BLACKFLIES OF

EASTERN CANADA

THE BLACKFLIES OF EASTERN CANADA

(Simuliidae, Diptera)

by

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A THESIS

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Introduction

Blackflies have long been recognized as among the worst bloodsucking insect pests affecting wild and domestic animals and man, in many parts of the world, and the literature contains numerous references to their serious depredations. Among the most famous and spectacular are the outbreaks of the buffalo or turkey gnat, Simulium pecuarum Riley, in the lower Mississippi valley of the United States, and of the Golubatz fly, S. columbaczense Schoenbauer, in parts of south-eastern Europe. The latter species was reported to have caused the deaths of many thousands of wild and domestic animals, in Rumania, in 1923. In recent years, blackflies have been implicated in the transmission of disease-producing organisms, and it is probable that further studies will prove them to be of greater importance in this connection than is at present known. In 1926, Blacklock (1) discovered that the intermediate host of Onchocerca volvulus Leuckart, a filarial worm causing disease in man in West Africa and Uganda, is the blackfly, Simulium damnosum Theo. Another filarial worm, O. caecutiens Brumpt, possibly only a variety of O. volvulus, which infests man in Mexico and Central America, was shown by Hoffman*, in 1930, to pass its intermediate stages in the blackfly, S. mooseri Dampf; since then certain other species of blackflies have also been

*Ann. Inst. Biol. Univ. Mexico, 1:59-62, 1930.

proven to be vectors of the organism. O'Roke (33) demonstrated that a serious protozoon blood parasite of ducks, Leucocytozoon anatis Wickware, prevalent in North America, passes the sexual stage of its life cycle in the blackfly, S. venustum Say, transmission in nature being effected by the bite of the fly. Both this fly and the disease are widespread in Canada, as I have reported elsewhere (53).

The published information on the blackflies of Canada, especially Eastern Canada, is very meagre. The late Eric Hearle, in 1932, prepared (20) a useful annotated list of the blackflies of British Columbia in which he included twenty species, two of which were new. Twinn (53), in 1933, published a short article on the general biology and distribution of Simulium venustum Say, in Canada. In 1927, Dyar and Shannon (5) published a revision of the Simuliidae of North America. Only two of the 47 species included were shown as occurring in Eastern Canada.

Scope of Work

The present paper includes twenty-three species and one variety belonging to three subgenera of the family Simuliidae. Twelve of these species and the variety are described as new to science. Of the remaining eleven species of other authors, only two, venustum Say and johannseni (Hart), have been recorded previously in Eastern Canada;

two, subexcisum Edw., and latipes Mgn., originally described in Europe, are recorded in North America for the first time; and the hitherto unknown male of mutatum (Mall.) is described, and the pupa associated with the adult forms.

The treatment followed throughout is essentially taxonomic. The adult forms are described, and brief descriptions of the pupae and cocoons are given; also notes on the habitats, distribution, species associations, and similar information of value in segregating and determining the species. Keys to the subgenera and species are presented; the latter include both sexes of adults and the pupae and cocoons, and should prove to be a valuable feature. The work is illustrated by 35 plates comprised of 119 figures, of which 93 are drawings of the male and female genitalia, and 26 are photographs of immature stages, and habitats.

It is hoped that an opportunity will later arise to extend the study to include adequate treatment of the immature stages, and the biology of the various species. Much material and information has already been brought together toward this end.

Material and Methods of Study

The study is based on material collected in the territory surrounding Ottawa, in Ontario and Quebec, known as the Ottawa district, and on specimens from other parts of Eastern Canada, including Baffin island. However, the number of specimens in the National Collection, or received

from collectors in this region was small, and therefore the work has been largely carried out with material collected and reared by me in the Ottawa district. This work was done with the permission of the Dominion Entomologist. Rather numerous collections of immature stages were made prior to 1935, but the systematic examination of breeding places, and rearing of adults from pupae was done, for the most part, during the spring and summer of 1935.

In the course of the investigation (necessarily restricted by other duties), five rivers including the Ottawa, Rideau, Blanche, Jock and Mississippi, and sixteen permanent, semi-permanent and temporary streams and rills, all within a few miles of Ottawa, were visited and examined at definite points, at intervals from late April to the end of September. During these visits notes were taken on the seasonal character of the water bodies, their rate of flow, temperature, and other data; more than 300 alcohol collections were made of the blackfly stages found, and live pupae were placed on moist cotton in stoppered vials for rearing, all being associated by means of experimental numbers.

The adult flies were reared from the pupae in the Confederation Building, Ottawa, after being roughly segregated by species under the low power objective of the microscope, by means of the number, arrangement and character of the filaments comprising the respiratory organs, and the nature of the cocoons. When Simulium pupae are kept moist (not wet) they will complete their development even though removed from their natural habitat, and will give rise to imagines, which

may be transferred to dry vials by taking advantage of the positive phototropic responses of the flies.

Rearing the adult flies in this manner is undoubtedly the most satisfactory method of securing material for a taxonomic study of the Simuliidae. By this method both sexes are secured in excellent condition, whereas if one confines his activities to collecting with a net he usually secures only the females, and these often in poor condition. Moreover, the rearing method definitely connects the adults with their immature stages, concerning which there has been much confusion, and establishes the nature and location of the breeding places. When the pupae are known, it is comparatively simple to identify the larvae, this being accomplished merely by dissecting out and examining the filaments in the pupal respiratory histoblasts, in the prothorax of the mature larva.

A satisfactory method of rearing adults from pupae consists of using glass vials $1\frac{1}{4}$" x 6", placed on their sides: in these, a narrow strip of cotton batting, wet, but with the surplus water removed, is inserted lengthwise along the glass, and the pupae gently placed on it. A similar vial containing a strip of dry blotting paper is placed with its mouth against that of the vial containing the pupae. The two vials are then wrapped in paper in this position, the paper held in place by rubber bands and completely covering the vial containing the pupae, but leaving two or three inches of the emergence vial uncovered. When the flies emerge

they are attracted by the light into the emergence tube, where the blotting paper absorbs any surplus moisture and provides them with a resting place. The flies were usually left for 18-24 hours after emergence to allow the body integument to harden before pinning. The pupal skins and cocoons were preserved in alcohol-glycerine solution under the same experimental number as the pinned adults; when the latter were numerous some of them were also preserved with the skins.

The Characters of the Group

Blackflies are small compact, stoutly-built flies, with the thorax greatly developed and curiously arched. The wings are broad with the anterior veins thickened, and the others indistinct; the legs are short and strong; the abdomen is nine-segmented. The antennae are short and typically eleven-jointed, but sometimes ten or nine-jointed; the palpi are four-jointed. The eyes are large and holoptic in the male, dichoptic in the female, the upper facets of the male much larger than the lower*; ocelli are absent. The mouthparts of both sexes are adapted for piercing, but only the females suck blood. The immature stages develop in running water. Illustrations of the eggs will be found on Plate XXII; of the larvae, on Plate XXIII; of the pupae, on Plates XXIV-XXVI. Puri (40) has published an excellent account of the life history and structure of the early stages

*Edwards (8) described two South American species in which the eyes of the males are dichoptic and all the facets small.

of Simuliidae; Johannsen (22 & 23), Pomeroy (37), Edwards (7) and others, have also made important contributions to this interesting subject.

Explanatory and illustrated accounts of the wing venation and other external characters of the Simuliidae, a knowledge of which is necessary for students of the group, will be found in the works of Malloch (28), Edwards (6 and 8), Pomeroy (37) and Dyar and Shannon (5), and need not be repeated here. Two terms used in the following keys and descriptions to describe certain important tarsal characters were adopted by Edwards (8, p.122) from Enderlein. To prevent possible confusion, Edwards' definition of these terms is given as follows: "(1) Pedisulcus, the dorsal segment of the hind tarsi; and (2) Calcipala, the flattened projection at the tip of the first segment (basitarsus) of the hind tarsi, projecting beyond the base of the second segment on the outer side".

In the taxonomic study of the material brought together as already outlined, the genitalia of both sexes were studied, in addition to external characters and the characters of the pupae and cocoons. This work entailed a great deal of delicate and painstaking dissection work under the binocular microscope, and the making of more than 300 permanent microscopic preparations mounted in euparal on slides. Furthermore, 93 separate drawings illustrating the genital structures were made with the aid of a camera lucida, and are included in the plates with this paper. These were all drawn to the same scale and reveal quite striking variations

in the size of the genitalia of the different species, as well as in form.

The use of the male genitalia in taxonomic studies of the Simuliidae is comparatively recent. According to Edwards (6, p.23) and Gibbins (17, p.317), Lundstrom (26), in 1911, was the first to pay attention to these structures, in an account of the Finnish species, but he did not study them closely and his drawings were not sufficiently detailed. Edwards (6) made use of them in 1915, in describing the British species of Simulium, and also in a paper (8) on South American species, published in 1931. Among American authors, Pomeroy (37) drew attention, in 1916, to the remarkably constant specific characters exhibited by the genitalia of the males; Cameron (2) made use of them, in 1922, in describing the cattle-infesting S. simile (= S. arcticum Mall.), and Dyar and Shannon (5) largely based their descriptions on the genitalia of the males and females in their revision of the North American species of the family. The last named authors appear to have been the first to use the female terminalia in this connection. Gibbins (15) also described and figured the genitalia of both sexes in a paper on Ethiopian Simuliidae published in 1934.

In describing the genitalia of the species of Eastern Canada included in the present study, I have followed the terminology of Dyar and Shannon. Since the major part of this work was done, a paper by Gibbins (17) on the male terminalia has come to hand. In this he states that the

organ situated between the coxites (side-pieces) and referred to by Pomeroy (37), Dyar and Shannon (5), and herein, as the adminiculum is actually the anterior part of the phallosome; the adminiculum arms are the posterior part of that organ.

Classification

Until 1914, the family Simuliidae was considered to consist of only the genus Simulium. In that year, Malloch (28) in his study of American blackflies adopted the name Prosimulium Roubaud in a generic sense, and set up the new genus Parasimulium. Enderlein, in 1921 (10), recognized seventeen genera, and, in 1930 (11), increased this to thirty. Edwards, in 1931 (8), after a study of more than 120 species of Simuliidae in the British Museum, concluded that, with the exception of Parasimulium, none of the divisions recognized by other authors should be admitted as full genera, and, at most, seven of them as subgenera: namely, Prosimulium, Morops, Gigantodax, Austrosimulium, Cnephia, Eusimulium and Simulium.

The present study of Canadian species has led me to follow Edwards in recognizing as genera only Parasimulium and Simulium, admitting the others as subgenera of the latter. The genus Parasimulium has not been recorded in Canada. Only a single female specimen, of one species, P. furcatum Malloch, is known; this was collected in Humboldt county, California, on June 9, 1903, by H. S. Barber.

Three subgenera are represented among the species dealt with here: namely, Prosimulium Roubaud, Eusimulium Roubaud and Simulium Latreille. I have followed Dyar and Shannon (5, p.12) in placing a fourth, Cnephia Enderlein, with the subgenus Eusimulium. Three of the species: mutatum, boreale and lascivum have characters of Cnephia as outlined by Edwards (8, p.144); however, to admit it as a subgenus would result in separating the two closely related species, boreale and baffinense. The characters used to define the subgenera included in this paper are given in the following key.

Key to the Subgenera of Simulium in Eastern Canada

1. Radius setose on its entire length..... 2

   Radius bare between the stem vein and radial sector; sector simple; calcipala and pedisulcus present and distinct; length of hind second tarsus less than twice the width of basitarsus; front usually broad; hairs on costa mixed with spinules.....Simulium Latreille (p.55)

2. Radial sector with a long fork; setae on costa not mixed with spinules; calcipala and pedisculcus absent; hind second tarsus much longer than width of basitarsus; front usually broad .....Prosimulium Roubaud (p.14)

   Radial sector simple (slightly forked in lascivum); setae on costa mixed with spinules; calcipala and pedisulcus present or absent; length of hind second tarsus less than twice the width of basitarsus; front narrowed...Eusimulium Roubaud (p.28)

Key to the Pupae of Simulium in Eastern Canada*

1. Cocoon of indefinite form; shapeless, loosely woven..... 2.

   Cocoon of definite form; more or less closely woven. 6.

2. Pupal respiratory filaments 9; nearly as long as pupa.....*decemarticulatum* n.sp.

   Filaments 12-16, distinctly shorter than pupa..... 3.

3. Filaments 12 (sometimes 13 or 14), arising from two branches; about three-quarters as long as pupa.....*mutatum* (Mall.)

   Filaments 14, arising from three branches..... 4.

   Filaments 16, about one-half length of pupa .....*hirtipes* Fries

   Filaments more numerous..... 5.

4. Dorsal branch dividing into two stalks, each stalk bearing three filaments; filaments two-thirds length of pupa.....*gibsoni* n.sp.

   Dorsal branch dividing into three stalks, each stalk bearing a pair of filaments; filaments two-fifths length of pupa, arctic species...*browni* n.sp.

5. Filaments 23-28; average 26.....*multidentatum* n.sp.

   Filaments 27-40; average 30.....*lascivum* n.sp.

6. Pupal respiratory filaments 4, in two pairs..... 7.

   Respiratory filaments 6..... 10.

   Respiratory filaments more numerous..... 12.

7. Cocoon with long anterior process..... 8.

   Cocoon without such process..... 9.

*Pupae of *baffinense* and *boreale*, unknown; *johannseni* not included.

8. Both pairs of filaments distinctly stalked....*latipes* Meigen

   One pair stalked, the other sessile, or nearly so.....*rivuli* n.sp.

9. Both pairs of filaments on short stalks, the lower pair longer than the upper.....*quebecense* n.sp.

   Lower pair sessile, upper pair shortly stalked... .....*aureum* Fries.

10. Cocoon with long anterior process; filaments nearly as long as pupae, in three stalked pairs, the upper pair divergent from the lower pairs.... .....*subexcisum* Edwards

    Cocoon without anterior process..... 11.

11. Respiratory filaments slender, normal, about one-half as long as pupa; cocoon of wall-pocket type, entire.....*venustum* Say
    perissum D.& S.

    Filaments stout, inflated, about one-fourth as long as pupa; cocoon slipper-shaped, with an anterior aperture on each side.....*fibrinflatum* n.sp.

12. Respiratory filaments 8, six paired, two unpaired; about one-half as long as pupa; cocoon wall-pocket shaped.....*ottawaense* n.sp.

    Respiratory filaments 9; about two-fifths as long as pupa; cocoon boot-shaped.....*pictipes* Hagen

    Respiratory filaments 10; cocoon slipper-shaped..... 13.

    Respiratory filaments 16; about three-quarters as long as pupa; cocoon wall-pocket shaped....*vittatum* Zett.

13. Filaments dividing from two short branches, eight paired, two unpaired; about one-fourth as long as pupa, which averages 2.5 mm.; cocoon with anterior aperture on each side.....*nigroparvum* n.sp.

    Filaments arising in sessile pairs from a common base; about three-eights as long as pupa which averages 3.5 mm.; cocoon with anterior apertures and an interlacing basket-like extension.... .....*corbis* n.sp.

Subgenus PROSIMULIUM Roubaud

Prosimulium Roubaud, Comp. Rend. Acad. Sci. Paris, 143:519, 1906.

Helodon Enderlein, Deuts, Tier. Woch., 29:199, 1921.

Taeniopterna Enderlein, Zool. Anz., 62:203, 1925.

Genotype.— Simulium hirtipes Fries.

Key to the Females of Prosimulium

(Based on external characters and genitalia)

1. Claws bifid (i.e., with basal tooth); antennae nine or ten-jointed..... 2.

   Claws simple; antennae eleven-jointed..... 3.

2. Antennae nine-jointed; tergal plates strongly chitinized, 3, 4, and 5 reduced in width; sternites 2, 3, 4, and 5 membranous; anal lobe sub-quadrate; apical expansions of genital rod transversely wrinkled; upper margins toothed... .....gibsoni new species

   Antennae ten-jointed; tergal plates weakly chitinized, 3, 4, 5, 6, and 7 greatly reduced in width; all sternites membranous; anal lobe broadly L-shaped; apical expansions of genital rod smooth, upper margins thickened.....decemarticulatum new species

3. Tergal plates on segments 3, 4, and 5 greatly reduced; sternites 2, 3, 4, 5, and 6 membranous; anal lobe triangular; apical expansions of genital rod lanceolate, incurved, inner margins broadly chitinized.....browni new species

4. Ovipositor reaching tip of abdomen; apical expansions of genital rod quadrate; a large species..... .....multidentatum new species

   Ovipositor shorter and weaker; apical expansions of genital rod more or less triangular; medium sized species.....hirtipes Fries.

Key to the Males of Prosimulium

(Based on genitalia)

1. Claspers with a single terminal tooth; adminiculum arms broad medially..... 2.

   Claspers with two or more terminal teeth; adminiculum arms narrow, strap-shaped..... 3.

2. Setae on side-pieces only on apical margin; claspers of even width throughout; prongs of adminiculum long, blunt; median process pointed at apex .....gibsoni new species

   Setae on side-pieces more generally distributed; claspers sharply tapered; prongs of adminiculum short, pointed; median process broad and flat at apex.....decemarticulatum new species

3. One clasper with two, the other with three terminal teeth.....hirtipes Fries.

   One clasper with four, the other with five terminal teeth.....multidentatum new species

Simulium (Prosimulium) hirtipes Fries.

Simulia hirtipes Fries, Mono. Simul. Suec., 1824:17.

Female.— Length[1], 2-3 mm.; wing, 2.8 - 3 mm. Integument dark-brown to black; pile pale yellow. Head: front moderately broad, distinctly narrowed below; front and clypeus covered with pale yellow pilosity. Antenna 11-jointed, black, two basal joints paler. Thorax: mesonotum rather densely covered with pale yellow pile; pleural tuft pale yellow; scutellum with rather long, upright, yellow hairs. Wings: brownish; stem vein with pale yellow pilosity, other hairs dark brown;

Male of browni n.sp. unknown.
The linear measurements of the complete insect of this and all other included species were made from dried pinned specimens.

radial sector with a long fork; small basal cell present. Legs: brown, the coxae and tarsi darker; pubescence largely pale yellow; fore tarsi cylindrical, fore basitarsus a little shorter than the antenna; calcipala and pedisulcus absent; claws simple. Abdomen: basal fringe and short scattered pilosity on all segments, pale yellow; tergites three, four and five distinctly reduced; sternites two to six entirely membranous. Genitalia (Plate I, figs. 5-6): ovipositor well developed, largely membranous, spiculate; inner margins thickly chitinized except the apical third: anal lobe broadly L-shaped, the basal portion equal in length to width of cercus and extending beneath it to the posterior margin; cercus rectangular, a little more than twice as wide as long; both evenly setulose and moderately setose; forks of the genital rod more or less triangularly expanded apically.

Male.— Similar in size, but darker than the female; pubescence on mesonotum coarse, yellow, rather dense, longer on posterior part and scutellum; pilosity on abdomen and legs longer and darker, particularly on the basal scale, venter and hind legs; legs uniformly darker; hind basitarsus more dilated, about equal in width to the tibia; claws bifid; abdominal tergites not greatly reduced; sternites not entirely membranous. Genitalia (Plate I, figs. 1-4): side-piece slightly longer than broad, tapering; claspers shorter than side-piece, conical; one clasper bears two short, stout, terminal teeth, and the other, three (Edwards, 6, p.42,

mentions this character as an abnormality in a British specimen he described, but evidently it is normal for the species); adminiculum broad, membranous, minutely pubescent medially; adminiculum arms smooth, strap-shaped, without teeth.

Pupa.— Length about 5 mm.; the respiratory tuft one-half as long as the pupa, consisting of 16 filaments. This character is constant for all the numerous pupae taken from streams in the Gatineau hills, Que., north of Ottawa, from which adult flies were reared. Various authors: Johannsen (22 and 23), Malloch (28), and others have indicated up to 60 or more respiratory filaments for this species in the United States. Puri (40, p.362) states that pupae from France attain a total number of 50-60 filaments. He found, however, that pupae from Norway have only 16, and that as the species was originally described from Scandinavia the specimens must be regarded as typical. Puri's description of the filaments of the Norwegian specimens is in perfect agreement with my material and I cannot do better than quote from him: "The first division is near the base into three short stems, each of the two ventral stems dividing almost immediately into two branches, each of which bifurcates again. The upper stem again divides into three branches, the two lower ones dividing into three each and the upper into two. All the filaments are more or less of equal thickness and length". The cocoon consists of a mat of silk of indefinite shape which sometimes only partially covers the pupa, and to which extraneous matter,

such as sand and tiny pebbles and fragments of stone is often attached.

Distribution.— Widespread in Europe and North America. Malloch (28, p.29) and Dyar and Shannon (5, p.9) give records from several of the states of the Eastern United States, and Labrador and Newfoundland. Dyar and Shannon state that the species appears to be confined to the region east of the Mississippi river and north of the Carolinas, but Malloch also includes records from Arizona, Idaho and British Columbia. Hearle (20, p.8) records it from Banff, Alberta. It is possible that the western records concern allied species.

Simulium hirtipes occurs widely in Eastern Canada. I have examined specimens from the following localities. Nova Scotia: Kentville, 24.V. & 13.VI.23 (R.P. Gorham); New Brunswick: Fredericton, 21.VI.13 (collector unknown), Barber Dam, 23.VI.14 (J.D. Tothill); Quebec: Grande Cascapedia, Gaspe, 16.IX.32 (M.L. Prebble), Federal Mine, Cascapedia (2000') 4.X.32 (R.E. Balch), Gaspe, 26.VII.33 (E.B. Watson), Hemmingford, 31.V.26 & 25.VII.28 (G.H. Hammond), St. Hilaire, 24.V.06 (Beaulieu), Miners Bay, 26.V.27 (F.P. Ide), Montebello, 21-31.V.30 (N.J. Atkinson), Kingsmere, 14.V.22 (J. McDunnough), Meach Lake, 24.V.32 (C.R. Twinn), Hull, 22.V. & 10.VI. 23 (C.H. Curran), Chelsea, 5.VI.19 (Arthur Gibson); Ontario: Ottawa, 13.V.22 (J. McDunnough), Algonquin Park, 17.V.32 (C.R. Twinn). I have also collected the immature stages and reared and collected adults in the Gatineau hills, Que., north of Ottawa, on several occasions in recent years.

Notes.— In the Ottawa district, the larvae and pupae of S. hirtipes have been found only in cold streams flowing down wooded hillsides from small lakes, in the Gatineau hills (Laurentians), Que. In one of these streams (Plate XXXIV, fig.2), pupae were found on May 2, 1935, when the temperature of the water was 47° Fah.; adults emerged indoors on May 4. Even in July, I found the temperature of this stream to be only 62° F. (July 22), but on that date hirtipes was replaced by venustum. Smart (48, p.24) who gives the type locality as Lapland, states that hirtipes is typically a northern species, and an inhabitant of hill streams at Fortingal, in Scotland. In Eastern Canada, the adults are numerous in hilly, forested country in early spring, and may become abundant again in the autumn. I have found the pupae only in spring, and the species appears to have but one generation; overwintering in the larval stage. The females attack animals and man. Specimens of troublesome blackflies sent in by field officers of the Dominion Entomological Branch, from points in the forested region of New Brunswick and the Gaspé peninsula, have been this species and S. venustum.

Simulium (Prosimulium) multidentatum new species

Female.— Length 2.7 - 3.5 mm.; wing 3.5 - 3.9 mm. closely allied to hirtipes Fries, but of more robust appearance; legs darker; general pilosity paler and more conspicuous; fore basitarsus slightly shorter than antenna (differs from magnum D. & S.). Genitalia (Plate II, figs. 2-3): similar to, but

larger and stronger than hirtipes; ovipositor chitinized, strigate, reaching tips of anal lobes which in turn extend beyond the cercus, and are strongly setose along the postero-ventral margin; cercus much wider than long, with elongate setae on the posterior margin; arms of genital rod quadrately expanded.

Male.— Essentially as in hirtipes, but more robust, and easily separated from it, and from magnum, by the number of teeth at the tip of the claspers. Genitalia (Plate II, fig.1): one clasper bears five short, stout, terminal teeth, the other four (the number being constant in several specimens examined); in other respects the genitalia are similar to hirtipes.

Holotype.— Male, near Hull, Que., reared from pupa, 3.V.35. Can. Nat. Coll. (slide).

Allotype.— Female, same data.

Paratypes.— 11 males, 13 females, 1-3.V.35.

Pupa.— Length 5-6 mm. Respiratory tuft about one-third as long as pupa, comprised of 23-28 filaments (counts of six specimens gave 23, 25, 25, 26, 27, 28; an average of 26) branching from the main trunk, close to the base. The cocoon is indefinite in shape and dirty-grey in colour. The pupae occur in close masses on submerged obstacles such as rocks, stones, pieces of wood and other debris.

Notes: Gross infestations of larvae and pupae of multidentatum were found on April 29, 1935, in two small, shallow, more or less parallel streams (Plate XXXV), a few miles in length, which have their source south of the Gatineau hills

and flow through agricultural land, finally emptying in the Ottawa river, near Hull, Que. The temperature of the water was 52° F. in one, and 54° F. in the other. No empty pupal skins were seen, but large numbers of adults of both sexes emerged between May 1 and 3 from pupae placed in moist vials at room temperatures.

A goodly proportion of the larvae were parasitized by nematodes. Infested individuals had distended abdomens and undeveloped histoblasts. The nematodes were coiled up in the abdomen; some of them measured more than an inch in length (one was 39 mm.), or three to four times as long as their hosts. An examination of 276 larvae showed 63, or 22.8 per cent parasitized. The nematodes left the larvae shortly after the latter were removed from the water. This may be the same species of parasite that Strickland (49 and 50) recorded, in 1911, from larvae of S. hirtipes taken in streams near Boston, Mass. He concluded (49, p.326) that the parasite, Mermis sp., "does not affect the larval development to any extent, except by slightly increasing its size, but it inhibits the development of the histoblasts to such an extent that pupation becomes impossible".

Emergence of the adults in the field had commenced on May 8, and was practically complete by May 14. No signs of the larvae were found throughout the summer, but their place was taken by sparse numbers of vittatum, venustum and aureum. Pupae and larvae which I collected on May 17, 1932, from Cranberry creek, Algonquin Park,Ontario, proved to be multidentatum.

Simulium (Prosimulium) gibsoni new species

Female.— Length 1.6 - 1.9 mm.; wing 2.2 - 2.4 mm. Integument dark-brown to black; vestiture pale yellow. Head: front moderately broad, divergent-sided; front and clypeus with scattered pale hairs. Antenna dark reddish-brown; 9-jointed; a little shorter than the fore basitarsus; joints sub-equal, gradually tapering to the apex; joints eight and nine distinct, but incompletely separated; palpi black. Thorax: pile pale yellowish, the long hair on and in front of the scutellum also pale. Wings: with the characters of the subgenus; stem vein pale pilose; a few pale hairs mixed with the dark hairs elsewhere on the veins; halteres brown. Legs: dark-brown, distal segments of tarsi almost black; hairs pale-yellowish, especially long and conspicuous on the fore femora and hind legs; claws with a pointed basal tooth. Abdomen: basal fringe and short, rather sparse general pilosity pale yellow; plates on the dorsum strongly chitinized, those on segments three, four and five reduced in width; sternites two to five largely membranous. Genitalia (Plate III, figs. 2-3): anal lobe with few setae, small, more or less quadrate, slightly produced antero-dorsally; cerci rectangular, outwardly rounded, about twice as wide as long, moderately setose; arms of genital rod with apical membranous expansions transversely ridged or fluted, the upper margin crenulate.

