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REVISION OF THE MALES OF THE Hydrospyche scalaris GROUP IN NORTH AMERICA (TRICHOPTERA: HYDROPSYCHIDAE)

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REVISION OF THE MALES OF THE *Hydropsyche scalaris* GROUP IN NORTH AMERICA (TRICHOPTERA: HYDROPSYCHIDAE)

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ABSTRACT

The genus *Hydrospsyche* Pictet *sensu stricto* in North America is divided into three species groups, the *Hydrospyche cuanis* Ross Group Ross, the *Hydropsyche depravata* Hagen Group Ross, and the *Hydropsyche scalaris* Hagen Group Banks. Thirty-one of thirty-six described species are recognized in the *Hydropsyche scalaris* Group. Examination of adult males resulted in 5 junior subjective synonyms and one possible new species based on a single exemplar from Sevier County, Utah. *Hydropsyche bidens* Ross 1938, *H. orris* Ross 1938, and *H. alvata* Denning 1949 are junior synonyms of *Hydropsyche incommoda* Hagen 1861. *Hydrospyche rossi* Flint, Voshell and Parker, 1979 and *H. fenestra* Lago and Harris 2006 are junior synonyms of *H. simulans* Ross 1938. A key to the adult males is provided and intraspecific variation illustrated. Scanning electron microscopy, cross-sectioned material, careful hand dissections, and a summary of relevant literature were used to formulate a revised description of phallic morphology. The phallobase forms the copulatory organ with the endotheca indistinguishable. The sclerotized, non-eversible, internal atrium of *Hydropsyche s.s.* is considered phallicata based on the presence of internal longitudinal muscle and its attachment points. Parameres and endophallus are absent. Conflicting and supporting evidence for alternative interpretations of the phallic apparatus is considered.

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Completion of this revision would not have been possible without the assistance, collaboration, and support of numerous colleagues and friends. The large scope and difficult nature of this project is reflected in the number of people whose assistance proved invaluable.

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As my major advisor, Dr. John C. Morse provided guidance and expert knowledge that facilitated the progress of this revision. Dr. Peter H. Adler, as a committee member and instructor further ignited my love for entomology both inside and outside of the classroom. His broad scientific knowledge, thought provoking lectures, and practical taxonomic insight catalyzed my drive for accurate observation of the natural world. Dr. Patrick D. McMillan proved an invaluable addition to my committee and assisted greatly in the completion of this project. His knowledge of principal component analysis and familiarity with species delineation problems were invaluable. For all these reasons and more, I offer my sincere thanks to those who served on my graduate committee.

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Many fellow graduate students have made significant contributions to this project, provided much needed encouragement, and at times offered necessary distractions to preserve the integrity of my sanity. I would like to thank Ozlem Kalkar and Yayi Kasumah for sharing their knowledge of scanning and transmission electron microscopy. The graduate students of the Comparative Entomology Laboratory have offered critical discussion that helped shape my ideas. In particular, our lively discussions of caddisfly genitalia and numerous outbursts of exasperation left little to the imagination for unfortunate passerbys, but served to motivate the expolortion of novel ideas expressed in this study. Special thanks to Will K. Reeves, Mark P. Nelder, and Layla Burgess for many endless adventures rapelling bridges, crawling through caves, and climbing trees in the interests of science.

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CHAPTER 1: INTRODUCTION

Hydropsyche Pictet *sensu lato* contains approximately 350 species worldwide. *Hydropsyche* Pictet *sensu stricto* contains approximately 150 species in the Nearctic and Western Paleartic biogeographic regions. In North America *Hydropsyche s.s.* is divided into three species groups, the *Hydropsyche cuanis* Group, the *Hydropsyche depravata* Group, and the *Hydropsyche scalaris* Group. The *Hydropsyche scalaris* Hagen Group in North America consists of 31 recognized species. Ross (1944) is usually credited with establishing the *H. scalaris* Group as one of four species groups within the genus *Hydropsyche*. However, Ross (1938a, 1938c, 1941) placed a number of species in this group prior to Ross 1944. The first reference to the *H. scalaris* Group was by Banks (1936), as he criticized Milne (1934-36) for synonymizing several *Hydropsyche* species based solely on the general appearance of the phallus to the exclusion of other diagnostic characters. Banks (1936) did not follow these synonymies and supported his reasoning by describing characters useful for the species-level discrimination of *H. scalaris* Hagen, *H. hageni* Banks, *H. incommoda* Hagen, and *H. phalerata* Hagen. A discussion surrounding the taxonomic disagreement between Banks and Milne is an ironic, if not fitting inception to the *H. scalaris* Group because it has been plagued with many difficult species delineations based on subtle genitalic differences ever since.

Much of the taxonomic literature is confusing for this group due to frequent misidentifications that perpetuate taxonomic mistakes (Ross, 1938c; Flint, 1979; Flint, 1992). Identifications made prior to lectotype designations are suspect unless retrospectively determined, and in some cases this is not possible (Ross, 1938c; Banks, 1936). Designating lectotypes helped to stabilize species concepts that resulted from conflicting interpretations of original descriptions, problems associated with the lack of illustrations, absence of holotype designations, and type series that contained multiple species (Ross, 1938c; Banks, 1936). Banks (1936) designated lectotypes for *H. phalerata* and *H. scalaris* in an attempt to stabilize the nomenclature. Ross clearly accepted Banks' (1936) criticisms of Milne's work (1934-36) and continued to describe new species and place them in the *H. scalaris* Group (Ross 1938a, 1938c, 1941, 1944, 1962). Ross (1938c) established lectotypes for *H. californica* Banks, *H. hageni*, *H. incommoda*, *H. occidentalis* Banks, and *H. venularis* Banks. The designation of an allotype for *H. phalerata* by Ross (1938c) is not legitimate because it is the same sex as the lectotype (Denning, 1943). Ross (1944) placed a total of 13 species in this group and subsequent descriptions of new species in isolated publications have added 23 others.

A comprehensive revision of all described species of the *H. scalaris* Group is overdue and will provide key taxonomic, geographic, and life history information for these important components of stream communities. Current biomonitoring practices use larval caddisflies in assessing the health of streams and the presence or absence of pollutants in water systems. This study emphasizes species discrimination of adult males and will provide a reliable key for identification purposes. Stabilizing the taxonomy of the males will help facilitate further investigations of the biology and life history of all life stages of these organisms.

Several authors have used eye size as a diagnostic character for species discrimination (Banks, 1936; Ross, 1944; Flint, 1979; Flint and Butler, 1983; Flint, 1992) but not all authors have described this character when writing species descriptions. Even fewer authors have illustrated or measured the eyes, and eye size often varies consistently between sexes of the same species. The stability of eye size within the group has not been established and a great deal of confusion has resulted for the general diagnostician.

Ross (1963) constructed a rudimentary family tree for the group and mapped terrestrial biomes for the terminal taxa. The study was not based on uniquely shared characters and the validity of the relationships is uncertain.

During the course of my study it became apparent that a revised description of phallic morphology was necessary. The terminology of the phallic apparatus is variable and at times authors have relied heavily on imprecise descriptive terms to communicate the subtle shapes of the phallus apex. Competing hypotheses for homologizing the phallic apparatus exist and have made descriptive taxonomy more difficult than necessary (Nielsen, 1957; Ross and Unzicker, 1977; Schmid 1979; Shuster and Etnier 1984). To communicate clearly the subtle shapes of the phallus apex and to further our understanding of the *Hydropsyche* phallic apparatus, a detailed analysis of phallic ultrastructure was necessary. The objectives of my study are to identify morphologically stable characters useful for species-level discrimination, provide detailed illustrations of each species including intraspecific variation, develop a reliable diagnostic key to the adult males, provide a comprehensive revision of all described species of the *H. scalaris* Group, and to homologize the phallic apparatus of *Hydrospyche sensu stricto*.

CHAPTER 2: MATERIALS AND METHODS

Specimen Preparation and Observation

The internal tissues of the abdomen were removed by maceration in lactic acid to observe and interpret structures of the genitalia (Blahnik, and Holzenthal, 2004). Care was taken to cut the abdomen between segments II and III to preserve the internal glands of abdominal sternum V for observation. Excess internal tissue was removed after treatment in lactic acid by flushing with distilled water, using a fine-needle syringe.

Drawings of the internal glands on abdominal segment V were made while in distilled water after removal from lactic acid to avoid collapse of the gland. Specimens were then transferred to 80% ethanol until further observation.

Details of the genitalia, including phallic structures and microsculpturing, were examined by placing the terminalia in glycerin and viewed using a Leica DMLS compound microscope. All drawings were made using a Meiji Techno RZ dissecting microscope equipped with a grid eyepiece calibrated for taking measurements. Images were captured using a Nikon eclipse E600 compound microscope with a micropublisher camera.

Borrowed Material

Material for this study was borrowed from several institutions and the following list represents those museums that graciously provided specimens. In addition, material from the personal collection of Dave Ruiter proved useful.

- Clemson University Arthropod Collection, Clemson, South Carolina, USA (CUAC)
- California Academy of Sciences (CAS)
- C.P. Gillette Museum of Arthropod Biodiversity at Colorado State University, Fort Collins, Colorado (CSU)
- Harvard Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA (MCZ)
- Illinois Natural History Survey, Urbana, Illinois, USA (INHS)
- Royal Ontario Museum, Toronto, Ontario, Canada (ROM)
- United States National Museum of Natural History, Washington, District of Columbia, USA (NMNH)

Material Examined

A complete list of the material examined, with collection data, is provided for each species in chapter IV. Standard two-letter postal abbreviations for states and provinces are used to denote geographic distribution (Table III).

Scanning Electron Microscopy (SEM)

A preliminary SEM study of the external structures of the genitalia of *H. bidens* Ross and *H. alvata* Denning helped provide a better understanding of *Hydropsyche* morphology and aided in the understanding of phallic structure. This study also facilitated a search for possible phylogenetic and diagnostic characters. Because live adults were not available, specimens were obtained from material fixed in 80% ethanol. Samples were dehydrated overnight in 100% ethanol. The ethanol was removed from all samples by critical-point drying, thereby preventing surface distortion that could result if samples were left to dry by evaporation in ambient air (Clemson EM Lab Protocol 2002).

Specimens were mounted on aluminum mounting stubs using double-stick carbon tape, sputter-coated with gold (Denton Vacuum, LLC Desk II Cold Sputter Unit), and examined in a Hitachi S-3500N scanning electron microscope. Voucher specimens are deposited in the CUAC.

Embedding and Sectioning

Difficulty in interpreting internal phallic morphology led to a light microscope study of cross-sectioned phallic material from specimens fixed in 80% ethanol. The phallus was dissected from one specimen each of *H. orris* Ross, *H. bidens*, and *H. occidentalis*. The dissected material was placed in 3.5% buffered glutaraldehyde (pH 7.4) and post-fixed for 1 hour in 1% osmium tetroxide. Samples were dehydrated in a series of increasing concentrations of ethanol (50%, 70%, 80%, 95%, 100%) for 15 minutes at each concentration and then rinsed with the transitional fluid, propylene oxide. Samples were infiltrated with plastic, with an initial 1:1 ratio of propylene oxide and Spurr's embedding medium (Spurr, 1969) and left overnight. Samples were then placed in plastic capsules containing only Spurr's resin and baked at 60˚C in an oven until hard (Spurr, 1969). After removal from the plastic capsules the material was sectioned (1µ-20µ) with a diamond knife (Diatome 45˚), using a microtome (Reichert-Jung, Ultracut-E®). Samples were slide mounted and stained with methylene blue and observed with a compound microscope (Nikon eclipse E600) and photographed with a micropublisher camera. Slide mounts and voucher specimens are deposited in the CUAC.

Principal Component Analysis

Species descriptions based on subtle morphological variation of the phallic apparatus have resulted in taxa difficult to diagnose. Mensural evaluation of body characters were used to resolve morphological distinctions of species difficult to diagnose based on subtle genitalic differences. Characters examined included forewing length, hindwing length, interocular distance, cephalic width, occipital setal wart width, and eye width. Two ratios were also included, interocular distance:cephalic width, and occipital setal wart width:eye width. Analysis of *Hydropysche franclemonti* Flint, *H. rossi* Flint, Voshell, and Parker (= *H. simulans* Ross), *H. simulans* Ross, and *H. mississippiensis* Flint included measurements of the harpago length, coxopodite length, and the ratio of the harpago:coxopodite. The data were analyzed by principal components analysis (PCA) using PC-ORD version 5.0 (McCune and Mefford, 1999). Cluster integrity was analyzed via Multi-Response Permutation Procedures (MRRP) to determine if clustering was greater than expected due to chance. PCA output was utilized to identify potentially misinterpreted specimens, overlap among multiple variables, and identification of the most informative characters for use in key construction.

Species Concept

A typological (morphological) species concept was utilized to determine species boundaries. Decisions about species boundaries were based both on body characters and structures of the genitalia. The absence of consistent morphological differences resulted in synonyms.

CHAPTER 3: MORPHOLOGY

Head. Figs. 3.1-3.3, 3.5.

The trichopteran head has many sulci, sclerites and setal warts (Crichton, 1957; Ivanov, 1990; Frania and Wiggins, 1997). The interpretation of these structures is not always clear and the terminology used in my study provides hypotheses on the homologies of diverse structures of the trichopteran head. One problem is whether the setal warts traditionally interpreted as the occipital setal warts are located on the occiput or another sclerite, the dorsoparietal sclerite (Fig. 3.1C, 3.2C). Alternatively, the dorsoparietal sulci may be anterior extensions of the occipital sulci and the occiput is modified to have a bisecting, medioposterior sulcus. In my study the head is treated as having two distinct sclerites, the occipital and parietal sclerites, and two distinct sulci, the occipital sulcus and dorsoparietal sulcus. Two cephalic forms exist within the *H. scalaris* Group, represented by those of *H. occidentalis* and *H. aerata* Ross.

Ivanov (1990) studied and named the setal warts of caddisflies and his terminology is followed in my study (Figs. 3.1A-3.1D).

A pair of occipital setal warts (occ.s.w) is located posterodorsally on the head. These warts are well developed and are the only setal warts on the *Hydropsyche* head with a distinct peripheral boundary. The ocellar (ocl.s.a), antennal (ant.s.a), and frontal setal warts (fron.s.a) have poorly defined peripheral boundaries and often appear as aggregations of setae that may or may not be raised. The setal warts lacking a thickened boundary are treated as setal areas.

The size and shape of the occipital setal warts/areas vary interspecifically. The most common form is that of *H. occidentalis* (Figs. 3.1A-3.1B), for which occipital warts are transverse and dorsolateral on the occiput, with the anteromesal margin forming a diagonal straight edge that intercepts the transverse occipital sulcus (occ.su). In species with enlarged eyes, such as *H. aerata* (Fig. 3.1C-3.1D), the occipital setal wart is ovoid, longer than wide, with the anteromesal margin nearly perpendicular to the occiput.

Each dorsal parietal sulcus (d.par.su) connects with the temporal membrane (tmp.mb) in *H. aerata* (Figs. 3.1C-3.1D) to form a subtriangular, anterodorsal parietal sclerite (ad.par.sc) that is anterior of the occipital setal wart. In *H. occidentalis* (Figs. 3.1A-3.1B), the dorsoparietal sulci do not intercept the temporal membrane and the anterodorsal parietal sclerite is open anteriorly. In *Hydropsyche scalaris* the dorsoparietal sulci appear open posteriorly and the suture forms only a posterolateral boundary to the ocellar setal area. In this reduced condition, the anterodorsal dorsoparietal sulci can be mistaken for an incomplete boundary of the ocellar setal area. Small, sclerotized tubercles (oc.tub) are present on the anterodorsal parietal sclerite and might represent ocellar remnants. The tubercles are not visible in all specimens.

The temporal membranes form the lateral boundaries of the occipital setal warts and separate the temporal sclerites (tmp.sc) from the anterodorsal parietal sclerites, the presence of temporal membrane indicating an open condition of the temporal suture (Frania and Wiggins 1997). In *H. aerata* (Figs. 3.1C-3.1D), the temporal membranes separate the posterodorsal parietal sclerites (pd.par.sc) from the postgenae (pge.) posterior of the occipital setal warts. The occipital setal warts divide the dorsoparietal sclerites into anterior and posterior parts. The temporal sclerites are either absent or more likely fused to the postgenae, each visible only as a darkly pigmented portion of a postgena. In *H. occidentalis* (Figs. 3.1A-3.1B), the posterodorsal parietal sclerites are absent and the occipital setal warts are not part of the dorsoparietal sclerites but are, instead, situated on the occiput. The temporal sclerites are well developed and are separated from the postgenae by the postgenal sutures (pge.su). Each temporal sclerite also has a distinct depression.

