots; triangular shaped fulvous area with base extending full width across posterior of frontoclypeal plate, becoming narrower anteriorly forming a blunt point about one-half distance from posterior margin of head capsule to apex of labrum. **Throat** cleft bowed-V-shaped, longer than width at base; pointed apically; widest about one-fourth distance from posterior margin to apex; extending about one-half distance from posterior margin of head capsule to teeth of submentum. Suboesophageal ganglion distinctly black. Submentum typical for genus; lateral margin serrate distally. Usually three or four long and one or two short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anterior-most epicranial seta on same side slightly less than distance between outermost teeth. Mandible with small teeth having relative lengths 14-8-6 from distalmost basad. Inner subapical margin with large double tooth, anterior portion twice as long as posterior. Antenna long, as long as 0.8 the distance from base to posterior margin of head capsule; segment length ratios from base to apex, 12-12.8-9-1 (Puri, 1925 reported five segments); uniformly yellow except that basal area of venter of first segment is light. Each cephalic fan with about 38 fan rays. Length of maxillary palpus slightly less than three times basal width. Pupal respiratory histoblast with six filaments. Abdomen of preserved specimens black, with broad white intersegmental areas; segments 7 and 8 lightened ventrally. Anal cross-piece well sclerotized; areas between arms not sclerotized; ventral arms longer than dorsal arms. Anal hooks 11 to 15 to a row in about 72 rows.

**Distribution.** Holarctic. In the Nearctic region, Hudsonian from Alaska to Greenland, and south to the Upper Austral of Texas and Florida.

### New York State Distribution

Abundant throughout the State.

**Biology.** Although Smart (1944) and Davies (1950) reported that there are possibly two generations a year of this species, in the Adirondacks there are at least three and probably four generations a year. In this area, larvae begin emerging from the eggs in early May, somewhat after the first *S. venustum* larvae are found. They occur in all types of permanent streams and by late June or early July are the dominant species present. Females of this species closely resemble those of *S. venustum*. Together they make up a complex which is annoying from late May to early July in the Adirondacks. Although adults of *S. tuberosum* emerge during the entire summer, they are not annoying after early July. There is some evidence to indicate that only the first generation is anthropophilic in the Adirondacks.

*S. tuberosum* has been reported attacking man, horses, domestic animals and mammals (Davies, 1950; DeFoliart, 1951; Edwards, 1915; Edwards *et al.*, 1939; Jannback, 1952; Hocking and Richards, 1952; and Smart, 1944).

### *Simulium (Simulium) venustum* Say

(Figs. 26, 27, 59, 78, 87, 92)

*Simulium venustum* Say, 1823:28-29 (female); Johannsen, 1903:379-81, pl. 37, figs. 1-6 (female, male, pupa, larva); Malloch, 1914:43-44, pl. 2, fig. 7, pl. 4, fig. 3, pl. 5, fig. 1 (male, female, pupa, larva); Jobbins-Pomeroy, 1916:3-6, 16, text figs. 1, 2, 5, 8, 12, 15, pl. I, figs. 1-5, pl. II, fig. 2, pl. III, figs. 1-6, pl. IV, figs. 4, 9, pl. V, fig. 2 (male, female, pupa, larva, egg); Puri, 1925:347-48, text fig. 13 (pupa, larva); Hearle, 1932:17-18; Johannsen, 1934:63-64, pl. 24, fig. 213 (pupa, larva); Nicholson, 1945:282-96, figs. 7, 8, 11, 12, 14, 15, 16, 19, 20, 22 (mouth-parts); Nicholson and Mickel, 1950:48-52, figs. 30 A-F (male, female, pupa); Grenier, 1953:129-130, figs. 43, 54, 94, 112, 144, 168, 199-201 (female, male, pupa, larva)

*Simulium (Simulium) venustum* Say: Twinn, 1936:136-38, pl. I, figs. 2, 5; text fig. 11B (male, female, pupa); Sommerman, 1953:269, 272, fig. 27 (larva)

*Simulium molestum* Harris, 1841:405 (female)

*Simulium minutum* Lugger, 1896: fig. 143 (female)

*Simulium irritatum* Lugger, 1896: figs. 145, 146 (male, female)

*Boophtora rileyana* Enderlein, 1922:75 (female)

*Simulium groenlandicum* Enderlein, 1935:363 (female)

(The references to *venustum* with the exception of the original one and those by Puri and Grenier, probably include the new species *verecundum*, which follows).

**Female.** Agreeing with *tuberosum* with the following exceptions: Pleural tuft usually yellowish; hairs at base of costa and on stem vein usually yellow.

**Male.** Agreeing with *tuberosum*, with the following exceptions: Fine hairs of scutum often paler, sometimes nearly white; pale areas

behind humeri often somewhat larger, and pale area in front of scutellum somewhat broader. Basistyle subquadrate, about two-thirds length of dististyle, which is about 2.8 times as long as broad, flattened, somewhat constricted medially, the apex rounded with a short spine at apex of inner margin; ventral plate with central portion a compressed, tapering trough, the margins before the rounded apex with teeth, and these margins spread outward, at least slightly; basal arms divergent, without lateral projections; arm of paramere with numerous hooks.

**Pupa.** Very similar to that of *S. tuberosum*. Respiratory filaments often somewhat longer, from one-half to two-thirds as long as pupa; filaments of dorsal pair often somewhat more divergent than in *tuberosum*.

**Larva.** Mature specimens 6 to 7 mm long. Head capsule with distinct light yellow head spots; with dark fulvous area around median head spots and median posterior fulvous area also present; fulvous area extending to outer margins of anterolateral head spots or beyond; with median anterior and posterior groups separated by narrow isthmus; with anterolateral and posterolateral head spots present and distinct in most specimens. Epicranial plate fumeous brown, lacking light yellow area just anterior to throat cleft. Throat cleft bulbous arrowhead-shaped; width and length subequal; pointed apically; widest about one-third distance from posterior margin to apex. Suboesophageal ganglion light. Submentum typical for genus. Usually three long and one short epicranial setae present on each side. Distance from apex of outermost tooth of submentum to anteriormost epicranial seta on same side subequal to distance between outermost teeth. Mandible with small teeth having relative lengths of 12-9-8 from distalmost basad. Antenna moderately long, about two-thirds as long as distance from base to posterior margin of head capsule; segment length ratios base to apex 11.8-13.4-11.6-1; uniformly light yellow except for light basal area beneath on first segment. Each cephalic fan with about 51 rays. Length of maxillary palpus almost three times width at base. Pupal respiratory histoblast with six filaments. Abdomen of preserved specimens dirty gray to brown with light intersegmental areas. Anal cross-piece well sclerotized, the areas between arms lightly sclerotized; ventral arms longer than dorsal arms. Anal hooks 9 to 15 to a row in 60 to 75 rows.

**Distribution.** Holarctic. In the Nearctic region, Hudsonian from Alaska to Greenland, and south to the Lower Austral zone of Mississippi and Texas.

## New York State Distribution

Abundant throughout State.

**Biology.** The separation of what was formerly considered to be the single species *S. venustum* into two species reduces the value of earlier biological studies, although most of the biting and annoyance records do probably refer to the true *venustum*. In the Adirondacks it is annoying to man from late May until early July. It does not bite as readily as *P. hirtipes*, but it may be extremely annoying at times.

It apparently overwinters in the egg stage, the larvae first appearing in large number during the latter half of May. The number of larvae declines rapidly during the spring and early summer, most of them pupating by early July. *S. venustum* is found in both large and small permanent streams. There is apparently only one generation each year.

**Simulium (Simulium) verecundum, new species**

(Figs. 25, 41)

**Female.** Not distinguishable from *tuberosum* or *venustum*. Some of the specimens have the hairs of the stem vein and pleural tuft pale as is usual in *venustum*, while others have these dark as usual in *tuberosum*. A slightly shinier appearance to the scutum may be present, but it is not sufficient to serve as a character.

**Male.** Externally not distinguishable from *venustum*. The ventral plate of the genitalia is shaped much like that of *venustum* except that the lateral serrate portion to each side of the dorsal trough is turned inward so that the teeth are not noticeable from a dorsal view, but approach each other over the central depression, and the apex of the ventral plate is likewise considerably narrowed.

**Pupa.** Not distinguishable from *venustum*.

**Larva.** Not separable from *venustum* except in living or freshly killed specimens. In these, the body is entirely white, while in *venustum* the body has a distinctly reddish tinge.

**Holotype.** Male, Monroe co., Pennsylvania, June 4, 1948, with associated pupal skin and cocoon mounted dry and genitalia on slide (Stone). Paratypes: ALASKA: Anchorage, June 12, 1947 (Stone), 1 female, 1 male; Anchorage-Palmer, June 25, 1947 (Jenkins), 1 female, 2 males; Matanuska, October 6, 1945 (Chamberlin), 1 male. MASSACHUSETTS: Berkshire co., July 5, 1948 (Stone), 4 females,

5 males; MINNESOTA: Mississippi river, Itasca Park, May 23, 1939 (Nicholson), 3 males. NEW YORK: Copake, September 1, 1952 (Stone) 5 females, 5 males; Forestport, July 28 and August 27, 1952 (Jannback), 2 males; PENNSYLVANIA: Same data as holotype, 3 females, 2 males; SOUTH CAROLINA: Richland co., April 7, 1954 (Stone), 1 female, 1 male; Spartansburg, July 3d to November 1st (Pomeroy; Jennings and King) 26 males; VIRGINIA: New Kent co., May 31, 1941 (Stone) 6 females, 9 males; Charles City co., May 31, 1941 (Stone) 3 females, 2 males; WASHINGTON: Twinn Buttes, June 25, 1941 (Knipling and Yates) 1 male.

Holotype, U. S. National Museum No. 62361. Paratypes, U. S. National Museum, New York State Museum and University of Minnesota.

This species is widespread in North America and the paratypes listed above are selected from many more specimens.

The name is derived from the Latin adjective meaning modest, shy or diffident, in reference to its nonannoying habits.

**Biology.** Very similar to that of *venustum* except that it appears not to annoy man, it is somewhat later in appearance than *venustum* and it apparently has two or three generations a year in New York State. There remains much to be learned about the biological relationship of these two species, if they are specifically distinct, throughout the ranges of the species.

## LITERATURE CITED

## Baranov, N.

- 1926 Eine neue Simuliiden-Art und einige Bemerkungen ueber das System der Simuliiden. N. Beitr. Syst. Insektenk., 3:161-64  
 1935 Contribution to the knowledge of *Simulium reptans columbaccense*. Vet. Archiv., 5:58-96, 97-140  
 1937 Contribution to the knowledge of the Golumbatz fly. V. (Study of the epidemiology of the fly in 1936). Vet. Archiv., 7:229-76

## Bequaert, J.

- 1938 The black-flies, or Simuliidae, of the Belgian Congo. Amer. Jour. Trop. Med., 18:116-36  
 1945 Dr Luis Vargas on American Black-flies—A review with critical notes (Diptera). Bul. Brooklyn Ent. Soc., 40:111-15

## Bromley, S.

- 1952 Notes on Stamford bloodsucking flies. Ent. News, 63:97-100

## Cameron, A. E.

- 1922 The morphology and biology of a Canadian cattle-infesting black fly, *Simulium simile* Mall. (Diptera, Simuliidae). Dom. Can. Dep't Agr., Bul. 5:1-26

## Comstock, J. H.

- 1895 Simuliidae in, A manual for the study of insects. Ithaca, N. Y. p. 451-53

## Coquillett, D. W.

- 1898 The buffalo-gnats, or black-flies of the United States. U. S. Dep't Agr., Div. Bul., 10:66-69  
 1902 Simuliidae in, New Diptera from North America. U. S. Nat. Mus. Proc., 25:96-97

## Cox, James A.

- 1938 Morphology of the digestive tract of the blackfly (*Simulium nigroparvum*). Jour. Agr. Res., 57:443-48

## Dalmat, H. T.

- 1950 Studies on the flight range of certain Simuliidae, with the use of *aurifine* dye marker. Ann. Ent. Soc. Amer., 43:537-45  
 1952 Longevity and further flight range studies on the blackflies (Diptera, Simuliidae), with the use of dye markers. Ann. Ent. Soc. Amer., 45:23-37

## — &amp; Gibson, C. L.

- 1952 A study of the flight range and longevity of blackflies (Diptera, Simuliidae) infected with *Onchocerca volvulus*. Ann. Ent. Soc. Amer., 45:605-12

## Davies, D. M.

- 1949 Variations in taxonomic characters of some Simuliidae (Diptera). Can. Ent., 81:18-21  
 1950 A study of the black fly population of a stream in Algonquin Park, Ontario. Trans. Royal Can. Inst., 28:121-59

## DeFoliart, G. R.

- 1951 The life histories, identification and control of blackflies (Diptera: Simuliidae) in the Adirondack mountains. (Unpublished thesis, Cornell Univ., 98p.