Male.— Similar to female in size and colour; pilosity somewhat longer; antennal joints eight and nine less distinctly separated; hind basitarsus equal in width to the tibia; tergal plates of abdomen not reduced; sternal plates weakly chitinized. Genitalia (Plate III, fig.1): side-pieces longer than broad, gently tapering, smooth, with a row of setae on the apical margin. Claspers a little longer than the side-pieces, with few setae and a short, stout, apical tooth. Adminiculum somewhat membranous, about as broad as long, setulose throughout, basal prongs chitinized, slender, divergent; adminiculum arms without teeth, broad medially and narrowed at both ends. Median process (penis ?) pointed at tip.

Holotype.— Female, near Carleton Place, Ont., emerged from pupa, 10.V.35. Can. Nat. Coll.

Allotype.— Male, same data, 9.V.35.

Paratypes.— 5 females, 2 males, near Hull, Que., reared from pupae, 21-23.V.35.

This species is dedicated to Dr. Arthur Gibson, Dominion Entomologist, whose kind approval made the present study possible.

Pupa.— Length about 3.8 mm. Respiratory tuft about two-thirds the length of pupa and comprised of 14 filaments, which divide from three branches, one dorsal and two ventral, arising from the main trunk. The dorsal branch divides into two, each part bearing three filaments, a single one and a short-stalked pair, thus forming six filaments; the ventral

branches each bifurcate twice making eight filaments; or 14 in all. The cocoon, in which the pupa lies partially or wholly concealed, has no definite shape, and consists of loosely woven silk encrusted with tiny particles of sand. Sometimes the pupa is nearly naked.

Notes.— Larvae and pupae were collected during May, 1935, with other species, from three small, shallow, temporary streams draining pasture land near Hull, Que., and Carleton Place, Ont. A male emerged on May 9, and a female on May 10, from pupae taken, on May 8, from the two streams near Carleton Place (C.P.H.1 & 2: Plate XXXII, figs.21 & 22). Two males and five females emerged May 21-23, from pupae taken on May 19, on stones and pebbles in the stream (S.R.S.1) near Hull, Que. Specimens were not seen during subsequent examinations, and the streams were dry in August. Numbers of empty pupal skins of gibsoni were found in the Blanche river, south of Perkins Mills, Que., on May 22. This is an early spring species with probably only one generation annually.

Simulium (Prosimulium) decemarticulatum new species

Female.— Length about 2 mm.; wing 3 mm. A species with dark-brown integument, yellowish pilosity and yellowish-brown legs. Head: front moderately broad, distinctly narrowed below; surface hairs on front and clypeus largely pale, yellowish, postocular hairs black. Antenna 10-jointed; about one third longer than the fore basitarsus; brown, basal joints

paler; joints sub-equal, gradually tapering. Thorax: mesonotum rather densely covered with yellowish pubescence; the longer, upright hairs on and in front of scutellum, yellow; pleural tuft yellow. Wings: hairs on the stem vein pale yellow; elsewhere on the veins, dark; radial sector with a long fork; small basal cell present; halteres pale-brown. Legs: yellowish-brown, apical tarsal segments darker; pilosity yellow; calcipala and pedisulcus absent; claws bifid. Abdomen: basal fringe yellow; pilosity on the dorsum pale, sparse denser at the sides; tergites weakly chitinized, the plates on segments three to seven greatly reduced in width; sternites entirely membranous. Genitalia (Plate IV, figs. 2-3): ovipositor valves weakly chitinized, extending slightly beyond base of anal lobe; cercus evenly and moderately setose, rectangular, twice as wide as long, the postero-ventral angle cut off by the inwardly directed posterior margin; anal lobe L-shaped, the broad basal portion nearly twice the length of the cercus, sparsely setose; upper arm narrow, thinly chitinized, bare; arms of genital rod narrowly divergent, expanded portions with upper margins thickened.

Male.— Similar in size to the female, but distinctly darker; integument dark-brown to black; mesonotal pile golden; pleural tuft black; hairs on scutellum dark; legs dark-brown, pilosity brown to black, in some places intermixed with paler, golden hairs, especially on femora; hind basitarsus dilated to about the width of tibia. Genitalia (Plate IV, fig.1): similar to gibsoni, but side-pieces more setose; claspers sharply tapering; adminiculum broader than long, chitinized

basal prongs very short and tapered; median process broad and flattened at apex.

Holotype: Female, near Carleton Place, Ont., emerged from pupa 10.V.35. Can. Nat. Coll.

Allotype: Male, same data, 8.V.35.

Paratypes: 2 females, same data, 9.V. and 13.V.35.

Pupa.— Length about 4 mm. The respiratory tuft consists of nine long filaments, the longest nearly equalling the length of the pupa, arranged in a whorl, and bent almost at right-angles to the short base. The cocoon is of the usual Prosimulium type; shapeless and loosely woven. Those collected were encrusted with sand particles, which made the insect difficult to find.

Notes.— Larvae and pupae were found with immature stages of other species, in two shallow, temporary streams (Plate XXXII, figs. 20 & 21) near Carleton Place, Ont., on May 8. One of the streams was a pebbly-bottomed, roadside drainage ditch, and the other flowed over a rock bottom through pasture fields. This is evidently an early spring species; no specimens were found two weeks later, and the stream dried up during the summer.

Simulium (Prosimulium) browni new species

Female.— Length 2.5 - 3 mm.; wing 3.3 - 4; integument black, pilosity pale, yellowish. Head: front and clypeus black, rather sparsely clothed with black and pale hairs

intermixed; front very broad, moderately narrowed below. Antenna 11-jointed, entirely black, distinctly longer than head and about one-third longer than the fore basitarsus; three basal segments enlarged, remainder smaller, tapering. Thorax: dull-black, concolorous; mesonotum with pale, sparse, recumbent pile; pleural tuft yellowish-brown, inconspicuous; marginal fringe of scutellum yellowish-brown, moderate. Wings: with a brown tinge; anterior veins brown; stem vein pale pilose; radial sector with a long fork; minute basal cell present; halteres dark-brown. Legs: dark-brown to black; pilosity pale yellowish, moderate; calcipala and pedisulcus absent; claws simple. Abdomen: black; basal fringe dark-brown; short, sparse, pale hairs on the tergites, longer and denser at the sides; tergites not markedly reduced; sternites all with small chitinized plates. Genitalia (Plate V): ovipositor valves similar to hirtipes, but infuscated, the setae longer, more numerous, basal half of inner margin chitinized, incurved; anal lobe scarcely larger than cercus, with numerous long setae on the ventral half; cercus rectangular, twice as wide as long, rounded distally, setose; genital rod stout, strongly chitinized, the arms broadly expanded, incurved.

Holotype.— Female, Lake Harbour, Baffin Island, 10.VIII.35, reared from pupa (W.J. Brown). Can. Nat. Coll.

Paratypes.— 11 females, same data.

Pupa.— Length 4.5 mm. Respiratory tuft about two-fifths as long as pupa, consisting typically of 14 filaments (one specimen had 15). The short main trunk gives rise to three branches, one dorsal and two ventral. The dorsal branch divides into three stalks, each of which bifurcates forming six filaments. The two ventral branches each give rise to four filaments, making 14 in all. The cocoon is of the usual type; a rather loosely woven sheath of indefinite shape. When undamaged it largely conceals the pupa.

Notes.— W.J. Brown, of the Dominion Entomological Branch, Ottawa, collected larvae and pupae from a stream at Lake Harbour, and reared the adults which comprise the type material. He also collected nine females on the wing, 5-10.VIII.35. The species is dedicated to him.

Subgenus EUSIMULIUM Roubaud

Eusimulium Roubaud, Comp. Rend. Acad. Sci. Paris, 143:519, 1906.

Cnephia Enderlein, Deuts. Tier. Woch., 29:199, 1921

Cnetha Enderlein, ibid.

Nevermannia Enderlein, ibid.

Schönbaueria Enderlein, ibid.

Pseudonevermannia Baranoff, Neue Beitr. Syst. Ins., 3:164, 1926.

Genotype.— Simulium aureum Fries.

Key to the Females of Eusimulium*

(Based on external characters and genitalia)

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1. Radial sector simple..... 2.

   Radial sector weakly furcate..... 7.

2. Claws simple..... 3.

   Claws bifid (i.e., with basal tooth)..... 4.

3. Pedisulcus present, distinct; calcipala small; hind tibial spurs normal; thorax with three faint mesonotal vittae; hairs on stem vein largely yellow; anal lobe small, subquadrate, with a distal, rounded, setose protuberance; arms of genital rod quadrately expanded (arctic species) .....baffinense n.sp.

   Pedisulcus absent; calcipala prominent; hind tibial spurs unusually long; mesonotum unstriped; hairs on stem vein black; anal lobe narrowed behind cercus, ventrally expanded, lobed beneath; arms of genital rod quadrately expanded, irregularly toothed.....mutatum (Mall.)

4. Postnotum with patch of yellow scales; mesonotal pubescence brassy-yellow, scale-like; two basal joints of antennae pale-brown; anal lobe small, narrow, curved beneath cercus, ventral margin setose,.....aureum Fries.

   Postnotum without scales; mesonotal pubescence pale; antennae entirely black..... 5.

5. Mesopleural membrane with a tuft of pile; calcipala and pedisulcus absent; anal lobe normal, posteriorly setose.....boreale (Mall.)

   Mesopleural membrane bare..... 6.

6. Calcipala prominent; pedisulcus deep; hind basitarsus about 7.5 x 1; anal lobe normal; arms of genital rod irregularly expanded and terminating in a blunt chitinized tooth.....quebecense n.sp.

   Calcipala small; pedisulcus shallow; hind basitarsus about 6 x 1; anal lobe sub-quadrate, the distal margin with a rounded, chitinized, setose process; arms of genital rod quadrately expanded..... .....subexcisum Edw.

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*Female of rivuli unknown; latipes and johannseni not included

7. Calcipala minute; pedisulcus shallow; claws with small, sub-basal tooth; anal lobe elongate quadrangular, strongly setose; expansions of genital rod toothed and ribbed.....*lascivum* n.sp.

Key to the Males of Eusimulium*

(Based largely on genitalia)

1. Adminiculum narrow, conical; basal prongs widely divaricate.....*aureum* Fries

   Adminiculum broad, rounded; basal prongs incurved, or only slightly divergent..... 2.

2. Adminiculum with hirsute nipple in medial depression; adminiculum arms each with a single long, stout tooth.....*quebecense* n.sp.

   Adminiculum without hirsute nipple; adminiculum arms with few to many, smaller teeth..... 3.

3. Clasper with a pair of close-set terminal teeth .....*mutatum* (Mall.)

   Clasper with a single terminal tooth..... 4.

4. Radial sector weakly furcate; basal prongs of adminiculum roundly expanded.....*lascivum* n.sp.

   Radial sector simple; basal prongs not rounded..... 5.

5. Mesopleural membrane with a tuft of pile....*boreale* (Mall.)

   Mesopleural membrane bare..... 6.

6. Pedisulcus deep; upper margin of adminiculum depressed; arms with numerous small teeth; large (arctic) species.....*baffinense* n.sp.

   Pedisulcus shallow; upper margin of adminiculum convex; arms with few teeth; smaller species..... 7.

7. Hind basitarsus about 6 x 1; adminiculum minutely hirsute, basal prongs incurved; arms with short stout teeth.....*subexcisum* Edw.

   Hind basitarsus about 5 x 1; adminiculum with longer hairs, basal prongs not incurved; teeth on arms larger.....*rivuli* n.sp.

*_latipes_ and _johannseni_ not included.

Simulium (Eusimulium) aureum Fries.

Simulia aureus Fries, Monogr. Simul. Suec., p.16, 1824.
Simulium bracteatum Coquillet, U.S.D.A. Bur. Ent. Bull. 10, r.s. p.69, 1898.
Simulium angustipes Edwards, Bull. Ent. Res. 6:40, 1915.

Female.— Length, 2-3 mm.; wing, the same; integument black, greyish to brownish pollinose; pubescence silvery to brassy yellow. Head: front narrow, sides divergent; pilosity scale-like, creamy-yellow; clypeus distinctly longer than broad, pile finer and looser than on front; post-ocular hairs numerous, scale-like, pale yellow. Antenna 11-jointed, hardly tapering; black, the two basal joints pale-brown; palpi black. Thorax: mesonotum rather densely clothed with a yellow or brassy scale-like pile, somewhat silvery on the anterior margin; the recumbent pile and upright hairs on the scutellum, and a patch of scales on the postnotum, yellow; pleural tuft pale yellowish. Wings: hairs on the stem vein and base of costa pale-yellow; other hairs black, those on the costa mixed with minute spinules; the basal two-thirds of sub-costa with a sparse row of hairs. The radial vein hairy on its entire length, the hairs in a single row apically, interspersed with spinules. The radial sector simple; basal cell absent; halteres pale, the stem darker. Legs: pale-brown, except the mid and hind coxae, the apices of the femora and tibiae, and the tarsal joints, which are black. Pilosity on the pale parts silvery to yellowish; that on the dark parts black. Fore

basitarsus a little shorter than antenna; hind basitarsus 6 x 1, about four-sevenths as wide as tibia; calcipala and pedisulcus distinct; claws distinctly bifid. Abdomen: basal fringe pale yellow; general pilosity rather dense, scale-like, yellow, sometimes silvery. The chitinized plates of tergites three to seven markedly reduced; sternites one to six membranous. Genitalia (Plate VI, figs. 3-4): ovipositor valves weakly chitinized, conical, pointed, reaching posterior margin of anal lobe; setose, spicular on distal two-thirds. Anal lobe smaller than cercus, curved, narrowed to a rounded point beneath cercus, but not reaching distal margin; setose on posterior margin only. Cercus slightly more than twice as wide as long, distally rounded, setose. Arms of genital rod broadly expanded, a blunt chitinized tooth on the outer margins.

Male.— Similar to the female except as follows: antenna more slender and entirely black; mesonotum densely clothed with golden pubescence, except the disk which is velvet black; halteres darker; legs as in female, but the pale parts a little darker, and the pilosity somewhat longer, particularly on the hind legs; the hind basitarsus about 5 x 1; narrower than the tibia; abdomen velvet black, the yellow pilosity less generally distributed, and rather longer and more hair-like; short and sparse on the apical segments; tergal plates not markedly reduced; chitinized sternal plates present on all but the second segment. Genitalia (Plate VI, figs. 1, 2, 5): side piece conic-quadrate; clasper small, angled, terminating with a short tooth. Adminiculum narrow, somewhat conical, hirsute,

the basal prongs widely divaricate and outwardly triangularly expanded. Adminiculum arms connected medially with a convex membrane; lateral chitinous plates broad.

Pupa.— Length about 3 mm.; the respiratory filaments a little longer than the pupa, four in each tuft, all of about equal thickness, arising in two pairs; the lower pair directly from the main trunk, and the upper pair on a very short stalk. The cocoon is of rather tightly woven silk, of the typical wall-pocket form; about one-third longer than wide. The thickened anterior margin bulges to form a slight median salient.

Synonymy.— Dyar and Shannon (5, p.14) placed bracteatum Coquillett as a race of the European aureum Fries. Edwards (7, p.243) stated that he examined a male of bracteatum from Spartanburg, S.C., and could find no appreciable difference from the European aureum in the genitalia or other characters; furthermore, descriptions of the larvae and pupae by Strickland* and Jobbins-Pomeroy (37, p.13) also agreed with the British form. After careful comparison of my material with Edwards' descriptions of the male and female of aureum (6, pp.39-40), the former under the synonym angustipes, and with descriptions of the larvae and pupae by Edwards (7, p.242) and Puri (40, p.355), I am convinced that the North American form is identical with the European aureum and have placed bracteatum as a synonym of the former.

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*Jour. Morph. XXIV, p.45, 1913.

Notes.— I have collected the larvae and pupae in several localities in Ontario and Quebec, in the Ottawa region, always in small, shallow, streams, and usually associated with venustum and vittatum, but never very numerous. The type of stream (Plates XXIV, fig.1, & XXXV, fig.2) favoured, commonly has a stony, pebbly, or shaly bottom, and is usually temporary or semi-permanent in character. There are probably two, perhaps three, generations annually. Pupae were found in June, July, and September. Both sexes were reared from Pinks lake stream, near Hull, Que., Sept. 25, 1934, and June 12, 1935, and from McKay lake stream, Rockcliffe, Ont., June 28 and July 24, 1935. Apparently nothing is known of the habits of this species as a bloodsucker.

Distribution.— The records given by Dyar and Shannon (5, p.14) and by Malloch (28, p.38) under the name bracteatum show this species to occur widely in the eastern United States. It is also recorded from the West by the same authors (Alaska, California and Colorado). Edwards (8, p.150) states that it occurs throughout Europe and North America. I have the following records for Canada; the collections were pupae unless otherwise indicated. Ontario: Bowesville, June 12, 1926; Billings Bridge, Sept. 23, 1926; Rockcliffe, Sept. 27, 1926, June 2, 1931 (reared adults, June 28 and July 24, 1935); Hawkesbury (larvae), July 25, 1927. Quebec: Gracefield, July 13, 1926; Luskville, July 22, 1931; Pinks lake (near Hull), July 21, 1931 (reared adults Sept. 25, 1934 and June 12, 1935). The species is probably widespread in Eastern Canada.

Simulium (Eusimulium) quebecense new species

Female.— Length about 1.6 mm.; wing 2.6 mm.; integument black with greyish pollinosity; vestiture pale. Closely related to aureum Fries, and with identical characters except as follows: pubescence paler throughout, silvery to yellowish-white or grey, less scale-like; antenna entirely black; postnotum bare; hairs on stem vein pale; legs more slender and darker, the apical bands on the femora and tibiae indistinct, even in cleared specimens; pilosity on the legs pale, the hairs darker on the tarsal joints; hind basitarsus 7.5 x 1; abdominal pubescence pale and much sparser. Genitalia (Plate VII, figs. 4-5): ovipositor valves membranous, chitinized on the inner margins, tips not reaching ninth sternite. Anal lobe about twice as long as cercus, broadly rounded, apically produced, pyriform, with sparse long setae postero-ventrally; cercus a little more than twice as wide as long, setose. Genital rod widely forked, each arm irregularly expanded and terminating with a blunt chitinized tooth.

Male.— Slightly larger than female; integument and pubescence much darker; antennae and palpi more slender. Mesonotum velvet black, with pale-yellowish rather scale-like pilosity, the hairs most numerous anteriorly, sparse on the disk; recumbent scales on the scutellum pale, upright hairs black; pleural tuft black. Hairs on the stem vein black; halteres black. Legs dark-brown to black, the pile dark and rather long, especially posteriorly on the front femora and hind legs; hind basitarsus broad, about 3.5 x 1, six-sevenths the width of the tibia; basal tooth on claws somewhat smaller.

Abdomen velvet brown, almost black; other pubescence the same, but short and sparse on the dorsum, long on the sides and sternites. Tergal plates two to six slightly reduced; second sternite entirely membranous. Genitalia (Plate VII, figs. 1-3): side-piece conic-quadrate; clasper about as long as side-piece, apical portion conically produced at right-angles to the main axis, and with a small terminal tooth. Adminiculum broad, the centre of the upper margin depressed and bearing a rounded hirsute nipple; basal prongs long, chitinized, incurved. Adminiculum arms rounded-quadrate basally, each bearing a single long, stout, pointed tooth.

Holotype.— Female, near Perkins Mills, Que., 26.V.35 (reared). Can. Nat. Coll.

Allotype.— Male; same data.

Paratypes.— 4 females, 5 males; same data.

Pupa.— The pupa and cocoon closely resemble those of aureum Fries., but both pairs of filaments are arranged on short stalks arising from the main trunk, the lower stalk a little longer than the upper stalk: the uppermost filament slightly swollen at the base. The cocoon is more tightly woven, and the anterior margin thicker.

Notes.— Pupae from which the type material was reared were collected on May 22, 1935, from stones in the rapids of the Blanche river, a short distance below the falls, about five miles south of Perkins Mills, Que. (Plate XXVII, fig.1). The temperature of the water was 53° Fah. At this point the river is shallow and swift, over a stony bottom. A pupal skin

of hirtipes, some mature larvae of venustum, and a number of pupae of corbis, were taken at the same time, the latter on submerged dogwood.

Simulium (Eusimulium) subexcisum Edwards

Simulium subexcisum Edwards, Bull. Ent. Res. 6:41, 1915.

Female.— A small, dark-coloured species, integument brown to black; pubescence pale. Head: antenna entirely black, 11-jointed; second joint swollen, about equal in length to third joint, remainder smaller, sub-equal, gradually tapering to a point. Wings: hairs on apical half of costa mixed with spinules; an irregular row of hairs present on the basal two-thirds of the sub-costa; radial vein clothed with fine hairs throughout its length, the apical ones in a single row interspersed with several spinules; radial sector simple; there is a slight but perceptible thickening of the vein, and a slight divergence of the two rows of hairs at the apical margin. Legs: all the joints in the cleared specimen uniformly dark; fore and mid basitarsi cylindrical; hind basitarsus flattened, about 6 x 1 and three-fifths width of tibia; calcipala small, narrow; pedisulcus shallow; claws with a prominent basal tooth. Abdomen: width of tergal plates three to seven much reduced; sternites largely membranous. Genitalia (Plate VIII, figs.2-3): anal lobe small, sub-quadrate, weakly chitinized; ventral margin curved, minutely nodulose, spiculate; distal margin, ventrad of cercus, with a rounded chitinized process bearing two or three long setae.

Cercus wider than long, distally rounded, moderately setose. Arms of genital rod quadrately expanded outwardly, the expanded portion weakly chitinized and with the upper-inner margin drawn into a small pointed tooth-like process.

Male.— Differs from female as follows: maxillary palpi markedly shorter than antennae; row of hairs on sub-costa absent; legs in cleared specimen paler, apices of hind and mid femora and all tibiae distinctly darkened; hairs on front femora, hind femora and tibiae longer; abdominal tergites not greatly reduced; only second sternite entirely membranous. Genitalia (Plate VIII, figs. 1, 4, 5): side-piece conic-quadrate, about as broad as long. Clasper as long as the side-piece, tapering, pointed, with a very small terminal tooth. Adminiculum broadly rounded, minutely hirsute, the basal prongs stout, chitinous, incurved. Adminiculum arms with a group of several short, rather stout teeth.

Pupa.— Length about 3 mm. Respiratory tuft almost as long as the pupa, consisting of six filaments arranged in pairs; the upper pair with a long stalk, widely divergent from the two lower pairs. The cocoon is about 4 mm., less closely woven than latipes, and with a thickened anterior margin and long anterior process.

Notes.— This species has not previously been recorded in North America. Edwards described both sexes from specimens collected in England, and has recorded it (6, p.41 and 7, p.244) from various localities in the British Isles, where it appears to be somewhat rare. Apparently little is known of its habits.

Edwards states that, "there cannot normally be more than one brood in the year". Several pupae were found on May 8, on stones in a temporary rill (Plate XXXII, fig.2) near Carleton Place, Ont., with pupae of certain other species. Two males and one female emerged on May 13, and were placed on slides with genitalia dissected. I have not seen European specimens of the species, but have compared my material with the descriptions and illustrations of the adults published by Edwards (6, p.41), and of the pupae published by Edwards (7, p.244) and Puri (40, p.358).

Simulium (Eusimulium) rivuli n.sp.

Male.— Closely allied to subexcisum Edw., but may be separated from it by the following structural characters, and by the pupa. Palpi almost as long as antennae; hind basitarsus about 5 x 1, and four-fifths the width of tibia. Genitalia (Plate IX): similar to subexcisum, but about one-fourth smaller; hairs on adminiculum longer, basal prongs not distinctly incurved; teeth on adminiculum arms larger.

Holotype.— Male, near Carleton Place, Ont., emerged from pupa 13.V.35: Can. Nat. Coll.

Paratypes.— One male, dissected from pupa taken near Hull, Que., May 19, 1935.

Pupa.— Length 3.1 mm. Respiratory filaments about 3.6 mm., of equal thickness; four in number in two pairs: the first pair almost sessile; the second, distinctly stalked.

The cocoon has a long anterior process, and is similar to the cocoon of subexcisum Edw.

Notes.— The male emerged on May 13, 1935, from a pupa taken, May 8, in a temporary rill, or drainage ditch, with a pebbly bottom (Plate XXXII, fig.2) several miles from Carleton Place, Ont. Unfortunately the specimen was cleared and mounted with its genitalia dissected before a note was made of its colour and pubescence. Two other pupae were secured but died: one was collected with the type; the other came from S.R.S.1, a temporary rill of similar character, near Hull, Que. In the latter, an adult male had almost completed its development, and I was able to dissect out the genitalia. The pupae were found in association with subexcisum, latipes, and several other species.

Simulium (Eusimulium) latipes Meigen

Simulium latipes Meigen, Klass. 1. 96. 5, 1804; Syst. Beschr. 1. 297. 11, 1818.

A pupa and cocoon that agree with the description of the European latipes published by Puri (40, p.352), was collected on May 19, 1935, on a stone in the temporary rill (S.R.S.1) near Hull, Que., with larvae and pupae of several other species. The pupa is smaller than Puri's specimens, measuring 3.2 mm. The respiratory filaments are about 3.7 mm., four in number, arising from a short main trunk in two distinctly stalked pairs held in the vertical plane. The cocoon is closely woven, its anterior border strongly thickened and extending

forward in a flat median process about 1.1 mm. long. It measures 3.6 mm., without the process, and is about one and one-quarter times as long as broad. The floor is restricted to the posterior half of the cocoon.

Simulium latipes has not been recorded in North America, but is widespread in Europe. Edwards (7, p.239) states that its habitat, in the British Isles, is small temporary rills and streams, with stony bottoms, the flies emerging in spring. He recorded the females biting humans.

Simulium (Eusimulium) johannseni Hart

Simulium johannseni Hart, 27th Rept. Sta. Ent. Ill. p.32, 1912.

Dyar and Shannon (5, p.23) record the taking of johannseni at Waubamic, Parry Sound, Ontario, by J.M. Aldrich, on June 8, 1915. There appear to be no other Canadian records. I have no specimens of this species.