The occiput is reduced and forms only the dorsal boundary to the cephalic foramen. The major sclerites of the posterocaudal head are the postgenae, which form the lateral boundaries of the cephalic foramen. The postorbital setal warts occur between the postgenae and posterocaudal margins of the compound eyes, each constituting a vertical row of approximately 5-8 socketed setae. According to Snodgrass (1935) there are two landmarks useful for marking the location of the postoccipital suture. The posterior tentorial pits mark the ventral border and the muscle attachments of the neck and anterior prothoracic muscles connect to the postoccipital sclerite. In *Hydropsyche* the postocciput is a narrow sclerite on the posterior edge of the occiput and mediodorsal postgena. Since the purported postoccipital sclerite is difficult to see, the head was dissected and the muscle attachments were used to confirm that this sclerite is the postoccipital sclerite. The postoccipital condyle is located adjacent to the posterior tentorial pits and articulates with the prothoracic preepisternal sclerite.

The tentorial bridge connects the posterior tentorial pits and is visible when the head is dissected from the body and placed in a posterocaudal view. The cephalic foramen is dorsal of the tentorial bridge and the anterior digestive tract passes from the head to the prothorax through this opening. Ventral to the tentorial bridge the ventral nerve cord passes from the head to the prothorax. The posteroventral membranous areas of the postgenae are where the labial palps attach to the head. The labial palps are posterior of the maxillary palps.

Antennal length is variable, with many caddisfly species having antennae longer than the length of the body. The pair of antennae is attached to the anterodorsal part of the head. Each antennifer articulates with the ventromedial margin of its scape. A scape is wider than its pedicel. Each pedicel is approximately half the length of a hydropsychid flagellomere. Obliquely sclerotized bands are present on the basal six to ten flagellomeres of an antenna. One sclerotized band is present on each basal flagellomere but it is not uncommon to find two bands on the first flagellomere. A single specimen might have two bands on the first flagellomere of one antenna and one band on the other. In teneral specimens, these markings are difficult to see, but with proper lighting they are visible; furthermore, the sclerotization always lacks setae, clothing hairs, and sensilla (Fig. 3.5D).

Wells (1983) described the special sensory structures of hydroptilid antennae and recognized 19 morphological types. SEM study of the antennae of *H. incommoda* males revealed structures that resemble the *sensilla placodea* of Wells (1983) but with undulate margins (Figs. 3.5D,3.5E). The function of these sensilla in *Hydropsyche* is unknown but one likely function is the chemoreception of sternal gland secretions or other pheromones.

The vertex is divided by the coronal suture, which in some specimens is partially absent. The coronal suture is forked anteriorly, forming the frontoclypeal sutures that bound the frontal setal area and mark the posterodorsal apex of the frontoclypeus. The genae are between the anterior tentorial pits and the anteroventral margins of the eyes. Subgenal sutures form the ventral boundaries of the genae. The anteroventral portion of the frontoclypeus lies between the anterior tentorial pits and has a raised frontoclypeal setal area.

The mouthparts agree in general with the description of *H. angustipennis* Curtis by Crichton (1957). Mandibles are sclerotized and positioned posterior to the labrum. The membranous haustellum is a transverse, trilobed structure that is often withdrawn in fixed specimens. Each maxillary palp has five segments, with the second segment twice as long as the first segment. The fifth segment is irregularly annulated and equal to, or longer than the combined length of the preceding four segments. The labial palps are three-segmented, with the second segment subtriangular in lateral view. The third segment is irregularly annulated and equal to, or longer than the preceding two segments.

<u>Thorax. Figs. 3.3-3.4.</u>

The prothorax is shorter than the other thoracic segments, transverse, with the dorsum about 5-6X wider than long. Two pairs of setal warts are present on the prothorax. The medial pronotal setal warts are transversely ovate and cover the majority of the dorsum. The lateral pronotal setal warts are circular and one-fourth as long as the pronotal setal warts. Anterolaterally the prothoracic pre-episterna project on each side as sclerotized extensions that articulate with the postoccipital condyles. Each thin, cervical extension is equal in length to the main body of its prothoracic pre-episternum.

The mesonotum of the mesothorax is composed anteriorly of the mesoscutum and posteriorly of the mesoscutellum. The mesoscutum narrows posteriorly and the tegulae and forewings attach to its anterolateral margins. The mesoscutum also has an anterior lobe that projects toward the prothorax and is probably a point of articulation. Setal warts are noticeably absent from the mesoscutum and only clothing hairs are occasionally present. The mesoscutellum has a single, undivided setal wart. Setae are present on the lateral and posterior margins, but are absent medially and along the anterior border of the mesoscutellar setal wart. The postmesoscutellum is saddle-shaped, with the posterior margin articulating with the metascutum.

The metanotum of the metathorax is composed anteriorly of the metascutum and posteriorly of the metascutellum. The anterior margin of the metascutum is notched medially and forms a pair of cosine curves. The hind wings attach to the anterolateral margins of the metascutum, which narrows posteriorly and also bears no setal warts. The metascutellum is pointed anteriorly and gradually widens posteriorly.

Because pinned material was not available for the majority of species, I am uncertain if there are any species-specific color patterns on the wings. However, each forewing for species in the *H. scalaris* Group typically has a brown and white irrorate color pattern. The five main veins of a forewing are the costal, subcostal, radial, medial, and anal veins. Apical forks 1-5 (forks of R2+3, R4+5, M1+2, M 3+4, and Cu1a+b) are present. Each forewing contains two nygmata, one at the base of Fork 2 and the other medially in the thyridial cell. The discoidal cell, median cell, and thyridial cell are all present. The thyridial cell is elongate, about half the length of the forewing and widens distally. Anal veins 1-3 merge distally to form A_{1+2+3}, which ventrally bears a row of stout setae. Distally A_{1+2+3} and Cu_2 curve posterad and join near the posterior apical wing margin. Crossveins include the humeral, r, r_3-r_4 (or sectoral), r-m, m, m-cu, cu, and cu-a crossveins. The arculus, a small hyaline notch, is posterior of the merged A_{1+2+3} and

Cu_2 veins. An opaque and thickened stigma is present in the distal portions of the costal and subcostal cells, and also in the R_1 cell.

A hamular wing-coupling mechanism is present in *Hydropsyche* and a row of setae on the costal vein of each hind wing catches the stout, ventral setae of the corresponding forewing A_{1+2+3} to couple the wings (Ian Stocks, pers. comm.). Each hind wing is hyaline and has elongate setae on the medioposterior margin. The subcostal vein is enlarged and easily visible. Forks 1-3, and 5 are present and Fork 4 is absent. A single nygma is present at the base of Fork 2 and the discoidal cell, median cell, and thyridial cell are all present. The thyridial cell is narrow with M and Cu_1 parallel. The wing base has an incomplete jugal bar that disappears distally and forms a crease in the wing membrane, the jugal fold.

Abdomen. Figs. 3.7-3.8, 3.11.

The abdomen is composed of 11 segments, segments IX , X, and XI forming the terminalia (or genitalia). Abdominal sternum V bears internally a pair of secretory glands laterally. Ivanov (1999) studied the structure of these glands in Trichoptera and noted four forms: ampulliform, sacculous, kidney-shaped, and window glands. All sternal glands in the *H. scalaris* Group are of the ampulliform variety, "elongate shape, the gland having the widened reservoir smoothly turning to the thin duct in a narrow stalk" (Ivanov, 1999). A few species tend to have sternal glands with reservoirs sac-like and equal to or longer than a single abdominal segment. Distinguishing between ampulliform and sacculous forms is difficult at times. Ivanov (1999) defined sacculous glands as "small spheroid glands with reduced duct" and noted that this form is derived from the ampulliform type. The sac-like glands in the *H. scalaris* Group are neither small nor equipped with a reduced duct when compared with the more clearly ampulliform types and are subsequently treated as greatly enlarged ampulliform glands. The external gland opening is a slightly elevated mound that lacks projections in *Hydropsyche sensu stricto.* Sternal glands are present in both males and females but appear reduced in size for most female caddisflies. I observed the enlarged male glands and reduced female glands in an *in copula* pair of *H. phalerata*. However, because many females remain unassociated, further investigation is needed to reveal the extent of reduced sternal glands in females of the *H. scalaris* Group.

Caddisflies are subject to parasitism like any other organism. Some of the parasites of caddisflies include hymenopterans, gregarines, microsporidians, planarians, rotifers, and mites (Resh and Haag, 1973). In my study, unidentified mites were observed to attach to the abdominal intersegmental membrane of *H. mississippiensis* Flint, *H. occidentalis, and H. dicantha* Ross (Fig. 3.12). Typically, the mites were greatest in number near the wing bases. One specimen of *H. dicantha* had 25 mites attached to the abdomen. The relationship between the mites and the caddisflies is uncertain and might be parasitic or phoretic. However, a parasitic relationship is likely because the mouthparts appear imbedded in the caddisfly abdomen. Nematodes were also found protruding from the intersegmental membrane of caddisfly abdomens (Fig. 3.12).

The internal anatomy of adult caddisflies is often neglected and much work on the comparative morphology of internal structures remains to be done. To better understand phallic morphology, numerous dissections of *H. occidentalis* were made. In the course of these dissections, the reproductive tract was illustrated and helped to identify the ejaculatory duct and gonopore. The digestive tract and musculature of the terminalia were also illustrated and notes about the nervous system taken during these dissections. Although all body systems are not fully illustrated a comparative study of the internal anatomy is needed and has the potential to provide additional insight into generic relationships within Hydropsychidae.

The digestive tract of *H. occidentalis* consists of the foregut, midgut, and hindgut (Fig. 3.8). The foregut is greatly reduced as it travels through the muscle-crowded thorax. In all but one specimen examined, the midgut was withdrawn inside the abdomen and contained a 180° turn. One specimen had the truncate anterior end of the midgut flush against the posterior metathoracic wall and lacked a clear 180° turn. Because all of the material examined was fixed in 80% ethanol, the act of fixation might have artificially withdrawn the midgut inside the abdomen and account for the shape, but this situation is uncertain because fresh material was not available. The midgut contained whitish flocculent material that was unidentifiable. There are six Malpighian tubules that connect at the junction of the midgut and the hindgut. The hindgut is divided into an anterior ileum and a posterior rectum of nearly equal lengths. The rectum is swollen and has six circular rectal pads. The rectum of some but not all individuals contained 1 or 2 white, spherical balls ranging in diameter from 0.38 mm to 0.6 mm. This food bolus is likely the result of the adult caddisfly imbibing fluids. The anus discharges fecal material below tergite X and above the phallic apparatus.

The basic components of the reproductive tract of *H. occidentalis* are the testes, vas deferens, seminal vesicles, ejaculatory duct, and phallic apparatus (Fig. 3.7). The testes each consist of a conglomerate of several spherical sperm tubes. The vas deferens is a pair of elongated, thin tubules that each has an enlarged, ovoid seminal vesicle posteriorly. The pair of seminal vesicles presumably function to store sperm released from the testes until needed during copulation. The ejaculatory duct is differentiated anteriorly as a thickened, banana-shaped duct located anteroventral of the phallic foramen. Posteriorly, the ejaculatory duct narrows and enters the phallic apparatus, ending with the gonopore opening inside the phallobase.

Phallic Apparatus. Figs. 3.6, 3.9-3.10, 3.12.

Several competing theories have been advanced on how to interpret the phallic apparatus of Hydropsychinae caddisflies and a satisfactory answer has yet to emerge (Nielsen 1957, Ross and Unzicker, 1977; Schmid, 1979; Nielsen, 1981; Schuster, 1984). The Hydropsychinae phallic apparatus has been used for species recognition by numerous trichopterologists, but fewer studies use the phallic apparatus to infer relationships due to uncertain homologies (Schefter, 2005). My study attempts to provide a summary of current hypotheses and an analysis of supporting and conflicting evidence for each interpretation as it relates to *Hydropsyche sensu stricto* (Schuster, 1984). New evidence from careful hand dissections, scanning electron microscopy, and cross-sectioned material helped to interpret the morphology of *Hydropsyche s.s*. and provide additional insight for inferring homologies of the phallic apparatus.

The major components of the trichopteran phallic apparatus are the phallotheca, endotheca (phallobase = phallotheca + endotheca), parameres/endothecal processes, phallicata (aedeagus), and endophallus (Schmid, 1979, Morse, 1975). Rarely are all parts present and a great degree of modification has made homologizing the phallic apparatus difficult. The phallicata, when present, is usually partially withdrawn inside the phallotheca and able to be everted during copulation with the female caddisfly, as in *Rhyacophila* spp. (Schmid, 1970), *Pycnopsyche scabripennis* (Rambur) and some species of *Ceraclea*. The internal longitudinal phallic muscle is responsible for the retraction of the phallicata (Ivanov, 2001; Nielsen, 1957).

The phallic apparatus of *Hydropsyche s.s.* is externally composed of an undivided sclerotized tube and internally of a non-eversible, sclerotized atrium. The strongly sclertotized phallic apparatus provides few landmarks useful for interpretation. The lack of membrane has led to a number of hypotheses. Answers to the following questions might be able to provide important clues for interpreting the phallic apparatus. Where is the gonopore? Which structure(s) is/are missing? Where does the internal longitudinal phallic muscle attach? A comparison of interpretations and additional alternative hypotheses is provided in Table 1.

The phallic foramen is the proximal opening through which the ejaculatory duct, trachea, nerves, and hemolymph enter the copulatory apparatus. The posterodorsal everted phallocrypt is formed by a tongue-like membranous lobe that attaches to the dorsolateral phallobase and covers a pair of external anterior phallic muscles, the levators (Nielsen, 1957) (Fig.3.6A; Fig. 3.7). The anteroventral inverted phallocrypt is composed of the sclerotized phallocrypt walls and the membranous lateroventral continuation of the posterodorsal tongue-like lobe. The sclerotized phallocrypt walls articulate against the basal plate of the claspers and are connected by membrane (sclerotized connection according to Nielsen, 1957). The phallocrypt floor might be completely sclerotized or partially membranous. The portion of the phallic apparatus within the body cavity is the phallic apodeme. The dorsal proximal edge of the phallic apodeme bears an almost imperceptible ridge that serves as the anterior attachment site for the external posterior phallic muscle, the depressor (Nielsen, 1957) (Fig. 3.6A). The phallic apodeme and phallobase form a sclerotized tube with an approximate 90-degree turn.

The phallobase is composed of the phallotheca and endotheca (Schmid, 1979). Various parts of the phallic apparatus have been interpreted as endotheca and, depending on interpretation, the endotheca may be reduced, partially present, or absent altogether (Table 1). In *Hydropsyche s.s*., the endotheca is treated as indistinguishable because the phallic apparatus is an undivided, sclerotized tube and the morphological variation within extant Hydropsychinae species is not sufficient to identify the endotheca conclusively. The endotheca could be lost completely or permanently sclerotized. Therefore, the more general term "phallobase" has been retained.

The distal apex of the phallobase is cleft and forms a pair of apicolateral lobes and an apicodorsal roof that together enclose a subapicomesal cavity. Cross sections reveal that the cuticular connections and intra-phallobase space are continuous between the proximal phallobase, the apicolateral lobes, and the apicodorsal roof (Fig. 3.9F). Schmid (1979) is correct in interpreting this structure as cleft and not comparable to parameres/endothecal processes (Ross and Unzicker, 1977; Nielsen, 1981).

The subapical sclerite at the proximal margin of the subapicomesal cavity (Figs. 3.6B, C) appears superficially as a pair of sclerites, but is a single sclerite fused anteroventrally and separated posteriorly (Fig. 3.9G, continued; Fig. 3.9H continued; Fig. 3.12D) (Nielsen, 1957). No muscles were found attached to the subapical sclerite. The proximal margin of the subapicomesal cavity wall is connected to the subapical sclerite (Fig. 3.10B) and prevents the internal atrium's eversion. The subapical sclerite is most likely part of the inverted phallicata, the parameres, or the complete phallicata (Table 1). Ross and Unzicker (1977) incorrectly identified this structure as the phallotremal sclerite.

