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A REVISION OF THE NEARCTIC SPECIES OF HYDRELLIA (DIPTERA: EPHYDRIDAE)

by

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INTRODUCTION AND LITERATURE REVIEW

Introduction

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

At least two species of Hydrellia, H. griseola and H. ischiaca, are economically important. In 1953, H. griseola destroyed 10 to 20 per cent 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. Lilljeborg reported the fairly widespread damage of barley, oats, and timothy grass by H. griseola in southern and southeastern Sweden, during the summer of 1860. After this, several authors reported outbreaks of H. griseola in various places in the Palaeartic Region including Egypt. Balachowsky and Mesnil (1935) reported 50 per cent 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 182 available specific names in Hydrellia other than my designations. Of these, perhaps 130 have existing holotypes and 132 have Palaearctic type localities. Possibly 110 of the available names are valid. These 110 species are distributed as follows: 52 Palaearctic, 35 Nearctic, 1 Holarctic, 2 Oriental, 12 Australian, 2 Ethiopian, and 7 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 in the summer of 1961, 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.

Literature Review

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. 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 done until 1915, when Cresson started describing new species. Johannsen (1935) reviewed and presented a key to the known immature instars of Nearctic species. Hennig (1943) 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 (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 life-cycle stages of *H. griseola*; Deonier (1964) wrote a key 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.

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.

In the Australian Region, Coquillett (1903), Tonnoir and Malloch (1926), Cresson (1948) and Harrison (1959) published on some or all of the 12 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 Kuwayana (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_.

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 Trägårdh (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 precisely 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*.

Although many authors contributed ecological data on *Hydrellia*, the following authors 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 on species of *Hydrellia* in the Palaearctic Region.

METHODS AND MATERIALS

Adults

Collecting

When inspecting a locality, I first looked for *Hydrellia* adults on the vegetation. I collected them by two methods during the first two years of the project. If they were on emergent vegetation, I collected them by sweeping with a standard aerial insect net. If they were on pleustonic plants, I waded among these and collected the adults by rapidly lowering a killing tube over them. When the tube was lowered over them, the adults nearly always flew up or crawled into it far enough for me to raise the tube sufficiently to stopper it. Occasionally I used my hand or the top of one of my hip boots to close the tube. I had to keep the tube nearly vertical while lifting it from the leaf, for if I tilted the inverted tube as much as 15-20 degrees, the flies often escaped. After their immobilization, I quickly transferred them to another killing tube labelled with locality and microhabitat, i.e., the leaves of *Nuphar advena*, *Potamogeton natans*, etc. By repeating this entire capture sequence as rapidly as possible, I often collected 50-75 adults per hour. Whereas, by sweeping emergent vegetation for species preferring that kind of microhabitat, I frequently collected 50-75 per minute and occasionally 200-300 per minute for a short interval.

The tube-capture method just described is obviously very slow, but because of the biomes worked in during 1961 and 1962, I did not discover a faster, and in some ways better, method of collecting Hydrellia from floating leaves until the summer of 1963. At that time, while observing nocturnal behavior of Hydrellia adults, I discovered what may be called the lighted-receptacle method of collecting the adults. Essentially, I inserted an open 3-ounce collecting 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 sufficient accumulation of adults in the jar, I replaced it with another jar.

When collecting adults solely for dissection purposes, I often used an aerial net by swinging it forcefully against a floating leaf harboring many Hydrellia adults. By forcing the net through the water and out again, I netted nearly all of the adults on such leaves. I killed and preserved these adults in 70 per cent ethanol.

As a census method for adults, I used a device invented and described by Grigarick (1959). As modified for this project, it 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 approximately 1.25 cm in diameter bored through each corner of the styrofoam float accommodated dowels, or rods, approximately 0.82 cm in diameter that were run vertically through them and into the bottom substrate to provide anchorage. A detergent solution in the pan constituted the actual trap mechanism. The effectiveness of this Grigarick floating trap depended upon the intensity, concentration, and durability of the detergent, or surfactant, added to the water in the floating pan. This detergent destroyed the effectiveness of the fly's tarsal hydrofuge setae, but more importantly, it reduced the surface tension below the force required to support the fly's mass. Consequently, the fly sank immediately upon landing on this solution.

Additionally, I modified the device by using deeper pans where wave action created a need for them, by omitting the central depression in the pan bottom and the roof shelter, and by painting the exposed surfaces of float and pan a dark green. I constructed and used 20 of these modified Grigarick floating traps. By using styrofoam, the trap weight was reduced so that I could readily transport all of them by hand or canoe. Sometimes, I saturated certain sites with these traps to obtain an approximate specific density of the Hydrellia adults.

Excepting numerous accidents, e.g., aquatic animals landing on or walking over the traps, floods washing them away, people disturbing or destroying them, etc., the Grigarick floating insect trap seemed to be one of the best stationary devices for sampling neustonic insects. I caught specimens of Donaciinae, Gerridae, Veliidae, Mesoveliidae, Hydrometridae, Hydrophilidae, Tridactylidae, Collembola, Hymenoptera, Odonata, and species of several dipterous families including several ephydrid species other than those of *Hydrellia* in these traps. Perhaps the trap's utilization could be broadened by sloping the pan bottom centripetally, cutting a hole about 7.5 cm in diameter in the central depression, and soldering a shallow funnel and threaded jar ring to the outer circumference of this hole for fitting a collecting jar. With this modification, the trapped insects would slide through the funnel into the collecting jar.

There was insufficient time to test other methods of collecting *Hydrellia* adults, but since I found a few adults in scattered light-trap collections and since the lighted-receptacle method worked satisfactorily, I think a battery-powered floating light trap could be devised for sampling neustonic insects. However, one disadvantage of all such light-trap samples is the loss of exact microhabitat data. This disadvantage seemed to be less using the lighted-receptacle method because I directed the light to one small surface area and simultaneously shaded the sides of the jar to prevent diffusion. Despite these precautions, I know that several specimens flew to the illuminated leaf and thence to the jar from distant leaves.

Behavioral observation

I made most of my behavioral observations while collecting. I observed the behavior of the individual, captured it, labelled it with locality, microhabitat (immediate substrate), date, and a code designation, and recorded in detail the behavior under its code. Depending upon several factors, one being the type of behavior, e.g. epigamic, gamic, feeding, etc., I used either a killing tube or a live-capture tube. I tried to keep captured adults alive long enough in the laboratory to make additional observations or long enough for inseminated females to oviposit. Frequently, such attempts were unsuccessful. After observing specimens preying upon *Hydrellia* adults or *Hydrellia* adults preying upon other specimens, congeneric or otherwise, and interactions between *Hydrellia* and associates of other genera, I always used a killing tube for capture so determinations would be insured.

Preparation

For taxonomic preparation of adults, I used point-mounting. I attached the point to the right thoracic pleuron with Shawinigan's Gelva Resin glue. Before adhering the fly to the point, I adjusted the orientation of the legs and wings with forceps and micropin (minute nadel). I flipped, or raised the wings of the majority to a vertical attitude away from the pleura. With the wings in this attitude, I could mount the specimens faster, I could see readily more of each mounted specimen including the wing veins. The raised wings obscured the supra-alar area and the postalar bridge. I left the wings down on some specimens so I could see clearly these two areas. I could only elevate the wings of freshly killed specimens, i.e., specimens killed and kept in a tightly closed moist metal pill box for no longer than 8-12 hours. To elevate the wings, I placed the specimen venter up under a stereomicroscope and very gently compressed the thorax at both pleural wing processes with fine forceps. The resulting muscular displacement apparently raised the wings.

I killed and preserved in 70 per cent ethanol only 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.

In preparing terminalia for microscopic study, I first relaxed the mounted specimen in a relaxing chamber. Then, after placing the specimen in a museum unit tray and dipping the tips of the cutting forceps in glycerol, I cut off the posterior part of the abdomen. The film of glycerol on the forceps and the surrounding unit tray reduced losses of terminalia from air currents.

To clear the terminalia, I placed them in a hot 10 per cent solution of potassium hydroxide for 2 minutes and then added two to ten drops of 30 per cent hydrogen peroxide over and around the terminalia as they floated on the surface of the hot caustic. 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 somewhat with the species of Hydrellia and the condition of the specimen. The average was about 0.5 minute. If the terminalia were not quickly removed after the critical time limit, they were often overcleared to an unusable condition. The terminalia had to be transferred quickly to distilled water and left there for about 1 minute before being passed through glacial acetic acid, distilled water, and absolute ethanol. I transferred the terminalia to a small quantity of glycerol in a depression slide for microscopic study. I used hot potassium hydroxide and hydrogen peroxide for clearing the terminalia of Hydrellia only after testing the conventional methods and finding them unsatisfactory for Hydrellia. Cold potassium hydroxide did not give satisfactory clearing in five days. Hot potassium hydroxide cleared terminalia after 1-2 hours, but with this amount of exposure to hot caustic, the conjunctivae disintegrated rendering the preparation all but useless. The method adopted gave preparations very similar to those in other insect groups for which hot potassium hydroxide was used.

I used an ocular grid and squared paper to draw to scale the terminalia and other adult structures. Except for the structures that required a bilateral, or whole view for proper interpretation, I showed 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.

Immatures

Collecting

In collecting the immature stages of Hydrellia, I first searched for eggs on or near potential host plants in the habitats of the adults. If I discovered eggs, I placed the entire plant, when this was feasible, into a plastic bag containing only a small quantity of water. After searching for eggs, I sampled the potential host plants in the locality for larvae and puparia. This was a random process, for, except for the puparia of several species, searching for larvae *in situ* can be accomplished better in the laboratory with strong direct illumination and a stereomicroscope. If I thought I would be unable to revisit the site, I collected very large samples of the potential host plants. Many times, this amounted to filling 12 to 15 6-liter plastic bags with plants. Sometimes also, the samples consisted of 15 species from one site (occasionally nearly the entire composition of the littoral flora).

When there was reason to concentrate on a single host-plant species, e.g., *Zizania aquatica* or *Glyceria grandis*, I used a canoe to transport several kilograms of the plants. In sampling some submergents and emergents in depths greater than 1.3 meters, I used a pike pole or employed a scuba diver. In studying the overwintering of Hydrellia, I used a large ice chisel to cut through the ice to obtain samples of some host plants.

In the laboratory, I examined the leaves, stems, stolons, and rhizomes of each plant of the samples for the presence of immature Hydrellia by holding them before a strong illuminator. When there was evidence of mining, but no larvae apparent, I examined the area of tissue with a stereomicroscope. When I discovered an immature specimen, I removed the leaf or other plant part on or in which it was situated and placed it in a small culture dish containing tap water. I kept the pertinent data with each isolated specimen and also entered them in a record book.

Rearing and behavioral observations

I isolated puparia in 75-ml test tubes by placing the plant part so the puparium was slightly above the tap water in each tube and then loosely plugging the tube with cotton.

Daily I observed and recorded behavior (larval eclosion, moulting, and ecdysis, mining activity, pupariation, adult, emergence, etc.) and associated morphological changes. During these microscopic examinations, I would occasionally find a first or second-instar larvae previously undetected. I isolated such specimens if I could distinguish between them and the originals. When such distinction was impossible, I appended a note of this condition to the isolation label and record. This difficulty in detecting first- and second-instar larvae existed because of their small size, translucency, and the depth and length of the mine. Because of this difficulty, I kept all examined plant material, except tall emergents, in screen-covered aquaria containing a sufficient amount of water. I kept tall emergents in open aquaria or other suitable containers. I examined all of this plant material periodically for two weeks for immature *Hydrellia*. I prepared voucher specimens of each 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*.

Since temperature control was usually unavailable for the rearing laboratory, I could only attempt to record the temperature of the rearing and holding water. During the summer of 1963, at the University of Minnesota Biological Station, Lake Itasca, I used a circular thermograph with the sensor element suspended 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

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 that I allowed all to develop to the adult instar.

I preserved some Hydrellia eggs in 70 per cent ethanol and some between filter-paper strips moistened with AFA and placed in small shell vials (about 5-ml capacity). When I had plugged the vials with cotton, I immersed them in either ethanol or AFA in museum jars. I preserved the larvae by the same method, after killing them in hot water. To insure good specimens for anatomical and food-habits studies, I used AFA. It had the one deleterious effect of bleaching and diffusing the chlorophylls and carotenoids in the larval gut contents.

For stereomicroscopic study, I placed larvae in 70 per cent 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 mounted 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 absent in permanent glass-slide mounts, and 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 only necessary 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 immature structures 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.

In converting measurements of most larvae and puparia from microscope ocular units to millimeters, I rounded off the second digit to the right of the decimal point and therefore one should not regard this digit as significant.

MORPHOLOGY

Definitions and Explanations of Taxonomic Terms

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.

Adult

A-index: the quotient of the subcranial breadth divided by the anteclypeal breadth. Fig. 10.

Anteclypeal breadth: the maximum transverse distance between the outer edges of the paraclypeal phragmata of the anteclypeus. Fig. 10.

Predorsocentral (adc): a seta inserted in the dorsocentral line anterior to the transverse sulcus. Fig. 8.

Anteocellar distance: the distance between the anterior margin of the median ocellus and the upper edge of the ptilinal fissure along the frontal midline. Fig. 10.

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

Apicodorsal antennal: a spinous seta on the dorsal apex of antennal segment 2.

Aristal rays: all of the trichoid projections of each arista including the apical one. Fig. 1.

B-index: the quotient of the maximum anteroposterior extent of the valvulae laterales divided by the length of the cercus as measured in ventral view. Fig. 6.

Basal coxal: a seta inserted laterally on the mid coxa. Fig. 8.

Basal end of the costa: the enlarged basal portion of the costa proper adjacent to the humeral plate. Fig. 123.

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 longitudinally.

C-index: the quotient of the midline anteroposterior extent of sternum 5 divided by the projected length of the postgonital 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: one of a pair of posterior lobes, or projections, of male sternum 5. Fig. 6.

Costal section I: the distance between the distal edges of crossvein h and R_1 apex. Fig. 123.

Costal section II: the distance between the distal edges of R_1 and R_{2+3} apices. Fig. 123.

Costal section III: the distance between the distal edges of R_{2+3} and R_{4+5} apices. Fig. 123.

Costal section IV: the distance between the distal edges of R_{4+5} and M_{1+2} apices. Fig. 123.

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

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. Fig. 1.

Epistomal index: the quotient of the epistomal breadth divided by the minimum interocullar distance.

Frontal vitta: the median quadrangular area of the frons on which are situated the ocellar triangle and the ocellar and postocellar setae. Fig. 10.

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. Fig. 1.

Interfissural costal: a seta inserted on the costa between the two costal fissures. Fig. 123.

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. Fig. 123.

Mesofacial height: the distance between the outer edge of the subcranial cavity and the lower edge of the ptilinal fissure along the midline of the face. Fig. 10.

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

Minimum interocular distance: the minimum transverse distance between the compound eyes in the area of the face. Fig. 1.

Ocular index: the quotient of the nearly vertical ocular height divided by the subocular height. Fig. 12.

Parafrontale: the region of the frons between the frontal vitta and the upper edge of the compound eye. Fig. 10.

Postdorsocentral (pdc): a seta inserted in the dorsocentral line posterior to the transverse sulcus. Fig. 8.

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

Postgonite: 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. Fig. 4, 6, 9.

Postgonital uncus: the apical section of the postgonite which is often hooklike or clawlike and usually distinctly more heavily sclerotized than the remainder of the postgonite. Fig. 4, 9.

Postocular: one of the setae inserted in a row posterior to and more or less parallel with the posterior edge of each compound eye.

Pregonite: 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. Fig. 4, 6, 9.

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. Fig. 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: the maximum transverse distance between the outer lateral edges of the subcranial cavity. Fig. 10.

Subocular height: the minimum distance between the lower edge of each compound eye and the outer lateral edge of the subcranial cavity. Fig. 12.

Vertex breadth: the distance between the upper edges of the compound eyes at the level of the lateral ocelli. Fig. 10.

Vertex index: the quotient of the vertex breadth divided by the anteocellar distance. Fig. 10.

Vertical ocular height: the maximum distance between the upper and lower edges of the compound eye. The line of measurement is not quite vertical in most species. Fig. 12.

Wing length: the distance between the apex of the tegula and the wing tip. Fig. 123.

Immatures

Anal-plate index: the quotient of the transverse extent of the anal plate divided by the midline anteroposterior extent of the anal plate. Fig. 104.

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. Fig. 84.

Clypeal arch: the area of inclination in the frontoclypeus just anterior to the cheliform spot. Fig. 84.

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. Fig 84.

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.

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. Fig. 81, 84.

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. Fig. 135.

Maximum egg breadth: the maximum transverse extent of the egg as measured in dorsal view. Fig. 72-75.

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. Fig. 84.

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. Fig. 84.

Minimum puparial breadth: the minimum transverse extent of abdominal segment 8 as measured in dorsal view anterior to the tracheospiracular siphon. Fig. 104.

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. Fig. 84.

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. Fig. 104.

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. Fig. 84.

Adult

External morphology

Head There are several controversies concerning the morphology of the schizophoran head. The major one of these is centered on the clypeus and frons. Snodgrass (1935, p. 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 fulcrum 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 (1944, p. 70), Snodgrass withdrew 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, Snodgrass 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 in the evolution of the schizophoran head capsule.

Frick (1952) and Downes (1958) showed some evidence of the epistomal sulcus in Agromyzidae and Sarcophagidae respectively. Frick (1952) labelled 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 Fig. 1, 10, 122, 123, 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 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) labelled the facial areas between the extensions of the ptilinal fissure and the epistomal sulcus as facial ridges, while for some reason, Frick (1952) labelled 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 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 Fig. 1-4, p. 189-190 of Bonhag's (1951) paper. 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 (Fig. 1, 121). 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 (Fig. 1, 121). 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 (Fig. 12). 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 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 is often 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 (Fig. 1, 121). In the basiproboscis, the conjunctiva encloses the cibarium, the paraclypeal phragmata, and the stipes. Only the anteclypeus, or fulcrum, and the maxillary palpi are exposed. 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 ventral, or anterior, end of the cibarium and a biseriate row running dorsolaterally from each of these initial clusters to the end of the anteclypeus (Fig. 1, 121, 122). 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 specifically 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 each biseriate row.

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. 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 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 (Fig. 8). 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, 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, mesocutum, mesoscutellum, and the 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 (Fig. 8), 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 <u>Tabanus</u>. 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 <u>Hydrellia</u> 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 as 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 mesepimeral 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 none from this view.

Of the metathorax only thoracic phragma 2, the greatly narrowed metapleura, the halteres, and the hind legs remain distinct (Fig. 8). 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 (Fig. 123). The halter has three apparent divisions, the knoblike capitellum, the pedicel, and the basal scabellum.

My thoracic chaetotaxic 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 the 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 fissures, 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 fissures, the anterior and the dorsal interfissural costals, are of main taxonomic importance (Fig. 123).

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, the postabdomen. The male sternum 5 must also be considered part of the terminalia (Fig. 5, 6) 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 (Fig. 6). 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) seemed to support this course.

I have illustrated the male postabdomen in Fig. 4-7, 9, 125-127. 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 valvulae laterales 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) called the valvulae laterales the surstyli, while Dahl (1959) called them 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 and a usually narrower, lightly sclerotized distal part. The basiphallus may be the actual phallobase and the distiphallus, the aedeagus of Snodgrass (1935, 1959).

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, usually anterior pair are considered the postgonites. The smaller, often inconspicuous pair with setose, bifurcated tips are considered the pregonites despite their usual posterior position. 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 postgonital 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

(Fig. 7). This contraction and phallapodeme movement has two effects: first, it lowers, or depresses, the phallus as a result of leverage between the superior condyle of the basiphallic socket, and second, 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 as 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 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 Fig. 2, 13, 15, 16A-D. 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 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

Gut I have illustrated most of the gut of H. griseola in Fig. 1, 3. These illustrations seemed to apply fairly well for H. tibialis, H. bilobifera, H. harti, and H. columbata as well. 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 eight 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 Fig. 3 may actually represent the peritrophic membrane.

Internal genitalia The internal genitalia of *H. bilobifera* illustrated in Fig. 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 an apparent common 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 did not locate the gonopore, but as Snodgrass (1935) inferred, it probably opens into an endophallus, the external opening of which is the apical phallotreme.

The internal female genitalia (Fig. 2, 128) 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 occyte, 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 extensive 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.

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 (Fig. 72, 74, 75). In lateral view, their shape is often boatlike, with the ends upcurved almost symmetrically (Fig. 70, 71, 136). 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 valve or are simply incidental follicular impressions. It is possible that they serve as egg guides to maintain some necessary orientation of the egg in the common oviduct and genital chamber. 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 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 Fig. 134, 135, and measures 1.00-1.80 by 0.18-0.25 mm. I have illustrated the changes in the feeding apparatus in Fig. 89, 100, 101 for the three mobile larval instars of _H. spinicornis_ Cresson. The conspicuous differences are in size, color, and clypeal arch contour. In Fig. 78, 81, 84, I have illustrated the morphological nomenclature of the feeding apparatus, or the so-called cephalopharyngeal skeleton. I synthesized 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 mouth-hooks 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 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, especially rotatability, of the feeding apparatus. The selecting factor or at least the factor compatible with this anatomical modification has been leaf mining. Metapneustism 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 so the whole body would not have to be rotated in feeding and thus interfere with the position of the spiracular peritremes in a suitably oxygenated area of the plant tissue. Much of the rotatability increase has been in the fusion of the two mouth-hooks and of the sclerites of the paraclypeal phragmata and in overall compression of the feeding mechanism. All of these modifications have enabled the larva to rotate the feeding apparatus 90° 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) proved 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 involved with the mouth-hook depressor apodeme in depression.

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 Fig. 78, 81, 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. Developmentally, the caudal tracheospiracular siphon changes considerably between the first two larval instars of several species at least. I have illustrated (Fig. 77) 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 Fig. 76 is of a different species than Fig. 77, it is representative of the change after the first moult. 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 (Fig. 76, 80, 134). In species where supraspiracular protuberances and spinous processes occur in the second-instar larvae, these are lost at the second moult.

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 Fig. 76, 80. 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 11 apparent segments and a head lobe. I have shown the head lobe bearing apparently three-segmented antennae (Fig. 78). 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) and called 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 two-segmented antennae, anterior cephalic papillae, a pair of frontal papillae, maxillary palps, and two labral lobes. Also, Nye showed definitely 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 truely 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 Fig. 104-120, 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 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 are often 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 chlorophylls and carotenoids.

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 moults, 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 5.50 by 0.60 mm to 4.00 by 1.00 mm and 6.50 by 1.20 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 (Fig. 104). 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 and 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 (Fig. 129-133). The translucency of the puparia of some species, e.g., those in Fig. 130, 131, seems to make the term tanning seem somewhat inappropriate. The puparial cuticle is sclerotized, but tanning 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 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 insects trapped in the surface film. Among these are specimens of Hydrellia (including H. 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 influence largely 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, 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. I have tabulated the known host plants, including those serving only for pupariation, in Table 1.

Hydrellia play an important role in many aquatic ecosystems, especially eutrophic ones. Lange *et al*. (1953) estimated that *H. griseola* destroyed 10 to 20 per cent of the California rice crop in 1959. At Lake Itasca, Minnesota, I found the infestation of several stands of wild rice, *Z. aquatica*, by *H. ischiaca* ranged from 33 to 89 per cent 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*, *Notiphila loewi*, 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 soil fertility, low temperatures, strong wind, extensive algal and *Lemna* mats, and excessive water depth make 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 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 per cent. He found hymenopterous parasitism low on the first host generation mining rice, but rising rapidly on succeeding generations to nearly 90 per cent 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 per cent parasitism in 132 puparia of *H. ischiaca* and 63 per cent 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 pupariation. In Fig. 135, I have photographed an opiine larva situated in the host larva. 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 Fig. 130. At emergence, it usually leaves a dark meconium in its pupal exuviae located in the puparium as in Fig. 132. I observed several escape exits cut anteroventrally in the puparium as in Fig. 133 and a few posteroventrally. 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.

I have tabulated the known hymenopterous parasites of Hydrellia in Table 2. In addition to these parasites, species of Stigmatomyces (Laboulbeniales) parasitize Hydrellia adults and larvae. This fungus 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 3 or 4 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. Eggs and immature instars are particularly susceptible to this passive dissemination. The phenomenon probably accounts for the presence of larvae in plants at depths of 3-6 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.

Behavior

Adult

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 12 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 forelegs 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 at several times during the daylight and darkness 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 minutes after emergence, when they rapidly expand. Often, they cannot fly until 25 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 per cent 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 5 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 3 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.

Larvae

Eclosion After about 2 to 6 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 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 mouth-hook and slicing the epidermis. The larvae ingest the loosened tissues. By continuing this excavation process, the first-instar larvae completely enter their mines in 2 to 2.5 hours. Third-instar larve require only about one-half of 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.

Mining larvae depend on the host plant for oxygen. According to Hering (1951), grass 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 periodically raise their spiracular peritremes above the surface film. Larvae do occasionally drown, at least in the laboratory.

Mines of first-instar larvae are often inconspicuous because of the small larvae and also perhaps because of partial plant tissue repair. As the larva grows, the mine enlarges, 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 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 8 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 is 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 midribs of *Potamogeton* leaves. This fact seems to support the hypothesis that puparia must take air from the plant, but other data seems 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 to adult and larval activities of *H. griseola*.

Adult

heat death	110°-114° F
heat paralysis	107°-110° F
dropping	104°-107° F
heat rest	98°-104° F
normal locomotion	52°- 92° F
slow walking	40°- 50° F

Larva

heat death	112°-114° F
heat paralysis	104°-111° F
agitated movement	95°-103° F

normal mining................. 50°- 90° F

quiescence.................... 36°- 50° F

In one of Grigarick's tests, 50 per cent of a sample of 12 wild adults lived 34 days at 29° F and in another one, 20 per cent 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 one is also the principal extrinsic factor affecting fecundity.

Table 1. Checklist of known host plants of Hydrellia

Species of Hydrellia	Host plant	Zoogeographic region	Major references
albiceps	Alismataceae Alisma plantago-aquatica[a]	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[a]	Nearctic	

[a]Reared from host for the first time during this study.

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
bilobifera	Potamogetonaceae *Potamogeton* *berchtoldii*[a] *gramineus*[a] *epihydrus*[a]	Nearctic	
	Najadaceae *Zannichellia* *palustris*[b]	Nearctic	
biloxiae	Juncaceae *Juncus* *repens*[a]	Nearctic	
butomi	Butomaceae *Butomus*	Palaearctic	Hendel (1926), Hering (1937, 1951, 1957)
	Gramineae	Palaearctic	Hering (1951)
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)

[b]Recorded first in this study.

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
cochleariae	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[c] epihydrus foliosus gramineus illinoensis natans nodosus praelongus[c] richardsonii[c] zosteriformis	Nearctic	Berg (1949, 1950)
deceptor	Alismataceae Sagittaria sp.[b]	Nearctic	
discursa	Potamogetonaceae Potamogeton gramineus[a]	Nearctic	
fascitibia	Potamogetonaceae Potamogeton	Palaearctic	Hering (1937, 1950, 1951)

[c]Reared from host during this study.

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
flaveola	Geraniaceae *Tropaeolum* *minus* *majus*	Palaearctic	Frost (1924) [as *Notiphila flaveola*], Marchal (1903)
	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*[b]	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)

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
griseola	Gramineae 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)
	Ergrostis	Palaearctic	Grigarick (1959)
	Festuca pratensis	Palaearctic	Grigarick (1959), Hering (1957), Wilke (1924)

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
griseola	Gramineae *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)
	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)

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
griseola	Gramineae		
	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)

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
griseola	Gramineae *Zizania aquatica*[a]	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), Hering (1957)
	Compositae *Bellis*	Palaearctic	Grigarick (1959), Hering (1937, 1957)
	Cruciferae *Nasturtium officinale*[a]	Nearctic	
	Cyperaceae *Carex*	Palearctic Nearctic	Grigarick (1959), Hendel (1926), Hering (1937, 1957), Séguy (1950)
	Cyperus	Palaearctic Nearctic	Grigarick (1959), Hendel (1926)

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
griseola	Cyperaceae *Scirpus*	Nearctic	Grigarick (1959), Lange *et al*. (1953)
	Hydrocharitaceae *Hydrocharis morsus-ranae*	Palaearctic	Grigarick (1959), Hendel (1926), Grimshaw (1925) de Meijere (1902) [all questionable]
	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)

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
griseola	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[a] Glyceria grandis[a] obtusa[a]	Nearctic	
	Potamogetonaceae Potamogeton natans[a]	Nearctic	
itascae	Potamogetonaceae Potamogeton zosteriformis[a]	Nearctic	
leucostoma	Chenopodiaceae Chenopodium album	Palaearctic	Frost (1924)
luctuosa	Potamogetonaceae Potamogeton alpinus amplifolius richardsonii natans zosteriformis[c]	Nearctic	Berg (1949, 1950)
maura	Cruciferae Nasturtium officinale	Palaearctic	Séguy (1950), Hering (1951)

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
maura	Potamogetonaceae Potamogeton perfoliatus	Palaearctic	Hering (1957), Bertrand (1954), Hering (1950)
modesta	Hydrocharitaceae Hydrocharis	Palaearctic	Keilin (1915)
	Potamogetonaceae Potamogeton natans sp.	Palaearctic	Keilin (1915), Hering (1937), Hendel (1926), Thienemann (1912)
mutata	Alismataceae Alisma plantago	Palaearctic	Hendel (1926), Hering (1937, 1957), Grünberg (1910)
	Hydrocharitaceae Stratiotes aloides	Palaearctic	Séguy (1950), Wahlgren (1947), Hering (1959)
	Hydrocharis morsus-ranae	Palaearctic	Hendel (1926), Linnaniemi (1913), Gercke (1878), Hering (1925, 1926), Grünberg (1910)
	Lemnaceae Lemna	Palaearctic	Linnaniemi (1913)
nasturtii	Cruciferae Nasturtium officinale	Palaearctic	Séguy (1950), Hering (1937), Taylor (1928), Vayssière (1933), Collin (1928), Hering (1957)
nigricans	Juncaginaceae Juncus bufonius articulatus	Palaearctic	Hering (1957)

Table 1. (Continued)

Species of Hydrellia	Host plant	Zoogeographic region	Major references
nigripes	Potamogetonaceae Potamogeton	Palaearctic	Hering (1937, 1957)
potamogeti	Potamogetonaceae Potamogeton natans drucei	Palaearctic	Hering (1937, 1957)
propinqua	Hydrocharitaceae Stratiotes aloides	Palaearctic	Wahlgren (1947), Hering (1957)
pulla	Potamogetonaceae Potamogeton amplifolius[c] gramineus richardsonii	Nearctic	Berg (1949, 1950)
ranunculi	Cruciferae Nasturtium officinale	Palaearctic	Thienemann (1912), Hendel (1926), Hering (1925), Taylor (1928)
spinicornis	Gramineae Hydrochloa caroliniensis[a]	Nearctic	
stratiotae	Hydrocharitaceae Stratiotes aloides	Palaearctic	Hering (1926, 1937, 1957), Séguy (1950), Hendel (1926)
stratiotella	Hydrocharitaceae Stratiotes aloides	Palaearctic	Hering (1957), Wahlgren (1947)
tibialis	Cyperaceae Eleocharis obtusa[a]	Nearctic	
thoracica	Gramineae Glyceria aquatica	Palaearctic Palaearctic	Hering (1926) Hering (1925)

Table 1. (Continued)

Species of *Hydrellia*	Host plant	Zoogeographic region	Major references
viridescens	Alismataceae *Alisma*	Palaearctic	Hering (1957)
	Potamogetonaceae *Potamogeton* *perfoliatus* *crispus* sp.	Palaearctic	Hering (1950, 1951, 1957)
williamsi	Lemnaceae *Lemna*	Australian	Hardy (1960)
xenophaga	Potamogetonaceae *Potamogeton*	Palaearctic	Hering (1957)
sp.	Alismataceae *Alisma*	Palaearctic	Hering (1957)
	Sagittaria *latifolia*[c]	Nearctic	
sp.	Ranunculaceae	Palaearctic	Hering (1937)
sp.	Haloragaceae *Myriophyllum*	Palaearctic	Schiner (1864)
	Potamogetonaceae *Potamogeton*	Palaearctic	Schiner (1864), Séguy (1930)
sp.	Potamogetonaceae *Potamogeton* *amplifolius*	Nearctic	Frost (1924)
sp.	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*	Palaearctic	Fulmek (1962)
	Chorebus uliginosus		
	Dacnusa liminicola		
ascita	Braconidae *Chorebidella sp.*	Nearctic	Berg (1950)
	Dacnusa sp.		
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)
bergi	Braconidae *Ademon niger*	Nearctic	Berg (1950)
	Chorebidea sp. 2		
	Dacnusa sp. 1		
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)
bilobifera	Braconidae *Aphanta sp.*[a]	Nearctic	
	Chorebidella bergi[a]		

[a]Reared from host for the first time during this study.

Table 2. (Continued)

Species of *Hydrellia*	Parasitic wasp	Zoogeographic region	Major references
bilobifera	Braconidae *Opius*[a] sp.		
butomi	Braconidae *Ademon decrescens*	Palaearctic	Hering (1925)
	Pteromalidae gen. undet. (hyperparasite)	Palaearctic	Hering (1925)
cochleariae	Braconidae *Ademon decrescens*	Palaearctic	Fulmek (1962), Thienemann (1916)
	Chaenusa conjungens		
	Chorebus uliginosus		
	Opius caesius		
	Pachysema discolor		
	Chalcidae *Gonatocerus uliginosus*	Palaearctic	Fulmek (1962)
cruralis	Braconidae *Ademon niger*	Nearctic	Berg (1950)
	Chorebidea sp.		
	Chorebidella bergi		
	Diapriidae *Trichopria columbiana*	Nearctic	Berg (1950)

Table 2. (Continued)

Species of Hydrellia	Parasitic wasp	Zoogeographic region	Major references
cruralis	Pteromalidae gen. 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)
	Chorebus uliginosus nixoni densepunctatus orghidani	Palaearctic	Burghele (1959a, 1959b), Grigarick (1959), Fulmek (1962), Kuwayama (1955)
	aquaticus[b]	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)

[b]Reared from host during this study.

Table 2. (Continued)

Species of *Hydrellia*	Parasitic wasp	Zoogeographic region	Major references
griseola	Braconidae		
	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)

Table 2. (Continued)

Species of *Hydrellia*	Parasitic wasp	Zoogeographic region	Major references
griseola	Eulophidae		
	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)
	Ichneumonidae		
	Hemiteles sp.	Palaearctic	Kuwayama (1955)
	Horogenes *fenestralis*	Palaearctic	Fulmek (1962)
	Proctotrupidae	Palaearctic	Kuwayama (1955)
	Ismarus sp.		
	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)

Table 2. (Continued)

Species of *Hydrellia*	Parasitic wasp	Zoogeographic region	Major references
griseola	Pteromalidae *Trichomalus* sp.	Palaearctic	Kuwayama (1955)
ischiaca	Braconidae *Chorebus aquaticus*[a]	Nearctic	
	Chorebidella bergi[a]		
	Chaenusa sp.[a]		
	Opius sp.[a]		
	Diapriidae *Trichopria columbiana*[a]	Nearctic	
itascae	Braconidae *Aphanta* sp.[a]	Nearctic	
	Chorebidella bergi[a]		
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. (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*[a]	Nearctic	
	Diapriidae *Trichopria columbiana*[b]	Nearctic	Berg (1950)
stratiotae	Braconidae *Ademon decrescens*	Palaearctic	Fulmek (1962)
	Chorebus uliginosus		
sp.	Braconidae *Dacnusa obscuripes* [listed as probable parasite]	Palaearctic	Thienemann (1916), Burghele (1959b)
sp.	Braconidae *Gyrocampa* sp.	Palaearctic	Thienemann (1916)
sp.	Braconidae *Ademon mutator*	Palaearctic	Thompson (1953)
sp.	Braconidae *Chorebidea motasi*	Palaearctic	Burghele (1959a)
sp.	Braconidae *Chorebus striola*	Palaearctic	Burghele (1959b)

Table 2. (Continued)

Species of *Hydrellia*	Parasitic wasp	Zoogeographic region	Major references
spp.	Braconidae *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*]

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 species. Since H. flaviceps was not an originally included nominal species and since Westwood did not synonymize it with H. aurifacies, his designation is invalid.