Simulium (Eusimulium) baffinense new species

Female.— Length, 2.7 mm.; wing 3 mm. Integument black, greyish pollinose; pubescence yellow. Head: front rather narrow, sides moderately divergent; median furrow distinct; front and clypeus greyish pollinose, sparsely pale haired; postocular hairs largely yellow, some black. Antenna 11-jointed, entirely black, rather slender, tapering, basal joints slightly enlarged; maxillary palpi black, nearly as long as antenna. Thorax: mesonotum with fairly dense,

sub-appressed, rather scale-like pilosity, golden on the disk, longer and paler along the margins; the integument of the mesonotum bears three faintly marked vittae, obscured by the hairs, the lateral ones diverging posteriorly; scutellum with numerous upright yellow, marginal hairs; postnotum bare, pollinose; pleural tuft yellowish. Wings: yellowish hyaline; anterior veins brown; posterior veins not darkened; hairs on stem vein yellow, or with a few black ones intermixed; hairs on costa intermixed with spinules, these most numerous and prominent apically; sub-costa with a weak row of hairs on basal half; radius rather sparsely haired throughout its length, those on apical half in a single row alternating with spinules; the radial sector simple and bearing a single row of fine hairs; basal cell present, minute, indistinct; halteres pale, the stem black. Legs: dark-brown to black, with yellowish pile; apices of femora, and bases and apices of tibiae with chitinized black bands (very distinct in cleared specimens); basitarsus and second hind joint less heavily chitinized than front and mid tarsal joints; fore basitarsus cylindrical, about four-fifths as long as antenna; hind basitarsus about 6 x 1, and two-thirds width of tibia; calcipala small; pedisulcus present, near the base of the second hind tarsal joint, the incision deep and distinct; claws simple. Abdomen: basal fringe pale yellow; dorsum with somewhat sparse yellowish pubescence, hairs longer and more numerous at the sides; width of tergal plates three to seven moderately reduced; sternites two to six entirely membranous.

Genitalia (Plate X, figs.2-5): ovipositer rather short and broad; valves membranous, inner margins chitinized. Anal lobe small, chitinized, sub-quadrate, sparsely setose distally, membranous and spiculate ventrally, postero-ventral margin lobed; posterior margin above lobe with a heavily chitinized rounded protuberance ventrad and anterior to cercus, bearing several rather long setae (some of characters not well shown in figure). Arms of genital rod expanded outwardly into rounded quadrate, weakly chitinized plates.

Male.— Similar to female, but postocular hairs black; hairs on stem vein black; sub-costa bare; halteres black; legs entirely black; hind tibia and basitarsus somewhat enlarged, the basitarsus about 4 x 1, and four-fifths the width of tibia; claws with a rather strong basal tooth; abdominal tergites not greatly reduced; only the second sternite entirely membranous. Genitalia (Plate X, figs.1, 3, 4): side-piece large, conic-quadrate; clasper a little shorter, tapering, and terminating with a small tooth. Adminiculum twice as wide as long, weakly chitinized and clothed with longish hairs; upper margin depressed; basal prongs prominent, chitinous and slightly incurved. Adminiculum arms with numerous short teeth mixed with fimbriae; narrow laterally.

Holotype.— Female, Lake Harbour, Baffin Island, 10.VIII.35 (W.J. Brown). Can. Nat. Coll.

Allotype.— Male, same data.

Paratypes.— 2 females, 9 males, with types. A pair of these were pinned in copula and have been cleared and mounted on the same slide.

I have also five females structurely indistinguishable from the types, but with distinctly paler pubescence; the mesonotal vittae more distinct; the hairs on radial sector arranged in an **irregular** double row.

In the event that these characters prove to be constant, the name pallidum is proposed for this form.

Simulium (Eusimulium) boreale (Malloch)

Prosimulium borealis Malloch, Rept. Can. Arctic Exp., 1913-18, Vol.3, p.41 C, 1918.

Female.— Length about 2.5 mm.; wing 3.5 mm. Integument black, dusted with grey to brownish pollinosity. Differs from baffinense as follows: vestiture, including the anterior veins of the wings, pale, silvery; pleural tuft longer, more conspicuous; a tuft of pale pile on the mesopleural membrane; mesonotal vittae more distinct; hairs on stem vein silvery; the row of hairs on sub-costa confined to outer three-fourths of vein; hairs on radius more numerous; basal cell small, but distinct; legs entirely dark; chitinous black bands absent; fore basitarsus about six-sevenths the length of antenna; hind basitarsus about 7 x 1; calcipala and pedisulcus absent; claws with a rather strong, pointed, basal tooth; reduction of width of tergal plates slightly less marked. Genitalia (Plate XI, figs.3, 5): ovipositor valves short, broad at base, membranous, except along inner margins, sparsely spicular, tips remote and not reaching ninth sternite. Anal lobe weakly chitinized, more or less triangular, ventral margin rounded; setae rather numerous on postero-ventral two-thirds. Cercus sub-quadrangular, broader

than long, slightly narrowed below, setose. Arms of genital rod expanded into more or less quadrangular plates, each with a transverse, strongly chitinized ridge which forms a large blunt tooth.

Male.— Postocular hairs black; general pilosity pale as in female, the hairs on the mesonutum rather sparser and longer; vittae less distinct; hind basitarsus about 4 x 1, as wide as tibia; tergites and sternites not much reduced. Genitalia (Plate XI, figs.1, 2, 4): side-piece and clasper similar in size and shape to baffinense, but with fewer setae; adminiculum about three-fourths as wide, and basal prongs slightly produced laterally. Adminiculum arms with long, conspicuous teeth medially, fimbrious above; lateral plates broadly expanded.

Notes.— Malloch's type material (a male) was collected on the Wollaston peninsula, Victoria island, during the summer of 1915, by D. Jenness; a female was taken at Bernard Harbour, Northwest Territories, August 25, 1916, by F. Johansen (29). Dyar and Shannon (5, p.22) record the collection of three females by Dr. Dyar at Two Medecine River, Montana, on July 27, 1921. My material consists of a male and seven females collected at Lake Harbour, Baffin island, August 5-10, 1935, by W.J. Brown. The immature stages are not known.

Simulium (Eusimulium) mutatum (Malloch)

Prosimulium mutatum Malloch, U. S. Dept. Agr. Bur. Ent. Tech. Ser. No.26, 1914, p.20.

Undescribed species No.2, Ritcher, Ent. News XLII:241, 1931.

Female.— Length, 2-3 mm.; wing, 2.5 - 3.5 mm.; integument greyish or brownish to black, sub-opaque. Head: front narrow, sides moderately divergent, median groove distinct; clypeus longer than broad; front and clypeus sparsely pale haired; orbital hairs largely pale. Antenna 11-jointed; entirely black; joints sub-equal except the second, which is somewhat enlarged, and the apical joint, which tapers to a point; palpi black. Thorax: mesonotum moderately densely clothed with greyish-yellow, hair-like pilosity; scutellum with pale and dark hairs intermixed; postnotum bare, silvery pollinose, shining; pleural tuft pale. Wings: hairs on stem vein black; other hairs dark, those on the apical two-thirds of costa mixed with numerous spinules; hairs on lower surface of sub-costa in a double row at the base, singly outwardly; radial vein hairy throughout its length, the distal hairs in a single row. Radial sector simple; a small basal cell present and distinct; halteres pale-brown. Legs: yellowish-brown to dark-brown, more or less concolorous; pilosity largely pale-yellow. Fore and mid tarsi cylindrical; hind tibial spurs unusually long, length nearly four-fifths width of tibia; calcipala distinct; pedisulcus absent; claws simple. Abdomen: basal fringe pale; general pubescence pale, sparse, minute, and largely confined to apical segments. Width of chitinized plates of tergites three to six

markedly reduced; tergites two and seven also reduced, but less so; sternites of all but the first and terminal segments membranous. Genitalia (Plate XII, figs.3, 4): ovipositor valves small, inconspicuous. Anal lobe narrowed behind cercus, expanding ventrally to about twice the length of cercus; distal portion lobed, setose, and projecting beneath it; cercus about twice as wide as long, setose. Arms of genital rod broadly and quadrately expanded; lower margins irregularly toothed.

Male*.— Similar in size, but distinctly darker than the female. Mesonotum dull velvet-black, with rather sparse, scattered, bronzy-brown to black scale-like pilosity; marginal fringe on scutellum black; pleural tuft longer than in female, black; hateres dark-brown. Legs uniformly darker and more hirsute, the hairs bronzy black, and longer, especially on the fore femora and hind legs. Hind tibia and basitarsus broader than in female, but in the same relation to each other, the basitarsus about five-sixths the width of tibia. Calcipala smaller; hind second tarsus with an indistinct pedisulcus. Claws trifid. Abdomen velvet black, the apical margins paler; basal fringe black; pubescence short, rather sparse, bronzy black. Tergal plates less markedly reduced than in female, the reduction progressively descreasing from segments two to seven; only the sternite of second segment entirely membranous. Genitalia (Plate XII, figs.1, 2, 5): side-piece conic-quadrate, longer than broad, setose distally. Clasper setose, shorter than side-piece, rather wide, uniform, but suddenly tapering near tip and

*Previously undescribed.

bearing a pair of closely set, blunt, terminal teeth. Adminiculum broadly rounded, chitinized, hirsute; basal prongs strong, divergent. The adminiculum arms bear a marginal row of irregular, blunt teeth medially.

Allotype.— Male, near Carleton Place, Ont., reared from pupa, 9.V.35. Can. Nat. Coll.

Paratypes.— 3 males, same data, 9-13.V.35.

Pupa.— Length about 3-4 mm.; respiratory tuft about three-quarters the length of pupa. The main trunk divides close to the base into two branches held in the vertical plane. The upper branch further subdivides into seven filaments; the lower, into five, forming twelve in all. In some specimens the unpaired filament of the lower group divides into two near the apex, or one of the paired filaments gives rise to a short branch, or a weak filament arises from the main stem of the upper group. Thus the number of filaments varies from twelve to fourteen, but the usual number is thirteen. The cocoon is similar to that of Simulium (Prosimulium) gibsoni; indefinite in shape and consisting of loosely woven silk encrusted with coarse sand particles.

Synonomy.— Under the name Undescribed Species No.2, Ritcher (43, p.241) published a description of the immature stages of a species collected from a small temporary woodland stream near Urbana, Illinois, in April, 1930. Comparison of his descriptions and figures of the larva and pupa with my specimens show them to be identical.

Notes.— During May, 1935, I found small numbers of larvae and pupae in three small temporary streams flowing through rough pasture land in the Ottawa district, and succeeded in rearing four males and eight females. These males are the first to be recorded, and this is the first time that the immature stages have been associated with the adults. The species was found in association with venustum, latipes, subexcisum, decemarticulatum and gibsoni. The details of the collections are as follows. On May 8, larvae and pupae were found on stones in a shallow drainage ditch (C.P.H.1), and in a rock-bottomed stream (C.P.H.2), several miles from Carleton Place, Ont. (Plate XXXII). Three males emerged from the pupae on May 10, and a male and a female on May 13. Several larvae and pupae were also collected in a somewhat grass-grown, pebbly-bottomed rill (S.R.S.1), near Hull, Que., on May 19. From these, seven females emerged on May 21 and 23. The temperature of the three streams ranged from 55° to 62° Fah.

Distribution.— S. mutatum has a wide distribution in North America. Malloch (28, p.20) described the species from a female taken at Glassboro, New Jersey. He also recorded it from localities in Illinois, Missouri, Washington, British Columbia and Alaska. Dyar and Shannon (5, p.17) added Virginia, Maryland and Indiana. I have specimens from the following localities. Quebec: Hemmingford, May 15 and July 25, 1928 (G.H. Hammond); Montebello, May 21, 1930 (N.J. Atkinson); Pinks lake, near Hull, June 5, 1931 (C.R. Twinn), also reared females from near Hull, May 21 and 23, 1935. Ontario: Niagara

Glen, June 23, 1926 (G.S. Walley); near Carleton Place, reared males and females, May 10 and 13, 1935 (C.R. Twinn).

Simulium (Eusimulium) lascivum new species

Female.— Length, 3-4 mm.; wing, the same; integument dark-brown to black, with pollinose dusting. Head: front moderate, about twice as wide at vertex as at base of antennae; median furrow distinct; clypeus somewhat broader than long; front and clypeus black, covered with dull yellowish pollinosity, and short decumbent yellowish pubescence; orbital hairs black. Antenna 11-jointed, joints four to ten sub-equal, the three basal joints larger, and the apical joint more elongate, tapering to a rounded point; colour dull-black, the second joint and the distal margin of the basal joint reddish; palpi black. Thorax: mesonotum black with a faint yellowish or greyish pollinose dusting, and fine short yellow pubescence; three rather indistinct mesonotal vittae present, the median stripe a thin straight line, lateral ones broader, somewhat sinuate. Scutellum dark-brown to black with sparse yellow pubescence and rather short black hairs; postnotum black, pollinose. Pleurae dark-brown to black posteriorly; the lower part black with whitish pollinosity; pleural tuft small, black, with a tinge of yellow. Wings: hairs on stem vein black; costa with numerous short black hairs mixed with minute spinules; subcosta with a single row of hairs; radial sector shortly and indistinctly furcate, the posterior branch with a single row of hairs on the upper surface; small basal cell present;

halteres light-brown. Legs: coxae and underside of fore trochanters black, whitish pollinose; other joints dark-brown, with fine black and yellowish pilosity; hind tibial spurs prominent; hind basitarsus about 6 x 1, and five-sevenths width of tibia; calcipala minute; length of second hind tarsus one and one-half times the width of basitarsus; pedisulcus present but shallow; claws long, slender, with a minute sub-basal tooth. Abdomen: black; greyish pollinose; apices of all tergites pale-brown, terminal segment almost wholly brown; basal fringe short, of fine yellowish hair; pubescence on dorsum sparse, minute, yellowish; longer and more numerous black and yellow hairs on lateral margins of dorsal plates, and on sternal plates; tergites well developed and chitinized, none greatly reduced in width; ninth tergite (viewed laterally) dorsally emarginate and caudally prolonged, the prolongation narrow, setose; sternites one and two membranous. Genitalia (Plate XIII, figs. 3, 4): ovipositor valves as broad at base as long, tapering, extending to one-third length of ninth sternite; weakly chitinized, spiculate, inner margins strongly chitinized; tips divergent. Anal lobe quadrangular, longer than wide, length slightly exceeding width of cercus; more heavily chitinized postero-ventrally; slightly prolonged beneath cercus; strongly setose except anteriorly and apically. Cercus quadrangular, twice as wide as long, setose. Arms of genital rod widely divaricate, expanded, toothed, the expansions each reinforced with a chitinous bar.

Male.— Essentially similar to female, but smaller; antenna entirely black; hind tibia about one-fifth wider than basitarsus, both much swollen; hind basitarsus about 3.5 x 1; length of second hind tarsal joint slightly less than width of basitarsus; basal tooth on claws more prominent. Genitalia (Plate XIII, figs.1-3): side-piece and clasper unusually large; side-piece conical, with long setae distally; clasper almost as long as side-piece, with long setae basally and tapered, curved, terminating with a small tooth. Adminiculum similar to mutatum, but about twice as wide, and the basal prongs roundly expanded. Adminiculum arms with a row of small, pointed, marginal teeth.

Holotype.— Female, Rockcliffe, Ont., reared from pupa, 13.V.35; Can. Nat. Coll.

Allotype.— Male; same data.

Paratypes.— 4 males, 5 females, Rockcliffe, Ont., emerged 13.V.35; 6 males, 7 females, Carleton Place, Ont., emerged 27.V.35.

Pupa (Plate XXIV, figs.1, 2).— Length 4-6 mm.; respiratory tuft bush-like in shape, usually less than one-half the length of the pupa, and composed of about 30 slender filaments (counts of twelve specimens showed as few as 27 and, in one case, as many as 40; the average was 30) arranged in a number of groups branching from a short, stout, base. The cocoon is of the Prosimulium type, consisting of a loosely woven silk sheath, indefinite in shape.

Notes.— Larvae and pupae were found in great numbers in May, 1935, in a small stream at Rockcliffe, Ont., connecting McKay lake with the Ottawa river, and also in the falls and rapids of the Mississippi river, at Carleton Place, Ont. I first collected pupae in the stream at Rockcliffe, on May 29, 1928, but did not then rear adults.

The McKay lake stream (McL.) is about half a mile in length, and rarely exceeds several feet in width and a few inches in depth. During the summer, with the fall of the lake level, it often dries up. The bed is of clay formation, and near the source of the stream there is a heavy growth of bulrushes and grasses. When first examined on April 13, the temperature of the water was 41° F., and only a few mature overwintering larvae of another species were found. On April 26, when the temperature of the water was 56° F., immense numbers of young larvae were present on the dead grasses, leaves and other obstructions in the water, the concentration being heaviest near the source of the stream. It seems probable that they had recently hatched from eggs laid the previous season. The young larvae (Plate XXIII, fig.1) were pale reddish-brown in colour, before immersion in alcohol, owing to patches of pigmented cells in the thorax and abdomen. The intestinal tracts showed green through the integument, indicating that the larvae were feeding on the algae which occurred in gelatinous masses on the grasses covering the stream bottom. By May 9, when the water temperature was 59° F., the majority were mature and many had pupated. The infestation had become more evenly distributed throughout the course of the stream. Stones, rocks

and other obstructions were thickly covered with the pupae (Plate XXIV, figs.1, 2) which were hidden from casual observation by the grey-green webbing of the cocoons, and often by writhing masses of larvae. Adult flies began to emerge a few days later. By June 8, the stream was reduced to a tiny rill, and only the immature stages of vittatum could be found.

The Mississippi river (Plates XXX, fig.17; XXXI, figs.1, 2) issues from the lake of the same name above Carleton Place, Ont. Where it passes through the town it is rather shallow and swift and has a bottom of shaly rock, its passage interrupted by concrete dams. During the spring freshet the river level is high and the current strong, but often during the summer it is much diminished, and in places almost dry.

When visited on May 8, 1935, the river was high and flowing over the dam with a roar. The temperature of the water was 53° F. Examination revealed the presence of myriads of larvae on the dam oscillating in dark-green, moss-like masses in the current. The larvae were small to well-grown, but none showed the developed pupal respiratory histoblasts. When visited again on May 24, many had pupated, the pupae inconspicuous under the protective greyish covering of the cocoons. The temperature of the water was 58° F. Emergence of the flies had commenced, and numerous males were flying erratically above the water surface of the falls, or resting on the retaining walls nearby. A collection of the pupae was made and a goodly number of both sexes emerged in confinement, on May 27. It is evident that the species reaches the peak

of its emergence from the Mississippi river during the latter part of May, as no trace of it was found during subsequent months either in 1935, or in previous years. On May 30, 1933, I found the adults crawling in thousands on nearby walls, many of them mating.

S. lascivum was the only species observed to mate in captivity. Numerous adults of both sexes that emerged on May 13, were actively mating in the small, damp, rearing vials, at 8 a.m. During copulation the male bends the tip of his abdomen downward and forward to connect with that of the female. Several specimens frequently clung together during this operation, tumbling about awkwardly within the confining walls of the vial. It was observed, too, that lascivum is not strongly attracted to light as are the adults of the other species reared.

Subgenus SIMULIUM Latreille

Simulium Latreille, Hist. Nat. Ins. et. Crust., 3:426, 1802.

Atratocera Meigen, Klass., 1:94, 1804.

Boophthora Enderlein, D. Tier. Woch., 29:199, 1921.

Chirostilbia Enderlein, ibid.

Edwardsellum Enderlein, ibid.

Gynonychodon Enderlein, ibid.

Odagmia Enderlein, ibid.

Wilhelmia Enderlein, ibid.

Gomphostilbia Enderlein, ibid.

Stilboplax Enderlein, ibid.

Friesia Enderlein, Konowia, 1:69, 1922.

Discosphyria Enderlein, ibid., 1:72.

Byssoden Enderlein, Zool. Anz., 62:209, 1925.

Pseudosimulium Baranoff, Neue Beitr. Sys. Ins., 3:164, 1926.

Pseudodagmia Baranoff, ibid.

Pternaspatha Enderlein, Arch. Klass. phyl. Ent.1:88, 1930.

Anasolen Enderlein, ibid., 1:94.

Notolepria Enderlein, ibid., 1:95.

Genotype.— (Culex colombaschensis Fabricius) = Culex reptans Linnaeus.

Key to the Females of Simulium

(Based on external characters and genitalia)

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1. Fore coxae black, greyish pollinose; mesonotum distinctly striped; abdomen opaque-grey with black markings..... 2.

   Fore coxae yellow; mesonotum not distinctly striped; abdomen dark-brown or black..... 3.

2. With three mesonotal vittae; hairs on stem vein black; sub-costa with a ventral row of hairs.....Simulium pictipes Hgn.

   With five mesonotal vittae; hairs on stem vein pale; sub-costa bare.....Simulium vittatum Zett.

3. Pleural tuft pale..... 4.

   Pleural tuft black..... 6.

4. Claws with a small sub-basal tooth; medium sized species close to venustum; anal lobe rounded quadrate, as long as ninth tergite, moderately setose posteriorly.....corbis n.sp.

   Claws simple..... 5.

5. Tergites six to nine black, shining; anal lobe strap-shaped, shorter than cercus (horizontally), and less than twice as wide, evenly setose; hairs on stem vein all pale.....venustum Say

Tergites six to nine greyish black, sub-opaque; anal lobe pyriform, narrow behind cercus, broadly rounded below, twice as long as cercus and twice as wide, anterior margin bare of setae; hairs on stem vein variable, pale and dark intermixed.....ottawaense n.sp.

6. Sub-costa with a row of hairs on ventral surface; anal lobe not produced anteriorly; about same horizontal length as cercus; medium sized species.....perissum D.& S.

Sub-costa bare; median area of anal lobe produced anteriorly to about twice length of cercus; smaller species..... 7.

7. Forks of genital rod tapered beyond tooth; hairs on stem vein all black.....fibrinflatum n.sp.

Forks of genital rod roundly expanded beyond tooth; hairs on stem vein variable, yellow, bronzy-brown, black, or the pale and dark hairs mixed.....nigroparvum n.sp.

Key to the Males of Simulium

(Based on the genitalia)

1. Clasper with three terminal teeth or none..... 2.

Clasper with a single terminal tooth, or spine..... 3.

2. Clasper shorter than side-piece, with three terminal teeth; adminiculum arched.....vittatum Zett.

Clasper longer than side-piece, terminal teeth absent; adminiculum deeply cleft mesially.....pictipes Hgn.

3. Adminiculum narrow, inverted Y-shaped, with posterior process or keel..... 4.

Adminiculum broader, tooth-shaped, without posterior process..... 5.

4. Posterior process apically rounded, marginally denticulate.....corbis n.sp.

Posterior process rounded, smooth, setulose, without marginal denticles.....ottawense n.sp.

5. Clasper with a small inner basal process; prongs of adminiculum simple..... 6.

Clasper simple; prongs of adminiculum each with a posterior sub-basal arm..... 7.

6. Basal process of clasper smooth; side-piece with rather numerous setae; adminiculum quadrate .....venustum Say

Basal process spinose; side-piece setose only on distal margin; adminiculum sub-quadrate, apically emarginate and denticulate .....perissum D.& S.

7. Adminiculum one and one-fourth times as long as broad, upper margin denticulate at sides, hirsute medially.....fibrinflatum n.sp.

Adminiculum twice as long as broad, upper margin denticulate throughout, hairs sparse or absent.....nigroparvum n.sp.

Simulium (Simulium) vittatum Zetterstedt

Simulium tribulatum Lugger, 2nd. Rep. Ent. Minn. p.205, 1896.

Simulium glaucum Coquillett, Proc. U. S.Nat. Mus., Vol.25:97, 1903.

Simulium dahlgrüni Enderlein, Deut. Tierarz. Woch. Hanover, 1921, p.43; Zool. Anz. Vol.53, p.45.

Female.— Length, 2-3 mm.; wing, 2.8 - 4 mm. Integument black, covered with opaque grey pollinosity, and brown to black markings; pubescence pale, rather sparse. Head: opaque-grey; front broad, with sparse pale hairs; clypeus as broad as long, about as wide as front at vertex, hairs longer, more numerous. Antenna 11-jointed, the two basal joints brownish, remainder black, tapering; palpi black. Thorax: mesonotum with five dark-brown to black vittae; pubescence short, sparse, pale; scutellum with a few recumbent pale scales and numerous upright pale hairs; postnotum silvery pollinose with a central

dark spot; pleural tuft pale. Wings: hairs on stem vein and base of costa pale, remainder black; those on costa and a row on the outer part of radial vein mixed with spinules; subcosta bare; radius bare between stem vein and base of radial sector; sector simple, reaching the costa close to the tip of radial vein, lower surface with a row of hairs; basal cell absent; halteres pale, yellowish, the base of stem black. Legs: black, except the basal half of tibiae and mid and hind basitarsi which are yellowish; fore coxae grey pollinose; fore tibiae with a basal pollinose white patch; fore tarsi slightly flattened; hind basitarsus about 6 x 1, and two-thirds the width of tibia; calcipala small; pedisulcus distinct; claws simple. Abdomen: opaque-grey, with three rather indefinite rows of opaque black spots on the dorsum, the median row often coalescing to form a central black stripe; basal fringe, and general short, sparse pubescence, pale; chitinization of tergites three to five reduced to small median plates; sternites two to seven entirely membranous. Genitalia (Plate XIV, figs. 4, 5): valves of ovipositor membranous. Anal lobe rather sparsely setose, about as long as cercus, but twice as wide (ventral measurement), one-half its width conically lobed ventrad of cercus and concealing the ovipositor; lower margin clear and setulose. Cercus rounded distally; setose. Arms of genital rod quadrately expanded, the corners produced; chitinization of outer portion denser than inner.

Male.— Distinctly darker than female. Antenna entirely black, more slender. Mesonotum white or silvery pollinose on lateral and posterior margins; disk velvety black and bearing two short, rather indefinite pale striped; pilosity hair-like, moderate, yellowish. Hairs on stem vein and base of costa black. Legs as in female, but darker, the hairs longer, especially on the fore femora and posterior margins of the hind legs. Abdomen opaque black with silvery pollinose patches on the sides; basal fringe dark-brown to black, other pilosity pale, rather long; none of the tergal plates greatly reduced; only the second sternite entirely membranous. Genitalia (Plate XIV, figs.1-3): side-piece longer than wide, conical; clasper shorter than side-piece, obliquely truncate, with three terminal teeth. Adminiculum broad, convex above, emarginate below; rather weakly chitinized, hirsute, basal prongs abbreviated. Adminiculum arms chitinous, laterally expanded; inner margin with elongate teeth.

Pupa (Plate XXVI, fig.1).— Length 3-5 mm.; the respiratory filaments about three-fourths that of the pupa. The respiratory tuft consists of a short main trunk which gives rise to eight branches, each again dividing to produce sixteen filaments in all. The cocoon is of the usual wall-pocket type.

Notes.— This blackfly is one of the most common species in the Ottawa district, both in Ontario and Quebec, and occurs in many of the smaller rivers and streams in that area, often in great abundance, and usually associated with Simulium venustum. It attacks domestic animals, particularly horses, and occasionally

man. There are two or three generations a year, the broods overlapping, so that during the summer months all stages may commonly be found together. I have collected pupae as early as April 12, and as late as the end of September. The winter is spent in the larval stage. Larvae taken from a small stream by breaking through the covering of ice and snow, on Dec.15, 1931, were mostly well-grown, although some were barely one-third grown. In all of them the histoblasts were undeveloped. Despite the low temperature they were feeding, as was evidenced by an examination of the gut contents.

The eggs and mature larvae of vittatum are shown on Plate XXII, fig.1, and Plate XXIII, fig.2. The pupae and cocoons are depicted on Plate XXVI, fig.1.