The non-eversible, sclerotized atrium inside the phallobase is strongly sclerotized proximally and weakly sclerotized distally (Fig. 3.9A,C; Fig. 3.9J continued). The ejaculatory duct connects to the proximal end of the internal atrium, with the gonopore invaginated well inside the confines of the phallobase (Ross and Unzicker, 1977) (Figs. 3.6B, 3.6C). A U-shaped sclerotized rod runs the ventral length of the internal atrium and fuses with the subapical sclerite (Figs. 3.6B, 3.6C). The weakly sclerotized distal part of the internal atrium is also connected to the subapical sclerite. The internal longitudinal phallic muscle originates within the phallic apodeme on the internal mesodorsal surface (Fig. 3.6B) and attaches to the proximal dorsolateral surfaces of the internal atrium (Figs. 3.6C, 3.9B). Based on the muscle attachments, degree of sclerotization, location of the gonopore, and presence of specialized structures (ventral rod, subapical sclerite), the internal atrium is considered an inverted phallicata (Table 1). Possible alternative interpretations include an inverted endotheca and inverted endophallus. Nielsen (1957) incorrectly interpreted this structure as the dilated portion of the ejaculatory duct.

Nielsen 1957, 1981.

Nielsen (1957) provided an in depth analysis of the genital morphology of male Trichoptera. He emphasized the North European fauna and examined 26 species, including *Hydropsyche angustipennis* Curtis. The current study finds fault primarily in the interpretation of the components rather than an inaccuracy of description. Nielsen (1957) interprets the sclerotized, non-eversible atrium of the *Hydropsyche* phallic apparatus as the dilated portion of the ejaculatory duct, with the gonopore located at the distal opening. According to him, the endophallus and phallicata are absent and the phallobase forms the copulatory organ. Nielsen's (1981) interpretation of the *Hydropsyche* phallic apparatus adds assent to Ross and Unzicker's (1977) interpretation of the external lips as parameres/endothecal processes. Both Nielsen (1981) and Ross and Unzicker (1977) considered the subapical sclerite as homologous with other similar structures within Hydropsychinae.

Supporting evidence for Nielsen 1957, 1981.

The ejaculatory duct contains a cuticular lining of ectodermal origin (Snodgrass, 1935). The persistence of the dilated atrium in the presence of lactic acid or KOH supports the interpretation of this structure as the ejaculatory duct or some other ectodermal structure, such as phallicata. The dilated atrium is connected with the posterior end of the ejaculatory duct, and based on this anatomical position, may represent a sclerotized continuation of the duct.

Conflicting evidence for Nielsen 1957, 1981.

The beginning of the ejaculatory duct is marked by the fusion of the vas deferens outside the phallic apparatus (Fig. 3.7). The ejaculatory duct does not persist in the presence of lactic acid or KOH and appears to be surrounded by circular muscle (Figs. 3.9D, 3.10E).

Proximally, the ejaculatory duct is enlarged forming a banana-shaped structure that is located near the phallic foramen. Distally, the ejaculatory duct forms a narrow, membranous, tube-like structure (Figs. 3.7, 3.6B-C). The internal atrium is structurally differentiated from the ejaculatory duct with its strongly sclerotized, dilated condition, the presence of specialized structures (ventral rod, subapical sclerite) and lack of circular muscle. In addition, the internal longitudinal phallic muscles attach to the internal atrium. In *Pycnopsyche* and *Rhyacophila*, a sclerotized, tubular invagination forms the distal part of the ejaculatory duct but there are no associated muscles and the duct is simply an elongate, narrow tube. The structural differentiation, presence of specialized structures, and location of muscle attachments make it unlikely that the internal atrium is part of the ejaculatory duct.

Ross and Unzicker 1977.

Ross and Unzicker (1977) used structures of the phallic apparatus to determine relationships among genera of North American Hydropsychinae. The internal atrium-like structure of the *Hydropsyche* phallic apparatus is interpreted as a sclerotized, non-eversible endophallus. The apicolateral lobes of the phallobase are treated as endothecal processes that lack membrane. The gonopore is located at the proximal end of the endophallus and the distal margin contains the phallotreme and phallotremal sclerite. The phallicata is absent.

Supporting evidence for Ross and Unzicker 1977.

According to Snodgrass (1935), one possible form of the male copulatory apparatus in insects is a permanently withdrawn endophallus that is well developed and might be confused with the ejaculatory duct. In the case of *Hydropsyche s.s.*, I have confirmed the internal atrium to be permanently withdrawn. I analyzed cross sections of the phallic apparatus and the scleritized connections betweeen the subapical scerite and apicolateral lobes of the phallobase support a non-eversible structure (Figs. 3.9, 3.10). I also observed *in copula* specimens of *Hydropsyche phalerata* fixed in 80% ethanol and the sclerotized atrium remained inside the phallobase of the male caddisfly. I consider the specialized structures (ventral rod, subapical sclerite) and the dilated condition of the internal atrium to meet Snodgrass' 1935 description of "well developed." In addition, the gonopore and phallotremal sclerite are associated with the endophallus in some species of *Ceraclea* (Morse, 1975).

Conflicting evidence for Ross & Unzicker 1977.

If the endophallus is permanently withdrawn inside the phallic apparatus, then I would expect the gonopore to be located at the distal margin of the internal atrium, the membranous endophallus simply having collapsed into a retracted position and subsequently developed an additional proximal opening. However, if the endophallus inverts within the phallobase, then I would predict the gonopore's location to be proximally on the internal atrium. And a meso-internal gonopore on the proximal margin of the internal atrium is exactly what I found. Because the phallotremal sclerite when present is associated with the gonopore (Integripalpia) (Morse, 1975), the gonopore should also be located at the proximal margin of the internal atrium. In the case of *Hydropsyche*, the gonopore and phallotremal sclerite (*sensu* Ross and Unzicker, 1977) are at opposite ends of the same structure and should not be considered homologous to the phallotremal sclerites of Integripalpia. In Trichoptera, the endophallus is membranous, as in *Rhyacophila*, and lacks muscle attachments and in many cases is completely absent. The internal longitudinal phallic muscle attaches to the phallicata (aedeagus) in Trichoptera and when the phallicata is absent the muscle attaches to the phallotremal sclerite (Ivanov, 2001).

Parameres (endothecal processes) exist independent of phallotremal sclerites. If endothecal processes and parameres are synonymous terms (Schmid, 1979, argues they are not), then parameres exist independent of phallotremal sclerites, which are at opposite ends of a phallicata+endophallus. The internal atrium may be the phallicata+endophallus given the meso-internal location of the gonopore, the degree of sclerotization, and the attachment of the internal longitudinal phallic muscle.

Schmid 1979.

Schmid (1979) argued that the copulatory organ is formed by the phallotheca. The apicolateral lobes, apicodorsal roof, and subapicomesal cavity walls are the result of a cleft phallotheca and do not represent paramers/endothecal processes. No alternative interpretations for the internal atrium or subapical sclerite were provided.

Supporting Evidence for Schmid 1979.

I did not find any membrane associated with the undivided, sclerotized tube that forms the external phallic apparatus. The cuticular connections and intra-phallotheca space are continuous between the proximal phallotheca, the apicolateral lobes, and the apicodorsal roof. I consider Scmid's 1979 interpretation of cleft phallotheca plausible given the absence of membrane.

Conflicting Evidence for Schmid 1979.

The presence/absence of the endotheca in the phallic apparatus of *Hydropsyche* s.s. is difficult to interpret due to the high degree of sclerotization. I am unable to determine if the endothecal membrane is absent or secondarily fused with the phallotheca based on ulttrastructure of *Hydropsyche sensu stricto*.

Korecki Alternative Hypothesis #1.

The phallobase forms an undivided, sclerotized tube with a cleft distal tip. The endotheca is indistinguishable and the subapicomesal slerite represents a reduced phallicata. The internal atrium is an inverted endophallus. Treating the subapicomesal sclerite as phallicata was suggested by Ross and Unzicker 1977, but they concluded there was insufficient evidence to support this claim.

Supporting Evidence for Korecki's Alternative Hypothesis #1.

Treating the internal atrium as inverted endophallus helps resolve the problem of the meso-internal location of the gonopore, a condition Ross and Unzicker's (1977) interpretation could not explain. An inverted endophallus would lead me to predict an internal gonopore proximally located within the phallobase. Additionally, the subapicomesal sclerite is positionally located in the appropriate place, between the phallobase and endophallus.

Conflicting Evidence for Korecki's Alternate Hypothesis #1.

No muscles attach to the subapicomesal sclerite. Because the internal longitudinal muscle attaches to the internal atrium and not the subapicomesal sclerite, the subapicomesal sclerite is unlikely to be phallicata. Furthermore, if the internal longitudinal muscle is homologous throughout Trichoptera, then the attachment points suggest the internal atrium is inverted phallicata, not inverted endophallus.

Korecki's Alternative Hypothesis #2.

The phallotheca forms an undivided, sclerotized tube with a cleft distal tip. The endotheca is inverted, with the subapicomesal slerite representing parameres. The phallicata and endophallus are absent.

Supporting Evidence for Korecki's Alternative Hypothesis #2.

The positional alignment of structures (phallotheca+parameres+endotheca) provides superficial support for this hypothesis, and an inverted endotheca would lead one to predict a meso-internal gonopore located within the phallobase.

Conflicting Evidence for Korecki's Alternative Hypthesis #2.

The subapicomesal sclerite appears paired but is fused anteroventrally forming a single sclerite and is unlikey to represent parameres. The internal longitudinal muscle should attach to the phallicata.

Korecki's Hypothesis.

The phallobase forms an undivided, sclerotized tube with a cleft distal tip. The endotheca is indistinguishable and the internal atrium is the inverted phallicata with specialized structures, the ventral rod and subapicomesal sclerite. The endophallus is absent.

Korecki's Supporting Evidence.

The undivided, sclerotized phallobase lacks membrane and landmarks necessary to identify conclusively the endotheca. The endotheca is likely to be fused with the phallobase or lost completely. Because either scenario is possible, the more general term phallobase better expresses the indistinguishable nature of the endotheca in *Hydropsyche sensu stricto*. The attachments of the internal longitudinal muscle and the meso-internal gonopore within the phallobase support the identification of the internal atrium as an inverted phallicata.

Korecki's Conflicting Evidence.

The phallicatae of Trichoptera outside Hydropsychinae lack specialized structures. Interpreting the internal atrium as an inverted phallicata helps explain the gonopore location but requires the *de novo* appearance of a second opening between the vertical arms of the subapicomesal sclerite.

Table I. Proposed hypotheses for interpreting homologies of the *Hydropsyche s.s.* phallic apparatus.

Accepted term	Nielsen 1957/1981	Ross and Unzicker 1977	Scmid 1979	Alt. Hypothesis #1	Alt. Hypothesis #2
Phallic foramen	Not mentioned	Not mentioned	Not mentioned	Phallic foramen	Phallic foramen
Phallic apodeme ridge	Not mentioned	Not mentioned	Not mentioned	Phallic apodeme ridge	Phallic apodeme ridge
Phallic apodeme	Phallic apodeme	Not mentioned	Not mentioned	Phallic apodeme	Phallic apodeme
Posteriodorsal everted phallocrypt	Tongue-like lobe of genital chamber	Not mentioned	Not mentioned	Posteriodorsal everted phallocrypt	Posteriodorsal everted phallocrypt
Anterioventral inverted phallocrypt	Sclerotic and membranous wall of phallocrypt	Not mentioned	Not mentioned	Anterioventral inverted phallocrypt	Anterioventral inverted phallocrypt
Sclerotized phallocrypt wall (*phcrpt.wl.*)	Sclerotized phallocrypt wall	Not mentioned	Not mentioned	Sclerotized phallocrypt wall	Sclerotized phallocrypt wall
Phallocrypt floor (*phcrpt.fl.*)	Phallocrypt floor	Not mentioned	Not mentioned	Phallocrypt floor	Phallocrypt floor
Phallobase	Phallus/Phallobase	Phallobase	Phallotheca	Phallobase	Phallotheca
Apicodorsal phallobase roof (*phlbs.rf.*)	External lips/parameres [in part]	Endothecal Processes [in part]	Cleft Phallotheca	Apicodorsal phallobase roof	Apicodorsal phallothecal roof
Apicolateral lobes of phallobase (*lb.phlbs.*)	External lips/parameres [in part]	Endothecal Processes [in part]	Cleft phallotheca	Apicolateral lobes of phallobase	Apicolateral lobes of phallotheca
Subapicomesal cavity wall of phallobase (*cv.wl.*)	Reduced, non-eversible endotheca/parameres [in part]	Endothecal Processes [in part]	Cleft Phallotheca	Subapicomesal cavity wall of phallobase	Subapicomesal cavity wall of phallotheca
Endotheca indistinguishable [fused/absent]	Not mentioned	Endothecal membrane absent	Endotheca absent [implied]	Endotheca indistinguishable [fused/absent]	Not mentioned
Inverted phallicata (*iv.phct.*)	Dilated ejaculatory duct	Endophallus	Endophallus	Inverted endophallus	Inverted endotheca
Apical sclerite at base of inverted phallicata [subapical sclerite] (*sc.iv.phct.*)	Internal lips surrounding gonopore	Phallotremal sclerite	Phallotremal sclerite	Phallicata	Parameres
Endophallus absent	Endophallus absent	Not mentioned	Not mentioned	Not mentioned	Endophallus absent
Opening at base of inverted phallicata	Gonopore	Phallotreme	Phallotreme [implied]	Opening at base of inverted endophallus	Opening at base of inverted endotheca
Gonopore (*gnpr.*)	Proximal opening of dilated ejaculatory duct	Gonopore	Not mentioned	Gonopore	Gonopore
Ejaculatory duct (*ej.dct.*)	Not mentioned [presence implied]	Sperm duct	Not mentioned	Ejaculatory duct	Ejaculatory duct

CHAPTER 4: *Hydropsyche scalaris* GROUP

Hydropsyche aerata Ross Figure 4.1

Hydropsyche aerata Ross 1938a: 144, fig. 71,72 [adult male, male genitalia].

Type locality: Aurora, Illinois 17 July 1927, male holotype (INHS); Kankakee, Illinois, 08 August 1935, female allotype (INHS).

Hydropsyche aerata Ross; Ross 1944:101, fig. 392, 372, 386G, 349 [adult male, male and female genitalia, larval head and pronotum].

Hydropsyche aerata Ross; Fischer 1963:9; 1972:100 [bibliography].

Hydropsyche aerata Ross; Schuster and Etnier 1978:77, fig. 37 [larval head; biological notes].

Hydropsyche aerata Ross; Flint and Butler 1983:206, fig. 8 [apex of phallus, clasper].

Hydropsyche aerata Ross; Nimmo 1987:83, map 31, fig. 182-188 [male and female genitalia].

Description. Male (n=15). Forewing length 6.5-8.5 mm, 7.6 mm; hind wing length 4.8-6.1 mm, 5.5 mm. Interocular distance 0.38-0.48 mm, 0.43 mm, cephalic width 1.7-1.8 mm, 1.8 mm; interocular distance:cephallic width 0.21-0.27, 0.24. Eye width 0.65-0.7 mm,0.69 mm; occiputal setal wart width 0.19-0.21 mm, 0.2 mm; occipital setal wart width:eye width 0.27-0.31, 0.29. Antennal length (n=12) 6.5-7.5 mm, 7.0 mm, each with oblique, sclerotized bands on basal 7-8 flagellomeres. Sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment approximately 3 times as tall as greatest length in lateral view; posterolateral projections rounded. Tergum X rectangular, dorsal posteromesal lobes projecting posterodorsad to level of dorsum IX; apicomesally emarginate, notch length one-quarter to one-half as long as length of tergum X. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, blunt distally in lateral view, distal tip ogival to obliquely truncate in caudoventral view. Phallic apparatus with ventral opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular in vental view; apicodorsal roof of phallobase declivous, apicolateral lobes of phallobase sloping upward.

Etymology. Possibly derived from the Latin "*aera*" for epoch.