**De Leon, J. Romeo**

- 1945 Nuevas especies de Simulidos en la region occidental de Guatemala. p. 1-12

**Dimond, John B. & Hart, William G.**

- 1953 Notes on the blackflies (Simuliidae) of Rhode Island. Mosq. News, 13:238-42

**Dyar, H. G. & Shannon, R. C.**

- 1927 The North American two-winged flies of the family Simuliidae. Proc. U. S. Nat. Mus., 69:1-54 (No. 2636)

**Edwards, F. W.**

- 1915 On the British species of *Simulium*. I. The adults. Bul. Ent. Res., 6:23-42  
1920 On the British species of *Simulium*. II. The early stages; with corrections and additions to part I. Bul. Ent. Res., 11:211-46

---

**Oldroyd, M. A. & Smart, J.**

- 1939 Simuliidae in, British blood-sucking flies, Wm. Clowes & Sons, Ltd. London & Beccles, p. 50-66

**Emery, W. T.**

- 1913 Morphology and biology of *Simulium vittatum* and its distribution in Kansas. Kansas Univ. Sci. Bul., 8:323-62

**Enderlein, G.**

- 1921a Das system der Kriebelmücken (Simuliidae). Deutsch. Tierärz. Wochenschr., 16:197-200  
1921b Neue paläarktische Simuliiden. Sitz.-Ber. Ges. nat. Freunde Berlin, 1920:212-24  
1921c Die systematische Gliederung der Simuliiden. Zool. Anz., 53:43-46  
1922 Weiter beiträge zur kenntnis der Simuliiden. Konowia, 1:67-76  
1925 Weiter beiträge zur kenntnis der Simuliiden und ihrer verbreitung. Zool. Anz., 62:201-12  
1930 Der heutige stand der klassifikation der Simuliiden. Arch. Klassif. Phylog. Ent., 1:77-97  
1934 Weiterer ausbau des systems der Simuliiden (Dipt.) Deut. Ent. Ztschr., 1933:273-92  
1935 Neue Simuliiden, besonders aus Afrika. Sitz. Ges. Nat. Freunde Berlin, 1934:273-92

**Forbes, S. A.**

- 1912 On black flies and buffalo gnats (*Simulium*) as possible carriers of pellagra in Illinois. In 27th Rep't State Entom. Ill., p. 21-55

**Fredeen, F. J. H., Rempel, J. G. & Arnason, A. P.**

- 1951 Egg laying habits, overwintering stage, and life cycle of *Simulium arcticum* Mall. (Diptera: Simuliidae). Can. Ent., 83:73-76

**Freeman, Paul**

- 1950 The external genitalia of male Simuliidae. Ann. Trop. Med. and Parasit., 44:146-52

**Friederichs, K.**

1920. Neues ueber Kriebelmuecken. Berlin. Tierarz. Wochenschr., 36:567-69  
1921 Untersuchungen ueber Simuliiden, Teil II. Zeitschr. Angew. Ent., 8:31-92



**Fries, F.**

- 1824 *Observationes entomologicae*, Pt I N. 5. *Simulium* Sveciae, Lundae

**Frisson, T. H.**

- 1927 *Simuliidae in*, A list of the insect types in the collections of the Illinois State Natural History Survey and the University of Illinois. Ill. Nat. Hist. Surv. Bul., 16:181

**Frohne, W. C. & Sleeper, D. A.**

- 1951 Reconnaissance of mosquitoes, punkies, and blackflies in southern Alaska. *Mosq. News*, 11:209-13

**Frost, S. W.**

- 1949 The *Simuliidae* of Pennsylvania (Dipt.). *Ent. News*, 60:129-31

**Fuller, H. S.**

- 1940 Black-flies bite woodchuck. *Brooklyn Ent. Soc.*, 35:155

**Gambrell, L. A.**

- 1933 The embryology of the black fly, *Simulium pictipes* Hagen. *Ann. Ent. Soc. Amer.*, 26:641-71

**Gibbins, E. G.**

- 1934 Further studies on Ethiopian *Simuliidae*. *Trans. Roy. Ent. Soc. London*, 82:51-97

**Grenier, P.**

- 1953 *Simuliidae* de France et d'Afrique du Nord. *Encyc. Ent.*, 29, 170p.

**Hagen, H. A.**

- 1880 A new species of *Simulium* with a remarkable nymphal case. *Proc. Boston Soc. Nat. Hist.*, 20:305-7  
1881 On *Simulium*. *Canad. Ent.*, 13:150-51

**Harris, T. W.**

- 1841 *Diptera in*, A report on the insects of Massachusetts injurious to vegetation, p. 401-47

**Headlee, T. J.**

- 1906 Blood gills of *Simulium pictipes*. *Amer. Natur.*, 40:875-85

**Hearle, E.**

- 1932 The blackflies of British Columbia (*Simuliidae*, *Diptera*). *Proc. Ent. Soc. Brit. Columbia*, 29:5-19

**Hocking, B. & Richards, W. R.**

- 1952 Biology and control of Labrador blackflies (*Diptera: Simuliidae*). *Bul. Ent. Res.*, 43:237-57

**Howard, L. O.**

- 1901 The black flies and buffalo gnats *in*, *The insect book*. Doubleday, Page and Co., p. 120-23

**Hungerford, H. B.**

- 1913 Anatomy of *Simulium vittatum*. *Kansas Univ. Sci. Bul.*, 8:365-82

**Jamnback, H.**

- 1952 The importance of correct timing of larval treatments to control specific blackflies (*Simuliidae*). *Mosq. News*, 12:77-78

**Jenkins, D. W.**

- 1948 Ecological observations on the blackflies and punkies of central Alaska. Mosq. News, 8:148-55

**Jobbins-Pomeroy, A. W.**

- 1916 Notes on five North American buffalo gnats of the genus *Simulium*. U. S. Dep't Agr. Bul., 329:1-48

**Johannsen, O. A.**

- 1903 Simuliidae in, Aquatic insects in New York State. N. Y. State Mus. Bul., 68:336-88  
1934 Simuliidae in, Aquatic diptera. Part I. Nemocera exclusive of Chironomidae and Ceratopogonidae. Cornell Univ. Agric. Exp. Sta. Mem., 164:56-64

**Johnson, Charles W.**

- 1925 Simuliidae in, Diptera of the Harris collection. Proc. Boston Soc. Nat. Hist., 38:(2):65

**Johnson, E. P., Underhill, G. W., Cox, J. A. & Threlkeld, W. L.**

- 1938 A blood protozoon of turkeys transmitted by *Simulium nigroparvum* (Twinn). Amer. Jour. Hyg., 27:649-65

**Knowlton, G. F.**

- 1935 Simuliids annoy livestock. Jour. Econ. Ent., 28:1073

---

**& Maddock, D. R.**

- 1944 Snipe flies in Utah. Jour. Econ. Ent., 37:119

---

**& Rowe, J. A.**

- 1934a New blood-sucking flies from Utah (Simuliidae, Diptera). Ann. Ent. Soc. Amer., 27:580-84  
1934b Preliminary studies of insect transmission of equine encephalomyelitis. Utah Acad. Sci. Proc., 11:267-70

**Krafchick, Bernard**

- 1943 The mouthparts of blackflies with special reference to *Eusimulium lascivum* Twinn. Ann. Ent. Soc. Amer., 35:426-34

**Latreille, P. A.**

- 1802 Histoire naturelle, generale et particuliere, des Crustaces et des Insectes. III. Diptera. p. 418-67. Paris

**Longstaff, T. G.**

- 1932 An ecological reconnaissance in west Greenland. Jour. Anim. Ecol., 2:119-42

**Lugger, O.**

- 1896 Simuliidae in, Second report of the entomologist of Minnesota, Bul. 48, p. 172-82

**Lundstroem, C.**

- 1911 Beitrage zur kenntnis der Dipteren Finlands. VII. Melusinidae (Simuliidae). Acta Soc. pro Fauna Flor. Fennica, 34(12):1-23

**Malloch, J. R.**

- 1914 American black flies or buffalo gnats. U. S. Dep't Agr. Bur. Ent. Tech. Ser., 26:1-72

**Matheson, R.**

- 1950 Simuliidae in, *Medical entomology*, 2d edition, p. 401-14, 419-420 Comstock Pub. Co. Inc., Ithaca, N. Y.

**Meigen, J. W.**

- 1804 Klassifikation und Beschreibung der europäischen zweiflügeligen insekten (Diptera Linn.) p. I-XXVIII and 1-314 Braunschweig  
1818 Systematische beschreibung der bekannten enropäischen zweiflügeligen insekten. Aachen und Hamm., Erster Theil.

**Nicholson, H. P.**

- 1945 The morphology of the mouthparts of the non-biting blackfly, *Eusimulium dacotense* D. & S., as compared with those of the biting species, *Simulium venustum* Say. Ann. Ent. Soc. Amer., 38:281-97

**& Mickel, C. E.**

- 1950 The black flies of Minnesota. Univ. Minnesota Agr. Expt. Sta. Tech. Bul., 192:1-64

**O'Kane, W. C.**

- 1926 Blackflies in New Hampshire. N. H. Agr. Exp. Sta. Tech. Bul., 32:1-23

**Osborn, Herbert**

- 1896 Simuliidae in, *Insects affecting domestic animals*, U. S. Dep't Agr., Div. Ent. Bul., 5:31-58

**Pacaud, Andre**

- 1942 Notes biologiques sur une station de *Simulium aurum* Fries aux environs de Paris. Bul. Biol. de la France et Belg., 76:226-38

**Puri, I. M.**

- 1925 On the life history and structure of the early stages of Simuliidae (Diptera, Nematocera). Pts I-II. Parasitology, 17:295-369

**Rempel, J. G. & Arnason, A. P.**

- 1947 An account of three successive outbreaks of the black fly, *Simulium arcticum*, a serious livestock pest in Saskatchewan. Sci. Agr., 27:428-45

**Riley, C. V.**

- 1870 The death-web of young trout. Amer. Ent. and Bot., 2:227-28; The so-called web-worm of trout, *ibid.* 365-67

**Ritcher, P. O.**

- 1931 An undescribed species of Simuliid larva (from Illinois) and the corresponding pupa (Diptera, Simuliidae). Ent. News, 42:241-46

**Roubaud, M. E.**

- 1906 Aperçus nouveaux, morphologiques et biologiques sur les Dipteres piqueurs du groupe des Simulies. C. Rend. Acad. Sci., 143:519-21

