D. L. DEONIER

A Systematic and Ecological Study of Nearctic Hydrellia (Diptera: Ephydridae)

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY NUMBER 68

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ABSTRACT

Deonier, D. L. A Systematic and Ecological Study of Nearctic *Hydrellia* (Diptera: Ephydridae). *Smithsonian Contributions to Zoology,* 68:1–147. 1971.—The adults of 57 species of *Hydrellia* are described for the Nearctic Region. Adults of *Hydrellia* are semiaquatic and the larvae are leafminers in aquatic and semiaquatic plants. Twenty-one of the described species are new, and one represents a new geographic distribution record. Some or all of the immature instars of 18 species are described. The male terminalia and certain other critical characters are figured for the adults of 52 species. The larval feeding apparatus of 16 species and the puparia of 17 species are illustrated. Geographic distribution data are given for all species. New and previously recorded host plants are listed for several species, and other biological information such as habitats and behavior is given for most of the species. The general morphology of the genus, including morphology of the adult feeding apparatus and gut and internal genitalia, is discussed and illustrated. The general ecology of *Hydrellia* is discussed in regard to ecological role and distribution, parasitological data, dispersal and zoogeography, behavior, and environmental tolerance. Additional ecological data are included in checklists of known host plants and known hymenopterous parasites of *Hydrellia.* Literature pertinent to the genus is reviewed.

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Contents

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Introduction

The Ephydridae constitute a medium-size family of acalyptrate Diptera. They lead several different modes of life, mostly in aquatic habitats. *Hydrellia* and *Lemnaphila* are the only known genera of aquatic leaf-mining ephydrids.

At least two species of *Hydrellia*—*H. griseola* and *H. ischiaca*—are economically important. In 1953, *H. griseola* destroyed from 10 to 20 percent of California's rice crop, with an estimated loss of $16 million. The same species caused heavy losses of rice in California in 1922. It has damaged rice in Japan in the last two decades. Lilljeborg (1861) first recorded the pest status of *H. griseola*. He reported the fairly widespread damage of barley, oats, and timothy grass by that species in southern and southeastern Sweden during the summer of 1860. After this, several authors reported outbreaks of *H. griseola* in various places in the Palaearctic Region, including Egypt. Balachowsky and Mesnil (1935) reported 50 percent infestation of barley by *H. griseola* in northern Europe. *Hydrellia ischiaca* attacks wild rice, which is now a minor crop in Minnesota. Most of the known larvae of other *Hydrellia* species feed mainly in plants of Potamogetonaceae, Alismataceae, and Hydrocharitaceae.

There are 185 available specific names in *Hydrellia* other than my new species. Of these, perhaps 133 have existing holotypes, and perhaps 132 of the 185 have Palaearctic type-localities. Possibly 113 of the available names are valid. These 113 species are distributed as follows: 55 Palaearctic, 35 Nearctic, 1 Holarctic, 2 Oriental, 12 Australian, 2 Ethiopian, and 6 Neotropical. This essentially cosmopolitan generic distribution has caused some interest in the dispersal center. Some data possibly indicate this was in the northern temperate zone.

I started this research with the following objectives: (1) to describe, redescribe, and construct keys to the adults and as many immature stages as possible of Nearctic species; (2) to describe the life cycles and behavior of as many as possible of the Nearctic species; (3) to present a brief morphology of the genus.

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Review of Literature

The taxonomic literature on *Hydrellia* dates from 1813, when Fallén described *Notiphila griseola* and several congeneric species from southern Sweden. In 1830, Robineau-Desvoidy erected the new genus *Hydrellia*. Macquart (1835), Zetterstedt (1846), Walker (1856), Loew (1860), Schiner (1864), Brischke (1883), Gobert (1887), Kowarz (1894), and Becker (1896, 1903) made many of the initial contributions to the taxonomy of Palaearctic species. Strobl (1904), Grünberg (1910), Becker (1919), Collin (1928), Frey (1933), de Meijere (1939), Goetghebuer (1942), Grensted (1944), Kloet and Hincks (1945), and Tsacas (1959, 1960) added some descriptions of new species, but primarily they presented reviews and new distribution records. Dahl (1967) presented a zoogeographical synopsis of eleven European species and (1968) described three new species along with new records from eastern Siberia. Becker's (1896, 1926) synoptic keys to and descriptions of Palaearctic adult *Hydrellia* and Hennig's (1943) specific key to larval *Hydrellia* including Palaearctic species contributed most to the taxonomy of Palaearctic species of *Hydrellia.* The recent revision by Dahl (1964) of the Stenhammar and Zetterstedt collections eliminated much confusion and synonymy in Palaearctic *Hydrellia.*

Loew (1861, 1862) described the first new species of Nearctic *Hydrellia.* Loew (1872), Osten Sacken (1878), Becker (1896), Aldrich (1905), Jones (1906), and Coquillett (1910a) presented short sections on Nearctic *Hydrellia.* Very little additional taxonomic study of the genus was made until 1915, when Cresson started describing new species. Johannsen (1935) has reviewed and presented a key to the known immature instars of Nearctic species. Hennig (1943) has summarized the literature on immature *Hydrellia* and presented a specific key to all known immature instars, including the few in the Nearctic. Cresson's studies culminated in a key (Cresson, 1944b) to the adults of the 35 Nearctic species then known. Subsequent to this, Berg (1949, 1950) contributed to the biology and taxonomy, including a key, of the immature instars of six species; Hennig (1952) presented morphological interpretations of immature *Hydrellia*; Wirth and Stone (1956) included a key to California species and a Nearctic generic key; Grigarick (1959) redescribed the lifecycle stages of *H. griseola*; Deonier (1964) presented keys to the adults of species of Iowa and adjacent states; and Wirth (1965) cataloged many Nearctic species.

Cresson (1918, 1947a) described and presented keys to the six species of *Hydrellia* known from the Neotropical Region. Wirth (1968) cataloged these, and included data on their distribution. Wirth (1969) reported *H. vulgaris* Cresson from the Galapagos Islands.

Little study has been made of *Hydrellia* in the Oriental Region. Cresson (1948) listed only two species, *H. latipalpis* Cresson and *H. luteipes* Cresson, from the Oriental Region in his Indo-Australian synopsis. The latter species is known only from Formosa, which is more or less transitional between the Oriental and Palaearctic Regions.

Of *Hydrellia* in the Australian Region, Coquillett (1903), Tonnoir and Malloch (1926), Cresson (1948), and Harrison (1959) published on some or all of the twelve known indigenous species. The relatively small amount of attention given to Oriental and Australian *Hydrellia* is matched only for the Ethiopian *Hydrellia.* Cresson (1932, 1947b) listed two species, both from the Cape of Good Hope.

The works of the following authors provide some framework for a more searching morphological study of adult *Hydrellia.* Becker (1896, 1926), Grünberg (1910), Cresson (1918), and Wilke (1924) dealt mainly with chaetotaxy, but Cresson did briefly discuss facial contour and the supposed absence of vibrissae in Ephydridae. Frey (1921) discussed the mouthparts of *H. obscura* and the cibaria of other ephydrids. Séguy (1934) illustrated the head and wing of *H. griseola,* and Scotland (1940) illustrated by photographs the proboscis, antenna, and wing of the closely related genus *Lemnaphila.*

Hering (1950) briefly described and illustrated the excised male terminalia of *H. xenophaga* and *H. nigricans.* Kato (1955) and Kuwayama (1955) described and illustrated several aspects of the external morphology of adult *H. griseola.* Hennig (1958) discussed the external morphology of the head and the thoracic chaetotaxy of several ephydrid representatives including *H. griseola.* With phylogenetic interpretations as a primary objective, Hennig made an important contribution here, especially in proposing the presence of vibrissae in Ephydridae. Dahl (1959) illustrated the adult mouthparts, female abdomen, and hind tarsus of *H. griseola.* Grigarick (1959) illustrated the male and female abdomina, the wing, and the mesonotum of *H. griseola.* Harrison (1959) illustrated the head, wing, and portions of the male terminalia of five New Zealand species of *Hydrellia.* Dahl (1964) illustrated the male terminalia of 17 species of *Hydrellia* from the Stenhammar and Zetterstedt collections. Deonier (1964) illustrated the head of *H. harti* and the chaetotaxy and sclerite nomenclature of the head and thorax exemplified in *Ephydra riparia.* Dahl (1968) illustrated parts of the male and female genitalia for three new species of *Hydrellia* in eastern Siberia.

Sturtevant (1925, 1926) made the only contributions to the internal morphology of *Hydrellia* in his survey of spermathecae in Acalyptratae. Bolwig (1940, 1941) described and illustrated the internal genitalia and mouthparts of *Scatophila unicornis.*

These studies helped in understanding the morphology of these structures in *Hydrellia.*

Several authors contributed morphological data on the immatures of *Hydrellia*: von Frauenfeld (1866) described the gross aspects of the metamorphosis of *H. albilabris;* Stein (1867) summarized briefly the life cycle of *H. griseola;* Gercke (1879, 1882, 1889) briefly described and illustrated the puparia and feeding apparatus of *H. mutata* and *H. fulviceps*; and Marchal (1903) figured in gross aspect the third-instar larva of *H. ranunculi.*

Though concerned with *Ephydra riparia,* an investigation by Trägardh (1903) so lucidly illustrated the larval feeding apparatus, gut, musculature, and tracheal system that it formed a basis for anatomical study of larval *Hydrellia.* Brocher (1910) examined the gross morphological, ecological, and physiological aspects of the tracheal system of *H. mutata.* Keilin (1915) also studied the metapneustic tracheal system of larval *Hydrellia* and illustrated the larval feeding apparatus. Malloch (1915) briefly described the larva and illustrated the puparium of *H. griseola* (as *H. scapularis*). Ping (1921), with his morphological descriptions and illustrations, especially of the feeding-apparatus musculature of the larvae of *Ephydra riparia* (as *E. subopaca*), provided a very good basis for such work in *Hydrellia.* Likewise, Schütte (1921), in discovering the phenomenon of seasonal (summer and winter) forms of the puparia of *Hydromyza livens,* provided the starting point for a similar investigation in *Hydrellia* which could answer several ecological questions.

Wilke (1924) and Schøyen (1930) described the gross morphology of the immature instars of *H. griseola.* Collin (1928) illustrated the habitus of the third-instar larva of *H. nasturtii.* Johannsen (1935) briefly described the gross morphology of immature *Hydrellia.* Hennig (1943) summarized the known morphology of immature *Hydrellia.* Berg (1950) contributed much to the external morphological data on immature *Hydrellia* by describing and illustrating most immature instars of six species. Séguy (1950) referred briefly to some aspects of morphological interest in immature *Hydrellia.* Hering (1951) commented generally on larval respiration and the puparial operculum. In 1952, Hennig discussed and illustrated much of the morphological data on immature *Hydrellia.* Lange et al. (1953) presented some significant photographs of the life-cycle stages of *H. griseola.* Kato (1955), Kuwayama (1955), and Grigarick (1959) showed detailed figures of the egg, feeding apparatus, larval body, puparium, spiracular peritremes, spinulosity, and setulosity of *H. griseola.*

Many authors have contributed ecological data on *Hydrellia,* and the following have made major contributions: Störmer and Kleine (1911), Sorauer and Reh (1913), Linnaniemi (1913), Hendel (1926), and Kreuter (1927) reported some host plants of *Hydrellia,* principally of *H. griseola;* DeOng (1922) investigated the phenology of *H. griseola* and its damage to domestic rice; Hering (1924, 1937, 1951, 1957) contributed much to host-plant data and host damage of Palaearctic species of *Hydrellia;* Balachowsky and Mesnil (1935) reported a host-plant list and host damage for *H. griseola;* Thompson (1943) listed some hymenopterans parasitic on a few species of *Hydrellia;* Wahlgren (1947) published on the species of *Hydrellia* mining in *Stratiotes aloides;* Berg (1949, 1950) recorded some larval behavior, oviposition behavior, and some host-plant species of six species of *Hydrellia;* Laurence (1952) described some entomophagous behavior of *H. griseola;* Lange et al. (1953) discussed the biology and control of *H. griseola* in California; Grigarick (1959) studied the ecology of *H. griseola* in California rice fields; and Burghele (1959a, 1959b) and Fulmek (1962) recorded several hymenopterans parasitic in species of *Hydrellia* in the Palaearctic Region.

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The following institutions and individuals loaned material to me for this research (abbreviations of those serving as paratype repositories are included in parentheses): Academy of Natural Sciences of Philadelphia (ANSP), American Museum of Natural History (AMNH), California Academy of Sciences (CAS), University of California at Davis (UCD), Canadian National Collection (CNC), Carnegie Museum, Chicago Natural History Museum, Cornell University (CU), Illinois State Natural History Survey, Iowa State University (ISC), University of Kansas (UKC), Kansas State University, University of Massachusetts (UMM), University of Michigan, University of Minnesota (UMC), University of Missouri, Museum of Comparative Zoology, Harvard University (MCZ), University of Nebraska, Oregon State University, United States National Museum of Natural History (USNM), Utah State University, Washington State University (WSC), Dr. C. O. Berg of Cornell University, Mr. Kenneth Goeden of the Oregon State Department of Agriculture (KG), Dr. W. W. Judd of the University of Western Ontario, Mr. George Steyskal of the United States Department of Agriculture, and Dr. M. R. Wheeler of the University of Texas (MRW).

My own paratype holdings are labeled (DLD) under the pertinent new species.

Methods and Materials

Collecting of adults.—I collected adults by sweeping emergent vegetation, by lowering a killing tube over them on floating vegetation, and by a lighted-receptacle method. In the last method, I inserted the bottom of an open jar into the recessed lens of a flashlight and beamed the light to floating leaves. Adults of *Hydrellia, Lispe, Hydromyza,* Donaciinae, and a few others flew readily into the lighted jar. After several adults were in the jar, I closed it and replaced it with another. This method failed with *H. bilobifera, H. trichaeta,* and *H. crassipes* in North Carolina. Altogether, it was tried on about ten species.

As a survey method for adults, I used a device invented and described by Grigarick (1959). As modified for this project, the device consisted of a circular aluminum pan 3 cm deep and 25 cm in diameter inserted in a hole of similar dimensions cut centrally in a square piece of styrofoam 50 by 3 cm. Holes in the corners of the styrofoam float accommodated dowels run vertically through them and into the lake bottom to anchor the device. A detergent solution in the pan constituted the actual trap mechanism. The detergent destroyed the effectiveness of the tarsal hydrofuge setae so that flies landing on the solution sank immediately. In these traps I caught specimens of Donaciinae, Gerridae, Veliidae, Hydrometridae, Hydrophilidae, Tridactylidae, Collembola, Hymenoptera, and several dipterous families in addition to those of *Hydrellia.*

I made most of my behavioral observations while collecting. After observing the behavior of the individual, I collected it with a killing tube or live-capture tube. I tried to keep some captured adults alive in the laboratory long enough to make additional observations or for inseminated females to oviposit.

Preparation of adults.—I killed and preserved in 80 percent ethanol specimens intended for anatomical and food-habits studies. I used a hydration series on these specimens before dissecting or sectioning them. I hydrated some specimens just before dissection and some just after fixation in Bouin's solution or dioxane in preparation for serial sectioning.

To clear terminalia, I placed them in a hot, 10 percent potassium hydroxide solution for about 3 minutes and then added two to ten drops of 30 percent hydrogen peroxide over and around the floating terminalia. By closely watching the terminalia, I could ascertain when they were sufficiently bleached and desclerotized. The time required for this combined clearing and bleaching process varied with the condition of the terminalia and with the species. The average time was about 3.5 minutes—3 minutes in hot caustic followed by a few seconds in the mixture of peroxide and caustic. Terminalia not quickly removed after the critical time limit often were overcleared and not usable. Apparently, the oxygen released from the hydrogen peroxide acts as the bleaching agent. After passing the terminalia through glacial acetic acid, distilled water, and absolute ethanol, I placed them in a small drop of glycerol in a depression slide for microscopic study. I used an ocular grid and squared paper to draw to scale the terminalia and other adult structures. Except for the structures that require a bilateral or whole view for proper interpretation, I show only the left half of bilaterally symmetrical structures in most drawings. I drew most of the adult structures with the aid of a compound microscope.

Collecting of immatures.—In collecting the immatures of *Hydrellia*, I first searched for eggs on or near potential host plants in the habitats of the adults. When I discovered eggs I placed the entire plant on which they were laid into a plastic bag. After searching for eggs, I sampled the potential host plants in the locality for larvae and puparia. This was a random process in regard to larvae, for they can be found in situ most readily in the laboratory with strong direct illumination and a stereomicroscope. In sampling some submergent plants in depths greater than 1.3 meters, I used a pike pole or employed a scuba diver. In studying the overwintering of some *Hydrellia*, I used an ice chisel to cut through the ice to obtain samples of some host plants.

In the laboratory, I examined all parts of each plant for immature *Hydrellia* by holding the plant part before a strong light. When there was evidence of mining, but no larvae apparent, I examined the tissue with a stereomicroscope.

Rearing.—When I discovered an egg or larva, I removed the plant part in or on which it was situated and placed the part in a small culture dish with tap water. I isolated each puparium together with some of the surrounding plant part in a 75–ml test tube containing a small amount of tap water and loosely plugged with cotton.

I observed and recorded behavior (larval eclosion, molting, and ecdysis, mining activity, pupariation, adult emergence, etc.) and associated morphological changes daily. During these microscopic examinations, I would occasionally find a first- or second-instar larva previously undetected. In almost all cases I could distinguish between it and the original. This difficulty in detecting first-instar and some second-instar larvae existed because of their small size, translucency, the greater depth and shorter length of the mine. Because of this difficulty, I kept all plant material examined in screen-covered aquaria. I examined all of this plant material for immature *Hydrellia* periodically for two weeks.

I prepared voucher specimens of each plant species examined for *Hydrellia* and also of some species collected for ecological indicators. Because of the large number of plants of many species examined, I could not preserve each plant found to be a host of *Hydrellia*. These specimens are on deposit at the Iowa State University Herbarium.

Since temperature control was unavailable for the rearing work, I attempted only to record the temperature of the water in which specimens were reared. During the summer of 1963 at the University of Minnesota Biological Station and at most times thereafter to the present, I used a circular thermograph with sensor element kept in a beaker of tap water for recording daily temperature fluctuations in the laboratory. I changed the tap water around the sensor each time I changed the tap water in the rearing vessels.

Preparation of immatures.—For species of *Hydrellia* for which I had collected sufficient specimens of each of the immature instars, I preserved some of each instar, but for several species I had so few specimens that I allowed all to develop to the adult instar.

I preserved some *Hydrellia* eggs in 80 percent ethanol and some between filter-paper strips moistened with AFA and placed in small shell vials (about 5-ml capacity). I plugged the vials with cotton and immersed them in either ethanol or AFA in large museum jars. I preserved the larvae and puparia by the same method, after killing them in hot water. To insure good specimens for anatomical and food-habits studies, I used AFA, but it had the one deleterious effect of bleaching the chlorophylls and carotenoids in the larval gut contents.

For stereomicroscopic study, I placed larvae in 80 percent ethanol in depression slides. To study the same material with a compound microscope, I had only to add a few drops of glycerol to the ethanol in the concavity. I used this method for studying, drawing, and photographing eggs, larvae, and puparia.

To store egg choria and puparia from which adults had been reared, I placed them in small drops of glycerol in the bottom of cork-stoppered, glass microvials and placed them on the pin holding the corresponding adult. This method afforded a flexibility in studying specimens that was not afforded in the use of permanent glass-slide mounts; also, it kept most of the life-cycle stages together.

Because of the microscopic size of some structures, e.g., setulae, spinules, and some other cuticular processes, I did not risk clearing immature specimens with potassium hydroxide. Clearing was necessary only infrequently, and then it usually involved parts of puparia, for which a very mild agent such as methyl salicylate sufficed.

I used the same procedures and materials for drawing structures of immatures as I did for adults, except that I made the habitus drawings of puparia initially with a stereomicroscope and then filled in some details under a compound microscope.

Morphology

Glossary

New structures, configurations, and indices encountered in a taxonomic study must be named. Since zoological terminology is already burdened with much ambiguity, I constructed the following definitions and explanations of structural and index names. In these, all distance measurements are straight-line and uniplanar on preserved specimens unless otherwise specified.

Terminology for Adults

A-index: The quotient of the subcranial breadth divided by the anteclypeal breadth. (Figure 11.)

Anteclypeal breadth (*acb*): The maximum transverse distance between the outer edges of the paraclypeal phragmata of the anteclypeus. (Figure 11.)

Anteocellar distance (*aod*): The distance between the anterior margin of the median ocellus and the upper edge of the ptilinal fissure along the frontal midline. (Figure 11.)

Anterior fronto-orbital (*afr*): The anterior seta of the two setae commonly prominent in each fronto-orbital area. (Figure 1.)

Apicodorsal antennal (*a3ap*): A spinous seta on the dorsal apex of antennal segment 2.

Aristal rays (*arr*): All of the trichoid projections of each arista including the apical one. (Figure 1.)

B-index: The quotient of the maximum anteroposterior extent of the fused surstyli divided by the length of the sclerotized portion of the cercus as measured in ventral view. (Figure 4.)

Basal coxal (*bc*): A seta inserted laterally on the mid coxa. (Figure 6.)

Basal end of costa (*bec*): The enlarged basal portion of the costa proper adjacent to the humeral plate. (Figure 135.)

Body length: The distance between the most prominent part of the face and the posterior end of the abdomen. It is measured in lateral view and as if the head and abdomen were aligned horizontally.

C-index: The quotient of the midline anteroposterior extent of sternum 5 divided by the projected length of the postgonite uncus.

Color: The descriptions of color apply to views perpendicular to the sclerite concerned unless otherwise stated. Color designations follow the ISCC–NBS method (Kelly and Judd, 1955).

Copulobus (*cl*): One of a pair of posterior lobes, or projections, of male sternum 5. (Figures 4, 136–138.)

Costal section I: The distance between the distal edges of crossvein h and R_1 apex. (Figure 135.)

Costal section II: The distance between the distal edges of R_1 and R_{2+3} apices. (Figure 135.)

Costal section III: The distance between the distal edges of R_{2+3} and R_{4+5} apices. (Figure 135.)

Costal section IV: The distance between the distal edges of R_{4+5} and M_{1+2} apices. (Figure 135.)

Costal section V: The distance between the distal edge of M_{1+2} apex and the proximal edge of M_3+Cu_1 apex. (Figure 135.)

Epistomal breadth: The transverse distance between the pair of primary facial rows at the level of the epistoma, measured from the inner edge of the setal sockets. (Figure 1.)

Epistomal index: The quotient of the epistomal breadth divided by the minimum interocular distance .(Figure 1.)

Frontal vitta (*mf*): The median quadrangular area of the frons on which are situated the ocellar triangle and the ocellar and postocellar setae. (Figure 1.)

Fronto-orbital area: The narrow lateral section of each parafrontale parallel and contiguous to the compound eye on which the fronto-orbital setae are inserted. This usage differs from that of some other authors. (Figure 1.)

Interfractural costal: A seta inserted on the costa between the two costal "fractures." (Figure 135.)

Laterotergite (*lt*): The metapleuron of other terminology. (Figure 6.)

M_{1+2} index: The quotient of the distance between the distal edge of the junction of crossvein m and M_{1+2} divided by the distance between the distal edge of the m and M_{1+2} junction and the distal edge of the r–m and M_{1+2} junction. (Figure 135.)

Mesanepimeron (*aem*$_2$): Part of the pteropleuron of other terminology. (Figure 6.)

Mesanepisternum (*aes*$_2$): The mesopleuron of other terminology. (Figure 6.)

Mesofacial height (*mfh*): The distance between the outer edge of the subcranial cavity and the lower edge of the ptilinal fissure along the midline of the face. (Figure 11.)

Mesofacial index: The quotient of the mesofacial height divided by the minimum interocular distance.

Mesokatepisternum (*kes*$_2$): The sternopleuron of other terminology. (Figure 6.)

Metapleuron (*mp*): The hypopleuron of other terminology. (Figure 6.)

Minimum interocular distance: The minimum transverse distance between the compound eyes in the area of the face. (Figures 1, 11, 139.)

Ocular height (*vod*): The maximum distance between the upper and lower edges of the compound eye. The line of measurement is not quite vertical in most species. (Figure 9.)

Ocular index: The quotient of the nearly vertical ocular height divided by the subocular height. (Figure 9.)

Parafrontale (*lf*): The region of the frons between the frontal vitta and the upper edge of the compound eye. (Figure 11.)

Postdorsocentral (*pdc*): A seta inserted in the dorsocentral line posterior to the transverse sulcus. (Figure 6.)

Posterior fronto-orbital (*pfr*): The posterior seta of the two setae commonly prominent in each fronto-orbital area. (Figure 1.)

Postgonite (*pog*): One of a pair of curved, fingerlike projections of the gonal arch on each side of the distiphallus. In terminalia preparations, the postgonite usually appears to be anterior to the pregonite. (Figures 4, 10, 13, 136, 137.)

Postgonite uncus (*pu*): The apical section of the postgonite which is often hooklike or clawlike and usually distinctly more heavily sclerotized than the remainder of the postgonite. (Figures 10, 13.)

Postocular: One of the setae inserted in a row posterior to and more or less parallel with the posterior edge of each compound eye. (Figure 9.)

Predorsocentral (*adc*): A seta inserted in the dorsocentral line anterior to the transverse sulcus. (Figure 6.)

Pregonite (*prg*): One of a pair of bifurcate setose projections of the gonal arch on each side of the basiphallus. In terminalia preparations, the pregonite usually appears to be posterior to the postgonite. (Figures 4, 10, 13.)

Primary facial (*pfa*): One of the longer facial setae inserted in a row on each side of the face parallel and medial to the ptilinal fissure. The primary facial row is parallel to the outer edge of the obscured epistomal sulcus. (Figure 1.)

Secondary facial (*sfa*): One of the shorter facial setae that are often in a row parallel and lateral to the primary facial row.

Subcranial breadth (*scb*): The maximum transverse distance between the outer lateral edges of the subcranial cavity. (Figure 11.)

Subocular height (*soh*): The minimum distance between the lower edge of each compound eye and the outer lateral edge of the subcranial cavity. (Figure 9.)

Vertex breadth (*vb*): The distance between the upper edges of the compound eyes at the level of the lateral ocelli. (Figure 11.)

Vertex index: The quotient of the vertex breadth divided by the anteocellar distance. (Figure 11.)

Wing length: The distance between the apex of the tegula and the wing tip. (Figure 135.)

Terminology for Immatures

Anal-plate index: The quotient of the transverse extent of the anal plate divided by the midline anteroposterior extent of the anal plate. (Figure 107.)

Bifurcation index: The quotient of the longitudinal distance between the level of the phragmatal bifurcation and the posterior end of the ventral phragmatal ramus divided by the minimum distance between the end of the dorsal phragmatal ramus and the upper edge of the ventral phragmatal ramus. (Figure 85.)

Clypeal arch: The area of inclination in the frontoclypeus just anterior to the cheliform spot. (Figure 85.)

Clypeal-arch index: The dorsoventral extent of the frontoclypeus at the level of the anterior edge of the cheliform spot divided by the dorsoventral extent of the frontoclypeus at the level of the anterior edge of the labial gland orifice. (Figure 85.)

Early pupa: The pupa as it appears prior to the time when its compound eyes become apparent.

Egg length: The distance between the ends of the egg as measured in dorsal view. (Figures 75, 77, 78, 125.)

Frontoclypeal length: The distance between the anterior edge of the frontoclypeus and the posterior end of the ventral phragmatal ramus as measured in lateral view. (Figures 84, 75.)

Late pupa: The pupa as it appears after the time when its compound eyes become apparent.

Larval length: The distance between the anterior edge of the head lobe and the posterior end of the spiracular peritreme measured with the larva outstretched. (Figure 124.)

Maximum egg breadth: The maximum transverse extent of the egg as measured in dorsal view. (Figures 75–78.)

Maximum larval breadth: The maximum transverse extent of the larva as measured in dorsal view.

Maximum mouth-hook base thickness: The maximum thickness of the articulated end of the mouth-hook as measured in lateral view. (Figure 85.)

Maximum mouth-hook beak thickness: The maximum thickness of the free (or beak) end of the mouth-hook just distal to the enlarged base as measured in lateral view. (Figure 85.)

Minimum puparial breadth: The minimum transverse extent of abdominal segment 8 as measured in dorsal view anterior to the tracheospiracular siphon. (Figure 107.)

Phragmatal index: The quotient of the longitudinal distance between the anterior edge of the frontoclypeus and the level of the phragmatal bifurcation divided by the longitudinal distance between the level of the phragmatal bifurcation and the posterior end of the ventral phragmatal ramus. (Figure 85.)

Puparial length: The distance between the anterior prothoracic margin of the puparium and the posterior end of the spiracular peritreme measured as if the puparium were outstretched. (Figure 107.)

Ventral frontoclypeal index: The quotient of the distance between the anterior edge of the frontoclypeus and the anterior edge of the labial gland orifice divided by the dorsoventral extent of the frontoclypeus midway between the anterior edge of the frontoclypeus and the anterior edge of the labial gland orifice. (Figure 85.)

External Morphology of Adult

HEAD.—There are several controversies concerning the morphology of the schizophoran head. The major of these is centered on the clypeus and frons. Snodgrass (1935, pp. 317, 322, 323), in elucidating the morphology of the clypeus, stated:

In the higher Diptera, the median part of the clypeus becomes an independent sclerite, but the dilator muscles of the pump retain their attachments upon it. . . . The inverted V-shaped plate of the anterior wall of the rostrum (Fig. 174, C, D, *clp*) bears upon its lateral arms the origins of the dilator muscles of the cibarial pump (D, *3*). There can be little question, therefore, that this sclerite represents at least the median part of the clypeus in the head of *Tabanus* (Fig. 171 B, *clp*). . . . The attachment of the dilator muscles of the cibarial pump on the arms of the V-shaped rostral plate, however, clearly demonstrates the clypeal origin of this sclerite, and confirmatory evidence of its homology with the median clypeal region in *Tabanus* is seen in the fact that a pair of labral muscles (Fig 174 D, *2*) take their origin on its dorsal part. The smaller sclerite above the V-shaped clypeal plate (C, *c*) is either a part of the clypeus or a secondary sclerotization hinging the latter to the lower margin of the face.

In his discussion, Snodgrass did not commit himself on the morphology of the region of the head capsule between the subcranial margin, antennal sockets, and the compound eyes, but by emphasizing that the hinged anterior plate of the basiproboscis is homologous with the median clypeal region in *Tabanus* he inferred that some part of the clypeus remains above the subcranial margin. In a later paper Snodgrass (1944, p. 70) withdraw this inference by stating that "In the Cyclorrhapha and some of the Brachycera, the median, muscle-bearing plate of the clypeus becomes isolated by a membranization of the surrounding clypeal area, and is thus flexible on its hinge with the frons." Between 1935 and 1944, Snodgrass decided that the muscoid homologue of the tabanid median clypeal plate was hinged "with the frons" and not "to the lower margin of the face." In 1953 he omitted any discussion of the partial membranization of the clypeus and the boundaries of the frons in explanations of the evolution of the dipterous cibarium and proboscis.

Snodgrass never explained the fate of the epistomal (frontoclypeal) sulcus, but since, by the accepted definition, the epistomal sulcus is the external cuticular furrow, or groove, between the anterior tentorial pits which delimits clypeus and frons, I must assume that in the Snodgrass view the anterior tentorial pits and epistomal sulcus disappeared completely by membranization in the evolution of the schizophoran head capsule.

Kim and Cook (1966, p. 79) stated that "The clypeus (tormae of Peterson (1916)) lies below the ventral margin of the prefrons (Figures 1, 2, 10, 11) between the labrum and the frons and is anteriorly delimited by the membrane above the labrum and posteriorly by the membranous frontoclypeal suture." These authors apparently failed to answer the question of how the frontoclypeal (epistomal) suture or sulcus, which they interpreted to be the basiproboscis membrane between anteclypeus and head capsule proper, became entirely disconnected from its origin in the anterior tentorial pits. They stated: "The anterior tentorial pit is indistinct externally in sphaerocerids but is situated at the upper lateral angle of the prefrons below the eye and above the frontal ridge" (Kim and Cook, 1966, p. 79).

Frick (1952) and Downes (1958) showed some evidence of the epistomal sulcus in Agromyzidae and Sarcophagidae respectively. Frick (1952) labeled what he considered the anterior tentorial pits in the apparent epistomal sulcus in Agromyzidae. My investigation of the problem in *Hydrellia* indicated the validity of the interpretations of Frick and Downes. As shown in Figures 1, 11, 139, the epistomal, or frontoclypeal, sulcus extends from the lateral subcranial margins dorsad along the primary facial rows as faint internal cuticular thickenings. These thickenings were visible only after clearing, and they were not connected above in the two species studied closely. The epistomal sulcus is incomplete in several species of insects. The ptilinal fissure apparently extends ventrolaterad from its conspicuous supra-antennal arc to the subocular genal regions. These paraocular extensions delimit the lateral facial areas next to the orbits as the parafacialia. Downes (1958) labeled the facial areas between the extensions of the ptilinal fissure and the epistomal sulcus as facial ridges, while, for some reason, Frick (1952) labeled the same areas parafacial regions. Frick did not label the areas contiguous to the eyes and set off by the ptilinal fissure extensions.

Bolwig (1941) illustrated the upper extremities of the epistomal sulcus in *Scatophila unicornis* Czerny (Ephydridae), but he interpreted them as dorsal tentorial pits. It is possible that Bolwig (1941, p. 3) was nearer to the truth than Snodgrass, Frick, or Downes when he stated "that those extending from the impression beneath the antennae to the mouth opening [subcranial cavity] (d.t.) are homologous with the *dorsal arms* of the tentorium. The lateral thickenings (ant.t.) of the edge of the mouth opening are then supposed to be homologous with the *anterior arms* of the tentorium, while the thickenings stretching from the occipital foramen downwards (p.t.) to the mouth opening are supposed to be homologous with the *posterior arms* of the tentorium." This concept of continuous sulci from dorsal tentorial pits through anterior tentorial pits to posterior tentorial pits can be visualized in illustrations by Bonhag (1951, figs. 1–4). For Bolwig's interpretation to obtain, the anterior tentorial pits need have shifted posteroventrad only a short distance. It is perhaps impractical with our present knowledge to attempt to distinguish pit and sulcus. In the classical view, the thickening between dorsal and anterior tentorial pits would be the epistomal sulcus, while the thickening between anterior and posterior tentorial pits would be the subgenal sulcus (in part, hypostomal sulcus).

In my synthesis of several concepts, I have attempted to present a working scheme very similar to that used in modern calypterate taxonomy. In this collation, the question of the limits of postclypeus and the frons was considered moot and relatively unimportant because tradition has favored such terms as mesofacial plate, medifacies, medifacial plate, and facial plate and because specialization in cibarial muscles has obscured ordinary divisions. I have called the anterior edge of the subcranial cavity between the extremities of the epistomal sulcus the epistoma (Figures 1, 11, 139). There is considerable precedent for this designation, and the term is extensively used in chaetotaxy. The area superior to this epistoma between the indistinct arms of the epistomal sulcus I have called the facial plate (Figures 1, 11, 139). The ptilinal fissure forms the dorsal and lateral limits of the face. Frick (1952) called this area the mesofacial plate and placed the antennal sockets as the upper limit. Downes (1958) termed a similar area in Sarcophagidae the facial plate. The antennal sockets may be considered to demarcate a facial subregion above and between them and the ptilinal fissure called the frontal lunule.

The cuticular area bounded by the lower edge of the compound eye, the lateral subcranial margin, the lower angle of the face, and the posterolateral postgenal inflection is commonly called the gena. Since, however, the gena is rather ill-defined, I have used the term subocular height in defining the ocular index (Figure 9). The term defined is identical to the genal height illustrated by Dahl (1959), but it avoids the ambiguity of the gena concept, for theoretically much of the immediate postocular area is also part of the gena.

Above and posterior to the ptilinal fissure is the frontal vitta, bordered on each side by an indistinct parafrontale, or genovertical plate. It often is convenient to distinguish a narrow paraocular section of the parafrontale as the fronto-orbital area. The frontal vitta and the parafrontalia constitute the frons. Frick (1952) distinguished only the frontal vitta, and lateral to it a genovertical plate, which is apparently synonymous with the parafrontale. At the vertex in the frontal vitta, the ocellar triangle protrudes only slightly in *Hydrellia*. Posteroventrad of the ocellar triangle, the frons transcends with the occiput, i.e., the occipital sulcus is absent. The incomplete postoccipital sulcus only partially defines the postocciput with its inconspicuous occipital condyles.

One can distinguish three major divisions of the proboscis: the basiproboscis extending from the subcranial margin to and including the bases of the maxillary palpi, the mediproboscis extending from the bases of the maxillary palpi to the distal end of the hypopharynx, and the distiproboscis extending from the distal end of the hypopharynx to the extremities of the labella (Figures 1, 134, 139). In the basiproboscis, the conjunctiva (membrane) encloses the cibarium, the paraclypeal phragmata, and the stipes. Only the anteclypeus, or rostral plate, and the maxillary palpi are exposed (Figures 134, 139, 140). In the mediproboscis, the sclerotized prementum is the prominent structure. Anteromedially from the prementum is the labial gutter containing the hypopharynx and the labrum. Enclosed within the conjunctiva basal to the labrum are the labral apodemes and the trachea-like siphon connecting the labial gutter with the cibarium. The distiproboscis consists essentially of the labella. Each labellum is partially supported above by a labellar sclerite and consists of seven canaliculi which radiate from the margin of the prestomum. Apparently, the canaliculi terminate in the prestomum posterior to the apparent sclerotized prestomal margin. Each canaliculus has a row of several canalicular teeth.

The schizophoran cibarium is homologous with the generalized orthopteroid cibarium, i.e., it is the chamber between the connected epipharyngeal clypeal wall and sitophore (anterior and posterior cibarial walls). Since in Diptera the chamber has a pumping function, it is stabilized either by antagonistic muscles as in Nematocera and many Brachycera or by inflections of the lateral borders of the anteclypeus, called paraclypeal phragmata.

Within the cibarium, inserted on the anterior, or epipharyngeal, wall are small trichoid sensilla: paired clusters of three near the distal end of the cibarium and a biseriate row running dorsolaterally from each of these initial clusters to the end of the anteclypeus (Figures 1, 140–142). Frey (1921) apparently first illustrated these cibarial sensilla in *Hydrellia* and other ephydrid genera, but he simply called them setae as did Bolwig (1941). I closely examined and counted these cibarial sensilla only in several specimens of *H. griseola*, but I confirmed their presence in several congeners and in representatives of all dipterous suborders. The number and arrangement of the cibarial sensilla apparently varies somewhat in *Hydrellia*, for Frey (1921, p. 137) stated: "Die obere Pharynxwand hat 2 Reihen von 5–6 Borsten, wozu vorn jederseits eine Gruppe von 3 kürzeren, dichter gestellten kommt." This concerned *H. obscura* Meigen. In *H. griseola*, I found four pairs of sensilla in the two long rows.

Regarding the function of the cibarial sensilla, I offer the following hypothesis. The cibarium is the first and primary ingestion pump, and among the Schizophora the sole pump. This being the case, proprioceptors are necessary to maintain cibarial rhythm. The cibarial pump must perform the initial ingestive suction and in Schizophora the subsequent expulsion from the cibarium into the esophagus. To perform these two progressive functions, the shape of the cibarium must change rhythmically, for no valve has been demonstrated distal to the cibarium to prevent backflow from the contracting cibarium. My hypothesis is that during the initial ingestive phase the cibarium dilates progressively proximad, and during the subsequent emptying it constricts progressively proximad, and that the cibarial sensilla coordinate or govern these rhythmic changes. As proprioceptors, these sensilla enable the cibarium to act as a valve as well as a pumping chamber. As they touch the opposite wall, impulses pass from their neurones. In this way, regurgitative loss of cibarial contents is reduced.

Before conducting this investigation, I thought the high rates of proboscis protraction and retraction observed in *Parydra* (Ephydridae) was evidence that pinching of the siphon connecting the food meatus and cibarium prevented regurgitative cibarial loss. The absence of such repeated flexion in many Schizophora, including *Hydrellia,* controverted this interpretation.

Bonhag (1951) illustrated and described a functional mouth (and valve) just distal to the cibarium operated by muscles termed the labral compressors. If this functional mouth exists in the Schizophora, it can only be the trachea-like siphon of the food meatus. I did not find the unpaired labral compressors in the preparations of *H. griseola* nor did I find the median labral process on which they would be inserted.

The cranial chaetotaxy differs very little from that common in Acalyptratae. The conspicuous macrochaetae are the genal, inner and outer verticals, and postocellar. The ocellar, anterior and posterior fronto-orbitals, apicodorsals of antennal segment 2, postocular, and primary facial setae are less conspicuous. In most species, smaller secondary facials occur, usually lateral to the primary facial row.

According to Hennig (1958), the vibrissa is present but indistinguishable in Ephydridae. Also, according to Hennig, the postocellar has replaced the postvertical at least in prominence and approximate location.

THORAX.—My presentation of the gross external morphology of the thorax proper of *Hydrellia* is essentially an interpretative synthesis of the contributions of Osten Sacken (1881), Curran (1934), Snodgrass (1935), Comstock (1940), Crampton (1942), Bonhag (1949), and Downes (1955).

The prothorax consists of the greatly reduced antepronotum as part of the border of the prothoracic foramen, the postpronotum, the propleura, the prosternum, and the fore legs (Figure 6). The prosternum consists of a small presternum and a considerably larger probasisternum with a median sulcus and a prosternellum, the defining sternacostal sulcus of which is continuous with the median probasisternal sulcus. I am uncertain about the nature of an apparent sclerite just above and posterior to pleurocoxal condyle 1 (Figure 6), but it is similar to the proepimeron illustrated by Crampton (1942) and Bonhag (1949).

The anterior spiracle—or, as I have called it, the prothoracic spiracle according to Keilin's (1944) analysis—is situated in a small fossa inferior to the postpronotum and posterior to the superior termination of the propleural sulcus.

The mesonotum is divided by the transverse and scutoscutellar sulci and the postscutellar suture into the notopleuron, mesoscutum, mesoscutellum, and mesopostscutellum respectively. The mediotergite and the laterotergites are the ordinary discernible sclerites of the mesopostscutellum, but often an anatergite and katatergite can be distinguished as constituents of the laterotergite. The expanded mesopleura, each divided by the mesopleural sulcus into the mesepisternum and the mesepimeron (Figure 6), the wings, and the mid legs are the remaining main constituents of the mesothorax.

The dorsopleural (or notopleural) sulcus separates the notopleuron and the mesopleuron. At the anterior end of this sulcus is a slightly distinguishable sclerotization, which may represent part of the mesoprescutum. Bonhag (1949) illustrated the mesoprescutum as a pair of small triangular lobes interposed between the evident notopleura and mesopleura; however, Snodgrass (1935) illustrated the notopleura as the prescutal lobes.

The large mesepisternum is partially divided by the incomplete mesanepisternal sulcus into the mesanepisternum and the mesokatepisternum. The posterior part of the mesanepisternum is traversed by a secondary suture, or membranous cleft. A conspicuous sclerite occupies the upper corner of this cleft. Crampton (1942) showed a sclerite which resembles this one except for its apparent fusion with the posterior mesanepisternal lobe isolated by the secondary cleft. Crampton called this sclerite the anterior basalare. Downes (1955) showed two sclerites, basalarites A and B situated in the upper part of this cleft. Basalarite A is separated and occupies the uppermost part of the cleft. Basalarite B is connected by a narrow neck to the isolated mesanepisternal lobe. Bonhag (1949) showed two separate sclerites occupying this cleft in *Tabanus*. The anterior sclerite called the basalare extends down to the mesokatepisternum. Bonhag did not name the small, second sclerite in the uppermost part of the cleft. The arrangement of sclerites in the secondary cleft and the course of the mesopleural sulcus in *Hydrellia* approximates most closely Downes' illustration except that the basalar ampulla has evidently been displaced posteriad. The subalar ampulla is a distinct crescentic sclerotization in the lower wing area.

The mesepimeron is distinctly represented only by the mesanepimeron. The mesokatepimeron is probably represented by the small sclerite contiguous to the anterior edge of the metathoracic spiracular peritreme. It is possible that this small sclerite is part of the metapleuron, as may be inferred from Crampton's illustration. According to Crampton, the mesokatepimeron is usually indistinguishably fused with the large meron (meropleurite). Downes showed the mesokatepimeron to be slightly distinguished by the coxopleural streak from the upper meral margin. The laterotergite extends down farther in *Hydrellia* than shown by Crampton, Bonhag, and Downes. This fact and the partial demarcation of a small triangular lobe anterior to the metathoracic peritreme illustrated by Bonhag led me to emphasize the first-mentioned interpretation of the location of the mesokatepimeron.

The precoxale (anterior to and above the mid coxa) of the mesokatepisternum is distinguished as a narrow glossy sclerotization. The posterior meral margin is similarly distinguished.

The apparent ventral extension of the mesokatepisternum is considered by Snodgrass (1935) a composite of the sternum, precoxale, and episternum. Basically, Bonhag differed little or not at all from this view.

Of the metathorax, only thoracic phragma 2, the greatly narrowed metapleura, the halteres, and the hind legs remain distinct (Figure 6). The metapleuron consists of a metathoracic precoxale, apparently defined by the lower part of the sclerotized posterior meral margin and a continuation of this heavy sclerotization posteriad of coxa 3, the metepisternum, which is sharply narrowed and apparently divided by a transverse sulcus near the posterior meral lobe, and the very linear metepimeron behind the indistinct metapleural sulcus.

The wing-vein nomenclature is modified from the Comstock-Needham system as illustrated by Downes (1955). Because of taxonomic importance, I added the designation "basal end of the costa" (Figure 135). The halter has three apparent divisions: the knoblike capitellum, the pedicel, and the basal scabellum.

My thoracic chaetotactic nomenclature is modified from Osten Sacken (1881), Curran (1934), and Comstock (1940). The main modifications are in the pleural setae, which are named according to the sclerite on which they are inserted, e.g., postpronotals, propleural, mesanepisternals, mesokatepisternal(s), and basicoxal(s). On the mesonotum, the dorsocentrals and acrostichals anterior to the incomplete transverse sulcus are termed predorsocentrals and preacrostichals, while those posterior to this point are called the postdorsocentrals and postacrostichals. The prescutellar macrochaeta is often considered a dorsocentral, though it is inserted between the dorsocentral and acrostichal lines. There is one large postalar macrochaeta and a small one inserted midway on the postalar bridge. More or less in line with the large postalar and the prescutellar is one large interalar (corrected from "intraalar" by Sturtevant and Wheeler, 1954). Above the mesopleural wing process are two small supra-alar setae. There are two notopleural macrochaetae and one lateral macrochaeta just anterior to the notopleural apex. Inserted on the scutellar margin are the basal scutellar, intermediate scutellar, and the apical scutellar.

The predominant features of the wing are the two costal fractures or discontinuities, one just proximal to R_1 apex and one slightly distal to crossvein h. Although the whole costa is setose, the setae on the enlarged basal end of the costa and the setae between the costal fractures, the anterior and the dorsal interfractural costals, are of main taxonomic importance (Figure 135).

Abdomen.—Except for dimensional and color characters, secondary sex characters in *Hydrellia* appear to be limited to the abdomen, especially the postabdomen. Only Hering (1950), Dahl (1959, 1964), Grigarick (1959), and Harrison (1959) have studied the abdomen other than superficially.

It is convenient and traditional to distinguish two abdominal regions—the preabdomen and the postabdomen. According to Steyskal's (1957) hypothetical illustration, the division in the male abdomen should be between terga 6 and 7. Unfortunately, these two terga are obliterated in male *Hydrellia* so that, from a practical view, I placed the division just posterior to tergum 5 in both sexes. Thus, in my discussion, the first five segments (except sternum 5) constitute the preabdomen and the remainder constitute the postabdomen. The male sternum 5 must also be considered part of the terminalia (Figures 4, 5, 136–138) in *Hydrellia.*

Tergum 1 is partially fused with tergum 2 and is so short that it is very much obscured in dorsal view in its normal relation to the thorax. This condition led some earlier workers to assume there were four instead of five preabdominal terga. This assumption was enhanced by the slight displacement posteriad of sternum 1 and the highly modified form of sternum 5 in the male (Figure 4). Although there is some assumption in simple sequential identification of the sterna, the condition of the female sternum in *H. griseola* as shown by Grigarick (1959, pl. 1, fig. 3) seems to support this course.

I have illustrated the male postabdomen in Figures 4, 5, 10, 12, 13, 136–138. Snodgrass (1957) believed that his analysis of the evolution and homologies of external male genitalia could be applied to all insect groups, but he failed to do this for the higher Diptera. Insufficient morphological knowledge has precluded the homologizing of the parts of the terminalia with paramere or mesomere. For this reason, I selected a system of terminalia nomenclature synthesized from Crampton (1944), van Emden and Hennig (1956), and Tuxen (1956). I think this system is more appropriate to the situation in *Hydrellia* than that of Crampton (1944), Wirth (1948), or Steyskal (1957).

I have considered the terminal tergum a syntergum of segments 9 and 10. Steyskal (1957) and previous authors have called this tergum the epandrium. There is little need for this name in *Hydrellia* because the tergum is only occasionally important taxonomically, and it seems to be only slightly involved in copulation. The surstyli have fused to a variable extent, forming a ventral flap partially covering the phallus (often most of the basal half). Crampton (1944) and Steyskal (1957) used the term surstyli, while Dahl (1959) called the two structures together the hypandrium. I have called the entire intromittent structure the phallus, partly because I was uncertain how much of it represented the true aedeagus and partly because phallus was a convenient suffix (basiphallus and distiphallus). I needed these terms because of the taxonomic importance of the common division of the phallus into a somewhat bulbous, heavily sclerotized basal part (basiphallus) and a usually narrower, lightly sclerotized distal part (distiphallus). The basiphallus may be the actual phallobase and the distiphallus—the aedeagus of Snodgrass (1935, 1959). Phase microscopy confirms the presence of a duct (presumably the ejaculatory duct) passing through the length of the distiphallus.

The phallus is suspended from the posterior ends of a structure I have called the gonal arch (after Tuxen, 1956, and Phillip Clausen, of the University of Minnesota, in litt., 1964). Crampton (1944) and Steyskal (1957) did not discuss or illustrate any comparable structure. Tuxen (1956) illustrated a structure in *Aedes* called the proctiger, which is somewhat similar to the gonal arch. The anterior ends of the gonal arch articulate with or are continuous with a median phallapodeme, or aedeagal apodeme, and with sternum 5. Projecting from the gonal arch at sternum 5 are two pairs of sclerites or lobes called gonites (after Tuxen, 1956). The larger pair are considered the postgonites. The smaller, often inconspicuous pair with setose, bifurcated tips are considered the pregonites despite their usual posterior termination. In many species, the pregonites appear to have a more definite articulation with the phallapodeme. I have called the more heavily sclerotized, clawlike end of the postgonite the postgonite uncus. This specific designation was needed because of its taxonomic significance.

Sternum 5 varies specifically in shape. Usually, the general impression is a horseshoe shape. The posterior lobes are so significant taxonomically that I have designated them copulobi after Crampton (1944).

Although almost certainly additional unillustrated muscles function in phallic movement, I have analyzed the process in the following manner. The phallapodeme and the gonal arch are pulled anteriad by contraction of phallic depressors inserted at their anterior ends and originating on or near sternum 4 (Figure 12). This contraction and phallapodeme movement has two effects: (1) it lowers, or depresses, the phallus as a result of leverage between the superior condyle of the basiphallic socket and the posterior end of the phallapodeme; and (2) it lowers the postgonites, which in most cases are attached or closely appressed to the anterior end of the phallapodeme. (I surmise that the copulobi are simultaneously depressed by the same or associated muscles. When depressed, the bilobate sternum 5 would fit the female postabdomen just anterior to the cerci like a saddle). The postgonites either titillate some female terminalia or hold the cerci erect to permit coitus. This hypothesis is supported by the fact that in several species the distiphallus in repose projects anteriorly over the free posterior margin of sternum 5, and by the angle, or attitude, of the mounted male in several species. Phallic elevation is effected by the phallic levators levering the posterior end of the phallapodeme against the inferior condyle of the basiphallic socket and by the phallic depressors and associated muscles relaxing synchronously. Once elevated into the genital pouch, or cubiculum (after Crampton, 1944), the phallus is apparently retained by the gonites, sternum 5, or by both of these structures.

I have illustrated parts of the female terminalia of a few species in Figures 2, 67–72. Grigarick (1959) accurately illustrated the female abdomen in ventrolateral view. Dahl (1959) illustrated only a portion of the female abdomen of *H. griseola*. Wirth (1948) and Tuxen (1956) referred to the cerci as anal lobes and valvulae mediales respectively. This is understandable, since in female *Hydrellia* and many other Diptera segments 9 and 10 have been obliterated so that tergum and sternum 8 are immediately anterior to the cerci. Sternum 8 is often called the subgenital, or pregenital, plate.

Internal Morphology of Adult

GUT.—I have illustrated most of the gut of *H. griseola* in Figures 1, 3. These illustrations seem also to apply fairly well for *H. tibialis*, *H. bilobifera*, *H. harti*, and *H. columbata*. In gross anatomy, the foregut, or stomodeum, is a uniform tube from the dorsal cornua of the paraclypeal phragmata to the vicinity of the cardia near the level of thoracic phragma 2. Here there is a diverticulum from the esophagus, the crop meatus, leading to the crop proper. Distended, the crop occupies nearly the ventral half of the abdominal cavity. The midgut starts with the cardia, which contains the stomodeal valve. From this structure to a level about midlength of the crop, the midgut is a linear tube with the labial gland ducts and labial, or salivary, glands parallel and contiguous. At about midlength of the crop the midgut is bent sharply dorsad and coiled three or four times. The pyloric valve and most of the ileum are similarly coiled. The site of evagination of the Malpighian tubules is obscured by the gut coils. In *H. griseola* and *H. tibialis* the Malpighian tubules branch from two stems, or bases, arising near the pyloric valve. Two tubules run anteriad and two posteriad, both pairs parallel and close to the gut.

The rectal valve and rectum with its rectal glands are the conspicuous parts of the hindgut, or proctodeum. The anus is located between the cerci.

The inner lines apparently representing the intima of the midgut and hindgut in Figure 3 may actually represent the peritrophic membrane.

INTERNAL GENITALIA.—The internal genitalia of *H. bilobifera* illustrated in Figures 2, 14 are similar in outline to those of *H. griseola, H. tibialis,* and *H. columbata.* The internal male genitalia consist of testes, vasa deferentia, pouchlike enlargements of the vasa deferentia called seminal vesicles, a median, unpaired ejaculatory duct, and accessory glands. The testis and the initial portion of the vas deferens are suspended and covered by a thin peritoneal sheath. Although this sheath partially obscured the testicular components, I observed a germarium of spermatogonia in the apex anterior to the compactly coiled spermatic tubule. Snodgrass (1959, p. 78) stated that "Each testis, however, appears in its entirety to be a single testicular tube. The same is true of the testes in other Diptera." In the posterior end of the testis and in the seminal vesicle I saw what appeared to be packets of spermatids or spermatozoa.

The accessory gland appeared dense and had a reniform contour. The accessory gland ducts joined the ejaculatory duct where it is convoluted anteriad between the testes. Posteriorly the ejaculatory duct is looped over the rectum as a result of pupal circumversion. Between the rectum and the phallapodeme, the ejaculatory duct is noticeably dilated for some distance before it passes into the posterodorsal region of the basiphallus. I located the apparent gonopore but, as Snodgrass (1935) inferred, the gonoduct probably opens into an endophallus, the external opening of which is the apical phallotreme instead of the true gonopore.

The internal female genitalia (Figures 2, 133) consist of ovaries, lateral oviducts, common oviduct, genital chamber, median spermatheca, two lateral spermathecae, and two accessory glands. Each ovary is composed of several polytrophic ovarioles. Each of these consists of a short terminal filament, a long egg tube, and a very short pedicel connecting with the lateral oviduct. Histologically, the egg tube is composed of a very short germarium of oogonia and a long vitellarium of follicles. Each immature follicle contains cystocytes, or follicle cells, trophocytes, and an oocyte. The basal follicle contains a large oocyte, complete with yolk and chorion. Covering each ovariole is an epithelial sheath which seems to be continuous with the terminal filament. The expanded receptacular area of fusion of pedicels and lateral oviduct is the calyx. I found a peritoneal sheath over the ovary as shown by Snodgrass (1935) in *Rhagoletis pomonella* and by Miller (1950) in *Drosophila.* It is very delicate and is apparently the ovarian suspensorium, or suspensory ligament.

Sturtevant (1925, 1926) first illustrated and described the spermathecae and accessory glands of *Hydrellia* in his comparative morphological study of these structures in Aschiza and Schizophora Acalyptratae. To the lateral spermathecae, which arise dorsally from the junction of common oviduct and genital chamber, Sturtevant was inclined to ascribe a glandular function. He illustrated the accessory glands, or parovaria, as arising just posterior to the lateral spermathecae and showed them subequal to the lateral spermathecae in *H. griseola.* Sturtevant (1926), unlike Snodgrass (1935) and Imms (1957), distinguished the median spermatheca as basically different from the lateral spermathecae and called it the ventral receptacle.

Regarding the function of the ventral receptacle, Sturtevant (1926, p. 11) stated: "Sperm have been found in this organ [median spermatheca] in *Dimecoenia, Discocerina, Hydrellia, Ilythea,* and *Philygria.* In no case in this family [Ephydridae] have any sperm been found in any other part of the female reproductive system." He did not ascribe a specific function to the accessory glands, but I surmise that they or the lateral spermathecae secrete a lubricant and adhesive for the egg as it passes from the genital chamber through the vulva. The bases for this supposition are several observations of eggs protruding from the vulva ventral to the cerci and the fact that eggs are cemented to the oviposition substrate.

Morphology of Immatures

Egg.—*Hydrellia* eggs exhibit some variability in shape, condition of the chorion, and in size. The size range of known eggs is 0.40 by 0.12 to 0.71 by 0.22 mm. In dorsal view the eggs are usually subfusiform, or cucumiform, with fairly symmetric contours except on the ends (Figures 75, 77, 78). In lateral view, their shape is often boatlike, with the ends upcurved almost symmetrically (Figures 73, 74, 125). The micropylar end is often somewhat more acute than the opposite end. In all known eggs of *Hydrellia* the chorion is corrugated or rugulose, with alternate longitudinal ridges and channels. It is not known if these ridges, or cristulae, have an adaptive value or are simply incidental follicular impressions. It is possible that the ridges serve as egg guides to maintain some necessary orientation of the egg in the common oviduct and genital chamber or that they help maintain chorion shape. The identification of the micropylar protuberance is presumptive, since Berg (1950), Kato (1955), and Grigarick (1959) offered no conclusive proof such as direct observation of sperm entry or sperm tracing.

The nature of the globose, lacunose, pluglike structure on the end opposite the micropylar protuberance is still unknown. Whether the chorion is unilaminate or multilaminate is also unknown.

Larva.—Basically, the three mobile larval instars differ little morphologically. The most conspicuous developmental changes occur in the feeding apparatus and the spiracular peritreme. Von Frauenfeld (1866), Stein (1867), Gercke (1879, 1882, 1889), Brocher (1910), Keilin (1915, 1944), Hennig (1943, 1952), Berg (1950), Kato (1955), Nye (1958), and Grigarick (1959) contributed to the description and analysis of these changes.

The first instar appears setulose and warty and is about 0.35–0.75 by 0.10–0.15 mm when newly eclosed. It changes rapidly so that at the end of the stadium it is similar to depictions in Figures 124 and 127 and measures about 1.00–2.25 by 0.18–0.25 mm. I have illustrated the changes in the feeding apparatus in Figures 93, 103, and 105 for the three mobile larval instars of *H. spinicornis* Cresson. The conspicuous differences are in size, color, and clypeal arch contour. In Figures 81, 84, and 85 I have illustrated the morphological nomenclature of the feeding apparatus, or the so-called cephalopharyngeal skeleton. I collated the nomenclature of the feeding apparatus from Berg (1950), Hollande et al. (1951), Frick (1952), Snodgrass (1953), Downes (1955), and Allen (1957a, 1957b). From paired symmetrical parts as shown by Berg (1950) in *Notiphila loewi* Cresson, the feeding apparatus has evolved in *Hydrellia* to the single, partially fused state. The two mouthhooks have become entirely fused, the posterior or proximal ends of the H-shaped sclerite (called hypostomal sclerite by Berg, 1950) and the anterior ends of the paraclypeal phragmata have become fused, and the cross piece lost in all species studied. The paraclypeal phragmata are closely apposed and are united dorsally by the frontoclypeal plate anteriad to the bottom of the clypeal arch (area of inclination near the usually distinct cheliform spot). Ventrally, they are united by the sitophore, or hypopharyngeal plate.

Each paraclypeal phragma is bifurcated posteriorly into dorsal and ventral phragmatal rami between which the cibarial dilator muscles can be seen stretching from the dorsal rami to the epipharyngeal clypeal wall (dorsal cibarial wall). Anterior to each phragmatal bifurcation is a protuberance, which, because of its shape, Berg (1950) termed the cheliform spot. From my dissections, it is evidently a process for muscle insertion. Supported by unillustrated observations of feeding mechanics and some dissections, I hypothesize that the fossae of the cheliform spots serve as insertions for protractor muscles of the feeding apparatus, as does the prominent clypeal arch, or dorsal angle of Allen (1957a), illustrated by Berg (1950) in *Notiphila*, Hollande et al. (1951), Frick (1952), Snodgrass (1953), and Downes (1955). Retractor muscles insert on the rami of the paraclypeal phragmata and rotators on the phragmata below the cheliform spots.

The primary factor underlying the reduction of the clypeal arch and probably the entire streamlining of the feeding apparatus in *Hydrellia* has been selective pressure for manipulative flexibility and for an anterior end capable of extreme flattening during feeding. The selecting factor, or at least the factor compatible with this anatomical modification, has been leaf mining—feeding internally in very thin submergent leaves such as in most *Potamogeton*. Metapneustism and perhaps some kind of cuticular respiration opened the way to obtaining oxygen from the aerenchyma of certain plants, and this in turn provided the opportunity to move deeper into plant tissues. But before this opportunity could be utilized, manipulative flexibility of the feeding mechanism had to be increased greatly to allow for feeding in very tight places. Much of the increase in rotatability of "head" and feeding apparatus has been due to the reductive fusion of the two mouth-hooks and of the sclerites of the paraclypeal phragmata and to the overall compression of the feeding mechanism. All of these modifications have enabled the larva to rotate the head lobe and feeding apparatus 90 degrees either way from the vertical attitude.

Anteroventrally on the feeding mechanism are two projections which Berg (1950) called ventral projections. Hollande et al. (1951), Frick (1952), Snodgrass (1953), and Allen (1957a) showed the larger, posterior one of these to be the aperture of the common labial gland (salivary) duct. After several dissections, I could concur with the findings of these authors. I have called the anterior projection the labial sclerite, although there is some reason to think it is a remnant of the H-shaped sclerite and is involved with the mouth-hook depressor apodeme in depression of the mouth-hook.

It became obvious after making several dissections that the labrum, contrary to Snodgrass's (1953) illustration, is noticeably anterior to the base of the mouth-hook. This is obvious from Figures 81 and 84, where the fusion of sclerites can be seen to eliminate any space for the labrum in the position shown by Snodgrass. Nye (1958) showed the labrum as bilobate, with a lobe on each side and above the beak of the mouth-hook in *H. incana*.

The tracheospiracular system of *Hydrellia* is metapneustic, but Keilin (1915, 1944) demonstrated a vestigial, closed prothoracic spiracular atrium. According to Hennig (1943, 1952) there appears to be a trend toward functional metapneustism in the Ephydridae. Developmentally, the caudal tracheospiracular siphon changes considerably between the first two larval instars of several species at least. I have illustrated (Figure 80) a spiracular condition which may be representative of the first-instar larvae of many species of *Hydrellia*. The peritreme is conical with a terminal aciculous spine, the spiracular atrium narrow, and the secondary atrial orifice medially located. The spiracular peritreme is probably nonretractile. On abdominal segment 8 are supraspiracular and subspiracular protuberances: the supraspiracular protuberance has one long spinous seta, and the subspiracular one several shorter setae. I did not discover the function of these setae and spines, but they may possibly aid in locomotion and anchorage.

Although Figure 79 is of a different species than Figure 80, it is representative of the change after the first molt. The conical peritreme is larger and less aciculate, and the secondary atrial orifice is dorsally situated. The spiracular atrium and the primary tracheal orifice at the junction of atrium and the main longitudinal trachea are discernible (Figures 79, 83, 127). In species where supraspiracular protuberances and conspicuous spinous processes occur in the second-instar larvae, these are lost at the second molt.

According to Hennig (1943, 1952), the third-instar spiracular peritreme has three secondary atrial orifices; however, since he did not make an extensive survey, this may not be a generic character. Grigarick (1959) illustrated one secondary atrial orifice per peritreme in the second instar as in Figures 79, 83. Keilin (1915) did not specify the instar but he illustrated a single, dorsal secondary atrial orifice in each peritreme in *H. modesta* Loew. Kato (1955) also showed a single, dorsal secondary orifice.

In the third-instar larvae, the increased prominence of the creeping welts makes it possible to discern the eleven apparent segments and a head lobe. I have shown the head lobe bearing apparently three-segmented antennae (Figure 81). Immediately posterior to the head lobe, the dorsal and ventral head folds of Snodgrass (1953) can be seen. I have followed Hollande et al. (1951) in calling the setulose ventral fold the postlabial pad. Berg (1950) called it the postoral tuft. Although Nye (1958) gave it no specific designation, he showed it as the anteromedial part of the prothoracic venter, as did

Hollande et al. (1951) in a nonephydrid species. Nye considered the postlabial pad a constituent of the facial mask, along with the pair of two-segmented antennae, anterior cephalic papillae, a pair of frontal papillae, maxillary palps, and two labral lobes. Also Nye definitely showed two-segmented antennae, whereas Berg (1950) and Kato (1955) illustrated three-segmented antennae. Grigarick (1959, p. 10) stated, "Antennae (Fig. 11) two-segmented, set on a small enlargement which may be a third segment . . . ." Obviously, the question will be difficult to resolve even with dissection because of the small size of the structure.

Keilin's (1944) concept that all dipterous larvae have three thoracic and eight apparent abdominal segments can be applied to *Hydrellia*, but with some difficulty, for all known larvae exhibit a postanal extension of abdominal segment 8 in the third instar and puparium, which appears to be a ninth segment. According to Nye (1958), tracheation and innervation prove it is not a true segment.

As inferred by Hinton (1955), the creeping welts are homologous with prolegs. These creeping welts and specifically variable portions of the segments are covered by microcuticular processes called spinules by Berg (1950) and Hollande et al. (1951), locomotory spinules by Hinton (1955), tubercles by Allen (1957b), and spiculi by Nye (1958) and Grigarick (1959). Because the term is more descriptively flexible than either tubercles or spiculi, I have called these microcuticular processes spinules. They are seldom truly needle-shaped, or spiculiform, nor are they often truly tuberculiform in *Hydrellia*. According to Hinton (1955), the large locomotory spinules are similar in origin, structure, and function to the crochets of most dipterous prolegs.

Allen (1957b) and Nye (1958) placed considerable significance on tubercular (or spicular) zones and the number of processes and rows in each. But as Berg (1950) illustrated, and as I have shown in Figures 107–123, in the puparia the shape and size of creeping-welt spinular zone in relation to the lateral spinular pattern is the more readily usable taxonomic character in *Hydrellia*. Anterior to each creeping welt, Berg (1950), Grigarick (1959), and I found a transverse row of six setulae. Keilin (1915) and Nye (1958) showed only four setulae in this location in *H. incana*. Both of the latter also showed no cheliform spot on the feeding apparatus. Perhaps it was rudimentary or so uniformly sclerotized as to be indistinguishable. The spinulosity and setulosity of the third-instar larva often are less distinct than in the puparium because the cuticle of the former is more translucent than that of the latter. The translucency is such that the living larva in situ appears green or yellow, depending upon the combined effect of labial gland color and aliment color. In some species, the fat body appears to retain some plant pigments.

PUPARIUM.—Although it is actually part of the third instar, the puparium is a distinct morphological phase. The changes involved in the formation of this uniquely economic "cocoon" are physiologically complex. Keilin (1944) used the term pupariogenesis to describe this formation. An equally satisfactory term and one more readily usable verbally is pupariation. In *Hydrellia,* the third-instar larva becomes quiescent and opaque just as at the first two molts, and within a few hours the cuticle has contracted lengthwise, expanded transversely, and hardened. For two species I found dimensional changes from third-instar larva to puparium to be from 5.53 by 0.60 mm to 4.00 by 1.06 mm and 6.50 by 1.22 mm to 4.75 by 1.60 mm. The puparial shape varies specifically from subcylindrical to fusiform. Some are noticeably attenuated posteriad and the puparia of four species have almost symmetrical ends in ventral view. In lateral view, the puparia are cyphosomatic.

Conspicuous structures other than the creeping welts are the head-lobe scar and the anal plate (both ventral) and the dorsocephalothoracic cap (Figure 107). A better name for this latter structure is operculum, for it is simply the dorsal thoracic section of the puparium delimited by a continuous ecdysial cleavage line. There is nothing cephalic about it. Regarding the head-lobe scar, some authors such as Brocher (1910) called it the mouth scar, but Trägårdh (1903, p. 33), in discussing pupariation in *Ephydra riparia* Fallén, stated: "Das Verschliessen der vorderen Öffnung erfolgt in der Weise dass die Larve den Kopfabschnitt so tief hineinzieht, dass eine tiefe trichterförmige Einstülpung der ventralen Seite des Prothoracalsegmentes gebildet wird. Dieser Trichter zieht sich im proximalen Teil zusammen und erhärtet stark (Fig. 6, Taf. 1) zu einem schwarzen, in das Puparium hineinragenden zapfenförmigen Gilde." This complete retraction of the head lobe upon pupariation seems to occur also in *Hydrellia;* thus, I have referred to the anterior end of the puparium as prothoracic.

According to Wigglesworth (1956), in third-instar larvae of higher Diptera the epidermis initiates sclerotization of the soft endocuticle, making it chemically identical to the exocuticle in the puparium, except in aquatic larvae where lime deposition is substituted for this endocuticular sclerotization. Because of their endophytic environment and perhaps other factors, *Hydrellia* puparia do not exhibit any apparent endocuticular lime deposition (Figures 126, 128, 131, 132). The translucency of the puparia of some species, e.g., those in Figure 131, seems to make the term "tanning" seem somewhat inappropriate. The puparial cuticle is sclerotized, but darkening seems to vary ecologically and perhaps genetically. Hering (1950) observed that the prevalent translucency of *Hydrellia* puparia makes them some of the most suitable of all Acalyptratae for investigating pupation.

Ecology

Ecological Role and Distribution

Adult *Hydrellia* are polyphagous, but since the larvae are endophytophagous and since they consume much more food than the adults the species can be classified trophically as primary consumers. It is probable that this classification will be found to apply to all Notiphilinae.

No species of *Hydrellia* has been studied sufficiently to integrate it completely in a food web, but food chains involving some species are known. Larvae of *H. griseola* parasitize hydrophytes of many species, primarily grasses. Adults of this fly prey upon very small insects and upon insects trapped in the surface film. Among these are specimens of *Hydrellia* (including *Hydrellia griseola*), Psyllidae, early-instar Ephemeroptera and Odonata, Collembola, Braconidae, several species of nematocerous Diptera, *Musca autumnalis,* and *Sarcophaga* sp. Adults of some species prey actively on Collembola. Yeasts and similar fungi, Cyanophyta, Chrysophyta, nectars, and leaf epidermis are other dietary items of adults. Several species of lycosid and ctenid spiders, species of *Ochthera* (Ephydridae), and species of *Lispe* and *Hydromyza* (Muscidae) prey upon adults of *Hydrellia.* The chain continues through fishes, e.g., bluegills and sunfishes, to ichthyophagous reptiles, birds, and mammals. A side chain exists for the larvae. Several hymenopterous species parasitize the larvae. From these parasites, the energy flows through most of the same species as it does from the adult flies. Similar food chains exist for *H. cruralis* and *H. pulla.*

Host-plant preferences of the larvae likely influence the ecological distribution of *Hydrellia* species. Predominantly, these preferences center on species of Potamogetonaceae and Gramineae. Other preferences include species of Alismataceae, Cyperaceae, Hydrocharitaceae, Lemnaceae, and Liliaceae. Mines of *Hydrellia* in dicotyledonous plants of Caryophyllaceae, Labiatae, Chenopodiaceae, Scrophulariaceae, and Compositae apparently serve only for pupariation, and as such they are relatively short and simple. Apparently, larvae that leave their old mines just before pupariating have little host preference. I found *H. ischiaca* puparia in the floating leaves of *Potamogeton natans* growing near *Zizania aquatica,* the preferred host plant of the locality, and *H. bergi* puparia in leaves of *Z. aquatica* growing near a preferred species, *Potamogeton richardsonii. Nasturtium officinale* (Cruciferae) is the one established exception to the general absence of feeding mines in dicotyledons. European authors reported certain *Hydrellia* species parasitizing *N. officinale,* and I have confirmed *H. griseola* as a fairly common miner feeding in plants of this species in some localities in the United States. The known host plants, including those serving only for pupariation, are listed in Table 1.

Hydrellia play an important role in many aquatic ecosystems, especially eutrophic ones. Lange et al. (1953) estimated that *H. griseola* destroyed from 10 to 20 percent of the California rice crop in 1959. At Lake Itasca, Minnesota, I found that the infestation of several stands of wild rice, *Z. aquatica,* by *H. ischiaca* ranged from 33 to 89 percent in 1963. No one has measured the effects of the mining of many *Hydrellia* species in several *Potamogeton* species, but they are obviously considerable judging from observed leaf damage in many stands at several localities. The same can be said of many other host plants. *Hydrellia* larvae function, together with some Aphididae, Delphacidae, donaciine Chrysomelidae, Trichoptera, Lepidoptera (especially *Nymphula* spp.), Chironomidae (*Cricotopus, Polypedilum,* *Glyptotendipes,* and *Tanytarsus* spp.), *Hydromyza confluens,* and numerous other phytophagous insects in producing subtle, and sometimes conspicuous, changes in the littoral macroflora. Temperature and humidity requirements of adult and immature *Hydrellia* as well as requirements of host plants influence the effect and extent of mining. Wind and wave action and temperature and humidity tolerance tend to restrict oviposition to sheltered, eutrophic habitats. In such habitats, low mineral availability, low temperatures, wind, extensive algal and *Lemna* mats, and excessive water depth make some species of plants more susceptible to heavy infestation. The newest plant growth is generally most susceptible to infestation and is most severely damaged.

Berg (1949) found 26 insect species in addition to those of *Hydrellia* living upon or in 17 species of *Potamogeton.* Most of these insects may not have to compete extensively with one another because of the abundance of the plants and of narrowly defined ecological roles. There is obviously interspecific competition with aquatic caterpillars, snails, phytophagous fishes, waterfowl, muskrats, beavers, deer, and moose. According to Fassett (1960), bluegills eat the leaves of several *Potamogeton* species and *Vallisneria americana*; trout eat parts of *Nasturtium officinale* and *Zannichellia palustris*; waterfowl and muskrats use several *Potamogeton* species and *Sagittaria latifolia* tubers as a staple; waterfowl, muskrats, deer, and moose feed extensively on *Zizania aquatica*; and ducks use *Echinochloa* species as a staple.

Parasitological Data

Burghele (1959a) stated: "It is a well established fact that all aquatic Hymenoptera are parasites, the female laying her eggs in the eggs or larvae of aquatic insects." This cannot be entirely true, for I observed a specimen of *Chorebus aquaticus* ovipositing repeatedly for 5 minutes in a *Z. aquatica* leaf harboring neither eggs nor larvae of *Hydrellia.* Also, I watched a submerged specimen of *Trichopria columbiana* oviposit in leaf tissue around an empty puparium of *H. pulla.* One of my observations, in which *Chaenusa* sp. parasitized three or four puparia of *H. ischiaca* reared from eggs, indicates that some eggs or larvae of parasites may enter the host larva through the gut, for adult hymenopterans had no access to these larvae. Grigarick (1959) believed *Pnigalio* sp., *Sympiesis* sp., and *Solenotus intermedius* to be external larval feeders because they pupated free of the host. He discovered abundant eggs of *S. intermedius* and many larvae in the mines of *H. griseola.* Some larvae fed externally on *H. griseola* larvae.