Diagnosis. Similar to *H. alabama*, *H. brunneipennis*, *H. phalerata*, and *H.* NA1 in having tergum X with dorsal posteromesal lobes projecting posterodorsad. *Hydropsyche aerata* differs in having the interocular distance narrow, less than the eye width, and the occipital setal warts ovaliform, less than half the eye width.

Distribution.

IL (Ross, 1938a; Schuster and Etnier, 1978; Nimmo, 1987);

IN (Ross, 1938a; Schuster and Etnier, 1978; Waltz and McCafferty, 1983; Nimmo, 1987);

MI (Ross, 1944; Schuster and Etnier, 1978; Nimmo, 1987);

MO (Harris and Lawrence, 1978);

OH (Huryn and Foote, 1983);

VT (Bilger, 1986).

Material Examined. ILLINOIS: [**Kankakee Co**.], Kankakee, Kankakee River, 01 August 1933, Ross and Mohr, 1 male [paratype] (INHS); 26 May 1935, cage no. 3, 1 male Ross and Mohr [paratype] (INHS); 06 June 1935, Ross and Mohr, 78 males [paratypes] (INHS); 21 July 1935, Ross and Mohr, 23 males [paratypes] (INHS); 08 August 1935, Ross and Delong, 1 male [paratype] (INHS); 17 May 1937, Ross and Burks, 71 males (INHS); 31 May 1938, Mohr and Burks, 1 male (INHS). Momence, Kankakee River, 26 May 1936, H. H. Ross, 1 male [paratype] (INHS); 04 August 1936, 4 males, Frison and Burks [paratypes] (INHS); 17 May 1937, 13 males, Ross and Burks (INHS); 24 May 1937, 2 males, H. H. Ross (INHS); 01 June 1937, 2 males, B. D. Burks (INHS). Momence, Kankakee River, 17 May 1933, H. H. Ross, 1 male [paratype] (INHS); 20 August 1934, Delong and Ross, 2 males [paratypes] (INHS); 12 May 1935, Frison and Ross, 10 males [paratypes] INHS); 17 May 1935, H. H. Ross, 37 males, [paratypes] (INHS); 06 June 1935, Ross and Mohr, 7 males, [paratypes] [Figs. 5.1] (INHS); 01 July 1935, Delong and Ross, 1 male [paratype] (INHS); 17 May 1937, Ross and Burks, 1 male, (INHS). INDIANA: [**Martin Co**.], Shoals, White River, 10 September 1936, 61 males [paratypes] (INHS).

Pupa and egg unknown.

Hydropsyche alabama Lago and Harris

Figure 4.2

Hydropsyche alabama Lago and Harris 1991: 3, fig. 1 [male genitalia].

Type locality: Alabama, Houston Co., Cowarts Creek at unnumbered Co. Hwy, 8.8km ENE Cottonwood, (Sec. 10, T 1 N, R 28 E), 24 May 1989, male holotype (NMNH).

Description. Male (n=10). Forewing length 7.7-8.8 mm, 8.4 mm; hind wing length 5.6-6.4 mm, 6.1 mm. Interocular distance 0.7-0.8 mm, 0.75 mm, cephalic width 1.3-1.45

mm, 1.38 mm; interocular distance:cephalic width 0.53-0.58, 0.54. Eye width 0.25-0.33 mm, 0.3 mm; occipital setal wart width 0.3-0.34 mm, 0.32 mm; occipital setal wart width:eye width 1.0-1.2, 1.1. Antennal length (n=7) 13.2-15.0 mm, 14.2 mm, each with oblique, sclerotized bands on basal 8-9 flagellomeres. Sternum V glands ampulliform.

Abdominal segment IX with carina, segment about 2.7 times as tall as greatest length; posterolateral projections nearly truncate. Tergum X with dorsal posteromesal lobes that project posterodorsad nearly to level of dorsum IX; apicomesally emarginate, notch length one-third to one-half as long as length of tergum X. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, apicodorsally excised in lateral view, triangular in ventral view. Phallic apparatus with ventral opening of subapicomesal cavity obpyriform; subapicomesal cavity rotund; apicodorsal roof of phallobase flat.

Etymology. Named for the state of Alabama.

Diagnosis. Similar to *H. aerata*, *H. brunneipennis*, *H. phalerata*, and *H.* NA1 in having tergum X with dorsal posteromesal lobes projecting posterodorsad. *Hydropsyche alabama* differs from *H. aerata* in having the interocular distance broad, greater than the eye width, and occipital setal warts transverse. Unlike *H. brunneipennis* and *H.* NA1, the harpagones of *H. alabama* are triangular in ventral view. *Hydropsyche phalerata* may have triangular harpagones in ventral view, but the mesal margin is usually concave.

Distribution.

AL (Lago and Harris, 1991; Morse et al 1997);

FL (New State Record).

<u>Material Examined</u>. ALABAMA: **Houston Co**., Cowarts Creek at unnumbered Co. Hwy., 8.8km ENE Cottonwood, (Sec. 10, T 1 N, R 28 E), 24 May 1989, Shepard and McGregor, 3 males, Paratype [Fig. 5.2] (NMNH). FLORIDA: **Calhoun Co**., Chipola River at Hwy274, 15 miles S of Marianna, N30°32'03", W85°09'54", 18 May 1994, Flowers, Harris and Pescador, 20 males (CUAC).

<u>Female and immature stages unknown</u>.

Hydropsyche arinale Ross

Figure 4.3

Hydropsyche arinale Ross 1938a: 143, fig. 69 [male genitalia].

Type locality: Oregon, Illinois, 18 July 1927, male holotype (INHS).

Hydropsyche arinale Ross; Ross 1944: 104, fig. 376, 386E, 351 [male and female genitalia, larva head and pronotum]; female allotype, Serena, Illinois, 12 May 1938 (INHS).

Hydropsyche arinale Ross; Fischer 1963: 19 [bibliography].

Hydropsyche reiseni Ross; Denning 1975: 322 (synonym according to Moulton and Stewart, 1996).

Hydropsyche arinale Ross; Schuster and Etnier 1978: 86, fig. 42 [larval head, biological notes].

Hydropysche arinale Ross; Smude and Hilsenhoff 1986: 137, fig. 11 [larval habitat, adult emergence date].

Hydropsyche arinale Ross; Nimmo 1987: 84, map 33, fig. 199-205 [male and female genitalia].

Description. Male (n=13). Forewing length 6.5-9.2 mm, 7.6 mm; hind wing length 4.8-6.8 mm, 5.6 mm. Interocular distance 0.5-0.7 mm, 0.57 mm, cephalic width 1.5-1.8 mm, 1.6 mm; interocular distance:cephalic width 0.32-0.4, 0.35. Eye width 0.48-0.55 mm, 0.52 mm; occiputal setal wart width 0.25-0.33 mm, 0.29 mm; occipital setal wart width:eye width 0.5-0.62, 0.56. Antennal length (n=9) 7.3-8.5 mm, 7.9 mm, each with oblique, sclerotized bands on basal 5-7 flagellomeres. Sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 1.9 times as tall as greatest length in lateral view; posterolateral projections broadly rounded, occasionally obliquely truncate. Tergum X subtriangular in lateral view with dorsal margin declivous; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, ogival to obliquely truncate in ventral view. Phallic apparatus with phallobase subapically moniliform in ventral view; ventral opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular; apicodorsal roof of phallobase slightly convex, bearing shallow carina.

Etymology. Unknown.

Diagnosis. Interocular distance less than or greater than eye width, occipital setal warts as long as wide. The phallobase is subapically moniliform in ventral view with the opening of the subapicomesal cavity obpyriform. The phallobase is also subapically swollen in *Hydropsyche philo*, *H. californica, and H. patera* and may appear moniliform. However, *H. philo* and *H. californica* have the apex of the phallic apparatus dorsoventrally compressed and the opening of the subapicomesal cavity of *H. philo* is U-shaped and orbicular in *H. californica*. The subapicomesal cavity opening of

Hydropsyche patera is oblong, 2 to 3 times as long as wide with the apicolateral lobes extended distally 0.5 to 1.0 times the length of the subapicomesal cavity.

Distribution.

AR (Ross, 1944; Unzicker, Aggus, and Warren, 1970; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Bowles and Mathis, 1989; Moulton and Stewart 1996);

IL (Ross, 1938; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

IN (Waltz and McCafferty, 1983; Moulton and Stewart, 1996);

KS (Ross, 1944; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

MO (Ross, 1944; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Mathis and Bowles, 1992; Moulton and Stewart, 1996);

OK (Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Bowles and Mathis, 1992; Moulton and Stewart, 1996);

ON (Nimmo, 1987; Moulton and Stewart, 1996);

WI (Ross, 1944; Longridge and Hilsenhoff, 1973; Hilsenhoff, 1975; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Schmude and Hilsenhoff, 1986; Nimmo, 1987; Hilsenhoff, 1995;Moulton and Stewart, 1996).

Material Examined. ARKANSAS: **Johnson Co**., Hagarville, Piney and Dry Creeks, 21 August 1986, C. Rowbotham, 1 male (CUAC); Hagarville, Little Piney Cr., 22 July 1986, C. Rowbotham, 6 males (CUAC); Hagarville, Piney and Sulfur Creek, 20 August 1986, C. Rowbotham, 2 males (CUAC); Lamar Hwy 359, Little Piney Cr., 27

June 1986, C. Rowbotham, 1 male (CUAC); **Newton Co**., Buffalo National River, Cecil Creek, low-water slab near Erbie, 20 August 1990, M. Mathis, 3 males (CUAC). **Pike Co**., Wolf creek at AR 301, 1 mile S of Antoine, 21 May 1992, S. R. Moulton, 2 males [Fig. 5.3] (CUAC). **Washington Co**., 20 May 1962, O. and M. Hite, 1 male (CUAC). 16 September 1963, L. R. Aggus, 1 male (CUAC). OKLAHOMA: **Johnston Co**., Blue River, 01 October 1974, 1 male (CUAC). **Murray Co**., Turner Falls Park, Rt. 77 S. of Davis, Arbuckle Mtns., 07 May 1970, #700321, Wiggins & Yamamoto, 20 males, (ROM).

Pupa and eggs unknown.

Hydropsyche auricolor Ulmer

Figure 4.4

Hydropsyche auricolor Ulmer 1905: 33, fig. 21 [Apex of phallus].

Type locality: Mexico, male holotype (Museum National d'Histoire Naturelle, Paris).

Hydropsyche solex Ross 1944: 271, fig. 913-914 [male and female genitalia] (synonym according to Bueno-Soria and Flint 1978: 190).

Hydropsyche auricolor Ulmer; Fischer 1963: 20 [bibliography].

Hydropsyche solex Ross; Fischer 1963: 87 [bibliography].

Description. Male. (n=18) Forewing length 8.8-10.4 mm, 9.5 mm; hind wing length 6.4-7.5 mm, 6.9 mm. Interocular distance 0.7-0.8 mm, 0.75 mm; cephalic width 1.8-1.9 mm, 1.8 mm; interocular width 0.39-0.43, 0.41 times the cephalic width. Eye width 0.5-0.58 mm, 0.55 mm; postocciputal setal wart width 0.33-0.39 mm, 0.36 mm; postoccipital setal wart width 0.6-0.72, 0.67 times the eye width. Antennal length 8.5-10 mm, 9.2 mm, each with oblique, sclerotized bands on basal 6-8 flagellomeres. Abdominal sternum V glands ampulliform, each approximately as long as two abdominal segments.

Abdominal segment IX with dorsal carina, segment about 2.2 times as tall as greatest length in lateral view; posterolateral projections rounded. Tergum X rectangular in dorsal view; apicomesally emarginate; distal margin truncate, occasionally rounded in lateral view. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, subrectangular with tip obliquely truncate in ventral view. Phallic apparatus with phallobase constricted proximally and swollen subapically; subapicomesal cavity and its ventral opening orbicular in ventral view; apicodorsal roof of phallobase flat. Sternal V glands ampulliform, each approximately as long as two abdominal segments.

<u>Translation of Ulmer 1905</u>. "Head, thorax and abdomen brown-black to black; prothorax with only few black hairs. Antennae thin, yellow-brown; usual basal part with sloping black lines; rest of antennae dark brown. Palps black-brown; maxillary palps with hairs on internal edge especially on the second and third segments; ratios of length as usual. Coxae with black on edges and yellow and with hairs present; femora brown; tibiae and tarsi tan; forelegs darker than other pairs. Spurs 2, 4, 4; mesal spurs longer than lateral spurs, also true for foretibiae. Forewing covered with yellow-gold hairs that are bent over so that entire areas appear golden; dark brown hairs at crossvein near apical edge and crossvein about 1 mm wide; furthermore some dark brown hairy points are found on the area at the costal section, at the arculus, and everywhere a crossvein lies. Also the basal part of the front edge (to the humeral crossvein) and the rear edge are brown. posterior margin hairs brown. Hind wings entirely covered with brown hairs but gray membrane visible through hairs. Posterior margin hairs also brown. The structure of the veins is completely uniform. Median cell of forewing also rather long; crossvein of second apical cell [sectoral crossvein] straight; median cell of hind wing lying closely against fifth terminal fork. Genital appendages of male fig. 21. Tergite X long and divided at the end (fig. 21a; dorsal view); in lateral view broad. Phallus (fig. 21b) in dorsal view weakly expanded before distal apex, hollow and split at end; in lateral view end narrowing, tip slightly bent upward (fig. 21c), inferior appendages with short part [harpago] at end; all dark brown. Body length 8 mm; wingspan 23 mm, 2 specimens (1 not complete): Mexico. *Genin*. 27.97. in the Paris Museum."

Etymology. Latin neuter noun "*aurum*" ("gold") and masculine noun "*color*, *-is*" ("hue," "tint," "complexion"), referring probably to the distinctive yellow-gold hairs on the forewings.

Diagnosis. Similar to *H. californica*, *H. winema*, and *H.* NA1. *Hydropsyche auricolor* differs in having the harpagones subrectangular with tip obliquely truncate in ventral view and the sternal V glands ampulliform, approximately as long as two abdominal segments.

Distribution.

AZ (Moulton and Stewart, and Young, 1994);

NM (New state record);

TX (Ross, 1944; Bueno-Soria and Flint, 1978);

Mexico (Ulmer, 1905; Flint 1967).

Material Examined. ARIZONA: **Yavapai Co**., Verde River at US Hwy 89A bridge, Cottonwood, 4-5 June 1993, S. R. Moulton and K. D. Alexander, 29 males (NMNH). East Verde River, Campe Verde, 29 April 1995, Kondratieff, 1 male (CSU). NEW MEXICO: **Catron Co**., Taylor Creek, below Wall Lake, Gila National Forest, 24 July 1994, Kondratieff and Durfee, 22 males, 15 females, 1 pair *in copula* (CSU). Swarming by Taylor Creek,0.5 miles downstream of Wall Lake, 28 April 1994, R. Durfee, 20 males (CSU). **Dona Ana Co**., Radium Springs, 13 May 1989, H. E. Evans, 9 males (CSU).

Immature stages unknown.

Hydropsyche bassi Flint, Voshell and Parker

Figure 4.5

Hydropsyche bassi Flint, Voshell and Parker 1979: 842, map 5, fig. 19-23 [male genitalia].

Type locality: Big Cedar Creek at route 19 Russell Co., Virginia, May 1978, male holotype (NMNH).

Description. Male (n=1). Forewing length 9.4 mm; hind wing length 5.8 mm (broken). Interocular distance 0.5 mm; cephalic width 1.85 mm; interocular distance:cephalic width 0.27. Eye width 0.7 mm; occipital setal wart width 0.23; occipital setal wart width:eye width 0.33. Antennal length 11.2 mm. Sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment approximately 1.7 times as tall as greatest length in lateral view; posterolateral projection obliquely truncate. Tergum X subrectangular with distal margin rounded in lateral view; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, wider proximally and narrowing distally with tip truncate in ventral view. Phallic apparatus with ventral opening of subapicomesal cavity narrow, approximately 4 times as long as wide; subapicomesal cavity orbicular in ventral view; apicodorsal roof of phallobase with shallow mesal dome; apicolateral lobes of phallobase with ventral margin tapering caudodorsad.

Etymology. Named for Dr. Michael L. Bass, Mary Washington College.