**Rubzov, I. A.**

- 1940 Faune de l'URSS, insectes Dipteres, fam. Simuliidae. Inst. Zool. de l'Acad. Sci. de l'URSS. N.S., 23, 6(6):1-532

**Sailer, R. I.**

- 1953 The blackfly problem in Alaska. Mosq. News, 13:232-35

**Say, Thomas**

- 1823 Descriptions of dipterous insects of the United States. Jour. Acad. Nat. Sci. Phila., 3:28

**Smart, John**

- 1934 Notes on the biology of *Simulium pictipes*. Canad. Ent., 66:62-66
- 1936 Notes on the Simuliidae occurring at Fortingal, Perthshire. Scot. Nat., 217:22-26
- 1944 The British Simuliidae, with keys to the species in the adult, pupal, and larval stages. Freshwater Biol. Ass'n. Brit. Empire, Sci. Publ. No. 9, 57p.
- 1945 The classification of Simuliidae. Trans. Roy. Ent. Soc. London, 95: 463-532

**Sommerman, K. M.**

- 1953 Identification of Alaskan black fly larvae (Diptera, Simuliidae). Proc. Ent. Soc. Wash., 55:258-73

**Speiser, P.**

- 1904 Zur nomenklatur blutsaugender Diptern Amerikas. Insektenboerse, 21:148

**Stains, G. S. & Knowlton, G. F.**

- 1940 Three new western Simuliidae (Diptera). Ann. Ent. Soc. Amer., 33:77-80
- 1943 A taxonomic and distributional study of Simuliidae of western United States. Ann. Ent. Soc. Amer., 36:259-80

**Stone, Alan**

- 1949 The identity of two Nearctic Simuliidae. Bul. Brooklyn Ent. Soc., 44: 138-40
- 1952 The Simuliidae of Alaska. Proc. Ent. Soc. Wash., 54:69-96

**Strickland, E. H.**

- 1911 Some parasites of *Simulium* larvae and their effects on the development of the host. Biol. Bul., 21:302-34
- 1913 Further observations on the parasites of *Simulium* larvae. Jour. Morphol., 24:43-94

**Twinn, C. R.**

- 1933 The black fly, *Simulium venustum* Say, and a protozoan disease of ducks. Canad. Ent., 65:1-3
- 1936 The blackflies of eastern Canada (Simuliidae, Diptera). Canad. Jour. Res., (D)14:97-150
- 1938 Blackflies from Utah and Idaho, with descriptions of new species (Simuliidae, Diptera). Canad. Ent., 70:48-55
- 1952 A review of studies of blood-sucking flies in northern Canada. Canad. Ent., 84:22-28

**Underhill, G. W.**

- 1940 Some factors influencing feeding activity of Simuliidae in the field. Jour. Econ. Ent., 33:915-17
- 1944 Blackflies found feeding on turkeys in Virginia (*Simulium nigroparvum* Twinn and *Simulium slossonae* Dyar and Shannon). Va. Agr. Exp. Sta. Tech. Bul., 94:1-32

**Vargas, L.**

- 1943 Nuevos datos sobre simúlidos mexicanos. Rev. Inst. Salub. y Enferm. Trop., 4:359-70

**———, Martinez Palacios, A. & Diaz Najera, A.**

- 1946 Simúlidos de Mexico. Inst. Salub y Enferm. Trop., 7:101-92

**Vargas, L. & Diaz Najera, A.**

- 1948a Nota sobre la identificacion de los simúlidos de Mexico. El subgenero *Mallochianella*, n. n. Rev. Inst. Salub. y Enferm. Trop., 9:65-74  
1948b Nuevas especies de simúlidos de Mexico y consideraciones diversas sobre especies ya descritas. Rev. Inst. Salub. y Enferm. Trop., 9:321-69  
1949 Claves para identificar las pupas de los simúlidos de Mexico. Rev. Inst. Salub. y Enferm. Trop., 10:283-319  
1951 Notas sobre sistematica y morfologia de simúlidos. Rev. Soc. Mex. de Hist. Nat., 12:123-62

**Walker, F.**

- 1848 List of the specimens of dipterous insects in the collection of the British Museum, 1:1-229

**Wanson, M.**

- 1950 Contribution à l'étude de l'Onchocercose Africaine humaine (problèmes de prophylaxie à Leopoldville). Ann. Soc. Belge Med. Trop., 30:667-863

**———— & Henrard, C.**

- 1945 Habitat et comportement larvaire du *Simulium damnosum* Theobald. Rec. Trav. Sci. Méd. Congo Belge, 4:113-21

**Webster, F. M.**

- 1887 Report on the buffalo-gnats. U. S. Dep't Agr., Div. Ent. Bul., 14:29-39

**Wu, Yi-Fang**

- 1931 A contribution to the biology of *Simulium* (Diptera). Mich. Acad. Sci., Arts and Letters, 13:543-99

**Zetterstedt, J. W.**

- 1838 Diptera in Insecta Lapponica descripta p. 447-868

George D. A. Hays

1900-1901

1901-1902

1902-1903

1903-1904

1904-1905

1905-1906

1906-1907

1907-1908

Walter B.

## PLATES

## PLATE 1

## ADULT

Head capsule

- 1 *Simulium* (N.) *vittatum* Zett.

Wing

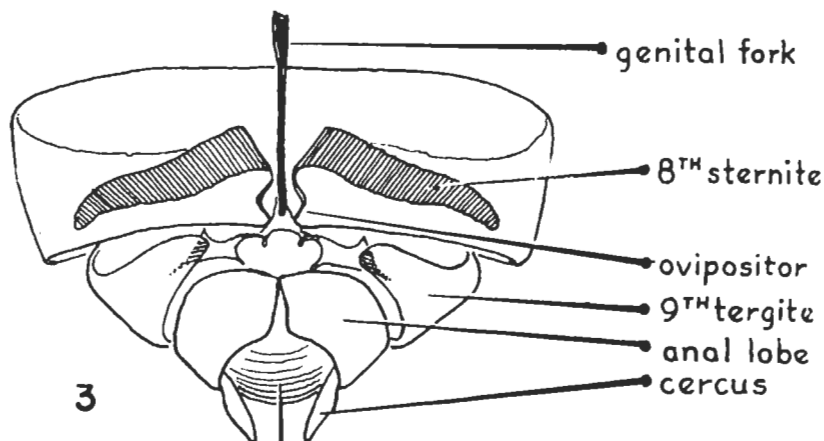
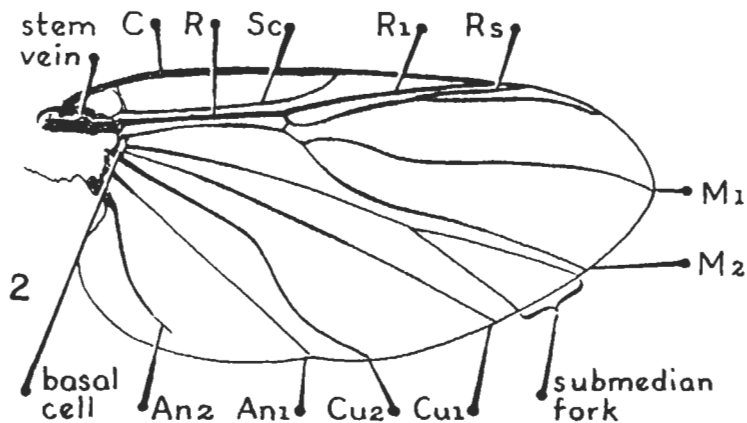
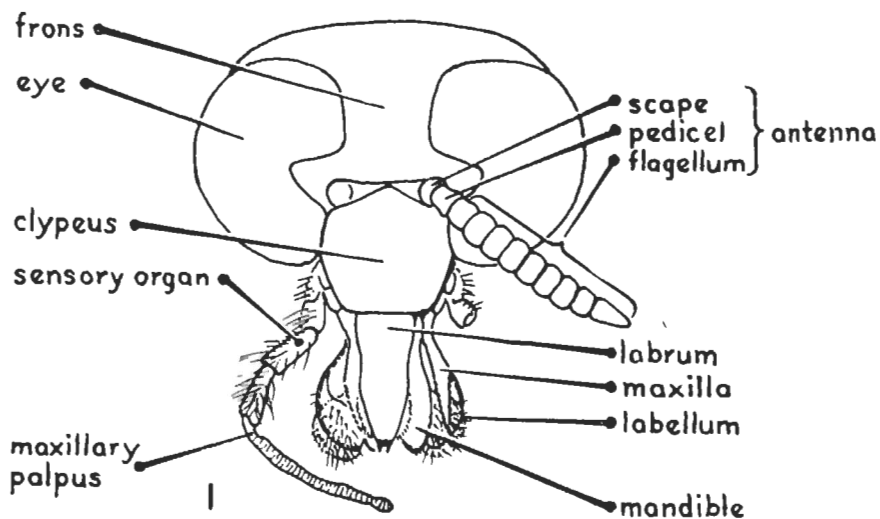
- 2 *Prosimulium hirtipes* (Fries)

