BULLETIN 390 APRIL 1969

THE BLACK FLIES of ALABAMA (Diptera: Simuliidae)

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FIRST PRINTING 4M, APRIL 1969

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INTRODUCTION

THE BLACK FLIES have few equals among the haematophagous Diptera in their persistent attack on man and animals. They are distributed worldwide, but their degree of annoyance and dissemination of pathogenic organisms varies from place to place. The immature forms are found almost invariably in the lotic communities of fresh water. They occur where combinations of temperature, pH, current speed, substrate, food, oxygen, and silt are present within the tolerance range for each species concerned.

Research on the taxonomy and ecology of black flies is increasing rapidly, with the species of the northeastern United States relatively well known. Some recent important works include those by Davies, Peterson, and Wood *(1)*, Sommerman *(5)*, Stone *(6)*, Stone *(7)*, Stone and Jamnback *(8)*, Twinn *(9)*, and Wood, Peterson, Davies, and Gyorkos *(11)*.

Studies on the taxonomy and ecology of the black flies of the Southeast have been somewhat neglected. This is particularly true for Alabama, with the exception of occasional collections and the survey of the Tennessee River Basin by Snow, Pickard, and Moore *(4)*. Alabama has a topography commonly divided into five areas – Limestone Valleys and Uplands, Appalachian Plateau, Piedmont Plateau, Black Belt, and Coastal Plains. The

* For completeness four species found in states adjacent to Alabama were included. These black flies probably occur in Alabama but have not been collected at the present time.

varied topography produces a wide variety of black fly habitats and therefore many species of black flies. Included in this bulletin are 28 species, 9 described as new to science. A new subgenus is also described.

BIOLOGY

Nearly all Alabama streams are inhabited by one or more species of immature black flies. They do not occur in grossly polluted streams nor in headwater springs, which contain little food and oxygen. The relatively mild winter and hot summer temperatures of Alabama permit a greater number of generations of black flies than is found in the northern United States. Many species, generally considered as spring and summer forms in cooler regions, reproduce during the winter and early spring in Alabama but diminish in numbers as the summer season advances. Species able to tolerate the high summer temperatures fill the habitat spaces as they are vacated by the cool-weather group.

The egg laying habits of some species are well known, but no information is available on many species. *Simulium vittatum* oviposits on almost any object on or just below the surface of the water. Its eggs are laid in masses beneath a thin sheet of water which flows over a desirable substrate. *Simulium decorum* generally oviposits on the top surface of a dam, on rocks, or objects trailing in the current. Females of this species sometimes lay so many eggs on their own pupae that adult emergence is difficult. In the early evening (6:00-7:30), *S. underhilli* and *S. nyssa* oviposit by intermittently touching their abdomens to the thin sheets of water flowing over dams or large rocks. The eggs are apparently scattered by the current and eventually settle to the stream bottom. *Simulium venustum* and *S. tuberosum* generally oviposit on plants trailing in the water along the margin of the stream. Large numbers of eggs have been taken from aquatic plants trailing in the water in the habitats of *S. dixiense* and *S. jonesi,* but these eggs were not positively identified. Females of *P. magnum* oviposit by touching their abdomens to the water just above the crest of waterfalls.

The larvae of many species of black flies have a narrow range of ecological tolerance whereas others tolerate a wide range of conditions and are widely distributed. *Prosimulium rhizophorum* occurs only in small permanent or semipermanent woodland streams. *Simulium jenningsi, S. luggeri,* and *C. pecuarum* are

generally collected in inland rivers; *P. magnum, S. decorum, S. verecundum,* and S. *vittatum* generally occur in the outflow of impoundments; S. *aranti, S. notiale, S. nyssa, S. pictipes, S. snowi, S. tuberosum, S. underhilli,* and S. *venustum* occur in medium-sized, inland streams. *Simulium jonesi, S. haysi, S. dixiense,* and S. *slossonae* are generally collected from streams in coastal swamps.

Larvae emerge from the eggs resting on the bottom of the stream or stuck to substrata above the bottom. There are normally six larval instars in the family Simuliidae. Some black flies may complete their life cycle in a few weeks while others require several months, depending on the species, available food, and water temperature, e.g., winter forms may grow quickly at 10°C. while summer forms will show little or no growth. Most of the larvae are filter feeders, catching food with a pair of cephalic fans located anteroventrally on the head. A few species are predaceous on small simuliids and other invertebrates, but some scrape food, consisting primarily of microscopic plant material, from the substrate. The first-stage larvae find an acceptable habitat by spinning silk threads and drifting with the current. The silk thread tangles in the habitat and holds the small larva in place. If the habitat is acceptable, they clean a place with the mouth, apply a pad of silk, and attach themselves to it by a circular row of hooks on the posterior end. If the habitat is unsuitable, they cut the thread, spin another, and drift to a different habitat.

The larvae of S. *pictipes* give the appearance of a black carpet spread on waterfalls, dams, and large rocks. The larvae and pupae of S. *vittatum* are commonly collected in the outflow from impoundments or in the organic waste of sewage treatment plants. Larvae of the subgenus *Phosterodoros* occur in both large and small inland and coastal streams. *Simulium slossonae* larvae are usually collected from medium-sized swamp streams. Larvae of *P. magnum* generally occupy all available habitat niches in the streams where they occur. *Cnephia pecuarum* usually develops in large streams or rivers.

Just prior to pupation a mature larva spins a silken cocoon. Some cocoons are closely woven. Others have lateral apertures which may provide additional circulation of water around the pupal respiratory filaments. Each species weaves a cocoon of characteristic shape. The pupa is held in its case by spines and

hooks. The cocoon is generally oriented with the open end downstream to protect the pupa from sediment and the current. The pupal stage lasts from a few days to several weeks, depending on the species and temperature of the water. The adult emerges from the pupal case through an elongate slit in the dorsum of the pupal skin and floats to the surface of the water in a bubble of gas. Many species copulate almost immediately after emergence.

Both sexes of adult *S. vittatum, S. tuberosum, S. nyssa,* and *S. underhilli* feed regularly on the nectar of alfalfa *(Medicago sativa* L.) blossoms. These species were observed feeding in an alfalfa field in Lee County, Alabama, only a few hundred yards from the larval and pupal habitat in Chewacla Creek. The females of the above mentioned species require a blood meal for the production of eggs. The females of *P. magnum, S. nyssa, S. pictipes, S. underhilli,* and *S. vittatum* feed on cattle in pastures near the streams inhabited by black flies. *Cnephia ornithophilia* and species of the subgenera *Eusimulium* and *Byssodon* feed primarily on birds.

ECONOMIC IMPORTANCE

Female black flies are attracted in large swarms to humans and other animals. They swarm about the heads of the animals and get into the nose, eyes, ears, and mouth. They follow animals and people into buildings and also crawl inside clothing. Female black flies have piercing mouthparts and suck blood. They do not penetrate the skin deeply but lacerate the skin and suck oozing blood. Strong anti-coagulants in their saliva prevent coagulation of the blood for some time after the bite. A lesion develops at the site of the bite, followed by an exudate, edema, and itching.

Several species of simuliids serve as vectors of human and animal diseases. Human onchocerciasis is prevalent in Africa and Central America, and bovine onchocerciasis is found in Australia. Various parasitic diseases of domestic and wild birds are also transmitted by certain species of these insects.

Since black fly larvae feed on organic debris in water, certain species increase in numbers in polluted streams. Thus water pollution indirectly contributes additional insects to bite man and transmit diseases to him.

COLLECTION AND PRESERVATION TECHNIQUES

Adult black flies can be caught by sweeping vegetation or swinging an insect net through swarms of flies that are seeking food or mating. They can be trapped in Malaise or light traps of various kinds, or by collecting from emergence cages placed in streams where the immature stages are abundant. In Alabama, a CO_2 trap was very effective in collecting females *(3)*.

Identification of adult black flies often depends on specimens positively associated with the pupal stage, consequently one of the best ways to provide specimens for research is to rear them individually from isolated pupae. Adults can be obtained by carefully removing the pupae from the substrate and placing them on a small piece of moist cellucotton, paper toweling, or filter paper in a vial that is losely plugged with cotton. After emergence, teneral flies are allowed to mature before they are placed in alcohol with the pupal exuvium and cocoon. They may be dry mounted together on the same pin or on separate points. Collections of pupae may be associated with larvae through the structure of the respiratory histoblast, and the male genitalia can often be dissected from fully developed pupae, thus associating immature and adult forms.

In this investigation, the ecology of each species was studied by determining the size and depth of the stream, temperature, pH, rate of flow of the water, sources of the water, and the type of substrate to which the larvae or pupae were attached.

TAXONOMY

The classification of the Simuliidae has developed largely during the 20th century. In 1905, only a single genus was recognized in the family. Since then about 80 generic names have been proposed and presently at least 11 genera and many subgenera are recognized. There is a considerable difference of opinion concerning the number of genera that should be recognized. The authors have adhered to the principle that nomenclature better serves its purpose if the number of generic names is limited and further taxonomic divisions are represented by subgeneric and species group names.

The primary taxonomic aim of this bulletin is to make pos-

sible the identification of the species of Simuliidae occuring in Alabama. Adults and larvae of the subgenus *Phosterodoros* are particularly difficult to recognize. It is also recognized that the family contains cryptic species perhaps recognizable only by cytological characters that may be manifested only by differences in behavior. There is some evidence of such biological differences in the species here treated as *S. fibrinflatum* and *S. tuberosum,* but sufficient material is not at hand to display anatomical differences to support this evidence. This bulletin must be recognized as a preliminary study aimed at stimulating more intensive and fruitful studies.

GLOSSARY

An alphabetical glossary of terms used in the keys and descriptions is presented below. Well-known terms such as those used for the head sclerites, mouthparts, wing veins, and legs are not included, but these structures are usually labeled in the figures.

Adult

ABDOMINAL SCALE. The anterior area of the first abdominal tergum that has developed into flattened lateral lobes bearing long hairs (basal fringe).

ANAL LOBE. The lateral sclerite between the ovipositor lobe and the cercus of the female terminalia, Figures 3 and 34-59.

BASAL CELL. A tiny cell at the point of origin of the cubital vein; found in the genera *Prosimulium* and *Cnephia,* Figure 2.

BASAL FRINGE. The long lateral hairs arising from the abdominal scale.

BASAL TOOTH. A small to large tooth at the base of the female claw, sometimes giving the claw a bifid appearance, Figures 77, 81.

BASIMERE. The basal segment (sidepiece) of the true paramere of the male terminalia, Figure 4.

CALCIPALA. A flattened lobe located on the inner side and apex of hind tarsomere 1, Figure 69.

CERCUS. The distal sclerite of the female terminalia, Figures 3 and 34-59.

DISTIMERE. The apical division (clasper, telomere) of the paramere in the male terminalia, usually provided with one or more distal spines, Figures 4 and 119-140.

ENDOPARAMERAL ORGAN. A sclerotized structure, often called the paramere, bridging the space between the anal and genital openings. Bears several strong teeth submedially which are known as the endoparameral hooks, Figure 4.

FLAGELLOMERE. One of the subdivisions of the flagellum, usually 9 in number, Figure 1.

GENITAL FORK. A sclerotized ventral structure in the middle of the female terminalia consisting of a central anterior stem and a pair of posterior arms, the latter connected laterally with tergum 9, Figure 3.

MEDIAN SCLERITE. A weakly sclerotized structure, probably the 10th sternum, lying ventrad the anal opening of the male, Figure 4.

OVIPOSITOR LOBE. The posterior median corners to either side of a median cleft in sternum 8 of the female, Figure 3.

PARAMERE. The ventrolateral, two-segmented structure of the male terminalia (see basimere and distimere), Figure 4.

PEDISULCUS. A notch, usually deep, located dorsally near the basal third of hind tarsomere 2, Figure 71.

SENSORY VESICLE. An organ in the third segment of the maxillary palpus, Figure 1.

STEM VEIN. The short, stout vein basad the humeral cross-vein, bearing abundant long hairs dorsally, Figure 2.

SUBMEDIAN FOLD. A vein-like fold usually forking distally between the medial and cubital veins, Figure 2.

TARSOMERE. Each of the 5 subdivisions of the tarsus.

VENTRAL PLATE. A sclerotized, ventral, median structure of the male terminalia with a median ventral projection or lip, usually heavily setose and with basal lateral arms. Each arm may bear a sclerotized, posteriorly directed process. The median portion of the plate may be compressed and serrate laterally and a subapical ventral keel may be present, Figures 4 and 141-186.

Immature Stages

ANAL SCLERITE. A sclerotized structure lying behind the anal opening and in front of the posterior circlet of the larva, Figure 6.

CEPHALIC APOTOME. The dorsal portion of the larval head lying between the cephalic cleavage lines (epicranial suture), Figure 7.

CEPHALIC FANS. Groups of long, stiff filaments located on the cephalic fan stem at the anterior of the larval head immediately below the antenna. The main fan consists of very long, ventrally curved filaments arising from the apex of the cephalic fan stem. The secondary fan is of shorter, nearly straight filaments attached to the ventral surface of the cephalic fan stem, Figure 7.

CERVICAL SCLERITE. A small sclerite behind the cephalic apotome and mesiad the postocciput, Figure 7.

COLLAR. That portion of certain cocoons connecting the two sides anteroventrally and raising the anterior aperture above the substrate, Figure 8.

HEAD SPOTS. The usually darker, but sometimes paler markings on the cephalic apotome of the larva, subdivided into anteromedian, posteromedian, anterolateral, and posterolateral groups, Figure 7.

HYPOSTOMIUM. The sclerotized area at the anterior margin of the larval head, bounded posteriorly by a suture (hypostomial groove). The hypostomium bears several long setae on the lateral anterior margin. A row of hypostomal teeth are present anteriorly. These usually have a strongly developed median tooth and corner teeth with intermediate teeth between. Lateral serrations are present laterocaudad the corner teeth, Figures 5, 7, and 262-285.

MANDIBULAR PHRAGMA. A dark, sclerotized bar on the gena, basad the mandible in the larva, Figure 7.

POSTERIOR CIRCLET. The structure at the apex of the larval abdomen, consisting of a circlet of closely set rows of fine hooklets used to attach the larva to the substrate, Figure 6.

POSTGENAL BRIDGE. The ventral portion of the larval head behind the hypostomium and in front of the postgenal cleft, Figure 7.

POSTGENAL CLEFT. An indentation of the ventral hind margin, between the postgenae of the larval head, Figure 7.

POSTOCCIPUT. The sclerotized rim at the hind margin of the head extending from near the cephalic cleavage line above to the posterior corners of the postgenal cleft below, Figure 7.

PROLEG. A median ventral lobe of the larval thorax bearing a circlet of hooklets at the apex and a small, sclerotized lateral plate, Figure 6.

RECTAL GILL. A membranous organ arising dorsally from the last abdominal segment of the larva. The organ is retractible and may or may not be visible, Figure 6.

RESPIRATORY HISTOBLAST. The developing pupal respiratory organ seen through the epidermis at sides of the larval thorax. Its shape is often characteristic and it may be dissected to determine the number and arrangement of the respiratory filaments, Figures 6 and 286-306.

RESPIRATORY ORGAN. The organ on the side of the pupal thorax, usually consisting of more or less slender filaments. Descriptions of the organ begin with the dorsal (posterior) filaments and end with the ventral (anterior) filaments. If a single filament arises from the base, it is termed sessile; if it is the result of a bifurcation some distance from the base, it is petiolate, Figures 8 and 187-216.

SUBOESOPHAGEAL GANGLION. The nerve ganglion beneath the semitransparent exoskeleton in or near the postgenal cleft of the larva. The color of this organ is of some diagnostic value, Figure 7.

TAIL HOOKS. A pair of acute, sclerotized, dorsal protuberances at the posterior end of the pupa, Figure 8.

TRICHOMES. Erect setae on the head and thorax of the pupa, Figure 8.

VENTRAL TUBERCLES. A pair of fleshy protuberances often found on the under side of the last abdominal segment of the larva, Figure 6.

LIST of INCLUDED SPECIES

Prosimulium magnum Dyar and Shannon
Prosimulium mixtum Syme and Davies
Prosimulium rhizophorum Stone and Jamnback
Cnephia (Stegopterna) mutata (Malloch)
Cnephia (Cnephia) ornithophilia Davies, Peterson, and Wood
Cnephia (Cnephia) pecuarum (Riley)
Simulium (Eusimulium) clarkei, new species (4)[1]
Simulium (Eusimulium) congareenarum Dyar and Shannon
Simulium (Byssodon) meridionale Riley
Simulium (Byssodon) slossonae Dyar and Shannon
Simulium (Psilozia) vittatum Zetterstedt
Simulium (Hagenomyia) pictipes Hagen
Simulium (Phosterodoros) aranti, new species (116)
Simulium (Phosterodoros) dixiense, new species (17)
Simulium (Phosterodoros) fibrinflatum Twinn
Simulium (Phosterodoros) haysi, new species (114)
Simulium (Phosterodoros) jenningsi Malloch
Simulium (Phosterodoros) jonesi, new species (58)
Simulium (Phosterodoros) luggeri Nicholson and Mickel
Simulium (Phosterodoros) notiale, new species (52)
Simulium (Phosterodoros) nyssa, new species (117)
Simulium (Phosterodoros) snowi, new species (16)
Simulium (Phosterodoros) underhilli, new species (7)
Simulium (Simulium) decorum Walker
Simulium (Simulium) parnassum Dyar and Shannon
Simulium (Simulium) tuberosum (Lundstroem)
Simulium (Simulium) venustum Say
Simulium (Simulium) verecundum Stone and Jamnback

[1] The new species of this bulletin were first assigned tentative numbers and the species have been referred to by these numbers in correspondence and in labeling. This is the reason for indicating these numbers in this list.

KEYS to GENERA, SUBGENERA, and SPECIES

Key to Females

The female of S. *clarkei* is not known, but it will probably be very similar to S. *congareenarum*.

1a. Macrotrichia of anterior wing veins hairlike, without spiniform macrotrichia; radial sector always forked *(Prosimulium)* 2

1b. Macrotrichia of anterior wing veins both hairlike and spiniform; radial sector usually not forked 3

2a. First flagellomere distinctly longer than pedicel; wing usually more than 4 mm. long; anterior margin of anal lobe nearly straight without a distinct anterior projection (Fig. 34) ..... *P. magnum* p. 22

2b. First flagellomere not conspicuously longer than pedicel; wing usually less than 4 mm. long; anterior margin of anal lobe with a distinct anterior projection (Fig. 35) ..... *P. mixtum* p. 22
..... *P. rhizophorum* p. 23

3a. Second hind tarsomere without pedisulcus although a shallow depression may be present (Fig. 69, 70); basal section of vein R with setae on dorsal surface; basal cell usually present *(Cnephia)* 4

3b. Second hind tarsomere with a deep pedisulcus (Fig. 71, 72); basal section of vein R with or without dorsal setae; basal cell absent *(Simulium)* 6

4a. Claw simple, without basal tooth (Fig. 76) ..... *C. mutata* p. 24

4b. Claw with a distinct basal tooth 5

5a. Margins of tooth of claw convex; the space between tooth and claw a narrow curved slit (Fig. 77); sensory vesicle of maxillary palpus about 0.57 length of segment ..... *C. ornithophilia* p. 25

5b. Margins of tooth of claw straight; the space between tooth and claw distinctly wider, V-shaped (Fig. 78); sensory vesicle of maxillary palpus about 0.42 length of segment ..... *C. pecuarum* p. 25

6a. Basal section of vein R with hair dorsally ..... *S. congareenarum* p. 27

6b. Basal section of vein R without hair dorsally 7

7a. Claw with a basal projection or subbasal tooth 8

7b. Claw simple 10

8a. Claw long and basally straight, tip downcurved, with a small tooth medianly (Fig. 91); subcosta with hairs ventrally ..... *S. parnassum* p. 48

8b. Claw short and curved with a large basal tooth (Fig. 80, 81); subcosta without hairs ventrally 9

9a. Frons opaque with gray pollinosity ..... *S. meridionale* p. 28

9b. Frons shining black ..... *S. slossonae* p. 29

10a. Frons and terminal abdominal terga shining black or dark brown 11

10b. Frons and terminal abdominal terga with at least a thin pollinosity 18

11a. Subcosta with a row of hairs on ventral surface; scutum not particularly shiny 12

11b. Subcosta without hairs on ventral surface; scutum rather shiny ..... 14[2]

12a. Fore tibia with, at most, a narrow, grayish-white streak on anterior surface covering not more than 0.33 width of tibia ..... *S. tuberosum* p. 48

12b. Fore tibia with a conspicuous, bright white patch on the anterior surface covering 0.50 or more of the width of tibia 13

13a. Inner margin of ovipositor flaps straight and slightly diverging distally; anterior margin of anal lobe not noticeably more sclerotized than rest of lobe ..... *S. venustum* p. 50

13b. Inner margin of ovipositor flaps concave, with an oval space between them; anterior margin of anal lobe noticeably more sclerotized than rest of lobe ..... *S. verecundum* p. 50

14a. Scutum viewed from front shows a pair of rather distinct, rounded, pollinose spots, the anterior median portion darker 15

14b. Pollinosity, if present on the scutum, a diffuse area across the front and along the sides, but without a contrasting central dark area anteriorly; a pair of elongate submedian stripes may be visible 16

15a. Hairs of stem vein pale yellow ..... *S. luggeri* p. 40

15b. Hairs of stem vein dark brown to black ..... *S. jenningsi* p. 38
..... *S. notiale* p. 40
..... *S. nyssa* p. 42

16a. Scutum shiny; disk without a pair of stripes 17

16b. Scutum not so shiny; a pair of short stripes on the disk, pale when viewed from front, dark when viewed from behind ..... *S. aranti* p. 33

17a. Clypeus nearly or quite as wide as long ..... *S. jonesi* p. 38

17b. Clypeus not more than 0.85 as wide as long ..... *S. dixiense* p. 34
..... *S. fibrinflatum* p. 36
..... *S. haysi* p. 36
..... *S. snowi* p. 44
..... *S. underhilli* p. 45

18a. Fore tibia with white pile but with no distinct patch of white pollinosity; sternum 7 with conspicuous fringe of long hairs; outer surface of anal lobe highly polished ..... *S. pictipes* p. 31

18b. Fore tibia with a very distinct patch of white pollinosity; sternum 7 without conspicuous fringe of long hairs; outer surface of anal lobe not highly polished 19

19a. Abdomen with a distinct black and light gray pattern; frons pale opaque gray ..... *S. vittatum* p. 29

19b. Abdomen blackish posteriorly with a thin grayish pollinosity without pattern; frons dark with thin grayish pollinosity ..... *S. decorum* p. 47

[2] The females of this group, the subgenus *Phosterodoros*, are difficult to separate and this key (couplets 14 to 17) will separate a few of the species only if the specimens are in excellent condition. The key can best be understood by those familiar with known species based on pupal association.

Key to Males

The male of *C. ornithophilia* is unknown. It is probably very similar to *C. pecuarum.*

1a. Macrotrichia of anterior wing veins hairlike, without spiniform macrotrichia *(Prosimulium)* 2

1b. Macrotrichia of anterior wing veins both hairlike and spiniform 3

2a. First flagellomere distinctly longer than pedicel; basal fringe of abdominal scale dark basally and pale apically; ventral plate, viewed from end, long, broad, conical in outline, with a bluntly pointed ventral projection (Fig. 141) ..... *P. magnum* p. 22

2b. First flagellomere slightly, if any, longer than pedicel; basal fringe of abdominal scale entirely dark; ventral plate viewed from end, shorter, more compressed and with a more acute ventral projection (Fig. 142, 143) ..... *P. mixtum* p. 22
..... *P. rhizophorum* p. 23

3a. Second hind tarsomere without pedisulcus although a shallow depression may be present (Fig. 69, 70); basal section of vein R with setae on dorsal surface; basal cell present *(Cnephia)* 4

3b. Second hind tarsomere with a deep pedisulcus (Fig. 71, 72); basal section of vein R with or without dorsal setae; basal cell absent *(Simulium)* 5

4a. Calcipala well developed (Fig. 69); distimere with 2 apical teeth (Fig. 122) ..... *C. mutata* p. 24

4b. Calcipala short, undeveloped (Fig. 70); distimere with only 1 apical tooth (Fig. 123) ..... *C. pecuarum* p. 25

5a. Basal section of vein R with hair dorsally 6

5b. Basal section of vein R without hair dorsally 7

6a. Recumbent hairs of scutum golden yellow; distimere tapering rather evenly to apex (Fig. 125); anterior margin of ventral plate straight (Fig. 101); ventral plate viewed from end with a large, triangular, ventral projection (Fig. 147) ..... *S. congareenarum* p. 27

6b. Recumbent hairs of scutum pale yellow; distimere with apex obliquely truncate (Fig. 124); anterior margin of ventral plate convex (Fig. 100); ventral plate viewed from end without a large ventral projection (Fig. 146) ..... *S. clarkei* p. 26

7a. Distimere short and stout, with 3 or more teeth (Fig. 128) .....
..... *S. vittatum* p. 29

7b. Distimere longer, subcylindrical, with 1 tooth or none 8

8a. Distimere with a rounded lobe internally near base 9

8b. Distimere without a lobe or other projection near base 10

9a. Basal lobe of distimere with short, stout, spinelike setae (Fig. 138) ..... *S. tuberosum* p. 48

9b. Basal lobe of distimere with fine hairs only (Fig. 127) .....
..... *S. slossonae* p. 29

10a. Ventral plate more or less compressed with denticles on the margin....11

10b. Ventral plate triangular or broadly rounded without denticles on the margin....17

11a. Basal arms of ventral plate with distinct lateral projections; posterior 0.33 of scutum shiny and with only indistinct hairs....12

11b. Basal arms of ventral plate without lateral projections; posterior 0.25 or less of scutum shiny with some to many strong, erect hairs....15

12a. Ventral plate, viewed ventrally, with median portion longer than wide, and with sides parallel or nearly so....13[3]

12b. Ventral plate, viewed ventrally, with median portion not longer than wide, widened toward apex....14

13a. Iridescent anterior spots of scutum large, triangular; the dark area between them narrowed anteriorly....*S. notiale* p. 40

13b. Iridescent anterior spots of scutum narrow, usually oblique; the dark area between them always broadened anteriorly....*S. dixiense* p. 34
....*S. jenningsi* p. 38
....*S. luggeri* p. 40
....*S. underhilli* p. 45

14a. Iridescent anterior spots on scutum large; the intervening dark area strongly narrowed to anterior margin....*S. jonesi* p. 38

14b. Iridescent anterior spots not so large; the intervening dark area broader, less convergent, with the narrowest portion near center of length of the iridescent spots....*S. fibrinflatum* p. 36
....*S. haysi* p. 36
....*S. nyssa* p. 42
....*S. snowi* p. 44

15a. Ventral plate narrow, V-shaped (Fig. 114); a ventral keel present (Fig. 182)....*S. decorum* p. 47

15b. Ventral plate broader (Fig. 161-162), the median portion not so strongly compressed, there being a space between the serrated sides; no distinct ventral keel present....16

16a. Toothed lateral margins of ventral plate flaring outward; when viewed on end appearing somewhat trilobed, the 2 lateral lobes with teeth (Fig. 161)....*S. venustum* p. 50

16b. Toothed margins of ventral plate turned inward toward each other concealing ventral region; distoventral lobe narrower (Fig. 162)....*S. verecundum* p. 50

17a. Ventral plate with broad median notch nearly dividing it into 2 parts (Fig. 105)....*S. pictipes* p. 31

17b. Ventral plate without broad median notch....18

[3] As no whole dry males of *S. aranti* are available the species cannot be carried beyond this point. The separation of the species of the subgenus *Phosterodoros* here (couplets 12-14) is extremely difficult.