Diagnosis. Similar to *H. scalaris*, *H. patera*, and *H. placoda*. Differs from *H. scalaris* in having the interocular distance less than the eye width, occipital setal warts as long as wide and less than half the eye width. Differs from *H. patera* in having the phallobase of uniform width, not subapically swollen. Differs from *H. placoda* in having the harpagones truncate in ventrocaudal view rather than triangular with tip forming acute angle.

Distribution.

TN (Schuster and Etnier, 1978; Schuster and Etnier, 1979; Flint, Voshell and Parker, 1979);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981).

Material Examined. VIRGINIA: **Smyth Co**., North Fork Holston River at Route 620, sweeping, 08 May 1982, Kondratieff, 1 male (ROM).

Female and immature stages unknown.

Hydropsyche brunneipennis Flint and Butler

Figure 4.6

Hydropsyche brunneipennis Flint and Butler 1983: 205, fig. 1-7, 10, 11 [male genitalia and larva].

Type locality: Potamac River at Carderock, Montgomery Co., Maryland; 27 Aug. 1981, male holotype (NMNH); female same data as holotype except 21 Sep. 1981 (NMNH).

Description. Male (n=10). Forewing length 7.5-8.4 mm, 7.8 mm; hind wing length 5.0-5.9 mm, 5.4 mm. Interocular distance 0.6-0.65 mm, 0.63 mm; cephalic width 1.2-1.3 mm, 1.3 mm; interocular distance:eye ratio 0.46-0.53, 0.49. Eye width 0.27-0.35 mm, 0.3 mm; occipital setal wart width 0.27-0.29 mm, 0.28 mm; occipital setal wart width:eye width 0.83-1.0, 0.95. Antennal length 12.4-14.1 mm, 13.2 mm, each with oblique, sclerotized bands on basal 7-8 flagellomeres. Sternum V glands ampulliform.

Abdominal segment IX carinate, segment approximately 2.8 times as tall as greatest length in lateral view; posterolateral projection rounded. Tergum X with dorsal posteromesal lobes that project postero-dorsad; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, distal tip rounded in lateral view, truncate or rounded in ventral view. Phallic apparatus with ventral opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular in ventral view; apicodorsal roof of phallobase declivous, not projecting above plane of proximal phallobase; apicolateral lobes of phallobase with ventral margin angled caudodorsad.

Etymology. Possibly Latin "*brunneus*, *-a*, *-um*" ("brown") and from the feminine noun "*penna*" ("wing"), perhaps referring to the brown wings.

Diagnosis. Similar to *H. aerata*, *H. alabama*, *H. phalerata*, and *H.* n NA1. Differs from *H. aerata* in having the interocular distance longer than the eye width and the occipital setal warts transverse. Differs from *H. alabama* and *H. phalerata* in having the harpagones with tip rounded in lateral view and rounded or truncate in ventral view, not triangular. Differs from *H.* n NA1 in having the phallobase of uniform width and not subapically swollen.

Distribution.

MD/VA (Flint and Butler, 1983);

MD (Flint and Butler, 1983);

PA (Masteller and Flint, 1992);

TN (Flint and Butler, 1983);

WV (Flint and Butler, 1983; Tarter, 1990).

Material Examined. MARYLAND: **Montgomery Co**., Potomac River, Carderock, 27 August 1981, Flint and Butler, 46 males, paratype [Fig. 4.6] (NMNH).

Female, pupa, and egg unknown.

Hydropsyche californica Banks

Figure 4.7

Hydropsyche californica Banks 1899: 217 [male genitalia]. No holotype designated.

Hydropsyche scalaris sensu Milne 1936: 73, *nec* Hagen, 1861.

Hydropsyche californica Banks; Ross 1938c: 16, fig. 26 [male genitalia],

Lectotype locality: Tahoma, California 28 Aug. 1897, No. 11304, male lectotype (MCZ).

Hydropsyche californica Banks; Denning 1943: 115, pl. XVIII fig. 6 [female genitalia];

Allotype locality: Cowichan Lake, British Columbia, Canada, Aug. 1940, female allotype, specimen code UMSP000217631, female allotype (University of Minnesota).

Hydropsyche californica Banks; Denning 1956a: 253 [male genitalia].

Hydropsyche californica Banks; Fischer 1963: 23; 1972: 105 [bibliography].

Hydropsyche californica Banks; Nimmo 1987: 84, map 35, fig. 213-219 [male and female genitalia].

Description. Male. (n=10) Forewing length 8.7-9.8 mm, 9.2 mm; hind wing length 6.5-7.3 mm, 6.7 mm. Interocular distance 0.7-0.75 mm, 0.73 mm; cephallic width 1.7-1.8 mm, 1.7 mm; interocular distance:cephalic width ratio 0.4-0.44, 0.42. Eye width 0.4-0.49 mm, 0.44 mm; occipital setal wart width 0.35-0.39 mm, 0.38 mm; occipital setal wart width:eye width ratio 0.8-0.98, 0.88. Antennae each with oblique, sclerotized bands on basal 6-7 flagellomeres. Sternal gland of abdominal segment V large, nearly as long as one abdominal segment.

Abdominal segment IX with dorsal carina, segment 2.4 times as tall as greatest length; posterolateral projection rounded or obliquely truncate. Tergum X subrectangular with distal margin truncate in lateral and dorsal views; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, tip rounded in ventral view. Phallic apparatus with phallobase constricted proximally and swollen subapically; ventral opening of subapicomesal cavity and subapicomesal cavity both orbicular in ventral view; apicodorsal roof of phallobase flat.

Etymology. Named for the state of California.

Diagnosis. *Hydropsyche californica* is similar in appearance to *H. auricolor* and *H. winema*. The ventral view of the harpago is truncate in *H. auricolor* and ogival in *H. californica* and *H. winema*. In ventral view, the harpago of *H. californica* often has an almost imperceptible distal tooth (see Nimmo, 1987). See the diagnosis section of *H. winema* for characters useful for distinguishing *H. californica* from *H. winema*.

Distribution.

BC (Denning, 1943; Ross and Spencer, 1952; Nimmo, 1987);

CA (Banks, 1899; Denning, 1956; Nimmo, 1987;
McElravy and Resh, 1987);

ID (Denning, 1943; Nimmo, 1987);

MN (Denning, 1943; Etnier, 1965; Nimmo, 1987);

MT (Nimmo, 1987);

OR (Denning, 1943; Anderson, 1976; Nimmo, 1987;

Anderson and Hansen, 1987; Anderson and Anderson, 1995);

UT (Knowlton and Harmston, 1939; Baumann and Unzicker, 1981;

Nimmo, 1987);

WA (Smith, 1981; Nimmo, 1987; Newell, Ruiter, and Strenge, 2001).

Material Examined. CALIFORNIA: **Tulare Co**., Kaweah Oaks, near Farmersville, 25 May 1983, D. J. Burdick, 19 males (CUAC).

Notes. Newell et. al. (2001) reported emergence of *H. californica* in WA from May to September, with peak abundance in late June, using mercury vapor and ultraviolet light traps. Anderson and Anderson (1995) reported *H. californica* from spring habitats in central Oregon, using emergence traps.

Immature stages unknown.

Hydropsyche catawba Ross

Figure 4.8

Hydropsyche catawba Ross 1939a: 67, fig. 6 [male genitalia].

Type locality: Catawba River, Catawba, N.C., 23 April 1938, male holotype (INHS).

Hydropsyche catawba Ross; Fischer 1963: 24 [bibliography].

Description. Male. (n=10) Forewing length 9.3-10.4 mm, 9.8 mm; hind wing length 6.6-7.3 mm, 6.9 mm. Interocular distance 0.75-0.88 mm, 0.82 mm; cephallic width 1.6-1.9 mm, 1.8 mm; interocular distance:cephalic width ratio 0.44-0.5, 0.47. Eye width 0.38-0.48 mm, 0.42 mm; occiputal setal wart width 0.35-0.43 mm, 0.39 mm; occipital setal wart width:eye width ratio 0.83-1.0, 0.94. Antennae (n=2, both broken) 6.4 mm, each with oblique, sclerotized bands on basal 7-8 flagellomeres.

Abdominal segment IX with dorsal carina, segment 2.2 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X short, as long as wide in lateral view; distal margin rounded or occasionaly truncate in lateral view; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, subtriangular in ventral view with mesal margin convex. Phallic apparatus with ventral opening of subapicomesal cavity obpyriform; subapicomesal cavity ovaliform in ventral view; apicodorsal roof of phallobase with carinate mesal dome; apicolateral lobes of phallobase with ventral margin tapering caudodorsad.

Etymology. Named for the type locality and the native American tribe that occupied the region.

Diagnosis. Similar to *H. mississippiensis*, *H. franclemonti,* and *H. fattigi*. Differs from *H. mississippiensis* and *H. franclemonti* in having the harpagones subtriangular in ventral view. Differs from *H. fattigi* in having tergum X short, as long as wide and apicodorsal roof of phallobase with carinate mesal dome.

Distribution.

NC/SC (Unzicker, Resh, and Morse, 1982);

NC (Ross, 1939);

GA (Gordon and Wallace, 1975);

VA (Flint, Voshell, and Parker, 1979; Morse et al., 1997);

Material Examined. GEORGIA: **Baker Co**., Ichuaway River, July 1995, C. O. Mohr, 3 males (NMNH). [**Bibb Co**.] Macon, May 1944, R. H. Dodge, 2 males (CAS). Macon, June 1944, R. H. Dodge, 6 males (CAS). Macon, July 1944, R. H. Dodge, 6 males (CAS). Macon, August 1944, R. H. Dodge, 2 males (CAS); **Crawford Co.**, Spring Cr., ~ 5 mi. SSE of Roberta, UV light trap, 11 May 1983, Hamilton and Holzenthal, 4 males (CUAC). SOUTH CAROLINA: [**Aiken Co**.] N. Augusta, 26 July 1943, Denning, 1 male (CAS).

Female and immature stages unknown.

Hydropsyche delrio Ross

Figure 4.9

Hydropsyche delrio Ross 1941a: 85, fig. 67, [male genitalia].

Type locality: Del Rio, Texas, near San Felipe Springs; 19 Apr. 1939, male holotype (INHS), female allotype (INHS).

Hydropsyche delrio Ross; Ross 1944: 294 [checklist, distribution].

Hydropsyche delrio Ross; Fischer 1963: 27 [bibliography].

Description. Male. (n=4) Forewing length 6.9-7.4 mm, 7.2 mm; hind wing length 5-5.2 mm, 5.1 mm. Interocular distance 0.68 mm; cephallic width 1.2-1.3 mm, 1.3 mm; interocular distance:cephalic width ratio 0.52-0.57, 0.53. Eye width 0.25-0.28 mm, 0.27 mm; occiputal setal wart width 0.3-0.33 mm, 0.31 mm; occipital setal wart width:eye width ratio 1.1-1.2, 1.2. Antennae 8.5-9.0 mm, each with oblique, sclerotized bands on basal 7-9 flagellomeres. Abdominal sternum V glands ampulliform

Abdominal segment IX carinate, segment 2.4 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X with distal margin rounded in lateral view; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view, falcate in ventral view with tip pointed . Phallic apparatus with ventrodistal opening of subapicomesal cavity oblong, 2.5 times as long as wide; subapicomesal cavity orbicular in ventral view; apicolateral lobes of phallobase globose in lateral view.

Etymology. Named for the type locality.

Diagnosis. Similar to *H. incommoda*. Differs in having the phallobase subapically swollen in ventral view and the apicolateral lobes globose.

Distribution.

TX (Ross, 1941);

Mexico (Ross, 1944).

Material Examined. MEXICO: 2 miles North of Tamazunchale, S.L.P. 400', 16-18 July 1963, Duckworth and Davis, 4 males [Fig. 4.9] (NMNH). TEXAS: **Val Verde Co.**, Devils River, Dolon Falls, 24 April 1998, Kondratieff, 30 males (CSU).

Female undescribed, immature stages unknown.

Hydropsyche demora Ross

Figure 4.10

Hydropsyche demora Ross1941a: 86, fig. 68 [male genitalia].

Type locality: Demorest, Georgia; 01 July1939, male holotype (INHS).

Hydropsyche demora Ross; Fischer 1963: 27.

Hydropsyche demora Ross; Schuster and Etnier 1978: 83 fig. 40 [larva; biological notes].

Description. Male (n=2) Forewing length 8.2-8.5 mm, 8.4 mm; hind wing length 6.1-6.3 mm, 6.2 mm. Interocular distance 0.5-0.53 mm, 0.52 mm; cephalic width 1.8-1.9 mm, 1.85 mm; interocular distance:cephalic width ratio 0.28. Eye width 0.73 mm; occipital setal wart width 0.29 mm; occipital setal wart width:eye width ratio 0.4. Antennal length (n=1, broken) 9.4 mm. Abdominal sternum V glands ampulliform.

Abdominal segment IX carinate, segment 2.2 times as tall as greatest length; posterolateral projection rounded, occasionally obliquely truncate. Tergum X with dorsal margin convex; distal margin rounded, setae often projecting posterad; apicomesally emarginate. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted, saber-shaped in lateral view, tip ogival to obliquely truncate in ventral view. Phallic apparatus with ventrodistal opening of subapicomesal cavity pandurate; subapicomesal cavity orbicular in ventral view; apicolateral lobes of phallobase with ventral margin tapering caudodorsad; apicodorsal roof declivous.

Etymology. Possibly Latin "*de-*" ("down," "from," "of") and feminine noun "*mora*" ("delay").

Diagnosis. The phallobase has the subapicomesal cavity opening pandurate, the apicodorsal phallobase roof declivous, and tergum X with a convex dorsal margin.

Distribution.

GA/NC/SC (Gordon and Wallace, 1975);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Lago and Harris, 1987; Harris, 1990; Harris, O'Neil, and Lago, 1991);

GA (Ross, 1941; Schuster and Etnier, 1978);

NC (Penrose, Lenat, and Eagleson, 1982);

TN (Schuster and Etnier, 1978; Etnier and Schuster, 1979).

Material Examined. TENNESSEE: **Bradley Co**., Conasauga River at Tn. 74 bridge, 01 July 1972, Etnier, 2 males [Fig. 4.10] (NMNH).

Female, pupa, egg unknown.

Hydropsyche dicantha Ross

Figure 4.11

Hydropsyche dicantha Ross 1938a: 146, fig. 74 [male genitalia].

Type locality: Swansea, Ontario, 15 Aug. 1934, male holotype (INHS).

Hydropsyche venularis sensu Betten 1934: 191-192, textfig. 53f, pl. 19 fig. 13-14 [corrected by Ross 1938a: 146].

Hydropsyche occidentalis sensu Milne 1934-36: 73 [description fits *H. dicantha* -- see below].

Hydropsyche dicantha Ross; Ross 1944: 102, fig. 373, 386a [male and female genitalia]; Costello Lake, Algonquin Park, Ontario, 07 July 1938, female allotype (INHS).

Hydropsyche dicantha Ross; Fischer 1963: 28; 1972a: 107 [bibliography].

Hydropsyche dicantha Ross; Mackay 1978: 499, fig. 7c [larva].

Hydropsyche dicantha Ross; Schuster and Etnier 1978:80, fig. 39 [larva, biological notes].

Hydropsyche dicantha Ross; Rutherford 1985: 128, fig. 4 [pupa].

Hydropsyche dicantha Ross; Scmude and Hilsenhoff 1986: 138, fig. 11 [larval habitat and biology].

Hydropsyche dicantha Ross; Nimmo 1987: map 36, fig. 220-224, 225-226 [male genitalia, female genitalia].

Description. Male (n=14) Forewing length 7.5-9.5 mm, 8.6 mm; hind wing length 5.5-7 mm, 6.4 mm. Interocular distance 0.7-0.8 mm, 0.74 mm; cephalic width 1.4-1.6 mm, 1.5 mm; interocular distance:cephalic width ratio 0.44-0.52, 0.49. Eye width 0.3-0.38 mm, 0.35 mm; occipital setal wart width 0.33-0.38 mm, 0.35 mm; occipital setal wart width:eye width ratio 0.94-1.2, 1.0. Antennal length 7.3-9.4 mm, 8.6 mm, each with oblique, sclerotized bands on basal 8-10 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 1.9 times as tall as greatest length; posterolateral projection broadly rounded. Tergum X with dorsal margin declivous in lateral view, bearing scattered setae and dorsolateral spine; distal margin with posterolateral edges excised; apicomesally emarginate. Inferior appendages each with coxopodite distally bearing elongate setae; harpago intorted, subquadrate in lateral view, subtriangular in ventral view with lateral margin convex. Phallic apparatus with subapical phallobase swollen; apicolateral lobes of phallobase dorsoventrally depressed; ventrodistal opening of subapicomesal cavity obpyriform, occasionaly subelliptic; subapicomesal cavity ovaliform in ventral view; inverted phallicata much less than half as long as phallobase.