Distribution.— S. vittatum is extremely widely distributed over North America, from Mexico to the Arctic, and from the Atlantic to the Pacific. It is a common species in Europe where it was originally described, probably from Lapland; it also occurs in Greenland. I have found the immature stages in most of the rivers and streams in the Ottawa district, wherever blackflies develop, and have reared adults of both sexes from pupae taken from streams in the wooded Gatineau hills, in Quebec, and in the more level country in Ontario, south of the Ottawa river. In addition, there are specimens in the National Collection from the following localities in Ontario: Nipigon, 1.VII.23 (N.K. Bigelow); Biscotasing, 9.VII.30 (K.E. Schedl); Dundonald ("in horse's ear") 27.VIII.00; Trenton, 20.VI.01 (Evans); Strathroy (attacking horses and cows), 22.VIII.32,

(H.F. Hudson); Toronto, 27.VII.28 (C.R. Twinn); Algonquin Park, 18.V.32 (C.R. Twinn). W.J. Brown collected seven females at Lake Harbour, Baffin Island, August 9-14, 1935.

Simulium (Simulium) pictipes Hagen

Simulium pictipes Hagen, Proc. Bos. Soc. Nat. Hist., 20:305, 1879.
Simulium innoxium Comstock, Manual for the Study of Insects, p.452, 1895.

Female.— Closely allied to vittatum Zetterstedt, from which it may be separated by the following characters: length, 3-4 mm.; thorax with three mesonotal vittae; upright hairs on the scutellum and the hairs on the stem vein of the wing black; lower surface of the sub-costa with a row of fine hairs; abdomen darker, the opaque black markings on the dorsum undivided. Genitalia (Plate XV, figs.4, 5): ovipositor valves narrow, thin, membranous. Anal lobe scarcely larger than cercus, rounded quadrate, broadly conical ventrally; chitinized, especially along anterior margin, a group of spicules anterior to this; ventral and posterior margins setulose. Cercus rounded quadrangular, wider than long, setose. Arms of genital rod triangularly divaricate, the apical expanded portions chitinized and singly toothed.

Male.— Similar to male of vittatum Zett., but larger; two basal joints of antenna brownish; palpi about one-third longer than antenna; logs generally darker, base of hind tibiae not broadly pale; abdominal basal fringe paler, yellowish-brown; sub-costa bare. Genitalia (Plate XV, figs.1-3): side-

piece quadrate, outer apical angle produced; clasper longer than side-piece, rounded and somewhat constricted at middle, without terminal tooth. Adminiculum weakly chitinized, nearly twice as wide as long, broadly and deeply cleft mesially, minutely hirsute; basal prongs more strongly chitinized, tapering. Adminiculum arms with a few long, pointed teeth; lateral plates broad.

Pupa.— Length 3.5 - 5 mm. The respiratory tuft is about two-fifths as long as the pupa, and consists of nine rather stout filaments, eight of them arranged in pairs on very short stalks and the ninth arising directly from the short main trunk. The cocoons are boot-shaped, with open weave, and the anterior margin not thickened. The pupa and its respiratory filaments lie concealed within the cocoon.

Notes.— I have found the immature stages of this species only in very swift water such as in, or just below, waterfalls. Masses of the pupae and large numbers of the distinctive black larvae, in various stages, were discovered under the cascading water on the steep rock face of a waterfall of the Blanche river (Plate XXVII, fig.2), at Perkins Mills, Que., on August 24, 1932. Egg masses were also plentiful in the shallow water along the sides of the falls in places where the rock was continually wetted by the spray, or by the intermittent rise and fall of the water level. Adults were flying above the falls; specimens captured were all males. Again, on July 26, 1935 (9-10 a.m.), large numbers of males were seen and many netted at the foot of another waterfall, several miles south of Perkins Mills (Plate XXVI, fig.2). These were in erratic flight from just above

the surface of the swift and broken water to a height of probably 15-20 feet.

Adults of both sexes were reared on July 26, 1935, from pupae taken with difficulty from the smooth rock surface beneath the tumultous waters of the falls of the Blanche river, at Perkins Mills; also from pupae found on August 2, 1935, in crevices in the masonry near the foot of a concrete dam in the Mississippi river, at Carleton Place, Ont. (Plate XXXI, fig.2).

Smart (47, p.62) who studied the biology of this species at Ithaca, N.Y., found that it passes through four (possibly five) generations in a year, the winter being passed in the larval stage. The number of generations annually is probably fewer in our more northern latitude. Malloch (28, p.57) states that the female will bite horses, and Jobbins-Pomeroy (37, p.6) records the removal of an engorged female from a mule's ear. Smart induced specimens in captivity to bite his arm. Apparently, however, it does not normally attack humans.

Distribution.— It has been recorded hitherto only from the Eastern United States. Malloch (28, p.56) and Dyar and Shannon (5, p.28) list records from New York, Maryland, District of Columbia, Virginia, South Carolina, Indiana and Minnesota. My records are all from the Ottawa district including rearings and collections at Carleton Place, Ont., and Perkins Mills, Que. There are two specimens in the National Collection labelled Ottawa, 30.VII.12 (Beaulieu) and 7.VIII.23 (C.H. Curran). Its distribution in Eastern Canada is probably much wider than indicated by these records.

Simulium (Simulium) venustum Say

Simulium venustum Say, Journ. Acad. Sci. Phila. 3:28, 1823.

Simulium molestum Harris, Ins. Injur. to Veg., ed. 3:601, 1862.

Simulium piscicidium Riley, Amer. Ent. 2:367, 1870.

Simulium irritatum Lugger, 2nd. Rep. Ent. Minn. p.177, 1896.

Simulium minutum Lugger, ibid.

Simulium jenningsi Malloch (part), U. S. Dept. Agr. Bur. Ent. Tech. Ser. No.26, p.41, 1914.

Simulium austeni Edwards, Bull. Ent. Res. 6:33, 1915.

Simulium rileyana Enderlein, Konowia, 1:75, 1922.

Female.— Length, 2 - 2.5 mm.; wing, 2.5 - 3 mm. Head: black; front glossy black with slight white pollinosity, as broad at vertex as clypeus; clypeus opaque white pollinose, as broad as long; antenna 11-jointed, black, basal joints reddish-brown; palpi about as long as antennae. Thorax: shining black, the mesonotum with whitish to brownish pollinosity, strongest at the margins, also on the pleurae; pubescence short, fine, yellowish; scutellum dark-brown, with a few recumbent pale scales and numerous upright brown to black hairs; postnotum bare, shining pollinose, a narrow silvery band along the anterior margin; pleural tuft pale. Wings: hairs on the stem vein and base of costa pale; remainder pale to dark, those on costa and a row on the outer part of radial vein mixed with spinules; subcosta with a row of hairs on lower surface, terminating before apex; radius bare between stem vein and base of radial sector; the sector simple, reaching the costa close to tip of radial

vein, lower surface with a row of hairs; basal cell absent; halteres pale yellowish, the base of stem black. Legs: largely yellowish with darker areas, notably the mid and hind coxae, the tibiae apically, the fore tarsi and terminal joints of mid and hind tarsi; all tibiae silvered on dorsal surfaces; pillosity pale to dark, moderate; fore tarsi flattened; hind basitarsus approximately 6 x 1 and two-thirds width of tibia; calcipala and pedisulcus present; claws simple. Abdomen: basal fringe pale yellow, general pubescence short, sparse, brown; segments three to five opaque velvet black; second segment silvery at the sides; remaining segments dark-brown to black, shining; tergal plates of segments three to five greatly reduced in width; sternites of all but the terminal segments membranous. Genitalia (Plate XVI, figs.3, 5): valves small, broader than long, truncate, minutely setulose, and with a group of setae; membranous, weakly chitinized medially. Anal lobe dorsally one-half as long as cercus, increasing in length ventrally and truncately produced; setose throughout. Cercus rounded distally; evenly setose. Arms of genital rod divaricate, the more thickly chitinized expanded portions each with a broad, blunt tooth, and irregular ventral margin.

Male.— Mesonotum opaque black, with a posterior and lateral marginal band of light-reflecting silver-grey pollinosity, most conspicuous anteriorly where it forms two backward and inwardly directed silvery striped which stop short of the middle of the disk; pubescence yellowish-brown; pleural tuft black. Hairs on stem vein and other hairs black; sub-costa bare. Legs black;

basal half of anterior tibiae yellowish, dorsal surface with a white pollinose patch; mid and hind tibiae yellow narrowly at bases, the dorsal surfaces faintly white pollinose and pale haired; fore coxae, base of mid basitarsus and bases of hind basitarsus and second joint, yellow; fore coxae with white pollinose dusting; hind tibia and basitarsus slightly inflated; basitarsus about 5 x 1 and two-thirds width of tibia. Abdomen opaque black, with more or less conspicuous ventro-lateral pearlaceous pollinose markings on segments two, six and seven; basal fringe and other pubescence dark-brown to black; tergal plates not greatly reduced; second sternite membranous, others with small chitinized plates. Genitalia (Plate XVI, figs.1, 2, 4): side-piece rounded quadrate, wider than long, setae rather numerous. Clasper about twice as long as side-piece; stout, rounded, slightly constricted beyond the middle, a small basal projection on inner side, a spine at tip. Adminiculum stout, quadrate, strongly chitinized; basal prongs divaricate, incurved near tips. Adminiculum arms with numerous long teeth mixed with fimbriae; widening, angled, and broad at base.

Pupa.— Variable in size; respiratory tuft about one-half as long as the pupa, and consisting of six filaments arranged in three pairs on short stalks held in the vertical plane, the stalks sub-equal and somewhat variable in length. The cocoon is of the usual wall-pocket type, closely woven, with a thickened anterior margin (Plate XXV, fig.2). The pupa and other immature stages have been described and figured by several authors including Malloch (28), Jobbins-Pomeroy (37), Edwards (7), Puri (40), and Johannsen (22, 23).

Notes.— S. venustum is probably the most common and abundant species in the Ottawa district, on both sides of the Ottawa river, in Ontario and Quebec. It is found in all types of bodies of running water, permanent and temporary; in rivers, streams, rills and drainage ditches. Figures of such breeding places are shown in Plates XXVII - XXXV. The immature stages commonly occur in association with other species attached to rocks, stones, aquatic plants, logs, debris, and other obstructions in the water. The larvae are often found in remarkable numbers: 734 in various stages of development were counted on an area of approximately one square inch on a submerged tree branch in Cranberry creek, Algonquin Park, on May 18, 1932; another count on a similar area revealed 742. The adult flies are found on the wing from May to October, but occur in greatest numbers in June and early July. There are probably three or four generations of the flies in a year; the various generations overlap, and during the summer all stages may be found together. The winter is passed in the larval stage. The eggs are illustrated on Plate XXII, fig.2, and the cocoons and pupal skins on Plate XXV, fig.2. This species is a troublesome pest of animals and man, and serves as the intermediate host of a protozoon blood parasite of ducks, Leucocytozoon anatis Wickware, as recorded by O'Roke (33). O'Roke found that this parasite caused a mortality rate of from 10 to 100 per cent in ducklings, but for adult ducks less than one per cent. The disease is common in Canada as I have recorded elsewhere (53).

Distribution.— S. venustum occurs in Europe and throughout North America. It has been taken in many localities in every province in Canada. A detailed account of its distribution in the Dominion was published in 1933 (53), and need not be repeated here.

Simulium (Simulium) perissum Dyar and Shannon

Simulium perissum Dyar and Shannon, Proc. U. S. Nat. Mus., Vol.69, Art.10, p.43, 1927.

Simulium jenningsi Malloch (part), U. S. Dept. Agr. Bur. Ent. Tech. Ser. No.26, p.42, 1914.

Dyar and Shannon confined their description of perissum almost entirely to the genitalia of both sexes. Among adults of venustum reared from pupae collected in the Jock river, near Ottawa, Ont.,on May 12, 1935, I found a male and female with genitalia which appear identical with those described and figured for perissum. The only external characters mentioned by Dyar and Shannon are contained in the statement quoted as follows: "A medium sized species, very close to venustum and very difficult to separate from the typical form. It is somewhat darker, with evidence of three mesonotal vittae; the stem vein is black pilose." I can find no trace of mesonotal vittae in my specimens. They differ from venustum as follows.

Female.— Somewhat darker; the antennae black, with basal joints faintly reddish; front sharply narrowed from vertex to base of antennae, sides strongly divergent; pleural tuft black;

hairs on stem vein and base of costa black. Genitalia (Plate XVII, figs.2, 3): ovipositor valves broader than long, remote at tips; membranous, weakly chitinized along inner margins; minutely setulose, with one or two fine setae basally. Anal lobe with rather broad median area; moderately and irregularly setose. Cercus distally rounded; evenly setose. Arms of genital rod divaricate; the thickly chitinized part of outward expansions with a long basal tooth and irregular margin.

Male.— Generally darker in appearance than venustum; pollinose areas less conspicuous; legs almost entirely black, the pale portions of the hind tarsal joints indistinct; hind legs much inflated, the hind basitarsus slightly more than 3 x 1, and three-fourths the width of tibia. Genitalia (Plate XVII, fig.1): side-piece rounded quadrate, broader than long; setose only on distal margin. Clasoers twice as long as side-piece, with an inward, basal, spinose projection, and a slender terminal tooth. Adminiculum strongly chitinized, sub-quadrate, wider than long, apically emarginate, denticulate; basal prongs stout, divaricate, truncated. Adminiculum arms with long close teeth mixed with fimbriae; moderately broad basally.

Pupa.— The species was reared from a collection of pupae with six resporatory filaments thought to be venustum. Both species emerged from these pupae. It will probably be necessary to rear perissum from isolated pupae to establish the presence of specific differences in the latter, if such are present.

Notes.— Two females and six males emerged with numerous adults of venustum on May 14-16, 1935, from pupae collected on submerged stones, tufts of grass and twigs in the Jock river, Ont. (Plate XVI, fig.1), at a point about ten miles from Ottawa, where it enters the Rideau river. The Jock river is shallow and has a rocky bed thickly strewn with rocks and boulders. During the summer it often largely dries up in places, but in early May it was flowing swiftly over the algae-covered rocks. The temperature of the water was 62° F. I failed to find specimens among the adults of venustum reared from eight other rivers and streams in the Ottawa district.

Distribution.— Jock river, near Ottawa, Ont. Dyar and Shannon (5, p.44) recorded the species from Maryland, South Carolina and Virginia.

Simulium (Simulium) fibrinflatum new species

Female.— Length about 2 mm.; wing, 2.5 mm.; closely allied to venustum Say, from which it differs as follows: palpi distinctly longer than antennae (possibly variable); pollinosity much less thickly dusted on front and mesonotum, the integument showing through glossy black, that on the pleurae more silvery; pleural tuft black; hairs on stem vein and base of costa black; sub-costa bare; the pollinose patches on the dorsal surfaces of all tibiae more conspicuous, silvery; terminal abdominal segments glossy black. Genitalia (Plate XVIII, figs.2, 3): ovipositor valves short, wider than long, weakly chitinized, setose, blunt tips remote. Upper part of

anal lobe short, expanding medially to twice the length of cercus; narrowing, bluntly rounded, and slightly produced ventrally; rather sparsely setose along posterior margin and on ventral portion. Cercus rounded quadrate; setose. Genital rod similar to venustum, but the tooth on chitinized expanded portion of arms longer, more slender, bluntly pointed.

Male.— Similar to venustum, but with the following differences: pollinose band on margins of mesothorax and extending backward on disk more brilliant, iridescent anteriorly, and pearlaceous posteriorly; radial sector of wing bare of hairs except sparsely apically where it joins costa; legs paler, scarcely darker than in female: fore coxae, trochanters, femora except at apices, and the basal portions of first and second joints of mid and hind tarsi, yellow, elsewhere black; the pollinose patches on dorsal surfaces of fore tibiae and bases of mid and hind tibiae conspicuous, silvery; joints of hind legs similar to female, none inflated. Genitalia (Plate XVIII, figs.1, 2, 4): side-piece rounded quadrate, wider than long; clasper twice as long as side-piece, stout, somewhat swollen near base, a spine at tip. Adminiculum tooth-like, one-fourth longer than broad, strongly chitinized, especially the margins and basal prongs; hirsute medially; upper margin laterally denticulate; basal prongs stout, moderately divaricate, each with a short, posterior curved, sub-basal arm. Adminiculum arms with an open row of long pointed teeth against a strigate membrane; more or less pocket-shaped laterally, strigate, the inner margin more thickly chitinized.

Holotype.— Male, Ottawa, Ont., 17.VIII.35 (reared).
Can. Nat. Coll.

Allotype.— Female, same data.

Paratypes.— 14 females, 19 males, 23-25.VII. and 17-19.VIII.35 (reared).

Pupa.— Length about 3 mm.; the respiratory tuft about one-fourth as long as the pupae; the filaments in the tuft six in number, short, stout, inflated, with the appearance of a cluster of minute, semi-transparent, sausage-shaped balloons, almost sessile, branching off in the vertical plane from a short base. Cocoon about 3.5 mm. (Plate XXV, fig.1), somewhat slipper-shaped, rather closely woven, with a narrow, elongate-oval, window-like aperture in each side near the anterior border. The pupa lies completely within the cocoon, the respiratory tufts opposite the "windows".

Notes.— The characteristic pupae were found for the first time on July 22, 1935, in the Remic rapids (Plate XXVIII, fig. 2), of the Ottawa river, at Cunningham island. The exact location (not shown in illustration) was a narrow channel dividing the east end of the island from a tiny islet through which the shallow water was rushing at a speed of about five feet per second, over a shale-rock bottom. The temperature of the water was 76° F. The infestation was largely confined to the submerged branches and leaves of sweet gale, a shrub growing in profusion along the margins of the channel, and was mixed with two other species, nigroparvum and venustum, the former predominent. Large numbers of the three species had

emerged, as was revealed by the empty pupal skins. Observations had been made at this point at intervals during the spring and summer, and on the most recent visit (July 3) no pupae of fibrinflatum were seen, although it is probable the species was present in the larval stage. On August 16, fibrinflatum predominated to a striking extent, only occasional pupae of nigroparvum and venustum being found. The speed of the water had dropped to about 3.5 feet per second, and the temperature was unchanged. On August 29, the infestation consisted chiefly of larvae of the three species; a rare pupa was found on Sept. 13 (water temperature 64° F.), and none at all on Sept.30 (water temperature 56° F.), the date of the last visit, when only very young larvae were found. Numbers of adults of both sexes were reared from the pupae collected on July 22 and August 16.

Simulium (Simulium) nigroparvum new species

Simulium venustum var. jenningsi Twinn (not Malloch), Can. Ent. Vol. LXV, p.3, 1933.

Female.— Average length 1.6 mm.; wing, 2.3 mm. A very small, glossy black species, similar to venustum in all other respects except as follows: general pollinosity less opaque; front glossy black; clypeus greyish pollinose, sub-opaque; mesonotum glossy black with faint greyish pollinosity, strongest at the margins; pubescence yellowish-brown, rather sparse, scattered, hairlike; scutellum black, marginal hairs black, recumbent pale scales absent; pleural tuft black; hairs on

stem vein variable, yellow, bronzy-brown or black, or the pale and dark hairs intermixed; sub-costa bare; terminal abdominal segments darker and more glossy. Genitalia (Plate XIX, figs.3, 5): ovipositor valves small, remote, weakly chitinized; setose, especially on the inner margins, which are also somewhat embrowned. Anal lobe triangular, the postero-ventral angle slightly produced posteriorly behind cercus; chitinized, moderately setose, the anterior part of basal margin clear. Cercus rounded quadrate, wider than long; setose. Arms of genital rod chitinized, roundly expanded, and with a long slender tooth.

Male.— Similar in size to female, but much darker. It differs from the male of venustum as follows: mesonotum opaque velvet-black, the marginal pollinose band which terminates on the disk, silvery or pearlaceous, somewhat iridescent anteriorly; pilosity dark-brown, almost black; radial sector bare, except close to the apical margin at the junction with the costa; legs predominently black, the pollinose patches on tibiae silvery; hind basitarsis about 6 x 1, and three-fifths the width of tibia. Genitalia (Plate XIX, figs.1, 2, 4): similar to fibrinflatum. Side-piece rounded quadrate, wider than long; clasper twice as long as side-piece, a slender spine at tip. Adminiculum tooth-like, twice as long as broad, densely chitinized, centrally paler, strigate; upper margin denticulate; basal prongs stout, divaricate, truncate, each with a posterior sub-basal arm. Adminiculum arms with several long slender teeth mixed with fimbriae; lateral plates broad, darkly strigate.

Holotype.— Female, Ottawa, Ont., 10.VI.35 (reared).
Can. Nat. Coll.

Allotype.— Male, same data.

Paratypes.— 7 females, 9 males, Ottawa (Remic rapids), 10-18.VI.35; 1 female, 5 males, near Perkins Mills, Que. (Blanche river) 13.VI.35 and 1 male 26.VII.35; 2 females, 3 males, Ottawa (Rideau river), 6-7.VI.35. All reared from pupae.

Pupa.— Average length 2.5 mm. Respiratory tuft about one-fourth the length of the pupa, consisting of ten filaments. These are arranged as follows: two main trunks arise in approximately the same plane (vertical) from a short base; the lower trunk bears two branches each of which gives rise to three filaments, a single filament basally and a pair distally; the upper branch divides twice near the base to form two pairs of filaments, thus making ten in all. The cocoon (Plate XXV, fig.1) measures about 3 mm., and is similar to that of fibrinflatum, slipper-shaped, with a "window" anteriorly on each side.

Synonymy.— Johannsen (22, p.381) described a species of blackfly under the name S. venustum var. a, which was reared from larvae and pupae with ten respiratory filaments taken from Fall creek, Ithaca, N.Y. The adults were 1.5 mm. long, with the terminal abdominal segments shining black. Johannsen's figure of the pupa shows the arrangement of the respiratory filaments different from that of my specimens. The submentum of the larva of nigroparvum, however, is similar to that of

Johannsen's var. a, and has the ventral setae three in one marginal row and four in the other. Malloch (28, p.42) in describing jenningsi mentioned that among the material were adults reared from pupae at Friersons Mill, La., which were in all probability the species described by Johannsen. This seems doubtful, as Jobbins-Pomeroy (37, p.24) described and figured the pupa of jenningsi as having eight respiratory filaments: these pupae were determined from adults reared from them and compared with the type. Moreover, Dyar and Shannon (5, pp.34, 43, 45), after examining Malloch's material in the United States National Museum, showed jenningsi to be a composite species made up of venustum Say, slossonae D.& S., and perissum D.& S. My material is specifically distinct from all of these. The species erroneously recorded by me (53, p.3) as venustum var. jenningsi Malloch, from the Remic rapids of the Ottawa river, is nigroparvum.

Notes.— Pupae and larvae of nigroparvum were first found in the Remic rapids (Plate XXVIII, fig.2), of the Ottawa river, close to the river bank on the Quebec side, near Hull, on June 25, 1931, attached to a round, smooth pole caught among the rocks in the rapids. They were next found with larvae in the same rapids on Sept.16, 1932, on leaves and twigs of sweet gale growing on the eastern shore of Cunningham island, and hanging in the fast-running water. Numerous adults of both sexes emerged within a day or two from specimens placed in a sealer.

During 1935, visits were made to the Remic rapids twice or thrice a month from late April to the end of September.

Recently transformed pupae were found on slabs of shale in the rapids on June 6 (water temperature 63° F.), and adults emerged from these, June 8-10.VI. By June 14, large numbers of empty pupal skins of this species were observed in the river; many pupae were collected and several score that emerged were preserved in alcohol. The pupae again began to appear early in July, and by July 22 (water temperature 76° F.) empty pupal skins predominated and may have marked the end of the second generation. A few pupae were found with those of venustum and fibrinflatum during visits on August 2 and 16. On August 29 (water temperature 70° F.), S. nigroparvum predominated in numbers over the other two species, but the pupae were not very abundant: on Sept.13, only one pupa was found after a 40-minute search; on Sept.30 (water temperature 56° F.) very young larvae, the species of which was not determined, were quite numerous, but no mature larvae or pupae could be found. It would seem from these observations that there are at most three generations of nigroparvum annually in the Ottawa region, the winter probably being spent in the immature larval stage.

Adult flies were also secured from pupae collected in the Hog's Back rapids of the Rideau river (Plate XXIX) near Ottawa, Ont., June 5, 1935, and from submerged stones and grasses in the rapids of the Blanche river (Plate XXVIII, fig.1), south of Perkins Mills, Que., on June 12, July 26 and August 18, 1935.

Simulium (Simulium) ottawaense new species

Female.— Length, 2-3 mm.; wing, 2.8 - 3.5 mm. Very close to venustum and rather difficult to distinguish from it: somewhat larger and more robust than my specimens of venustum; front opaque greyish pollinose; the pale hairs on stem vein intermixed with a few dark hairs (one specimen with these hairs largely dark); terminal abdominal segments greyish-black, sub-opaque. Genitalia (Plate XX, figs.4, 5): ovipositor valves conical, about as long as wide at base; weakly chitinized on inner margins; even setose. Anal lobe dorsally about one-third length of cercus, expanding to twice its length ventrally, broadly and roundly produced; bare on anterior margin, a few spicules below; elsewhere more or less evenly setose. Cercus rounded quadrate, a little wider than long; setose. Arms of genital rod moderately divaricate, angulate, outward expansions each with lower margin extended into a broad, long, roundly-pointed tooth.

Male.— Very similar to the male of venustum, but general appearance somewhat paler, the white pollinosity on the thorax more opaque, the legs less heavily chitinized (observable in cleared specimens). Genitalia (Plate XX, figs.1-3): side-piece rounded quadrate, nearly as long as wide, reinforced with a transverse bar of denser chitin as figured. Clasper broad, somewhat strap-shaped, a little more than one and one-half times as long as side-piece; a spine at tip. Adminiculum inverted Y-shaped, strongly chitinized; narrow, laterally compressed, with a rounded, setulose, posterior process or keel; basal arms

stout, oblique, truncated. Adminiculum arms held on a convex membrane; chitinized, slender medially, and with a row of rather numerous, close-set short to long teeth; broad laterally.

Pupa.— Length about 4 mm. The respiratory tuft consists of eight filaments, and is slightly more than one-half the length of the pupa. The respiratory filaments arise from a short main trunk: six are in pairs, one upper pair and two lower; two are unpaired. One of the unpaired filaments arises directly from the apex of the main trunk, the other from near the base of the upper stalk. The stalks bearing the two lower pairs of filaments are unequal in length, the upper being about one-half that of the lower. The cocoon is of the wall-pocket type; loosely woven, especially anteriorly, the anterior border not thickened to form a rim.

Holotype.— Male, Pinks lake, near Hull, Que., 26.VII.35 (reared from pupa). Can. Nat. Coll. (slide).

Allotype.— Female, Carleton Place, Ont., 7.VIII.35; other data as above.

Paratypes.— 7 females, 5 males (reared from pupae).

Notes.— The type material was reared from pupae collected in the Leamy creek close to its source, at Pinks lake, in the Gatineau hills, near Hull, Que., and in the Mississippi river, at Carleton Place, Ontario. In the Mississippi river (Plate XXXI, figs.1, 2) several pupae, and numerous larvae, were found (Aug.5) with vittatum on pieces of Myriophyllum entrapped in the fast-flowing water below a concrete dam in the town.