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 this rejection in the 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: about three palpal and five labellar setae; one very fine, ventrally directed, secondary facial setula inserted above primary facial row; two fronto-orbitals (anterially and posterially 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 (*sic*). Cresson (1930, 1942, 1944b), Wirth and Stone (1956), Dahl (1959), and Deonier (1964) grouped *Hydrellia* with *Notiphila*, *Dichaeta*, *Ilythea*, *Philygria*, *Nostima*, *Oenenops*, 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 11 species and redescribed those of seven species previously known.

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. I have indexed each species in the keys with the page number of the description. Descriptions of male terminalia pertain to the ventral view of the structures.

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 fronto-orbitals present. 3
   Three fronto-orbitals present; (male terminalia as in Fig. 44). . . . . *H. ainsworthi*, p. 123

3. Anterior fronto-orbital anteriorly inclined, posterior one posteriorly inclined. 4
   Both fronto-orbitals anteriorly inclined. 51

4. Face 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 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 Fig. 62). . . . . *H. cruralis*, p. 169

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 Fig. 65). . . *H. pulla*, p. 270

9. Hind basitarsus without or with only 2 black, anterior basal setae; antennal segment 3 dark brown. 10
   Hind basitarsus with 3 black, anterior basal setae; antennal segment 3 partly moderate yellow; (male terminalia as in Fig. 56). . . . . *H. penicilli*, p. 257

10. Fore coxa and tibia mostly dark gray or moderate brown; hind tibia without or with only 1 black, anterior apical seta. 11
    Fore coxa and tibia moderate yellow; hind tibia with 2 black, anterior apical setae; (male terminalia as in Fig. 41). . . . . *H. ischiaca*, p. 221

11. One large mesokatepisternal; basal coxals variable. 12
One large and 3-4 small mesokatepisternals; 2 basal coxals; (male terminalia as in Fig. 47). . . . . H. flavicoxalis, p. 188

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; mesogacial index 2.6 or more; (male terminalia as in Fig. 42). H. spinicornis, p. 282

14. Large areas of body brown; usually 12 or fewer anterior interfissural costals. 15
Body uniformly light gray (except mesonotum and thoracic pleuron infrequently with sparse light yellowish-brown pruinosity in small areas); 12-15 anterior interfissural costals; (male terminalia as in Fig. 23). . . . . . H. valida, p. 300

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 Fig. 46). . . . . H. deceptor, p. 178

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 Fig. 22). . H. griseola, p. 197

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 Fig. 37). . . . . *H. rixator*, p. 276

18. Parafrontalia velvety black, contrasting with frontal vitta; 8-10 aristal rays; costal section III:IV 2.5 or less; (male terminalia as in Fig. 54). . . . *H. caliginosa*, p. 157
Parafrontalia not velvety black; 6-8 aristal rays; costal section III:IV 2.5 or more; (male terminalia as in Fig. 57). . . . . *H. notiphiloides*, p. 253

19. Male and female lengths under 2.3 and 2.7 mm respectively; fewer than 12 dorsal and 14 anterior interfissural 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 interfissural costals; costal section II:I usually under 2.0; (male terminalia as in Fig. 43). . . . . *H. itascae*, p. 232

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 valvulae laterales 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 valvulae laterales always exposed and moderate yellow; (male terminalia as in Fig. 51). . . . . *H. bergi*, p. 137

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 Fig. 59). . . . . *H. insulata*, p. 220

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) . . . . <u>H</u>. <u>lata</u>, p. 235

23. Parafrontalia velvety black, contrasting with frontal vitta; 2-3 basal coxals; mesanepisternum bronzed in posterolateral view; (male terminalia as in Fig. 35). . . . . <u>H</u>. <u>serena</u>, p. 279
Parafrontalia not velvety black; 1 basal coxal (infrequently 2); mesanepisternum not bronzed in posterolateral view; (male terminalia as in Fig. 24). . . . . <u>H</u>. <u>cessator</u>, p. 163

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 Fig. 60). . <u>H</u>. <u>biloxiae</u>, p. 151

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 Fig. 64). . . . . <u>H</u>. <u>cavator</u>, p. 161

28. Ocular index 13.0 or less; 8-9 aristal rays; costal section II:I 2.4 or more; (male terminalia as in Fig. 33). . . . . . <u>H</u>. <u>subnitens</u>, p. 287
Ocular index 15.0 or more; 6-8 aristal rays; costal section II:I 2.3; (male terminalia not figured). . . . . <u>H</u>. <u>suspecta</u>, p. 290

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 Fig. 36). . .
. . . . *H. crassipes*, p. 167
Antenna velvety black; ocular index 7.0 or less;
2 basal coxals; (male terminalia as in Fig. 31). .
. . . . *H. saltator*, p. 278

31. Fore and mid coxae light gray anteriorly; 7 or
more dorsal and 9 or more anterior inter-
fissural costals; ocular index usually more
than 9.0. 32
Fore and mid coxae moderate yellow anteriorly;
7 or fewer anterior interfissural costals;
ocular index usually under 9.0; (male terminalia
as in Fig. 29). . . . . *H. advenae*, p. 120

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 Fig. 52). . . . . *H. procteri*, p. 265
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
Fig. 33). . . . . *H. subnitens*, p. 287

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*, p. 136

34. Wing length 2.3 mm or more; vertex index 6.0
or more; ocular index usually over 17.0; (male
terminalia as in Fig. 28). . . . . *H. nobilis*, p. 248
Wing length 2.1 mm or less; vertex index 5.5
or less; ocular index usually under 17.0;
(male terminalia as in Fig. 53). . *H. idolator*, p. 217

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 Fig. 30). . . *H. platygastra*, p. 261

Face white; antenna velvety black; 9-11 setae on basal end of costa; (male terminalia as in Fig. 30). . . . . *H. wilburi*, p. 303

37\. One basal coxal; 12 or fewer anterior interfissural costals; wing length 3.0 mm or less. . . . 38
Two basal coxals; 11-14 anterior interfissural costals; wing length 3.0 mm or more; (male terminalia as in Fig. 26). . . . *H. manitobae*, p. 241

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 (Fig. 11); (male terminalia as in Fig. 34). .*H. morrisoni*, p. 245

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 Fig. 11; (male terminalia as in Fig. 25). . . . . *H. borealis*, p. 155

40\. Dorsal and anterior interfissural costals subequal; 2 or more pdc; male mid tibia variable. 41
Dorsal interfissural costals twice size of anterior ones; 1 pdc; male mid tibia not expanded; (male terminalia as in Fig. 67). . . . . *H. personata*, p. 269

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 Fig. 68). . . . . *H. americana*, p. 127

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 Fig. 45). . . . . *H. tibialis*, p. 292

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 Fig. 40). . . . . *H. definita*, p. 180

45. Antenna and parafrontalia velvety dark brown; 6-8 aristal rays; M_{1+2} index 1.5 or less; (male terminalia as in Fig. 58). . . . . *H. amnicola*, p. 129
Antenna and parafrontalia not velvety dark brown; 8-9 aristal rays; M_{1+2} index 1.6 or more; (male terminalia as in Fig. 38). . . . . *H. agitator*, p. 121

46. Face not entirely dark brown; usually 9 or fewer anterior interfissural costals.
Face entirely dark brown; usually 9 or more anterior interfissural costals; (male terminalia as in Fig. 61). . *H. luctuosa*, p. 237

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 Fig. 49). . . . . *H. floridana*, p. 190

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 Fig. 39). .H. columbata, p. 164

49\. Palpus, antenna, and parafrontalia velvety black; 4-7 sfa; lower half of mesokatepisternum light gray; (male terminalia as in Fig. 48). . . . . H. surata, p. 288
Palpus, antenna, and parafrontalia dark brown, not velvety; 1-3 sfa; thoracic pleuron moderate olive-brown; (male terminalia as in Fig. 63). . . . . . H. prudens, p. 267

50\. Thoracic pleuron nearly uniformly light gray; 3 fronto-orbitals; (male terminalia as in Fig. 55). . . . . H. notata, p. 251
Thoracic pleuron velvety brownish-black and light gray; 2 fronto-orbitals; (male terminalia as in Fig. 66). . . . . . H. formosa, p. 192

51\. Thoracic pleuron with 1 continuous light-gray area. 52
Thoracic pleuron with 2 distinct light-gray areas; (male terminalia as in Fig. 27). . . . . H. proclinata, p. 263

52\. Arista with 6-8 rays; 8-11 dorsal and 9-12 anterior interfissural costals; (male terminalia as in Fig. 32). . . . H. melanderi, p. 243
Arista with 9-11 rays; 6-8 dorsal and 8-9 anterior interfissural costals; (male unknown). . . . . H. decens, p. 176

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 3 times as long as wide (Fig. 16A); (male terminalia as in Fig. 20). . . . . H. bilobifera, p. 143

54. Antennal segment 3 at least partly moderate yellow. 55
Antennal segment 3 dark brown; (female terminalia as in Fig. 16D; male as in Fig. 18). . . . . *H. harti*, p. 215

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 (Fig. 16B); (male terminalia as in Fig. 50). . . . . *H. trichaeta*, p. 297
Male abdominal syntergum 9+10 truncate posteriorly; female cercus acute apically (Fig. 15); (male terminalia as in Fig. 17). . . . . *H. ascita*, p. 131

57. Wing length under 2.0 mm; female cercus ovoid apically, truncate basally (Fig. 13); (male terminalia as in (Fig. 21). . . . . *H. discursa*, p. 182
Wing length over 2.2 mm; female cercus acute apically, rounded basally (Fig. 16C); (male terminalia as in Fig. 19). . . . . *H. gladiator*, p. 195

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 (Fig. 83). . . . . *H. biloxiae*, p. 151
Bifurcation index 4.8-5.4; cheliform spot not touching clypeal arch margin; clypeal arch gradually sloping (Fig. 96). . . *H. bergi*, p. 137

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. . . . *H. ainsworthi*, p. 123

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 (Fig. 86). . . . . *H. spinicornis*, p. 282

8. Dorsal phragmatal ramus all dark. . *H. griseola*, p. 197
Dorsal phragmatal ramus partly hyaline (Fig. 88). . . . . *H. ischiaca*, p. 221

9. Mouth-hook beak and base lengths subequal; mouth-hook light spot discal (encompassed) (Fig. 95)... . . . . *H. discursa*, p. 182
Mouth-hook beak only 0.7-0.8 as long as base; mouth-hook light spot touching top margin of base (Fig. 97). . . . . *H. trichaeta*, p. 297

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 (Fig. 91). . . . . *H. itascae*, p. 232

11. Feeding apparatus partly hyaline. 12
Feeding apparatus entirely dark. . *H. morrisoni*, p. 245

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 (Fig. 93); bifurcation index usually over 4.5; ventral frontoclypeal index 3.0 or more. . . . . _H. notiphiloides_, p. 253

13. Ventral frontoclypeal index 2.7 or less; mouth-hook beak distinctly longer than base; ventral phragmatal ramus moderately dark (Fig. 98). . . _H. ascita_, p. 131
Ventral frontoclypeal index 2.8 or more; mouth-hook beak and base lengths subequal; ventral phragmatal ramus mostly hyaline (Fig. 99). . _H. bilobifera_, p. 143

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 (Fig. 90). . . . . _H. cruralis_, p. 169

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_, p. 157

16. Feeding apparatus hyaline except dark mouth-hook and cheliform spot (Fig. 82); mouth-hook beak distinctly longer than base. . . . . _H. pulla_, p. 270
Feeding apparatus mostly dark except partly hyaline ventral phragmatal ramus (Fig. 102); mouth-hook beak only 0.9 as long as base. . . . . _H. luctuosa_, p. 237

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 (Fig. 109). . . . . H. ascita, p. 131

3. Length: minimum breadth about 20.0; maximum breadth: minimum breadth about 4.2; anal-plate index about 2.6 (Fig. 112). . . . . H. trichaeta, p. 297
   Length: minimum breadth 12.0-15.0; maximum breadth: minimum breadth 2.4-3.2; anal-plate index 1.8-2.4 (Fig. 106). . . . . H. bilobifera, p. 143

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 (Fig. 105). . . . . H. cruralis, p. 169

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 index 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 (Fig. 120). . . . . <u>H</u>. <u>bergi</u>, p. 137

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 (Fig. 104). . . . . <u>H</u>. <u>luctuosa</u>, p. 237

9. Distinctly bifurcate supra- and sub-spiracular spinules absent. 10

Distinctly bifurcate supra- and sub-spiracular spinules present. . . <u>H</u>. <u>ainsworthi</u>, p. 123

10. Length: minimum breadth about 20.0 or less; spiracular peritremes terminal. 11

Length: minimum breadth about 24.0; spiracular peritremes subterminal (Fig. 118). . . . . <u>H</u>. <u>morrisoni</u>, p. 245

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 (Fig. 115). . . . .<u>H</u>. <u>tibialis</u>, p. 292

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 (Fig. 114). . . . . *H. spinicornis*, p. 282

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 (Fig. 119). . . . . *H. griseola*, p. 197
H. ischiaca, p. 221

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 (Fig. 113). . . . . *H. notiphiloides*, p. 253

14. Anal-plate index 3.8 or more; maximum breadth: minimum breadth 5.5 or less; length: minimum breadth 15.0 or less (Fig. 107). . . . . . *H. itascae*, p. 232

Anal-plate index 3.0 or less; maximum breadth: minimum breadth 6.0 or more; length: minimum breadth 18.0 or more (Fig. 108). . . . . *H. caliginosa*, p. 157

15. Prothorax constricted posterolaterally; anal-plate index 3.0 or less. 16

Prothorax not constricted posterolaterally (Fig. 110); anal-plate index 3.5 or more. . . . . *H. discursa*, p. 182

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 (Fig. 111). . . . . . . *H. pulla*, p. 270

Prothorax semicircular anteriorly, rounded
laterally; length: minimum breadth 16.0
or more; abdomen tapering posteriad from
segment 4 (Fig. 116). . . . . . . *H. biloxiae*, p. 151

Hydrellia advenae Cresson

1934 Hydrellia advenae Cresson, p. 236.
1936 Hydrellia advenae; Cresson, p. 257.
1938 Hydrellia advenae; Procter, p. 351.
1944b Hydrellia advena; Cresson, p. 165, 174.
1965 Hydrellia advenae; Wirth, p. 743. [Catalog listing].

Adult

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 Fig. 29.

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- or moderate brown; 5-7 setae on basal end of costa; 5-7 dorsal and 6-8 anterior interfissural 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.

<u>Abdomen</u> 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 postgonital uncus slightly laterad; distiphallus constricted near basiphallus, apex acute. Anterior margin of fused valvulae laterales concave and narrow (only about half the midbreadth of structure); B-index about 5.2; C-index 1.7-2.0.

<u>Holotype</u>

Male in the Academy of Natural Sciences of Philadelphia, No. 6513. Type locality: Bar Harbor, Mount Desert Island, Maine (VII-15-1933, W. Procter).

<u>Distribution</u>

Maine. July. Locality data for the 8 adults examined are listed in Appendix B.

<u>Hydrellia</u> <u>agitator</u>, sp. nov.

<u>Adult</u>

<u>Diagnosis</u> 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 Fig. 38.

<u>Head</u> 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.

<u>Thorax</u> 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 interfissural 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.

<u>Abdomen</u> Terga semiglossy 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; postgonital uncus short, bent laterad; distal half of distiphallus narrow, spatulate, and ventrally lamellate (distinctly delimited from basiphallus and protruding far beyond valvulae laterales). Anterior margin of fused valvulae laterales deeply and broadly concave; B-index about 1.2; C-index 2.0-2.2.

Holotype

Male in the U.S. National Museum. Type locality: Port Saint Joe beach, Gulf Co., Florida (III-17-1954, G. Steyskal).

Distribution

Florida, Georgia, and Mississippi. March-July. Locality data for the 5 adults examined are listed in Appendix B.

Biology

Adult Habitat recorded: mats of *Hydrochloa caroliniensis*.

Hydrellia ainsworthi, sp. nov.

Adult

Diagnosis Palpus moderate yellow; 6-8 aristal rays; vertex index 5.2-6.8; body length: wing length 1.0; 3 fronto-orbitals, all anterially 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 Fig. 44.

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 anterially 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 interfissural 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; antero-lateral 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 postgonital uncus slightly laterad from general anterior direction; distiphallus slightly constricted at mid-length, ventrally carinate, and mucronate apically. Anterior margin of fused valvulae laterales truncate; B-index about 6.0; C-index 1.0-1.2.

Immatures

Second-instar larva Length 1.75-2.50 mm; maximum breadth 0.35-0.50 mm. Frontoclypeal length 0.29 mm (Fig. 100). 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 (Fig. 92). 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 (Fig. 117). 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.

Holotype

Male in the U.S. National Museum. Type locality: Lake Shady, 7 miles west of Hattiesburg, Lamar Co., Mississippi (VII-11-1962, D. L. Deonier).

Material examined

Locality data for the 373 adults examined are listed in Appendix B. Immatures: 23 specimens from Dickinson's Pond and Lake Shady, Lamar Co., Mississippi.

Distribution

This is perhaps a Neotropical species, the range of which extends to the Gulf States. Florida and Mississippi. March-July.

Taxonomic 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.

Biology

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 Co., 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 6 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

1931 *Hydrellia americana* Cresson, p. 106.
1944b *Hydrellia americana*; Cresson, p. 164, 172.
1965 *Hydrellia americana*; Wirth, p. 743. [Catalog listing].

Adult

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 Fig. 68.

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 interfissural 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 valvulae laterales broadly notched; B-index about 0.8.

Holotype

Female in the U.S. National Museum, No. 43454. Type locality: Chesapeake Beach, Maryland (VIII-2, J. M. Aldrich).

Distribution

California, Maine, Maryland, Massachusetts, Michigan, Mississippi, and New York. March-August. Locality data for the 12 adults examined are listed in Appendix B.

Taxonomic remarks

This species is very similar to *H. tibialis*, but its male terminalia are distinctive.

Biology

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

Hydrellia amnicola, sp. nov.

Adult

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 Fig. 58.

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 interfissural 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 valvulae laterales and nearly straight except preapical part bent sharply laterad; postgonital uncus straight and directed laterad; distiphallus acuminate; basiphallus completely covered by valvulae laterales. Anterior margin of fused valvulae laterales cleft medially to about midlength of structure; B-index about 2.2; C-index 1.8-2.2.

Holotype

Male in the U.S. National Museum. Type locality: Sucker Creek, 100 yards north of Highway 31, Clearwater Co., Minnesota (VII-23-1963, D. L. Deonier).

Distribution

Minnesota. July. Locality data for the 27 adults examined are listed in Appendix B.

Taxonomic 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.

Biology

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

1942 *Hydrellia ascita* Cresson, p. 78.
1944b *Hydrellia ascita*; Cresson [in part], p. 170, 175.
1949 *Hydrellia ascita*; Berg [in part], p. 284.
1950 *Hydrellia ascita*; Berg [in part], p. 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].
1964 *Hydrellia ascita*; Deonier, p. 115, 125, fig. 4.
1965 *Hydrellia ascita*; Deonier, p. 500. [Biology].
1965 *Hydrellia ascita*; Wirth, p. 743. [Catalog listing].

Adult

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 Fig. 17; female as in Fig. 15.

Head Differing mainly from H. bilobifera in: 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: 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 postgonital 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 valvulae laterales 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_ (Fig. 13).

Immatures

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 (Fig. 98). 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 (Fig. 109). 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6621. Type locality: Nigger Creek, Cheboygan Co., Michigan (VIII-21-1941, C. O. Berg, reared from *Potamogeton tenuifolius*).

Material examined

Locality data for the 30 adults examined are listed in Appendix B. Immatures: 20 specimens from Michigan: Nigger Creek, Cheboygan Co.; Sodon Lake, Oakland Co.

Distribution

Illinois, Iowa, Michigan, Minnesota, Ontario, and Tennessee. June-July.

Taxonomic remarks

As with many of the 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.

Biology

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 Co. and Oakland Co., Michigan.

Larva and puparium   Berg found 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. epihydrus*, *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

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

Adult

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 postero-lateral 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 interfissural 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).

Syntypes

One male and two females; the male and one female in the U.S. National Museum, No. 13101. Type locality: Biscayne Bay, Florida (Mrs. A. T. Slosson).

Distribution

Florida. January. Locality data for the 3 adults examined are listed in Appendix B.

Taxonomic 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 interfissural costals.

Hydrellia bergi Cresson

1941 *Hydrellia bergi* Cresson, p. 37.
1944b *Hydrellia bergi*; Cresson, p. 170, 175.
1950 *Hydrellia bergi*; Berg, p. 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].

1964 Hydrellia bergi; Judd, p. 411. [Biology].
1965 Hydrellia bergi; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 51.

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 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 interfissural 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 postgonital uncus bent 90° anteriad; distiphallus long, asymmetrical, with apex curved to right. Anterior margin of fused valvulae laterales slightly convex; valvulae laterales yellow and mostly exposed; B-index 3.2; C-index 0.2-0.4.

Immatures

Egg   Length 0.59-0.68 mm; maximum breadth 0.14-0.17 mm. Chorion (Fig. 71) 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 (Fig. 96). 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 (Fig. 120). 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.

Holotype

Male in the U.S. National Museum. Type locality: Nigger Creek, Cheboygan Co., Michigan (VI-27-1940, C. O. Berg).

Material examined

Locality data for the 112 adults examined are listed in Appendix B. Immatures: 32 specimens from Michigan: Douglas Lake; Cheboygan Co.; Presque Isle Co.; Washtenaw Co. Minnesota:

Rapid River Logging Camp, Hubbard Co.; 1.3 miles south of main entrance, Itasca State Park.

Distribution

Michigan, Minnesota, New York, Ontario, and Quebec. June-September.

Taxonomic remarks

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

Biology

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, and 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 cautiously 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 4 days.

Larva All of the larvae that eclosed from the eggs died except one. The one 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

1936 Hydrellia bilobifera Cresson, p. 262.
1942 Hydrellia bilobifera; Cresson, p. 78.
1944b Hydrellia bilobifera; Cresson [at least in part], p. 170-175.
1964 Hydrellia bilobifera; Deonier, p. 115.
1965 Hydrellia bilobifera; Deonier, p. 500. [Biology].
1965 Hydrellia bilobifera; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 20; female as in Fig. 16A.

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 interfissural 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 valvulae laterales 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.

Immatures

Egg Length 0.47-0.64 mm; maximum breadth 0.14-0.18 mm. Chorion (Fig. 72) white or light yellowish-gray, with inconspicuous, frequently anastomosing longitudinal ridges; wide spaces between ridges smooth (in contrast to Fig. 75). 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* (Fig. 77), 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 (Fig. 99). 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 (Fig. 106). 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6531. Type locality: Atherton, Missouri (VI-no year, C. F. Adams).

Material examined

Locality data for the 272 adults examined are listed in Appendix B. Immatures: 66 specimens from Iowa: Spring Lake, Greene Co.; Siewer's Springs State Park, Decorah. Kansas: Kansas University Natural History Reservation, near Lawrence; 1 mile northeast of Lawrence. Tennessee: Brewer's Bar Ditch and Samburg, Reelfoot Lake.

Distribution

California, District of Columbia, Iowa, Kansas, Michigan, Minnesota, Mississippi, Missouri, Ontario, South Carolina, Tennessee, and Texas. March-October.

Taxonomic 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*.

Biology

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 catch an adult chironomid, another female grasping an adult chironomid, and yet another one probing a specimen of _Podura aquatica_ held with its fore tarsi. The gut contents of ten adults from this locality consisted of greenish-yellow, granular material. 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.

Egg and larva I found eggs on the floating leaves of _Potamogeton nodosus_ at Spring Lake, Greene Co., Iowa. These eggs incubated for 2 days after collection. The first larval stadium ranged from 5 to 7 days; the second and third, from 5 to 11 and 4 to 14 days respectively in the laboratory for nine specimens. The maxima in these measurements were from rearings of over-wintering larvae.

I made the following observations on larvae from _P. nodosus_ collected from ice at Spring Lake, January 25. One third-instar larva migrated from its first host plant to a leaf of _P. berchtoldii_ placed near it and pupariated in it. On February 24, 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 moulted on February 26, 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 skeletonized two leaves of P. berchtoldii and part of a submerged leaf of P. amplifolius before puppariating 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 6 to 14 days in the laboratory for ten 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 P. nodosus and P. gramineus in the field, but I made laboratory rearings in P. berchtoldii and P. amplifolius. Grigarick reared H. bilobifera from Zannichellia palustris in Davis, California, during his research on *H. griseola*. It is uncertain whether this represents a larval host or an incidental puparial host. My survey of potential host plants included *Potamogeton pectinatus*, *P. natans*, *P. epihydrus*, *P. spirillus*, *Mimulus glabratus*, *Alisma* sp., *Heteranthera dubia*, *Ceratophyllum demersum*, *Sagittaria australis*, *Jussiaea repens*, *Nasturtium officinale*, *Eleocharis palustris*, *Polygonum amphibium*, *Anacharis 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. Alexopoulos (1960) 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, sp. nov.

Adult

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 Fig. 60.

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, mesocutum posterior to transverse sulcus, and scutellum semiglossy moderate brown; mesocutum anterior to transverse sulcus semiglossy dark brown; notopleuron and post-alar 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 interfissural 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 postgonital uncus slightly laterad; distiphallus tapering to ovoid, ventrally transversely lamellate apex. Anterior margin of fused valvulae laterales ovoid; B-index about 3.5; C-index 2.0-2.5.

Immatures

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 (Fig. 83). 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 orifice. 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 (Fig. 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.

Holotype

Male in the U.S. National Museum. Type locality: near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co., Mississippi (VI-17-1962, D. L. Deonier).

Material examined

Locality data for the 78 adults examined are listed in Appendix B. Immatures: 23 specimens from Mississippi: Vancleave Road, Jackson Co. (30°28' north, 88°43' west) and near U.S. Highway 90, sec, 20 T.7 south, R.5 west, Jackson Co.

Distribution

Mississippi. June-July.

Biology

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

At the above-mentioned locality, an adult probed a partially desicated 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 specimen came to 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 4 centimeters of rhizome 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 millimeters from the puparium in a stolon without an escape slit, growing about 0.75 meters 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_, _Rynchospora cymosa_, _Eleocharis tuberculosa_, _E. wolfii_, _E. mammillata_ and _Cyperus strigosus_.

Hydrellia borealis Cresson

1944b _Hydrellia borealis_ Cresson, p. 164, 171, 172.
1965 _Hydrellia borealis_; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 25.

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 moderate 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 (Fig. 11). 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 interfissural 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; antero-lateral 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 postgonital uncus slightly laterad; distiphallus slightly expanded (oblong) on distal two-thirds. Anterior margin of fused valvulae laterales narrowly cleft medially to about one-third of length of structure; B-index about 1.0; C-index 0.5-0.7.

Holotype

Male, which may be at the Academy of Natural Sciences of Philadelphia, but is probably either lost or in the Melander Collection. ANSP No. 6653. Type locality: Mer Bleue, Ottawa, Canada (VII-2-1938, A. L. Melander).

Distribution

Alaska, British Columbia, Michigan, Nebraska, New Hampshire, Ontario, Quebec, Washington, and Wyoming. June-August. Locality data for the 10 adults examined are listed in Appendix B.

Taxonomic 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

1936 *Hydrellia caliginosa* Cresson, p. 257-258.
1942 *Hydrellia caliginosa*; Cresson, p. 78.

1944b *Hydrellia caliginosa*; Cresson, p. 170, 175.
1950 *Hydrellia caliginosa*; Berg, p. 375, 376, 378, 384-385, 392-393, 396. [Biology].
1965 *Hydrellia caliginosa*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 54.

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 interfissural 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; postgonital uncus distinctly clawlike; distiphallus tapering to mucronate apex. Anterior margin of fused valvulae laterales truncate; B-index about 0.6; C-index 0.1-0.2.

Immatures

Third-instar larva Body of larva not examined. Frontoclypeal length 0.46-0.59 mm (Fig. 94). 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 (Fig. 108). 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* (Fig. 107); anal plate subovoid, with anterior margin slightly convex. Empty puparium moderate brown.

Holotype

Male at the Academy of Natural Sciences of Philadelphia, No. 6528. Type locality: New Mill Pond, Mount Desert Island, Maine (VII-25-1935, W. Procter).

Material examined

Locality data for the 66 adults examined are listed in Appendix B. Immatures: 10 specimens from Matanuska Valley, Alaska and Rapid River Logging Camp, Hubbard Co., Minnesota.

Distribution

Alaska, Idaho, Maine, Michigan, Minnesota, Montana, Quebec, and Wyoming. July-September.

Taxonomic 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.

Biology

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 Co., Minnesota.

Hydrellia cavator, sp. nov.

Adult

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 Fig. 64.

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 interfissural 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 postgonital uncus sharply laterad; distiphallus uniform in breadth to truncate and ventrally lamellate apex. Anterior margin of fused valvulae laterales smoothly convex; B-index about 3.0; C-index 2.0-2.5.

Holotype

Male in the U.S. National Museum. Type locality: Biscayne Bay, Florida (Mrs. A. T. Slosson).

Distribution

Florida. April-August. Locality data for the 5 adults examined are listed in Appendix B.

Taxonomic 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, sp. nov.

Adult

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 Fig. 24.

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 interfissural 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 postgonital uncus anteriad; distal half of distiphallus tapering to acute and ventrally bicarinate apex. Anterior margin of fused valvulae laterales only slightly concave; B-index about 0.6; C-index 1.0-1.2.

Holotype

Male in the U.S. National Museum. Type locality: Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co., Minnesota (VII-8-1963, D. L. Deonier).

Distribution

Manitoba and Minnesota. July. Locality data for the 8 adults examined are listed in Appendix B.

Biology

Habitats recorded: leaves of *Glyceria grandis* and sedge meadow.

Hydrellia columbata, sp. nov.

Adult

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 Fig. 39.

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 interfissural 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 lateral than valvulae laterales; copulobus unusually long with end bent posteromediad, with terminal cluster of setae, and with 5-7 setae anteriorly. Postgonite long and bent anteromediad; postgonital uncus distinctly long and hooklike; distiphallus narrow, of uniform breadth to acute apex. Anterior margin of fused valvulae laterales deeply cleft medially to midlength of structure; B-index about 1.0; C-index 0.5-0.8.

Holotype

Male in the U.S. National Museum. Type locality: Squaw Lake, Itasca State Park, Clearwater Co., Minnesota (VIII-14-1963, D. L. Deonier).

Distribution

Maine and Minnesota. June-August. Locality data for the 46 adults examined are listed in Appendix B.

Taxonomic 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.

Biology

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

1931 *Hydrellia crassipes* Cresson, p. 107.
1944b *Hydrellia crassipes*; Cresson, p. 169, 174.
1965 *Hydrellia crassipes*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 36.

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 2 anteroventral rows of close-set short setae; male mid tibia flanged anteroventrally (Fig. 69). 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 interfissural 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; postgonital uncus short, blunt, and straight; distiphallus finely lamellate ventrally and tapering to mucronate apex. Anterior margin of fused valvulae laterales broadly emarginate with about 8-9 setae on lateral corners; B-index about 2.5; C-index 1.8-2.0.

Holotype

Male (as of 1931) in collection at Ohio State University. Type locality: Sandusky, Cedar Point, Ohio (VIII-4-1902).

Distribution

Illinois, Iowa, Maine, Michigan, Minnesota, New Jersey, Ohio, Ontario, Oregon, Pennsylvania, and Quebec. June-September. Locality data for the 121 adults examined are listed in Appendix B.

Taxonomic 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.

Biology

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

I observed two instances of copulation. In one of these, at a pond near Itasca State Park, Minnesota, the pair *in copulo* were surrounded by an aggregation of eight to ten specimens circling and following one another in an agitated manner, and attempting repeatedly to mount. A large specimen of *Notiphila* sp. kept walking through this aggregation with its wings raised and probably added largely to the agitation.

Hydrellia cruralis Coquillett

1910a *Hydrellia cruralis* Coquillett, p. 131.
1924 *Hydrellia cruralis*; Cresson, p. 162.
1931 *Hydrellia cruralis*; Cresson, p. 104, 106.

1934 Hydrellia cruralis; Cresson, p. 235.
1944b Hydrellia cruralis; Cresson, p. 169, 172.
1950 Hydrellia cruralis; Berg, p. 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].
1956 Hydrellia cruralis; Wirth, p. 16.
1964 Hydrellia cruralis; Judd, p. 411. [Biology].
1964 Hydrellia cruralis; Deonier, p. 116.
1965 Hydrellia cruralis; Deonier, p. 500, 505. [Biology].
1965 Hydrellia cruralis; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 62.

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 corsal and 9-14 anterior interfissural

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; antero-lateral margin of sternum 5 roundly right-angled; copulobus irregularly setose, acutangular posteriorly (apex rounded). Postgonite bent anteriad and postgonital uncus about 90° laterad; distiphallus very short, tapering to acute apex. Anterior margin of fused valvulae laterales varying from acutangular (posterior breadth of valvulae laterales about 15.0 times anterior breadth) to truncate; B-index about 2.5; C-index 0.8-1.2.

Immatures

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* (Fig. 73); 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

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; antero-lateral margin of sternum 5 roundly right-angled; copulobus irregularly setose, acutangular posteriorly (apex rounded). Postgonite bent anteriad and postgonital uncus about 90° laterad; distiphallus very short, tapering to acute apex. Anterior margin of fused valvulae laterales varying from acutangular (posterior breadth of valvulae laterales about 15.0 times anterior breadth) to truncate; B-index about 2.5; C-index 0.8-1.2.

Immatures

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* (Fig. 73); 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 (Fig. 90). Ventral frontoclypeal index 4.0-4.5; phragmatal index 1.3-1.4; bifurcation 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 (Fig. 105). 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.

Holotype

Female in the U.S. National Museum, No. 13102. Type locality: Riverton, New Jersey (IX-1909, H. S. Harbeck).

Material examined

Locality data for the 556 adults examined are listed in Appendix B. Immatures: 60 specimens from Michigan: Third Sister Lake, Washtenaw Co.; Cheboygan Co., Minnesota: Biological Station, Lake Itasca; Squaw Lake, Itasca State Park; Rapid River Logging Camp, Hubbard Co.; Long Lake.

Distribution

Alaska, Connecticut, Florida, Idaho, Illinois, Iowa, Kansas, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, Ohio, Ontario, Pennsylvania, Quebec, Texas, Virginia, and West Virginia. May-October.

Biology

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 copulo* 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 Co., Minnesota. This 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 m. _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*.

Hydrellia decens Cresson

1931 *Hydrellia decens* Cresson, p. 107.
1944b *Hydrellia decens*; Cresson p. 170, 171.
1965 *Hydrellia decens*; Wirth, p. 744. [Catalog listing].