Etymology. Apparently from Latin "*di-*" ("in two") and the masculine noun "*canthus*" ("edge"), perhaps referring to the deep narrow division of tergum X.

Diagnosis. *Hydropsyche dicantha* is the only described species in the *Hydrospyche scalaris* Group with tergum X having a pair of dorsolateral spines.

Distribution.

MD/VA (Flint and Butler, 1983);

AL (Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Frazer, Harris, and Ward,1991; Harris, O'Neil, and Lago, 1991;Hicks and Haynes, 2000a);

DC (Ross, 1944; Schuster and Etnier, 1978);

DE (Lake, 1984; Nimmo, 1987);

GA (Frazer, Harris, and Ward, 1991);

IN (Waltz and McCafferty, 1983);

KY (Ross, 1944; Resh, 1975; Schuster and Etnier, 1978; Haag, Resh, and Neff, 1984; Nimmo, 1987; Phillippi and Schuster, 1987; Floyd and Schuster, 1990);

MD (Harris, O'Neil, and Lago, 1991);

MI (Ross, 1944; Leonard and Leonard, 1949; Nimmo, 1987);

MN (Etnier, 1965; Schuster and Etnier, 1978; Nimmo, 1987);

NH (Morse and Blickle, 1953; Schuster and Etnier, 1978; Nimmo, 1987);

NY (Ross, 1944; Schuster and Etnier, 1978; Bilger, 1986; Nimmo, 1987);

OH (Flint, Voshell, and Parker, 1979; Petersen and Foote, 1980; Huryn and Foote, 1983; Usis and MacLean, 1986; Nimmo, 1987; Garono and MacLean, 1988);

ON (Ross, 1938; Ross, 1944; Mackay, 1978; Schuster and Etnier, 1978; Rutherford, 1985; Nimmo, 1987);

PA (Flint, Voshell, and Parker, 1979; Nimmo, 1987; Masteller and Flint, 1992);

PQ (Robert, 1958; Roy and Harper, 1975; Roy and Harper, 1979; Nimmo, 1987);

TN (Etnier and Schuster, 1979; Nimmo, 1987);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981; Nimmo, 1987);

WI (Longridge and Hilsenhoff, 1973; Hilsenhoff, 1975; Schuster and Etnier, 1978; Schmude and Hilsenhoff, 1986; Nimmo, 1987; Hilsenhoff, 1995);

WV (Nugen and Tarter, 1983; Tarter, 1990.

Material Examined. KENTUCKY: **Powell Co**., National Bridge State Park, Mill Creek, Hwy 11, 25 June 1973, B. Stark, 7 males (NMNH). OHIO: **Ashland Co**., Clear Fork River at Mohican State Park, SE Pleasant Hill Res., 01 Aug. 1968, T. Yamamoto and L. Kohalmi, 20 males (ROM). **Lake Co**., Walden II TNC Preserve, LeRoy Twp., 19-20 Aug. 1989, S. Tevaguchi, 6 males [Fig. 4.11] (CSU). ONTARIO: L. Traverse Petawawa River, Nipissing Dist., 12 July 1936, 2 males (ROM). Rainy River Dist., Hardtack L., For. Rd. 22-4, ca. 7.3km N Hwy 622 (8.2km W. Atikokan G.S.) 30 June 1984, 841051f at light, ROM Field Party, 2 males (ROM). Algonquin Park, Tea L., 02 July 1954, G. B. Wiggins, 4 males (ROM). Algonquin Park, Tea L., 04 July 1954, G. B. Wiggins, 4 males (ROM). Algoma Dist., Chippewa River x-ing Hwy 17 below falls, 04 June 1980, #801017, P. Schefter and L. Staples, 1 male metamorphotype (ROM). TENNESSEE: **VanBuren Co**., Fall Creek Falls State Park, 15 May 1985, #850016, H. Frania, 3 males (ROM). VanBuron Co., Fall Creek Falls State Park, 14 May 1985, #850012, R. Vinyard and P. Schefter, 1 male (ROM).

Notes. One adult male from Algonquin Park, Ontario had 25 mites attached to the intersegmental membranes of abdominal segments I-IV. The material determined to be *H. occidentalis* by Milne (1934-36) is most likely an incorrect application of the name.

Based on Milne's description of the "tenth tergite with a small spine on lateral face [of] each side" there can be little doubt that he was dealing with *H. dicantha* and not *H. occidentalis sensu* Ross (1938c).

Egg unknown.

Hydropsyche fattigi Ross

Figure 4.12

Hydropsyche fattigi Ross1941a: 88, fig.70 [male genitalia].

Type locality: 6 miles west of Concord, Georgia, 11 May 1939, P. W. Fattig, male holotype (INHS), female allotype same data as holotype (INHS).

Hydropsyche fattigi Ross; Fischer 1963: 3 [bibliography].

Description. Male (n=12) Forewing length 6.3-7.2 mm, 6.8 mm; hind wing length 4.7-5.3 mm, 5.0 mm. Interocular distance 0.55-0.59 mm, 0.57 mm; cephalic width 1.3-1.4 mm, 1.3 mm; interocular distance:cephalic width ratio 0.41-0.45, 0.43. Eye width 0.33-0.38 mm, 0.35 mm; occipital setal wart width 0.27-0.28 mm, 0.27 mm; occipital setal wart width:eye width ratio 0.71-0.85, 0.78. Antennal length 6.6-7.4 mm, 6.9 mm, each with oblique, sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 1.9 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subrectangular in lateral view with distal margin rounded to truncate; apicomesally emarginate. Inferior appendages each with coxopodite distally bearing elongate setae; harpago intorted; subtriangular in ventral view. Phallic apparatus with ventral margin of apicolateral lobes tapering caudodorsad; apicodorsal roof declivous; ventrodistal opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular in ventral view.

Etymology. Named in honor of Dr. P. W. Fattig, former Head of the Department of Entomology at the University of Georgia and collector of the holotype.

Diagnosis. Phallobase of uniform width, the apicodorsal roof declivous with a dorsomesal diamond-shaped notch. Harpagones subtriangular in ventral view. Tergum X longer than wide.

Distribution.

GA/SC (Wallace, 1975);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Lago and Harris, 1987; Harris, 1990; Harris, O'Neil, and Lago, 1991);

GA (Ross, 1941; Gordon and Wallace, 1975);

TN (Etnier and Schuster, 1979);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981).

Material Examined. VIRGINIA: **Culpeper Co**., Hazel River off Route 707, 03 July1981, Kondratieff, 3 males (ROM). **Fauquier Co**., Broad Run Throughfare Gap, 26 July 1975, O. S. Flint, Jr., 8 males [Fig. 4.12] (NMNH).

Female and immature stages unknown.

Hydropsyche franclemonti Flint

Figure 4.13

Hydropsyche franclemonti Flint 1992: 322, fig. 1-5, 6 [male genitalia, map].

Type locality: Hazel River, off Rt. 707, Culpepper Co., Virginia, 03 July 1981,

B. C. Kondratieff, male holotype (NMNH).

Description. Male (n=4) Forewing length 9.3-10.6 mm, 10 mm; hind wing length 6.4-7.4 mm, 7 mm. Interocular distance 0.5-0.59 mm, 0.54 mm; cephalic width 1.7-1.8 mm, 1.7 mm; interocular distance:cephalic width ratio 0.29-0.33, 0.31. Eye width 0.6-0.64 mm, 0.62 mm; occipital setal wart width 0.24-0.28 mm, 0.26 mm; occipital setal wart width:eye width ratio 0.39-0.44, 0.41. Coxopodite 0.68-0.7 mm, 0.69 mm; harpago 0.23 mm; coxopodite:harpago ratio 0.33-0.34, 0.34. Antennal length (n=2) 10.4-11.4 mm, 10.9 mm, each with obliquely sclerotized bands on basal 7 or 8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX carinate, segment about 2.3 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X with small apicomesal notch; posterior margin rounded in dorsal and lateral views, dorsal edge occasionally declivous in lateral view. Inferior appendages with coxopodite long, slender and only slightly swollen distally; harpago intorted, saber-shaped in lateral view, in ventral view apex variable, obliquely truncate or truncate. Phallic apparatus with apicodorsal roof of phallobase forming weak dome, height less than half as high as apicolateral lobes or apicodorsal roof flat; apicolateral lobes of phallobase with ventral edge tapering upward; subapicomesal cavity orbicular in ventral view, ventral subapicomesal cavity opening obpyriform.

Etymology. Named in honor of Dr. J. G. Franclemont, Cornell University.

Diagnosis. Similar to *H. mississippiensis* and *H. rossi* but differs in having the interocular distance less than the eye width and the occipital setal warts approximately as long as wide, less then half as wide as the eye width.

Distribution.

CT (Flint, 1992; Nelson and Downs, 1995);

GA (Flint, 1992);

NC (Flint, 1992);

NY (Flint, 1992);

PQ (Flint, 1992);

SC (Flint, 1992);

VA (Flint, 1992).

Material Examined. CONNECTICUT: [**Litchfield Co**.], Housatonic Meadows State Park 21-24 May 1983, Rodrigo Andrade, 2 males, paratype (NMNH); NEW YORK: **Delaware Co**., Beaver Kill River near Horton, 13 June 1987, 875003, Schefter and MacCulloch, 1 male, paratype (ROM); SOUTH CAROLINA: **Oconee Co**., Chattooga River at Burrell's Ford, near Route 107, 26-27 May 1981, Ent. 412/612 class, 1 male, paratype (CUAC).

Female and immature stages unknown.

Hydropsyche frisoni Ross

Figure 4.14

Hydropsyche frisoni Ross 1938a: 142, fig 68. [male genitalia].

Type locality: Oakwood, Illinois, along Salt Fork River 24 April 1925; male holotype (INHS), female allotype (INHS).

Hydropsyche frisoni Ross; Ross 1944: 105, fig. 354, 379, 386J [larval head and pronotum, male genitalia, female genitalia].

Hydropsyche frisoni Ross; Fischer 1963: 32 [bibliography].

Hydropysche frisoni Ross; Schuster and Etnier 1978: 93, fig. 51 [larva, biological notes].

Hydropsyche frisoni Ross; Nimmo 1987: 85, map 37 fig. 227-231, 232-233 [male genitalia, female genitalia].

Hydropsyche frisoni Ross; Lago and Hariss 2006: 561, fig. 2, [male genitialia]

Description. Male (n=10). Forewing length 8.6-10 mm, 9.3 mm; hindwing length 6.2-7.0 mm, 6.6 mm. Interocular distance 0.5-0.58 mm, 0.54 mm; cephalic width 1.8-2.0 mm, 1.95mm; interocular distance:cephalic width ratio 0.26-0.31, 0.28. occipital setal wart width 0.3-0.33, 0.31; eye width 0.68-0.75 mm, 0.71; occipital setal wart width:eye width ratio 0.4-0.45, 0.43. Antennal length (n=9) 10.0-12.6 mm, 10.9 mm, each with oblique, sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.35 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subrectangular in lateral view, with distal margin rounded; apicomesally emarginate. Inferior appendages each clavate with coxopodite distally bearing elongate setae; harpago intorted; subrectangular in ventral view with apex obliquely truncate. Phallic apparatus with ventrodistal opening of subapicomesal cavity oblanceolate; subapicomesal cavity orbicular or ovaliform in ventral view; ventral margin of apicolateral lobes tapering caudodorsad; apicodorsal roof strongly carinate.

Etymology. Named in honor of Dr. Theodore H. Frison, Chief of the Illinois Natural History Survey.

Diagnosis. Interocular distance less than eye width, occipital setal warts less than half as wide as eye width. Phallic apparatus with subapicomesal opening oblanceolate and apicodorsal roof strongly carinate. Hapagones subrectangular in ventral view with apex obliquely truncate.

Distribution.

AL (Schuster and Etnier, 1978; Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Nimmo, 1987; Harris, O'Neil, and Lago, 1991);

CO (Harris and Lawrence, 1978);

CT (Bilger, 1986);

IA (Nimmo, 1987);

IL (Ross, 1938; Schuster and Etnier, 1978; Nimmo, 1987);

IN (Waltz and McCafferty, 1983; Nimmo, 1987);

KS (Harris and Lawrence, 1978);

KY (Thoeny and Batch, 1983; Floyd and Schuster, 1990);

MI (Ross, 1938; Schuster and Etnier, 1978; Nimmo, 1987);

MO (Harris and Lawrence, 1978);

MN (Schuster and Etnier, 1978; Nimmo, 1987);

NE (Harris and Lawrence, 1978);

OH (Nimmo, 1987);

TN (Etnier, 1973; Schuster and Etnier, 1978; Nimmo, 1987).

Material Examined. ALABAMA: **Bibb Co**., Little Cahaba River at Bulldog Bend, 13 May 1981, Harris and O’Neil, 14 males, [Fig. 4.14] (NMNH); OHIO: **Ashland Co**., Clear Fork River at Mohican State Park, southeast Pleasant Hill Res., 01 Aug 1968, Yamamoto and Kohalmi, 2 males (ROM).

Pupa and egg unknown.

Hydropsyche hageni Banks

Figure 4.15

Hydropsyche hageni Banks 1905b: 14, fig. 6,12 and 10 [male genitalia, adult head].

Hydrospyche scalaris sensu Milne 1934-36: 73 *nec* Hagen, 1861.

Hydrospyche hageni Banks; Ross 1938c: 17, fig. 22 [male genitalia].

Lectotype locality: Travilah, Maryland, July; No. 11996, male lectotype (MCZ).

Hydropsyche hageni Banks; Denning 1943: 119, fig. 10 [female genitalia].

Allotype locality: Anoka Co., Fridley Sand Dunes, Minnesota, 17 Sept. 1937, female allotype (University of Minnesota, specimen code UMSP000005181).

Hydropsyche hageni Banks; Ross 1944: 103, fig. 353, 374, 386D [larval head and pronotum, male genitalia, female genitalia].

Allotype locality: Momence, Illinois, 17 May 1937, female allotype (INHS).

Hydropsyche hageni Banks; Fischer 1963: 42 [bibliography].

Hydropsyche hageni Banks; Schuster and Etnier 1978: 102, fig. 49 [larva, biological notes].

Hydropsyche hageni Banks; Schmude and Hilsenhoff 1986: 138, [larva].

Hydropsyche hageni Banks; Nimmo1987: 86, map 38, fig. 234-238, 239-240 [male genitalia, female genitalia].

Description. Male (n=4). Forewing length 8.8-10.6 mm, 9.9 mm; hind wing length 6.4-7.5 mm, 7.2 mm. Interocular distance 0.45-0.55 mm 0.51 mm; cephalic width 1.8-2.2 mm, 2 mm; interocular distance:cephalic width ratio 0.25-0.28, 0.26. Eye width 0.68-0.8 mm, 0.72 mm. Occiputal setal wart width 0.3-0.37 mm, 0.33 mm; occiputal setal wart width:eye width ratio 0.43-0.49, 0.46. Antennal length (n=1, broken) 11.1 mm, each with obliquely sclerotized bands on basal 8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.1 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subtriangular in lateral view, dorsal margin declivous, distal margin rounded; apicomesally emarginate. Inferior appendages each with coxopodite distally bearing elongate setae; harpago intorted; falcate in ventral view, with mesal margin convex. Phallic apparatus with apicolateral lobes dorsoventrally depressed, extend posterad beyond subapicomesal cavity 2 times length of subapicomesal cavity, lateral margin lobed in ventral view; apicodorsal roof convex, without carina; ventrodistal opening of subapicomesal cavity oblong, 2.5 to 4.0 times as long as wide; subapicomesal cavity orbicular in ventral view.

Etymology. Named in honor of Dr. Hermann A. Hagen, Museum of Comparative Zoology, Harvard University.