Female terminalia

- 3 *Simulium* (N.) *vittatum*, Zett., ventral aspect



Plate 1



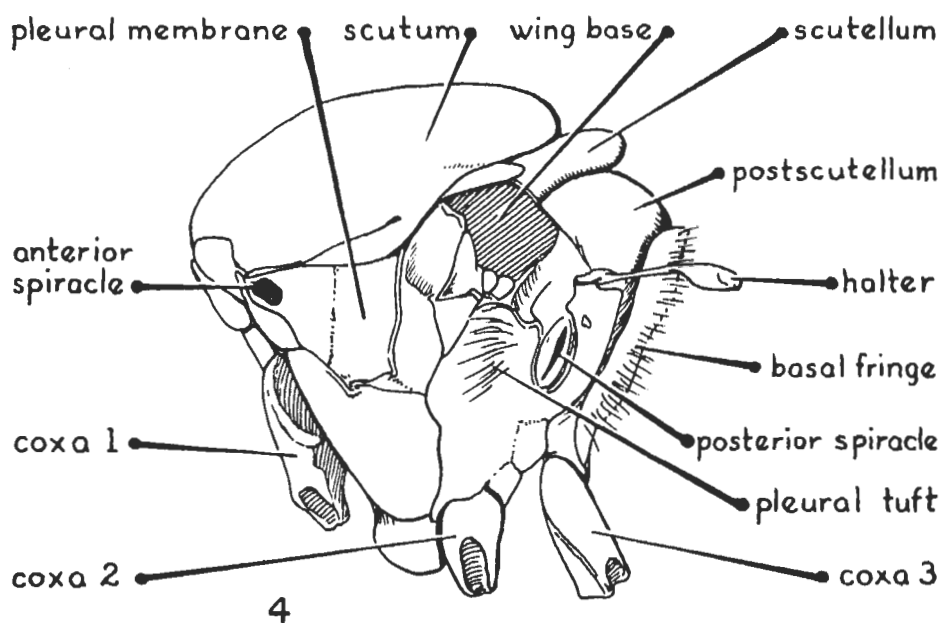
## PLATE 2

## ADULT

Thorax

4 *Prosimulium magnum*, D. & S., lateral aspect

Plate 2



## P L A T E 3

## ADULT

Hind tarsus

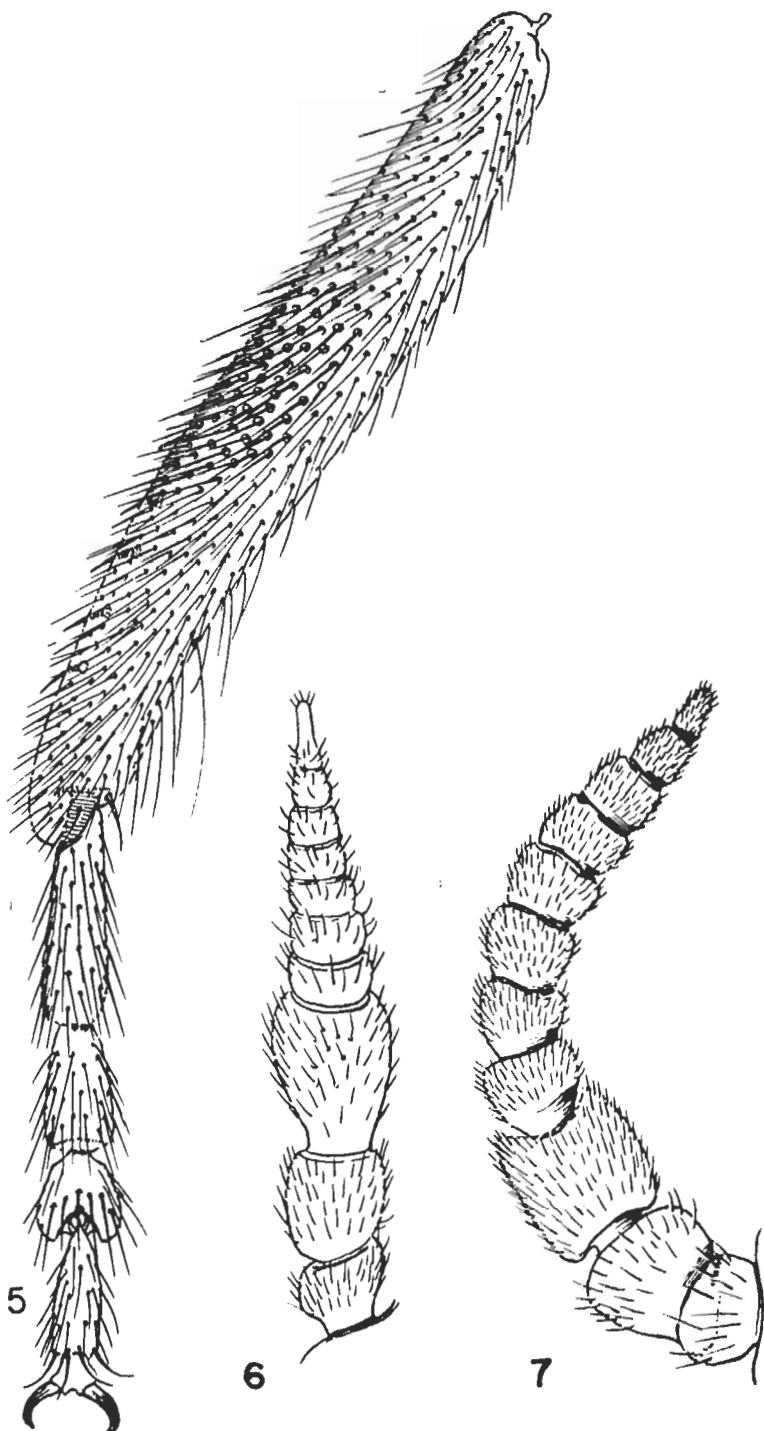
5 *Cnephia* (*M.*) *mutata* (Mall.)

Antennae

6 *Prosimulium magnum* D. & S., male

7 *Prosimulium magnum* D. & S., female

Plate 3



## P L A T E 4

## ADULT

## Claws

- 8 *Simulium* (*S.*) *parnassum* Mall.
- 9 *Cnephia* (*C.*) *dacotensis* (D. & S.)
- 10 *Simulium* (*S.*) *corbis* Twinn

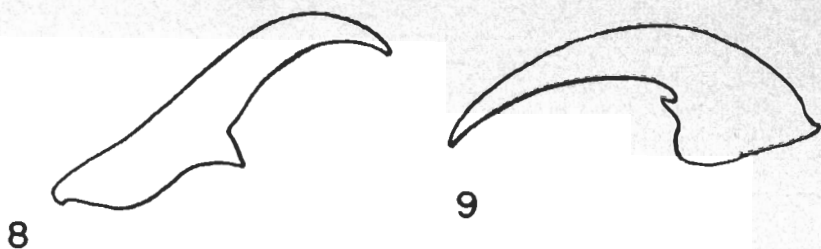
## Male genitalia

- 11 *Simulium* (*S.*) *jenningsi* Mall., ventral structures
- 12 *Simulium* (*S.*) *jenningsi* Mall., dorsal structures

## Thorax

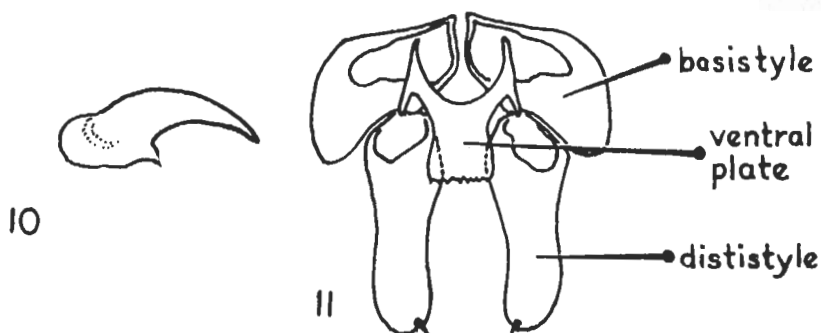
- 13 *Simulium* (*N.*) *vittatum* Zett., dorsal aspect

Plate 4



8

9

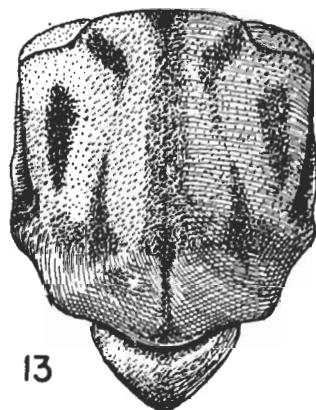


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## PLATE 5

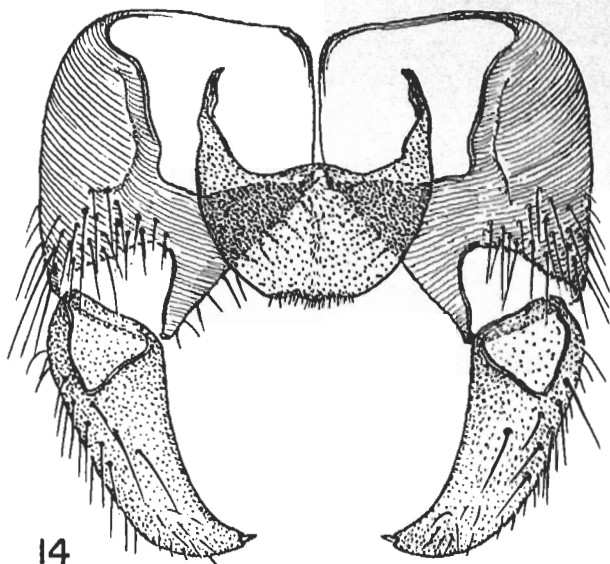
## ADULT

## Male genitalia

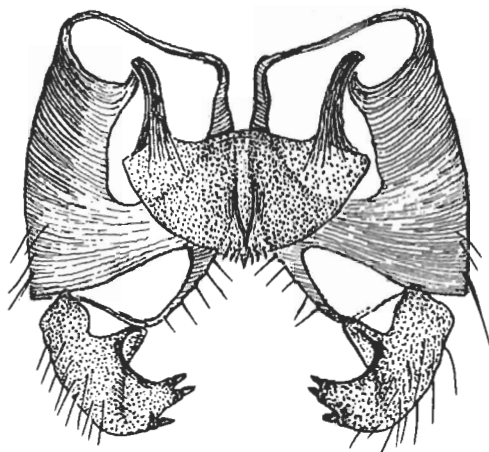
- 14 *Cnephia* (C.) *dacotensis* (D. & S.)
- 15 *Prosimulium* *hirtipes* (Fries)
- 16 *Cnephia* (M.) *mutata* (Mall.)
- 17 *Twinnia* *tibblesi* n.g., n. sp.



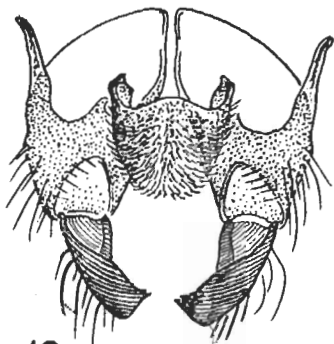
Plate 5



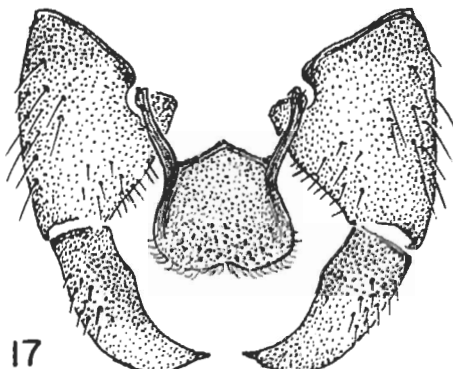
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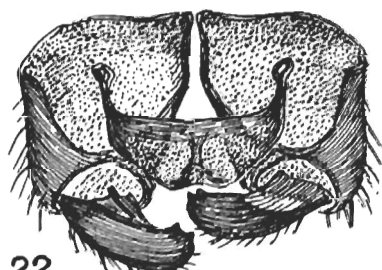
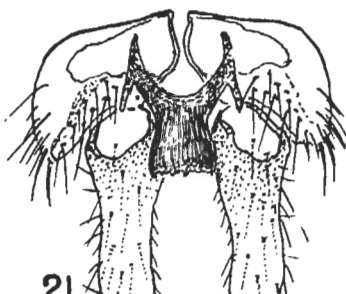
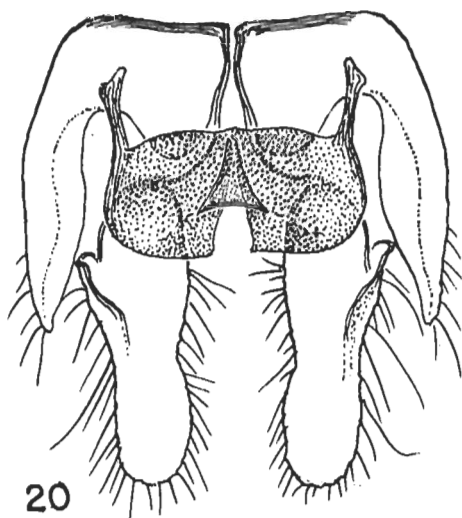
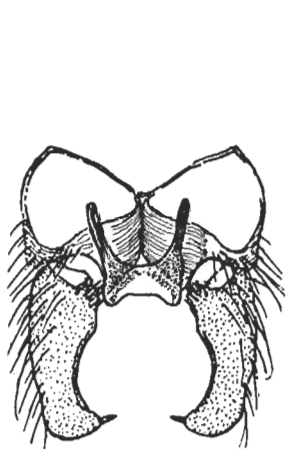
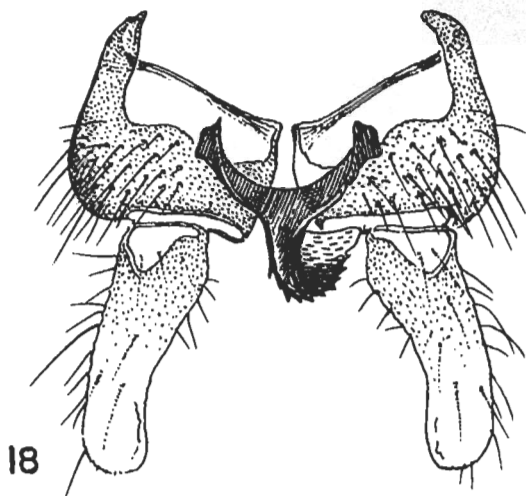
## PLATE 6

## ADULT

## Male genitalia

- 18 *Simulium* (*S.*) *corbis* Twinn
- 19 *Simulium* (*S.*) *tuberosum* (Lund.)
- 20 *Simulium* (*S.*) *pictipes* Hagen
- 21 *Simulium* (*S.*) *jenningsi* Mall.
- 22 *Cnephia* (*E.*) *loisae* n. sp.