Parasitic Hymenoptera undoubtedly exert considerable control on population densities of *Hydrellia,* especially in certain marginal habitats and when population densities are very high. Grigarick found parasitism of *H. griseola* by external parasites repeatedly higher in pools that were drying or very low. In one sample the parasitism was 60 percent. He found hymenopterous parasitism low on the first host generation mining rice but rising rapidly on succeeding generations to nearly 90 percent by July. *Opius hydrelliae* and *Chorebus aquaticus* (Braconidae) were most abundant. After July, parasitism declined and remained low for the rest of the year. This seemed to be correlated both with a great decrease in host density and with less vulnerability of *Hydrellia* larvae to parasitism when in certain restricted survival habitats, e.g., fall rain pools. I found 38 percent parasitism in 132 puparia of *H. ischiaca* and 63 percent in 61 puparia of *H. pulla* collected through one summer.

Hormone concentration and balance and perhaps other physiological factors may stimulate development of endoparasitic larvae, for in several observations they began to feed actively on host tissues only after host pupariation. I have photographed an opiine larva situated in the host larva (Figure 124). After one host pupariated, I saw the leechlike larva of *Ademon niger* devour the host tissues in a matter of hours. When the parasite pupates, it usually orients its head toward the prothoracic end of the puparium (as in Figure 131). At emergence, it usually leaves a dark meconium in its pupal exuviae located in the puparium (as in Figure 128). I observed several escape exits cut anteroventrally in the puparium (as in Figure 132) and a few posteroventrally. I have observed only one case in which the hymenopteron used the puparial operculum and did not cut its own exit. According to Burghele (1959a), the Dacnusinae cut the escape exit with their mandibles, while the Chalcidoidea make the exit by shaving off tiny pieces of the puparium. Inflow of water would not necessarily kill the emerging adult hymenopteron for *Ademon niger* and

Trichopria columbiana, at least, can remain submerged for several hours. I noted four adults of the latter species to live submerged for 24 hours. Two of these had already emerged and then submerged again.

The known hymenopterous parasites of *Hydrellia* are listed in Table 2. In addition to these parasites, species of *Stigmatomyces* (Laboulbeniales) parasitize *Hydrellia* adults and larvae. This fungus apparently killed several larvae of *H. bilobifera* during laboratory rearings.

Dispersal and Zoogeography

Most adults of *Hydrellia* locomote by a combination of walking and short, hopping flight. Flight through a distance of a few meters occurs in a zigzag pattern. Of all the species, *H. griseola* most probably has the longest flight range because it has the widest distribution and the largest wings. Perhaps its large wings and flight behavior often subject it to upward wind currents, for it is the most common species of *Hydrellia* captured in the few aerial surveys performed thus far in North America. Dispersal via passive dissemination by high-altitude atmospheric currents is probably efficient in most cases only over a few hundred miles because of body water loss. Strong wind often causes adults to congregate at the downwind end of lakes and pools. Some dispersal in most species probably occurs over relatively short distances in or on plants caught in water currents. Immature instars are particularly susceptible to this passive dissemination. The phenomenon probably accounts for the presence of larvae in plants at depths of from 3.0 to 6.0 meters in some lakes. Wind action and currents may carry floating puparia for variable distances.

I have collated the following data for zoogeographic consideration: (1) the known host preferences center on plant species having their greatest densities mostly between latitudes 25° and 65° north; (2) *H. griseola* and probably many other species have a temperature tolerance of 50°–90°F for adults and larvae; (3) high temperatures lower the surface tension of water and thus probably adversely affect locomotion of adults and migrating larvae; (4) most of the known species are Holarctic, the greatest number being in the Nearctic Region; (5) *H. griseola* has the most extensive distribution, being reported from all zoogeographic regions except the Oriental and Australian Regions; (6) *H. griseola* has the greatest host-plant range within the genus.

Behavior

Emergence.—The pharate adult must do more to emerge than simply shed the pupal cuticle; it must escape from the puparium and from the plant tissue holding the puparium. Pharate adults start making slight movements as early as twelve hours before emergence. They use their ptilina to open the operculum of the puparium. Initially, the operculum remains attached posteriorly because the ecdysial cleavage line extends only around the front and sides. Once the fly gets its head through the opening it pushes with its proboscis against the tip of the puparium until its fore legs are free. After this, it rapidly leaves the puparium. To emerge completely, adults of most species have only to force their way through thin, and often partially decomposed, plant epidermis and then rise in an air bubble if the puparium was submerged. However, adults of species pupariating in stems and rhizomes sometimes fail to escape and die. This can occur also in *H. griseola* and other species mining grasses if the leaves dry and become impliable. According to Grigarick (1959), flies emerged several times during the daylight and darkness at between 50° and 90°F. After emergence, flies of at least several species walk around slowly for several minutes, stopping periodically to clean their bodies and evert and then withdraw the ptilinum. The wings remain folded until about 15–30 minutes after emergence, when they rapidly expand. Often, they cannot fly until 45 minutes after emergence.

Feeding.—Adults often search over the surface film for entrapped insects and sometimes mistakenly pounce on inanimate floating objects and manipulate them with their fore tarsi as they do with small insects. They often protect their catches by making short rushes toward intruders. Adults have labellar canalicular teeth, which apparently function carnassially in lacerating conjunctival membranes of trapped insects. According to Berg (1950), adult *H. cruralis* chew small holes in floating leaves of several *Potamogeton* species. They probably use their labellar teeth for this chewing as well as for loosening yeast, Chrysophyta, and other periphytic microorganisms. Adults of several species often congregate within corollae of flowers of certain aquatic plants, e.g., *Nymphaea odorata, Nuphar advena,* and *Ranunculus longirostris.* Some species exhibit peculiar behavior while feeding, e.g., *H. biloxiae* rhythmically pushes its body up and down and *H. ischiaca* sometimes touches its food-insects with its abdomen. *Hydrellia biloxiae* and *H. pulla* protect their catches of dead or dying arthropods by partially extending their wings and making short rushes to drive away intruders.

MATING.—Dahl (1959) distinguished six phases in the mating process: (1) initiation, in which the male approaches the female from the front or side; (2) posturing, in which the male scissors his wings, curves his abdomen, or assumes some other distinctive posture, often while moving back and forth before the female; (3) restimulation, in which the male repeats his posturing to secure the female's full attention; (4) mounting, in which the male climbs on the female and grasps her partially extended wings; (5) insemination, in which the male inserts his phallus and ejaculates, often while titillating the female's abdomen with his hind legs; (6) dismounting, in which the male disengages and the female pushes at him with her hind legs. Although I have observed all of these phases in the mating of *Hydrellia,* I found the terms epigamic and gamic more flexible in describing mating behavior because of variations in different species. One pair of *H. nobilis* copulated without exhibiting any apparent epigamic behavior. Another male *H. nobilis* repeatedly climbed on this copulating pair and exerted his phallus each time. Epigamic behavior in many species consists of wing scissoring and walking to and fro before the female, but males of *H. definita* rhythmically push their bodies up and down, and *H. bergi, H. surata,* and *H. columbata* touch their faces or antennae before mounting. The mechanisms of species and sex recognition remain obscure, but surfaces reflecting ultraviolet rays may constitute at least one mechanism. Highly reflective objects such as automobiles, clean water surfaces, and polished aluminum pans attract several insect species, especially Diptera and Hymenoptera. One could hypothesize that the predominant silvery or yellow facial pruinosity in *Hydrellia* (and other schizophorans) reflect considerable ultraviolet radiation. Nickel and silver reflect about 40 percent of radiation with wavelengths of 251 millimicra, and the percentage reflected should be greater in the normal ultraviolet band of 292–400 millimicra. Density patterns of the pruinosity may be important if this hypothesis is valid. Several authors, e.g., Milne and Milne (1959), have emphasized the importance of ultraviolet radiation in insect optics.

Mechanisms of sex and species recognition sometimes fail, as in cases where a male *H. nobilis* tried to mount a male *H. ischiaca* after repeatedly scissoring his wings, or a male *H. nobilis* tried to mount a female *H. ischiaca,* or a female *H. amnicola* attempted to mount another female of the same species. Some cases of agonistic behavior are difficult to distinguish from those involving failure in sex or species recognition. In *H. bergi,* small males scissored before large males in two instances, and the large males grasped them by the thorax as if to mount. However, most observed agonistic behavior was interspecific, especially between *Hydrellia* species and predators such as spiders, *Lispe* spp., and *Ochthera mantis.* Adults of several *Hydrellia* species made short rushes toward these predators, often with their wings partially extended.

Copulation time varies specifically and with several other conditions. A pair of *H. ischiaca* copulated for 10 minutes and a pair of *H. nobilis* for 19 minutes. *Hydrellia griseola* have copulated from 1 to 50 minutes and at various times during daylight between 55° and 90°F. Copulation between the same pair may occur repeatedly in one day and, in *H. griseola,* for five consecutive days (according to Grigarick, 1959). However, continuous mating is unnecessary, for a female *H. griseola* has laid viable eggs 93 days after being isolated. Grigarick (1959) found the shortest time between emergence and copulation for *H. griseola* of the same age was three days, but Berg (1950) reported that *H. cruralis* copulated 24 hours after they emerged. In the laboratory, pairs of *H. griseola* have copulated as late as 70 days after emergence (Grigarick, 1959). Pairs may copulate in various types of microhabitats, but most frequently on pleustonic vegetation. One pair of *H. cruralis* copulated while skimming over the surface film, and (according to Grigarick) pairs of *H. griseola* copulated on emergent vegetation. In all species observed, the female continues to walk and occasionally to feed during copulation.

OVIPOSITION.—When forced by environmental conditions, females oviposit on nearly any surface.

In the laboratory, they will oviposit on glass, and in the field they will oviposit on dead stems, twigs of shrubs, and several hydrophytes that are not their hosts, e.g., *Nelumbo lutea, Polygonum scabum, Equisetum* sp., and *Sagittaria* sp. Most *Hydrellia* females can apparently distinguish preferred hosts when they are available. Usually, they prefer to lay their eggs in at least partially concealed places, such as beneath folded leaf margins and on the adaxial surfaces of sepals and stipules, but females of the *H. griseola* group lay their eggs on the exposed leaf blades of grasses close to the water surface. Most species deposit eggs in irregular masses, but some, notably *H. spinicornis,* scatter their eggs over the leaf. It is not uncommon for females to lay eggs on top of another's eggs. If females oviposit on linear objects, e.g., leaf blades of grasses and various stems, they align their eggs with the long axis of the object. Hering (1951) reported that females of some *Hydrellia* species submerge to oviposit. I have not observed this nor have I seen any other report of it.

Eclosion.—After about two to six days of incubation, the pharate larvae often begin to make slight movements several hours before eclosion. They slit the micropylar end of the chorion with their mouth-hook and either crawl entirely out of the chorion or only protrude their head lobe sufficiently to begin excavating a mine. Sometimes the larvae remain in the ruptured chorion for several hours. Mortality is probably high among newly eclosed larvae judging from oviposition sites quite removed from the host plants and from the number of recently eclosed larvae that fall into deeper water. Many larvae must eclose while submerged because of water level fluctuations. Those eclosing from eggs on the adaxial surface of floating leaves usually avoid direct sunlight by crawling onto the abaxial surface. Larvae locomote on the surface by anchoring their mouth-hook and contracting the body segments and by pushing with their spiracular peritremes and creeping welts. Partial desiccation stimulates larvae, especially newly eclosed ones, to twist and roll. This emergency reaction often carries them into water, but once there they may sink into an area devoid of plants.

Mining.—When the newly eclosed larvae find an area they can penetrate because of either weakened or thinner epidermis or some other condition, they first break the epidermis by striking it perpendicularly with their mouth-hook and then extend the opening by rotating the head lobe and mouth-hook and slicing the epidermis. The larvae ingest the loosened tissues. The prothoracic end flattens down to little more thickness than that of the feeding apparatus to project the mouth-hook into the extremely thin mesophyll. By continuing this excavation process, the first-instar larvae completely enter their mines in 2 to 2.5 hours. Third-instar larvae require only about half this time. The initial opening does not have to be as broad as the larva because of segmental contraction. Inside the mine, larvae move forward by peristalsis, in which contraction waves pass anteriad through the creeping welts, and occasionally by pushing with the spiracular peritremes and pulling with the mouth-hook. They can move slowly backward by reversing the peristalsis. Also, even late third-instar larvae can turn about within the mine. During endophyllous locomotion, the spinules of the dorsum and creeping welts press against the upper and lower epidermis and sometimes penetrate it.

Mining larvae apparently depend on the host plant for oxygen. According to Hering (1951), frass and other debris seal the mine entrance and prevent the entrance of water. Air then enters through the plant tissue and accumulates in the mine around the larva. This does not always happen, for I found larvae in old mines partially filled with either water or tissue fluid, and I observed larvae of *H. griseola, H. ischiaca,* and *H. bilobifera* pierce several different tissue areas in their mines with their spiracular peritremes until they found an apparent oxygen source. Larvae crawling on the underside of the surface film or starting a mine just below the surface film were observed periodically raising their spiracular peritremes above the surface film. Observations by Aldrich (1912) and Nemenz (1960) indicate a strong possibility that some kind of plastron or cuticular respiration operates in *Hydrellia* larvae. Nemenz (1960, p. 222) showed in *Ephydra* that "die Larven gelegentlich eine Luftblase aus den Abdominalstigmen auspressen und wieder einziehen, die offenbar als 'physiologische Kieme' wirkt."

Mines of first-instar larvae often are inconspicuous because of the small larvae and also, perhaps, because of partial plant tissue repair. As the larva grows, the mine is enlarged, but it may remain inconspicuous if it is in the middle of a relatively thick leaf, e.g., floating leaves of several *Potamogeton* species. Feeding mines of first- and second-instar larvae in narrow leaves such as those of grasses and some narrow-leafed *Potamogeton* species are fairly straight, but those of third-instar larvae are usually tortuous and have blotch-like chambers. In broad leaves, the feeding mines of even first-instar larvae may be tortuous. Larvae eat the mesophyll and, since various conditions will cause several larvae to congregate in a single leaf, skeletonization often results. If this occurs before the larvae are ready to pupariate, they migrate to fresh leaves.

Some species of *Hydrellia* overwinter as larvae. Larvae of *H. bilobifera* can survive in *Potamogeton nodosus* encased in ice.

PUPARIATION.—Pupariation is a fairly new term for the distinct process of the formation of a puparium. It is not equivalent to pupation, since it is essentially reformation of the third-instar cuticle and since a short fourth larval stadium occurs within the puparium before pupation. This fourth instar is very abortive, for a new feeding apparatus is not formed. When larvae are ready to pupariate, they become quiescent, with a greatly lowered heart rate. Pupariation occurs within a period of eight hours in some species. Larvae usually pupariate just under the epidermis of thick leaves. This improves the emerging adult's chances of escaping from the leaf. In thin leaves, such as those of grasses, position of the puparium seems unimportant. Third-instar larvae of *H. bergi* and *H. biloxiae* make escape slits for the adults in the stems and stolons that they mine. Third-instar larvae of several species often migrate to a new plant part for pupariation. This behavior probably aids survival by providing a more stable anchorage than the old, mined plant part. Also, this behavior partly accounts for the broad range of host plants of *H. griseola*. Apparently the larvae are nonspecific for these pupariation plants. According to Berg (1950), several species always pupariate with their spiracular peritremes anchored in the midribs of *Potamogeton* leaves. This fact seems to support the hypothesis that puparia must take air from the plant, but other data seem to refute this hypothesis. For instance, larvae of *H. ischiaca* often pupariate in skeletonized or wilted grass leaves, with their spiracular peritremes embedded only in the epidermis, and pupate successfully. Larvae of *H. griseola* usually make a blotch mine and pupariate in its center. Grigarick (1959) reported that *H. griseola* larvae pupariated on glass, in sand, and in blotting paper in the laboratory. Burghele (1959a) reported finding many *H. griseola* puparia on the bottoms of ice-covered pools. This may indicate overwintering capacity of puparia. Schütte (1921) reported the existence of summer and winter puparia in *Hydromyza livens* (Muscidae). The winter puparium has a wall eight times as thick as that of the summer one. Such seasonal forms may exist in *Hydrellia*.

Environmental Tolerance

Hydrellia are fairly stenotopic and stenohygric. The adult tolerance range for wind and temperature is relatively small. Wind often precludes oviposition on suitable host plants located in the limnetic zone of ponds and lakes, and it often causes host plants to break loose and pile up on the shore where the mining larvae have no opportunity to escape. Wind is probably one limitation to the height at which oviposition can occur on emergent vegetation. Grigarick (1959) presented the following temperature limits (in degrees Fahrenheit) to adult and larval activities of *H. griseola*:

	Adult
Heat death:	110–114
Heat paralysis:	107–110
Dropping:	104–107
Heat rest:	98–104
Normal locomotion:	52– 92
Slow walking:	40– 50
	Larva
Heat death:	112–114
Heat paralysis:	104–111
Agitated movement:	95–103
Normal mining:	50– 90
Quiescence:	36– 50

In one of Grigarick's tests, 50 percent of a sample of twelve wild adults lived 34 days at 29°F, and, in another one, 20 percent of 80 eggs hatched after 120 hours of exposure to 29°F. The principal extrinsic factors affecting the length of stadia of *Hydrellia* are temperature, atmospheric saturation deficit, and food (composition and quantity). The last factor is also the principal extrinsic one affecting fecundity.

Host Plants and Parasitic Wasps

The known host plants and parasitic wasps of *Hydrellia* are listed in tables starting on page 106.

Systematic Treatment

Classification

The type-species of *Hydrellia* Robineau-Desvoidy (1830) is *Hydrellia aurifacies* Robineau-Desvoidy, the first known valid designation of which was made by Coquillett (1910b). Coquillett cited *Notiphila flaviceps* Meigen (with *H. aurifacies* as a synonym) as the type. According to Article 69a (iv) of the International Code of Zoological Nomenclature (1961), Coquillett effectively designated *H. aurifacies* as the type-species. According to Wirth (1965), Westwood (1840) first designated *H. aurifacies* as the type-species, but Westwood actually designated *H. flaviceps* Meigen as the type-series. Since *H. flaviceps* was not an originally included nominal species and since Westwood did not synonymize it with *H. aurifacies,* his designation is invalid.

Ever since 1896 (and perhaps before), *Notiphila griseola* Fallén has generally been considered the type-species of *Hydrellia* Robineau-Desvoidy (1830). Macquart (1835) first reported the synonymy of *Hydrellia communis* Robineau-Desvoidy (1830) and *Notiphila griseola* Fallén (1813). Macquart also transferred several other species from *Notiphila* to *Hydrellia.* Kloet and Hincks (1945) rejected the name *Hydrellia* as a homonym of *Hydrelia* Huebner and replaced it with *Hydropota* Rondani. Article 56a of the International Code (1961) specifically prohibits such rejection in this statement: "Even if the difference between two genus-group names is due to only one letter, these two names are not to be considered homonyms."

The adults of *Hydrellia* can be distinguished from those of other Ephydridae by the following characters: ocular pubescence moderately dense; face usually slightly convex (distinctly receding and planate in one group); postocellar as long or longer than ocellar; two or three dorsocentrals present, at least one of which is as long or longer than longest facial; median spermatheca cupuliform, heavily sclerotized. Some additional characters present in adults of most species are as follows: about three palpal and five labellar setae; one very fine, ventrally directed, secondary facial setula inserted above primary facial row; two fronto-orbitals (anteriorly and posteriorly inclined); apicodorsal antennals not projecting noticeably; three scutellars (basal, intermediate, and apical); one mesanepisternal, mesokatepisternal, and basal coxal; ground color of cuticle usually dark brown or black.

The larvae can be distinguished from those of other ephydrid genera by these characters: metapneustic; spiracular peritreme spinous; mouth-hook single.

Cresson (1944b) erected the tribe Hydrelliini solely for *Hydrellia* and indicated its close relationship to the tribes Hydrinini and Ilytheini. As characters for Hydrelliini, he listed essentially the generic characters. No author has disputed this classification. However, some controversy has existed on the subfamilial classification. Loew (1860) placed *Hydrellia* with *Atissa, Philygria* (as *Hydrina*), *Hyadina,* and *Axysta* in Hydrellina, which corresponded to a subfamily. Becker (1926) grouped *Hydrellia, Philygria,* and several parydrine genera in his subfamily "Hydrellinae." Cresson (1930, 1942, 1944b), Wirth and Stone (1956), Dahl (1959), and Deonier (1964) grouped *Hydrellia* with *Notiphila, Dichaeta, Ilythea, Philygria, Nostima, Oedenops,* and several other genera in the Notiphilinae.

I found 57 species of *Hydrellia* in the Nearctic Region, of which 21 are new and one is a new Nearctic record. I discovered and described immature instars of twelve species and redescribed those of seven species previously known.

The phylogeny of this genus remains obscure concerning most details. The entire genus seems to be in a very active speciation phase. The absence of noticeable larval divergence within certain species groups is very likely an indication of relatively recent speciation. In the *H. bilobifera* species group, for example, *H. bilobifera* and *H. trichaeta* can be distinguished by male and female terminalia, but the larvae are very difficult to distinguish. Where the species occur together, the larvae of each are often found in the same host-plant species and even in the same leaf of a plant. Berg (1950) and others have reported this food (host) overlap in some other *Hydrellia* species. The adults, however, are different enough that they do not attempt to interbreed in a laboratory colony nor, as so far observed, in natural habitats. Most of the species groups of Nearctic *Hydrellia* may well have in them similar situations regarding speciation.

This state of the genus in the Nearctic Region has prohibited any objective segregation of its constituents into morphologically discrete species groups. A tentative, subjective grouping based upon overall impressions of similarity in habitus is presented below. This corresponds somewhat with Cresson's impressions. A preliminary attempt to obtain a grouping based upon computer analysis of ratios of various measurements of male terminalia structures proved inconclusive. In this attempt, 25 ratios were established between the following characters: fused surstyli length and breadth, lateral and median lengths of fused surstyli, cercus length and breadth, copulobus length and breadth, sterna 4 and 5 breadths, lateral and median lengths of sternum 5, postgonite uncus length and thickness, cerci breadth (spread), total phallus length, length and breadth of phallus (including, in some cases, part of basiphallus) anterior to fused surstyli, and breadth of distiphallus at midlength. The ratios represented the mean of usually ten specimens (in a very few species only one). These ratios for 53 of the species were subjected to stepwise discriminant analysis and then to clustering by the unweighted pair-group method in a computer. Each species was categorized as uncertain, present, or absent for each ratio character depending upon whether the actual ratio was above or below the all-species mean of that ratio character. Eleven species groups ranging from one to ten species resulted from this program. All of these groups had a similarity coefficient (S_{sm}) of 0.62 or greater (where a coefficient of 1 is identity). Only four of these correlated much with any of my 14 habitus groups. One group, *bilobifera*, was identical in both groupings. Another computer group correlated fairly well with two habitus groups—*morrisoni* and *platygastra*. A computer program integrating all quantitative and qualitative characters gathered for the species is needed to obtain a better generic analysis.

Species groups.—The following represent habitus or physiognomic groups of Nearctic *Hydrellia*:

griseola group: (1) *griseola*, (2) *valida*, (3) *flavicoxalis*, (4) *spinicornis*, (5) *rixator*, (6) *ischiaca*.
notiphiloides group: (7) *notiphiloides*, (8) *deceptor*, (9) *caliginosa*, (10) *pulla*.
subnitens group: (11) *subnitens*, (12) *suspecta*, (13) *definita*, (14) *manitobae*, (15) *itascae*, (16) *amnicola*, (17) *agitator*.
morrisoni group: (18) *morrisoni*, (19) *borealis*, (20) *cessator*, (21) *serena*, (22) *lata*, (23) *penicilli*.
cruralis group: (24) *cruralis*.
tibialis group: (25) *tibialis*, (26) *americana*, (27) *biloxae*.
formosa group: (28) *formosa*, (29) *notata*, (30) *ainsworthi*.
crassipes group: (31) *crassipes*, (32) *saltator*, (33) *procteri*, (34) *advenae*.
nobilis group: (35) *nobilis*, (36) *idolator*, (37) *atroglauca*, (38) *cavator*.
proclinata group: (39) *proclinata*, (40) *melanderi*, (41) *decens*.
platygastra group: (42) *platygastra*, (43) *wilburi*.
bergi group: (44) *bergi*, (45) *insulata*, (46) *personata*.
prudens group: (47) *prudens*, (48) *surata*, (49) *columbata*, (50) *luctuosa*, (51) *floridana*.
bilobifera group: (52) *bilobifera*, (53) *gladiator*, (54) *discursa*, (55) *ascita*, (56) *harti*, (57) *trichaeta*.

Remarks on keys and descriptions.—The high degree of homogeneity in this genus has severely hampered my construction of utilitarian keys to the adults, larvae, and puparia. The extensive use of various indices and the need to refer to male terminalia limit the utility of the keys. I have not always been able to group apparently closely related species in the keys. Initial use of the keys will require reference to the section on definitions in the chapter on morphology. Descriptions of male terminalia pertain to the ventral view of the structures. Because of the possibility that a specimen may represent a new sibling species, one should consult the descriptions after using the keys.

I studied the holotype or a syntype of each species unless stated otherwise under the taxonomic remarks.

Key to Adult *Hydrellia*

1. Ocellar present..........2
   Ocellar absent..........50
2. Two subequal fronto-orbitals present..........3
   Three subequal fronto-orbitals present. (Male terminalia as in Figure 32.) ***H. ainsworthi*, new species**
3. Anterior fronto-orbital anteriorly inclined, posterior one posteriorly inclined..........4
   Both fronto-orbitals anteriorly inclined..........51
4. Face slightly convex or protruding in profile..........5
   Face planate and receding at constant angle in profile..........53
5. Palpus moderate yellow or moderate orange-yellow..........6
   Palpus at least partly dark brown or black..........35
6. Fore tarsus dark brown or gray in dorsal view..........7
   Fore tarsus moderate yellow or moderate orange-yellow..........24
7. Some tibiae moderate brown or dark gray; mesokatepisternals variable..........8
   All tibiae moderate yellow; 1 large and 3 small mesokatepisternals. (Male terminalia as in Figure 63.)..........***H. cruralis* Coquillett**
8. Lower half of face not conically prominent; palpus moderate yellow; no sfa or 1–5 seriated sfa..........9
   Lower half of face conically prominent; palpus moderate orange-yellow; 4–7 scattered sfa. (Male terminalia as in Figure 61.)..........***H. pulla* Cresson**
9. Antennal segment 3 dark brown, or if partly yellow then hind basitarsus without or with usually 2 black anterior basal setae (except *H. cessator,* with 4–7.)..........10
   Antennal segment 3 partly moderate yellow; hind basitarsus with 3–5 black, anterior basal setae. (Male terminalia as in Figure 66.)..........***H. penicilli* Cresson**
10. Fore coxa and tibia mostly dark gray or moderate brown; hind tibia without or with usually 3–5 black, anterior apical setae..........11
    Fore coxa and tibia moderate yellow; hind tibia with 2 or 3 black, anterior apical setae. (Male terminalia as in Figure 44.)..........***H. ischiaca* Loew**
11. One large mesokatepisternal; basal coxals variable..........12
    One large and 3 or 4 small mesokatepisternals; 2 basal coxals. (Male terminalia as in Figure 62.)..........***H. flavicoxalis* Cresson**
12. Thoracic pleuron and side of abdomen mostly light gray or light bluish gray, strongly contrasting with mesonotum and abdominal dorsum (except in nearly uniformly light gray *H. valida*)..........13
    Thoracic pleuron or side of abdomen mostly moderate brown or yellowish gray, not strongly contrasting with mesonotum or abdominal dorsum..........19
13. Female fore femur without distinct, black, anteroventral spines on distal half; costal section II:I 2.8 or less; mesofacial index 2.5 or less..........14
    Female fore femur with distinct, black, anteroventral spines on distal half; costal section II:I 3.0 or more; mesofacial index 2.6 or more. (Male terminalia as in Figure 40.) ***H. spinicornis* Cresson**
14. Large areas of body brown; usually 12 or fewer anterior interfractural costals..........15
    Body uniformly light gray (except mesonotum and thoracic pleuron infrequently with sparse light yellowish brown pruinosity in small areas); 12–15 anterior interfractural costals. (Male terminalia as in Figure 22.)..........***H. valida* Loew**
15. Antenna not velvety dark brown; frontal vitta and parafrontalia of different hues; prementum usually glossy brownish black..........16
    Antenna velvety dark brown; frontal vitta and parafrontalia uniformly semiglossy dark brown; prementum light gray. (Male terminalia as in Figure 42.) ***H. deceptor*, new species**
16. Body length:wing length 0.9 or more; costal section II:I 2.6 or less; vertex index usually under 7.0 (except 7.5 in *H. rixator*)..........17
    Body length:wing length 0.8; costal section II:I 2.6 or more; vertex index 7.0 or more. (Male terminalia as in Figure 26.)..........***H. griseola* (Fallén)**
17. Frontal vitta and parafrontalia of different hues; vertex index 5.5 or less; male length usually over 1.8 mm; wing length usually over 2.0 mm..........18
    Frontal vitta and parafrontalia uniformly velvety dark brown; vertex index 5.5 or more;

male length usually 1.7 mm or less; wing length usually under 2.0 mm. (Male terminalia as in Figure 29.) .... ***H. rixator,*** new species

18. Parafrontalia velvety black, contrasting with frontal vitta; 8–10 aristal rays; costal section III:IV 2.5 or less. (Male terminalia as in Figure 19.) .... ***H. caliginosa*** Cresson

Parafrontalia not velvety black; 6–8 aristal rays; costal section III:IV 2.5 or more. (Male terminalia as in Figure 65.) .... ***H. notiphiloides*** Cresson

19. Male and female lengths under 2.3 and 2.7 mm respectively; fewer than 12 dorsal and 14 anterior interfractural costals; costal section II:I usually over 2.0 20

Male and female lengths over 2.8 and 2.9 mm respectively; 12–14 dorsal and 14–16 anterior interfractural costals; costal section II:I usually under 2.0. (Male terminalia as in Figure 28.) .... ***H. itascae,*** new species

20. Face not silky light yellowish brown, without median crease or with one distinct in other views; apicodorsal antennal prominent only in *H. lata;* most of fused surstyli concealed in repose or if exposed, then not moderate yellow 21

Face silky light yellowish brown, with median crease distinct only in anteroventral view; apicodorsal antennal prominent; most of fused surstyli always exposed and moderate yellow. (Male terminalia as in Figure 17.) .... ***H. bergi*** Cresson

21. Prementum not glossy brownish black; antenna not velvety dark brown; costal section V:IV usually 3.5 or less 22

Prementum glossy brownish black; antenna velvety dark brown; costal section V:IV 3.5 or more. (Male terminalia as in Figure 46.) .... ***H. insulata,*** new species

22. Prementum pale yellow; apicodorsal antennal not prominent; costal section II:I usually 2.4 or less 23

Prementum light gray; apicodorsal antennal prominent; costal section II:I 2.4 or more. (Male unknown.) .... ***H. lata*** Cresson

23. Parafrontalia velvety black, contrasting with frontal vitta; 2 or 3 basal coxals; mesanepisternum bronzed in posterolateral view. (Male terminalia as in Figure 35.) ***H. serena*** Cresson

Parafrontalia not velvety black; 1 basal coxal (infrequently 2); mesanepisternum not bronzed in posterolateral view. (Male terminalia as in Figure 59.) ***H. cessator,*** new species

24. Abdominal terga 2–4 not velvety purplish black medially; frontal vitta, parafrontalia, occiput, and antennal segment 2 not uniformly velvety black 25

Abdominal terga 2–4 velvety purplish black medially; frontal vitta, parafrontalia, occiput, and antennal segment 2 uniformly velvety black. (Male terminalia as in Figure 34.) ***H. biloxiae,*** new species

25. Tibiae moderate brown with light gray pruinosity 26

Tibiae moderate yellow on one-third or more of their length 33

26. Antennal segment 3 at least partly moderate yellow 27

Antennal segment 3 dark brown or black 29

27. Parafrontalia not velvety black; wing length 2.4 mm or more; 6–9 aristal rays 28

Parafrontalia velvety black; wing length 2.1 mm or less; 4–6 aristal rays. (Male terminalia as in Figure 54.) .... ***H. cavator,*** new species

28. Ocular index 13.0 or less; 8 or 9 aristal rays; costal section II:I 2.4 or more. (Male terminalia as in Figure 45.) .... ***H. subnitens*** Cresson

Ocular index 15.0 or more; 6–8 aristal rays; costal section II:I 2.3. (Male terminalia not figured.) .... ***H. suspecta*** Cresson

29. Tarsi moderate yellow; male hind femur without posteroventral flange and anteroventral rows of close-set, short setae 31

Tarsi moderate orange-yellow; male hind femur with posteroventral flange and 2 anteroventral rows of close-set, short setae 30

30. Antenna dark brown; ocular index 8.0 or more; 1 basal coxal. (Male terminalia as in Figure 33.) .... ***H. crassipes*** Cresson

Antenna velvety black; ocular index 7.0 or less; 2 basal coxals. (Male terminalia as in Figure 56.) .... ***H. saltator,*** new species

31. Fore and mid coxae light gray anteriorly; 7 or more dorsal and 9 or more anterior interfractural costals; ocular index usually more than 9.0 32

Fore and mid coxae moderate yellow anteriorly; 7 or fewer anterior interfractural costals; ocular index usually under 9.0. (Male terminalia as in Figure 39.) ...... ***H. advenae*** Cresson

32. Wing length 2.1 mm or less; epistomal index 1.4 or less; male hind femur very stout and hind tibia expanded distally. (Male terminalia as in Figure 20.) .... ***H. procteri*** Cresson
Wing length 2.4 mm or more; epistomal index 1.4 or more; male hind femur not stout and hind tibia not expanded distally. (Male terminalia as in Figure 45.) ***H. subnitens*** Cresson

33. Face moderate or pale yellow; ocular index 13.0 or more; abdominal terga without distinct bluish gray posterolateral wedges 34
Face light gray; ocular index 12.0 or less; abdominal terga with distinct light bluish gray posterolateral wedges. (Male terminalia not figured.) .... ***H. atroglauca*** Coquillett

34. Wing length 2.3 mm or more; vertex index 6.0 or more; ocular index usually over 17.0. (Male terminalia as in Figure 36.) .... ***H. nobilis*** (Loew)
Wing length 2.1 mm or less; vertex index 5.5 or less; ocular index usually under 17.0. (Male terminalia as in Figure 21.) .... ***H. idolator,*** new species

35. Mid and hind tarsi moderate orange-yellow; posterior part of male abdomen compressed 36
Mid and hind tarsi dark brown; posterior part of male abdomen not compressed 37

36. Face velvety dark brown; antenna dark brown; 10–14 setae on basal end of costa. (Male terminalia as in Figure 38.) .... ***H. platygastra*** Cresson
Face white; antenna velvety black; 9–11 setae on basal end of costa. (Male terminalia as in Figure 38.) .... ***H. wilburi*** Cresson

37. One basal coxal; 12 or fewer anterior interfractural costals; wing length 3.0 mm or less 38
Two basal coxals; 11–14 anterior interfractural costals; wing length 3.0 mm or more. (Male terminalia as in Figure 48.) .... ***H. manitobae,*** new species

38. Thoracic pleuron dark yellowish gray, brown, or light gray; wing length 2.7 mm or less; 9 or fewer aristal rays; male mid and hind tibiae not both expanded 39
Thoracic pleuron light yellowish gray; wing length 2.7 mm or more; 9–11 aristal rays; male mid and hind tibiae expanded (Figure 8). (Male terminalia as in Figure 16.) ***H. morrisoni*** Cresson

39. At least one adc much longer than others; face not light yellowish brown; apicodorsal antennal not prominent (except in *H. personata*); male hind tibia not expanded 40
All adc more or less uniordinate; face light yellowish brown; apicodorsal antennal prominent; male hind tibia expanded as in Figure 8. (Male terminalia as in Figure 53.) ***H. borealis*** Cresson

40. Dorsal and anterior interfractural costals subequal; 2 or more pdc; male mid tibia variable 41
Dorsal interfractural costals twice size of anterior ones; 1 pdc; male mid tibia not expanded. (Male terminalia as in Figure 49.) .... ***H. personata,*** new species

41. Face not white; frontal vitta and parafrontalia not uniformly velvety black; 1 or more sfa; male mid tibia variable 42
Face white; frontal vitta and parafrontalia (except light-brown ocellar triangle) uniformly velvety black; no sfa; male mid tibia expanded. (Male terminalia as in Figure 27.) ***H. americana*** Cresson

42. Mesonotum and abdominal dorsum not glossy dark grayish green; face not both light gray and slightly carinate (except in *H. columbata*); male mid tibia variable 43
Mesonotum and abdominal dorsum glossy dark grayish green; face light gray and slightly carinate; male mid tibia expanded. (Male terminalia as in Figure 41.) ***H. tibialis*** Cresson

43. Thoracic pleuron mostly light gray or yellowish gray; wing length 1.8 mm or more; male mid tibia not expanded 44
Thoracic pleuron mostly moderate olive-brown (body mostly with dense moderate or dark olive-brown pruinosity); wing length 1.8 mm or less (except 2.1 mm in *H. luctuosa*); male mid tibia expanded 46

44. Ocular index 7.0 or less; mesofacial index 2.0 or less; costal section V:IV 3.5 or less 45
Ocular index 8.0 or more; mesofacial index 2.0 or more; costal section V:IV 3.6 or more. (Male terminalia as in Figure 60.) .... ***H. definita*** Cresson

45. Antenna and parafrontalia velvety dark brown; 6–8 aristal rays; M_{1+2} index 1.5 or less. (Male terminalia as in Figure 47.) .... ***H. amnicola,*** new species

Antenna and parafrontalia not velvety dark brown; 8 or 9 aristal rays; M_{1+2} index 1.6 or more. (Male terminalia as in Figure 58.) .... ***H. agitator,*** new species

46. Face not entirely dark brown; usually 9 or fewer anterior interfractural costals 47
Face entirely dark brown; usually 9 or more anterior interfractural costals. (Male terminalia as in Figure 64.) .... ***H. luctuosa*** Cresson

47. Ocular index 8.0 or less; face partly brown (except in *H. columbata*), protuberant or carinate 48
Ocular index 9.0 or more; face entirely light gray or yellowish gray, slightly convex. (Male terminalia as in Figure 31.) .... ***H. floridana,*** new species

48. Face centrally protuberant, light gray only on lower third; vertex index 4.5 or less; mesofacial index usually 1.4 or more 49
Face slightly carinate on upper two-thirds, usually entirely light gray; vertex index 4.6 or more; mesofacial index 1.4 or less. (Male terminalia as in Figure 55.) ***H. columbata,*** new species

49. Palpus, antenna, and parafrontalia velvety black; 4–7 sfa; lower half of mesokatepisternum light gray. (Male terminalia as in Figure 25.) .... ***H. surata,*** new species
Palpus, antenna, and parafrontalia dark brown, not velvety; 1–3 sfa; thoracic pleuron moderate olive-brown. (Male terminalia as in Figure 18.) .... ***H. prudens*** Curran

50. Thoracic pleuron nearly uniformly light gray; 3 fronto-orbitals. (Male terminalia as in Figure 52.) .... ***H. notata,*** new species
Thoracic pleuron velvety brownish black and light gray; 2 fronto-orbitals. (Male terminalia as in Figure 43.) .... ***H. formosa*** Loew

51. Thoracic pleuron with 1 continuous light-gray area 52
Thoracic pleuron with 2 distinct light-gray areas. (Male terminalia as in Figure 57.) ***H. proclinata*** Cresson

52. Arista with 6–8 rays; 8–11 dorsal and 9–12 anterior interfractural costals. (Male terminalia as in Figure 51.) .... ***H. melanderi,*** new species
Arista with 9–11 rays; 6–8 dorsal and 8–9 anterior interfractural costals. (Male unknown.) .... ***H. decens*** Cresson

53. Male abdominal syntergum 9+10 rounded or only slightly bilobate posteriorly; female cercus less than twice as long as wide 54
Male abdominal syntergum 9+10 prominently bilobate posteriorly; female cercus about three times as long as wide (Figure 72). (Male terminalia as in Figure 50.) ***H. bilobifera*** Cresson

54. Antennal segment 3 at least partly moderate yellow 55
Antennal segment 3 dark brown. (Female terminalia as in Figure 69; male as in Figure 15.) ***H. harti*** Cresson

55. Ocular index over 6.0 56
Ocular index under 6.0 57

56. Male abdominal syntergum 9+10 rounded posteriorly; female cercus mucronate apically (Figure 68). (Male terminalia as in Figure 37.) .... ***H. trichaeta*** Cresson
Male abdominal syntergum 9+10 truncate posteriorly; female cercus acute apically (Figure 67). (Male terminalia as in Figure 23.) .... ***H. ascita*** Cresson

57. Wing length under 2.0 mm; female cercus ovoid apically, truncate basally (Figure 70). (Male terminalia as in Figure 30.) .... ***H. discursa,*** new species
Wing length over 2.2 mm; female cercus acute apically, rounded basally (Figure 71). (Male terminalia as in Figure 24.) .... ***H. gladiator,*** new species

Male Terminalia Key to *Hydrellia*

[The descriptions herein apply only to the ventral view and to the sclerotized portions of structures unless otherwise stated. Only maximum dimensions are used unless otherwise stated. The copulobus length is measured from a level perpendicular through the base of the copulobus to the median point on the posterior margin of sternum 5.]

1. Phallus and cerci bilaterally symmetrical 2
Phallus and cerci bilaterally asymmetrical; copulobus about 25.0 times as long as median length of sternum 5 (Figure 17) .... ***H. bergi*** Cresson

2. Copulobus length about 4.5 times (or more) as great as cercus breadth....47
   Copulobus length about 3.2 times (or less) as great as cercus breadth....3
3. Basiphallus with black spinous process anterolaterally....4
   Basiphallus without such process....5
4. Sternum 5 distinctly angular and prominent anterolaterally; posterolateral corner of copulobus acutangular (Figure 26)....***H. griseola*** (Fallén)
   Sternum 5 rounded anterolaterally; posterolateral corner of copulobus nearly 90° angular (Figure 22)....***H. valida*** Loew
5. Sternum 5 with rounded prominence anterolaterally; posteromedial margin of sternum 5 and its copulobi forming squared recess; distiphallus not lamellate....6
   Sternum 5 without rounded prominence anterolaterally, or if so then posteromedial margin of sternum 5 and its copulobi not forming a squared recess; distiphallus variable....7
6. Fused surstyli narrowly and deeply cleft anteromedially, with anterolateral lobe, and without posterolateral spicate projection; cercus about 1.5 times as long as broad (Figure 62)....***H. flavicoxalis*** Cresson
   Fused surstyli narrowly and shallowly notched anteromedially, without anterolateral lobe, but with posterolateral spicate projection; cercus about 2.0 times as long as broad (Figure 44)....***H. ischiaca*** Loew
7. Posteromedial part of sternum 5 with paired, long bispinate processes directed toward anterior margin of fused surstyli; fused surstyli narrowly and deeply cleft anteromedially, with anterolateral bladelike lobe and central gibba (Figure 40)....***H. spinicornis*** Cresson
   Sternum 5 without such processes; fused surstyli variable, but without anterolateral bladelike lobe and central gibba....8
8. Fused surstyli with 3 narrow, deep clefts anteriorly; median third of anterior margin of sternum 5 broadly notched; copulobus with incurved posterior arm and shorter medial arm, both with macrochaetae on ends (Figure 29)....***H. rixator***, new species
   Fused surstyli without or with only 1 cleft in anterior margin; sternum 5 not notched anteromedially; copulobus without such arms....9
9. Postgonite uncus truncate apically and about 4.0 times as long as thick; cerci longer than fused surstyli; copulobus sharply tapered to small tip nearly touching fused surstyli (Figure 65)....***H. notiphiloides*** Cresson
   Postgonite uncus acute or rounded apically, or if truncate then cerci shorter than fused surstyli; copulobus not sharply tapered, or if so then not nearly touching fused surstyli....10
10. Sternum 5 acutangular, hooklike anterolaterally; fused surstyli convex anteriorly with narrow, shallow anteromedial notch; distiphallus longitudinally lamellate (Figure 42). ***H. deceptor***, new species
    Sternum 5 not hooklike anterolaterally; fused surstyli not so formed anteriorly, or if so then longer than broad; distiphallus variable....11
11. Fused surstyli about 2.0 times as broad as long and about 0.6–0.8 as long as cercus; copulobus angularly notched medially and nearly touching fused surstyli (Figure 19). ***H. caliginosa*** Cresson
    Without such combination of characters....12
12. Pregonite 2.5–3.0 times as thick as postgonite; postgonite uncus buttonlike, about 1.5 times as long as thick; sternum 5 noticeably broader than fused surstyli (Figure 61). ***H. pulla*** Cresson
    Pregonite about 2.0 times (or less) as thick as postgonite; postgonite uncus not buttonlike; sternum 5 variable....13
13. Cerci together as broad or broader than broadest part of fused surstyli and as long or longer than median part of fused surstyli....14
    Cerci not nearly as broad as broadest part of fused surstyli, or if so not as long as median part of fused surstyli....22
14. Postgonite uncus projecting anteriad to or beyond distiphallus apex....15
    Postgonite uncus not projecting much beyond midlength of distiphallus, or if so then it is directed laterad....17
15. Sternum 5 noticeably broader than fused surstyli; postgonite uncus 12.0–15.0 times as long as thick and hooked apically; copulobus about 4.0 times as long as broad (Figure 55)....***H. columbata***, new species
    Sternum 5 not noticeably broader than fused surstyli; postgonite uncus about 4.0–6.0

times as long as thick, not distinctly hooked apically; copulobus about 2.0 times as long as broad or broader than long....16

16. Copulobus about 2.0 times as long as broad; distiphallus broadest at midlength; postgonite uncus nearly straight (Figure 25)....***H. surata***, new species

Copulobus not prominent, broader than long; distiphallus broadest proximally; postgonite uncus tip curved laterad (Figure 18)....***H. prudens*** Curran

17. Fused surstyli narrowly and deeply cleft medially along 0.9 of the length; uncus not noticeably darker than rest of postgonite; copulobus about 4.0–5.0 times as long as broad (Figure 28)....***H. itascae***, new species

Fused surstyli cleft no deeper than about 0.7 of the length; uncus noticeably darker than rest of postgonite; copulobus about 2.0–3.0 times as long as broad....18

18. Copulobus with sharp projection at midlength of medial margin; distiphallus longitudinally lamellate (Figure 58)....***H. agitator***, new species

Copulobus without such projection; distiphallus not longitudinally lamellate....19

19. Fused surstyli slightly concave anteriorly (nearly truncate); exposed part of basiphallus near fused surstyli about 4.0 times as broad as distiphallus at midlength (Figure 59). ***H. cessator***, new species

Fused surstyli indented or cleft anteromedially; exposed part of basiphallus near fused surstyli about 3.0 times (or less) as broad as distiphallus at midlength....20

20. Copulobus about 2.0 times as long as postgonite uncus; fused surstyli widely V-cleft anteromedially (Figure 16)....***H. morrisoni*** Cresson

Copulobus about 5.0 times as long as postgonite uncus; fused surstyli narrowly cleft anteromedially....21

21. Fused surstyli about 3.5 times as broad as copulobus and narrowly and deeply cleft medially along about 0.7 of the length (Figure 66)....***H. penicilli*** Cresson

Fused surstyli about 6.0 times as broad as copulobus and narrowly cleft medially along 0.5 (or less) of the length (Figure 53)....***H. borealis*** Cresson

22. Cercus only about 0.6 as long as broad; distiphallus nearly uniform in breadth with mucronate apex; fused surstyli broadly V-cleft anteriorly (Figure 60). ***H. definita*** Cresson

Cercus more than 0.6 as long as broad, or if not then distiphallus broadly tapered to apex that is not mucronate; fused surstyli variable....23

23. Fused surstyli about 1.4 times as long as broad, smoothly convex anterolaterally to narrow shallow anteromedial indentation; distiphallus carinate and constricted at midlength (Figure 48)....***H. manitobae***, new species

Fused surstyli usually more than or less than 1.4 times as long as broad, or if 1.4 then concave or deeply cleft anteriorly; distiphallus not both carinate and constricted (except in *H. ainsworthi*)....24

24. Anterolateral margin of sternum 5 a bare acutangular prominence; distiphallus longitudinally lamellate; copulobus about 6.0 times as long as broad (Figure 45). ***H. subnitens*** Cresson

Anterolateral margin of sternum 5 not a bare acutangular prominence, or if so then copulobus only about 2.0 times as long as broad; distiphallus variable....25

25. Fused surstyli broadly and deeply V-cleft anteromedially; distiphallus not projecting much beyond anterior margin of fused surstyli; postgonite above surstyli, not the copulobus (Figure 47)....***H. amnicola***, new species

Fused surstyli not broadly and deeply V-cleft anteromedially, or if so then distiphallus projecting nearly to sternum 5; postgonite above copulobus (except in *H. americana* and *H. floridana*)....26

26. Fused surstyli papilliform or triangular anteriorly (about 12.0–15.0 times as broad posteriorly as anteriorly)....27

Fused surstyli not papilliform or triangular anteriorly....28

27. Fused surstyli 2.0–3.0 times as long as copulobus; pregonites and postgonites ending near each other (Figure 63)....***H. cruralis*** Coquillet

Fused surstyli about as long as copulobus; pregonite much larger and projecting more anteriorly than postgonite (Figure 49)....***H. personata***, new species

28. Sternum 5 with broad, flat, shallow recess anteriorly; copulobus concave posteromedially and ending close to fused surstyli; fused surstyli about as long as broad, narrowly notched anteromedially, and lobate anterolaterally (Figure 46)....***H. insulata***, new species

Sternum 5 convex or straight-edged anteriorly; copulobus without such posteromedial concavity, or if so then not ending close to surstyli; fused surstyli not so formed............29

29. Fused surstyli slightly mucronate anteromedially, about 1.6 times as long as cercus, and about 2.0 times as broad as sternum 4; copulobus papilliform posteriorly (Figure 41). ***H. tibialis*** Cresson

Fused surstyli not mucronate anteromedially, usually more than or less than 1.6 times cercus length, and less than 1.6 times as broad as sternum 4; copulobus variable............30

30. Fused surstyli, except for posterior end, evenly semicircular or ovoid and covering basiphallus laterally..........31

Fused surstyli cleft, indented, or some form other than semicircular or ovoid..........32

31. Fused surstyli about 1.5 times as long as cercus; copulobus with 2 prominent macrochaetae on tip; distiphallus apex not lamellate (Figure 64)..........***H. luctuosa*** Cresson

Fused surstyli about 3.0 times as long as cercus; copulobus without macrochaetae; distiphallus apex transversely lamellate (Figure 34)..........***H. biloxiae***, new species

32. Distiphallus distinctly expanded proximally and distally, entirely lamellate longitudinally and bicarinate distally; fused surstyli 2.0 times (or more) as broad as long, with 3 broad anterior lobes (Figure 31)..........***H. floridana***, new species

Distiphallus not so expanded nor bicarinate, or if so then not lamellate; fused surstyli 2.0 times (or more) as broad as long in only one species *(H. americana)*..........33

33. Postgonite absent; copulobus much broader than long; fused surstyli broadly and deeply concave anteriorly and about 2.0 times as broad as long (Figure 27). ***H. americana*** Cresson

Postgonite present; copulobus longer than broad; fused surstyli deeply cleft anteromedially, or if broadly and deeply concave then not over 1.3 times as broad as long..........34

34. Sternum 5 convex posteromedially, projecting as far or farther posteriad than papilliform copulobus; fused surstyli broadly and deeply V-cleft anteromedially along 0.6 of the length (Figure 52)..........***H. notata***, new species

Sternum 5 concave posteromedially; copulobus, if papilliform, much longer than median length of sternum 5; fused surstyli not V-cleft along 0.6 of the length..........35

35. Fused surstyli truncate anteriorly, about as long as broad and about 4.0–6.0 times as long as cercus; copulobus notched medially (Figure 32)..........***H. ainsworthi***, new species

Fused surstyli concave, convex, cleft, or indented and variable in proportions; copulobus variable..........36

36. Fused surstyli broadly and shallowly concave anteriorly and slightly broader than long; cercus about as long as broad; distiphallus constricted along middle portion and not lamellate (Figure 43)..........***H. formosa*** Cresson

Fused surstyli deeply concave, V-cleft, notched or indented anteriorly, or if broadly and shallowly concave then longer than broad or cercus only about 0.5 times as long as broad; distiphallus lamellate if constricted along middle portion..........37

37. Copulobus with 1 or 2 posterolateral winglike projections; basiphallus not covered laterally by fused surstyli; distiphallus longitudinally lamellate..........38

Copulobus without such projections; basiphallus covered laterally, or if not then distiphallus not longitudinally lamellate throughout..........39

38. Fused surstyli about 2.5 times as long as broad; copulobus with 1 posterolateral projection; basiphallus broadest near anterior end of surstyli (Figure 36)..........***H. nobilis*** (Loew)

Fused surstyli about 1.3 times as long as broad; copulobus with 2 posterolateral projections; basiphallus broadest at about middle third of surstyli length (Figure 21). ***H. idolator***, new species

39. Fused surstyli convex anteriorly; copulobus with 2 setae on posterior tip about 0.5 times as long as copulobus; distiphallus longitudinally lamellate distally (Figure 54). ***H. cavator***, new species

Fused surstyli concave, cleft, or notched anteriorly; copulobus without such long setae; distiphallus variable..........40

40. Fused surstyli shallowly concave anteriorly and about 1.4 times as long as broad; copulobus verrucate on middle portion and acutangular posterolaterally (Figure 39). ***H. advenae*** Cresson

Fused surstyli broader than long if shallowly concave anteriorly; copulobus not verrucate on middle portion, tip variable..........41

41. Distiphallus longitudinally lamellate from apex to anterior margin of fused surstyli............42
Distiphallus not longitudinally lamellate, or if so then only distally...................................44
42. Fused surstyli broadly and shallowly concave anteriorly and broader than long; median length of sternum 5 about 1.3 times greater than copulobus breadth; distiphallus about 2.5 times longer than copulobus breadth (Figure 20)........................***H. procteri*** Cresson
Fused surstyli U- or V-cleft anteriorly and longer than broad; median length of sternum 5 about 0.9 of copulobus breadth; distiphallus length about 5.0 times greater than copulobus breadth...43
43. Postgonite uncus about 2.0 times as long as thick; sternum 5 nearly right-angled anterolaterally; cercus about 1.4 times as long as broad; fused surstyli broadly U-cleft or concave anteriorly (Figure 33)...***H. crassipes*** Cresson
Postgonite about 3.0 times as long as thick; sternum 5 broadly rounded anterolaterally; cercus about as long as broad; fused surstyli V-cleft anteriorly (Figure 56). ***H. saltator,*** new species
44. Fused surstyli about 1.2 times as long as broad and V- or somewhat U-cleft anteriorly........45
Fused surstyli about 1.2 times as broad as long and shallowly indented or notched anteromedially...46
45. Sternum 5 acutangular and prominent anterolaterally; distiphallus acute apically, carinate distally, but not longitudinally lamellate; cercus broader than long (Figure 35). ***H. serena*** Cresson
Sternum 5 smoothly rounded anterolaterally; distiphallus rounded apically and longitudinally lamellate on distal half; cercus longer than broad (Figure 38)............***H. platygastra*** group
46. Sternum 5 acutangular and prominent anterolaterally; copulobus and fused surstyli separated by about 1.0 times copulobus breadth; postgonite uncus about 5.0 times (or more) longer than thick (Figure 57)..***H. proclinata*** Cresson
Sternum 5 obtusangular anterolaterally; copulobus and fused surstyli separated by about 3.0 times copulobus breadth; postgonite uncus about 2.0 times longer than thick (Figure 51)..***H. melanderi,*** new species
47. Posterior end of copulobus with fascicula of long macrochaetae..48
Posterior end of copulobus without such fascicula..51
48. Copulobus noticeably concave posteromedially just anterior to fascicula; sternum 5 with small acutangular prominence anterolaterally; fused surstyli shallowly concave anteromedially (Figure 50)..***H. bilobifera*** Cresson
Copulobus not concave posteromedially; sternum 5 without small acutangular prominence anterolaterally; fused surstyli concave or not...49
49. Sternum 5 with anterolateral right-angled projection from above; fused surstyli truncate anteriorly; postgonite uncus about 3.0 times as long as thick (Figure 23). ***H. ascita*** Cresson
Sternum 5 without such projection; fused surstyli shallowly or moderately concave anteriorly; postgonite uncus about 5.0 times (or more) as long as thick........................50
50. Copulobus with posteromedial digitiform lobe projecting posteriad beyond postgonite uncus and without medial verruca; postgonite uncus bent (Figure 24). ***H. gladiator,*** new species
Copulobus without such lobe, but with slight medial verruca; postgonite uncus nearly straight (Figure 30)..***H. discursa,*** new species
51. Posterior margin of fused surstyli truncate; copulobus without noticeable convexity posteromedially just anterior to postgonite uncus; basiphallus not covered laterally by fused surstyli (Figure 15)..***H. harti*** Cresson
Posterior margin of fused surstyli sinuous; copulobus with noticeable convexity posteromedially just anterior to postgonite uncus; basiphallus covered laterally by fused surstyli (Figure 37)...***H. trichaeta*** Cresson

Key to Third-Instar Larvae of some *Hydrellia*

1. Ventral frontoclypeal index 2.0 or less..2
Ventral frontoclypeal index over 2.0...3
2. Bifurcation index 2.5–2.7; cheliform spot touching clypeal arch margin in lateral view; clypeal arch distinctly angular (Figure 101).................................***H. biloxiae,*** new species

Bifurcation index 4.8–5.4; cheliform spot not touching clypeal arch margin; clypeal arch gradually sloping (Figure 89) .... ***H. bergi*** Cresson

3. Ventral frontoclypeal index under 4.0 4
   Ventral frontoclypeal index 4.0 or more 14
4. Bifurcation index 4.0 or less 5
   Bifurcation index over 4.0 10
5. Ventral frontoclypeal index 3.0 or more 6
   Ventral frontoclypeal index under 3.0 9
6. Bifurcation index 3.4 or more; part of dorsal phragmatal ramus dark 7
   Bifurcation index 3.0 or less; dorsal phragmatal ramus hyaline (Figure 90). ***H. ainsworthi,*** new species
7. Mouth-hook, in lateral view, with distinct, thick base and thin beak; mouth-hook light spot ovoid, less than 2.0 times as long as wide; cheliform spot arms connected 8
   Mouth-hook, in lateral view, without distinct base and beak; mouth-hook light spot narrow, triangular, and 3.0 times as long as wide; cheliform spot arms separate (Figure 103). ***H. spinicornis*** Cresson
8. Dorsal phragmatal ramus all dark .... ***H. griseola*** (Fallén)
   Dorsal phragmatal ramus partly hyaline (Figure 100) .... ***H. ischiaca*** Loew
9. Mouth-hook beak and base lengths subequal; mouth-hook light spot discal, encompassed (Figure 97) .... ***H. discursa,*** new species
   Mouth-hook beak only 0.7–0.8 as long as base; mouth-hook light spot touching top margin of base (Figure 88) .... ***H. trichaeta*** Cresson
10. Bifurcation index 5.5 or less; cheliform spot arms not removed from clypeal arch margin by their length; clypeal arch not concave in lateral view 11
    Bifurcation index 5.8 or more; cheliform spot arms removed from clypeal arch margin by their length; clypeal arch slightly concave between 2 prominences in lateral view (Figure 102) .... ***H. itascae,*** new species
11. Feeding apparatus partly hyaline 12
    Feeding apparatus entirely dark .... ***H. morrisoni*** Cresson
12. Cheliform spot nearly parallel with dorsal phragmatal ramus; bifurcation index usually under 4.5; ventral frontoclypeal index usually 3.0 or less 13
    Cheliform spot distinctly oblique to dorsal phragmatal ramus (Figure 95); bifurcation index usually over 4.5; ventral frontoclypeal index 3.0 or more ... ***H. notiphiloides*** Cresson
13. Ventral frontoclypeal index 2.7 or less; mouth-hook beak distinctly longer than base; ventral phragmatal ramus moderately dark (Figure 86) .... ***H. ascita*** Cresson
    Ventral frontoclypeal index 2.8 or more; mouth-hook beak and base lengths subequal; ventral phragmatal ramus mostly hyaline (Figure 91) .... ***H. bilobifera*** Cresson
14. Ventral frontoclypeal index over 4.5; bifurcation index 3.5 or more; mouth-hook light spot small, elliptical; dorsal phragmatal ramus variable 15
    Ventral frontoclypeal index 4.5 or less; bifurcation index 2.7 or less; mouth-hook light spot large, ovoid; dorsal phragmatal ramus mostly hyaline (Figure 96). ***H. cruralis*** Coquillett
15. Mouth-hook with light spot; clypeal-arch index 1.8 or more; mouth-hook base about twice as thick as beak in lateral view 16
    Mouth-hook without light spot; clypeal-arch index 1.7 or less; mouth-hook base about 1.5 times as thick as beak in lateral view .... ***H. caliginosa*** Cresson
16. Feeding apparatus hyaline except dark mouth-hook and cheliform spot (Figure 106); mouth-hook beak distinctly longer than base .... ***H. pulla*** Cresson
    Feeding apparatus mostly dark except partly hyaline ventral phragmatal ramus (Figure 92); mouth-hook beak only 0.9 as long as base .... ***H. luctuosa*** Cresson

Key to Puparia of some *Hydrellia*

1. Prothoracic end describing over half of a circle in ventral view; maximum breadth of prothorax at midlength 2
   Prothoracic end variable in shape, if describing more than half of a circle, then maximum breadth of prothorax at or near its posterior margin 4

2. Head-lobe scar much longer than wide, nearly as long as prothorax....................................3
Head-lobe scar nearly circular, its diameter about half of prothorax length (Figure 112). ***H. ascita*** Cresson
3. Length:minimum breadth about 20.0; maximum breadth:minimum breadth about 4.2; anal-plate index about 2.6 (Figure 115)...***H. trichaeta*** Cresson
Length:minimum breadth 12.0–15.0; maximum breadth:minimum breadth 2.4–3.2; anal-plate 1.8–2.4 (Figure 109)...***H. bilobifera*** Cresson
4. Intersegmental constrictions inconspicuous; prothorax variable posterolaterally; bifurcate supraspiracular spinules present or absent...5
Intersegmental constrictions extensive, making puparium distinctly scalloped laterally; prothorax constricted posterolaterally; distinct bifurcate supraspiracular spinules present (Figure 108)...***H. cruralis*** Coquillett
5. Maximum puparial breadth in abdomen..6
Maximum puparial breadth in metathorax 15
6. Maximum puparial breadth 5.0 times or less than maximum breadth of head-lobe scar......7
Maximum puparial breadth 5.5 times or more than maximum breadth of head-lobe scar...13
7. Maximum breadth:minimum breadth 6.2 or less; length:minimum breadth 24.0 or less; anal-plate variable...8
Maximum breadth:minimum breadth 7.0 or more; length:minimum breadth usually 24.0 or more; anal-plate index 2.8–3.2 (Figure 123)...........................***H. bergi*** Cresson
8. Maximum breadth of head-lobe scar subequal to minimum puparial breadth; length: minimum breadth 10.0 or more; maximum breadth:minimum breadth variable............9
Maximum breadth of head-lobe scar distinctly less than minimum puparial breadth; length: minimum breadth 10.0 or less; maximum breadth:minimum 2.6–3.6 (Figure 107). ***H. luctuosa*** Cresson
9. Distinctly bifurcate supra- and subspiracular spinules absent...10
Distinctly bifurcate supra- and subspiracular spinules present......***H. ainsworthi***, new species
10. Length:minimum breadth about 20.0 or less; spiracular peritremes terminal....................11
Length:minimum breadth about 24.0; spiracular peritremes subterminal (Figure 121). ***H. morrisoni*** Cresson
11. Anal-plate index 2.6 or more; anal plate ovoid or elliptical, definitely not nearly rectangular...12
Anal-plate index 2.2 or less; anal plate subrectangular (Figure 118)......***H. tibialis*** Cresson
12. Length:minimum breadth 18.0 or more; anal plate reniform, anterior margin convex; maximum puparial breadth 1.7 times or less than maximum prothoracic breadth (Figure 117)...***H. spinicornis*** Cresson
Length:minimum breadth 18.0 or less; anal plate subelliptical, anterior margin straight or slightly concave; maximum puparial breadth 1.8 times or more than maximum prothoracic breadth (Figure 122) ....***H. griseola*** (Fallén) and ***H. ischiaca*** Loew
13. Maximum puparial breadth 6.0 times or less than maximum breadth of head-lobe scar; maximum puparial breadth 2.3 times or less than maximum prothoracic breadth..........14
Maximum puparial breadth 7.5 times or more than maximum breadth of head-lobe scar; maximum puparial breadth 2.5 times maximum prothoracic breadth (Figure 116). ***H. notiphiloides*** Cresson
14. Anal-plate index 3.8 or more; maximum breadth:minimum breadth 5.5 or less; length:minimum breadth 15.0 or less (Figure 110) ....***H. itascae***, new species
Anal-plate index 3.0 or less; maximum breadth:minimum breadth 6.0 or more; length:minimum breadth 18.0 or more (Figure 111)....................***H. caliginosa*** Cresson
15. Prothorax constricted posterolaterally; anal-plate index 3.0 or less..................................16
Prothorax not constricted posterolaterally (Figure 113); anal-plate index 3.5 or more. ***H. discursa***, new species
16. Prothorax convex or somewhat triangular anteriorly, angular laterally; length:minimum breadth 16.0 or less; abdomen nearly uniform in breadth posteriad to segment 7 (Figure 114)...***H. pulla*** Cresson
Prothorax semicircular anteriorly, rounded laterally; length:minimum breadth 16.0 or more; abdomen tapering posteriad from segment 4 (Figure 119). ***H. biloxiae***, new species

Hydrellia advenae Cresson

FIGURE 39

Hydrellia advenae Cresson, 1934, p. 236; 1936, p. 257; 1944, pp. 165, 174.—Procter, 1938, p. 351.—Wirth, 1965, p. 743 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 5–8 aristal rays; vertex index 3.6–4.5; ocular index 6.0–9.3; thoracic pleuron indistinctly splotched light gray and moderate olive-brown; fore and mid coxae moderate yellow anteriorly. Male length 1.29–1.58 mm; female 1.62–1.99 mm. Male terminalia as in Figure 39.

HEAD.—Face yellowish gray; 4–5 pfa; epistomal index 1.2–1.7; mesofacial index 1.8–2.2; vertex index 3.6–4.5; A-index 1.6–1.9; ocular index 6.0–9.3. Palpus moderate yellow; 5–8 aristal rays; antenna dark brown; frontal vitta dark gray; parafrontale strong yellowish brown; 10–14 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 3–4 adc and 2 pdc; pleuron indistinctly splotched light gray and moderate olive-brown; fore and mid coxae moderate yellow anteriorly, light gray laterally; rest of legs light-gray pruinose except moderate-yellow tarsi and mid and hind tibial apices. Wing length 1.63–1.90 mm; veins light yellowish brown or moderate brown; 5–7 setae on basal end of costa; 5–7 dorsal and 6–8 anterior interfractural costals; costal-section ratios: II:I 2.0–2.3; III:IV 2.6–3.3; V:IV 2.9–3.5; M_{1+2} index 1.5–1.8.

ABDOMEN.—Terga moderate brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 smoothly rounded; posterolateral angle of copulobus about 35° from lateral corner; copulobus irregularly setose and slightly verrucate at midlength laterally. Postgonite bent anteriad and postgonite uncus slightly laterad; distiphallus constricted near basiphallus, apex acute. Anterior margin of fused surstyli concave and narrow (only about half the midbreadth of structure); B-index about 5.2; C-index 1.7–2.0.

TYPE.—Holotype male, ANSP 6513.

TYPE-LOCALITY.—Bar Harbor, Mount Desert Island, Maine (VII-15-1933, W. Procter).

SPECIMENS EXAMINED.—9 (4♂♂, 5♀♀) from 2 localities:

Maine: Bar Harbor, Mount Desert Island (VII-15-1933, W. Procter), 2♂♂, 1♀; Mount Desert Island (VII-12 and 25, 1935, W. Procter), 1♂, 4♀♀.

Hydrellia agitator, new species

FIGURE 58

DIAGNOSIS.—Palpus dark brown; 8–9 aristal rays; ocular index 6.0–7.0; M_{1+2} index 1.6–1.8; mesonotum strong yellowish brown; thoracic pleuron light gray except upper half of mesanepisternum semiglossy moderate olive-brown; abdominal dorsum glossy dark grayish green in posterior view. Male length 1.70–1.79 mm; female 1.79–2.21 mm. Male terminalia as in Figure 58.

HEAD.—Face yellowish gray or light gray; 3–5 pfa; epistomal index 1.3–1.5; mesofacial index 1.8–2.0; vertex index 6.3–8.7; A-index 1.8–2.4; ocular index 6.0–7.0. Palpus dark brown; 8–9 aristal rays; antenna dark brown; frons usually uniformly light brown; 14–16 postoculars.

THORAX.—Ppn and mesonotum moderate olive-brown; 3–4 adc and 2 pdc; pleuron light gray except upper half of mesanepisternum semiglossy moderate olive-brown; legs sparsely moderate olive-brown pruinose except light-gray or yellowish-gray coxae and trochanters. Wing length 1.87–2.30 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 6–8 dorsal and 7–8 anterior interfractural costals; costal-section ratios: II:I 2.3–3.4; III:IV 2.8–3.2; V:IV 3.2–3.5; M_{1+2} index 1.6–1.8.

ABDOMEN.—Terga semiglossy and with moderate olive-brown pruinosity over dark brown (glossy dark grayish green in posterior view). Male terminalia: median third of posterior margin of sternum 5 deeply concave and congruent with distiphallus; anterolateral margin of sternum 5 rounded; copulobus regularly setose, acutangular posterolaterally and with acuminate, peninsulate, posteromedial projection. Postgonite bent anteromediad; postgonite uncus short, bent laterad; distal half of distiphallus narrow, spatulate, and ventrally lamellate (distinctly delimited from basiphallus and protruding far beyond fused surstyli). Anterior margin of fused surstyli deeply and broadly concave; B-index about 1.2; C-index 2.0–2.2.

TYPE.—Holotype male, USNM 70525.

TYPE-LOCALITY.—Port Saint Joe Beach, Gulf County, Florida (III-17-1954, G. Steyskal).

PARATYPES.—3♀♀ from 3 localities:

Florida: Green Cove Springs (III-24-1952, J. Vockeroth), 1♀ (ISC).

Georgia: Billy's Island (VI-1912, collector unknown), 1♀ (ANSP).

Mississippi: Lake Shady, Lamar County (VII–11–1962, D. L. Deonier), 1 ♀ (ISC).

REMARKS.—*Adult.* Habitat recorded: on mats of *Hydrochloa caroliniensis.*

Hydrellia ainsworthi, new species

FIGURES 32, 83, 90, 99, 120

DIAGNOSIS.—Palpus moderate yellow; 6–8 aristal rays; vertex index 5.2–6.8; body length:wing length 1.0; 3 fronto-orbitals, all anteriorly inclined; antecosta of male tergum 3 strongly curved posteriad in lateral view. Male length 1.33–1.53 mm; female 1.45–1.79 mm. Male terminalia as in Figure 32.

HEAD.—Face light yellowish brown; 4–5 pfa; 3–7 sfa; epistomal index 1.6–1.8; mesofacial index 2.5–3.5; vertex index 5.2–6.8; A-index 1.5–2.0; ocular index 7.0–7.5. Palpus moderate yellow; 6–8 aristal rays; antenna and most of frons moderate brown; fronto-orbital area strong yellowish brown; 3 fronto-orbitals, all anteriorly inclined; 11–15 postoculars.

THORAX.—Ppn and mesonotum dark gray except light-gray postalar wall; 2–4 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except dark-brown tarsi. Wing length 1.36–1.82 mm; veins dark brown; 5–7 setae on basal end of costa; 5–7 dorsal and 6–9 anterior interfractural costals; costal-section ratios: II:I 2.0–2.5; III:IV 2.6–3.0; V:IV 3.0–3.5; M_{1+2} index 1.2–1.8.

ABDOMEN.—Terga semiglossy and bronzed medially, light gray laterally and ventrally; antecosta of male tergum 3 strongly curved posteriad in lateral view; ventral lobes of male terga 1–4 overlapped to form hillock. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 rounded (115°–120° angular); copulobus slightly convex posteriorly, notched at midlength on medial side, and regularly setose. Postgonite bent slightly mediad and postgonite uncus slightly laterad from general anterior direction; distiphallus slightly constricted at midlength, ventrally carinate, and mucronate apically. Anterior margin of fused surstyli truncate; B-index about 6.0; C-index 1.0–1.2.

SECOND-INSTAR LARVA.—Length 1.75–2.50 mm; maximum breadth 0.35–0.50 mm. Frontoclypeal length 0.29 mm (Figure 90). Thorax with several rows of dorsal spinules. Other characters similar to those in third-instar larva.

THIRD-INSTAR LARVA.—Length 2.50–3.50 mm; maximum breadth 0.50–0.65 mm. Frontoclypeal length 0.40–0.45 mm; dorsal phragmatal ramus hyaline (Figure 99). Ventral frontoclypeal index 3.4–3.6; phragmatal index 0.9–1.0; bifurcation index 2.8–3.0; clypeal-arch index 1.4–1.6. Clypeal arch sloping at 25°–30° and slightly concave. Mouth-hook beak and base lengths subequal; maximum mouth-hook base thickness about 1.2 times that of beak. First two thoracic segments moderately spinulose; prothorax faintly rugulose ventrally; abdominal segment 8 with only about 5 annuli of spinules, many black and distinctly bifurcate; other dorsal spinules mostly intersegmental. Body translucent, yellowish gray.

PUPARIUM.—Length 2.25–3.25 mm; maximum breadth 0.65–0.75 mm; subcylindrical (Figure 120). Puparial length:minimum breadth 14.0–15.5; maximum breadth:minimum breadth 4.0–4.5; anal-plate index 2.3–2.6. Prothoracic end semicircular in ventral view; head-lobe scar subcircular or ovoid; maximum puparial breadth in abdomen and 5.0 times or less than maximum breadth of head-lobe scar; breadth of head-lobe scar and minimum puparial breadth subequal; anal plate subovoid, with anterior margin straight or slightly convex. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, USNM 70526.

TYPE-LOCALITY.—Lake Shady, 7 miles west of Hattiesburg, Lamar County, Mississippi (VII–11–1962, D. L. Deonier).

PARATYPES.—433 (261 ♂ ♂, 172 ♀ ♀) from 9 localities:

Florida: Inglis (VII–7–1948, E. Todd), 1 ♂ (UKC); Lake Worth's Bay Shore (VIII–8–1951, W. Wirth), 1 ♀ (USNM); Lacoochee (VIII–18–1930, P. Oman), 1 ♀ (UKC); Orange Park (III–25–1952, J. Vockeroth), 1 ♀ (CNC); Punta Gorda (IV–11–1952, J. Vockeroth), 1 ♀ (CNC); Silver Springs, near Ocala, Marion County (IV–5–1953, W. Mason), 1 ♀ (CNC).

Mississippi: Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar County (VII–11–1962, D. L. Deonier), 48 ♂ ♂, 45 ♀ ♀, (VII–24–1962, D. L. Deonier), 16 ♂ ♂, 20 ♀ ♀ (USNM and ISC); Lake Shady, Lamar County (VI–29–1962, D. L. Deonier), 41 ♂ ♂, 19 ♀ ♀, (VI–29–1962, J. H. Ainsworth), 4 ♂ ♂, 3 ♀ ♀, (VII–11–1962, D. L. Deonier), 151 ♂ ♂, 78 ♀ ♀ (USNM, ISC, and DLD); Vancleave Road, Jackson County (VI–15–1962, D. L. Deonier), 1 ♂, 1 ♀ (USNM and DLD).

IMMATURE SPECIMENS EXAMINED.—23 from 2 localities:

Mississippi: Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar County (collected and reared by D. L. Deonier); Lake Shady, Lamar County (collected and reared by D. L. Deonier).

REMARKS.—This species is similar in some respects to *H. notata*, but it differs from it and other species by the orientation of the male ventral tergal lobes.

Adult. In June and July, I collected adults from leaves of *Hydrochloa caroliniensis* and *Nelumbo lutea* and one specimen with several *H. biloxiae* in a Grigarick floating trap in Jackson County, Mississippi.

Larva and puparium. Larvae mined in the stems, leaf sheaths, and leaf blades of the host plants. Three larvae pupariated in leaf sheaths in the laboratory. One adult emerged six days later. I found no escape slits in any of the many mines containing puparia.

Host plants. Of several species examined, I found water grass, *Hydrochloa caroliniensis,* to be the sole host plant. My survey included water grass and its associates, *Polygonum hyperpiperoides, Xyris caroliniana, Hypericum punctatum, Potamogeton diversifolius,* and *Juncus repens.* The mats of water grass seemed to have a low percent of infestation. I found no infestation in several samples collected in September, during a drought.

Hydrellia americana Cresson

FIGURE 27

Hydrellia americana Cresson, 1931, p. 106; 1944b, pp. 164, 172.—Wirth, 1965, p. 743 [catalog listing].