Diagnosis. Similar to *H. leonardi* and *H. hoffmani*. Differs from *H. leonardi* in having the interocular distance less than the eye width, occipital setal warts less than half as wide as eye width, and subapicomesal cavity opening of phallobase oblong, 2.5 to 4.0 times as long as wide. Differs from *H. hoffmani* in having tergum X subtriangular and harpagones saber-shaped in lateral view, falcate in ventral view.

Distribution.

MD/VA (Flint and Butler, 1983);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Nimmo, 1987);

DC (Flint, pers comm);

IL (Denning, 1943; Schuster and Etnier, 1978; Nimmo, 1987);

KY (Ross, 1944; Resh, 1975; Schuster and Etnier, 1978; Nimmo, 1987);

MB (Denning, 1943 [record suspect according to Schmude and Hilsenhoff, 1986]; Schuster and Etnier, 1978; Flannagan and Flannagan, 1982; Nimmo, 1987);

MD (Ross, 1938; Schuster and Etnier, 1978; Nimmo, 1987);

MI (Davis, Hudson, and Armitage, 1991);

MN (Denning, 1943 [record suspect according to Schmude and Hilsenhoff, 1986]; Etnier, 1965; Schuster and Etnier, 1978; Nimmo, 1987);

NC (Banks, 1908; Schuster and Etnier, 1978; Nimmo, 1987);

OH (McElravy and Foote, 1978; doubtful record according to Huryn and Foote, 1983; Petersen and Foote, 1980);

ON (Nimmo, 1987);

PA (Masteller and Flint, 1992);

PQ (Roy and Harper, 1979);

TN (Schuster and Etnier, 1978; Etnier and Schuster, 1979; Nimmo, 1987);

VA (Banks, 1905; Schuster and Etnier, 1978; Flint et al. 1979; Parker and Voshell, 1981; Nimmo, 1987);

WI (Hilsenhoff, 1975; Schuster and Etnier, 1978; Nimmo, 1987);

WV (Nugen and Tarter, 1983; Tarter, 1990).

Material Examined. KENTUCKY: **McCreary Co**., seeps near Cumberland Falls, Cumberland Falls State Park, 11 May 1988, Kondratieff, 1 male (CSU). Cumberland River, Cumberland Falls State Park, 11 May 1988, Kondratieff, 1 male (D. Ruiter pers. coll.). MARYLAND: **Montgomery Co**., near Bethesda at Cabin John Regional Park, sweep [net] 12 September 1981, Turner, 1 male (ROM). VIRGINIA: **Giles Co.**, Pembroke, at store lights, 28 July 1984, 1 male (CUAC). **Montgomery Co**., Poverty Hollow, Poverty Creek, 16 June 1987, Stein, 1 male [Fig. 4.15] (CSU). WEST VIRGINIA: **Summers Co**., New River, Bluestone Dam, 27 June 1983, Kondratieff, 1 male (CSU)

Pupa and egg unknown.

Hydropsyche hoffmani Ross

Figure 4.16

Hydropsyche hoffmani Ross 1962: 129, fig. 1 [male genitalia].

Type locality: Radford Arsenal, Montgomery Co., Virginia 4-10 Aug. 1956, male holotype (INHS).

Hydropsyche hoffmani Ross; Schuster and Etnier 1978: 98, fig. 16, 47 [larva, biological notes].

Hydropsyche hoffmani Ross; Schuster 1984: 343, fig. 13 [pupa].

Description. Male. (n=12) Forewing length 8.0-11.3 mm, 9.4 mm; hind wing length 5.7-7.9 mm, 6.5 mm. Interocular distance 0.53-0.63 mm, 0.56 mm; cephalic width 1.7-1.9 mm, 1.8 mm; interocular distance:cephalic width ratio 0.29-0.33, 0.31. Eye width 0.55-0.65 mm, 0.6 mm; occiputal setal wart width 0.31-0.36 mm, 0.33 mm; occiputal setal wart width:eye width ratio 0.51-0.59, 0.55. Antennal length (n=9) 8.9-10.5 mm, 9.7 mm, each with obliquely sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 1.95 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subrectangular in lateral view, distal margin rounded or truncate; apicomesally emarginate. Inferior appendages each with coxopodite distally bearing elongate setae; harpago intorted, apex bifurcate in lateral view; subtriangular in ventral view, with lateral margin convex. Phallic apparatus with apicolateral lobes dorsoventrally depressed, extending posterad beyond subapicomesal cavity 1 to 1.5 times length of subapicomesal cavity, lateral margins lobed in ventral view; apicodorsal roof convex, without carina; ventrodistal opening of subapicomesal cavity obpyriform; subapicomesal cavity ovaliform to orbicular in ventral view.

Etymology. Named in honor of Dr. Richard L. Hoffman, Virginia Museum of Natural History.

Diagnosis. Similar to *H. leonardi* and *H hageni* in having the apicolateral lobes of the phallobase depressed and extending posterad 1 to 2 times the length of the subapicomesal cavity. Differs from *H. leonardi* and *H. hageni* in having each harpago bifurcate in lateral view and subtriangular in ventral view.

<u>Distribution</u>.

MD/VA (Flint and Butler, 1983);

DE (Lake, 1984);

MD (Flint, Voshell, and Parker, 1979; Nugen and Tarter, 1983);

VA (Ross, 1962; Schuster and Etnier, 1978; Parker and Voshell, 1981; Nugen and Tarter, 1983);

WV (Nugen and Tarter, 1983; Tarter, 1990).

<u>Material Examined</u>. MARLYAND: **Montgomery Co**., Carderock, Potmac River, 27 August 1981, Flint and Butler, 9 males (NMNH). VIRGINIA: **Fairfax Co**., Scott's Run, 21 July 1963, 1 male (CAS). WEST VIRGINIA: **Summers Co**., New River at Bluestone Dam, 27 June 1983, Kondratieff, 1 male (CSU). **Mercer Co**., Blue Stone River, I-77 bridge, 16 May 1990, Kondratieff, Welch and Kirchner, 1 male (CSU).

<u>Female and egg unknown</u>.

Hydropsyche impula Denning

Figure 4.17

Hydropsyche impula Denning 1948c: 398, fig. 3 [male genitalia].

Type locality: Sunderland, Massachusetts, 17 July 1938, male holotype (University of Wyoming).

Hydropysche impula Denning; Fischer 1972a: 111 [bibliography].

<u>Description</u>. Male (n=3). Forewing length 8.4-8.8 mm, 8.6 mm; hind wing length 6.0-6.5 mm, 6.2 mm. Interocular distance 0.5-0.53 mm, 0.51 mm; cephalic width 1.7 mm; interocular distance:cephalic width ratio 0.29-0.31, 0.30. Eye width 0.5-0.58 mm, 0.54 mm; occiputal setal wart width 0.33-0.35 mm, 0.34 mm; occiputal setal wart

width:eye width ratio 0.57-0.7, 0.62. Antennal length (n=1) 9 mm, each with obliquely sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with carina, segment about 2.45 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subrectangular in lateral view, distal margin rounded; apicomesally emarginate. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted, saber-shaped in lateral view; apex rounded in ventral view, with mesal margin slightly to markedly convex. Phallic apparatus with apicolateral lobes dorsoventrally depressed, lateral margin sinate in ventral view, distal margin of apicolateral lobes subtriangular; apicodorsal roof declivous; ventrodistal opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular in ventral view.

Etymology. Unknown.

Diagnosis. Apicolateral lobes of phallobase dorsoventrally depressed, subtriangular in ventral view. Apicomesal roof of phallobase with diamond-shaped notch. Each harpago with mesal margin markedly convex.

Distribution.

DE (Lake, 1984);

MA (Denning, 1948);

PA (Masteller and Flint, 1992).

Material Examined. MASSACHUSETTS: [**Franklin Co**.], Sunderland, 06 July 1941, Hanson, 1 male (CAS). Sunderland 17 July 1938, Hanson; 1 male Paratype (CAS). PENNSYLVANIA: **Adams Co**., Biglerville, PSU Fruit farm, light trap, 03 July 1980, Starner and Quinn, 1 male [Fig. 4.17] (NMNH).

Female and immature stages unknown.

Hydropsyche incommoda Hagen

Figures 3.9,3.12, 4.18

Hydropsyche incommoda Hagen 1861: 290 [no holotype designated].

Hydropsyche bidens Ross 1938a: 142, fig. 67 [male genitalia], **NEW SYNONYM**.

Hydropsyche orris Ross 1938c: 121 [*nomen novum* for *H. cornuta* Ross 1938b: 141, fig. 66, preoccupied by Martynov 1909: 539], **NEW SYNONYM**.

Hydropsyche incommoda Hagen; Ross 1938c: 17, fig. 29 [lectotype, male genitalia]. Lectotype locality: Georgia, Winthem. No. 11028, lectotype male (MCZ).

Hydropsyche bidens Ross; Denning 1943: 118, fig. 8 [female genitalia].

Hydropsyche orris Ross; Denning 1943: 119, fig. 9 [female genitalia].

Hydropsyche bidens Ross; Ross 1944: 107, fig. 382, 386L [male and female genitalia].

Hydropsyche orris Ross; Ross 1944: 106, fig. 383, 386, 346 [male and female genitalia, larval head and pronotum].

Hydropsyche alvata Denning1949: 40, fig. 5 [male genitalia], **NEW SYNONYM**.

Hydropsyche orris Ross; Fremling 1960: 856 [biology].

Hydropsyche incommoda Hagen; Fischer 1963:43; 1972a: 111 [bibliography].

Hydropsyche bidens Ross; Fischer 1963: 20; 1972: 104 [bibliography].

Hydropsyche orris Ross; Fischer 1963: 65; 1972: 118 [bibliography].

Hydropsyche orris Ross; Wallace 1975: 550 [photos of larvae].

Hydropsyche orris Ross; Wallace and Malas 1976: 208 [net].

Hydropsyche incommoda Hagen; Wallace, Webster and Woodall 1977: 515 [photo of net].

Hydropsyche orris Ross; Wallace, Webster and Woodall 1977: 514 [photos of net].

Hydropsyche bidens Ross; Schuster and Etnier 1978: 75, fig. 36 [larva head, biological notes].

Hydropsyche orris Ross; Schuster and Etnier 1978: 71, fig. 35 [larva, biological notes].

Hydropsyche alvata Denning; Flint et al. 1979: 842, fig. 1-5 [male genitalia].

Hydropsyche incommoda Hagen; Flint et al. 1979: 849, fig. 8-13, map 1 [male genitalia].

Hydropsyche orris Ross; Flint et al. 1979: 843, fig. 6, 7 [male genitlia].

Hydropsyche incommoda Hagen; Parker and Voshell 1982: 1734 [biology].

Hydropsyche incommoda Hagen; Parker and Voshell 1983: 70 [biology].

Hydropsyche incommoda Hagen; Benke et al. 1984: 31 [biology].

Hydropsyche incommoda Hagen; Schuster 1984: 341 [female genitalia].

Hydropsyche orris Ross; Schuster 1984: 343 [male segment V].

Hydropsyche bidens Ross; Schmude and Hilsenhoff 1986: 137, fig. 11 [larval habitat].

Hydropsyche orris Ross; Schmude and Hilsenhoff 1986: 139, fig. 11 [larval habitat].

Hydropsyche alvata Denning; Nimmo1987: 84, map 32, fig. 189-193 [male genitalia].

Hydropsyche bidens Ross; Nimmo 1987: 84, map 34, fig. 206-212, [male and female genitalia].

Hydropsyche orris Ross; Nimmo 1987: 87, map 41, fig. 248-252, 253-254[male and female genitalia].

<u>Description</u>. Male (n=52). Forewing length 7.5-11.3 mm, 9.1 mm, hind wing length

5.5-7.8 mm, 6.5 mm. Interocular distance 0.68-0.9 mm, 0.77 mm; cephalic width 1.3-1.7 mm, 1.5 mm; interocular distance:iephalic width ratio 0.47-0.56, 0.51. Eye width 0.28-0.43 mm, 0.35 mm; occiputal setal wart width 0.3-0.4 mm, 0.35 mm; occiputal setal wart width:eye width ratio 0.88-1.2, 0.99. Antennal length (n=41) 10.5-19.5 mm , 14. 3 mm, each with obliquely sclerotized bands on basal 8-10 flagellomeres. Abdominal sternal V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.25 times as tall as greatest length; posterolateral projection rounded or obliquely truncate. Tergum X subrectangular in lateral view, dorsal margin occasionally declivous; distal margin rounded; apicomesally emarginate. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted, saber-shaped in lateral view; extorsely falcate with tip pointed in ventral view. Phallic apparatus with apex highly variable; ventrodistal opening of subapicomesal cavity oblong to obpyriform; subapicomesal cavity orbicular in ventral view; apicolateral lobes with ventral marign tapered caudodorsad.

Etymology. Unknown.

Diagnosis. Tergum X subrectangular in lateral view with distal margin rounded. Each harpago saber-shaped in lateral view and extorsely falcate in ventral view. Differs from *H. delrio* in having the phallobase of uniform width. Differs from *H. leonardi* and *H. hageni* in having the apicolateral lobes of phallobase extending posterad beyond subapicomesal cavity 0.2 to 0.5 times the length of subapicomesal cavity.

Distribution.

NC/SC (Unzicker, Resh, and Morse, 1982 as *incommoda*);

AL (Ross, 1944 as *H. orris*; Schuster and Etnier, 1978 as *H. orris*; Hamilton and Schuster, 1979 as *H. orris*; Harris, Lago, and O'Neil, 1984 as *H. incommoda*, *H. alvata, H. orris*; Harris, 1987 as *H. incommoda*, *H. alvata, H. orris*; Lago and Harris, 1987 as *H. incommoda*, *H. alvata, H. orris*; Nimmo, 1987 as *H. orris*; Harris, O'Neil, and Lago, 1991 as *H. incommoda*, *H. alvata, H. orris*); Moulton and Stewart, 1996 as *H. alvata, H. orris*; Hicks and Haynes, 2000 as *H. alvata, H. orris*);

AR (Ross, 1944 as *H. orris*; Unzicker, Aggus, and Warren, 1970 as *H. incommoda*, *H. alvata*, *H. bidens, H. orris*; Schuster and Etnier, 1978 as *H. incommoda*, *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. incommoda*, *H. bidens, H. orris*; Nimmo, 1987 as *H. alvata*, *H. bidens, H. orris*; Bowles and Mathis, 1989 as *H. incommoda*, *H. alvata*, *H. bidens, H. orris*; Moulton and Stewart 1996, as *H. alvata*, *H. bidens, H. orris*);

CO (Ruiter, 1990 as *H. bidens*; Moulton and Stewart, 1996 as *H. bidens*);

FL (Schuster and Etnier, 1978 as *H. incommoda*; Flint, Voshell, and Parker, 1979 as *H. incommoda*; Hamilton and Schuster, 1979 as *incommoda*; Parker and Voshell, 1981 as *H. incommoda*; Harris, Lago, and Scheiring, 1982 as *H. incommoda*; Gordon, 1984 as *H. incommoda*, *H. alvata, H. orris*; Pescador Rasmussen, and Harris, 1995 as *H. incommoda*, *H. alvata, H. orris*); Moulton and Stewart 1996 as *H. alvata*, *H. orris*);

GA (Ross, 1944 as *H. orris*; Wallace, 1975b as *H. orris*; Gordon and Wallace, 1975 as *H. alvata*; Webster and Woodall, 1977 as *H. orris*; Wallace, Webster, and Woodall, 1977 as *H. incommoda*; Schuster and Etnier, 1978 as *H. incommoda, H. orris*; Flint,Voshell, and Parker, 1979 as *H. incommoda*; Hamilton and Schuster, 1979 as *H. incommoda*, *H. orris*; Nimmo, 1987 as *H. orris;* Bowles and Mathis, 1989 as *H. incommoda*, *H. alvata*, *H. bidens*; Moulton and Stewart, 1996 as *H. alvata, H. orris*);

IA (Ross, 1938 as *H. bidens*; Wenke, 1967 as *H. orris*; Schuster and Etnier, 1978 as *H. bidens*; Hamilton and Schuster, 1979 as *H. bidens*; Nimmo, 1987 as *H. bidens*, *H. orris*; Moulton and Stewart, 1996 as *H. bidens, H. orris*);