18a. Scutum deep black with 2 large, silvery-white spots anteriorly; distimere rather elongate with a distinct angle before middle (Fig. 137) ..... *S. parnassum* p. 48

18b. Scutum dark reddish brown without silvery spots; distimere shorter, tapering to a somewhat truncate tip (Fig. 126) ..... *S. meridionale* p. 28

Key to Pupae

1a. Cocoon without definite shape, closely appressed to pupa, and without a clearly defined anterior margin (Fig. 217); abdomen of pupa with strong dorsal tail hooks 2

1b. Cocoon with definite shape, and with a clearly defined anterior margin; abdomen of pupa with dorsal tail hooks very small or absent *(Simulium)* 6

2a. Respiratory filaments arising from a rounded knob on a short petiole (Fig. 190) *(Cnephia)* ..... *C. ornithophilia* p. 25
..... *C. pecuarum* p. 25

2b. Respiratory filaments arising from an irregularly swollen club (Fig. 189) or from 2 or more main trunks (Fig. 192) 3

3a. Respiratory filaments 12, arising from 2 main trunks ..... *C. mutata* p. 24

3b. Respiratory filaments 16 or more, arising from more than 2 main trunks or from an irregularly swollen club *(Prosimulium)* 4

4a. Respiratory filaments arising from an irregularly swollen club from which arise smaller tubercles bearing a total of 16 filaments (Fig. 189) ..... *P. rhizophorum* p. 23

4b. Respiratory filaments 16 or more, arising from more than 2 main trunks 5

5a. Respiratory filaments 16 (Fig. 188) ..... *P. mixtum* p. 22

5b. Respiratory filaments more than 21 (Fig. 187) ..... *P. magnum* p. 22

6a. Cocoon wholly reticulate, the opening with a broad, raised collar at a distinct angle to surface so that the cocoon is boot-shaped (Fig. 224); pupa with 9 respiratory filaments (Fig. 196) ..... *S. pictipes* p. 31

6b. Cocoon tightly woven except occasionally near anterior margin, the front with a narrow collar, little raised above surface, or this lacking, the sides of the cocoon not touching anteroventrally; pupa with more or less than 9 respiratory filaments 7

7a. Cocoon with 1-3 lateral openings near anterior margin, the anterior margin usually distinctly convex in profile (Fig. 225-233) 8

7b. Cocoon without lateral openings anteriorly, the anterior margin not distinctly convex in profile 18

8a. Respiratory filaments 4 on very short petioles (Fig. 206) .....
..... *S. snowi* p. 44

8b. Respiratory filaments more than 4 9

9a. Respiratory filaments 6 10

9b. Respiratory filaments more than 6 12

10a. Respiratory filaments short, stout, swollen, with rounded ends (Fig. 199) ..... *S. fibrinflatum* p. 36

10b. Respiratory filaments tapering distally 11

11a. Respiratory filaments usually rather short, the whole organ shorter than length of abdomen beyond end of wing pads (Fig. 208) ..... *S. underhilli* p. 45

11b. Respiratory filaments longer, the whole organ exceeding length of abdomen beyond end of wing pads (Fig. 205) ..... *S. notiale* p. 40

12a. Respiratory filaments 7, the organ consisting of a long ventral filament from which arise dorsally 3 pairs of filaments, the middle pair sometimes sessile (Fig. 202) ..... *S. haysi* p. 36

12b. Respiratory filaments 10 or 12 13

13a. Respiratory filaments 10 14

13b. Respiratory filaments 12 (Fig. 204) ..... *S. luggeri* p. 40

14a. Respiratory organ as in *haysi* but with 10 filaments (Fig. 203) ..... *S. jonesi* p. 38

14b. Respiratory filaments not arising from a long ventral filament 15

15a. Respiratory filaments with the 4 dorsal filaments usually on 2 short petioles, the 6 ventral filaments arranged as 2 pairs with a third filament arising from the petiole of each 16

15b. Respiratory filaments in pairs with petioles of varying lengths, the fourth and fifth pairs (ventral) on rather long petioles and that of the fourth pair noticeably stouter (Fig. 200) ..... *S. dixiense* p. 34

16a. Respiratory organ less than 0.50 length of wing pad, the filaments short, stout, erect and strongly annulated (Fig. 197) ..... *S. aranti* p. 33

16b. Respiratory organ longer, the filaments rather smooth or with a reticulated pattern 17

17a. Respiratory filaments long and slender, the surface smooth (Fig. 207, 216) not showing a distinct reticulate pattern ..... *S. nyssa* p. 42

17b. Respiratory filaments shorter, usually slightly swollen basally, the surface with a distinct reticulate-annulate pattern (Fig. 201, 215) ..... *S. jenningsi* p. 38

18a. Respiratory filaments 4, each pair with a long petiole (Fig. 191) ..... *S. clarkei* p. 26

18b. Respiratory filaments more than 4 19

19a. Respiratory filaments 6 20

19b. Respiratory filaments more than 6 22

20a. Respiratory filaments long, each pair with a long petiole (Fig. 195); anterior margin of cocoon strongly concave in profile (Fig. 222) ..... *S. slossonae* p. 29

20b. Respiratory filaments with shorter petioles (Fig. 211-212); cocoon not strongly concave in profile (Fig. 234-237) 21

21a. Dorsum of thorax with a pronounced reticulate rugosity ..... *S. parnassum* p. 48

21b. Dorsum of thorax smooth or finely granulose ..... *S. tuberosum* p. 48
..... *S. venustum* p. 50
..... *S. verecundum* p. 50

22a. Respiratory filaments 8 (Fig. 209) ..... *S. decorum* p. 47

22b. Respiratory filaments 12 or more 23

23a. Respiratory filaments 12 (Fig. 193) ..... *S. congareenarum* p. 27

23b. Respiratory filaments more than 12 24

24a. Respiratory filaments 16 (Fig. 198) ..... *S. vittatum* p. 29

24b. Respiratory filaments 22-26 (Fig. 194) ..... *S. meridionale* p. 28

Key to Larvae

The larvae of *S. aranti* and *S. notiale* are unknown.

1a. Basal 2 segments of antenna colorless, distal 2 segments dark; postocciput nearly complete dorsally, enclosing cervical sclerites; secondary cephalic fan with few rays, when open forming a flat triangle *(Prosimulium)* 2

1b. Basal 2 segments of antenna partly colored, distal 2 segments seldom of a contrasting dark color; postocciput with a wide gap dorsally, not enclosing cervical sclerites; secondary cephalic fan with many rays, when open forming a cupped fan 4

2a. Antenna distinctly shorter than cephalic fan stem ..... *P. magnum* p. 22

2b. Antenna extending to or beyond cephalic fan stem 3

3a. Cephalic apotome with distinct dark brown anterolateral head spots (Fig. 240); respiratory histoblast with 16 filaments arising from 3 main branches ..... *P. mixtum* p. 22

3b. Cephalic apotome without distinct dark brown anterodorsal head spots (Fig. 241); respiratory histoblast with 16 slender filaments arising from a swollen club (Fig. 287) ..... *P. rhizophorum* p. 23

4a. Abdomen with single transverse bulge on segment 8; postgenal cleft narrow and shallow, acutely pointed, V-shaped *(Cnephia)* ..... *C. mutata* p. 24

4b. Abdomen without transverse bulge on segment 8, but may have 2 ventral tubercles; postgenal cleft wider and deeper, or if small, then squared 5

5a. Front margin of hypostomium convex, the teeth usually rather small, larger corner tooth not extending forward of median tooth (Fig. 266, 267) *(Cnephia)* ..... *C. ornithophilia* p. 25
..... *C. pecuarum* p. 25

5b. Front margin of hypostomium truncate or concave, the corner teeth extending as far anteriorly as the median tooth *(Simulium)* 6

6a. Ventral tubercles of abdominal segment 8 large and conical; postgenal cleft usually not pointed anteriorly; suboesophageal ganglion and epidermis of postgenal cleft not distinctly black; spots of cephalic apotome, if present, dark 7

6b. Ventral tubercles of abdominal segment 8 absent or small and rounded, inconspicuous; postgenal cleft usually either pointed anteriorly or suboesophageal ganglion and/or epidermis of postgenal cleft distinctly black, or both; spots of cephalic apotome light or dark 12

7a. Second antennal segment without hyaline bands 8

7b. Second antennal segment with several hyaline bands 11

8a. Abdominal tubercles large, stout, blunt and tending to be directed posteriorly ..... *S. haysi* p. 36

8b. Abdominal tubercles slender and acute, directed ventrally 9

9a. Cephalic apotome pale yellow dorsally with a single, dark posterior blotch, the sides of the blotch diverging posteriorly (Fig. 247); head spots within this blotch often pale; area posterior to hypostomium pale, contrasting with the darkened sides (Subgenus *Byssodon*) ..... *S. meridionale* p. 28

9b. Cephalic apotome pale with several darker spots; area posterior to the hypostomium not contrastingly paler than the sides 10

10a. Two setae on each side of the hypostomium ..... *S. slossonae* p. 29

10b. At least 3 setae on each side of the hypostomium ..... *S. dixiense* p. 34
S. jonesi p. 38
S. nyssa p. 42

11a. Corner teeth of hypostomium about equal in size to median tooth (Fig. 268) ..... *S. clarkei* p. 26

11b. Corner teeth of hypostomium massive, extending well forward of median tooth (Fig. 269) ..... *S. congareenarum* p. 27

12a. Suboesophageal ganglion and epidermis in postgenal cleft not black; abdomen not darkened 13

12b. Suboesophageal ganglion and epidermis in postgenal cleft black; abdomen mostly dark 21

13a. Spots on cephalic apotome dark on a paler ground 14

13b. Spots on cephalic apotome pale on a darker ground 19

14a. Postgenal cleft narrowly V-shaped, extending 0.33 distance from posterior margin of head capsule to teeth of hypostomium ..... *S. parnassum* p. 48

14b. Postgenal cleft bulbous, extending 0.50 distance from posterior margin of head capsule to teeth of hypostomium 15

15a. Cephalic apotome pale yellow to brownish yellow with light brown spots; respiratory histoblast with 4, 10, or 12 filaments; full grown larva, 4.5-5.0 mm. long 16

15b. Cephalic apotome yellowish brown with dark brown spots; respiratory histoblast with 6 filaments; full grown larva 5.0-6.0 mm. long 18

16a. Respiratory histoblast with 4 filaments (Fig. 301)..... *S. snowi* p. 44

16b. Respiratory histoblast with 10 or 12 filaments..... 17

17a. Respiratory histoblast with 10 filaments (Fig. 297)..... *S. jenningsi* p. 38

17b. Respiratory histoblast with 12 filaments (Fig. 300)..... *S. luggeri* p. 40

18a. Respiratory histoblast with filaments very stout, with 4 showing externally near base; no evidence of apices curled toward base (Fig. 296)..... *S. fibrinflatum* p. 36

18b. Respiratory histoblast with filaments more slender, usually with 3 showing externally near base; apices clearly curled toward base..... *S. underhilli* p. 45

19a. Infuscation around spots of cephalic apotome not extending beyond inner edge of anterolateral spots (Fig. 255); apex of antenna not extending beyond apex of stalk of cephalic fan; fully grown larvae 8-10 mm. long..... *S. decorum* p. 47

19b. Infuscation around spots of cephalic apotome extending to outer edge of anterolateral spots; apex of antenna extending beyond apex of stalk of cephalic fan; fully grown larvae 6-7 mm. long..... 20

20a. Lateral plate of proleg heavily sclerotized; cephalic fan with less than 48 rays; anal ring with more than 70 rows of hooks; postgenal cleft bordered by a narrow fulvous band..... *S. venustum* p. 50

20b. Lateral plate of proleg lightly sclerotized; cephalic fan with more than 52 rays; anal ring with about 66 rows of hooks; postgenal cleft bordered by a fulvous band..... *S. verecundum* p. 50

21a. Postgenal cleft extending less than 0.50 distance to teeth of hypostomium, lacking narrow anterior extension; second segment of antenna without light spot beyond middle; anal hooks 11-15 per row; fully grown larva 5.5-7.0 mm. long..... *S. tuberosum* p. 48

21b. Postgenal cleft not as above; second segment of antenna with light spot beyond middle; anal hooks 18-27 per row; fully grown larva 9-11 mm. long..... 22

22a. Hypostomium with large median tooth extending well forward of the corner teeth (Fig. 273); second antennal segment with bilobed ventral pale spot; rectal gill with 3 lobes bearing numerous large ventral accessory lobes; postgenal cleft extending 0.50 distance toward apex of hypostomium; posterior sucker with 127-135 rows of hooks; a dark species..... *S. pictipes* p. 31

22b. Hypostomium not with large median tooth extending far beyond corner teeth (Fig. 282); second antennal segment with entire ventral pale spot; rectal gills with 3 lobes, occasionally with small ventral accessory lobes; postgenal cleft extending slightly more than 0.25 distance toward apex of hypostomium; sucker with 67-88 rows of hooklets; a gray species..... *S. vittatum* p. 29

Genus *Prosimulium* Roubaud

Simulium, subgenus *Prosimulium*—Roubaud, 1906. [Paris] Acad. des Sci. Compt. Rend. 143:521. Type-species: *Simulium hirtipes* Fries.

Species of this genus are usually rather large, dull brownish, unicolorous. Adults may be recognized by having only hairlike macrotrichia on the costa not mixed with spiniform macrotrichia; the radial sector forked; the basal section of vein R with hair dorsally; calcipala and pedisulcus absent. Larva has the central tooth of the hypostomium trifid, Figures 262-264, and the last two antennal segments are black in contrast to the two pale basal segments, Figures 239-241. Pupa has prominent tail hooks and the cocoon is loose and irregular in structure, Figure 217.

Prosimulium magnum Dyar and Shannon

Figures 9, 34, 73, 95, 119, 141, 163, 187, 217, 239, 262, 286

Prosimulium magnum—Dyar and Shannon, 1927, Proc. U.S. Nat. Mus. 69(10):6 (female, male, pupa).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349: 26 (female, male, pupa, larva).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:94 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:108 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:20 (female, male, larva, pupa).

This is the most abundant and largest species of *Prosimulium* in the Southeast. It can be recognized by the characters shown in the keys.

Distribution: Eastern North America from Michigan, Connecticut, and Illinois, south to Georgia and Alabama.

Alabama localities: Cypress Creek, near Florence; Six Mile Creek, near Killen, Lauderdale Co.; Little Uchee Creek at Meadows Mill, Lee Co.

Biology: Females of *P. magnum* deposit eggs on the surface of water flowing over dams or rapids. In central and northern Alabama, the eggs are dormant from April until the following January. They are apparently stimulated to hatch by the decreasing temperature of the water. The small, first-instar larvae appear in early January and drift in the current, attaching to any available substrate where the current speed is less than 1 foot per second. Older larvae may endure currents of 3-4 f.p.s. The water temperature apparently delays pupation of the fully grown larvae of this species until there is a peak emergence from late March to early April. Immature forms tolerate water temperatures from 3° to 18°C. in Alabama.

P. magnum is a pest of man and livestock during late March and April. The females feed inside the ears of cattle and bite man on the exposed parts of the body, usually on the uncovered arms and face.

Prosimulium mixtum Syme and Davies

Figures 10, 35, 74, 96, 120, 142, 164, 188, 240, 263

Prosimulium mixtum—Syme and Davies, 1958, Can. Ent. 90:706 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:95 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:108 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 47:20 (female, male, larva, pupa).

A medium-sized species of the *S. hirtipes* group that is difficult to distinguish from other members of the group.

The characters for adults, larvae, and pupae as given in the keys and figures will distinguish *P. mixtum* from other regional species. The senior author has seen specimens from North and South Carolina, Tennessee, Georgia, and Arkansas that appear to be *P. mixtum;* therefore it is probable that this species also occurs in Alabama.

Distribution: Labrador, New Brunswick, Nova Scotia, Quebec, and New York. The records attributed to "*S. hirtipes*" farther south appear to be *P. mixtum,* but until the complex can be studied further the determinations are uncertain. The species is included in this work primarily to alert southeastern collectors to the possibility of a species with 16-filamented, *S. hirtipes*-like pupa.

Biology: This species is univoltine and usually feeds on mammals but occasionally on birds. Immature stages appear to favor small, slow flowing, intermittent streams.

Prosimulium rhizophorum Stone and Jamnback

Figures 11, 36, 75, 97, 121, 143, 165, 189, 241, 264, 287

Prosimulium rhizophorum—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349: 28 (female, male, larva, pupa).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:21 (female, male, larva, pupa).

Characters for separating the adults of this species from *P. mixtum* have not been found. The pupal respiratory organ, Figure 189, and the larval respiratory histoblast, Figure 287, are very distinctive.

Distribution: Alabama, Connecticut, Illinois, Maine, New York, Pennsylvania, and Rhode Island.

Alabama localities: Junction of highways 67 and 278, Blount Co.; Meadows Mill, Lee Co.

Biology: *P. rhizophorum* breeds in small, semi-permanent, woodland streams in Alabama. These streams average about 2 inches deep and 2 feet wide, with clear, cold water (14° to 16°C.). This black fly is believed to be univoltine as mature larvae, pupae, and adults have been collected only in March. Larvae are found in relatively large numbers attaching to bare mud, leaves, moss, and stones in the areas of the fastest current. Pupae are commonly found on dead hardwood leaves and occasionally in sphagnum moss on the bottom of the stream. Larvae were commonly observed feeding upon a small isopod which was always associated with them. Adults have been collected from vegetation along the stream as they rested in sunny openings of the woodland areas.

Genus *Cnephia* Enderlein

Cnephia—Enderlein, 1921, Deutsch, Tierärtzl. Wochenschr. 16:199. Type-species: *Simulium pecuarum* Riley.

This genus, as currently treated in America, is composed of species with a rather wide range of anatomical and biological characteristics. *Cnephia* appears to be intermediate between the genus *Prosimulium* and the subgenus *Eusimulium* of the genus *Simulium.* The characters that define *Cnephia* as here treated are as follows: costa with a mixture of fine hairs

and spiniform macrotrichia; basal section of vein R with setae dorsally; radial sector unbranched; basal cell present; pedisulcus absent or very shallow; male distimere curved and tapering; ventral plate broad.

Subgenus *Stegopterna* Enderlein

Stegopterna—Enderlein, 1930, Arch. f. Klass. u. Phylog. Ent. 1:89. Type-species: *Cnephia richteri* Enderlein.

In addition to the characters given for the genus, the species of this subgenus have a strong calcipala, Figure 69, and the claw of the female is simple or has a very small basal tooth; the distimere, Figure 122, of the male has two apical teeth; the larval hypostomium, Figure 265, has two large lateral teeth with a small median tooth and smaller teeth between; the pupal respiratory organ has 12 to 22 filaments arising at different levels; the tail hooks are long; and the cocoon is irregular in shape.

Cnephia (Stegopterna) mutata (Malloch)

Figures 12, 37, 69, 76, 98, 122, 144, 166, 192, 244, 265, 288

Prosimulium mutatum—Malloch, 1914, USDA, Bur. Ent. Tech. Ser. 26:20 (female).

Cnephia mutata (Malloch)—Nicholson and Mickel, 1950, Minn. Agr. Exp. Sta. Tech. Bull. 192:25 (female, male, pupa).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:38 (female, male, pupa, larva).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:101 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:109 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:25 (female, male, larva, pupa).

This is a medium-sized, grayish-black species with hairs on the basal section of vein R, claw of the female without a basal tooth, calcipala well developed in both sexes, Figure 69, and no pedisulcus present; the distimere of the male with two apical teeth. The cocoon is an irregular mass of threads, and the respiratory organ of the pupa usually consists of 12 filaments arising from two main trunks, Figure 192; segment 8 of the larval abdomen has a single, transverse bulge ventrally.

Distribution: Alaska to Labrador and south to northern California, Utah, and in the Appalachian Mountains to Alabama. It has been reported from Japan, but this record probably refers to a different species. Chromosome studies show that diploid and triploid forms have been found living together in Ontario.

Alabama locality: Wilson Dam, Colbert Co.

Biology: This species is apparently univoltine. Adults emerge in May after overwintering in the larval stage. Larvae inhabit streams with sandy bottoms with abundant grass trailing in the water. Cocoons are found on the undersides of stones and foliage in the water. Adults rarely annoy man, but they have been found feeding in the ears of deer and horses.

Subgenus *Cnephia* Enderlein

In addition to the characters given for the genus, the species of this subgenus have: hairs dorsally on the radial sector of the female; first hind tarsomere of male much broader than that of female; female claw with

strong tooth; male distimere with single apical tooth; abdomen of larva without ventral tubercles on last segment; abdomen of pupa with twisted, often bifurcate or trifurcate hooklets on sides of segments 7 and 8; cocoon loose and irregular.

Cnephia (Cnephia) ornithophilia Davies, Peterson, and Wood

Figures 13, 38, 77, 266

Cnephia ornithophilia—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:102 (female).

This is a large, grayish-brown species closely resembling the usually more abundant *C. pecuarum*. It differs from that species in the slightly larger size and in the shape of the female claw, which has a very narrow slit between the main claw and the basal lobe, compare Figures 77, 78.

Distribution: Louisiana, Mississippi, South Carolina, Virginia, and Ontario. It has not been collected in Alabama, but the known distribution indicates it probably occurs in the state.

Biology: This species appears to be univoltine. Larvae have been collected in South Carolina from January 11 to March 18, and adult females reared from pupae February 6; in Louisiana and Mississippi, females have been collected from February 6 to May 1; in Ontario, adults are present from May 20 to June 2; and in southern Virginia, larvae and pupae were collected and females emerged May 1. In Ontario, one female was collected in an emergence cage in rapids below a dam. In Ontario, the females were found to feed on woodland birds in the forest canopy late in the evening in late May. An adult was collected from a flicker in Mississippi on February 8.

Cnephia (Cnephia) pecuarum (Riley)

Figures 14, 39, 60, 70, 78, 99, 123, 145, 167, 190, 243, 267, 289

Simulium pecuarum—Riley, 1887 Rep. of Ent., Com. Agr. Rep. 1886: 512 (female, male, larva, pupa).

This medium-sized, grayish species is characterized by the shape of the female claw, Figure 78. No means have been found to separate *C. pecuarum* from *C. ornithophilia* except in the female. The male of *C. ornithophilia* is not known, and the larvae and pupae of the two species are apparently indistinguishable.

Distribution: Alabama, Arkansas, Florida, Illinois, Louisiana, Mississippi, Oklahoma, and Texas.

Alabama locality: Meadows Mill, Lee Co.

Biology: *C. pecuarum* has occurred in immense numbers and its massive attacks are reputed to cause the death of many livestock. It breeds most frequently in the bayous of the Mississippi Valley, and emergence probably is heaviest as water recedes after a flood. Adults are present from January to early May, but only one generation is present each year.

Genus *Simulium* Latreille

Simulium—Latreille, 1802, Hist. Nat. Gen. part Crust. Ins. 3:426. Type-species: *Rhagio colombaschensis* Fabricius.

This genus is large and consists of a number of subgenera, some of which are treated as genera by other authors. Six subgenera, one of which is new, are treated in this bulletin. The genus *Simulium* may be recognized by the following combinations of characters: adult having antenna with 9 flagellomeres; radial sector not forked, basal section of vein R bare above; calcipala and pedisulcus present. Larva with the central tooth of the hypostomium not trifid; postgenal cleft rarely reaching the base of the hypostomium; and the anal sclerite with four arms. Pupa has tergum 5 without an anterior row of spines; end of the abdomen lacking cleft or strongly twisted hooklets laterally; without dorsal tail hooks at the end of the abdomen; and the cocoon is regular in form and characteristic of the species.

Subgenus *Eusimulium* Roubaud

Simulium, subgenus *Eusimulium*—Roubaud, 1906, [Paris] Acad. des. Sci. Compt. Rend. 143:521. Type-species: *Simulium aureum* Fries.

This subgenus has the characters of the genus *Simulium* but differs from most of the other subgenera in having hairs on the base of vein R and the claws of the female with a prominent basal projection. Certain species of *Cnephia* have claws similar to *Eusimulium*, but in *Cnephia* there is a small basal cell in the wing and the pedisulcus is absent or vestigial. The pupal respiratory filaments of *Eusimulium* are usually four in number, and the larva has ventral papillae at the end of the abdomen.

Simulium (Eusimulium) clarkei, new species

Figures 100, 124, 146, 168, 191, 218, 246, 268, 290

Female: Unknown.

Male: Antenna black, clypeus pale grayish, with abundant, long, pale hair. Palpus brown, with mixed brown and pale hairs. Scutellum yellowish, with long, erect, yellowish-brown hair. Postnotum covered with gray pollinosity. Pleuron reddish brown, with thin gray pollinosity; pleural tufts pale. Wing 2.4 mm. long; veins pale; hairs of stem vein brown. Halter brown. Legs pale yellowish brown, the tarsi darker. Abdomen reddish brown; basal fringe light brown. Terminalia as shown in Figures 100, 124, 146, 168.

Pupa: Length 2 mm. Trichomes absent from head. Trichomes on thorax long, pale, simple, with three on each side of midline. Respiratory organ longer than pupa, Figure 191, with 2 pairs of filaments; dorsal pair with long, stout, somewhat annulate petiole; ventral pair also with long, slender, petiole, arising just beyond base of dorsal pair and shorter than dorsal pair. Terga 3 and 4 each with 4 hooklets on each side near posterior margin; 6 to 9 with a small irregular patch of hooklets on each side; tail hooks very small; sternum 6 with 2 hooklets on each side, 7 with only one pair. Cocoon as shown in Figure 218.

Larva: Length 4.5-5.5 mm. Cephalic apotome pale yellow with a pale brown pattern as shown in Figure 246. Postgenal cleft extending about 0.33 of way to hypostomium, subrectangular. Hypostomium, Figure 268, with 3 large and 3 smaller lateral setae. Main cephalic fan with 52-54 filaments. Pupal respiratory histoblast as in Figure 290. Rectal gills multiple. A pair of long, conical tubercles near apex of abdomen ventrally.

Holotype: Male, with associated pupal exuvium and cocoon, Blackwater Swamp, Prince George Co., Virginia, April 19, 1942 (USNM 68977) (Clarke).

Paratypes: 8 larvae, 1 pupa, 2 pupal exuviae, Morristown, Hamblen Co., Tennessee; April 19, 1955, (Snow).