Adult

Diagnosis Palpus dark brown; 9-11 aristal rays; all fronto-orbitals anterially inclined; 6-8 dorsal and 8-9 anterior interfissural costals; face light yellowish-brown or yellowish-gray medially, with light-gray vitta along secondary facial row; thoracic pleuron with 1 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 anterially 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 interfissural 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.

Holotype

Female in the U.S. National Museum, No. 21842. Type locality: Plummer's Island, Potomac River, Maryland (VIII-12-1914, R. C. Shannon).

Distribution

Maryland. July-August. Locality data for the 3 adults examined are listed in Appendix B.

Taxonomic 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, sp. nov.

Adult

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 Fig. 46.

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.

<u>Thorax</u> 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 interfissural 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.

<u>Abdomen</u> 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 postgonital uncus bent slightly laterad; distiphallus ventrally lamellate and tapering to acutangular, retuse apex. Anterior margin of fused valvulae laterales narrowly indented medially from broad convexity; B-index about 2.2; C-index 0.6-1.0.

<u>Holotype</u>

Male in collection at University of California (Davis). Type locality: Sacramento, California (IX-20-1957, A. A. Grigarick).

<u>Distribution</u>

California. September (reared). Locality data for the 4 adults examined are listed in Appendix B.

Taxonomic remarks

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

Biology

Host plants Grigarick reared a few specimens from *Sagittaria* sp. collected near Sacramento, California, September 20 and 21, 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

1944b *Hydrellia definita* Cresson, p. 165-166.
1964 *Hydrellia definita*; Deonier, p. 116.
1965 *Hydrellia definita*; Deonier, p. 500, 505. [Biology].
1965 *Hydrellia definita*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 40.

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 interfissural costals; costal-section ratios: II:I 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; antero-lateral margin of sternum 5 roundly obtusangular; copulobus somewhat sinuate posteriorly and irregularly setose. Post-gonite bent anteriad and postgonital uncus straight; disti-phallus of uniform breadth to mucronate and ventrally lamellate apex. Anterior margin of fused valvulae laterales broadly emarginate; B-index about 2.8; C-index 1.8-2.0.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 890. Type locality: Spanish Fork, Utah (D. E. Hardy).

Distribution

Alaska, California, Illinois, Iowa, Kansas, Michigan, Minnesota, Nebraska, New York, Ontario, Saskatchewan, South Dakota, Utah, Wyoming. June-August. Locality data for the 55 adults examined are listed in Appendix B.

Taxonomic remarks

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

Biology

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, Tomkins Co., New York.

Hydrellia discursa, sp. nov.

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

Adult

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 Fig. 21; female as in Fig. 13.

Head   Differing mainly from H. bilobifera in: 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; postgonital 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 valvulae laterales 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.

Immatures

Egg Length 0.47-0.56 mm; maximum breadth 0.14-0.16 mm. Chorion (Fig. 74) 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 (Fig. 95). 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 (Fig. 110). 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_.

Holotype

Male in the U.S. National Museum. Type locality: Miller's Camp, Reelfoot Lake, Tennessee, 36°24.3' north, 89°20' west (VIII-12-1962, D. L. Deonier).

Material examined

Locality data for the 110 adults examined are listed in Appendix B. Immatures: 45 specimens from Samburg, Miller's Camp, and Brewer's Bar Ditch, Reelfoot Lake, Tennessee.

Distribution

California, District of Columbia, Florida, Iowa, Kansas, Michigan, Minnesota, Mississippi, Ontario, Tennessee, and Texas. April-September.

Taxonomic 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_.

Biology

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 Co., Mississippi, the male of a pair observed in copulo 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 some 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 moulting 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

1944b *Hydrellia flavicoxalis* Cresson, p. 167.
1965 *Hydrellia flavicoxalis*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 47.

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.

<u>Thorax</u> 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 interfissural 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.

<u>Abdomen</u> 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 postgonital uncus straight; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused valvulae laterales 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6666. Type locality: Walden, Jackson Co., Colorado (VII-27-1938, M. T. James).

Material examined

I examined the holotype and one female with the same collection data, which are the only known specimens of this species.

Distribution

Walden, Colorado, is in North Park, a high basin isolated by a ring of mountain ranges having several peaks 11,000-12,000 feet high.

Taxonomic remarks

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

Hydrellia floridana, sp. nov.

Adult

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 Fig. 49.

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 interfissural 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); postgonital 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 valvulae laterales undulate (convex medially); length of fused valvulae less than half the breadth; C-index 1.0-1.3.

Holotype

Male in the U.S. National Museum. Type locality: Lacoochee, Florida (VIII-18-1930, P. W. Oman).

Distribution

Georgia, Florida, Louisiana, and Mississippi. March-September. Locality data for the 52 adults examined are listed in Appendix B.

Taxonomic remarks

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

Biology

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

Hydrellia formosa Loew

1861 *Hydrellia formosa* Loew, p. 355-356.
1862 *Hydrellia formosa*; Loew, p. 154.
1864 *Hydrellia formosa*; Loew, p. 94.
1878 *Hydrellia formosa*; Osten Sacken, p. 202.
1896 *Hydrellia formosa*; Becker, p. 269. [Bibliographic listing].
1900 *Hydrellia formosa*; Howard, p. 593. [Biology].
1905 *Hydrellia formosa*; Aldrich, p. 626.

1906 <u>Hydrellia formosa</u>; Jones, p. 185.
1917 <u>Hydrellia formosa</u>; Kahl, p. 385. [Biology].
1925 <u>Hydrellia formosa</u>; Johnson, p. 271.
1931 <u>Hydrellia formosa</u>; Cresson, p. 104.
1936 <u>Hydrellia formosa</u>; Cresson, p. 259.
1938 <u>Hydrellia formosa</u>; Cresson, p. 33.
1944b <u>Hydrellia formosa</u>; Cresson, p. 163, 172.
1964 <u>Hydrellia formosa</u>; Deonier, p. 115.
1965 <u>Hydrellia formosa</u>; Deonier, p. 500-506. [Biology].
1965 <u>Hydrellia formosa</u>; Wirth, p. 744. [Catalog listing].

<u>Adult</u>

<u>Diagnosis</u> 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 Fig. 66.

<u>Head</u> 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.

<u>Thorax</u> 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 interfissural 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; postgonital uncus straight, directed, anterolaterad; distiphallus gradually constricted at midlength, with semicircular apex. Anterior margin of fused valvulae laterales broadly concave; B-index about 2.0; C-index 1.8-2.2.

Holotype

Female in the Museum of Comparative Zoology, Harvard University, No. 11153. Type locality: Pennsylvania (Osten Sacken).

Distribution

This species is recorded from 29 states or provinces east of the Rocky Mountains. March-September. Locality data for the 599 adults examined are listed in Appendix B.

Taxonomic remarks

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

Biology

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 Co., 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 so many from mats of water grass and *Eragrostis hypnoides*.

Hydrellia gladiator, sp. nov.

Adult

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; 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 Fig. 19; female as in Fig. 16 C.

Head Differing mainly from H. bilobifera in: 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: 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 postgonital 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 valvulae laterales 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* (Fig. 13).

Holotype

Male in the U.S. National Museum. Type locality: Reared from *Vallisneria* sp. leaves from Florida (XII-28-1957, D. M. Wood).

Material examined

Male holotype and a female reared from aquarium stock of *Vallisneria* sp. leaves from Florida (XII-28-1957, D. M. Wood). These are the only known specimens of this species.

Taxonomic 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)

1813 *Notiphila griseola* Fallén, p. 250-251.
1830 *Hydrellia communis* Robineau-Desvoidy, p. 790.
1835 *Hydrellia griseola*; Macquart, p. 523.
1846 *Notiphila griseola*; Zetterstedt, p. 1849, 1869-1871.
1856 *Hydrellia griseola*; Walker, p. 345.
1860 *Hydrellia griseola*; Loew, p. 17, 22, 46.
1861 *Notiphila griseola*; Lilljeborg, p. 205-215; fig. 2 [adult], 3 and 4 [immatures]. [Biology].

1862 Hydrellia hypoleuca; Loew, p. 151.
1862 Hydrellia obscuriceps; Loew, p. 152.
1862 Hydrellia scapularis; Loew, p. 153.
1864 Hydrellia griseola; Schiner [at least in part], p. 246-247.
1867 Hydrellia griseola; Kawall, p. 120-121. [Biology].
1867 Hydrellia griseola; Stein, p. 395-397. [Biology].
1869 Hydrellia griseola; von Frauenfeld, p. 603. [Biology].
1870 Hydrellia griseola; Loew, p. 7.
1878 Hydrellia hypoleuca; Osten Sacken, p. 202.
1878 Hydrellia obscuriceps; Osten Sacken, p. 202.
1878 Hydrellia scapularis; Osten Sacken, p. 202.
1883 Hydrellia griseola; Brischke, p. 107.
1887 Hydrellia griseola; Gobert, p. 41.
1894 Hydrellia griseola; Bezzi, p. 340-341.
1894 Hydrellia griseola; Kowarz, p. 65.
1894 Hydrellia griseola; Moragues y de Manzanos, p. 86.
1896 Hydrellia griseola; Becker, p. 171, 180-181; pl. 4, fig. 15.
1896 Hydrellia hypoleuca; Becker, p. 269. [Index listing].
1896 Hydrellia obscuriceps; Becker, p. 269. [Index listing].
1896 Hydrellia scapularis; Becker, p. 269. [Index listing].
1898 Hydrellia griseola; van der Wulp and deMeijere, p. 132.
1900 Hydrellia griseola; Strobl, p. 1.
1900 Hydrellia scapularis; Coquillett, p. 461.
1902 Hydrellia griseola; deMeijere, p. 685. [Biology].
1902a Hydrellia obscuriceps; Slosson, p. 8.
1902b Hydrellia scapularis; Slosson, p. 320.
1903 Hydrellia griseola; Marchal, p. 237. [Biology].
1903 Hydrellia griseola; Becker, p. 171.
1903 Hydrellia hypoleuca; Becker, p. 171, 172.
1903 Hydrellia obscuriceps; Becker, p. 171.
1903 Hydrellia scapularis; Becker, p. 171.
1904 Hydrellia griseola; Strobl, p. 564.
1904 Hydrellia scapularis; Coquillett, p. 75.
1905 Hydrellia hypoleuca; Aldrich, p. 627. [Catalog listing].
1905 Hydrellia obscuriceps; Aldrich, p. 627. [Catalog listing].
1905 Hydrellia scapularis; Aldrich, p. 627. [Catalog listing].
1906 Hydrellia griseola; Jones, p. 186. [Catalog listing].
1906 Hydrellia hypoleuca; Jones, p. 185. [Catalog listing].
1906 Hydrellia scapularis; Jones, p. 160, 185. [Catalog listing].
1906 Hydrellia griseola; Lampa, p. 19. [Biology].
1906 Hydrellia hypoleuca; Washburn, p. 80.
1907 Hydrellia griseola; Lameere, p. 580.
1910 Hydrellia griseola; Grünberg, p. 275, 278.
1913 Hydrellia griseola; Linnaniemi, p. 45. [Biology].
1913 Hydrellia griseola; Sorauer and Reh, p. 408-409. [Biology].
1915 Hydrellia scapularis; Malloch, p. 345-346. [Biology].

1915 Hydrellia griseola; Moreley and Atmore, p. 162. [Biology].
1918 Hydrellia hypoleuca; Cresson, p. 49.
1918 Hydrellia scapularis; Cresson, p. 49.
1919 Hydrellia griseola; Becker, p. 203-204.
1921 Hydrellia griseola; Bezzi, p. 7.
1922 Hydrellia scapularis; DeOng, p. 432. [Biology].
1922 Hydrellia griseola; Hering, p. 36. [Biology].
1924 Hydrellia griseola; Frost, p. 94, 169. [Biology].
1924 Hydrellia griseola; Wilke, p. 172-179. [Biology].
1925 Hydrellia griseola; Grimshaw, p. 19. [Biology].
1925 Hydrellia griseola; Hering, p. 538. [Biology].
1925 Hydrellia hypoleuca; Johnson, p. 271.
1925 Hydrellia scapularis; Johnson, p. 272.
1926 Hydrellia griseola; Becker, p. 68.
1926 Hydrellia griseola; Hendel, p. [many; see index]. [Biology].
1926 Hydrellia griseola; Hering, p. 180. [Biology].
1926 Hydrellia hypoleuca; Sturtevant, p. 10; pl. 3, fig. 26. [Female internal genitalia].
1927 Hydrellia griseola; Kreuter, p. 92-98. [Biology].
1928 Hydrellia griseola; Collin, p. 129.
1932 Hydrellia griseola; Cresson, p. 3, 4, 5-8, 9, 16-17, 22.
1933 Hydrellia griseola; Frey, p. 83.
1933 Hydrellia griseola; Hendel, p. 52.
1933 Hydrellia griseola; Vayssière, p. 86-87. [Biology].
1934 Hydrellia griseola; Séguy, p. 430.
1935 Hydrellia griseola var. hypoleuca; Johannsen, p. 56-57.
1937 Hydrellia griseola; Hering, p. [many; see index]. [Biology].
1939 Hydrellia griseola; deMeijere, p. 163.
1942 Hydrellia griseola; Goetghebuer, p. 8.
1944b Hydrellia griseola; Cresson, p. 166-167, 173. [Included var. hypoleuca, obscuriceps, and scapularis].
1944 Hydrellia griseola; Grensted, p. 202.
1945 Hydropota griseola; Kloet and Hincks, p. 396.
1947 Hydrellia griseola; Cresson, p. 38.
1947 Hydrellia griseola; Wahlgren, p. 77-79. [Biology].
1950 Hydrellia griseola; Berg, p. 375.
1950 Hydrellia griseola; Séguy, p. 286, 290. [Biology].
1951 Hydrellia griseola; Hering, p. [many; see index]. [Biology].
1951 Hydrellia griseola; Séguy, p. 96-97; pl. 5, fig. 52. [Biology].
1953 Hydrellia griseola var. scapularis; Lange et al., p. 8-9. [Biology].
1954 Hydrellia griseola; Bertrand, p. 490-491. [Biology].
1955 Hydrellia griseola; Kato, p. 11, 13. [Morphology].
1956 Hydrellia griseola; Wirth and Stone, p. 469.
1957a Hydrellia griseola; Hering, p. [many; see index]. [Biology].

1958 Hydrellia griseola; Hennig, p. 665, fig. 332. [Morphology].
1959 Hydrellia griseola; Dahl, p. [many; see index]. [Biology].
1959 Hydrellia griseola; Grigarick, p. 1-80. [Biology].
1959 Hydrellia griseola; Harrison, p. 223.
1959 Hydrellia griseola; Tsacas, p. 129.
1960 Hydrellia griseola; Glick, p. 12. [Biology].
1960 Hydrellia griseola; Tsacas, p. 243.
1961 Hydrellia griseola; Timon-David, p. 228-230.
1961 Hydrellia griseola; Dahl, p. 44.
1962 Hydrellia griseola; Darby, p. 1, 137. [Biology].
1962 Hydrellia griseola; Fulmek, p. 37. [Biology].
1962 Hydrellia griseola; Le Berre et al., p. 151-160. [Biology].
1964 Hydrellia griseola; Dahl, p. 179-187.
1965 Hydrellia griseola; Deonier, p. 500, 506. [Biology].
1965 Hydrellia griseola; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 22.

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 interfissural 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 postgonital uncus laterad; distal two-thirds or so of distiphallus uniform in breadth; basiphallus with black, spinous, lateral process. Anterior margin of fused valvulae laterales broadly emarginate; B-index about 2.0; C-index 6.0-9.0.

Immatures

Egg Length 0.59-0.71 mm; maximum breadth 0.15-0.17 mm. Chorion very similar to that of *H. ischiaca* (Fig. 73), 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 (Fig. 79).

Third-instar larva   Length 1.67-5.10 mm; maximum breadth 0.23-0.75 mm. Frontoclypeus very similar to that of H. ischiaca (Fig. 88) 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. Richard Dahl (Halsingfors, Sweden, *in litt.*, 1965) informed me that Fallén's collection has been distributed between 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 syntypes 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 females (syntypes) in the Museum of Comparative Zoology, Harvard University, labelled "Type 11158". Type locality: "Middle States". Loew (1862) recorded Osten Sacken as the collector.

Hydrellia obscuriceps Loew   Male and female (syntypes) in the Museum of Comparative Zoology, Harvard University, labelled "Type 11157". Type locality: "Middle States". Loew (1862) stated that Osten Sacken collected the type specimens.

Hydrellia scapularis Loew   Syntypes (1 female examined) in the Museum of Comparative Zoology, Harvard University, labelled "Type 11155". Type locality: "Middle States". Loew (1862) recorded Osten Sacken as the collector.

Material examined

Locality data for the 4,196 adults examined are listed in Appendix B. Immatures: 30 specimens from Iowa: Ames; Siewer's Springs State Park, near Decorah. Minnesota: Rapid River Logging Camp, Hubbard Co; Mississippi River at Sucker Creek, Clearwater Co.

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.

Taxonomic remarks

I have studied specimens of the listed types except those of Notiphila griseola Fallén and Hydrellia communis

Robineau-Desvoidy. In addition, I 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 will probably find additional ones.

Biology

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, thalli of _Lemna minor_, sedge meadow, reed marsh, stems of _Eleocharis_ sp., thalli of _Riccia_ sp., and mats of _Eragrostis hypnoides_.

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 per cent sucrose and 5 per cent hydrolysate solution, and therefore his ranges of the maxima for the adult stadium should be regarded probably as physiological rather than ecological, especially in consideration of the findings of Le Berre _et al_. (1962). Le Berre _et al_. 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 per cent 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 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°-114° F	heat death
107°-110° F	heat paralysis
104°-107° F	dropping
98°-104° F	heat rest
52°-92° F	normal locomotion
40°-50° F	slow walking

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

I observed adults attacking and feeding on adult chironomids, an adult tipulid, and a collembolan. The collembolan was free when captured, but the others were 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 a 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. 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 per cent 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.

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 observations, it stalked some adults. 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 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 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, 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 per cent yeast hydrolysate to a female that had been isolated and fed 10 per cent 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_. (1962) 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.

<u>Egg</u> 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 per cent hatched after 24 hours exposure, 20 per cent hatched after 48 to 120 hours exposure, and none hatched after 148 hours exposure. Normal incubation periods obtained for submerged eggs. Unfertilized eggs collapsed soon after deposition.

<u>Larva</u> According to Grigarick, each larval stadium varied from 2 to 3 days at 80° F. The larval stadia totalled 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 per cent completed development. Larvae eclosed from the

micropylar end of the egg after slitting the chorion with their mouth-hook. Grigarick observed some larvae that remained within the opened chorion from minutes to hours. He stated that generally the larvae began 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°-114° F	.... heat death
104°-111° F	.... heat paralysis
95°-103° F	.... agitated movement
50°- 90° F	.... normal mining and locomotion
36°- 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 per cent mortality in first, second, and third instars after 24 hours exposure and uniformly 100 per cent after 48 hours exposure. In a similar experiment, at 29° F he obtained 20, 70, and 80 per cent mortality in first, second, and third instars after 24 hours exposure and 80, 100, and 100 per cent mortality after 48 hours exposure. These last results do not agree with the overwintering of larvae in sub-boreal and boreal habitats.

In my observations and 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° F. 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 per cent 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, I have listed 40 gramineous genera reported as containing host plants for this species. Additionally, various authors have reported hosts in 20 non-gramineous genera. Most of the latter probably represent incidental puparial hosts. However, I found all three larval instars and puparia in *Nasturtium officinale*. Taylor (1928) reported miners of *H. nasturtii* [as *H. ranunculi*] in this 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 per cent 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 per cent of the California rice crop with a probable loss of $16,000,000. Grigarick (1959) listed the four following 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 rarely after the middle of July.

Parasites I have listed in Table 2, 43 species of Hymenoptera reported as having been reared from *H.* *griseola*. Grigarick reported *Chorebus* *aquaticus*, *Opius* *hydrelliae*, and *Halticoptera* sp. as the most abundant species, overall. He found the parasite density maximum immediately followed the host density maximum. The first generation of *H.* *griseola* had 50 to 60 per cent parasitism. The third generation (first generation on rice) had 1.0 to 2.5 per cent parasitism, but some later generations had 80 to 87 per cent by July. *Opius* *hydrelliae* and *Chorebus* *aquatious* showed the highest densities at this time.

Hydrellia *harti* Cresson

1936 *Hydrellia* *harti* Cresson [in part], p. 262.
1944b *Hydrellia* *harti*; Cresson, p. 170, 175.
1964 *Hydrellia* *harti*; Deonier, p. 115, 125, fig. 4.
1965 *Hydrellia* *harti*; Deonier, p. 500, 506. [Biology].
1965 *Hydrellia* *harti*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 18; female as in Fig. 16D.

Head   Differing mainly from H. bilobifera in: 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: 3-4 adc and 2 pdc; legs mostly light-gray pruinose except moderate yellow tarsi; 5-7 dorsal and 8-11 anterior interfissural 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 postgonital uncus anteriad; distiphallus constricted proximally and preapically and bicarinate ventrally; carinae partly lamellate; most of basiphallus exposed ventrally. Anterior margin of fused valvulae laterales 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* (Fig. 13).

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 2078. Type locality: Havana, Illinois (IX-19-1895, C. A. Hart).

Distribution

California, Illinois, Iowa, Kansas, Mexico, Nebraska, Ontario, Rhode Island, and Quebec. June-September. Locality data for the 57 adults examined are listed in Appendix B.

Biology

Adult Habitats recorded: leaves of *Potamogeton nodosus*, *P. epihydrus*, and *Nuphar advena*; limnic wrack and sedge meadow.

Hydrellia idolator, sp. nov.

Adult

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 Fig. 53.

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 interfissural 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 postgonital uncus directed anterolaterad; distiphallus uniformly tapering to ovoid apex;

basiphallus not nearly covered laterally by valvulae laterales. Anterior margin of fused valvulae laterales narrowly notched medially (for about one-fifth of length); B-index about 5.0; C-index 1.6-2.0.

Holotype

Male in Canadian National Collection, Ottawa. Type locality: Ottawa, Canada (VIII-2-1947, G. E. Shewell).

Distribution

Mississippi, Ontario, and Quebec. June-July. Locality data for 5 adults examined are listed in Appendix B.

Taxonomic 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. However, *H. atroglauca* has a moderate orange-yellow prementum, an ocular index of 7.0-12.0, and 8-10 dorsal and 10-13 anterior interfissural costals.

Biology

Adult   Habitats recorded: mats of *Hydrochloa caroliniensis* and sedges.

Hydrellia insulata, sp. nov.

Adult

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 Fig. 59.

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 interfissural 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 postgonital uncus bent anterolaterad; distiphallus uniform in breadth to papillate apex. Anterior margin of fused valvulae laterales with narrow, shallow notch medially in broad notch; B-index about 3.0; C-index 3.0-3.6.

Holotype

Male in the U.S. National Museum. Type locality: Plummer's Island, Potomac River, Maryland (IX-1-1962, K. V. Krombein).

Material examined

This species is known only by the holotype and 13 others in the series from Plummer's Island, Maryland.

Distribution

Maryland. August-September.

Hydrellia ischiaca Loew

1862 *Hydrellia ischiaca* Loew, p. 150-151.
1896 *Hydrellia ischiaca*; Becker, p. 269. [Index listing].
1906 *Hydrellia ischiaca*; Jones, p. 185. [Catalog listing].
1925 *Hydrellia ischiaca*; Johnson, p. 271.
1944b *Hydrellia ischiaca*; Cresson, p. 165, 173.
1964 *Hydrellia ischiaca*; Deonier, p. 116.

1965 Hydrellia ischiaca; Deonier, p. 500, 506. [Biology].
1965 Hydrellia ischiaca; Wirth; p. 744. [Catalog listing].

Adult

Diagnosis Palpus moderate yellow; 8-10 aristal rays; body length:wing length 0.8-0.9; fore coxa and tibia moderate yellow; 2 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 Fig. 41.

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 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 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 interfissural

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 postgonital uncus laterad; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused valvulae laterales with a narrow, shallow U-shaped notch medially; spicate projection posterolaterally on valvulae laterales; B-index about 2.0, C-index 5.0-8.0.

Immatures

Egg Length 0.59-0.71 mm; maximum breadth 0.15-0.17 mm. Chorion (Fig. 73) 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 (Fig. 79).

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 (Fig. 88). 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 (Fig. 119). 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.

Holotype

Female in the Museum of Comparative Zoology, Harvard University, labelled, "Type 11154." Type locality: "Middle States". Loew (1862) stated that Osten Sacken was the collector.

Material examined

Locality data for the 336 adults examined are listed in Appendix B. Immatures: 322 specimens from Minnesota: 6.5 miles east of Waubun; Sucker Creek, 100 yards north of Highway 31, Clearwater Co.; Douglas Lodge Bay, Lake Itasca; Rapid River Logging Camp, Hubbard Co.; Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co.; Mississippi River at Sucker Creek, Clearwater Co.; Mississippi River, 150 yards north of Highway 31, Clearwater Co.; Biological Station, Lake Itasca.

Distribution

Alaska, California, Connecticut, Georgia, Indiana, Illinois, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New York, North Carolina, Nova Scotia, Ontario, Pennsylvania, Quebec, South Carolina, Tennessee, Texas, Virginia, and West Virginia. May-September.

Taxonomic 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.

Biology

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 increase in population density other than one 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. I tentatively estimated the mean ecological adult stadium of this species in sub-boreal 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 *Hydrellia*). 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 which emerged July 21, were caged July 22, in a large culture dish containing clean rice leaves in tap water. On July 23, 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 July 26, 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 antagonistically 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 aggressively on a specimen of Chorebus aquatious ovipositing in a rice leaf. On another occasion, a male struck aggressively 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 Glyceria grandis. As in Grigarick's (1959) observations of H. griseola, the females showed notable preference for floating leaves of wild rice, especially the leaf apices. At the end of the summer, when floating leaves were uncommon, the females oviposited on the leaves closest to the water surface.

Egg I collected and observed the eggs only on the adaxial 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. The mean period was 4 days. The ecological incubation period probably ranges from 2 to 4 days in sub-boreal and boreal habitats.

Larva The first larval stadium ranged from 3 to 5 days in the laboratory for three larvae. The first-instar larvae moved about actively after eclosion 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 in the laboratory for nine larvae. The third larval stadium ranged from 3 to 9 days, with a mean of 5 days for 11 larvae.

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. The leaf mined by a third-instar larva was usually yellowish and the apical half often completely skeletonized.

Puparium   The puparial phase ranged from 4 to 20 days, with a mean of 6 days in the laboratory for 30 puparia. The time from larval eclosion to adult emergence ranged 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 skeletonized leaves. Rarely, I found puparia in the stems. Often the puparia had their spiracular peritremes embedded in the adaxial epidermis but many were lying unattached between the abaxial and adaxial epidermis. I found puparia oriented in various attitudes to the leaf axis, but commonly they were oriented parallel to the leaf axis. In one leaf, I found six puparia, two of which were contiguous and parallel.

Host plants I found the preferred host plant to be *Zizania aquatica* in the region of Itasca State Park, Minnesota. *Glyceria grandis* and *G. obtusa* were the only other species in which I found larvae feeding. I reared *H. ischiaca* from *G. obtusa* and *G. grandis* collected both from areas near *Z. aquatica* and from areas quite far from it. I found one puparium in a floating leaf of *Potamogeton natans* near a stand of infested *Z. aquatica*, and a third-instar larva pupariated in a floating leaf of *P. natans* in the laboratory. Since both 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 infested rice growing in quiet water supported this assumption.

I measured the per cent 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, July 28, 33 per cent of 23 plants showed obvious infestation. Of the infesting immatures, 90 per cent 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 August 13, had 50 per cent infested. The third sample of 27 plants taken August 19, from a sparse stand of *Z. aquatica* and

Scirpus sp. exposed to the prevailing westerly wind and waves near the Biological Station had 89 per cent infestation.

Earlier in the season, on June 20, at Douglas Lodge Bay, Lake Itasca, I found eggs on the floating leaves of 50 per cent of a sample of 25 rice plants and larvae in 80 per cent of the same sample. On July 2, at Rapid River Logging Camp, Hubbard Co., Minnesota, I found an infestation of about 70 per cent 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.

I reared the following Hymenoptera from *H. ischiaca* puparia: *Chorebus aquaticus*, *Chorebidella bergi*, *Chaenusa* sp. nov. (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 July 9, pupariated, and on July 15, the puparium containing a late, white, fly pupa was transferred to a large test tube. On August 27, when the diapriid emerged, an examination showed a pupal exuviae within the original puparium.

On July 28, 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.

Hydrellia itascae, sp. nov.

Adult

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 interfissural costals. Male length 2.89-3.06 mm; female 2.98-3.23 mm. Male terminalia as in Fig. 43.

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 interfissural 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 postero-medially (about 100° from lateral corner) and irregularly setose, with verrucate anteromedial lobe. Postgonite directed anterolaterad; postgonital uncus absent; distiphallus uniform in breadth (all but apex covered by fused valvulae laterales). Anterior margin of fused valvulae laterales deeply cleft medially; B-index about 0.8.

Immatures

Third-instar larva Body of larva not examined. Fronto-clypeal length 0.50-0.60 mm; cheliform spot arms removed from clypeal arch by their length (Fig. 91). 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 (Fig. 107). 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.

Holotype

Male in the U.S. National Museum. Type locality: University of Minnesota Biological Station, Itasca State Park, Clearwater Co., Minnesota (VI-26-1963, D. L. Deonier).

Material examined

Locality data for the 16 adults examined are listed in Appendix B. Immatures: 9 specimens from Douglas Lodge Bay, Lake Itasca, Minnesota.

Distribution

Minnesota. June.

Taxonomic remarks

This species may be confused with *H. manitobae* in a macroscopic field examination.

Biology

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

1944b *Hydrellia lata* Cresson, p. 165.
1965 *Hydrellia lata*; Wirth, p. 744. [Catalog listing].

Adult

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 interfissural 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 interfissural 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.

Holotype

Female in the Academy of Natural Sciences of Philadelphia, No. 6655. Type locality: Nasel River, Pacific Co., Washington (VII-15-1922, A. L. Melander).

Material examined

I examined the holotype and two females with the same collection data. They are the only known specimens of the species.

Distribution

Washington. July.

Taxonomic 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 very similar to that of either *H. platygastra* or *H. serena*.

Hydrellia luctuosa Cresson

1942 *Hydrellia luctuosa* Cresson, p. 78.
1944b *Hydrellia luctuosa*; Cresson, p. 170, 171.
1950 *Hydrellia luctuosa*; Berg, p. 375, 376, 377, 384, 385 (pl. 2, fig. 1), 387, 388, 389 (pl. 3, fig. 1), 396. [Biology, morphology, and taxonomy of immatures].
1964 *Hydrellia luctuosa*; Deonier, p. 117.
1965 *Hydrellia luctuosa*; Deonier, p. 500, 506. [Biology].
1965 *Hydrellia luctuosa*; Wirth, p. 744. [Catalog listing].

Adult

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 interfissural costals; body generally dark olive-brown. Male length 1.79-1.97 mm; female 1.87-2.04 mm. Male terminalia as in Fig. 61.

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.

<u>Thorax</u> 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 interfissural 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.

<u>Abdomen</u> 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 postgonital uncus laterad; distiphallus tapering distally and carinate ventrally. Anterior margin of fused valvulae laterales ovoid; B-index about 1.2; C-index 1.8-2.3.

<u>Immatures</u>

<u>Second-instar larva</u> 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.

<u>Third-instar larva</u> Length 3.00-4.20 mm; maximum breadth 0.40-0.60 mm. Frontoclypeal length 0.40-0.55 mm;

feeding apparatus mostly dark (Fig. 102). Ventral fronto-clypeal 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 (Fig. 104). 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6620. Type locality: Bessey Creek, Cheboygan Co., Michigan (VIII-14-1941, C. O. Berg).

Material examined

Locality data for the 133 adults examined are listed in Appendix B. Immatures: 42 specimens from Michigan: Cheboygan Co. Minnesota: Douglas Lodge Bay, Lake Itasca; Squaw Lake, Itasca State Park.

Distribution

Iowa, Kansas, Michigan, Minnesota, Ontario, and Quebec. June-September.

Taxonomic remarks

This species probably belongs to the *H. prudens* group.

Biology

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 per cent 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 moult 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, June 20, and only puparia at Squaw Lake, Itasca State Park, August 14.

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, sp. nov.

Adult

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 interfissural 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 Fig. 26.

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 interfissural 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 postgonital uncus posterolaterad; distiphallus constricted at midlength and carinate ventrally. Anterior margin of fused valvulae laterales convex with medial indentation; B-index about 1.8; C-index 0.8-1.3.

Holotype

Male in the U.S. National Museum. Type locality: La Trappe, Quebec, Canada (VIII-14-1934, J. Ouellet).

Distribution

Alaska, Alberta, Manitoba, Ontario, Quebec, and Saskatchewan. June-August. Locality data for the 40 adults examined are listed in Appendix B.

Taxonomic 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, sp. nov.

Adult

Diagnosis Palpus dark brown; 6-8 aristal rays; vertex index 5.0-6.8; all fronto-orbitals anterially inclined; 8-11 dorsal and 9-12 anterior interfissural costals; thoracic pleuron with light-gray area. Male length 1.70-1.87 mm; female 1.87-2.30 mm. Male terminalia as in Fig. 32.

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 anterially 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 interfissural 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; postgonital uncus almost straight; distiphallus transversely expanded proximally and near papillate apex; basolateral bladelike process projecting from basiphallus dorsal to valvulae laterales. Anterior margin of fused valvulae laterales broadly and shallowly concave with medial indentation; B-index about 1.8; C-index 3.0-4.0.

Holotype

Male in the U.S. National Museum. Type locality: Sardine Creek, Mono Co., California, 8500 ft. (VII-11-1951, A. T. McClay).

Distribution

Arizona, California, Colorado, Mexico, Nevada, New Mexico, and Oregon. February-October. Locality data for the 63 adults examined are listed in Appendix B.

Taxonomic 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*.

Biology

Adult Habitats recorded: *Eleocharis* sp., *Equisetum* sp., and margins of hot springs.

Hydrellia morrisoni Cresson

1924 *Hydrellia morrisoni* Cresson, p. 162.
1925 *Hydrellia morrisoni*; Johnson, p. 271.
1931 *Hydrellia morrisoni*; Cresson, p. 105.
1944b *Hydrellia morrisoni*; Cresson, p. 168, 171.
1964 *Hydrellia morrisoni*; Deonier, p. 117, 124, Fig. 11.
1965 *Hydrellia morrisoni*; Deonier, p. 500, 506. [Biology].
1965 *Hydrellia morrisoni*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 34.

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 (Fig. 11). 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 interfissural 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 postgonital uncus slightly laterad; distiphallus tapering to retuse apex. Anterior margin of fused valvulae laterales broadly emarginate; B-index about 1.2; C-index 0.7-1.0.

Immatures

Third-instar larva   Body of larva not examined. Frontoclypeal length 0.60 mm; entire feeding apparatus dark (Fig. 85). 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 (Fig. 118). 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.

Holotype

Male in the U.S. National Museum. Type locality: White Mountains of New Hampshire (Morrison).

Material examined

Locality data for the 47 adults examined are listed in Appendix B. Immatures: 1 specimen from Inlet Valley, Ithaca, New York.

Distribution

Alaska, Iowa, Manitoba, Massachusetts, Michigan, Minnesota, New Hampshire, New Mexico, New York, North Carolina, Ontario, Quebec, Tennessee, Washington. May-August.

Taxonomic remarks

The holotype of this species is in very poor condition.

Biology

Adult Habitats recorded: leaves of *Glyceria grandis* and *Sagittaria latifolia*; reed marsh and sedge meadow.