Plate 6



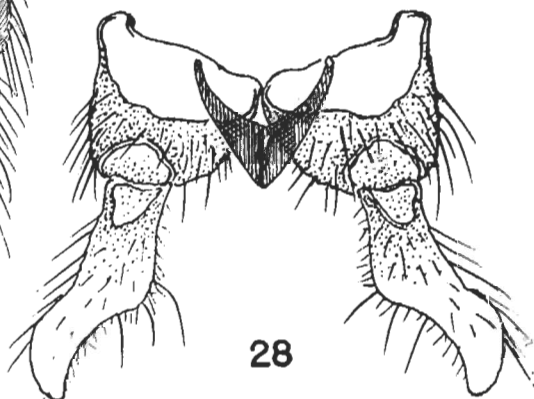
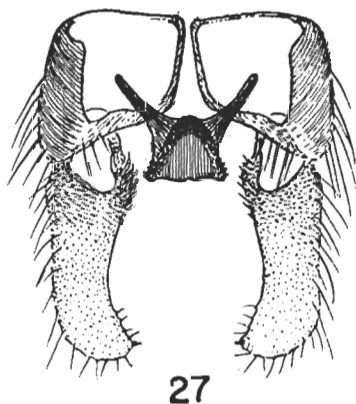
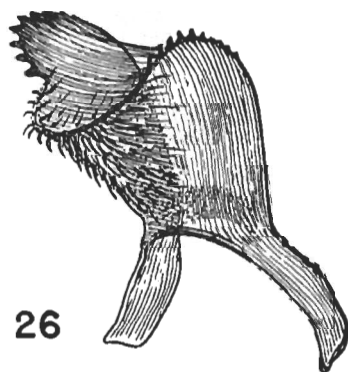
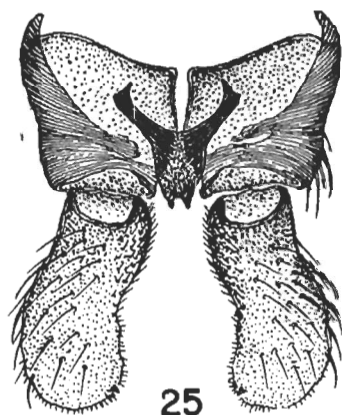
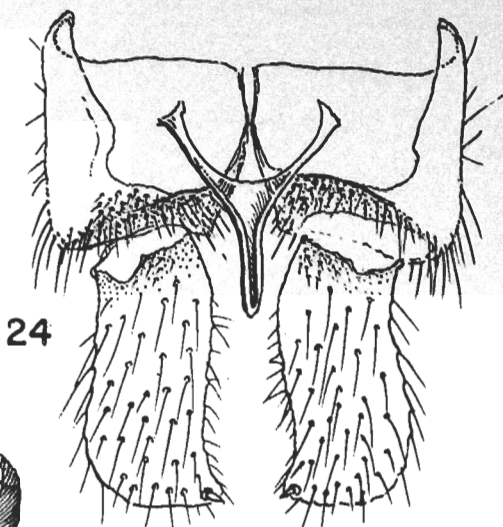
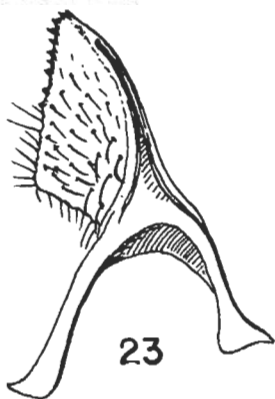
## P L A T E 7

## ADULT

## Male genitalia

- 23 *Simulium* (*S.*) *decorum* Walker, ventral plate
- 24 *Simulium* (*S.*) *decorum* Walker
- 25 *Simulium* (*S.*) *verecundum* n. sp.
- 26 *Simulium* (*S.*) *venustum* Say, ventral plate
- 27 *Simulium* (*S.*) *venustum* Say
- 28 *Simulium* (*S.*) *parnassum* Mall.

Plate 7



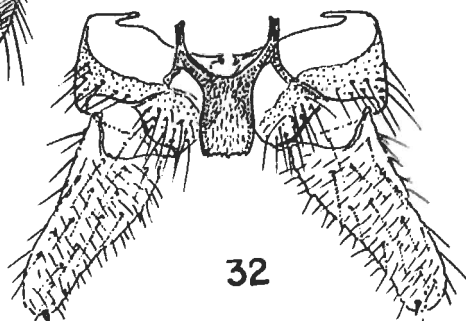
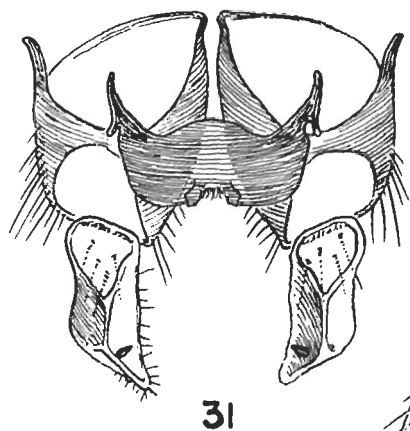
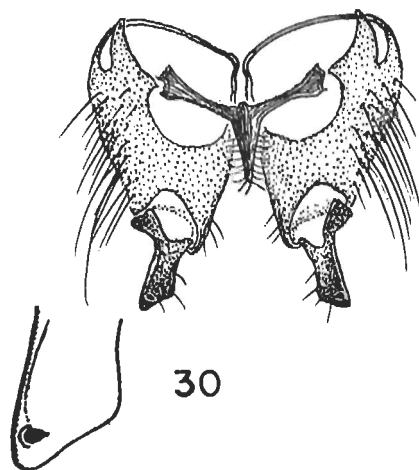
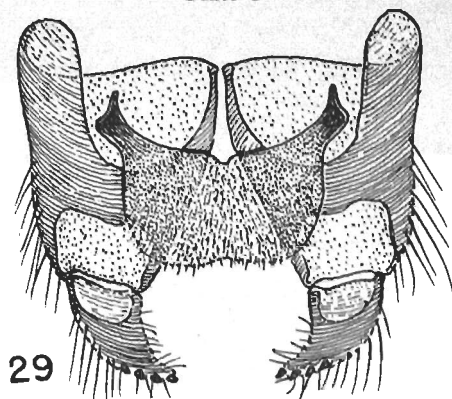
## PLATE 8

## ADULT

## Male genitalia

- 29 *Simulium* (*N.*) *vittatum* Zett.
- 30 *Simulium* (*E.*) *aureum* Fries
- 31 *Simulium* (*E.*) *pugetense* (D. & S.)
- 32 *Simulium* (*S.*) *fibrinflatum* Twinn

Plate 8



## PLATE 9

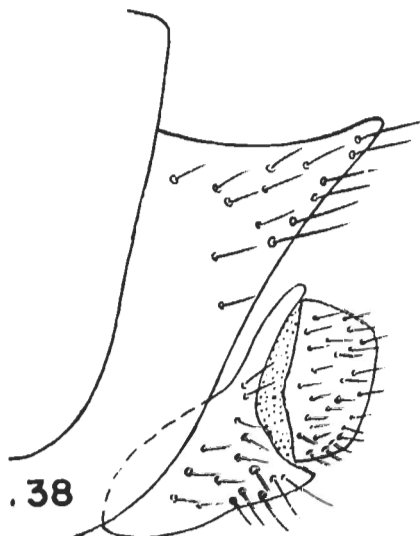
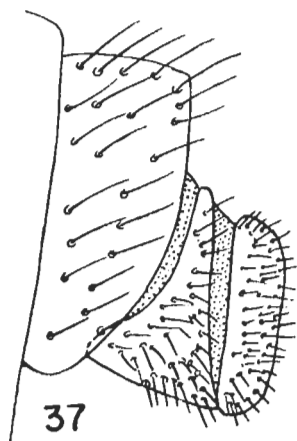
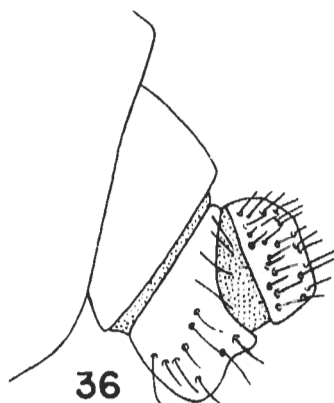
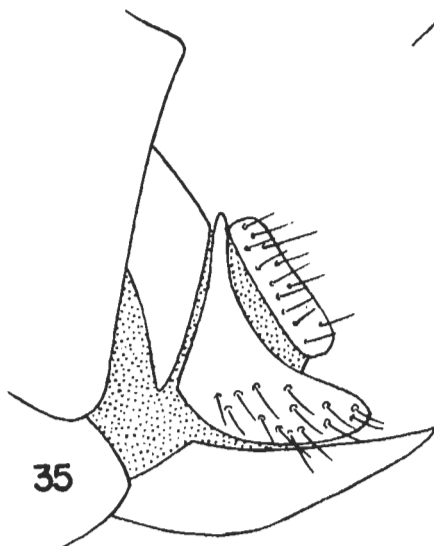
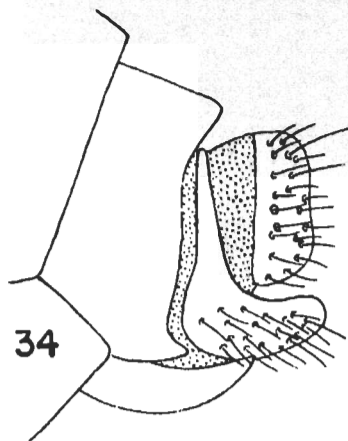
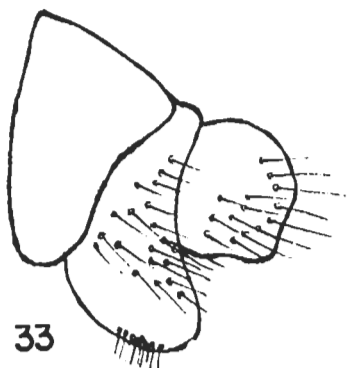
## ADULT

## Female genitalia

- 33 *Twinnia tibblesi* n.g., n. sp.
- 34 *Prosimulium hirtipes* (Fries)
- 35 *Prosimulium magnum* D. & S.
- 36 *Cnephia* (M.) *mutata* (Mall.)
- 37 *Simulium* (S.) *parnassum* Mall.
- 38 *Cnephia* (C.) *dacotensis* (D. & S.)