DIAGNOSIS.—Palpus black; 5–6 aristal rays; face white; body length:wing length 0.8–1.0; frons (except light-brown ocellar triangle and fronto-orbital sockets) velvety black; thoracic pleuron dark brown except light-brown mesanepisternum and mesepimeron. Male length 1.29–1.68 mm; female 1.45–1.80 mm. Male terminalia as in Figure 27.

HEAD.—Face white; 4–5 pfa; no sfa; epistomal index 1.0–1.3; mesofacial index 1.5–1.8; vertex index 4.4–5.6; A-index 1.5–2.7; ocular index 5.5–6.5. Palpus black; 5–6 aristal rays; antenna very dark brown (segment 2 velvety); frons (except light-brown ocellar triangle and fronto-orbital sockets) velvety black; postocular area dark brown except lower one-fourth moderate olive-brown; 12–14 postoculars.

THORAX.—Ppn and mesonotum dark gray; 3–4 adc and 2 pdc; pleuron dark brown except light-brown mesanepisternum and mesepimeron; legs dark brown except yellowish-gray coxae; male mid tibia expanded. Wing length 1.53–1.80 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 6–8 dorsal and 6–10 anterior interfractural costals; costal-section ratios: II:I 2.0–2.5; III:IV 3.0–3.7; V:IV 3.0–3.7; M_{1+2} index 1.5–2.0.

ABDOMEN.—Terga semiglossy dark gray. Male terminalia: median third of posterior margin of sternum 5 broadly notched; anterolateral corner of sternum 5 right-angled; copulobus broader than long and irregularly setose except 4–5 macrochaetae seriated on posterior margin. Postgonite inapparent; distiphallus uniformly tapering to about two-thirds of length, the remaining distal third of uniform breadth to blunt apex. Anterior margin of fused surstyli broadly notched; B-index about 0.8.

TYPE.—Holotype female, USNM 43454.

TYPE-LOCALITY.—Chesapeake Beach, Maryland (VIII–2–no year, J. M. Aldrich).

SPECIMENS EXAMINED.—13 (3♂♂, 10♀♀) from 11 localities:

Maine: Machias (VII–17 and 19–no year, C. Johnson), 2♀♀.

Maryland: Chesapeake Beach (VIII–18–1922, J. Malloch), 1♂, (VII–3–1924, J. Malloch), 1♀; Kent Narrows (VII–1954, M. Wheeler), 1♀.

Massachusetts: Woods Hole (VII–21–1954, M. Wheeler), 1♀.

Michigan: Baraga County (III–27–1952, R. Dreisbach), 1♀.

Mississippi: Bay St. Louis (VI–17–1917, collector unknown), 1♀; Bellefontaine Point, Jackson County (VII–10–1962, D. L. Deonier), 1♀; Dickinson's Pond, Lamar County (VII–24–1962, D. L. Deonier), 1♀; Gulf Coast Research Laboratory, Ocean Springs (VI–5–1962, D. L. Deonier), 1♂; Vancleave Road, Jackson County, 30°25.1′ N, 88°46′ W (VI–23–1962, D. L. Deonier), 1♂.

New York: Cold Spring Harbor, Long Island (VII–date and collector unknown), 1♀; Wilmington Notch, Adirondacks (VII–3–no year, J. Aldrich), 1♀.

REMARKS.—This species is very similar to *H. tibialis,* but its male terminalia are distinctive. This species also reportedly occurs in California.

Adult. Habitat recorded: leaves of *Sporobolus indica* on sea beach.

Hydrellia amnicola, new species

FIGURE 47

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; body length:wing length 0.9–1.0; antenna velvety dark brown; thoracic pleuron light gray except upper one-sixth of mesanepimeron light brown; M_{1+2} index 1.3–1.5. Male length 1.87–2.04 mm; female 2.04–2.38 mm. Male terminalia as in Figure 47.

HEAD.—Face light gray or yellowish gray; 4–5 pfa; epistomal index 1.1–1.5; mesofacial index 1.5–1.8; vertex index 5.5–7.0; A-index 1.6–2.0; ocular index 5.5–6.2. Palpus dark brown; 6–8 aristal rays; antenna and most of parafrontale velvety dark brown; frontal vitta semiglossy dark brown; fronto-orbital area moderate olive brown; 13–17 postoculars.

THORAX.—Ppn and mesonotum dark brown; 3–4 adc and 2 pdc; pleuron light gray except upper one-sixth of mesanepimeron light brown; legs dark brown with light-gray pruinosity sparse except on coxae and trochanters. Wing length 2.13–2.38 mm; veins dark brown; 7–8 setae on basal end of costa; 6–10 dorsal and 8–11 anterior interfractural costals; costal-section ratios II:I 2.0–2.3; III:IV 2.5–3.0; V:IV 2.7–3.3; M_{1+2} index 1.3–1.5.

ABDOMEN.—Terga dark brown dorsally, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 slightly concave; anterolateral margin of sternum 5 smoothly rounded; copulobus inapparent (actually widely curving and acuminate). Postgonite covered by surstyli and nearly straight except preapical part bent sharply laterad; postgonite uncus straight and directed laterad; distiphallus acuminate; basiphallus completely covered by surstyli. Anterior margin of fused surstyli cleft medially to about midlength of structure; B-index about 2.2; C-index 1.8–2.2.

TYPE.—Holotype male, USNM 70527.

TYPE-LOCALITY.—Sucker Creek, 100 yards north of Highway 31, Clearwater County, Minnesota (VII-23-1963, D. L. Deonier).

PARATYPES.—28 (8♂♂, 20♀♀), with same collection data as for holotype (USNM, ISC, and DLD).

REMARKS.—There are some similarities between the male terminalia of this species and those of the *H. prudens* species group, but the habitus is very dissimilar.

Adult. Habitat recorded: leaves of *Glyceria grandis.* At the type-locality, I observed three pairs attempting to copulate. Also, I saw one female try to mount another female, and a male advance aggressively upon a female *H. griseola.* I tried unsuccessfully to force two captive females to oviposit. Both of them died after three days of captivity.

Hydrellia ascita Cresson

FIGURES 23, 67, 86, 112

Hydrellia ascita Cresson, 1942, p. 78; 1944b [in part], pp. 170, 175.—Berg, 1949 [in part], p. 284; 1950 [in part], pp. 375, 376, 378, 384, 385 (pl. 2, fig. 2), 388, 389 (pl. 3, fig. 2), 391–392, 393, 396 [biology, morphology, and taxonomy of immatures].—Deonier, 1964, pp. 115, 125, fig. 4; 1965, p. 500 [ecology].—Wirth, 1965, p. 743 [catalog listing].

Diagnosis.—Palpus moderate yellow; 5–8 aristal rays; face planate; vertex index 5.4–6.8; ocular index 6.2–8.0; male abdomen truncate posteriorly; female cercus triangular with truncate base; antennal segment 3 at least partly moderate yellow; apicodorsal antennal prominent. Male length 1.79–2.10 mm; female 1.60–2.28 mm. Male terminalia as in Figure 23; female as in Figure 67.

HEAD.—Differing mainly from *H. bilobifera* in the following: epistomal index 1.4–1.8; mesofacial index 1.8–2.4; ocular index 6.2–8.0.

THORAX.—Differing mainly from *H. bilobifera* in the following: 3–4 adc and 2 pdc; wing length 1.87–2.04 mm.

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply, rectangularly recessed; anterolateral margin of sternum 5 with dorsal process projecting laterad (forming 90°–100° angle with copulobus); posterior margin of copulobus only slightly convex (partly or wholly obscured by loose fascicula of 5–7 strong macrochaetae); medial margin of copulobus distinctly concave on posterior third and with seriated setae on medial third, verrucate laterally with bare space just posteriad from verruca. Postgonite bent mediad; acuminate postgonite uncus curved anteriad; distiphallus constricted proximally and preapically, with notched ventrally lamellate apex, and bicarinate ventrally on basal two-thirds; most of basiphallus exposed ventrally. Anterior margin of fused surstyli truncate (much narrower than posteriorly); B-index about 1.8; C-index 0.8–1.0. Syntergum 9+10 truncate posteriorly. Female terminalia: tergum 8 shorter than sternum 8; cercus irregularly setose dorsally and laterally, triangular with truncate base, and less than 1.5 times as long as wide (lateral view). Segment 7 with group of about 6 seriated setae laterally on posterior margin; median spermatheca similar to that of *H. discursa* (Figure 70).

FIRST-INSTAR LARVA.—Length 0.80–1.20 mm; maximum breadth 0.16–0.18 mm. Frontoclypeal length 0.16–0.18 mm; frontoclypeus moderate brown except black cheliform spot. As with most of the other species investigated, the creeping welts of the first instar are larger and more distinct than in later instars. This description in part after Berg (1950).

SECOND-INSTAR LARVA.—Length 1.20–2.40 mm; maximum breadth 0.20–0.50 mm. Frontoclypeal length 0.23–0.29 mm. Other characters similar to those in the first-instar larva.

THIRD-INSTAR LARVA.—Length 2.40–5.00 mm; maximum breadth 0.60–0.80 mm. Frontoclypeal length 0.35–0.49 mm; ventral phragmatal ramus moderately dark (Figure 86). Ventral frontoclypeal index 2.5–2.7; phragmatal index 1.0–1.2; bifurcation index 4.2–4.4; clypeal-arch index 1.5–1.8. Clypeal arch sloping at 10°–15°, with slight indentation at level of cheliform spot. Mouth-hook beak distinctly longer than base; maximum mouth-hook base thickness about 2.0 times that of beak. Prothorax and mesothorax sparsely spinulose; abdominal segment 8 without ventral, transverse row of setulae, but with 3–4 annuli of spinules. Body translucent, with greenish-yellow tinge.

PUPARIUM.—Length 2.80–4.25 mm; maximum breadth 0.80–1.15 mm; subcylindrical (Figure 112). Puparial length: minimum breadth 14.0–21.0; maximum breadth: minimum breadth 3.5–4.0; anal-plate index 1.8–2.2. Prothoracic end describing more than half of a circle in ventral view; head-lobe scar subcircular, with maximum breadth about half of prothorax length; anal plate subovoid, with distinctly convex anterior margin. Empty puparium translucent, light yellowish brown. Early pupa with greenish-yellow tinge.

TYPE.—Holotype male, ANSP 6621.

TYPE-LOCALITY.—Nigger Creek, Cheboygan County, Michigan (VIII–21–1941, C. O. Berg; reared from *Potamogeton tenuifolius*).

ADULT SPECIMENS EXAMINED.—32 (11 ♂♂, 21 ♀♀) from 12 localities:

Illinois: Havana (IX–17–1895, C. Hart), 1 ♀.
Iowa: Ledges State Park, Boone County, 41°59.5′ N, 93°53.5′ W (IX–12–1959, J. Laffoon, 1 ♀, (VII–28–1954, J. Laffoon), 1 ♀; Springbrook State Park, Guthrie County (VI–23–1961, D. L. Deonier), 2 ♀♀.
Kansas: Leavenworth County Lake (VIII–27–1962, D. L. Deonier), 3 ♀♀.
Michigan: Cheboygan County (VI–12–1940, C. Berg), 1 ♂, (VI–26–1946, C. Berg), 1 ♂, 2 ♀♀, (VII–5–1946, C. Berg), 1 ♀, (VIII–7–1947, C. Berg), 1 ♂; Bessey Creek, Cheboygan County (VIII–14–1941, C. Berg), 1 ♀; Douglas Lake, Cheboygan County (VII–3–1941, C. Berg), 1 ♀; Nichol's Bog, Cheboygan County (VII–5–1940, C. Berg), 1 ♂, (VII–5–1941, C. Berg), 1 ♀; Nigger Creek, Cheboygan County (VI–20–1940, C. Berg), 2 ♂♂, (VI–21–1941, C. Berg), 6 ♀♀.
Minnesota: Chisago County (no date, O. Oestlund), 1 ♀.
Ontario: Midland (VIII–18–1955, J. Chillcott), 3 ♂♂, 1 ♀.
Tennessee: Samburg, Reelfoot Lake (VIII–11–1962, D. L. Deonier), 2 ♂♂.

IMMATURE SPECIMENS EXAMINED.—20 from 2 localities:

Michigan: Nigger Creek, Cheboygan County (collected and reared by C. Berg); Sodon Lake, Oakland County (collected and reared by C. Berg).

REMARKS.—As with many other species, especially those of the *H. bilobifera* group, there is some possibility of misdetermination, since I was not allowed to prepare the holotype terminalia for study.

Adult. Habitats recorded: leaves of *Potamogeton nodosus, P. angustifolius, P. gramineus,* and *Nuphar advena.* I found too few adults of *H. ascita* to make any observations on their behavior. According to Berg (1950), *H. ascita* showed no emergence maxima in Cheboygan County and Oakland County, Michigan.

Larva and puparium. Berg found that the larvae preferred flaccid, submerged leaves, but that many mined in floating leaves and in linear submerged leaves of *P. foliosus.* He discovered that third-instar larvae commonly pupariate in the leaf axil and insert their spiracular peritremes in the main stem. Berg observed no puparia situated entirely in stems. Many times the leaves disintegrated, leaving the puparia projecting out from the nodes.

No stadial measurements have been made for this species.

Host plants. Berg reared this fly from *Potamogeton* *alpinus, P. amplifolius, P. ephihydrus, P. foliosus, P. illinoensis, P. oakesianus, P. richardsonii,* and *P. zosteriformis.*

Parasites. Berg reared two braconids—*Chorebidella bergi* and *Dacnusa* sp.—and the diapriid *Trichopria columbiana* from the puparia of *H. ascita.*

Hydrellia atroglauca Coquillett

Hydrellia atroglauca Coquillett, 1910a, p. 131.—Cresson, 1931, pp. 107, 108; 1944b, pp. 169, 172.—Wirth, 1956, p. 16; 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 9–11 aristal rays; face light gray; vertex index 5.8–6.4; ocular index 12.0 or less; antennal segment 3 partly or wholly moderate yellow; thoracic pleuron light gray; tibiae (one-third or more of length) moderate yellow; abdominal dorsum semiglossy moderate brown medially, and with distinct light blue-gray posterolateral wedges. Male length 2.13 mm; female 2.55–2.64 mm.

HEAD.—Face light gray; 6–8 pfa; 1–2 sfa; epistomal index 1.5–1.8; mesofacial index 2.2–2.7; vertex index 5.8–6.4; A-index 1.6–2.0; ocular index 7.0–12.0. Palpus moderate yellow; 9–11 aristal rays; frons uniformly strong yellowish brown; antenna moderate brown except segment 3 partly or wholly moderate yellow; 16–18 postoculars.

THORAX.—Ppn and mesonotum light brown; 3–4 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except moderate-yellow (one-third or more of length) tibiae and tarsi. Wing length 2.72–2.79 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 8–10 dorsal and 10–13 anterior interfractural costals; costal-section ratios: II:I 2.2–2.5; III:IV 2.7–3.1; V:IV 3.0–3.8; M_{1+2} index 1.4–1.6.

ABDOMEN.—Terga semiglossy moderate brown medially and with conspicuous light blue-gray posterolateral wedges (in some females entire posterior margin of tergum 5 light blue-gray).

TYPES.—Syntype male and two females (the male and one female, USNM 13101).

TYPE-LOCALITY.—Biscayne Bay Florida (no date, Mrs. A. T. Slosson).

SPECIMENS EXAMINED.—1 ♂, 1 ♀ syntype, and 1 ♀ from Royal Palm Park, Florida (I–29–1933, A. L. Melander).

REMARKS.—*Hydrellia idolator* is very similar to this species, but the former has a pale-yellow prementum, an ocular index of 13.0–17.5, and 6–8 dorsal and 6–10 anterior interfractural costals.

Hydrellia bergi Cresson

FIGURES 17, 74, 89, 123

Hydrellia bergi Cresson, 1941, p. 37; 1944b, pp. 170, 175.—Berg, 1950, pp. 375, 376, 378, 382, 383 (pl. 1, figs. 1–3) 384, 385 (pl. 2, fig. 3), 387–388, 389 (pl. 3, fig. 3), 390–391, 393, 396 [biology, morphology, and taxonomy of immatures].—Judd, 1964, p. 411 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 7–8 aristal rays; vertex index 5.8–6.4; apicodorsal antennal prominent; median facial crease distinct only in anteroventral view; thoracic pleuron mostly light gray. Male length 2.04–2.13 mm; female 2.04–2.21 mm. Male terminalia as in Figure 17.

HEAD.—Face silky light yellowish brown with median crease distinct only in anteroventral view; 4–5 pfa; epistomal index 1.3–1.7; mesofacial index 1.9–2.3; vertex index 5.8–6.4; A-index 1.5–1.8; ocular index 6.0–7.0. Palpus moderate yellow; 7–8 aristal rays; antenna and most of parafrontale very dark brown or black; fronto-orbital area and frontal vitta light brown; 13–17 postoculars.

THORAX.—Ppn semiglossy dark gray; mesonotum dark brown; 3–4 adc and 2 pdc; pleuron light gray except moderate olive-brown on posterior half of mesanepimeron; legs sparsely light-gray pruinose except dark-brown tarsi. Wing length 1.87–2.21 mm; veins usually dark brown; 6–8 setae on basal end of costa; 5–7 dorsal and 7–9 anterior interfractural costals; costal-section ratios: II:I 2.0–2.3; III:IV 3.0–3.4; V:IV 3.4–3.7; M_{1+2} index 1.2–1.6.

ABDOMEN.—Terga semiglossy dark gray. Male terminalia: median third of posterior margin of sternum 5 notched at obtuse angles; anterolateral margin of sternum 5 angular (90°–100°); copulobus acutangular and slightly incurved posteriorly, and regularly setose. Postgonite covered by copulobus and postgonite uncus bent 90° anteriad; distiphallus long, asymmetrical, with apex curved to right. Anterior margin of fused surstyli slightly convex; surstyli yellow and mostly exposed; B-index 3.2; C-index 0.2–0.4.

EGG.—Length 0.59–0.68 mm; maximum breadth 0.14–0.17 mm. Chorion (Figure 74) yellowish gray, corrugate, with light-brown (frequently dark) ridges flanked by regular, wavy, perpendicular striae. General color aspect variable within one population, with some being uniformly yellowish gray and others with ridges light brown or dark gray. Micropylar protuberance infundibulate, concealed in dorsal view by a hoodlike chorionic projection.

First-instar larva.—Length 0.80–1.50 mm; maximum breadth 0.16–0.22 mm. Feeding apparatus similar in shape and coloration to that of third-instar larva; frontoclypeal length 0.16–0.18 mm. General color aspects of body similar to those of *H. ischiaca*.

Second-instar larva.—Length 1.50–3.00 mm; maximum breadth 0.20–0.50 mm. Frontoclypeal length 0.25–0.27 mm. Other characters similar to those of first-instar larva.

Third-instar larva.—Length 2.00–5.20 mm; maximum breadth 0.25–0.75 mm. Frontoclypeal length 0.40–0.52 mm (Figure 89). Ventral frontoclypeal index 1.6–1.8; phragmatal index 0.9–1.0; bifurcation index 4.8–5.4; clypeal-arch index 1.6–1.8. Clypeal arch sloping slightly convexly at about 20°. Mouth-hook beak and base equal in length; maximum mouth-hook base thickness about 1.5 times that of beak. Body translucent, greenish yellow.

Puparium.—Length 3.50–4.50 mm; maximum breadth 0.80–1.15 mm; subcylindrical (Figure 123). Puparial length:minimum breadth 23.0–27.0; maximum breadth:minimum breadth 7.0–9.0; anal-plate index 2.8–3.2. Prothoracic end slightly convex in ventral view; head-lobe scar subcircular and 0.2 or less of maximum puparial breadth; prothorax distinctly rugulose in ventral view; abdominal segment 8 without ventral, transverse row of setulae and with spinules sparse, irregular; anal plate subovoid, with anterior margin straight or slightly convex. Empty puparium translucent, light brown.

Type.—Holotype male, USNM 7451.

Type-locality.—Nigger Creek, Cheboygan County, Michigan (VI–27–1940, C. O. Berg).

Adult specimens examined.—108 (46♂♂, 62♀♀) from 20 localities:

Michigan: Bessey Creek, Cheboygan County (VI–10–1940, C. Berg), 4♂♂, 2♀♀, (VIII–14–1941, C. Berg), 1♂, 2♀♀; Cheboygan County (VII–12–1946, C. Berg), 1♀, (VII–18–1946, C. Berg), 1♂, (VIII–18–1946, C. Berg), 1♀, (VII–21–1947, C. Berg), 1♀, (VIII–7–1947, C. Berg), 1♀; Douglas Lake, Cheboygan County (VII–5–1940, C. Berg), 1♂, (VI–16–1941, C. Berg), 1♂, (VII–9–1941, C. Berg), 2♂♂, 7♀♀; Gaylord (VII–17–1938, C. Sabrosky), 1♀; Ocqueoc Lake, Presque Isle County (VII–13–1941, C. Berg), 1♀, (VIII–1–1941, C. Berg), 2♂♂; Third Sister Lake, Washtenaw County (VI–28–1942, C. Berg), 1♀.

Minnesota: Eaglenest (IX–1–1958, W. Balduf), 1♀; Iron Corner Lake, Itasca State Park (VI–18–1963, D. L. Deonier), 1♀; Mississippi River at Sucker Creek, Clearwater County (VII–9–1963, D. L. Deonier), 1♂, 2♀♀; Mississippi River, 150 yards north of Highway 31, Clearwater County (VII–9–1963, D. L. Deonier), 1♂, 3♀♀; Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 5♂♂, 3♀♀; Rapid River Logging Camp, Hubbard County (VII–2–1963, D. L. Deonier), 1♀; 1.3 miles south of main entrance, Itasca State Park (VI–26–1963, D. L. Deonier) 9♂♂, 7♀♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 17♂♂, 19♀♀; Franklinton (VI–20–1923, M. Leonard), 2♀♀.

Ontario: London (IX–12–1958, W. Judd), 1♀; Marmora (IX–9–1952, J. McAlpine), 1♀; Ottawa (VII–2–1947, G. Shewell), 1♂.

Quebec: Lac Bernard (VIII–7–1938, G. Shewell), 1♀; Mt. Albert (VII–24–1954, J. Martin), 2♀♀.

Immature specimens examined.—32 from 6 localities:

Michigan: Douglas Lake (collected and reared by C. Berg); Cheboygan County (collected and reared by C. Berg); Presque Isle County (collected and reared by C. Berg); Washtenaw County (collected and reared by C. Berg).

Minnesota: Rapid River Logging Camp, Hubbard County (collected and reared by D. L. Deonier); 1.3 miles south of main entrance, Itasca State Park (collected and reared by D. L. Deonier).

Remarks.—The one external character of most utility for rapid determination is the median facial crease distinct only in anteroventral view.

Adult. Habitats recorded: leaves of *Potamogeton nodosus, P. natans, P. amplifolius,* and *Nuphar advena.*

No data is available on the adult stadium. On food habits, I observed a female rapidly probing a dead, fungus-covered chironomid. In other behavioral observations, one male became aware of a second male about 6 cm away and advanced upon it, then, when both were only a few millimeters apart, the second male jumped and grasped the thorax of the protagonist as if to mount. A male advanced actively upon two other specimens, and, in another observation, a smaller male scissored its wings after facing a larger male, and then the larger male flew across and rapidly grasped the thorax of the smaller one.

On another occasion, two females "faced off" and began to slowly approach each other. This agonistic behavior of *H. bergi* extended to its enemies. In several observations made at Squaw Lake, Itasca State Park, *H. bergi* rapidly approached and retreated from water spiders repeatedly.

In the only example of epigamic behavior observed, a male and female stood with faces touching for several seconds before the wind disturbed the meeting. I captured two females after they oviposited on sepals of *Potamogeton natans*. Berg (1950) found an egg mass on a stipule of this species.

Egg. The incubation period for 24 of 36 eggs laid by two females was four days.

Larva. All of the larvae that eclosed from the eggs died except one, which was a late third instar when it died 14 days later. According to Berg (1950), the larvae mine nearly exclusively in stems and petioles where they can be readily located only when the epidermis over the longitudinal mine collapses.

Puparium. The puparia often bulge partially through the epidermis of stems and petioles. Berg (1950, p. 390) stated that prior to pupariation "the larva provides for emergence of the adult by cutting a U-shaped incision in the epidermis of the stem." The incision is always made in the epidermis covering the future puparial operculum.

Host plants. Berg (1950) found larvae and puparia in *Potamogeton natans, P. richardsonii*, and *P. zosteriformis*. I reared an adult from a puparium in *Zizania aquatica*. This host plant grew near a stand of *P. richardsonii*. Judd (1964) recorded one specimen of *H. bergi* from an emergence trap floating near *P. amplifolius*.

Parasites. Berg reared three species of Braconidae—*Ademon niger, Chorebidea* sp., and *Dacnusa* sp.—and one of Diapriidae—*Trichopria columbiana*—from puparia of *H. bergi*.

Hydrellia bilobifera Cresson

FIGURES 2, 12, 14, 50, 72, 73, 75, 85, 91, 109

Hydrellia bilobifera Cresson, 1936, p. 262; 1942, p. 78; 1944b [at least in part], pp. 170–175.—Deonier, 1964, p. 115; 1965, p. 500 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 5–8 aristal rays; face planate; vertex index 5.4–6.8; male abdomen prominently bilobate posteriorly; female cercus about 3.0 times as long as wide; antennal segment 3 at least partly moderate yellow; apicodorsal antennal prominent. Male length 1.63–2.04 mm; female 1.70–2.31 mm. Male terminalia as in Figure 50; female as in Figure 72.

HEAD.—Face planate, light yellowish brown, yellowish gray, or light gray; 5–6 pfa; epistomal index 1.7–2.2; mesofacial index 2.4–2.7; vertex index 5.4–6.8; A-index 1.8–2.8; ocular index 5.3–6.2. Palpus moderate yellow; 6–8 aristal rays; apicodorsal antennal prominent; antennal segments 1 and 2 dark brown, segment 3 at least partly moderate yellow; fronto-orbital area moderate olive-brown; frontal vitta semiglossy dark gray; most of parafrontale dark brown; 14–17 postoculars.

THORAX.—Ppn light gray; mesonotum semiglossy dark brown; 3 adc and 2 pdc; pleuron light gray except light brown around metathoracic spiracle; legs mostly moderate yellow except light-gray pruinose femora. Wing length 1.79–1.87 mm; veins light brown; 6–7 setae on basal end of costa; 5–8 dorsal and 9–11 anterior interfractural costals; costal-section ratios: II:I 2.0–3.2; III:IV 2.5–3.2; V:IV 3.0–3.5; M_{1+2} index 1.2–1.7.

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply recessed and congruent with distiphallus; anterolateral margin of sternum 5 rounded to a posteriorly directed notch; posterior third of copulobus distinctly concave in relation to sagittal plane (arcuate and digitiform); copulobus verrucate laterally and with a compact terminal fascicula of 5–7 strong macrochaetae projecting anteriad to one-third of copulobus length. Postgonite completely concealed; distiphallus expanded proximally and bicarinate ventrally on proximal two-thirds; most of basiphallus exposed ventrally. Anterior margin of fused surstyli concave medially; B-index about 1.6. Syntergum 9+10 prominently bilobate posteriorly. Female terminalia: tergum 8 longer than sternum 8; cercus setose mostly dorsally, digitiform and 3.0 times as long as wide (lateral view). Segment 7 with group of 4 seriated setae laterally on posterior margin; median spermatheca cupuliform and nearly as long as cercus.

EGG.—Length 0.47–0.64 mm; maximum breadth 0.14–0.18 mm. Chorion (Figure 75) white or light yellowish gray, with inconspicuous, frequently anastomosing longitudinal ridges; wide spaces between ridges smooth (in contrast to Figure 78). Micropylar protuberance infundibulate, visible in dorsal view; end opposite micropylar protuberance with distinctly lacunose papilla.

First-instar larva.—Length 0.35–0.75 mm; maximum breadth 0.10–0.15 mm. Clypeal arch distinctly more angular at level of cheliform spot in lateral view than in third-instar larva; frontoclypeal length not measured. Very similar to *H. discursa* (Figure 80), especially in having supraspiracular protuberance with central spinous seta; dorsal setae and spinules apparently absent. Newly eclosed larva translucent, light yellowish gray; late first-instar larva translucent, with greenish-yellow tinge.

Second-instar larva.—Length 1.00–3.75 mm; maximum breadth 0.20–0.50 mm. Frontoclypeal length not measured. Dorsal setae absent; dorsal spinules restricted to intersegmental grooves on abdominal segments 1–7; abdominal segment 8 with 3–4 annuli of spinules and 1 conspicuous dorsolateral seta (perhaps supraspiracular spinous seta of first-instar larva). Body translucent, with light-green tinge.

Third-instar larva.—Length 2.17–5.85 mm; maximum breadth 0.30–0.85 mm. Frontoclypeal length 0.45–0.52 mm; ventral phragmatal ramus mostly hyaline (Figure 91). Ventral frontoclypeal index 2.8–3.2; phragmatal index 1.0–1.2; bifurcation index 4.2–4.5; clypeal-arch index 1.7–2.0. Clypeal arch gradually sloping at about 35° in relation to lower frontoclypeal margin. Mouth-hook beak and base lengths subequal; maximum mouth-hook base thickness about 2.2 times that of beak. Prothorax and mesothorax sparsely spinulose ventrally and laterally; abdominal segment 8 without ventral, transverse row of setulae, but with 3–5 annuli of spinules. Body translucent, with light-green tinge.

Puparium.—Length 3.10–4.25 mm; maximum breadth 0.75–1.00 mm; fusiform (Figure 109). Puparial length: minimum breadth 12.0–15.0; maximum breadth: minimum breadth 2.4–3.2; anal-plate index 1.8–2.4. Prothoracic end semicircular in ventral view; head-lobe scar obovoid, nearly as long as prothorax; prothorax moderately rugulose ventrally and laterally; abdominal segment 8 ornamented as in third-instar larva; anal plate subrectangular, with anterior margin straight or slightly convex. Empty puparium translucent, light yellowish brown; early pupa light green.

Type.—Holotype male, ANSP 6531.

Type-locality.—Atherton, Missouri (VI-no year, C. F. Adams).

Adult specimens examined.—349 (210♂♂, 139♀♀) from 40 localities:

California: Buena Park (V–19–1944, A. Melander), 1♂; Davis (VIII–13–1954, A. Grigarick), 1♂, (X–21–1954, A. Grigarick), 3♂♂, 1♀, (VII–26–1955, W. Lange), 1♂, (IX–10–1957, A. Grigarick), 2♀♀, (IX–17–1957, A. Grigarick), 2♂♂; Maxwell, Colusa County (VIII–12–1954, A. Grigarick), 11♂♂, 7♀♀, (VIII–3–1955, W. Lange), 1♀; Putah Canyon, Yolo County (X–20–1954, A. Grigarick), 3♂♂; Sacramento (IX–3–1957, A. Grigarick), 3♂♂.

District of Columbia: Washington (VIII–13–1923, W. McAtee), 1♂.

Iowa: Banner Mine Area, Warren County, 41°26.4′ N, 93°33.8′ W (VIII–7–1960, D. L. Deonier), 1♂; Ledges State Park, Boone County (VII–28–1954, J. Laffoon), 1♀; Ledges State Park, Boone County, south pond at 41°58.8′ N, 93°53.5′ W (VII–10–1960, D. L. Deonier), 1♀; Lewis and Clark State Park, Monona County 42°2′ N, 96°10′ W (VI–6–1960, D. L. Deonier), 1♀; Little Wall Lake, Hamilton County (VIII–27–1960, D. L. Deonier), 2♂♂, 1♀; McIntosh Woods State Park, Clear Lake (IX–10–1961, D. L. Deonier), 2♂♂; Pilot Knob State Park, Hancock County (VI–15–1960, D. L. Deonier), 1♂; Siewer's Springs State Park near Decorah (IX–9–1961, D. L. Deonier) 8♂♂; Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 4♂♂, 7♀♀; Springbrook State Park, Guthrie County (IX–2–1955, J. Laffoon), 1♂, (VII–19–1960, D. L. Deonier), 2♂♂.

Kansas: Kansas State College Natural History Area near Pittsburg (VI–4–1963, D. L. Deonier), 2♂♂, 1♀; Kansas University Natural History Reservation near Lawrence, Douglas County (VI–7–1963, D. L. Deonier), 35♂♂, 21♀♀, (VI–10–1963, D. L. Deonier), 1♂, 2♀♀; Leavenworth County Lake (VIII–27–1962, D. L. Deonier), 21♂♂, 17♀♀; Marais des Cygnes Wildlife Refuge, Linn County (IX–5–1961, D. L. Deonier), 1♂; 1 mile northeast of Lawrence, Douglas County, in sandpits (VI–2–1963, D. L. Deonier), 1♂.

Michigan: Bessey Creek, Cheboygan County (VIII–14–1941, C. Berg), 1♀; Cheboygan County (VII–26–1946, C. Berg) 1♀, (XI–26–1946, C. Berg), 2♂♂, (VIII–11–1947, C. Berg), 1♂.

Minnesota: Biological Station, Itasca State Park (VI–26–1963), D. L. Deonier), 1♂; Bohall Lake, Itasca State Park (VI–25–1963, D. L. Deonier), 2♂♂, 1♀ (VIII–17–1963, D. L. Deonier), 2♂♂; Chambers Creek, Itasca State Park (VII–18–1963, D. L. Deonier), 1♂; Headwaters of La Salle Creek, Itasca State Park (VIII–6–1963, D. L. Deonier), 5♂♂; Mississippi River near north entrance, Itasca State Park (VII–9–1963, D. L. Deonier), 7♂♂, 8♀♀; Two Island Lake, Itasca State Park (VI–28– 1963, D. L. Deonier), 1♂, (VIII–8–1963, D. L. Deonier), 1♂; 6.5 miles east of Waubun (VIII–18–1963, D. L. Deonier), 5♀♀.

Mississippi: Vancleave Road, Jackson County, 30°28′ N. 88°43′ W (VI–15–1962, D. L. Deonier), 1 ♀.

North Carolina: Highlands Biological Station, Highlands, Macon County (VI–15–26–1968, D. L. Deonier), 20 ♂ ♂, 31 ♀ ♀.

Ontario: Marmora (VIII–25–1952, E. H. Smith), 1 ♂, (IX–9–1957, J. McAlpine), 1 ♂.

South Carolina: Jamestown (VII–2–1953, M. Wheeler), 1 ♂.

Tennessee: Brewer's Bar Ditch, Reelfoot Lake, 36°27.1, N, 89°21.2′ W (VIII–10–1962, D. L. Deonier), 4 ♂ ♂, 2 ♀ ♀; Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett County (VIII–19–1962, D. L. Deonier), 4 ♂ ♂; Miller's Camp, Reelfoot Lake, 36°24.3′ N, 89°20′ W (VIII–12–1962, D. L. Deonier), 15 ♂ ♂, 15 ♀ ♀; Samburg, Reelfoot Lake, 36°22.9′ N, 89°21.3′ W (VIII–10–16–1962, D. L. Deonier), 30 ♂ ♂, 11 ♀ ♀.

Texas: Galveston (IV–11–1952, M. Wheeler), 1 ♂, (IX–13–1953, M. Wheeler), 1 ♂; Kerrville (III–17–1955, W. Wirth), 1 ♂.

IMMATURE SPECIMENS EXAMINED.—296 from 7 localities:

Iowa: Siewer's Springs State Park near Decorah (collected and reared by D. L. Deonier); Spring Lake, Greene County (collected and reared by D. L. Deonier).

Kansas: Kansas University Natural History Reservation near Lawrence, Douglas County (collected and reared by D. L. Deonier); 1 mile northeast of Lawrence, Douglas County (collected and reared by D. L. Deonier).

North Carolina: Highlands Biological Station, Highlands, Macon County (collected and reared by D. L. Deonier).

Tennessee: Brewer's Bar Ditch and Samburg, Reelfoot Lake (collected and reared by D. L. Deonier).

REMARKS.—Determination should be confirmed by examination of the terminalia. The *H. bilobifera* group includes this species, *H. ascita, H. gladiator, H. harti, H. discursa,* and *H. trichaeta.* These sibling species constitute the most well-defined group in *Hydrellia.* There is some probability that I misdetermined some females of this group because I was unable to dissect the genitalia of every specimen examined.

Adult. Habitats recorded: floating parts of *Potamogeton nodosus, P. gramineus, P. epihydrus, Zizania aquatica, Oryza sativa,* and *Nymphaea tuberosa*; mats of *Lemna minor*; limnic wrack. I collected one male by the lighted-receptacle method.

At the Kansas University Natural History Reservation, I observed one female catching an adult chironomid, another female grasping an adult chironomid, and yet another one probing a specimen of *Podura aquatica* that it held with its fore tarsi. The gut contents of ten adults from this locality consisted of greenish-yellow, granular material, the identity of which could not be determined. At this locality also, several pairs of adults approached each other until their antennae touched. These meetings usually culminated in one adult jumping rapidly away or attempting to mount the other from the side. At Itasca State Park, Minnesota, I watched a male approach a female *H. trichaeta*; the latter struck aggressively at the male. One adult female emerged from a host plant collected at Highlands, North Carolina, mated, oviposited, and lived a total of 18 days while being fed 5 percent sucrose solution.

Egg and larva. I found eggs on the floating leaves of *Potamogeton nodosus* at Spring Lake, Greene County, Iowa, and on those of *P. epihydrus* at Ravenel Lake, Highlands, North Carolina. I observed deposition of 10 eggs at the latter locality. The incubation period ranged from 4 to 5 days. Eggs from the Iowa locality incubated 2 days after collection. The first larval stadium ranged from 5–10 days; the second and third, from 5 to 14 and 4 to 9 days, respectively, at laboratory room temperatures for 20 specimens.

Puparium. The puparial phase ranged from 6 to 15 days in the laboratory for 37 specimens. In one case, one larva pupariated in the open water of a culture dish. The adult did not emerge.

Host plants. I found larvae and puparia only in *Potamogeton nodosus, P. epihydrus,* and *P. gramineus* in the field, but field observations indicate that they infest any *Potamogeton* with floating leaves. Grigarick reared *Hydrellia bilobifera* from *Zannichellia palustris* in Davis, California, during his research on *Hydrellia griseola.* It is uncertain whether this represents a larval host or an incidental puparial host. My survey of potential host plants included also *Potamogeton pectinatus, P. natans, P. spirillus, Mimulus glabratus, Alisma* sp., *Heteranthera dubia, Ceratophyllum demersum, Sagittaria australis, Jussiaea repens, Nasturtium officinale, Eleocharis palustris, Polygonum amphibium, Elodea canadensis, Zannichellia palustris,* and *Echinodorus cordifolius.*

Parasites. Fungi of the genus *Stigmatomyces* (Laboulbeniales) killed several specimens in two lots of larvae being reared in the laboratory. It is commonly stated that these insect parasites apparently do not injure the host in any way. Every larva infested with this parasite in my laboratory died. The thalli first appeared as small dark brown spots on the cuticle. The hyphae appeared to penetrate just through the cuticle.

I reared *Chorebidella bergi, Aphanta* sp. (probably new), and *Opius* sp. (all Hymenoptera: Braconidae) from puparia of this species. The time from pupariation to emergence of the hymenopterans ranged from 12 to 23 days. Five hymenopterans emerged from 42 puparia reared or collected.

Hydrellia biloxiae, new species

FIGURES 34, 81, 101, 119

DIAGNOSIS.—Palpus moderate yellow; 6–10 aristal rays; vertex index 4.4–5.0; abdominal terga 2–4 velvety purplish black medially; thoracic pleuron moderate olive-brown with bronze reflections; frons (except light brown around fronto-orbital sockets) velvety black. Male length 1.22–1.45 mm; female 1.36–1.56 mm. Male terminalia as in Figure 34.

HEAD.—Face light yellowish brown; 4–5 pfa; epistomal index 1.1–1.5; mesofacial index 2.0–2.4; vertex index 4.4–5.0; A-index 2.0–2.4; ocular index 12.0–14.0. Palpus moderate yellow; 6–10 aristal rays; antennal segment 1 pale yellow medially, 2 velvety black, and 3 moderate brown with moderate orange-yellow splotches; frons (except light brown around fronto-orbital sockets) and occiput velvety black; 13–16 postoculars.

THORAX.—Ppn, mesoscutum posterior to transverse sulcus, and scutellum semiglossy moderate brown; mesoscutum anterior to transverse sulcus semiglossy dark brown; notopleuron and postalar wall moderate olive-brown; 3–4 adc and 2–3 pdc; pleuron moderate olive-brown with bronze reflections; coxae light gray laterally, moderate yellow anteriorly and ventrally; trochanters, tarsi, and distal fifth of tibiae moderate yellow; remaining areas of legs light-gray pruinose. Wing length 1.39–1.70 mm; veins light brown; 6–7 setae on basal end of costa; 5–7 dorsal and 7–10 anterior interfractural costals; costal-section ratios: II:I 1.4–2.2; III:IV 2.6–3.5; V:IV 3.2–3.6; M_{1+2} index 1.6–2.2.

ABDOMEN.—Terga 2–4 velvety purplish black medially, the sides, ventral lobes, and tergum 5 dark brown. Male terminalia: median third of posterior margin of sternum 5 concave and congruent with distiphallus; anterolateral margin of sternum 5 about 110° angular; copulobus acute posteriorly and irregularly setose. Postgonite bent anteriad and postgonite uncus slightly laterad; distiphallus tapering to ovoid, ventrally transversely lammellate apex. Anterior margin of fused surstyli ovoid; B-index about 3.5; C-index 2.0–2.5.

FIRST-INSTAR LARVA.—Length 0.52 mm. Feeding apparatus lighter and less heavily sclerotized, but of same general shape as that of third-instar larva. Body translucent, yellowish gray.

SECOND-INSTAR LARVA.—Length 2.75–3.10 mm; maximum breadth 0.30–0.40 mm. Frontoclypeus not measured. Abdominal segment 8 with bidentate and tridentate spinules dorsally.

THIRD-INSTAR LARVA.—Length 3.40–4.00 mm; maximum breadth 0.40–0.50 mm. Frontoclypeal length 0.35–0.40 mm; cheliform spot touching clypeal arch margin (Figure 101). Ventral frontoclypeal index 1.5–2.0; phragmatal index 0.75–0.85; bifurcation index 2.5–2.7; clypeal-arch index 1.5–1.8. Clypeal arch sloping upward very slightly from subrectangular prominence dorsal to labial-gland duct opening. Mouth-hook beak and base lengths subequal; maximum mouth-hook base thickness about 1.2 times that of beak. Body opaque, yellowish gray.

PUPARIUM.—Length 2.40–3.25 mm; maximum breadth 0.60–0.80 mm; subfusiform (Figure 116). Puparial length:minimum breadth 16.0–19.0; maximum breadth:minimum breadth 3.6–4.2; anal-plate index 1.8–3.2. Prothoracic end semicircular in ventral view; maximum puparial breadth in metathorax; prothorax and mesothorax very sparsely spinulose; prothorax distinctly transversely rugulose in ventral view; head-lobe scar subcircular to transversely elliptical; dorsal spinules restricted to thorax and abdominal segment 8; caudal segment without ventral, transverse row of setulae, but with 3–4 annuli of spinules; anal plate subovoid, with anterior margin slightly convex. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, USNM 70528.

TYPE-LOCALITY.—Gravel pit near U. S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson County, Mississippi (VI–17–1962, D. L. Deonier).

PARATYPES.—84 (29♂♂, 55♀♀) from 4 localities:

Mississippi: Gravel pit near U. S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson County (VI–17–1962, D. L. Deonier), 8♂♂, 4♀♀ (USNM and DLD); Lake Shady, 7 miles west of Hattiesburg, Lamar County (VII–11–1962, D. L. Deonier), 1♂ (ISC); Lake Shelby State

Park, Forrest County (VII–24–1962, D. L. Deonier), 2♂♂, 4♀♀ (USNM); Vancleave Road, Jackson County, 30°28′ N, 88°43′ W (VI–15–1962, D. L. Deonier), 18♂♂, 47♀♀ (USNM, ISC, and DLD).

IMMATURE SPECIMENS EXAMINED.—23 specimens from 2 localities:

Mississippi: Gravel pit near U. S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson County (collected and reared by D. L. Deonier); Vancleave Road, Jackson County, 30°28′ N, 88°43′ W (collected and reared by D. L. Deonier).

REMARKS.—*Adult.* Habitats recorded: leaves of *Juncus repens, Hydrochloa caroliniensis,* and *Nymphaea odorata.* In one locality near Vancleave Road, Jackson County, Mississippi, from 23 to 28 June and from 7 to 10 July I collected 54 and 68 adults, respectively, in three Grigarick model floating traps (25 cm diameter).

At the above-mentioned locality, an adult probed a partially dessicated chironomid larva on a leaf of *Nymphaea odorata* for about 5 minutes. When it left the larva and touched its proboscis to the water, another adult approached the larva. The first adult drove off the intruder by scissoring its wings and rushing rapidly toward it. While feeding, the specimen pushed its body forward and upward rhythmically. Shortly afterward, in another case, I observed the same behavior and sequence of events, except for a more vigorous defense against the intruder. Here, too, I saw a ctenid spider grasping an adult and a smaller undetermined spider leap at an adult that landed near its resting site.

I did not observe oviposition, but some females among several adults on leaves of *Juncus repens* and *Eleocharis wolfii* protracted their ovipositors and touched them to various places on the leaves.

Larva and puparium. Mines in stolons and the presence of agromyzid leaf miners hampered the discovery of the larvae. For four specimens, the time from about the middle of the first larval stadium to adult emergence ranged from 19 to 21 days. One larva passed the third larval stadium in 12 days. One third-instar larva mined through a 4-cm length of stolon into a leaf sheath. I did not measure the puparial phase. Adults may encounter occasional difficulty in escaping from mines, for I found two adults that had emerged from the puparia but remained trapped in the mines. One of these adults was trapped about 5 mm from the puparium in a stolon, without an escape slit, growing about 0.75 m below the surface. In some cases, the escape slit in the stolon mine was over the operculum, and in others it was anterior to it. Evidently, the larvae made escape slits before pupariation.

Host plants. I found larvae and puparia only in *Juncus repens.* At the Vancleave Road locality, I estimated the infestation to be light to moderate. In addition to *J. repens,* I examined *Orontium aquaticum, Zizaniopsis miliacea, Polygonum setaceum, Rhynchospora cymosa, Eleocharis tuberculosa, E. wolfii, E. mammillata,* and *Cyperus strigosus.*

Hydrellia borealis Cresson

FIGURE 53

Hydrellia borealis Cresson, 1944b, pp. 164, 171, 172.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown (infrequently partly moderate orange-yellow); 7–8 aristal rays; vertex index 4.5–9.5; body length:wing length 0.8–0.9; apicodorsal antennal prominent; adc more or less uniordinate; thoracic pleuron light gray; male hind tibia expanded. Male length 1.96–2.21 mm; female 1.79–2.13 mm. Male terminalia as in Figure 53.

HEAD.—Face silky light yellowish brown; 4–6 pfa; 1–3 sfa; epistomal index 1.0–1.4; mesofacial index 1.7–2.3; vertex index 4.5–9.5; A-index 1.5–2.0; ocular index 6.8–8.0. Palpus dark brown (infrequently partly moderate orange-yellow); 7–8 aristal rays; apicodorsal antennal prominent; antenna and frontal vitta brown; most of parafrontale olive-brown; lower third of postocular area light gray, upper two-thirds light brown; 13–16 postoculars.

THORAX.—Ppn and mesonotum dark gray; 3–4 adc (none macrochaetous) and 2 pdc; pleuron light gray; legs light-gray pruinose except moderate-yellow trochanters; male hind tibia slightly expanded (as in Figure 8). Wing length 2.13–2.47 mm; veins light brown; 5–7 setae on basal end of costa; 6–8 dorsal and 6–9 anterior interfractural costals; costal-section ratios: II:I 2.3–2.9; III:IV 2.8–3.3; V:IV 3.5–4.0; M_{1+2} index 1.2–1.8.

ABDOMEN.—Terga dark gray. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 rounded through 110°–115° angle; copulobus slightly convex posteriorly and regularly setose, with about 7–8 seriated setae on medial margin. Postgonite bent strongly anteromediad and postgonite uncus slightly laterad; distiphallus slightly expanded (oblong) on distal two-thirds. Anterior margin of fused surstyli narrowly cleft medially to about one-third of length of structure; B-index about 1.0; C-index 0.5–0.7.

TYPE.—Holotype male, type no. 6653, which may be at the Academy of Natural Sciences of Philadelphia in an unlabelled condition, but is probably either lost or in the Melander Collection.

TYPE-LOCALITY.—Mer Bleue, Ottawa, Canada (VII-2-1938, A. L. Melander).

SPECIMENS EXAMINED.—11 (6♂♂, 5♀♀) from 9 localities:

Alaska: King Salmon, Naknek River (VIII-1-1952, W. Mason), 1♀.
British Columbia: Atlin, 2,200 feet (VII-6-1955, B. Gibbard), 1♀; Brilliant (VIII-3-1947, H. Foxlee), 1♂.
Michigan: Dickinson County (VII-1-1955, R. Dreisbach), 1♀.
Nebraska: Crete (VII-3-1960, W. Rapp), 1♂.
Ontario: Ottawa (VI-1-1951, J. McAlpine), 1♂, (VII-14-1952, G. Shewell), 1♂, (VII-2-1958, J. Vockeroth), 1♂.
Quebec: Beech Grove (VII-18-1951, J. McAlpine), 1♀.
Washington: 23 miles west of Republic (VII-14-1960, collector unknown), 1♂.
Wyoming: Lander (VIII-16-1950, M. Wheeler), 1♀.

REMARKS.—I did not see the holotype; thus, I based my determinations entirely upon Cresson's description and key and upon specimens that had been compared with the holotype.

Hydrellia caliginosa Cresson

FIGURES 19, 98, 111

Hydrellia caliginosa Cresson, 1936, pp. 257–258; 1942, p. 78; 1944b, pp. 170, 175.—Berg, 1950, pp. 375, 376, 378, 384–385, 392–393, 396 [biology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–10 aristal rays; vertex index 4.5–5.5; thoracic pleuron light gray; costal section III:IV 2.3–2.5; fronto-orbital area and frontal vitta strong yellowish brown; most of parafrontale velvety black. Male length 2.11–2.60 mm; female 1.97–2.47 mm. Male terminalia as in Figure 19.

HEAD.—Face light yellowish brown or light gray; 4–6 pfa; epistomal index 1.2–1.6; mesofacial index 1.6–2.2; vertex index 4.5–5.5; A-index 0.8–2.0; ocular index 4.2–7.0. Palpus moderate yellow; 8–10 aristal rays; prementum glossy brownish black; antenna very dark brown; fronto-orbital area and frontal vitta strong yellowish brown; most of parafrontale velvety black; 14–17 postoculars.

THORAX.—Ppn and notopleuron strong yellowish brown; remainder of mesonotum usually moderate brown; 3–4 adc and 2–4 pdc; pleuron light gray; 1–2 basal coxals (1 macrochaetous); legs light-gray pruinose except dark-brown tarsi. Wing length 2.30–2.75 mm; veins moderate brown; 8–9 setae on basal end of costa; 8–10 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.2–2.6; III:IV 2.3–2.5; V:IV 2.8–3.3; M_{1+2} index 1.0–1.3.

ABDOMEN.—Terga moderate brown medially and anterolaterally, light gray elsewhere. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral corner of sternum 5 right-angled (90°–100°); posterolateral angle of copulobus roundly 45° from the lateral corner; the medial margin broadly notched; copulobus irregularly setose. Postgonite bent mediad and then sharply anteriad; with peninsulate projection along lateral margin of copulobus; postgonite uncus distinctly clawlike; distiphallus tapering to mucronate apex. Anterior margin of fused surstyli truncate; B-index about 0.6; C-index 0.1–0.2.

THIRD-INSTAR LARVA.—Body of larva not examined. Frontoclypeal length 0.46–0.59 mm (Figure 98). Ventral frontoclypeal index 5.0–5.5; phragmatal index 1.0–1.2; bifurcation index 3.6–3.8; clypeal-arch index 1.6–1.7. Clypeal arch sloping at about 20° in relation to lower frontoclypeal margin. Mouth-hook beak longer than base; maximum mouth-hook thickness about 1.5 times that of beak; mouth-hook without light spot.

PUPARIUM.—Length 3.30–4.15 mm; maximum breadth 0.95–1.40 mm; subfusiform, suddenly tapering at segment 7 (Figure 111). Puparial length: minimum breadth 18.0–20.0; maximum breadth: minimum breadth 6.0–8.0; anal-plate index 2.5–3.0. Prothoracic end semicircular in ventral view; head-lobe scar circular; maximum puparial breadth 5.5–6.0 times diameter of head-lobe scar and 2.3 times or less than maximum prothoracic breadth; prothorax with fewer rugulae ventrally than *H. itascae*; lateral spinules conspicuous, but no large spinules in annuli of abdominal segment 8 as in *H. itascae* (Figure 107); anal plate subovoid, with anterior margin slightly convex. Empty puparium moderate brown.

TYPE.—Holotype male, ANSP 6528.

TYPE-LOCALITY.—New Mill Pond, Mount Desert Island, Maine (VII–25–1935, W. Procter).

ADULT SPECIMENS EXAMINED.—66 (40♂♂, 26♀♀) from 11 localities:

Alaska: Matanuska Valley (VI–27–1950, C. Berg), 2♂♂, (VII–6–1950, C. Berg), 3♂♂, (VII–20–1950, C. Berg), 8♂♂, 5♀♀, (VIII–5–1950, C. Berg), 1♂.

Idaho: Priest Lake, Tule Bay (VIII–19–1919, A. L. Melander), 1♂.

Maine: Mount Desert Island (VII–12–1935, W. Procter), 1♂, (VII–25–1935, W. Procter), 2♂♂, 3♀♀.

Michigan: Cheboygan County (VII–21–1947, C. Berg), 4♂♂, 7♀♀, (VIII–7–1947, C. Berg), 4♂♂, 5♀♀.

Minnesota: Eaglenest (IX–1–1958, W. Balduf), 1♂; Rapid River Logging Camp, Hubbard County (VII–2–1963, D. L. Deonier), 1♂.

Montana: St. Marys (VII–22–1935, A. L. Melander), 1♂.

Quebec: Mt. Albert (VII–24–1954, J. Martin), 11♂♂, 3♀♀; Rupert House (XI–17–1949, E. LeRoux), 1♀.

Wyoming: Kemmerer (VIII–14–1950, collector unknown), 1♂, 1♀; Yellowstone National Park, 4,750 feet (VII–20–no year, collector unknown), 1♀.

IMMATURE SPECIMENS EXAMINED.—10 from 2 localities:

Alaska: Matanuska Valley (collected and reared by C. Berg).

Minnesota: Rapid River Logging Camp, Hubbard County (collected and reared by D. L. Deonier).

REMARKS.—Using the key of Cresson (1944b, p. 175), one encounters difficulty in the critical couplet mainly in the ocellar:postocellar length ratio. I found this character unreliable.

Adult. Habitat recorded: leaves of *Nuphar advena.*

Host plants. Berg (1950) reared one adult from a puparium in a leaf of *Potamogeton praelongus.* In personal communication with Berg, he indicated he had reared several adults from an unspecified species of *Potamogeton* in Matanuska Valley, Alaska. I reared one adult from a puparium in a leaf of *P. richardsonii* collected at Rapid River Logging Camp, Hubbard County, Minnesota.

Hydrellia cavator, new species

FIGURE 54

DIAGNOSIS.—Palpus moderate yellow; 4–6 aristal rays; parafrontale velvety black; wing length 1.53–2.13 mm; antennal segment 3 moderate yellow; mesoscutum and abdominal dorsum dark brown medially; thoracic pleuron and side of abdomen light gray. Male length 1.63–1.70 mm; female 1.45–1.84 mm. Male terminalia as in Figure 54.

HEAD.—Face light gray; 5–6 pfa; epistomal index 1.5–1.8; mesofacial index 2.1–2.5; vertex index 4.5–4.8; A-index 1.6–2.2; ocular index 6.5–12.0. Palpus moderate yellow; 4–6 aristal rays; antennal segments 1 and 2, fronto-orbital area, and frontal vitta moderate brown; antennal segment 3 moderate yellow; most of parafrontale velvety black; 13–16 postoculars.

THORAX.—Ppn and notopleuron moderate olive-brown; remainder of mesonotum dark brown; 3–4 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except moderate-yellow tarsi. Wing length 1.53–2.13 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 5–7 dorsal and 7–9 anterior interfractural costals; costal-section ratios: II:I 2.0–2.5; III:IV 2.6–3.5; V:IV 3.4–4.0; M_{1+2} index 1.2–1.7.

ABDOMEN.—Terga dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 truncate between angles of about 120° and 90°–100°; copulobus acutangular posteriorly and irregularly setose. Postgonite bent anterolaterad and postgonite uncus sharply laterad; distiphallus uniform in breadth to truncate and ventrally lamellate apex. Anterior margin of fused surstyli smoothly convex; B-index about 3.0; C-index 2.0–2.5.

TYPE.—Holotype female, AMNH (no. not used). A male specimen originally intended to be the holotype was damaged in shipment. It was collected at Biscayne Bay, Florida, by Mrs. A. T. Slosson.

TYPE-LOCALITY.—Lake Worth, Florida (collection of Mrs. A. T. Slosson, Acc. 26226).

PARATYPES.—4 (1♂, 3♀♀) from 4 localities:

Florida: Biscayne Bay (no date, Mrs. A. T. Slosson), 1♂ (AMNH); Gainesville (IV–23–1952, J. Vockeroth), 1♀ (CNC); Lake Worth (no date, Mrs. A. T. Slosson), 1♀ (AMNH); Lake Worth, bay shore (VIII–8–1951, W. Wirth), 1♀ (USNM).

REMARKS.—I found some specimens of this species in material determined as *H. atroglauca. Hydrellia atroglauca* is much larger and has 8–10 aristal rays.

Hydrellia cessator, new species

FIGURE 59

DIAGNOSIS.—Palpus moderate yellow; 7–9 aristal rays; vertex index 4.0–4.8; mesofacial index 1.5–2.0; ocular index 6.0–7.0; thoracic pleuron moderate olive-brown except mesokatepisternum and mesomeron light gray. Male length 1.79–2.19 mm; female 2.38–2.55 mm. Male terminalia as in Figure 59.

HEAD.—Face light gray or light yellowish brown; 3–6 pfa; 0–5 sfa; epistomal index 1.0–1.4; mesofacial index 1.5–2.0; vertex index 4.0–4.8; A-index 1.5–2.0; ocular index 6.0–7.0. Palpus moderate yellow; 7–9 aristal rays; prementum pale yellow; antenna dark gray; fronto-orbital area and frontal vitta moderate olive-brown; most of parafrontale dark brown; 13–16 postoculars.

THORAX.—Ppn light gray; mesonotum moderate brown; 4–5 adc and 2–3 pdc; pleuron moderate olive-brown except mesokatepisternum and mesomeron light gray; 1–2 basal coxals (1 macrochaetous); legs sparsely light-gray pruinose except densely gray pruinose coxae and dark-brown tarsi. Wing length 2.04–2.64 mm; veins moderate brown; 6–8 setae on basal end of costa; 6–8 dorsal and 8–11 anterior interfractural costals; costal-section ratios: II:I 2.2–2.4; III:IV 2.4–3.3; V:IV 3.0–3.6; M_{1+2} index 1.2–1.4.

ABDOMEN.—Terga moderate brown medially and light gray laterally. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 with 2 angles (100° and 140°); copulobus acutangular posteriorly and irregularly setose. Postgonite bent laterad and postgonite uncus anteriad; distal half of distiphallus tapering to acute and ventrally bicarinate apex. Anterior margin of fused surstyli only slightly concave; B-index about 0.6; C-index 1.0–1.2.

TYPE.—Holotype male, USNM 70529.

TYPE-LOCALITY.—Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater County, Minneosta (VII–8–1963, D. L. Deonier).

PARATYPES.—23 (7♂♂, 16♀♀) from 6 localities:

Manitoba: Two miles north of Forrest (VII–19–1958, J. Chillicott), 1♀ (CNC).

Minnesota: Headwaters of La Salle Creek, Itasca State Park (reared adults between V–15 and VI–7–1967, D. L. Deonier), 4♂♂, 7♀♀ (DLD); Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater County (VII–8–1963, D. L. Deonier), 6♀♀ (ISC and USNM); Mississippi River near north entrance, Itasca State Park (reared adults VI–4–1967, D. L. Deonier), 1♂, 1♀ (DLD); Rapid River Logging Camp, Hubbard County (VII–2–1963, D. L. Deonier), 2♂ (DLD); Sucker Lake at dam (reared adult V–27–1967, D. L. Deonier), 1♀ (DLD).

REMARKS.—*Adult.* Habitats recorded: floating leaves of *Glyceria grandis, Zizania aquatica,* and in sedge meadow. The adults appeared to move about very little on the leaves and for this reason they were difficult to detect.

Host plants. Immatures were found in the submerged leaves of *Glyceria grandis* during the late winter and early spring of 1967 in Itasca State Park and vicinity. Of the 12 specimens found in this grass, two were second-instar larvae, six were third-instar, and four were puparia. The larvae (probably first- or second-instar) evidently overwinter in the green, submerged leaves of this species along with the larvae of *H. ischiaca, H. morrisoni,* and *H. nobilis* . The second-instar larvae were collected in the host plants on 30 April, 15 days after ice had thawed in the lakes and while mean daily temperatures were still in the 35–45°F range. Circumstantial evidence indicates that *G. grandis* plants are also normal summer hosts of the larvae. I also surveyed *Potamogeton epihydrus, P. praelongus, P. zosteriformis, Zizania aquatica,* and *Glyceria striata* as species of potential host plants.

Hydrellia columbata, new species

FIGURE 55

DIAGNOSIS.—Palpus dark brown; 5–7 aristal rays; vertex index 4.6–6.0; mesofacial index 1.0–1.4; face light gray, carinate only on upper two-thirds; thoracic pleuron moderate olive-brown except lower half of mesokatepisternum light gray; male mid tibia expanded. Male length 1.53–1.99 mm; female 1.70–2.09 mm. Male terminalia as in Figure 55.

HEAD.—Face light gray, carinate only on upper two-thirds; 4–5 pfa; 5–7 sfa; epistomal index 0.9–1.4; mesofacial index 1.0–1.4; vertex index 4.6–6.0; A-index 1.8–2.2; ocular index 4.3–5.0. Palpus dark brown; 5–7 aristal rays; antenna and most of frons velvety dark brown; fronto-orbital area moderate olive-brown; 13–15 postoculars.

THORAX.—Ppn and mesonotum moderate olive-brown; 3–4 adc and 2–4 pdc; pleuron moderate olive-brown except lower half of mesokatepisternum light gray; legs moderate olive-brown pruinose except dark-brown tarsi; male mid tibia expanded. Wing length 1.62–1.87 mm; veins dark brown; 6–7 setae on basal end of costa; 5–7 dorsal and 7–10 anterior interfractural costals; costal-section ratios: II:I 2.0–2.4; III:IV 2.5–3.0; V:IV 2.8–3.4; M_{1+2} index 1.3–1.8.

ABDOMEN.—Terga moderate olive-brown pruinose over dark gray. Male terminalia: median third of posterior margin of sternum 5 broadly and shallowly concave; anterolateral corner of sternum 5 roundly right-angled (90°–100°) and projecting distinctly more laterad than surstyli; copulobus unusually long with end bent posteromediad, with terminal cluster of setae, and with 5–7 setae anteriorly. Postgonite long and bent anteromediad; postgonite uncus distinctly long and hooklike; distiphallus narrow, of uniform breadth to acute apex. Anterior margin of fused surstyli deeply cleft medially to midlength of structure; B-index about 1.0; C-index 0.5–0.8.

TYPE.—Holotype male, USNM 70530.

TYPE-LOCALITY.—Squaw Lake, Itasca State Park, Clearwater County, Minnesota (VIII–14–1963, D. L. Deonier).

PARATYPES.—43 (18♂♂, 25♀♀) from 4 localities:

Maine: Mount Desert Island (VIII–12–1935, W. Procter), 2♀♀ (ANSP).

Minnesota: Basswood Lake, Lake County (VIII–16–1950, R. Namba), 1♂ (UMC); Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 6♂♂, 2♀♀ (ISC and USNM); Two Island Lake, Itasca State Park (VI–28–1963, D. L. Deonier), 6♂♂, 16♀♀, (VIII–8–1963, D. L. Deonier), 5♂♂, 5♀♀ (USNM, ISC, and DLD).

REMARKS.—*Hydrellia columbata, H. surata,* and *H. prudens* are sibling species and, as in several other such cases in the genus, examination of the male terminalia may be necessary for positive diagnosis.

Adult. Habitats recorded: leaves of *Potamogeton natans, P. gramineus, Nuphar advena, Sparganium chlorocarpum,* and *Eleocharis palustris.*

I collected many adults of *H. columbata* by the lighted-receptacle method on Two Island Lake, Itasca State Park, Minnesota. There, on a small floating island, the adults covered most of nearly every spike-rush stem examined. During the daytime I saw adults nearly covering leaves of *S. chlorocarpum* and *P. natans* at several localities in this vicinity. Many of these adults stood with faces or antennae touching. This seemed to be epigamic behavior.

Host plants. In my unsuccessful search for immatures of this species I examined *Potamogeton amplifolius, P. natans, P. gramineus, P. robbinsii, Zannichellia palustris, Eleocharis palustris, Sparganium chlorocarpum,* and *Glyceria* sp.

Hydrellia crassipes Cresson

FIGURES 7, 33

Hydrellia crassipes Cresson, 1931, p. 107; 1944b, pp. 169, 174.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 7–10 aristal rays; antenna dark brown; ocular index 8.0–10.0; 1 basal coxal; male hind femur grooved ventrally and hind tibia flanged. Male length 2.13–2.30 mm; female 2.30–2.55 mm. Male terminalia as in Figure 33.

HEAD.—Face yellowish gray or occasionally light gray; 4–8 pfa; epistomal index 1.2–1.7; mesofacial index 2.0–2.5; A-index 1.7–2.2; ocular index 8.0–10.0. Palpus moderate yellow; 7–10 aristal rays; antenna, fronto-orbital area, and frontal vitta dark brown; most of parafrontale velvety black; 15–19 postoculars.

THORAX.—Ppn and mesonotum dark gray; 3–4 adc and 2–3 pdc; pleuron light gray; legs light-gray pruinose except moderate orange-yellow tarsi; male hind femur flanged posteroventrally and with two anteroventral rows of close-set short setae; male mid tibia flanged anteroventrally (Figure 7). Wing length 2.21–2.55 mm; veins usually dark brown; 5–9 setae on basal end of costa; 8–9 dorsal and 10–13 anterior interfractural costals; costal-section ratios: II:I 2.2–2.6; III:IV 2.8–3.2; V:IV 3.5–4.0; M_{1+2} index 1.2–1.8.

ABDOMEN.—Terga semiglossy dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 rounded through angle of 100°; copulobus acutangular (about 20°) posteriorly, notched medially at midlength, and irregularly setose. Postgonite bent anterolaterad; postgonite uncus short, blunt, and straight; distiphallus finely lamellate ventrally and tapering to mucronate apex. Anterior margin of fused surstyli broadly emarginate with about 8–9 setae on lateral corners; B-index about 2.5; C-index 1.8–2.0.

TYPE.—Holotype male, in Ohio State University collection (type no. not used).

TYPE-LOCALITY.—Sandusky, Cedar Point, Ohio (VIII–4–1902, collector unknown).

SPECIMENS EXAMINED.—153 (66♂♂, 87♀♀) from 24 localities:

Illinois: Havanna (IX–19–1895, C. Hart), 1♀.

Iowa: Goose Lake, Hamilton County (VII–2–1961, D. L. Deonier), 7♂♂, 12♀♀; Little Wall Lake, Hamilton County (IX–22–1962, D. L. Deonier), 1♂, 1♀; Springbrook State Park, Guthrie County (VI–23–1961, D. L. Deonier), 1♀; Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 11♂♂, 7♀♀.

Maine: Mount Desert Island (VII–12–1935, W. Procter, 1♀.

Michigan: Hamburg, Livingston County (VI–8–1930, G. Steyskal), 1♂, (VIII–13–1933, G. Steyskal), 1♀.

Minnesota: Basswood Lake, Lake County (VIII–16–1950, R. Namba), 1♀; Chambers' Creek, Itasca State Park (VII–18–1963, D. L. Deonier), 4♂♂, 2♀♀; Douglas Lodge Bay, Itasca State Park (VI–20–1963, D. L. Deonier), 1♀; Mississippi River near north entrance Itasca State Park (VII–9–1963, D. L. Deonier), 1♂; Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 2♀♀; Two Island Lake, Itasca State Park (VI–28–1963, D. L. Deonier), 3♂♂, 7♀♀; 1.3 miles south of main entrance Itasca State Park (VI–26–1963, D. L. Deonier), 2♂♂, 6♀♀; 6.5 miles east of Waubun (VIII–18–1963, D. L. Deonier), 1♂, 1♀.

New Jersey: Manahawkin (VIII–1–1912, collector unknown), 1♂.

North Carolina: Highlands Biological Station, Highlands, Macon County (VI–15–VII–10–1968, D. L. Deonier), 10♂♂, 6♀♀; Trussell's Pond, Horse Cove near Highlands, Macon County (IX–2–1968, D. L. Deonier), 6♂♂, 8♀♀.

Ohio: Cedar Point, Sandusky River (VIII–4–1902, collector unknown), 8♂♂, 5♀♀; (VII–14–1903, collector unknown), 2♂♂, 2♀♀.

Ontario: Bark Lake (VII–22–1939, D. Bullock), 1♀; Marmora (VII–24 and VIII–7–1952, C. Boyle), 2♀♀, (VIII–7–1952, J. McAlpine), 3♂♂, 5♀♀, (IX–9–1952, J. McAlpine), 1♂, 6♀♀, (VIII–25 and IX–8–1952, E. Smith), 3♀♀.

Oregon: Oregon City (IX–no date and year, collector unknown), 1♀.

Pennsylvania: Pittsburgh (VIII–22–1931, H. Kahl), 1♀.

Quebec: Perkins' Mills (VIII–25–1949, E. Shewell), 4♂♂, 3♀♀.

REMARKS.—This species would be very distinct, because of the male hind femoral modification, if the cryptic sibling species *H. saltator* did not exist. I did not see the holotype, but I did study several paratypes of this species.

Adult. Habitats recorded: leaves of *Potamogeton nodosus, P. natans, P. epihydrus, Nuphar advena, Nymphaea tuberosa,* and *N. odorata*; sedge meadow, riffle rocks, and limnic wrack.

I observed copulation many times in the field. In one instance, at a pond near Itasca State Park, Minnesota, the pair was surrounded by an aggregation of eight to ten specimens circling and following one another in an agitated manner and showing repeated mounting attempts. A large specimen of *Notiphila* sp. kept walking through this aggregation with its wings raised; this may have contributed to the highly active, repetitious movement of the aggregation. Observed under a microscope, a male in copulation can be seen to have the posterolateral edges of tergum 5 or 6 of the female firmly clamped between his hind femora and tibiae with his hind tarsi pushing against the female's sterna. I have illustrated in Figure 7 the enlarged, grooved male hind femur and flanged hind tibia. The short, stout, seriated setae in the male hind femoral groove may function for both sexes during copulation. In the male, they could receive stimuli that aid in proper mount positioning, and in the female the setae could stimulate various copulatory movements of her abdomen. I could detect no differences in the male hind femoral apparatus between *H. crassipes* and *H. saltator*.

This species seems to mate more readily in captivity than several others of the genus. If this is true it offers opportunities of establishing a laboratory colony for the purpose of studying the copulatory act microscopically. Perhaps because the male tightly clamps the female abdomen, quick freezing of specimens while they are in copulation could be accomplished.

Host plants. During the summer of 1968 I reared three adults from *Juncus debilis* at Highlands Biological Station, North Carolina. I found eggs deposited on the tips of these rushes, which were growing in very shallow water. Several white *Hydrellia* larvae, determined as *H. crassipes,* were found in these rush plants and in *Scirpus smithii* plants, however most of these could not be reared to the adult stage. My host-plant determinations for this fly have not been confirmed by a plant taxonomist. The adults spend most of their time feeding and mating on floating vegetation, such as water lilies and pond weeds, and they very seldom go to the host rushes and sedges except to oviposit. This information I gathered during about 20 hours of field observation. Various population studies have now been started on this species, one of which hopefully will provide data on the behavior of these flies at localities lacking floating vegetation.

Hydrellia cruralis Coquillett

FIGURES 63, 96, 108, 128, 132

Hydrellia cruralis Coquillett, 1910a, p. 131.—Cresson, 1924, p. 162; 1931, pp. 104, 106; 1934, p. 235; 1944b, pp. 169, 172.—Berg, 1950, pp. 375, 376, 377, 378–382, 383 (pl. 1, figs. 5–8), 384, 385 (pl. 2, fig. 4), 386, 387, 388, 389 (pl. 3, fig. 4), 390, 396 [biology, morphology, and taxonomy of immatures].—Wirth, 1956, p. 16.—Judd, 1964, p. 411 [ecology].—Deonier, 1964, p. 116; 1965, pp. 500, 505 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 6–9 aristal rays; body length:wing length 1.0–1.2; antennal segment 3 moderate yellow; thoracic pleuron light gray; 4 mesokatepisternals; tibiae moderate yellow. Male length 1.96–2.55 mm; female 2.21–3.23 mm. Male terminalia as in Figure 63.

HEAD.—Face light yellowish brown or light gray; 4–7 pfa; no sfa; epistomal index 1.4–1.9; mesofacial index 1.5–2.3; vertex index 3.3–4.7; A-index 1.6–1.8; ocular index 4.8–8.6. Palpus moderate yellow; 6–9 aristal rays; antenna dark brown except moderate-yellow segment 3; fronto-orbital area and frontal vitta strong yellowish brown; most of parafrontale velvety dark brown; 12–16 postoculars.

THORAX.—Ppn light gray; mesonotum strong yellowish brown; 3–4 adc and 3–4 pdc; pleuron light gray; 4 mesokatepisternals (1 macrochaetous); 2 basal coxals (1 macrochaetous); legs light-gray pruinose except moderate-yellow tibiae. Wing length 1.94–2.64 mm; veins light yellowish brown; 8–11 setae on basal end of costa; 7–9 dorsal and 9–14 anterior interfractural costals; costal-section ratios: II:I 1.8–2.2; III:IV 2.8–3.2; V:IV 3.0–3.5; M_{1+2} index 1.1–1.5.

ABDOMEN.—Terga sparsely strong yellowish-brown pruinose over dark brown medially and light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 nearly square-notched and congruent with distiphallus; anterolateral margin of sternum 5 roundly right-angled; copulobus irregularly setose, acutangular posteriorly (apex rounded). Postgonite bent anteriad and postgonite uncus about 90° laterad; distiphallus very short, tapering to acute apex. Anterior margin of fused surstyli varying from acutangular (posterior breadth of surstyli about 15.0 times anterior breadth) to truncate; B-index about 2.5; C-index 0.8–1.2.

EGG.—Length 0.50–0.60 mm; maximum breadth 0.12–0.17 mm. Chorion (not illustrated) white or light yellowish brown, corrugate, with about twice as many ridges as in *H. ischiaca* (Figure 76); these infrequently anastomosing and somewhat more undulate than in *H. ischiaca*. Micropylar protuberance infundibulate and visible in dorsal view. This description in part after Berg (1950).

FIRST-INSTAR LARVA.—Length 0.80–1.50 mm; maximum breadth 0.15–0.22 mm. Frontoclypeal length 0.15–0.19 mm. Creeping welts large and conspicuous. Newly eclosed larva translucent light yellowish gray; late first-instar larva translucent, light green. This description in part after Berg (1950).

SECOND-INSTAR LARVA.—Length 1.50–4.15 mm; maximum breadth 0.25–0.60 mm. Frontoclypeal length 0.25–0.40 mm. Creeping welts not so conspicuous. Body translucent, light green.

THIRD-INSTAR LARVA.—Length 3.00–6.50 mm; maximum breadth 0.60–1.20 mm. Frontoclypeal length 0.40–0.62 mm; dorsal phragmatal ramus mostly hyaline (Figure 96). Ventral frontoclypeal index 4.0–4.5; phragmatal index 1.3–1.4; bifurcation index 2.4–2.7; clypeal-arch index 1.8–2.3. Clypeal arch smoothly sloping at about 20° in relation to lower frontoclypeal margin. Mouth-hook beak distinctly longer than base; maximum mouth-hook base thickness about 1.5 times that of beak; mouth-hook light spot large and ovoid. Prothorax and mesothorax only moderately spinulose; creeping welts of 8–13 transverse spinular rows; abdominal segment 8 with ventral, transverse row of 6 setulae and about 3–4 annuli of spinules; these spinules heavy and bidentate or tridentate dorsally. Body translucent, light green.