This species is named after J. F. G. Clarke of the U.S. National Museum, who first found it in southern Virginia. A single pupa, probably of this species, was collected at Florence, Alabama, April 21, 1954, but the specimen has not been re-examined so it is not included in the type series.

Biology: Available material does not offer much biological information. Pupae were collected on the same day of the month in different years on opposite sides of the Appalachians.

Simulium (Eusimulium) congareenarum (Dyar and Shannon)

Figures 15, 40, 79, 101, 125, 147, 169, 193, 220, 221, 242, 269, 291

Eusimulium congareenarum—Dyar and Shannon, 1927, U.S. Nat. Mus. Proc. 69(10):20 (female).

Simulium (Eusimulium) congareenarum—Jamnback and Stone, 1957, Ann. Ent. Soc. Amer. 50:395 (female, male, larva, pupa).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:36 (female, male, larva, pupa).

Simulium congareenarum—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:107 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:110 (larva).

Adult is small with a bluish-gray scutum in the female and yellowish-brown legs in both sexes. This is an atypical *Eusimulium* and is similar to *Cnephia* in some characters. The pedisulcus is not as deep as in most species of *Simulium;* there is a small basal cell; the hypostomium approaches that of *Cnephia mutata,* and the respiratory organ of the pupa has more filaments than usual for the subgenus. For the present it is preferable to retain it in the taxon where originally placed.

Distribution: Ontario to Florida and Louisiana; the localities, except for those in Ontario, are in the coastal plain.

Alabama locality: Meadows Mill, Lee Co.

Biology: The rather conflicting biological information available supports the possibility that this actually is a species complex. It may be univoltine, the species overwintering as eggs or larvae. Larvae are most abundant in April, less abundant in May, and scarce in June. However, adults begin to emerge in February and the first females were collected in early March at Meadows Mill, Lee County, Alabama. Adults feed on turkeys and ducks and apparently are not attracted to man.

Subgenus *Byssodon* Enderlein

Byssodon—Enderlein, 1925, Zool. Anz. 62:209. Type-species: *Simulium forbesi* Malloch = S. *meridionale* Riley.

Females of this subgenus have a claw with a strong basal projection as in *Eusimulium,* Figures 80, 81, but they lack the hairs on the dorsobasal section of vein R. Some *Cnephia* species have similar claws, but in these species the basal section of vein R is hairy and the pedisulcus is shallow or absent. The ventral plate of the male terminalia is broad; the larva has a pair of ventral tubercles at the end of the abdomen.

Simulium (Byssodon) meridionale Riley

Figures 16, 41, 61, 80, 102, 126, 148, 170, 194, 219, 247, 270, 292

Simulium meridionale—Riley, 1887, Rep. of Ent., Com. Agr. Rep. 1886; 513 (female)[4].—Stone, 1952, Proc. Ent. Soc. Washington 54:94 (female, male, pupa).
Simulium occidentale—Townsend, 1891, Psyche 6:107 (female).—Nicholson and Mickel, 1950, Minn. Agr. Exp. Sta. Tech. Bull. 192:47 (female, male).
Simulium tamaulipense—Townsend, 1897, J. N.Y. Ent. Soc. 5:171 (female).
Simulium forbesi—Malloch, 1914, USDA, Bur. Ent. Tech. Ser. 26:63 (females, male, pupa).

The female of this species is small and gray, with three narrow dark lines on the scutum, Figure 61, and the frons pollinose. The ventral plate of the male terminalia is broad with no median notch, Figures 102, 148. The distimere is short and truncate, Figure 126, and the scutum lacks silvery spots. The cocoon is pocket-shaped and the pupal respiratory organ consists of 22 to 26 filaments. The larva has a pair of prominent ventral tubercles on segment 8, the antenna lacks hyaline bands, the cephalic apotome is as shown in Figure 247, and the respiratory histoblast is scarcely concave posteriorly, Figure 292.

Distribution: S. *meridionale,* as now recognized in this country, may represent a group of sibling species. Consequently, the distribution given here may exceed the true range. The species is reported from Alaska to Indiana and south to California, Florida, and Mexico. As S. *meridionale* was described from Mississippi, it is presumably the correct name for the Southeastern species and this name would only be endangered if it became evident that S. *meridionale* represents a subspecies or synonym of the Palearctic S. *maculatum* Meigen.

Alabama localities: Frisco City, Monroeville, Monroe Co.; Flatwood, Wilcox Co.

Biology: This species is multivoltine, with at least four generations per year, overwintering in the egg stage. Larvae and pupae are found in large rivers attached to small rocks or grass blades 2 to 6 inches below the surface of the water. Adults have been collected from March 16 to December 24 and they have been reported 15 miles from a known breeding site. This is the turkey gnat of the Mississippi Valley, and it is a serious pest of turkeys, chickens, and pheasants. It is known to transmit *Leucocytozoon smithi* to

[4] The larva, pupa, and possibly the male of the original description and many subsequent ones were misidentified. They were apparently members of the S. *venustum* group and probably S. *tuberosum* (Lundstroem).

turkeys. DeFoliart and Rao *(2)* have described in detail the feeding of this species on man during autumn in Wisconsin and suggested that it might transmit encephalitis to him.

Simulium (Byssodon) slossonae Dyar and Knab

Figures 17, 42, 62, 81, 103, 127, 149, 171, 195, 222, 245, 271, 293

Simulium slossonae—Dyar and Shannon, 1927, U.S. Nat. Mus. Proc. 69(10): 34 (male).—Underhill, 1944, Va. Agr. Exp. Sta. Tech. Bull. 94:21 (female, male, pupa, larva).

A small, shining black species, with a shining black frons in the female. The thorax of the male, Figure 62, is mostly shiny, with only an anterior patch and a transverse median band or pair of opaque, velvety black spots. The cocoon is simple, Figure 222, and the pupa bears a long, 6-filamented respiratory organ, the three pairs of filaments with long petioles, Figure 195.

Distribution: Alabama, North Carolina, Florida, Georgia, Mississippi, South Carolina, Texas, and Virginia.

Alabama localities: Escambia Co.; Lewis Creek at Highway 43, Washington Co.

Biology: *S. slossonae* breeds in the swamp rivers of the South and is abundant in Florida. It was collected from January to late December, except in June and September. There are probably several generations a year. It has been reported to feed on turkeys in Virginia *(10)*, and the shape of the tarsal claw suggests that birds are the normal hosts.

Subgenus *Psilozia* Enderlein

Psilozia—Enderlein, 1936, Gesell. Naturf. Freunde, Berlin Sitzber. 1936: 113. Type-species: *P. groenlandica* Enderlein = *S. vittatum* Zetterstedt.

This subgenus may be recognized by the following characters: female ashy gray with diffuse dark stripes on the scutum, Figure 63, and black abdominal pattern; basal section of vein R bare above; first hind tarsomere narrow, calcipala small, ending well before pedisulcus; claw large, untoothed; anal lobe directed ventrally, triangular, Figure 43. Male distimere short, flattened, with 2 to 5 teeth, Figure 128. Pupa with thoracic trichomes well developed; respiratory organ with 10 to 24 slender filaments; terga 6 to 8 with combs of small teeth; cocoon simple, pocket-shaped, Figure 223.

Simulium (Psilozia) vittatum Zetterstedt

Figures 18, 43, 63, 64, 82, 104, 128, 150, 172, 198, 223, 249, 272, 294

Simulium vittatum—Zetterstedt, 1838, Insecta Lapponica, 1838-40: 803 (female).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:57 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92: 125 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:114 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:40 (female, male, larva, pupa).

The female of this medium-large species is readily recognizable by the generally pale gray color with five darker lines on the scutum, Figure 43, and a pattern of black spots on the abdomen. The male has a short, stout

distimere, Figure 128, with three teeth, and the legs are bicolored. The pupa has a firm, simple cocoon, Figure 223, and there are 16 respiratory filaments, Figure 198.

Distribution: Alaska and Greenland south to California, Texas, Louisiana, and Georgia, but has not been found south of 29°N. latitude. Southern records are Uvalde, Texas, and Baton Rouge, Louisiana.

Alabama localities: Fort Payne, DeKalb Co.; Florence, Lauderdale Co.; Wheeler Dam, Lawrence Co.; Parkerson's Mill Creek west of Auburn, Lee Co.; Flint, Morgan Co.; Haleyville, Winston Co.

Biology: *S. vittatum* is one of the most abundant and widespread species of black flies in Alabama, common everywhere except in coastal areas. It has a broad range of habitats, occurring with *S. decorum* and *S. tuberosum* in water relatively free of pollution, and in habitats intolerable for other species; e.g. streams with high temperatures, low pH and oxygen tension, and receiving sewage effluent, silt, or other undesirable water-borne materials.

S. vittatum is multivoltine, with at least seven generations per year in Alabama. Reproduction is slowed during the winter months but does not cease. Females readily feed on pastured livestock, seeking the inside of the ears as the most desirable feeding site. They occasionally bite man but are usually considered only a nuisance in flying about the face and ears. Males and females are commonly collected from plant blossoms near the habitat. During warm weather they swarm in open areas near the streams, but in winter they swarm over sun-warmed rocks. Females deposit eggs on almost anything at or near the surface of the water. Larvae will tolerate temperatures from 0° to 33°C. and water speeds from 0.5 to 6 f.p.s. Larvae are able to utilize organic matter directly without food chain conversions. When an abundance of food is available, they form a dense, slippery carpet on the surface of dams and outflows of impoundments, making it extremely hazardous to walk in the area.

Subgenus *Hagenomyia* Shewell

Simulium, subgenus *Hagenomyia*—Shewell, 1959, Can. Ent. 91:83. Type-species: *Simulium pictipes* Hagen.

This subgenus is distinguished from the other subgenera included here by having vein R bare dorsally, the female claw simple, Figure 83, the head and thorax conspicuously gray pollinose and the scutum with three narrow dark lines, Figure 65, the tibiae without bright white patches, sternum 7 of the female with a conspicuous fringe of long hairs, and the anal lobe with a large, highly polished, ventral prolongation, Figure 44. The male distimere is long and flattened without an apical tooth, Figure 129, and without a basal projection; the ventral plate is broad with a broad median notch, Figure 105. The cocoon is reticulate and has a broad collar at a distinct angle to the surface so that it is boot-shaped, Figure 224. The larva is exceptionally long and slender, evenly expanded posteriorly with the seventh abdominal segment strongly bulbous ventrally and the hypostomium with 8 to 11 hairs on each side, Figure 273.

Simulium (Hagenomyia) pictipes Hagen

Figures 19, 44, 65, 66, 71, 83, 105, 129, 151, 173, 224, 250, 273, 295

Simulium pictipes—Hagen, 1880, Proc. Boston, Soc. Nat. Hist. 20:305 (female, male, pupa).—Johannsen, 1903, N.Y. State Mus. Bull. 68:374 (female, male, larva, pupa).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:74 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:120 (female, male, pupa)—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:113 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:42 (female, male, larva, pupa).

This is a large, dark grayish species. The frons is broad and pollinose. The scutum is gray and in the female has three dark stripes, Figure 65. The characters in the key readily distinguish this species from the only closely related species, *S. longistylatum* Shewell.

Distribution: Alabama, Arkansas, Georgia, Maryland, Michigan, Minnesota, New York, North Carolina, Pennsylvania, South Carolina, Virginia, West Virginia, and Wisconsin to Ontario and Quebec.

Alabama localities: Elgin, Florence, Killen, and Edgewater Beach, Lauderdale Co.; Meadows Mill, Lee Co.

Biology: *S. pictipes* has seven generations per year in Alabama. The species overwinters as mature larvae with occasional pupation between late November and late February.

Males of *S. pictipes* apparently emerge a little earlier than females. They take a position over the pupal beds or above the rapids just below the beds and await the emerging females, which are contacted as soon as they leave the water. When populations of flies are heavy and habitat space is scarce, the males build up mating swarms in layers facing upstream if there is no wind, but into the wind if a breeze is present. The males of *S. pictipes* form coneshaped swarms over the pupal beds. These swarms range up to 15 feet wide at the bottom and taper to a point 10 to 12 feet above the water. The males at the bottom of the swarm hover about 2 inches apart, but at the 10-foot level they may be up to 12 inches apart. Flies in the outer group have an up-and-down rhythm in their flight pattern. They all remain within the general limits of a fixed position from each other. Flies in the bottom layers are generally emaciated, and their abdomens are only a fraction of their original size; the upper parts of the swarms are in prime condition. As the flies in the lower part of the swarm die from exhaustion or mate and leave the swarm, those in the upper layers move down. The males generally grasp the females as they emerge from the pupal beds and mating occurs immediately. A male sometimes grasps another male but releases him quickly. This occurs generally when the flight pattern is interrupted by a predator or when the light intensity decreases in the late afternoon. The males may fly all night when the air temperature permits (15°C. or more).

In central Alabama, *S. pictipes* lays eggs from early March to November. Females deposit eggs on rocks where a thin sheet of water is rising and falling over the substrate. In the absence of rocks, they oviposit on sticks and plants in the current. Females swarm for oviposition over the crest of waterfalls, flying down to touch their abdomens to the substrate as

the water oscillates over the surface. They deposit 5 to 8 eggs at each touch. *S. pictipes* normally oviposits in the early morning (6:00-9:00) and late afternoon (5:00-7:30), but when the weather is cool and cloudy they oviposit all day. Oviposition sites commonly contain bodies of females entangled in the matrix of sticky eggs that sometimes builds up to 5-10 mm. thick. Eggs are ovate, with a slight swelling on one side. When first laid they are yellow-white, but turn yellow by the end of the first day, light brown to dark brown the second day, and by the third day most eggs are black and a few larvae may emerge. If the water temperature remains high (24-27°C.), about 90 per cent of the eggs hatch the fourth day and 10 per cent remain dormant. The dormancy of some eggs may be a safety factor to protect the species when a catastrophe destroys the first hatch of larvae.

When the larvae emerge from the egg masses, they drift in the current on a silken thread. The first-instar larvae generally attach to the substratum where the current speed is 1 f.p.s. or less. As they grow larger they move to where the flow rates are higher. The sixth-instar larvae are commonly found in water currents of 4-5 f.p.s. Larvae gather in large numbers to form dense black carpets on water falls and in rapid currents flowing over sedimentary rocks. Larvae of *S. pictipes* spin pupal cocoons which resemble minature brown suede boots. The generations are very distinct in the early part of the year, but by mid-summer a mixture of all instars are observed. Females of *S. pictipes* are serious pests of horses and cattle pastured in areas where large populations of the flies are present. They seek the insides of the ears of animals as feeding sites. *S. pictipes* will physically force other species of *Simulium* from the ears of the animals by alighting between them and pushing them aside. The junior author was bitten by this species on two occasions.

Subgenus *Phosterodoros*, new subgenus

Type-species: *Simulium jenningsi* Malloch.

This is a group of 11 species, all treated in this bulletin, that form a natural group that is sufficiently well defined to constitute a subgenus of *Simulium*. The combination of characters that differentiate *Phosterodoros* from other species of the genus are as follows:

Female: Rather small, dark, shiny. Frons broad, not greatly widened above. Antenna with scape and pedicel yellow brown, flagellum dark with short, pale pile. Wing with no hair on basal section of vein R above nor on under surface of subcosta; halter pale, the stem darkened. Fore coxa yellow, mid and hind coxae darker, trochanters yellow, fore tarsus dark, fore tibia and first three tarsomeres somewhat flattened; calcipala short, truncate; pedisulcus deep; claws simple.

Male: Scutum with a dark, velvety background and a pair of anterior oblique or triangular iridescent spots. Sides and posterior declivity of scutum gray, shiny, denuded. Terga 2, 5, 6, and 7 each with a pearlaceous lateral spot; distimeres moderately elongate, flattened, simple. Ventral plate in ventral view with mid portion parallel-sided or widened distally, with a

few teeth along each margin laterally and long ventromedian hairs. Each arm of ventral plate with a median posterior projection.

Pupa: Dorsum of thorax smooth; trichomes few, small, simple. Respiratory organ of 4 to 12 filaments. Terga 3 and 4 each posteriorly with 4 hooklets on each side; tergum 8 with a few hooklets on each side near middle; tergum 9 with very small conical tail hooks; sterna 5 to 7 each with 4 hooklets on posterior margin, those on 5 in 2 pairs, those on 6 and 7 widely, evenly spaced. Cocoon rather short, the anterior margin convex in profile and the sides usually only narrowly connected anteroventrally if at all (greatest development of anteroventral connection in S. *luggeri*); a large aperture near anterior of each side, sometimes subdivided into two smaller apertures, posterior half of cocoon floored.

Larva: Antenna 4-segmented, the terminal segment minute. Postgenal cleft broad, rounded, or broadly angulate anteriorly, narrowed posteriorly. Suboesophageal ganglion pale; rectal gills compound.

The name of this subgenus is derived from *phoster* = window and *doros* = wallet, in reference to the windows in the side of the cocoon. The subgenus ranges from the Northwest Territory of Canada to Maine and south to Texas and Florida, reaching its greatest development in the southeastern United States.

Biology: The subgenus *Phosterodoros* includes nearly 40 per cent of the species presented in this bulletin. These closely related species have no peers in adaptive radiation. Because of their tolerance of various conditions (temperature, pH, etc.) or their ability to compete more effectively for food and habitat space than other species, they have adapted to a great variety of environmental niches that were either vacant or formerly filled by species of a more temperate environment unable to compete for the choice habitat space.

The basic similarities of all members of the group indicate a common ancestry, perhaps stemming from a basic type of the very tolerant and widespread S. *jenningsi*. The group appears to be somewhat subtropical in origin as evidenced by its tolerance of high temperature and marked development in the Southeast. The shifting of land masses in the southern part of North America during the past few million years may be a factor in substantiating the hypothesis that changes in the physical and organic environment cause a rapid increase in speciation.

The inland species prefer river weed (*Podostemon ceratophyllum* Michaux) growing in rapids (2.5-3.5 f.p.s.) of both large and small unpolluted streams as substrate for attachment of the immature forms. Some will tolerate a slower speed and others a little higher than the optimum for the group, but their numbers decrease as they populate less desirable water speeds. The species of this group that occur in swamp streams of the coastal plain also prefer green plant material for attachment.

Simulium (Phosterodoros) aranti, new species

Figures 20, 45, 106, 174, 197, 214, 225, 251, 274

The female of this species is distinguished from other members of *Phosterodoros* by a pair of short stripes on the scutum, pale or dark depending

on the light angle. The pupa has a very short respiratory organ of 10 strongly annulated filaments.

Female: (Description based on slightly teneral specimens removed from alcohol or in alcohol.) Frons dark brown, subshining, clothed with short, scattered pale hairs; width at narrowest about equal to height of eye above this level. Vertex and postocular area with mostly pale hair. Clypeus about as broad as long, thinly gray pollinose with rather long, scattered, pale hair. Palpus brown. Thorax dark brownish, subshining with abundant, short, pale yellowish to brownish, recumbent hairs. Humerus orange brown. Scutum with a thin grayish pollinosity along anterior margin and sides and a pair of tapering stripes from the anterior margin to about the level of wing bases, pale in anterior view, dark when viewed from the posterior. Scutellum reddish brown with dark brown hairs. Legs with the usual color pattern for the subgenus. Wing length 2.5 mm. Tergum 1 pale centrally, terga 3 to 5 opaque dark brown, 6 to 9 shiny brown. Terminalia as shown in Figure 20.

Male: All available specimens mounted on slides so color pattern was not visible. Terminalia as shown in Figures 106, 174.

Pupa: Length 2.25 to 2.75 mm. Dorsum of thorax smooth, the head with 2 pairs of short simple trichomes, the thorax with 2 somewhat longer trichomes on each side. Respiratory organ, Figure 197, short, compact, less than 0.50 length of wing pad, with 10 strongly annulated filaments, Figure 214, arranged as 2-2-3-3, although the 4 dorsal filaments are not always clearly paired. Cocoon, Figure 225, with lateral aperture crossed by one or two longitudinal strands.

Larva: Unknown.

Holotype: Female, Swamp Creek, Rockford, Coosa Co., Alabama, June 12, 1964 (USNM 68978) (Snoddy).

Paratypes: 7 males, 21 females, and 5 pupae; same data as holotype; 3 males and 2 females, Elkahatchee Road at Russell Mills Dam, Tallapoosa Co., Alabama, June 13, 1964 (all Snoddy).

This species is named for F. S. Arant of the Department of Zoology-Entomology of Auburn University.

Biology: This species was collected in streams with water temperatures of 18°-21°C. in early June. The species appears to be univoltine and probably overwinters in the egg stage as it has been collected only in the early summer. It prefers medium-sized streams with water of relatively high quality. It was collected almost exclusively from river weed (*Podostemon ceratophyllum* Michaux) in shallow rapids. *S. aranti* was commonly associated with *S. fibrinflatum*.

Simulium (Phosterodoros) dixiense, new species

Figures 46, 200, 226

Adults and larvae of this species appear indistinguishable from several other members of the subgenus although not the same species for females, males, and larvae. The pupa differs from all others of the subgenus by having 10 respiratory filaments divided into 5 pairs.

Female: Frons shiny black, the width at narrowest level slightly less than height of eye above this level. Vertex and postocular area with dark brown hairs. Scape and pedicel orange, flagellum black. Clypeus distinctly longer than wide with a thin gray pollinosity and a few yellowish-brown hairs. Palpus dark. Thorax dark brown. Scutum shiny with slightly pearlaceous gray pollinosity anterolaterally, but not forming well-marked spots; fine recumbent hairs of scutum yellowish brown. Scutellum black with erect dark hairs along margin; postnotum dark. Pleuron dark with thin gray pollinosity. Fore and hind femora yellowish basally; mid femur yellow; fore tibia blackish except for large white dorsal spot on basal 0.75; mid tibia dark with a white streak on basal 0.50 dorsally; hind tibia dark with a white area on basal 0.50 dorsoposteriorly; tarsi dark, the hind basitarsus mostly yellow. Wing length 2.0 mm; fine hairs of costa yellowish brown; hairs of stem vein dark. Abdomen dark, yellowish basally, the first 5 terga mat, the last 4 shiny; cercus and anal lobe as shown in Figure 46.

Male: Anterior 0.66 of scutum deep black with fine, recumbent, dark coppery hair; a pair of large white, somewhat iridescent spots on front of scutum, the inner margin of each rounded so that the intervening dark space widens anteriorly. Abdomen deep black with the usual pearlaceous spots; color otherwise as in female. Terminalia not distinguishable from those of *S. jenningsi* or *S. luggeri.*

Pupa: Length 2.6 mm. Trichomes of head not evident; of thorax strong, erect, three on each side dorsally, a smaller trichome lateral of these. Respiratory organ, Figure 200, of ten filaments arranged in five pairs, the second from the top usually sessile, the fourth pair stouter than the others with the petiole usually the longest. Cocoon, Figure 226, somewhat longer and lower than usual for the subgenus with the anterior margin more sloping and less convex.

Larva: Probably not distinguishable from *S. jonesi* or *S. nyssa* unless the respiratory filaments are dissected out from the histoblast and their arrangement determined.

Holotype: Female, with associated pupal exuvium and cocoon, Lewis Creek, Washington Co., Alabama, November 6, 1965 (USNM 68979) (Snoddy).

Paratypes: 1 pupa and 1 pupal exuvium, Burnt Corn Creek, Escambia Co., Alabama, June 1, 1963; 1 pupal exuvium, Meadows Mill, Lee Co., Alabama, March 1, 1965; 1 pupa and 7 pupal exuviae, Sand Hill Creek, Mobile Co., Alabama, March 11, 1965; 6 males, 1 female, 6 larvae, and 2 pupae, Lewis Creek, Washington Co., Alabama, November 6 and 7, 1965 (all Snoddy). One pupa, Shaw Creek at Highway 191, Aiken Co., South Carolina, March 25, 1954; 3 males, 1 female, 1 pupa, and 8 pupal exuviae, Cedar Creek, Congaree, Richland Co., South Carolina, April 7, 1964 (all Stone).

The authors derived the name for this species from the nickname for the southeastern portion of the United States.

Biology: This species is believed to be multivoltine as exuviae were collected in early March and larvae and pupae taken in November. *S. dixiense* prefers the small swamp streams of the Southeast and in Alabama have been

taken only from the Lower Coastal Plain. It is commonly collected in streams 6-8 inches deep and 3-4 feet wide with sandy bottoms. Larvae and pupae prefer green plant material, as do most species of the subgenus, and are collected from grasses and *Juncus* sp. Generally, they were taken where the stream was constricted by a narrow channel or where some object acted as a dam causing an increase in the rate of flow to 1-3 f.p.s.

S. *dixiense* is sometimes collected with S. *slossonae* and more rarely with S. *jonesi*. It appears to prefer smaller streams of a lower temperature than do S. *jonesi* species.

Simulium (Phosterodoros) fibrinflatum Twinn

Figures 21, 47, 84, 107, 130, 152, 175, 199, 227, 248, 275, 296

Simulium fibrinflatum—Twinn, 1936, Can. J. Res., D. 14:141 (female, male, pupa).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:66 (female, male, pupa, larva).—Davies, Peterson and Wood, 1962, Proc. Ent. Soc. Ont. 92:114 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:111 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:44 (female, male, pupa, larva).

Adults of this species are similar to S. *haysi* and S. *snowi*, and satisfactory characters that will separate them in a key have not been discovered. It is possible that S. *fibrinflatum* is a bit larger and browner than the nearly black S. *haysi*. The 6 stout, smooth, blunt respiratory filaments, Figure 199, readily distinguish the pupae, although there is some variation in their thickness and length. The larva is very difficult to distinguish from that of S. *jenningsi* and the respiratory histoblast, Figure 296, provides the only certain character.

Distribution: Alabama, Georgia, Maine, New York, North Carolina, Pennsylvania, Virginia, and West Virginia to Ontario.

Alabama localities: Fort Payne, DeKalb Co.; Little River Canyon, Cherokee-DeKalb county line; Burnt Corn Creek, Brewton, Escambia Co.; North Fork Creek, Russell Co.; Elkahatchee Creek, 6 miles east of Alexander City, Tallapoosa Co.

Biology: Two forms of S. *fibrinflatum* appear to exist in Alabama. The typical form has short, swollen filaments, but the less common form has longer, thinner filaments. This species is multivoltine with at least three generations per year. It apparently overwinters in the egg stage, as larvae were not commonly collected until early June. Adults have not been observed feeding on animals.

The immature stages were generally collected from plants in rapid areas of streams. The typical form is commonly associated with S. *nyssa* in the small cold streams of central and northern Alabama, whereas the typical form is collected with S. *haysi* in the large streams of the Lower Coastal Plain.

Simulium (Phosterodoros) haysi, new species

Figures 22, 52, 202, 228, 252, 298

This species is very similar to other members of the subgenus. Adults apparently are not distinguishable from S. *fibrinflatum* or several other

species, but immature forms are quite distinct. The pupal respiratory organ has 6 filaments arising from a long ventral one, usually as 3 pairs. The larva has a pair of rather large, stout, blunt, ventral tubercles.