Plate 9



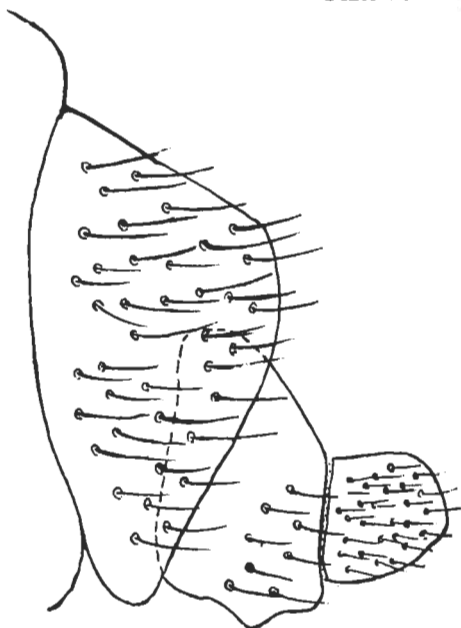
## PLATE 10

## ADULT

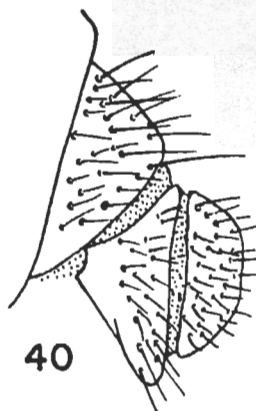
## Female genitalia

- 39 *Cnephia* (*E.*) *loisae* n. sp.
- 40 *Simulium* (*S.*) *jenningsi* Mall.
- 41 *Simulium* (*S.*) *verecundum* n. sp.
- 42 *Simulium* (*S.*) *corbis* Twinn
- 43 *Simulium* (*S.*) *decorum* Walker

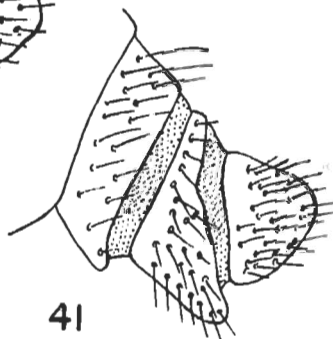
Plate 10



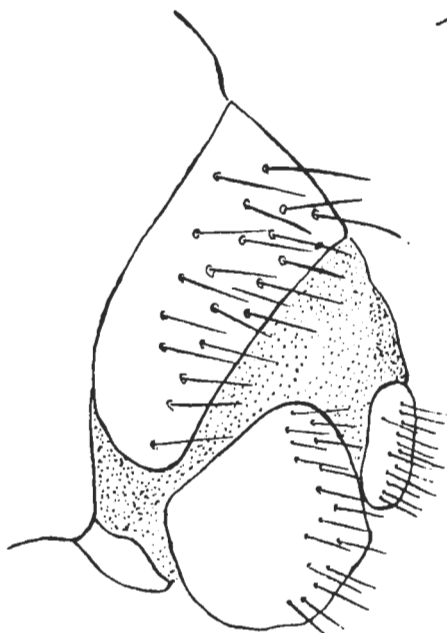
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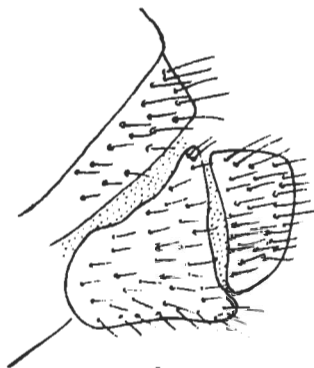
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41



42



43

## PLATE 11

## ADULT

## Female genitalia

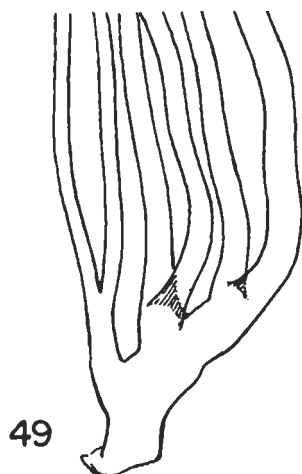
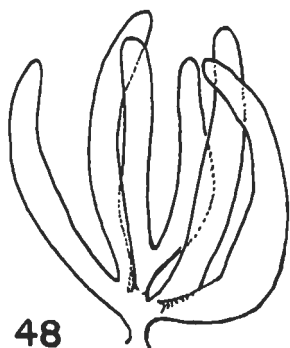
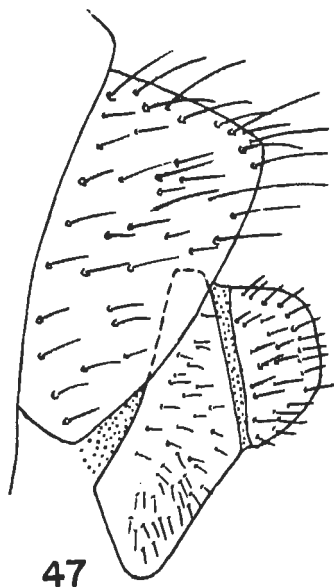
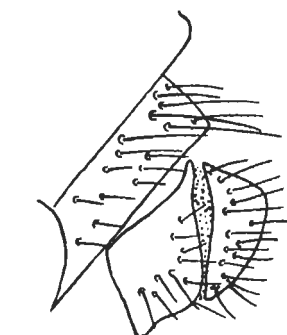
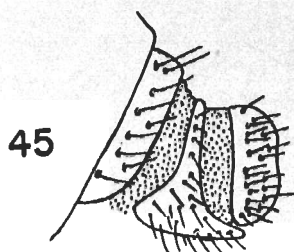
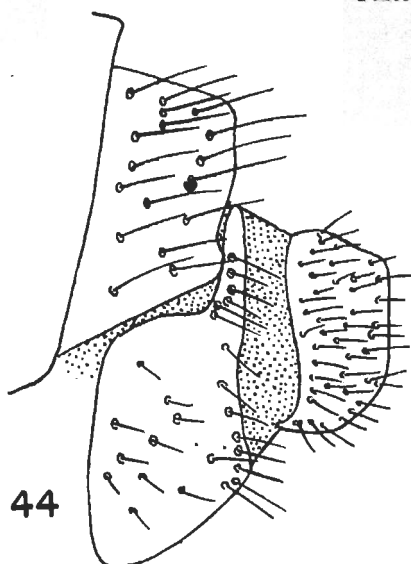
- 44 *Simulium* (S.) *pictipes* Hagen
- 45 *Simulium* (E.) *aureum* Fries
- 46 *Simulium* (E.) *latipes* (Meigen)
- 47 *Simulium* (N.) *vittatum* Zett.

## PUPA

## Respiratory filaments

- 48 *Simulium* (S.) *fibrinflatum* Twinn
- 49 *Simulium* (S.) *tuberosum* (Lund.)

Plate 11



## PLATE 12

## PUPA

## Respiratory filaments

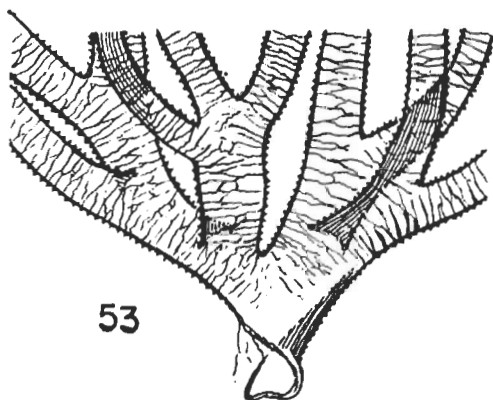
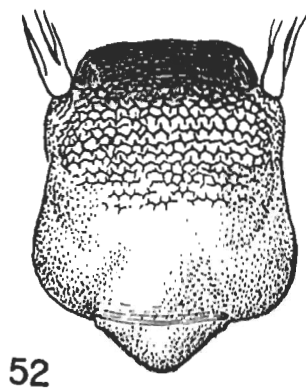
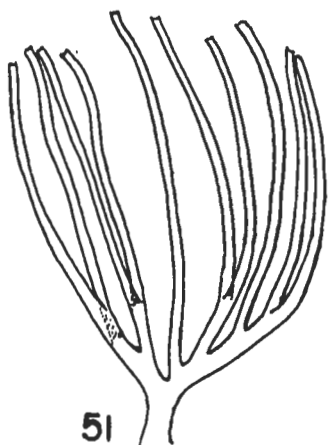
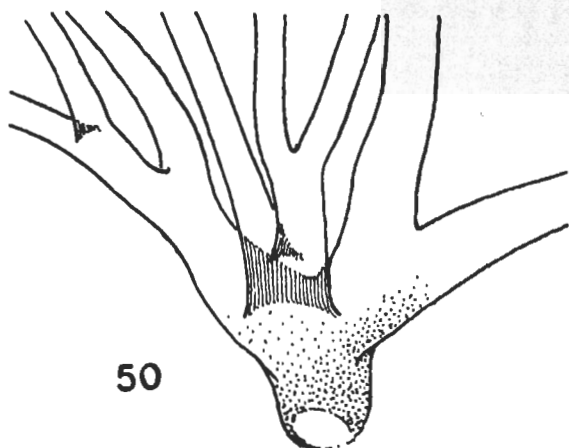
50 *Simulium* (*E.*) *croxtoni* N. & M.

51 *Simulium* (*S.*) *corbis* Twinn

52 *Simulium* (*S.*) *parnassum*, Mall., showing dorsal aspect thorax

53 *Simulium* (*S.*) *jenningsi* Mall.

Plate 12



## PLATE 13

## PUPA

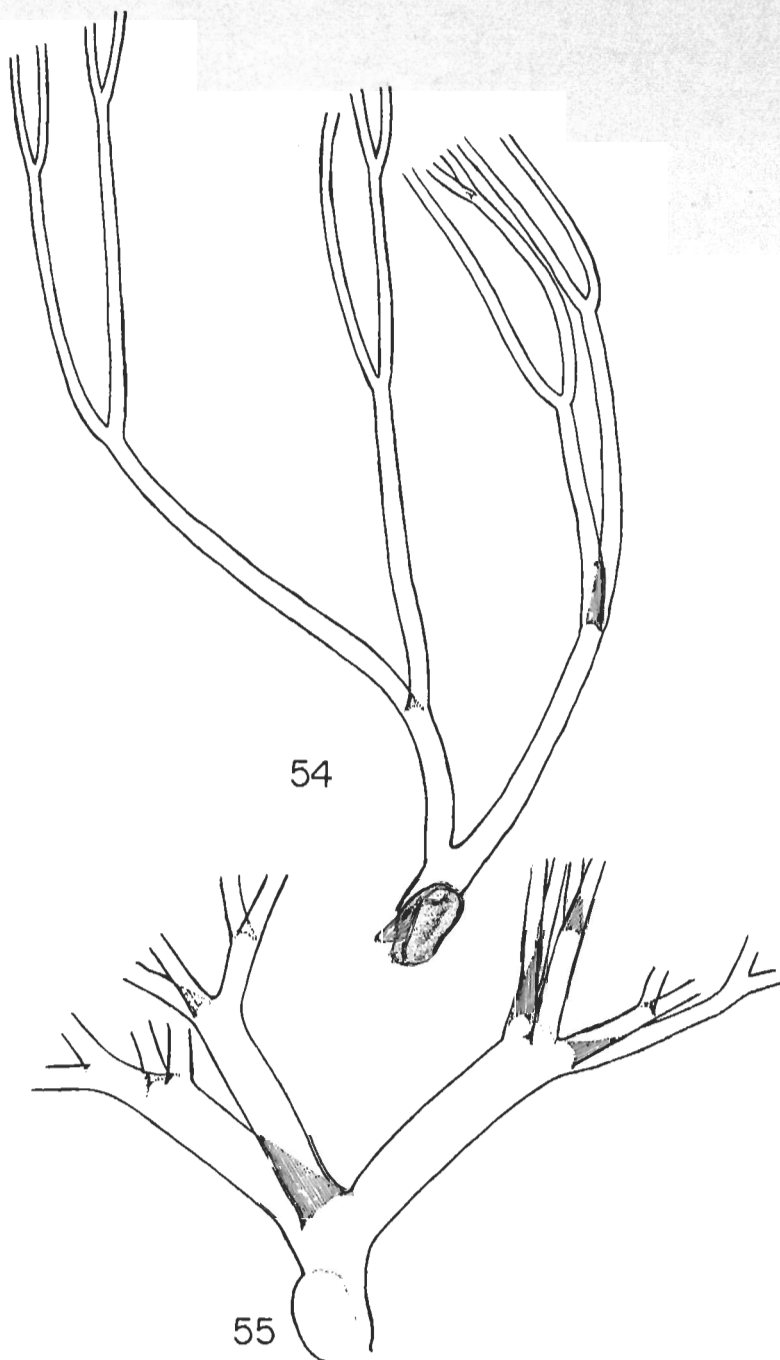
Respiratory filaments

54 *Cnephia* (M.) *mutata* (Mall.)