PUPARIUM.—Length 3.50–4.75 mm; maximum breadth 1.00–1.60 mm; distinctly scalloped laterally and subcylindrical (Figure 108). Puparial length: minimum breadth 12.0–13.0; maximum breadth: minimum breadth 3.7–4.2; anal-plate index 2.8–3.2. Prothoracic end truncate or slightly convex in ventral view (constricted posterolaterally); prothorax only slightly rugulose ventrally; head-lobe scar obovoid to subtriangular; anal plate subrectangular to crescentric, with anterior margin slightly concave.

Empty puparium usually dark brown. Early pupa light green.

TYPE.—Holotype female, USNM 13102.

TYPE-LOCALITY.—Riverton, New Jersey (IX–1909, H. S. Harbeck).

ADULT SPECIMENS EXAMINED.—560 (207♂♂ 353♀♀) from 48 localities:

Alabama: Mobile (VI–14–1953, M. Wheeler), 1♀.

Alaska: Valdez (VIII–15–1948, E. Marks), 2♀♀.

Connecticut: Candlewood Lake (VIII–30–1941, A. Melander), 1♂.

Florida: Fruit-fly survey (no dates—1951, collector unknown), 5♀♀.

Idaho: Priest Lake, Tule Island (VIII–19–no year, A. Melander), 1♂.

Illinois: Pistakee Bay (VII–7–1933, A. Melander), 2♀♀.

Iowa: Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 4♂♂, 2♀♀.

Kansas: Leavenworth County Lake (VIII–27–1962, D. L. Deonier), 7♂♂, 8♀♀.

Maryland: Chesapeake Beach (IX–8–1920, J. Aldrich), 2♂♂, 3♀♀, (IX–18–1922, J. Malloch), 1♀; Plummer's Island, Potomac River (IX–1–1962, K. Krombein), 10♂♂, 7♀♀.

Massachusetts: Fall River (VII–3–1930, A. Melander), 1♀.

Michigan: Black River, Cheboygan County (VI–20–1941, C. Berg), 8♂♂, 8♀♀; Carp River, Cheboygan County (VII–1–1941, C. Berg), 5♀♀; Cheboygan Pool, Cheboygan County (VIII–6–1941, C. Berg), 1♂, 1♀; Cheboygan County (VI–12–1940, C. Berg), 1♂, (VIII–14–1940, C. Berg), 1♂, (VIII–6–1941, C. Berg), 1♂, (VI–26–1946, C. Berg), 3♀♀, (VII–5–1946, C. Berg), 2♂♂, 1♀, (VII–16–1946, C. Berg), 1♂, (VIII–15–1946, C. Berg), 1♀, (VII–21–1947, C. Berg), 2♂♂; Chippewa County (VIII–26–1941, R. Dreisbach), 1♀; Douglas Lake, Cheboygan County (VI–25–1940, C. Berg), 1♂, 1♀, (VII–3–17–1941, C. Berg), 3♀♀, (VI–26–1946, C. Berg), 1♀, Grosse Isle, Wayne County (IX–12–1948, G. Steyskal), 1♀; Hamburg, Livingston County (VIII–13–1933, G. Steyskal), 1♀; Huron River, Washtenaw County (all reared by C. Berg: III–26 and V–7–1941, III–24 and IV–15–1942), 7♂♂, 6♀♀; Indian River, Cheboygan County (VI–29–1940, C. Berg), 1♀, (VI–6–1941, C. Berg), 1♂, (VI–29–1941, C. Berg), 3♂♂, 10♀♀; Midland County (IX–5–1937, G. Steyskal), 1♀; Monroe (VII–2–1939, G. Steyskal), 1♀; Ocqueoc Lake, Presque Isle County (VII–13–1941, C. Berg), 2♂♂, 2♀♀, (VII–15–1941, C. Berg), 1♂; Third Sister Lake, Washtenaw County (all reared by C. Berg: III–15–30–1940, V–11–20–1940, VI–29–1940, VII–2–1940, I–3–1941, II–1–3–1941, VI–20–1941, II–2–1942, IV–3–1942, and V–3–1942), 21♂♂, 23♀♀; Washtenaw County (all reared by C. Berg: VI–24–25–1940, I–31–1941, II–5–11–1941 and III–7–21–1941), 6♂♂, 10♀♀; Whitmore Lake, Washtenaw County (all reared by C. Berg: II–1–1941, III–3–18–1941, and I–23–1942), 5♂♂, 8♀♀.

Minnesota: Biological Station, Itasca State Park (VI–26–1963, D. L. Deonier), 4♀♀; Detroit Lakes (VIII–9–1935, A. Melander), 2♀♀; Eaglenest (IX–11–1958, W. Balduf), 1♀; Headwaters of LaSalle Creek, Itasca State Park (VIII–6–1963, D. L. Deonier), 1♀; Long Lake, Clearwater County (VII–15–1963, W. Schmid), 2♀♀, (VIII–8–1963, W. Schmid), 2♂♂; Rapid River Logging Camp, Hubbard County (VII–2–1963, D. L. Deonier), 1♀; Squaw Lake, Itasca State Park, (VIII–14–1963, D. L. Deonier), 4♂♂, 4♀♀.

New Jersey: Trenton (VII–21–1909, collector unknown), 2♀♀.

Ohio: Cedar Point, Sandusky River (VIII–5–1902, collector unknown), 1♂.

Ontario: Arnprior (VIII–19–22–1930, C. Curran), 1♂, 2♀♀; Black Rapids, Ottawa (VIII–6–1959, J. Vockeroth), 3♀♀; London (all trapped by W. Judd: VIII–27–1956, V–29–1958, VI–2–1958, VI–5–1958, VI–15–1958, VII–8–30–1958, VIII–14–31–1958, IX–2–27–1958, and X–9–1958), 101♂♂, 186♀♀; Marmora (VII–21–1952, J. McAlpine), 2♂♂, 1♀, (VIII–4–1952, J. McAlpine), 1♀, (VIII–7–1952, J. McAlpine), 1♀, (VIII–11–1952, J. McAlpine), 1♀, (IX–9–1952, J. McAlpine), 1♀.

Pennsylvania: West Fairview (VII–no date–1960, M. Wheeler), 1♂.

Quebec: Lac Bernard (VIII–7–1938, G. Shewell), 2♀♀.

Texas: Comal River (III–24–1942, A. Melander), 2♂♂, 8♀♀; Devil's River (VIII–29–1940, A. Melander), 1♂, (IV–27–1942, A. Melander), 1♀; Garner State Park, Uvalde County (IV–3–1955, W. Wirth), 1♂; Pedernales River, Gillespies County (III–19–1955, W. Wirth), 4♀♀.

Virginia: Alexandria (VIII–5–1922, J. Aldrich), 1♂.

West Virginia: Marlington (VIII–15–1930, G. Auxier), 1♂, 4♀♀.

IMMATURE SPECIMENS EXAMINED: 60 from 6 localities:

Michigan: Cheboygan County (collected and reared by C. Berg); Third Sister Lake, Washtenaw County (collected and reared by C. Berg).

Minnesota: Biological Station, Itasca State Park (collected and reared by D. L. Deonier); Long Lake, Clearwater County (collected by W. Schmid); Rapid River Logging Camp, Hubbard County (collected and reared by D. L. Deonier); Squaw Lake, Itasca State Park (collected and reared by D. L. Deonier).

REMARKS.—*Adult.* Habitats recorded: leaves of *Potamogeton amplifolius, P. natans, P. richardsonii, P. nodosus, Polygonum scabum, Nuphar advena,* and fern.

According to Berg (1950), adult *H. cruralis* feed on *Potamogeton* leaves by chewing small holes in them. However, they are polyphagous, for they attack insects, especially congeners, trapped in the surface film. From these and from dead and decaying arthropods, they suck tissue fluids and possibly fungal fragments.

Berg surmised that the unperfected motor coordination observed in newly emerged adults of this species indicated a high risk of drowning during emergence in rough water.

I observed what may have been epigamic behavior at Squaw Lake, Itasca State Park, when two specimens approached each other while holding their wings about 45° from their abdomina. They suddenly flew away before I could capture them. At this same locality, I briefly observed a pair, in copulation, skim rapidly over the water surface for about 2 meters between two floating leaves. Berg reared flies which mated within 24 hours after emergence and oviposited within 24 hours after mating. He found that females deposited eggs parallel in a single-layered mass in partially concealed sites, especially in broken midribs of leaves and in old, open leaf mines. Oviposition observed was always near the water surface. In natural microhabitats, the females oviposited in folded leaves and stipules, and on stems near the water surface.

Egg and larva. In Berg's work, the incubation period ranged from 2 to 7 days. The newly hatched larva immediately tried to excavate a mine in any nearby leaf. This leaf could be floating or submerged. The first larval stadium ranged from 2 to 3 days, the second from 5 to 8 days, and the third from 10 to 18 days. I found the third larval stadium ranged from 5 to 7 days for eight larvae. Berg found that the larvae migrated from dying or skeletonized leaves to fresh ones. In several observations on infestations of *Potamogeton richardsonii,* he found a lower leaf with a mine containing first-instar exuviae, the next higher leaf with second-instar exuviae in a mine, and two successively higher leaves containing, respectively, an empty mine and a mature third-instar larva or a puparium.

Dr. W. Schmid collected a second-instar larva and several puparia in *Potamogeton amplifolius* growing at a depth of 5.8 meters in Long Lake, Clearwater County, Minnesota. Occurrence of larvae at this depth indicates that larvae are sometimes affected by water current and wind either directly during their random migrations between leaves or indirectly by dislocation of host plants. Judd (1964) caught 297 adults in floating emergence traps over sites with depths ranging from 0.6 to 9.0 meters. *Potamogeton amplifolius* grew at all of these sites in Saunders Pond, near London, Ontario.

Berg found larvae of the three instars overwintering in a quiescent state in the winter buds of several species of *Potamogeton* under the ice.

Puparium. The puparial phase ranged from 8 to 14 days in Berg's laboratory. For six puparia, I found the phase range to be 7–9 days. The third-instar larva usually pupariated with its spiracular peritremes inserted in a leaf midrib. The life cycle from egg to egg completed several times in Berg's laboratory ranged from 32 to 53 days, with a mean of 41 days.

Host plants. Berg collected larvae and puparia from *Potamogeton alpinus, P. amplifolius, P. epihydrus, P. foliosus, P. gramineus, P. illinoensis, P. natans, P. nodosus, P. praelongus, P. richardsonii,* and *P. zosteriformis. Potamogeton amplifolius, P. richardsonii,* and *P. praelongus* had the highest percentages of infestation.

Parasites. Berg reared the braconids *Ademon niger, Chorebidea* sp., and *Chorebidella bergi* and the diapriid *Trichopria columbiana* from puparia of *H. cruralis.* I have reared *Ademon niger* from specimens collected in Virginia.

Hydrellia decens Cresson

Hydrellia decens Cresson, 1931, p. 107; 1944b, pp. 170, 171.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 9–11 aristal rays; all fronto-orbitals anteriorly inclined; 6–8 dorsal and 8–9 anterior interfractural costals; face light yellowish brown or yellowish gray medially, with light gray vitta along secondary facial row; thoracic pleuron with one continuous light-gray area. Female length 2.04–2.21 mm.

HEAD.—Face light yellowish brown or yellowish gray medially with lunule and vitta along secondary facial row light gray; 4–6 medially inclined pfa; 5–8 medially inclined sfa; epistomal index 1.0–1.2; mesofacial index 2.0–2.2; vertex index 5.0–7.0; A-index 1.8–2.2; ocular index 5.5–8.0. Palpus dark brown; 9–11 aristal rays; antenna dark brown; frontal vitta semiglossy dark brown; parafrontale (except strong yellowish-brown fronto-orbital area) opaque very dark brown; fronto-orbitals anteriorly inclined; 13–16 postoculars.

THORAX.—Ppn semiglossy dark brown and mesonotum glossy dark grayish green; 3–4 adc and 2 pdc; pleuron light gray except semiglossy light brown on upper fifth of mesanepisternum, around wing base, and on laterotergite; legs (except light-gray coxae and dark-brown tarsi) dark brown with sparse light-gray pruinosity. Wing length 2.30–2.48 mm; veins dark brown; 6 setae on basal end of costa; 6–8 dorsal and 8–9 anterior interfractural costals; costal-section ratios: II:I 2.2–2.6; III:IV 2.8; V:IV 3.2–3.6; M_{1+2} index 1.3–1.5.

ABDOMEN.—Most of terga glossy dark grayish green.

TYPE.—Holotype female, USNM 21842.

TYPE-LOCALITY.—Near Plummer's Island, Potomac River, Maryland (VIII–12–1914, R. C. Shannon).

SPECIMENS EXAMINED.—2 ♀ ♀ from 2 localities:

Maryland: Plummer's Island, Potomac River (VIII–13–1913, W. McAtee), 1 ♀; near Plummer's Island, Potomac River (VII–14–1914, R. Shannon), 1 ♀.

REMARKS.—Although the male is still unknown, I consider this a distinct species on the basis of geographic distribution and the speciation trend in the *H. proclinata* group. At the present stage, one must rely on the geographic distribution and the small color differences to distinguish *H. decens* from *H. proclinata* and *H. melanderi.*

Hydrellia deceptor, new species

FIGURES 42, 94

DIAGNOSIS.—Palpus moderate yellow; prementum light gray; 7–9 aristal rays; vertex index 6.5–7.5; ocular index 7.5–9.5; lower half of postocular area light gray, upper half light brown; thoracic pleuron light gray. Male length 1.79 mm; female 2.04–2.13 mm. Male terminalia as in Figure 42.

HEAD.—Face light gray or yellowish gray; 4–6 pfa; epistomal index 1.1–1.4; mesofacial index 2.0–2.4; vertex index 6.5–7.5; A-index 2.0–2.3; ocular index 7.5–9.5. Palpus medium yellow; 7–9 aristal rays; prementum light gray; antenna velvety dark brown; frons semiglossy dark brown except moderate olive-brown fronto-orbital area; 13–17 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 3–4 adc and 2 pdc; pleuron light gray; legs densely light-gray pruinose except dark-brown tarsi. Wing length 1.99–2.55 mm; veins dark brown; 6–8 setae on basal end of costa; 6–9 dorsal and 8–11 anterior interfractural costals; costal-section ratios: II:I 2.2–2.5; III:IV 2.5–3.2; V:IV 3.0–4.0; M_{1+2} index 1.3–1.6.

ABDOMEN.—Terga moderate brown except light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 acutangular in form of blunt hook; copulobus acuminate posteriorly and irregularly setose. Postgonite and postgonite uncus bent slightly laterad; distiphallus ventrally lamellate and tapering to acutangular, retuse apex. Anterior margin of fused surstyli narrowly indented medially from broad convexity; B-index about 2.2; C-index 0.6–1.0.

TYPE.—Holotype male, USNM 70531.

TYPE-LOCALITY.—Sacramento, California (IX–20–1957, A. A. Grigarick).

PARATYPES.—3 ♀ ♀ from Sacramento, California (IX–21–1957, A. Grigarick), in UCD and ISC.

REMARKS.—This species is so similar to *H. notiphiloides* that one should study the male terminalia to confirm determinations.

Host plants. Grigarick reared a few specimens from *Sagittaria* sp. collected near Sacramento, California, 20 and 21 September, 1957 during his research on *H. griseola.* I found no indication as to whether this *Sagittaria* species was an incidental puparial host or a more constant host for larvae and puparia. Grigarick very probably collected the host plants in or near a rice field.

Hydrellia definita Cresson

FIGURE 60

Hydrellia definita Cresson, 1944b, pp. 165–166.—Deonier, 1964, p. 116; 1965, pp. 500, 505 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus mostly moderate yellow, but partly dark brown; 6–8 aristal rays; mesofacial index 2.0–2.3; body length:wing length 0.9–1.0; thoracic pleuron yellowish gray except light brown on lower half of propleuron, anterior part of mesokatepisternum, and laterotergite; costal section V:IV 3.6–4.2. Male length 1.73–2.13 mm; female 1.87–2.55 mm. Male terminalia as in Figure 60.

HEAD.—Face yellowish gray medially, light gray laterally; 4–6 pfa; 1–4 sfa; epistomal index 1.1–1.7; mesofacial index 2.0–2.3; vertex index 4.8–5.6; A-index 1.5–2.7; ocular index 8.0–13.0. Palpus mostly moderate yellow but partly, or infrequently wholly, dark brown; 6–8 aristal rays; antenna, fronto-orbital area, and frontal vitta dark brown; most of parafrontale velvety dark brown; 12–16 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 4–6 adc and 2–3 pdc; pleuron yellowish gray except light brown on lower half of propleuron, anterior part of mesokatepisternum, and laterotergite; legs light-gray pruinose except dark brown tarsi. Wing length 1.96–2.72 mm; veins light yellowish brown; 6–10 setae on basal end of costa; 7–10 dorsal and 8–12 anterior interfractural costals; costal-section ratios: II:1 2.5–3.0; III:IV 2.8–3.5; V:IV 3.6–4.2; M_{1+2} index 1.3–1.8.

ABDOMEN.—Terga semiglossy dark gray. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 roundly obtusangular; copulobus somewhat sinuate posteriorly and irregularly setose. Postgonite bent anteriad and postgonite uncus straight; distiphallus of uniform breadth to mucronate and ventrally lamellate apex. Anterior margin of fused surstyli broadly emarginate; B-index about 2.8; C-index 1.8–2.0.

TYPE.—Holotype male, ANSP 890.

TYPE-LOCALITY.—Spanish Fork, Utah (no dates, D. E. Hardy).

SPECIMENS EXAMINED.—64 (19♂♂, 45♀♀) from 24 localities:

Alaska: King Salmon, Naknek River (VII–31–1952, W. Mason), 1♀.

California: Jenks Lake (VII–7–1950, A. Melander), 1♂.

Illinois: Centerville, Sangamon River (VIII–16–1914, collector unknown), 1♀.

Iowa: Ames (VIII–4–1960, D. L. Deonier), 1♀; Banner Mine Area, Warren County (VIII–7–1960, D. L. Deonier), 1♂, 1♀; Lake Odessa, Louisa County (VIII–9–1960, D. L. Deonier, 1♂, 7♀♀; Little Wall Lake, Hamilton County (IX–22–1962, D. L. Deonier), 1♀; Springbrook State Park, west ½ sec. 33, T. 8 north, R. 31 west, Guthrie County (VII–19–1960, D. L. Deonier), 1♂.

Kansas: Kansas University Natural History Reservation near Lawrence, Douglas County (VI–7–1963, D. L. Deonier), 1♀; Leavenworth County Lake (VIII–27–1962, D. L. Deonier), 1♀; Sappa Lake, Decatur County (VIII–31–1961, D. L. Deonier), 1♀.

Michigan: Emmett County (VII–14–1954, C. Berg), 2♂♂, 3♀♀; Vineyard Lake (VIII–1–1954, G. Steyskal), 1♀.

Minnesota: Basewood Lake, sec. 9 T. 64 north, R. 10 west, Lake County (VIII–16–1950, R. Namba), 1♀; Itasca State Park (VI–20–1938, H. Milliron), 1♀; west side across from Biological Station, Lake Itasca (VII–28–1963, D. L. Deonier), 3♀♀; 2.5 miles west of Waubun (VIII–18–1963, D. L. Deonier), 4♂♂, 4♀♀.

Nebraska: Lincoln, Lancaster County (VIII–16–1960, W. Rapp), 1♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 7♂♂, 13♀♀.

Ontario: Pembroke (VII–3–1938, A. Melander), 1♀.

Saskatchewan: Rock Glen (VIII–2–1955, C. Miller), 1♂.

South Dakota: Hot Springs (VII–13–1924, collector unknown), 1♀.

Wyoming: Slide Lake (VIII–14–1951, collector unknown), 1♀; 12 miles northwest of Lusk (VII–no date–1895, collector unknown), 1♂.

REMARKS.—*Hydrellia definita, H. manitobae, H. suspecta, H. subnitens,* and *H. amnicola* seem to constitute a distinct species group.

Adult. Habitats recorded: leaves of *Potamogeton nodosus* and *Polygonum scabrum;* tundra, limnic wrack, sedge meadow, and at light.

I observed males pushing their head and thorax up and down before females at Dryden Lake, Tompkins County, New York.

Hydrellia discursa, new species

FIGURES 30, 70, 77, 80, 97, 113, 125, 127

Hydrellia ascita; Cresson, 1942 [in part], p. 78.

DIAGNOSIS.—Palpus moderate yellow; 5–8 aristal rays; face planate; vertex index 4.0–5.4; ocular index 4.4–5.6; male abdomen slightly convex posteriorly; female cercus ovoid apically and truncate basally; antennal segment 3 at least partly moderate yellow; apicodorsal antennal prominent. Male length 1.79–1.96 mm; female 1.70–2.30 mm. Male terminalia as in Figure 30; female as in Figure 70.

HEAD.—Differing mainly from *H. bilobifera* in the following: mesofacial index 1.8–2.4; vertex index 4.0–5.4; ocular index 4.4–5.6.

THORAX.—Mainly as in *H. bilobifera.*

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply recessed and nearly congruent with distiphallus apex; anterolateral margin of sternum 5 with dorsal process projecting anterolaterad and covered by sternum 4; posterolateral angle of copulobus about 75° from lateral corner (partly or wholly obscured by loose fascicula of 4–5 strong macrochaetae); posteromedial margin of copulobus with notch paralleled and mostly obscured by 7–10 seriated stout setae (almost a pecten); copulobus with distinct bare space posteriad from indistinct central verruca. Postgonite bent laterad then mediad; posgonite uncus spicate, directed anteromediad; distiphallus slightly constricted in middle third and indistinctly carinate and lamellate ventrally to mucronate apex; most of basiphallus exposed ventrally. Anterior margin of fused surstyli deeply and broadly concave; B-index about 2.0; C-index 0.5–0.8. Syntergum 9+10 slightly convex posteriorly. Female terminalia: tergum 8 slightly shorter than sternum 8; cercus irregularly setose laterally, ovoid apically, truncate basally and less than 1.5 times as long as wide (lateral view). Segment 7 with setae all along posterolateral margin; median spermatheca cupuliform and usually not as long as cercus.

Egg.—Length 0.47–0.56 mm; maximum breadth 0.14–0.16 mm. Chorion (Figure 77) white (initially) with inconspicuous, occasionally anastomosing longitudinal ridges; wide spaces between ridges smooth as in those of *H. bilobifera.* Micropylar protuberance infundibulate, visible in dorsal view; end opposite micropylar protuberance with indistinctly lacunose papilla.

First-instar larva.—Length 0.35–0.75 mm; maximum breadth 0.10–0.15 mm. Frontoclypeal length not measured; clypeal arch distinctly more angular at level of cheliform spot in lateral view than in third-instar larva; supraspiracular protuberance present with central spinous seta; terminal peritremal spine present; verriculose subspiracular protuberance present; dorsal setae and spinules apparently absent except on abdominal segment 8. Newly eclosed larva translucent, light yellowish gray; late first-instar larva same but with greenish-yellow tinge.

Second-instar larva.—Length 1.00–3.50 mm; maximum breadth 0.20–0.50 mm. Frontoclypeal length not measured. Dorsal setae absent; dorsal spinules restricted to thorax and abdominal segment 8; abdominal segment 8 with 3–4 annuli of spinules. Body translucent, light green.

Third-instar larva.—Length 3.50–5.50 mm; maximum breadth 0.30–0.60 mm. Frontoclypeal length 0.42–0.50 mm (Figure 97). Ventral frontoclypeal index 2.5–2.8; phragmatal index 1.0–1.2; bifurcation index 3.6–3.8; clypeal-arch index 1.7–2.0. Clypeal arch sloping gradually at 10°–15° and slightly convex at level of cheliform spot. Mouth-hook beak and base lengths subequal; maximum mouth-hook base thickness about 1.8 times that of beak; mouth-hook light spot small, discal. Prothorax and metathorax moderately spinulose; dorsal setae and spinules restricted to thorax and abdominal segment 8; abdominal segment 8 without ventral, transverse row of setulae, but with 3–4 annuli of spinules. Body translucent, light green.

Puparium.—Length 2.75–4.00 mm; maximum breadth 0.65–1.00 mm; fusiform (Figure 113). Puparial length:minimum breadth 15.0–23.0; maximum breadth:minimum breadth 4.2–5.0; anal-plate index 3.5–4.0. Prothoracic end semicircular or subtriangular in ventral view; head-lobe scar circular to obovoid; maximum puparial breadth in metathorax; prothorax distinctly rugulose ventrally and laterally; anal plate subrectangular with anterior margin straight to slightly convex. Empty puparium translucent, light yellowish brown. Pupal color as in *H. bilobifera.*

Type.—Holotype male, USNM 70532.

Type-locality.—Samburg, Reelfoot Lake, Tennessee, 36°22.9′ N, 89°21.3′ W (VIII-11-1962, D. L. Deonier).

Paratypes.—112 (48♂♂, 64♀♀) from 24 localities:

California: Davis (X-21-1954, A. Grigarick), 1♂ (UCD); Maxwell, Colusa County (VIII-12-1954, A. Grigarick), 1♂ (UCD); Vidal, San Bernadino (IV-no date-1948, R. Coleman), 1♀ (USNM).

District of Columbia: Washington (VIII-13-1923, W. McAtee), 1♀ (USNM).

Florida: Cape Sable (XII-18-1949, C. Sabrosky), 1♀ (USNM).

Iowa: Goose Lake, Hamilton County (VII-2-1961, D. L. Deonier), 4♂♂ (USNM and ISC); Siewers Springs State Park, Decorah (IX-9-1961, D. L. Deonier), 2♀♀ (USNM); Spring Lake, Greene County (IX-9-1961, D. L. Deonier), 3♂♂, 4♀♀ (USNM and ISC).

Kansas: Kansas University Natural History Reservation near Lawrence, Douglas County (VI-7-1963, D. L. Deonier), 1♂, 2♀♀ (USNM and ISC); Leavenworth County Lake (VIII-27-1962, D. L. Deonier), 3♂♂, 2♀♀ (USNM and ISC); Marais des Cygnes Wildlife Refuge, Linn County (IX-5-1961, D. L. Deonier), 5♂♂, 9♀♀ (USNM and ISC).

Michigan: Cheboygan County (VII-26-1946, C. Berg), 1♂ (USNM).

Minnesota: Biological Station, Itasca State Park (VI-26-1963, D. L. Deonier), 1♂ (USNM); Bohall Trail Bog, Itasca State Park (VI-25-1963, D. L. Deonier), 1♀ (USNM); Headwaters of LaSalle Creek, Itasca State Park

(VIII–6–1963, D. L. Deonier), 2♀♀ (USNM); Mississippi River near north entrance Itasca State Park (VII–9–1963, D. L. Deonier), 1♀ (USNM).

Mississippi: Dickinson's Pond, Lamar County (VII–24–1962, D. L. Deonier), 1♂, 1♀ (DLD); Lake Shelby State Park, Forrest County (VII–24–1962, D. L. Deonier), 1♂, 2♀♀ (USNM and ISC).

Ontario: Marmora (VIII–7–1952, J. McAlpine), 2♂♂, 1♀ (CNC), (IX–8–1952, E. Smith), 3♂♂ (CNC and USNM), (IX–9–1952, J. McAlpine), 4♂♂, 1♀ (CNC and USNM); Ottawa (VII–2–1947, G. Shewell), 4♂♂ (CNC).

Tennessee: Brewer's Bar Ditch, Reelfoot Lake, 36°27.1′ N, 89°21.2′ W (VIII–10–1962, D. L. Deonier), 8♀♀ (USNM and ISC), (VIII–14–17–1962, D. L. Deonier), 1♀ (DLD); Miller's Camp, Reelfoot Lake, 36°24.3′ N, 89°20′ W (VIII–12–1962, D. L. Deonier), 5♂♂, 7♀♀ (USNM and ISC); Samburg, Reelfoot Lake, 36°22.9′ N, 89°21.3′ W (VIII–11–16–1962, D. L. Deonier), 9♂♂, 16♀♀ (USNM and ISC).

Texas: Galveston (IX–13–1953, M. Wheeler), 1♂, 1♀ (USNM).

Immature specimens examined.—45 from 3 localities:

Tennessee: Samburg, Miller's Camp, and Brewer's Bar Ditch, Reelfoot Lake (collected and reared by D. L. Deonier).

Remarks.—According to Berg (1950, p. 391): "Cresson designated only the flies reared from *P. alpinus* (*P. tenuifolius*) collected at Nigger Creek, Cheboygan County, in his type series, and he identified the others from other *Potamogeton* species as a variety of *H. ascita.*" Since I discovered several specimens of *H. discursa* among material determined by Cresson as *H. ascita,* Cresson may have suspected the existence of a cryptic species when he designated some as a variety of *H. ascita.*

Adult. Habitats recorded: leaves of *Potamogeton gramineus, P. nodosus, P. epihydrus, Nuphar advena, Nymphaea tuberosa, Nelumbo lutea, Zizania aquatica,* and *Oryza sativa.*

At Dickinson's Pond, Lamar County, Mississippi, the male of a pair observed in copulation held an attitude almost perpendicular to the long axis of the female's abdomen.

Egg and larva. The incubation period ranged from 3 to 5 days for 26 eggs. This is approximate, for I collected the egg masses a short time after they were deposited. Examination immediately after collection revealed the eggs to be in an early embryonic stage. I collected the egg masses on floating leaves of *Potamogeton gramineus* at Samburg, Reelfoot Lake, Tennessee. I collected several egg masses on stems and leaves of *Nelumbo lutea* and *Alisma* sp. in the same locality. I did not determine the species, but circumstances indicated they were *H. discursa.* Three larvae passed the first stadium in three days. Since I collected several adults in the vicinity of water primrose, *Jussiaea repens,* I supplied leaves of this plant to first-instar larvae of *H. discursa.* They did not mine in them. I did not measure the second larval stadium, and I obtained only an approximate measurement of 6 days for the third stadium of one larva, since I only fixed the time of molting within two days.

Puparium. The puparial phase ranged from 7 to 10 days for four specimens. The larvae pupariated in the leaf axil, on the abaxial side of floating leaves, and on the adaxial side of submerged leaves.

Host plants. I found larvae and puparia only in *Potamogeton gramineus* and *P. nodosus.* In addition, I examined *Alisma* sp., *Heteranthera dubia, Sagittaria australis, Jussiaea repens,* and *Zizaniopsis miliacea* for larvae and puparia of this species.

Parasites. I reared one braconid of undetermined species from a puparium and observed an undetermined parasitic larva within a late pupa.

Hydrellia flavicoxalis Cresson

Figure 62

Hydrellia flavicoxalis Cresson, 1944b, p. 167.—Wirth, 1965, p. 744 [catalog listing].

Diagnosis.—Palpus moderate yellow; 7–8 aristal rays; vertex index 7.0–10.0; body length: wing length 0.9; male tergum 5 broadly rounded posteriorly; 4–5 mesokatepisternals; 2 basal coxals; thoracic pleuron light gray. Male length 2.38 mm; female 2.64 mm. Male terminalia as in Figure 62.

Head.—Face yellowish gray or light yellowish brown; 5–6 pfa; epistomal index 1.4–1.8; mesofacial index 2.0–2.5; vertex index 7.0–10.0; A-index 1.7–1.9; ocular index 5.0–6.0. Palpus moderate yellow; 7–8 aristal rays; antenna and most of parafrontale dark brown; frontal vitta and fronto-orbital area moderate olive-brown; 14–16 postoculars.

Thorax.—Ppn usually yellowish gray; mesonotum moderate brown; 4 adc and 4 pdc; pleuron light gray except upper posterior third of mesanepisternum moderate olive-brown; 4–5 mesokatepisternals (1 macrochaetous); 2 basal coxals (1 macrochaetous);

legs light-gray pruinose except dark brown tarsi. Wing length 2.60–2.81 mm; veins light yellowish brown; 6–8 setae on basal end of costa; 9–10 dorsal and 11–14 anterior interfractural costals; costal-section ratios: II:I 2.5–3.2; III:IV 2.6–3.0; V:IV 3.5–3.9; M_{1+2} index 1.3–1.5.

ABDOMEN.—Terga 1–3 or 2–4 moderate brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 straight; anterolateral margin of sternum 5 prominent and roundly right-angled; copulobus slightly angular posteriorly (about 100° from lateral corner), irregularly notched and irregularly setose. Postgonite bent anterolaterad and postgonite uncus straight; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused surstyli narrowly and deeply notched medially to about midlength of structure, and prominently lobate laterally; B-index about 2.0; C-index 6.0–8.0.

TYPE.—Holotype male, ANSP 6666.

TYPE-LOCALITY.—Walden, Jackson County, Colorado (VII–27–1938, M. T. James).

SPECIMENS EXAMINED.—1 ♀ with same collection data as for holotype; these two are the only known specimens of this species. Walden, Colorado, is in North Park, a high basin isolated by a ring of mountain ranges having several peaks from 11,000 to 12,000 feet high. Thus, this species may very well have a very small distribution.

REMARKS.—This is a member of the *H. griseola* species group as indicated by the male terminalia and the habitus.

Hydrellia floridana, new species

FIGURE 31

DIAGNOSIS.—Palpus dark brown; 6–7 aristal rays; ocular index 9.0 or more; wing length 1.32–1.53 mm; face light gray or yellowish gray; parafrontale mostly velvety dark brown; lower third of postocular region light gray, upper two-thirds moderate olive-brown; male mid tibia expanded. Male length 1.19–1.39 mm; female 1.36–1.60 mm. Male terminalia as in Figure 31.

HEAD.—Face light gray or yellowish gray; 4 pfa; epistomal index 1.2–1.4; mesofacial index 1.8–2.1; vertex index 4.5–5.5; A-index 2.0–2.3; ocular index 9.0–15.0. Palpus dark brown; 6–7 aristal rays; antenna and frontal vitta dark brown; parafrontale (except moderate olive-brown fronto-orbital area) velvety dark brown; 13–15 postoculars.

THORAX.—Ppn and scutellum bronzed moderate olive-brown; remainder of mesonotum dark gray; 3–4 adc and 2 pdc; pleuron mostly moderate olive-brown; coxae dark gray and tarsi dark brown; remainder of legs light-gray pruinose; male mid tibia expanded. Wing length 1.32–1.53 mm; veins light brown; 5–7 setae on basal end of costa; 5–6 dorsal and 6–8 anterior interfractural costals; costal-section ratios: II:I 2.0–2.4; III:IV 3.1–3.6; V:IV 3.4–3.7; M_{1+2} index 1.6–2.0.

ABDOMEN.—Terga semiglossy dark gray. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 obtusangular (115°–125°); posterolateral angle of copulobus roundly 45° from medial corner; copulobus regularly setose. Postgonite directed anteriad (bent slightly anterolaterad); postgonite uncus absent; pregonite projecting farther anteriad than postgonite; distiphallus transversely expanded proximally and near slightly convex apex; distiphallus lamellate ventrally and ventrally bicarinate preapically. Anterior margin of fused surstyli undulate (convex medially); length of fused surstyli less than half the breadth; C-index 1.0–1.3.

TYPE.—Holotype male, USNM 70533.

TYPE-LOCALITY.—Lacoochee, Florida (VIII–18–1930, P. W. Oman).

PARATYPES.—53 (25 ♂♂, 28 ♀♀) from 13 localities:

Florida: Baxter (IX–no date–1954, M. Wheeler), 5 ♂♂, 1 ♀ (USNM, ISC, and MRW); DeFuniak Springs, Walton County (VIII–1–1962, D. L. Deonier), 1 ♂, 1 ♀ (USNM and ISC); Lake Worth (VIII–8–1951, W. Wirth), 3 ♂♂, 5 ♀♀ (USNM); Orlando (IV–18–1956, W. Wirth), 1 ♂ (USNM); Winter Garden (III–6–1942, A. Melander), 1 ♂ (USNM).

Georgia: Waycross (VI–30–1953, M. Wheeler), 2 ♂♂, 2 ♀♀ (USNM and MRW).

Louisiana: Bethany (IX–2–1952, M. Wheeler), 1 ♂ (MRW).

Mississippi: Bluff Creek, Vancleave, Jackson County (VI–21–1962, D. L. Deonier), 1 ♀ (ISC); Dickinson's Pond, Lamar County (VII–24–1962, D. L. Deonier), 3 ♀♀ (DLD); gravel pit near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson County (VI–9–1962, D. L. Deonier), 1 ♀ (ISC), (VI–17–1962, D. L. Deonier), 4 ♂♂, 2 ♀♀ (USNM and ISC); Saucier (VI–13–1953, M. Wheeler), 1 ♂ (MRW); Vancleave Road, Jackson County, 30°25.1′ N, 88°46′ W (VI–23–1962, D. L. Deonier), 6 ♂♂, 7 ♀♀ (USNM and ISC); Vancleave Road, Jackson County, 30°28′ N, 88°43′ W (VI–28–1962, D. L. Deonier), 2♂♂, 2♀♀ (USNM, ISC, and DLD), (VII–7–1962, D. L. Deonier), 3♀♀ (USNM and ISC).

REMARKS.—Males of this species can be distinguished from the other members of the *H. prudens* species group by their extremely short fused surstyli.

Adult. Habitats recorded: leaves of *Nymphaea odorata*; stems of *Juncus repens, Eleocharis wolfii, E. mammilata,* and *E. tuberculosa.*

Hydrellia formosa Loew

FIGURE 43

Hydrellia formosa Loew, 1861, pp. 355–356; 1862, p. 154; 1864, p. 94.—Osten Sacken, 1878, p. 202.—Becker, 1896, p. 269 [bibliographic listing].—Howard, 1900, p. 593 [biology].—Aldrich, 1905, p. 626.—Jones, 1906, p. 185 [catalog listing].—Kahl, 1917, p. 385 [biology].—Johnson, 1925, p. 271.—Cresson, 1931, p. 104; 1936, p. 259; 1938, p. 33; 1944b, pp. 163, 172.—Deonier, 1964, p. 115; 1965, pp. 500–506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–11 aristal rays; body length:wing length 1.0–1.2; ocellar absent; frons (except vertical sockets and ocellar triangle) velvety black; notopleuron, supra-alar area, and scutellum velvety brownish black; thoracic pleuron contrastingly velvety brownish black and light gray. Male length 1.27–1.53 mm; female 1.39–1.79 mm. Male terminalia as in Figure 43.

HEAD.—Face light yellowish brown, light gray, or white; 3–4 pfa; no sfa; epistomal index 1.1–1.5; mesofacial index 2.0–2.8; vertex index 6.0–13.0; A-index 2.0–2.4; ocular index 5.5–7.5. Palpus moderate yellow; 8–11 aristal rays; antennal segment 3 mostly moderate yellow, 1 and 2 mostly dark brown; frons (except glossy dark-brown ocellar triangle and sockets of verticals) velvety black; ocellar absent; 11–14 postoculars.

THORAX.—Ppn and mesoscutum glossy brownish black; notopleuron, supra-alar area, and scutellum velvety brownish black; 2–3 adc and 2 pdc; upper posterior two-thirds of mesanepisternum, entire mesanepimeron and laterotergite light gray; remainder of pleuron velvety brownish black; legs light-gray pruinose except moderate-yellow trochanters, tarsi, and at least distal third of mid and hind tibiae. Wing length 1.36–1.96 mm; veins light yellowish brown; 4–7 setae on basal end of costa; 5–7 dorsal and 5–9 anterior interfractural costals; costal-section ratios: II:I 2.4–2.7; III:IV 3.4–4.2; V:IV 3.4–4.0; M_{1+2} index 1.6–2.0.

ABDOMEN.—Terga semiglossy brownish black. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 roundly obtusangular; copulobus acutangular posteriorly (rounded 75°); posterior half of copulobus irregularly setose. Postgonite bent laterad; postgonite uncus straight, directed anterolaterad; distiphallus gradually constricted at midlength, with semicircular apex. Anterior margin of fused surstyli broadly concave; B-index about 2.0; C-index 1.8–2.2.

TYPE.—Holotype female, MCZ 11153.

TYPE-LOCALITY.—Pennsylvania (collector: Osten Sacken).

SPECIMENS EXAMINED.—587 (217♂♂, 370♀♀) from 90 localities east of the Rocky Mountains:

Alabama: Chattahoochee State Park, Houston County (III–24–1954, G. Steyskal), 1♂, 1♀.

Arkansas: Calion, Union County (IX–3–1952, M. Wheeler), 1♀; Rison, Cleveland County (IX–3–1952, M. Wheeler), 4♂♂, 1♀.

Connecticut: Redding (V–23–1936, A. Melander), 1♀; Storrs (VI–8–1931, A. Melander), 1♂; southwest corner of Sleeping Giant State Park, near Hamden (VII–29–1961, J. Laffoon), 1♂, (VII–30–1961, J. Laffoon), 2♂♂, 2♀♀.

District of Columbia: Rock Creek Park, Washington (VI–15–1913, R. Shannon), 1♀, (VIII–14–1931, J. Aldrich), 1♀; Washington (VIII–17–1913, J. Aldrich), 5♀♀, (VIII–16–1952, J. Laffoon), 1♂.

Florida: Baxter (IX–no date–1954, M. Wheeler), 1♀; DeFuniak Springs, Walton County (VIII–1–1962, D. L. Deonier), 1♀; Fort Ogden, DeSoto County (IV–9–1952, J. Vockeroth), 1♂; Silver Springs, near Ocala, Marion County (IV–5–1953, W. Mason), 1♂, 4♀♀; Torreya State Park (IV–28–1952, O. Peck), 1♀.

Georgia: Clayton, Rabun County, 2,000 feet (V–18–1926, J. Bradley), 1♂; Waycross (VI–30–1953, M. Wheeler), 1♂, 3♀♀.

Indiana: LaFayette (VII–14–1915, J. Aldrich), 1♀, (VII–4–1916, J. Aldrich), 2♂♂, 2♀♀, (VI–25–1916, J. Aldrich), 2♂♂, 2♀♀, (VI–29–1916, J. Aldrich), 1♀, (VII–7–1916, J. Aldrich), 1♀, (VIII–31–no year, J. Aldrich), 1♀; Lake County (VII–25–1950, W. Kwolek), 1♀, (IX–15–1950, W. Kwolek), 1♀; Valparaiso (VI–29–1954, D. Cable), 1♂.

Iowa: Fraser Dam, Boone County (IX–4–1960, D. L. Deonier), 1♂, 2♀♀; Siewer's Springs State Park, Decorah (IX–9–1961, D. L. Deonier), 1♂, 1♀; 3 miles east-southeast of Waterville, Allamakee County (VIII–2–1960, D. L. Deonier), 3♂♂, 1♀.

Kansas: 1.5 miles south of Bonner Springs, Johnson County (VIII–28–1962, D. L. Deonier), 1♀.

Louisiana: Lake Providence (VII–14–1953, W. Wirth), 1 ♂, 5 ♀ ♀; White Sulphur Springs (IX–no date–1954, M. Wheeler), 3 ♂ ♂, 3 ♀ ♀.

Maine: Kennebec Point (VIII–no date–1900, G. Clapp), 1 ♂.

Maryland: Cabin John (VI–4–1916, R. Shannon), 1 ♂; Catoctin Furnace (VIII–9–1920, J. Aldrich), 2 ♀ ♀; Chesapeake Beach (VII–3–1924, J. Malloch), 1 ♀; (VIII–no date–1926, J. Aldrich), 1 ♀; Glen Echo (VIII–12–no year, J. Aldrich), 8 ♀ ♀, (VIII–22–1922, J. Malloch), 1 ♂; Pennyfield Lock of Chesapeake and Ohio Canal (VII–5–1953, A. Stone), 2 ♂ ♂, 5 ♀ ♀; Plummer's Island, Potomac River (VIII–5–1913, R. Shannon), 1 ♀, (IX–1–1913, W. McAtee), 1 ♀; near Plummer's Island, Potomac River (V–17–1914, R. Shannon), 1 ♀, (X–10–1914, R. Shannon), 1 ♀, (V–22–1915, R. Shannon), 2 ♂ ♂, 3 ♀ ♀; Prince Georges County (VII–4–1954, C. Sabrosky), 1 ♂.

Massachusetts: Boston (V–no dates, A. Melander), 1 ♂, (VI–no dates, collector unknown), 1 ♂; Woods Hole (VII–22–no year, A. Sturtevant), 1 ♀.

Michigan: Detroit (VI–19–1938, G. Steyskal), 1 ♀, (IX–6–1942, G. Steyskal), 1 ♂, (VII–3–1944, G. Steyskal), 2 ♀ ♀; Grand Rapids (IX–13–1937, collector unknown), 2 ♀ ♀; Midland County (VII–23–1948, R. Dreisbach), 1 ♀.

Mississippi: Bellefontaine Point, Jackson County (VII–10–1962, D. L. Deonier), 1 ♀; Bluff Creek, Vancleave, Jackson County (VI–18–1962, D. L. Deonier), 1 ♀; Dickinson's Pond, sec. 3, T. 4 north, R. 14 west, Lamar County (VII–11–1962, D. L. Deonier), 11 ♂ ♂, 39 ♀ ♀, (VII–24–1962, D. L. Deonier), 13 ♂ ♂, 27 ♀ ♀; Highway 59, George County, 30°45.7′ N, 88°45.1′ W, (VII–24–1962, D. L. Deonier), 1 ♀; Lake Shady, Lamar County (VII–11–1962, D. L. Deonier), 5 ♂ ♂, 13 ♀ ♀, (VI–29–1962, D. L. Deonier), 3 ♂ ♂, 3 ♀ ♀; gravel pit near U.S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson County (VI–9–1962, D. L. Deonier), 2 ♂ ♂; Saucier (VI–13–1953, M. Wheeler), 3 ♀ ♀.

Missouri: Atherton (VIII–21–1915, C. Adams), 1 ♀, (IX–27–1915, C. Adams), 1 ♀, (VI–25–1916, C. Adams), 2 ♂ ♂, 1 ♀.

New Jersey: Trenton (VII–11–1914, collector unknown), 1 ♂; Vineland (VII–no date–1954, M. Wheeler), 1 ♀.

New York: Bear Mountain (V–18–1941, A. Melander), 1 ♂, 1 ♀; Cold Spring Harbor, Long Island (VII–no dates, A. Melander), 2 ♂ ♂; Ithaca, campus (IX–24–1925, P Babing), 1 ♀; Ithaca (VI–no dates, collector unknown), 1 ♀; Lancaster (VII–25–1946, L. Beamer), 1 ♂, (VII–25–1946, R. Beamer), 1 ♂; 1 mile northwest of Pine Lake, Fulton County, 1,600 feet (VIII–5–1961, D. L. Deonier), 1 ♀.

North Carolina: Asheville (V–3–1957, J. Vockeroth), 1 ♂; Clingman's Dome, Great Smoky Mountains National Park, 6,300–6,642 feet (V–20–1957, J. Vockeroth), 1 ♂, 1 ♀, (V–28–1957, J. Vockeroth), 2 ♀ ♀; Highlands, 3,800 feet (V–8–1957, J. Vockeroth), 1 ♀, (V–10–1957, J. Vockeroth), 1 ♂, (V–13–1957, J. Vockeroth), 1 ♀, (VII–23–1957, J. Vockeroth), 1 ♀; Highlands, Macon County, 35°8.2′ N, 83°11.3′ W, 3,850 feet (VI–28–1958, J. Laffoon), 1 ♀.

Nova Scotia: Truro (no dates–1913, R. Matheson), 1 ♂.

Ohio: Rome (VII–19–1946, R. Beamer), 1 ♂.

Ontario: Ottawa (VIII–31–1908, J. Fletcher), 1 ♀, (VI–3–1958, J. Vockeroth), 1 ♂, 5 ♀ ♀, (VIII–26–1959, J. Vockeroth), 1 ♂.

Pennsylvania: Alleghany County (VII–10–no year, H. Smith), 2 ♂ ♂; Harmarville, Alleghany County (VII–23–1916, H. Kahl), 1 ♂, 2 ♀ ♀; Hartstown, Crawford County (VII–4–1921, H. Kahl), 1 ♀; Hills Station (VIII–30–1905, H. Kahl), 1 ♀; Lansdale (VII–3–1910, E. Cresson, Jr.), 2 ♂ ♂, 1 ♀; Ohiopyle, Fayette County (VII–26–1905, H. Kahl), 1 ♂, (VII–28–1905, H. Kahl), 1 ♂, 4 ♀ ♀, (VIII–7–1905, H. Kahl), 36 ♂ ♂, 52 ♀ ♀, (VIII–10–1905, H. Kahl), 25 ♂ ♂, 15 ♀ ♀, (VIII–11–1905, H. Kahl), 5 ♂ ♂, 8 ♀ ♀, (VIII–no date–1907, H. Kahl), 34 ♂ ♂, 33 ♀ ♀; Pittsburgh (VIII–29–1908, H. Kahl), 2 ♂ ♂, (VI–28–1909, H. Kahl), 1 ♀; Point Pleasant (V–30–1914, E. Cresson, Jr.), 1 ♂; Swarthmore (V–13–1906, E. Cresson, Jr.), 1 ♀, (VII–1–1908, E. Cresson, Jr.), 1 ♂, 6 ♀ ♀, (VI–20, VII–18, VIII–22–1909, E. Cresson, Jr.), 8 ♀ ♀, (V–1, VII–31–1910, E. Cresson, Jr.), 1 ♂, 3 ♀ ♀, (V–16, VI–27–1920, E. Cresson, Jr.), 2 ♂ ♂, 2 ♀ ♀; Westmoreland County (no dates, H. Kahl), 1 ♂, 3 ♀ ♀.

Quebec: Lac Phillipe, 45°37′ N, 76° W (VIII–22–1959, J. Vockeroth), 1 ♀.

South Carolina: Aiken (VI–13–1957, J. Vockeroth), 1 ♀; Cross Anchor (VII–3–1953, M. Wheeler), 2 ♀ ♀.

Tennessee: Clarksville (VII–2–1939, A Hardy), 1 ♀; Knoxville (VIII–18–1939, D. Hardy), 1 ♀, (IV–16–no year, collector unknown), 1 ♀; Reelfoot State Park, Reelfoot Lake, 36°21.1′ N, 89°25.5′ W (VIII–16–1962, D. L. Deonier), 7 ♂ ♂, 10 ♀ ♀.

Texas: Carthage (IX–2–1952, M. Wheeler), 1 ♂, 4 ♀ ♀; Palmetto State Park, near Ottine (VII–10–1950, M. Wheeler), 1 ♀.

Virginia: Alexandria (VI–14–1952, W. Wirth), 1 ♀; Falls Church (VII–4–1950, W. Wirth), 1 ♀, (VIII–8–1950, W. Wirth), 1 ♀, (VI–30–1951, W. Wirth), 1 ♀; (VII–22–1951, W. Wirth), 1 ♀, (VI–9–1954, W. Wirth), 1 ♀, (VII–15–1954, W. Wirth), 1 ♂, 1 ♀, (VII–no date–1954, M. Wheeler), 1 ♀, (VI–30–1960, W. Wirth), 1 ♀, (VII–24–1960, W. Wirth), 1 ♀, (VIII–6–1960, W. Wirth), 1 ♀, (VIII–8–1960, W. Wirth), 1 ♂; Great Falls (VII–21–1962, G. Steyskal), 1 ♀; Holmes Run, Falls Church (VI–20–1960, W. Wirth), 1 ♂, (VII–1–1960, W. Wirth), 1 ♀, (VII–3–1960, W. Wirth), 1 ♀, (VII–31–1960, W. Wirth), 1 ♀; Maywood, Alexandria County (VII–9–1922, M. McAtee), 1 ♀; Pimmit Run (VI–3–1923, J. Aldrich), 1 ♀; Potomac River at Scott Run, Fairfax County VI–7–1955, C. Sabrosky), 2 ♀ ♀; Saltville, Smyth County (V–4–1962, W. Wirth), 1 ♂.

West Virginia: Cranberry Glades, Pocahontas County (VII–16–1955, C. Sabrosky), 2 ♀ ♀; Fairmont (VI–22–1908, collector unknown), 1 ♂.

REMARKS.—This species is the most readily distinguishable of Nearctic *Hydrellia.* It and *H. notata* constitute a distinct group.

Adult. Habitats recorded: mats of *Hydrochloa* *caroliniensis, Hypericum punctatum,* and *Eragrostis hypnoides*; leaves of *Sporobolus* sp. (tidal marsh), *Pontederia cordata,* and *Nelumbo lutea*; stems of *Eleocharis acicularis;* moist lawn, riffle rocks, limnic wrack, open sewer, old human feces, and light trap.

Kahl (1917) stated that he found *H. formosa* very abundant on moist lawns in Fayette County, Pennsylvania. Howard (1900) reported finding a few adults on human feces.

Host plants. There is one unconfirmed rearing of this species from wheat. I believe larvae of this species may prefer gramineous hosts, for I collected many from mats of water grass and *Eragrostis hypnoides.*

Hydrellia gladiator, new species

FIGURES 24, 71

DIAGNOSIS.—Palpus moderate yellow; 5–8 aristal rays; face planate; vertex index 5.0–5.4; ocular index 3.6–4.8; male abdomen slightly convex posteriorly in lateral view; female cercus rounded basally and acute apically; antennal segment 3 at least partly moderate yellow; apicodorsal antennal prominent; wing length 2.21–2.45 mm. Male length 1.96 mm; female 2.30 mm. Male terminalia as in Figure 24; female as in Figure 71.

HEAD.—Differing mainly from *H. bilobifera* in the following: mesofacial index 2.0–2.5; vertex index 5.0–5.4; ocular index 3.6–4.8.

THORAX.—Differing mainly from *H. bilobifera* in the following: wing length 2.21–2.45 mm.

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 deeply recessed and congruent with distiphallus; anterolateral margin truncate and prominent at about 130° angle from lateral margin of copulobus; anterolateral margin with dorsal digitiform process projecting anteromediad (covered by sternum 4); copulobus slightly convex posteriorly (partly or wholly obscured by loose fascicula of 6–8 strong macrochaetae); medial margin of copulobus peninsulate (narrow digitiform lobe projecting posteriad medial to postgonite) and serially setulose; remainder of copulobus irregularly setose. Postgonite bent mediad and acuminate postgonite uncus anteromediad; distiphallus only slightly constricted proximally and preapically, with notched apex and lamellate on proximal two-thirds; most of basiphallus exposed ventrally. Anterior margin of fused surstyli deeply concave medially; B-index about 1.4; C-index 0.3–0.5. Syntergum 9+10 slightly convex posteriorly. Female terminalia: tergum 8 much longer than sternum 8; cercus irregularly setose dorsally and laterally, triangular with nearly semicircular base and about 1.6–1.7 times as long as wide (lateral view). Segment 7 with group of 4 seriated lateral setae on posterior margin; median spermatheca similar to that of *H. discursa* (Figure 70).

TYPE.—Holotype male, USNM 70534.

TYPE-LOCALITY.—Florida, reared from *Vallisneria* sp. leaves from unspecified locality (XII-28-1957, D. M. Wood).

PARATYPES.—1 ♀ with same data as holotype (USNM). These are the only known specimens of this species.

REMARKS.—This species is most similar to *H. ascita,* but even here there are marked differences in the male and female terminalia.

Hydrellia griseola (Fallén)

FIGURES 1, 3–6, 10–11, 13, 26, 130, 131, 133–137, 139–142

Notiphila griseola Fallén, 1813, pp. 250–251.—Zetterstedt, 1846, pp. 1849, 1869–1871.—Lilljeborg, 1861, pp. 205–215; figure 2 [adult], 3 and 4 [immatures; biology].—Becker, 1896, p. 167.

Hydrellia communis Robineau-Desvoidy, 1830, p. 790.

Hydrellia griseola.—Macquart, 1835, p. 523.—Walker, 1856, p. 345.—Loew, 1860, pp. 17, 22, 46; 1870, p. 7.—Schiner, 1864 [at least in part], pp. 246–247.—Kawall, 1867, pp. 120–121 [biology].—Stein, 1867, pp. 395–397 [biology].—von Frauenfeld, 1869, p. 603 [biology].—Brischke, 1883, p. 107.—Gobert, 1887, p. 41.—Bezzi, 1894, pp. 340–341; 1921, p. 7.—Kowarz, 1894, p. 65.—Maragues y de Manzanas, 1894, p. 86.—Becker, 1896, pp. 171, 180–181, pl. 4, fig. 15; 1903, p. 171; 1919, pp. 203–204; 1926, p. 68.—van de Wulp and de Meijere, 1898, p. 132.—Strobl, 1900, p. 1; 1904, p. 564.—de Meijere, 1902, p. 685 [biology]; 1939, p. 163.—Marchal, 1903, p. 237 [biology].—Jones, 1906, p. 186 [catalog listing].—Lampa, 1906, p. 19 [biology].—Lameere, p. 580.—Grünberg, 1910, pp. 275, 278.—Linnaniemi, 1913, p. 45 [biology].—Sorauer and Reh, 1913, pp. 408–409 [biology].—Moreley and Atmore, 1915, p. 162 [biology].—Hering, 1922, p. 36 [biology]; 1925, p. 538 [biology]; 1926, p. 180 [ecology]; 1937 [for many page references see index of these volumes; ecology]; 1951 [for many page references see index of the volume; ecology]; 1957a [for many page references see index of the volume; ecology].—Frost, 1924, pp. 94, 169 [biology].—Wilke, 1924, pp. 172–179 [biology].—Grimshaw, 1925, p. 19 [biology].—Hendel, 1926 [for many page references see index of the volume; ecology]; 1933, p. 52.—Kreuter, 1927, pp. 92–98 [biology].—Collin, 1928, p. 129.—Cresson, 1932, pp. 3, 4, 5–8, 9, 16–17, 22; 1944b, pp. 166–167, 173 [includes var. *hypoleuca, obscuriceps,* and *scapularis*]; 1947, p. 38.—Frey, 1933, p. 83.—Vayssière, 1933, pp. 86–87 [biology].—Séguy, 1934, p. 430; 1950, pp. 286, 290 [biology]; 1951, pp. 96–97, pl. 5, fig. 52 [biology].—Goetghebuer, 1942, p. 8.—Grensted, 1944, p. 202.—Wahlgren, 1947, pp. 77–79 [biology].—Berg, 1950, p. 375.—Bertrand, 1954, pp. 490–491 [biology].—Kato, 1955, pp. 11, 13 [morphology].—Wirth and Stone, 1956, p. 469.—Hennig, 1958, p. 665, fig. 332 [morphology].—Dahl, 1959 [for many page references see index of the volume; ecology]; 1961, p. 44; 1964, pp. 179–187; 1967, p. 416 [ecology].—Grigarick, 1959, pp. 1–80 [biology and ecology].—Harrison, 1959, p. 223.—Tsacas, 1959, p. 129; 1960, p. 243.—Glick, 1960, p. 12 [ecology].—Timon-David, 1961, pp. 228–230.—Darby, 1962, pp. 1, 137 [biology].—Fulmek, 1962, p. 37 [ecology].—LeBerre et al., 1962, pp. 151–160 [biology].—Deonier, 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

Hydrellia hypoleuca Loew, 1862, p. 151.—Osten Sacken, 1878, p. 202.—Becker, 1896, p. 269 [index listing]; 1903, pp. 171, 172.—Aldrich, 1905, p. 627 [catalog listing].—Jones, 1906, p. 186 [catalog listing].—Washburn, 1906, p. 80.—Cresson, 1918, p. 49.—Johnson, 1925, p. 271.—Sturtevant, 1926, p. 10, pl. 3, fig. 26 [female internal genitalia].

Hydrellia obscuriceps Loew, 1862, p. 152.—Osten Sacken, 1878, p. 202.—Becker, 1896, p. 269 [index listing]; 1903, p. 171.—Slosson, 1902a, p. 8.—Aldrich, 1905, p. 627 [catalog listing].—Jones, 1906, p. 185 [catalog listing].

Hydrellia scapularis Loew, 1862, p. 153.—Osten Sacken, 1878, p. 202.—Becker, 1896. p. 269 [index listing]; 1903, p. 171.—Coquillett, 1900, p. 461; 1904, p. 75.—Slosson, 1902b, p. 320.—Aldrich, 1905, p. 627 [catalog listing].—Jones, 1906, pp. 160, 185 [catalog listing].—Malloch, 1915, pp. 345–346 [biology].—Cresson, 1918, p. 49.—DeOng, 1922, p. 432 [biology].—Johnson, 1925, p. 272.

Hydrellia griseola var. *hypoleuca*.—Johannsen, 1935, pp. 56–57.

Hydropota griseola.—Kloet and Hincks, 1945, p. 396.

Hydrellia griseola var. *scapularis*.—Lange et al., 1953, pp. 8–9 [biology and ecology].

DIAGNOSIS.—Palpus moderate yellow; prementum glossy brownish black; 5–7 aristal rays; body length: wing length 0.8; fore tarsus dark brown; most of mesonotum and abdominal dorsum moderate brown; thoracic pleuron and side and venter of abdomen light gray; epistomal index 1.2–1.8; costal section II:I 2.6–2.8. Male length 1.70–2.38 mm; female 1.96–2.81 mm. Male terminalia as in Figure 26.

HEAD.—Face light gray, moderate yellow, or dark brown; 4–6 pfa; epistomal index 1.2–1.8; mesofacial index 2.1–2.5; vertex index 7.0 or more; A-index 1.8–2.2; ocular index 4.0–8.0. Palpus moderate yellow; 5–7 aristal rays; prementum glossy brownish black; antenna and most of parafrontale dark brown; frontal vitta and fronto-orbital area moderate olive-brown; 11–15 postoculars.

THORAX.—Ppn usually light gray; mesonotum moderate brown; 3–5 adc and 2–3 pdc; pleuron light gray; legs light-gray pruinose except dark-brown tarsi. Wing length 2.09–3.40 mm; veins usually light brown; 6–8 setae on basal end of costa proper; 8–11 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.6–2.8; III:IV 2.1–3.8; V:IV 3.4–4.2; M_{1+2} index 1.2–1.6.

ABDOMEN.—Terga 1–4 moderate brown medially, light gray laterally and ventrally; tergum 5 usually mostly light gray. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral corner of sternum 5 projecting and obtusangular; posteromedial margin of copulobus concave; copulobus irregularly setose. Postgonite bent anterolaterad and postgonite uncus laterad; distal two-thirds or so of distiphallus uniform in breadth; basiphallus with black, spinous, lateral process. Anterior margin of fused surstyli broadly emarginate; B-index about 2.0; C-index 6.0–9.0.

EGG.—Length 0.59–0.71 mm; maximum breadth 0.15–0.17 mm. Chorion very similar to that of *H. ischiaca* (Figure 76), white, corrugate, the ridges occasionally anastomosing and flanked by regular perpendicular striae; sculpturing slightly less distinct ventrally. Micropylar protuberance infundibulate, concealed in dorsal view by a hoodlike chorionic projection.

FIRST-INSTAR LARVA.—Length 0.33–1.13 mm; maximum breadth 0.07–0.15 mm. Clypeal arch obtusangular and slightly concave in lateral view; frontoclypeal length 0.18–0.23 mm. With heavily sclerotized supraspiracular asteriform process of 2–4 spinous projections surrounding a translucent, blunt seta. Newly eclosed larva translucent, light yellowish gray; late first-instar larva opaque, with yellow tinge from labial glands and fat body.

SECOND-INSTAR LARVA.—Length 0.82–3.15 mm; maximum breadth 0.13–0.65 mm. Frontoclypeal length 0.28–0.33 mm. Color and other characters similar to those in first-instar larva except supraspiracular asteriform process with 4–7 spinous projections (Figure 82).

THIRD-INSTAR LARVA.—Length 1.67–5.10 mm; maximum breadth 0.23–0.75 mm. Frontoclypeus very similar to that of *H. ischiaca* (Figure 100) except dorsal phragmatal ramus black; frontoclypeal length 0.43–0.55 mm. Ventral frontoclypeal index 3.4–3.6; phragmatal index 0.9–1.0; bifurcation index 3.4–3.6; clypeal-arch index 1.6–1.8. Clypeal arch slightly concave and angled about 30° in relation to lower frontoclypeal margin. Mouth-hook beak slightly longer than base; maximum mouth-hook base thickness about 2.0 times that of beak. First two thoracic segments densely spinulose; abdominal segment 8 with 4–5 annuli of spinules and ventral, transverse row of 6 setulae; supraspiracular asteriform process absent. Body opaque, with yellow tinge.

PUPARIUM.—Length 3.25–5.00 mm; maximum breadth 0.75–1.25 mm; subcylindrical. Puparial length:minimum breadth 10.0–16.0; maximum breadth:minimum breadth 3.0–5.2; anal-plate index 2.0–3.0. Prothoracic end semicircular in ventral view; head-lobe scar circular; maximum puparial breadth 5.0 times or less than diameter of head-lobe scar and 1.8–2.0 times maximum prothoracic breadth; anal plate subelliptical, with anterior margin straight or slightly concave. Empty puparium translucent, light yellowish brown.

TYPES.—*Notiphila griseola* Fallén: Fallén apparently based his original description of the species on several syntypes. R. G. Dahl (Halsingfors, Sweden, in litt., 1965) informed me that Fallén's collection has been distributed among the University of Lund, National Museum of Natural History in Stockholm, and the British Museum (Natural History). TYPE-LOCALITY: Fallén and his students probably collected many of the syntype specimens near Kivik, in the Skanör District of southern Sweden, between 1810 and 1813.

Hydrellia communis Robineau-Desvoidy: Robineau-Desvoidy very probably used only syntypes for this binomen. Most of them are probably in the Paris Museum (Natural History). TYPE-LOCALITY: probably in the vicinity of Paris.

Hydrellia hypoleuca Loew: Two syntype females, (MCZ 11158). TYPE-LOCALITY: "Middle States" (Loew, 1862, recorded Osten Sacken as collector).

Hydrellia obscuriceps Loew: Syntype male and female, (MCZ 11157). TYPE-LOCALITY: "Middle States" (Loew, 1862, stated that Osten Sacken collected the type specimens).

Hydrellia scapularis Loew: Syntypes in MCZ. One female (MCZ 11155) examined. TYPE-LOCALITY: "Middle States" (Loew, 1862, recorded Osten Sacken as collector).

ADULT SPECIMENS EXAMINED.—Locality data for the more than 5,000 adults examined are too numerous for detailed presentation. Instead, these data are summarized in Map 1.

IMMATURE SPECIMENS EXAMINED.—30 from 4 localities:

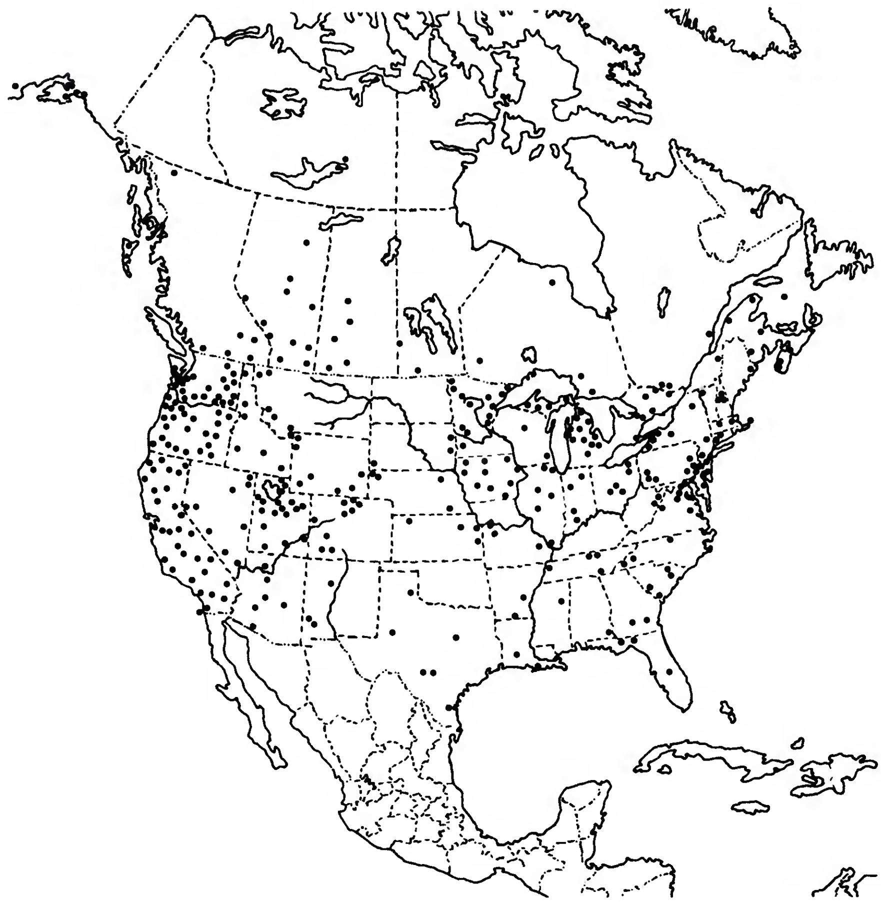
Iowa: Ames (collected and reared by D. L. Deonier); Siewer's Springs State Park, near Decorah (collected and reared by D. L. Deonier).

Minnesota: Mississippi River at Sucker Creek, Clearwater County (collected and reared by D. L. Deonier); Rapid River Logging Camp, Hubbard County (collected and reared by D. L. Deonier).

DISTRIBUTION.—Authors have recorded this species from all zoogeographic regions except the Oriental and Australian Regions. I found it the most abundant and widespread species in the Nearctic Region. Workers have collected it at 285 feet below sea level (Death Valley, California) and 9,700 feet above sea level (Mount Timpanogos, Utah); January–December.

REMARKS.—I have studied specimens of the types listed except those of *Notiphila griseola* Fallén and *Hydrellia communis* Robineau-Desvoidy. In addition, I have studied several Palaearctic specimens determined by Mik, Schiner, Loew, and Becker. The variations of facial color in *H. griseola* led many early workers astray. Sibling species are now a possible source of confusion. I found three such species in this research (*H. flavicoxalis, H. spinicornis,* and *H. rixator*), and other workers probably will find additional ones.

Adult. Habitats recorded: leaves of oats, strawberries, grass, *Salix* sp., sagebrush, *Leersia oryzoides, Polypogon monspeliensis, Oryza sativa, Zizania aquatica, Glyceria grandis, Echinochloa crusgalli, Nasturtium officinale, Polygonum scabrum,* celery, potatoes, and *Nuphar advena*; flowers of *Eupatorium perfoliatum,* choke-cherry, dandelion, wild plum, clover, *Heracleum lanatum, Ranunculus aquatilis,* and *R. longirostris*; sea beach, tamarack bog, cow pasture, lawn, limnic wrack, hot spring, gravel and sandbars, mud flat, stream-riffle rocks, algal mat, fronds of *Lemna minor,* sedge meadow, reed marsh, stems of *Eleocharis* sp., fronds of *Riccia* sp., and mats of *Eragrostis hypnoides.*



MAP 1.—Distribution of *Hydrellia griseola*. Each dot represents one or more localities within the county or district.

Glick (1960) collected 500 adults at 200 feet altitude in an aerial survey over parts of Louisiana, Arkansas, and Mississippi. He collected very few of any other species of *Hydrellia*. This can possibly be correlated with the greater dispersal potential of *H. griseola,* viz., factors such as their larger wings and frequent high-population densities.

Grigarick (1959) found the adult stadium to be 108 days (male) and 139 days (female) at 55°–81° F. for specimens collected in July, 130 days (male) and 135 days (female) at 50°–74° F. for October specimens, and 54 days (male) and 49 days (female) at 70° F. for February specimens. These represented maxima. He fed the specimens 10 percent sucrose and 5 percent yeast hydrolysate solution; therefore, his ranges of the maxima for the adult stadium probably should be regarded as physiological rather than ecological, especially in consideration of the findings of Le Berre et al. (1961), who found adult longevity to be directly correlated with the chemical composition of the food. Also, Grigarick showed in detail the effect of temperature and atmospheric saturation deficit on the physiological stadium. The percent mortality varied from 0 in 48 hours at 0.3 mm Hg saturation deficit and 58° F., to 50 in 48 hours at 0.5 mm Hg and 80° F., and then to 100 in 3 hours at 31.9 mm Hg saturation deficit and 100° F. With adults under constant high humidity, he obtained the following thermal limits to activity:

110° to 114° F:	heat death
107° to 110° F:	heat paralysis
104° to 107° F:	dropping

98° to 104° F:	heat rest	
52° to 92° F:	normal locomotion	
40° to 50° F:	slow walking	

Of 12 field-collected adults kept at 29° F. and supplied with food, 50 percent died after 34 days. Considering these and other factors, the mean ecological stadium may be 30 to 40 days in most Nearctic habitats.

I observed adults attacking and feeding on adult chironomids, adult tipulids, adult psyllids, and adult and immature collembolans. The collembolans were free when captured, but the others were trapped in the surface film. One adult fly pulled a small adult chironomid from the surface film and carried it off in a short flight.

Laurence (1952) listed as observed prey of *H. griseola* in Great Britain a symphypleonan species and an arthropleonan species (Collembola), a species of Braconidae (Hymenoptera), and the following Diptera: *Sciara* sp., an orthocladiine species, *Bibio marci, Bibio* sp., *Tachydromia agilis, Leptocera crassimana, Musca autumnalis,* and *Sarcophaga* sp. Laurence found both sexes feeding on some or all of these insects. He stated that the canalicular teeth of the labella are carnassial in *Hydrellia*. These teeth appeared similar to those in several other *Hydrellia* species examined. Grigarick observed adults feeding on collembolans, psyllids, mayflies, dragonflies, and adults of their own species. He saw adults searching over the surface film and grasping and manipulating various floating objects. Adults readily fed on banana flakes, fish meal, raw hamburger, and yeast hydrolysate with 10 percent sucrose solution presented in the field. In my survey, the gut contents of freshly killed specimens were greenish yellow and granular. Examination of sections of 125 adults revealed granular contents, some of which were macrophytic cells and diatoms. Culture of the gut contents from 15 adult males and 15 adult females show the presence of some aquatic yeasts.

I observed some instances of agonistic behavior in adults. In one of these, the adults adopted a defensive posture in the presence of *Ochthera mantis* (Ephydridae), and some made short rushes toward the latter. I did not gather enough data to establish the importance of *O. mantis* as a predator on *H. griseola* adults, but in a few instances it stalked some adults and very probably (as observation on *H. cruralis* populations showed) caught and fed on them. Grigarick considered lycosid spiders as important predators of adults. He witnessed several captures by these spiders. In June and July, he caught more lycosid spiders than *H. griseola* adults in floating traps. Predators of several kinds can prey more readily on freshly emerged adults and ovipositing females.

In one of my observations, a pair copulated for 15 minutes. During this time three other males attempted to mate with the female, first grasping her head, then her wing, and finally grasping the copulating male. When the third one intruded, the copulating male dismounted and the newcomer tried to mount the female, but she rejected him. Grigarick found copulation time ranged from 1 to 50 minutes. Both male and female exhibited wing scissoring as the conspicuous epigamic behavior. Mating occurred on both floating and erect leaves during daylight and even in overcast weather. In Grigarick's laboratory, pairs of the same age copulated as early as 3 days and as late as 70 days after emergence. The same pairs sometimes mated repeatedly in one day, and some mated through five consecutive days. One male inseminated at least three females. One female deposited viable eggs 93 days after isolation.

In my observations and those of Grigarick, females preferred to oviposit on floating leaves, but they would oviposit on leaves about 20 cm above the water. The female deposited eggs in loose aggregations parallel with the long axis of the leaf blade. Balachowsky and Mesnil (1935) reported that females oviposited on the basal part of the leaf blade of young barley. This is probably the preferred site on emergent plants because of shade and microenvironmental humidity. Grigarick found 52 eggs on one leaf blade and observed oviposition in the field every month of the year at temperatures above 50° F. In his laboratory, females started ovipositing 5 days after emergence while caged with males of the same age at temperatures from 54° to 72° F. Oviposition rates at 72° F. for field-collected females were 18 eggs in 2.5 hours, 28 in 24 hours, 40 in 48 hours, and 70 in 5 days. The maximum number of eggs per female varied from 73 in 52 days at 58° F. to 199 in 60 days at 72° F. No oviposition occurred at 43° F.

In one experiment, Grigarick fed 5 percent yeast hydrolysate to a female that had been isolated and fed 10 percent sucrose for 108 days after she last oviposited. She did not oviposit during isolation, but she laid viable eggs 3 days after taking the yeast hydrolysate. Le Berre et al. (1961) reported the following experimental data on oviposition:

1. mean survival of 2 days for females given only water;
2. females survived long enough to lay several eggs when fed sucrose or honey in water;
3. female survival and fecundity increased distinctly with a milk diet;
4. total number of eggs per female on milk diet was 88; total number on milk and sucrose or honey was 116 and 119;
5. delays in oviposition were directly related to the chemical composition of the food;
6. uninseminated females laid fewer eggs than inseminated females.

Egg.—Grigarick reported incubation periods of 1.9 days at 90° F., 2.3 at 80°, 2.9 at 72°, 7.5 at 58°, and 17.8 days at 50° F. Of 80 eggs exposed to 29° F. and then removed to 80° F., 80 percent hatched after 24 hours exposure, 20 percent hatched after 48 to 120 hours exposure, and none hatched after 148 hours exposure to 29° F. Normal incubation periods obtained for submerged eggs. Unfertilized eggs collapsed soon after deposition.