The temperature of the water was 73° F. Adults emerged, August 6-9. The Leamy creek, at Pinks lake, is a tiny stream flowing down a wooded hillside. The gradient is slight close to the lake where the collection was made, and the flow was only about one foot per second over the stone and debris-strewn bottom. The water temperature was 76° F. (July 24). Scattered pupae and pupal skins of vittatum and an occasional pupa of aureum were also present. Adults emerged on July 25-26. I have collected pupae of this species in late May and June from several streams in the Ottawa district, during recent years, but had not previously reared the adults. I also found them in the Madawaska river, Algonquin Park, Ontario, on June 30, 1931. The larvae and pupae usually occur in mixed infestations with venustum and vittatum.

Simulium (Simulium) corbis new species

Female.— Length about 2.2 mm.; wing, 3.4 mm. Close to venustum, and very similar in size, appearance and external characters, but differing as follows: antennae almost entirely black, the basal joints only faintly reddish; pubescence on front, vertex and mesonotum yellow, somewhat more scale-like; upright marginal hairs on scutellum pale yellow and black; hind basitarsus about 5 x 1; claws with a small but distinct, pointed, sub-basal tooth. Genitalia (Plate XXI, figs.2, 3): ovipositor valves about as long as wide, tips rounded; largely membranous, slightly embrowned on inner margins; minutely setulose; each with a median group of spicules. Anal lobe quadrate, rounded anteriorly; as long as ninth tergite, and one

and one-half times as wide as cercus (vertical width); minutely setulose; posterior third moderately setose; a group of tiny spicules antero-ventrally; dorsal and ventral margins each with a small, minutely spiculate, rounded protuberance. Cercus rounded quadrate, wider than long; setose. Arms of genital rod angled on lower margins; outward expanded portion more strongly chitinized, and with a broad, blunt tooth.

Male.— Similar in all respects to the male of venustum except as follows: pleural membrane reddish, tarsal joints of all legs entirely black; hind basitarsus about 4 x 1 and four-fifths width of tibia. Genitalia (Plate XXI, figs.1, 4, 5): side-piece and clasper similar to ottawaense; side-piece rounded quadrate, about as long as broad, a reinforcing chitinous bar present, but less distinct; claspers about one and one-half times as long as side-piece, broad, constricted slightly at middle, the setae on undersurface unusually long and stout; a slender spine at tip. Adminiculum narrow, strongly chitinized, inverted Y-shaped viewed dorsally; produced posteriorly into a flat, apically rounded process or keel, sparsely and minutely setulose on the sides, and marginally denticulate, the denticles backwardly directed sharply pointed, sub-equal; basal arms stout, oblique, truncated. Adminiculum arms on a supporting convex membrane, chitinized, and with a row of rather long teeth; the arms broadening and triangulate laterally.

Holotype.— Female, Blanche river, near Perkins Mills, Que. (reared). Can. Nat. Coll.

Allotype.— Male, same data.

Paratypes.— 10 females, 4 males, same data.

Pupa.— Length about 3.5 mm.; respiratory tuft approximately three-eighths as long as the pupa. Each tuft consists of ten filaments of about equal length and thickness, arising in sessile pairs from a short, common base, and held fanwise, all more or less in the vertical plane. The cocoon is slipper-shaped, about 5 mm. long; the posterior two-thirds rather closely woven: anterior to this portion, on each side, is an elongate opening next to the anterior border; extending beyond the border, except narrowly dorsally, and forming the cuff of the slipper is an interlacing network of filaments, like the ornamental rim of a basket. The pupa lies in the cocoon with the respiratory tufts protected by this basket-work extension, through the meshes of which the head and respiratory filaments are visible.

Notes.— The pupae were found on May 22, 1935, on submerged stems of dogwood growing close to the bank of the Blanche river, in the rapids, a short distance below a waterfall, five miles south of Perkins Mills, Que. (Plates XXVII, fig.1 and XXVIII, fig.1). The river was flowing swiftly over a stony bottom; the temperature of the water was 53° F. Pupae of venustum and quebecense occurred on stones nearby. Eighteen males and twelve females of corbis had emerged by May 26; several were damaged and preserved in alcohol-glycerine, the others pinned.

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Summary

Twenty-three species and one variety belonging to three subgenera of the family Simuliidae are recorded and described. Of these, twelve species and the variety are new to science. Only two of the remaining eleven species of other authors have been previously recorded in Eastern Canada; two others, originally described in Europe, are recorded in North America for the first time, and the hitherto unknown male of a fifth species is described. The adult forms and the pupae and cocoons of these species are described, and the genitalia of both sexes of flies are figured. In addition, notes on the habitats, distribution, species associations, and similar information of value in identifying the species are given. Keys to the subgenera and species, including both sexes of adults and the pupae are an important feature. The work is illustrated by 35 plates which include 119 separate drawings and photographs.

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Bibliography

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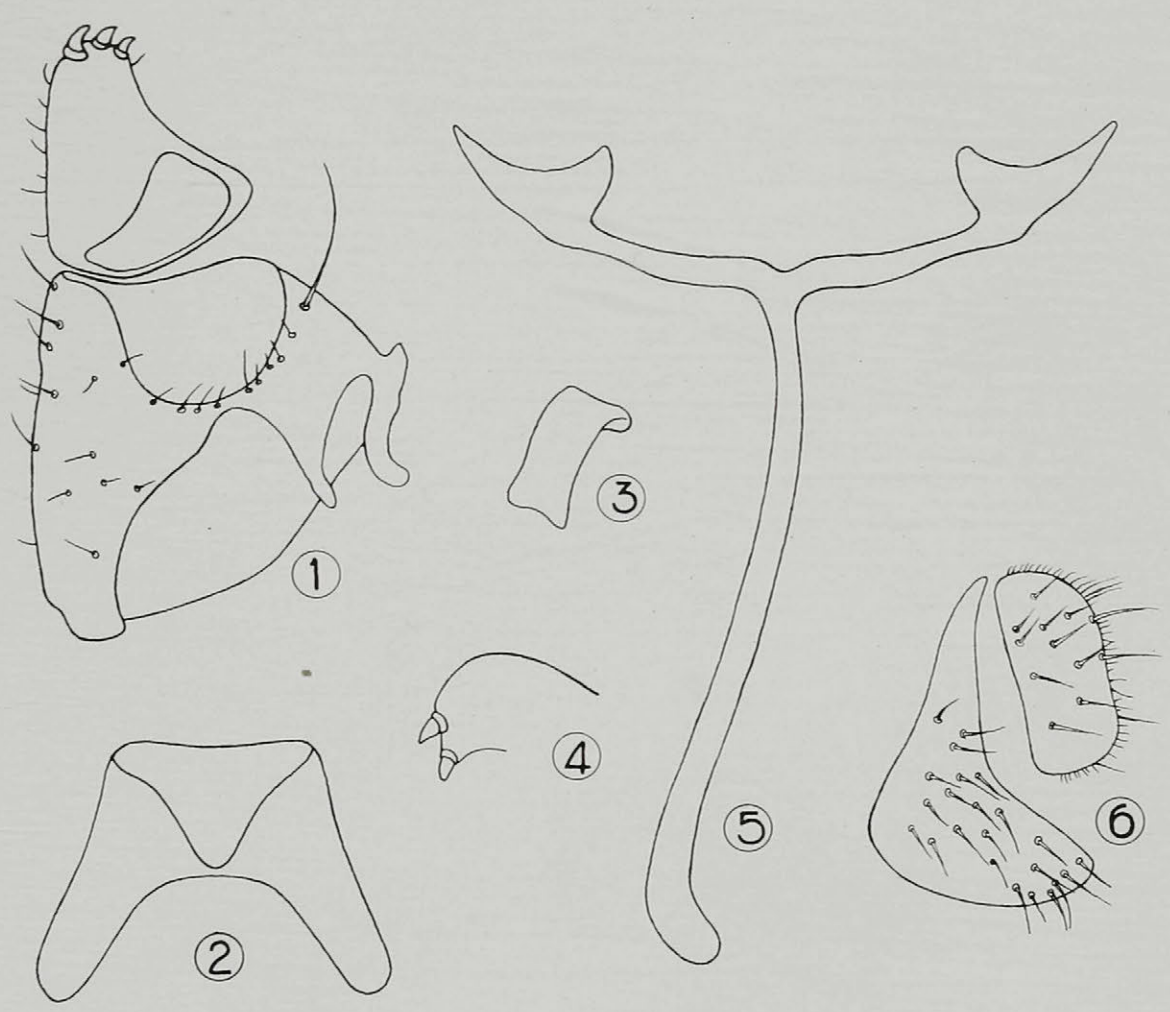

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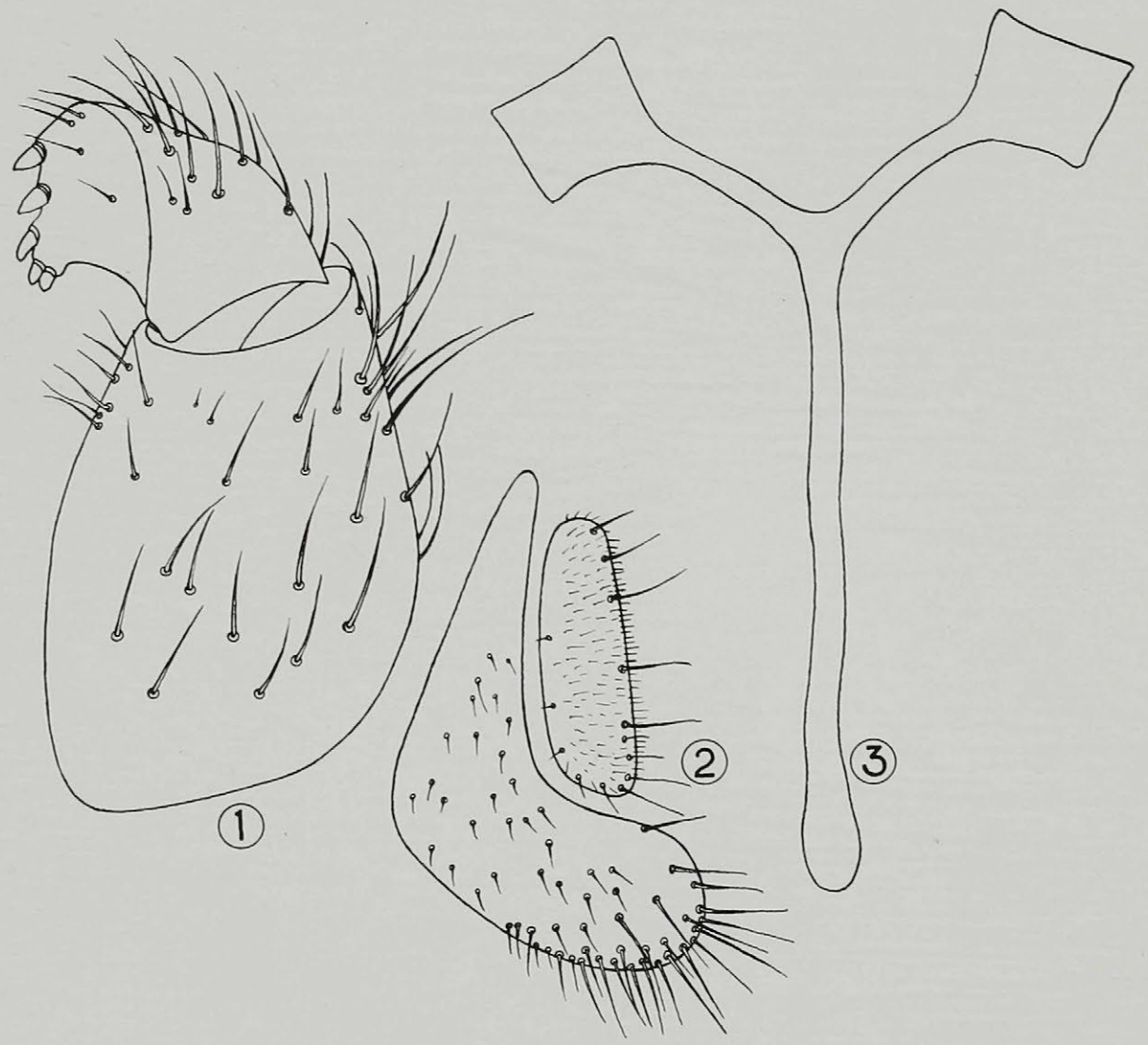
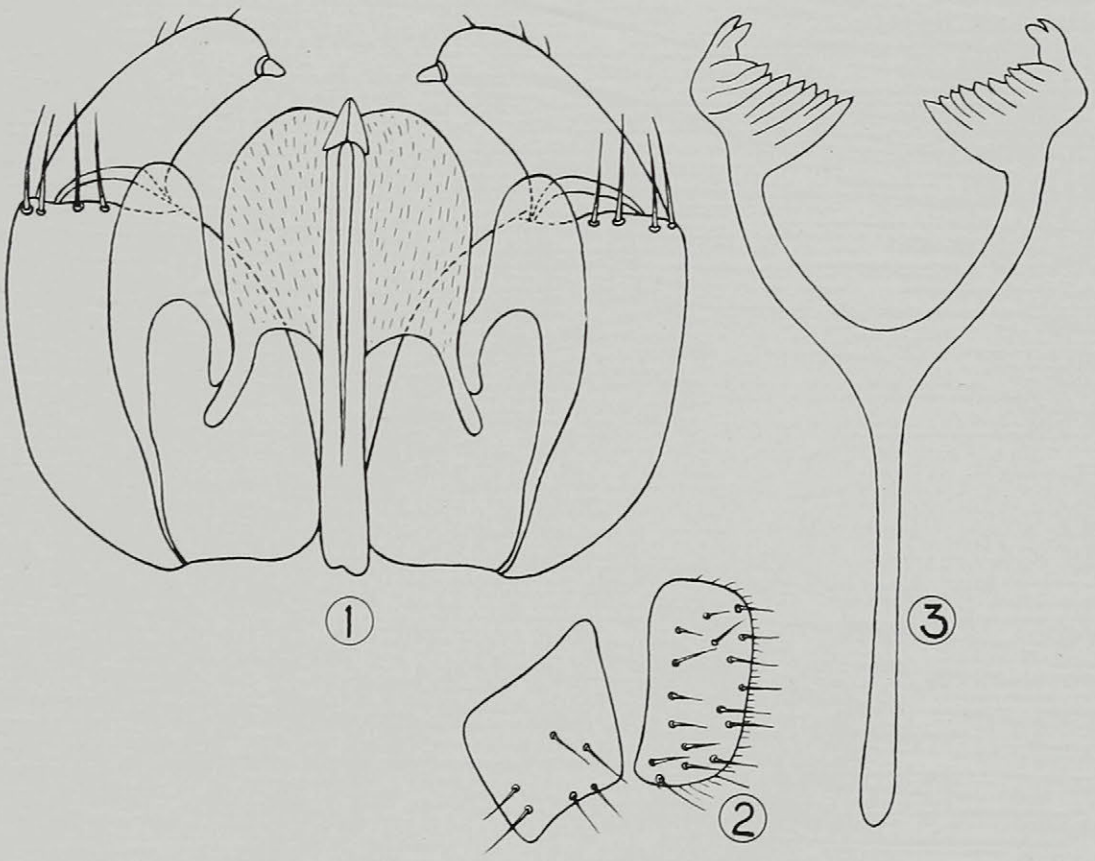


Parts of genitalia of Simulium (Prosimulium) multidentatum n.sp.: male (1) side-piece and clasper; female (2) anal lobe and cercus, (3) genital rod.



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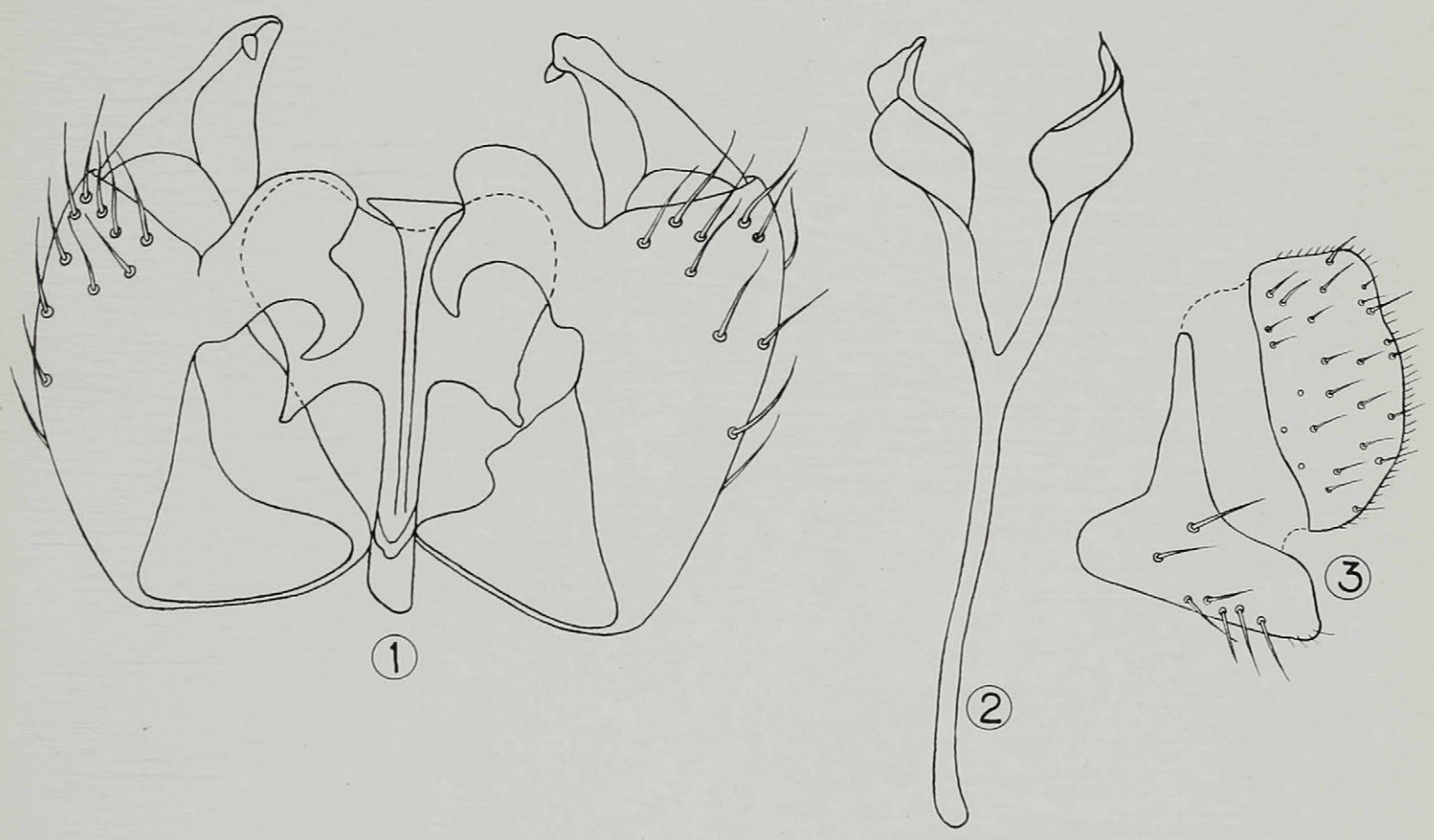

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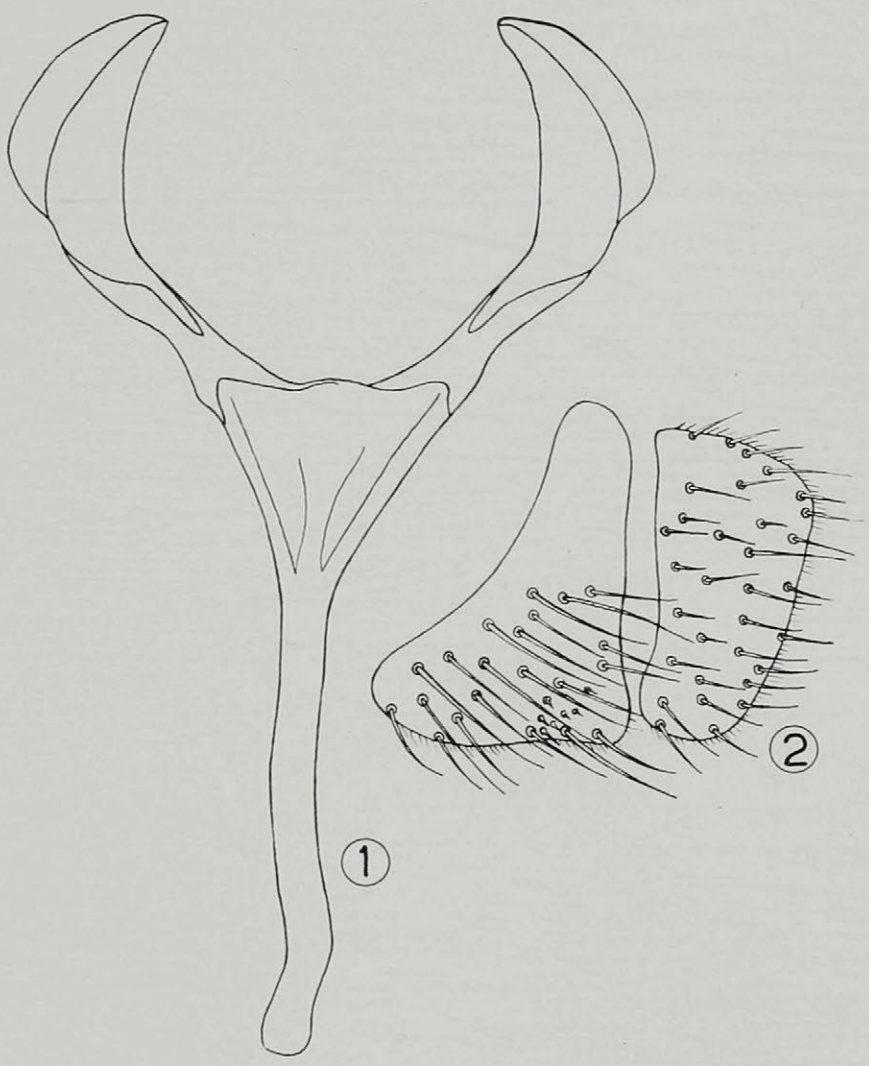

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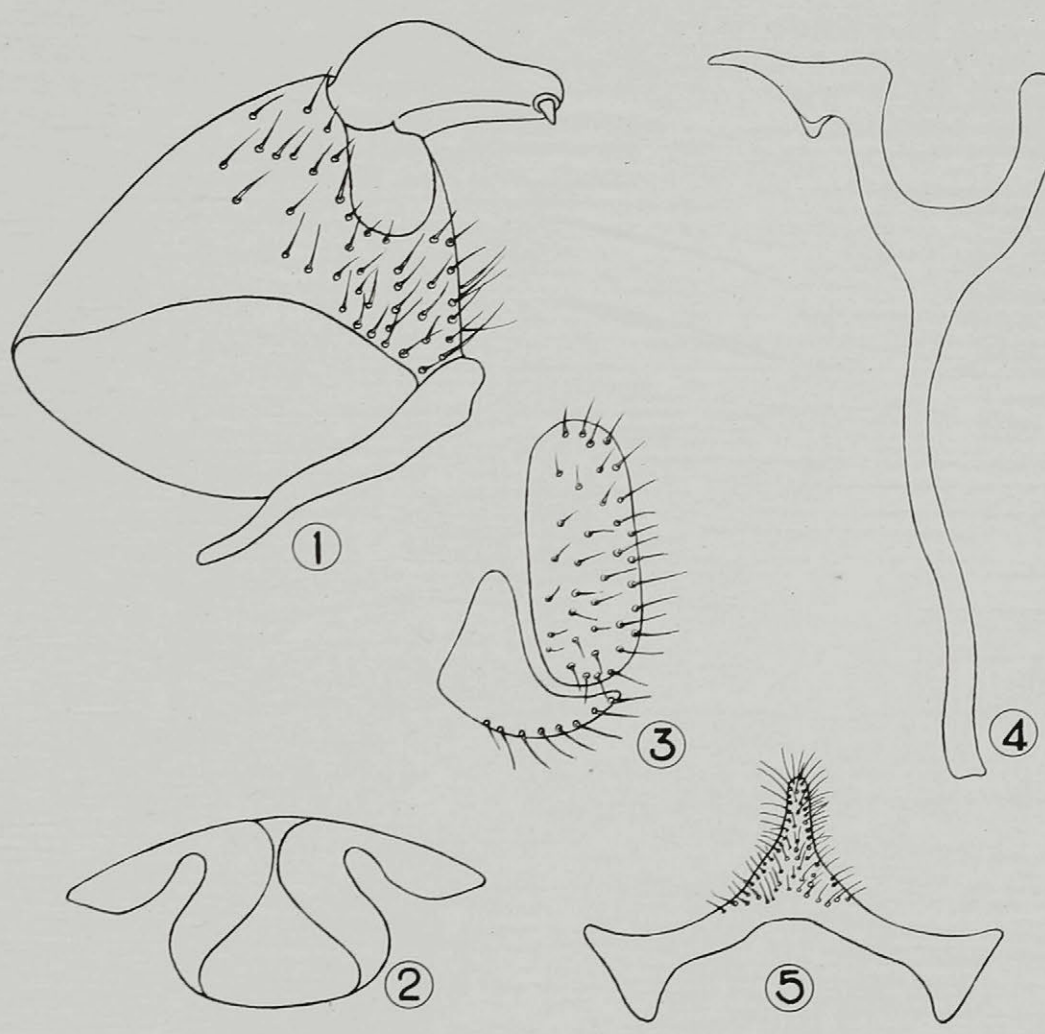