Female: Frons shiny black, the width at narrowest level slightly less than height of eye above this level. Vertex and postocular area without hairs. Antenna almost black, the scape and pedicel rarely paler. Clypeus distinctly longer than wide with a thin gray pollinosity. Palpus blackish. Thorax nearly black, the humeri somewhat yellowish. Scutum shiny with fine, recumbent, dark brown hairs but no pale pollinose anterior spots. Scutellum blackish with erect, black, marginal hairs; postnotum dark brown. Pleuron mostly dark with thin gray pollinosity. Legs mostly dark brown to black, the fore coxae and bases of all femora yellowish; most of mid and hind tarsomere 2 and hind tarsomere 3 pale basally; most of anterior part of fore tibia, dorsal basal 0.33 of mid tibia, and basal 0.50 of hind tibia shiny white. Wing 1.6-1.9 mm. long; hairs of stem vein black. Abdomen dark, the first 5 terga mat, the last 4 shiny. Terminalia as shown in Figures 22, 52.

Male: Anterior 0.66 of scutum deep black except for two large, iridescent spots that diverge anteriorly and posteriorly. Abdomen black, the pearlaceous spots scarcely visible because of shrinkage during drying. Terminalia as in S. *jonesi,* Figure 109.

Pupa: Length 2.5 mm. At least 1 pair of fairly large, simple, trichomes on head; and 3 or 4 pairs of large and 1 or 2 small trichomes on the thorax. Respiratory organ, Figure 202, with 7 slender filaments, usually arranged as 3 rather long petiolate pairs arising from a long ventral filament; entire organ about 1.5 mm. long.

Larva: Very similar to other members of the subgenus, but there is a pair of rather large ventral tubercles at the end of the abdomen.

Holotype: Female (on slide with pupal exuvium), Burnt Corn Creek, Brewton, Escambia Co., Alabama, September 20, 1964 (USNM 68980) (Snoddy).

Paratypes: 1 male and 2 females, Styx River, Baldwin Co., Alabama, August 20, 1963; 4 males and 3 females, April 25, 1964; 1 female, June 1, 1964; 1 male, August 28, 1963; 1 male and 1 female, September 20, 1964; all Escambia Co., Alabama (all Snoddy). Additional material was collected at the above localities and in Blackwater Creek, Baldwin Co., Alabama.

The authors named this species in honor of Dr. Kirby L. Hays of the Zoology-Entomology Department, Auburn University.

Biology: This tiny, black simuliid is found only in the large streams of the Lower Coastal Plain. It is multivoltine with three or more generations per year, apparently overwintering in the egg stage as no larvae, pupae, or adults have been collected during the winter months. It is common from June to September. S. *haysi* is a subordinate species associated with the undescribed form of S. *fibrinflatum.* Immature forms are generally collected from aquatic grasses and sedges in the rapid, shallow areas of large streams. They occur in small numbers. Adults have never been observed attacking man or other animals.

Simulium (Phosterodoros) jenningsi Malloch

Figures 23, 48, 85, 108, 131, 153, 176, 201, 215, 229, 253, 277, 297

Simulium jenningsi—Malloch, 1914, USDA, Bur. Ent. Tech. Ser. 26:41 (female, male, larva, pupa).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:69 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:118 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:112 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:44 (female, male, larva, pupa).

Simulium nigroparvum—Twinn, 1936, Can. J. Res., D, 14:142 (female, male, pupa).—Cox, 1938, J. Ag. Res. 57:443-449 (female anatomy).—Underhill, 1944, Va. Agr. Exp. Sta. Tech. Bull. 94:1-32 (female, male, pupa, larva).

The pale spots on the anterior portion of the scutum are more iridescent and with a more intense pinkish reflection than in most of the other species of the subgenus. The pupa has 10 filaments arranged as 2-2-3-3 going from the dorsoposterior to the ventroanterior filaments, Figure 201. This arrangement is also found in *S. aranti* and *S. nyssa,* but the three species may be separated by the differences in length of the filaments as well as the surface structure of the respiratory filaments as shown in Figures 214 to 216.

Distribution: Because of the apparent impossibility of distinguishing *S. jenningsi* from *S. nyssa* except in the pupal stage, the reported distribution is confined to pupal records. *S. jenningsi* is known from Alabama, Connecticut, Kentucky, Maryland, Michigan, New York, Virginia, and Wisconsin, and Ontario. Both *S. nyssa* and *S. jenningsi* have been found together in Connecticut in September and in Kentucky and Virginia in May.

Alabama localities: Florence, Lauderdale Co.; Line Cr., Montgomery Co. Females, probably of *S. jenningsi* were collected at Wilson Dam, Colbert Co. and Garden City, Cullman Co.

Biology: *S. jenningsi* is multivoltine, with five or more generations per year in Alabama. This species apparently overwinters in the egg stage as no larvae were found in late winter. Large numbers of larvae, pupae, and exuviae collected in June indicate that the eggs probably hatched in March or April. Immature forms have been collected from June through November in central Alabama. The species prefers the rapid areas of large inland streams and rivers which have relatively unpolluted water. Immature *S. jenningsi* are commonly collected from water willow (*Justicia americana* L.), but will accept other plant material. They are generally collected from the same substrate with a subordinate species, *S. luggeri.* Their zone of effective temperature is approximately 15°-28°C. The pH of the water is near neutral. The senior author considers *S. jenningsi* to be the major pest species in the vicinity of Washington, D.C., where it is very annoying throughout the summer.

Simulium (Phosterodoros) jonesi, new species

Figures 24, 49, 86, 109, 132, 154, 177, 203, 230, 254, 278, 299

This species has less pollinosity on the scutum and lacks the pinkish iridescence of the female of *S. jenningsi.* The respiratory organ has 10 filaments, 9 of which arise from a long ventral one.

Female: Frons shiny black, at narrowest width slightly less than height of eye above narrowest point. Vertex and postocular area with dark brown and a few pale hairs intermixed. Clypeus about as long as wide, thinly pollinose with dark hair. Palpus dark. Scutum nearly black, shiny with an indistinct area of grayish pollinosity behind the somewhat reddish humerus; fine recumbent hairs of scutum dark coppery. Scutellum brown with erect or semierect dark hairs. Pleuron mixed gray and yellow brown. Fore femur yellowish to brownish; mid and hind femora brownish, slightly paler at base; fore tibia brown with a large patch of white anteriorly on basal 0.75; mid tibia brown with white dorsally on basal 0.33 or more; hind tibia brown, the basal 0.50 with white dorsally; mid tarsus mostly yellow; hind tarsus mostly whitish, darkened at apex of tarsomere 1 and beyond pedisulcus. Wing 2.0 mm. long; fine hairs of costa brownish; hairs of stem vein dark. First tergum yellowish brown, the fringe slightly darker. Tergum 2 yellowish brown medially, gray anteriorly, and dark reddish brown posteriorly; terga 3 to 5 dark brown mat, 6 to 9 shiny brown with brown hair. Terminalia as in Figure 24.

Male: Anterior 0.66 of scutum deep black with fine, recumbent, dark coppery hair; humeri slightly reddish and front of scutum with a pair of large, pearlaceous triangles diverging posteriorly. Scutellum black with black hair. Abdomen deep black with the usual pearlaceous spots. Terminalia as in Figures 109, 132, 154, 177.

Pupa: Length 2 to 2.5 mm. Trichomes of head and thorax strong, erect, slightly curved; on head, 2 on each side anteriorly; on thorax, 3 in an oblique row centrally, the anterior most lateral. Respiratory organ, Figure 203, of 10 filaments, 9 arising dorsally from a main ventral filament that is basally thickened, anteriorly directed; 4 of these in a clump at the base and the other 5 scattered irregularly distad the 4. Cocoon as shown in Figure 230.

Larva: Length 4.5 to 5 mm. Cephalic apotome yellow with a brown pattern as shown in Figure 254. Postgenal cleft about as long as wide. Hypostomium, Figure 278, with 3 large and usually 1 small seta on each side. Main cephalic fan of about 50 filaments. Pupal respiratory histoblast as in Figure 299. Rectal gills with about 8 divisions in each of the 3 lobes. A pair of strong ventral tubercles near apex of abdomen.

Holotype: Female, with associated pupal exuvium and cocoon, Fish River, Baldwin Co., Alabama, August 28, 1963 (USNM 68981) (Snoddy).

Paratypes: 1 male, same data as holotype; 6 females, 1 male, same as holotype, September 19, 1964; 3 females, 1 male, larvae, and pupae, Fish River at Highway 104, Silverhill, Baldwin Co., Alabama, August 28, 1963; larvae and pupae, same as holotype, August 20, 1963; larvae and pupae, Robertsdale, Baldwin Co., Alabama, August 28, 1963; larvae and pupae, Styx River, Baldwin Co., Alabama, August 28, 1963; 2 pupae, Burnt Corn Creek, Atmore, Escambia Co., Alabama, June 1, 1963 (all Snoddy). Larvae and pupae, Hatchet Creek at Highway 24, Alachua Co., Florida; larvae and pupae, Santa Fe River at State Road 235, Bradford Co., Florida (both Anthony); larvae and pupae, Fenholloway River at Highway 27, Taylor Co., Florida, April 8, 1954 (Jones). Calhoun Co., Georgia, October 24, 1964

(Beshear). Three females and 2 males, Coosawhatchie River at Highway 128, Hampton Co., South Carolina, April 5, 1954 (Jones).

The authors named this species for Calvin M. Jones, who first discovered it in Florida and South Carolina.

Biology: *S. jonesi* breeds in permanent swamp streams of the South. It prefers green grasses or other aquatic plants for attachment of the pupae, larvae, and summer eggs (the eggs have not been found on plant materials in the winter). This species is believed to overwinter in the egg stage as no larvae, pupae, or adults have been taken from known habitats in November, December, January, or February. Eggs probably hatch in late February or early March since mature pupae have been collected in early April. There are at least four generations a year. *S. jonesi* generally occurs where the water is flowing 1 f.p.s. or faster because of some constriction or natural barrier. Immature forms of *S. jonesi* are known to occur at stream temperatures ranging from 19° to 30°C. The pH of a stream in which they were well established was 6.1, and the temperature was 24°C. Larvae are generally found in small numbers, only a few per square foot of preferred habitat space. Neither pupae nor larvae will tolerate sediment deposits on the substrate where they are found.

Simulium (Phosterodoros) luggeri Nicholson and Mickel

Figures 25, 50, 87, 110, 133, 155, 178, 204, 231, 256, 279, 300

Simulium jenningsi luggeri—Nicholson and Mickel, 1950, Minn. Agr. Exp. Sta. Tech. Bull. 192:54 (female, male, pupa).

Simulium luggeri—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:45 (female, male, larva, pupa).

This is one of the more readily recognizable species of the subgenus, the female having the hairs of the stem vein yellow in contrast to the dark brown or black of the others. The male is much like *S. jenningsi* and several other members of *Phosterodoros*, with the terminalia as shown in Figures 110, 133, 155, 178. The pupa of *S. luggeri* is the only member of the subgenus with 12 respiratory filaments. These are usually arranged as 6 sessile filaments and 3 petiolate pairs. The larva is similar to that of a number of the other species and probably cannot be distinguished without dissection of the respiratory histoblast.

Distribution: Alabama, Illinois, Indiana, Kentucky, Michigan, Minnesota, Mississippi, Nebraska, Oklahoma, Virginia, and Wisconsin to Alberta and Northwest Territory.

Alabama locality: Line Creek at Highway 35, Montgomery Co.

Biology: *S. luggeri* is found in essentially the same type of water as *S. jenningsi* and is often associated with it in small numbers. It has been reported to feed on cattle and horses in western Canada.

Simulium (Phosterodoros) notiale, new species

Figures 26, 51, 88, 111, 134, 156, 179, 205, 232

Adults of this species are difficult to distinguish from several other members of the subgenus. The pupa has six rather slender respiratory filaments all arising very close to the base.

Female: Frons shiny black, the width at narrowest point slightly less than height of eye above narrowest point. Vertex and postocular area with dark hairs. Clypeus about 0.85 as wide as long, thinly gray pollinose with dark hair. Palpus black. Scutum nearly black, shiny, with a pair of rather distinct, pale gray, weakly iridescent spots near front; fine recumbent hairs of scutum pale coppery. Scutellum dark with erect dark hairs. Pleuron mostly dark gray. Fore femur yellowish, sometimes slightly darkened; mid and hind femora progressively more darkened but base of each yellowish; fore tibia nearly black with large anterior patch of white on basal 0.80 except along ventral edge and white along dorsal edge posteriorly; mid and hind tibiae dark with white on dorsobasal 0.50; mid tarsus yellow, darkened beyond middle of tarsomere 2; hind tarsus yellow, darkened at apex of tarsomere 1 and beyond pedisulcus. Wing 2.3 mm. long; fine hairs of costa brownish; hairs of stem vein dark. Abdomen dark, the basal fringe pale yellowish; terga 3-5 velvety black, 6-9 shiny brown. Terminalia as in Figures 26, 51.

Male: Anterior 0.66 of scutum deep black with fine recumbent dark coppery hair; humeri slightly reddish and front of scutum with a pair of large pearlaceous triangles, the inner margins diverging posteriorly. Scutellum black with black hair. Abdomen deep black with the usual pearlaceous spots. Terminalia as shown in Figures 111, 134, 156, 179.

Pupa: Length 2.5 to 3.0 mm. Trichomes often very difficult to see but usually consisting of a pair on head anteriorly on each side and an oblique row of 3 slender, erect, simple trichomes on each side of the thorax, the rows converging posteriorly. Respiratory organ, Figure 205, of 6 slender filaments all arising very close to base; entire organ slightly longer than distance from end of wing pad to end of abdomen. Cocoon, Figure 232, joined anteroventrally.

Holotype: Male, with associated pupal exuvium and cocoon, Meadows Mill, Lee Co., Alabama, March 27, 1963 (USNM 68982) (Snoddy).

Paratypes: 12 males and 14 females, same data as holotype; 2 males, Little Uchee Creek, Meadows Mill, Lee Co., Alabama, March 27, 1964 (Snoddy). Eight males, 4 females, 6 pupae, Moores Creek at Highway 178, Saluda Co., South Carolina, March 25, 1944 (Stone). A pupa that appears to be this species was collected by Stone in Occaquan Creek, Fairfax Co., Virginia, May 16, 1945.

The larva of this species has not been positively identified. S. *notiale* is very similar to S. *underhilli,* but the pupae are found much earlier in the year. The male scutal pattern of S. *notiale* is different, the pupal respiratory filaments are longer and more slender, and the dorsal apical tubercles of the pupa less developed than in S. *underhilli.*

The name of this species is Latin for "southern."

Biology: For 2 consecutive years (1963-64) S. *notiale* was collected in late March from the type locality (water temperature 13°-16°C., pH 7.1-7.2). Pupae occurred in almost equal numbers with S. *venustum* on beaver cut sticks lodged in the crest of waterfalls of a gristmill dam where water speed was 2.5-3 f.p.s. It is assumed that this species is univoltine and over-

winters in the egg stage as it was collected only in the early spring. It apparently has a preferred temperature range of 4°-16°C., and it occurs in medium-sized streams with high quality water. *S. notiale* may prefer living plant material as larvae habitats and pupation sites as do most of the other species belonging to this subgenus, but in late March large populations of *P. magnum* cover almost every available aquatic plant, tree limb, root, or debris hanging in the water. The larger, stronger larvae of *P. magnum* apparently compete favorably for the most desirable habitat space, as they share only the rock or cement crest of falls with *S. pictipes* and force the smaller, weaker *Phosterodoros* to leave the more desirable spaces in the habitat. Collections in late April indicated an absence of *S. notiale* when most *P. magnum* had pupated or emerged. The *S. notiale* generation is replaced by large numbers of the closely related *S. underhilli* and small numbers of *S. nyssa.*

Simulium (Phosterodoros) nyssa, new species

Figures 207, 216

This species is separable from several other species of the subgenus only in the pupal stage. The female is apparently indistinguishable from that of *S. jenningsi* or *S. notiale,* the male from that of *S. fibrinflatum, S. haysi,* or *S. snowi,* and the larva from that of *S. dixiense* or *S. jonesi.* For this reason the authors have not prepared figures for the male, female, and larvae of *S. nyssa.*

Female: Frons shiny black, the width at narrowest point slightly less than height of eye above narrowest point. Vertex and postocular area with dark coppery hairs. Clypeus about 0.85 as wide as long, thinly gray pollinose, with a few dark hairs near lower edge. Palpus dark. Scutum nearly black, shiny, with a pair of rather distinct, pale gray, weakly iridescent spots near front; fine recumbent hairs of scutum pale coppery. Scutellum dark with erect dark hairs. Pleuron mostly dark gray. Fore femur yellowish brown; mid and hind femora usually more extensively darkened but base of each yellowish; fore tibia nearly black with large patch of white that narrows toward the apex, white along ventral edge, and white along dorsal edge posteriorly; mid and hind tibiae dark with white on about basal 0.50; mid tarsus yellow, darkened beyond middle of tarsomere 2; hind tarsus yellow, darkened at apex of tarsomere 1 and beyond pedisulcus. Wing 1.75 to 2.3 mm. long; fine hairs of costa brownish; hairs of stem vein dark. Abdomen dark, the basal fringe yellowish to coppery; terga 3 to 5 velvety black, 6 to 9 shiny brown to black. Terminalia as in *S. notiale,* Figures 26, 51.

Male: Face and clypeus gray pollinose, often with a pinkish iridescence and a few dark hairs. Palpus brown. Scutum almost black with brown hair, the posterior declivity and sides pearlaceous gray; a pair of large iridescent spots near anterior margin, the outer margin of each oblique, the inner margin somewhat angulate so that the central dark area between them widens both anteriorly and posteriorly. Dorsum of abdomen deep reddish brown, mat, with the usual silvery pollinose patches. Terminalia similar to that of *S. snowi,* Figure 112.

Pupa: Length 3 mm. Trichomes of head small, 2 pairs on each side, the inner one often bifid with a single hair on each side posteriorly; those of thorax long, slender, 3 or 4 on each side. Respiratory organ, Figure 207, of 10 slender filaments, the 2 dorsal (posterior) pairs short, petiolate to nearly sessile, and shorter than the ventral (anterior) filaments, which consist of 2 pairs with long petioles and a filament arising from the petiole of each; the filaments are rather smooth and shiny with very shallow constrictions, Figure 216, but without the distinct banding of *S. aranti* or *S. jenningsi.*

Larva: Apparently not separable from *S. dixiense* or *S. jonesi* without careful dissection of the respiratory histoblast.

The name *nyssa* is that of a water nymph and also the generic name of the tupelo, a tree often found in the vicinity of the breeding place of this fly.

Holotype: Male, Meadows Mill, Lee Co., Alabama, September 2, 1964 (USNM 68983) (Snoddy).

Paratypes: 1 male and 2 females, same data as holotype; 2 males and 4 females, same as holotype, September 15, 1964. One male and 2 females, Housatonic River, Canaan, Litchfield Co., Connecticut, September 1, 1952 (Stone). One male and 1 female, Triplet Creek near Bluestone Quarry, Bath Co., Kentucky, May 3, 1941 (Stone). One female, Stillwater Dam, Penobscot Co., Maine, June 2, 1965; 1 male and 1 female, Stillwater Dam, Penobscot Co., Maine, September 8, 1965; 2 males, North Argyle, Penobscot Co., Maine, June 9, 1965 (all I.N. McDaniel). Two males and 3 females, Big Black River, Hinds-Warren county line, Mississippi, April 16, 1941 (Stone). Two males, Dardenne, St. Charles Co., Missouri, April 30, 1941 (Stone). Two females, Big Otter Creek, Bedford Co., Virginia, May 30, 1941; 1 female, Beaver Creek, Lynchburg, Campbell Co., Virginia, May 30, 1941; 1 female, Herring Creek, Charles City Co., Virginia, May 31, 1941; 3 males and 4 females, Little River, Snowville, Montgomery Co., Virginia, May 29, 1941; 1 female, South Fork Roanoke River, Virginia, May 30, 1941 (all Stone).

In addition to the type series listed above there are many specimens, mostly pupal exuviae, from many of the same localities plus the following sites: Faulkner, Johnson, Logan, and Washington counties, Arkansas; Orange Co., Florida; Bienville and DeSoto parishes, Louisiana; LeFlore and Yazoo counties, Mississippi; Choctaw, Haskell, Muskogee, Pittsburgh, and Pushmataha counties, Oklahoma; Jasper County, South Carolina; Cherokee and Leon counties, Texas; Fairfax and Kent counties, Virginia.

Biology: This species is multivoltine with four to five generations per year in Alabama depending on whether the autumns are warm or cool. Seasonal collections indicate that *S. nyssa* overwinters in the egg stage. It is commonly collected in shallow rapids of both large and small streams of high quality water. It is relatively widespread in the Southeast and commonly collected with *S. underhilli* in the larger streams and with *S. snowi* in the small streams, but it has never been collected with both in the same habitat. In some areas it is collected with a very closely related species, *S. jenningsi. S. nyssa* is a warm weather species with a zone of preferred temperature of about 13°-28°C. The pH of known habitats is near neutral

(6.8-7.3). The largest numbers of the immature forms are collected on river weed (*Podostemon ceratophyllum* Michaux) growing in shallow rapids and narrow water channels where the current speed is about 2.5-3.5 f.p.s.

Large swarms of the females, presumably of this species and S. *underhilli*, have been observed ovipositing on the face of a gristmill dam where the water slowly trickled over the surface. They oscillated up and down tapping their abdomens to the surface of the water. S. *nyssa* is a nuisance to man but seldom bites. Adult females form clouds about the head and get into the mouth, eyes, and nose. Females are a serious pest to cattle pastured in areas where large populations occur. They attack cattle inside the ears and where the hair is thin on the stomach, udder, genitalia, etc. If large numbers of females of S. *pictipes* and S. *vittatum* are feeding, they also prefer the inside of the ears and will force S. *nyssa* and S. *underhilli* to move from the ears to the ventral area of the cow.

Simulium (Phosterodoros) snowi, new species

Figures 27, 53, 89, 112, 135, 157, 180, 206, 233, 257, 280, 301

The adult of this species is not distinguishable from that of S. *fibrinflatum* or S. *haysi*, but the pupa has only 4 short, slender, scarcely petiolate respiratory filaments.

Female: Frons shiny, dark orange brown, the width at narrowest level slightly greater than height of the eye above this level. Vertex and postocular area with dark brown hairs. Clypeus distinctly longer than wide, brown, with very thin gray pollinosity and a few yellowish-brown hairs. Palpus dark brown. Thorax dark brown, the scutum shiny with thin anterolateral pollinosity, slightly pearlaceous but not forming well-marked spots; fine recumbent hairs of scutum yellowish brown. Scutellum orange brown with slender erect dark hairs along lateral margins. Pleuron dark with thin gray pollinosity. Femora yellow, the hind femur slightly darkened near apex; fore tibia yellow except for dark brown apical 0.20 and white anterior surface; mid tibia yellow with a white streak dorsally on basal 0.50; hind tibia yellow, the apical portion somewhat darkened and with a white area on dorsoposterior basal 0.50; mid tarsus mostly yellow; hind tarsus mostly yellow, darkened beyond pedisulcus, the basitarsus largely white. Wing 2 to 2.5 mm. long; fine hairs of costa yellowish brown; hairs of stem vein dark orange brown. First tergum yellowish brown, the fringe yellowish; tergum 2 yellowish anteriorly and medially with a grayish pollinose area laterally; terga 3 to 5 dark brown mat, 6 to 9 dark reddish brown, shiny, with brown hair. Terminalia as shown in Figure 27.

Male: Face and clypeus gray pollinose, the latter with dark hairs. Palpus brown. Scutum dark brown with brown hair, the posterior declivity and sides shiny pearlaceous gray; a pair of large iridescent spots near margin, the outer margin of each oblique, the inner margin somewhat angulate so that the central dark area between them widens both anteriorly and posteriorly. Dorsum of abdomen deep reddish brown, mat, with the usual silvery pollinose patches. Terminalia as shown in Figure 112.

Pupa: Length 2 to 2.5 mm. Trichomes of head and thorax very weak or absent, unbranched. Respiratory organ rather short with 4 scarcely petiolate filaments, Figure 206. Cocoon as shown in Figure 233.

Larva: Length 4.5 to 5 mm. Cephalic apotome yellow with a light brown pattern, Figure 257. Antenna slightly longer than cephalic fan stem. Postgenal cleft broader than long. Hypostomium as in Figure 280. Main cephalic fan with 35 to 40 filaments. Pupal respiratory histoblast with 4 filaments, Figure 301. Rectal gills with 5 or 6 divisions in each of the 3 lobes. No ventral tubercles near end of abdomen.

Holotype: Female, with associated pupal exuvium and cocoon, Chewacla Creek, Lee Co., Alabama, August 17, 1963 (USNM 68984) (Snoddy).

Paratypes: 2 males, 3 females, and 10 larvae, Cypress Creek, Florence, Lauderdale Co., Alabama, April 2, 1956 (Moore and Snow); 1 male, Six Mile Creek, Alabama, April 13, 1941 (Stone); 3 males and 2 females, Florence, Lauderdale Co., Alabama, June 15, 1956 (Pickard and Snow); 14 larvae and 1 pupa, Florence, Lauderdale Co., Alabama, October 19, 1954 (Snow); 2 larvae and 1 pupa, Girth Fork Creek at Highway 43, Marion-Franklin county line, Alabama, September 17, 1963 (Snoddy).

The authors named this species after the late W. E. Snow, medical entomologist with the Tennessee Valley Authority.

Biology: *S. snowi* is believed to be multivoltine as immature forms were collected in the spring, summer, and fall. It apparently overwinters in the egg stage as no larvae, pupae, or adults were collected during the winter. In central Alabama *S. snowi* was collected from small and medium-sized clear streams. *S. snowi* pupae and larvae used *Podostemon ceratophyllum* Michaux for a substrate, as do many of the other members of the subgenus. All collections by the junior author were taken from stems of this plant, and the species is sometimes collected on the same substrate with *S. nyssa.* It generally occurs in very small numbers and is collected infrequently.

Simulium (Phosterodoros) underhilli, new species

Figures 28, 54, 113, 181, 208

Adults of this species are similar to several of the other species of the subgenus. The pupa has 6 respiratory filaments intermediate in thickness between those of *S. notiale* and *S. fibrinflatum.*

Female: Frons shiny black, the width at narrowest point slightly less than height of eye above narrowest point. Vertex and postocular area with dark hairs. Clypeus 0.75 to 0.85 as wide as long, thinly gray pollinose with dark hair. Palpus dark. Postnotum yellow orange. Scutum nearly black, shiny, with very thin gray pollinosity anteriorly and laterally, not forming distinct pale spots; fine recumbent hairs of scutum pale coppery. Scutellum dark reddish brown with erect dark hairs. Pleuron mostly reddish brown, very thinly pollinose. Femora yellow, the ends of fore and hind pairs narrowly darkened; fore tibia mostly pale, bright white anteriorly and dorsally, with only about apical 0.20 narrowly and dorsoposteriorly darkened; mid and hind tibiae darkened, with a white dorsal streak on basal 0.50 or more; mid and hind tarsi mostly yellow. Wing 2.2 to 2.4 mm. long; fine hairs of costa dark; hairs of stem vein black. Abdomen dark, the basal fringe pale yellow; terga 3-5 velvety black, 6-9 shiny brown. Terminalia as shown in Figures 28, 54.