Hydrellia nobilis (Loew)

1862 *Psilopa nobilis* Loew, p. 229.
1872 *Psilopa nobilis*; Loew, p. 92.
1878 *Psilopa nobilis*; Osten Sacken, p. 201.
1896 *Psilopa nobilis*; Becker, p. 270. [Bibliographic listing].
1905 *Psilopa nobilis*; Aldrich, p. 625. [Catalog listing].
1906 *Psilopa nobilis*; Jones, p. 180. [Catalog listing].
1931 *Hydrellia nobilis*; Cresson, p. 105.
1944b *Hydrellia nobilis*; Cresson, p. 164, 173.
1964 *Hydrellia nobilis*; Deonier, p. 116.
1965 *Hydrellia nobilis*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 28.

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 interfissural 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; postgonital uncus short, straight; distiphallus undulate laterally and lamellate ventrally; apical basiphallus breadth 2.0 times anterior breadth of fused valvulae laterales. Anterior margin of fused valvulae laterales emarginate medially; B-index about 5.5; C-index 2.5-3.5.

Holotype

Male in the Museum of Comparative Zoology, Harvard University, No. 11143. Type locality: District of Columbia (Osten Sacken).

Distribution

Illinois, Indiana, Iowa, Minnesota, New Jersey, New York, Pennsylvania, Quebec, and Virginia. June-September. Locality data for the 97 adults examined are listed in Appendix B.

Taxonomic remarks

Hydrellia nobilis, *H. atroglauca*, and *H. idolator* appear to constitute a species group.

Biology

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 *in copulo* 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 exserted its phallus for a few seconds before being forced off. It did this 11 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.

Hydrellia notata, sp. nov.

Adult

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 Fig. 55.

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 interfissural 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; postgonital uncus fusiform and straight; distiphallus short, almost uniform in breadth to slightly convex apex. Anterior margin of fused valvulae laterales deeply V-clefted medially to a central gibba; B-index about 2.6; C-index 5.0-6.5.

Holotype

Male in the U.S. National Museum. Type locality: Canaan, Connecticut (VIII-31-1952, A. Stone).

Distribution

Connecticut, Florida, Georgia, Mississippi, and New York. March-August. Locality data for the 6 adults examined are listed in Appendix B.

Taxonomic remarks

On the basis of several characters, this very distinct species belongs in the *H. formosa* species group.

Biology

Adult Habitats recorded: leaves of *Nymphaea odorata* and seepage slope.

Hydrellia notiphiloides Cresson

1924 *Hydrellia notiphiloides* Cresson, p. 162.
1944b *Hydrellia notiphiloides*; Cresson p. 170, 175.
1965 *Hydrellia notiphiloides*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 59.

Head Face light gray or pale yellow; 4-6 pfa; epistomal index 1.0-1.3; mesofacial index 1.3-1.9; vertex index 3.5-5.5; 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 interfissural 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 postgonital uncus posterolaterad and truncate apically; distiphallus tapering distally. Anterior margin of fused valvulae laterales shallowly notched medially; B-index about 1.0; C-index 2.0-2.5.

Immatures

Third-instar larva   Body of larva not examined. Frontoclypeal length 0.48-0.60 mm; cheliform spot oblique to dorsal phragmatal ramus (Fig. 93). 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 (Fig. 81).

Puparium   Length 3.25-4.00 mm; maximum breadth 1.00-1.25 mm; fusiform (Fig. 113). 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.

Holotype

Male in collection at Ohio State University. Type locality: Cedar Point, Sandusky, Ohio (VIII-5-1902).

Material examined

Locality data for the 123 adults examined are listed in Appendix B. Immatures: 8 specimens from Davis, California, and Cheboygan Co., Michigan.

Distribution

Widespread from central Mexico into Canada. April-September.

Taxonomic remarks

Adults of *H. notiphiloides* and *H. caliginosa* are so similar that inspection of the male terminalia may be often necessary. I have not seen the holotype of this species.

Biology

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 of 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

1944b Hydrellia penicilli Cresson, p. 168-169.
1964 Hydrellia penicilli; Deonier, p. 116.
1965 Hydrellia penicilli; Deonier, p. 500, 506. [Biology].
1965 Hydrellia penicilli; Wirth; p. 744. [Catalog listing].

Adult

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 Fig. 56.

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 interfissural 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 anddensely setulose and truncate posteriorly. Postgonite bent anteriad and postgonital uncus slightly laterad; distal two-thirds of distiphallus uniform in breadth. Anterior margin of fused valvulae laterales deeply and narrowly cleft medially to three-fourths of length of structure; B-index about 1.0; C-index 1.5-2.0.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6656. Type locality: Pembroke, Ontario, Canada (VII-3-1938, A. L. Melander).

Distribution

British Columbia, Iowa, Maine, Manitoba, Michigan, New York, Ontario, Quebec, and Washington. May-August. Locality data for the 14 adults examined are listed in Appendix B.

Taxonomic remarks

This species seems closely related to *H. cruralis*, *H. notiphiloides*, and *H. cessator*.

Biology

Adult Habitat recorded: reed marsh.

Hydrellia personata, sp. nov.

Adult

Diagnosis   Palpus dark brown; 6-8 aristal rays; dorsal interfissural 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 Fig. 67.

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 interfissural 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; antero-lateral margin of sternum 5 rounded through 95°-100° angle;

copulobus almost truncate posteriorly and irregularly setose. Postgonite straight and covered by valvulae laterales; postgonital 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 valvulae laterales acutely papilliform medially; B-index about 4.5; C-index 0.4-0.7.

Holotype

Male in collection at Washington State University. Type locality: O'Sullivan Dam, Grant Co., Washington (X-30-1954, H. G. Davis).

Distribution

Arizona, California, Iowa, Texas, and Washington. April-June. Locality data for the 25 adults examined are listed in Appendix B.

Taxonomic remarks

I have not placed 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.

Biology

Adult   Habitats recorded: sedge meadow and margin of Mono Lake, California.

Hydrellia platygastra Cresson

1931 Hydrellia platygastra Cresson, p. 105, 106.
1944b Hydrellia platygastra; Cresson, p. 168, 172.
1965 Hydrellia platygastra; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 30.

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 interfissural 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 postgonital uncus straight; distal half of distiphallus shallowly undulate laterally and lamellate ventrally. Anterior margin of fused valvulae laterales broadly emarginate; B-index about 2.0; C-index 0.5-0.8.

Holotype

Male in the Academy of Natural Sciences of Philadelphia. Type locality: Beaver Creek, Newport, Oregon (no date, J. M. Aldrich).

Distribution

British Columbia, California, Idaho, Nebraska(?), Oregon, and Washington. May-September. Locality data for the 71 adults examined are listed in Appendix B.

Taxonomic 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 justified 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

1915 *Hydrellia proclinata* Cresson, p. 69-70.
1931 *Hydrellia proclinata*; Cresson, p. 107.
1944b *Hydrellia proclinata*; Cresson, p. 165-171.
1956 *Hydrellia proclinata*; Wirth and Stone, p. 469.
1965 *Hydrellia proclinata*; Wirth, p. 744. [Catalog listing].

Adult

Diagnosis   Palpus dark brown; 6-8 aristal rays; all fronto-orbitals anterially 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 Fig. 27.

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 anterially 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 interfissural 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 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 postgonital 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 valvulae laterales nearly truncate with only slight medial indentation; B-index about 2.0; C-index 0.8-1.0.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6075. Type locality: Berkeley Hills, Alameda Co., California (IV-20-1908, E. T. Cresson, Jr.).

Distribution

From the High Plains west to the Pacific Coast and south to Mexico State, Mexico. March-January. Locality data for the 781 adults examined are listed in Appendix B.

Taxonomic remarks

Except for *H. decens*, the male of which is unknown, this species could probably be confused only with *H. melanderi*. *Hydrellia melanderi* and *H. proclinata* differ greatly only in the male terminalia, but the light-gray pleural spots are fused in *H. melanderi* and separate in *H. proclinata*.

Biology

Adult   Habitats recorded: *Equisetum* 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

1934 *Hydrellia proctori* Cresson, p. 235.
1936 *Hydrellia procteri*; Cresson p. 257. [Emendation of *lapsus calami*].
1944b *Hydrellia procteri*; Cresson, p. 169, 174.
1964 *Hydrellia procteri*; Deonier, p. 116.
1965 *Hydrellia procteri*; Deonier, p. 500, 506. [Biology].
1965 *Hydrellia procteri*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 52.

<u>Head</u> 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.

<u>Thorax</u> 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 interfissural 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.

<u>Abdomen</u> 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; postgonital uncus straight; distiphallus constricted preapically and lamellate ventrally. Anterior margin of fused valvulae laterales broadly and slightly concave; B-index about 5.0; C-index 1.0-1.5.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6152. Type locality: Bar Harbor, Mt. Desert Island, Maine (V-7-1933, W. Procter).

Distribution

Connecticut, Illinois, Iowa, Kansas, Maine, Michigan, and New Jersey. July-September. Locality data for the 53 adults examined are listed in Appendix B.

Taxonomic 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.

Biology

Adult Habitats recorded: leaves of *Potamogeton nodosus* and *Nelumbo lutea*; limnic wrack, sedge meadow, mud flat, and riffle rocks.

Hydrellia prudens Curran

1930 *Hydrellia prudens* Curran, p. 78.
1944b *Hydrellia prudens*; Cresson, p. 164, 172.
1965 *Hydrellia prudens*; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 63.

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 interfissural 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; postgonital uncus with tip bent about 45° laterad; distiphallus short, triangular, and furrowed ventrally between 2 carinae. Anterior margin of fused valvulae laterales moderately concave medially; B-index 0.8-1.0; C-index 0.8-1.0.

Holotype

Male in the American Museum of Natural History. Type locality: Station for Study of Insects, Tuxedo, New York (VI-29-1928, C. H. Curran).

Distribution

Massachusetts, New York, and Pennsylvania. June-August. Locality data for the 6 adults examined are listed in Appendix B. Wirth (1965) listed Idaho, Maine, New York, and eastern Canada as the geographic distribution of this species.

Taxonomic remarks

Cresson (1944, p. 164) listed *Hydrellia johnsoni* Cresson as a full synonym of *H. prudens*. I found this to be wrong after examination of the male terminalia in at least two specimens labelled by Cresson as paratypes of *H. johnsoni*. The exact status of *H. johnsoni* must remain undetermined until its holotype is made available for terminalia study.

Biology

Adult Habitat recorded: leaves of *Nuphar advena*.

Hydrellia pulla Cresson

1931 Hydrellia pulla Cresson, p. 108.
1944b Hydrellia pulla; Cresson, p. 170, 175.
1950 Hydrellia pulla; Berg, p. 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].
1964 Hydrellia pulla; Judd, p. 412. [Biology].
1965 Hydrellia pulla; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 65.

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 interfissural 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; postgonital uncus buttonlike; pregonite breadth 2-3 times postgonite breadth; distiphallus tapering distally and ventrally bicarinate. Anterior margin of fused valvulae laterales slightly concave; B-index about 1.0; C-index 3.0-4.0.

Immatures

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 (Fig. 82). 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 (Fig. 111). 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.

Holotype

Female in the Academy of Natural Sciences of Philadelphia. Type locality: Spencer Lake, New York (VI-30-1907). Labelled, "loaned property of Cornell."

Material examined

Locality data for the 72 adults examined are listed in Appendix B. Immatures: 67 specimens from Michigan: Cheboygan Co.; Washtenaw Co. Minnesota: Two Island Lake, Itasca State Park; 1.3 miles south of main entrance, Itasca State Park.

Distribution

British Columbia, Michigan, Minnesota, New York, Ontario, Quebec, Washington, and Wisconsin. May-October.

Taxonomic 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.

Biology

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 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 July 8 to July 12, when it pupariated. On July 12, 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 July 25. 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

August 2. On August 5, 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, sp. nov.

Adult

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 Fig. 37.

Head Face light yellowish-brown; 4-6 pfa; epistomal index 12.-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 interfissural 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 postgonital uncus anteromediad; distiphallus short and nearly uniform in breadth to ovoid apex. Anterior margin of fused valvulae laterales with 4 deep clefts; B-index about 2.0; C-index 1.5-2.0.

Holotype

Male in the U.S. National Museum. Type locality: Samburg, Reelfoot Lake, Tennessee, 36°22.9' north, 89°21.3' west (VIII-12-1962, D. L. Deonier).

Distribution

Kentucky, Tennessee, and Texas. July-August. Locality data for the 10 adults examined are listed in Appendix B.

Taxonomic 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*.

Biology

Adult Habitats recorded: leaves of *Heteranthera dubia* and *Sagittaria australis*.

Hydrellia saltator, sp. nov.

Adult

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 Fig. 31.

Head Differing mainly from *H. crassipes* in: mesofacial index 1.7-2.0; ocular index 6.0-7.0; antenna velvety black.

Thorax Differing mainly from *H. crassipes* in: 2 basal coxals; wing length 2.47-2.98 mm; 7-10 dorsal and 10-12 anterior interfissural 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; postgonital 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 valvulae laterales 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.

Holotype

Male in the U.S. National Museum. Type locality: Grand Bend, Ontario, Canada (VII-10-1939, G. E. Shewell). This male and a female from the type locality are the only known specimens of this species.

Taxonomic 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

1931 *Hydrellia serena* Cresson, p. 104.
1934 *Hydrellia serena*; Cresson, p. 236.
1944b *Hydrellia serena*; Cresson, p. 165, 174.
1965 *Hydrellia serena*; Wirth, p. 744. [Catalog listing].

Adult

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 interfissural costals. Male length 1.79-2.24 mm; female 2.18-2.40 mm. Male terminalia as in Fig. 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 interfissural 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 margin 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 postgonital uncus slightly laterad; distiphallus apex lanceolate; basiphallus not nearly covered laterally by valvulae laterales. Anterior margin fused valvulae laterales deeply and narrowly cleft medially, with 7-9 setae conspicuous on each corner; B-index about 5.0; C-index 0.3-0.8.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6482. Type locality: Ilwaco, Washington (VII-1917, A. L. Melander).

Distribution

Alaska, Alberta, British Columbia, Colorado, Idaho, Manitoba, Northwest Territories, Oregon, Washington. June-September. Locality data for the 193 adults examined are listed in Appendix B.

Biology

Adult Habitats recorded: *Equisetum* sp. at 9500 ft., peat bog, and unspecified at 10,856 ft.

Hydrellia spinicornis Cresson

1918 Hydrellia spinicornis Cresson, p. 48, pl. 3, fig. 5.
1947a Hydrellia spinicornis; Cresson, p. 38.

Adult

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 Fig. 42.

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 interfissural 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 posterially 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 valvulae laterales deeply cleft medially to central gibba; valvulae laterales with acute anterolateral processes; B-index about 3.3; C-index 8.0-10.0.

<u>Immatures</u>

<u>Egg</u> Length 0.40-0.55 mm; maximum breadth 0.14-0.15 mm. Chorion (Fig. 75), yellowish-gray, corrugate, with the few longitudinal ridges occasionally anastomosing; spaces between ridges regularly micropunctate. Micropylar protuberance infundibulate, exposed in dorsal view.

<u>First-instar larva</u> 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 (Fig. 89). Heavily sclerotized supraspiracular spinous processes present.

<u>Second-instar larva</u> 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 (Fig. 101). Spiracular peritreme distinct as in Fig. 76; 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 (Fig. 86). 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 (Fig. 114). 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6121. Type locality: Alajuela, Costa Rica, sweeping at 3100 feet (IX-15-1909, P. A. Calvert).

Material examined

Locality data for the 332 adults examined are listed in Appendix B. Immatures: 26 specimens from Lake Shady and Dickinson's Pond, Lamar Co., Mississippi.

Distribution

Florida, Georgia, and Mississippi. June-September.

Taxonomic 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.

Biology

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

1931 Hydrellia subnitens Cresson, p. 106.
1936 Hydrellia subnitens; Cresson, p. 258.
1941 Hydrellia subnitens; Cresson, p. 37.
1944b Hydrellia subnitens; Cresson, p. 169, 174.
1965 Hydrellia subnitens; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 33.

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 interfissural 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; postgonital uncus straight (directed anterolaterad); distiphallus tapering to nearly truncate apex; distiphallus lamellate ventromedially. Anterior margin of fused valvulae laterales broadly concave, with media cleft; B-index about 2.0; C-index 0.3-0.5.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6484. Type locality: Tacoma, Washington (VIII-27-1911, A. L. Melander).

Distribution

Oregon, Washington, and Wyoming. July-September. Locality data for the 4 adults examined are listed in Appendix B.

Hydrellia surata, sp. nov.

Adult

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 Fig. 48.

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 interfissural 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 valvulae laterales; postgonital uncus very conspicuous and nearly straight; distiphallus transversely expanded at midlength and with triangular apex. Anterior margin of fused valvulae laterales deeply and broadly concave; B-index about 0.6; C-index 0.9-1.1.

Holotype

Male in the U.S. National Museum. Type locality: Two Island Lake, Itasca State Park, Becker Co., Minnesota (VI-28-1963, D. L. Deonier).

Distribution

Connecticut, Florida, Idaho, Manitoba, Massachusetts, Minnesota, Mississippi, New York, Ontario, and Pennsylvania. June-September. Locality data for the 104 adults examined are listed in Appendix B.

Taxonomic remarks

See remarks under *H. columbata*.

Biology

Adult Habitats recorded: leaves of *Potamogeton natans*, *Nymphaea tuberosa*, *Nelumbo lutea*, *Hydrocotyle bonariensis*, and *Sparganium chlorocarpum*.

Hydrellia suspecta Cresson

1936 *Hydrellia suspecta* Cresson, p. 258-259.
1944b *Hydrellia suspecta*; Cresson, p. 169, 174.
1964 *Hydrellia suspecta*; Deonier, p. 117.
1965 *Hydrellia suspecta*; Deonier, p. 500, 506. [Biology].
1965 *Hydrellia suspecta*; Wirth, p. 744. [Catalog listing].

Adult

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 valvulae laterales 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 interfissural 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 [valvulae laterales] of male exerted, flattened much longer than broad."

Holotype

Male at Academy of Natural Sciences of Philadelphia, No. 6529. Type locality: New Mill Pond, Mount Desert Island, Maine (VII-12-1935, W. Procter).

Distribution

Iowa and Maine. July. Locality data for the 2 adults examined are listed in Appendix B.

Taxonomic 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.

Biology

Adult Habitats recorded: leaves of *Nuphar advena*; reed marsh.

Hydrellia tibialis Cresson

1917 *Hydrellia tibialis* Cresson, p. 341
1918 *Hydrellia tibialis*; Cresson, p. 47, 48.
1925 *Hydrellia tibialis*; Johnson, p. 272.
1931 *Hydrellia tibialis*; Cresson, p. 106.
1932 *Hydrellia tibialis*; Cresson, p. 14.
1941 *Hydrellia tibialis*; Cresson, p. 37.
1944b *Hydrellia tibialis*; Cresson, p. 164, 172.

1947 Hydrellia tibialis; Cresson, p. 38, 39.
1956 Hydrellia tibialis; Wirth and Stone, p. 469.
1964 Hydrellia tibialis; Deonier, p. 116.
1965 Hydrellia tibialis; Deonier, p. 500, 506. [Biology].
1965 Hydrellia tibialis; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 45.

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 interfissural 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; postgonital uncus directed anteriad or bent slightly laterad; distiphallus short, tapering distally. Anterior margin of fused valvulae laterales truncate (indistinctly mucronate); B-index about 1.6; C-index 0.8-1.2.

<u>Immatures</u>

<u>Third-instar larva</u> The frontoclypeus was lost in the extraction of the only puparium. It was entirely black like the mouth-hook (Fig. 103). Mouth-hook beak about 0.8 as long as base; maximum mouth-hook base thickness about 1.6 times that of beak.

<u>Puparium</u> Length approximately 3.75 mm; maximum breadth 0.95 mm; fusiform (Fig. 115). 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.

<u>Holotype</u>

Male in the Academy of Natural Sciences of Philadelphia, No. 6141. Type locality: Moscow, Idaho (X-9-1907, J. M. Aldrich).

Material examined

Locality data for the 2,847 adults examined are listed in Appendix B. Immatures: 1 specimen from Banner Mine Area, Warren Co., Iowa ($41^{\circ}26.4'$ north, $93^{\circ}33.8'$ west).

Geographic distribution

Widespread in 38 states or provinces from Alaska to Florida. March-December. According to Wirth (1965), this species occurs also in Mexico and Bolivia.

Taxonomic 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 those *H. americana*, *H. definita*, and *H. prudens*.

Biology

Adult   Habitats recorded: stems of *Eleocharis calva* and *E.* 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 Co., 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 Co., 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

1944a *Hydrellia trichaeta* Cresson, p. 7.
1925 *Hydrellia coniformis*; Johnson[in part], p. 271.
[*lapsus calami*, *fide* Cresson, 1944b, p. 135].
1936 *Hydrellia conformis*; Cresson [in part], p. 261.
1944b *Hydrellia trichaeta*; Cresson [in part], p. 170, 175.
1964 *Hydrellia trichaeta*; Deonier, p. 115, 125, fig. 4.

Adult

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 Fig. 50; female as in Fig. 16B.

Head Differing mainly from *H. bilobifera* in: ocular index 6.1-8.6; 8-9 aristal rays.

Thorax Differing mainly from *H. bilobifera* in: 3-4 adc and 2 pdc; wing length 1.67-2.04 mm; veins dark brown; 6-8 dorsal and 8-10 anterior interfissural 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 postgonital uncus having seriated setae, and with lateral triangular lobe. Postgonite bent mediad; acuminate postgonital 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 valvulae laterales 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* (Fig. 13).

Immatures

Third-instar larva   Body of larva not examined. Frontoclypeal length 0.50 mm (Fig. 97). 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 (Fig. 112). 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.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 816. Type locality: Redding, Connecticut (VIII-3-1931, A. L. Melander).

Material examined

Locality data for the 54 adults examined are listed in Appendix B. Immatures: 13 specimens from Lake Bohall, Itasca State Park, Minnesota.

Distribution

Connecticut, Iowa, Kansas, Massachusetts, Minnesota, New York, Ontario, Rhode Island, Tennessee, and Virginia. June-September.

Biology

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 July 18, copulated, produced eggs July 20, and died July 21. The females deposited 11 eggs on floating leaves of *P. nodosus*.

Egg and larva The incubation period for three eggs lasted 4 days. The first and second larval stadia combined amounted to 13 days for two larvae. I found larvae of Dytiscidae to be efficient predators on *H. trichaeta* larvae in the laboratory.

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* and *P. nodosus*.

Hydrellia valida Loew

1862 *Hydrellia valida* Loew, p. 153.
1878 *Hydrellia valida*; Osten Sacken, p. 202.
1896 *Hydrellia valida*; Becker, p. 269. [Index listing].
1904 *Hydrellia valida*; Johnson, p. 163.
1905 *Hydrellia valida*; Aldrich, p. 627. [Catalog listing].
1906 *Hydrellia valida*; Jones, p. 185. [Catalog listing].
1925 *Hydrellia valida*; Johnson, p. 271-272.
1944a *Hydrellia valida*; Cresson, p. 7.
1944b *Hydrellia valida*; Cresson, p. 167, 173.
1965 *Hydrellia valida*; Wirth, p. 744. [Catalog listing].

Adult

Diagnosis Palpus moderate yellow; 5-7 aristal rays; vertex index 6.0-7.5; 12-15 anterior interfissural 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 Fig. 23.

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 interfissural 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; antero-lateral margin of sternum 5 obtusely rounded; copulobus nearly truncate (occasionally slightly convex) posteriorly and irregularly setose except on posterior margin. Postgonite bent anterolaterad; postgonital uncus short, bent laterad; distiphallus uniform in breadth; basiphallus with black, spinous lateral process. Anterior margin of fused valvulae laterales broadly emarginate; B-index about 2.7; C-index 8.0-10.0.

Holotype

Female in the Museum of Comparative Zoology, Harvard University, No. 11156. Type locality: "Middle States". Loew (1862) stated that Osten Sacken was the collector.

Distribution

This species is most probably maritime from southern Texas to New Brunswick, Canada. It is recorded from 11 Atlantic and Gulf states or provinces. June-September. Locality data for the 84 adults examined are listed in Appendix B.

Taxonomic remarks

Hydrellia valida is a sibling species of *H. griseola*, but it has some differential characters other than the male terminalia.

Biology

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*.

Hydrellia wilburi Cresson

1944b Hydrellia wilburi Cresson, p. 168, 172.
1965 Hydrellia wilburi; Wirth, p. 744. [Catalog listing].

Adult

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 Fig. 30.

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 interfissural 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_.

Holotype

Male in the Academy of Natural Sciences of Philadelphia, No. 6657. Type locality: Bear Lake, Routt Co., Colorado, 8500 ft. (VIII-19-1935, D. A. Wilbur).

Distribution

British Columbia, California, Colorado, and Wyoming. July-August. Locality data for the 79 adults examined are listed in Appendix B.

Taxonomic remarks

The male terminalia of _H. wilburi_ and _H. platygastra_ appear to be identical. They 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.

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APPENDIX A

Illustration Labels

A3AP	apicodorsal antennals
AAC	preacrostichal
AC	anteclypeus
ACB	anteclypeal breadth
ADC	predorsocentral
ADT	accessory-gland duct
AEM2	mesanepimeron
AES2	mesanepisternum
AFR	anterior fronto-orbital
AG	accessory gland (Fig. 2, 14)
AG	pregonite (Fig. 4, 5, 6, 9)
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
BC	basicoxal
BEC	basal end of costa
BF	basal follicle
BP	basiproboscis
BPH	basiphallus
BS	basiphallic socket
BSC	basal scutellar
CA	canaliculi (Fig. 1, 121)
CA	cardia (Fig. 3)
CA	halter capitellum (Fig. 8)
CAR	clypeal arch
CB	cibarium
CE	compound eye (Fig. 1)
CE	cercus (Fig. 5, 6, 126, 128)
CF	distal costal fissure
CH	chorion
CL	copulobus
CM	crop meatus
CR	crop proper
CS	cervical sclerite 2 (Fig. 8)
CS	longitudinal ridges (Fig. 71, 136)
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 (collapsed)
DPH	distiphallus
DPR	dorsal phragmatal ramus
EDT	ejaculatory duct
EE	escape exit made by parasite
EO	dehydrated embryo
EP	epistoma
ES	esophagus (Fig. 1)
ES	epithelial sheath (Fig. 2)
FCS	epistomal sulcus
FPL	frontoclypeal plate
GA	gonal arch
GC	genital chamber
GE	genal
h	humeral crossvein
IA	interalar
IFC	interfissural costals
ISC	intermediate scutellar
IV	inner vertical
KES2	mesokatepisternum
LA	labellum (Fig. 1, 121)
LA	labium (Fig. 78)
LAP	labral apodeme
LDT	labial-gland duct (Fig. 3)
LF	parafrontale
LG	labial gland
LGD	labial-gland duct (Fig. 84)
LM	labrum
LO	lateral ocellus
LS	labial sclerite
LT	laterotergite
LU	frontal lunule

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
MG midgut
MH mouth-hook
MO median ocellus (Fig. 1)
MO mediotergite (Fig. 8)
MP maxillary palpus (Fig. 1, 121)
MP metapleuron (Fig. 8)
MP micropylar protuberance (Fig. 70, 136)
MS mesopleural sulcus
MT Malpighian tubules
NP notopleuron
OC ocellar
OL lateral oviduct
OR ovary
OV outer vertical (Fig. 1)
OV oocyte (Fig. 2)
PA postalar
PAC postacrostichal
PAP phallapodeme
PBS probasisternum
PCP paraclypeal phragma (Fig. 1, 121)
PCW posterior cibarial wall
PD ovariole pedicel (Fig. 2)
PD halter pedicel (Fig. 8)
PDC postdorsocentral
PF parafaciale
PFA primary facials
PFR posterior fronto-orbital
PG postgonite
PH2 thoracic phragma 2
PHD phallic depressors
PHL phallic levators
PLP postlabial pad
PM prementum
PO postocellar
PP propleuron
PPH paraclypeal phragma (Fig. 81, 84)
PPN postpronotum
PR prescutum
PRS prescutellar
PS head-lobe scar
PSP peritremal spinous seta
PT ptilinum (Fig. 1)
PT spiracular peritreme (Fig. 76, 77, 80, 104)
PTF ptilinal fissure
PTO primary tracheal orifice
PU postgonital 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 (Fig. 8)
SB subgenital plate (Fig. 128)
SCB subcranial breadth
SI food-meatus siphon
SL supra-alar
SO spermatogonia
SOH subocular height
SP lateral spermatheca
SP1 prothoracic spiracle
SP3 metathoracic spiracle
SPB supraspiracular protuberance
SPT subspiracular protuberance
SSP supraspiracular spinous seta
ST spermatic tubule
SV stomodeal valve (Fig. 3)
SV seminal vesicle (Fig. 14)
SZ spermatozoa

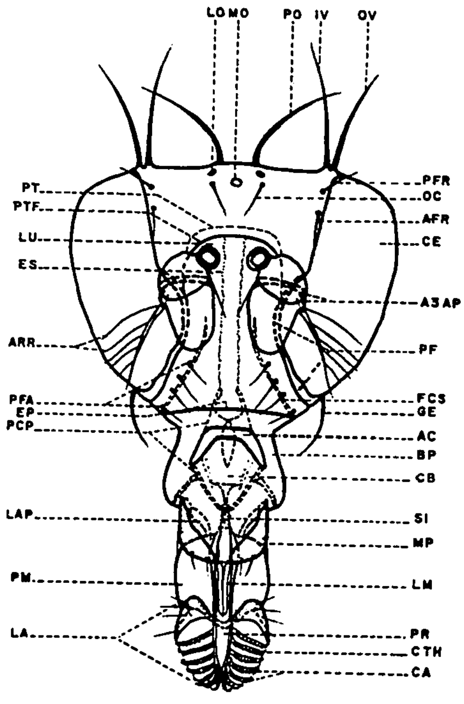
T4	tergum 4
T5	tergum 5
T9+10	syntergum 9+10
TF	terminal filament
TS	testis
VB	vertex breadth
VD	vas deferens
VL	fused valvulae laterales
VOD	vertical ocular height
VPR	ventral phragmatal ramus
VR	median spermatheca
WA	wing area
WL	wing length
WVR	wall of median spermatheca

Plate 1. Structures of adult *Hydrellia*

Fig. 1. *H. griseola*, male. Head, cleared, frontal view. (Little Wall Lake, Hamilton Co., Iowa).

Fig. 2. *H. bilobifera*, female. Internal genitalia, ventral view. (Kansas University Natural History Reservation, near Lawrence, Douglas County, Kansas).

Fig. 3. *H. griseola*, female. Gut, dorsal view. (Little Wall Lake, Hamilton Co., Iowa).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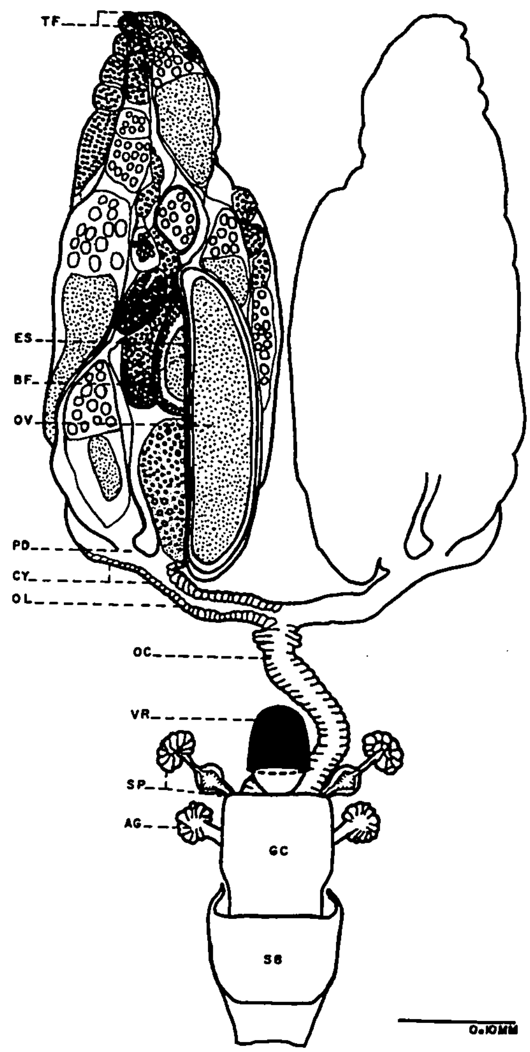
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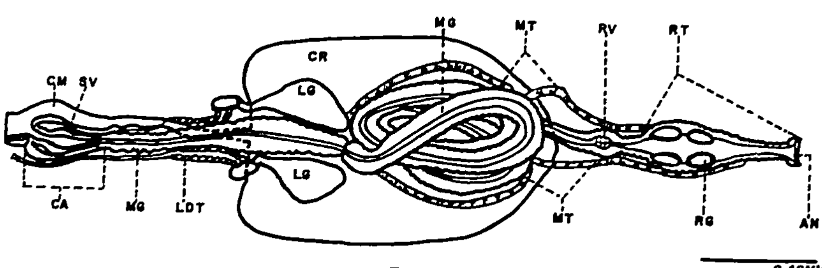
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3

Plate 2. Structures of adult *Hydrellia*

Fig. 4. *H. griseola*, male. Terminalia, dorsal view. (Little Wall Lake, Hamilton Co., Iowa).

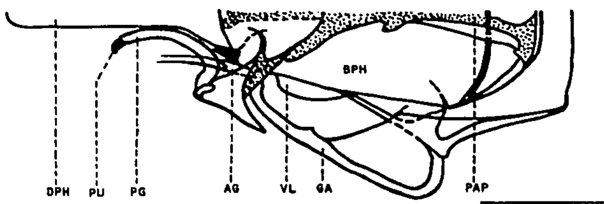
Fig. 5. *H. griseola*, male. Posterior half of abdomen, lateral view. (Little Wall Lake, Hamilton Co., Iowa).

Fig. 6. *H. griseola*, male. Abdomen, ventral view. (Little Wall Lake, Hamilton Co., Iowa).

Fig. 7. *H. bilobifera*, male. Musculature of gonal arch and phallapodeme, dorsal view. (Kansas University Natural History Reservation, near Lawrence, Douglas Co., Kansas).

Fig. 8. *H. griseola*, male. Thorax proper, lateral view. (Little Wall Lake, Hamilton Co., Iowa).