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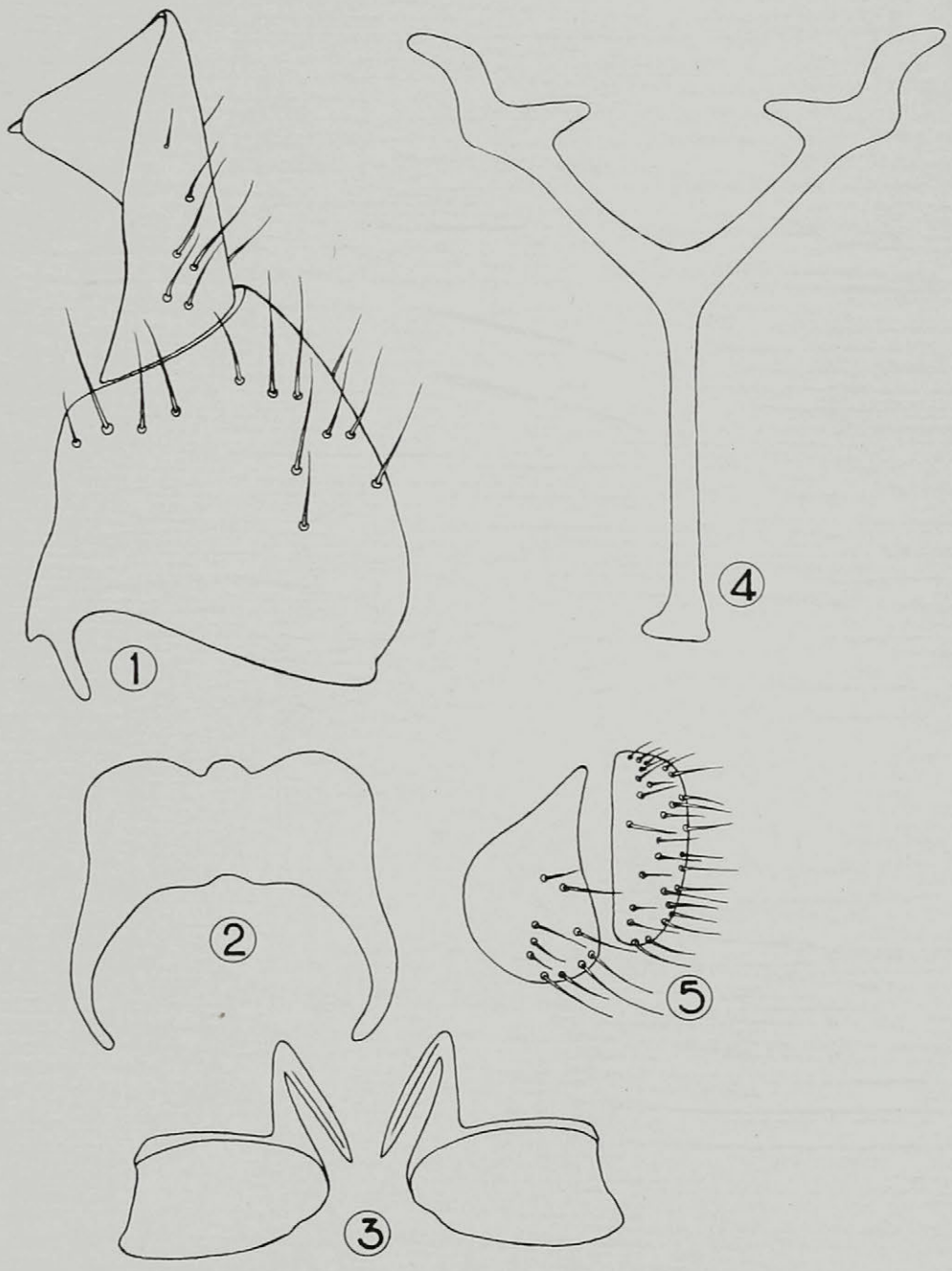

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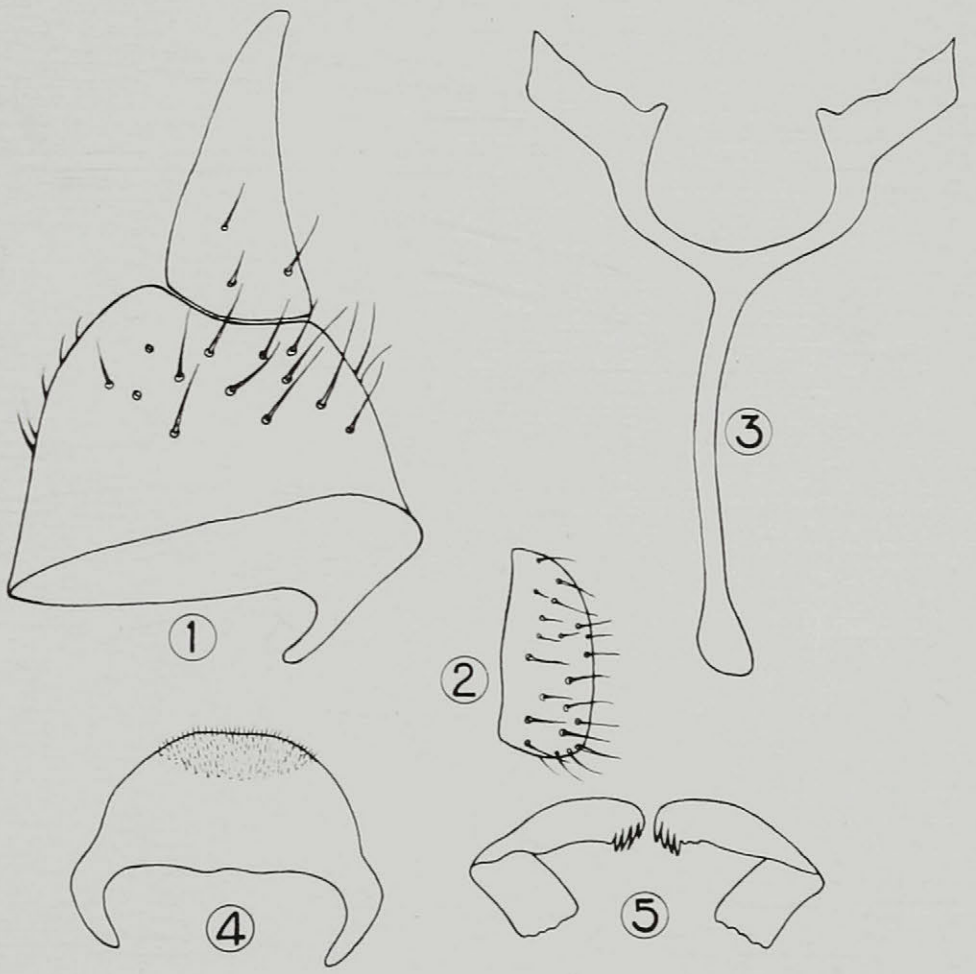
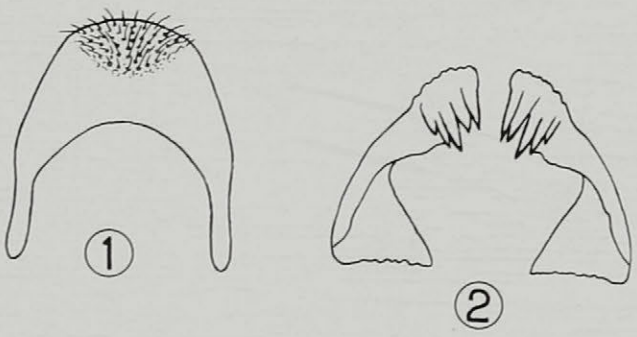
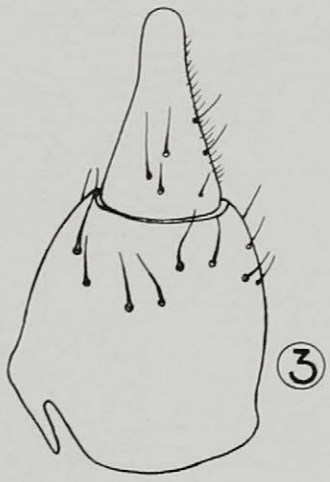
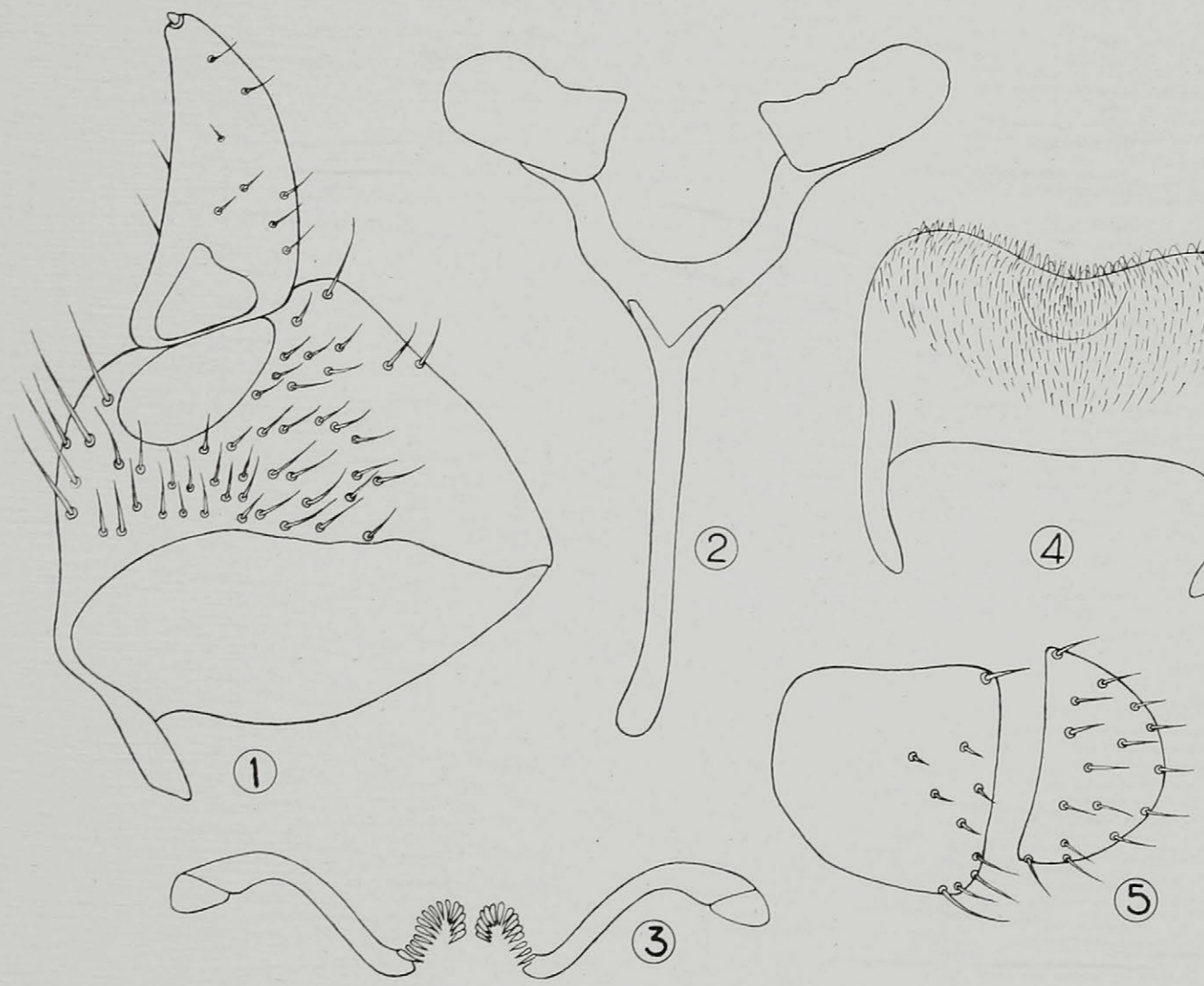


Parts of genitalia of Simulium (Eusimulium) subexcisum Edwards: male (1) side-piece and clasper, (4) adminiculum, (5) adminiculum arms; female (2) cercus, (3) genital rod.





Parts of male genitalia of Simulium (Eusimulium) rivuli n.sp.: (1) adminiculum, (2) adminiculum arms, (3) side-piece and clasper.



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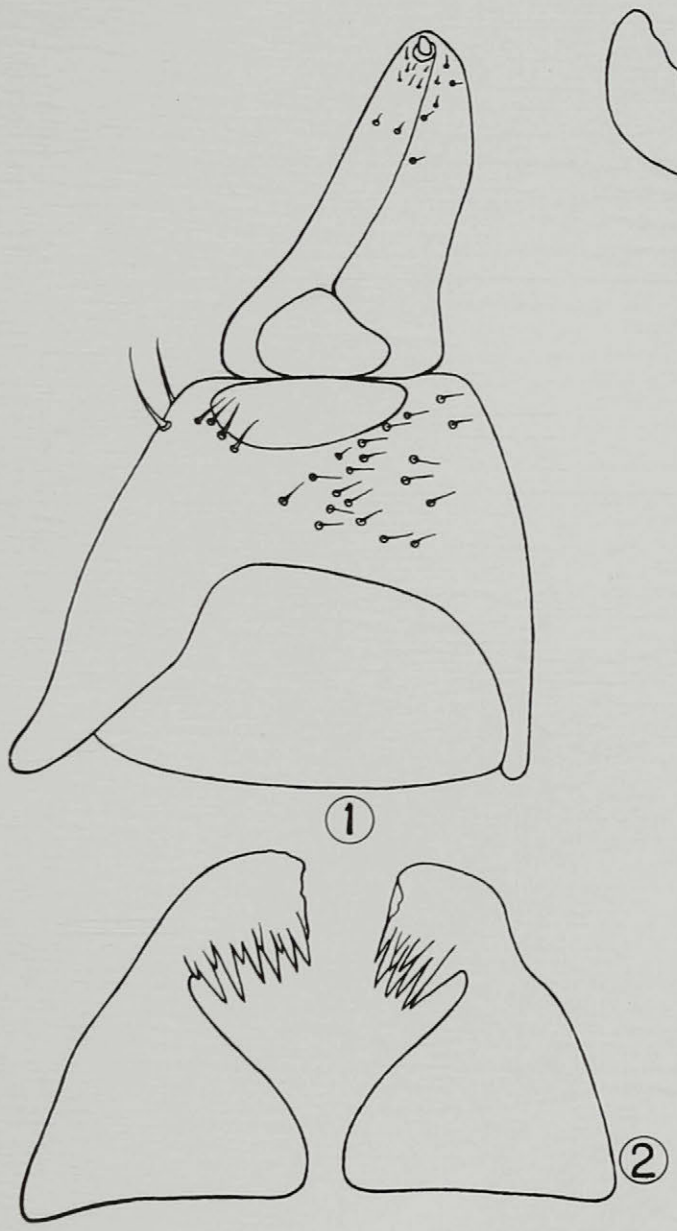
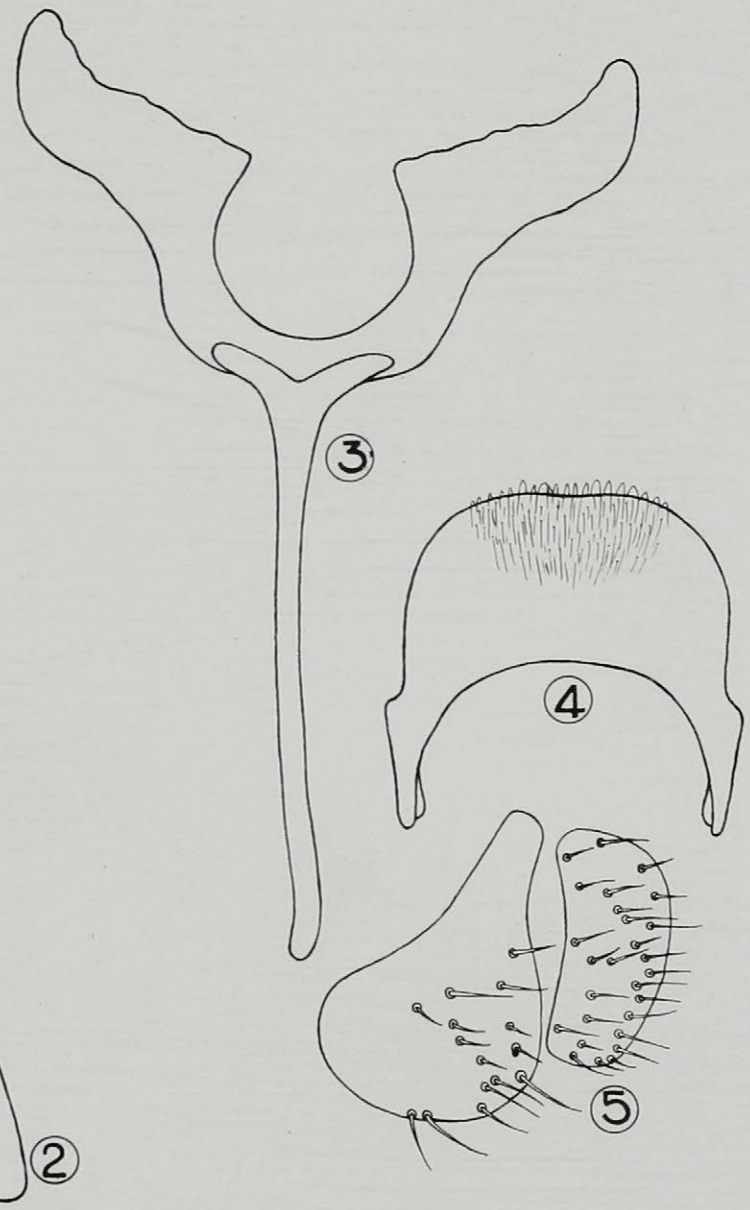
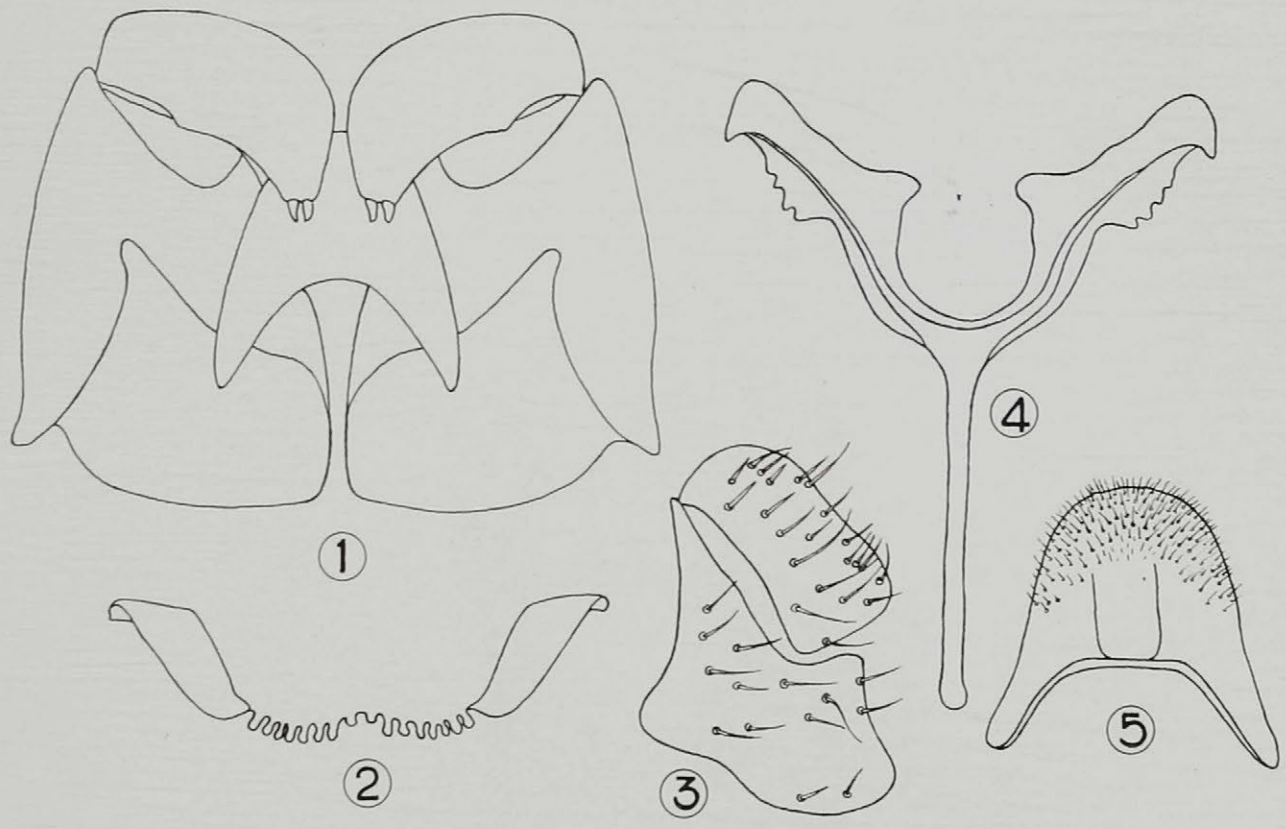
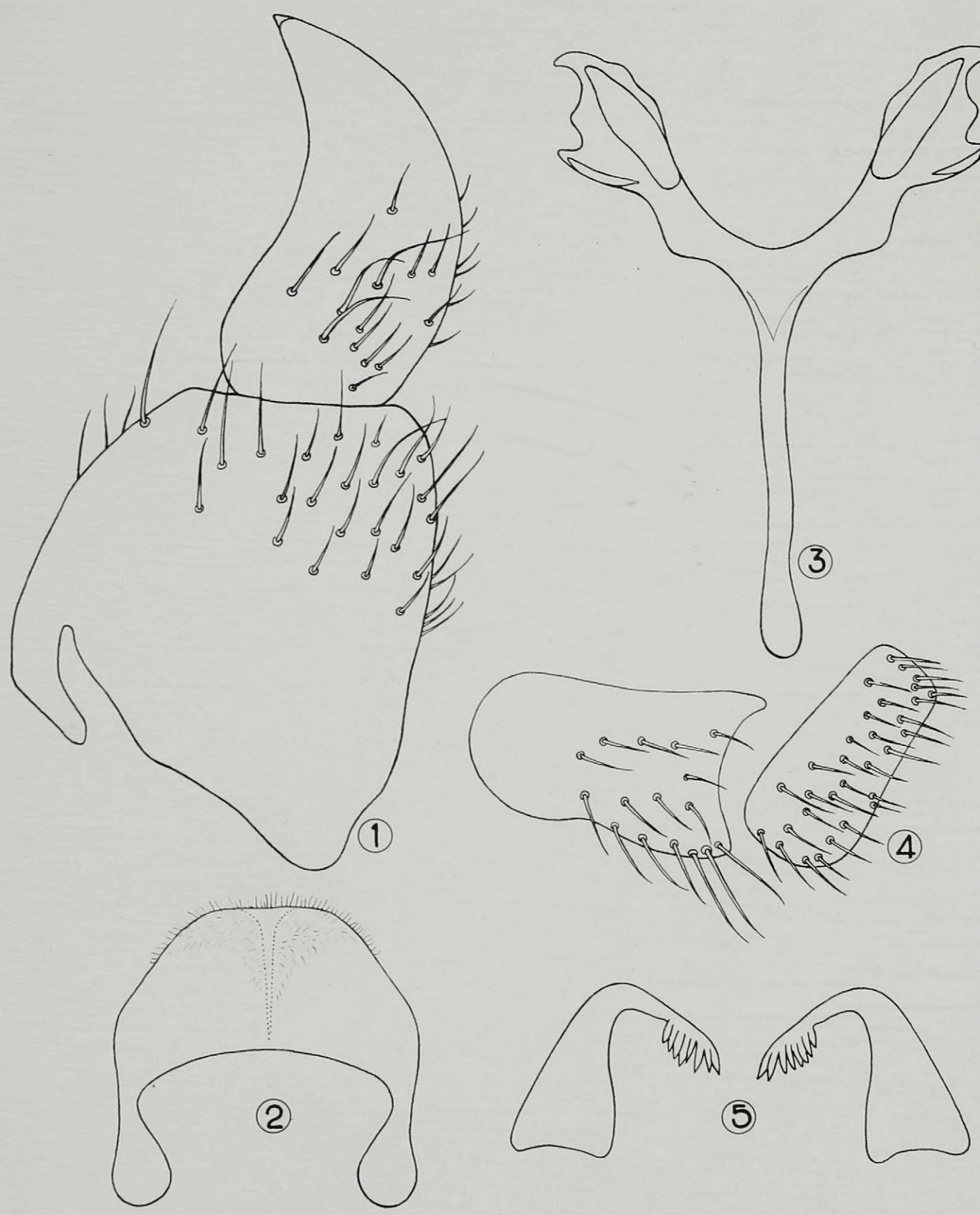




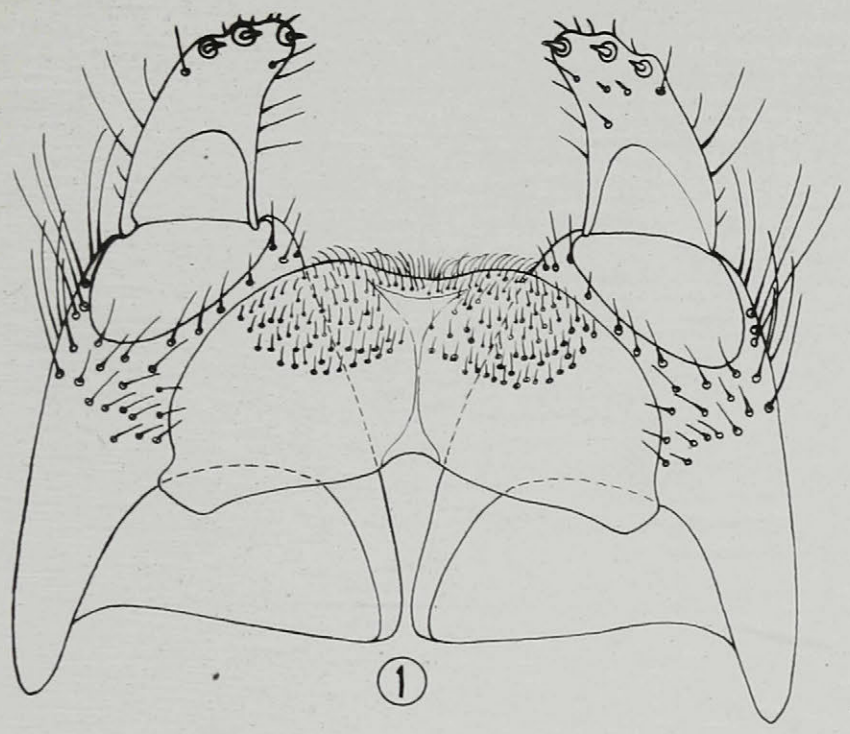
Parts of genitalia of Simulium (Eusimulium) boreale (Malloch): male (1) side-piece and clasper, (4) adminiculum arms; female (3) genital rod, (5) anal lobe and cercus.



Parts of genitalia of Simulium (Eusimulium) mutatum (Malloch): male (1) side-pieces and claspers, (5) adminiculum, (2) adminiculum arms; female (3) anal lobe and cercus, (4) genital rod.



Parts of genitalia of Simulium (Eusimulium) lascivum n.sp.: male (1) side-piece and clasper, (2) adminiculum, (5) adminiculum arms; female (3) genital rod, (4) anal lobe and cercus.