Male: Pronotum slightly reddish. Anterior 0.66 of scutum deep black dorsally with a pair of long, oblique, anterior pale iridescent spots; the median dark area broad anteriorly; fine recumbent hairs of scutum dark coppery. Scutellum black with black hair. Abdomen and basal fringe deep black with the usual pearlaceous spots. Terminalia, Figures 113, 181.

Pupa: Length 2.3-2.7 mm. Trichomes of head and thorax very weak or absent, unbranched. Respiratory organ, Figure 298, short, less than length of wing pad, with 6 rather stout, tapering filaments; dorsal pair sessile, the dorsal filament strongly curved; intermediate pair lateral with a different petiole; ventral pair sessile.

Larva: Length 4.5 to 5 mm. Cephalic apotome yellow with the usual brown pattern. Antenna with at least 0.50 of third segment extending beyond cephalic fan stem. Main cephalic fan with 38 to 43 filaments. Pupal respiratory histoblast with 6 filaments. Rectal gills with 5 or 6 divisions in each of the 3 lobes. No ventral tubercles near end of abdomen.

Holotype: Female, with associated pupal exuvium and cocoon, Meadows, Mill, Lee Co., Alabama, August 25, 1963 (USNM 68985) (Snoddy).

Paratypes: 1 male and 2 females, Meadows Mill, Lee Co., Alabama, July 16, 1963; 2 males and 2 females, same data, July 22, 1963; 7 males and 5 females, same data, August 25, 1963; 1 male and 2 females, same data, September 2, 1964; 5 pupae, same data, September 5, 1964; 1 pupa, same data, September 15, 1964; 5 larvae, same data, September 20, 1964; 2 males, same data, October 8, 1964 (all Snoddy). One female, 1 male, and 1 pupa, High Falls, Monroe Co., Georgia, September 23, 1965 (Snoddy). One female, Putnam Co., West Virginia, May 4, 1941 (Stone). Pupal fragments, Big Otter Creek, Bedford Co., Virginia, October 10, 1963 (Underhill).

The authors named this species after G. W. Underhill, who wrote an outstanding paper on *Simulium jenningsi* (*S. nigroparvum*) in Virginia.

This species is very close to *S. notiale* and more work is needed to establish the limits of the two. The male scutal pattern appears to be quite distinctive, but the pupae are not always readily separable. Some pupae collected in Spartanburg, South Carolina look very much like *S. notiale,* but they were taken in September so their identity is questionable.

Biology: This species is multivoltine with at least five generations in Alabama. Regular collections indicate this species may overwinter as eggs, larvae, and pupae, or a combination of these forms in the same stream. It is found in shallow rapids and below dams or natural impoundments of medium to large inland streams with water relatively free of sediment. This species has the ability to tolerate a temperature range of 2°-28°C., but apparently has an optimum temperature zone of only about 16°-28°C. The pH of known habitats of this fly is near neutral (6.8-7.3). It is relatively common and widespread in inland areas of the Southeast. Most larvae and pupae were collected from river weed (*Podostemon ceratophyllum* Michaux) growing in shallow rapids, with a secondary preference shown for water willow (*Justicia americana* L.). It will accept sticks or other substrate when green plant material is not available for attachment. Larvae are commonly collected on the top of plants trailing downstream, but pupae are taken from the more protected trunk or sheltered sides of the plants. The

current speed commonly observed for this species ranges from 2.5 to 3.5 f.p.s. It is closely associated with *S. nyssa,* apparently having almost the same ecological requirements, but is always the dominant species. Other species which are sometimes collected with it are *S. tuberosum* and *S. pictipes,* which have been dislodged from the crest of nearby falls.

Subgenus *Simulium* Latreille

This, the typical subgenus, may be recognized in this country by the following combination of characters: scutum and fore tibia usually with rather conspicuous silvery areas; tarsi bicolored; first fore tarsomere distinctly flattened and widened; basal section of vein R bare above; distimere of male longer than basimere; ventral plate narrow with beaklike apex and more or less pointed, but not at sharp right angles to body of plate; no sclerotized, posteriorly directed projection from the arm of the ventral plate; respiratory filaments of pupa slender, 6, 8, or rarely more, all arising near base; cocoon usually solid, pocket-shaped, Figures 234-238.

Simulium (Simulium) decorum Walker

Figures 29, 55, 67, 68, 72, 90, 114, 136, 158, 182, 209, 238, 255, 281, 302

Simulium decorum—Walker, 1848, List. Dipt. Brit. Mus. 1:112 (adult).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:63 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:109 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:111 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:44 (female, male, larva, pupa).

The female of this medium-sized, dark species is characterized by the thin gray pollinosity of the frons and abdominal terga. The scutum is also noticeably more convex in profile than in other local members of the subgenus. The pupa has 8 respiratory filaments, Figure 209, and the cocoon is simple, rather loosely woven, Figure 238. This species is very close to the European *S. noelleri* Friederichs, which is now synonymized with *S. argyreatum* Meigen, and the senior author has suggested using the name *S. argyreatum* in this country. It is probable, however, that two species are involved. Specimens with a less convex thorax are found in the far North and this is the form that Dyar and Shannon named *S. decorum katmai.* It is possible that this might be *S. argyreatum.*

Distribution: This is a widespread species, originally described from Ontario and known from Alaska to Newfoundland and south to Oregon, Colorado, and Florida. In the southeastern states it is generally confined to the Appalachian range.

Alabama localities: Cheaha State Park, Cleburne Co.; Fort Payne, DeKalb Co.; Lake Auburn, Lake Wilmore, Lee Co.

Biology: *S. decorum* is relatively common in central and northern Alabama, and uncommon only in the coastal areas. It apparently prefers or is able to tolerate extremely high rates of water flow (commonly 6 f.p.s.). It is almost invariably collected from the outflow of impoundments, on waterfalls, and dams. It is associated with *S. vittatum* but apparently is able to

tolerate much higher current speeds. *S. decorum* can tolerate water temperatures from 0° to 33°C. It overwinters as eggs, larvae, or pupae, or a combination of these stages. These overwintering forms are commonly found in old caddisfly cases, crevices in concrete, and plant materials caught on dams and spillways. This species is multivoltine with six or seven generations per year. In Alabama the first mass emergence of adults is in late April, followed by a new generation every 5 or 6 weeks. After the second generation, the exact time of each succeeding generation is not clear as all stages begin to overlap. Active breeding continues from April until late October or early November. A few adults emerge during warm periods throughout the winter season. They mate soon after emergence while crawling around on plants and stones at the edge of the water. The females lay eggs in irregular masses at the crest of falls and impoundments on almost any available object – plants, rocks, concrete, etc. – where there is a thin sheet of flowing water. Females of *S. decorum* deposit eggs on their own pupae, other females, caddisfly cases, and almost any animal which gets caught in earlier egg masses. This species attacks cattle where it occurs. It regularly bites man but is not considered a serious pest.

Simulium (Simulium) parnassum Malloch

Figures 30, 56, 91, 115, 137, 159, 183, 210, 234, 258, 282, 303

Simulium parnassum—Malloch, 1914, USDA, Bur. Ent. Tech. Ser. 26:36 (female).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:71 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:120 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:113 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:40 (female, male, larva, pupa).

The female of this medium-sized species is distinctive because of its shiny black color, hair on the underside of the subcosta, and elongate claw, Figure 91, with a small subbasal tooth. The cocoon, Figure 234, is simple and pocket-shaped, and there are 6 filaments in the pupal respiratory organ, Figure 210, as in members of the *S. venustum* group, but the very rugose thorax is distinctive.

Distribution: Appalachian Mountains and the foothills of Connecticut, Georgia, Maine, New Hampshire, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and Vermont to Nova Scotia, Ontario, and Quebec. It has not been collected in Alabama, but it is to be expected in the northeastern part of the State.

Biology: Adults fly from June 4 to August 17 in Georgia, suggesting that more than one generation per year occurs there. Immature stages were found in permanent cool streams. The species may be very annoying to man by swarming and biting.

Simulium (Simulium) tuberosum (Lundstroem)

Figures 33, 57, 92, 116, 138, 160, 184, 211, 235, 259, 283, 304

Melusina tuberosa—Lundstroem, 1911, Acta. Soc. Pro. Fauna Flora Fenn. 34(12): 14 (male).

Simulium tuberosum—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:78 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:123 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:114 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:45 (female, male, larva, pupa).

This species, S. *venustum,* and S. *verecundum* form a group difficult to distinguish from each other. The females all have a few fine hairs on the under surface of the subcosta. The male of S. *tuberosum* is quite easily recognized by the terminalia, Figures 116, 138, 160, and the larva can usually be separated by the characters given in the key. The legs of the female are darker than those of the other two species.

As this species is currently recognized in this country, there are four synonymous names. Quite possibly a group of sibling species is involved, so the synonyms are not listed. If it appears that the European S. *tuberosum* is different from the species in America, the oldest available name in America is S. *perissum* Dyar and Shannon, 1927. As this form is from Virginia, it would probably be the correct name for the form common in the southeastern United States. There is reason to believe that two species occur in Alabama, but until the complex can be studied as a whole with more material than is now available the authors are not describing a new species.

Distribution: S. *tuberosum* in the broad sense is a widespread, Holarctic species occurring on this continent from Greenland to Alaska and south to California, Texas, and Florida.

Alabama localities: Persimmon Ditch east of Loxley, Duck Pond Creek and Wolf Creek east of Foley, Baldwin Co.; Wilson Dam, Colbert Co.; Burnt Corn Creek, Sizemore Creek, Conecuh and Escambia counties; Woodville, Jackson Co.; Florence, Edgewater Beach, Waterloo, Six Mile Creek, Killen, Lauderdale Co.; Wheeler Dam, Lawrence Co.; French Mill Creek, Limestone Co.; Hazel Green, Madison Co.; Flint, Morgan Co.; North Fork Creek, Locust Fork, Russell Co.

Biology: There appears to be two ecologically different forms in Alabama that show subtle morphological differences. The most common form occurs in both large and small permanent and inland streams of northern and central Alabama. The undescribed form occurs in the medium and small swamp streams of the coastal area. Immature stages attach to almost any available substrate in rapid areas or near the outflow of impoundments. The species is multivoltine with at least five or more generations per year. Next to S. *vittatum,* it is probably the most common and widespread species in Alabama. It overwinters as larvae, pupae, and adults, with only a few adults emerging during sunny days when the temperature is above 10°C. Because of its wide range of tolerances, S. *tuberosum* is probably associated with most inland species of Alabama black flies during at least one season of the year. It is commonly associated with S. *venustum* but does not dominate the habitat until late spring when the numbers of S. *venustum* rapidly decline.

S. *tuberosum* is probably the most persistent pest of man and livestock in Alabama, feeding in the ears of livestock unless they are crowded out by the larger species, S. *pictipes* and S. *vittatum.* If the ears are too crowded, they feed beneath on the abdomen, udder, and genitalia of cattle. People

participating in outdoor activities are regularly bitten. Many complaints come from pulpwood cutters, who commonly work in undershirts. In May and June the flies sometimes get so numerous that the pulpwood cutters rub chainsaw oil on their exposed arms and faces to ward off attacks.

Simulium (Simulium) venustum Say

Figures 31, 58, 93, 117, 139, 161, 185, 212, 236, 260, 284, 305

Simulium venustum—Say, 1823, J. Acad. Nat. Sci. Philadelphia 3:28; 1859, Compl. Writings 2:51 (male, female).—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:81 (female, male, larva, pupa).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:124 (female, male, pupa).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:114 (larva).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:46 (female, male, larva, pupa).

This is one of several closely related species difficult to distinguish by external adult or pupal characters. All are of a medium size, dark, not extremely shiny species with the legs marked with white, the claw of the female simple, the frons and posterior abdominal terga not pollinose, and the under surface of the subcosta with hairs. The pupa, Figure 212, has 6 respiratory filaments from 3 rather short petioles, and the cocoon is simple. Separation from the closely related *S. tuberosum* and *S. verecundum* is possible, with some difficulty, by the characters given in the keys.

Distribution: Alaska and Greenland south through most of the United States. It is apparently less frequently encountered in the South than other members of the group.

Alabama localities: Cypress Creek, Florence, Six Mile Creek, Killen, Edgewater Beach, Lauderdale Co.; Woodville, Jackson Co.; Huntsville, Madison Co.

Biology: *S. venustum* is commonly collected from the medium and large permanent streams of central and northern Alabama. This species is multivoltine with about four generations per year. It apparently does not tolerate the high temperatures of the Southeast very well. Adults appear in large numbers in late winter and early spring, but as warm weather approaches the population declines. Immature forms are commonly associated with *S. notiale.* They are generally collected together from trailing plant material or beaver cut sticks caught on dams or in rapids. It is replaced by *S. tuberosum, S. underhilli,* and *S. nyssa* later in the season. Adults readily bite man and livestock in Alabama, but do not appear as aggressive as reported farther north.

Simulium (Simulium) verecundum Stone and Jamnback

Figures 32, 59, 94, 118, 140, 162, 186, 213, 237, 261, 285, 306

Simulium verecundum—Stone and Jamnback, 1955, N.Y. State Mus. Bull. 349:83 (male, female, larva).—Davies, Peterson, and Wood, 1962, Proc. Ent. Soc. Ont. 92:125 (female, male).—Wood, Peterson, Davies, and Gyorkos, 1963, Proc. Ent. Soc. Ont. 93:114 (larva).—Rubzov, 1963, Flieg. Pal. Reg., Fam. 14:567 (female, male, pupa).—Stone, 1964, Conn. State Geol. and Nat. Hist. Surv. Bull. 97:47 (female, male, larva, pupa).

This species is not distinguishable from S. *venustum* by external adult characters, but the ventral plate of the male terminalia, Figures 162, 186, is different. The pupal respiratory filaments are usually somewhat longer than in S. *venustum.* Live larvae are entirely white in contrast to the distinct reddish tinge of venustum.

Distribution: Alaska to Nova Scotia, south to Washington, Wyoming, and South Carolina. It also occurs in Europe and Northern Asia.

Alabama locality: Flint, Morgan Co.

Biology: This multivoltine species appears to be rather uncommon in Alabama, but it has been found associated with S. *vittatum* and S. *decorum* on spillways of dams. It is apparently more tolerant of high temperatures than the closely related S. *venustum* and is apt to be found in somewhat larger streams and to emerge a little later. Adults do not seem to annoy man.

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ACKNOWLEDGMENTS

This bulletin is the result of a long-time taxonomic interest of the senior author in the Simuliidae of the southeastern United States combined with an intensive study of the Simuliidae of Alabama undertaken by the junior author for his Ph.D. dissertation. The senior author is indebted to his wife, Louise B. Stone, who in April 1941 ably assisted him during a collecting and rearing trip that extended from South Carolina to Texas and back to Washington, D.C. He also gratefully acknowledges the cooperation of G. W. Underhill, then of the Virginia Polytechnic Institute, who showed him many interesting collecting sites in Virginia, and C. M. Jones of the Entomology Research Division of the U.S. Department of Agriculture, who performed the same service in southern South Carolina. Material has come to the United States National Museum from sources too numerous to list here, but we would like to mention in particular the specimens collected in southern Virginia by J. F. Gates Clarke of the U.S. National Museum, and those submitted by Eugene Pickard and the late W. E. Snow of the Tennessee Valley Authority from Tennessee and northern Alabama.

The junior author gratefully acknowledges the support of his investigations by Public Health Research Grant AI 04904 from the Institute of Allergy and Infectious Diseases, by Hatch Project 129 and State Research funds, and by an NDEA Fellowship, all administered by the Zoology-Entomology Department of Auburn University Agricultural Experiment Station, Auburn, Alabama. He expresses deep gratitude to Dr. Kirby L. Hays for his guidance during these studies and to Dr. F. S. Arant and staff members of the Zoology-Entomology Department, Auburn University, for their encouragement and direction. He also thanks Ramona J. Beshear and Wanda G. Styles for their technical assistance.

The illustrations in this bulletin are by artists of the 406th Medical General Laboratory, Tokyo, Japan; Arthur D. Cushman of the Entomology Research Division, ARS, USDA (31 figures); and the senior author, Figures 1-8. A number of the illustrations, differently arranged, appeared in the Connecticut State Geological and Natural History Survey Bulletin 97, 1964. Space does not permit us to give separate credit for each of the 306 figures; but we are pleased to list the artists of the Tokyo laboratory and the number of figures each contributed: S. Shibata (138), K. Daishoji

and S. Ohtawa (24 each), S. Asano and A. Tateichi (20 each), M. Hasanuma (17), K. Sawanuma (12), and Y. Sasaki (9). These drawings were made under the direction of Kakuzo Yamazaki. This scientific drawing project was supported by the Army Medical Research and Development Command, Washington, D.C.

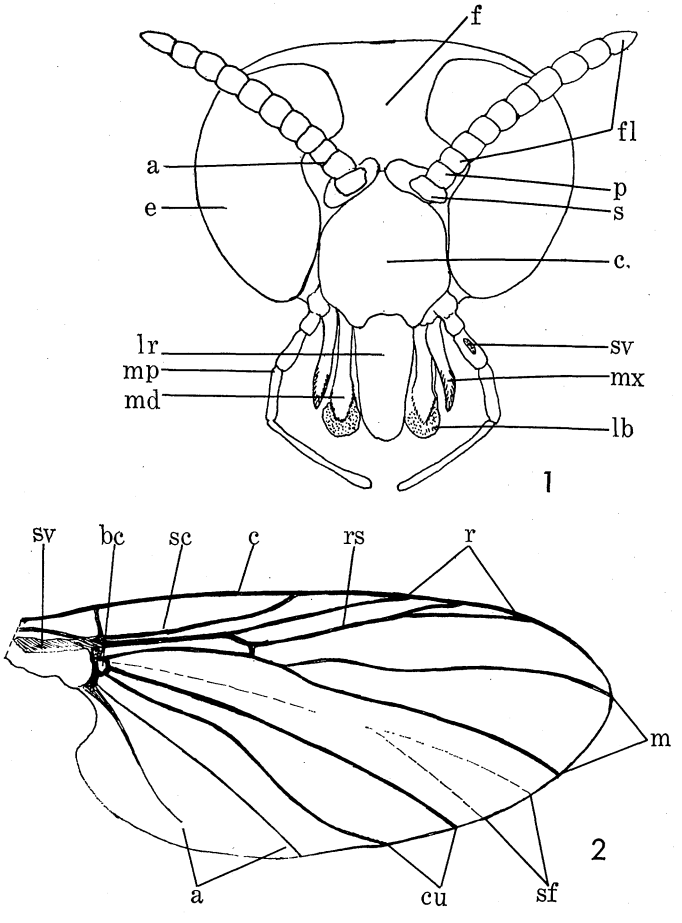


FIG. 1. Head of female: a=antenna; c=clypeus; e=eye; f=frons; fl=flagellum; lb=labellum; lr=labrum; md=mandible; mp=maxillary palpus; mx=maxilla; p=pedicel; s=scape; sv=sensory vesicle. FIG. 2. Wing: a=anal vein; bc=basal cell; c=costa; cu=cubital vein; m=median vein; r=radius; rs=radial sector; sc=subcosta; sf=submedian fold; sv=stem vein.

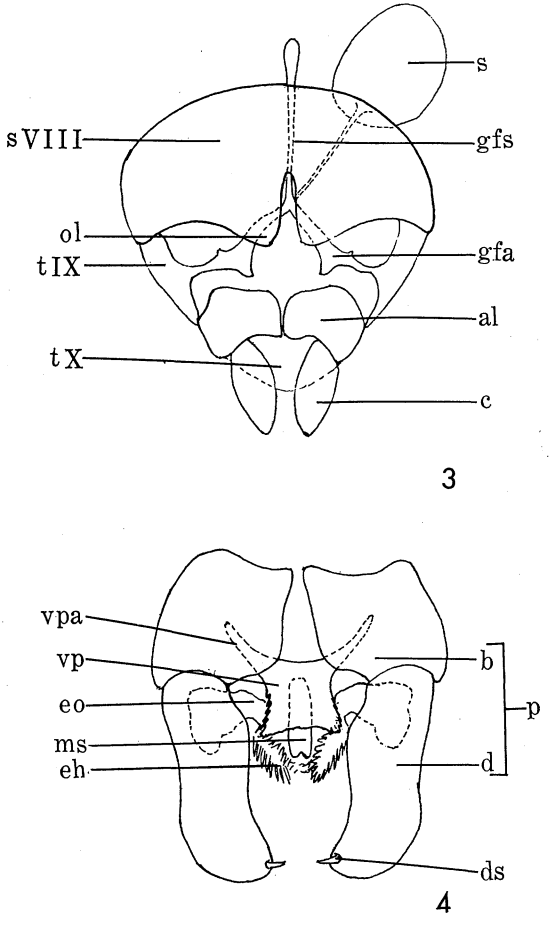
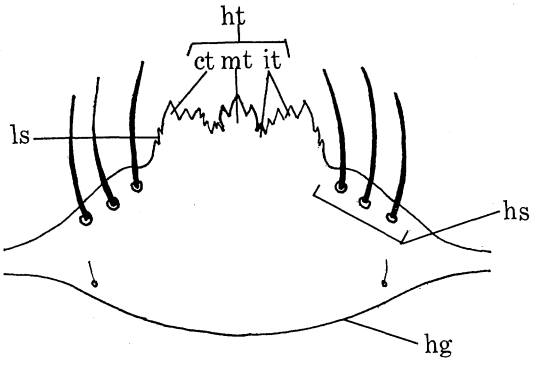


FIG. 3. Female terminalia: al=anal lobe; c=cercus; gfa=genital fork arm; gfs=genital fork stem; ol=ovipositor lobe; s=spermatheca; s VIII=sternum VIII; t IX=tergum IX; t X=tergum X. FIG. 4. Male terminalia: b=basimere; d=distimere; ds=distal spine; eh=endoparameral hooks; eo=endoparameral organ; ms=median sclerite; p=paramere; vp=ventral plate; vpa=ventral plate arm.



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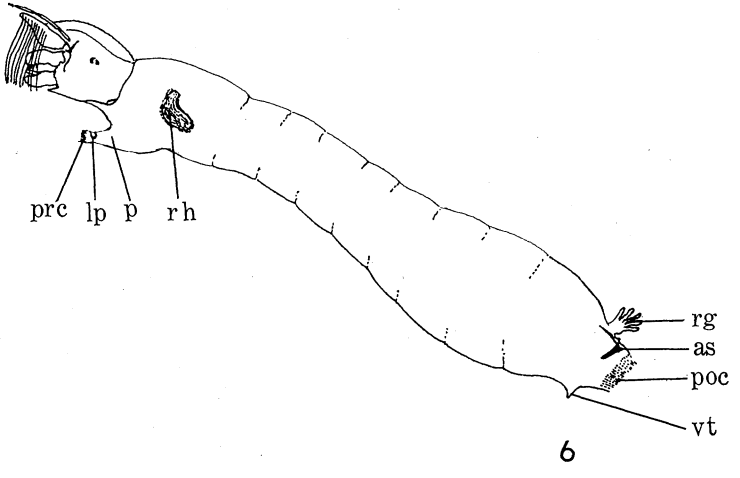

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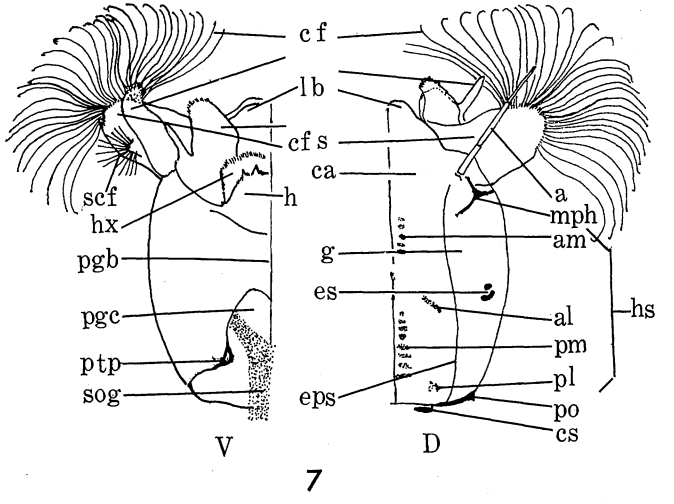
FIG. 5. Hypostomium of larva: ct=corner tooth; hg=hypostomial groove; hs=hypostomial setae; ht=hypostomial teeth; it=intermediate teeth; ls=lateral serrations; mt=median tooth. FIG. 6. Larva: as=anal sclerite; lp=lateral plate; p=proleg; poc=posterior circlet; prc=proleg circlet; rg=rectal gill; rh=respiratory histoblast; vt=ventral tubercle.



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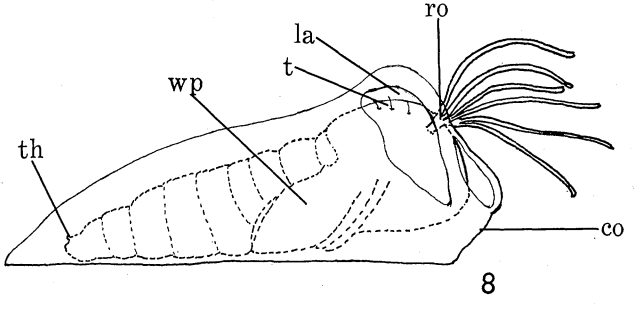

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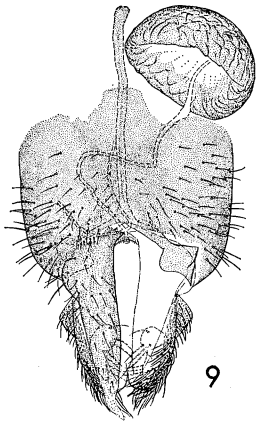
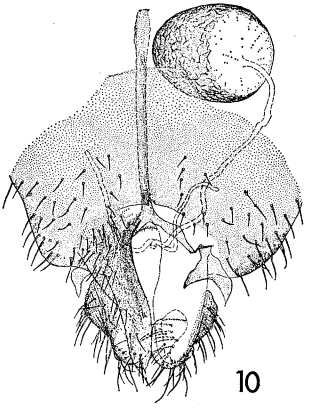
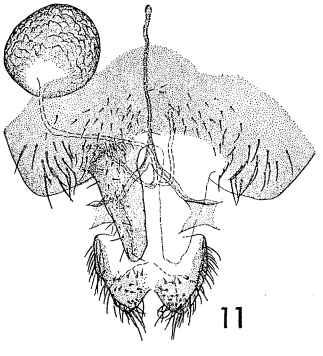
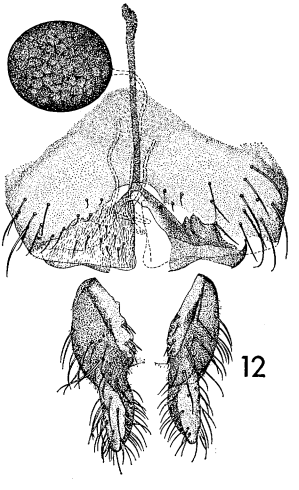
FIG. 7. Head of larva (V=ventral, D=dorsal): a=antenna; al=anterolateral head spot; am=anteromedian head spot; ca=cephalic apotome; cf=cephalic fan; cfs=cephalic fan stem; cs=cervical sclerite; eps=epicranial suture; es=eye spots; g=gena; h=hypostomium; hs=head spots; hx=hypopharynx; lb=labrum; mph =mandibular phragma; pgb=postgenal bridge; pgc=postgenal cleft; pl=posterolateral head spot; pm=posteromedian head spot; po=postocciput; ptp=posttentorial pit; scf=secondary cephalic fan; sog=suboesophageal ganglion. FIG. 8. Cocoon and pupa: co=collar; la=lateral aperture; ro=respiratory organ; t=trichrome; th=tail hook; wp=wing pad.