Fig. 9. *H. griseola*, male. Terminalia, lateral view. (Little Wall Lake, Hamilton Co., Iowa).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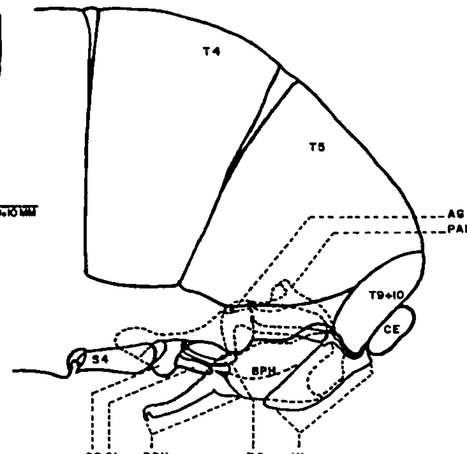
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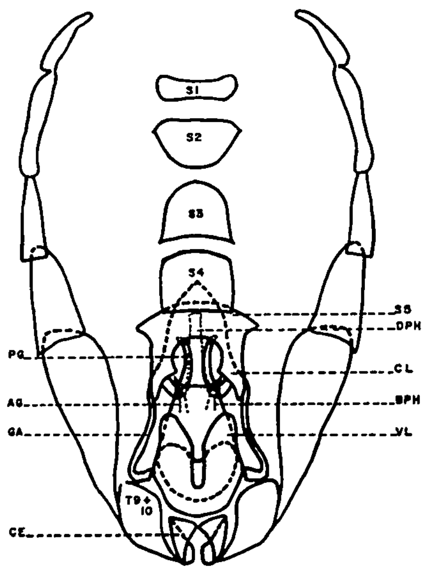
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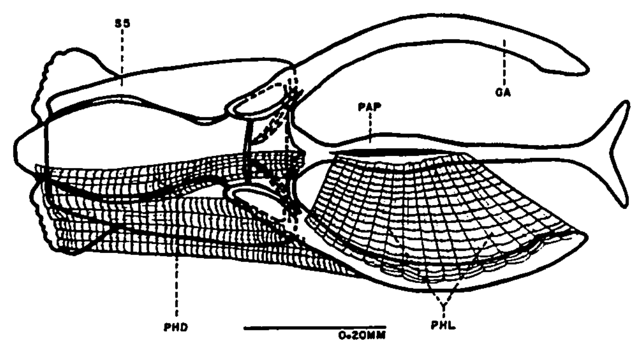
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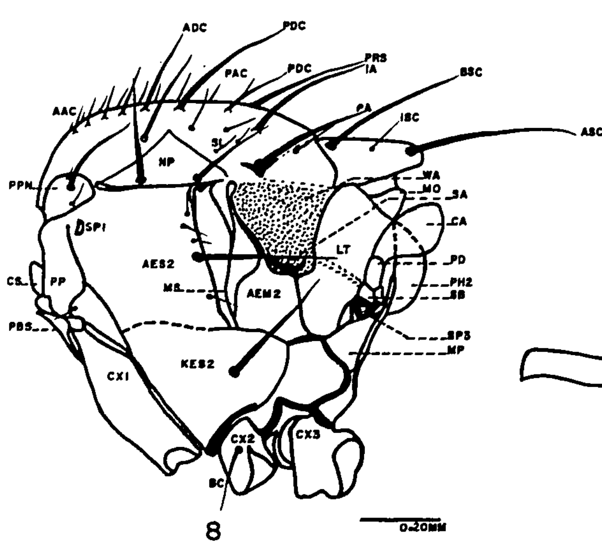
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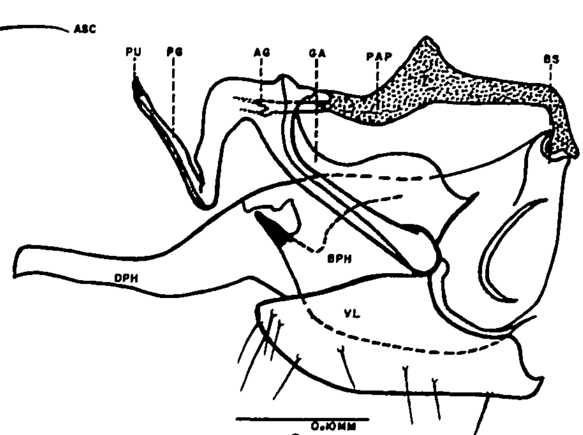
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Plate 3. Structures of adult *Hydrellia*

Fig. 10. *H. griseola*, male. Head, cleared, frontal view. All setae omitted. (Little Wall Lake, Hamilton Co., Iowa).

Fig. 11. *H. morrisoni*, male. Left hind tibia, anterior view. (3 miles east southeast of Waterville, Allamakee Co., Iowa).

Fig. 12. *H. harti*, male. Head, lateral view. (Springbrook State Park, Guthrie Co., Iowa).

Fig. 13. *H. discursa*, female. Terminalia, lateral view and median spermatheca, dorsal view. (Brewer's Bar Ditch, Reelfoot Lake, Tennessee).

Fig. 14. *H. bilobifera*, male. Internal genitalia, ventral view. (Kansas University Natural History Reservation, near Lawrence, Douglas Co., Kansas).

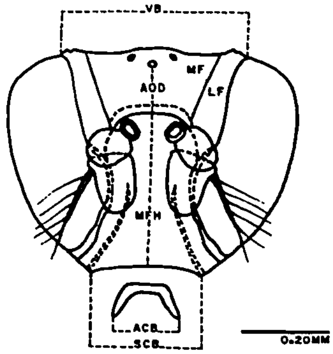
Fig. 15. *H. ascita*, female. Terminalia, lateral view. (Havana, Illinois).

Fig. 16A. *H. bilobifera*, female. Terminalia, lateral view and median spermatheca, dorsal view. (Brewer's Bar Ditch, Reelfoot Lake, Tennessee).

Fig. 16B. *H. trichaeta*, female. Terminalia, lateral view. (Bohall Lake, Itasca State Park, Minnesota).

Fig. 16C. *H. gladiator*, female. Terminalia, lateral view. (in *Vallisneria* sp. from Florida).

Fig. 16D. *H. harti*, female. Terminalia, lateral view. (Perkins Mills, Quebec).



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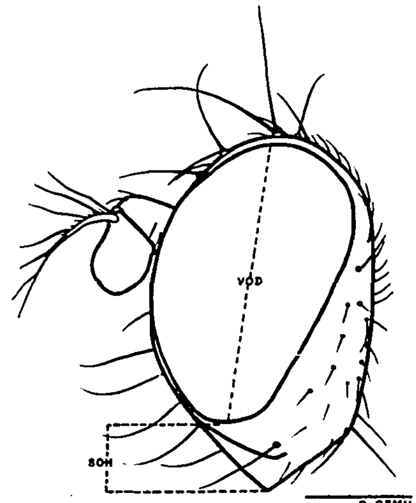

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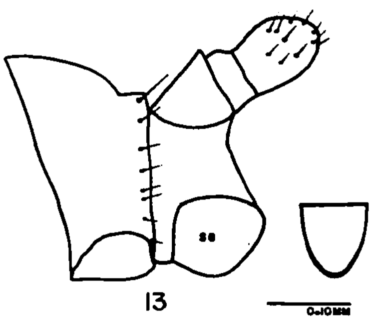

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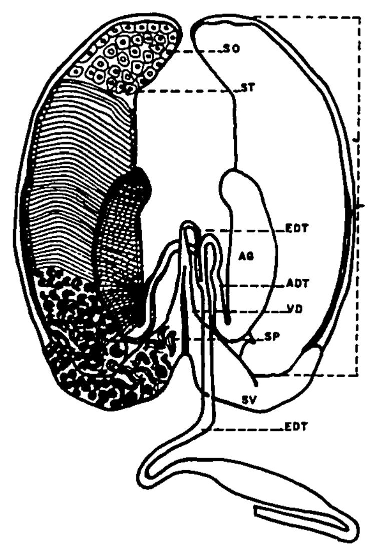

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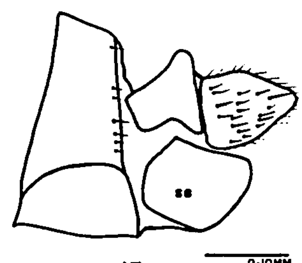

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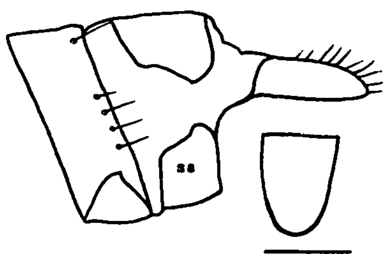

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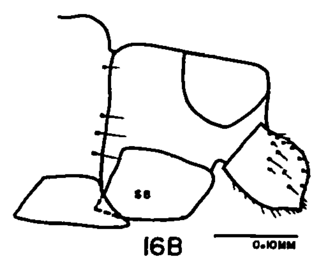

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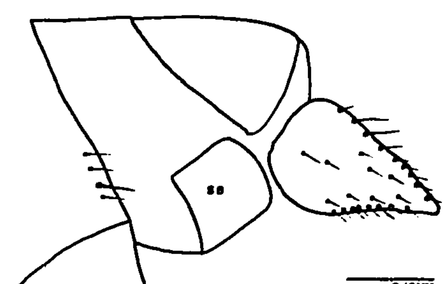

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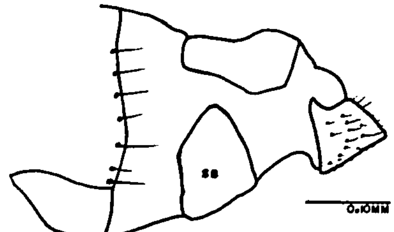


16D

Plate 4. Male terminalia of adult *Hydrellia* (ventral view of left half unless otherwise specified)

Fig. 17. *H. ascita*. (Midland, Ontario).

Fig. 18. *H. harti*. (Perkins Mills, Quebec).

Fig. 19. *H. gladiator*. (reared from *Vallisneria* sp. from Florida).

Fig. 20. *H. bilobifera*. (Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett Co., Tennessee).

Fig. 21. *H. discursa*. (Miller's Camp, Reelfoot Lake, Tennessee).

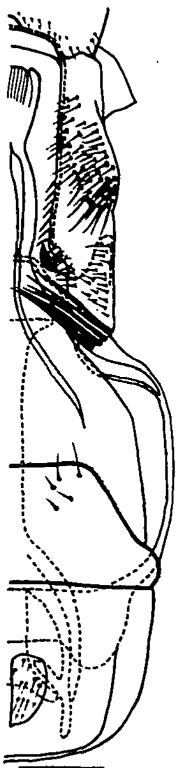
Fig. 22. *H. griseola*. (Ohiopyle, Pennsylvania).

Fig. 23. *H. valida*. (west shore of New Haven Harbor, Connecticut).

Fig. 24. *H. cessator*. (Mississippi River, sec. 34, T. 145 north, R. 36 west, Clearwater Co., Minnesota).

Fig. 25. *H. borealis*. (Ottawa, Ontario).

Fig. 26. *H. manitobae*. (La Trappe, Quebec).



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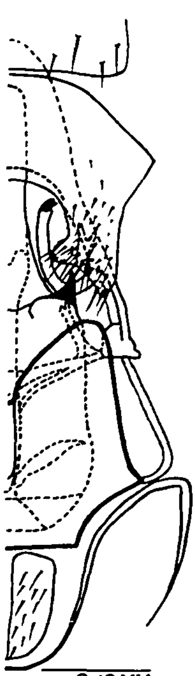

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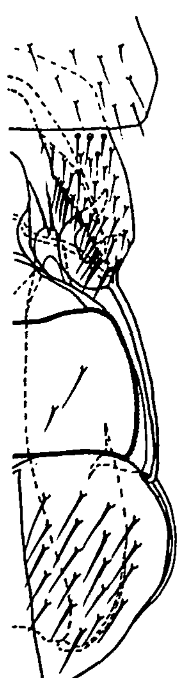

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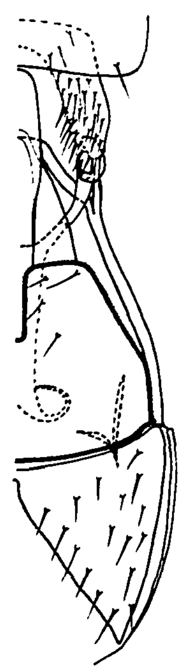

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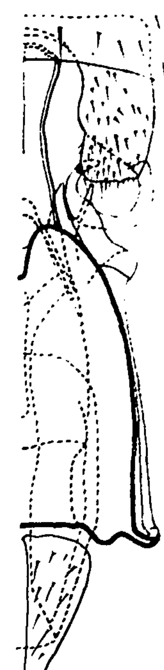

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Plate 5. Male terminalia of *Hydrellia*

Fig. 27. *H. proclinata*. (Monterey Co., California).

Fig. 28. *H. nobilis*. (Bohall Trail Bog, Itasca State Park, Minnesota).

Fig. 29. *H. advenae*. (Bar Harbor, Mount Desert Island, Maine).

Fig. 30. *H. platygastra*. (Ilwaco, Washington).

Fig. 31. *H. saltator*. (Grand Bend, Ontario).

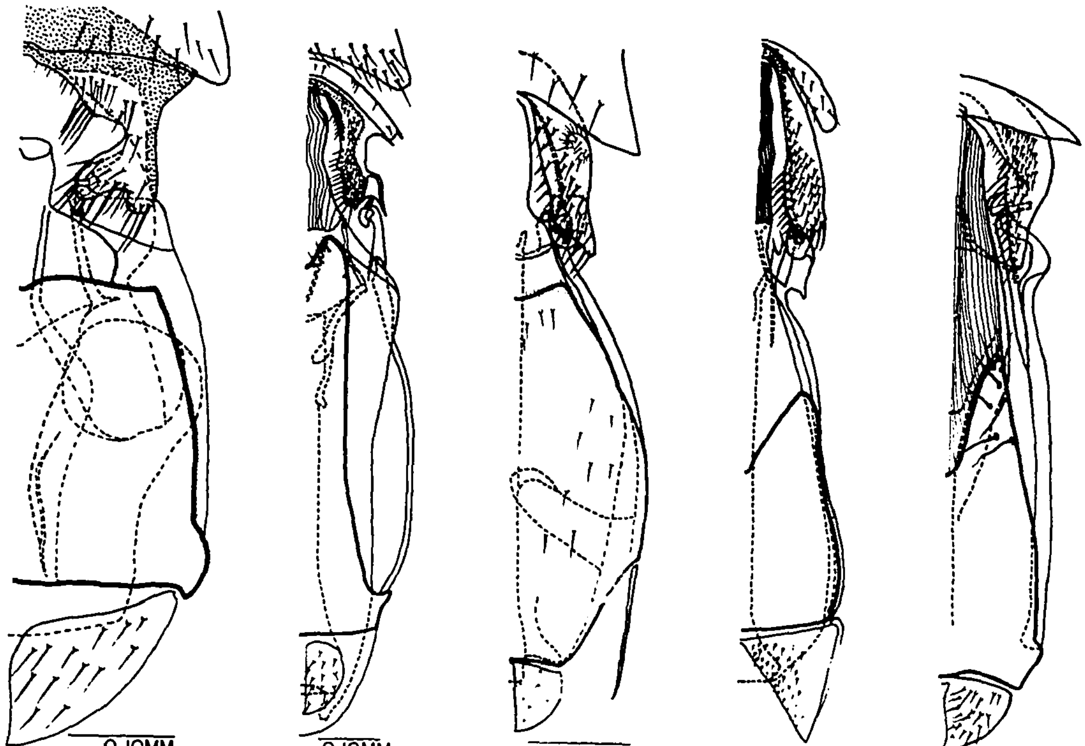
Fig. 32. *H. melanderi*. (Sardine Creek, Mono Co., California).

Fig. 33. *H. subnitens*. (Tacoma, Washington).

Fig. 34. *H. morrisoni*. (15 miles west of Kettle Falls, Washington).

Fig. 35. *H. serena*. (King Salmon, Naknek River, Alaska).

Fig. 36. *H. crassipes*. (1.3 miles south of main entrance, Itasca State Park, Minnesota).



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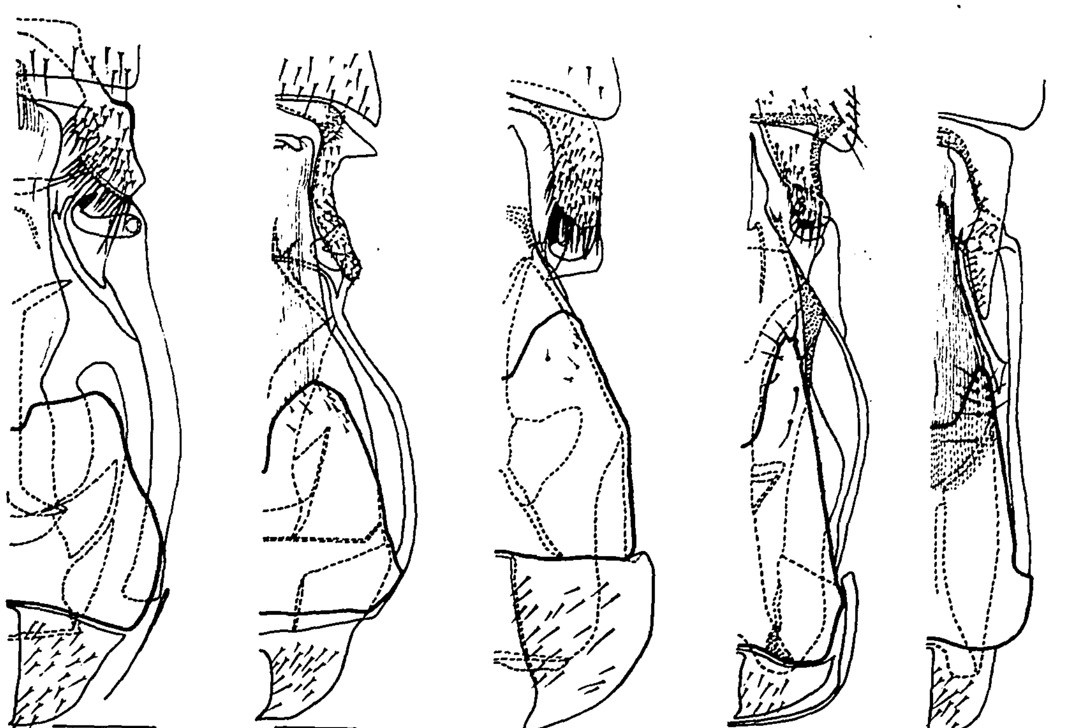

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Plate 6. Male terminalia of *Hydrellia*

Fig. 37. *H. rixator*. (Samburg, Reelfoot Lake, Tennessee).

Fig. 38. *H. agitator*. (Port St. Joe beach, Gulf Co., Florida).

Fig. 39. *H. columbata*. (Squaw Lake, Itasca State Park, Minnesota).

Fig. 40. *H. definita*. (Dryden Lake, Tompkins Co., New York).

Fig. 41. *H. ischiaca*. (Douglas Lodge Bay, Lake Itasca, Minnesota).

Fig. 42. *H. spinicornis*. (Lake Shady, Lamar Co., Mississippi).

Fig. 43. *H. itascae*. (Biological Station, Itasca State Park, Minnesota).

Fig. 44. *H. ainsworthi*. (Lake Shady, Lamar Co., Mississippi).

Fig. 45. *H. tibialis*. (Banner Mine Area, Warren Co., Iowa).

Fig. 46. *H. deceptor*. (Sacramento, California).

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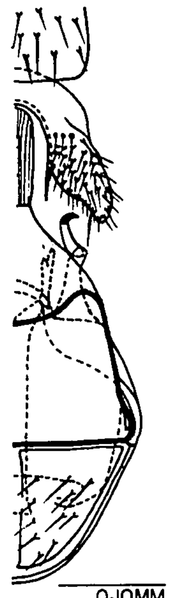

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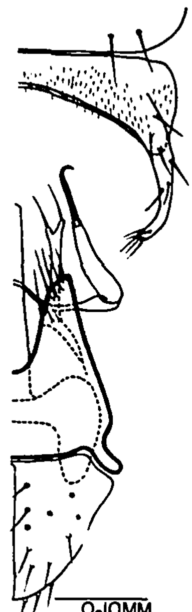

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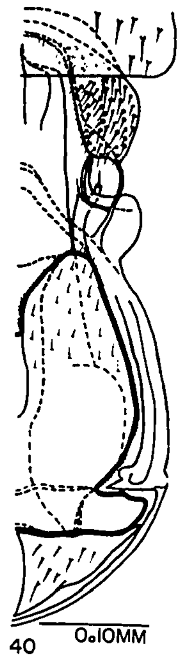

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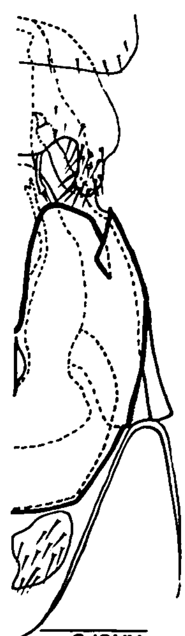

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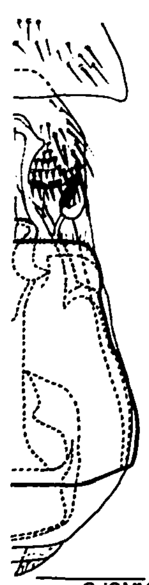

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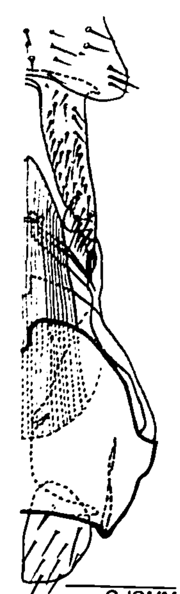

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Plate 7. Male terminalia of *Hydrellia*

Fig. 47. *H. flavicoxalis*. (Walden, Colorado).

Fig. 48. *H. surata*. (Two Island Lake, Itasca State Park, Minnesota).

Fig. 49. *H. floridana*. (Lacoochee, Florida).

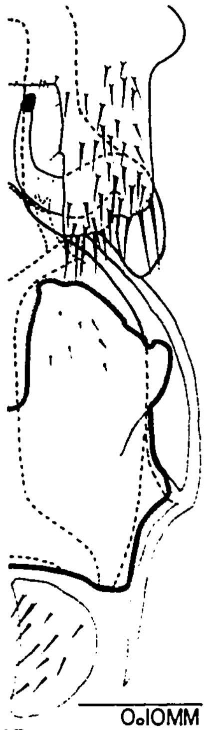
Fig. 50. *H. trichaeta*. (Spring Lake, Greene Co., Iowa).

Fig. 51. *H. bergi*. Ventral view of entire apparatus. (Dryden Lake, Tompkins Co., New York).

Fig. 52. *H. procteri*. (Spring Lake, Greene Co., Iowa).

Fig. 53. *H. idolator*. (Ottawa, Ontario).

Fig. 54. *H. caliginosa*. (Matanuska Valley, Alaska).



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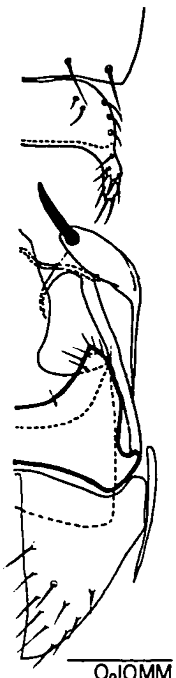

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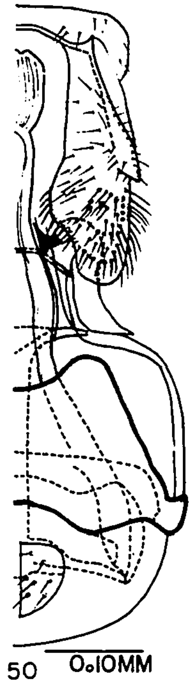

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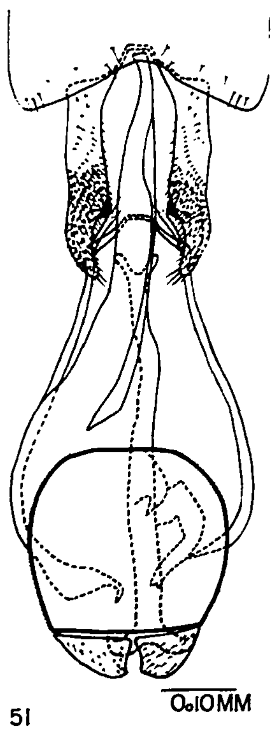

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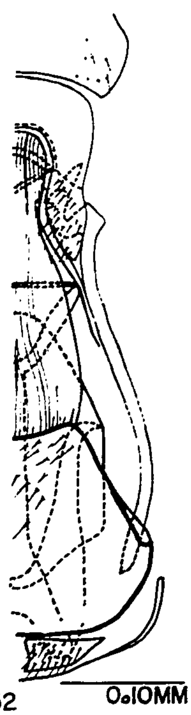

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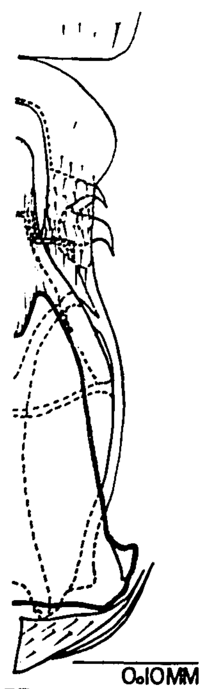

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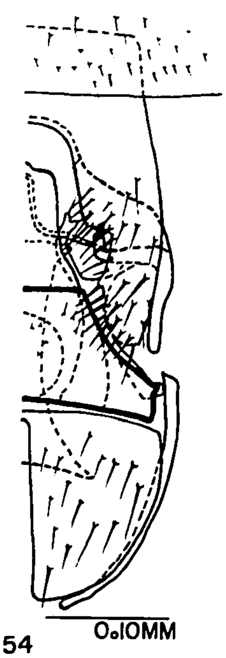

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Plate 8. Male terminalia of *Hydrellia*

Fig. 55. *H. notata*. (Canaan, Connecticut).

Fig. 56. *H. penicilli*. (Qualicum, British Columbia).

Fig. 57. *H. notiphiloides*. (Chamber's Creek, Itasca State Park, Minnesota).

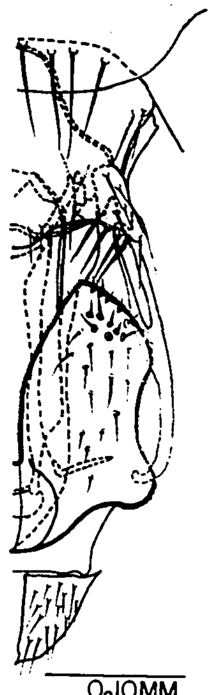
Fig. 58. *H. amnicola*. (Sucker Creek, 100 yards north of State Highway 31, Clearwater Co., Minnesota).

Fig. 59. *H. insulata*. (Plummer's Island, Potomac River, Maryland).

Fig. 60. *H. biloxiae*. (gravel pit near U.S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson Co., Mississippi).

Fig. 61. *H. luctuosa*. (Springbrook State Park, Guthrie Co., Iowa).

Fig. 62. *H. cruralis*. (Squaw Lake, Itasca State Park, Minnesota).



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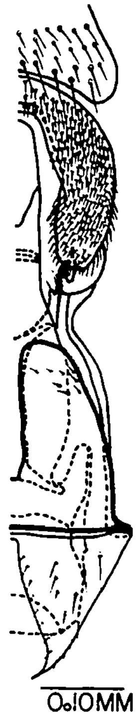

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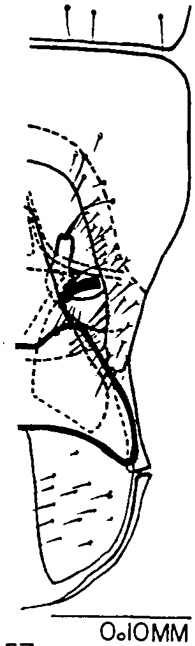

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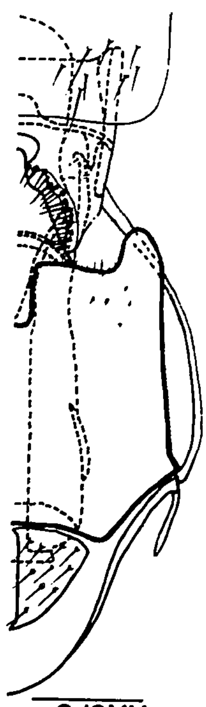

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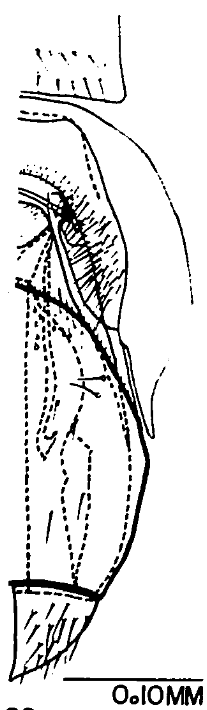

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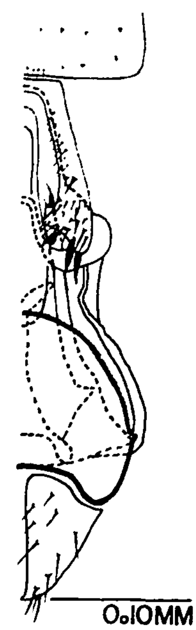

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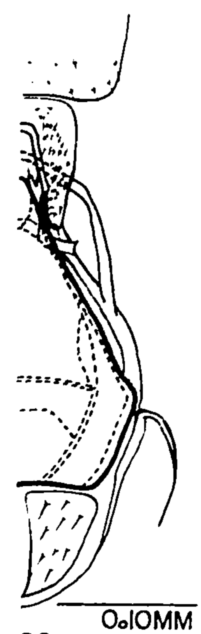

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Plate 9. Male terminalia and other structures of *Hydrellia*

Fig. 63. *H. prudens*. (Woodshole, Massachusetts).

Fig. 64. *H. cavator*. (Biscayne Bay, Florida).

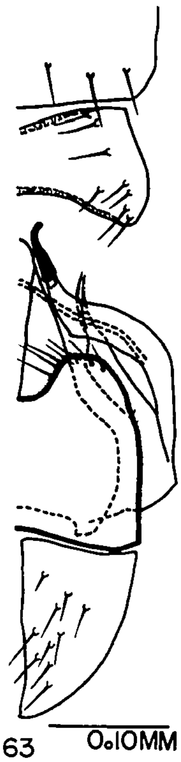
Fig. 65. *H. pulla*. (Third Sister Lake, Washtenaw Co., Michigan).

Fig. 66. *H. formosa*. (Dickinson's Pond, Lamar Co., Mississippi).

Fig. 67. *H. personata*. (O'Sullivan Dam, Grant Co., Washington).

Fig. 68. *H. americana*. (Gulf Coast Research Laboratory, Ocean Springs, Mississippi).

Fig. 69. *H. crassipes*, male. Left hind femur and tibia, anteroventral view. (Chamber's Creek, Itasca State Park, Minnesota).



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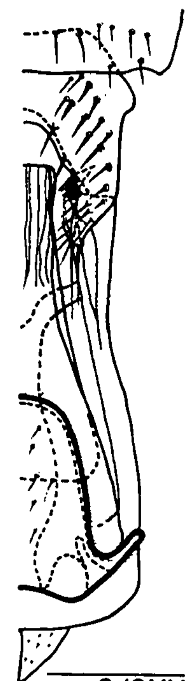

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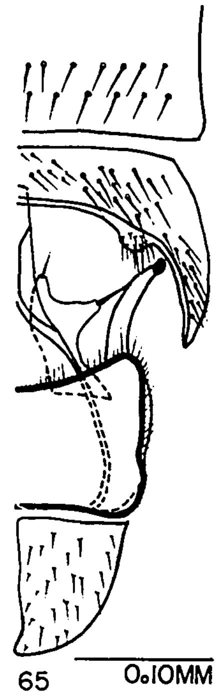

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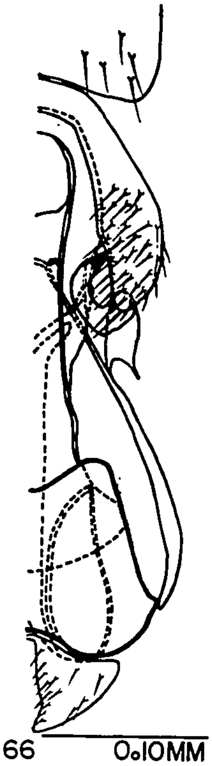

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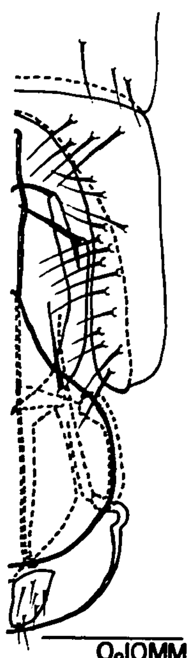

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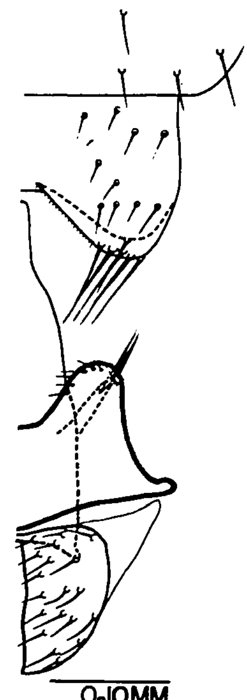

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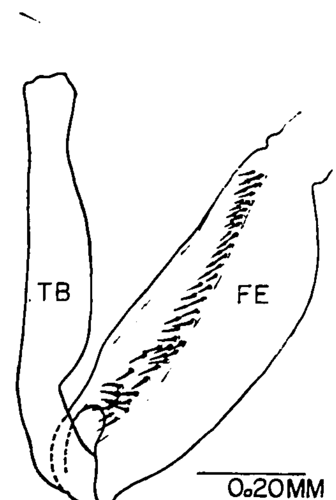

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Plate 10. Structures of immature *Hydrellia*

Fig. 70. *H. bilobifera*. Egg chorion, parasagittal section. (Spring Lake, Greene Co., Iowa).

Fig. 71. *H. bergi*. Egg, lateral view. (1.3 miles south of main entrance, Itasca State Park, Minnesota).

Fig. 72. *H. bilobifera*. Egg, dorsal view. (Spring Lake, Greene Co., Iowa).

Fig. 73. *H. ischiaca*. Egg, ventral view. (Douglas Lodge Bay, Lake Itasca, Itasca State Park, Minnesota).

Fig. 74. *H. discursa*. Egg, dorsal view. (Miller's Camp, Reelfoot Lake, Tennessee).

Fig. 75. *H. spinicornis*. Egg, dorsal view. Shaded area indicates numerous punctulae, or depressions. (Lake Shady, Lamar Co., Mississippi).

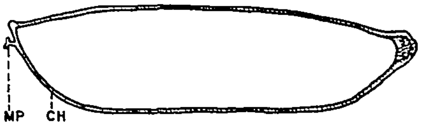
Fig. 76. *H. spinicornis*. Posterior part of abdominal segment 8 and the tracheospiracular siphon of second-instar larva, dorsal view. (Lake Shady, Lamar Co., Mississippi).

Fig. 77. *H. discursa*. Abdominal segment 8 and spiracular peritreme of first-instar larva, lateral view of left side. (Samburg, Reelfoot Lake, Tennessee).

Fig. 78. *H. biloxiae*. Anterior portion of third-instar larva, lateral view of left side. (gravel pit near U.S. Highway 90, sec. 20, T. 7 south, R. 5 west, Jackson Co., Mississippi).

Fig. 79. *H. ischiaca*. Posterior part of abdominal segment 8 and the tracheospiracular siphon of second-instar larva, dorsal view. (Lake Itasca, Itasca State Park, Minnesota).

Fig. 80. *H. ainsworthi*. Left spiracular peritreme and ramus of third-instar larva, lateral view. (Lake Shady, Lamar Co., Mississippi).