55 *Twinnia tibblesi* n.g., n. sp.



Plate 13



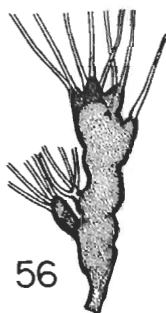
## PLATE 14

## PUPA

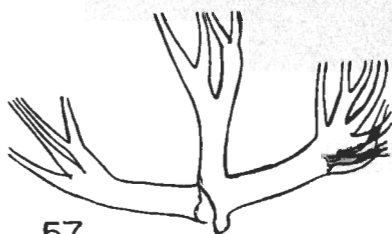
## Respiratory filaments

- 56 *Prosimulium rhizophorum* n. sp.
- 57 *Prosimulium saltus* n. sp.
- 58 *Simulium* (*S.*) *pictipes* Hagen
- 59 *Simulium* (*S.*) *venustum* Say
- 60 *Simulium* (*E.*) *gouldingi* Stone
- 61 *Simulium* (*S.*) *decorum* Walker

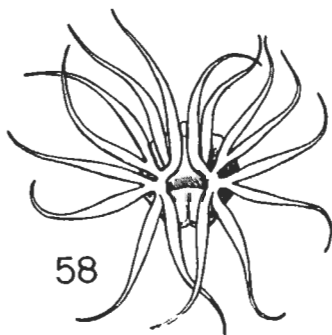
Plate 14



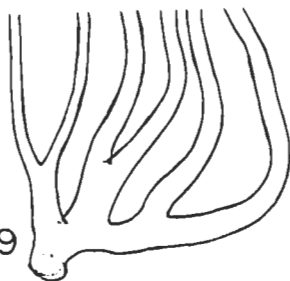
56



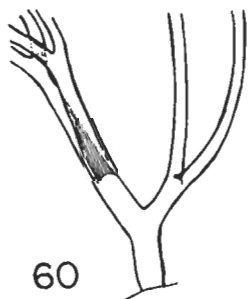
57



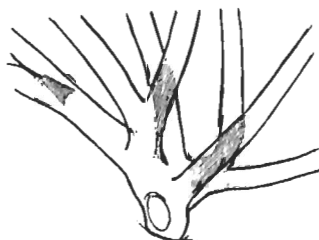
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59



60



61

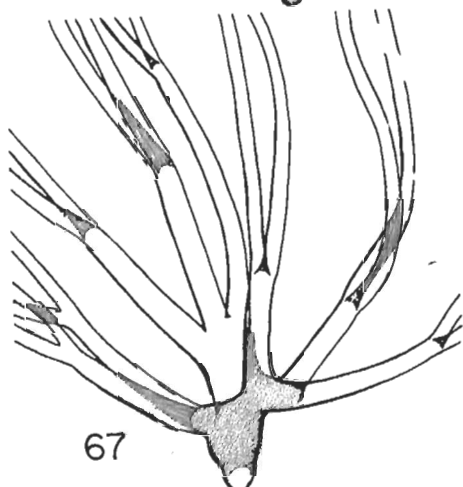
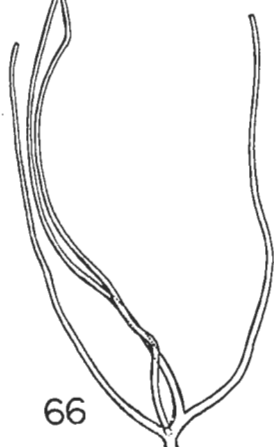
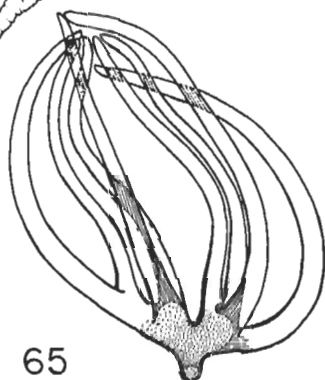
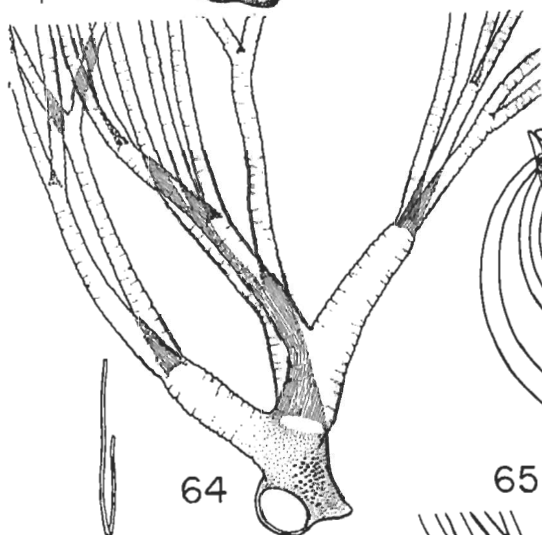
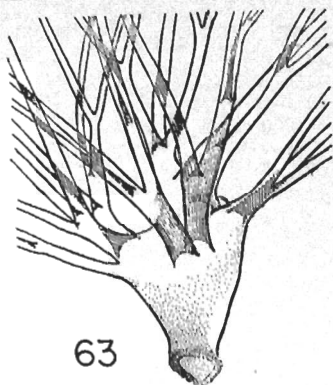
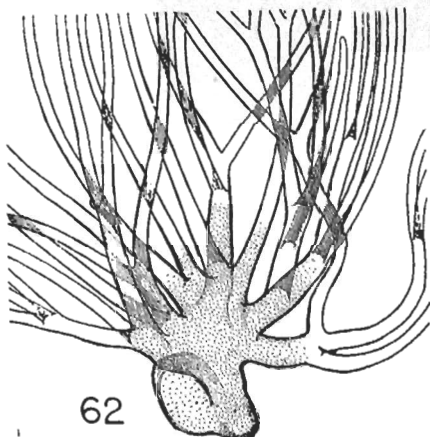
## PLATE 15

## PUPA

## Respiratory filaments

- 62 *Prosimulium magnum* D. & S.
- 63 *Cnephia* (C.) *dacotensis* (D. & S.)
- 64 *Prosimulium hirtipes* (Fries)
- 65 *Cnephia* (E.) *loisae* n. sp.
- 66 *Simulium* (E.) *aureum* Fries
- 67 *Simulium* (N.) *vittatum* Zett.

Plate 15



## PLATE 16

## PUPA

## Respiratory filaments

- 68 *Simulium (E.) latipes* (Meigen)

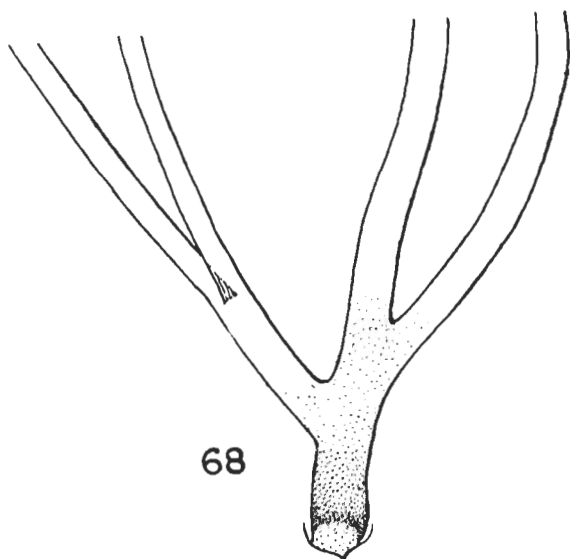
## Cocoons

- 69 *Simulium (S.) jenningsi* Mall.

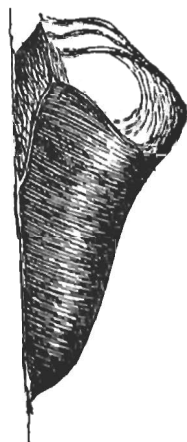
- 70 *Simulium (N.) vittatum* Zett.

- 71 *Simulium (S.) pictipes* Hagen

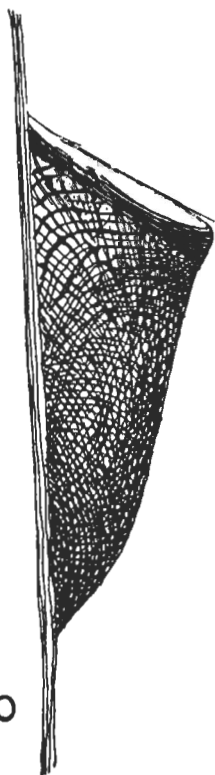
Plate 16



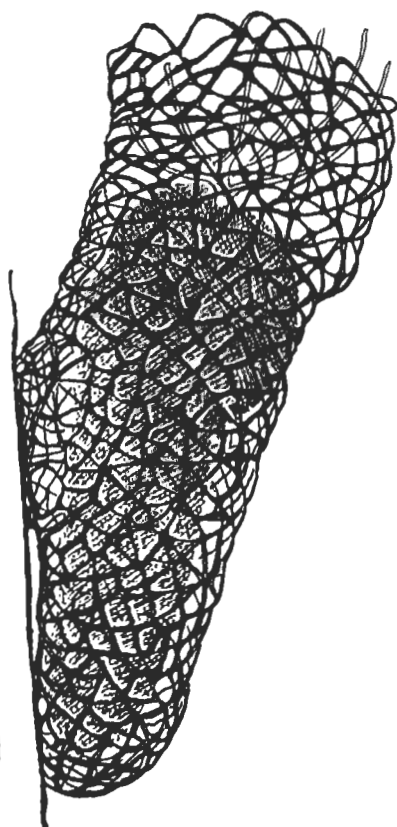
68



69



70



71

## PLATE 17

## PUPA

## COCOONS

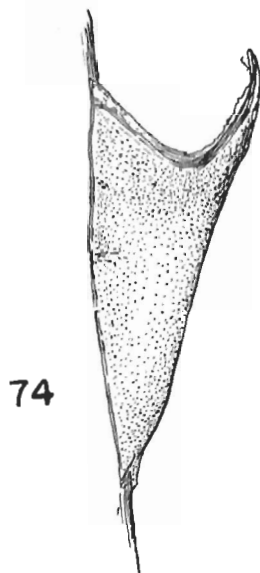
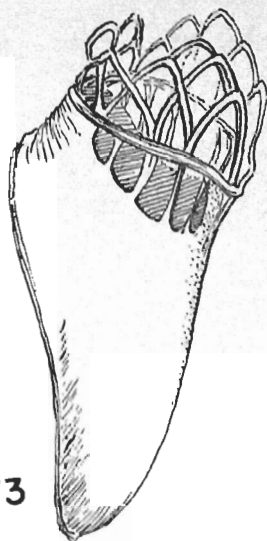
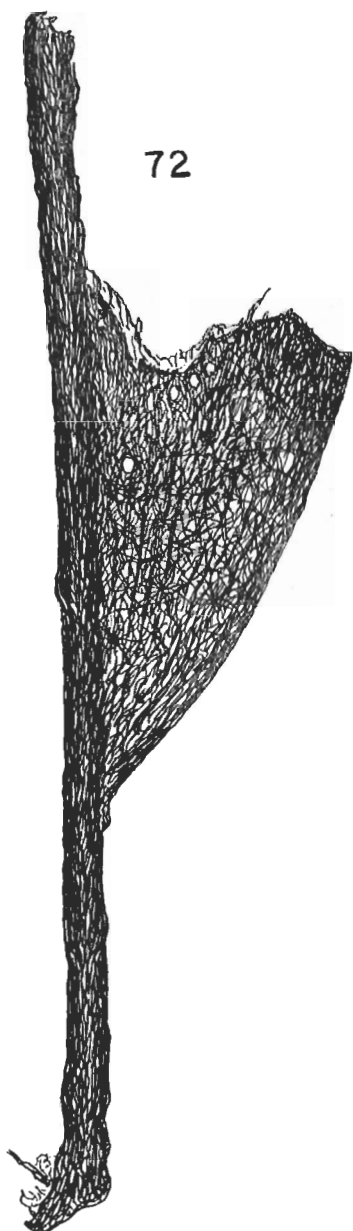
72 *Cnephia* (E.) *loisae* n. sp.