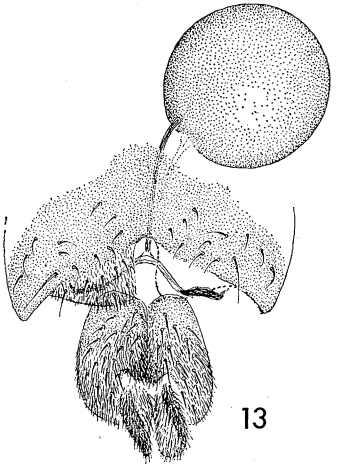


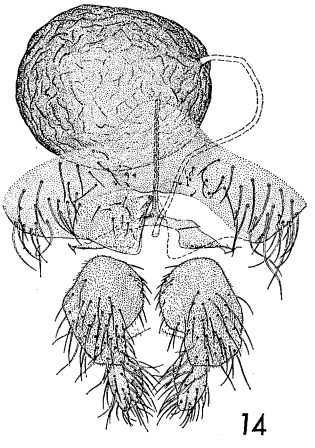


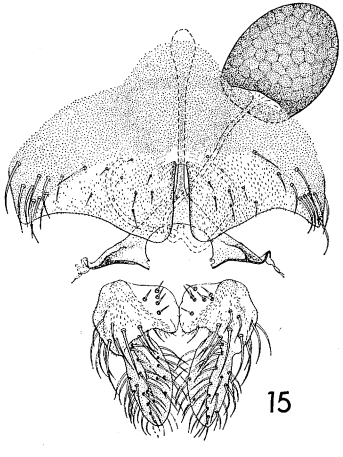


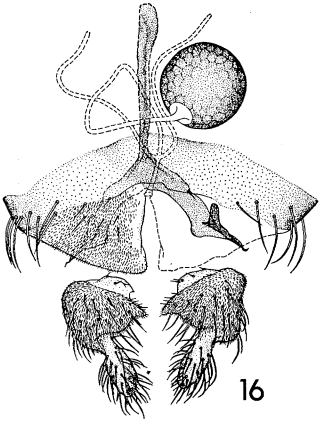


Female terminalia, ventral view: FIG. 9. *P. magnum.* 10. *P. mixtum.* 11. *P. rhizophorum.* 12. *C. mutata.*

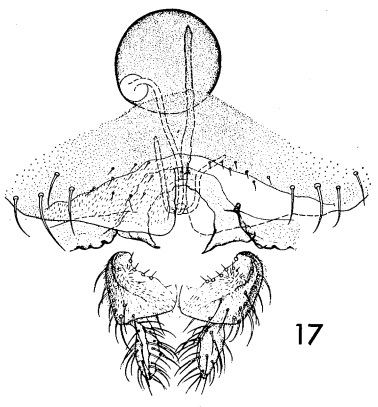


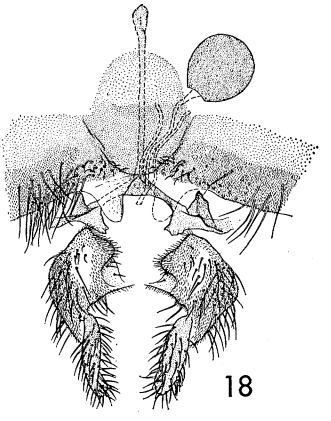


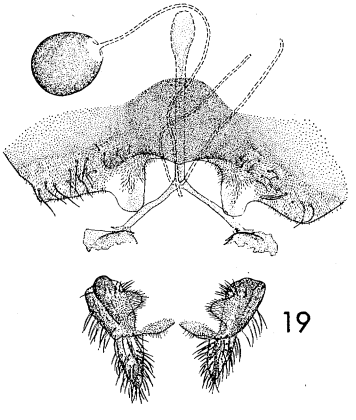


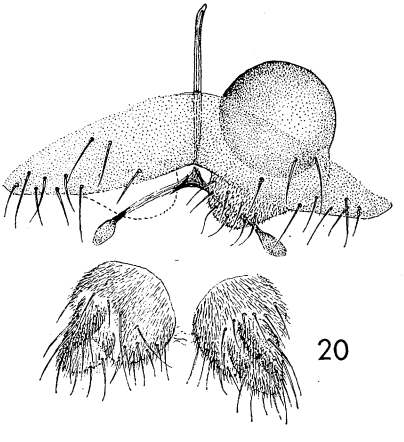


Female terminalia, ventral view: FIG. 13. *C. ornithophilia.* 14. *C. pecuarum.* 15. *S. congareenarum.* 16. *S. meridionale.*

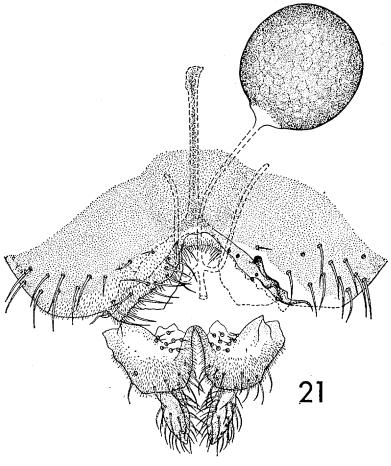


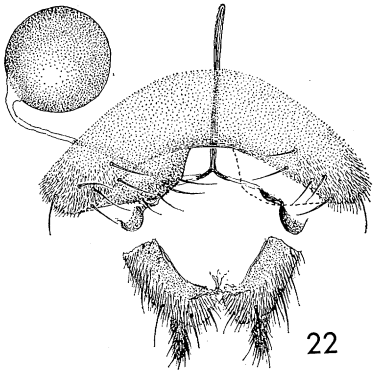


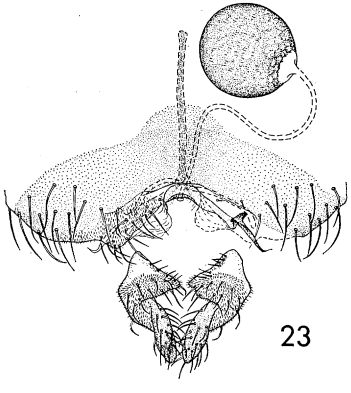


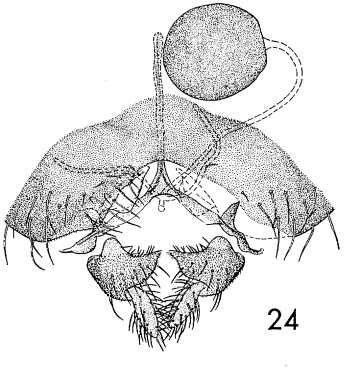


Female terminalia, ventral view: FIG. 17. *S. slossonae.* 18. *S. vittatum.* 19. *S. pictipes.* 20. *S. aranti.*

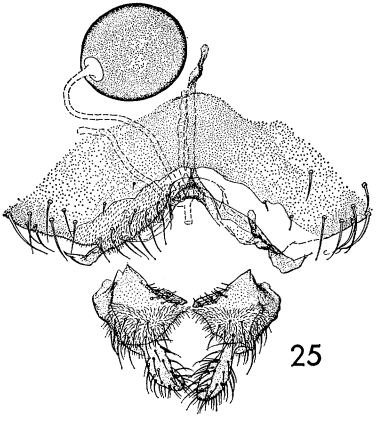


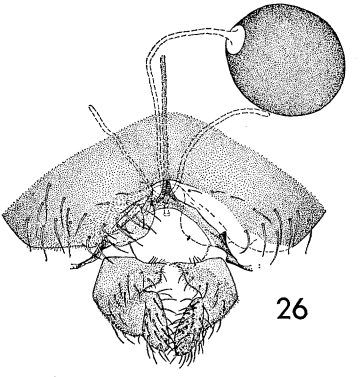


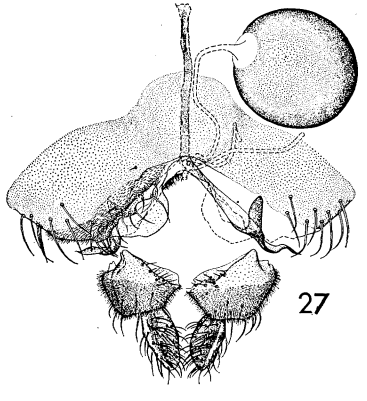


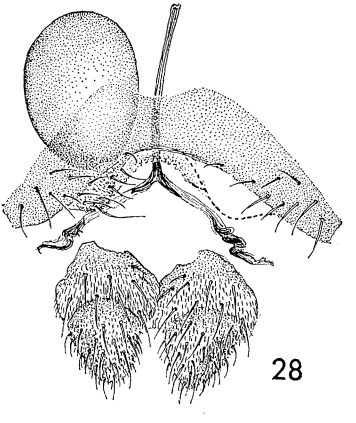


Female terminalia, ventral view: FIG. 21. *S. fibrinflatum.* 22. *S. haysi.* 23. *S. jenningsi.* 24. *S. jonesi.*

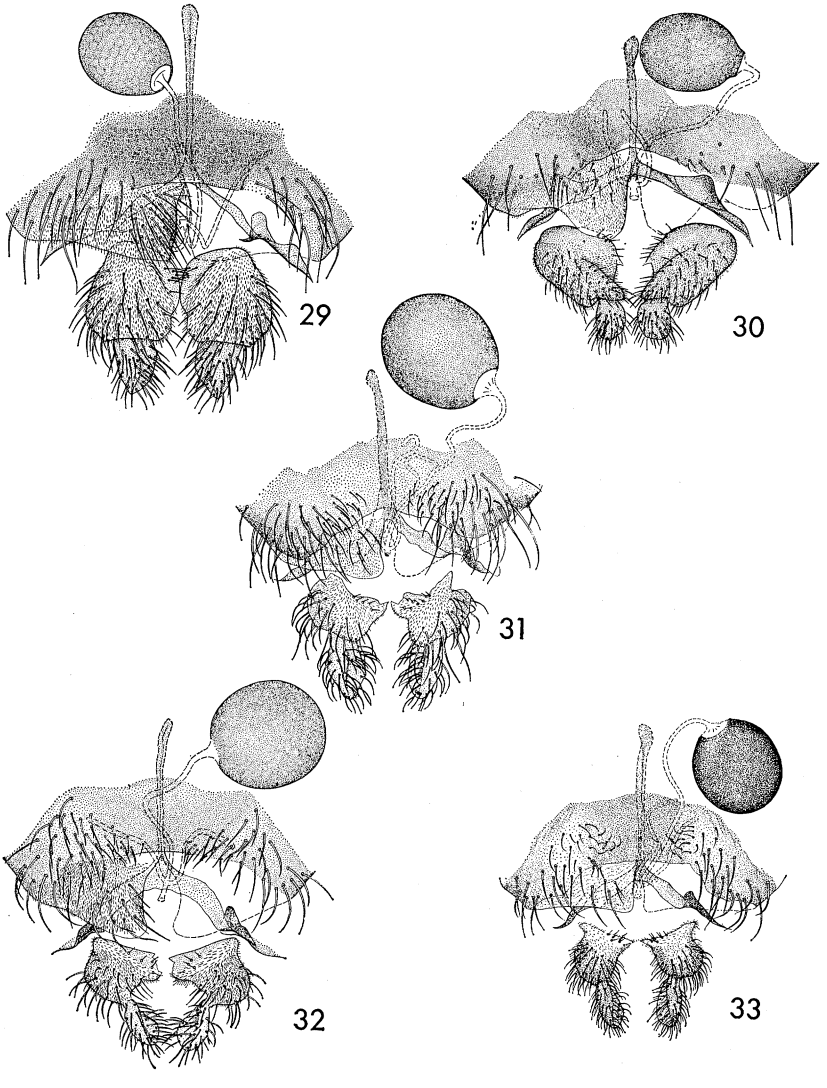




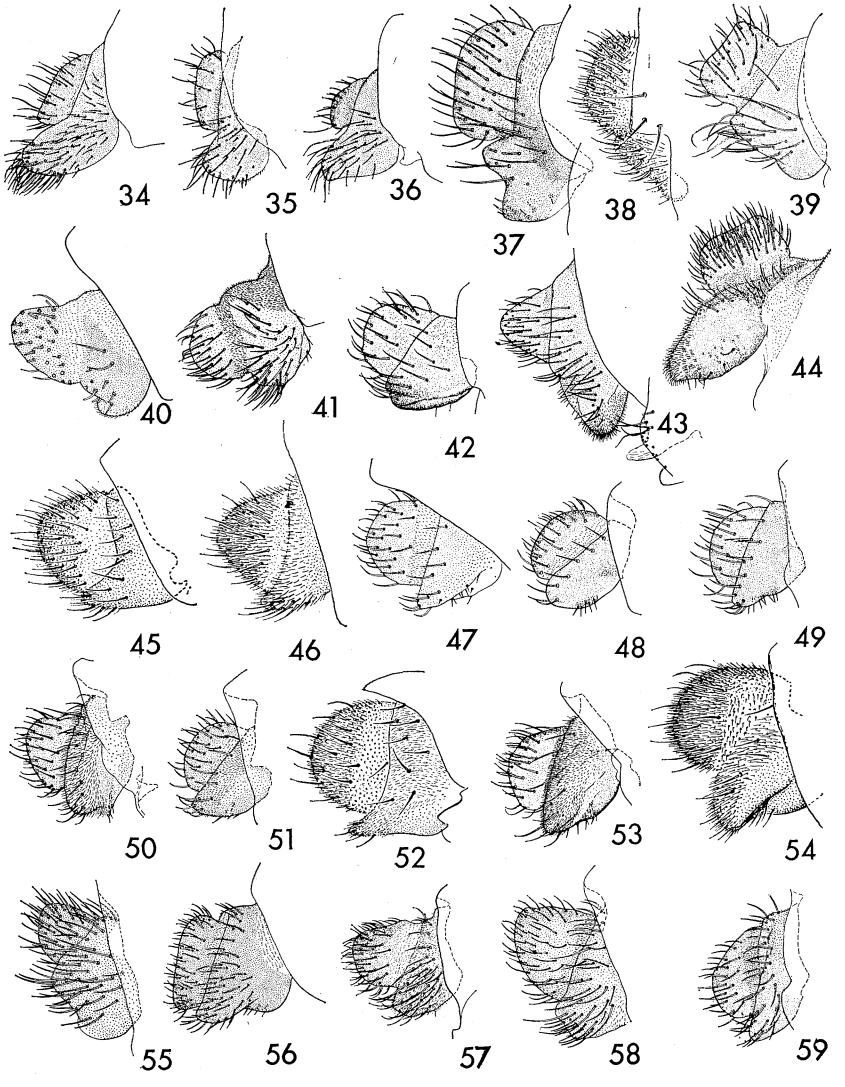




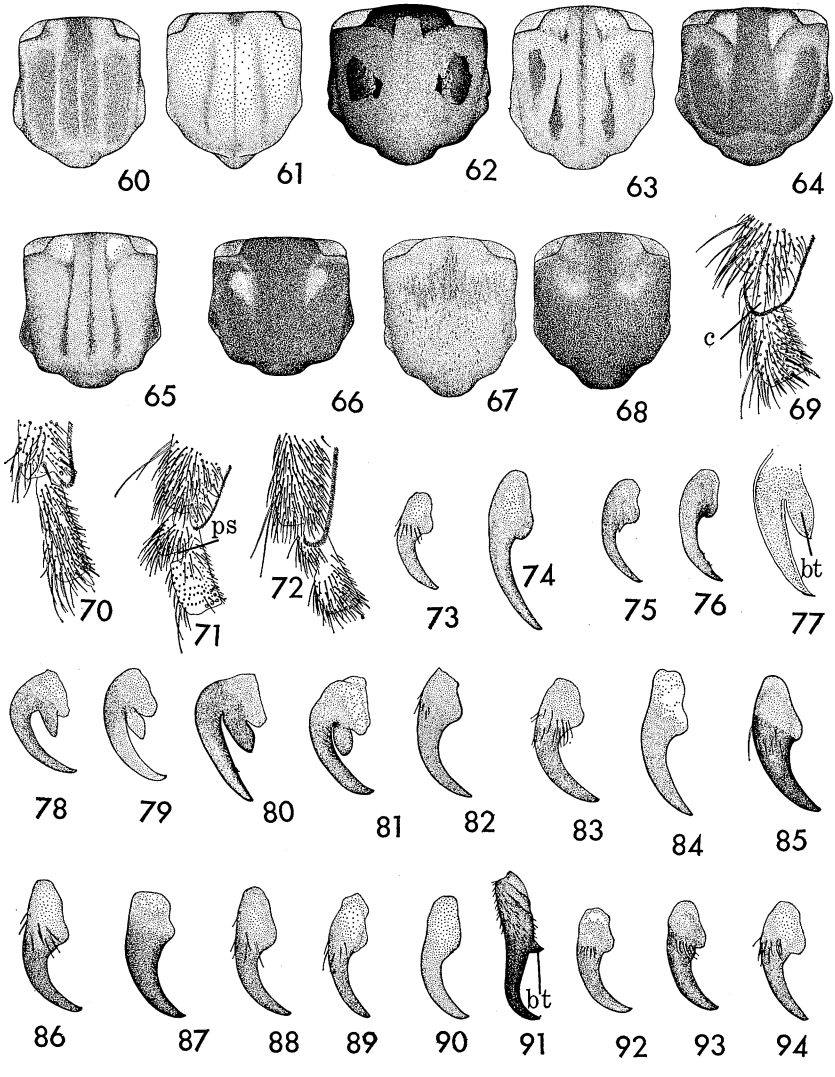
Female terminalia, ventral view: FIG. 25. *S. luggeri.* 26. *S. notiale.* 27. *S. snowi.* 28. *S. underhilli.*



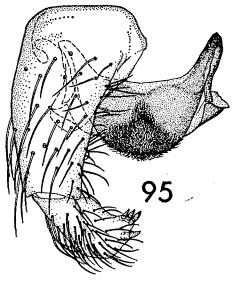
Female terminalia, ventral view: FIG. 29. *S. decorum.* 30. *S. parnassum.* 31. *S. venustum.* 32. *S. verecundum.* 33. *S. tuberosum.*

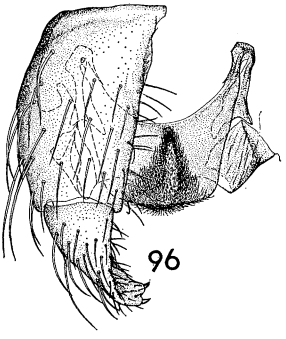


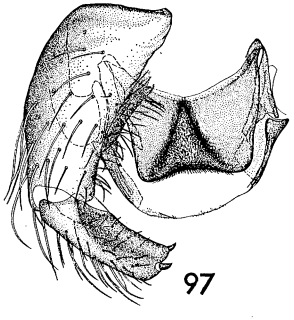
Cercus and anal lobe, lateral view: FIG. 34. *P. magnum.* 35. *P. mixtum.* 36. *P. rhizophorum.* 37. *C. mutata.* 38. *C. ornithophilia.* 39. *C. pecuarum.* 40. *S. congareenarum.* 41. *S. meridionale.* 42. *S. slossonae.* 43. *S. vittatum.* 44. *S. pictipes.* 45. *S. aranti.* 46. *S. dixiense.* 47. *S. fibrinflatum.* 48. *S. jenningsi.* 49. *S. jonesi.* 50. *S. luggeri.* 51. *S. notiale.* 52. *S. haysi.* 53. *S. snowi.* 54. *S. underhilli.* 55. *S. decorum.* 56. *S. parnassum.* 57. *S. tuberosum.* 58. *S. venustum.* 59. *S. verecundum.*

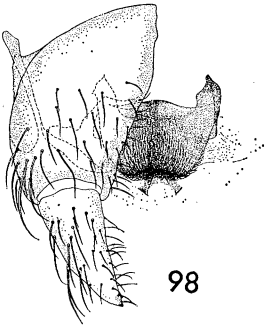


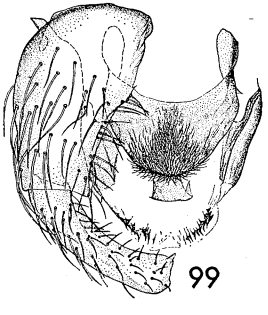
Scutum, dorsal view: FIG. 60. *C. pecuarum,* female. 61. *S. meridionale,* female. 62. *S. slossonae,* male. 63. *S. vittatum,* female. 64. *S. vittatum,* male. 65. *S. pictipes,* female. 66. *S. pictipes,* male. 67. *S. decorum,* female. 68. *S. decorum,* male. Calcipala and second tarsomere of hind leg (c=calcipala, ps=pedisulcus): 69. *C. mutata.* 70. *C. pecuarum.* 71. *S. pictipes.* 72. *S. decorum.* Claw of female (bt=basal tooth): 73. *P. magnum.* 74. *P. mixtum.* 75. *P. rhizophorum.* 76. *C. mutata.* 77. *C. ornithophilia.* 78. *C. pecuarum.* 79. *S. congareenarum.* 80. *S. meridionale.* 81. *S. slossonae.* 82. *S. vittatum.* 83. *S. pictipes.* 84. *S. fibrinflatum.* 85. *S. jenningsi.* 86. *S. jonesi.* 87. *S. luggeri.* 88. *S. notiale.* 89. *S. snowi.* 90. *S. decorum.* 91. *S. parnassum.* 92. *S. tuberosum.* 93. *S. venustum.* 94. *S. verecundum.*

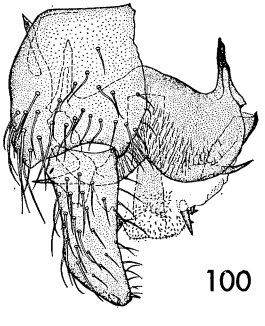




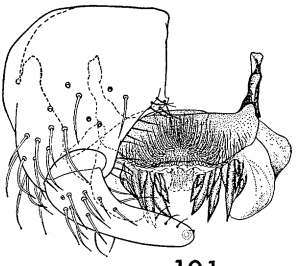




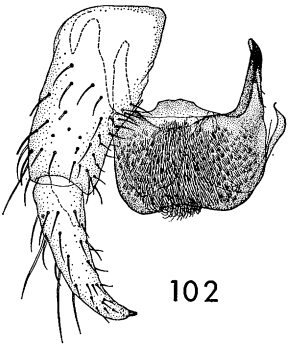




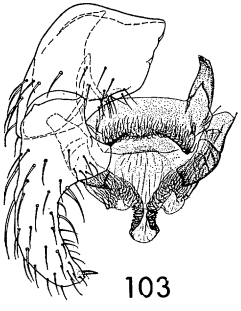
Male terminalia, ventral view: FIG. 95. *P. magnum.* 96. *P. mixtum.* 97. *P. rhizophorum.* 98. *C. mutata.* 99. *C. pecuarum.* 100. *S. clarkei.*



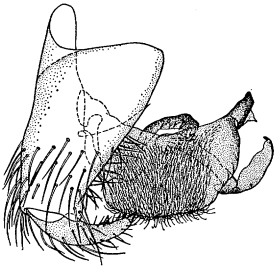
101



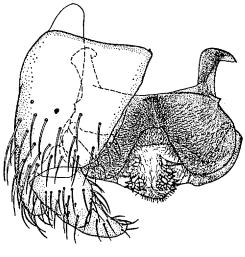
102



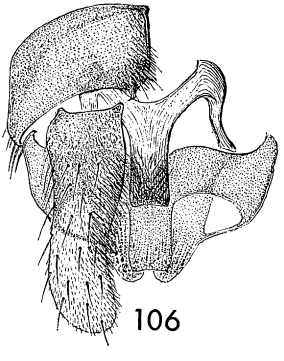
103



104



105



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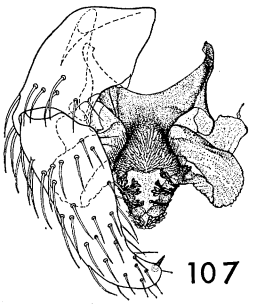
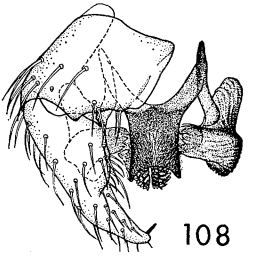
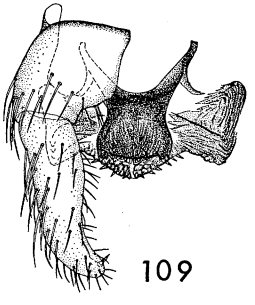
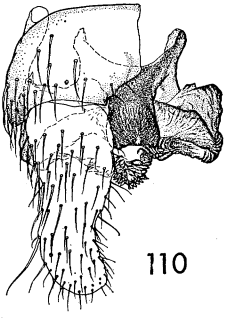
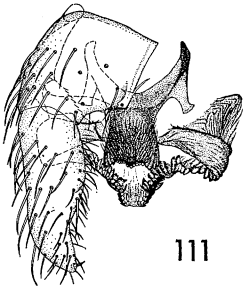
Male terminalia, ventral view: FIG. 101. *S. congareenarum.* 102. *S. meridionale.* 103. *S. slossonae.* 104. *S. vittatum.* 105. *S. pictipes.* 106. *S. aranti.*