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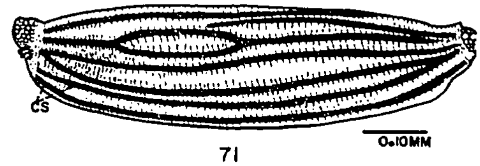

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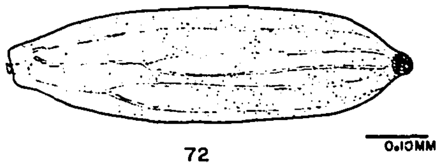

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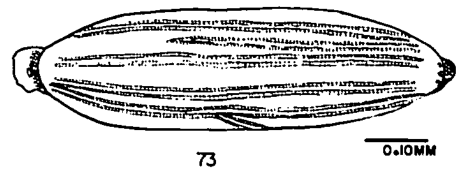

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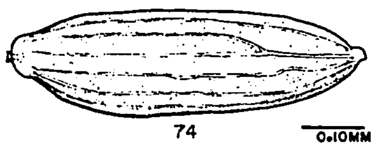

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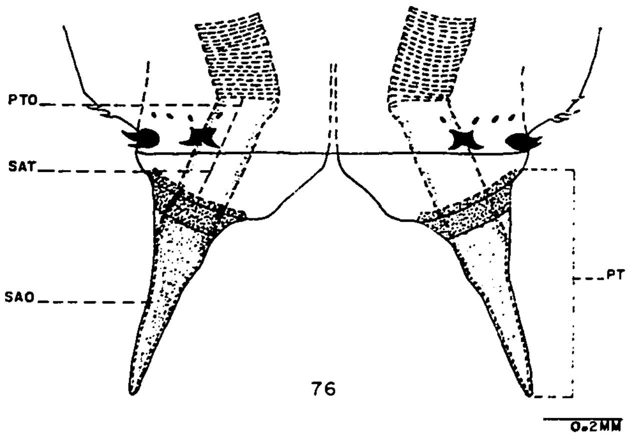

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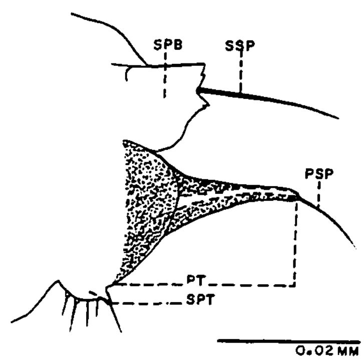

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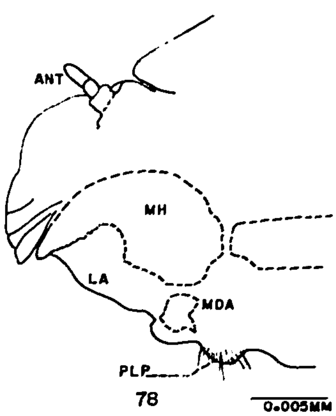

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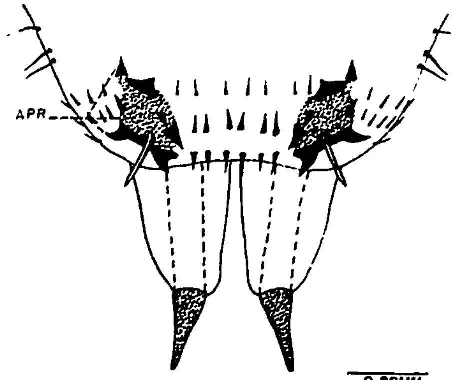

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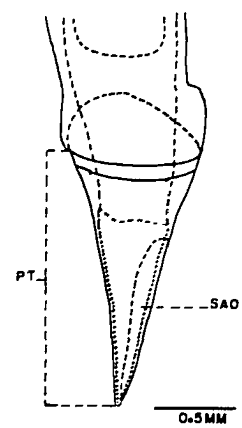

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Plate 11. Feeding apparatus of larval *Hydrellia* (third-instar unless otherwise specified)

Fig. 81. *H. notiphiloides*. Dorsal view. (Davis, California).
Fig. 82. *H. pulla*. Lateral view. (Third Sister Lake, Washtenaw Co., Michigan).
Fig. 83. *H. biloxiae*. Lateral view. (gravel pit near U.S. Highway 90, sec. 20, T-7 south, R-5 west, Jackson Co., Mississippi).
Fig. 84. *H. bilobifera*. Lateral view. (Kansas University Natural History Reservation, near Lawrence, Douglas Co., Kansas).
Fig. 85. *H. mossisoni*. Lateral view. (Inlet Valley, Ithaca, New York).
Fig. 86. *H. spinicornis*. Lateral view. (Dickinson's Pond, Lamar Co., Mississippi).
Fig. 87. *H. deceptor*. Lateral view. (Sacramento, California).
Fig. 88. *H. ischiaca*. Lateral view. (Mississippi River at Sucker Creek, Clearwater Co., Minnesota).
Fig. 89. *H. spinicornis*. First-instar, lateral view. (Lake Shady, Lamar Co., Mississippi).
Fig. 90. *H. cruralis*. Lateral view. (Douglas Lake, Cheboygan Co., Michigan).
Fig. 91. *H. itascae*. Lateral view. (Douglas Lodge Bay, Lake Itasca, Itasca State Park, Minnesota).
Fig. 92. *H. ainsworthi*. Lateral view. (Dickinson's Pond, Lamar Co., Mississippi).
Fig. 93. *H. notiphiloides*. Lateral view. (Davis, California).
Fig. 94. *H. caliginosa*. Lateral view. (Rapid River Logging Camp, Hubbard Co., Minnesota).
Fig. 95. *H. discursa*. Lateral view. (Brewer's Bar Ditch, Reelfoot Lake, Tennessee).
Fig. 96. *H. bergi*. Lateral view. (Douglas Lake, Chegoygan Co., Michigan).
Fig. 97. *H. trichaeta*. Lateral view. (Spring Lake, Greene Co., Iowa).
Fig. 98. *H. ascita*. Lateral view. (Nigger Creek, Cheboygan Co., Michigan).
Fig. 99. *H. bilobifera*. Lateral view. (Kansas University Natural History Reservation, Douglas Co., Kansas).
Fig. 100. *H. ainsworthi*. Second instar, lateral view. (Lake Shady, Lamar Co., Mississippi).
Fig. 101. *H. spinicornis*. Second instar, lateral view. (Lake Shady, Lamar Co., Mississippi).
Fig. 102. *H. luctuosa*. Lateral view. (Bessey Creek, Cheboygan Co., Michigan).
Fig. 103. *H. tibialis*. Mouth-hook, lateral view. (Banner Mine Area, Warren Co., Iowa).

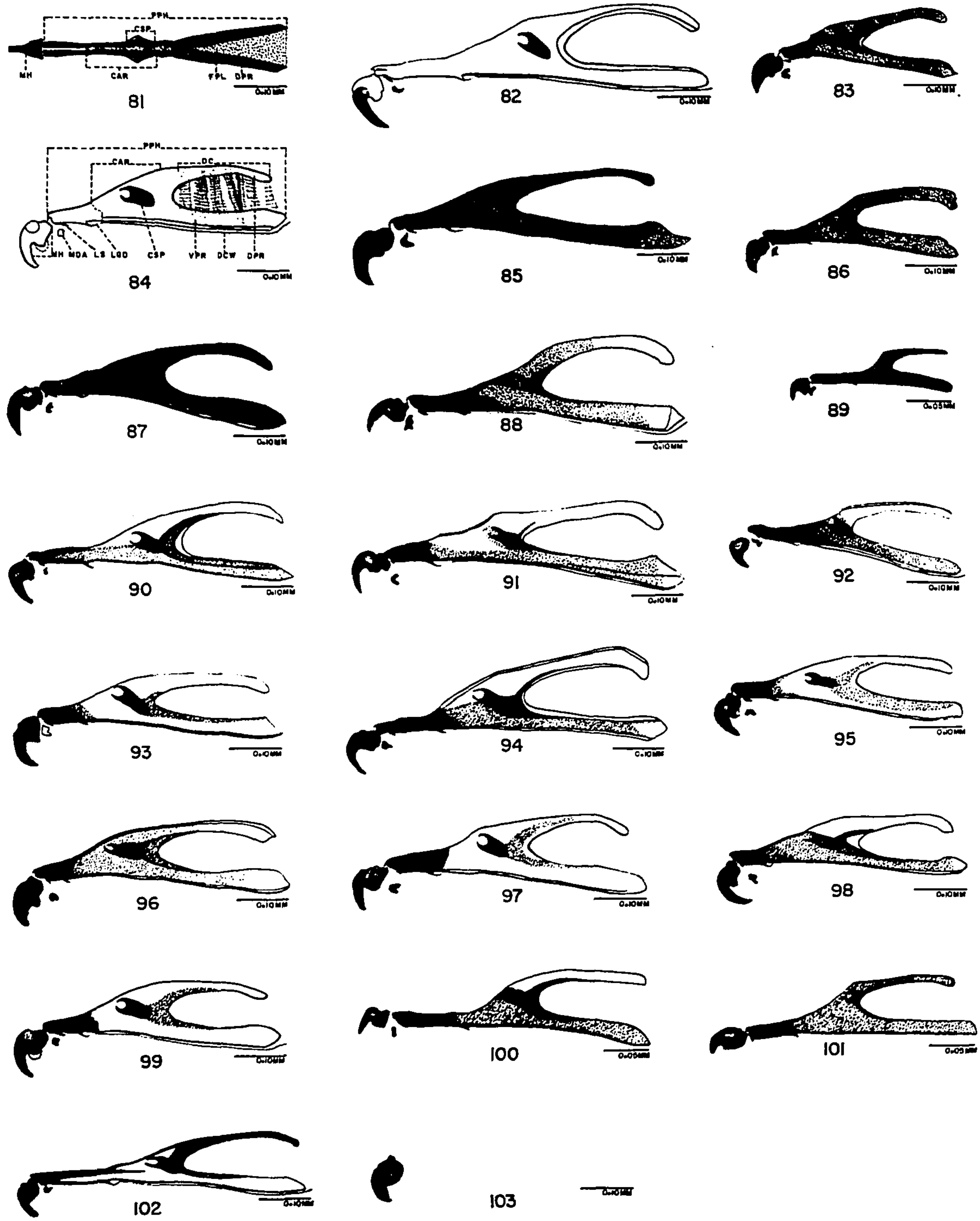
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Plate 12. Puparia of *Hydrellia* (ventral view)

Fig. 104. *H. luctuosa*. Setae and creeping welts on middle part omitted. (Douglas Lake, Cheboygan Co., Michigan).

Fig. 105. *H. cruralis*. (Third Sister Lake, Washtenaw Co., Michigan).

Fig. 106. *H. bilobifera*. (Kansas University Natural History Reservation, near Lawrence, Douglas Co., Kansas).

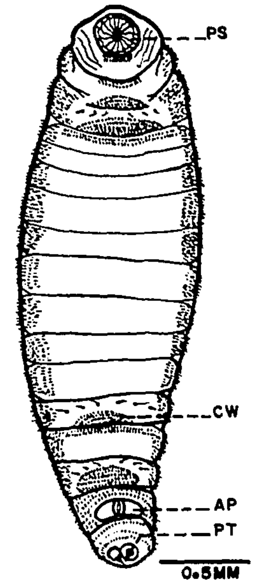
Fig. 107. *H. itascae*. (Douglas Lodge Bay, Lake Itasca, Itasca State Park, Minnesota.

Fig. 108. *H. caliginosa*. (Matanuska Valley, Alaska).

Fig. 109. *H. ascita*. (Nigger Creek, Cheboygan Co., Michigan).

Fig. 110. *H. discursa*. (Brewer's Bar Ditch, Reelfoot Lake, Tennessee).

Fig. 111. *H. pulla*. (Douglas Lake, Cheboygan Co., Michigan).



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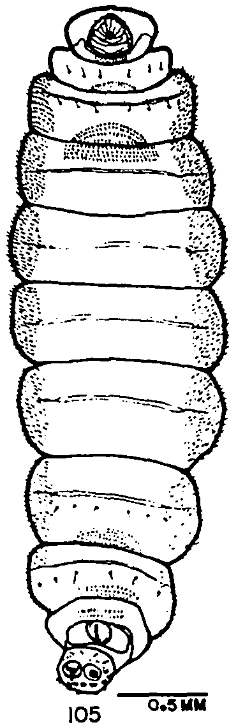

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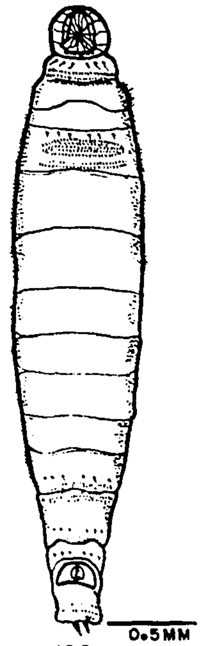

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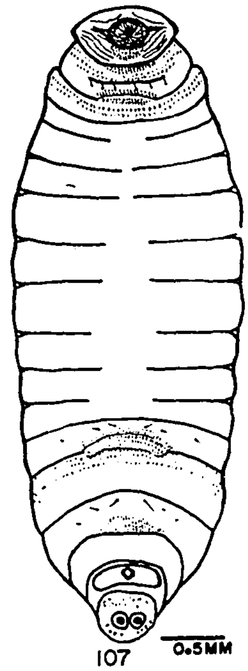

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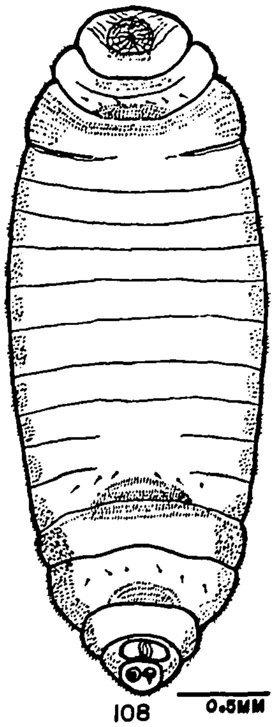

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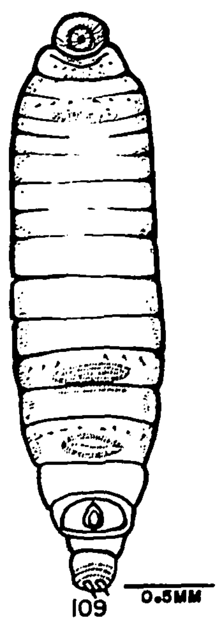

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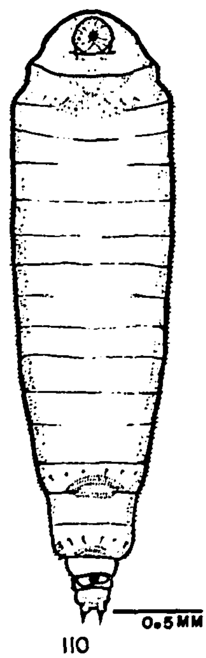

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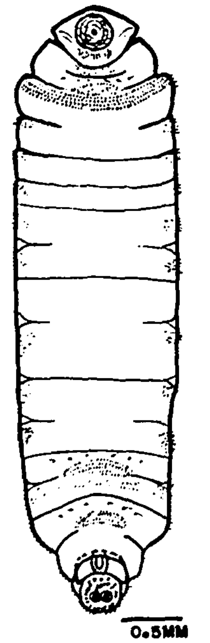

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Plate 13. Puparia of *Hydrellia* (ventral view)

Fig. 112. *H. trichaeta*. (Spring Lake, Greene Co., Iowa).

Fig. 113. *H. notiphiloides*. (Davis, California).

Fig. 114. *H. spinicornis*. (Dickinson's Pond, Lamar Co., Mississippi).

Fig. 115. *H. tibialis*. (Banner Mine Area, Warren Co., Iowa).

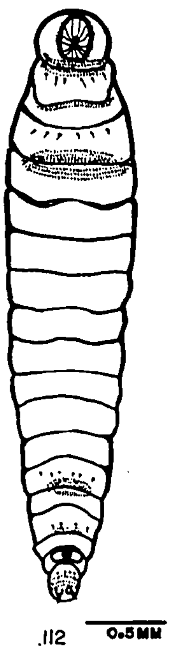
Fig. 116. *H. biloxiae*. (gravel pit near U.S. Highway 90, sec. 20, T. south, R. 5 west, Jackson Co., Mississippi).

Fig. 117. *H. ainsworthi*. (Dickinson's Pond, Lamar Co., Mississippi).

Fig. 118. *H. morrisoni*. (Inlet Valley, Ithaca, New York).

Fig. 119. *H. ischiaca*. (Mississippi River at Sucker Creek, Clearwater Co., Minnesota).

Fig. 120. *H. bergi*. (Michigan).



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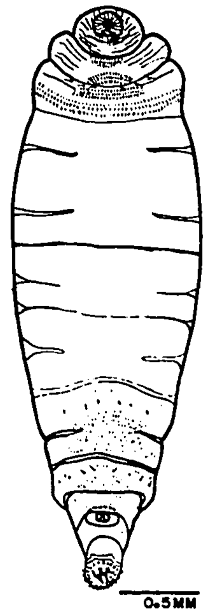

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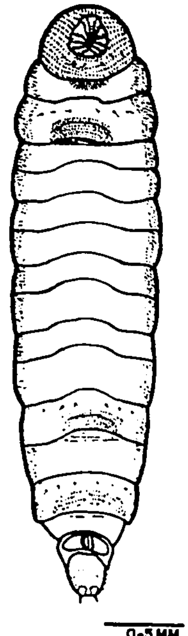

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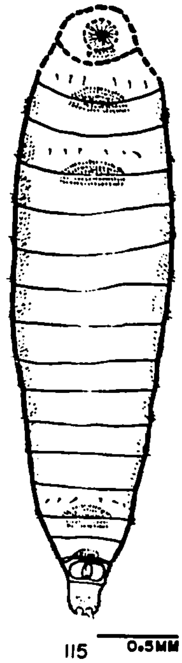

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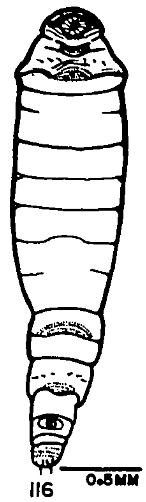

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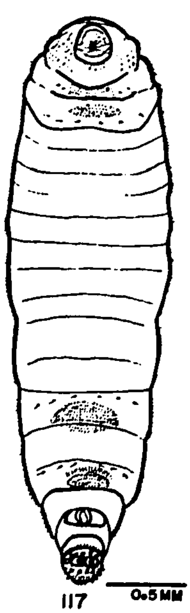

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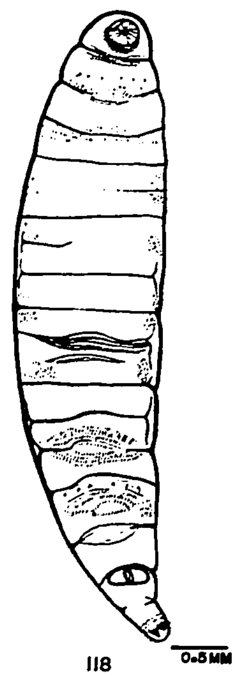

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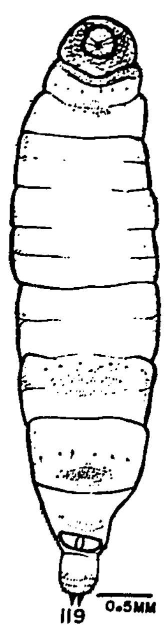

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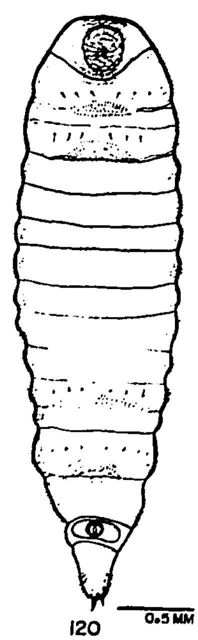

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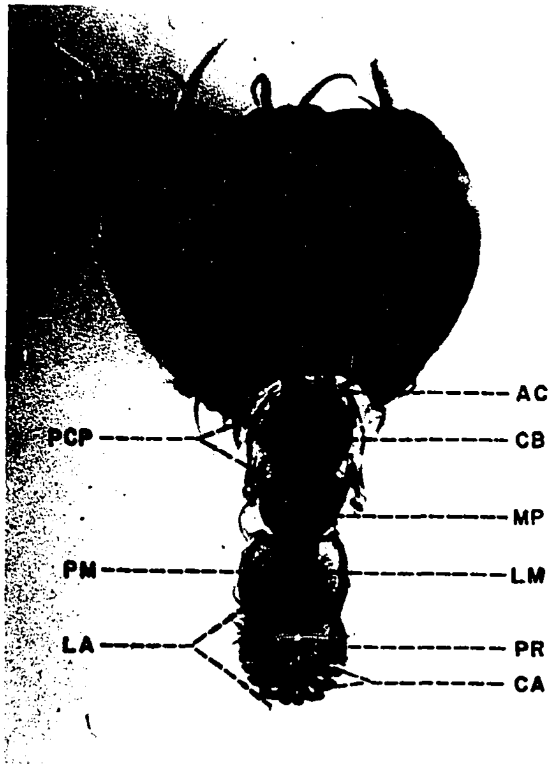
Plate 14. Structures of adult *Hydrellia*

Fig. 121. *H. bilobifera*, male. Head, slightly cleared, frontal view, photograph (73X). (Bohall Lake, Itasca State Park, Minnesota).

Fig. 122. *H. bilobifera*, male. Proboscis, uncleared, lateral view of left side, photograph (90X). (Bohall Lake, Itasca State Park, Minnesota).



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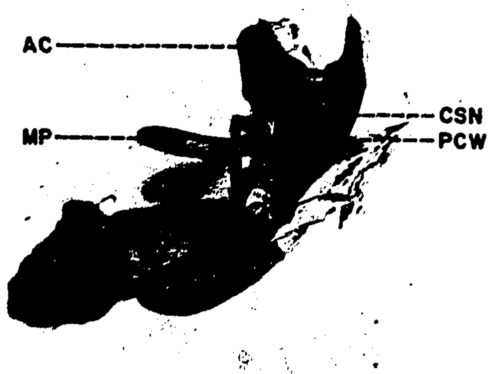

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Plate 15. Structures of adult *Hydrellia*

Fig. 123. *H. griseola*, female. Left wing, dorsal view, photograph (34X). (Little Wall Lake, Hamilton Co., Iowa).

Fig. 124. *H. tibialis*, male. Adult with attached hydryphantid mite, lateral view, photograph (15X). (Little Wall Lake, Hamilton Co., Iowa).

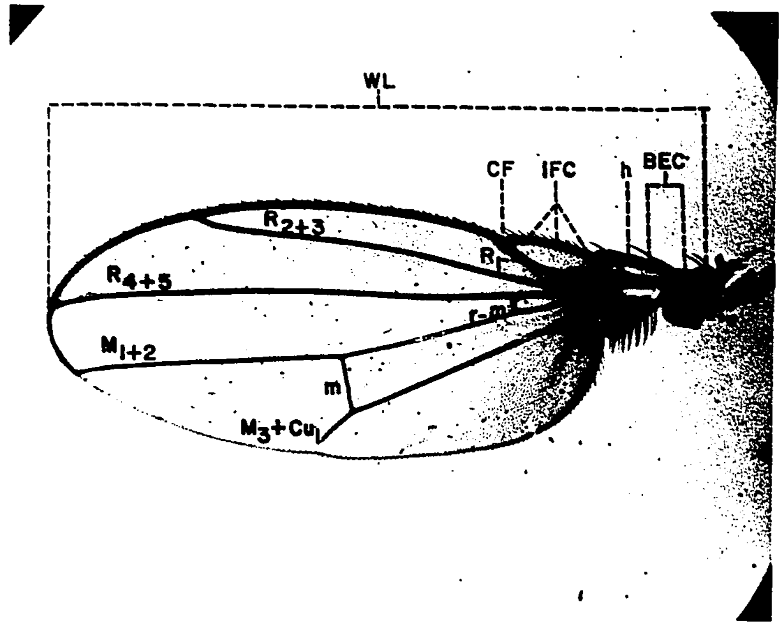

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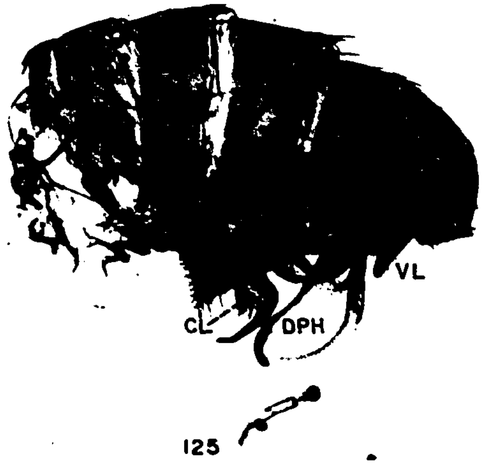
Plate 16. Structures of adult *Hydrellia*

Fig. 125. *H. bilobifera*, male. Abdomen, lateral view of left side, photograph (60X). Phallus depressed. (Davis, California).

Fig. 126. *H. griseola*, male. Abdomen, ventral view, photograph (60X). (Little Wall Lake, Hamilton Co., Iowa).

Fig. 127. *H. bilobifera*, male. Abdomen, lateral view of right side, photograph (60X). Phallus partly depressed. (Maxwell, Colusa Co., California).



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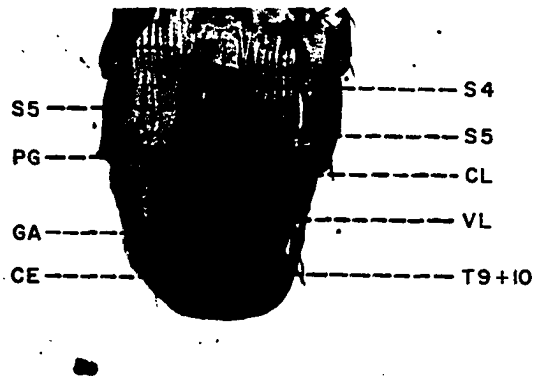

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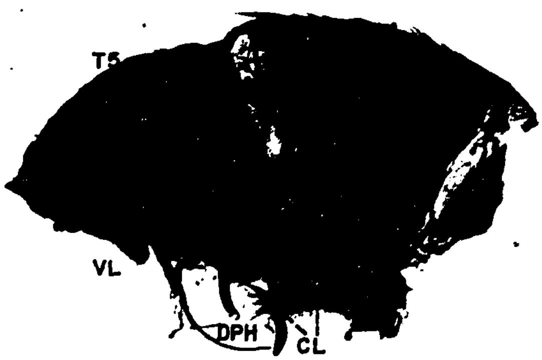

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Plate 17. Median spermatheca and puparium of *Hydrellia*

Fig. 128. *H. griseola*, female. Internal genitalia, left view of parasagittal section, photograph (30X). (Little Wall Lake, Hamilton Co., Iowa).

Fig. 129. *H. itascae*. Puparium *in situ*, dorsal view, photograph (9.5X). (Lake Itasca, Itasca State Park, Minnesota).

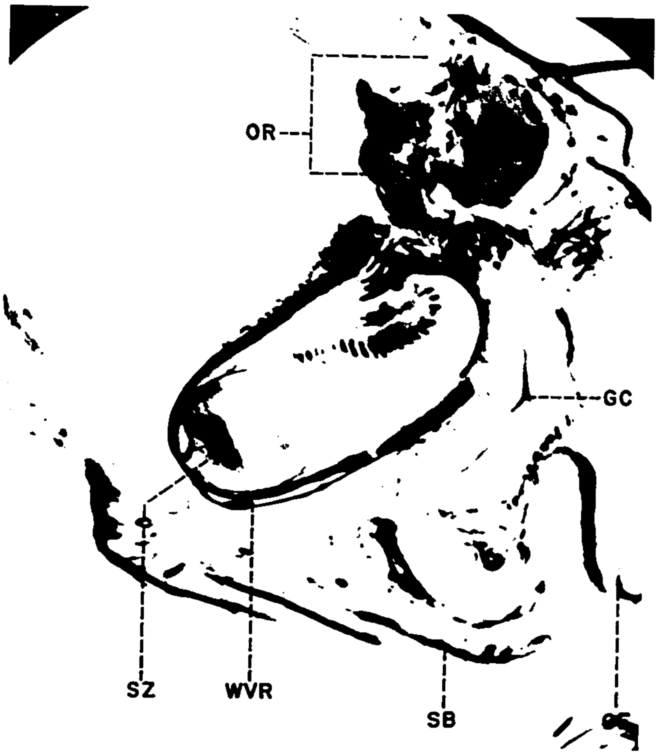

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Plate 18. Puparia of *Hydrellia*

Fig. 130. *H. ischiaca*. Dorsal view, photograph (18X). Right puparium contains pharate adult *H. ischiaca*; left one contains braconid parasite. (Rapid River Logging Camp, Hubbard Co., Minnesota).

Fig. 131. *H. griseola* and *H. ischiaca*. Right dorsolateral view, photograph (10X). Right puparium contains late pupa of *H. ischiaca*; left one contains early pupa of *H. griseola*. (Lake Itasca, Itasca State Park, Minnesota).

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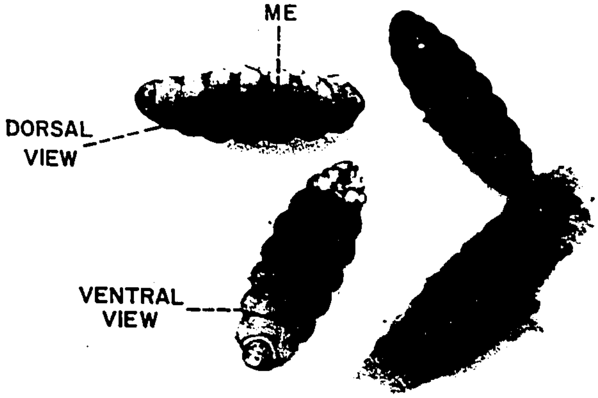
Plate 19. Puparia of _Hydrellia_

Fig. 132. _H. cruralis_. Dorsal and ventral views, photograph (9X). Puparia on right contain pupal hymenopterous parasites; ones on left are void. (Long Lake, Clearwater, Co., Minnesota).

Fig. 133. _H. cruralis_. Puparium, ventral view and emerged adult hymenopterous parasite, dorsal view, photograph of slide borrowed from C. O. Berg (12X). (Douglas Lake, Cheboygan Co., Michigan).



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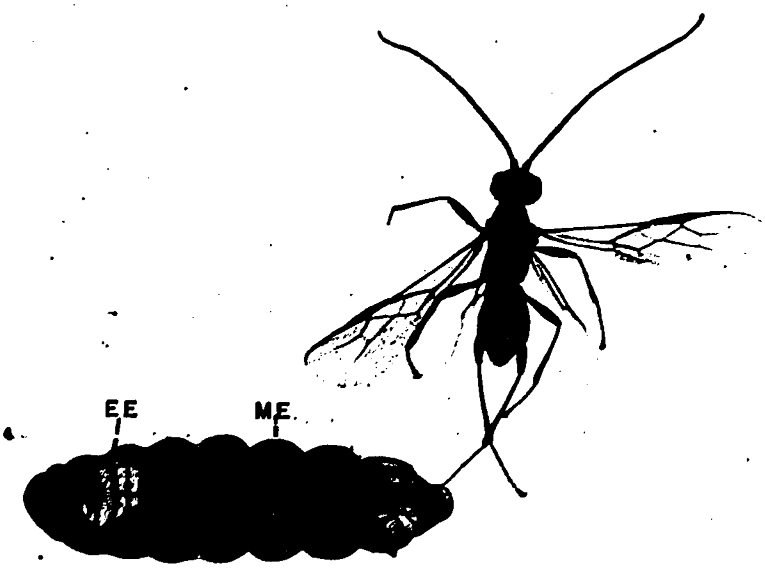

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Plate 20. Structures of immature *Hydrellia*

Fig. 134. *H. discursa*. Posterior third of third-instar larva, ventrolateral view, photograph (38X). (Samburg, Reelfoot Lake, Tennessee).

Fig. 135. *H. ainsworthi*. Early third-instar larva with opiine parasite, lateral view, photograph (20X). (Dickinson's Pond, Lamar Co., Mississippi).

Fig. 136. *H. discursa*. Egg, lateral view, photograph (90X). (Miller's Camp, Reelfoot Lake, Tennessee).


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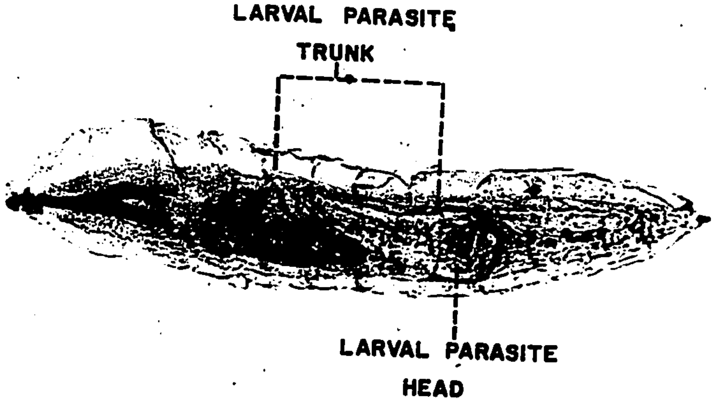
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TRUNK
LARVAL PARASITE
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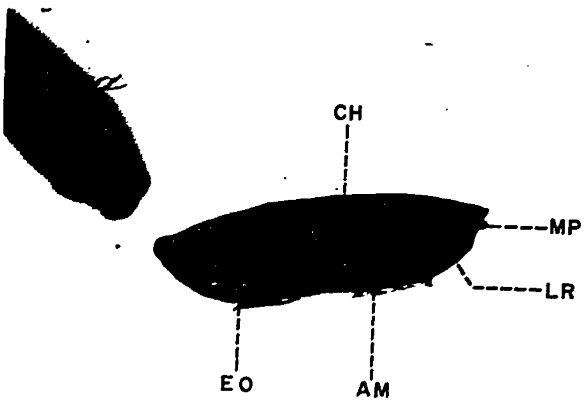
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APPENDIX B

Adult Material Examined

Hydrellia advenae Cresson. 3 males, 5 females.

MAINE: Mount Desert Island; Bar Harbor, Mount Desert Island.

Hydrellia agitator, sp. nov. 3 males, 2 females.

FLORIDA: Green Cove Springs, Clay Co.; Port Saint Joe, Gulf Co.

GEORGIA: Billy's Island, Okefenokee Swamp.

MISSISSIPPI: Lake Shady, Lamar Co.

Hydrellia ainsworthi, sp. nov. 182 males, 191 females.

FLORIDA: Silver Springs near Ocala, Marion Co.; Inglis; Lacoochee; Lake Worth's Bay Shore; Orange Park; Punta Gorda.

MISSISSIPPI: Lake Shady, Lamar Co.; Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar Co.; Vancleave Road, Jackson Co.

Hydrellia americana Cresson. 3 males, 9 females.

MAINE: Machias.

MARYLAND: Chesapeake Beach; Kent Narrows.

MASSACHUSETTS: Woodshole.

MICHIGAN: Baraga Co.

MISSISSIPPI: Gulf Coast Research Laboratory, Ocean Springs; Bellefontaine Point, Jackson Co.; Bay St. Louis; Vancleave Road, Jackson Co. (30° 25.1' north, 88° 46' west).

NEW YORK: Cold Spring Harbor, Long Island.

Hydrellia amnicola, sp. nov. 7 males, 20 females.

MINNESOTA: Sucker Creek, 100 yards north of Highway 31, Clearwater Co.

Hydrellia ascita Cresson. 11 males, 19 females.

ILLINOIS: Havana.

IOWA: Springbrook State Park, Guthrie Co.; Ledges State Park, Boone Co. (41° 59.5' north, 93° 53.5 west).

MICHIGAN: Cheboygan Co.; Nichol's Bog, Cheboygan Co.; Nigger Creek, Cheboygan Co.; Douglas Lake, Cheboygan Co.

MINNESOTA: Chisago Co.

ONTARIO: Midland.