Larva.—According to Grigarick, each larval stadium varied from 2 to 3 days at 80° F. The larval stadia totaled 6.9 days at 90° F., 7.6 at 80°, 8.1 at 72°, 21.1 at 58°, and 41.1 days at 50° F. These figures were based on the time 50 percent completed development. Larvae eclosed from the micropylar end of the egg after slitting the chorion with their mouth-hooks. Grigarick observed some larvae that remained within the opened chorion from minutes to hours. He stated that generally the larvae begin mining shortly after eclosion or even after partial eclosion. I think this would be so only under optimal conditions. First-instar larvae required 2–2.5 hours at 80° F. for making and entering a new mine, while third-instar larvae required only 0.5–1.5 hours for this task at 80° F. With mining third-instar larvae under constant high humidity, Grigarick obtained the following thermal limits to activity:

112° to 114° F:	heat death
104° to 111° F:	heat paralysis
95° to 103° F:	agitated movement
50° to 90° F:	normal mining and locomotion
36° to 50° F:	quiescence or very slow movement

In one mortality experiment in which ten larvae of each instar under constant high humidity were exposed to 100° F., Grigarick obtained 70, 80, and 100 percent mortality in first, second, and third instars after 24 hours exposure and uniformly 100 percent after 48 hours exposure. In a similar experiment, at 29° F., he obtained 20, 70, and 80 percent mortality in first, second, and third instars after 24 hours exposure and 80, 100, and 100 percent mortality after 48 hours exposure. That these last results do not agree with the fact of overwintering of larvae in subboreal and boreal habitats strongly suggests that harmful low temperatures are countered by the larvae entering diapause.

In my observations and in those of Grigarick, Lilljeborg (1861), Balachowsky and Mesnil (1935), and others, the larvae mined mostly in leaves, especially those in, on, or near water; however, I found many in leaf sheaths and several in the culm proper. Contrary to Hering's (1951, p. 203) statement that "The short blotch-mine of such species [*H. griseola* and *H. butomi*] always remains above water", I often found larvae and puparia in submerged plant tissues, especially in *Zizania aquatica*. I found as many as six first-instar larvae in a wild-rice leaf and Grigarick found as many as 15 to 30 first-instar larvae in one grass leaf. Wilke (1924) reported finding commonly over 40 larvae mining in one barley leaf.

Puparium.—The time between pupariation and adult emergence varied from 8 to 9 days for three larvae in my laboratory. Grigarick obtained the following temperature-related variations in length of the puparial phase (called pupa by Grigarick): 5.0 days at 90° F., 6.1 at 80°, 7.0 at 72°, 18.0 at 58°, and 33.8 days at 50°. At each of these temperatures, a higher saturation deficit increased the puparial phase or prevented emergence. Exposing new puparia to 28° F. for 5 days followed by removal to 72° F. resulted in only 50 percent emergence. No adults emerged after 10 days exposure of puparia to 28° F.

In the observations of most authors, the late third-instar larvae often sought a new mine for pupariation. These mines varied much in size and were usually blotch-shaped. Pupariation occurred toward the center of the mine where the larva anchored its spiracular peritremes in the plant tissue. Attachment to plant tissue is not necessary for pupariation, for Grigarick observed pupariation on moist soil, sand, blotting paper, and glass; Störmer and Kleine (1911) and Kuwayama (1955) found puparia in soil; and Burghele (1959a) collected thousands of puparia from the bottom of small, shallow, ice-covered pools in November, January, and February at Ghencea, Yugoslavia.

HOST PLANTS.—In Table 1 are listed 40 gramineous genera reported as containing host plants for this species. Additionally, various authors have reported hosts in 20 nongramineous genera. Most of the latter probably represent incidental puparial hosts; however, I found all three larval instars and puparia in *Nasturtium officinale,* and Taylor (1928) reported miners of *H. nasturtii* [as *H. ranunculi*] in that plant species. I observed that the larvae mined in leaves and moved up through linear mines in the stem cortex between successively younger leaves. They usually pupariated in the leaf axils. Because of the usual rapid growth of water cress and perhaps other factors, the larvae seemed not to disturb or harm the plants permanently.

Hydrellia griseola has attained its economic status because of its gramineous preference. Intermittent infestations of barley and oats in Europe prompted much of the early biological investigation of this fly. Lilljeborg (1861) reported heavy infestations of late-sown barley near coastal lowlands in Sweden. Störmer and Kleine (1911), Wilke (1924), and Grimshaw (1925) reported similar infestations of barley in northern Europe. Balachowsky and Mesnil (1935) reported that *H. griseola* developed more rapidly in barley than in oats and had almost no mortality in barley but up to 42 percent mortality in oats. DeOng (1922) first reported the serious infestations of domestic rice in California. In 1953, Lange et al. estimated the fly species destroyed 10 to 20 percent of the California rice crop with a probable loss of $16 million. Grigarick (1959) listed the following four conditions that increase susceptibility to infestation of rice with *H. griseola*: (1) low soil fertility and low temperatures weakening plants and retarding growth; (2) strong wind and wave action keeping plants down; (3) excessive water depth, through rain or mismanagement, retarding growth; (4) dense algal mats retarding emergent growth of plants. These conditions, by restraining rapid plant emergence, kept the rice in positions favorable for the rice leaf miner.

Grigarick estimated a maximum of 11 overlapping generations of *H. griseola* in the Sacramento Valley. Two generations occurred in January–April on species of *Polypogon, Avena, Hordeum,* and other wild grasses in rain pools and irrigated rice fields and three generations in May–June on rice and associated grasses, mainly young *Echinochloa crusgalli.* Four slightly overlapping generations occurred in June–September on *Polypogon monspeliensis* and *Echinochloa crusgalli* in cool water inlets to rice fields and two generations in September–January on several late-summer grass species along streams and canals and on fall grasses in fall rain pools. Primarily because of high temperatures, larvae infested rice plants only rarely after the middle of July.

Parasites. Forty-three species of Hymenoptera reported as having been reared from *H. griseola* are listed in Table 2. Grigarick reported *Chorebus aquaticus, Opius hydrelliae,* and *Halticoptera* sp. as the most abundant species, overall. He found that the parasite-density maximum immediately followed the host-density maximum. The first generation of *H. griseola* had 50 to 60 percent parasitism. The third generation (first generation on rice) had 1.0 to 2.5 percent parasitism, but some later generations had 80 to 87 percent parasitism by July. *Opius hydrelliae* and *Chorebus aquaticus* showed the highest densities at that time.

Hydrellia harti Cresson

FIGURES 15, 69

Hydrellia harti Cresson, 1936 [in part], p. 262; 1944b, pp. 170, 175.—Deonier, 1964, pp. 115, 125, fig. 4; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 6–8 aristal rays, face planate; vertex index 5.0–6.0; male abdomen often slightly bilobate posteriorly; female cercus less than 1.5 times as long as wide; antennal segments dark brown; apicodorsal antennal prominent. Male length 1.79–1.96 mm; female 1.70–2.31 mm. Male terminalia as in Figure 15; female as in Figure 69.

HEAD.—Differing mainly from *H. bilobifera* in the following: vertex index 5.0–6.0; antennal segment 3 dark brown; fronto-orbital area and frontal vitta darker than most of parafrontale.

THORAX.—Differing mainly from *H. bilobifera* in the following: 3–4 adc and 2 pdc; legs mostly light-gray pruinose except moderate-yellow tarsi; 5–7 dorsal and 8–11 anterior interfractural costals; wing length 1.70–1.97 mm.

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin deeply, rectangularly recessed and congruent with distiphallus; anterolateral margin of sternum 5 rounded through about 160° with conspicuous dorsal, rounded process projecting anterolaterad; copulobus slightly convex posteriorly, without macrochaetae, with seriated setulae on middle third of medial margin, and with mediolateral triangular lobe. Postgonite bent mediad and postgonite uncus anteriad; distiphallus constricted proximally and preapically and bicarinate ventrally; carinae partly lamellate; most of basiphallus exposed ventrally. Anterior margin of fused surstyli deeply and broadly concave; B-index about 1.5; C-index 0.4–0.6. Syntergum 9+10 often inconspicuously bilobate posteriorly. Female terminalia: tergum 8 much longer than sternum 8; cercus irregularly setose dorsally and laterally, triangular with trapezoid, hooked base, and less than 1.5 times as long as wide (lateral view). Segment 7 with group of about 7–8 seriated lateral setae on posterior margin; median spermatheca similar in size and shape to that of *H. discursa* (Figure 70).

TYPE.—Holotype male, ANSP 2078.

TYPE-LOCALITY.—Havana, Illinois (IX–19–1895, C. A. Hart).

SPECIMENS EXAMINED.—47 (38♂♂, 9♀♀) from 11 localities:

California: Laguna Canyon, Orange County (IX–no date–1922, J. Needham), 1♂.

Iowa: Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 1♂, 3♀♀.

Kansas: Kansas University Natural History Reservation near Lawrence, Douglas County (VI–7–1963, D. L. Deonier), 2♂♂.

Mexico: Ciudad Mante, Tamaulipas (VII–7–1960, H. Howden), 1♂.

Nebraska: Glen (VIII–no date–1960, W. Rapp), 1♀.

Ontario: Grand Bend (VII–10–1939, G. Shewell), 1♂; Marmora (VIII–7–1952, J. McAlpine), 4♂♂, (VIII–25–1952, E. Smith), 4♂♂, (IX–8–1952, E. Smith), 3♂♂, (IX–9–1952, J. McAlpine), 5♂♂; Midland (VIII–18–1955, J. Chillcott), 1♂; Ottawa (VII–2–1952, J. McAlpine), 1♂.

Quebec: Perkin's Mills (VIII–25–1949, G. Shewell), 13♂♂, 5♀♀.

Rhode Island: Providence (IX–16–no year, collector unknown), 1♂.

REMARKS.—Adult habitats recorded: leaves of *Potamogeton nodosus, P. epihydrus,* and *Nuphar advena*; limnic wrack and sedge meadow.

Hydrellia idolator, new species

FIGURE 21

DIAGNOSIS.—Palpus moderate yellow; 8–10 aristal rays; vertex index 4.5–5.5; ocular index 13.0–17.5; wing length 1.53–2.13 mm; prementum pale yellow; antennal segment 3 moderate yellow (contrasting with 1 and 2). Male length 1.50–1.70 mm; female 1.45–1.53 mm. Male terminalia as in Figure 21.

HEAD.—Face pale yellow; 6–7 pfa; epistomal index 1.3–2.0; mesofacial index 2.6–3.5; vertex index 4.5–5.5; A-index 1.5–2.2; ocular index 13.0–17.5. Palpus moderate yellow; 8–10 aristal rays; prementum pale yellow; apicodorsal antennal prominent; lower third of postocular area light gray, upper two-thirds light brown; frons (except light-brown fronto-orbital area) dark gray; 13–15 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 3–4 adc and 2 pdc; pleuron light gray except upper fifth light brown; legs light-gray pruinose except trochanters, tibiae, and tarsi moderate yellow. Wing length 1.53–2.13 mm; veins light brown; 5–7 setae on basal end of costa; 6–8 dorsal and 6–10 anterior interfractural costals; costal-section ratios: II:I 2.0–2.5; III:IV 2.8–3.2; V:IV 3.3–3.8; M_{1+2} index 1.3–1.7.

ABDOMEN.—Terga semiglossy dark brown medially, but with alternate light-gray and dark-brown lateral wedges and light-gray ventral lobes. Male terminalia: median third of posterior margin of sternum 5 deeply concave and congruous with distiphallus; anterolateral margin of sternum 5 smoothly rounded; copulobus roundly acutangular posteriorly (about 60° from lateral corner) and irregularly setose; 2 falciform lateral projections from above copulobus. Postgonite bent slightly anterolaterad and postgonite uncus directed anterolaterad; distiphallus uniformly tapering to ovoid apex; basiphallus not nearly covered laterally by surstyli. Anterior margin of fused surstyli narrowly notched medially (for about one-fifth of length); B-index about 5.0; C-index 1.6–2.0.

TYPE.—Holotype male, CNC 10896.

TYPE-LOCALITY.—Ottawa, Ontario, Canada (VII–2–1947, G. E. Shewell).

PARATYPES.—4 (1♂, 3♀♀) from 4 localities:

Mississippi: Bellefontaine Road, Jackson County (VI–12–1962, D. L. Deonier), 1♂ (ISC); gravel pit near U.S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson County (VI–17–1962, D. L. Deonier), 1♀ (USNM).

Ontario: Ottawa (VIII-24-1938, G. Shewell), 1♀ (USNM).
Quebec: Norway Bay (VIII-24-1938, G. Shewell), 1♀ (ISC).

REMARKS.—This species is very easily confused with *H. atroglauca,* and since no specimen of the latter was available for male terminalia study, conspecificity is possible. *H. atroglauca,* however, has a moderate orange-yellow prementum, an ocular index of 7.0–12.0, and 8–10 dorsal and 10–13 anterior interfractural costals.

Adult. Habitats recorded: mats of *Hydrochloa caroliniensis* and sedges.

Hydrellia insulata, new species

FIGURE 46

DIAGNOSIS.—Palpus moderate yellow; prementum glossy brownish black; 8–10 aristal rays; mesofacial index 2.2–2.6; antenna velvety dark brown; thoracic pleuron moderate olive-brown except anterior fourth of mesanepisternum, and mesokatepisternum light gray; costal section V:IV 3.5–4.5. Male length 1.70–2.30 mm; female 2.04–2.47 mm. Male terminalia as in Figure 46.

HEAD.—Face light yellowish brown or light gray; 4–6 pfa; epistomal index 1.4–1.8; mesofacial index 2.2–2.6; vertex index 8.5–12.5; A-index 2.0–2.4; ocular index 5.5–6.5. Palpus moderate orange-yellow; prementum glossy brownish black; 8–10 aristal rays; antenna velvety dark brown; fronto-orbital area and frontal vitta moderate olive-brown; most of parafrontale dark brown; 13–17 postoculars.

THORAX.—Ppn and postalar bridge densely moderate olive-brown pruinose; mesoscutum densely strong yellowish-brown pruinose; 3–4 adc and 2 pdc; pleuron moderate olive-brown except anterior fourth of mesanepisternum, and mesokatepisternum light gray; legs light-gray or moderate olive-brown pruinose except dark-brown tarsi. Wing length 1.79–2.47 mm; veins dark brown; 6–8 setae on basal end of costa; 8–11 dorsal and 10–13 anterior interfractural costals, costal-section ratios: II:I 2.0–2.4; III:IV 2.8–3.4; V:IV 3.5–4.5; M_{1+2} index 1.2–1.6.

ABDOMEN.—Terga dark gray medially, light brown laterally, and light gray ventrally. Male terminalia: median third of sternum 5 concave; anterolateral margin of sternum 5 acutangular (about 75°); posteromedial margin of copulobus concave and undulate with seriated setae; remainder of copulobus usually nonsetose. Postgonite concealed and directed posteriad, with postgonite uncus bent anterolaterad; distiphallus uniform in breadth to papillate apex. Anterior margin of fused surstyli with narrow, shallow notch medially in broad notch; B-index about 3.0; C-index 3.0–3.6.

TYPE.—Holotype male, USNM 70535.

TYPE-LOCALITY.—Plummer's Island, Potomac River, Maryland (IX-1-1962, K. V. Krombein).

PARATYPES.—14 (7♂♂, 7♀♀) from 1 locality:

Maryland: Plummer's Island, Potomac River (VIII-3-1962, K. Krombein), 4♂♂, 3♀♀, (VIII-7-1962, K. Krombein), 2♂♂, 3♀♀, (IX-1-1962, K. Krombein), 1♂, 1♀ (USNM, ISC, and DLD).

Hydrellia ischiaca Loew

FIGURES 44, 76, 82, 100, 122, 126, 131

Hydrellia ischiaca Loew, 1862, pp. 150–151.—Becker, 1896, p. 269 [index listing].—Jones, 1906, p. 185 [catalog listing].—Johnson, 1925, p. 271.—Cresson, 1944b, pp. 165, 173.—Deonier, 1964, p. 116; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–10 aristal rays; body length:wing length 0.8–0.9; fore coxa and tibia moderate yellow; 2–3 black anterior apical setae on hind tibia; thoracic pleuron light gray except upper fourth of mesanepisternum light yellowish brown. Male length 1.53–2.04 mm; female 1.75–2.23 mm. Male terminalia as in Figure 44.

HEAD.—Face moderate yellow or yellowish gray; 5–7 pfa; epistomal index 1.4–1.6; mesofacial index 2.2–2.5; vertex index 7.5–12.0; A-index 1.6–2.0; ocular index 6.5–7.5. Palpus moderate yellow; 8–10 aristal rays; antenna and most of parafrontale dark brown; frontal vitta and fronto-orbital area light gray with green reflection; 13–16 postoculars.

THORAX.—Ppn, most of anterior part of mesonotum, and notopleuron light gray; remainder of mesonotum moderate brown; 3–4 adc and 2 pdc; pleuron light gray except upper fourth of mesanepisternum light yellowish brown; 1–2 basal coxals (1 macrochaetous); legs light-gray pruinose except moderate-yellow coxae, trochanters, fore tibia, mid and hind tarsi, and dark-brown fore tarsus; 2–3 black anterior apical setae on hind tibia; 2 black anterior basal setae on hind tarsus. Wing length

1.77–2.43 mm; veins dark brown or moderate olive-brown; 6–8 setae on basal end of costa; 6–8 dorsal and 7–12 anterior interfractural costals; costal-section ratios: II:I 2.7–3.0; III:IV 2.1–2.6; V:IV 3.0–3.9; M_{1+2} index 1.4–1.6.

ABDOMEN.—Terga moderate brown medially and light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 prominent (roundly right-angled); posteromedial margin of copulobus angular from medial hooklike corner; copulobus with seriated setae on posteromedial and medial margins, otherwise bare. Postgonite bent anterolaterad and postgonite uncus laterad; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused surstyli with a narrow, shallow U-shaped notch medially; spicate projection posterolaterally on surstyli; B-index about 2.0; C-index 5.0–8.0.

EGG.—Length 0.59–0.71 mm; maximum breadth 0.15–0.17 mm. Chorion (Figure 76) white, corrugate, with longitudinal ridges occasionally anastomosing and flanked by regular perpendicular striae. Sculpturing distinct dorsally, indistinct ventrally. Micropylar protuberance infundibulate, concealed dorsally by hoodlike chorionic projection.

FIRST-INSTAR LARVA.—Length 0.33–1.10 mm; maximum breadth 0.07–0.15 mm. Clypeal arch distinctly obtusangular and slightly concave in lateral view; frontoclypeal length 0.18–0.23 mm. With heavily sclerotized supraspiracular asteriform process of 2–4 spinous projections surrounding a translucent, blunt seta. Newly eclosed larva translucent, yellowish gray; late first-instar larva opaque with yellow tinge from labial glands and developing fat body.

SECOND-INSTAR LARVA.—Length 0.80–3.15 mm; maximum breadth 0.15–0.65 mm. Frontoclypeal length 0.28–0.33 mm. Other characters similar to those in first-instar larva except supraspiracular asteriform process with 4–7 spinous projections (Figure 82).

THIRD-INSTAR LARVA.—Length 1.75–5.10 mm; maximum breadth 0.30–0.90 mm. Frontoclypeal length 0.43–0.55 mm; dorsal phragmatal ramus partly hyaline (Figure 100). Ventral fronto-clypeal index 3.4–3.6; phragmatal index 0.9–1.0; bifurcation index 3.4–3.6; clypeal-arch index 1.6–1.8. Clypeal arch angled 30°. Mouth-hook beak slightly longer than base; maximum mouth-hook base thickness about 2.0 times that of beak. Supraspiracular asteriform process absent; prothorax and mesothorax densely spinulose; abdominal segment 8 with ventral, transverse row of 6 setulae and 4–5 annuli of spinules. Body opaque, with yellow tinge.

PUPARIUM.—Length 3.35–5.00 mm; maximum breadth 0.75–1.15 mm; subcylindrical (Figure 122). Puparial length: minimum breadth 15.0–18.0; maximum breadth: minimum breadth 4.0–6.0; anal-plate index 2.0–3.0. Prothoracic end semicircular in ventral view; head-lobe scar circular; maximum puparial breadth 5.0 times or less than diameter of head-lobe scar and 1.8–2.0 times maximum prothoracic breadth; anal plate subelliptical, with anterior margin straight or slightly concave. Empty puparium translucent light yellowish brown.

TYPE.—Holotype female, MCZ 11154.

TYPE-LOCALITY.—"Middle States." Loew (1862) stated that Osten Sacken was collector.

ADULT SPECIMENS EXAMINED.—328 (136♂♂, 192 ♀♀) from 91 localities:

Alaska: Valdez (VII–15–1948, G. Marks), 1♀.

California: Lake Tahoe (VIII–11–1940, L. Lipovsky), 2♀♀.

Connecticut: Colebrook (VIII–28–1941, A. Melander), 1♀; Redding (VI–3–1933, A. Melander), 1♀.

Georgia: Holcomb Creek (VIII–1–1957, W. Richards), 1♂; Villa Rica (VII–5–1953, M. Wheeler), 1♀.

Indiana: Lafayette (VIII–1–1916, J. Aldrich), 1♀, (VIII–18–1916, collector unknown), 1♂.

Illinois: Peoria (VIII–26–1917, J. Aldrich), 1♂.

Iowa: Ames, Story County (VI–22–1960, D. L. Deonier), 2♂♂, 1♀; Ames, Izaak Walton League Reserve, Story County (VI–9–1960, D. L. Deonier), 1♂, (VII–1–1960, D. L. Deonier), 2♂♂, 3♀♀, (VII–7–1960, D. L. Deonier), 1♀, (VII–12–1960, D. L. Deonier), 1♂, 2♀♀, (VII–17–1960, D. L. Deonier), 1♀, (VII–18–1960, D. L. Deonier), 1♀, (VIII–31–1960, D. L. Deonier), 1♂; Lake Odessa, Louisa County (VIII–9–1960, D. L. Deonier), 2♀♀; Ledges State Park, Boone County (V–16–1947, J. Laffoon), (VII–10–1960, D. L. Deonier), 1♂; Little Wall Lake, Hamilton County (VIII–27–1960, D. L. Deonier), 1♀; Pilot Knob State Park, Hancock County (VI–15–1960, D. L. Deonier), 1♂; Siewer's Spring State Park, Decorah (IX–9–1960, D. L. Deonier), 1♂; Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 2♀♀; White Pine Hollow State Park, Dubuque County (VIII–2–1960, J. Laffoon), 2♂♂; 4 miles northeast of Wapello, Louisa County (VIII–9–1960, D. L. Deonier), 2♂♂, 2♀♀; 3 miles southeast of Waterville, Allamakee County (VIII–2–1960, D. L. Deonier), 1♂, 4♀♀.

Maine: Pittston (VIII–3–1930, A. Melander), 1♂, 1♀.

Maryland: Baltimore (V–16–1938, E. Fisher), 1♂, 1♀; Beltsville (V–21–1922, J. Malloch), 1♀; Glen Echo (VII–20–1924, J. Malloch), 1♀; Plummer's Island, Potomac

River (VIII–5–1913, R. Shannon), 1 ♀, (IX–5–1915, W. McAtee), 1 ♀; near Plummer's Island, Potomac River (V–22–1915, R. Shannon), 1 ♀, (IX–2–1915, R. Shannon), 1 ♀.

Massachusetts: Brookline (VI–17–no year, C. Johnson), 1 ♀; New Bedford (no dates, A. Melander), 1 ♂.

Michigan: Isabella County (IX–16–1955, R. Dreisbach), 1 ♀; Midland County (VIII–16–1936, R. Dreisbach), 1 ♀; Roscommon County (VII–1–1950, R. Dreisbach), 1 ♀; Vineyard Lake, Jackson County (VII–26–1954, G. Steyskal), 1 ♂.

Minnesota: Biological Station, Itasca State Park (VI–26–1963, D. L. Deonier), 3 ♂ ♂, 7 ♀ ♀; Bohall Lake, Itasca State Park (VIII–17–1963, D. L. Deonier), 1 ♂; Bohall Trail Bog, Itasca State Park (VIII–17–1963, D. L. Deonier), 2 ♂ ♂, 3 ♀ ♀; Douglas Lodge Bay, Lake Itasca, Itasca State Park (VI–20–1963, D. L. Deonier), 9 ♂ ♂, 15 ♀ ♀; headwaters of LaSalle Creek, Itasca State Park (VIII–6–1963, D. L. Deonier), 1 ♀; Kabekona Creek, Hubbard County (VIII–8–1963, D. L. Deonier), 1 ♂, 1 ♀; Iron Corner Lake, Itasca State Park (VI–18–1963, D. L. Deonier), 1 ♂, 2 ♀ ♀; Mississippi River, sec. 34, T. 145 north, R. 36 west, Clearwater County (VII–8–1963, D. L. Deonier) 1 ♂, 1 ♀; Mississippi River near north entrance Itasca State Park (VII–9–1963, D. L. Deonier), 2 ♀ ♀; Mississippi River, 150 yards north of Highway 31, Clearwater County (VII–9–1963, D. L. Deonier), 1 ♂, 4 ♀ ♀; Mississippi River at Sucker Creek, Clearwater County (VII–9–1963, D. L. Deonier), 1 ♂, 8 ♀ ♀; Rapid River Logging Camp, Hubbard County (VII–2–1963, D. L. Deonier), 30 ♂ ♂, 34 ♀ ♀; Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 1 ♂, 1 ♀; Sucker Creek, 100 yards north of Highway 31, Clearwater County (VII–23–1963, D. L. Deonier), 1 ♀; Two Island Lake, Itasca State Park (VI–28–1963, D. L. Deonier), 2 ♀ ♀; 6.5 miles east of Waubun (VIII–18–1963, D. L. Deonier), 2 ♂ ♂, 2 ♀ ♀; west side across from Biological Station, Lake Itasca, Itasca State Park (VII–28–1963, D. L. Deonier), 1 ♂, 3 ♀ ♀.

New Hampshire: Mount Washington (no dates–1917, A. Slosson), 1 ♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 1 ♀; Ithaca (VIII–28–1894, collector unknown), 1 ♂; vicinity of Six-Mile Creek, Ithaca (VIII–9–1961, J. Laffoon), 1 ♂; McLean (VII–7–1919, C. Johnson), 1 ♀; New York (V–31–1923, A. Sturtevant), 1 ♀; east foot of West Notch Mountain, Hamilton County, 43° 20.6′ N, 74°37.2′ W at 1,900 feet (VIII–6–1961, D. L. Deonier), 1 ♂, 1 ♀.

North Carolina: Clingsman Dome, Great Smoky Mountains National Park, 6,300–6,800 feet (V–28–1957, J. Vockeroth), 1 ♀; Forney Ridge, Great Smoky Mountains National Park (VI–26–1941, A. Melander), 1 ♀; Highlands, Macon County, 3,800 feet (V–10–1957, J. Vockeroth), 2 ♀ ♀, (VI–3–1957, J. Vockeroth), 1 ♂; Highlands, Macon County, 3,000 feet (VI–1–1957, W. Mason), 2 ♂ ♂, 1 ♀; Looking Glass Peak, Pisgah National Forest (VII–19–1957, W. Richards), 1 ♂; Wayah Gap, Macon County, 4,000 feet (VIII–16–1957, J. Chillcott), 1 ♂; Wilson's Gap, Highlands, 3,100 feet (V–12–1957, J. Vockeroth), 1 ♂, (V–25–1957, J. Vockeroth), 1 ♂, 1 ♀; 3 miles southwest of Glenville, Jackson County, 3,700 feet (VI–19–1958, J. Laffoon), 2 ♂ ♂.

Nova Scotia: Jordan Falls (VIII–5–1958, J. Vockeroth), 1 ♀; Lockeport (VIII–9–1958, J. Vockeroth), 1 ♀; Mount Uniacke (VIII–5–1958, J. Vockeroth), 2 ♂ ♂, 2 ♀ ♀.

Ontario: Ancaster (VI–26–1955, O. Peck), 1 ♂; Marmora (VII–5–1951, J. McAlpine), 1 ♀, (VIII–4–1952, J. McAlpine), 1 ♀; Normandale, 42°42′ N, 80°19′ W (V–27–1956, J. Vockeroth), 1 ♂; Ottawa (VIII–8–1923, C. Curran), 1 ♀.

Pennsylvania: Alleghany County (VII–no dates, H. Smith), 1 ♂; Castle Rock (V–28–no year, collector unknown), 1 ♂; Jack Run, Alleghany County (VI–14–1908, collector unknown), 1 ♂, 1 ♀; Ohiopyle, Fayette County (VII–22–1905, H. Kahl), 1 ♀, (VII–28–1905, H. Kahl), 1 ♂, (VIII–2–1905, H. Kahl), 1 ♂, 4 ♀ ♀, (VIII–7–1905, H. Kahl), 2 ♂ ♂, (VIII–11–1905, H. Kahl), 1 ♀, (VIII–no date–1907, H. Kahl), 8 ♂ ♂, 3 ♀ ♀; Point Pleasant (V–30–1914, collector unknown), 1 ♀; Swarthmore (V–28–1907, collector unknown), 1 ♀, (VII–no date–1908, collector unknown), 1 ♂, 1 ♀, (VI–13–1909, E. Cresson, Jr.), 1 ♂, (VIII–21–1910, E. Cresson, Jr.), 1 ♀; Westmoreland County (VIII–no date–1907, H. Kahl), 6 ♂ ♂, 15 ♀ ♀; 2 miles north of Narberth, Montgomery County (IX–14–1915, E. Cresson, Jr), 1 ♂.

Quebec: Laniel (VII–3–1944, A. Brooks), 1 ♀; Old Chelsea (VIII–31–1958, J. Vockeroth), 1 ♀; Rigaud (VIII–3–1919, J. Ouellet), 1 ♂.

South Carolina: Cross Anchor (VII–3–1953, M. Wheeler), 6 ♂ ♂, 6 ♀ ♀.

Tennessee: Greenbrier Cove, Great Smoky Mountains National Park, 2,000 feet (V–18–1957, J. Vockeroth), 2 ♀ ♀; Knoxville (VIII–17–1939, R. Beaman), 1 ♂; Shelby Forest State Park (IX–3–1952, M. Wheeler), 1 ♂.

Texas: Huntsville (IV–11–1952, M. Wheeler), 1 ♂.

Virginia: Fairfax (VII–19–1954, M. Wheeler), 1 ♂; Falls Church (V–26–1951, W. Wirth), 4 ♂ ♂, 2 ♀ ♀, (VII–15–1954, W. Wirth), 1 ♂, 1 ♀; Maywood, Alexandria (V–21–1922, W. McAtee), 1 ♂, 2 ♀ ♀, (VII–9–1922, W. McAtee), 1 ♀; Reddish Knob, Augusta County (VIII–29–1953, W. Wirth), 2 ♂ ♂, 5 ♀ ♀.

West Virginia: Cranberry Glades (VII–16–1955, C. Sabrosky), 2 ♂ ♂.

IMMATURE SPECIMENS EXAMINED.—360 collected and reared by D. L. Deonier from 9 localities:

Minnesota: Biological Station, Lake Itasca, Itasca State Park; Douglas Lodge Bay, Lake Itasca, Itasca State Park; Mississippi River, sec. 34, T. 145 north, R. 36 west, Clearwater County; Mississippi River at Sucker Creek, Clearwater County; Mississippi River, 150 yards north of Highway 31, Clearwater County; Rapid River Logging Camp, Hubbard County; Sucker Creek, 100 yards north of Highway 31, Clearwater County; 6.5 miles east of Waubun.

North Carolina: Harris Lake, Highlands, Macon County.

REMARKS.—Despite the obvious dissimilarities between the male terminalia, this species must be placed in the *H. griseola* species group. The immature stages are nearly identical in *H. griseola* and *H. ischiaca,* both in morphology and bionomics. The adults differ mainly in color characters.

Adult. Habitats recorded: leaves of *Zizania aquatica, Glyceria grandis, G. obtusa, Leersia oryzoides, Potamogeton natans, P. gramineus, P. nodosus, Nuphar advena, Nymphaea tuberosa,* and *Nasturtium officinale*; sedge meadow and mud flat.

Considering the close relationship of *H. griseola* and *H. ischiaca,* one could suppose that the data on the physiological stadium of *H. griseola* would apply fairly well to *H. ischiaca.* If this is true, then the ecological adult stadium of this species must be considerably shorter than the physiological one, for I observed no end-of-summer buildup in population density. The one density maximum occurred during July, in the region of Itasca State Park, Minnesota. This could be explained by a greater emergence of adults at that time resulting from ecological effects on oogenesis, oviposition rate, egg viability, and development rate, or it could have been due to slight generation overlap. I tentatively estimated the mean ecological adult stadium of this species in subboreal and boreal habitats to be between 20 and 30 days.

This species, like most of its congeners, is polyphagous. Contrary to Berg's (1950) report on the leaf feeding of *H. cruralis,* I did not observe *H. ischiaca* feeding on the leaves in its microhabitat. Normally, the adult diet consisted of periphytic microbiota such as yeasts, Chrysophyta, and Protozoa, nectar, and insect tissue fluids (especially of other *Hydrellia* specimens). During one observation, a female *H. ischiaca* probed a dead microcrustacean. After feeding for a few seconds, the female repeatedly touched her abdominal venter to the microcrustacean. In another pertinent observation, 40 adults that emerged on 21 July were caged on 22 July in a large culture dish containing clean rice leaves in tap water. On 23 July most of the flies were walking over the surface film and the leaves, and two specimens were probing and feeding on other dead specimens in the surface film; all specimens died by 26 July, without ovipositing.

I observed little distinct epigamic behavior in this species. In some observations the male circled the female closely, and in others the male moved to and fro or sideways in front of the female before attempting to mount. In one observation, copulation lasted for 10 minutes. The female walked intermittently during copulation. Modes of species and sex recognition fail occasionally, for I observed a male *H. nobilis* attempting to mount a female *H. ischiaca.* The latter responded by quickly advancing upon the protagonist and striking out with its fore tarsi. On another occasion, a male *H. nobilis* tried to mount a male *H. ischiaca.* I observed agonistic behavior in *H. ischiaca* several times. In one instance, a female advanced toward a specimen of *Chorebus aquaticus* ovipositing on a rice leaf. On another occasion, a male struck at a female *H. nobilis.* This could possibly have been misdirected epigamic behavior.

Although it is probable, as in some congeners, that the females oviposit on stubble, twigs, and plants other than hosts, I observed ovipositing and found egg masses only on *Z. aquatica* and the grasses *Glyceria grandis, striata,* and *obtusa.* As in Grigarick's (1959) observations of *H. griseola,* the females showed notable preference for floating leaves of wild rice (especially the leaf apices) as oviposition sites. At the end of the summer, when floating leaves were uncommon, females oviposited on the leaves hanging nearest to the water surface.

Egg. I collected and observed the eggs only on the upper leaf surfaces. Of 20 egg masses collected and isolated for rearing, the mean number of eggs per mass (an irregularly spaced aggregation) was 8 and the range 3–11. It is possible that more than one female contributed to some of the egg masses.

The incubation period ranged from 2 to 7 days in the laboratory for 47 eggs in a temperature range of 58° to 75° F. The mean period was 4 days. The ecological incubation period probably ranges from 2 to 4 days in subboreal and boreal habitats.

Larva. The first larval stadium ranged from 3 to 5 days with a mean of 4 for 20 larvae in a temperature range of 61°–81° F. The newly hatched larvae moved about actively and soon attempted to mine into the substrate leaf. Many of these first attempts were unsuccessful and the larvae randomly crawled or sank to nearby leaves where they attempted to mine. Occasionally, I found as many as six first-instar larvae in the same leaf. The second larval stadium ranged from 3 to 4 days with a mean of 4 days for 11 larvae in a temperature range of 64°–80° F. The third larval stadium ranged from 3 to 9 days, with a mean of 5 days for 9 larvae in a temperature range of 67°–81° F.

Any one larva usually required more than one leaf for development through the three instars because extensive mining depleted the mesophyll and damaged many veins. A leaf mined by a third-instar larva was usually yellowish and the apical half often completely devoid of mesophyll.

Puparium. The puparial phase ranged from 4 to 20 days, with a mean of 7 for 51 puparia in a temperature range of 58°–82° F. The time from larval eclosion to adult emergence range from 13 to 29 days for 20 specimens. The time from oviposition to adult emergence ranged from 15 to 35 days for 15 specimens. The third-instar larvae finished pupariation within 8 hours. The puparia were readily apparent in the partially mined leaves. Rarely, I found puparia in the stems. Often the puparia had their spiracular peritremes embedded in the plant epidermis, but some were lying unattached between the leaf surfaces. I found puparia oriented in various attitudes to the leaf axis, but commonly they were parallel to it. In one leaf, I found six puparia, two of which were contiguous and parallel.

Host plants. On the basis of frequency and distribution of larvae, I found the preferred host plant to be *Zizania aquatica* during summer in the region of Itasca State Park, Minnesota. *Glyceria grandis* and *G. obtusa* were the only other species in which I found larvae during summer. I reared *H. ischiaca* from *G. obtusa* and *G. grandis* collected from areas 0.5–20 miles from *Z. aquatica*. I found one puparium in a floating leaf of *Potamogeton natans* near infested *Z. aquatica,* and a third-instar larva pupariated in a floating leaf of *P. natans* in the laboratory. Since both of these lacked extensive feeding mines, I considered them incidental puparial hosts. The negative results of repeated searches for *H. ischiaca* in a stand of *Potamogeton richardsonii* in a strong current about 1 meter from a stand of heavily infested rice growing in quiet water supported this assumption.

I measured the percent of infestation of *Z. aquatica* with *H. ischiaca* in three samples from Lake Itasca, Minnesota. In the first sample taken at the west shore, opposite the Biological Station, 28 July, 33 percent of 23 plants showed obvious infestation. Of the infesting immatures, 90 percent were in parts on or above the water surface. The second sample of 36 plants collected from a lush stand at the same locality on 13 August had 50 percent infested. The third sample of 27 plants taken 19 August from a sparse stand of *Z. aquatica* and *Scirpus* sp., exposed to the prevailing westerly wind and waves near the Biological Station, had 89 percent infestation.

Earlier in the season, on 20 June, at Douglas Lodge Bay, Lake Itasca, I found eggs on the floating leaves of 13 of a sample of 25 rice plants and larvae in 20 plants of the same sample. On 2 July at Rapid River Logging Camp, Hubbard County, Minnesota, I found an infestation of about 70 percent in a sample of about 50 plants from one small riverside stand.

Parasites. From 132 puparia reared or collected, 50 hymenopterans emerged. The time from host pupariation to emergence of the adult hymenopteron ranged from 6 to 42 days. The mean time in the laboratory was 8 days. During the early spring of 1967, 12 braconids and one pteromalid emerged from 37 puparia reared from second- or third-instar larvae.

I reared the following Hymenoptera from *H. ischiaca* puparia: *Chorebus aquaticus, Chorebidella bergi, Chaenusa,* new species (all Braconidae), and *Trichopria columbiana* (Diapriidae). There has been some conjecture that *Trichopria columbiana* is a hyperparasite. I reared a single specimen of this species under the following circumstances: a third-instar larva collected as a second instar on 9 July, pupariated, and on 15 July the puparium containing a late, white, fly pupa was transferred to a large test tube. On 27 August, when the diapriid emerged, an examination showed a pupal exuviae (not that of the fly host) within the original puparium.

On 28 July at the west shore of Lake Itasca, opposite the Biological Station, I collected 28 adult *Chorebus aquaticus* in about 5 minutes from a stand of *Z. aquatica.* This indicated the high-population density of this parasite. At this time also, I observed a specimen of *C. aquaticus* ovipositing repeatedly for 5 minutes in a rice leaf free of eggs and larvae of *Hydrellia. Chaenusa* sp. (probably new) parasitized three of four *H. ischiaca* puparia reared from eggs collected only 2 days after they were deposited. The single specimen of *Opius* sp. emerged anteroventrally from the puparium.

Overwintering. The grasses *Glyceria grandis* and *striata* serve as overwinter hosts for several species of *Hydrellia,* including *H. griseola* and *H. ischiaca.* Some *Glyceria grandis* pass the winter as relatively short, green shoots submerged in moderately swift, shallow streams. If these streams freeze partly or completely, the grass and the *Hydrellia* larvae apparently tolerate the condition. In 1967 I collected 14 second- and 30 third-instar larvae in these grasses from the date of lake thaw (15 April) to date of first wild adult collected (23 May). Burghele (1959a) reported finding viable puparia of *griseola* on the bottoms of small, ice-covered pools in Rumania. My searches through ten large samples of old rice stubble revealed no larvae or puparia.

Many samples of infested grasses were from three small streams, all within 1,000 meters of wild-rice beds in Lake Itasca. The rapid infestation of young rice in the lake is thereby understandable.

Hydrellia itascae, new species

FIGURES 28, 102, 110, 129

DIAGNOSIS.—Palpus moderate orange-yellow; 6–9 aristal rays; body length:wing length 1.0–1.1; antenna velvety dark brown; apicodorsal antennal prominent; 2 basal coxals; costal section II:I 1.4–2.2; 12–14 dorsal and 14–16 anterior interfractural costals. Male length 2.89–3.06 mm; female 2.98–3.23 mm. Male terminalia as in Figure 28.

HEAD.—Face light yellowish brown; 6–7 pfa; 2 sfa; epistomal index 1.1–1.4; mesofacial index 1.5–1.9; vertex index 4.8–6.2; A-index 1.4–1.8; ocular index 4.8–6.2. Palpus moderate orange-yellow; 6–9 aristal rays; apicodorsal antennal prominent; antenna velvety dark brown; frons dark brown; 15–17 postoculars.

THORAX.—Ppn semiglossy dark gray; mesonotum semiglossy dark brown; 3–4 adc and 3–4 pdc; pleuron yellowish gray except upper fifth of mesanepimeron and anterior half of mesokatepisternum light brown; 2 basal coxals (1 macrochaetous); legs light-gray pruinose except dark-brown tarsi. Wing length 2.72–3.15 mm; veins dark brown; 10–11 setae basal end of costa; 12–14 dorsal and 14–16 anterior interfractural costals; costal-section ratios: II:I 1.4–2.2; III:IV 2.5–2.9; V:IV 3.0–3.5; M_{1+2} index 1.1–1.5.

ABDOMEN.—Terga semiglossy dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 roundly right-angled; copulobus angular posteromedially (about 100° from lateral corner) and irregularly setose, with verrucate anteromedial lobe. Postgonite directed anterolaterad; postgonite uncus absent; distiphallus uniform in breadth (all but apex covered by fused surstyli). Anterior margin of fused surstyli deeply cleft medially; B-index about 0.8.

THIRD-INSTAR LARVA.—Body of larva not examined. Frontoclypeal length 0.50–0.60 mm; cheliform spot arms removed from clypeal arch by their length (Figure 102). Ventral frontoclypeal index 2.2–2.8; phragmatal index 0.8–0.9; bifurcation index 5.8–6.5; clypeal-arch index 1.8–2.2. Clypeal arch slightly concave along angle of about 25°–30° in relation to lower frontoclypeal margin. Mouth-hook beak and base lengths subequal; maximum mouth-hook base thickness about 1.5 times that of beak.

PUPARIUM.—Length 4.50–5.00 mm; maximum breadth 1.00–1.50 mm; subcylindrical; suddenly tapering from abdominal segment 7 posteriad (Figure 110). Prothoracic end slightly convex in ventral view; head-lobe scar obovoid or subcircular; maximum puparial breadth 5.5–6.0 times maximum breadth of head-lobe scar and 2.3 times or less than maximum prothoracic breadth; prothorax with many ventral rugulae; lateral spinules inconspicuous in midlength of puparium; abdominal segment 8 without ventral, transverse row of setulae and with only few nonannular, distinct spinules; anal plate subrectangular, with anterior margin slightly convex. Empty puparium opaque moderate brown.

TYPE.—Holotype male, USNM 70536.

TYPE-LOCALITY.—University of Minnesota Biological Station, Lake Itasca, Itasca State Park, Clearwater County, Minnesota (VI–26–1963, D. L. Deonier).

PARATYPES.—16 (4♂♂, 12♀♀) from 2 localities:

Minnesota: Douglas Lodge Bay, Lake Itasca, Itasca State Park (VI–20–1963, D. L. Deonier), 1♂ (DLD); Prof Green Trail, Lake Itasca, Itasca State Park (VII–25–1963, D. L. Deonier), 1♂ (DLD); University of Minnesota Biological Station, Lake Itasca, Itasca State Park (VI–20–1963, D. L. Deonier), 5♀♀, (VI–26–1963, D. L. Deonier), 9♀♀ (USNM and ISC).

IMMATURE SPECIMENS EXAMINED.—Nine, from Douglas Lodge Bay, Lake Itasca, Itasca State Park, Minnesota (collected and reared by D. L. Deonier).

REMARKS.—This species may be confused with *H. manitobae* in a macroscopic field examination.

Adult. Habitats recorded: leaves of *Zizania aquatica* and *Nuphar advena*.

Host plants. I reared adults from nine puparia found in *Potamogeton zosteriformis.*

Parasites. I reared *Aphanta* sp. (probably new) and *Chorebidella bergi* (all Hymenoptera: Braconidae) from three of the puparia.

Hydrellia lata Cresson

Hydrellia lata Cresson, 1944b, p 165.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; prementum light gray; 8–10 aristal rays; ocular index 6.5–8.0; mesofacial index 1.5–1.9; apicodorsal antennal prominent; costal section II:I 2.4–2.8; 10–12 anterior interfractural costals. Female length 2.30–2.72 mm.

HEAD.—Face light yellowish brown or yellowish gray; 5–6 pfa; 1–2 sfa; epistomal index 1.1–1.4; mesofacial index 1.5–1.9; vertex index 4.2–8.6; A-index 1.5–1.9; ocular index 6.5–8.0. Palpus moderate yellow; 8–10 aristal rays; prementum light gray; apicodorsal antennal prominent; antenna dark brown; fronto-orbital area and frontal vitta moderate brown; most of parafrontale velvety dark brown; 15–18 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 2–5 adc and 2 pdc; pleuron light gray, with some light-brown areas on mesanepisternum and mesokatepisternum; legs light-gray pruinose except dark-brown tarsi. Wing length 2.82–3.06 mm; veins light brown; 6–7 setae on basal end of costa; 6–9 dorsal and 10–12 anterior interfractural costals; costal-section ratios: II:I 2.4–2.8; III:IV 2.5–3.0; V:IV 3.0–3.4; M_{1+2} index 1.3–1.8.

ABDOMEN.—Terga 1–4 semiglossy dark brown dorsally; tergum 5 dark-brown pruinose dorsally; ventral tergal lobes light gray.

TYPE.—Holotype female, ANSP 6655.

TYPE-LOCALITY.—Nasel River, Pacific County, Washington (VII–15–1922, A. L. Melander).

SPECIMENS EXAMINED.—4 ♀ ♀ from 3 localities:

Alaska: King Salmon, Naknek River (VII–31–1952, W. Mason), 1 ♀.

Manitoba: Eastern Creek near Churchill (VII–9–1952, J. Chillcott), 1 ♀.

Washington: Nasel River, Pacific County (VII–15–1922, A. Melander), 2 ♀ ♀.

REMARKS.—According to Cresson (1944b), this species is apparently closely related to the *H. proclinata* species group. I think that the male will be found to be very similar to that of either *H. platygastra* or *H. serena*.

Hydrellia luctuosa Cresson

FIGURES 64, 92, 107

Hydrellia luctuosa Cresson, 1942, p. 78; 1944b, pp. 170, 171. —Berg 1950, pp. 375, 376, 377, 384, 385 (pl. 2, fig. 1), 387, 388, 389 (pl. 3, fig. 1), 396 [biology, morphology, and taxonomy of immatures].—Deonier, 1964, p. 117; 1965, p. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown or black; 6–8 aristal rays; ocular index 4.6–5.4; face dark brown, centrally protuberant; male mid tibia expanded; 9–12 anterior interfractural costals; body generally dark olive-brown. Male length 1.79–1.97 mm; female 1.87–2.04 mm. Male terminalia as in Figure 64.

HEAD.—Face dark brown and centrally protuberant; 4–5 pfa; 0–3 dorsally inclined sfa; epistomal index 1.0–1.3; mesofacial index 1.4–1.9; vertex index 3.5–7.0; A-index 1.7–2.0; ocular index 4.6–5.4. Palpus dark brown or black; 6–8 aristal rays; antenna brownish black; fronto-orbital area and frontal vitta moderate olive-brown; most of parafrontale velvety black; 14–16 postoculars.

THORAX.—Ppn and mesonotum moderate or dark olive-brown; 3–4 adc and 3–4 pdc; pleuron moderate olive-brown except light-gray tinge on mesokatepisternum and mesanepimeron; legs very sparsely light-gray pruinose except dark-brown tarsi; male mid tibia expanded. Wing length 1.70–2.13 mm; veins dark brown; 5–8 setae on basal end of costa; 6–8 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.1–3.6; III:IV 2.4–2.8; V:IV 3.0–3.4; M_{1+2} index 1.2–1.5.

ABDOMEN.—Terga densely moderate olive-brown pruinose. Male terminalia: median third of posterior margin of sternum 5 concave and congruent with apex of distiphallus; anterolateral margin of sternum 5 about 100° angular; copulobus acutangular posterolaterally; copulobus about twice as broad posteriorly as anteriorly and regularly setose, with 2–3 distinct fusiform macrochaetae on posterolateral corner. Postgonite bent anteriad and postgonite uncus laterad; distiphallus tapering distally and carinate ventrally. Anterior margin of fused surstyli ovoid; B-index about 1.2; C-index 1.8–2.3.

SECOND-INSTAR LARVA.—Length 1.75–3.20 mm; maximum breadth 0.20–0.40 mm. Frontoclypeal length 0.26–0.31 mm. Other characters similar to those in third-instar larva except body light yellowish gray.

THIRD-INSTAR LARVA.—Length 3.00–4.20 mm; maximum breadth 0.40–0.60 mm. Frontoclypeal length 0.40–0.55 mm; feeding apparatus mostly dark (Figure 92). Ventral frontoclypeal index 5.0–5.5; phragmatal index 1.2–1.3; bifurcation index 3.6–4.0; clypeal-arch index 1.8–2.0. Clypeal arch sloping at about 20° except for slight hump dorsal to labial gland orifice. Mouth-hook beak only about 0.9 of base length; maximum mouth-hook base thickness about 2.0 times that of beak; mouth-hook with light spot. Prothorax and mesothorax sparsely spinulose; prothorax distinctly rugulose in ventral view; abdominal segment 8 without ventral, transverse row of setulae, but with 3 annuli of spinules. Body translucent, with bright green pigment showing through.

PUPARIUM.—Length 2.65–3.50 mm; maximum breadth 0.85–1.10 mm; fusiform (Figure 107). Puparial length:minimum breadth 8.8–10.0; maximum breadth:minimum breadth 2.6–3.6; anal-plate index 2.5–3.0. Prothoracic end nearly semicircular in ventral view; head-lobe scar subcircular, its maximum breadth distinctly less than minimum puparial breadth; maximum puparial breadth in abdomen; anal plate subelliptical, with anterior margin slightly convex. Empty puparium translucent, light brown.

TYPE.—Holotype male, ANSP 6620.

TYPE-LOCALITY.—Bessey Creek, Cheboygan County, Michigan (VIII–14–1941, C. O. Berg).

ADULT SPECIMENS EXAMINED.—131 (39♂♂, 94♀♀) from 22 localities:

Iowa: South Pond, Ledges Park, Boone County (VII–10–1960, D L. Deonier), 1♂, 1♀; Springbrook State Park, Guthrie County (VI–23–1961, D. L. Deonier), 1♂; Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 1♂, 3♀♀.

Kansas: Kansas University Natural Reservation, near Lawrence, Douglas County (VI–10–1963, D. L. Deonier), 3♂♂, 5♀♀.

Michigan: Bessey Creek, Cheboygan County (VIII–14–1941, C. Berg), 5♀♀; Cheboygan County (VII–15–1946, C. Berg), 1♀, (VII–26–1946, C Berg), 2♂♂, 16♀♀, (VII–21–1947, C. Berg), 1♂, (VIII–4–1947, C. Berg), 2♂♂, 1♀, (VIII–7–1947, C. Berg), 1♂, 1♀; Douglas Lake, Cheboygan County (VII–3–1941, C. Berg), 1♀; Nigger Creek, Cheboygan County (VIII–21–1941, C. Berg), 1♂.

Minnesota: Bohall Lake, Itasca State Park (VIII–17–1963, D. L. Deonier), 1♂, 1♀; Chamber's Creek, Itasca State Park (VII–18–1963, D. L. Deonier), 5♂♂, 21♀♀; Douglas Lodge Bay, Lake Itasca, Itasca State Park (VII–20–1963, D. L. Deonier), 5♂♂, 8♀♀; Eagles Nest (VI–25–1959, W Balduf), 1♀; Headwaters of LaSalle Creek, Itasca State Park (VIII–6–1963, D. L. Deonier), 1♀; Mississippi River near north entrance Itasca State Park (VII–9–1963, D. L. Deonier), 4♂♂, 6♀♀; Mississippi River at Sucker Creek, Clearwater County (VII–9–1963, D. L. Deonier), 1♀; Squaw Lake (VIII–14–1963, D. L. Deonier), 2♂♂; Two Island Lake (VI–28–1963, D. L. Deonier), 1♀, (VIII–8–1963, D. L. Deonier), 5♂♂, 11♀♀; 6.5 miles east of Waubun (VIII–18–1963, D. L. Deonier), 1♂, 3♀♀.

Ontario: Dundas Marsh (no dates–1948, W. Judd), 1♂; Marmora (VIII–7–1952, J. McAlpine), 2♂♂, 3♀♀; Ottawa (VII–2–1947, G. Shewell), 1♀.

Quebec: Mount Albert (VII–24–1954, J. Martin), 2♀♀.

IMMATURE SPECIMENS EXAMINED.—42 from 3 localities:

Michigan: Cheboygan County (collected and reared by C. Berg).

Minnesota: Douglas Lodge Bay, Lake Itasca, Itasca State Park; Squaw Lake, Itasca State Park (all collected and reared by D. L. Deonier).

REMARKS.—This species probably belongs to the *H. prudens* group.

Adult. Habitats recorded: leaves of *Sparganium chlorocarpum, Nymphaea tuberosa,* and *Potamogeton natans*; stems of *Eleocharis palustris.* I found 11 specimens congregated on a floating *Scirpus* stem. On Two Island Lake, Itasca State Park, Minnesota, I collected 17 specimens by the lighted-receptacle method and found several specimens resting on clumps of *Eleocharis palustris.* The adult population-density of this species increased by perhaps 50 percent 24 hours after a 20–cm rise in this lake.

In the laboratory, an adult of *Lispe* sp. killed and fed on a female *H. luctuosa.* In the field, a female *H. luctuosa* tried to feed on a chironomid captured by an adult *H. pulla,* but the latter quickly repulsed it.

Larva and puparium. The time from just after eclosion from the egg to the first molt was 10 days for two larvae. The second larval stadium ranged from 4 to 6 days for five larvae. The third larval stadium ranged from 2 to 6 days and the puparial phase from 6 to 10 days for eight specimens. The total time from just after eclosion from the egg to adult emergence ranged from 22 to 32 days. I found only first-instar larvae at Douglas Lodge Bay, Lake Itasca, 20 June, and only puparia at Squaw Lake, Itasca State Park, 14 August. These data, along with the observation of a sudden rise in adult population-density, may indicate distinct generations in this species.

Host plants. I found immatures only in *Potamogeton zosteriformis,* but Berg (1950) found the order of preference to be *Potamogeton alpinus, P. zosteriformis, P. richardsonii, P. amplifolius,* and *P. natans.*

Parasites. Berg (1950) listed *Trichopria columbiana* (Diapriidae) and *Dacnusa* sp. (Braconidae) as parasites of the puparia of *H. luctuosa.*

Hydrellia manitobae, new species

FIGURE 48

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; vertex index 3.5–4.5; wing length 3.06–3.40 mm; thoracic pleuron mostly light gray; 11–14 anterior interfractural costals; 2 basal coxals; male mid tibia moderately expanded. Male length 2.50–3.16 mm; female 2.89–3.18 mm. Male terminalia as in Figure 48.

HEAD.—Face light-brown pruinose over dark gray; 4–6 pfa; 4–5 sfa; epistomal index 1.2–1.5; mesofacial index 1.8–2.2; vertex index 3.5–4.5; A-index 1.3–1.7; ocular index 4.5–8.2. Palpus dark brown; 6–8 aristal rays; antenna and frons (except moderate olive-brown fronto-orbital area) dark brown; 13–18 postoculars.

THORAX.—Ppn and mesonotum light gray; 4–5 adc and 2–4 pdc; pleuron light gray except anterior half of mesokatepisternum, laterotergite, and mesomeron dark gray; 1–2 mesokatepisternals (1 macrochaetous); 2 basal coxals (1 macrochaetous); legs light-gray pruinose except dark-brown tarsi; male mid tibia moderately expanded. Wing length 3.06–3.40 mm; veins light yellowish brown; 7–10 setae on basal end of costa; 9–11 dorsal and 11–14 anterior interfractural costals; costal-section ratios: II:I 2.4–2.8; III:IV 2.8–3.2; V:IV 3.8–4.4; M_{1+2} index 1.0–1.5.

ABDOMEN.—Terga semiglossy dark gray. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin roundly right-angled; copulobus nearly truncate posteriorly and irregularly setose. Postgonite bent anterolaterad and postgonite uncus posterolaterad; distiphallus constricted at midlength and carinate ventrally. Anterior margin of fused surstyli convex with medial indentation; B-index about 1.8; C-index 0.8–1.3.

TYPE.—Holotype male, USNM 70537.

TYPE-LOCALITY.—LaTrappe, Quebec, Canada (VII–14–1934, J. Ouellet).

PARATYPES.—45 (8♂♂, 37♀♀) from 16 localities:

Alaska: Anchorage (VI–19–1921, J. Aldrich), 1♀ (ANSP); King Salmon, Naknek River (VII–31–1952, W. Mason), 1♀ (CNC), (VIII–11–1952, W. Mason), 1♀ (USNM).

Alberta: One Four (VI–1–1956, O. Peck), 1♀ (USNM).

Idaho: Sand Point (VIII–27–1918, A. Melase), 1♀ (USNM).

Maine: Princeton (VII–1–1912, collector unknown), 1♀ (ANSP).

Manitoba: Farnsworth Lake near Churchill (VII–14–1952), J. Chillcott), 1♀ (ISC); Fort Churchill (VI–23–1952, J. Chillcott), 1♀ (CNC); Whitewater Lake (VI–22–1958, R. Bird), 3♀♀ (USNM and ISC).

Ontario: Marmora (VIII–6–1952, Boyle), 1♂, 2♀♀ (CNC); Ottawa (VII–no date–1915, C. Johnson), 1♂ (ISC).

Quebec: Missisquoi Bay (VII–28–1936, G. Shewell), 3♂♂, 4♀♀ (CNC, USNM, and ISC); Rigaud (VII–27–1926, J. Ouellet), 1♂, 1♀ (ISC); Rupert House (VII–30–1949, E. LeRoux), 1♂, 1♀ (USNM and DLD).

Saskatchewan: Willows (VI–19–1955, J. Vockeroth), 1♂, 10♀♀ (CNC, USNM, and ISC); Val Marie (VI–5–1955, J. Vockeroth), 6♀♀ (CNC, USNM, and ISC), (VI–13–1955, A. Brooks), 1♀ (CNC).

Wyoming: Yellowstone National Park (VII–16–1923, A. Melander), 1♀ (ISC).

REMARKS.—This species is very similar to *H. definita* in habitus, except for its larger size and more robust mid legs. It is also similar in many respects to *H. tibialis.*

Hydrellia melanderi, new species

FIGURE 51

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; vertex index 5.0–6.8; all fronto-orbitals anteriorly inclined; 8–11 dorsal and 9–12 anterior interfractural costals; thoracic pleuron with light-gray area. Male length 1.70–1.87 mm; female 1.87–2.30 mm. Male terminalia as in Figure 51.

HEAD.—Face light gray or yellowish gray; 4–6 medially inclined pfa; 6–9 medially inclined sfa; epistomal index 1.0–1.5; mesofacial index 2.0–2.2;

vertex index 5.0–6.8; A-index 1.5–1.8; ocular index 4.5–5.2. Palpus dark brown; 6–8 aristal rays; antenna dark brown; frons moderate olive-brown; fronto-orbitals anteriorly inclined; 13–16 postoculars.

THORAX.—Ppn and mesonotum glossy dark grayish green; 3–4 adc and 2 pdc; pleuron light gray except moderate brown on upper third or so of mesanepisternum; legs dark brown except light-gray coxae. Wing length 2.04–2.80 mm; veins dark brown; 6–7 setae on basal end of costa; 8–11 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.5–3.0; III:IV 2.3–3.6; V:IV 3.4–3.8; M_{1+2} index 1.1–1.5.

ABDOMEN.—Most of terga glossy dark grayish green. Male terminalia: median third of posterior margin of sternum 5 very slightly concave with small medial indentation; anterolateral margin of sternum 5 obtusangular (about 110°) and covered by sternum 4; copulobus truncate posteromedially, with prominent anteromedial lobe and anterolateral lobe and irregularly setose except for seriated setae on posteromedial margin. Postgonite bent slightly anteriad; postgonite uncus almost straight; distiphallus transversely expanded proximally and near papillate apex; basolateral bladelike process projecting from basiphallus dorsal to surstyli. Anterior margin of fused surstyli broadly and shallowly concave with medial indentation; B-index about 1.8; C-index 3.0–4.0.

TYPE.—Holotype male, USNM 70538.

TYPE-LOCALITY.—Sardine Creek, Mono County, California, 8,500 feet (VII-11-1951, A. T. McClay).

PARATYPES.—64 (18♂♂, 46♀♀) from 33 localities:

Arizona: Oak Creek Canyon, 6,000 feet (VIII–no dates, F. Snow), 1♀ (USNM); Rustler Park, Chiricahua Mountains (VIII–27–1933, collector unknown), 1♀, (X–18–1958, M. Adachi), 1♂, 1♀ (USNM and DLD).

California: Barton Store (IX–3–1950, A. Melander), 1♀ (USNM); Big Bear Lake (V–24–1935, A. Melander), 1♀ (ANSP); Carson Pass (IX–11–38, M. Crazier), 1♂ (ISC); Cuyamaca Park (VI–5–1945, A. Melander), 1♀ (USNM); Echo (VIII–10–1940, L. Kuitert), 2♀♀ (USNM); Garden Valley (V–3–1952, E. Schlinger), 1♀ (USNM); Green Valley (VII–26–1944, A. Melander), 3♀♀ (USNM); Herkey Camp (V–14–1950, A. Melander), 1♂, 3♀♀ (USNM); Jenks Lake (VII–14–1950, A. Melander), 2♀♀ (USNM), (IX–7–1950, A. Melander), 1♂ (USNM); Keen Camp (VI–7–1942, A. Melander), 1♀ (USNM); Mammoth Lakes (VII–29–1940, L. Lipovsky), 1♂, 1♀ (USNM), (VII–29–1940, D. Hardy), 1♂, 3♀♀ (USNM and ISC); Mono Lake, Mono County (VI–7–1948, W. Wirth), 1♂, 1♀ (USNM); Pacific (VIII–9–1940, D. Hardy), 1♂ (USNM); Palm Canyon, Borego (V–5–1945, A. Melander), 1♀ (USNM); Riverside (II–3–1935, A. Melander), 1♂ (USNM); Sardine Creek, Mono County, 8,500 feet (VII–3–1951, collector unknown), 1♀ (USNM), (VII–6–1951, collector unknown), 2♀♀ (ISC); South Fork of Santa Ana River (VII–29–1942, A. Melander), 2♀♀ (USNM and ISC); Strawberry, Tuolumne County (VI–19–1951, A. McClay), 1♂ (UCD); Tuolumne Meadows (VII–1–1940, D. Hardy), 3♂♂ (USNM and ISC); Upper Santa Ana River (VI–4–1950, A. Melander), 1♂ (DLD).

Colorado: Electra Lake (VI–28–1919, collector unknown), 1♀ (USNM); Ohio Pass Road, Gunnison County (VIII–26–1961, D. L. Deonier), 1♀ (ISC).

Mexico: Mexico City (V–no date–1888, collector unknown), 2♀♀ (AMNH and ISC); 6 miles west of El Salto, Durango State (VIII–31–1957, J. Schaffner), 1♀ (ISC); Temecula (III–10–1950, M. Wheeler), 1♀ (ISC).

Nevada: Crystal Springs, Lincoln County (VI–21–1953, A. Gurney), 2♂♂ (USNM and ISC); Pyramid Lake (XI–5–1938, T. Aitkin), 1♀ (USNM).

New Mexico: Mescalero, Otero County (VI–27–1947, L. Beamer), 1♀ (USNM); Penisco River, Mayhill (VI–22–1953, W. Wirth), 1♀ (USNM); Ruidoso (VI–26–1940, R. Beamer), 1♂ (USNM).

Oregon: Crane Hot Springs, 25 miles southeast of Burns (IX–11–1962, K. Goeden), 2♀♀ (KG), (II–23–1963, K. Goeden), 7♀♀ (USNM and ISC).

REMARKS.—The few physiognomic differences between *H. melanderi* and *H. proclinata* were not explored before this revision. It is very probable that more members of this species group exist in western localities. For additional remarks, see *H. proclinata*.

Adult. Habitats recorded: *Eleocharis* sp., *Equisetum* sp., and margins of hot springs.

Hydrellia morrisoni Cresson

FIGURES 8, 16, 104, 121

Hydrellia morrisoni Cresson, 1924, p. 162; 1931, p. 105; 1944b, pp. 168, 171.—Johnson, 1925, p. 271.—Deonier, 1964, pp. 117, 124, fig. 11; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate brown; 9–11 aristal rays; vertex index 4.0–6.5; wing length 2.72–3.03 mm; thoracic pleuron yellowish gray except anterior half of mesokatepisternum and mesomeron; male mid and hind tibiae expanded. Male length 2.46–2.55 mm; female 2.21–2.89 mm. Male terminalia as in Figure 16.

HEAD.—Face light gray or yellowish gray; 4–6 pfa; epistomal index 1.0–1.4; mesofacial index 1.5–2.0; vertex index 4.0–6.5; A-index 1.4–1.8; ocular index 5.5–8.5. Palpus moderate brown; 9–11 aristal rays; antenna and most of parafrontale moderate brown; frontal vitta semiglossy dark gray; fronto-orbital area strong yellowish brown; 13–17 postoculars.

THORAX.—Ppn and mesonotum densely strong yellowish-brown pruinose; 3–4 adc and 2 pdc; pleuron yellowish gray except anterior half of mesokatepisternum and mesomeron; legs, except tibiae and tarsi, densely light-gray pruinose; tibiae very sparsely light-gray pruinose over dark brown; tarsi dark brown; male mid and hind tibiae expanded (Figure 8). Wing length 2.72–3.03 mm; veins light yellowish brown; 6–10 setae on basal end of costa; 7–8 dorsal and 8–11 anterior interfractural costals; costal-section ratios: II:I 2.0–2.6; III:IV 3.0–3.4; V:IV 3.3–4.0; M_{1+2} index 1.2–1.6.

ABDOMEN.—Terga dark gray. Male terminalia: median third of posterior margin of sternum 5 evenly and moderately concave; anterolateral margin of sternum 5 roundly right-angled; copulobus roundly angular posteriorly (40°–50° from lateral corner) and irregularly setose except large setae seriated on posterior margin. Postgonite bent anteromediad and postgonite uncus slightly laterad; distiphallus tapering to retuse apex. Anterior margin of fused surstyli broadly emarginate; B-index about 1.2; C-index 0.7–1.0.

THIRD-INSTAR LARVA.—Body of larva not examined. Frontoclypeal length 0.60 mm; entire feeding apparatus dark (Figure 104). Ventral frontoclypeal index 2.8; phragmatal index 0.72; bifurcation index 4.8; clypeal-arch index 1.5. Clypeal arch angled about 10°–15° in relation to lower frontoclypeal margin. Mouth-hook beak and base lengths equal; maximum mouth-hook base thickness about 1.8 times that of beak.

PUPARIUM.—Length 5.35 mm; maximum breadth 1.30 mm; fusiform (Figure 121). Puparial length: minimum breadth about 24.0; maximum breadth: minimum breadth 6.2; anal-plate index 2.5. Prothoracic end nearly semicircular in ventral view; head-lobe scar subcircular; prothorax relatively smooth ventrally; prothorax and mesothorax sparsely spinulose; abdominal segment 8 without ventral, transverse row of setulae, but with 3–4 annuli of spinules; anal plate subrectangular, with anterior margin slightly convex; spiracular peritremes subterminal. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, USNM 43453.

TYPE-LOCALITY.—White Mountains of New Hampshire (Morrison).

ADULT SPECIMENS EXAMINED.—45 (17♂♂, 28♀♀) from 20 localities:

Alaska: Lower Yukon River (VII–5–1951, C. Berg), 1♂.

Iowa: Pilot Knob State Park, Hancock County (VI–15–1960, D. L. Deonier), 1♀; 3 miles east southeast of Waterville, Allamakee County (VIII–2–1960, D. L. Deonier), 3♂♂, 2♀♀.

Manitoba: Deepdale (VIII–1–1937, R. Beamer), 1♀.

Massachusetts: Concord (VII–19–1961, W. Wirth), 2♂♂, 1♀.

Michigan: Dickinson County (VII–1–1955, R. Dreisbach), 1♀; Midland County (VI–10–14–1951, R. Dreisbach), 1♂.

Minnesota: Houston County (V–27–1940, W. Connell), 4♂♂, 5♀♀; Mississippi River, sec. 34 T. 145 north, R. 36 west, Clearwater County (VII–8–1963, D. L. Deonier), 1♂, 1♀; Sucker Creek, 100 yards north of Highway 31, Clearwater County (VII–23–1963, D. L. Deonier), 1♀.

New Hampshire: Pinkham Notch (VII–9–1931, J. Aldrich), 1♂, 6♀♀; Stinson Lake, White Mountains (VII–23–1961, W. Wirth), 1♀; White Mountains (no dates, Morrison), 1♂.

New Mexico: Jemez Springs (VII–4–1953, W. Wirth), 3♀♀.

New York: Bergen (VII–24–1946, L. Beamer), 1♂; Ithaca, Inlet Valley (V–7–1957, B. Foote), 1♂.

North Carolina: Bubbling Spring Creek, 5,100 feet (VII–17–1957, J. Chillcott), 1♀.

Ontario: Algonquin Park (VI–26–1955, C. Sabrosky), 1♀; Ottawa (VI–12–1946, G. Shewell), 1♀.

Quebec: Great Gaspe Valley (VII–20–1931, J. Aldrich), 1♂.

Tennessee: Indian Gap, 5,200 feet (VII–23–1957, W. Richards), 1♀, (VII–24–1957, W. Richards), 1♀, (VIII–3–1957, C. Hines), 1♂.

Washington: 15 miles west of Kettle Falls (VII–14–1960, W. Rapp), 1♂.

IMMATURE SPECIMENS EXAMINED.—7 from 4 localities:

Minnesota: Headwaters of LaSalle Creek, Itasca State Park; Sucker Creek, south of Highway 31, Clearwater County; Sucker Creek, north of Highway 31, Clearwater County (all collected and reared by D. L. Deonier).

New York: Ithaca, Inlet Valley (collected and reared by B. Foote).

REMARKS.—The holotype of this species is in very poor condition.

Adult. Habitats recorded: leaves of *Glyceria grandis* and *Sagittaria latifolia;* reed marsh and sedge meadow.

Larva. Third-instar larvae were found along with larvae of other *Hydrellia* overwintering in *Glyceria grandis* shoots in fast, shallow streams of the Lake Itasca, Minnesota region in April and May 1967. It is not known if this plant is a summer host, but this is probable.

Puparium. The time from pupariation to emergence ranged from 8 to 18 days with a mean of 11 for 8 puparia in a temperature range of 55°–75° F. No puparia were found prior to the middle of May when low air temperatures were still prevalent.

Hydrellia nobilis (Loew)

FIGURE 36

Psilopa nobilis Loew, 1862, p. 229; 1872, p. 92.—Osten Sacken, 1878, p. 201.—Becker, 1896, p. 270 [bibliographic listing].—Aldrich, 1905, p. 625 [catalog listing].—Jones, 1906, p. 180 [catalog listing].

Hydrellia nobilis.—Cresson, 1931, p. 105; 1944b, pp. 164, 173.—Deonier, 1964, p. 116.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–13 aristal rays; vertex index 6.0–7.5; ocular index 17.0–26.0; wing length 2.33–3.06 mm; apicodorsal antennal prominent; tibiae moderate yellow. Male length 2.19–2.46 mm; female 2.55–3.13 mm. Male terminalia as in Figure 36.

HEAD.—Face moderate yellow; 5–8 pfa; epistomal index 1.3–1.8; mesofacial index 2.2–3.0; vertex index 6.0–7.5; A-index 1.7–2.2; ocular index 17.0–26.0. Palpus moderate yellow; 8–13 aristal rays; apicodorsal antennal prominent; antennal segment 3 moderate yellow; antennal segments 1 and 2, fronto-orbital area, and frontal vitta moderate brown; most of parafrontale velvety black; 16–19 postoculars.

THORAX.—Ppn and mesonotum semiglossy dark gray; 4–5 adc and 2 pdc; pleuron light gray except dark gray upper fifth of mesanepisternum; legs light-gray pruinose except moderate-yellow tibiae and tarsi. Wing length 2.33–3.06 mm; veins light brown; 7–8 setae on basal end of costa; 6–11 dorsal and 9–13 anterior interfractural costals; costal-section ratios: II:I 2.2–2.6; III:IV 2.6–3.2; V:IV 3.6–4.0; M_{1+2} index 1.3–1.7.

ABDOMEN.—Terga dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 acutely prominent (30° angle); copulobus slightly convex posteriorly, notched on medial margin at midlength, and irregularly setose except on medial margin. Postgonite bent posteriad and then anteriad; postgonite uncus short, straight; distiphallus undulate laterally and lamellate ventrally; apical basiphallus breadth 2.0 times anterior breadth of fused surstyli. Anterior margin of fused surstyli emarginate medially; B-index about 5.5; C-index 2.5–3.5.

TYPE.—Holotype male, MCZ 11143.

TYPE-LOCALITY.—District of Columbia (collector, Osten Sacken).

SPECIMENS EXAMINED.—96 (37♂♂, 59♀♀) from 24 localities:

Illinois: Chicago (no dates–1899, collector unknown), 1♂; McHenry (VIII–21–no year, A. Melander), 1♂.

Indiana: Chesterton (VI–2–1916, collector unknown), 1♂.

Iowa: Siewer's Springs State Park, near Decorah (IX–15–1962, D. L. Deonier), 1♂, 2♀♀.

Minnesota: Biological Station, Itasca State Park (VI–26–1963, D. L. Deonier), 1♀; Bohall Lake, Itasca State Park (VIII–17–1963, D. L. Deonier), 1♀; Bohall Trail Bog (VIII–17–1963, D. L. Deonier), 11♂♂, 19♀♀; Crookston (IX–5–1936, D. Denning), 1♀; Douglas Lodge Bay, Lake Itasca, Itasca State Park (VI–20–1963, D. L. Deonier), 5♂♂, 4♀♀; Iron Corner Lake (VI–18–1963, D. L. Deonier), 1♂, 1♀; Itasca State Park (VII–14–1938, P. Schroeder), 1♀; Kabekona Creek, Hubbard County (VIII–8–1963, D. L. Deonier), 2♀♀; Mississippi River at Sucker Creek, Clearwater County (VII–9–1963, D. L. Deonier), 1♀; Mississippi River near north entrance Itasca State Park (VII–9–1963, D. L. Deonier), 1♂, 1♀; Prof Green Trail, Itasca State Park (VII–25–1963, D. L. Deonier), 1♂; Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 2♂♂; Two Island Lake, Itasca State Park (VI–28–1963, D. L. Deonier), 1♂; west side across from Biological Station, Lake Itasca, Itasca State Park (VII–28–1963, D. L. Deonier), 1♂, (VIII–14–1963, D. L. Deonier), 8♂♂, 20♀♀.

New Jersey: Trenton (VIII–5–1910, collector unknown), 1♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 2♀♀; Ithaca (VI–8–1937, collector unknown), 1♀.

Pennsylvania: 2 miles north of Narberth, Montgomery County (IX–9–1915, collector unknown), 1♂.

Quebec: Ile Jesus, 4 miles north of Montreal (VIII–19–1956, J. Laffoon), 1♂.

Virginia: Alexandria (VII–6–1952, W. Wirth), 1♀.

REMARKS.—*Hydrellia nobilis, H. atroglauca,* and *H. idolator* appear to constitute a species group.