73 *Simulium* (S.) *corbis* Twinn

74 *Simulium* (E.) *latipes* (Meigen)



Plate 17

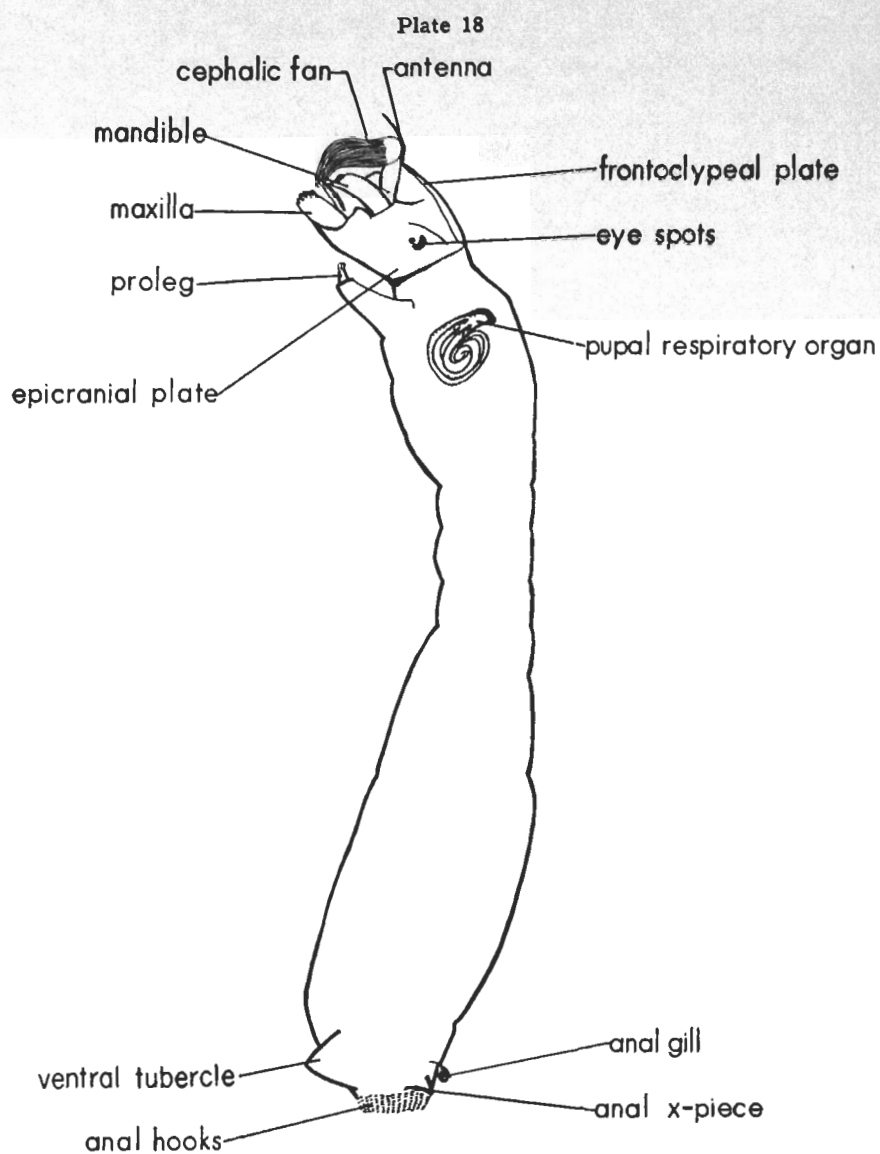


## PLATE 18

## LARVA

Habitus

75 *Simulium* (E.) *gouldingi* Stone



## PLATE 19

## LARVA

## Mandibles

76 *Twinnia tibblesi* n.g., n. sp.

77 *Simulium* (*N.*) *vittatum* Zett.

## Head capsules

78 *Simulium* (*S.*) *venustum* Say

79 *Twinnia tibblesi* n.g., n. sp.

80 *Cnephia* (*M.*) *mutata* (Mall.)

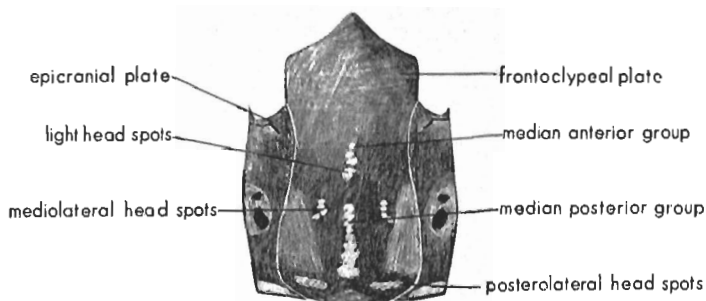
Plate 19 .



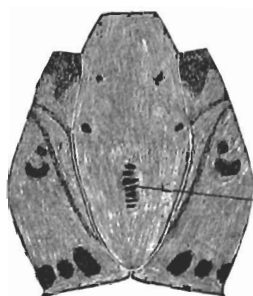
76



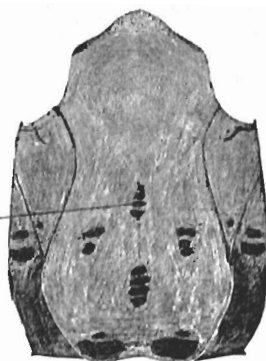
77



78



79



80

dark head spots

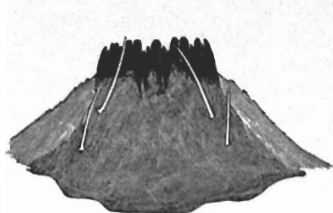
## PLATE 20

## LARVA

## Submenta

- 81 *Twinnia tibblesi* n.g., n. sp.
- 82 *Prosimulium rhizophorum* n. sp.
- 83 *Prosimulium magnum* D. & S.
- 84 *Cnephia* (M.) *mutata* (Mall.)
- 85 *Cnephia* (E.) *loisae* n. sp.
- 86 *Cnephia* (C.) *dacotensis* (D. & S.)
- 87 *Simulium* (S.) *venustum* Say
- 88 *Simulium* (S.) *pictipes* Hagen

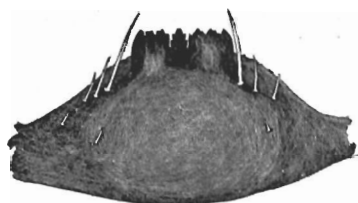
Plate 20



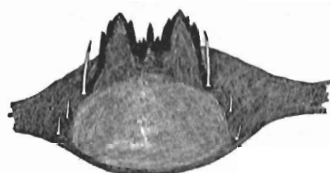
81



82



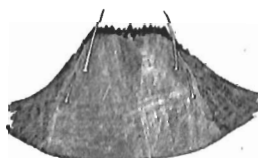
83



84



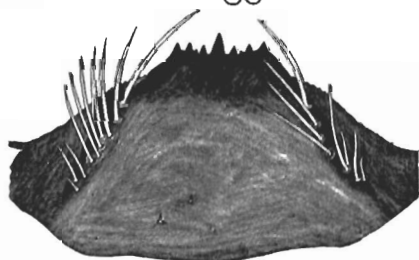
85



86



87



88

## PLATE 21

## LARVA

## Throat clefts

- 89 *Twinnia tibblesi* n.g., n. sp.
- 90 *Prosimulium hirtipes* Fries
- 91 *Cnephia* (*M.*) *mutata* (Mall.)
- 92 *Simulium* (*S.*) *venustum* Say
- 93 *Simulium* (*S.*) *tuberosum* (Lund.)
- 94 *Simulium* (*S.*) *parnassum* Mall.
- 95 *Simulium* (*N.*) *vittatum* Zett.
- 96 *Simulium* (*E.*) *aureum* Fries
- 97 *Simulium* (*E.*) *latipes* (Meigen)



Plate 21



89



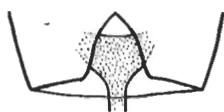
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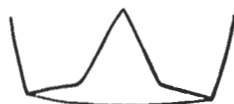
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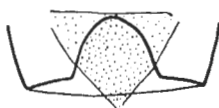
92



93



94



95



96



97

## PLATE 22

## LARVA

## Antennae

- 98 *Twinnia tibblesi* n.g., n. sp.
- 99 *Prosimulium hirtipes* (Fries)
- 100 *Prosimulium magnum* D. & S.
- 101 *Cnephia* (M.) *mutata* (Mall.)
- 102 *Cnephia* (E.) *loisae* n. sp.
- 103 *Cnephia* (C.) *dacotensis* (D. & S.)
- 104 *Simulium* (S.) *pictipes* Hagen
- 105 *Simulium* (N.) *vittatum* Zett.
- 106 *Simulium* (E.) *gouldingi* Stone
- 107 *Simulium* (E.) *pugetense* (D. & S.)

Plate 22



98



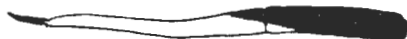
99



100



101



102



103



104



105



106



107

## PLATE 23

## LARVA

Inner subapical margin of mandibles

- 108 *Prosimulium hirtipes* (Fries)
- 109 *Prosimulium rhizophorum* n. sp.
- 110 *Prosimulium magnum* (D. & S.)
- 111 *Cnephia* (E.) *loisae* n. sp.
- 112 *Simulium* (E.) *latipes* (Meigen)
- 113 *Simulium* (N.) *vittatum* Zett.

Anal cross-pieces

- 114 *Simulium* (S.) *decorum* Walker
- 115 *Twinnia tibblesi* n.g., n. sp.
- 116 *Prosimulium hirtipes* (Fries)

Plate 23



108



109



110



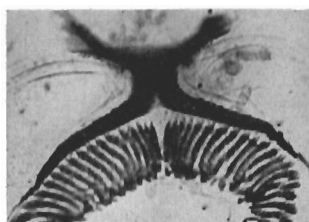
111



112



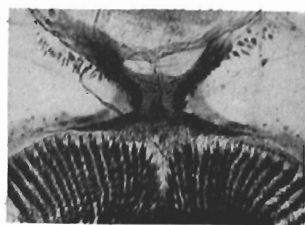
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