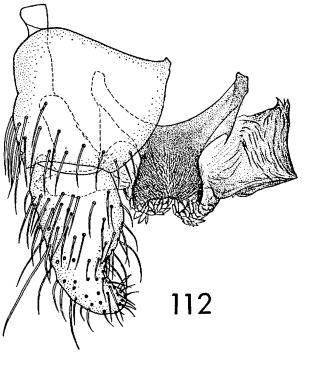




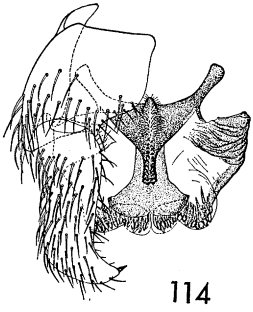


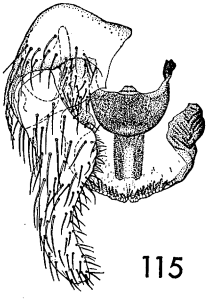


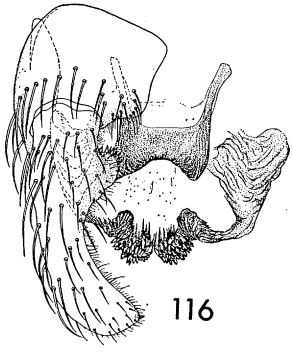


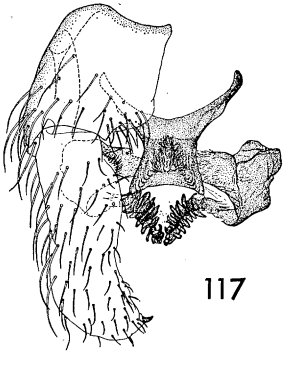


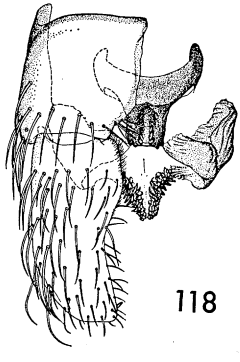
Male terminalia, ventral view: FIG. 107. *S. fibrinflatum.* 108. *S. jenningsi.* 109. *S. jonesi.* 110. *S. luggeri.* 111. *S. notiale.* 112. *S. snowi.*



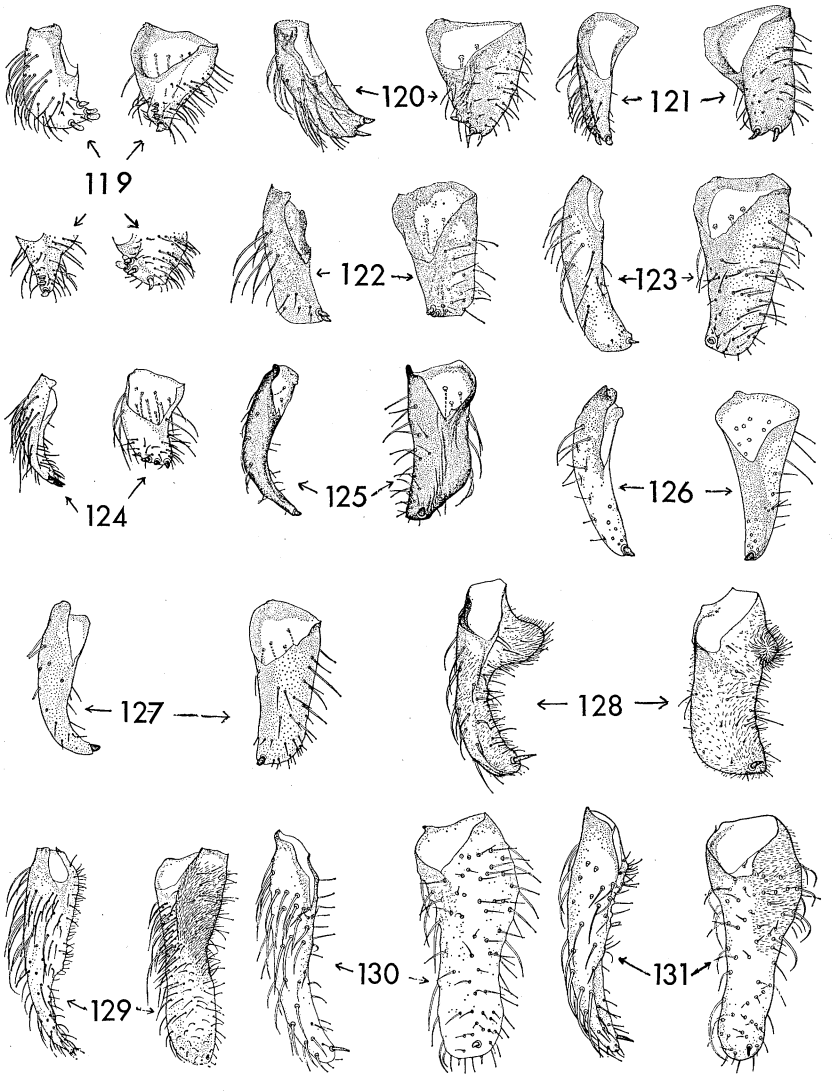




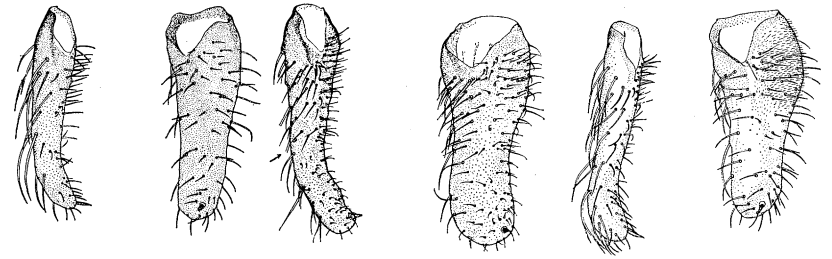


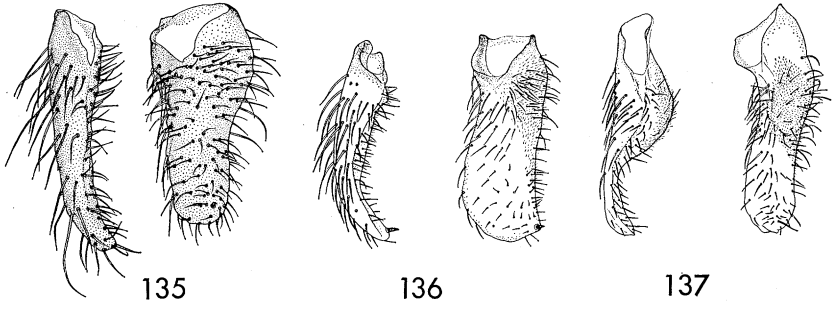


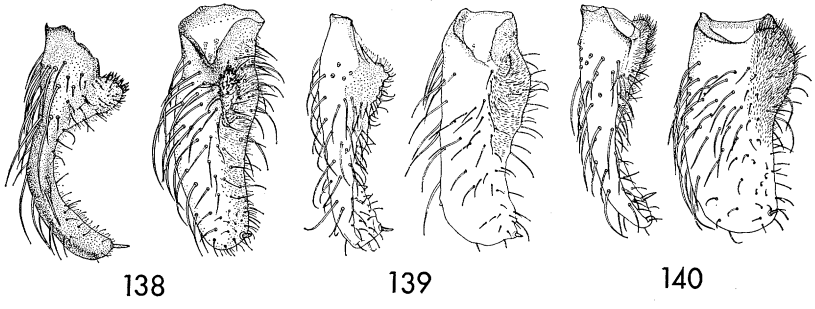
Male terminalia, ventral view: FIG. 113. *S. underhilli.* 114. *S. decorum.* 115. *S. parnassum.* 116. *S. tuberosum.* 117. *S. venustum.* 118. *S. verecundum.*



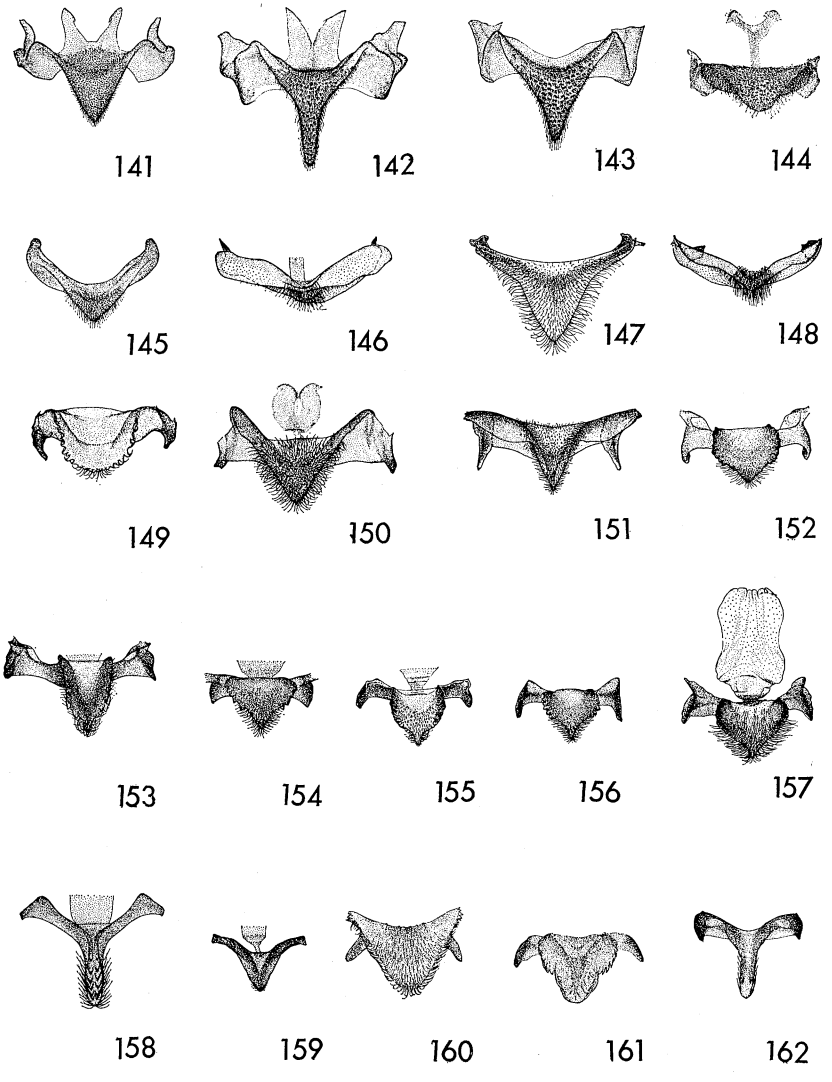
Distimere of male terminalia: FIG. 119. *P. magnum.* 120. *P. mixtum.* 121. *P. rhizophorum.* 122. *C. mutata.* 123. *C. pecuarum.* 124. *S. clarkei.* 125. *S. congareenarum.* 126. *S. meridionale.* 127. *S. slossonae.* 128. *S. vittatum.* 129. *S. pictipes.* 130. *S. fibrinflatum.* 131. *S jenningsi.*



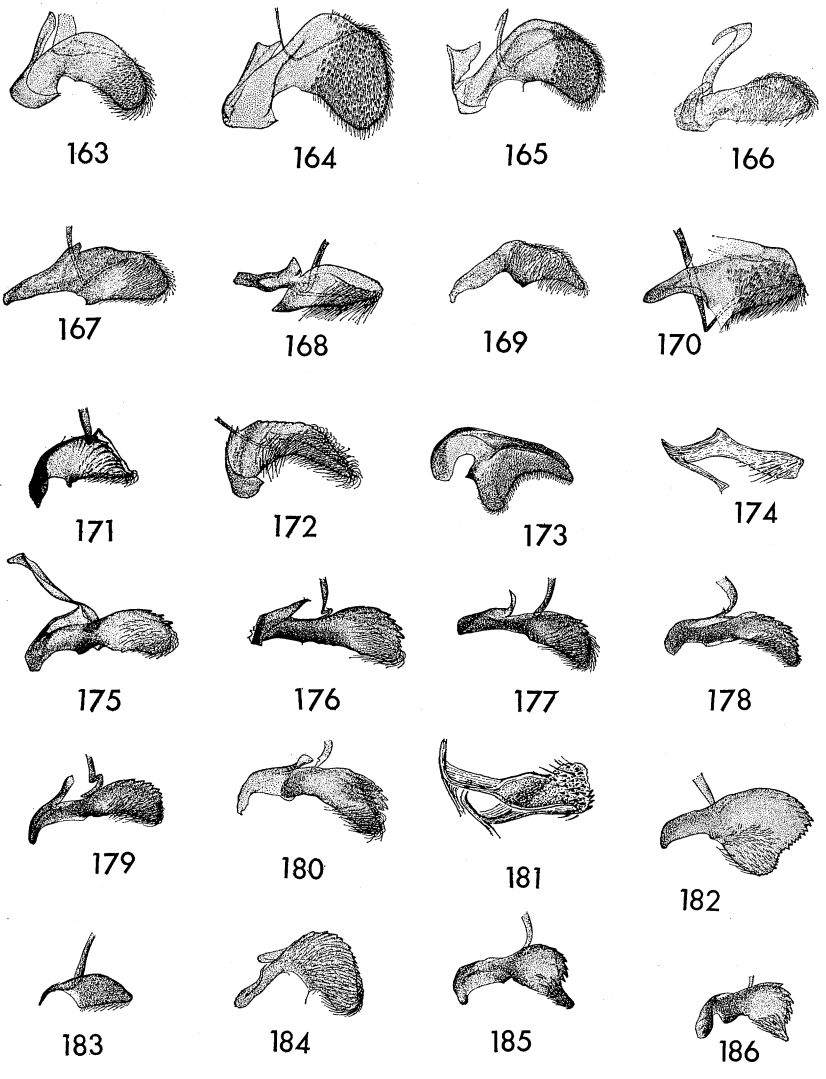




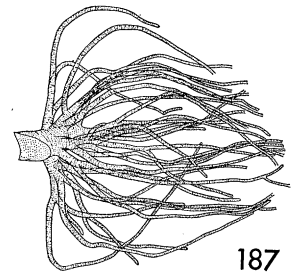
Distimere of male terminalia: FIG. 132. *S. jonesi.* 133. *S. luggeri.* 134. *S. notiale.* 135. *S. snowi.* 136. *S. decorum.* 137. *S. parnassum.* 138. *S. tuberosum.* 139. *S. venustum.* 140. *S. verecundum.*

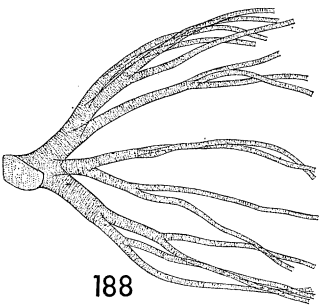


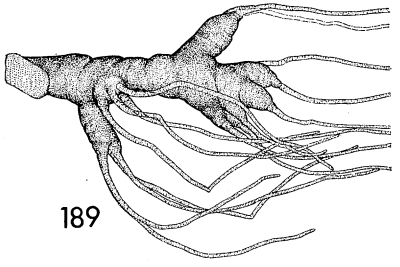
Ventral plate of male terminalia, end view: FIG. 141. *P. magnum.* 142. *P. mixtum.* 143. *P. rhizophorum.* 144. *C. mutata.* 145. *C. pecuarum.* 146. *S. clarkei.* 147. *S. congareenarum.* 148. *S. meridionale.* 149. *S. slossonae.* 150. *S. vittatum.* 151. *S. pictipes.* 152. *S. fibrinflatum.* 153. *S. jenningsi.* 154. *S. jonesi.* 155. *S. luggeri.* 156. *S. notiale.* 157. *S. snowi.* 158. *S. decorum.* 159. *S. parnassum.* 160. *S. tuberosum.* 161. *S. venustum.* 162. *S. verecundum.*

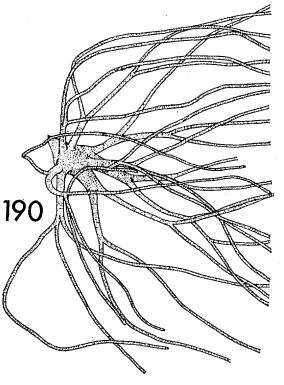


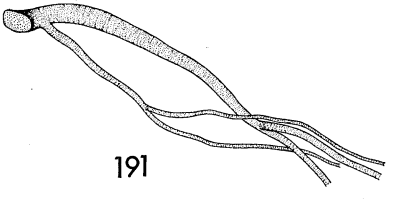
Ventral plate of male terminalia, lateral view: FIG. 163. *P. magnum.* 164. *P. mixtum.* 165. *P. rhizophorum.* 166. *C. mutata.* 167. *C. pecuarum.* 168. *S. clarkei.* 169. *S. congareenarum.* 170. *S. meridionale.* 171. *S. slossonae.* 172. *S. vittatum.* 173. *S. pictipes.* 174. *S. aranti.* 175. *S. fibrinflatum.* 176. *S. jenningsi.* 177. *S. jonesi.* 178. *S. luggeri.* 179. *S. notiale.* 180. *S. snowi.* 181. *S. underhilli.* 182. *S. decorum.* 183. *S. parnassum.* 184. *S. tuberosum.* 185. *S. venustum.* 186. *S. verecundum.*

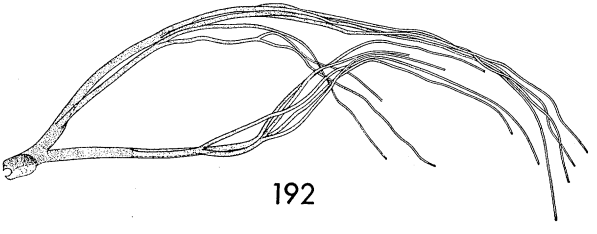




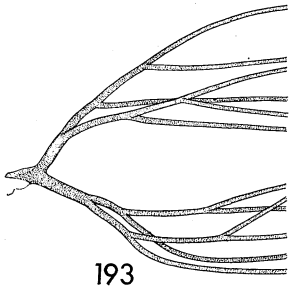


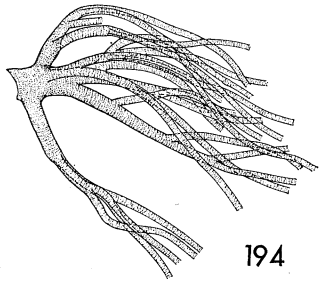


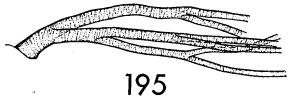


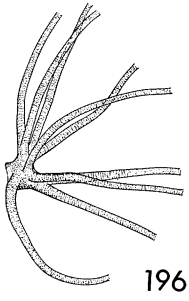


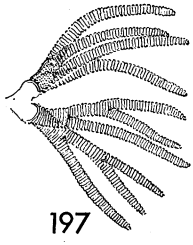
Respiratory organ of pupa: FIG. 187. *P. magnum.* 188. *P. mixtum.* 189. *P. rhizophorum.* 190. *C. pecuarum.* 191. *S. clarkei.* 192. *C. mutata.*

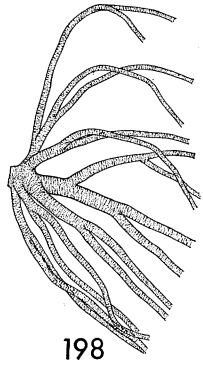


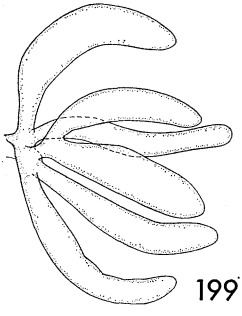


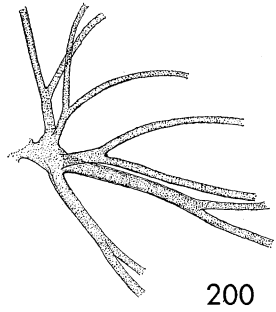


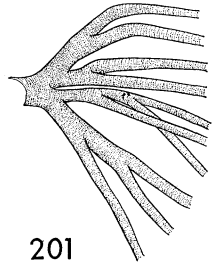






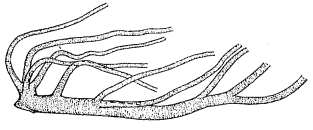






Respiratory organ of pupa: FIG. 193. *S. congareenarum.* 194. *S. meridionale.* 195. *S. slossonae.* 196. *S. pictipes.* 197. *S. aranti.* 198. *S. vittatum.* 199. *S. fibrinflatum.* 200. *S. dixiense.* 201. *S. jenningsi.*

202



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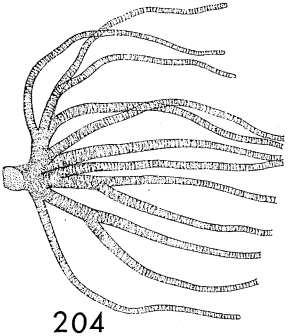

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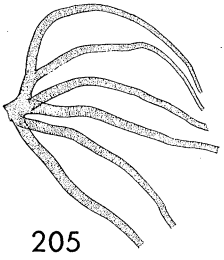

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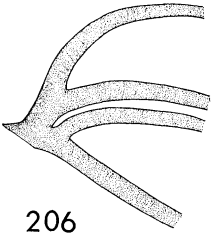

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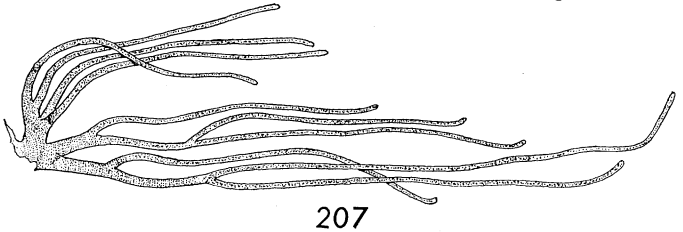
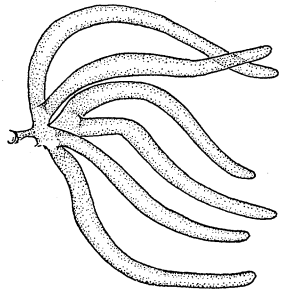


207

Respiratory organ of pupa: FIG. 202. *S. haysi.* 203. *S. jonesi.* 204. *S. luggeri.* 205. *S. notiale.* 206. *S. snowi.* 207. *S. nyssa.*



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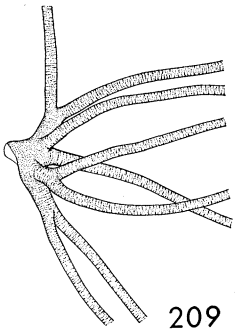

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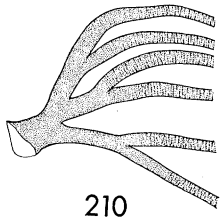

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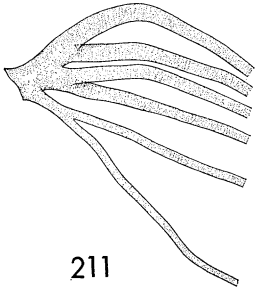

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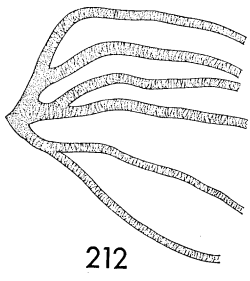

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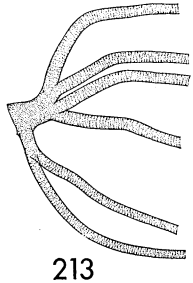

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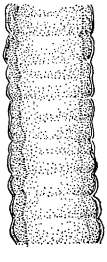

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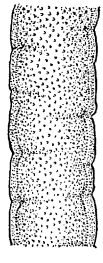

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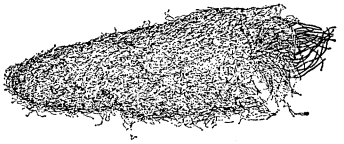
Respiratory organ of pupa: FIG. 208. *S. underhilli.* 209. *S. decorum.* 210. *S. parnassum.* 211. *S. tuberosum.* 212. *S. venustum.* 213. *S. verecundum.* Detail of respiratory filament; 214. *S. aranti.* 215. *S. jenningsi.* 216. *S. nyssa.*



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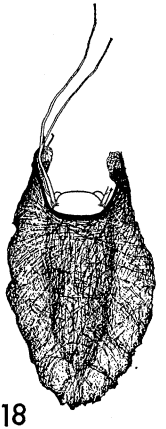

218

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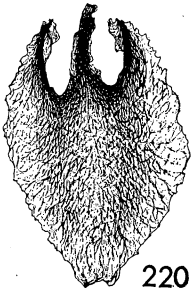

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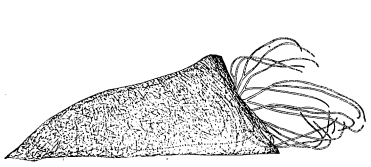
222

Cocoon: FIG. 217. *P. magnum.* 218. *S. clarkei.* 219. *S. meridionale.* 220. *S. congareenarum.* 221. *S. congareenarum.* 222. *S. slossonae.*



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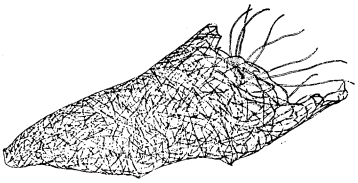

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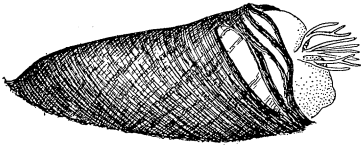

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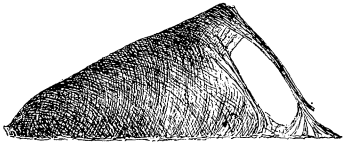

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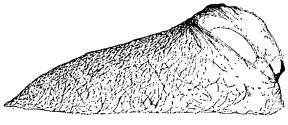

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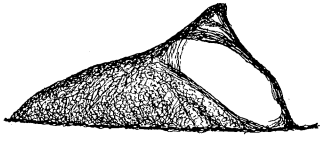

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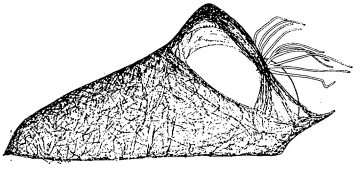

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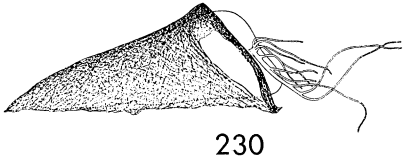

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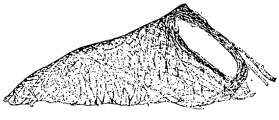

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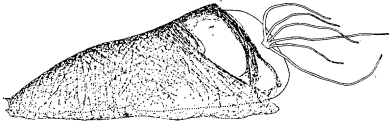

232

Cocoon: FIG. 223. *S. vittatum.* 224. *S. pictipes.* 225. *S. aranti.* 226. *S. dixiense.* 227. *S. fibrinflatum.* 228. *S haysi.* 229. *S. jenningsi.* 230. *S. jonesi.* 231. *S. luggeri.* 232. *S. notiale.*

233

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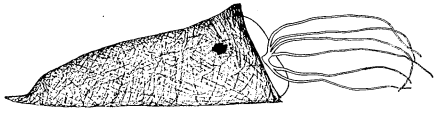

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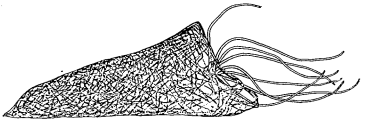

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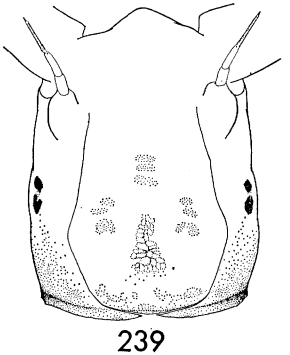