TENNESSEE: Samburg, Reelfoot Lake. (36° 22.9' north, 89° 21.3' west).

Hydrellia atroglauca Coquillett. 1 male, 2 females.

FLORIDA: Biscayne Bay; Royal Palm Park.

Hydrellia bergi Cresson. 48 males, 64 females.

MICHIGAN: Bessey Creek, Cheboygan Co.; Cheboygan Co.; Douglas Lake, Cheybogan Co.; Gaylord; Ocqueoc Lake, Presque Isle Co.; Third Sister Lake, Washtenaw Co.

MINNESOTA: Eaglesnest; 1.3 miles south of main entrance, Itasca State Park; Iron Corner Lake, Itasca State Park; Mississippi River, 150 yards north of Highway 31, Clearwater Co.; Mississippi River near north entrance, Itasca State Park; Mississippi River at Sucker Creek, Clearwater Co.; Squaw Lake, Itasca State Park; Rapid River Logging Camp, Hubbard Co.

NEW YORK: Dryden Lake, Tompkins Co.; Franklinton.

ONTARIO: London; Marmora; Ottawa.

QUEBEC: Lac Bernard; Mount Albert.

Hydrellia bilobifera Cresson. 179 males, 93 females.

CALIFORNIA: Maxwell, Colusa Co.; Davis; Sacramento; Putah Canyon, Yolo Co.; Buena; Colusa Co.

DISTRICT OF COLUMBIA: Washington.

IOWA: Spring Lake, Greene Co.; Pilot Knob State Park, Hancock Co.; Ledges State Park, Boone Co., south pond (41° 58.8' north, 93° 53.5' west); Little Wall Lake, Hamilton Co.; Lewis and Clark State Park, Monona Co. (42° 2' north, 96° 10' west); Banner Mine Area, Warren Co. (41° 26.4' north, 93° 33.8' west); Springbrook State Park, west 1/2 sec. 33, T.81 north, R.31 west, Guthrie Co.; McIntosh Woods State Park, Clear Lake; Siewer's Springs State Park, Decorah.

KANSAS: Kansas University Natural History Reservation, near Lawrence, Douglas Co.; Leavenworth Co. Lake; Kansas State College Natural History Area near Pittsburg; Marais des Cygnes Wildlife Refuge, Linn Co.; 1 mile northwest of Lawrence, Douglas Co. (sandpits).

MICHIGAN: Cheboygan Co.; Bessey Creek, Cheboygan Co.

MINNESOTA: Mississippi River near north entrance, Itasca State Park; Two Island Lake, Itasca State Park; Biological Station, Itasca State Park; Headwaters of LaSalle Creek, Itasca State Park; 6.5 miles east of Waubun; Lake Bohall, Itasca State Park; Chamber's Creek, Itasca State Park; Mississippi River near north entrance, Itasca State Park.

MISSISSIPPI: Vancleave Road, Jackson Co. (30° 28' north, 88° 43' west); near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co. (gravel pit).

ONTARIO: Marmora.

SOUTH CAROLINA: Jamestown.

TENNESSEE: Samburg, Reelfoot Lake (36° 22.9' north, 89° 21.3' west); Miller's Camp, Reelfoot Lake (36° 24.3' north, 89° 20' west); Brewer's Bar Ditch, Reelfoot Lake (36° 27.1' north, 89° 21.2' north); Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett Co.

TEXAS: Galveston; Kerrville.

Hydrellia biloxiae, sp. nov. 26 males, 52 females.

MISSISSIPPI: Lake Shelby State Park, Forrest Co.; Vancleave Road, Jackson Co. (30° 28' north, 88° 43' west); Lake Shady, Lamar Co.; near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co. (gravel pit).

Hydrellia borealis Cresson. 5 males, 5 females.

ALASKA: King Salmon, Naknek River.

BRITISH COLUMBIA: Atlin, 2200 ft.; Brilliant.

MICHIGAN: Dickinson Co.

NEBRASKA: Crete.

ONTARIO: Ottawa.

QUEBEC: Beech Grove.

WASHINGTON: 23 miles west of Republic.

WYOMING: Lander.

Hydrellia caliginosa Cresson. 39 males, 27 females.

ALASKA: Matanuska Valley.

IDAHO: Priest Lake, Tule Bay.

MAINE: Mount Desert Island.

MICHIGAN: Cheboygan County.

MINNESOTA: Eaglesnest; Rapid River Logging Camp, Hubbard Co.

MONTANA: St. Marys.

QUEBEC: Mount Albert; Rupert House.

WYOMING: Kemmerer; Yellowstone National Park, 4,750 ft.

Hydrellia cavator, sp. nov. 2 males, 3 females.

FLORIDA: Bay Shore, Leavenworth; Lake Worth; Gainesville; Biscayne Bay.

Hydrellia cessator, sp. nov. 4 males, 4 females.

MANITOBA: 2 miles north of Forrest.

MINNESOTA: Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co.

Hydrellia columbata, sp. nov. 18 males, 28 females.

MAINE: Mount Desert Island.

MINNESOTA: Squaw Lake, Itasca State Park; Basswood Lake, Lake Co.; Two Island Lake, Itasca State Park.

Hydrellia crassipes Cresson. 45 males, 76 females.

ILLINOIS: Havana.

IOWA: Goose Lake, Hamilton Co.; Little Wall Lake, Hamilton Co.; Springbrook State Park, Guthrie Co.; Spring Lake, Greene Co.

MAINE: Mount Desert Island.

MICHIGAN: Hamburg, Livingston Co.

MINNESOTA: Basswood Lake, Lake Co.; Chamber's Creek, Itasca State Park; 1.3 miles south of main entrance, Itasca State Park; Mississippi River near north entrance, Itasca State Park; Douglas Lodge Bay, Itasca State Park; Squaw Lake, Itasca State Park; Two Island Lake, Itasca State Park; 6.5 miles east of Waubun.

NEW JERSEY: Manahawkin.

OHIO: Cedar Point, Sandusky River.

ONTARIO: Bark Lake, Marmora.

OREGON: Oregon City.

PENNSYLVANIA: Pittsburgh.

QUEBEC: Perkin's Mills.

Hydrellia cruralis Coquillett. 202 males, 354 females.

ALASKA: Valdez.

CONNECTICUT: Candlewood Lake.

FLORIDA: Fruit-fly Survey (1951).

IDAHO: Priest Lake, Tule Island.

ILLINOIS: Pistakee Bay.

IOWA: Spring Lake, Greene Co.

KANSAS: Leavenworth Co. Lake.

MARYLAND: Chesapeake Beach; Plummer's Island.

MASSACHUSETTS: Fall River.

MICHIGAN: Black River, Cheboygan Co.; Carp River, Cheboygan Co.; Cheboygan Pool, Cheboygan Co.; Chippewa Co.; Douglas Lake, Cheboygan Co.; Grosse Isle, Wayne Co.; Hamburg, Livingston Co.; Huron River, Washtenaw Co.; Indian River, Cheboygan Co.; Midland Co.; Monroe; Ocqueoc Lake, Presque Isle Co.; Third Sister Lake, Washtenaw Co.; Washtenaw Co.; Whitmore Lake, Washtenaw Co.

MINNESOTA: Detroit Lakes; Long Lake, Clearwater Co.; Headwaters of LaSalle Creek, Itasca State Park; Biological Station, Itasca State Park; Squaw Lake, Itasca State Park; Eaglenest.

NEW JERSEY: Trenton.

OHIO: Cedar Point, Sandusky River.

ONTARIO: Arnprior; London; Marmora; Ottawa; Black Rapids.

PENNSYLVANIA: West Fairview.

QUEBEC: Lac Bernard.

TEXAS: Pedernales River, Gillespies Co.; Comal River; Garner State Park, Uvalde Co.; Devil's River.

VIRGINIA: Alexandria.

WEST VIRGINIA: Marlington.

Hydrellia decens Cresson. 2 females.

MARYLAND: Plummer's Island.

Hydrellia deceptor, sp. nov. 1 male, 3 females.

CALIFORNIA: Sacramento.

Hydrellia definita Cresson. 15 males, 40 females.

ALASKA: King Salmon, Naknek River.

CALIFORNIA: Jenks Lake.

ILLINOIS: Centerville, Sangamon River.

IOWA: Ames; Banner Mine Area, Warren Co.; Lake Odessa, Louisa Co.; Little Wall Lake, Hamilton Co.; Springbrook State Park, west 1/2 sec. 33, T.8 north, R.31 west, Guthrie Co.

KANSAS: Kansas University Natural History Reservation, near Lawrence, Douglas Co.; Leavenworth Co. Lake; Sappa Lake, Decatur Co.

MICHIGAN: Emmett County; Vineyard Lake.

MINNESOTA: Basswood Lake, sec. 9, T.64 north, R.10 west, Lake Co., Itasca State Park; west side across from Biological Station, Lake Itasca, Itasca State Park; 2.5 miles west of Waubun.

NEBRASKA: Lincoln, Lancaster Co.

NEW YORK: Dryden Lake, Tompkins Co.

ONTARIO: Pembroke.

SASKATCHEWAN: Rock Glen.

SOUTH DAKOTA: Hot Springs.

UTAH: Spanish Fork.

WYOMING: Slide Lake, 12 miles northwest of Lusk.

Hydrellia discursa, sp. nov. 46 males, 64 females.

CALIFORNIA: Davis; Maxwell, Colusa Co.; Vidal, San Bernardino Co.

DISTRICT OF COLUMBIA: Washington.

FLORIDA: Cape Sable.

IOWA: Spring Lake, Greene Co.; Goose Lake, Hamilton Co.; Siewers Springs State Park, Decorah.

KANSAS: Marais des Cygnes Wildlife Refuge, Linn Co.; Leavenworth Co. Lake; Kansas University Natural History Reservation, near Lawrence, Douglas Co.

MICHIGAN: Cheboygan Co.

MINNESOTA: Mississippi River near north entrance, Itasca State Park; Biological Station, Itasca State Park; Headwaters of La Salle Creek, Itasca State Park; Bohall Trail Bog, Itasca State Park.

MISSISSIPPI: Lake Shelby State Park; Forrest Co. (31° 9' north, 89° 14.6' west).

ONTARIO: Ottawa; Marmora.

TENNESSEE: Samburg, Reelfoot Lake (36° 22.9' north, 89° 21.3' west); Miller's Camp, Reelfoot Lake (36° 24.3' north, 89° 20' west); Brewer's Bar Ditch, Reelfoot Lake (36° 27.1' north, 89° 21.2' west).

TEXAS: Galveston.

Hydrellia flavicoxalis Cresson. 2 males, 1 female.

COLORADO: Walden.

Hydrellia floridana, sp. nov. 27 males, 25 females.

FLORIDA: Baxter; Orlando; Winter Garden; De Funiak Springs, Walton Co.; Lake Worth; Lacoochee.

GEORGIA: Waycross.

LOUISIANA: Bethany.

MISSISSIPPI: Vancleave Road, Jackson Co. (30^{o} 25.1' north, 88^{o} 46' west); Vancleave Road, Jackson Co. (30^{o} 28' north, 88^{o} 43' west); Bluff Creek, Vancleave, Jackson Co.; Saucier; near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co. (gravel pit).

Hydrellia formosa Cresson. 217 males, 382 females.

ALABAMA: Chattahoochee State Park, Houston Co.

ARKANSAS: Calion, Union Co.; Rison, Cleveland Co.

CONNECTICUT: Redding; Storrs; southwest corner of Sleeping Giant State Park, near Hamden.

DISTRICT OF COLUMBIA: Washington; Rock Creek Park, Washington.

FLORIDA: Baxter; De Funiak Springs, Walton Co.; Fort Ogden, De Soto Co.; Silver Springs near Ocala, Marion Co.; Torreya State Park.

GEORGIA: Clayton, Rabun Co., 2,000 ft.; Waycross.

INDIANA: LaFayette; Lake Co.; Valparaiso.

IOWA: Fraser Dam, Boone Co.; 3 miles east southeast of Waterville, Allamakee Co.; Siewer's Springs State Park, Decorah.

KANSAS: 1.5 miles south of Bonner Springs, Johnson Co.

LOUISIANA: White Sulphur Springs; Lake Providence.

MAINE: Kennebec Point.

MARYLAND: Chesapeake Beach; Glen Echo; Prince Georges Co.; near Plummer's Island; Catoctin Furnace; Cabin John; Pennyfield Lock of Chesapeake and Ohio Canal.

MASSACHUSETTS: Boston; Woodshole.

MICHIGAN: Detroit; Grand Rapids; Midland.

MISSISSIPPI: Highway 59, George Co. (30° 45.7' north, 88° 45.1' west); Lake Shady, Lamar Co.; Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar Co.; Bellefontaine Point, Jackson Co.; Bluff Creek, Vancleave, Jackson Co.; Saucier; near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co. (gravel pit).

MISSOURI: Atherton.

NEW JERSEY: Vineland; Trenton.

NEW YORK: Cold Spring Harbor, Long Island; Ithaca, campus; Ithaca; 1 mile northwest of Pine Lake (43° 12' north, 74° 32' west), 1,600 ft.; Lancaster; Bear Mountain.

NORTH CAROLINA: Clingman's Dome, Great Smoky Mountains National Park, 6,300-6,642 ft.; Highlands, Macon Co. (35° 8.2' north, 83° 11.3' west), 3,850 ft.; Highlands, 3,800 ft.; Asheville.

NOVA SCOTIA: Truro.

OHIO: Rome.

ONTARIO: Ottawa.

PENNSYLVANIA: Swarthmore; Point Pleasant; Lansdale; Ohiopyle, Fayette Co.; Pittsburgh; Westmoreland Co.; Harmarville, Alleghany Co.; Alleghany Co.; Hills Station; Hartstown, Crawford Co.

QUEBEC: Lac Phillipe (45° 37' north, 76° west).

SOUTH CAROLINA: Aiken; Cross Anchor.

TENNESSEE: Clarksville; Knoxville; Reelfoot State Park; Reelfoot Lake (36° 21.1' north, 89° 25.5' west).

TEXAS: Carthage; Palmetto State Park, near Ottine.

VIRGINIA: Alexandria; Falls Church; Holmes Run, Falls Church; Saltville, Smyth Co.; Great Falls; Maywood, Alexandria Co.; Potomac River at Scott Run, Fairfax Co.; Pimmit Run.

WEST VIRGINIA: Fairmont; Cranberry Glades, Pocahontas Co.

Hydrellia gladiator, sp. nov. 1 male, 1 female.

FLORIDA: From puparia from aquarium *Vallisneria*.

Hydrellia griseola (Fallén). 1652 males, 2544 females.

ALABAMA: Chattahoochee State Park, Houston Co.

ALASKA: Anchorage; Seward; Popoff Island; Cold Bay (160° west northwest on tundra); King Salmon, Naknek River; Sitka; Sitka National Monument; Dall Island; Baronof Island; Ketchikan; Yakutat; Douglas; Savonoski; Naknek Lake; Valdez; Kern Creek; Seward; Anchorage Highway.

ALBERTA: Lake Louise; Walsh; McMurray; Milk River; 2.5 miles east of Aden; Medicine Hat; Loop, Banff, 4,500 ft.; Vermilion Lake, Banff, 4,500 ft.; Buffalo Park, Banff, 4,500 ft.; Edmonton; High River; Paradise Valley, Laggan, 7,000 ft.; Laggan; Sulphur Mountain, Banff, 5,000-7,000 ft.; Cottonwood

Creek, Jasper National Park; Baptiste Lake, south of Athabasca; Banff National Park, 7 miles west of Banff.

ARIZONA: Prescott; Quitobaquito; Organ Pipe Park, Alamo Canyon; South Rim of Grand Canyon; Oak Creek Canyon; Hassayampa River, Wickenburg; Bright Angel Creek; Grand Canyon.

ARKANSAS: Calion, Union Co.; Arkansas Co.

BRITISH COLUMBIA: Kaslo; Carbonate, Columbia River; Mathew's Pond, Howser Lake; Hatzic Lake; Mission City; Masset, Queen Charlotte Islands; Ruskin; Robson; Milner; Cultus Lake; Mount Revelstoke; Duncan; Bowser; Tuskatla, Queen Charlotte Islands; Tlell, Queen Charlotte Islands; Mac Gillvray Creek Game Reserve near Chilliwack; 122-mile House; Queen Charlotte City; Cowichan Lake; Oliver; Salmon Arm, Shuswap Lake; Malahat; Aliford Bay, Queen Charlotte Islands; Moyie Mountain, east of Kootenays, 6,868 ft.; South Fork Creek; Clayton; Hope; Bear Lake; Carbonate, Columbia, 2,600 ft.; Loon Lake, Selkirk Mountains; Nelson; Howes Inlet; Alliford Bay, Queen Charlotte Islands.

CALIFORNIA: Mill Valley, Marin Co.; Winters; Richmond, Contra Costa Co.; Gibson, Shasta Co.; Fitzhugh Creek, Alturas, Modoc Co.; Swedringen Creek, Alturas, Modoc Co.; Tomales Bay, Marin Co.; Westwood, Lassen Co.; Del Puerto Canyon, Stanislaus Co.; 4 miles west of Viola, Shasta Co.; Montara; Modesto; Sutter City; Sutter Buttes, Sutter Co.; San Diego; Oakland; Umdhlelannyoni Novato, Marin Co.; Fresno; Inverness; Santa

Catalina Island; Alameda Co.; Martinez, Contra Costa Co.; 3 miles west of San Mateo; Alpine; Cathedral Canyon; Mountain Home; Rincon Point, Ventura; Cathedral City; Ortega Highway at San Juan Bridge; Alturas Inspection Station; Modoc Co.; Eureka; Ukiah; Santa Rosa; Santa Maria; Biggs; Pasadena; Arcata, Humboldt Co.; mountains near Claremont; Herkey Camp; Sequoia National Park; Palm City; Lone Pine; Alameda; La Honda, San Mateo Co.; Echo; Bray; Colfax; Cedar Pass, Modoc Co.; Hemet; Whitewater Canyon, Riverside Co.; Woodland; Auburn; Esparto, Yolo Co.; Davis; Mount San Jacinto; Santa Cruz; San Luis Obispo; Palter; Moraga; Harmony; Pleasanton; San Simeon; Lucia; Coalinga; Bates, Madera Co.; San Diego Co.; Hebron Summit, Siskiyou Co., 5,202 ft.; Whittier; Grass Lake, Siskiyou Co., 8,000 ft.; Rancho Santa Ana; Lake Henshaw; Yosemite National Park; Little Lake; Mammoth Lakes; Jamesburg; Danville; Majeska Canyon; La Honda, San Mateo; 4 miles west of Used, Siskiyou Co.; Banning; Berkeley; San Quentin Point, Marin Co.; Garden Valley, Eldorado Co.; Mount Diablo, east slope, Contra Costa Co.; Antioch, Contra Costa Co.; Thousand Palms; Madison, Yolo Co.; Grimes, Colusa Co.; Stockton; Irvine; Capistrano Hot Springs; Blue Lake, Humboldt Co.; Wildcat Canyon, San Pablo, Contra Costa Co.; Mesa Grande, Russian River; Riverside; Big Bear Lake; Badwater, Death Valley; Sonoma Co.; McClure Valley, Kings Co.; Desert Hot Springs; Palm Canyon, Palm Springs; Helendale; Willis Palms Oasis, Thousand Palms; Tourney Park;

Thorn, Mojave Desert; Valyermo; Big Sur; San Clemente; San Juan, Hot Springs; Idylwild; Putah Canyon, Yolo Co.; Yosemite Valley; Los Angeles Co.; San Mateo Co.; LaJolla; Orick, Humboldt Co.; Pacific Grove; Muir Woods; Samoa Beach Sand Dunes, Humbolt Co.; Furnace Creek, Death Valley; St. Helena, Napa Co.; Thermal; Snow Creek, 1,500 ft.; Whitewater; Victorville; Andreas Canyon, Palm Springs; Morongo Valley; Arvin; Monrovia; Lovejoy Spring, Mojave Desert; Laytonville; Ortega Highway, Mariana River; Laguna Beach; Live Oak Tank, Joshua National Monument; Keen Camp; Morro Bay; Los Gatos, Santa Clara Co.; Redwood City, San Mateo Co.; Stanford University, Santa Clara Co.; Beach, San Francisco; Dixon; Smith River; Bishop; Alhambra; Indio, Riverside Co.; Berkeley Hills, Alameda Co.; Truckee; near Firebaugh, Madera Co.; Gridley; Isabella Creek, Santa Cruz Co.; Forestville, Sonoma Co.; Nelson, Butte Co.; Green Valley Park, Solono Co.; Cayton, Shasta Co.; Willits; Claremont, Los Angeles Co.; Elkhorn Ferry, Yolo Co.; Loomis; Half Moon Bay; Hallelujah Junction, Lassen Co.; Monticello, Napa Co.; Escalon, San Joaquin Co.; Prairie Creek, Humbolt Co.; Vidal, San Bernardino Co.; Palo Alto; Lake Temescal, Berkeley; Big Spring, Shasta Co.; Alkali Lake, Antelope Valley; Elk Grove, Sacramento Co.; Lagunitas Creek, Marin Co.; Lagunitas Canyon, Marin Co.; Topaz Lake, Mono Co.; Maxwell, Colusa Co.; Panoche Oaks, Fresno Co.; Dunlap, Fresno Co.; Trinity River Camp, Trinity Co.; Twin Peaks, San Francisco

Co.; Carlsbad; Dutch Flat, Placer Co.; Clear Lake, Oaks, Lake Co.; Soledad, Monterey Co.; Onyx, Kern Co.; 5 miles west of Lemore, Kings Co.; Baxters, Placer Co.; Sacramento; Canby, Modoc Co.; Albany, Alameda Co.; Asilomar; Buena Park; Temecula River; Big Rock Wash, Mojave Desert; South Fork of Santa Ana River; Lake Cuyamaca; Cajon; Cathedral Canyon; southwestern slope of Yellow Mountain, southeast 1/4 sec. 11, T.47 north, R.15 east, Modoc Co.; Little Lake; Oak Grove; Boyes Springs; Cambria; Pinnacles National Monument; San Benito Co.; Half Moon Bay; Upper Santa Ana River; Albany.

COLORADO: Boulder Creek, Boulder Co.; Tahosa Valley, Larimer Co.; North Saint Urain Creek, Boulder Co.; Denver; Deckers; Electra; Golden; Tennessee Pass, 10,240 ft.; northwest slope of Sun Dance Mountain, 12,000 ft.; Rocky Mountain National Park, (40° 24.9' north, 105° 43.0' west); Rocky Mountain Biological Laboratory, Gunnison Co., 9,500 ft.; Ohio Pass Road, Gunnison Co., (38° 44.4' north, 108° 1.3' west); Grand Junction; Creede, 8,844 ft.; Fort Collins; Electra Lake.

CONNECTICUT: Redding; Cornwall; Avon; Avon Old Farms, Avon; 1 unspecified; Candlewood Lake; southwest corner of Sleeping Giant State Park near Hamden.

DELEWARE: Rehoboth Bay; 1 unspecified.

DISTRICT OF COLUMBIA: 2 unspecified.

FLORIDA: Rock Springs; Sebring; Apalachicola River bottoms at Chattahoochee, Gadsden Co.; Monticello.

GEORGIA: Cloudland Canyon State Park; Waycross; Tifton.

IDAHO: Moscow; Hauser Lake; Regina; Eureka; Divide Park, Snake River; Divide Oak, Snake River; Potlatch; Lake Merton, Moscow; Sweet; Divide Creek, Snake River; Lewiston; Four-mile Camp, Priest Lake; Moscow Mountains; Laird Park near Harvard; Mac Kay; Blackfoot Reservoir, Henry, Caribou Co.; McCammon; Juliaetta.

ILLINOIS: Peoria; River Forest; Urbana; Dongola; Springfield; Anna; Muncie; Chicago; Champaign; northwest of Forest City; Mason State Forest, northwest of Forest City; Oakwood; near Forest City; Algonquin.

INDIANA: Lafayette; Bloomington; Needmore, Lawrence Co.; Brown Co.; Cedar Lake.

IOWA: McIntosh Woods State Park, Clear Lake; Springbrook State Park, Guthrie Co.; Little Wall Lake, Hamilton Co.; 3 miles east southeast of Waterville, Allamakee Co. (43° 11' north, 91° 14.1' west); Banner Mine Area, Warren Co. (41° 26.4' north, 93° 33.8' west); Lakin Slough, Guthrie Co.; 4 miles northeast of Wapello, Louisa Co. (41° 12.1' north, 91° 5.5' west); Goose Lake, Hamilton Co.; Izaak Walton League Pond, Ames (42° 5' north, 93° 35' west); Ledges State Park, Boone Co.; Soper's Mills Dam, Story Co.; Lacey-Keosauqua State Park, Van Buren Co.; Ames; Lewis and Clark State Park, Monona Co. (42° 2' north, 96° 10' west); 3 miles southeast of Waterville, Allamakee Co. (43° 10.4' north, 91° 15.1' west); Jewell; White

Pine Hollow State Park, Dubuque Co.; Miniwakon State Park, Dickinson Co.; Lake Odessa, Louisa Co. (41° 12.1' north, 91° 5.5' west); Pilot Knob State Park, Hancock Co.; Harmon Lake, sec. 21, Logan Twp., Winnebago Co.; Fraser Dam, Boone Co.; Marble Beach, Big Spirit Lake, Dickinson Co.; Sioux City; Springbrook State Park, Guthrie Co. (west 1/2 sec. 33, T.81 north, R.31 west); Spring Lake, Greene Co.; Siewer's Springs State Park, Decorah; Oak Grove State Park, Sioux Co.; Skunk River, Ames; College Creek, Ames; Clear Creek, Ames; near Missouri River, 7 miles southwest of Whiting, Monona Co.; 3.5 miles west of Boone, Boone Co. (42° 5' north, 93° 57.8' west); 4 miles northeast of Wapello, Louisa Co. (41° 13.9' north, 91° 7.0' west); 1 mile south of Fraser, Boone Co.

KANSAS: Pottawatomie Co.; Manhattan; Kansas University Natural History Reservation, near Lawrence, Douglas Co.; Riley Co.; Leavenworth Co. Lake; 1 mile south of Bonner Springs, Johnson Co.; 1.5 miles south of Bonner Springs, Johnson Co.; Sappa Lake, Decatur Co.; Douglas Co., 900 ft.; Marais des Cygnes Wildlife Refuge, Linn Co.

LOUISIANA: Lake Alexandria; Opelousas; Avery Island; Houma.

MAINE: Pittson; Trenton; Machias; Seal Harbor, Mount Desert Island; Narrows, Mount Desert Island.

MANITOBA: Aweme; Treesbank; 5 miles southwest of Shilo; Deepdale; The Pas; Churchill; Ninette; Ewan River; 2 miles west of Stockton.

MARYLAND: Baltimore; Laurel; Chesapeake Beach; Plummer's Island; Rock Run, Montgomery Co.; Bladensburg; Prince Georges Co.

MASSACHUSETTS: Woodshole; Concord; Beverly; Provincetown; Spencer; Mount Greglock; Suncerland; Palmer; New Bedford; Peterham; Athol; Walden Pond; Concord.

MICHIGAN: Midland Co.; Copper Harbor; Detroit; Brevort; East Lansing; Isle Royal, Keweenaw Co.; Tuscola Co.; Alabaster; Gratiot Co.; Bay Co.; Chippewa Co.; Augusta; Nottawa; Gladwin Co.; Saginaw Co.; Alger Co.; Mecosta Co.; Dickinson Co.; Cheboygan Co.; Stevensville, Berrien Co.; Ann Arbor, Washtenaw Co.; Iron Co.; Arenac Co.; Lake Co.; Presque Isle Co.; Mackinac Co.; Sutton's Bay; Manistee Co.; Iosco Co.; Antrim Co.; Baraga Co.; Keweenaw Co.; Macomb Co.; Menominee Co.; Roscommon Co.; Kalkaska Co.; Schoolcraft Co.; Houghton Co.; Leelanau Co.; Wexford.

MINNESOTA: Basswood Lake, sec. 9, T.64 north R.10 west, Lake Co.; Yellow Medicine Co.; Iron Corner Lake, Itasca State Park; 6.5 miles east of Waubun; Bohall Trail Bog, Itasca State Park; Kabekona Creek, sec. 32, T.143 north, R.33 west, Hubbard Co.; Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co.; Mississippi River at Sucker Creek, Clearwater

Co.; Sucker Creek, 100 yards north of Highway 31, Clearwater Co.; Rapid River Logging Camp, Hubbard Co.; Kabekona Creek, sec. 4, T.143 north, R.33 west, Hubbard Co.; Itasca State Park; Washington Island, Basswood Lake, Lake Co.; Two Harbors; Wright Co.; Hennepin Co.; Lake Co.; Kandiyohi Co.; Cook Co.; Lancaster; Sandstone; Mille Lacs; Marshall Co.; Plummer; Jay Cooke Park, Carlton; Haydenville; St. Paul; Kittson Co.; Bigstone Co.; Hudson Bridge, Washington Co.; Houston Co.; Rochester; Ramsey Co.; Duluth, St. Louis Co.; Bendette; Norman Co.; Floodwood; Pope Co.; Vineland; Crow Wing Co.; Swift Co.; Bunker Lake, Anoka Co.; Washington Co.; Grand Marais; Willow River; Chisago Co.; Eaglenest.

MISSISSIPPI: Starksville.

MISSOURI: Atherton; Fredricktown; Silver Mine; Athens; Oak Grove.

MONTANA: Yellowstone Lake; Lake Mac Donald; Glacier Park; Upper St. Regia River; Avalanche Lake, Glacier National Park; Rock Creek and Madison River; Gallatin National Forest; Anaconda.

NEBRASKA: Lincoln, Lancaster Co.; Chadron; Hastings; Oakdale; Lincoln; Monroe Canyon, Sioux Co.

NEVADA: Holbrook, Douglas Co.; Wine Cup Ranch, Elko Co.; Sky Ranch, Reno Co.; Currant, Nye Co.; 25 miles north of Austin, Lander Co.; Harrison Pass; Green Mountain Creek, Elko Co.; Elko; Beatty; Las Vegas; Fallon, 4,000 ft.; Wells;

Crystal Springs, Lincoln Co.

NEW BRUNSWICK: Tabusintac; Chamcook; Birch Cove near Chamcook; St. Andrews.

NEW HAMPSHIRE: Benton; Bigelow Lawn, Mt. Washington, 5,400 ft.; Lake of the Clouds, Mt. Washington, 5,000 ft.; Alpine Garden, Mount Washington; Storm Lake, Mount Adams, 5,200 ft.; Mount Jefferson, Presidential Range of White Mountains, 5,200 ft.; Oakes Gulf, Mount Washington; Franconia; Toll Road, Mount Washington; Franconia Notch.

NEW JERSEY: Vineland; Trenton; Neshanic; Avon; Manahawkia.

NEW MEXICO: Jemez Springs, Sandhoval Co.; Silver City; Cherry Creek, Pinos Altos; Jemez Mountains.

NEW YORK: Ithaca; Montauk; Grand Island; East Aurora; McLean; vicinity of Jockeybush Outlet, Hamilton Co. (43° 18' north, 74° 34' west); Babylon, Long Island; Beaverkill; Cold Spring Harbor, Long Island; Gonawands; Middleport; Indian Falls, Niagara Falls; Bear Mountain; Lancaster; along Shanty Brook, Hamilton Co. (43° 17.2' north, 74° 33.4' west); Ringwood, Ithaca; Cornell University, Ithaca.

NORTH CAROLINA: Highlands, 3,800 ft.; Asheville; Highlands, Macon Co. (35° 32' north, 83° 11.3' west) 3,850 ft.; Cherokee.

NORTHWEST TERRITORIES: Hay River; Fort Wrigley.

NOVA SCOTIA: Lockeport; Truro; Smith's Cove.

OHIO: Columbus; Georgesville; Buckeye Lake; Summit Co.; Barberton.

ONTARIO: Ottawa; Pembroke; Orillia; Silver Creek; Constance Bay; Point Pelee; Rockcliffe, Ottawa; Marmora; Amprior; Sudbury; Bell's Corners; Guelph; Normandale (42° 42' north, 80° 19' west); Midland; Kenora; Maynooth; Haileybury; Port Ryerse; 30 miles south of Dryden; Algonquin Park; Ridgeway.

OREGON: Tumalo Reservoir, Deschutes Co.; Fort Klamath, Klamath Co.; Mount Hood; Corvallis; Hood Rapids, Mount Hood; Derby; Marshfield; Roseburg; Oregon Experimental Station, Corvallis; Booth State Park, 14 miles west of Lakeview; 20 miles south of Bend, Deschutes Co.; Hood River; Parkdale; Peoria; Butte Falls; Alsea; Klamath Falls, Algoma; Tillamook; Hat Point, Wallowa Co.; Brookings, Curry Co.; Aneroid Lake; Koizer Bottom, Marion Co.; 10 miles north of Tygh Valley; 1 mile north of Aneroid Lake; Lake Labish, Marion Co.; 3 miles southeast of Odell Lake; Moiser; Hart Mount; Deschutes River near Redmond; Oneonta Gorge; Seal Rock; Humbug Mountain State Park, Curry Co.; Newport; Cline Falls State Park, Deschutes Co.; Portland; Hereford; Cannon Beach; Harney Co.; Bend; Breitenbush Hot Springs, Marion Co.; Ophir; Scappoose; 3 miles south of Tygh Valley; Vernonia; Redmond; Trout Creek Camp, 6 miles east of Cascadia, Linn Co.; Powell Butte, Creek Co.; Lacomb; Lincoln Mountain, Weston; Wilton; Detroit; Summer Lake, Lake Co.; Alsea Mountain, 15 miles west of Corvallis; Mount Hood Meadows, Mount Hood; St. Helens; Summer Lake, 14 miles northwest of Paisley (sec. 35, T.32 south, R.76 east); Vale; Narrows; Fogarty Creek, Newport; Rock Creek, Philomath; Waldport; Chewaucan River near Paisley; McFadden Pond, 10 miles south of Corvallis; McMinnville, Yamhill Co.; Union; 10 miles northwest of Klamath Falls; Wild Horse Mountain; Athena; Rock Creek, 5 miles west of Philomath; Wallowa Lake; Sister Mountain; Green Lake; Sunshine Shelter, Three Sisters; Sulphur Springs, 10 miles west of Corvallis; St. Helena, Scapposse; Independence; Cornucopia, 7,100 ft.; Milwaukie; Windchuck River; Cayuse; The Dalles; Munsel Lake, Florence; Picture Flat, 26 miles northwest of Lakeview, Lake Co. (sec. 12, T.36 south, R.16 east).

PENNSYLVANIA: Jack Run, Allegheny; Swarthmore, Delaware Co.; Point Pleasant; 2 miles north of Narberth, Montgomery Co.; Castle Rock; Cresheim Creek Valley, Philadelphia; Hazelton; Lansdale; Delaware Co.; Holmesburg; Pittsburgh; Ohiopyle, Fayette Co.; Allegheny Co.; Hills Station; Westmoreland Co.; Guyasuta Run, Pittsburgh; Harmarville, Allegheny Co.

QUEBEC: Anse Au Griffon, Gaspe; Hull; Great Gaspe Valley; Harrington Lake, Gatineau Park; Gatineau Park; Mistassini; Wakefield; Notre Dame du Portage; Abbotsford; Gulf of St. Lawrence; Natashquan; Cap Rouge; Great Whale River; Grosse Pointe; Rupert House; Parke Reserve, Kam Co., 950 ft.; Old Chelsea; Perkin's Mills; Montreal Island; Gaspe; Gaspe Bay.