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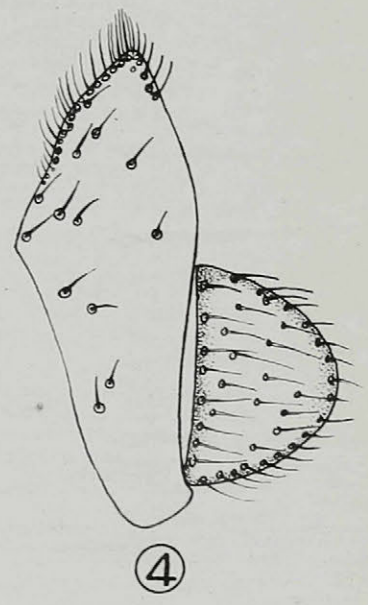

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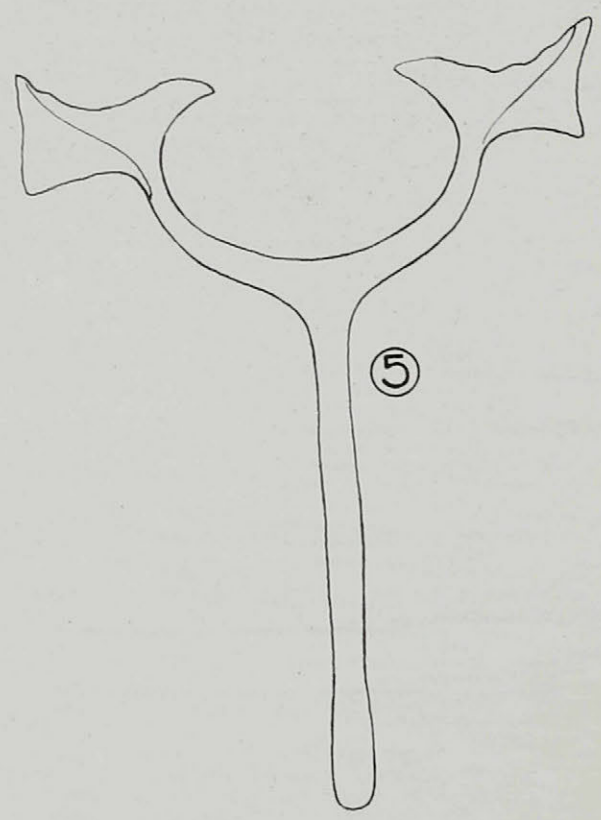

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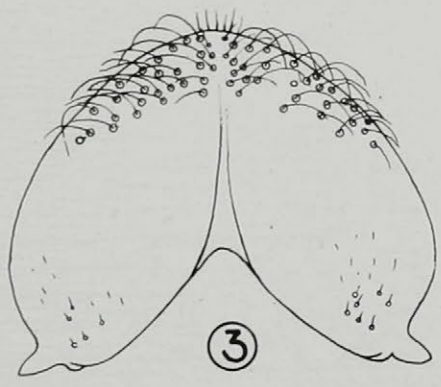

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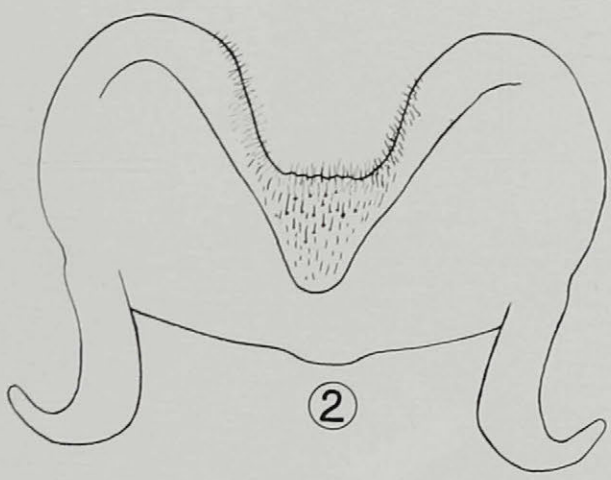
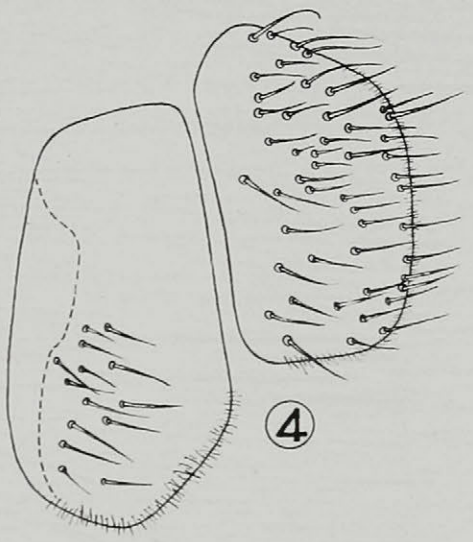
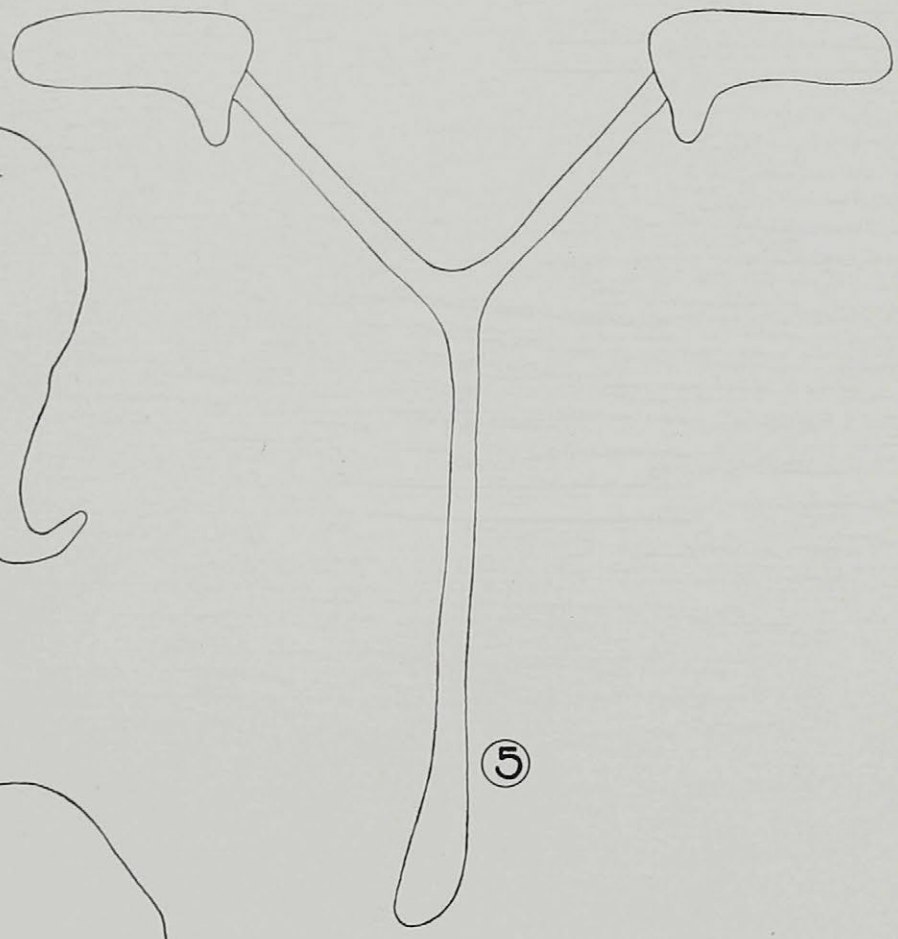
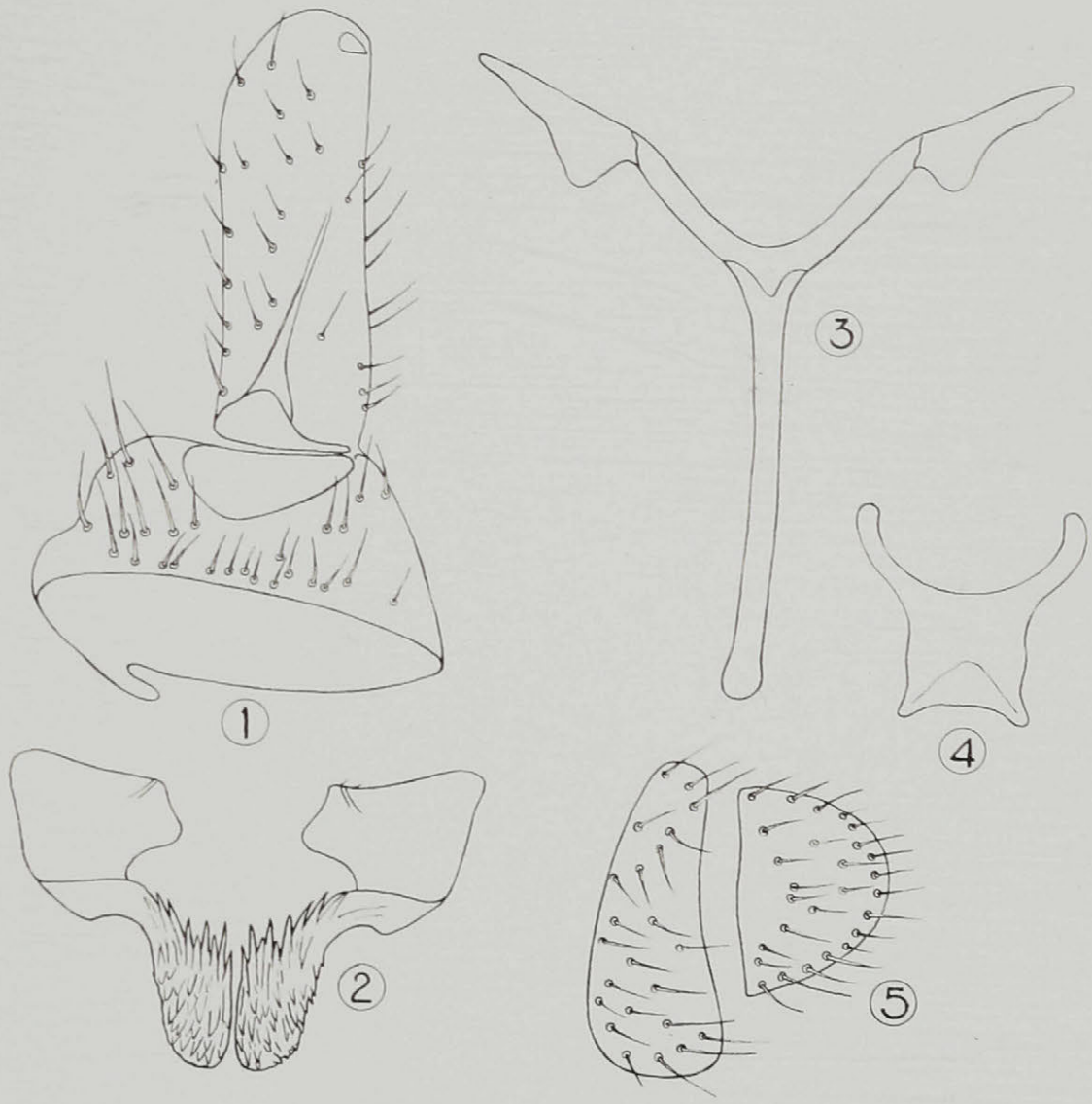
Parts of genitalia of Simulium (Simulium) vittatum Zett.: male (1) side-pieces, claspers and adminiculum, (2) adminiculum arms, (3) adminiculum detached; female (4) anal lobe and cercus (ventral side up), (5) genital rod.



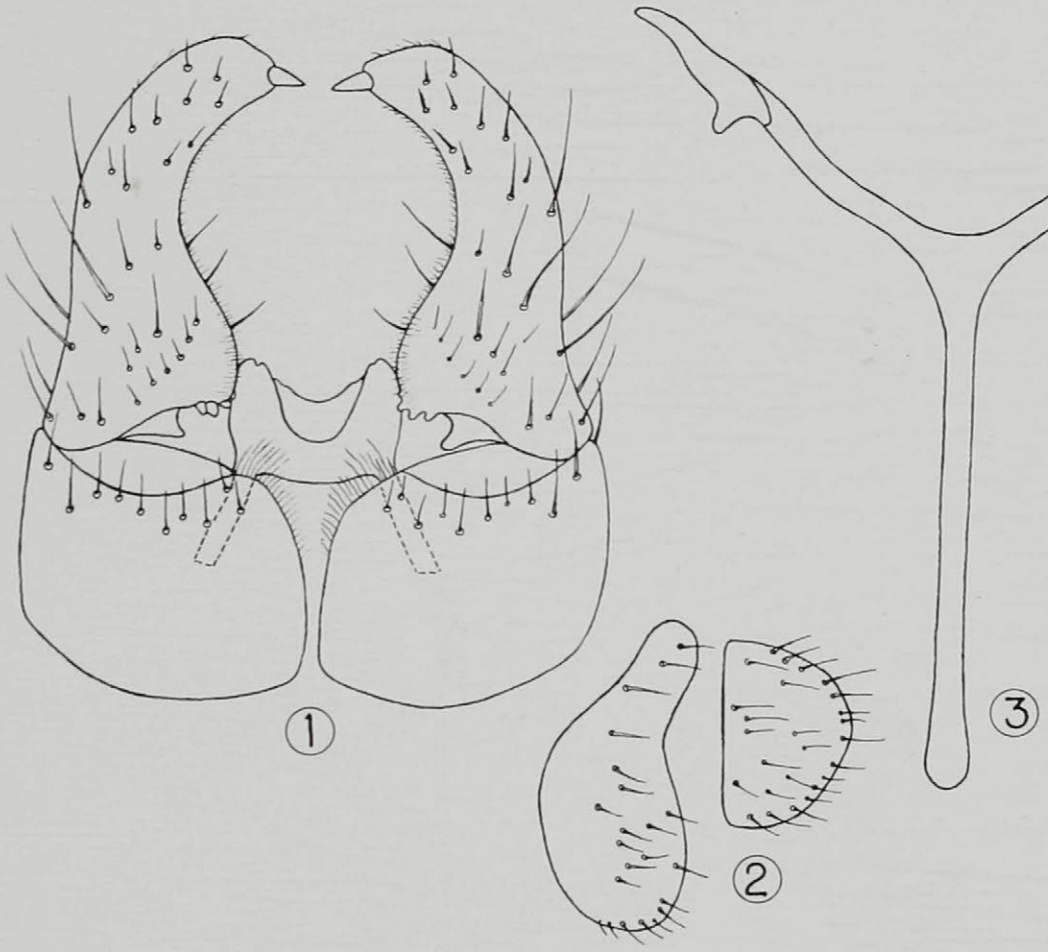




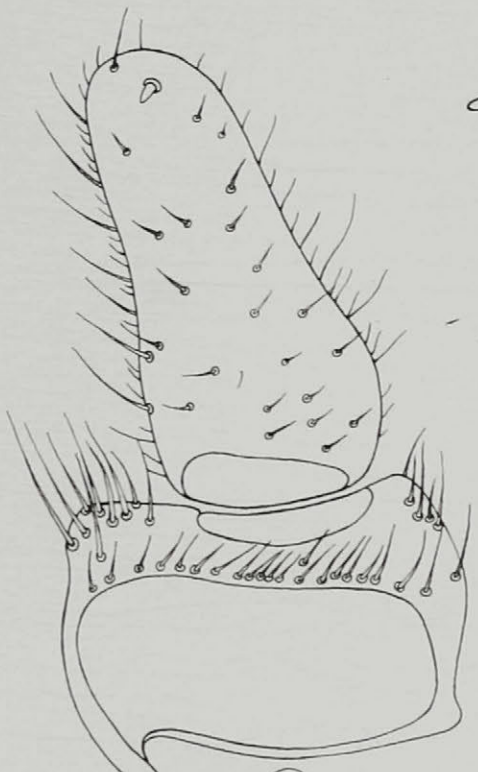
Parts of genitalia of Simulium (Simulium) pictipes Hagen: male (1) side-piece and clasper, (2) adminiculum, (3) adminiculum arms; female (4) anal lobe and cercus, (5) genital rod.

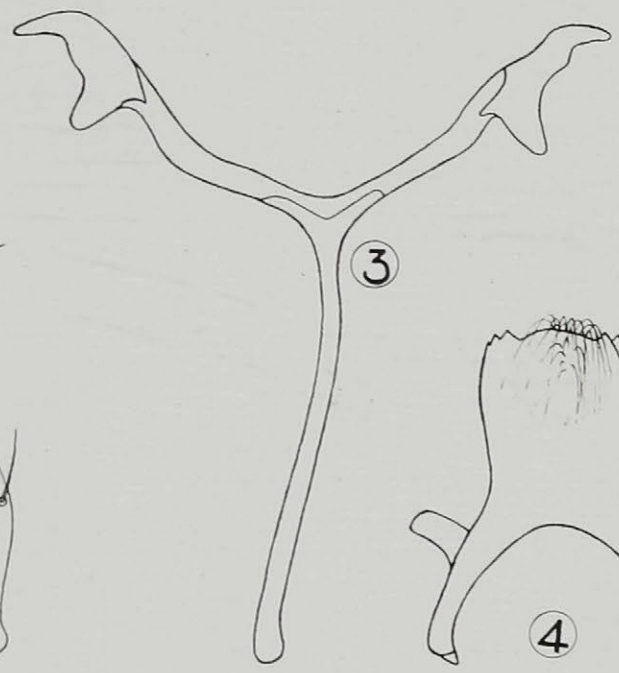


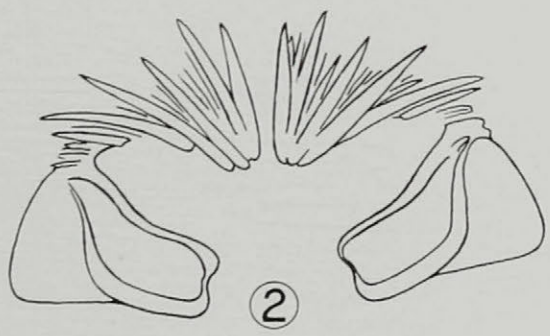
Parts of genitalia of Simulium (Simulium) venustum Say: male (1) side-piece and clasper, (4) adminiculum, (2) adminiculum arms (4 and 2 ventral side up); female (3) genital rod, (5) anal lobe and cercus.

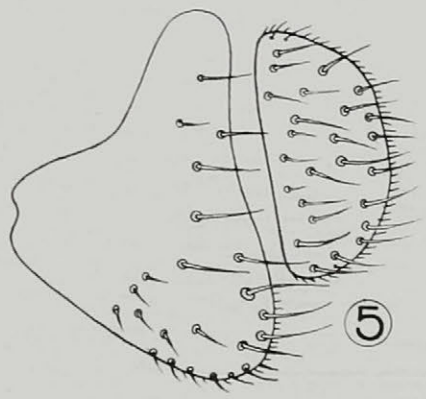


Parts of genitalia of Simulium (Simulium) perissum D.& S.: male (1) side-pieces, claspers and adminiculum; female (2) anal lobe and cercus, (3) genital rod.

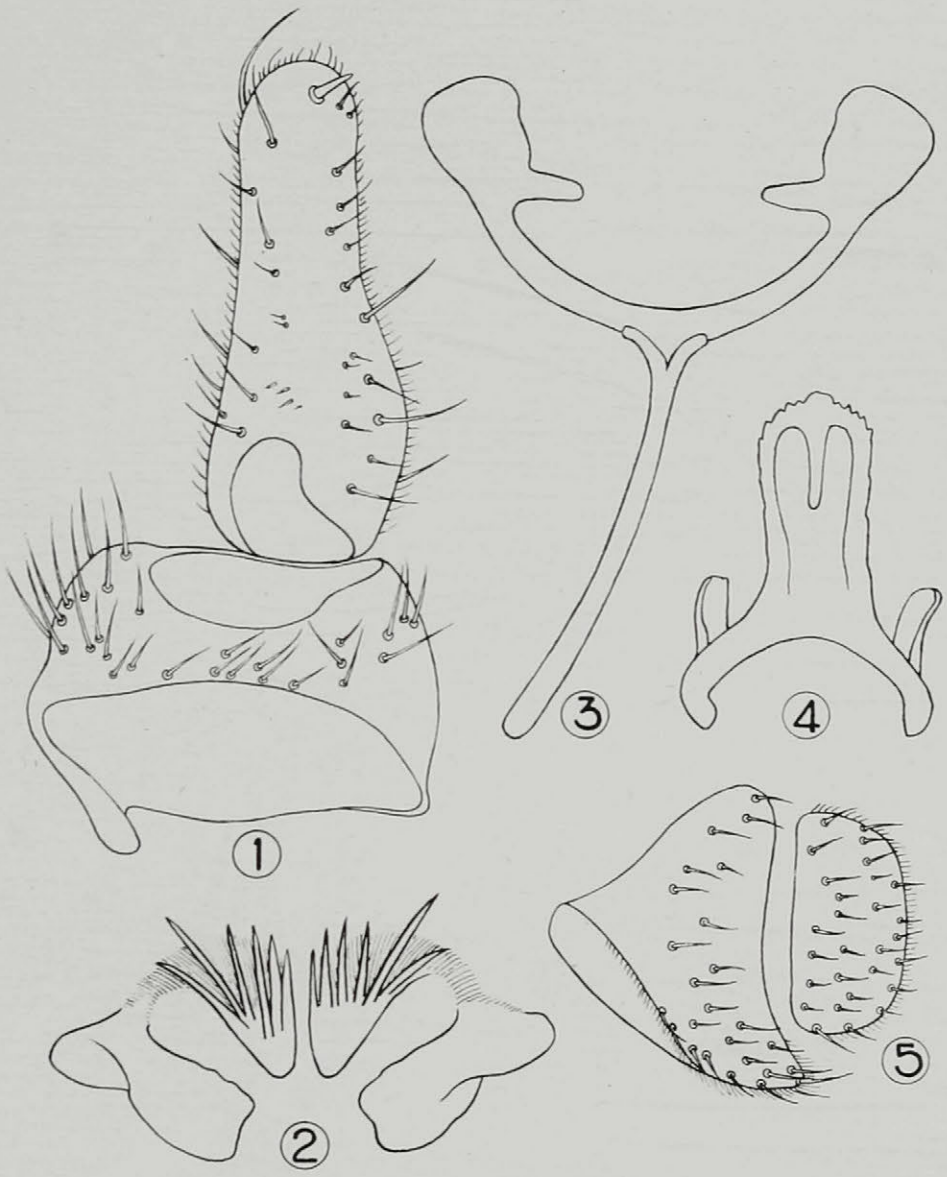




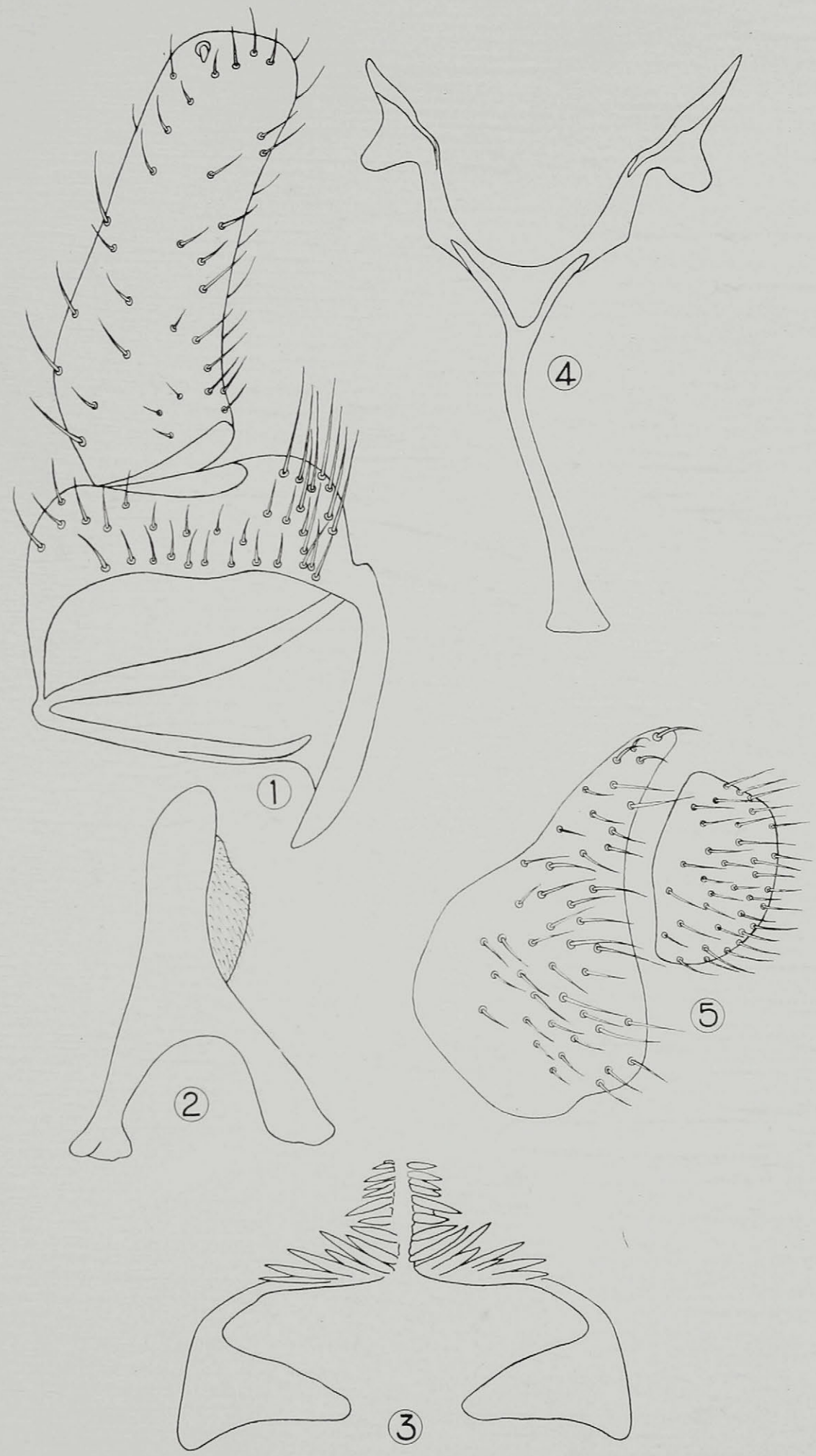




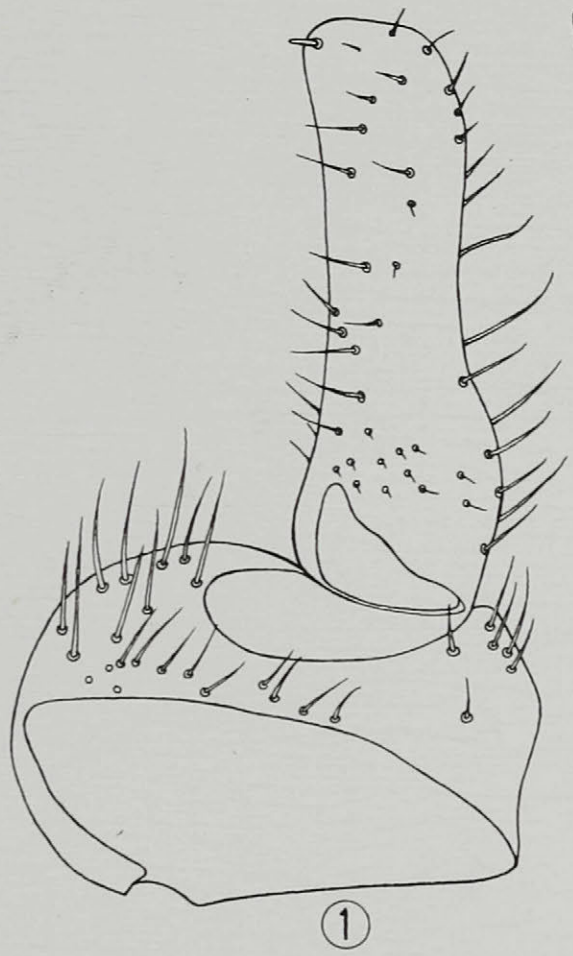
Parts of genitalia of Simulium (Simulium) fibrinflatum n.sp.: male (1) side-piece and clasper, (4) adminiculum, (2) adminiculum arms; female (3) genital rod, (5) anal lobe and cercus.