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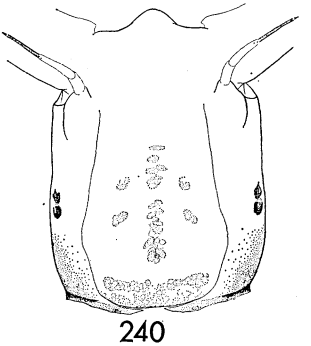
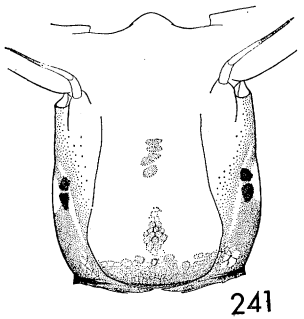
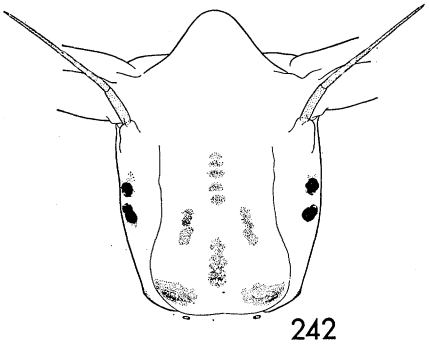
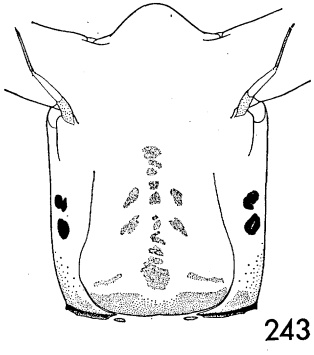


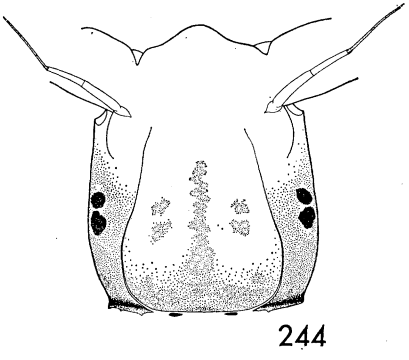
240

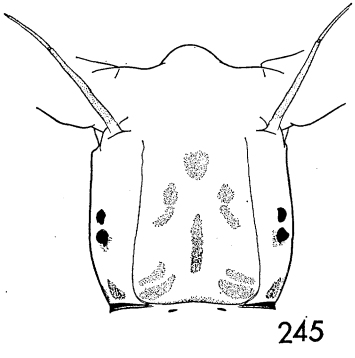
Cocoon: FIG. 233. *S. snowi.* 234. *S. parnassum.* 235. *S. tuberosum.* 236. *S. venustum.* 237. *S. verecundum.* 238. *S. decorum.* Head of larva, dorsal view: 239. *P. magnum.* 240. *P. mixtum.*

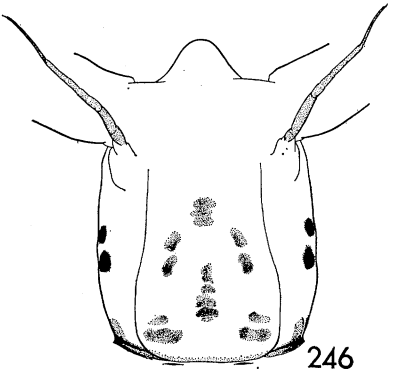




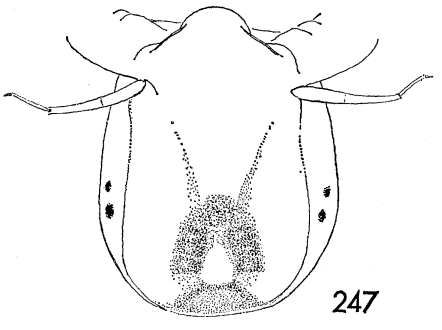


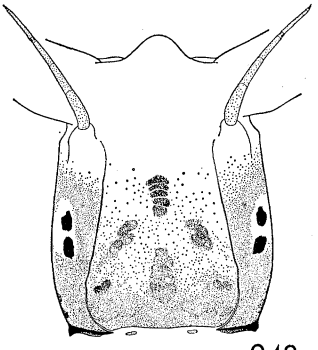


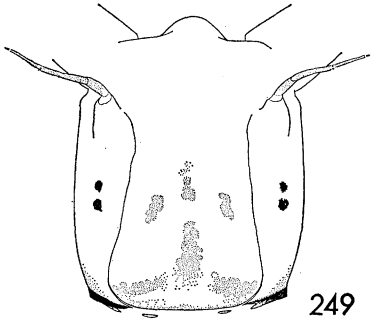


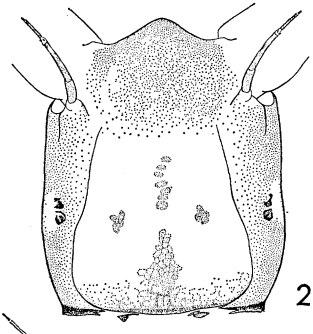


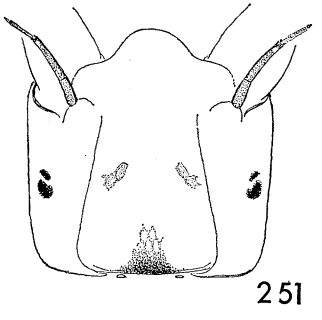
Head of larva, dorsal view: FIG. 241. *P. rhizophorum.* 242. *S. congareenarum.* 243. *C. pecuarum.* 244. *C. mutata.* 245. *S. slossonae.* 246. *S. clarkei.*

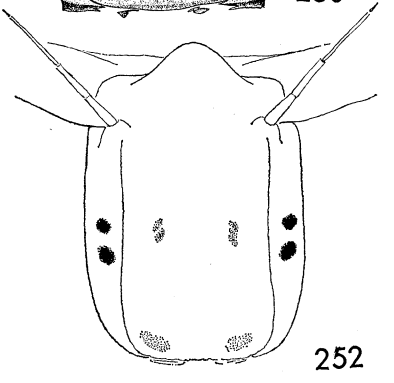




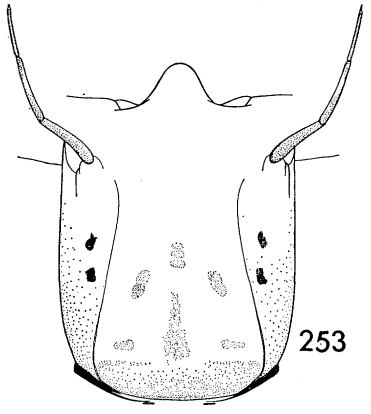


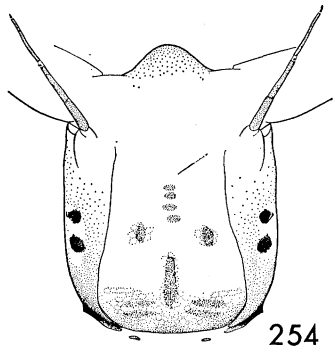


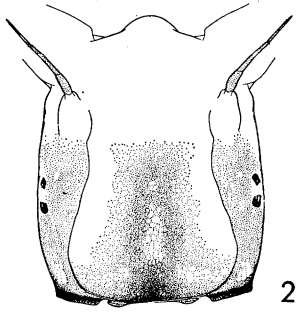


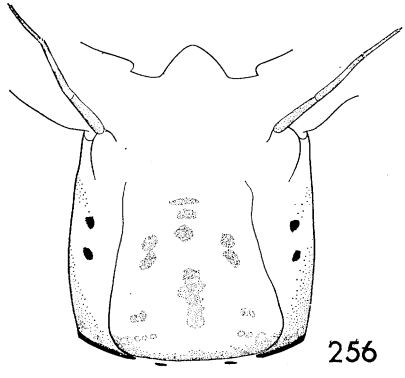


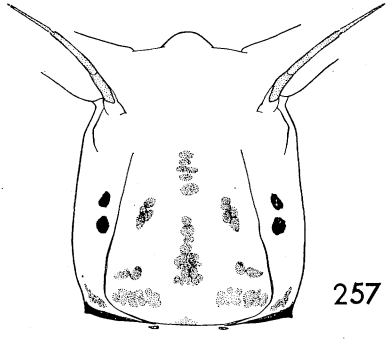
Head of larva, dorsal view: FIG. 247. *S. meridionale.* 248. *S. fibrinflatum.* 249. *S. vittatum.* 250. *S. pictipes.* 251. *S. aranti.* 252. *S. haysi.*

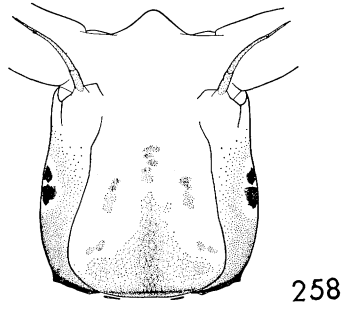




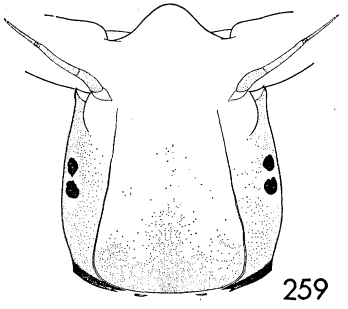


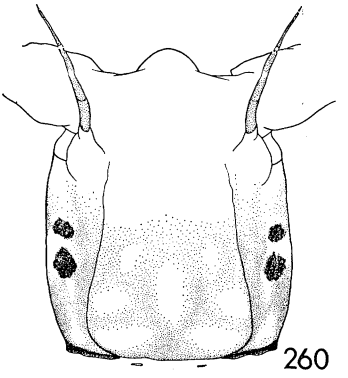


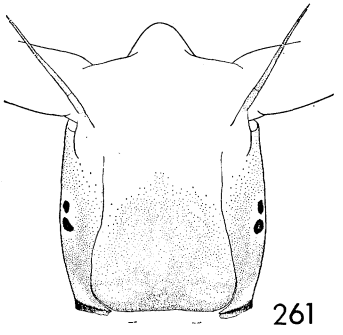


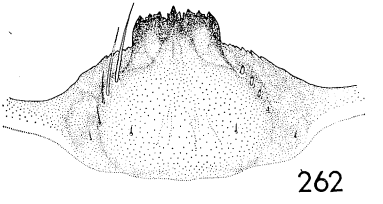


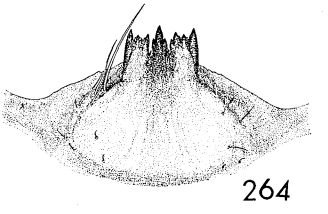
Head of larva, dorsal view: FIG. 253. *S. jenningsi.* 254. *S. jonesi.* 255. *S. decorum.* 256. *S. luggeri.* 257. *S. snowi.* 258. *S. parnassum.*

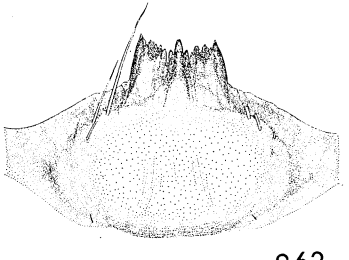


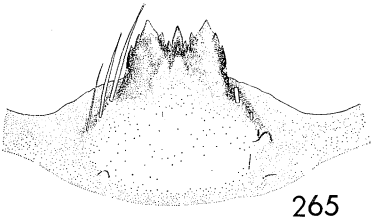




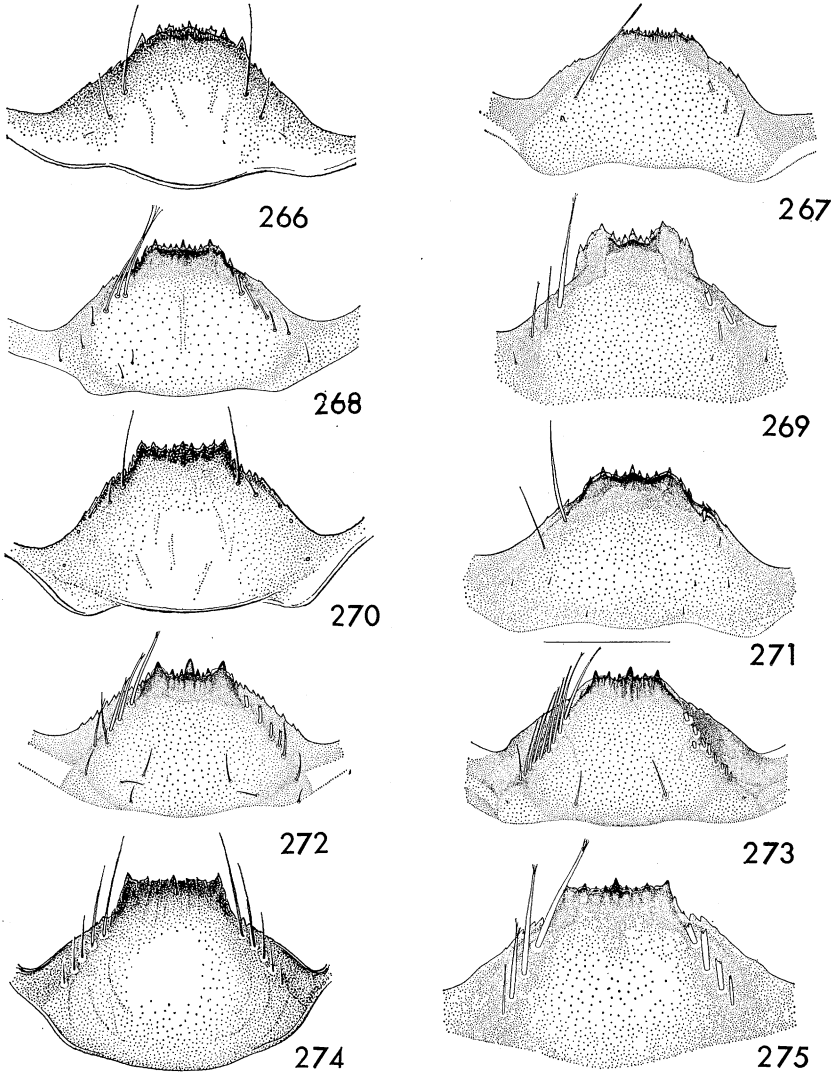




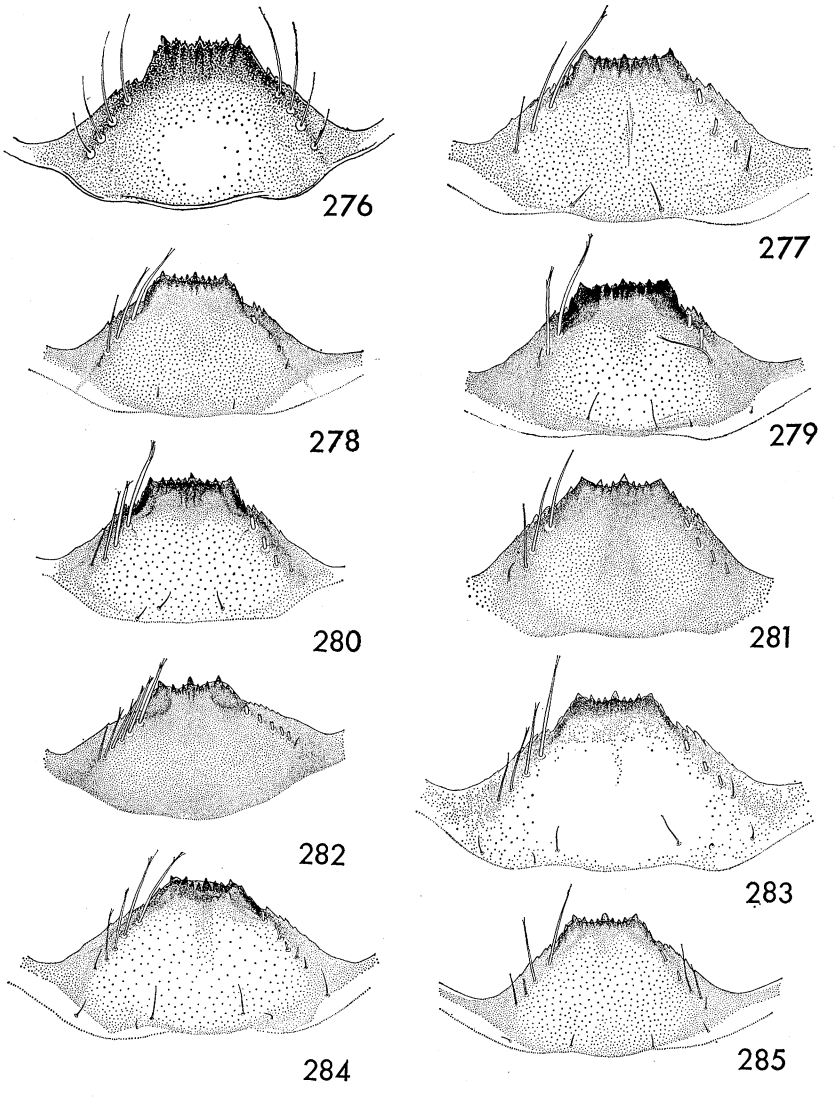




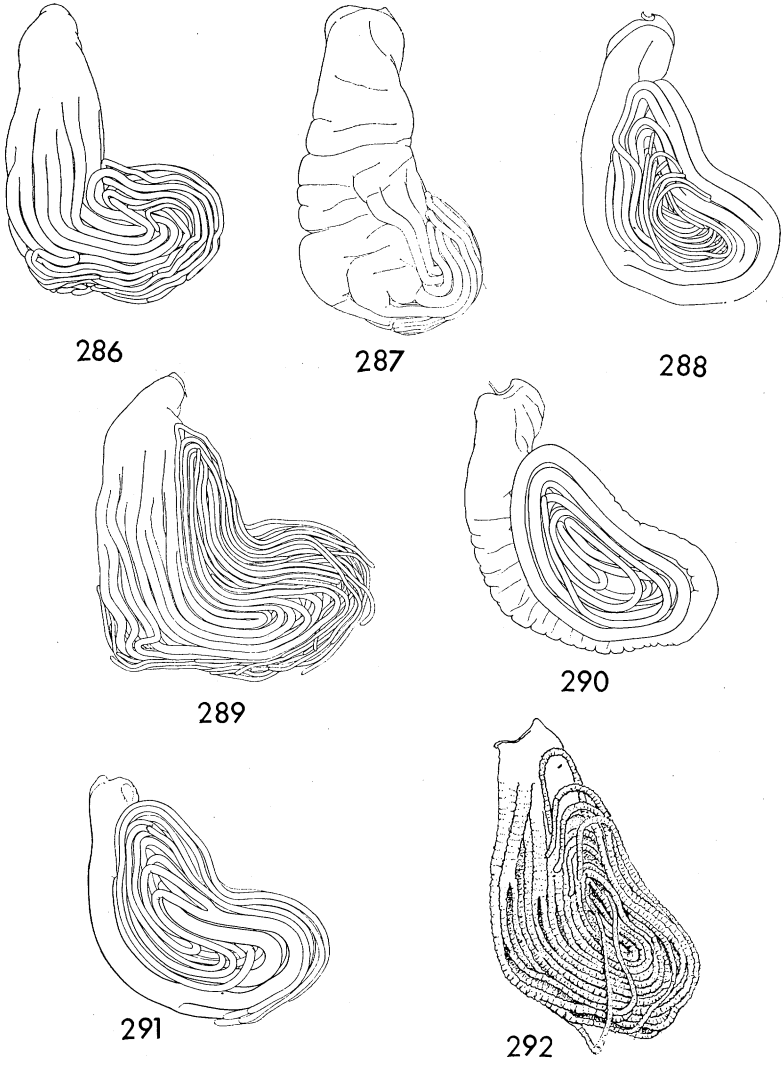
Head of larva, dorsal view: FIG. 259. *S. tuberosum.* 260. *S. venustum.* 261. *S. verecundum.* Hypostomium of larva: 262. *P. magnum.* 263. *P. mixtum.* 264. *P. rhizophorum.* 265. *C. mutata.*



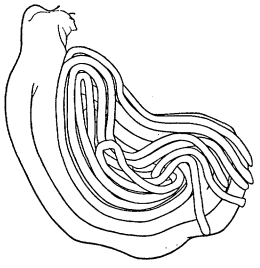
Hypostomium of larva: FIG. 266. *C. ornithophilia.* 267. *C. pecuarum.* 268. *S. clarkei.* 269. *S. congareenarum.* 270. *S. meridionale.* 271. *S. slossonae.* 272. *S. vittatum.* 273. *S. pictipes.* 274. *S. aranti.* 275. *S. fibrinflatum.*



Hypostomium of larva: FIG. 276. *S. haysi.* 277. *S. jenningsi.* 278. *S. jonesi.* 279. *S. luggeri.* 280. *S. snowi.* 281. *S. decorum.* 282. *S. parnassum.* 283. *S. tuberosum.* 284. *S. venustum.* 285. *S. verecundum.*



Respiratory histoblast: FIG. 286. *P. magnum.* 287. *P. rhizophorum.* 288. *C. mutata.* 289. *C. pecuarum.* 290. *S. clarkei.* 291. *S. congareenarum.* 292. *S. meridionale.*



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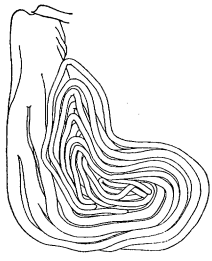

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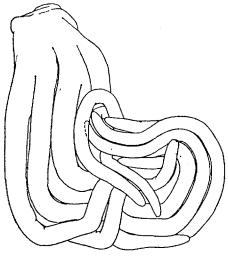

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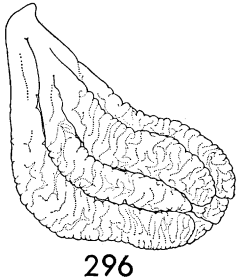

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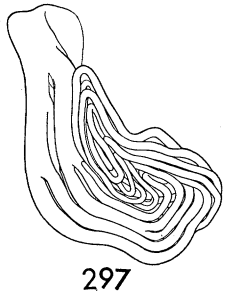

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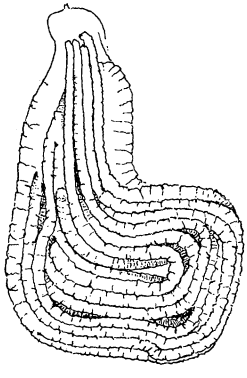

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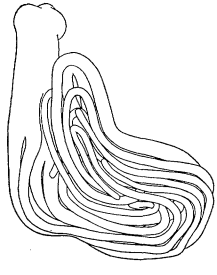

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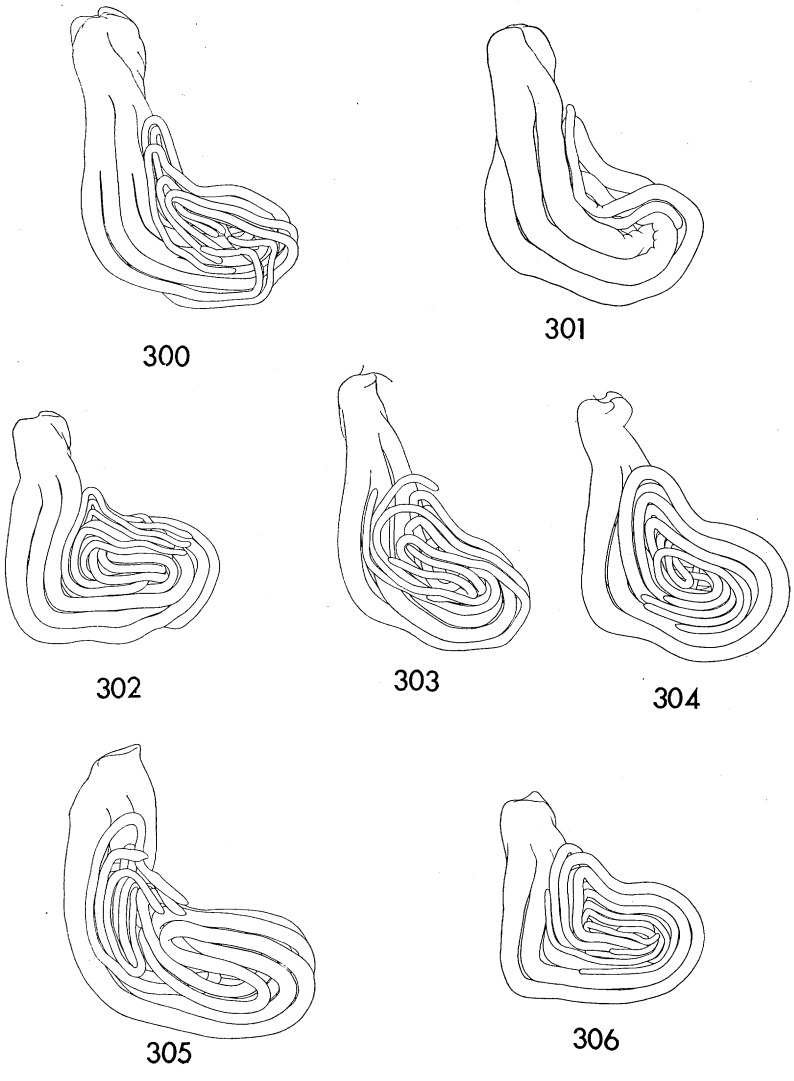
Respiratory histoblast: FIG. 293. S. *slossonae*. 294. S. *vittatum*. 295. S. *pictipes*. 296. S. *fibrinflatum*. 297. S. *jenningsi*. 298. S. *haysi*. 299. S. *jonesi*.

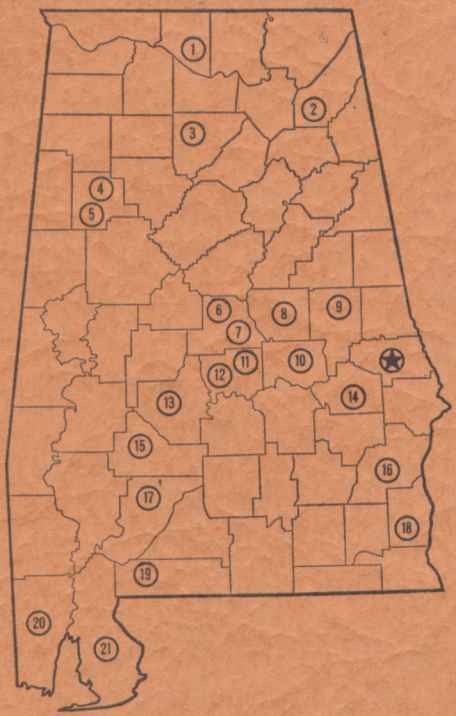


Respiratory histoblast: FIG. 300. *S. luggeri.* 301. *S. snowi.* 302. *S. decorum.* 303. *S. parnassum.* 304. *S. tuberosum.* 305. *S. venustum.* 306. *S. verecundum.*

INDEX TO GENERA, SUBGENERA, AND SPECIES

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.