SASKATCHEWAN: Saskatoon; Waskesiu River; Val Marie (49° 15' north, 107° 44' west); Willows (49° 37' north, 105° 52' west); Saskatchewan Landing.

SOUTH CAROLINA: Ridgeland; Aiken; Pee Dee Experimental Station, Florence.

SOUTH DAKOTA: Brookings; Custer; Milbank.

TENNESSEE: East Ridge; Reelfoot State Park, Reelfoot Lake (36° 21.1' north, 89° 25.5' west); Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett Co.; Samburg, Reelfoot Lake (36° 22.9' north, 89° 21.3' west).

TEXAS: Austin; Herke Pond, Kerrville; Kerrville; Unspecified; Wheeler Springs; Rio Hondo, Cameron Co.; Garner State Park, Uvalde Co.; Laguna Madre, 251 miles southeast of Harlington; 25 miles northwest of Austin; Double Lake.

UTAH: Emigrant Canyon, Wasatch Mountains; Dugway Proving Ground, Tuoole Co.; Hoopes; Kanesville; Eden; northwest of Ogden; Utah Experimental Station, Eden; Upton; Rond Valley; Pine Creek; Kanosh Flats; Hidden Lake Camp, Mount Timpanogos, Utah Co.; Roberts Pass, Uinta Mountains, Duehesne Co., 12,500 ft.; Logan Canyon; Kanab; Timpanogos Mountain, Utah Co.; Moab; Holden; Soldier Springs; Proro; Logan; Myton; Salt Lake City; Red Butte Canyon; Salt Lake Co.; Hanna; Cub Creek, Uinta Mountains; Payson, Utah Co.

VERMONT: St. Albans; Providence.

VIRGINIA: Mount Solon, Augusta Co.; Winlock; Natural Bridge National Monument; Laraz; Richmond; Potomac River at Scott Run, Fairfax Co.; Chain Bridge; Glencarlyn; Alexandria; Dead Run, Fairfax Co.; Mount Vernon; Great Falls; Virginia coast above Windy Run.

WASHINGTON: Humptulips; Uniontown; McElray Lake, Paha; Seattle; Coulee City; LaPush; Tacoma; Hoquiam; Winlock; Oroville; Lilliwaup; Mill Creek, Walla Walla; Mount Constitution, Orcas Island; Pullman; Bellingham; Washovaal; Centralia; Friday Harbor; South Fork of Dry Creek, Blue Mountains; Spokane; Almota; Klickitat River, Glenwood Road; Longmire Spring, Mount Rainier; Kamiac Butte; Central Ferry; Oreas Island, above Mount Lake; Keyport; Seaview; Ilwaco; Colfax; Lake Cushman; Colville Lake; Hanford Works, Benton Co.; Oaksdale; O'Sullivan Dam, Grant Co.; Lake Chelan, Stehekin; Husum; Toppenish; Lake Chelan, Lucerne; Soap Lake; Five Mile Lake; American River, Mount Rainier; Summerland, Mount Rainier; Lake Semanish State Park, King Co.; Ohanapecosh, Mount Rainier; Copalle; Mount Adams; Valley Ford; Narada Falls, Mount Rainier National Park; Berkeley Park, Mount Rainier National Park; Yakima Park, Mount Rainier National Park; Burroughs, Mount Rainier National Park; Big Springs Camp Ground of Peola; Ringold; Lind; Ocean Park; Entiat; Mount Vernon; Lake Crescent, Fairholm; Pateros; Mazama, Mount Rainier National Park; Asotin; Chambers, south of Pullman; Eagle Peak, Mount Rainier;

Knightmere, Yakima, at Donald; Yakima, at Naches; Yakima, at Moxee; Mill Creek, Walla Walla; Crescent Bay; Ritzville; Deer Park; Peshastin; Kalama River; Cusick; Dewatto; 15 miles west of Kettle Falls; Waterville; Rochester; Holland.

WEST VIRGINIA: Craneberry Glades, Pocahontas Co.; Cheat Mountains.

WISCONSIN: Delle; Black Falls; Price Co.; East Troy.

WYOMING: Jackson, 6,000 ft.; Old Faithful Geyser, Yellowstone National Park; Slide Lake; Lander; 12 miles northwest of Lusk; 40 miles north of Lusk; Granger, 6,400 ft.; 12 miles north of Lusk; Laramie; Lewis Lake, Yellowstone National Park; Riverside; Yellowstone National Park; Dunraven Pass, Yellowstone National Park; Sylvan Pass, Yellowstone National Park.

Hydrellia harti Cresson. 43 males, 14 females.

CALIFORNIA: Laguna Canyon, Orange Co.

ILLINOIS: Havana.

IOWA: Spring Lake, Greene Co.

KANSAS: Kansas University Natural History Reservation, near Lawrence, Douglas Co.

NEBRASKA: Glen.

ONTARIO: Marmora; Midland; Ottawa.

QUEBEC: Perkin's Mills.

RHODE ISLAND: Providence.

Hydrellia idolator, sp. nov. 2 males, 3 females.

MISSISSIPPI: near U.S. Highway 90, sec. 20, T.7 south, R.5 west, Jackson Co. (gravel pit); Bellefontaine Road, Jackson Co.

ONTARIO: Ottawa.

QUEBEC: Norway Bay.

Hydrellia insulata, sp. nov. 8 males, 7 females.

MARYLAND: Plummer's Island.

Hydrellia ischiaca Loew. 135 males, 201 females.

ALASKA: Valdez.

CALIFORNIA: Lake Tahoe.

CONNECTICUT: Redding; Colebrook.

GEORGIA: Holcomb Creek; Villa Rica.

INDIANA: Lafayette.

ILLINOIS: Peoria.

IOWA: 3 miles east southeast of Waterville, Allamakee Co.; 4 miles northeast of Wapello, Louisa Co.; Lake Odessa, Louisa Co.; Little Wall Lake, Hamilton Co.; White Pine Hollow State Park, Dubuque Co.; Siewer's Springs State Park, Decorah; Spring Lake, Greene Co.; Ames, Story Co.; Ames, Izaak Walton League Reserve, Story Co.; Ledges State Park, Boone Co.; Pilot Knob State Park, Hancock Co.

MAINE: Pittston.

MARYLAND: Plummer's Island; Baltimore; Beltsville; Glen Echo.

MASSACHUSETTS: Brookline; New Bedford.

MICHIGAN: Vineyard Lake, Jackson Co.; Midland Co.; Roscommon Co.; Isabella Co.

MINNESOTA: Two Island Lake, Itasca State Park; Rapid River Logging Camp, Hubbard Co.; Iron Corner Lake, Itasca State Park; 6.5 miles east of Waubun; Lake Bohall, Itasca State Park; Headwaters of LaSalle Creek, Itasca State Park; Mississippi River; Clearwater Co.; Biological Station, Itasca State Park; Bohall Trail Bog; Itasca State Park; Douglas Lodge Bay, Lake Itasca, Itasca State Park; Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co.; Mississippi River near north entrance, Itasca State Park; Squaw Lake, Itasca State Park; Kabekona Creek, Hubbard Co.; west side across from Biological Station, Lake Itasca, Itasca State Park; Mississippi River, 150 yards north of Highway 31, Clearwater Co.; Sucker Creek, 100 yards north of Highway 31, Clearwater Co.; Mississippi River at Sucker Creek, Clearwater Co.

NEW HAMPSHIRE: Mount Washington.

NEW YORK: Ithaca; Dryden Lake, Tompkins Co.; east foot of West Notch Mountain, Hamilton Co. (43° 20.6' north, 74° 37.2' west), 1,900 ft.; vicinity of Six-mile Creek, Ithaca; New York; McLean.

NORTH CAROLINA: Wilson's Gap, Highlands, 3,100 ft.; Highlands, 3,000 ft. and 3,800 ft.; Wayah Gap, Macon Co., 4,000 ft.; Looking Glass Peak, Pisgah Forest; Clingsman Dome, Great

Smoky Mountains National Park, 6,300-6,800 ft.; 3 miles southwest of Glenville, Jackson Co. (35° 8' north, 83° 9' west), 3,700 ft.; Forney Ridge, Great Smoky Mountains National Park.

NOVA SCOTIA: Mount Uniacke; Jordan Falls; Lockeport.

ONTARIO: Ancaster; Normandale (42° 42' north, 80° 19' west); Ottawa; Marmora.

PENNSYLVANIA: Ohiopyle, Fayette Co.; Point Pleasant; Westmoreland Co.; Alleghany Co.; 2 miles north of Narberth, Montgomery Co.; Swarthmore; Castle Rock; Jack Run, Alleghany Co.

QUEBEC: Rigaud; Old Chelsea; Laniel.

SOUTH CAROLINA: Cross Anchor.

TENNESSEE: Greenbrier Cove, Great Smoky Mountain National Park, 2,000 ft.; Shelby Forest State Park; Knoxville.

TEXAS: Huntsville.

VIRGINIA: Falls Church; Fairfax; Maywood, Alexandria Co.; Reddish Knob, Augusta Co.

WEST VIRGINIA: Cranberry Glades.

Hydrellia itascae, sp. nov. 3 males, 13 females.

MINNESOTA: Biological Station, Itasca State Park; Douglas Lodge Bay, Lake Itasca, Itasca State Park.

Hydrellia lata Cresson. 3 males.

ALASKA: King Salmon, Naknek River.

MANITOBA: near Eastern Creek.

WASHINGTON: Nasel River, Pacific Co.

Hydrellia luctosa Cresson. 36 males, 97 females.

IOWA: south pond, Ledges State Park, Boone Co.; Spring Lake, Greene Co.; Springbrook State Park, Guthrie Co.

KANSAS: Kansas University Natural History Reservation, near Lawrence, Douglas Co.

MICHIGAN: Douglas Lake, Cheboygan Co.; Nigger Creek, Cheboygan Co.; Bessey Creek, Cheboygan Co.; Cheboygan Co.

MINNESOTA: Chamber's Creek, Itasca State Park; Douglas Lodge Bay, Lake Itasca, Itasca State Park; Eagles nest; Headwaters of La Salle Creek, Itasca State Park; Mississippi River near north entrance Itasca State Park; Mississippi River at Sucker Creek, Clearwater Co.; Lake Bohall, Itasca State Park; Squaw Lake, Itasca State Park; Two Island Lake, Itasca State Park; 6.5 miles east of Waubun.

ONTARIO: Dundas Marsh; Marmora; Ottawa.

QUEBEC: Mount Albert.

Hydrellia manitobae, sp. nov. 6 males, 34 females.

ALASKA: King Salmon, Naknek River.

ALBERTA: One-Four.

IDAHO: Sand Point.

MANITOBA: Fort Churchill; Farnsworth Lake near Churchill; Whitewater Lake.

ONTARIO: Marmora.

QUEBEC: Rupert House; Missisquoi Bay; LaTrappe.

SASKATCHEWAN: Willows; Val Marie.

Hydrellia melanderi, sp. nov. 20 males, 43 females.

ARIZONA: Oak Creek Canyon, 6,000 ft.; Rustler Park, Chiricahua Mountains.

CALIFORNIA: Garden Valley; Riverside; Tuolumne Meadows; Pacific; Mono Lake, Mono Co.; South Fork of Santa River; Keen Camp; Big Bear Lake; Strawberry, Tuolumne Co.; Echo; Sardine Creek; Mono Co., 8,500 ft.; Green Valley; Cuyamaca Park; Palm Canyon, Borego; Herkey Camp; Carson Pass; Jenks Lake; Barton Store; Upper Santa Ana River.

COLORADO: Electra Lake; Ohio Pall Road, Gunnison Co.

MEXICO: Mexico City; 6 miles west of El Salto, Durango State; Temecula.

NEVADA: Crystal Springs, Lincoln Co.; Pyramid Lake.

NEW MEXICO: Pensico River, Mayhill; Mescalero, Otero Co.; Prudoso.

OREGON: Crane Hots Springs, 25 miles southeast of Burns; Harney Co.

Hydrellia morrisoni Cresson. 19 males, 28 females.

ALASKA: Lower Yukon River.

IOWA: Pilot Knob State Park, Winnebago Co.; 3 miles east southeast of Waterville, Allamakee Co.

MANITOBA: Deepdale.

MASSACHUSETTS: Concord.

MICHIGAN: Dickinson Co.; Midland Co.

MINNESOTA: Mississippi River, sec. 34, T.145 north, R.36 west, Clearwater Co.; Houston Co.; Sucker Creek, 100 yards north of Highway 31, Clearwater Co.

NEW HAMPSHIRE: Dinkham Notch; Stinson Lake, White Mountains; White Mountains.

NEW MEXICO: Jemez Springs.

NEW YORK: Bergen.

NORTH CAROLINA: Bubbling Spring Creek, 5,100 ft.

ONTARIO: Algonquin Park; Ottawa.

QUEBEC: Great Gaspe Valley.

TENNESSEE: Indian Gap, 5,200 ft.

WASHINGTON: 13 miles west of Kettle Falls.

Hydrellia nobilis (Loew). 38 males, 59 females.

ILLINOIS: Chicago; McHenry.

INDIANA: Chesterton.

IOWA: Siewer's Springs State Park, Decorah.

MINNESOTA: Biological Station, Itasca State Park; West-side across from Biological Station, Lake Itasca, Itasca State Park; Squaw Lake, Itasca State Park; Kabekona Creek, Hubbard Co.; Mississippi River at Sucker Creek; Clearwater Co.; Bohall Trail Bog, Itasca State Park; Crookston; Mississippi River near north entrance, Itasca State Park; Iron Corner Lake, Itasca State Park; Douglas Lodge Bay, Lake Itasca, Itasca State Park; Professor Green Trail, Itasca State Park.

NEW JERSEY: Trenton.

NEW YORK: Ithaca; Dryden Lake, Tompkins Co.

PENNSYLVANIA: 2 miles north of Narberth, Montgomery Co.

QUEBEC: Il Jesus, 4 miles north of Montreal.

VIRGINIA: Alexandria.

Hydrellia notata, sp. nov. 3 males, 3 females.

CONNECTICUT: Canaan.

FLORIDA: Hilliard, Nassau Co.; Liberty Co.

GEORGIA: Blackshear, Pierce Co.

MISSISSIPPI: Vancleave Road, Jackson Co.

NEW YORK: Fish Creek Pond.

Hydrellia notiphiloides Cresson. 49 males, 74 females.

ARIZONA: Granite Delta.

BRITISH COLUMBIA: Hatzic Lake.

CALIFORNIA: Davis; Maxwell, Colusa Co.; Big Bear Valley; Carpenteria; Jenks Lake, San Bernardino; Buena Park; Putah Canyon, Yolo Co.; Vidal, San Bernardino Co.; Green Valley; Santa Cruz, Santa Cruz Co.

IOWA: Little Wall Lake, Hamilton Co.; Spring Lake, Greene Co.

MASSACHUSETTS: Nantucket.

MEXICO: Tepexpan, Mexico State, 6,900 ft.

MICHIGAN: Cheboygan Co.; Ocqueoc Lake, Presque Isle Co.

MINNESOTA: Bigstone Co.; Chamber's Creek, Itasca State Park.

NEVADA: Ely.

OHIO: Cedar Point, Sandusky River.

ONTARIO: London.

QUEBEC: Rupert House.

SASKATCHEWAN: Saskatoon.

VIRGINIA: Colonial Beach.

WYOMING: Biscuit Basin, Yellowstone National Park; northwest park entrance, Yellowstone National Park; Biscuit Basin, Yellowstone National Park.

Hydrellia penicilli Cresson. 2 males, 12 females.

BRITISH COLUMBIA: Qualicum.

IOWA: Goose Lake, Hamilton Co.

MAINE: Salisbury Cove.

MANITOBA: Birtle.

MICHIGAN: Wexford Co.

NEW YORK: McLean.

ONTARIO: Pembroke; Waubumick.

QUEBEC: Natashquan; Thunder River.

Hydrellia personata, sp. nov. 9 males, 16 females.

ARIZONA: Patagonia, Santa Cruz Co.

CALIFORNIA: Mono Lake, Mono Co.; Sunol, Alameda Co.; Richmond, Contra Costa Co.; Victorville, San Bernardino Co.

IOWA: Ames, Story Co.

TEXAS: University of Texas Arboretum, Austin.

WASHINGTON: O'Sullivan Dam, Grant Co.

<u>Hydrellia</u> <u>platygastra</u> Cresson. 35 males, 36 females.

BRITISH COLUMBIA: Milner; Langley.

CALIFORNIA: Willits.

IDAHO: Soldier Creek, Priest Lake; Potlatch; Lake Coeur d'Alene.

NEBRASKA: Arapahoe.

OREGON: Marshfield; Sears Lake, Fort Lewis, Pierce Co.; Gold Beach; Hood River; Independence; Breitenbush Springs, 2,222 ft.; Newport; Albany; Beaver Creek, Newport.

WASHINGTON: Lake Stevens, Everett; Ilwaco; Tacoma; 15 miles west of Kettle Falls; Arlington; Cusick; Seaview; Five-mile Lake.

<u>Hydrellia</u> <u>proclinata</u> Cresson. 256 males, 525 females.

ALBERTA: Vermilion Lake, Banff, 4,500 ft.

ARIZONA: Hassayampa River, Wickenburg; Sunnyside Canyon, Huachuca Mountains; Chiricahua Mountains; Coconino Co.; Oak Creek Canyon, Sedona; Pinery Canyon, Chiricahua Mountains, Cochise Co., 6,000 ft.

BRITISH COLUMBIA: Okanagan Falls, 2,000 ft.; Oliver; Atlin, 2,200 ft.

CALIFORNIA: Echo Lake, Eldorado Co.; Grass Lake, Luther Pass, Eldorado Co.; Lake Fontanillis, 8,500 ft., Eldorado Co.; Jacumba; Laguna Mountains; San Jacinto Mountains; Hallelujah Junction; Lassen Co.; Clear Lake Oaks, Lake Co.; Trinity River Camp, Trinity Co.; Sonora Pass, 9,624 ft.; Sonora Pass; Cow

Creek, Tuolumne Co.; Garden Valley, Eldorado Co.; Sardine Creek, Mono Co.; 8,500 ft.; Strawberry, Tuolumne Co.; Lake City, Modoc Co.; Auburn; Mason Creek R. S., Modoc Co.; Putah Canyon, Yolo Co.; Yula Pass, Sierra Co.; Likeley, Modoc Co.; Sequoia National Park; San Gabriel River; Temecula, Riverside Co.; Bowerman Meadow, Trinity Co.; 10 miles west of Salinas, near Carmel Valley, Monterey Co.; Clarksville, Eldorado Co.; Campo; Asilomar; Yosemite Valley, Yosemite National Park; Tuolumne Meadows; Mono Lake, Mono Co.; Bishop; Tioga Pass; Mammoth Lakes; Echo; Yosemite National Park; Lake Tahoe; Big Pines; Green Valley; Palm Springs; Lake Cuyamaca; Sugarload Mountain, Cienaga; San Bernardino Mountains; Cienaga; Upper Santa Ana River; Cajon; Barton Store; Upper Santa Ana River, Cienaga; South Fork, Santa Ana River, San Bernardino Co.; Morro Bay; 1000 Springs, San Bernardino Mountains; Ortega Highway, El Cariso Camp; Glacial Point Road, Yosemite National Park; Riverside; Monterey Co.; Truckee; Big Meadow, 7,200 ft.; Manzanita Lake, Lassen National Park, San Diego; Sage Hen, 5 miles northwest of Hobart Mills; Sugarloaf, Barton Flat; South Fork Camp, Barton Flat; Keen Camp; Palomar Mountain; Big Bear Lake; Jenks Lake; Herkey Camp; Siberian Outpost, Tulare Co., 7,500-10,500 ft.; Pacific Grove; Crabtree Meadow, Tulare Co.; 10,500 ft.; Cassel, Shasta Co.; Ebbett's Pass, Alpine Co.; 3 miles east of Mount Lassen; Pinecrest Lookout, Tuolumne Co.; Big Springs, Shasta Co., 4,000 ft.; Leavitt Meadow, Mono Co.;

Convict Creek, Mono Co.; Redwood City, San Mateo Co.; Cedar Pass, Modoc Co.; Clio, Plumas Co.; Dellecker, Piumas Co.; Coalinga, Fresno Co., below 500 ft.; Berkeley Hills, Alameda Co.; Carson Pass; Felton, Santa Cruz Mountains; Lake Alpine; San Jose Mission; Cisco; Stanford University, Santa Clara Co.; Summit Lake, Lassen National Park; San Antonio R. S., Santa Clara Co.; near Hobart Mills, Nevada Co.; Hat Lake, Lassen National Park; Hope Valley, Alpine Co.; Guatay, San Diego; LaPosata Creek, San Diego; Adobe Creek, West Stanislaus Co.; Bishop; Marion Mountain Camp, San Jacinto Mountains; Idylwild.

COLORADO: Ohio Pass Road, Gunnison Co. (38° 48.2' north, 107° 5.2' west); Rocky Mt. Biological Laboratory, Gunnison Co., 9,500 ft.; Emerald Lake, Gunnison Co.; Cerro Summit, 9,500 ft.; Golden; Electra Lake, 8,400 ft. (37° 33' north, 107° 48' west); Glade Park, Mesa Co.; Lindland; Pingrie Park.

IDAHO: Priest Lake; Echo Bay, Coeur d'Alene Lake; Swan Lake, Bancock Co.; Potlatch; Moscow Mountain, Juliaetta; Yale.

MEXICO: 10 miles east of Toluca, Mexico Province, 8,600 ft.; 70 miles west of Durango, Durango State, 9,000 ft.

NEVADA: Beatty; Double Spring; Reno.

NEW MEXICO: Tajique.

OREGON: Pole Bridge Meadows, Crator Lake National Park, 6,000 ft.; Harney Co.; Pringle Falls, 9 miles west of LaPine, Deschutes Co.; 22 miles north of Prospect; Quartz Mountain Service Station; Fish Lake, Harney Co.; Sun Creek Meadow, Crater Lake National Park, 6,500-7,000 ft.; near Headquarters, Crater Lake National Park, 6,600 ft.

SASKATCHEWAN: Aftons Lake.

TEXAS: Henkes Pond, Kerrville.

UTAH: Cedar City; Provo Canyon; Timpanogos Mountain; Roberts Pass, Uinta Mountains; Duchesne Co., 12,500 ft.; Echo; Leeds; Lake Cottonwood Canyon, 8,000 ft.; Eden; Emigrant Canyon, Wasatch Mountains, 7,000 ft.

WASHINGTON: Yakima Park, Mount Rainier National Park; Kalama River; Summerland, Mount Rainier National Park; Berkeley Park, Mount Rainier National Park; Lyles Grove, Pullman; Rose Spring, Blue Mountains; Holland; O'Sullivan Dam, Grant Co.; Pullman; Glenwood, Klickitat River; Dungeness; Olga; Paradise Park, Mount Rainier National Park; Uniontown.

WYOMING: Upper Geyser Basin, Yellowstone National Park; Norris Basin, Yellowstone National Park; Kemmerer.

Hydrellia procteri Cresson. 14 males, 39 females.

CONNECTICUT: southwest corner of Sleeping Giant State Park, near Hamden.

ILLINOIS: Chicago.

IOWA: Goose Lake, Hamilton Co.; Ledges State Park, Boone Co.; Little Wall Lake, Hamilton Co.; Springbrook State Park, west 1/2 sec. 33, T.81 north, R.31 west, Guthrie Co.; Spring Lake, Greene Co.

KANSAS: Marais des Cygnes Wildlife Refuge, Linn Co.

MAINE: Mt. Desert Island.

MICHIGAN: Augusta.

Hydrellia prudens Curran. 2 males, 4 females.

MASSACHUSETTS: Woodshole.

NEW YORK: Station for Study of Insects, Tuxedo.

PENNSYLVANIA: Ohiopyle, Fayette Co.

Hydrellia pulla Cresson. 15 males, 57 females.

BRITISH COLUMBIA: Elk Lake, Vanonov Island.

MICHIGAN: Third Sister Lake, Washtenaw Co.; Whitmore Lake, Washtenaw Co.; Douglas Lake, Cheboygan Co.; Huron River, Washtenaw Co.; Ocqueoc Lake, Presque Isle Co.

MINNESOTA: Two Island Lake, Itasca State Park; 1.3 miles south of main entrance, Itasca State Park; Squaw Lake, Itasca State Park.

NEW YORK: Ithaca.

ONTARIO: London; Midland.

QUEBEC: Lac Bernard.

WASHINGTON: Orcas Island above Mountain Lake.

WISCONSIN: Squaw Lake, Vilas Co.

Hydrellia rixator, sp. nov. 5 males, 5 females.

KENTUCKY: Fulton, Fulton Co.

TENNESSEE: Samburg, Reelfoot Lake.

TEXAS: Laguna Madre, 25 miles south of Harlington; Kerrville.

Hydrellia saltator, sp. nov. 1 male, 1 female.

ONTARIO: Grand Bend.

Hydrellia serena Cresson. 74 males, 119 females.

ALASKA: King Salmon, Naknek River; Anchorage; Seward; Savonoski, Naknek Lake; Sitka.

ALBERTA: Manyberries.

BRITISH COLUMBIA: peat bog at Pitt Meadows; Milner; Huntingdon; Moresby Camp, Queen Charlotte Islands; Victoria; Vancouver; Atlin; Mission City; Masset, Queen Charlotte Islands.

COLORADO: Cameron Pass; Marshall Pass, 10,856 ft.; Bear Lake, Estes Park; Rocky Mountain Biological Laboratory, Gunnison Co., 9,500 ft.

IDAHO: Pottsville.

MANITOBA: Mile 505 of Hudson Bay Railway; Farnworth Lake near Churchill; Fort Churchill; Churchill.

NORTHWEST TERRITORIES: Alavik.

OREGON: Marshfield; Newport.

WASHINGTON: Ilwaco; Humptulips; Olympia; Pluvius; Longmire; Mount Rainier; Seaview; Everett; Blaine; Bellingham; Mount Constitution; Roche Harbor; Poulsbo; Olga; Sequin; Point Gamble.

Hydrellia spinicornis, sp. nov. 190 males, 142 females.

FLORIDA: Lacoochee.

GEORGIA: Rabun Bald Mountain, Rabun Co.

MISSISSIPPI: Lake Shady, Lamar Co.; Vancleave Rd.; Jackson Co.; Dickinson's Pond, sec. 3, T.4 north, R.14 west, Lamar Co.

Hydrellia subnitens Cresson. 1 male, 3 females.

OREGON: Oregon City.

WASHINGTON: Tacoma.

WYOMING: 12 miles northwest of Lusk.

Hydrellia surata, sp. nov. 20 males, 84 females.

CONNECTICUT: Avon Old Farms, Avon.

FLORIDA: DeFuniak Springs, Walton Co.

IDAHO: Echo Bay, Lake Coeur d'Alene; Worley.

MANITOBA: Whitewater Lake, 4 miles north of Whitewater.

MASSACHUSETTS: Woodshole; Mashbee.

MINNESOTA: Squaw Lake, Itasca State Park; Two Island Lake, Itasca State Park.

MISSISSIPPI: Lake Shelby State Park, Forrest Co. (31° 9' north, 89° 14.6' west); Lake Shady, Lamar Co.; Hattiesburg (gravel pits).

NEW YORK: vicinity of Jockeybush Outlet, Hamilton Co. (74° 34' west, 43° 18' north).

ONTARIO: Pembroke; Marmora; Midland.

PENNSYLVANIA: Ohiopyle, Fayette Co.

Hydrellia suspecta Cresson. 2 females.

IOWA: Springbrook State Park, Guthrie Co.

MAINE: Mount Desert Island.

<u>Hydrellia</u> <u>tibialis</u> Cresson. 1318 males, 1529 females.

ALABAMA: 1 unspecified.

ALASKA: King Salmon, Naknek River; Nakenek Lake.

ALBERTA: McMurray; Medicine Hat; Grizzly Mountain, Slave Lake, 3,000 ft.

ARIZONA: Superior, Pinal Co.

ARKANSAS: Calion, Union Co.; Rison, Cleveland Co.

BRITISH COLUMBIA: Mac Gillivray Creek Game Reserve, near Chilliwack.

CALIFORNIA: Green Valley; Big Pines; Jenks Lake; Carpenteria; Davis; San Diego; Likeley, Modoc Co.; Putah Canyon, Yolo Co.; Rio Linda, Sacramento Co.; El Capitan Reservoir, San Diego Co.; Manteca, San Joaquin Co.; Cassel, Shasta Co.

COLORADO: Deckers; Grand Junction; Tennessee Pass; Creede, 8,844 ft.; Electra Lake (37° 33' north, 107° 48' west), 8,400 ft.; Wray (40° 0' north, 102° 10' west), 3,700 ft.; Alamosa; Estes Park.

DELAWARE: Rehoboth.

FLORIDA: Fruitville; Baxter.

IDAHO: Tule Bay, Priest Lake; Priest Lake; Soldier Creek, Priest Lake; Moscow.

ILLINOIS: Champaign Co.; Peoria; Springfield; Meredosia.

INDIANA: Lafayette.

IOWA: Mississippi River, 4 miles north of Oakville, Louisa Co. (41° 9.8' north, 91° 0.8' west); Ames, Izaak Walton

League Reserve, Story Co.; Pilot Knob State Park, Hancock Co.; near Missouri River, 7 miles southwest of Whiting, Monona Co.; West Okoboji Lake, Dickinson Co.; McIntosh Woods State Park, Clear Lake; Sioux City; Banner Mine Area, Warren Co. (41° 26.4' north, 93° 33.8' west); Little Wall Lake, Hamilton Co.; 4 miles northwest of Wapello, Louisa Co. (41° 13.9' north, 91° 7.0' west); Ledges State Park, Boone Co.; 3 miles east southeast of Waterville, Allamakee Co. (43° 11.0' north, 91° 14.1' west); Springbrook State Park, Guthrie Co., west 1/2 sec. 33, T.81 north, R.31 north; Ames; Lake Odessa, Louisa Co. (41° 12.1' north, 91° 5.5' west); 4 miles east of Gilbert, Story Co.; Siewer's Springs State Park, Decorah; 3 miles southeast of Waterville, Allamakee Co. (43° 10.4' north, 91° 15.1' west); 5 miles west of Yale, Guthrie Co. (41° 46.5' north, 94° 27.6' west); Spring Lake, Greene Co.; Fraser Dam, Boone Co.; Ledges State Park, Boone Co., south pond (41° 58.8' north, 93° 53.5' west).

KANSAS: Douglas Co., 900 ft.; McPherson Co.; 1.5 miles south of Bonner Springs; Leavenworth Co. Lake; Meade Co.; Sappa Lake, Decatur Co.; Marais des Cygnes Wildlife Refuge, Linn Co.; Manhattan; Kansas University Natural History Reservation, near Lawrence, Douglas Co.

LOUISANA: 15 miles east of Creole.

MAINE: Mount Desert Island.

MANITOBA: Herchmer; Churchill; Whitewater Lake, 4 miles north of Whitewater.

MARYLAND: Plummer's Island.

MICHIGAN: Cass Co.; Bay Co.; Cheboygan Co.; Vineyard Lake, Jackson Co.; Baraga Co.

MINNESOTA: Freeborn Co.; Haydenville; Bellingham; Washington Co.; Cook Co.; Eaglenest; 1 mile south of main entrance Itasca State Park; west side across from Biological Station, Lake Itasca; Chisago Co.; Yellow Medicine Co.; Itasca State Park; St. Paul; Mille Lacs; Headwaters LaSalle Creek, Itasca State Park;

MISSISSIPPI: near U.S. Highway 90, sec. 20, T.75, R.5 west, Jackson Co. (gravel pit); Bellefontaine Point, Jackson Co.; Bluff Creek, Vancleave, Jackson Co.; Dickinson's Pond, Lamar Co., sec. 3, T.4 north, R.14 west; Vancleave Road, Jackson Co. (30° 28' west, 88° 43' west), (30° 25.1' north, 88° 46' west).

MISSOURI: 5 miles northeast of LaRussell, Lawrence Co.; 4 miles northeast of LaRussell, Lawrence Co.

NEBRASKA: Hastings; Oakdale; Lincoln Rapp, Lancaster Co.; Lincoln.

NEW HAMPSHIRE: Summit of Mount Washington, 6,100-6,280 ft.; Storm Lake, Mount Adams, 5,200 ft.

NEW JERSEY: Trenton.

NEW YORK: Dryden Lake, Tompkins Co.

NORTH CAROLINA: Clingman's Dome; Great Smoky Mountains National Park, 6,300-6,642 ft.

OKLAHOMA: Kingfisher.

ONTARIO: Marmora.

OREGON: North Powder, Corvallis.

PENNSYLVANIA: Swarthmore; Ohiopyle, Fayette Co.

QUEBEC: LaFerme; Notre Dame du Portage; Great Valley, Gaspe; Gaspe Bay; Rupert House.

TENNESSEE: Dale Hollow Reservoir, 6 miles south of Byrdstown, Pickett Co.; Samburg, Reelfoot Lake (36° 22.9' north, 89° 21.3' west); Reelfoot State Park, Reelfoot Lake (36° 21.1' north, 89° 25.5' west); Miller's Camp, Reelfoot Lake (36° 24.3' north, 89° 20' west).

TEXAS: Austin; San Antonio; Galveston; Double Lake; Goliad; Sinton; Guadalupe River, Gonzales; Rio Hondo, Cameron Co.

VIRGINIA: Fairfax; Norfolk; Warsaw, Richmond Co.

WASHINGTON: Union Flat.

WYOMING: Lander; Yellowstone Lake, Yellowstone National Park; Biscuit Basin, Yellowstone National Park; northwest entrance, Yellowstone National Park.

Hydrellia trichaeta Cresson. 27 males, 27 females.

IOWA: McIntosh Woods State Park, Clear Lake; Spring Lake, Greene Co.; Springbrook State Park, Guthrie Co.; Goose Lake, Hamilton Co.

KANSAS: Kansas University Natural History Reservation, near Lawrence, Douglas Co.

MINNESOTA: Lake Bohall, Itasca State Park; 1.3 miles south of main entrance, Itasca State Park; Squaw Lake, Itasca State Park; Biological Station, Lake Itasca.

NEW YORK: Dryden Lake, Tompkins Co.

ONTARIO: Marmora.

TENNESSEE: Miller's Camp, Reelfoot Lake (36° 24.3' north, 89° 20' west).

VIRGINIA: White Oak Canyon, south slope of Stony Man, 3,500 ft., Madison Co., (38° 3.5' north, 78° 22' west).

Hydrellia valida Loew. 20 males, 64 females.

CONNECTICUT: Goose Island; Greenwich; New Haven, west shore of harbor; Stony Creek; Westport.

DELEWARE: Rehoboth.

FLORIDA: unspecified.

MAINE: Machias; Orrs Island; Trenton.

MASSACHUSETTS: Brewster; Fall River; Horseneck Beach; Ipswich; New Bedford; Woodshole; 1 unspecified.

MISSISSIPPI: Camp Graveline, Jackson Co. (30° 22.3' north, 88° 42.3' west); Gulf Coast Research Laboratory, Ocean Springs.

NEW JERSEY: Waterwitch.

NEW YORK: Cold Spring Harbor, Long Island.

NOVA SCOTIA: Lockeport; Smith's Cove.

RHODE ISLAND: Watch Hill; 1 unspecified.

TEXAS: Galveston.

Hydrellia wilburi Cresson. 43 males, 36 females.

BRITISH COLUMBIA: Shuswap Lake.

CALIFORNIA: Sequoia National Park; Glacier Point Road, Yosemite Park.

COLORADO: Lake Brennan, 10,000 ft.; Nederland, Boulder Co.; Tennessee Pass; Bear Lake.

WYOMING: Kemmerer.