Adult. Habitats recorded: leaves of *Potomogeton* *gramineus, P. natans, Nuphar advena, Leersia oryzoides, Zizania aquatica, and Nasturtium officinale.*

I found several dead specimens on leaves of *P. natans* at Squaw Lake, Minnesota. I made the following observations on behavior of adults. At Lake Itasca, Minnesota, a male tried to mount a male *H. ischiaca* after repeatedly scissoring its wings, and another male tried to mount a female *H. ischiaca* but the latter repulsed it by rapidly striking out with its fore tarsi. Specimens at Lake Bohall, Itasca State Park, behaved similarly. At Bohall Trail Bog, a pair captured while in copulation remained so for 6 minutes in the live-capture tube. They copulated again in the laboratory two days later. At this locality, another pair approached each other and without any apparent epigamic behavior, the male mounted from the side. Shortly afterwards, a second male approached the pair frontally, crawled onto the pair and exerted its phallus for a few seconds before being forced off. It did this eleven times, and several times when it approached from the rear the copulating female turned quickly to meet it. Despite this interference, the pair copulated for 19 minutes. Here also, a male extended its wings straight out from the thorax and approached a second male, but it stopped abruptly and folded its wings. Then the second male extended its wings when faced by another specimen of *H. nobilis*. The latter immediately flew away and then the first male tried to mount the second. In another case, a male approached and tried to mount another male. The latter did not meet this advance with wing extension as it did in an immediately preceding instance.

Larva. Third-instar larvae were found along with larvae of other *Hydrellia* overwintering in *Glyceria striata* in slow, shallow streams and lakes of the Lake Itasca, Minnesota, region in May 1967. It is not known if this plant is a summer host. Specimens of this grass were found embedded in ice.

Puparium. The time from pupariation to emergence ranged from 10 to 14 days, with a mean of 11.8 days for 12 puparia in a temperature range of 55°–75° F.

Hydrellia notata, new species

FIGURE 52

DIAGNOSIS.—Palpus moderate yellow; 6–9 aristal rays; vertex index 7.2–8.7; ocellar absent; 2 anterior fronto-orbitals; supra-alar area velvety black; thoracic pleuron nearly all light gray. Male length 1.33–1.67 mm; female 1.70–2.00 mm. Male terminalia as in Figure 52.

HEAD.—Face light gray or yellowish gray; 4–6 pfa; epistomal index 1.2–1.6; mesofacial index 2.2–2.5; vertex index 7.2–8.7; A-index 1.4–2.0; ocular index 8.3–9.0. Palpus moderate yellow; 6–9 aristal rays; antenna dark brown; parafrontale velvety dark brown; frontal vitta glossy dark brown; subocular area to corner of postocular area dark brown; upper fourth of postocular area dark gray, remainder light gray; 2 anterior fronto-orbitals and 1 posterior fronto-orbital; ocellar absent; length of postocellar about 5.0 times that of posterior fronto-orbital; 10–15 postoculars.

THORAX.—Ppn and mesonotum dark brown except velvety black supra-alar area, light-brown postalar area with small light-gray spot, and densely light-brown pruinose scutellum; 3–4 adc and 2 pdc; pleuron light gray except brown spot above fore coxa; legs light-gray pruinose except moderate yellow tibial apices. Wing length 1.62–1.99 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 6–8 dorsal and 8–10 anterior interfractural costals; costal-section ratios: II:I 2.4–3.8; III:IV 2.8–3.6; V:IV 3.5–3.8; M_{1+2} index 1.5–1.8.

ABDOMEN.—Terga dark brown. Male terminalia: median third of posterior margin of sternum 5 convex; anterolateral margin of sternum 5 obtusangular (about 100°); copulobus conical, directed posterolaterad, and irregularly setose, with 4–5 medially inclined macrochaetae on posteromedial margin. Postgonite short, bent anteriad; postgonite uncus fusiform and straight; distiphallus short, almost uniform in breadth to slightly convex apex. Anterior margin of fused surstyli deeply V-clefted medially to a central gibba; B-index about 2.6; C-index 5.0–6.5.

TYPE.—Holotype male, USNM 70539.

TYPE-LOCALITY.—Canaan, Connecticut (VIII-31-1952, A. Stone).

PARATYPES.—5(2♂♂, 3♀♀) from 5 localities:

Florida: Hilliard, Nassau County (VIII-6-1939, R. Bessemer), 1♂ (ISC); Liberty County (III-22-1954, G. Steyskal), 1♀ (USNM).

Georgia: Blackshear, Pierce County (V-10-1911, collector unknown), 1♀ (CU).

Mississippi: Vancleave Road, Jackson County (VII-7-1962, D. L. Deonier), 1♂ (ISC).

New York: Fish Creek Pond (VIII-13-1941, A. Melander), 1 ♀ (USNM).

REMARKS.—On the basis of several characters, this very distinct species belongs to the *H. formosa* species group.

Adult. Habitats recorded: leaves of *Nymphaea odorata* and seepage slope.

Hydrellia notiphiloides Cresson

FIGURES 65, 84, 95, 116

Hydrellia notiphiloides Cresson, 1924, p. 162; 1944b, pp. 170, 175.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; prementum glossy brownish black; 6–8 aristal rays; ocular index 3.7–4.3; body length: wing length 0.9–1.0; lower three-fourths of postocular area light gray, upper fourth brown; thoracic pleuron light gray; costal section III:IV 2.5–3.5. Male length 1.89–2.30 mm; female 2.13–2.55. Male terminalia as in Figure 65.

HEAD.—Face light gray or pale yellow; 4–6 pfa; epistomal index 1.0–1.3; mesofacial index 1.3–1.9; vertex index 3.6–5.5; A-index 1.6–2.8; ocular index 3.7–4.3. Palpus moderate yellow; 6–8 aristal rays; prementum glossy brownish black; antenna and most of parafrontale dark brown; fronto-orbital area and frontal vitta moderate brown; 13–17 postoculars.

THORAX.—Ppn and pleuron light gray; mesonotum moderate brown; 3–4 adc and 2–3 pdc; legs light-gray pruinose except dark-brown tarsi. Wing length 2.04–2.72 mm; veins moderate brown; 7–11 setae on basal end of costa; 6–10 dorsal and 7–11 anterior interfractural costals; costal-section ratios: II:I 1.8–2.2; III:IV 2.5–3.5; V:IV 3.0–3.6; M_{1+2} index 1.1–1.6.

ABDOMEN.—Terga dark gray or moderate brown. Male terminalia: median third of posterior margin of sternum 5 evenly and moderately concave; anterolateral margin of sternum 5 roundly right-angled; copulobus acuminate posteriorly and irregularly setose. Postgonite bent anteriad and postgonite uncus posterolaterad and truncate apically; distiphallus tapering distally. Anterior margin of fused surstyli shallowly notched medially; B-index about 1.0; C-index 2.0–2.5.

THIRD-INSTAR LARVA.—Body of larva not examined. Frontoclypeal length 0.48–0.60 mm; cheliform spot oblique to dorsal phragmatal ramus (Figure 95). Ventral frontoclypeal index 3.0–3.5; phragmatal index 0.9–1.0; bifurcation index 4.5–5.5; clypeal-arch index 1.6–1.7. Clypeal arch sloping smoothly along about 20° angle relative to lower frontoclypeal margin. Mouth-hook beak longer than base; maximum mouth-hook base thickness about 2.0 times that of beak (Figure 84).

PUPARIUM.—Length 3.25–4.00 mm; maximum breadth 1.00–1.25 mm; fusiform (Figure 116). Puparial length: minimum breadth 15.0–17.0; maximum breadth: minimum breadth 5.0–6.0; anal-plate index 1.8–2.4. Prothoracic end semicircular in ventral view; head-lobe scar subcircular; maximum puparial breadth 7.5–8.0 times maximum breadth of head-lobe scar and 2.5 times maximum prothoracic breadth; prothorax with many ventral rugulae; mesothorax and metathorax prominently rounded laterally; lateral spinules inconspicuous in midlength of puparium; abdominal segment 8 without ventral, transverse row of setulae and with only 2–3 distinct annuli of spinules (immediately perispiracular); anal plate ovoid, with anterior margin slightly or distinctly convex. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, OSU (not numbered).

TYPE-LOCALITY.—Cedar Point, Sandusky, Ohio (VIII-5-1902, collector unknown).

ADULT SPECIMENS EXAMINED.—133 (56 ♂♂, 77 ♀♀) from 29 localities:

Arizona: Granite Delta (VII-3-1950, H. Wright), 1 ♀.

British Columbia: Hatzic Lake (VII-26-1953, W. Mason), 1 ♀.

California: Big Bear Valley (VIII-9-1933, collector unknown), 4 ♂♂, 6 ♀♀; Buena Park (V-19-1914, A. Melander), 2 ♂♂, 1 ♀; Carpenteria (VIII-11-1950, A. Melander), 6 ♂♂, 15 ♀♀; Davis (VII-21-1955, A. Grigarick), 1 ♂, 2 ♀♀, (VII-29-1955, A. Grigarick), 5 ♂♂, 8 ♀♀, (IX-16-1954, A. Grigarick), 1 ♀, (IX-17-1955, A. Grigarick), 7 ♂♂, 2 ♀♀, (IX-21-1957, A. Grigarick), 1 ♂, (IX-22-1955, A. Grigarick), 1 ♀, (IX-27-1955, A. Grigarick), 2 ♂♂, 4 ♀♀; Green Valley (VII-26-1944, A. Melander), 1 ♂; Jenks Lake, San Bernardino (VIII-3-1942, A. Melander), 2 ♀♀, (VII-22-1957, J. Hall), 1 ♀; Maxwell, Colusa County (VIII-12-1954, A. Grigarick), 7 ♂♂, 6 ♀♀; Putah Canyon, Yolo County (X-20-1954, A. Grigarick), 2 ♂♂; Vidal, San Bernardino County (IV-no date-1948, R. Coleman), 1 ♂; Santa Cruz, Santa Cruz County (VII-17-1940, B. Brookman), 2 ♀♀.

Iowa: Little Wall Lake, Hamilton County (IX-22-1962, D. L. Deonier), 2 ♂♂, 1 ♀; Spring Lake, Greene County (IX-19-1961, D. L. Deonier), 1 ♀; Springbrook State Park, Guthrie County (VI-23-1961, D. L. Deonier), 1 ♂.

Massachusetts: Nantucket (VII–20–year unknown, collector unknown), 1 ♂.

Mexico: Tepexpan, Mexico, 6,900 feet (VIII–12–1954, J. Chillcott), 1 ♀.

Michigan: Cheboygan County (VII–21–1947, C. Berg), 1 ♂, 5 ♀ ♀; Ocqueoc Lake, Presque Isle County (VII–13–1941, C. Berg), 1 ♂.

Minnesota: Bigstone County (VI–5–1938, C. Mickel), 1 ♀; Chamber's Creek, Itasca State Park (VII–18–1963, D. L. Deonier), 1 ♂.

Nevada: Ely (VIII–13–1940, R. Beamer), 1 ♂.

Ohio: Cedar Point, Sandusky River (VIII–5–1902, collector unknown), 1 ♂, 2 ♀ ♀.

Ontario: London (VII–31–1958, W. Judd), 1 ♀.

Quebec: Rupert House (VII–25–1949, D. Gray), 3 ♂ ♂, 4 ♀ ♀, (VII–26–1949, D. Gray), 1 ♀, (VII–29–1949, E. LeRoux), 1 ♂, 1 ♀, (VII–30–1949, E. LeRoux), 1 ♂, 4 ♀ ♀, (VIII–7–1949, E. LeRoux), 1 ♀.

Saskatchewan: Saskatoon (VIII–no date–1947, collector unknown), 1 ♀.

Virginia: Colonial Beach (VIII–no date–1916, collector unknown), 1 ♀.

Wyoming: Biscuit Basin, Yellowstone National Park (VIII–2–1954), A. Melander), 1 ♀; Northwest entrance Yellowstone National Park (VIII–3–1938, A. Melander), 1 ♂.

IMMATURE SPECIMENS EXAMINED.—8 from 2 localities:

California: Davis (collected and reared by A. Grigarick).

Michigan: Cheboygan County (collected and reared by C. Berg).

REMARKS.—Adults of *H. notiphiloides* and *H. caliginosa* are so similar that inspection of the male terminalia often may be necessary. I have not seen the holotype of this species.

Adult. Habitats recorded: leaves of *Oryza sativa* and *Potamogeton nodosus;* limnic wrack.

Host plants. Grigarick reared this species from *Zannichellia palustris* and *Polypogon monspeliensis* at Davis, California, September 1955 and 1957, during research on *H. griseola.* Judd (1964) recorded one adult from an emergence trap floating near *Potamogeton amplifolius* in Ontario in July. The water depth where the trap was anchored ranged from 5.3 to 5.4 meters.

Hydrellia penicilli Cresson

FIGURE 66

Hydrellia penicilli Cresson, 1944b, pp. 168–169.—Deonier, 1964, p. 116; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–10 aristal rays; vertex index 3.1–4.0; antennal segment 3 partly moderate yellow; mesonotum and abdomen strong yellowish brown; thoracic pleuron light gray; 3 black anterior basal setae on hind basitarsus. Male length 2.60–2.81 mm; female 2.62–3.15 mm. Male terminalia as in Figure 66.

HEAD.—Face yellowish gray; 4–6 pfa; 1–2 sfa; epistomal index 1.0–1.2; mesofacial index 1.5–1.8; vertex index 3.1–4.0; A-index 1.6–1.8; ocular index 6.0–8.0. Palpus moderate yellow; 8–10 aristal rays; antennal segments 1 and 2 and most of parafrontale moderate brown; antennal segment 3 partly moderate yellow; frontal vitta and fronto-orbital area yellowish gray or strong yellowish brown; 14–17 postoculars.

THORAX.—Ppn and mesonotum strong yellowish-brown; 3–4 adc and 2 pdc; pleuron light gray or strong yellowish brown; 1–2 basal coxals (1 macrochaetous); legs light-gray pruinose except dark-brown tarsi; 3 black anterior basal setae on hind basitarsus. Wing length 3.06–3.40 mm; veins light brown; 8–11 setae on basal end of costa; 7–10 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.5–2.9; III:IV 2.5–2.8; V:IV 3.1–3.9; M_{1+2} index 1.0–1.4.

ABDOMEN.—Terga and sterna strong yellowish brown. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 smoothly rounded; copulobus regularly and densely setulose and truncate posteriorly. Postgonite bent anteriad and postgonite uncus slightly laterad; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused surstyli deeply and narrowly cleft medially to three-fourths of length of structure; B-index about 1.0; C-index 1.5–2.0.

TYPE.—Holotype male, ANSP 6656.

TYPE-LOCALITY.—Pembroke, Ontario, Canada (VII–3–1938, A. L. Melander).

SPECIMENS EXAMINED.—11 (2 ♂ ♂, 9 ♀ ♀) from 10 localities:

British Columbia: Qualicum (VI–21–1955, G. Shewell), 1 ♂.

Iowa: Goose Lake, Hamilton County (VII–14–1960, D. L. Deonier), 1 ♀.

Maine: Salisbury Cove (VII–15–1923, C. Johnson), 1 ♀.

Manitoba: Birtle (VIII–13–1928, R. Bird), 2 ♀ ♀.

Michigan: Wexford County (VII–4–1952, R. Dreisbach), 1 ♂, 1 ♀.

New York: McLean (V–24–1915, collector unknown), 1 ♀.

Ontario: Pembroke (VII–3–1938, A. Melander), 2♀♀; Waubumick (VII–no date–1915, H. Parish), 1♀.

Quebec: Natashquan (VIII–5–1929, W. Brown), 1♀; Thunder River (VIII–19–1930, W. Brown), 1♀.

REMARKS.—This species seems closely related to *H. cruralis, H. notiphiloides,* and *H. cessator.*

Adult. Habitat recorded: reed marsh.

Hydrellia personata, new species

FIGURE 49

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; dorsal interfractural costals twice size of anterior ones; body length:wing length 0.7–0.8; apicodorsal antennal prominent; frons (except light-brown ocellar triangle) velvety dark brown; 1 pdc; thoracic pleuron moderate reddish brown. Male length 1.28–1.45 mm; female 1.45–1.62 mm. Male terminalia as in Figure 49.

HEAD.—Face light gray; 3–4 pfa; 1–3 sfa; epistomal index 1.0–1.4; mesofacial index 1.5–2.0; vertex index 5.5–7.0; A-index 1.3–2.0; ocular index 4.0–5.0. Palpus dark brown; 6–8 aristal rays; apicodorsal antennal prominent; antenna and frons (except light-brown ocellar triangle) velvety dark brown; 12–16 postoculars.

THORAX.—Ppn and mesonotum moderate olive-brown; 3–4 adc (1–2 macrochaetous) and 1 pdc; auxiliary apical scutellars usually present; pleuron moderate reddish brown; legs dark brown except yellowish-gray trochanters. Wing length 1.53–2.04 mm; veins dark brown; 6–8 setae on basal end of costa; 3–6 dorsal and 6–9 anterior interfractural costals (dorsals 2.0 times size of anteriors); costal-section ratios: II:I 1.8–2.2; III:IV 3.5–4.0; V:IV 3.0–3.6; M_{1+2} index 1.2–1.5.

ABDOMEN.—Terga dark brown. Male terminalia: median third of posterior margin of sternum 5 broadly concave; anterolateral margin of sternum 5 rounded through 95°–100° angle; copulobus almost truncate posteriorly and irregularly setose. Postgonite straight and covered by surstyli; postgonite uncus straight and aciculate; maximum breadth of pregonite 2.0 times that of postgonite, pregonite extending further anteriad; distiphallus slightly expanded at midlength. Anterior margin of fused surstyli acutely papilliform medially; B-index about 4.5; C-index 0.4–0.7.

TYPE.—Holotype male, WSC 322.

TYPE-LOCALITY.—O'Sullivan Dam, Grant County, Washington (X–30–1954; presumed collector, H. G. Davis).

PARATYPES.—27 (10♂♂, 17♀♀) from 9 localities:

Arizona: Patagonia, Santa Cruz County (VI–27–1953, W. Wirth), 1♀ (USNM).

California: Mono Lake, Mono County (VI–7–1948, W. Wirth), 1♀ (USNM); Richmond, Contra Costa County (VI–16–1948, W. Wirth), 5♀♀ (USNM); Sunol, Alameda County (IX–9–1947, W. Wirth), 1♀ (USNM); Victorville, San Bernadino County (V–2–1953, G. Moran and R. Schuster), 1♀ (USNM).

Iowa: Izaak Walton League reserve, near Ames, Story County (IV–27–1962, D. L. Deonier), 1♂, 2♀♀ (USNM and ISC); Ames (IV–23–1962, D. L. Deonier), 1♂ (DLD).

Texas: University of Texas Arboretum, Austin (I–20–1950, presumed collector, M. Wheeler), 2♂♂, 3♀♀ (MRW, USNM, ISC, and DLD).

Washington: O'Sullivan Dam, Grant County (X–30–1954, H. Davis), 6♂♂, 3♀♀ (USNM, ISC, and WSC).

REMARKS.—I have not been able to place this species in any particular group. It differs from the *H. prudens* and *H. tibialis* groups noticeably by its distinctly wide head, and its normal, unexpanded, male mid tibia.

Adult. Habitats recorded: sedge meadow and margin of Mono Lake, California.

Hydrellia platygastra Cresson

FIGURE 38

Hydrellia platygastra Cresson, 1931, pp. 105, 106; 1944b, pp. 168, 172.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 8–11 aristal rays; mid and hind tarsi moderate orange-yellow; face velvety dark brown; thoracic pleuron light brown except light gray on lower half of mesokatepisternum; 10–14 setae on basal end of costa; male abdomen compressed. Male length 2.30–2.38 mm; female 2.89–3.06 mm. Male terminalia as in Figure 38.

HEAD.—Face velvety dark brown; 3–4 pfa; 6–9 sfa; epistomal index 1.0–1.2; mesofacial index 1.7–2.2; vertex index 4.0–7.0; A-index 1.7–2.0; ocular index 4.5–6.0. Palpus dark brown; 8–11 aristal rays; apicodorsal antennal prominent; antenna, frontal vitta, and fronto-orbital area dark-brown pruinose; most of parafrontale velvety black; 17–18 postoculars.

THORAX.—Ppn and mesonotum brassy moderate brown; 4–5 adc and 2–3 pdc; pleuron semiglossy light brown except light gray on lower half of mesokatepisternum; legs dark brown except dark-yellow trochanters and moderate orange-yellow mid and hind tarsi. Wing length 2.89–3.40 mm; veins dark brown; 10–14 setae on basal end of costa; 6–9 dorsal and 9–11 anterior interfractural costals; costal-section ratios: II:I 2.2–2.5; III:IV 2.5–3.0; V:IV 3.0–3.8; M_{1+2} index 1.4–1.6.

ABDOMEN.—Terga and sterna dark gray. Male terminalia: median third of posterior margin of sternum 5 deeply concave; anterolateral margin of sternum 5 smoothly rounded on a very obtuse angle; copulobus curving elliptically posteriorly and regularly setose. Postgonite bent anteriad and postgonite uncus straight; distal half of distiphallus shallowly undulate laterally and lamellate ventrally. Anterior margin of fused surstyli broadly emarginate; B-index about 2.0; C-index 0.5–0.8.

TYPE.—Holotype male, ANSP 6483.

TYPE-LOCALITY.—Beaver Creek, Newport, Oregon (no dates, J. M. Aldrich).

SPECIMENS EXAMINED.—71 (35♂♂, 36♀♀) from 24 localities:

British Columbia: Langley (VIII–9–1917, A. Melander), 1♂; Milner (VII–12–1953, W. Mason), 1♂, (VIII–12–1953, W. Mason), 1♂, 2♀♀.

California: Willits (V–30–1955, E. Schlinger), 1♀.

Idaho: Lake Coeur d'Alene (VII–15–1926, E. Nast), 1♀; Potlatch (VI–17–1911, collector unknown), 1♂; Soldier Creek, Priest Lake (VIII–22–1919, A. Melander), 1♀.

Nebraska: Arapahoe (VIII–11–1960, W. Rapp), 1♂. (This specimen may have been incorrectly labeled, for it is the sole record east of the Rocky Mountains.)

Oregon: Albany (V–26–1941, Schuh and Gray), 1♀; Beaver Creek, Newport (no dates, J. Aldrich), 3♀♀; Breitenbush Springs, 2,222 feet (VII–6–1934, H. Scullen), 1♀; Gold Beach (VII–27–1951, collector unknown), 2♀♀; Hood River (no dates, Childs), 1♂, 5♀♀; Independence (VII–25–1934, N. Larson), 1♀; Marshfield (VI–27–no year, J. Aldrich), 2♂♂, 1♀; Newport (VI–9–1925, E. Van Dyke), 1♂; Sear Lake, Fort Lewis, Pierce County (IX–1–1945, P. Arnaud), 2♀♀.

Washington: Arlington (VII–28–1931, J. Nottingham), 1♀; Cusick (VII–14–1960, W. Rapp), 1♀; Five-Mile Lake (VII–4–1935, A. Melander), 1♂; Ilwaco (VII–no date–1917, A. Melander), 1♂, 1♀, (VIII–27–1917, A. Melander), 1♂, (VI–28–1925, A. Melander), 2♂♂; Lake Stevens, Everett (VIII–5–1917, A. Melander), 1♀; Seaview (VI–26–1925, A. Spuler), 1♂; Tacoma (VIII–27–1911, collector unknown), 1♂; 15 miles west of Kettle Falls (VII–14–1960, W. Rapp), 19♂♂, 11♀♀.

REMARKS.—*Hydrellia platygastra* and *H. wilburi* have identical male terminalia (as far as I could determine). The principal differential character is facial color. Even though these two species are sympatric to a great extent, I have jusified species designation for *H. wilburi* on the absence of intergradational phenotypes in several moderately large series and on the distinct possibility of ecological isolation of the two groups. The localities for *H. wilburi* are all at higher altitudes than those for *H. platygastra*.

Hydrellia proclinata Cresson

FIGURE 57

Hydrellia proclinata Cresson, 1915, pp. 69–70; 1931, p. 107; 1944b, pp. 165–171.—Wirth and Stone, 1956, p. 469.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; all fronto-orbitals anteriorly inclined; vertex index 4.5–7.0; body length:wing length 0.8–1.0; thoracic pleuron moderate brown with 2 light gray areas. Male length 1.87–2.21 mm; female 2.30–2.81 mm. Male terminalia as in Figure 57.

HEAD.—Face light gray; 4–6 medially inclined pfa; 6–8 medially inclined sfa; epistomal index 1.0–1.3; mesofacial index 2.0–2.2; vertex index 4.5–7.0; A-index 2.0–2.2; ocular index 7.0–7.5. Palpus dark brown; 6–8 aristal rays; antenna, frontal vitta, and fronto-orbital area moderate brown; most of parafrontale velvety black; apicodorsal antennal prominent; anterior and posterior fronto-orbitals anteriorly inclined; 14–17 postoculars.

THORAX.—Ppn light brown, with light-gray tinge; mesonotum glossy dark grayish green; 3–4 adc and 2–3 pdc; occasional auxiliary apical scutellars; pleuron moderate brown except middle third of propleuron and mesanepisternum and lower anterior corner of mesepimeron light gray (these forming 2 distinct spots); legs dark brown except fore coxa partly light gray. Wing length 2.13–2.89 mm; veins dark brown; 6–7 setae on basal end of costa; 8–11 dorsal and 9–12 anterior interfractural costals; costal-section ratios: II:I 2.2–3.5; III:IV 2.6–2.8; V:IV 3.0–3.8; M_{1+2} index 1.0–1.5.

ABDOMEN.—Most of the terga usually glossy dark grayish green. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 acutangular (80°–90°); copulobus distinctly bilobate posteromedially, deeply emarginate at midlength on medial margin, and irregularly setose. Postgonite bent anterolaterad and postgonite uncus laterad; distal half of distiphallus of uniform breadth (proximal half 3.0–4.0 times as broad as distal half). Anterior margin of fused surstyli nearly truncate with only slight medial indentation; B-index about 2.0; C-index 0.8–1.0.

TYPE.—Holotype male, ANSP 6075.

TYPE-LOCALITY.—Berkeley Hills, Alameda County, California (IV–20–1908, E. T. Cresson, Jr.).

SPECIMENS EXAMINED.—797 (269♂♂, 528♀♀) from 169 localities:

Alberta: Vermilion Lake, Banff, 4,500 feet (VIII–17–1925, O. Bryant), 2♀♀.

Arizona: Chiricahua Mountains (VII–5–1940, D. Hardy), 1♀, (VII–3–1947, L. Beamer), 2♀♀; Coconino County (VIII–18–1927, R. Beamer), 1♂; Hassayampa River, Wickenburg (VI–29–1953, W. Wirth), 1♀; Oak Creek Canyon, Sedona (VI–29–1953, W. Wirth), 2♀♀; Pinery Canyon, Chiricahua Mountains, Cochise County, 6,000 feet (VI–23–1919, W. Stone), 1♂; Sunnyside Canyon, Huachuca Mountains (VII–9–1940, L. Lipovsky), 1♀.

British Columbia: Atlin, 2,200 feet (VI–13–1955, H. Huckel), 1♀, (VIII–11–1955, B. Gibbard), 1♀; Okanagan Falls, 2,000 feet (VI–16–1953, J. McGillis), 4♂♂, 2♀♀; Oliver, 1,000 feet (VIII–18–1953, J. McGillis), 1♀.

California: Adobe Creek, West Stanislaus County (V–6–1948, J. Mac Swain), 1♂; Asilomar (IX–29–1946, A. Melander), 1♂, (X–2–1946, A. Melander), 1♂, 1♀; Auburn (V–12–1953, J. Hall), 1♂, 1♀; Barton Flats (VIII–3–1942, A. Melander), 5♀♀; Barton Store (VII–4–1946, A. Melander), 1♂; Berkeley Hills, Alameda County (IV–11–1908, collector unknown), 1♀, (IV–20–1908, collector unknown), 3♂♂, 5♀♀; Big Bear Lake (V–24–1935), A. Melander), 1♀; Big Meadow, 7,200 feet (VII–30–1937, G. Spurlock), 1♂; Big Pines (VIII–2–1944, A. Melander), 2♂♂, 7♀♀, (VIII–9–1944, A. Melander), 5♂♂, 7♀♀, (V–23–1945, A. Melander), 2♀♀; Big Springs, Shasta County, 4,000 feet (VI–26–1947, H. Chandler), 1♀; Bishop (VII–28–1940, D. Hardy), 1♂, 1♀, (VII–28–1940, L. Kuitert), 1♂, (VII–28–1940, L. Lipovsky), 1♂, 1♀; Bowerman Meadow Trinity County (VI–3–1951, A. McClay), 1♀; Cajon (VIII–9–1944, A. Melander), 1♀; Campo (VII–18–1940, R. Beamer), 1♀; Carson Pass (IX–11–1938, M. Cazier), 1♂; Cassel, Shasta County (VII–15–1955, E. Schlinger), 1♀; Cedar Pass, Modoc County (V–15–1948, W. Wirth), 1♀; Cisco (VI–5–1940, M. James) 1♂; Clarksville, Eldorado County (IV–27–1929, H. Keefer), 1♀; Clear Lake Oaks, Lake County (IV–19–1954, E. Schlinger), 1♀; Clio, Plumas County (VII–9–1916, H. Dyar), 1♂; Coalinga, Fresno County below 500 feet (VI–1–3–1907, J. Bradley), 1♀; Convict Creek, Mono County (VI–6–1948, W. Wirth), 1♂; Cow Creek, Tuolumne County (VI–25–1951, A. McClay), 2♀♀; Crabtree Meadow, Tulare County, 10,500 feet (VII–29–1915, collector unknown), 1♂; Dellecker, Plumas County (VII–4–1951, E. Schlinger), 1♀; Ebbett's Pass, Alpine County (IX–11–1938, M. Cazier), 2♂♂, (VII–22–1957, E. Mezger), 1♀, (VIII–24–1957, E. Mezger), 1♀, (VIII–29–1957, E. Mezger), 1♀; Echo (VIII–10–1940, D. Hardy), 4♂♂, (VIII–10–1940, L. Kuitert), 1♂, 4♀♀, (VIII–10–1940, L. Lipovsky), 2♀♀; Echo Lake, Eldorado County (VII–23–1955, E. Schlinger), 4♂♂, 5♀♀; Felton, Santa Cruz Mountains (V–20–25–1907, J. Bradley), 1♂, 1♀; Garden Valley, Eldorado County (V–3–1952, E. Schlinger), 1♂, 2♀♀; Glacial Point Road, Yosemite National Park (VII–6–1947, A. Melander), 1♀; Grass Lake, Luther Pass, Eldorado County (VII–24–1955, E. Schlinger), 5♀♀; Green Valley (VII–26–1944, A. Melander), 1♂, 5♀♀; Guatay, San Diego (IV–10–1950, L. Quate), 1♀; Hallelujah Junction, Lassen County (VII–4–1949, J. MacSwain), 1♀, (VII–16–1953, E. Schlinger), 1♂; Hat Lake, Lassen National Park (VII–23–1950, P. Arnaud), 1♀; Herkey Camp (V–14–1950, A. Melander), 1♂, 1♀; near Hobart Mills, Nevada County (X–10–1952, E. Schlinger), 1♀; Hope Valley, Alpine County (VII–18–1948, L. Quate), 1♀; Idylwild (VI–4–1935, P. Oman), 1♀; Jacumba (VII–17–1940, D. Hardy), 2♀♀; Jenks Lake (VIII–18–1950, A. Melander), 1♀; Keen Camp (VI–7–1942, A. Melander), 2♂♂, 1♀; Laguna Mountains (VII–6–1929, L. Anderson), 1♀, (VII–6–1929, R. Beamer), 1♀; Lake Alpine (IX–11–1938, M. Cazier), 3♂♂, 2♀♀; Lake City, Modoc County (X–11–1952, E. Schlinger and J. Hall), 1♂, 3♀♀; Lake Cuyamaca (VII–5–1945, A. Melander), 3♀♀; Lake Fontanillia, 8,500 feet, Eldorado County (VIII–21–1955, E. Schlinger), 1♂, 1♀; Lake Tahoe (VIII–11–1940, E. Kenaga), 1♀, (VIII–11–1940, L. Kuitert), 1♀, (VIII–11–1940, L. Lipovsky), 3♂♂, 3♀♀; LaPosata Creek, San Diego (IV–10–1950, L. Quate), 1♀; Leavitt Meadow, Mono County (VII–6–1951, A. McClay), 1♀, (X–11–1952, J. Hall), 1♀; Likeley, Modoc County (VII–6–1951, A. McClay), 1♀, (X–11–1952, E. Schlinger), 2♀♀, (X–11–1952, J. Hall), 1♂; Mammoth Lakes (V–29–1940, R. Beamer), 3♂♂, 1♀, (VII–29–1940, D. Hardy), 32♂♂, 99♀♀, (VII–29–1940, E. Kenaga), 1♂, 2♀♀, (VII–29–1940, L. Lipovsky), 9♂♂, 11♀♀; Manzanita Lake, Lassen National Park (III–1–1941, J. Fisher), 1♂; Marion Mountain Camp, San Jacinto Mountains (VII–1–1952, A. McClay), 1♀; Mason Creek R. S., Modoc County (X–12–1952, E. Schlinger), 2♂♂, 4♀♀; Mono Lake, Mono County (VII–31–1940, E. Kenaga), 1♀; Monterey County (VII–5–1896, collector unknown), 1♂, 1♀, (VII–8–1896, W. Wheeler), 1♂, (VII–9–1896, W. Wheeler), 1♂, 1♀, (VII–17–1896, G. Hough), 1♀; Morro Bay (VII–27–1940, A. Melander), 1♀; Ortega Highway, El Cariso Camp (V–26–1944, A. Melander), 1♂; Pacific Grove (V–7–1906, J. Aldrich), 3♀♀, (V–13–1906, J. Aldrich), 1♀ (VI–no dates, W. Mann), 1♀; Palm Springs (XII–14–17–1917, J. Bradley), 2♂♂, (XI–19–1943, A. Melander), 1♂, 1♀, (XI–22–1943, A. Melander), 1♂, 2♀♀; Palomar Mountain (VI–14–1948, A. Melander), 1♂, 2♀♀; Pinecrest Lookout, Tuolumne County (VII–7–1948, P. Arnaud), 1♂, (VII–30–1948, P. Arnaud), 1♀; Putah Canyon, Yolo County

(XI-10-1942, E. Schlinger), 1 ♀, (XI-6-1954, W. Lange), 1 ♂; Redwood City, San Mateo County (XII-26-1951, P. Arnaud), 1 ♀; Riverside (XII-22-1934, A. Melander), 1 ♂, (X-28-1944, A. Melander), 1 ♀; Sage Hen, 5 miles northwest of Hobart Mills (VI-20- 1954, M. James), 1 ♂, 3 ♀ ♀, (VII-2-1954, J. Downey), 1 ♀; San Antonio R. S., Santa Clara County (VI-27-1953, R. Schuster), 1 ♀; San Bernardino Mountains, Cienaga (IX-28-1947, A. Melander), 1 ♂, 1 ♀; San Diego (IV-no date-1913, E. Van Duzee), 1 ♀; San Gabriel River (IX-18-1949, M. Wheeler), 1 ♀, (I-21-1950, M. Wheeler), 4 ♂ ♂, 2 ♀ ♀; San Jacinto Mountains (VII-21-1929, R. Beamer), 1 ♂; San Jose Mission (X-no date-1897, collector unknown), 1 ♂; Sardine Creek, Mono County (VII-2-1951, A. McClay), 2 ♀ ♀, (VII-5-1951, A. McClay), 1 ♂, (VII-6-1951, A. McClay), 2 ♀ ♀, (VII-11-1951, A. McClay), 1 ♂, 2 ♀ ♀, (VII-12-1951, A. McClay), 1 ♀, (VII-18-1951, A. McClay), 2 ♀ ♀, (VII-29-1954, J. Downey), 1 ♀; Sequoia National Park (VIII-6-1940, L. Kuitert), 1 ♀; Siberian Outpost, Tulare County, 9,500-10,500 feet (VII-3-1915, collector unknown), 1 ♀; Sonora Pass, 9,624 feet (VII-12-1951, A. McClay), 1 ♀, (VII-17-1951, A. McClay), 6 ♀ ♀; South Fork, Santa Ana River (VII-29-1942, A. Melander), 1 ♂, 1 ♀, (VIII-4-1945, A. Melander), 1 ♀; South Fork Camp, Barton Flats (VIII-31-1944, A. Melander), 1 ♂, (IX-3-1944, A. Melander), 1 ♀; South Fork Camp, Santa Ana River, San Bernardino County (VI-28-1952, R. Beamer et al.), 1 ♀; Stanford University, Santa Clara County (XII-29-1897, collector unknown), 1 ♀; Strawberry, Tuolumne County (VI-15-1951, A. McClay), 1 ♂, 1 ♀, (VI-19-1951, A. McClay), 1 ♂, 1 ♀, (VI-22-1951, A. McClay), 2 ♀ ♀; Sugarloaf, Barton Flats (IX-17-1945, A. Melander), 1 ♂, 5 ♀ ♀; Sugarloaf Mountain (V-11-1947, J. Sperry), 1 ♀, (V-30-1947, J. Sperry), 2 ♀ ♀; Summit Lake, Lassen National Park (VII-23-1950, L. Quate), 1 ♂; Temecula, Riverside County (IV-24-1951, E. Schlinger), 1 ♀; Thousand Springs, San Bernardino Mountains (X-24-1946, A. Melander), 5 ♀ ♀; Tioga Pass (VII-31-1940, D. Hardy), 3 ♂ ♂, 6 ♀ ♀, (VII-31-1940, L. Lipovsky), 2 ♀ ♀; Trinity River, Trinity County (VII-13-1953, A. McClay), 1 ♀, (VII-17-1953, A. McClay), 8 ♂ ♂, 13 ♀ ♀, (VII-18-1953, A. McClay), 1 ♀; Truckee (VII-5-1936, A. Pritchard), 1 ♂, (VII-6-1927, E. Van Duzee), 3 ♂ ♂, 3 ♀ ♀; Tuolumne Meadows (VIII-1-1940, R. Beamer), 1 ♂, 2 ♀ ♀, (VII-1-1940, D. Hardy), 8 ♂ ♂, 20 ♀ ♀; Upper Santa Ana River (V-20-1947, A. Melander), 1 ♀, (VI-18-1950, A. Melander), 1 ♀, (IX-4-1950, A. Melander), 2 ♂ ♂, 1 ♀; Upper Santa Ana River, Cienaga (V-28-1948, J. Sperry), 1 ♂, 4 ♀ ♀, (V-31-1948, J. Sperry), 2 ♀ ♀; Yosemite Valley (V-22-1908, collector unknown), 1 ♂, 1 ♀; (VIII-1-1940, R. Beamer), 1 ♂, (VIII-1-1940, D. Hardy), 1 ♂, 2 ♀ ♀, (VIII-1-1940, E. Kenaga), 1 ♀, (VIII-1-1940, L. Kuitert), 1 ♀, (VIII-1-1940, L. Lipovsky), 2 ♂ ♂, 2 ♀ ♀; Yuba Pass, Sierra County (VIII-20-1953, E. Schlinger), 1 ♀; 3 miles southeast of Mount Lassen (VIII-8-1955, A. Mueller), 2 ♀ ♀; 10 miles west of Salinas near Carmel Valley, Monterey County (IV-4-1953, J. Lattin), 1 ♂.

Colorado: Cerro Summit, 9,500 feet (IX-5-1938, A. Hardy), 1 ♀; Electra Lake, 37°33′ N, 107°48′ W, 8,400 feet (VI-28-VII-1-1919, collector unknown), 1 ♂; Emerald Lake, Gunnison County (VIII-27-1961, D. L. Deonier), 1 ♂; Glade Peak, Mesa County (VII-8-1953, A. Gurney), 2 ♂ ♂, 2 ♀ ♀, Golden (VI-17-1940, A. Melander), 1 ♂; Lindland (VII-27-1938, M. James), 1 ♀; Ohio Pass Road, Gunnison County, 38°42.2′ N, 107°5.2′ W (VIII-26-1961, D. L. Deonier), 43 ♂ ♂, 55 ♀ ♀; Pingree Park (VIII-13-1934, C. Sabrosky), 1 ♀; Rocky Mountain Biological Laboratory, 9,500 feet, Gunnison County (VIII-27-1961, D. L. Deonier), 5 ♂ ♂, 3 ♀ ♀; 3 miles north of Rocky Mountain Biological Laboratory, Gunnison County (VIII-27-1961, D. L. Deonier), 2 ♂ ♂, 3 ♀ ♀; 1 mile north of Rocky Mountain Biological Laboratory (VIII-27-1961, D. L. Deonier), 4 ♀ ♀.

Idaho: Echo Bay, Coeur d'Alene Lake (VIII-3-1924, A. Melander), 1 ♀; Juliaetta (no dates, J. Aldrich), 1 ♀; Moscow Mountain (VIII-23-1908, collector unknown), 1 ♂, 3 ♀ ♀; Potlatch (IX-21-1918, A. Melander), 1 ♂, 2 ♀ ♀; Priest Lake (IX-3-1919, A. Melander), 1 ♀; Swan Lake, Bancock County (VI-19-1952, E. Schlinger), 1 ♀; Yale (IX-10-1912, J. Aldrich), 1 ♀.

Mexico: 70 miles west of Durango, Durango, 9,000 feet (V-7-1961, Howden and Martin), 1 ♂, 1 ♀; 10 miles east of Toluca, Mexico, 9,000 feet (VIII-17-1954, J. Chillcott), 2 ♂ ♂, 2 ♀ ♀.

Nevada: Beatty (V-26-1940, G. Bohart), 1 ♀; Double Spring (VI-21-1916, H. Dyar), 1 ♂; Reno (X-20-1915, H. Dyar), 2 ♀ ♀.

New Mexico: Jemez Mountains (IX-10-1914, collector unknown), 1 ♀; Tajique (VI-28-1947, R. Beamer), 1 ♀.

Oregon: Crater Lake (IX-16-1934, A. Melander), 1 ♀; Crater Lake National Park, near headquarters, 6,600 feet (VII-30-1930, F. Wynd), 3 ♂ ♂, 8 ♀ ♀; Crater Lake National Park, Pole Bridge Meadows, 6,000 feet (VIII-15-1930, F. Wynd), 1 ♀; Crater Lake National Park, Sun Creek Meadow, 6,500-7,000 feet (VIII-26-1930, H. Scullen), 1 ♀; Fish Lake, Harney County (VII-16-1957, J. Lattin), 1 ♀; Harney County (VI-29-1958, A. Gurney), 1 ♀; Pringle Falls, 9 miles west of La Pine, Deschutes County (VII-13-1957, G. Kraft), 1 ♀; 22 miles north of Prospect (VI-8-1948, Schuh and Gray), 2 ♂ ♂, 1 ♀; Quartz Mountain Service Station (VI-18-1934, J. Schuh), 1 ♀.

Saskatchewan: Aftons Lake (IX-4-1940, A. Brooks), 1 ♀.

Texas: Henkes Pond, Kerrville (IV-4-1955, W. Wirth), 1 ♂, 1 ♀.

Utah: Cedar City (VIII-13-1939, P. Oman), 1 ♂, 7 ♀ ♀; Echo (X-16-1943, G. Knowlton), 2 ♂ ♂; Eden (VI-21-1937, D. Hardy), 1 ♀; Emigrant Canyon, 7,000 feet, Wasatch Mountains (VII-8-1911, J. Aldrich), 2 ♀ ♀; Lake Cottonwood Canyon, 8,000 feet (VI-23-1940, A. Melander), 7 ♂ ♂, 13 ♀ ♀; Leeds (VI-27-1945, G. Knowlton), 2 ♀ ♀; Provo Canyon (VIII-15-1940, R. Beamer), 1 ♀; Roberts Pass, Uinta Mountains, Duchesne County, 12,500 feet (VII-9-1946, collector unknown), 1 ♀; Timpanogos Mountain (VI-25-1940, A. Melander), 2 ♂ ♂, 6 ♀ ♀.

Washington: Blue Mountains, Rose Spring (VI–19–1921, A. Melander), 1♀; Dungeness (VIII–24–1910, collector unknown), 1♂, 1♀; Holland (VII–3–1919, A. Melander), 1♀; Kalama River (VII–21–1931, R. Beamer), 1♂; Klickatack River, Glenwood (VI–27–1917, A. Melander), 1♂; Mount Rainier National Park, Berkeley Park (VIII–23–1934, A. Melander), 1♀; Mount Rainier National Park, Paradise Park (VIII–no date–1917, A. Melander), 1♀; Mount Rainier National Park, Summerland (VIII–29–1934, A. Melander), 2♂♂, 4♀♀; Mount Rainier National Park, Yakima Park (VIII–19–1934, A. Melander), 2♂♂, 1♀; Olga (VII–26–1909, collector unknown), 1♂; O'Sullivan Dam, Grant County (X–30–1954, H. Davis), 1♀; Pullman (VI–16–1912, collector unknown), 2♀♀, (X–17–1915, A. Melander), 1♂; Pullman, Lyles Grove (VIII–10–1923, A. Melander), 1♀; Uniontown (VI–26–1932, J. Aldrich), 1♀.

Wyoming: Kemmerer (VIII–14–1950, M. Wheeler), 1♂; Yellowstone National Park, Geyser Basin (VIII–7–1919, A. Melander), 1♂, 2♀♀; Yellowstone National Park, Norris Basin (VII–26–1923, A. Melander), 1♀.

REMARKS.—Except for *H. decens,* the male of which is unknown, this species probably could be confused only with *H. melanderi. Hydrellia melanderi* and *H. proclinata* differ conspicuously only in the male terminalia, but the light-gray pleural spots are fused in *H. melanderi* and separate in *H. proclinata.*

Adult. Habitats recorded: *Equisetem* sp., *Eleocharis* sp., sedge meadow, and flowers of *Prunus emarginata.* An observer found this species swarming near some black scale infestations of trees at San Jose Mission, California.

Hydrellia procteri Cresson

FIGURE 20

Hydrellia proctori Cresson, 1934, p. 235.
Hydrellia procteri; Cresson, 1936, p. 257 [emendation of *lapsus calami*]; 1944b, pp. 169, 174.—Deonier, 1964, p. 116; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 7–8 aristal rays; epistomal index 1.0–1.4; wing length 1.70–2.13 mm; thoracic pleuron light gray except light-brown upper edge of mesanepimeron; distal half of male hind femur depressed and distal end of hind tibia expanded slightly. Male length 1.50–2.04 mm; female 1.70–2.04 mm. Male terminalia as in Figure 20.

HEAD.—Face light gray or yellowish gray; 4–5 pfa; epistomal index 1.0–1.4; mesofacial index 2.0–2.5; vertex index 4.0–4.4; A-index 1.8–2.6; ocular index 11.5–14.0. Palpus moderate yellow; 7–8 aristal rays; antenna and frons moderate brown; 13–16 postoculars.

THORAX.—Ppn and mesonotum dark gray; 3–4 adc and 2 pdc; pleuron light gray except light brown upper edge of mesanepimeron; legs light-gray pruinose except light-gray coxae and moderate-yellow tarsi; distal half of male hind femur depressed and distal end of hind tibia expanded slightly. Wing length 1.70–2.13 mm; veins dark brown; 6–7 setae on basal end of costa; 7–8 dorsal and 10–12 anterior interfractural costals; costal-section ratios: II:I 2.0–2.3; III:IV 3.0–3.5; V:IV 3.6–4.2; M_{1+2} index 1.5–2.0.

ABDOMEN.—Terga dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 very slightly concave (congruent with apex of distiphallus); anterolateral margin of sternum 5 roundly obtusangular (about 100°); copulobus lanceolate; posterior half of copulobus irregularly setose, anterior half mostly bare. Postgonite bent anterolaterad; postgonite uncus straight; distiphallus constricted preapically and lamellate ventrally. Anterior margin of fused surstyli broadly and slightly concave; B-index about 5.0; C-index 1.0–1.5.

TYPE.—Holotype male, ANSP 6152.

TYPE-LOCALITY.—Bar Harbor, Mount Desert Island, Maine (V–7–1933, W. Procter).

SPECIMENS EXAMINED.—52 (15♂♂, 37♀♀) from 11 localities:

Connecticut: Southwest corner of Sleeping Giant State Park, near Hamden (VII–30–1961, J. Laffoon), 1♀.

Illinois: Chicago (VIII–29–1896, W. Wheeler), 1♀.

Iowa: Goose Lake, Hamilton County (VII–14–1960, D. L. Deonier), 1♂; Ledges State Park, Boone County (VIII–16–1960, D. L. Deonier), 1♂; Little Wall Lake, Hamilton County (VIII–13–1960, D. L. Deonier), 2♂♂, 8♀♀, (VIII–27–1960, D. L. Deonier), 2♀♀, (IX–22–1962, D. L. Deonier), 1♂, 1♀; Spring Lake, Greene County (IX–19–1961, D. L. Deonier), 4♂♂, 12♀♀; Springbrook State Park, west ½ sec. 33, T.81 north, R.31 west, Guthrie County (VII–19–1960, D. L. Deonier), 1♀.

Kansas: Marais des Cygnes Wildlife Refuge, Linn County (IX–5–1961, D. L. Deonier), 5♂♂, 8♀♀.

Maine: Bar Harbor, Mount Desert Island (VII–15–1933, W. Procter), 1♂; Mount Desert Island (VII–25–1935, W. Procter), 2♀♀.

Michigan: Augusta (X–4–1953, collector unknown), 1♀.

REMARKS.—This species seems to belong in the

H. crassipes group. Most of the similarities are in coloration and modification of the male hind leg, but there are some in the male terminalia. The distiphallus is ventrally lamellate in both *H. crassipes* and *H. procteri,* and the posteromedial edge of sternum 5 is heavily sclerotized in both.

Adult. Habitats recorded: leaves of *Potamogeton nodosus* and *Nelumbo lutea;* limnic wrack, sedge meadow, mud flat, and riffle rocks.

Hydrellia prudens Curran

FIGURE 18

Hydrellia prudens Curran, 1930, p. 78.—Cresson, 1944b, pp. 164, 172.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 6–8 aristal rays; vertex index 3.8–4.5; 1–3 sfa; antenna and parafrontale not velvety; thoracic pleuron bronzed moderate olive-brown; male mid tibia expanded. Male length 1.53–1.67 mm; female 1.53–1.70 mm. Male terminalia as in Figure 18.

HEAD.—Face light brown except lower third or so light gray; 4–5 pfa; 1–3 sfa; epistomal index 1.0–1.3; mesofacial index 1.7–2.0; vertex index 3.8–4.5; A-index 2.0–2.6; ocular index 4.5–6.5. Palpus dark brown; 6–8 aristal rays; antenna and most of parafrontale very dark brown; fronto-orbital area and frontal vitta moderate olive-brown; 12–16 postoculars.

THORAX.—Most of thorax and legs bronzed moderate olive-brown; 3–4 adc and 2 pdc; male mid tibia expanded; thoracic pleuron bronzed moderate olive-brown. Wing length 1.62–1.87 mm; veins dark brown; 5–7 setae on basal end of costa; 5–7 dorsal and 6–8 anterior interfractural costals; costal-section ratios: II:I 2.0–2.6; III:IV 2.8–3.4; V:IV 2.8–3.8; M_{1+2} index 1.3–1.8.

ABDOMEN.—Terga bronzed moderate olive-brown. Male terminalia: median third of posterior margin of sternum 5 slightly concave and more heavily sclerotized than remainder; anterolateral margin of sternum 5 right-angled (90°–100°); copulobus not prominently produced, slightly convex posteriorly and the whole with 6–9 large scattered setae. Postgonite bent distinctly anteromediad then laterad; postgonite uncus with end bent about 45° laterad; distiphallus short, triangular, and furrowed ventrally between 2 carinae. Anterior margin of fused surstyli moderately concave medially; B-index 0.8–1.0; C-index 0.8–1.0.

TYPE.—Holotype male, AMNH (not numbered).

TYPE-LOCALITY.—Station for Study of Insects, Tuxedo, New York (VI–29–1928, C. H. Curran).

SPECIMENS EXAMINED.—7 (3♂♂, 4♀♀) from 4 localities (Wirth, 1965, listed Idaho, Maine, New York, and eastern Canada as the known distribution for this species):

Massachusetts: Woods Hole (VIII–no date–1922, A. Sturtevant), 1♂.

Mississippi: Lake Shady, Lamar County (VI–29–1962, D. L. Deonier), 1♂.

New York: Station for Study of Insects, Tuxedo (VI–29–1928, C. Curran), 1♂, 3♀♀.

Pennsylvania: Ohiopyle, Fayette County (VIII–no date–1907, H. Kahn), 1♀.

REMARKS.—Cresson (1944, p. 164) listed *Hydrellia johnsoni* Cresson as a full synonym of *H. prudens.* I found this to be incorrect after examination of the male terminalia in at least two specimens labeled by Cresson as paratypes of *H. johnsoni.* The exact status of *H. johnsoni* must remain undetermined until the holotype terminalia can be studied.

Adult. Habitat recorded: leaves of *Nuphar advena.*

Hydrellia pulla Cresson

FIGURES 61, 106, 114

Hydrellia pulla Cresson, 1931, p. 108; 1944b, pp. 170, 175.—Berg, 1950, pp. 375, 376, 377, 379, 382, 383 (pl. 1, fig. 4), 384, 385 (pl. 2, fig. 5), 386, 387, 388, 389 (pl. 3, fig. 5), 390, 396. [biology, morphology, and taxonomy of immatures].—Judd, 1964, p. 412. [biology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate orange-yellow; 7–9 aristal rays; pfa and sfa nonseriated (4–7 of each); body length:wing length 0.9–1.0; face carinate and conically prominent on lower half; 2–3 basal coxals. Male length 2.38–2.55 mm; female 2.55–3.15 mm. Male terminalia as in Figure 61.

HEAD.—Face light gray, carinate and conically prominent on lower half; 4–7 nonseriated pfa; 2–5 sfa more or less parallel to pfa; 2 sfa, ventrally directed and above pfa; epistomal index 1.0–1.4; mesofacial index 1.7–2.0; vertex index 4.5–6.5; A-index 1.6–1.9; ocular index 4.3–5.2. Palpus moderate orange-yellow; 7–9 aristal rays; antenna, fronto-orbital area, and frontal vitta light brown;

most of parafrontale velvety dark brown; 14–20 postoculars.

THORAX.—Ppn and mesonotum dark brown; 3–4 adc and 2 pdc; pleuron light gray except strong yellowish brown on posterior half of mesanepisternum and on mesokatepisternum and laterotergite; 2–3 basal coxals (1 macrochaetous); legs sparsely strong yellowish-brown pruinose except dark-brown tarsi. Wing length 2.21–3.06 mm; veins dark brown; 9–14 setae on basal end of costa; 7–11 dorsal and 9–13 anterior interfractural costals; costal-section ratios: II:I 2.3–3.6; III:IV 2.6–3.8; V:IV 3.4–4.6; M_{1+2} index 1.2–1.6.

ABDOMEN.—Terga dark brown medially and light gray laterally and ventrally. Male terminalia: median third of posterior margin very slightly concave; anterolateral margin of sternum 5 obtusangular (about 110°); copulobus acutangular posteriorly, verrucate anteromedially, and irregularly setose. Postgonite bent laterad; postgonite uncus buttonlike; pregonite breadth 2–3 times postgonite breadth; distiphallus tapering distally and ventrally bicarinate. Anterior margin of fused surstyli slightly concave; B-index about 1.0; C-index 3.0–4.0.

EGG.—Length 0.57–0.65 mm; maximum breadth 0.18–0.22 mm. Chorion indistinctly corrugate, with longitudinal ridges anastomosing infrequently; end opposite micropylar protuberance acute. Micropylar protuberance infundibulate, but long and visible in dorsal view. This description in part after Berg (1950).

FIRST-LARVAL INSTAR.—Length 1.00–1.80 mm; maximum breadth 0.18–0.25 mm. Frontoclypeal length 0.18–0.22 mm. Opaque, yellowish gray. This description in part after Berg (1950).

SECOND-INSTAR LARVA.—Length 1.80–3.50 mm; maximum breadth 0.25–0.65 mm. Frontoclypeal length 0.28–0.35 mm. This description in part after Berg (1950).

THIRD-INSTAR LARVA.—Length 3.35–6.00 mm; maximum breadth 0.80–1.20 mm. Frontoclypeal length 0.50–0.66 mm; feeding apparatus hyaline except mouth-hook and cheliform spot (Figure 106). Ventral frontoclypeal index 4.8–5.2; phragmatal index 1.2–1.4; bifurcation index 3.5–3.8; clypeal-arch index 1.8–2.0. Clypeal arch angled 20°–25° in relation to lower frontoclypeal margin. Mouth-hook beak distinctly longer than base; maximum mouth-hook base thickness about 2.0 times that of beak; mouth-hook light spot small, elliptical. Prothorax and mesothorax sparsely spinulose; abdominal segment 8 without ventral, transverse row of setulae, but with many irregular dark spinules ventrally. Body opaque yellowish gray.

PUPARIUM.—Length 3.35–5.25 mm; maximum breadth 0.90–1.50 mm; subcylindrical (Figure 114). Puparial length: minimum breadth 15.0–16.0; maximum breadth: minimum breadth 3.5–4.5; anal-plate index 2.5–3.0. Prothoracic end slightly convex or slightly triangular in ventral view; head-lobe scar subcircular; anal plate crescentric, with anterior margin distinctly convex. Empty puparium translucent, light brown.

TYPE.—Holotype female, ANSP (not numbered).

TYPE-LOCALITY.—Spencer Lake, New York (VI-30-1907, collector unknown). Labeled "loaned property of Cornell."

ADULT SPECIMENS EXAMINED.—84 (17♂♂, 67♀♀) from 15 localities:

British Columbia: Elk Lake, Vanonov Island (VII–11–1934, A. Melander), 1♀.

Michigan: Douglas Lake, Cheboygan County (VII–17–1941, C. Berg), 1♂, 1♀; Huron River, Washtenaw County (V–15–1941, C. Berg), 1♀; Ocqueoc Lake, Presque Isle County (VII–13–1941, C. Berg), 1♀; Third Sister Lake, Washtenaw County (IV–22–1940, C. Berg), 1♀, (V–20–1940, C. Berg), 1♀, (VII–17–1941, C. Berg), 1♀, (II–2–1942, reared by C. Berg), 2♀♀, (III–30–1942, C. Berg), 3♀♀, (V–3–1942, C. Berg), 5♂♂, 23♀♀, (VI–12–1942, C. Berg), 2♀♀, (VI–13–1942, C. Berg), 1♀; Whitmore Lake, Washtenaw County, (III–5–1941, reared by C. Berg), 2♂♂, (III–11–1941, reared by C. Berg), 1♀.

Minnesota: Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 1♀; Two Island, Itasca State Park (VI–28–1963, D. L. Deonier), 1♂, (VIII–8–1963, D. L. Deonier), 7♀♀, (VIII–18–1963, D. L. Deonier), 1♀; 1.3 miles south of main entrance, Itasca State Park (VI–26–1963, D. L. Deonier), 7♀♀.

New York: Ithaca (no dates or collector), 1♂.

Ontario: London (V–20–1958, W. Judd), 1♀, (V–21–1958, W. Judd), 1♀, (VII–16–1958, W. Judd), 1♂, (VII–19–1958, W. Judd), 1♂; Midland (VIII–18–1955, J. Chillcott), 3♂♂, 6♀♀.

Quebec: Lac Bernard (VIII–7–1938, G. Shewell), 1♂, 3♀♀.

Washington: Orcas Island above Mountain Lake (VIII–18–1925, A. Melander), 1♀.

Wisconsin: Squaw Lake, Vilas County (VIII–19–1954, J. Laffoon), 1♂.

IMMATURE SPECIMENS EXAMINED: 67 from 4 localities:

Michigan: Cheboygan County (collected and reared by

C. Berg); Washtenaw County (collected and reared by C. Berg).

Minnesota: Two Island Lake, Itasca State Park (collected and reared by D. L. Deonier); 1.3 miles south of main entrance Itasca State Park (collected and reared by D. L. Deonier).

REMARKS.—The prominent face bordered by the nonseriated primary facials together with its relatively large size makes this species recognizable even macroscopically in its habitat.

Adult. Habitats recorded: leaves of *Potamogeton amplifolius, P. gramineus, P. natans, Sagittaria latifolia,* and *Nuphar advena.*

Many observations of this conspicuous species yielded little information on its behavior. In one instance, a female caught a live chironomid and acted very protective of her catch when a female *H. luctuosa* darted in near it. On another occasion, a female *H. bergi* attacked a female *H. pulla.* I collected several adults by the lighted-receptacle method.

Berg found eggs in masses one layer deep concealed in leaf folds, stipules, and broken mines of *Potamogeton* species from June through August. I observed a female return repeatedly over a 10-minute period to an old aphid exoskeleton on a *Sagittaria* leaf into which she inserted her ovipositor each time; however, I found no eggs in it. In Berg's laboratory, adults mated and oviposited within 48 hours after emergence.

Egg and larva. According to Berg, the incubation period ranged from 4 to 6 days, the first larval stadium 4 to 8 days, and the second and third larval stadia 6 to 10 and 5 to 15 days, respectively. In one case, I found the third larval stadium to be 4 days. All of these measurements were made in the laboratory.

Puparium. The third-instar larva pupariates with its spiracular peritremes inserted in the leaf midrib or petiole. The puparial phase ranged from 10 to 15 days. Berg found several puparia in two bluegill stomachs.

Host plants. I found larvae and puparia of this species only in *Potamogeton amplifolius.* Berg found them in *P. amplifolius, P. gramineus,* and *P. richardsonii.*

Parasites. Berg (1950, p. 386) stated that "Apparently *H. pulla* is much less susceptible to parasitism than any other species of *Hydrellia* studied in this investigation. Although *H. pulla* was often observed closely associated with *H. cruralis,* the two braconid parasites *Chorebidea* and *Ademon,* so frequently reared from the latter, were never encountered in puparia of the former." He reared only *Trichopria columbiana* from *H. pulla* puparia. He found no parasites in 80 *H. pulla* puparia collected along with 71 of *H. cruralis* from which 12 braconids emerged. I reared *Ademon niger* and *T. columbiana* from *H. pulla* puparia. Of 61 puparia collected or reared, 39 harbored hymenopterous parasites.

In one case of parasitism, a third-instar larva of *H. pulla* fed actively from 8 July to 12 July, when it pupariated. On 12 July, shortly after pupariation, I observed a leechlike larva of *Ademon niger* moving in the anterior part of the puparium. A subsequent examination revealed that the anterior half of the puparium was devoid of tissue. The adult hymenopteron emerged 25 July. In another case, the hymenopteron emerged 18 days after pupariation. In four puparia, I found pharate adult hymenopterans with their ventral side toward the puparial dorsum, and in another one, the hymenopteron's head faced the posterior end of the puparium.

Several observations on the behavior of *T. columbiana* adults support previous statements about its oviposition habit. Four adults lived submerged for 24 hours. In one instance, an adult emerged from the puparium and surfaced immediately on 2 August. On 5 August, this adult submerged and deposited three eggs near its former host puparium. The hymenopteron held its wings in repose while moving about submerged. She scraped a small bubble loose from the wings and then tried to surface. The next day she was alive on the surface.

Hydrellia rixator, new species

FIGURE 29

DIAGNOSIS.—Palpus moderate yellow; prementum glossy brownish black; 6–8 aristal rays; vertex index 5.5–7.5; nearly all of frons velvety dark brown; wing length 1.70–2.04 mm; body length:wing length 1.0–1.2. Male length 1.50–1.70 mm; female 1.96–2.47 mm. Male terminalia as in Figure 29.

HEAD.—Face light yellowish brown; 4–6 pfa; epistomal index 1.2–1.5; mesofacial index 2.0–2.3; vertex index 5.5–7.5; A-index 1.3–1.7; ocular index

5.3–6.0. Palpus moderate yellow and triangular; 6–8 aristal rays; prementum glossy brownish black; antenna dark brown; posterior half of fronto-orbital area strong yellowish brown; remainder of frons velvety dark brown; 12–16 postoculars.

THORAX.—Ppn and notopleuron yellowish gray; remainder of mesonotum strong yellowish brown; 3–4 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except dark-brown tarsi. Wing length 1.70–2.04 mm; veins light yellowish brown; 6–7 setae on basal end of costa; 6–10 dorsal and 8–11 anterior interfractural costals; costal-section ratios: II:I 1.6–2.3; III:IV 2.7–3.2; V:IV 2.8–3.6; M_{1+2} index 1.2–1.8.

ABDOMEN.—Terga light gray except medial parts of 2–4 moderate brown. Male terminalia: median third of posterior margin of sternum 5 concave and congruent with distiphallus; median third of anterior margin of sternum 5 broadly notched; anterolateral margin of sternum 5 smoothly rounded, with linear, bladelike process projecting laterad from above; copulobus irregularly setose, with incurved posterior arm bearing 5–6 fusiform macrochaetae distally and a shorter posteriorly directed medial arm bearing 3–4 macrochaetae distally. Postgonite bent posteromediad and postgonite uncus anteromediad; distiphallus short and nearly uniform in breadth to ovoid apex. Anterior margin of fused surstyli with 3 deep clefts; B-index about 2.0; C-index 1.5–2.0.

TYPE.—Holotype male, USNM 70540.

TYPE-LOCALITY.—Samburg, Reelfoot Lake, Tennessee, 36°22.9′ N, 89°21.3′ W (VIII–12–1962, D. L. Deonier).

PARATYPES.—9 (4♂♂, 5♀♀) from 4 localities:

Kentucky: Fulton, Fulton County (no dates, W. Phillips), 1♂ (ISC).

Tennessee: Samburg, Reelfoot Lake (VIII–12–1962, D. L. Deonier), 4♀♀ (USNM and ISC).

Texas: Kerrville (VII–no date–1954, L. Bottimer), 1♀ (USNM); Laguna Madre, 25 miles southeast of Harlington (VII–7–1945, D. Hardy), 3♂♂ (USNM and ISC).

REMARKS.—Except for some inconspicuous color differences and the ratio of body length to wing length, this species could be readily confused physiognomically with *H. griseola* or with the predominantly Neotropical *H. spinicornis*.

Adult. Habitats recorded: leaves of *Heteranthera dubia* and *Sagittaria australis*.

Hydrellia saltator, new species

FIGURE 56

DIAGNOSIS.—Palpus moderate yellow; 7–10 aristal rays; ocular index 6.0–7.0; antenna velvety black; 2 basal coxals; male hind femur grooved ventrally and hind tibia flanged, but not so distinctly as in *H. crassipes*. Male length 2.72 mm; female length 3.06 mm. Male terminalia as in Figure 56.

HEAD.—Differing mainly from *H. crassipes* in the following: mesofacial index 1.7–2.0; ocular index 6.0–7.0; antenna velvety black.

THORAX.—Differing mainly from *H. crassipes* in the following: 2 basal coxals; wing length 2.47–2.98 mm; 7–10 dorsal and 10–12 anterior interfractural costals.

ABDOMEN.—Terga semiglossy dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 obtusely recessed; anterolateral margin of sternum 5 rounded through about 120° angle; copulobus acutangular posteriorly (about 20°) and irregularly setose except for medial marginal row. Postgonite bent anterolaterad; postgonite uncus straight, truncate, long, and directed laterad; distiphallus tapering to mucronate apex (except small preapical constriction); distiphallus carinate and finely lamellate ventrally. Anterior margin of fused surstyli narrowly notched medially to about one-third the length of structure, with about 6–8 setae on anterolateral corners; B-index about 3.6; C-index 1.2.

TYPE.—Holotype male, CNC 11652.

TYPE-LOCALITY.—Grand Bend, Ontario, Canada (VII–10–1939, G. E. Shewell).

PARATYPE.—1♀ with same data as holotype. These are the only known specimens of this species.

REMARKS.—To distinguish this sibling of *H. crassipes*, it may be necessary to examine the male terminalia. One should not place too much reliance on the basal-coxal differential at this time.

Hydrellia serena Cresson

FIGURE 35

Hydrellia serena Cresson, 1931, p. 104; 1934, p. 236; 1944b, pp. 165, 174.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; prementum pale yellow; 7–9 aristal rays; ocular index 5.8–6.8;

most of parafrontale velvety black; thoracic pleuron light gray except upper fifth dark brown and mesanepisternum bronzed in posterolateral view; 2–3 basal coxals; 7–10 anterior interfractural costals. Male length 1.79–2.24 mm; female 2.18–2.40 mm. Male terminalia as in Figure 35.

HEAD.—Face light gray or yellowish gray; 4–5 pfa; epistomal index 1.2–1.6; mesofacial index 1.9–2.3; vertex index 6.0–9.0; A-index 1.4–2.2; ocular index 5.8–6.8. Palpus moderate yellow; 7–9 aristal rays; prementum pale yellow; antenna dark brown; fronto-orbital area and frontal vitta strong yellowish brown; most of parafrontale velvety black; 14–16 postoculars.

THORAX.—Ppn and notopleuron strong yellowish brown; rest of mesonotum dark brown; 3–4 adc and 2–3 pdc; pleuron light gray except upper fifth dark brown and mesanepisternum bronzed in posterolateral view; legs light-gray pruinose except dark-brown tarsi. Wing length 2.04–2.64 mm; wing veins dark brown; 6–9 setae on basal end of costa; 6–9 dorsal and 7–10 anterior interfractural costals; costal-section ratios: II:I 2.0–2.5; III:IV 2.5–3.0; V:IV 3.0–3.4; M_{1+2} index 1.3–1.7.

ABDOMEN.—Terga light brown dorsally and light gray ventrally. Male terminalia: median third of posterior margin of sternum 5 narrowly notched (almost congruent with distiphallus); anterolateral margins of sternum 5 acutangular (45°–50°); anterior and lateral margins of sternum 5 distinctly more heavily sclerotized; copulobus truncate posteriorly and irregularly setose. Postgonite bent anterolaterad and postgonite uncus slightly laterad; distiphallus apex lanceolate; basiphallus not nearly covered laterally by surstyli. Anterior margin of fused surstyli deeply and narrowly cleft medially, with 7–9 setae conspicuous on each corner; B-index about 5.0; C-index 0.3–0.8.

TYPE.—Holotype male, ANSP 6482.

TYPE-LOCALITY.—Ilwaco, Washington (VII–no date–1917, A. L. Melander).

SPECIMENS EXAMINED.—181 (70♂♂, 111♀♀) from 42 localities:

Alaska: Anchorage (VI–19–1921, J. Aldrich), 1♂; King Salmon, Naknek River (VII–10–1952, W. Mason), 1♂, 6♀♀, (VII–23–1952, W. Mason), 1♀, (VIII–1–1952, W. Mason), 6♂♂, 6♀♀, (VIII–11–1952, W. Mason), 4♂♂, 9♀♀; Savonoski, Naknek Lake (VII–26–1919, A. Basinger), 1♂, 1♀; Seward (VII–24–1921, J. Aldrich), 1♀; Sitka (VII–10–1907, W. Shaw), 1♀.

Alberta: Manyberries (VI–4–1956, O. Peck), 1♀.

British Columbia: Atlin (VII–7–1955, H. Huckel), 7♂♂, 17♀♀; (VII–20–1955, H. Huckel), 3♀♀, (VIII–4–1955, B. Gibbard), 1♀; Huntingdon (VI–30–1953, W. Mason), 1♂; Masset, Queen Charlotte Islands (VI–3–1957, E. MacDougall), 3♂♂, 9♀♀; Milner (VII–12–1953, G. Spencer), 2♀♀; Mission City (VI–6–1953, W. Mason), 1♂, 6♀♀, (VI–9–1953, W. Mason), 1♂, 1♀, (VI–18–1953, E. Mason), 1♂, (VI–20–1953, W. Mason), 1♀, (VII–2–1953, E. Mason), 2♀♀, (VII–5–1953, G. Spencer), 1♀, (VII–10–1953, W. Mason), 1♂; Moresby Camp, Queen Charlotte Islands (V–31–1957, E. MacDougall), 1♂; peat bog at Pitt Meadows (VII–9–1953, W. Mason), 1♂, 2♀♀; Vancouver (VI–20–1958, H. and A. Howden), 1♀; Victoria (VII–10–1924, A. Melander), 1♂, 2♀♀.

Colorado: Bear Lake, Estes Park, 1,000 feet (VII–11–1934, A. Melander), 1♀; Cameron Pass (VIII–19–22–1940, C. Sabrosky), 1♂; Marshall Pass, 10,856 feet (VII–28–1906, collector unknown), 1♂, 1♀; Rocky Mountain Biological Laboratory, Gunnison County, 9,500 feet (VIII–26–1961, D. L. Deonier), 1♂.

Idaho: Pottsville (VIII–23–1916, A. Melander), 1♂.

Manitoba: Churchill (VII–8–1952, J. Chillcott), 1♀, (VII–30–1952, J. Chillcott), 1♂; Farnsworth Lake near Churchill (VII–14–1952, J. Chillcott), 1♀; Fort Churchill (VI–24–1952, J. Chillcott), 2♀♀, (VII–4–1952, J. Chillcott), 1♂, (VII–10–1952, J. Chillcott), 1♀; Mile 505 of Hudson Bay Railway (VI–29–1952, J. Chillcott), 1♀, (VII–16–1952, J. Chillcott), 1♀, (VII–26–1952, J. Chillcott), 1♀.

Northwest Territories: Alakvik (VII–27–1932, Bryant), 1♂.

Oregon: Marshfield (VI–27–no year, J. Aldrich), 3♀♀; Newport (VI–9–1925, E. Van Dyke), 1♂.

Washington: Bellingham (VII–no date–1930, collector unknown), 4♂♂, 3♀♀; Blaine (VIII–7–1917, A. Melander), 1♂; Everett (VI–19–1920, A. Melander), 1♂, (VI–20–1920, A. Spuler), 1♂; Humptulips (IX–5–1934, A. Melander), 1♂, 1♀; Ilwaco (VII–no date–1917, A. Melander), 2♂♂, 2♀♀, (VIII–27–1917, A. Melander), 1♀, (VI–10–1918, A. Spuler), 2♂♂, 2♀♀, (VI–18–1918, A. Spuler), 6♂♂, 7♀♀, (VII–no date–1918, O. Miner), 2♀♀, (VI–28–1925, A. Melander), 1♂; Longmire (VI–27–1935, A. Melander), 1♂; Mount Constitution (VII–31–1909, collector unknown), 1♂, 1♀; Olga (V–17–1910, collector unknown), 1♀; Olympia (VII–17–1922, A. Melander), 1♂; Pluvius (VII–16–1922, A. Melander), 1♂, 1♀; Point Gamble (VIII–16–1910, collector unknown), 1♂; Poulaho (VIII–17–1910, collector unknown), 1♂; Roche Harbor (VII–3–1909, A. Melander), 1♂; Seaview (VI–28–1925, A. Spuler), 3♂♂, 3♀♀, (VI–30–1925, A. Spuler), 1♂; Sequim (VIII–2–1951, collector unknown), 1♂.

REMARKS.—*Adult.* Habitats recorded: *Equisetum* sp. at 9,500 feet, peat bog, and unspecified at 10,856 feet.

Hydrellia spinicornis Cresson

FIGURES 40, 78, 93, 103, 105, 117, 124

Hydrellia spinicornis Cresson, 1918, p. 48 (pl. 3, fig. 5); 1947a, p. 38.—Wirth, 1968, p. 13 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 6–8 aristal rays; mesofacial index 2.6–3.4; body length:wing length 0.9–1.0; thoracic pleuron light gray; distinct black anteroventral spines on distal half of female fore femur; costal section II:I 3.0–3.7. Male length 1.53–1.75 mm; female length 1.70–1.87 mm. Male terminalia as in Figure 40.

HEAD.—Face light gray; 5–7 pfa; epistomal index 1.5-1.9; mesofacial index 2.6–3.4; vertex index 8.0 or more; A-index 1.7–2.3; ocular index 5.8–7.6. Palpus moderate yellow; 6–8 aristal rays; antenna and most of parafrontale dark brown; fronto-orbital area and frontal vitta strong yellowish brown; 13–16 postoculars.

THORAX.—Ppn light gray; mesonotum strong yellowish brown; 3–4 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except moderate-yellow trochanters and dark-brown tarsi. Wing length 1.53–1.87 mm; veins light yellowish brown; 6–8 setae on basal end of costa; 5–7 dorsal and 6–10 anterior interfractural costals; costal-section ratios: II:I 3.0–3.7; III:IV 2.6–3.5; V:IV 3.4–4.2; M_{1+2} index 1.4–1.7.

ABDOMEN.—Terga moderate brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 convex, with paired, posteriorly directed bispinate processes; anterolateral margin of sternum 5 rounded; copulobus rounded or nearly truncate posteriorly and irregularly setose. Postgonite directed anteromediad, with short, medially incurved uncus; distiphallus uniform in breadth (except preapical constriction) and covered by sternum 5. Anterior margin of fused surstyli deeply cleft medially to central gibba; surstyli with acute anterolateral processes; B-index about 3.3; C-index 8.0–10.0.

EGG.—Length 0.40–0.55 mm; maximum breadth 0.14–0.15 mm. Chorion (Figure 78), yellowish gray, corrugate, with the few longitudinal ridges occasionally anastomosing; spaces between ridges regularly micropunctate. Micropylar protuberance infundibulate, exposed in dorsal view.