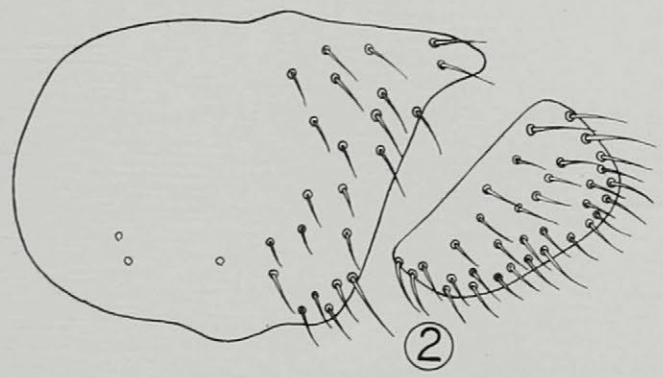


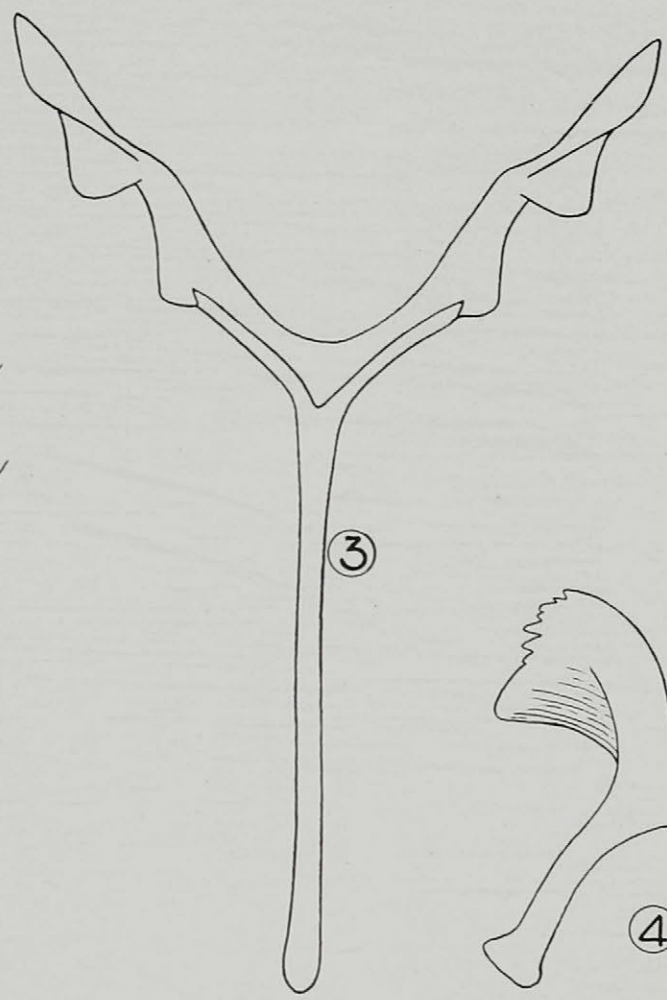
Parts of genitalia of Simulium (Simulium) nigroparvum n.sp.: male (1) side-piece and clasper, (4) adminiculum, (2) adminiculum arms; female (3) genital rod, (5) anal lobe and cercus.

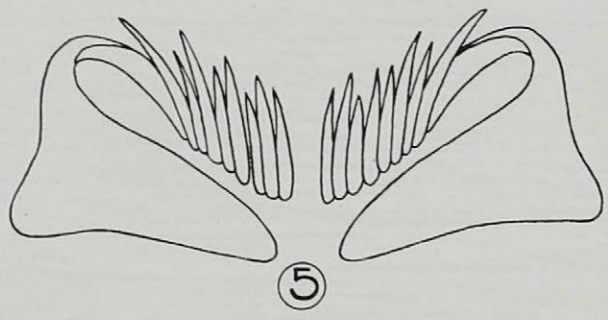


Parts of genitalia of Simulium (Simulium) ottawaense n.sp.: male (1) side-piece and clasper, (2) adminiculum, (3) adminiculum arms; female (4) genital rod, (5) anal lobe and cercus.









Parts of genitalia of Simulium (Simulium) corbis n.sp.: male (1) side-piece and clasper, (4) adminiculum, (5) adminiculum arms; female (2) anal lobe and cercus, (3) genital rod.

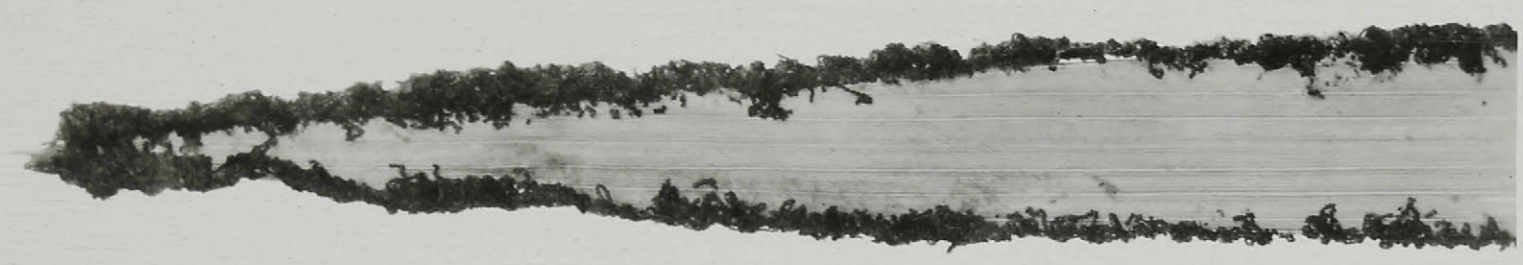


Fig.1.— Egg masses of S. vittatum Zett., on submerged leaf; about twice natural size.

Fig.2.— Egg mass of S. venustum Say, X 17.

Fig.1.— Immature larvae of S. lascivum n.sp., showing great numbers from small pieces of vegetation.

Fig.2.— Mature larvae of S. vittatum Zett., lateral and dorsal views; about 10 times natural size.

Fig.1.— Pupae and cocoons of S. lascivum n.sp., massed on twig: slightly enlarged.

Fig.2.— Pupae and emerging adult of S. lascivum n.sp.: about five times natural size.

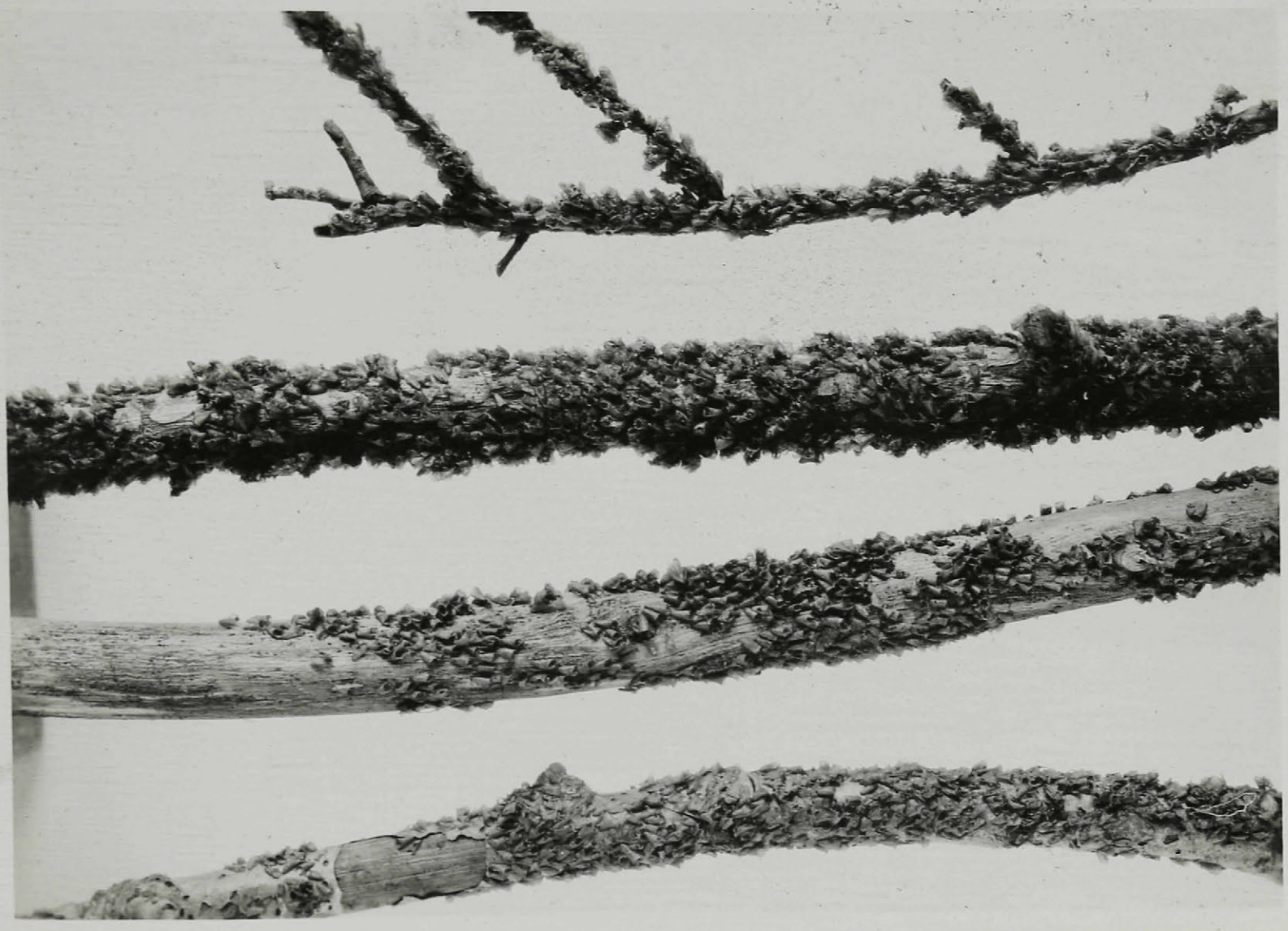


Fig.1.— Cocoons and pupal skins of S. fibrinflatum n.sp., and S. nigroparvum n.sp., on twigs: about natural size.

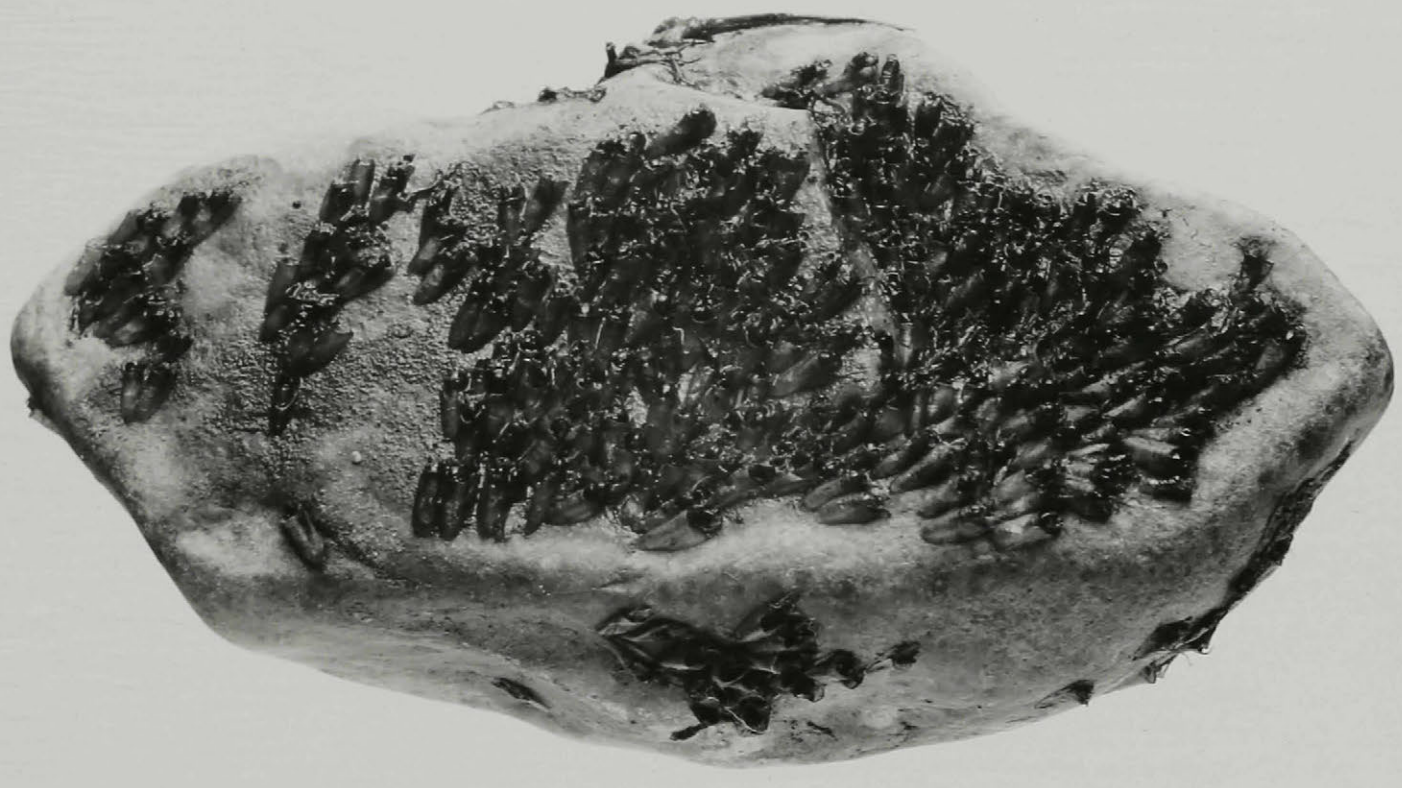


Fig.2.— Cocoons and pupal skins of S. venustum Say on stone: about 1.5 times natural size.

Fig.1.— Pupae and cocoons of S. vittatum Zett.: about six times natural size.

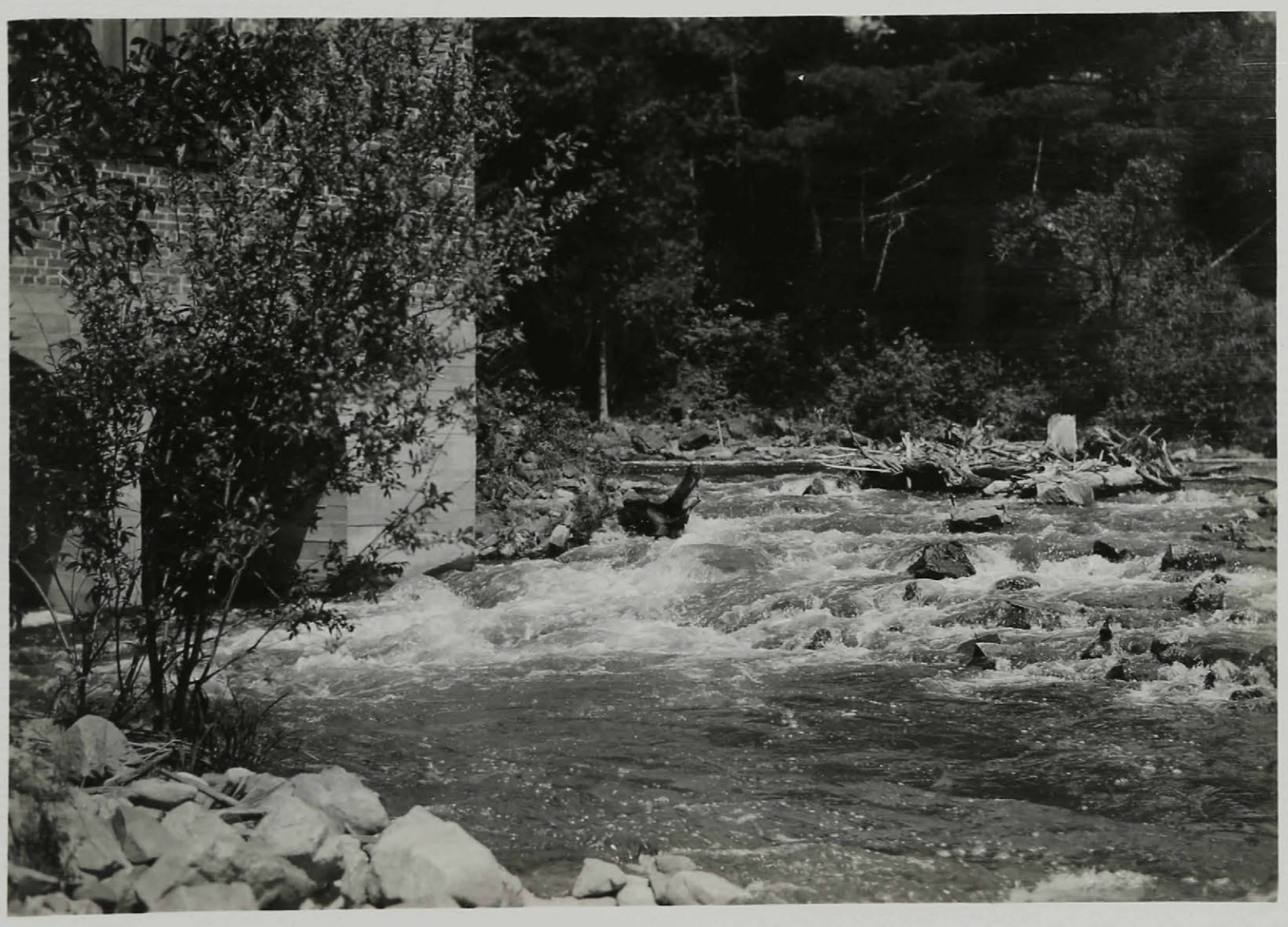


Fig.2.— Rapids of Blanche river below falls, south of Perkins Mills, Que. Males of S. pictipes Hgn., were caught swarming here.

Fig.1.— Blanche river south of Perkins Mills, Que.; S. gibsoni n.sp., S. venustum Say, S. quebecense n.sp., S. corbis n.sp. and S. nigroparvum n.sp., breed here.

Fig.2.— Falls of Blanche river at Perkins Mills, Que.; breeding place of S. pictipes Hgn.

Fig.1.— Blanche river, north of Perkins Mills, Que.; S. venustum Say, S. vittatum Zett., S. corbis n.sp. and S. nigroparvum n.sp. found here.

Fig.2.— Remic rapids, Ottawa river; breeding place of S. venustum Say, S. nigroparvum n.sp., S. fibrinflatum n.sp. and S. vittatum Zett.

Section of Rideau river, near Ottawa, breeding place of S. venustum Say, S. vittatum Zett., and S. nigroparvum n.sp.

Fig.1.— Jock river, near Ottawa, Ont. S. venustum Say, S. perissum D.& S. and S. vittatum Zett., develop here.

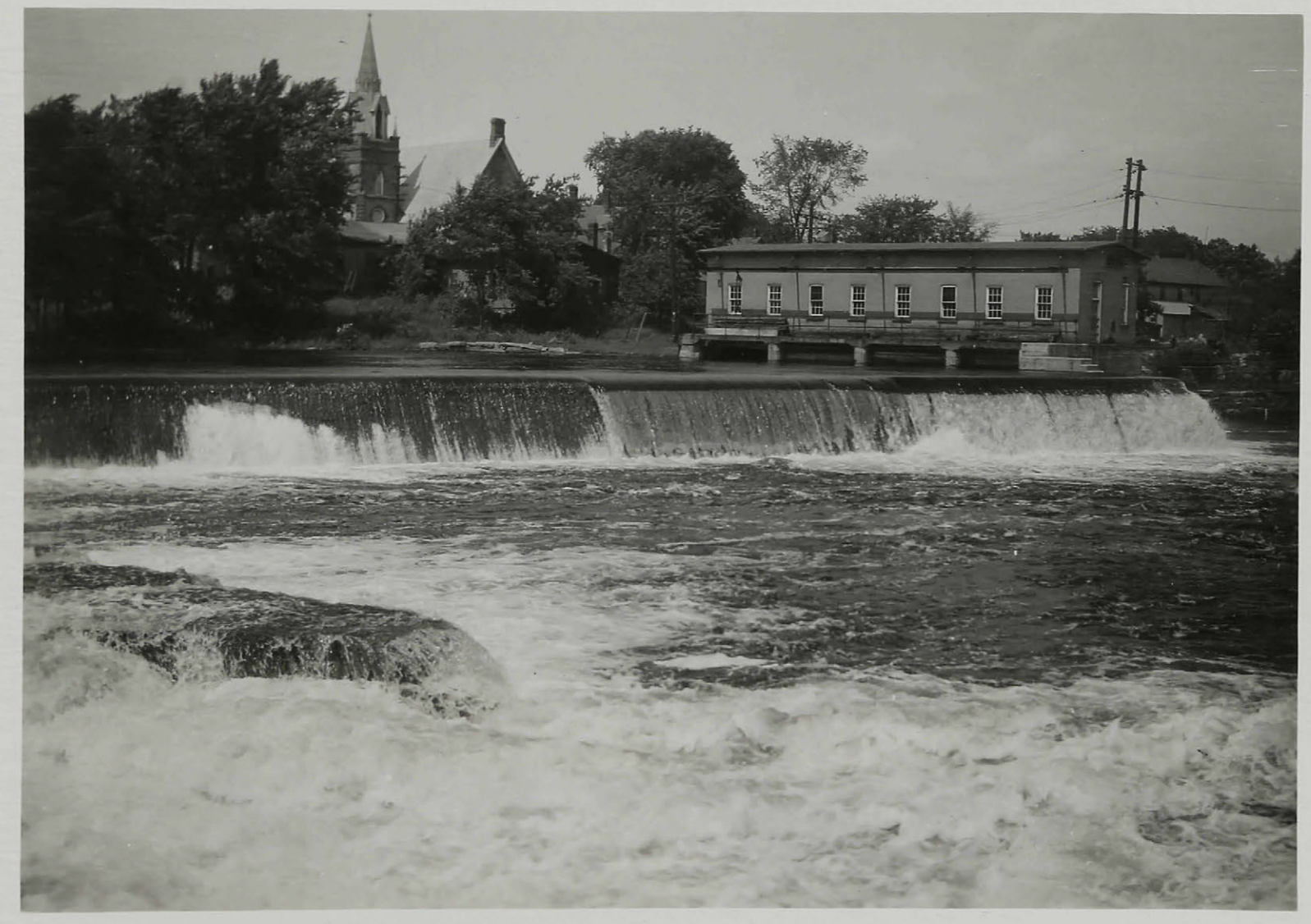


Fig.2.— Mississippi river, Carleton Place, Ont.; breeding place of S. lascivum n.sp., S. pictipes Hgn., and other species.

Fig.1.— Mississippi river, Carleton Place, Ont., breeding place of S. lascivum n.sp., S. pictipes Hgn., S. venustum Say, S. vittatum Zett., S. ottawaense n.sp.

Fig.2.— Another view of the above; S. ottawaense n.sp., was found to the right.

Fig.1.— Stream (C.P.H.2) near Carleton Place, Ont., habitat of S. gibsoni n.sp., S. decemarticulatum n.sp., S. mutatum Mall., S. subexcisum Edw., S. venustum Say.

Fig.2.— Roadside ditch (C.P.H.1) near Carleton Place, Ont., breeding place of the above species and S. rivuli n.sp.

Hartwell locks stream flowing from Rideau canal to Rideau river. Breeding place of S. vittatum Zett., and S. venustum Say.

Fig.1.— McEwan creek, near Ottawa, Ont., breeding place of S. vittatum Zett., S. venustum Say, and S. aureum Fries.

Fig.2.— Stream (M.R.1) in Gatineau hills, near Hull, Que., habitat of S. hirtipes Fries and S. venustum Say.

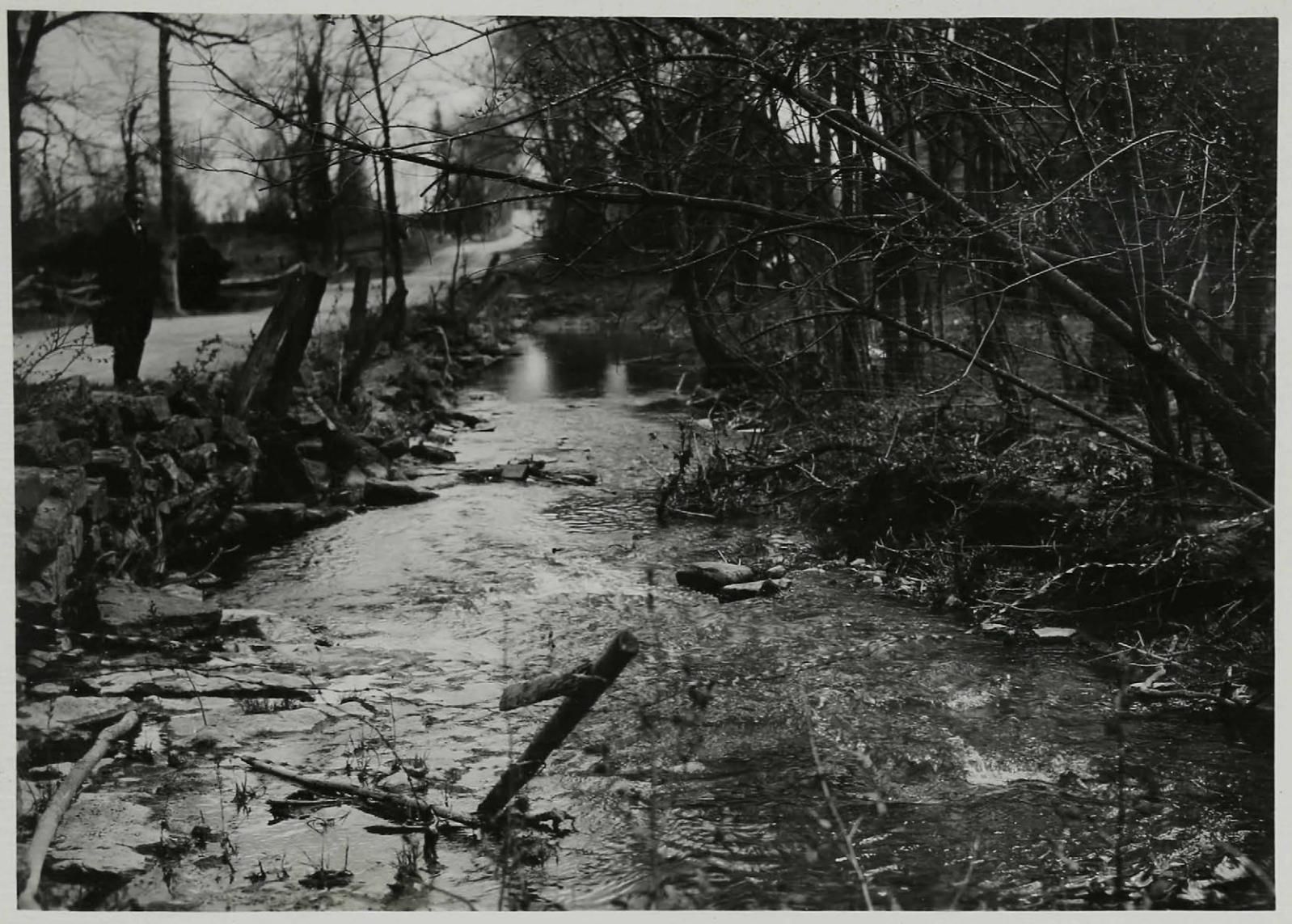


Fig.1.— Simmons creek, near Hull, Que., breeding place of S. multidentatum n.sp., S. vittatum Zett., and S. venustum Say.

Fig.2.— Fairy lake stream, near Hull, Que., breeding place of the above species and S. aureum Fries.