FIRST-INSTAR LARVA.—Length 0.38–1.20 mm; maximum breadth 0.06–0.20 mm. Clypeal arch distinctly angular (about 100°); feeding apparatus black; frontoclypeal length 0.14–0.18 mm (Figure 105). Heavily sclerotized supraspiracular spinous processes present.

SECOND-INSTAR LARVA.—Length 0.90–3.50 mm; maximum breadth 0.20–0.80 mm. Clypeal arch not so angular. Frontoclypeal length 0.24–0.28 mm (Figure 93). Spiracular peritreme distinct as in Figure 79; 2 bispinate asteriform processes and 4–6 smaller spines just anterodorsal to each spiracular peritreme; peritreme extraordinarily long and spicate. Body translucent, yellowish gray.

THIRD-INSTAR LARVA.—Length 2.00–4.50 mm; maximum breadth 0.50–1.00 mm. Frontoclypeal length 0.36–0.42 mm (Figure 103). Ventral frontoclypeal index 3.4–3.6; phragmatal index 0.8–0.9; bifurcation index 3.4–3.8; clypeal-arch index 1.4–1.6. Clypeal arch sloping at 20°–30° in relation to lower frontoclypeal margin. Mouth-hook beak and base indistinct; mouth-hook light spot narrow, triangular, and about 3.0 times longer than wide. Supraspiracular bispinate processes absent or at least indistinct; prothorax densely spinulose, abdominal segment 8 without ventral, transverse row of setulae, but with 4–5 annuli of spinules. Body opaque, with yellow tinge.

PUPARIUM.—Length 3.00–4.00 mm; maximum breadth 0.75–0.90 mm; fusiform (Figure 117). Puparial length:minimum breadth 18.0–20.0; maximum breadth:minimum breadth 3.5–4.5; anal-plate index 2.6–3.2. Prothoracic end semicircular in ventral view; head-lobe scar triangular or obovoid; maximum puparial breadth 1.5–1.7 times maximum prothoracic breadth; anal plate reniform, with anterior margin convex. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, ANSP 6121.

TYPE-LOCALITY.—Alajuela, Costa Rica, sweeping at 3,100 feet (IX–15–1909, P. A. Calvert).

ADULT SPECIMENS EXAMINED.—328 (190♂♂, 138♀♀) from 5 localities:

Florida: Lacoochee (IX–18–1930, P. Oman), 4♀♀.

Georgia: Rabun Bald, Rabun County (VIII–9–1957, W. Richards), 1♂.

Mississippi: Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar County (VII–11–1962, D. L. Deonier), 79♂♂, 58♀♀, (VII–24–1962, D. L. Deonier), 70♂♂, 47♀♀; Lake Shady, Lamar County (VI–29–1962, D. L. Deonier), 2♂♂, 4♀♀, (VII–11–1962, D. L. Deonier), 38♂♂, 24♀♀; Vancleave Road, Jackson County (VI–28–1962, D. L. Deonier), 1♀.

IMMATURE SPECIMENS EXAMINED.—26 from 2 localities:

Mississippi: Dickinson's Pond and Lake Shady, Lamar County (collected and reared by D. L. Deonier).

REMARKS.—I have determined my material as *Hydrellia spinicornis* without access to the holotype; however, paratype comparison was made, and it seems unlikely the material represents a new species. It is so similar to *Hydrellia griseola* that a study of body and wing lengths and male terminalia was necessary to detect its different status. *Hydrellia spinicornis* is definitely a cryptic member of the *H. griseola* species group.

Adult. Habitats recorded: leaves of *Hydrochloa caroliniensis, Nymphaea odorata,* and *Nelumbo lutea.*

Several observations yielded no information on adult behavior.

Egg and larva. I collected a few eggs from leaves of *H. caroliniensis,* but I did not obtain any data on the incubation period. The larvae left evidence that they initially enter the mesophyll of the leaf sheath in most cases and then mine into the exceedingly thin leaf blade. I had too few larvae to allow them to develop sufficiently to measure the stadia.

Puparium. Most of the puparia I collected contained late pupae. Mines in stems and stolons containing puparia had an escape slit either lateral to or slightly anterior to the operculum of the puparium, while those in leaves usually had none. The larvae apparently made these slits before they pupariated.

Host plants. I found larvae and puparia only in *Hydrochloa caroliniensis,* a water grass growing in vast mats in bay-tree swamps and small ponds bordering lakes in southern Mississippi. Infestation ranged from sparse to moderate in the three localities examined. Plants collected from isolated pools during a late summer drought in September had a lower percent infestation. The drought may have indirectly decreased the local population of *H. spinicornis* by causing numerous larvae to become trapped in drying mats of water grass.

I examined samples of the following additional plant species for immatures of *H. spinicornis: Juncus repens, Potamogeton diversifolius, Polygonum hyperpiperoides, Xyris caroliniana,* and *Hypericum punctatum.*

Parasites. One undetermined hymenopteron emerged through the posterior end of a puparium.

Hydrellia subnitens Cresson

FIGURE 45

Hydrellia subnitens Cresson, 1931, p. 106; 1936, p. 258; 1941, p. 37; 1944b, pp. 169, 174.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 8–9 aristal rays; epistomal index 1.4–3.0; ocular index 9.0–13.0; thoracic pleuron light gray; costal section II:I 2.4–3.0. Male length 2.04–2.21 mm; female 2.04–2.89 mm. Male terminalia as in Figure 45.

HEAD.—Face light gray or yellowish gray; 4–8 pfa; epistomal index 1.4–3.0; mesofacial index 2.0–4.8; vertex index 4.4–6.3; A-index 2.1–2.6; ocular index 9.0–13.0. Palpus moderate yellow; 8–9 aristal rays; antennal segment 3 moderate yellow or dark brown; antennal segments 2 and 3, fronto-orbital area, and frontal vitta light brown; most of parafrontale dark brown; 14–17 postoculars.

THORAX.—Ppn and mesonotum dark brown; 4 adc and 2 pdc; pleuron light gray; 1–2 basal coxals (1 macrochaetous); legs light-gray pruinose except moderate-yellow tibial apices and tarsi. Wing length 2.47–3.23 mm; veins light yellowish brown; 6–8 setae on basal end of costa; 7–9 dorsal and 8–14 anterior interfractural costals; costal-section ratios: II:I 2.4–3.2; III:IV 2.5–3.5; V:IV 3.6–4.6; M_{1+2} index 1.3–1.6.

ABDOMEN.—Terga dark brown medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 prominent (30°–40° angular; this prominence bare); copulobus long, linguiform, curved slightly laterad, irregularly setose, and verrucate anterolaterally. Postgonite bent anterolaterad; postgonite uncus straight (directed anterolaterad); distiphallus tapering to nearly truncate apex; distiphallus lamellate ventromedially. Anterior margin of fused surstyli broadly concave, with medial cleft; B-index about 2.0; C-index 0.3–0.5.

TYPE.—Holotype male, ANSP 6484.

TYPE-LOCALITY.—Tacoma, Washington (VIII-27-1911, A. L. Melander).

SPECIMENS EXAMINED.—4 (1♂, 3♀♀) from 3 localities:

Oregon: Oregon City (IX–no other dates, collector unknown), 1♀.
Washington: Tacoma (VIII–27–1911, A. Melander), 1♂, 1♀.
Wyoming: 12 miles northwest of Lusk (VII–no date–1895, collector unknown), 1♀.

Hydrellia surata, new species

FIGURE 25

DIAGNOSIS.—Palpus velvety black; 5–8 aristal rays; vertex index 3.8–4.5; 4–7 sfa; antenna and most of parafrontale velvety black; face centrally protuberant, the lower third contrastingly light gray; thoracic pleuron moderate olive-brown except lower half of mesokatepisternum light gray; male mid tibia expanded. Male length 1.39–1.78 mm; female 1.19–1.67 mm. Male terminalia as in Figure 25.

HEAD.—Face centrally protuberant, the lower third contrastingly light gray; 3–4 pfa; 4–7 sfa; epistomal index 1.0–1.4; mesofacial index 1.3–2.0; vertex index 3.8–4.5; A-index 2.0–2.6; ocular index 4.8–8.0. Palpus velvety black; 5–8 aristal rays; antenna and most of parafrontale velvety black; fronto-orbital area and frontal vitta moderate olive-brown; 12–15 postoculars.

THORAX.—Ppn and mesonotum moderate olive-brown; 4–6 adc and 2–3 pdc; pleuron moderate olive-brown except lower half of mesokatepisternum light gray; legs moderate olive-brown pruinose except dark-brown tarsi; male mid tibia expanded. Wing length 1.36–1.79 mm; veins dark brown; 6–7 setae on basal end of costa; 5–6 dorsal and 6–8 anterior interfractural costals; costal-section ratios: II:I 1.7–2.3; III:IV 2.5–3.0; V:IV 2.8–3.2; M_{1+2} index 1.4–1.8.

ABDOMEN.—Terga densely moderate olive-brown pruinose over dark gray. Male terminalia: median third of posterior margin of sternum 5 straight; anterolateral margin of sternum 5 rounded; copulobus short, ovoid posteriorly, with about 7–10 scattered setae. Postgonite large, bent anteromediad, and not covered by copulobus or surstyli; postgonite uncus very conspicuous and nearly straight; distiphallus transversely expanded at midlength and with triangular apex. Anterior margin of fused surstyli deeply and broadly concave; B-index about 0.6; C-index 0.9–1.1.

TYPE.—Holotype male, USNM 70542.

TYPE-LOCALITY.—Two Island Lake, Itasca State Park, Becker County, Minnesota (VI–28–1963, D. L. Deonier).

PARATYPES.—111 (24♂♂, 87♀♀) from 19 localities:

Connecticut: Avon Old Farms, Avon (VI–27–1929, C. Curran), 2♀♀ (AMNH).
Florida: DeFuniak Springs, Walton County (VIII–1–1962, D. L. Deonier), 2♀♀ (USNM and ISC).
Idaho: Echo Bay, Lake Coeur d' Alene (VIII–3–1934, A. Melander), 1♀ (ANSP); Worley (VI–29–1919, A. Melander), 1♂ (ANSP).
Manitoba: Whitewater Lake, 4 miles north of Whitewater (VI–22–1958, C. Miller), 1♀ (ISC).
Massachusetts: Mashbee (VII–28–1950, collector unknown), 2♀♀ (USNM and ISC); Woods Hole (VIII–no date–1916, A. Sturtevant), 1♀ (USNM).
Minnesota: Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 3♂♂, 2♀♀ (USNM, ISC and DLD); Two Island Lake, Itasca State Park (VI–28–1963, D. L. Deonier), 1♂, 5♀♀, (VIII–8–1963, D. L. Deonier), 2♂♂, 6♀♀ (USNM, ISC, and DLD); 0.5 mile south of junction U.S. 71 and 113, Hubbard County (VII–5–1963, D. L. Deonier), 1♂, 2♀♀ (DLD).
Mississippi: Gravel pit at Hattiesburg (VI–30–1962, D. L. Deonier), 1♂, (VI–30–1962, J. Ainsworth), 11♀♀ (USNM, ISC, and DLD); Lake Shady, Lamar County (VI–29–1962, D. L. Deonier), 1♂, 5♀♀ (USNM and ISC); Lake Shelby State Park, Forrest County, 31°9′ N, 89°14.6′ W (VII–24–1962, D. L. Deonier), 1♂, 12♀♀ (USNM and ISC).
New York: Vicinity of Jockeybush Outlet, Hamilton County, 43°18′N, 74°34′ W (VIII–5–1961, D. L. Deonier), 1♀ (USNM).
Ontario: Marmora (VIII–7–1952, J. McAlpine), 1♂, 2♀♀, (VIII–9–1952, J. McAlpine), 6♂♂, 12♀♀, (IX–8–1952, E. Smith), 1♀, (IX–9–1952, J. McAlpine), 5♂♂, 6♀♀ (CNC, USNM, and ISC); Midland (VIII–18–1955, J. Chillcott), 11♀♀ (CNC, USNM, and ISC); Pembroke (VII–3–1938, A. Melander), 1♂ (ANSP).
Pennsylvania: Ohiopyle, Fayette County (VIII–no date–1907, H. Kahl), 1♀ (ISC).
Yukon: Reflection Lake, mile post 1160 of Alaska Highway (VII–29–1952, C. Alexander), 1♀ (UMM).

REMARKS.—For taxonomic remarks see under *H. columbata*.

Adult. Habitats recorded: leaves of *Potamogeton natans, Nymphaea tuberosa, Nelumbo lutea, Hydrocotyle bonariensis,* and *Sparganium chlorocarpum.*

Hydrellia suspecta Cresson

Hydrellia suspecta Cresson, 1936, pp. 258–259; 1944b, pp. 169, 174.—Deonier, 1964, p. 117; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 6–8 aristal rays; ocular index 15.0 (measured in 1 female only); costal section II:I 2.3; 6 pfa; antennal segment 3 moderate yellow or splotched with moderate yellow; fused surstyli moderate yellow and much longer than broad. Female length 2.47 mm (measured in 1 female only).

HEAD.—Face yellowish gray; 6 pfa; epistomal index 1.7; mesofacial index 2.2; vertex index 5.2; A-index 1.8; ocular index 15.0. Palpus moderate yellow; 6–8 aristal rays; antennal segments 1 and 2 dark brown, segment 3 moderate yellow or splotched moderate yellow and dark brown; fronto-orbital area and frontal vitta strong yellowish brown; most of parafrontale dark brown, but flecked with strong yellowish brown pruinosity; 18 postoculars.

THORAX.—Ppn and mesonotum moderate brown; 3 adc and 2 pdc; pleuron light gray; legs light-gray pruinose except tibial apices and tarsi moderate yellow. Female wing length 2.60 mm; veins pale yellow; 6 setae on basal end of costa; 8 dorsal and 12 anterior interfractural costals; costal-section ratios: II:I 2.3; III:IV 2.7; V:IV 3.6; M_{1+2} index 1.4.

ABDOMEN.—Female terga semiglossy moderate brown medially, with posterolateral light-gray wedges; these terga light gray laterally and ventrally. Male terminalia: unavailable for study, but Cresson (1936, p. 259) stated: "Abdomen of male ovate; tergites II to V subequal in length; V of male narrowly truncated apically. Genital segment surstyli of male exerted, flattened much longer than broad."

TYPE.—Holotype male, ANSP 6529.

TYPE-LOCALITY.—New Mill Pond, Mount Desert Island, Maine (VII–12–1935, W. Procter).

SPECIMENS EXAMINED.—3 ♀♀ from 2 localities:

Iowa: Springbrook State Park, Guthrie County (VII–19–1960, D. L. Deonier), 2 ♀♀.

Maine: Mount Desert Island (VII–12–1935, W. Procter), 1 ♀.

REMARKS.—I have studied the holotype, but careful measurements could be made only on the female designated by Cresson as the paratype. The male holotype was unavailable for dissection of the terminalia.

Adult. Habitats recorded: leaves of *Nuphar advena*; reed marsh.

Hydrellia tibialis Cresson

FIGURES 41, 87, 118

Hydrellia tibialis Cresson, 1917, p. 341; 1918, pp. 47, 48; 1931, p. 106; 1932, p. 14; 1941, p. 37; 1944b, pp. 164, 172; 1947, pp. 38, 39.—Johnson, 1925, p. 272.—Wirth and Stone, 1956, p. 469.—Deonier, 1964, p. 116; 1965, pp. 500, 506 [ecology].—Wirth, 1965, p. 744 [catalog listing]; 1968, p. 13 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 5–7 aristal rays; body length:wing length 0.7–0.9; face light gray, with small median carina; mesonotum and abdominal dorsum glossy dark grayish green; male mid tibia expanded. Male length 1.28–1.62 mm; female 1.82–2.21 mm. Male terminalia as in Figure 41.

HEAD.—Face light gray; 4–5 pfa; 1 sfa; epistomal index 1.0–1.3; mesofacial index 1.7–2.1; vertex index 3.5–7.0; A-index 1.6–2.0; ocular index 7.5–8.0. Palpus dark brown; 5–7 aristal rays; antenna, fronto-orbital area, and frontal vitta dark brown; most of parafrontale velvety dark brown; 12–18 postoculars.

THORAX.—Ppn semiglossy dark brown; mesonotum glossy dark grayish green; 4–5 adc and 2 pdc; pleuron densely strong yellowish-brown pruinose; legs very sparsely light-gray pruinose except dark-brown tarsi. Wing length 1.82–2.35 mm; veins light brown; 5–7 setae on basal end of costa; 6–8 dorsal and 8–10 anterior interfractural costals; costal-section ratios: II:I 2.0–2.3; III:IV 2.8–3.2; V:IV 3.2–3.8; M_{1+2} index 1.7–2.1.

ABDOMEN.—Terga glossy dark grayish green medially, light gray laterally and ventrally. Male terminalia: median third of posterior margin of sternum 5 concave and congruent with distiphallus; anterolateral margin of sternum 5 smoothly rounded; copulobus papilliform posteriorly (15° angular) and irregularly setose. Postgonite bent anteriad; postgonite uncus directed anteriad or bent slightly laterad; distiphallus short, tapering distally. Anterior margin of fused surstyli truncate (indistinctly mucronate); B-index about 1.6; C-index 0.8–1.2.

THIRD-INSTAR LARVA.—The frontoclypeus was lost in the extraction of the only puparium. It was entirely black like the mouth-hook (Figure 87). Mouth-hook beak about 0.8 as long as base; maximum mouth-hook base thickness about 1.6 times that of beak.

PUPARIUM.—Length approximately 3.75 mm; maximum breadth 0.95 mm; fusiform (Figure 118). Puparial length: minimum breadth approximately 18.0; maximum breadth: minimum breadth 5.2; anal-plate index 2.0. Prothorax and mesothorax damaged, but apparently prothoracic end semicircular in ventral view; abdominal segment 8 without ventral, transverse row of setulae, but with 4–5 annuli of spinules; anal plate subrectangular, with anterior margin slightly convex; spiracular peritremes terminal. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, ANSP 6141.

TYPE-LOCALITY.—Moscow, Idaho (X–9–1907, J. M. Aldrich).

ADULT SPECIMENS EXAMINED.—840 (318♂♂, 522♀♀) from 148 localities:

Alabama: Unspecified locality, 1♀.

Alaska: King Salmon, Naknek River (VII–23–1952, W. Mason), 2♂♂, 8♀♀, (VII–31–1952, W. Mason), 2♀♀, (VIII–1–1952, W. Mason), 2♀♀, (VIII–11–1952, W. Mason), 1♀; Savonoski, Naknek Lake (VII–26–1919, A. Basinger), 2♂♂, 3♀♀.

Alberta: Grizzly Mountain, Slave Lake, 3,000 feet (VIII–15–1924, O. Bryant), 1♀; McMurray (VII–14–1953, G. Ball), 1♀; Medicine Hat (VI–16–1928, F. Carr), 1♂.

Arizona: Superior, Pinal County (IV–13–1935, A. Melander), 1♀.

Arkansas: Calion, Union County (IX–3–1952, M. Wheeler), 1♂, 1♀; Rison, Cleveland County (IX–3–1952, M. Wheeler), 1♀.

British Columbia: MacGillivray Creek Game Preserve near Chilliwack (VII–14–1953, G. Spencer), 1♀.

California: Big Pines (VIII–2–1944, A. Melânder), 1♂; Carpenteria (VIII–11–1950, A. Melander), 2♀♀; Cassel, Shasta County (VII–15–1955, E. Schlinger), 2♀♀; Davis (IV–17–1952, A. McClay), 1♂, 1♀, (VIII–13–1954, A. Grigarick), 2♀♀, (X–21–1954, A. Grigarick), 2♀♀, (VII–27–1955, W. Lange), 1♀; El Capitan Reservation, San Diego County (IX–25–1955, P. Arnaud), 4♀♀; Green Valley (VII–26–1944, A. Melander), 1♀; Jenks Lake (VII–14–1950, A. Melander), 2♀♀, (VIII–18–1950, A. Melander), 4♂♂, 6♀♀, (VIII–24–1950, A. Melander), 2♂♂, 5♀♀, (IX–7–1950, A. Melander), 20♀♀; Likeley, Modoc County (X–11–1952, E. Schlinger), 1♂, 6♀♀; Manteca, San Joaquin County (IX–29–1902, J. Hesten), 1♀; Putah Canyon, Yolo County (XI–6–1954, W. Lange), 1♀; Rio Linda, Sacramento County (VIII–30–1957, A. Grigarick), 1♂; San Diego (XI–18–1916, H. Dyar), 1♀.

Colorado: Alamosa (VIII–1–no year, M. T. and G. M. James), 1♀; Creede, 8,844 feet (VIII–no date–1914, S. Hunter), 1♀; Creede (VII–1–1936, L. Tuthill), 1♀, (VII–10–1939, L. Tuthill), 1♀; Deckers (VIII–25–1950, collector unknown), 1♀; Electra Lake, about 37°33′ N, 107°48′ W, 8,400 feet (VI–28–VII–1–1919, collector unknown), 2♂♂; Estes Park (VIII–11–1952, R. Dreisbach), 1♀; Grand Junction (IX–4–1938, D. Hardy), 1♂, 3♀♀; Tennessee Pass, 10,240 feet (VII–8–no year, J. Aldrich), 1♀, (VII–24–1917, collector unknown), 1♀; Wray, about 40° N, 102°10′ W (VIII–17–19–1919, collector unknown), 1♀.

Delaware: Rehoboth (VI–25–1939, A. Melander), 1♀; (VIII–4–1941, A. Melander), 1♂.

Florida: Baxter (IX–no date–1954, M. Wheeler), 1♀; Fruitville (VIII–11–1930, R. Beamer), 1♀.

Idaho: Moscow (X–9–1907, collector unknown), 1♀; Soldier Creek, Priest Lake (VIII–22–1919, A. Melander), 1♂, (VIII–22–1920, A. Melander), 1♀; Tule Bay, Priest Lake (VIII–19–1919, A. Melander), 2♀♀, (VIII–20–1920, A. Melander), 1♀, (VIII–22–1920, A. Melander), 2♀♀.

Illinois: Champaign County (IV–26–1925, M. Shackleford), 2♀♀, (VII–10–1926, V. Smith), 1♀; Meredosia (V–29–1917, collector unknown), 1♀; Peoria VIII–26–1917, J. Aldrich), 1♀; Springfield (IX–7–1952, M. Wheeler), 1♀.

Indiana: Lafayette (X–22–1915, collector unknown), 1♂.

Iowa: Ames (IV–16–1927, collector unknown), 1♂, 1♀, (IV–24–1927, collector unknown), 1♀, (V–12–1927, collector unknown), 1♀; Ames, Skunk River (VII–17–1960, D. L. Deonier), 1♀; Ames, Izaak Walton League Reserve, Story County (IV–28–1960, D. L. Deonier), 1♀, (VI–17–1960, D. L. Deonier), 1♀, (IV–23–1962, D. L. Deonier), 1♂, 2♀♀; Banner Mine Area, Warren County (VIII–7–1960, D. L. Deonier), 62♂♂, 29♀♀, (V–23–1963, D. L. Deonier), 1♂, 1♀; Fraser Dam, Boone County (IX–4–1960, D. L. Deonier), 1♀, (VII–6–1961, D. L. Deonier), 1♂, 1♀; Lake Odessa, Louisa County, 41°12.1′ N, 91°5.5′ W (VIII–9–1960, D. L. Deonier), 12♂♂, 16♀♀; Ledges State Park, Boone County (V–7–1956, J. Laffoon), 1♂, (V–6–1958, J. Laffoon), 1♂, (VI–14–1960, J. Laffoon), 1♀, (VIII–16–1960, D. L. Deonier), 1♀, (VIII–18–1960, D. L. Deonier), 1♂, 2♀♀; Ledges State Park, Des Moines River (IX–12–1959, D. L. Deonier), 2♀♀, (VIII–31–1960, D. L. Deonier), 3♂♂, 5♀♀; Ledges State Park, south pond (VII–10–1960, D. L. Deonier), 1♀; Little Wall Lake, Hamilton County (VII–13–1960, D. L. Deonier), 1♂, 3♀♀, (VIII–27–1960, D. L. Deonier), 3♂♂, 3♀♀, (VI–18–1961, D. L. Deonier), 4♂♂, 2♀♀; McIntosh Woods State Park, Clear Lake (IX–10–1961, D. L. Deonier), 4♂♂, 3♀♀; Mississippi River, 4 miles north of Oakville, Louisa County (VIII–10–1960, D. L. Deonier), 1♀; near Missouri River, 7 miles southwest of Whiting, Monona County (VI–6–1960, D. L. Deonier), 1♂; Pilot Knob State Park, Hancock County (VI–15–1960, D. L. Deonier), 1♀; Siewer's Springs State

Park, Decorah (IX–9–1961, D. L. Deonier), 2♂♂, 7♀♀, (IX–15–1962, D. L. Deonier), 4♂♂, 3♀♀; Sioux City (VI–20–1938, C. Ainslie), 1♀; Spring Lake, Greene County (V–4–1962, D. L. Deonier), 6♂♂, 14♀♀, (IX–19–1962, D. L. Deonier), 2♂♂, 1♀; Springbrook State Park, Guthrie County (VII–19–1960, D. L. Deonier), 1♂, (VI–23–1961, D. L. Deonier), 1♂; West Okoboji Lake, Dickinson County (IX–3–1949, J. Laffoon), 1♀; 4 miles east of Gilbert, Story County (VI–25–1960, D. L. Deonier), 1♂; 3 miles east-southeast of Waterville, Allamakee County, 43°11′ N, 91°14.1′ W (VIII–2–1960, D. L. Deonier), 6♂♂, 11♀♀; 3 miles southeast of Waterville, Allamakee County, 43°10.4′ N, 91°15.1′ W (VIII–2–1960, D. L. Deonier), 5♂♂, 9♀♀, (VIII–2–1960, J. Laffoon), 2♂♂, 3♀♀; 4 miles northeast of Wapello, Louisa County, 41°13.9′ N, 91°7.0′ W (VIII–9–1960, D. L. Deonier), 6♂♂, 8♀♀; 5 miles west of Yale, Guthrie County, 41°46.5′ N, 94°27.6′ W (VII–19–1960, J. Laffoon), 1♂.

Kansas: Douglas County, 900 feet (no dates, R. Beamer), 1♂; Kansas University Natural History Reservation near Lawrence, Douglas County (VI–7–1963, D. L. Deonier), 1♂; Leavenworth County Lake (VIII–27–1962, D. L. Deonier), 12♂♂, 19♀♀; Manhattan (X–18–1934, C. Sabrosky), 1♂; Marais des Cygnes Wildlife Refuge, Linn County (IV–9–1962, D. L. Deonier), 2♀♀; McPherson County (VI–26–1923, W. Brown), 1♀; Meade County (VIII–15–1915, R. Beamer), 1♀; Sappa Lake, Decatur County (VIII–31–1961, D. L. Deonier), 4♂♂, 10♀♀; 1.5 miles south of Bonner Springs (VIII–28–1962, D. L. Deonier), 1♀.

Louisiana: 15 miles east of Creole (VI–18–1948, B. McDermott), 1♂.

Maine: Mount Desert Island (VII–25–1935, W. Procter), 1♀.

Manitoba: Churchill (VIII–2–1937, D. Denning), 1♂, (VIII–2–9–1937, D. Denning), 1♀; Herchmer (VIII–1–1937, D. Denning), 1♂, 2♀♀; Whitewater Lake, 4 miles north of Whitewater (VII–17–1958, J. Chillcott), 1♀.

Maryland: Plummer's Island, Potomac River (IV–28–1914, R. Shannon), 1♀; unspecified locality (no dates, H. Loew), 1♂.

Michigan: Baraga County (VIII–27–1952, R. Dreisbach), 1♀; Bay County (VIII–11–1951, R. Dreisbach), 1♀; Cass County (VIII–2–1953, R. Dreisbach), 1♂, 1♀; Cheboygan County (VII–26–1935, L. Penner), 1♀; Vineyard Lake, Jackson County (VII–26–1954, G. Steyskal), 2♂♂, 9♀♀, (VIII–1–1954, G. Steyskal), 1♂.

Minnesota: Bellingham (IX–11–1935, H. Telford), 1♀; Chisago County (no dates, O. Oestlund), 2♀♀; Cook County (VIII–21–1938, H. Milliron), 3♀♀, (VIII–21–1938, H. Peters), 1♀; Eaglenest (VIII–26–1959, W. Balduf), 1♂; Freeborn County (IX–3–1937, R. Daggy), 1♂, 1♀; Haydenville (IX–11–1935, A. Pritchard), 1♂, 2♀♀; Headwaters of LaSalle Creek, Itasca State Park (VIII–6–1963, D. L. Deonier), 1♂, 2♀♀; Itasca State Park (VI–20–1938, H. Milliron), 1♀; Mille Lacs (VI–2–1937, D. Denning), 1♀; St. Paul (V–25–1926, S. Kepperley), 1♀; Washington County (V–7–1938, H. Milliron), 1♀; west side across from Biological Station, Lake Itasca (VII–28–1963, D. L. Deonier), 1♀; Yellow Medicine County (IX–15–1938, C. Mickel), 2♀♀; 1 mile south of main entrance, Itasca State Park (VI–26–1963, D. L. Deonier), 1♂.

Mississippi: Bellefontaine Point, Jackson County (VII–10–1962, D. L. Deonier), 4♂♂, 9♀♀; Bluff Creek, Vancleave, Jackson County (VI–18–1962, D. L. Deonier), 2♀♀, (VI–21–1962, D. L. Deonier), 1♂, 1♀; Dickinson's Pond, Lamar County, sec. 3, T.4 north, R.14 west (VII–11–1962, D. L. Deonier), 5♂♂, 6♀♀; near U.S. Highway 90, sec. 20, T.7 south, R.5 west, gravel pit (VI–9–1962, D. L. Deonier), 1♂, 6♀♀, (VI–17–1962, D. L. Deonier), 2♂♂, 4♀♀; Vancleave Road, Jackson County, 30°28′ N, 88°43′ W (VI–21–1962, D. L. Deonier), 2♀♀, (VI–28–1962, D. L. Deonier), 1♂; Vancleave Road, Jackson County, 30°25.1′ N, 88°46′ W (VI–23–1962, D. L. Deonier), 1♀.

Missouri: Four miles northeast of LaRussell, Lawrence County (IX–6–1961, D. L. Deonier), 9♂♂, 15♀♀; 5 miles northeast of LaRussell, Lawrence County (IX–6–1961, D. L. Deonier), 1♂.

Nebraska: Hastings (VIII–22–1950, collector unknown), 1♀; Lincoln, Lancaster County (IX–30–1952, W. Stevens), 1♀, (VII–16–1960, W. Rapp), 1♂; Oakdale (VIII–21–1950, collector unknown), 1♀.

New Hampshire: Storm Lake, Mount Adams, 5,200 feet (VIII–29–1943, M. Smith), 2♀♀; Summit of Mount Washington, 6,100–6,280 feet (VIII–14–1958, J. Vockeroth), 2♀♀.

New Jersey: Trenton (VII–11–1914, collector unknown), 1♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 3♂♂, 2♀♀.

North Carolina: Clingman's Dome, Great Smoky Mountains National Park, 6,300–6,642 feet (V–28–1957, J. Vockeroth), 1♂.

Oklahoma: Kingfisher (IX–13–1952, M. Wheeler), 1♂.

Ontario: Marmora (VIII–12–1952, J. McAlpine), 1♀.

Oregon: Corvallis (VII–1–1925, collector unknown), 1♀, (V–16–1941, J. Schuh), 6♂♂, 2♀♀; North Powder (VII–13–1931, R. Beamer), 1♀.

Pennsylvania: Ohiopyle, Fayette County (VIII–7–1905, H. Kahl), 1♂, 2♀♀, (VIII–11–1905, H. Kahl), 3♂♂, 1♀; Swarthmore (VIII–22–1909, E. Cresson), 1♀.

Quebec: Gaspe (VIII–9–1937, C. Alexander), 1♀; Gaspe Bay (VII–18–1931, J. Aldrich), 1♀; Great Valley, Gaspe (VII–20–1931, J. Aldrich), 3♀♀; La Ferme (VII–no date–1943, A. Roberts), 1♀; Notre Dame du Portage (VIII–17–1957, W. Mason), 1♀; Rupert House (VII–25–1949, D. Gray), 1♀.

Tennessee: Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett County (VIII–19–1962, D. L. Deonier), 44♂♂, 67♀♀; Miller's Camp, Reelfoot Lake, 36°24.3′ N, 89°20′ W (VIII–12–1962, D. L. Deonier), 1♀; Reelfoot State Park, Reelfoot Lake (VIII–16–1962, D. L. Deonier), 33♂♂, 38♀♀; Samburg, Reelfoot Lake (VIII–11–1962, D. L. Deonier), 2♂♂, (VIII–12–1962, D. L. Deonier), 4♀♀.

Texas: Austin (III–2–1900, A. Melander), 2 ♀ ♀, (X–19–1950, M. Wheeler), 1 ♂, (XI–19–1950, collector unknown), 1 ♀, (XII–1–1951, M. Wheeler), 1 ♀; Double Lake (IV–11–1952, collector unknown), 1 ♂; Galveston (IX–13–1953, M. Wheeler), 1 ♀; Goliad (IX–5–no year, Townsend), 1 ♀; Guadalupe River, Gonzales (IV–22–1956, W. Wirth), 2 ♂ ♂; Rio Hondo, Cameron County (VIII–2–1950, M. Wheeler), 2 ♂ ♂, 3 ♀ ♀; San Antonio (III–28–1942, A. Melander), 2 ♀ ♀; Sinton (XII–25–1945, R. Beamer), 1 ♂.

Virginia: Fairfax (VII–no date–1954, M. Wheeler), 1 ♂; Norfolk (IX–4–1943, R. Beamer), 1 ♂; Warsaw, Richmond County (VII–26–1952, W. Wirth), 1 ♀.

Washington: Union Flat (IX–8–1918, collector unknown), 1 ♂.

Wyoming: Lander (VIII–16–1950, M. Wheeler), 1 ♀; Yellowstone National Park, Biscuit Basin (VIII–2–1934, A. Melander), 4 ♀ ♀; Yellowstone National Park, northwest entrance (VII–27–1923, A. Melander), 1 ♀; Yellowstone National Park, Yellowstone Lake (VII–18–1923, A. Melander), 2 ♀ ♀.

IMMATURE SPECIMENS EXAMINED.—1 from Banner Mine Area, Warren County, Iowa (collected and reared by D. L. Deonier).

REMARKS.—This species is relatively readily recognized by the light-gray, slightly carinate face and metallic appearance of the mesonotum and abdomen; however, female *H. tibialis* may be confused with females of *H. americana, H. definita,* and *H. prudens.*

Adult. Habitats recorded: stems of *Eleocharis calva* and *Eleocharis* sp.; leaves of *Sagittaria latifolia, Potamogeton nodosus, Nasturtium officinale, Sporobolus indicus, Leersia oryzoides, Hydrochloa caroliniensis, Heteranthera dubia, Glyceria* sp., *Juncus repens, Nuphar advena, Nymphaea tuberosa, Zizania aquatica, Oryza sativa, Pontederia cordata,* and *Polygonum scabrum;* mats of *Eragrostis hypnoides;* flowers of *Ranunculus aquatilis;* limnic wrack, sandbars, rocky shore, riffle rocks, and aquatic liverwort (*Riccia fluitans*).

I found this species to be nearly as eurytopic and abundant as *H. griseola.* It was one of the most characteristic dipterous species in my samplings of the sedge meadow community. At Banner Mine Area, Warren County, Iowa, 50 net sweeps yielded 212 adults from a clump of *Eleocharis calva* covering about a square meter. Also, I found adults very abundant in mats of *Eragrostis hypnoides* in central Iowa. My surveys revealed a greater preference for emergent vegetation than for floating leaves as indicated by data from Grigarick floating traps set among floating leaves of *P. gramineus* and *Jussiaea repens* on Reelfoot Lake. Four traps set for a total of 5 days yielded only 14 adults.

Adults collected on flowers of *R. aquatilis* were evidently feeding on nectar or pollen. I examined the gut contents of 75 adults and found greenish-yellow, granular material with some diatoms.

Host plants. I reared two adults from *Eleocharis obtusa* collected at Banner Mine Area, Warren County, Iowa, in April. Either the larvae had overwintered in the plants or had recently hatched, for the adults did not emerge until 28 days after collection of the plants. The larvae pupariated in the basal sheaths of the culms. Judd (1962) trapped four adults in June and July in an emergence trap floating where the depth ranged from 0.6 to 1.4 meters.

Hydrellia trichaeta Cresson

FIGURES 37, 68, 88, 115

Hydrellia trichaeta Cresson, 1944a, p. 7; 1944b [in part], pp. 170, 175.—Deonier, 1964, pp. 115, 125, fig. 4.
Hydrellia coniformis.—Johnson [in part], 1925, p. 271 [*lapsus calami,* fide Cresson, 1944b, p. 135].
Hydrellia conformis.—Cresson, 1936, p. 261.

DIAGNOSIS.—Palpus moderate yellow; 8–9 aristal rays; face planate; vertex index 5.4–6.8; ocular index 6.1–8.6; male abdomen rounded posteriorly; female cercus mucronate apically and truncate basally; antennal segment 3 partly moderate yellow; apicodorsal antennal prominent. Male length 1.82–2.13 mm; female 1.71–2.21 mm. Male terminalia as in Figure 37; female as in Figure 68.

HEAD.—Differing mainly from *H. bilobifera* in the following: ocular index 6.1–8.6; 8–9 aristal rays.

THORAX.—Differing mainly from *H. bilobifera* in the following: 3–4 adc and 2 pdc; wing length 1.67–2.04 mm; veins dark brown; 6–8 dorsal and 8–10 anterior interfractural costals.

ABDOMEN.—Terga semiglossy dark gray medially, light gray laterally and ventrally (at least on posterior half of each segment). Male terminalia: median third of posterior margin of sternum 5 deeply, rectangularly recessed and congruent with distiphallus; anterolateral margin of sternum 5 with inconspicuous dorsal process projecting laterad; copulobus slightly convex posteriorly, without macrochaetae, the medial margin with convexity just anteriad of postgonite uncus having seriated setae, and with lateral triangular lobe. Postgonite bent mediad; acuminate postgonite uncus curved anteriad; distiphallus constricted proximally at midlength and preapically, with ventrally lamellate apex, and bicarinate ventrally on proximal two-thirds (carinae connected preapically); basiphallus covered. Anterior margin of fused surstyli concave medially with moderately prominent lateral convexities; B-index about 2.0; C-index 0.6–0.8. Syntergum 9+10 rounded posteriorly. Female terminalia: length of tergum 8 and sternum 8 subequal; cercus irregularly setose dorsally and laterally, mucronate apically, truncate basally and less than 1.5 times as long as wide (lateral view). Segment 7 with group of 3–4 seriated setae laterally on posterior margin; median spermatheca similar to that of *H. discursa* (Figure 70).

THIRD-INSTAR LARVA.—Body of larva not examined. Frontoclypeal length 0.50 mm (Figure 88). Ventral frontoclypeal index 2.7; phragmatal index 1.0; bifurcation index 3.6; clypeal-arch index 2.0. Clypeal arch slightly concave from noticeable convexity at the level of the cheliform spot (angled 25° in relation to lower frontoclypeal margin). Mouth-hook beak length only 0.7–0.8 of base length; maximum mouth-hook base thickness about 2.2 times that of beak; mouth-hook light spot touching margin of mouth-hook base.

PUPARIUM.—Length 3.70 mm; maximum breadth 0.76 mm; fusiform (Figure 115). Puparial length: minimum breadth 20.0; maximum breadth:minimum breadth 4.2; anal-plate index 2.6. Prothoracic end describing more than half a circle in ventral view; head-lobe scar ovoid to obovoid, nearly as long as prothorax; prothorax and mesothorax sparsely spinulose ventrally and laterally; abdominal segment 8 with ventral, transverse row of 6 setulae and 3–4 annuli of spinules; anal plate subelliptical, with anterior margin straight to slightly convex. Empty puparium translucent, light yellowish brown.

TYPE.—Holotype male, ANSP 816.

TYPE-LOCALITY.—Redding, Connecticut (VIII-3-1931, A. L. Melander).

ADULT SPECIMENS EXAMINED.—98 (44♂♂, 54♀♀) from 45 localities:

Iowa: Goose Lake, Hamilton County (VII–2–1961, D. L. Deonier), 4♀♀; McIntosh Woods State Park, Clear Lake (IX–10–1961, D. L. Deonier), 3♂♂, 4♀♀; Spring Lake, Greene County (VII–14–1961, D. L. Deonier), 4♂♂, 7♀♀, (IX–19–1961, D. L. Deonier), 6♂♂, 3♀♀, (V–4–1962, D. L. Deonier) 1♀; Springbrook State Park, Guthrie County (VI–23–1961, D. L. Deonier), 1♂, 1♀.

Kansas: Kansas University Natural History Reservation near Lawrence, Douglas County (VI–7–1963, D. L. Deonier), 1♂.

Massachusetts: Horseneck Beach (VIII–10–1896, Hough), 1♀.

Minnesota: Biological Station, Lake Itasca (VI–26–1963, D. L. Deonier), 1♀; Bohall Lake, Itasca State Park (VI–25–1963, D. L. Deonier), 6♂♂, 3♀♀, (VIII–17–1963, D. L. Deonier), 10♂♂, 4♀♀; Squaw Lake, Itasca State Park (VIII–14–1963, D. L. Deonier), 1♀; 1.3 miles south of main entrance, Itasca State Park (VI–26–1963, D. L. Deonier), 3♂♂, 1♀.

New York: Dryden Lake, Tompkins County (VIII–8–1961, D. L. Deonier), 1♀.

North Carolina: Highlands Biological Station, Highlands, Macon County (VI–15–26–1968, D. L. Deonier), 8♂♂, 20♀♀.

Ontario: Marmora (VII–25–1952, E. Smith), 1♂.

Tennessee: Miller's Camp, Reelfoot Lake, 36°24.3′ N, 89°20′ W (VIII–12–1962, D. L. Deonier), 1♂, 1♀.

Virginia: White Oak Canyon, south slope of Stony Man, 3,500 foot, Madison County (VII–22–1961, D. L. Deonier), 1♀.

IMMATURE SPECIMENS EXAMINED.—23 from 3 localities:

Iowa: Spring Lake, Greene County (collected and reared by D. L. Deonier).

Minnesota: Bohall Lake, Itasca State Park (collected and reared by D. L. Deonier).

North Carolina: Highlands Biological Station, Highlands, Macon County (collected and reared by D. L. Deonier).

REMARKS.—*Adult.* Habitats recorded: leaves of *Potamogeton natans, P. nodosus, P. gramineus,* and *Nuphar advena.*

One male and two females reared in the laboratory and caged on 18 July copulated. The females deposited 11 eggs on floating leaves of *P. nodosus* on 20 July. The specimens died on 21 July.

Egg and larva. The incubation period for three eggs lasted 4 days. The first larval stadium ranged from 4–7 days for two larvae. The first and second larval stadia combined amounted to 13 days for two larvae. The second and third larval stadia ranged from 5 to 11 and 4 to 14 days respectively for five specimens. I found larvae of Dytiscidae to be efficient predators on *H. trichaeta* larvae in the laboratory.

I made the following observations on larvae from *P. nodosus* collected from ice at Spring Lake, Greene County, Iowa, on 25 January. One third-instar larva migrated from its first host plant to a leaf of *P. berchtoldii* placed near it and pupariated in it. On

24 February, I found a late first-instar larva mining in a leaf of *P. nodosus* and placed a fresh leaf of *P. berchtoldii* near it. The larva molted on 26 February and crawled around the bottom of the dish until I placed it on the fresh leaf. It started excavating a mine at 2:10 p.m. and had burrowed in entirely by 3:35 p.m. During this period, the larva did not pierce the water surface with its spiracular peritremes. After it had burrowed in entirely, a small bubble formed at the mine entrance. This larva mined out most of the mesophyll of two leaves of *P. berchtoldii* and part of that of a submerged leaf of *P. amplifolius* before pupariating in the apex of a second submerged leaf of *P. amplifolius*. As a third instar, the larva burrowed completely into a leaf in 1 hour. Another larva starting as a first instar mined throughout a submerged leaf of *P. berchtoldii* and partially in one of *P. amplifolius* before pupariating. As a second instar, this larva required 2 hours to burrow into a leaf. In one observation of it as a third instar, it defecated explosively, with the green feces so particulate that it diffused rapidly in water within the old mine. Shortly after this occasion, the larva pierced the water surface film with its spiracular peritremes three times in about 3 minutes.

Puparium. The puparial phase ranged from 8 to 10 days for six puparia in the laboratory. All of these six pupariated in leaf axils or on the abaxial side of floating leaves.

Host plants. I found larvae and puparia only in *Potamogeton gramineus, P. epihydrus, P. nodosus,* and *Elodea = Anacharis*) *canadensis.*

Hydrellia valida Loew

FIGURE 22

Hydrellia valida Loew, 1862, p. 153.—Osten Sacken, 1878, p. 202.—Becker, 1896, p. 269 [index listing].—Johnson, 1904, p. 163; 1925, pp. 271–272.—Aldrich, 1905, p. 627 [catalog listing].—Jones, 1906, p. 185 [catalog listing].—Cresson, 1944a, p. 7; 1944b, pp. 167, 173.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus moderate yellow; 5–7 aristal rays; vertex index 6.0–7.5; 12–15 anterior interfractural costals; mesonotum light gray; thoracic pleuron light gray; abdomen light gray. Male length 2.21–2.50 mm; female 2.38–2.81 mm. Male terminalia as in Figure 22.

HEAD.—Face light yellowish brown; 4–6 pfa; 1–2 sfa; epistomal index 1.0–1.2; mesofacial index 2.0–2.2; vertex index 6.0–7.5; A-index 1.5–2.0; ocular index 6.3–6.7. Palpus moderate yellow; 5–7 aristal rays; antenna and most of parafrontale dark brown; frontal vitta and fronto-orbital area strong yellowish brown; 12–15 postoculars.

THORAX.—Ppn light gray; mesonotum light gray (infrequently with sparse light yellowish-brown pruinosity); 3–4 adc and 2–3 pdc; pleuron light gray except upper edge of mesanepisternum infrequently light yellowish brown; legs light-gray pruinose except dark-brown tarsi. Wing length 2.47–3.01 mm; veins light yellowish brown; 6–8 setae on basal end of costa; 8–12 dorsal and 12–15 anterior interfractural costals; costal-section ratios: II:I 2.2–2.8; III:IV 2.3–2.5; V:IV 3.4–4.4; M_{1+2} index 1.1–1.5.

ABDOMEN.—Terga and sterna light gray. Male terminalia: median third of posterior margin of sternum 5 concave; anterolateral margin of sternum 5 obtusely rounded; copulobus nearly truncate (occasionally slightly convex) posteriorly and irregularly setose except on posterior margin. Postgonite bent anterolaterad; postgonite uncus short, bent laterad; distiphallus uniform in breadth; basiphallus with black, spinous lateral process. Anterior margin of fused surstyli broadly emarginate; B-index about 2.7; C-index 8.0–10.0.

TYPE.—Holotype female, MCZ 11156.

TYPE-LOCALITY.—"Middle States." (Loew, 1862, stated that Osten Sacken was the collector.)

SPECIMENS EXAMINED.—86 (22♂♂, 64♀♀) from 24 localities:

Connecticut: Goose Island (VII–21–1913, collector unknown), 1♀; Greenwich (VI–21–1916, E. Kalmbach), 1♂; New Haven, west shore of harbor (VII–29–1961, D. L. Deonier), 3♂♂, 18♀♀, (VII–29–1961, J. Laffoon), 1♂; Stony Creek (VII–27–1904, H. Viereck), 1♀; Westport (VII–13–1932, A. Melander), 4♀♀.

Delaware: Rehoboth (VI–25–1939, A. Melander), 1♀.

Florida: Unspecified locality (no data), 1♂.

Maine: Machias (VII–17–no year, collector unknown), 1♂, 1♀; Orrs Island (VII–26–no year, collector unknown), 2♀♀; Trenton (VIII–1–1930, A. Melander), 1♀.

Massachusetts: Brewster (VIII–24–1936, A. Melander), 1♀; Fall River (VII–3–1930, A. Melander), 2♀♀; Horseneck Beach (VIII–6–1896, Hough), 1♀; Ipswich (VII–22–1961, W. Wirth), 1♂, 1♀; New Bedford (VIII–20–1896, Hough), 2♀♀; Woods Hole (VII–14–1899, W. Wheeler), 6♀♀, (VI–20–30–1923, collector unknown), 1♂, (VII–21–1954, M. Wheeler), 5♂♂, 8♀♀; 3 specified localities (no data), 2♂♂, 1♀.

Mississippi: Camp Graveline, Jackson County, 30°22.3′ N. 88°42.3′ W (VI–12–1962, D. L. Deonier), 1 ♀; Gulf Coast Research Laboratory, Ocean Springs (VI–5–1962, D. L. Deonier), 1 ♀.

New Jersey: Waterwitch (VI–5–1937, A. Melander), 3 ♀ ♀.

New York: Cold Spring Harbor, Long Island (VII–no other data), 4 ♂ ♂, 2 ♀ ♀, (VII–6–1927, A. Melander), 1 ♂, 1 ♀ (VII–26–1932, C. Curran), 1 ♀.

Nova Scotia: Lockeport (VII–18–1958, J. Vockeroth), 1 ♀; Smith's Cove (VI–24–1955, G. Steyskal), 1 ♀.

Rhode Island: Watch Hill (VIII–5–1939, A. Melander), 1 ♀; unspecified locality (no dates, Osten Sacken), 1 ♂.

Texas: Galveston (IX–13–1953, M. Wheeler), 1 ♀.

REMARKS.—*Hydrellia valida* is a sibling species of *H. griseola,* but it has some differential characters other than the male terminalia.

Adult. Habitats recorded: tidal marsh and moist intertidal sand.

I examined the following plant species for immatures of *H. valida: Cyperus* sp., *Scirpus olneyi, Juncus* sp., *Spartina patens, Spartina* sp., and *Sporobolus indicus.* All were negative.

Hydrellia wilburi Cresson

FIGURE 38

Hydrellia wilburi Cresson, 1944b, p. 168, 172.—Wirth, 1965, p. 744 [catalog listing].

DIAGNOSIS.—Palpus dark brown; 8–11 aristal rays; mid and hind tarsi moderate orange-yellow; face white; thoracic pleuron moderate brown; 9–11 setae on basal end of costa; male abdomen compressed. Male length 2.30–2.42 mm; female 2.38–2.72 mm. Male terminalia as in Figure 38.

HEAD.—Face white; 3–5 pfa; 4–11 sfa; epistomal index 1.0–1.4; mesofacial index 1.6–2.2; vertex index 4.2–7.0; A-index 1.7–2.0; ocular index 4.5–6.0. Palpus dark brown; 8–11 aristal rays; apicodorsal antennal prominent; antennal segments 2 and 3 and frons (except light-brown ocellar triangle and dark-brown fronto-orbital area) velvety black; antennal segment 1 dark brown; 13–16 postoculars.

THORAX.—Ppn and mesonotum semiglossy dark brown; 4–5 adc and 2–3 pdc; pleuron semiglossy moderate brown; legs dark brown except dark-yellow trochanters and moderate orange-yellow mid and hind tarsi. Wing length 2.70–3.32 mm; veins light yellowish brown; 9–11 setae on basal end of costa; 6–8 dorsal and 9–11 anterior interfractural costals; costal-section ratios: II:I 2.2–2.5; III:IV 2.5–3.0; V:IV 3.0–3.8; M_{1+2} index 1.3–1.8.

ABDOMEN.—Terga and sterna dark brown. Male terminalia: see the description for *H. platygastra.*

TYPE.—Holotype male, ANSP 6657.

TYPE-LOCALITY.—Bear Lake, 8,500 feet, Routt County, Colorado (VIII–19–1935, D. A. Wilbur).

SPECIMENS EXAMINED.—71 (35 ♂ ♂, 36 ♀ ♀) from 9 localities:

British Columbia: Shuswap Lake (VII–22–1926, J. McDunnough), 1 ♂, 1 ♀.

California: Glacier Point Road, Yosemite National Park (VII–6–1947, A. Melander), 1 ♀; Sequoia National Park (VIII–6–1940, D. Hardy), 1 ♂, 2 ♀ ♀.

Colorado: Bear Lake, Routt County, 8,500 feet (VIII–19–1935, D. Wilbur), 1 ♂; Lake Brennan, 10,000 feet (VII–15–1934, C. Alexander), 31 ♂ ♂, 27 ♀ ♀; Nederland, Boulder County (VII–10–1937, H. Peters), 1 ♀; Tennessee Pass (VII–25–1917, J. Aldrich), 1 ♀.

Wyoming: Kemmerer (VIII–14–1950, M. Wheeler), 1 ♂, 3 ♀ ♀.

REMARKS.—The male terminalia of *H. wilburi* and *H. platygastra* appear to be identical. The two species may be conspecific, but since they are sympatric and no evidence of intergradation in the facial color is apparent I am treating them as separate species. See additional remarks under *H. platygastra.*

TABLE 1.—*Checklist of known host plants of* Hydrellia.

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
albiceps	Alismataceae *Alisma plantago-aquatica*	Palaearctic	Hendel (1926), Hering (1935, 1957)
	Cruciferae *Nasturtium officinale*	Palaearctic	Séguy (1950)
albifrons	Alismataceae *Alisma plantago-aquatica*	Palaearctic	Marchal (1903), Hering (1925, 1926), Thieneman (1912)
albilabris	Lemnaceae *Lemna minor* *Spirodela*	Palaearctic	von Frauenfeld (1866), Linnaniemi (1913), Hendel (1926), Hering (1925, 1926, 1937, 1957), Séguy (1950)
ascita	Potamogetonaceae *Potamogeton* *alpinus* *amplifolius* *epihydrus* *foliosus* *illinoensis* *oakesianus* *richardsonii* *zosteriformis*	Nearctic	Berg (1949, 1950)
bergi	Potamogetonaceae *Potamogeton* *natans* *richardsonii* *zosteriformis*	Nearctic	Berg (1949, 1950)
bilobifera	Potamogetonaceae *Potamogeton* *nodosus** *berchtoldii** *gramineus** *epihydrus**	Nearctic	
	Najadaceae *Zannichellia palustris*†	Nearctic	
biloxiae	Juncaceae *Juncus repens**	Nearctic	
butomi	Butomaceae *Butomus*	Palaearctic	Hendel (1926), Hering (1937, 1951, 1957)
	Gramineae	Palaearctic	Hering (1951)

NOTE: * Reared from host for the first time during this study. † Recorded first in this study. ‡ Reared from host during this study.

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
caliginosa	Potamogetonaceae *Potamogeton* *praelongus*	Nearctic	Berg (1949, 1950)
chrysostoma	Alismataceae *Alisma* *plantago-aquatica*	Palaearctic	Hendel (1926), Grünberg (1910), Hering (1937, 1957)
	Potamogetonaceae *Potamogeton* *lucens*	Palaearctic	Hering (1925, 1937, 1957)
cochleariae	Callitrichaceae *Callitriche*	Palaearctic	Hering (1957)
	Hydrocharitaceae *Hydrocharis* *morsus-ranae*	Palaearctic	Séguy (1950)
	Potamogetonaceae *Potamogeton* *crispus* *perfoliatus*	Palaearctic	Hering (1950, 1951, 1957), Séguy (1950)
concolor	Alismataceae *Alisma* *plantago-aquatica*	Palaearctic	Hering (1924, 1925, 1926, 1937, 1957)
	Hydrocharitaceae *Stratiotes* *aloides*	Palaearctic	Hering (1924, 1925, 1957), Wahlgren (1947)
cruralis	Potamogetonaceae *Potamogeton* *alpinus* *amplifolius*‡ *epihydrus* *foliosus* *gramineus* *illinoensis* *natans* *nodosus* *praelongus*‡ *richardsonii*‡ *zosteriformis*	Nearctic	Berg (1949, 1950)
deceptor	Alismataceae *Sagittaria* sp.†	Nearctic	
discursa	Potamogetonaceae *Potamogeton* *gramineus**	Nearctic	
fascitibia	Potamogetonaceae *Potamogeton*	Palaearctic	Hering (1937, 1950, 1951)
flaveola	Geraniaceae *Tropaeolum* *minus* *majus*	Palaearctic	Frost (1924) [as *Notiphila flaveola*], Marchal (1903)

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
flaveola (cont'd)	Papaveraceae *Papaver* sp.	Palaearctic	Frost (1924) [as *Notiphila flaveola*]
flavicornis	Alismataceae *Alisma plantago-aquatica*	Palaearctic	Hering (1925, 1926, 1937, 1957)
fulviceps	Alismataceae *Alisma plantago-aquatica*	Palaearctic	Gercke (1882)
gladiator	Hydrocharitaceae *Vallisneria americana*†	Nearctic	
glyceriae	Gramineae *Glyceria aquatica*	Palaearctic	Hendel (1926), Hering (1937, 1957)
griseola	Gramineae		
	Agropyron	Palaearctic	Grigarick (1959), Hering (1957)
	Agrostis	Palaearctic	Grigarick (1959), Hering (1957)
	Alopecurus	Palaearctic	Grigarick (1959), Hering (1937, 1957), Linnaniemi (1913)
	Anthoxanthum odoratum	Palaearctic	Grigarick (1959), Wilke (1924)
	Apera	Palaearctic	Hering (1957)
	Avena sativa	Palaearctic Nearctic	Grigarick (1959), Balachowsky and Mesnil (1935), Hering (1937), Hendel (1926), von Frauenfeld (1869), Sorauer and Reh (1913), Kirchner (1923)
	Briza	Palaearctic	Hering (1957)
	Bromus	Palaearctic Nearctic	Grigarick (1959), Hering (1937), Hendel (1926)
	Brachypodium	Palaearctic	Hering (1957)
	Calamagrostis	Palaearctic	Grigarick (1959), Hering (1957)
	Catabrosa	Palaearctic	Grigarick (1959), Hering (1957)
	Cynodon	Palaearctic	Grigarick (1959)
	Dactylis glomerata	Palaearctic	Grigarick (1959), Hering (1957), Wilke (1924)
	Digitaria	Palaearctic	Grigarick (1959), Hering (1957)
	Echinochloa crusgalli	Nearctic	Grigarick (1959)
	Eleusine	Palaearctic	Hering (1957)
	Eragrostis	Palaearctic	Grigarick (1959)
	Festuca pratensis	Palaearctic	Grigarick (1959), Hering (1957), Wilke (1924)
	Gaudinia	Palaearctic	Hering (1957)
	Glyceria aquatica	Palaearctic	Grigarick (1959), Hering (1922)
	Hierchloe	Palaearctic	Grigarick (1959)
	Holcus lanatus	Palaearctic	Grigarick (1959), Hering (1951, 1957), Wilke (1924)

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
griseola (cont'd)	*Hordeum vulgare*	Palaearctic Nearctic	Kirchner (1923), Grigarick (1959), Frost (1924), Balachowsky and Mesnil (1935), von Frauenfeld (1869), Hendel (1926), Brischke (1883), Séguy (1951)
	Lagurus	Palaearctic	Hering (1957)
	Lolium perenne	Palaearctic Nearctic	Sorauer and Reh (1913), Wilke (1924), Hering (1925, 1937, 1957), Grigarick (1959), Frost (1924), Hendel (1926)
	Muhlenbergia	Palaearctic	Grigarick (1959)
	Oryza	Palaearctic	Grigarick (1959), Lange, et al. (1953), DeOng (1922) [as *H. scapularis*], Darby (1962), Hendel (1926)
	Panicum	Palaearctic Nearctic	Grigarick (1959), Hering (1957), Malloch (1915) [as *H. scapularis*]
	Paspalum	Nearctic	Grigarick (1959)
	Phalaris arundinacea	Palaearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1937, 1957)
	Phleum pratense	Palaearctic	Grigarick (1959), Hendel (1926), Hering (1937), Linnaniemi (1913), Wilke (1924)
	Phragmites	Palaearctic	Grigarick (1959), Hering (1957)
	Poa annua pratensis trivialis	Palaearctic	Grigarick (1959), Frost (1924), Hendel (1926), Hering (1937), Kirchner (1923)
	Polypogon	Nearctic	Grigarick (1959)
	Scleropoa	Palaearctic	Hering (1957)
	Secale cereale	Palaearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1957)
	Setaria	Palaearctic	Grigarick (1959), Hering (1957)
	Triticum sativum	Palaearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1957)
	Zea	Palaearctic	Grigarick (1959)
	*Zizania aquatica**	Palaearctic Nearctic	Grigarick (1959)
	Alismataceae		
	Alisma plantago-aquatica	Palaearctic Nearctic	Grigarick (1959), Grimshaw (1925)
	Sagittaria	Nearctic	Grigarick (1959), Lange et al. (1953)
	Damasonium	Nearctic	Grigarick (1959)
	Caryophyllaceae		
	Lychnis sp. *flos-cuculi*	Palaearctic	Grigarick (1959), Balachowsky and Mesnil (1935), Hendel (1926), Hering (1951, 1957)
	Stellaria media	Palaearctic	Grigarick (1959), Frost (1924), Hendel (1926), Hering (1957)
	Chenopodiaceae *Kochia*	Palaearctic	Grigarick (1959), Hering (1937, 1957)
	Compositae *Bellis*	Palaearctic	Grigarick (1959), Hering (1937, 1957)

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
griseola (cont'd)	Cruciferae *Nasturtium officinale**	Nearctic	
	Cyperaceae *Carex*	Palaearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1937, 1957), Séguy (1950)
	Cyperus	Palaearctic Nearctic	Grigarick (1959), Hendel (1926)
	Scirpus	Nearctic	Grigarick (1959), Lange et al. (1953)
	Hydrocharitaceae *Hydrocharis morsus-ranae*	Palaearctic	Grigarick (1959), Hendel (1926), Grimshaw (1925), de Meijere (1902)
	Stratiotes aloides	Palaearctic	Grigarick (1959), Hendel (1926), Ruschka and Thienemann (1913), Séguy (1950), Wahlgren (1947)
	Labiatae *Lamium purpureum*	Palaearctic	Grigarick (1959), Frost (1924), Hendel (1926), Hering (1937, 1957)
	Leguminosae *Trifolium*	Palaearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1937, 1951, 1957)
	Lemnaceae *Lemna minor*	Palaearctic	Grigarick (1959), Bertrand (1954), Grimshaw (1925)
	Liliaceae *Allium cepa porrum*	Palaearctic	Grigarick (1959), Balachowsky and Mesnil (1935), Hering (1957)
	Polygonaceae *Polygonum*	Palaearctic	Grigarick (1959), Hendel (1926)
	Scrophulariaceae *Veronica*	Palaearctic	Grigarick (1959), Hering (1937, 1957)
	Typhaceae *Typha latifolia*	Nearctic	Grigarick (1959)
hydrocharitis	Hydrocharitaceae *Hydrocharis morsus-ranae*	Palaearctic	Hendel (1926), Hering (1925, 1926, 1931, 1937, 1951, 1957)
ischiaca	Gramineae *Zizania aquatica** *Glyceria grandis** *obtusa**	Nearctic	
	Potamogetonaceae *Potamogeton natans**	Nearctic	
itascae	Potamogetonaceae *Potamogeton zosteriformis**	Nearctic	
leucostoma	Chenopodiaceae *Chenopodium album*	Palaearctic	Frost (1924)

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
luctuosa	Potamogetonaceae	Nearctic	Berg (1949, 1950)
	Potamogeton		
	alpinus		
	amplifolius		
	richardsonii		
	natans		
	zosteriformis‡		
maura	Cruciferae	Palaearctic	Séguy (1950), Hering (1951)
	Nasturtium		
	officinale		
	Potamogetonaceae	Palaearctic	Hering (1957), Bertrand (1954), Hering (1950)
	Potamogeton		
	perfoliatus		
modesta	Hydrocharitaceae	Palaearctic	Keilin (1915)
	Hydrocharis		
	Potamogetonaceae	Palaearctic	Keilin (1915), Hering (1937), Hendel (1926), Thienemann (1912)
	Potamogeton		
	natans		
	sp.		
mutata	Alismataceae	Palaearctic	Hendel (1926), Hering (1937, 1957), Grünberg (1910)
	Alisma		
	plantago		
	Hydrocharitaceae		
	Stratiotes	Palaearctic	Séguy (1950), Wahlgren (1947), Hering (1959)
	aloides		
	Hydrocharis	Palaearctic	Hendel (1926), Linnaniemi (1913), Gercke (1878), Hering (1925, 1926), Grünberg (1910)
	morsus-ranae		
	Lemnaceae	Palaearctic	Linnaniemi (1913)
	Lemna		
nasturtii	Cruciferae	Palaearctic	Séguy (1950), Hering (1937), Taylor (1928), Vayssière (1933), Collin (1928), Hering (1957)
	Nasturtium		
	officinale		
nigricans	Juncaginaceae	Palaearctic	Hering (1957)
	Juncus		
	bufonius		
	articulatus		
nigripes	Potamogetonaceae	Palaearctic	Hering (1937, 1957)
	Potamogeton		
potamogeti	Potamogetonaceae	Palaearctic	Hering (1937, 1957)
	Potamogeton		
	natans		
	drucei		
propinqua	Hydrocharitaceae	Palaearctic	Wahlgren (1947), Hering (1957)
	Stratiotes		
	aloides		

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
pulla	Potamogetonaceae	Nearctic	Berg (1949, 1950)
	Potamogeton		
	amplifolius‡		
	gramineus		
	richardsonii		
ranunculi	Cruciferae	Palaearctic	Thienemann (1912), Hendel (1926), Hering (1925), Taylor (1928)
	Nasturtium		
	officinale		
spinicornis	Gramineae	Nearctic	
	Hydrochloa		
	*caroliniensis**		
stratiotae	Hydrocharitaceae	Palaearctic	Hering (1926, 1937, 1957), Séguy (1950), Hendel (1926)
	Stratiotes		
	aloides		
stratiotella	Hydrocharitaceae	Palaearctic	Hering (1957), Wahlgren (1947)
	Stratiotes		
	aloides		
tibialis	Cyperaceae	Nearctic	
	Eleocharis		
	*obtusa**		
thoracica	Gramineae	Palaearctic	Hering (1926)
	Glyceria		
	aquatica	Palaearctic	Hering (1925)
trichaeta	Hydrocharitaceae	Nearctic	
	Elodea		
	*canadensis**		
	Potamogetonaceae	Nearctic	
	Potamogeton		
	*epihydrus**		
	*gramineus**		
	*nodosus**		
viridescens	Alismataceae	Palaearctic	Hering (1957)
	Alisma		
	Potamogetonaceae	Palaearctic	Hering (1950, 1951, 1957)
	Potamogeton		
	perfoliatus		
	crispus		
	sp.		
williamsi	Lemnaceae	Australian	Hardy (1960)
	Lemna		
xenophaga	Potamogetonaceae	Palaearctic	Hering (1957)
	Potamogeton		
spp.	Alismataceae	Palaearctic	Hering (1957)
	Alisma		
	Sagittaria	Nearctic	
	latifolia‡		

TABLE 1.—*Checklist of known host plants of* Hydrellia.—Continued

Species of Hydrellia	*Host plant*	*Zoogeographic region*	*Major references*
	Ranunculaceae	Palaearctic	Hering (1937)
	Haloragaceae *Myriophyllum*	Palaearctic	Schiner (1864)
	Potamogetonaceae *Potamogeton*	Palaearctic	Schiner (1864), Séguy (1930)
	Potamogetonaceae *Potamogeton amplifolius*	Nearctic	Frost (1924)
	Polygonaceae *Polygonum amphibium persicaria*	Palaearctic	Frost (1924)

TABLE 2.—*Checklist of known parasitic wasps of* Hydrellia.

Species of Hydrellia	*Parasitic wasp*	*Zoogeographic region*	*Major references*
albilabris	Braconidae *Chaenusa conjungens* *Chorebus uliginosus* *Dacnusa liminicola*	Palaearctic	Fulmek (1962)
ascita	Braconidae *Chorebidella* sp. *Dacnusa* sp.	Nearctic	Berg (1950)
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)
bergi	Braconidae *Ademon niger* *Chorebidea* sp. 2 *Dacnusa* sp. 1	Nearctic	Berg (1950)
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)

NOTE: * Reared from host for the first time during this study. † Reared from host during this study.

TABLE 2.—*Checklist of known parasitic wasps of* Hydrellia.—Continued

Species of Hydrellia	*Parasitic wasp*	*Zoogeographic region*	*Major references*
bilobifera	Braconidae *Aphanta* sp.* *Chorebidella bergi** *Opius** sp.	Nearctic	
butomi	Braconidae *Ademon decrescens*	Palaearctic	Hering (1925)
	Pteromalidae genus undet. (hyperparasite)	Palaearctic	Hering (1925)
cochleariae	Braconidae *Ademon decrescens* *Chaenusa conjungens* *Chorebus uliginosus* *Opius caesius* *Pachysema discolor*	Palaearctic	Fulmek (1962), Thienemann (1916)
	Chalcidae *Gonatocerus uliginosus*	Palaearctic	Fulmek (1962)
cruralis	Braconidae *Ademon niger* *Chorebidea* sp. *Chorebidella bergi*	Nearctic	Berg (1950)
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)
	Pteromalidae genus undet.	Nearctic	Berg (1950)
fascitibia	Braconidae *Ademon decrescens*	Palaearctic	Fulmek (1962)
griseola	Braconidae *Ademon decrescens* sp.	Palaearctic	Burghele (1959a, 1959b), Grigarick (1959), Séguy (1934), Fulmek (1962)
	Chaenusa conjungens sp.	Palaearctic Nearctic	Burghele (1959a, 1959b), Grigarick (1959), Fulmek (1962)

TABLE 2.—*Checklist of known parasitic wasps of* Hydrellia.—Continued

Species of Hydrellia	*Parasitic wasp*	*Zoogeographic region*	*Major references*
griseola (cont'd)	*Chorebus uliginosus nixoni densepunctatus orghidani*	Palaearctic	Burghele (1959a, 1959b), Grigarick (1959), Fulmek (1962), Kuwayama (1955)
	aquaticus†	Palaearctic Nearctic	Burghele (1959a, 1959b), Grigarick (1959)
	sp.	Nearctic	Grigarick (1959), Malloch (1915) [as *Gyrocampa*]
	Coelinius hydrelliae	Palaearctic	Kawall (1867), Grigarick (1959), Fulmek (1962)
	Merites(?)	Palaearctic	Kuwayama (1955), Grigarick (1959)
	Opius hydrelliae	Palaearctic Nearctic	Burghele (1959a, 1959b), Fulmek (1962), Grigarick (1959)
	punctiventris	Palaearctic	Grigarick (1959), Thompson (1943)
	sp.	Palaearctic	Kuwayama (1955)
	sp.	Neotropical	Parker, et al. (1952)
	Pachysema temula	Palaearctic	Fulmek (1962)
	Diapriidae *Trichopria columbiana* sp.	Nearctic	Grigarick (1959)
	Eucoilidae *Kleidotoma striaticollis*	Palaearctic	Burghele (1959a, 1959b), Fulmek (1962)
	Eulophidae		
	Achrysocharis sp.	Neotropical	Parker, et al. (1952)
	Asecodes sp.	Palaearctic	Kuwayama (1955)
	Chrysocharis sp.	Palaearctic	Grigarick (1959)
	Derostemus sp.	Nearctic	Grigarick (1959)
	Elachertus(?) sp.	Palaearctic	Kuwayama (1955)
	Mestocharis(?) sp.	Palaearctic	Kuwayama (1955)
	Neochrysocharis sp.	Palaearctic	Kuwayama (1955)
	Paracrias sp.	Palaearctic	Kuwayama (1955)
	Pnigalio sp.	Nearctic	Grigarick (1959)
	Rhopalotus sp.	Palaearctic	Kuwayama (1955)
	Solenotus sp.	Palaearctic	Kuwayama (1955)
	intermedius	Nearctic	Grigarick (1959)
	Sympiesis sp.	Nearctic	Grigarick (1959)

TABLE 2.—*Checklist of known parasitic wasps of* Hydrellia.—Continued

Species of Hydrellia	*Parasitic wasp*	*Zoogeographic region*	*Major references*
griseola (cont'd)	Ichneumonidae *Hemiteles* sp.	Palaearctic	Kuwayama (1955)
	Horogenes fenestralis	Palaearctic	Fulmek (1962)
	Proctotrupidae *Ismarus* sp.	Palaearctic	Kuwayama (1955)
	Pteromalidae		
	Eupteromalus americanus	Nearctic	Grigarick (1959)
	Halticoptera sp.	Nearctic	Grigarick (1959)
	Merismus sp.	Palaearctic	Kuwayama (1955)
	Polycystis clavicornis	Palaearctic	Burghele (1959a, 1959b), Fulmek (1962)
	Pteromalus sp.	Neotropical	Parker, et al. (1952)
	Trichomalus sp.	Palaearctic	Kuwayama (1955)
ischiaca	Braconidae	Nearctic	
	*Chorebus aquaticus**		
	*Chorebidella bergi**		
	Chaenusa sp.*		
	Opius sp.*		
	Diapriidae *Trichopria columbiana**	Nearctic	
itascae	Braconidae	Nearctic	
	Aphanta sp.*		
	*Chorebidella bergi**		
luctuosa	Braconidae *Dacnusa* sp.	Nearctic	Berg (1950)
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)
maura	Braconidae *Pachysema discolor*	Palaearctic	Fulmek (1962)
mutata	Braconidae *Chaenusa conjungens*	Palaearctic	Fulmek (1962), Rimsky-Korsakov (1917)

TABLE 2.—*Checklist of known parasitic wasps of* Hydrellia.—Continued

Species of Hydrellia	*Parasitic wasp*	*Zoogeographic region*	*Major references*
nasturtii	Braconidae *Ademon decrescens*	Palaearctic	Thompson (1943, 1953), Fulmek (1962), Vayssière (1933)
pulla	Braconidae *Ademon niger**	Nearctic	
	Diapriidae *Trichopria columbiana*†	Nearctic	Berg (1950)
stratiotae	Braconidae *Ademon decrescens* *Chorebus uliginosus*	Palaearctic	Fulmek (1962)
spp.	Braconidae *Dacnusa obscuripes* [listed as probable parasite]	Palaearctic	Thienemann (1916), Burghele (1959b)
	Gyrocampa sp.	Palaearctic	Thienemann (1916)
	Ademon mutator	Palaearctic	Thompson (1953)
	Chorebidea motasi	Palaearctic	Burghele (1959a)
	Chorebus striola	Palaearctic	Burghele (1959b)
	Ademon decrescens mutator *Chaenusa najadum natator* *Dacnusa obscuripes* *Gyrocampa stagnalis* *Opius hydrelliae* *Pachysema discolor* Diapriidae *Ceratopria lacustris*	Palaearctic	Fulmek (1962)
viridescens	Braconidae *Ademon decrescens* *Chorebus najadum natator*	Palaearctic	Fulmek (1962), Thienemann (1916) [as *H. chrysostoma*]

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Localities of Specimens Illustrated

ALASKA

King Salmon, Naknek River; Figure 35.
Matanuska Valley; Figures 19, 111.

BRITISH COLUMBIA

Qualicum; Figure 66.

CALIFORNIA

Davis; Figures 84, 95, 116.
Maxwell, Colusa County; Figure 138.
Monterey County; Figure 57.
Sacramento; Figures 42, 94.
Sardine Creek, Mono County; Figure 51.

COLORADO

Walden Lake; Figure 62.

CONNECTICUT

Canaan; Figure 52.
New Haven Harbor, west shore; Figure 22.

FLORIDA

Biscayne Bay; Figure 54.
Lacoochee; Figure 31.
Port St. Joe Beach, Gulf County; Figure 58.
(Unspecified) Figures 24, 71.

ILLINOIS

Havana; Figure 67.

IOWA

Banner Mine Area, Warren County; Figures 41, 87, 118.
Little Wall Lake, Hamilton County; Figures 1, 3, 4, 5, 6, 10, 11, 13, 130, 133–137, 139–142.
Springbrook State Park, Guthrie County; Figures 9, 64.
Spring Lake, Greene County; Figures 20, 37, 73, 75, 88, 115.
Three miles east-southeast of Waterville, Allamakee County; Figure 8.

KANSAS

Kansas University Natural History Reservation, Douglas County; Figures 2, 12, 14, 85, 91, 109.

MAINE

Bar Harbor, Mount Desert Island; Figure 39.

MARYLAND

Plummer's Island, Potomac River; Figure 46.

MASSACHUSETTS

Woods Hole; Figure 18.

MICHIGAN

Bessey Creek, Cheboygan County; Figure 92.
Douglas Lake, Cheboygan County; Figures 89, 96, 107, 114, 132.
Nigger Creek, Cheboygan County; Figures 86, 112.
Third Sister Lake, Washtenaw County; Figures 61, 106, 108.
(Unspecified) Figure 123.

MINNESOTA

Biological Station, Itasca State Park; Figure 28.
Bohall Trail Bog, Itasca State Park; Figure 36.
Bohall Lake, Itasca State Park; Figure 68.
Chambers' Creek, Itasca State Park; Figures 7, 65.
Douglas Lodge Bay, Lake Itasca; Figures 44, 76, 102, 110.
Lake Itasca, Itasca State Park; Figures 82, 126, 129.
Long Lake, Clearwater County; Figure 128.
Mississippi River at Sucker Creek, Clearwater County; Figures 100, 122.
Mississippi River, sec. 34, T. 145 north, R. 36 west, Clearwater County; Figure 59.
One and three-tenths miles south of main entrance to Itasca State Park; Figures 33, 74.
Rapid River Logging Camp, Hubbard County; Figures 98, 131.
Sucker Creek, 100 yards north of State Highway 31, Clearwater County; Figure 47.
Squaw Lake, Itasca State Park; Figures 55, 63.
Two Island Lake, Itasca State Park; Figure 25.

MISSISSIPPI

Dickinson's Pond, Lamar County; Figures 43, 99, 103, 117, 120.
Gravel pit near U.S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson County; Figures 34, 81, 101, 119.
Gulf Coast Research Laboratory, Ocean Springs; Figure 27.
Lake Shady, Lamar County; Figures 32, 40, 78, 79, 83, 90, 93, 105, 124.

NEW YORK

Dryden Lake, Tompkins County; Figures 17, 60.
Inlet Valley, Ithaca; Figures 104, 121.

ONTARIO

Grand Bend; Figure 56.
Midland; Figure 23.
Ottawa; Figures 21, 53.

PENNSYLVANIA

Ohiopyle; Figure 26.

QUEBEC

Perkins Mills; Figures 15, 69.
LaTrappe; Figure 48.

TENNESSEE

Brewer's Bar Ditch, Reelfoot Lake; Figures 70, 72, 97, 113.
Dale Hollow Reservoir, six miles south of Byrdstown, Pickett County; Figure 50.
Miller's Camp, Reelfoot Lake; Figures 30, 77, 125.
Samburg, Reelfoot Lake; Figures 29, 80, 127.

WASHINGTON

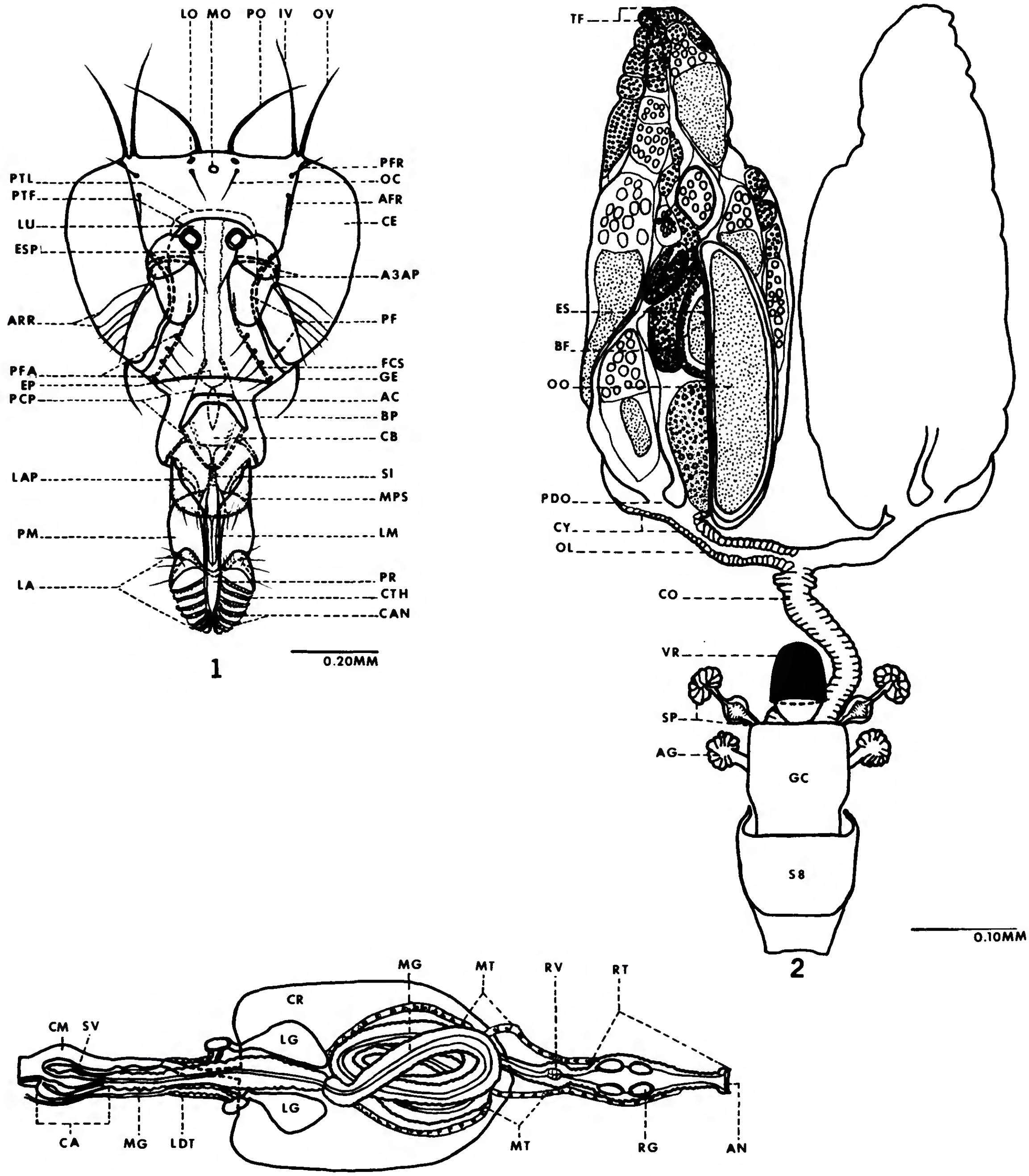
Ilwaco; Figure 38.
O'Sullivan Dam, Grant County; Figure 49.
Tacoma; Figure 45.
Three miles west of Kettle Falls; Figure 16.

Abbreviations Used on Illustrations

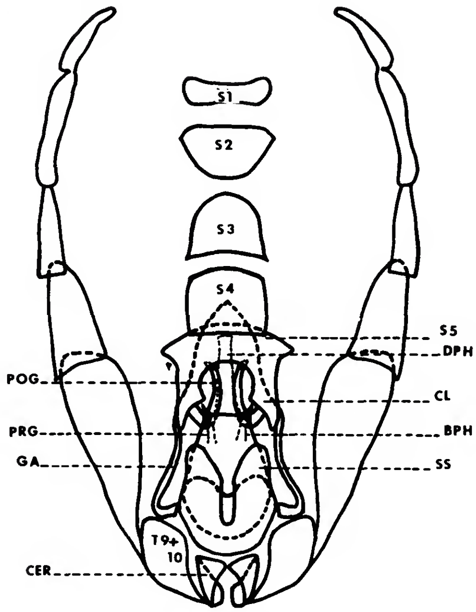
AAC, preacrostichal
AC, anteclypeus
ACB, anteclypeal breadth
ACW, anterior cibarial wall
ADC, predorsocentral
ADT, accessory-gland duct
AEM2, mesanepimeron
AES2, mesanepisternum
AFR, anterior fronto-orbital
AG, accessory gland
AM, adhesive material
AN, anus
ANT, antenna
AOD, anteocellar distance
AP, anal plate
APR, supraspiracular asteriform process
ARR, aristal rays
AS, annuli of spinules
ASC, apical scutellar
A3AP, apicodorsal antennals
BC, basicoxal
BEC, basal end of costa
BF, basal follicle
BP, basiproboscis
BPH, basiphallus
BS, basiphallic socket
BSC, basal scutellar
CA, cardia
CAN, canaliculi
CAP, halter capitellum
CAR, clypeal arch
CB, cibarium
CE, compound eye
CER, cercus
CF, distal costal fracture ("break")
CH, chorion
CL, copulobus
CM, crop meatus
CO, common oviduct
CR, crop proper
CS, cervical sclerite 2
CSN, cibarial sensillum
CSP, cheliform spot
CTH, canalicular teeth
CW, creeping welt
CX1, fore coxa
CX2, mid coxa
CX3, hind coxa
CY, calyx
DC, cibarial dilators
DCW, dorsal cibarial wall
DPH, distiphallus
DPR, dorsal phragmatal ramus
EDT, ejaculatory duct
EE, escape exit made by parasite
EO, dehydrated embryo
EP, epistoma
ES, epithelial sheath
ESP, esophagus
FCS, epistomal sulcus
FE, femur
FPL, frontoclypeal plate
GA, gonal arch
GC, genital chamber
GE, genal
h, humeral crossvein
HLS, head-lobe scar
IA, interalar
IFC, interfractural costals
ISC, intermediate scutellar
IV, inner vertical
KES2, mesokatepisternum
LA, labellum
LAB, labium (LA in Figure 81)
LAP, labral apodeme
LDT, labial-glad duct
LF, parafrontale
LG, labial gland
LGD, labial-gland duct opening
LM, labrum
LO, lateral ocellus
LR, longitudinal ridges
LS, labial sclerite
LT, laterotergite
LU, frontal lunule
M, mesomeron
m, medial crossvein
M_{1+2}, combined first and second medial vein
$M_3 + Cu_1$, combined third medial and first cubital vein
MDA, mouth-hook depressor apodeme
ME, meconium
MF, frontal vitta
MFH, mesofacial height
MG, midgut
MH, mouth-hook
MO, median ocellus
MOT, mediotergite
MPS, maxillary palpus
MP, metapleuron
MPP, micropylar protuberance (MP in Figure 125)
MS, mesopleural sulcus
MT, Malpighian tubules
NP, notopleuron
OC, ocellar
OL, lateral oviduct
OO, oocyte
OR, ovary
OV, outer vertical
PA, postalar
PAC, postacrostichal
PAP, phallapodeme
PBS, probasisternum
PCP, paraclypeal phragma
PCW, posterior cibarial wall
PD, halter pedicel
PDC, postdorsocentral
PDO, ovariole pedicel
PF, parafaciale
PFA, primary facials
PFR, posterior fronto-orbital
POG, postgonite
PH2, thoracic phragma 2
PHD, phallic depressors
PHL, phallic levators
PLP, postlabial pad
PM, prementum
PO, postocellar
PP, propleuron
PPH, paraclypeal phragma (Figures 84, 85).
PPN, postpronotum
PR, prestomum
PRG. pregonite
PRS, prescutellar
PSP, peritremal spinous seta
PT, spiracular peritreme
PTF, ptilinal fissure
PTL, ptilinum
PTO, primary tracheal orifice
PU, postgonite uncus
R_1, first radial vein
R_{2+3}, combined second and third radial vein
R_{4+5}, combined fourth and fifth radial vein
RG, rectal gland
r-m, radiomedial crossvein
RT, rectum
RV, rectal valve
S1–5, sterna 1–5
S8, sternum 8
SA, subalare
SAO, secondary atrial orifice
SAT, spiracular atrium
SB, halter scabellum
SBP, subgenital plate
SCB, subcranial breadth
SI, food-neatus siphon
SL, supra-alar

Abbreviations Used on Illustrations—Continued

SO, spermatogonia
SOH, subocular height
SP, lateral spermatheca
SP1, prothoracic spiracle
SP3, metathoracic spiracle
SPP, supraspiracular protuberance
SSP, supraspiracular spinous seta
SPT, subspiracular protuberance
SS, fused surstyli
ST, spermatic tubule
SV, stomodeal valve
SVS, seminal vesicle
SZ, spermatozoa
T4, tergum 4
T5, tergum 5
T_{9+10}, syntergum 9+10
TB, tibia
TF, terminal filament
TS, testis
VB, vertex breadth
VD, vas deferens
VOD, vertical ocular height
VPR, ventral phragmatal ramus
VR, median spermatheca
WA, wing area
WL, wing length
WVR, wall of median spermatheca



Figures 1–3.—1, *Hydrellia griseola* (Fallén), male: head, cleared, frontal view. 2, *H. bilobifera* Cresson, female: internal genitalia, ventral view. 3, *H. griseola* (Fallén), female: gut, dorsal view.



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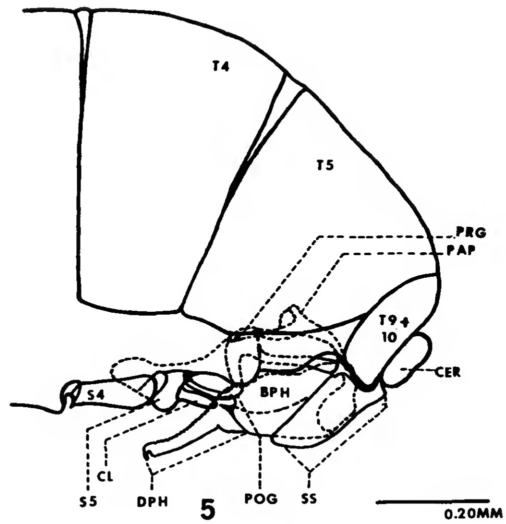

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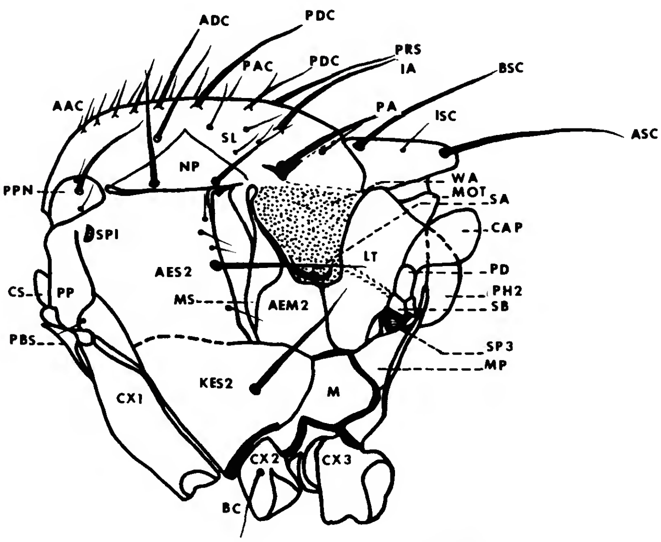

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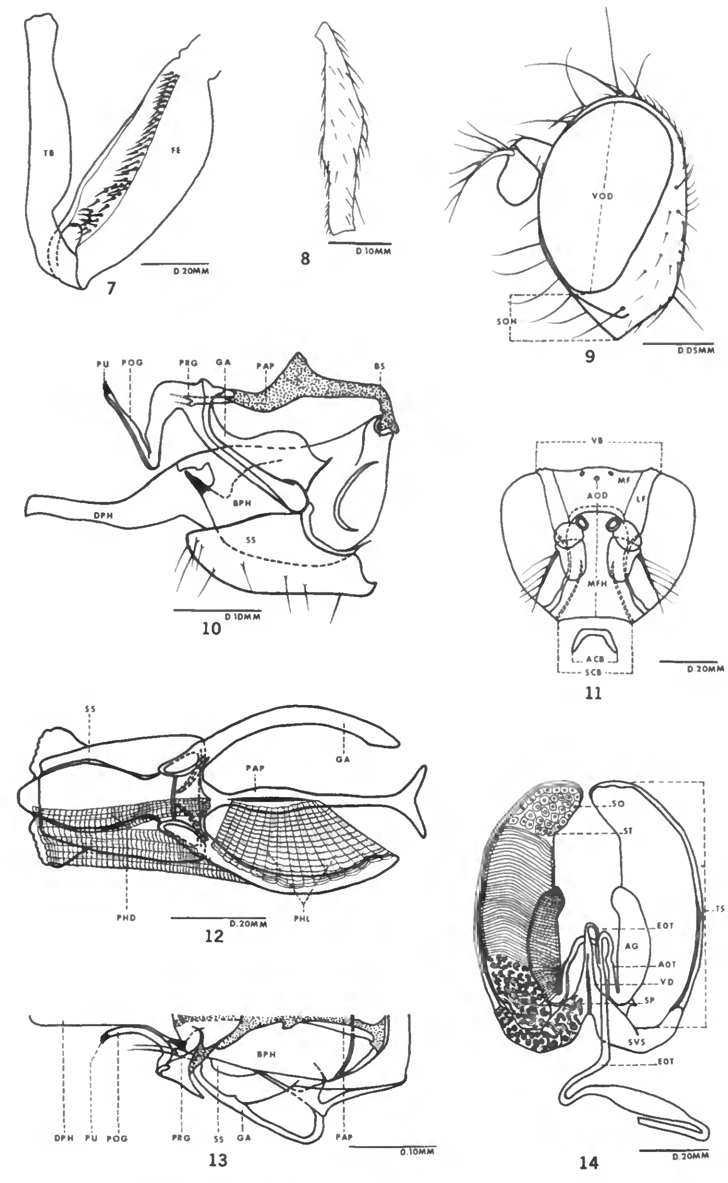
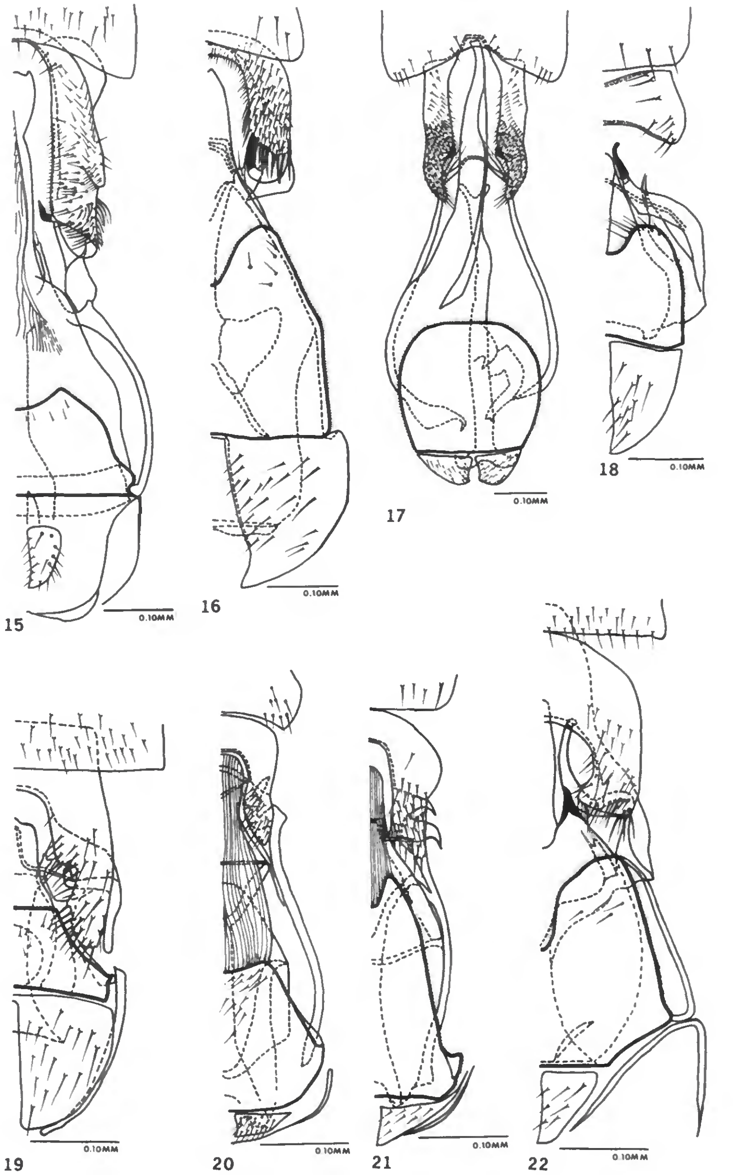
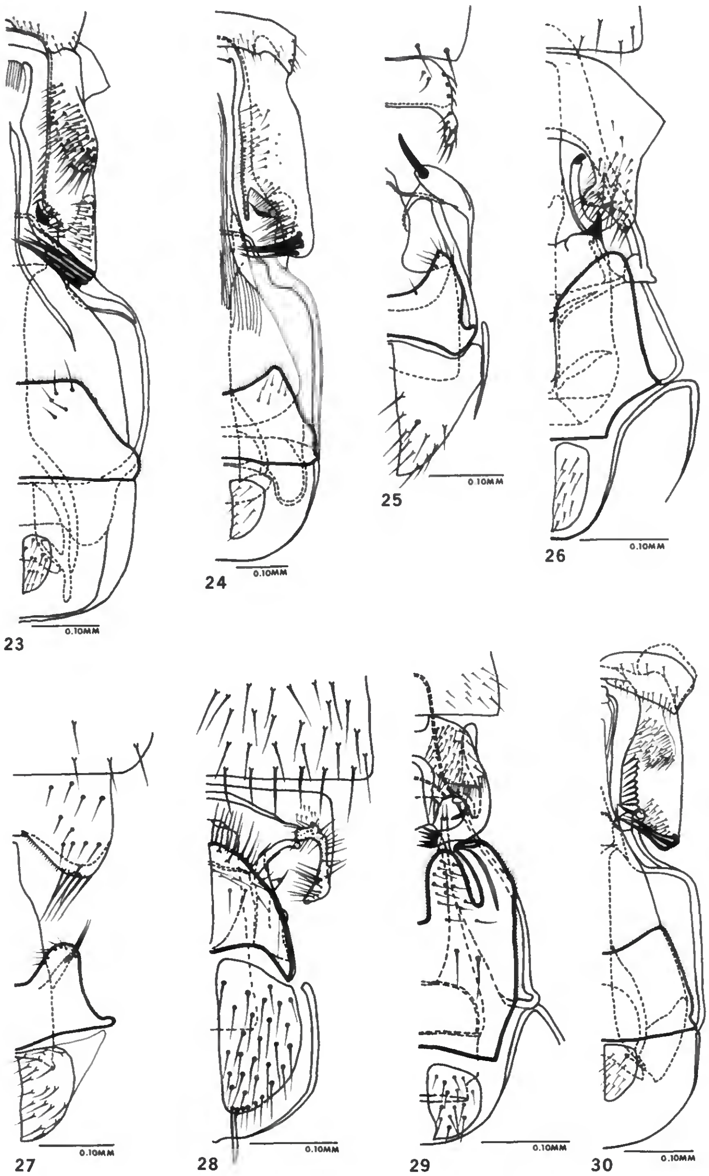
FIGURES 4–6.—*Hydrellia griseola* (Fallén): 4, abdomen, male, ventral view; 5, posterior half of abdomen, male, lateral view; 6, thorax proper, male, lateral view.



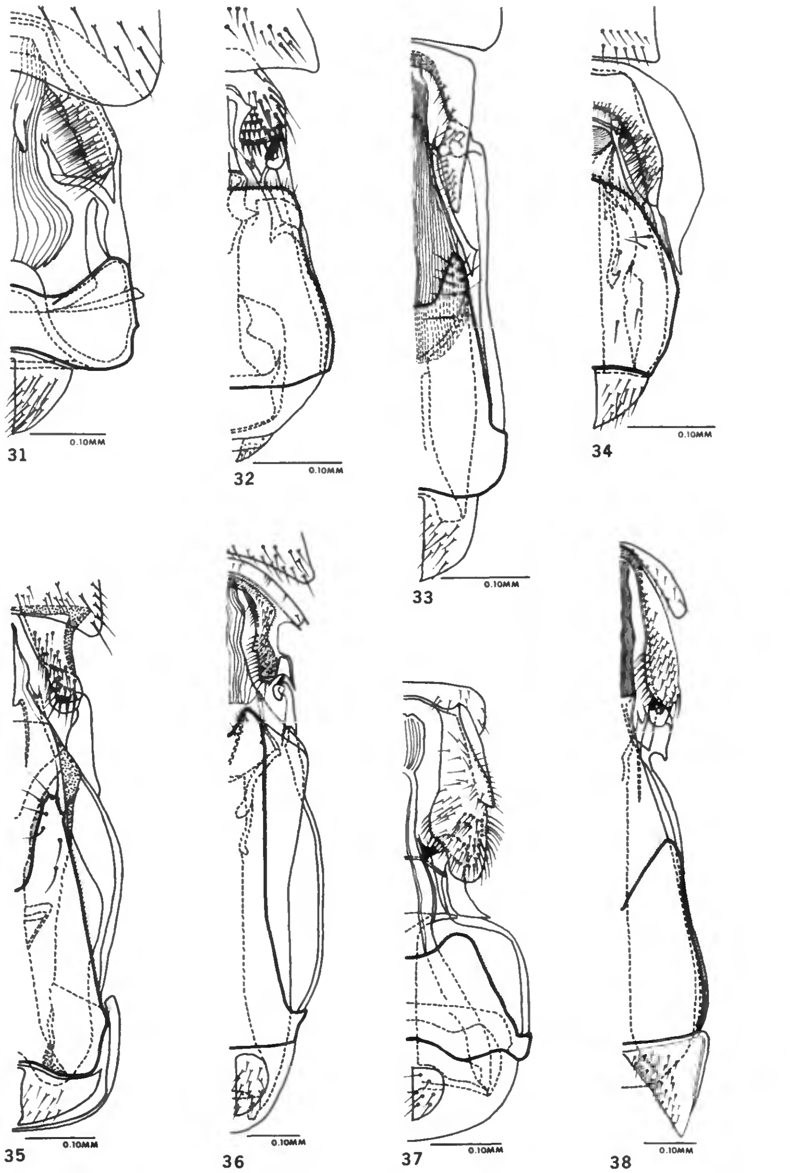
FIGURES 7–14.—7, *Hydrellia crassipes* Cresson, male: left hind femur and tibia, anteroventral view. 8, *H. morrisoni* Cresson, male: left hind tibia, anterior view. 9, *H. harti* Cresson, male: head, lateral view. 10, 11, *H. griseola* (Fallén): 10, male, terminalia, lateral view; 11, male, head, cleared, frontal view. 12, *H. bilobifera* Cresson, male: musculature of gonal arch and phallapodeme, dorsal view. 13, *H. griseola* (Fallén): male terminalia, dorsal view. 14. *H. bilobifera* Cresson: male internal genitalia, ventral view.



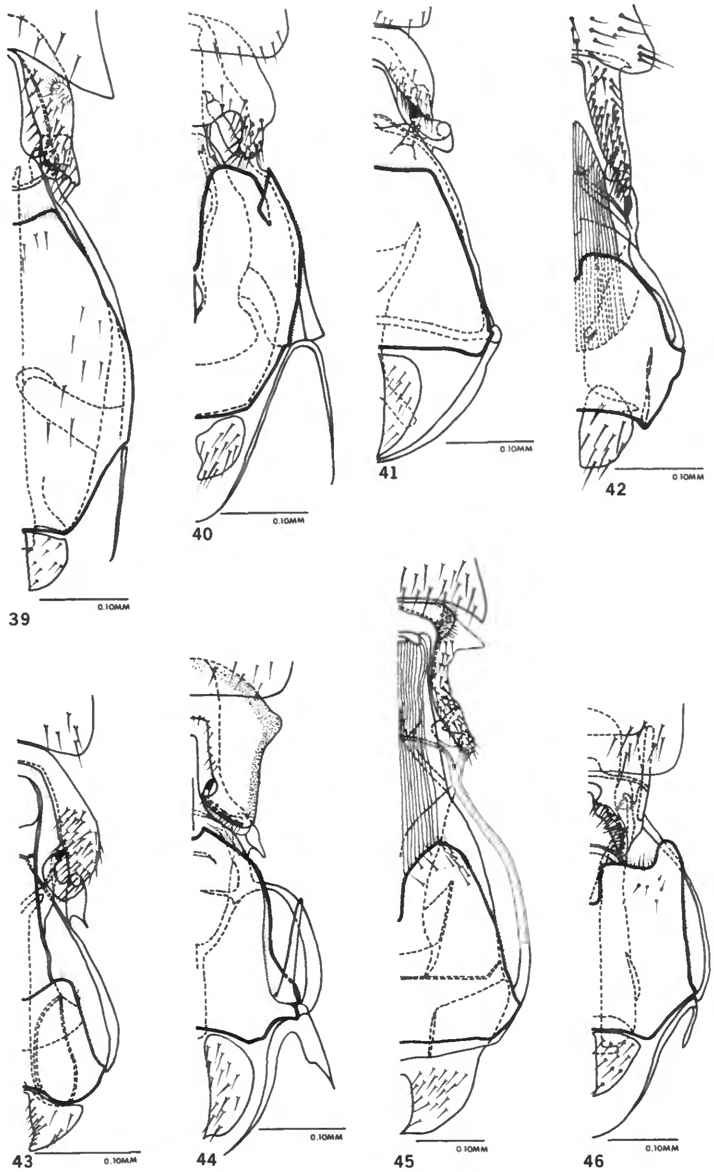
FIGURES 15–22.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 15, *H. harti* Cresson; 16, *H. morrisoni;* 17, whole structure for *H. bergi* Cresson; 18, *H. prudens* Curran; 19, *H. caliginosa* Cresson; 20, *H. procteri* Cresson; 21, *H. idolator,* new species; 22, *H. valida* Loew.



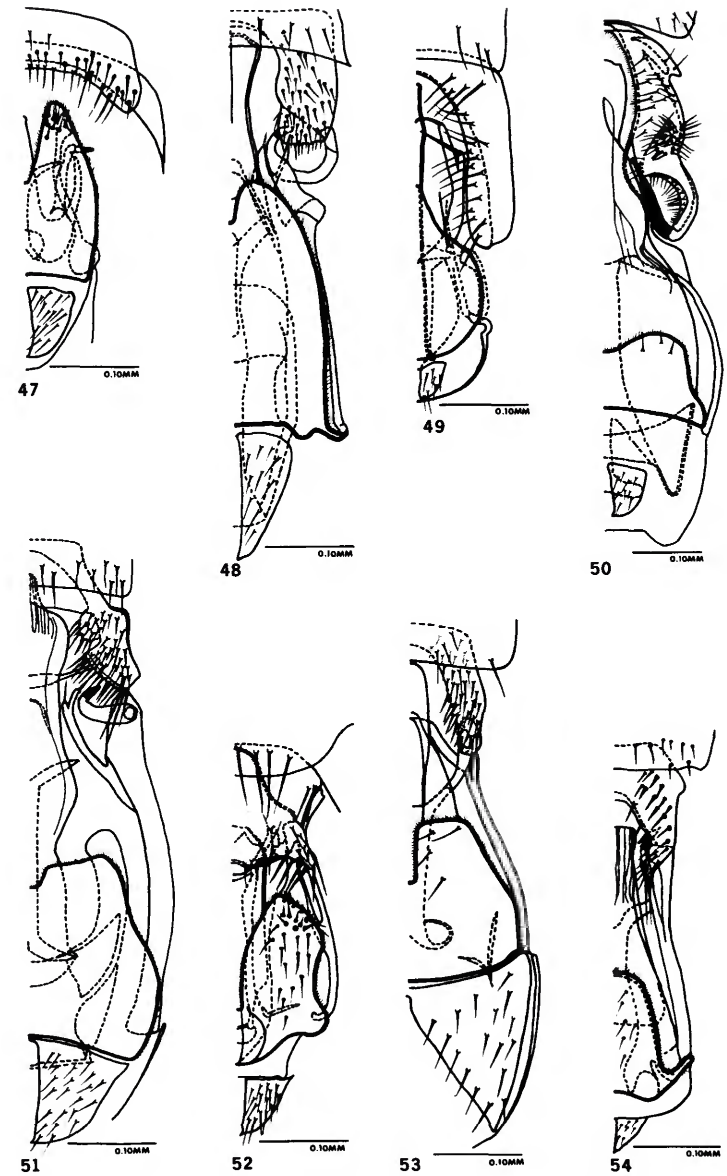
FIGURES 23–30.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 23, *H. ascita* Cresson; 24, *H. gladiator,* new species; 25, *H. surata,* new species; 26, *H. griseola* (Fallén); 27, *H. americana* Cresson; 28, *H. itascae,* new species; 29, *H. rixator,* new species; 30, *H. discursa,* new species.



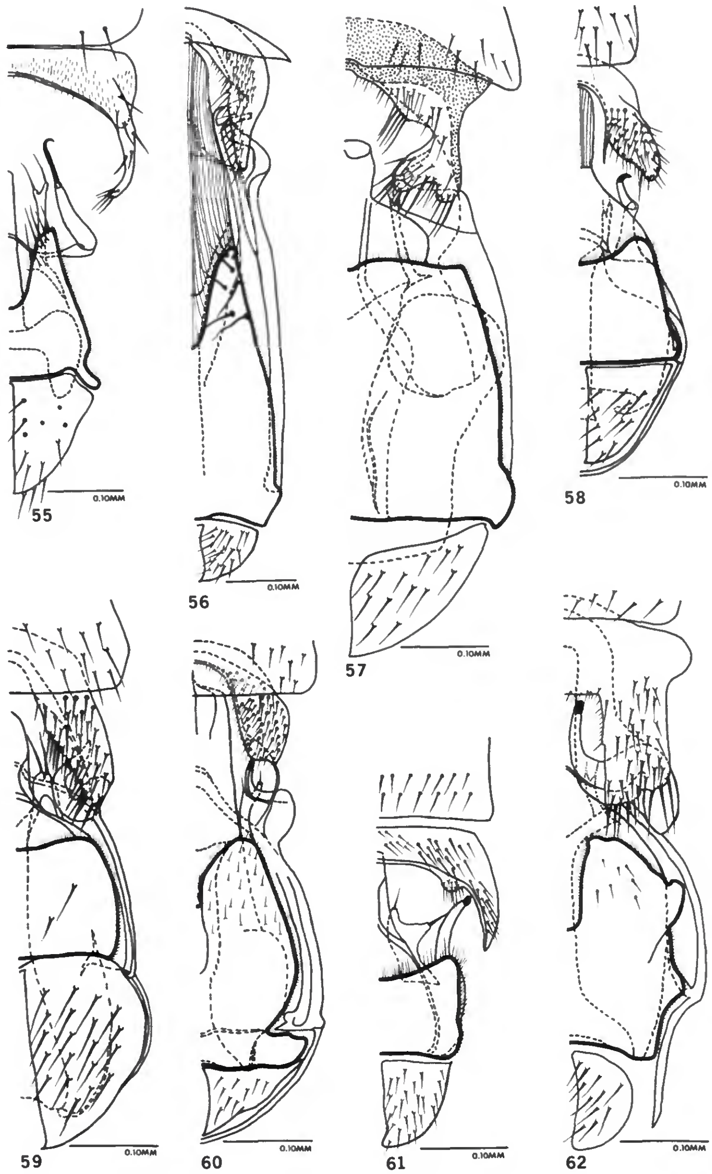
FIGURES 31–38.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 31, *H. floridana,* new species; 32, *H. ainsworthi,* new species; 33, *H. crassipes* Cresson; 34, *H. biloxiae,* new species; 35, *H. serena* Cresson; 36, *H. nobilis* (Loew); 37, *H. trichaeta* Cresson; 38, *H. platygastra* Cresson.



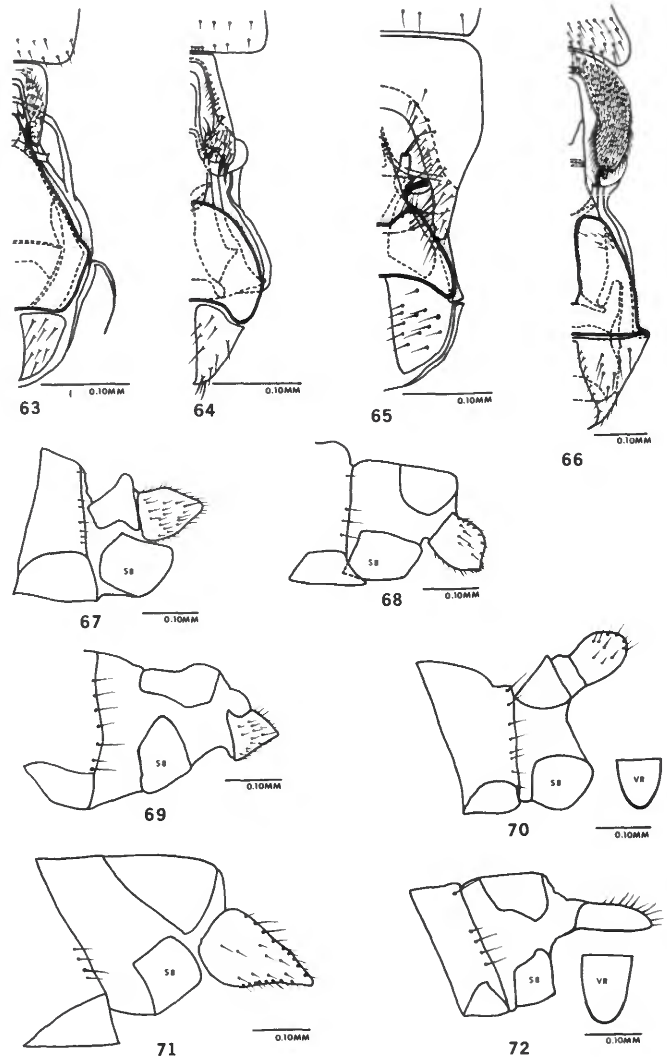
FIGURES 39–46.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 39, *H. advenae* Cresson; 40, *H. spinicornis* Cresson; 41, *H. tibialis* Cresson; 42, *H. deceptor,* new species; 43, *H. formosa* Loew; 44, *H. ischiaca* Loew; 45, *H. subnitens* Cresson; 46, *H. insulata,* new species.



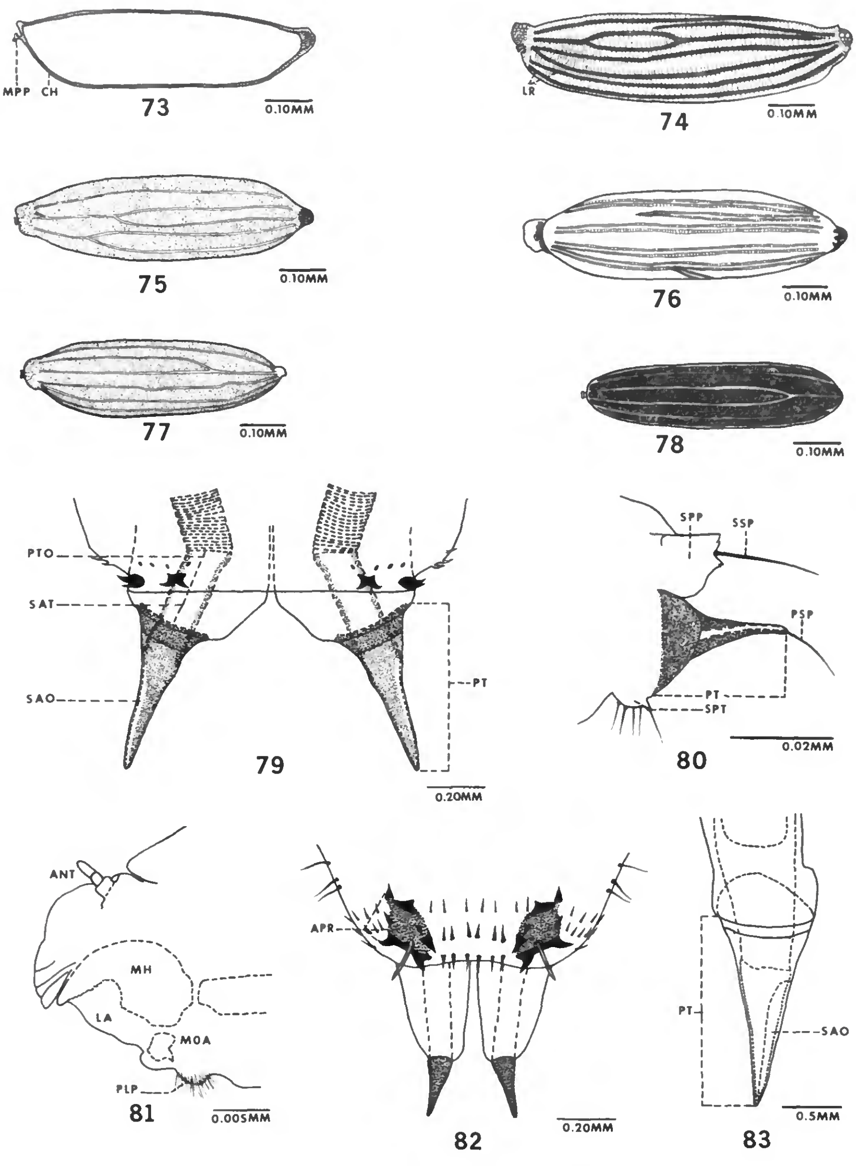
FIGURES 47–54.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 47, *H. amnicola*, new species; 48, *H. manitobae*, new species; 49, *H. personata*, new species; 50, *H. bilobifera* Cresson; 51, *H. melanderi*, new species; 52, *H. notata*, new species; 53, *H. borealis* Cresson; 54, *H. cavator*, new species.



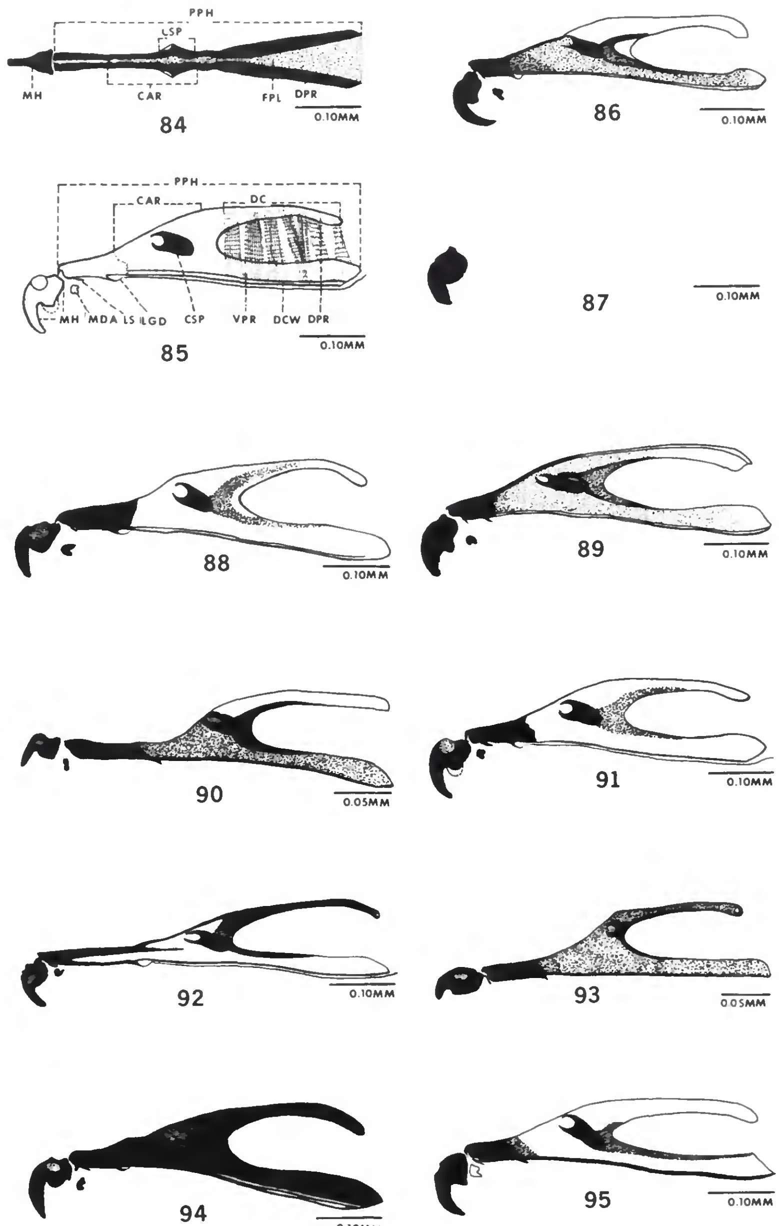
FIGURES 55–62.—Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 55, *H. columbata*, new species; 56, *H. saltator*, new species; 57, *H. proclinata* Cresson; 58, *H. agitator*, new species; 59, *H. cessator*, new species; 60, *H. definita* Cresson; 61, *H. pulla* Cresson; 62, *H. flavicoxalis* Cresson.



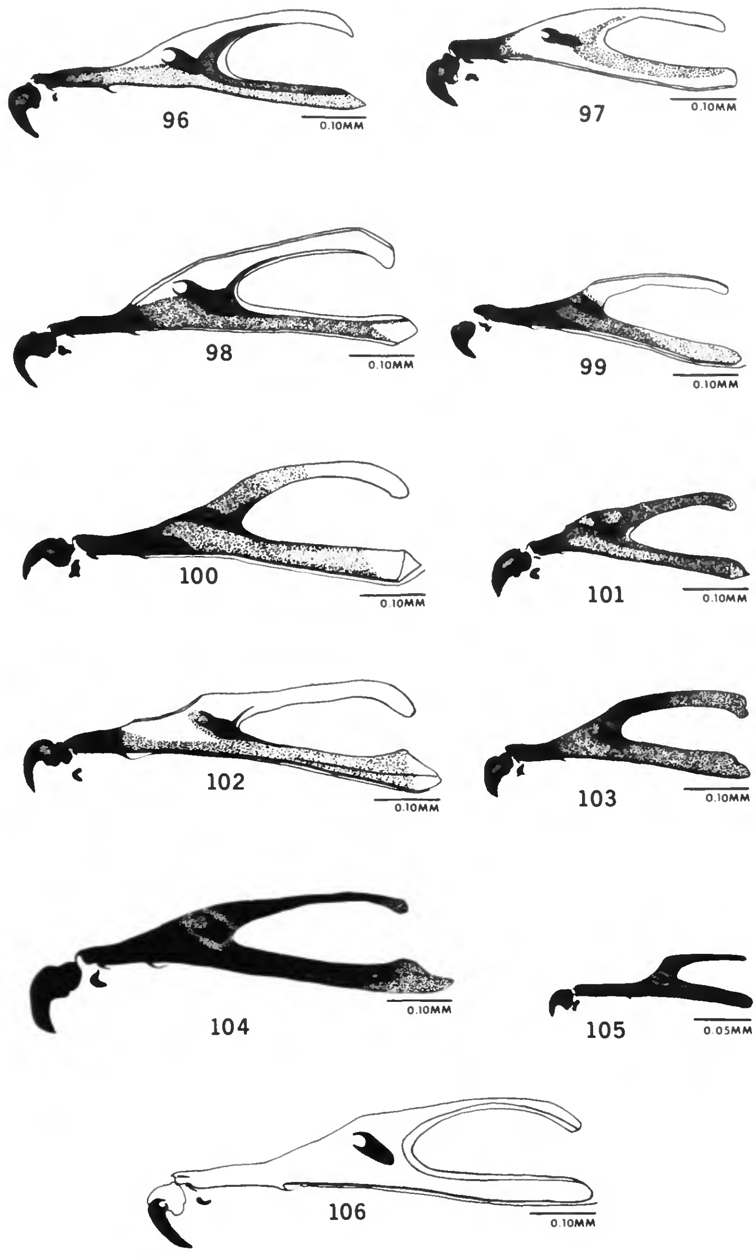
FIGURES 63–72.—63–66, Male terminalia of adult *Hydrellia* species (ventral view of left half unless otherwise specified): 63, *H. cruralis* Coquillett; 64, *H. luctuosa* Cresson; 65, *H. notiphiloides* Cresson; 66, *H. penicilli* Cresson. 67–72, Female terminalia of adult *Hydrellia* species (lateral view of left side): 67, *H. ascita* Cresson; 68, *H. trichaeta* Cresson; 69, *H. harti* Cresson; 70, *H. discursa*, new species; 71, *H. gladiator*, new species; 72, *H. bilobifera* Cresson.



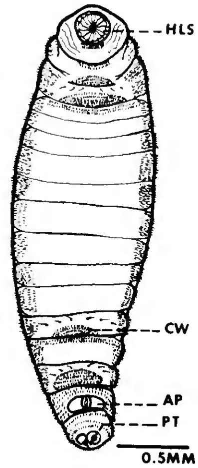
FIGURES 73–83.—73, *Hydrellia bilobifera* Cresson: egg chorion, parasagittal section. 74, *H. bergi* Cresson: egg, lateral view. 75, *H. bilobifera* Cresson: egg, dorsal view. 76, *H. ischiaca* Loew: egg, ventral view. 77, *H. discursa,* new species: egg, dorsal view. 78, *H. spinicornis* Cresson: egg, dorsal view, shading indicates numerous punctulae or pits. 79, *H. spinicornis* Cresson: posterior part of abdominal segment 8 and tracheospiracular siphon of second-instar larva, dorsal view. 80 *H. discursa,* new species: abdominal segment 8 and spiracular peritreme of first-instar larva, lateral view of left side. 81, *H. biloxiae,* new species: anterior part of third-instar larva, lateral view of left side. 82, *H. ischiaca* Loew: posterior part of abdominal segment 8 and tracheospiracular siphon of second-instar larva, dorsal view. 83, *H. ainsworthi,* new species: left spiracular peritreme and ramus of third-instar larva, lateral view.



FIGURES 84–95.—Feeding apparatus of larval *Hydrellia* (third-instar and lateral view unless otherwise specified): 84, *H. notiphiloides* Cresson: dorsal view; 85, *H. bilobifera* Cresson; 86, *H. ascita* Cresson; 87, *H. tibialis* Cresson: mouth-hook, lateral view; 88, *H. trichaeta* Cresson; 89, *H. bergi;* 90, *H. ainsworthi,* new species: second instar; 91, *H. bilobifera* Cresson; 92, *H. luctuosa* Cresson; 93, *H. spinicornis* Cresson: second instar; 94, *H. deceptor,* new species; 95, *H. notiphiloides* Cresson.



FIGURES 96–106.—Feeding apparatus of larval *Hydrellia* (third instar and lateral view unless otherwise specified): 96, *H. cruralis* Coquillett; 97, *H. discursa*, new species; 98, *H. caliginosa* Cresson; 99, *H. ainsworthi*, new species; 100, *H. ischiaca* Loew; 101, *H. biloxiae*, new species; 102, *H. itascae*, new species; 103, *H. spinicornis* Cresson; 104, *H. morrisoni* Cresson; 105, *H. spinicornis* Cresson: first instar; 106, *H. pulla* Cresson.



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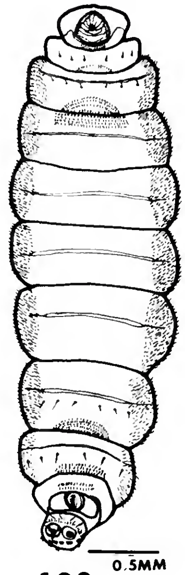

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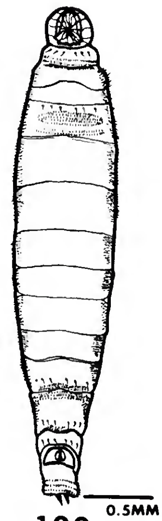

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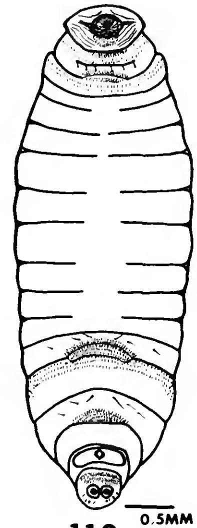

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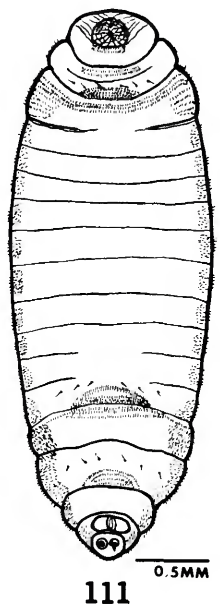

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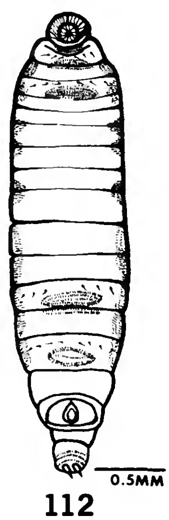

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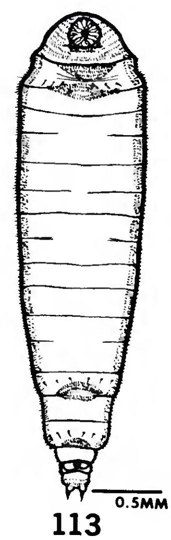

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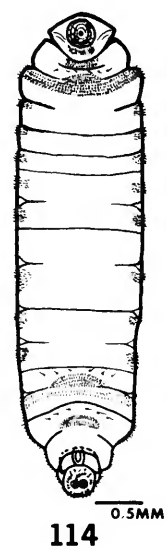
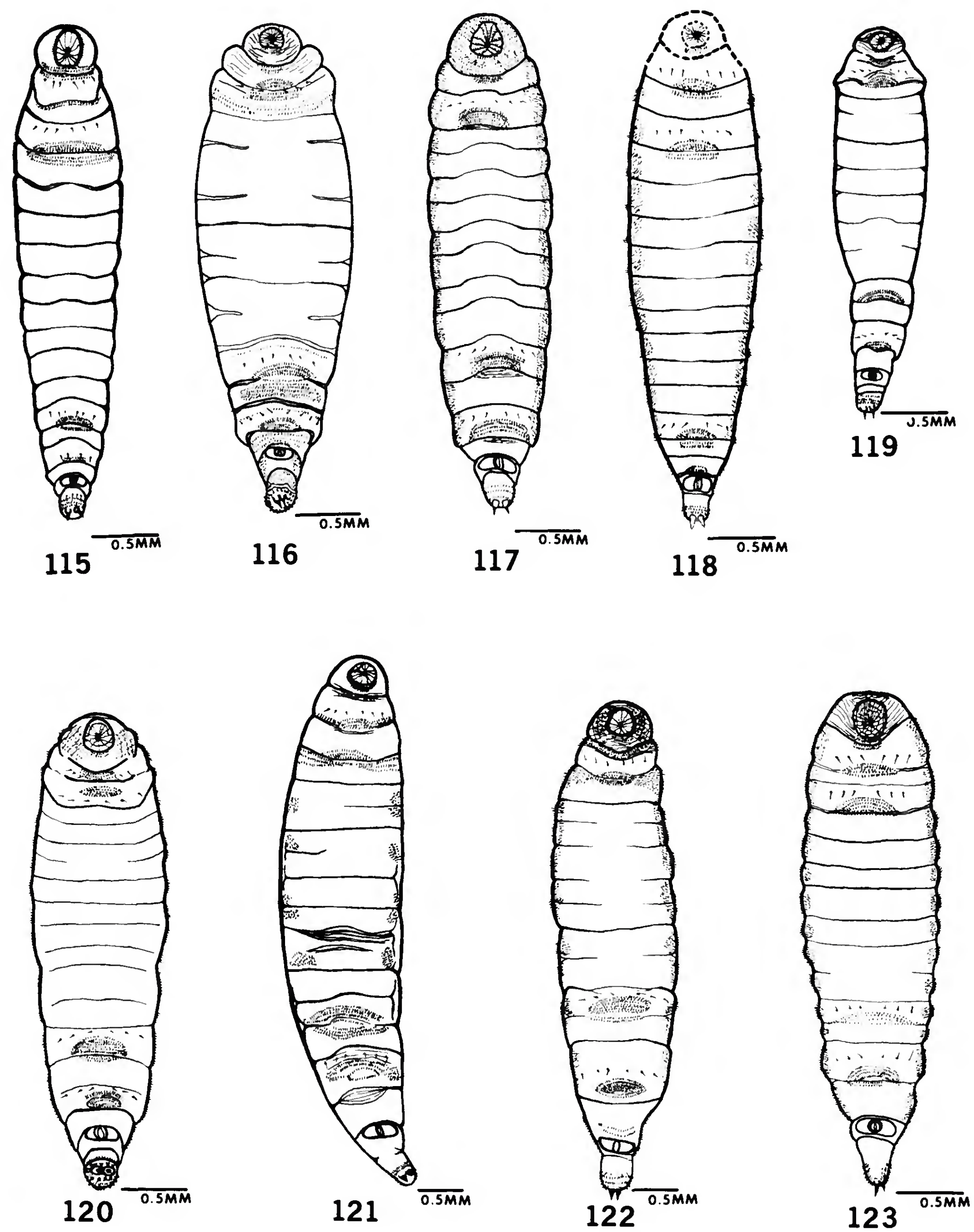
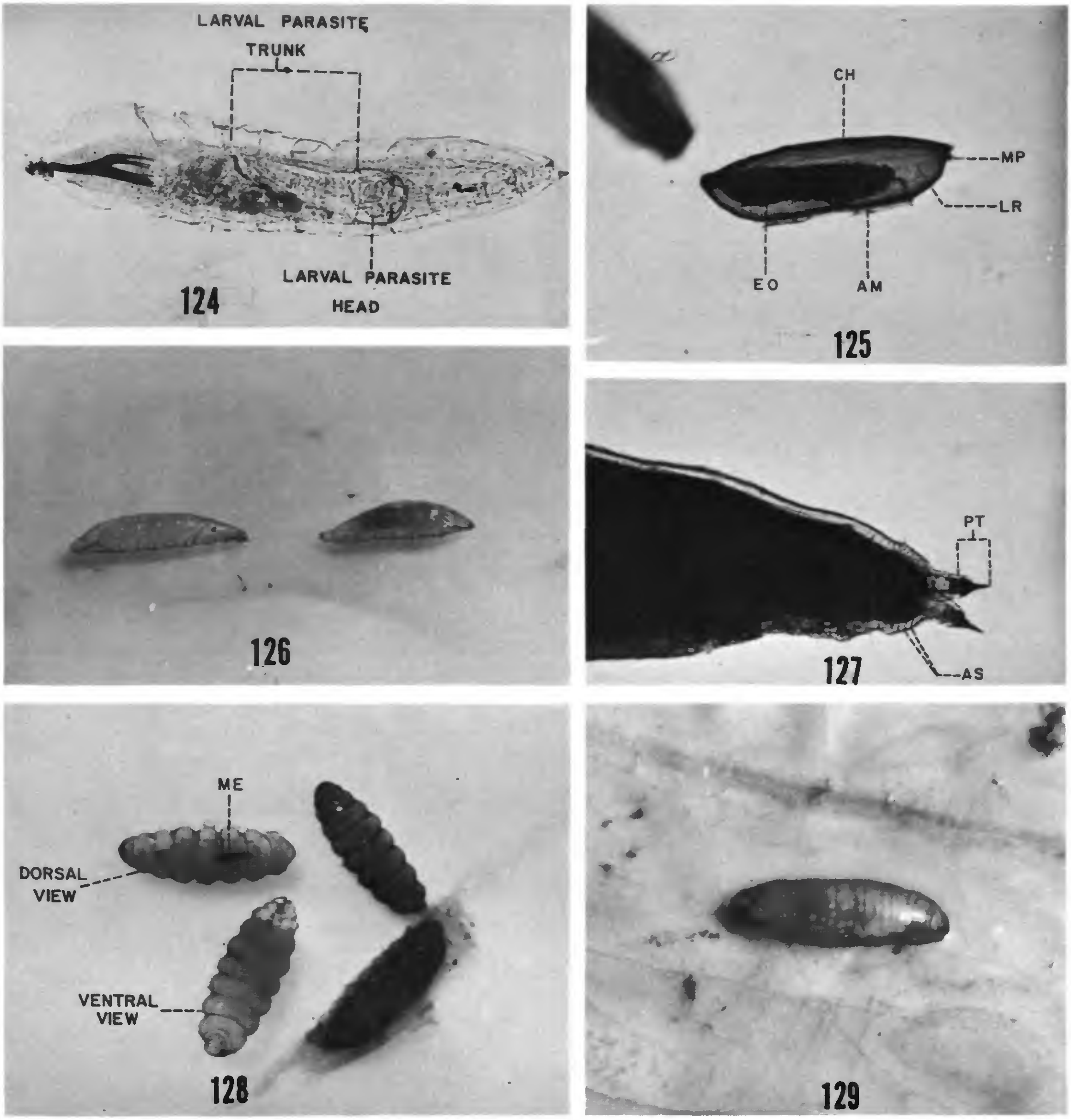


114

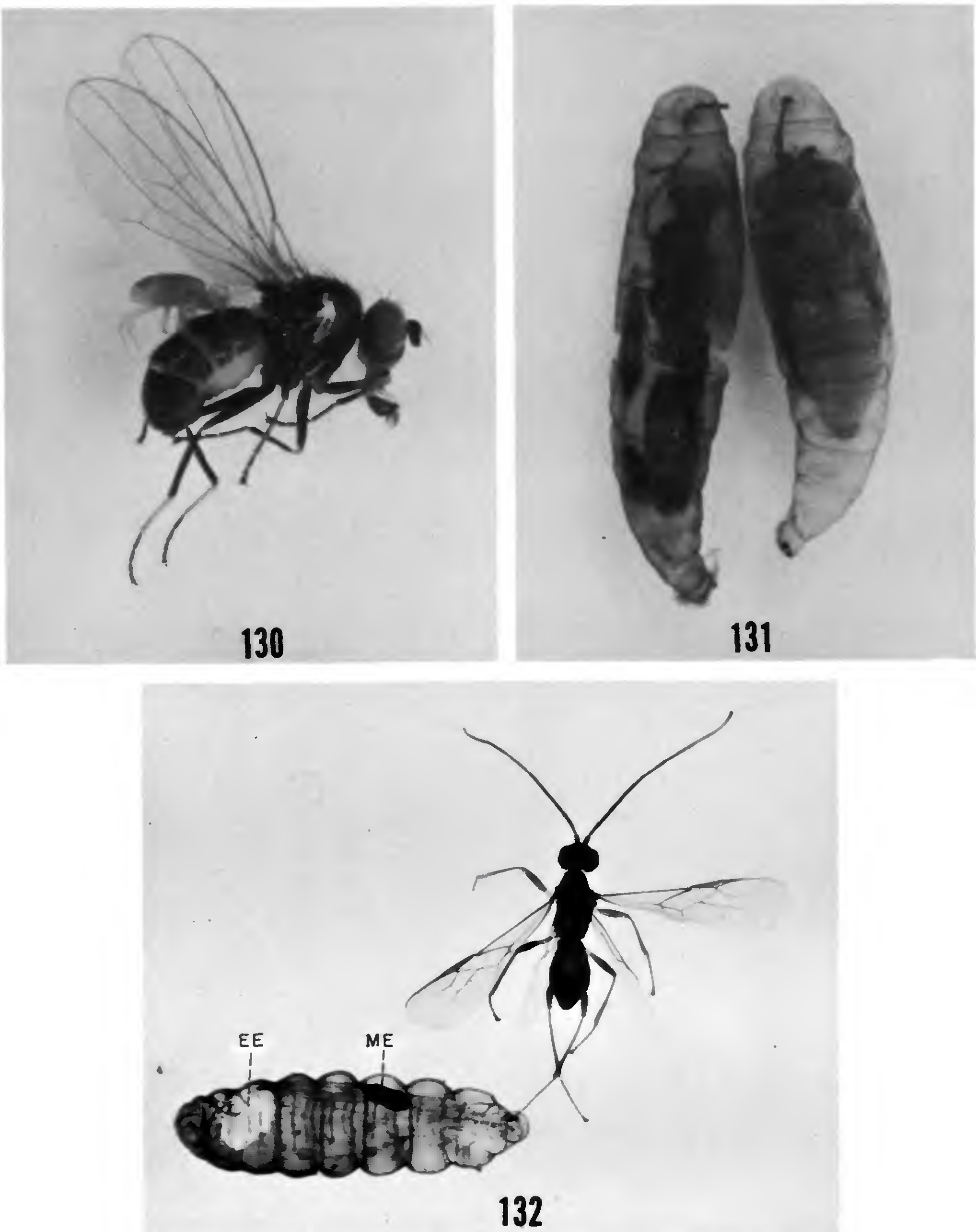
FIGURES 107–114.—Puparia of *Hydrellia* (ventral view; setae and creeping welts on middle part omitted): 107, *H. luctuosa* Cresson; 108, *H. cruralis* Coquillett; 109, *H. bilobifera* Cresson; 110, *H. itascae,* new species; 111, *H. caliginosa* Cresson; 112, *H. ascita* Cresson; 113, *H. discursa,* new species; 114, *H. pulla* Cresson.



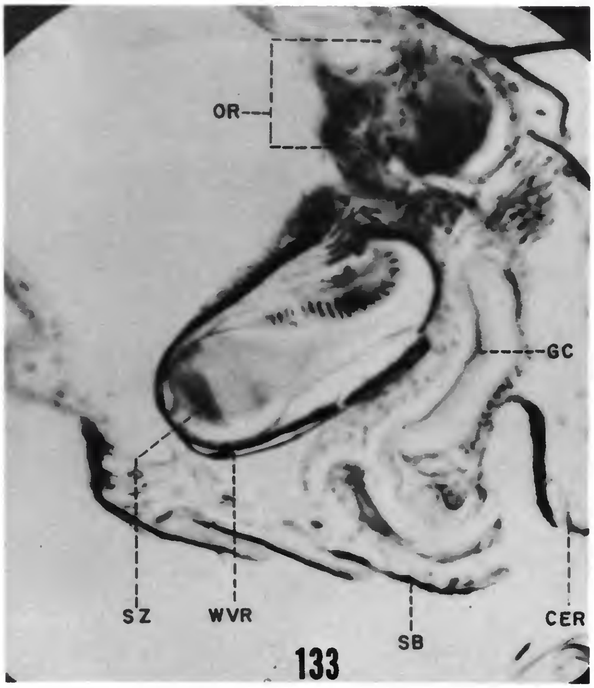
FIGURES 115–123.—Puparia of *Hydrellia* (ventral view; setae and creeping welts on middle part omitted): 115, *H. trichaeta* Cresson; 116 *H. notiphiloides* Cresson; 117, *H. spinicornis* Cresson; 118, *H. tibialis* Cresson; 119, *H. biloxiae*, new species; 120, *H. ainsworthi*, new species; 121, *H. morrisoni* Cresson; 122, *H. ischiaca* Loew; 123, *H. bergi* Cresson.



FIGURES 124–129.—124, *Hydrellia spinicornis* Cresson: late second-instar larva with opiine Hymenoptera parasite, lateral view (× 16). 125, *H. discursa*, new species: egg, lateral view (× 48). 126, *H. griseola* (Fallén) and *H. ischiaca* Loew: left puparium with early pupa of *H. griseola;* right one with late pupa of *H. ischiaca*, lateral view (× 4). 127, *H. discursa*, new species: posterior third of third-instar larva, ventrolateral view (× 17). 128, *H. cruralis* Coquillett: puparia on left void, two on right with hymenopterous parasites, dorsal and ventral views (× 4.5). 129, *H. itascae*, new species: puparium in situ in submergent *Potamogeton* leaf, dorsal view (× 5.2).



FIGURES 130–132.—130, *Hydrellia griseola* (Fallén): male with mite parasite, right lateral view (× 8.2). 131, *H. ischiaca* Loew: puparia, left one with braconid Hymenoptera parasite, right one with pharate adult fly, dorsal view (× 9.5). 132, *H. cruralis* Coquillett: puparium, ventral view, and emerged adult hymenopterous parasite, dorsal view (× 6.2; photograph from slide borrowed from C. O. Berg).



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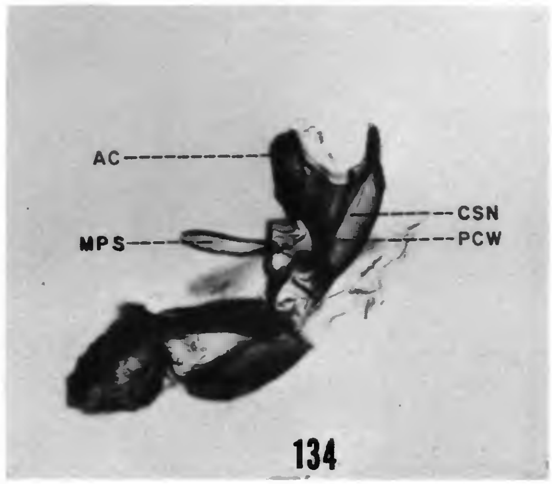

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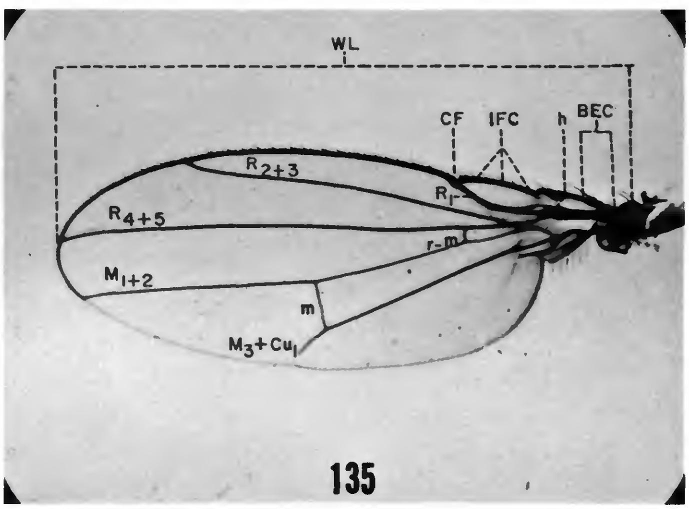
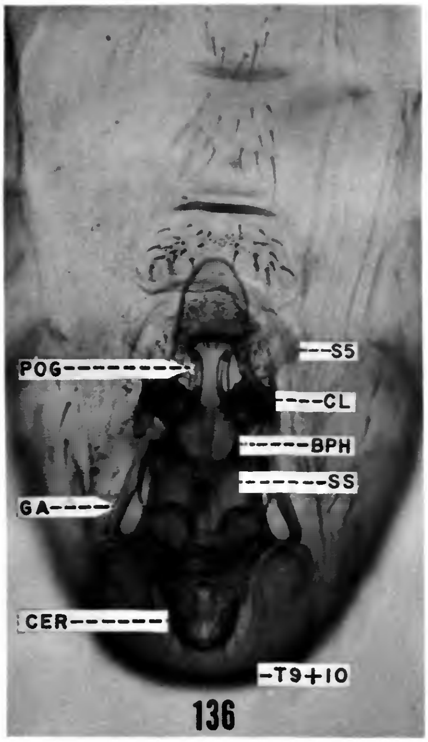
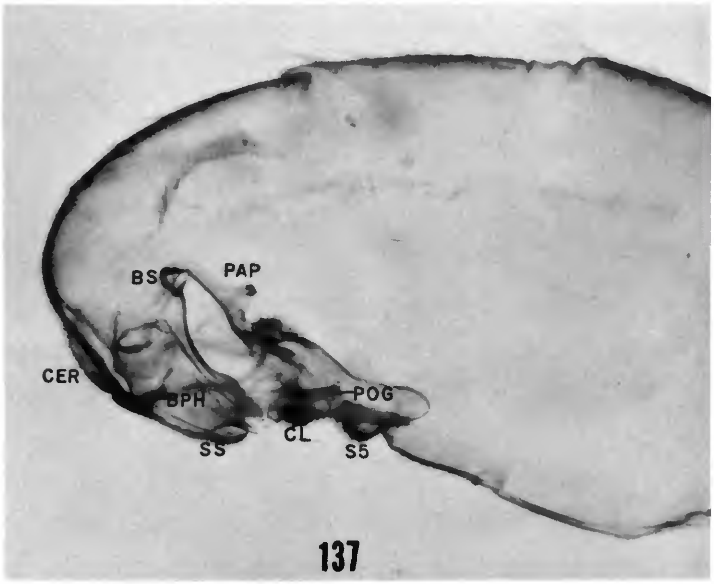
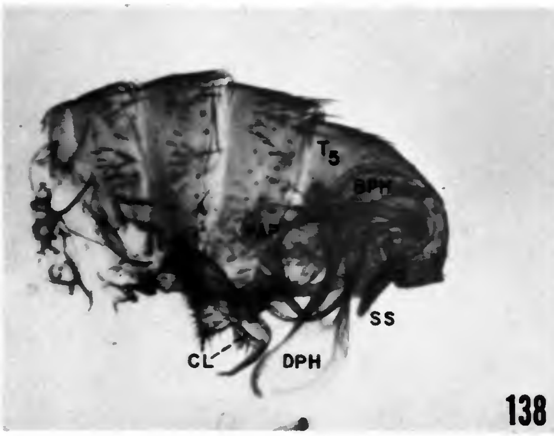


135

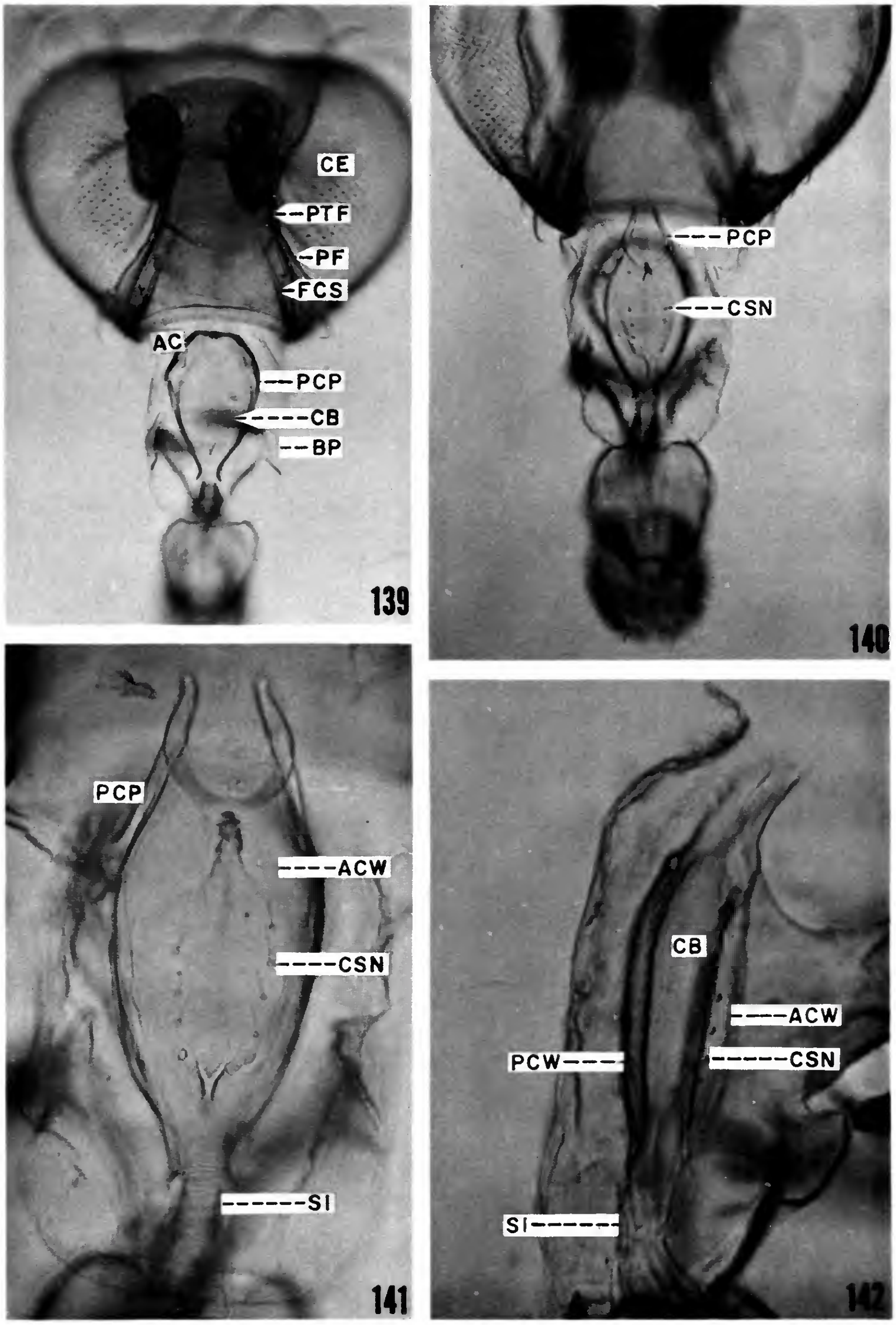
FIGURES 133–135.—133, *Hydrellia griseola* (Fallén): female internal genitalia, left view of parasagittal section (× 17). 134, *H. griseola* (Fallén), male: proboscis, uncleared, left lateral view (× 54). 135, *H. griseola* (Fallén), female: left wing, dorsal view (× 18.7).







FIGURES 136–138.—136, *Hydrellia griseola* (Fallén), male: abdomen, ventral view (× 34). 137, *H. griseola* (Fallén), male: abdomen, left lateral view (× 34). 138, *H. bilobifera* Cresson, male: abdomen, left lateral view (× 36.5), phallus partly depressed.



FIGURES 139–142.—139, *Hydrellia griseola* (Fallén), male: head, front view (× 32). 140, *H. griseola* (Fallén), male: cibarium of probosis, front view (× 32). 141, *H. griseola* (Fallén), male: cibarium, posterior view (× 80). 142, *H. griseola* (Fallén), male: cibarium, right lateral view (× 80).

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