IL (Ross, 1938 as *H. bidens, H. orris*; Denning, 1949 as *H. alvata*; Harris, 1971 as *H. incommoda*, *H. bidens*; Schuster and Etnier, 1978 as *H. incommoda*, *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. incommoda*, *bidens, H. orris*; Nimmo; 1987 as *H. alvata*, *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. alvata*, *H. bidens, H. orris*);

IN (Ross, 1938 as *H. bidens*; Ross, 1944 as *H. orris*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Waltz and McCafferty, 1983 as *H. alvata*, *H. bidens, H. orris*; Nimmo, 1987 as *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. alvata*, *H. bidens, H. orris*);

KS (Hamilton and Schuster, 1979 as *H. incommoda*, *H. bidens, H. orris;* Moulton and Stewart, 1996 as *H. orris*);

KY (Ross, 1944 as *H. orris*; Resh, 1975 as *H. incommoda, H. orris*; Schuster and Etnier, 1978 as *H. incommoda, H. orris*; Hamilton and Schuster, 1979 as *H. incommoda, H. orris*; Nimmo, 1987 as *H. orris*; Moulton and Stewart, 1996 as *H. orris*);

LA (Schuster and Etnier, 1978 as *H. incommoda*; Hamilton and Schuster, 1979 as *H. incommoda*; Lago, Holzenthal, and Harris, 1982 as *H. alvata*; Moulton and Stewart, 1996 as *H. alvata*);

MB (Nimmo, 1987 as *H. bidens*; Moulton and Stewart, 1996 as *H. bidens*);

MD (Flint, Voshell, and Parker, 1979 as *H. incommoda*)

MI (Ross, 1938 as *H. bidens, H. orris*; Denning, 1949 as *H. alvata*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Nimmo, 1987 as *H. alvata*, *H. bidens, H. orris*; Davis, Hudson, and Armitage, 1991 as *H. incommoda*; Moulton and Stewart, 1996 as *H. alvata*, *H. bidens, H. orris*);

MN (Denning, 1943 as *H. bidens, H. orris*; Etnier, 1965 as *H. bidens, H. orris*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Lager, Johnson, Williams, and McCullough, 1979 as *H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Nimmo, 1987 as *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. bidens, H. orris*);

MO (Ross, 1944 as *H. bidens*; Schuster and Etnier, 1978 as *H. bidens*; Hamilton and Schuster, 1979 as *H. bidens*; Nimmo, 1987 as *H. bidens, H. orris*; Mathis and Bowles, 1992 as *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. alvata*, *H. bidens*);

MS (Denning, 1949 as *H. alvata*; Lago, Holzenthal, and Harris, 1982 as *H. alvata, H. orris*; Nimmo, 1987 as *H. alvata, H. orris*; Moulton and Stewart, 1996 as *H. alvata, H. orris*);

MT (Roemhild, 1982 as *H. bidens*; Nimmo, 1987 as *H. bidens*; Moulton and Stewart, 1996 as *H. bidens*);

NC (Wray, 1950 as *H. orris*; Schuster and Etnier, 1978 as *H. incommoda*; Hamilton and Schuster, 1979 as *H. incommoda*; Nimmo, 1987 as *H. orris*; Moulton and Stewart, 1996 as *H. orris*);

NC/SC (Unzicker, Resh, and Morse, 1982 as *H. alvata*);

ND (Harris, Lago, and Carlson, 1980 as *H. bidens*; Nimmo, 1987 as *H. bidens*; Moulton and Stewart, 1996 as *H. bidens*);

NE (Harris, Kondratieff, and Boyle, 2000 as *H. orris*);

NY (Schuster and Etnier, 1978 as *H. incommoda*; Hamilton and Schuster, 1979 as *H. incommoda*; Bilger, 1986 as *H. orris*; Moulton and Stewart, 1996 as *H. orris*);

OH (Ross, 1944 as *H. bidens, H. orris*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Huryn and Foote, 1983 as *H. bidens, H. orris*; Usis and MacLean, 1986 as *H. orris*; Nimmo, 1987 as *H. bidens, H. orris*; Garono and MacLean, 1988 as *H. incommoda*, *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. bidens, H. orris*);

OK (Nimmo, 1987 as *H. orris*; Bowles and Mathis, 1992 as *H. alvata, H. orris*; Moulton and Stewart, 1996 as *H. alvata*, *H. bidens, H. orris*);

PA (Masteller and Flint, 1992 as *H. orris*);

PQ (Roy and Harper, 1975 as *H. incommoda*, *H. bidens*; Roy and Harper, 1979 as

H. incommoda, *H. bidens*; Nimmo, 1987 as *H. bidens*; Moulton and Stewart, 1996 as *H. bidens*);

SC (Cudney and Wallace, 1980 as *H. incommoda*);

SD (Nimmo, 1987 as *H. orris*; Moulton and Stewart, 1996 as *H. orris*);

VA (Flint, Voshell, and Parker, 1979 as *H. incommoda*, *H. alvata*; Parker and Voshell, 1979 as *H. incommoda*; Parker and Voshell, 1981 as *H. incommoda*, *H. alvata* ; Parker and Voshell, 1982 as *H. incommoda*; Parker and Voshell, 1983 as *H. incommoda*; Nimmo, 1987 as *H. alvata*; Moulton and Stewart, 1996 as *H. alvata*; Hoffman and Parker, 1997 as *H. incommoda*, *H. alvata*);

TN (Ross, 1944 as *H. orris*; Edwards, 1955 as *H. orris*; Edwards, 1956 as *H. orris*; Edwards, 1966 as *H. orris*; Etnier and Schuster, 1979 as *H. orris*; Hamilton and Schuster, 1979 as *H. orris*; Nimmo, 1987 as *H. orris*; Moulton and Stewart, 1996, as *H. orris*);

TX (Ross, 1941 as *H. orris*; Edwards and Arnold, 1961 as *H. orris*; Edwards, 1973 as *H. orris*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Nimmo, 1987 as *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. bidens, H. orris*; Abbot, Stewart, and Moulton, 1997 as *H. bidens, H. orris*);

WI (Ross, 1938 as *H. bidens, H. orris*, Longridge and Hilsenhoff, 1973 as *H. bidens, H. orris*; Hilsenhoff, 1975 as *H. bidens, H. orris*; Shapas and Hilsenhoff, 1976 as *H. orris*; Schuster and Etnier, 1978 as *H. bidens, H. orris*; Hamilton and Schuster, 1979 as *H. bidens, H. orris*; Steven and

Hilsenhoff, 1984 as *H. bidens*; Schmude and Hilsenhoff, 1986 as *H. bidens, H. orris*; Nimmo, 1987 as *H. bidens, H. orris*; Lillie and Hilsenhoff, 1992 as *H. bidens, H. orris*; Hilsenhoff, 1995 as *H. bidens, H. orris*; Moulton and Stewart, 1996 as *H. orris*);

WV (Tarter, 1990 as *H. orris*; Moulton and Stewart, 1996 as *H. orris*).

Material Examined. ALABAMA: **Baldwin Co.**, Pine Log Cr., 2 mi. SE Tensaw on AL hwy 59, T2N, R3E, Sec 7, SE 1/4 , UV light, 19 May 1983, 1 male (CUAC). ARKANSAS: **Clark Co.**, Degray St. Park, Degray Lake, 12 July 1978, M. Kopeck, 1 male (CUAC); **Greene Co.**, Crowleys Ridge, St. Park, 02 August, 1985, S. Tedder, 1 male (CUAC); **Johnson Co**., Lamar, Hwy 359, Little Piney Cr., 27 June 1986, C. Rowbotham, 2 males (CUAC); Clarksville, Arkansas River, 17 July 1986, C. Rowbotham, 18 males (CUAC); Hagarville, Cedar and Piney CRS, 07 July 1986, C. Rowbotham, males (CUAC); **Logan Co.**, Mt. Magazine, East End, no spec. local., 09 May 1988, R. Leschen, 1 male (CUAC); Magazine, Petite Jean R., 17 July 1985, D.E. Bowles, 2 males (CUAC); **Newton Co**., Buffalo National River, Cecil Creek, Low-water slab nr. Erbie, 20 August 1990, M. Mathis 1 male (CUAC); **Polk Co**., reservoir spring S lodge on Rich Mt., Queen Wilhelmina St. Park, 14 May 1991, H.W. Robison 1 male (CUAC); **Washington Co**., 01 July 1974, W.D. Wylie, 6 males (CUAC); 23 July 1974, W.D. Wylie, 2 males (CUAC); 06 August 1974, W. D. Wylie, 5 males (CUAC); 15 miles South Prairie Grove, Cove Creek, 21 June 1986, D.E. Bowles, 6 males (CUAC). GEORGIA: **Crawford Co.**, Spring Cr., ~ 5 mi. SSE of Roberta, UV light trap, 11 May 1983, Hamilton and Holzenthal, 18 males (CUAC). ILLINOIS: **Champaign Co**., 3.5 mi. NE Mahomet, in mixed forest, 40°15’N 88°29’W, 31 May 1985, #850100b, ROM

Fld. Pty. 1 male (ROM); Kiser L. Cpgrd., Kiser L. St. Pk., 02 August 1968, T. Yamamoto and L. Kohalmi, 1 male (ROM); **Whiteside Co.**, Sterling, 22 May 1941, Ross and Burks, 24 males (ROM). LOUISIANNA: **East Baton Parish**, Baton Rouge, 08 June 1976, H. W. Homan, 1 male (ROM); Baton Rouge, street light, 14 May 1974, 23 males (CUAC). **Jackson Parish**, Schoolhouse Springs, 03 June 1973, J. Morse and J. Louton, 1 male (CUAC); **St. Tammany Parish**, Abita Creek at LA Hwy 435, 7.2 km East of Abita Springs, 05 June 1979, R.W. Holzenthal, 2 males (CUAC); Talisheek Creek at LA Hwy 41, RWH 172, 01 Oct. 1979, 1 male (CUAC). MISSISSIPPI: **Amite Co.**, Wagoner Cr. at MS Hwy 48, just W of Liberty, 23 May 1979, R. W. Holzenthal, 1 male (CUAC); Amite R. at unmarked gravel Rd., 14.6 km S [of] Liberty, 23 June 1979, R. W. Holzenthal, 1 male (CUAC); Amite R., W. fork at unmarked gravel Rd., 14.5 air km SSW [of] Liberty, 23 May 1979, R. W. Holzenthal, 1 male (CUAC); **Claiborne Co.**, Bayou Pierre at Carlisle, 09 July 1979, R. W. Holzenthal, 5 males (CUAC); **Harison Co**., Moss Point, Combest Saw Mill, Black light trap, 26 May 1969, 8 males (CUAC); **Jasper Co.**, Tallahoma Cr. At MS. Hwy. 528, 4.0 km E. Bay Springs , 06 July 1979, 2 males (CUAC); **Pearl River Co.**, Chinquapin Cr. at MS Hwy 43, 1.0 km Crosswoads, 03 July 1979, R. W. Holzenthal, 1 male (CUAC); **Simpson Co.**, Strong R. at MS Hwy 28, 3.7 km W. [of] Pinola, 20 June 1979, R. W. Holzenthal, 1 male (CUAC). MISSOURI: **Shannon Co.**, Jack's Fork River, Hwy 106 bridge, 5 mi. W. [of] Eminenee, 16 August 1987, Tedder and Mathis, 1 male (CUAC). NEBRASKA: **Blaine Co**., Dismal River, Hwy 2 South of Dunning, 13 June 2000, Kondratieff and Zuellig, 1 male (D. Ruiter pers.coll.); **Brown Co**., Calamus River, Hwy 7, 13 June 2000, Kondratieff and Zuellig, 2 males (D. Ruiter pers. coll.). OHIO: [**Defiance Co.**], Maumee R., Independence Dam, nr. Defiance, 1 male (ROM); **Hamilton Co.**, Miamitown, Great Miami River at Harrison Ave. bridge, 05 July 2003, J. A. Korecki, 2 males (CUAC). OKLAHOMA: Red Rock Canyon State Park, 14 May 1961, G. B. Wiggins, 2 males (ROM); **Comanche Co.**, Med. Cr. at Medicine Bluffs, 03 July 2003, 1 male (CSU); Mixed Grass, East Range, Ft. Sill, 11 June 2002, Kondratieff, 2 males (CSU); East Cache Creek, South Boundary Road, Ft. Sill, 13 June 2002, 1 male (CSU); Nat. Res. Bldg., East Range, Fort Sill, 28 May 2003, M. Garhart, 1 male (CSU); **Pushmataha Co.**, Kiamichi River, county road bridge 2.5 miles east of Albion, Blacklight 2200 to 2300, 12 June 1991, Roger Tucker Site #1B, Okla. Nat. Heritage Inventory, 3 males (CUAC). OKLAHOMA/TEXAS: **Montague Co.**, Red River, Hwy 81, 26 April 2003, 4 males [Fig. 4.18, B.6] (CSU). SOUTH CAROLINA: **Aiken Co**., Savannah River Plant, Upper Three Runs Creek at SRP Rd. 8-1, 27 May 1979, R. Kelley & E. McEwan, 1 male, (CUAC); Savannah River Plant, Upper Three Runs Creek, SRP 8-1, 29 March 1977, Herlong and Prichard, 2 males (CUAC); **Barnwell Co.**, Site G, Savannah River Plant, Lower Three Runs Cr. at SRP Rds. 8 and 8-8, 29 May 1984, J. Morse, 3 males (CUAC). TEXAS: San Felipe, S.F. St. Pk., 18 May 1958, Flint and Evans, 66 males (ROM); San Felipe, S.F. Austin St. Pk., 16 May 1958, O. S. Flint, numerous males (ROM); **Bandera Co.**, Lost Maples State Natural Area, 5 mi. N Vanderpool, 07 June 1985, ROM 850112, ROM Fld. Pty, 3 males (ROM). SOUTH DAKOTA: Missouri R., 900 m. below Gavins Point Dam, Yankton, 06 July-28 August 1968, P. L. Hudson, pupae (ROM); **Beadle Co.**, James River, USGS Gage and Railroad Bridge at Huron, 13 July 1999, D. Ruiter, 38 males (DER).

Notes. *Hydrospsyche incommoda* Hagen is one of the oldest names in the *Hydropsyche scalaris* Group. Additional authors described *H. bidens* (Fig. 4.18, B.5), *H. orris* (Fig.

4.18, B.6), and *H. alvata* (Fig.4.18, B.3; 3.12) based on differences of the phallobase apex. All four species have tergum X subrectangular with the distal margin rounded and the harpagones extorsely falcate. Historically, identification of these species has been difficult and misidentifications common (Flint et al., 1979). The phallobase apex suggests at least 5 forms exist (Fig. 4.18, B.2-B.6) but the gradation of shapes as a whole makes it impossible to identify material consistently. Initial identification of material and subsequent examination of the same material often resulted in application of different names. Flint et al. (1979) used the ventrodistal opening of the subapicomesal cavity to distinguish *H. orris*, *H. incommoda*, and *H. alvata*. However, this shape varies from oblong to obpyriform with a number of intermediate shapes. *Hydropsyche bidens*, including paratype material, was often indistinguishable from *H. orris* due to similar ventrodistal openings of the subapicomesal cavity. Although obvious in some specimens, the upturned apicolateral phallobase lobes of *H. orris* (Fig. 4.18, B.6) are difficult to see in many specimens. In *H. alvata,* the apicodorsal phallobase roof is convex, forming a strong dome and appearing larger than the proximal phallobase (Fig. 4.18, B.3; Fig. 3.12, A-B) (Flint et al., 1979). However, intermediates exist (Fig. 4.18, B.1-B.4) and the stability of this character is uncertain. Given the wide geographic distribution and diversity of forms, *Hydropsyche incommoda* could represent a species complex. However, if that is the case, the current names are likely to be inaccurately applied. After examining numerous specimens, including type material, from a wide geographic range, and given the variable nature of the phallobase apex, *H. orris*, *H. bidens*, and *H. alvata* are treated as junior subjective synonyms of *H. incommoda*. The decision to consider all forms as one highly variable species represents the best taxonomic treatment possible given current knowledge. Further investigation of all life stages across the full geographic range, utilizing morphological and molecular analysis may result in the resurrection of one or more of these names.

Pupa and egg unknown.

Hydropsyche leonardi Ross

Figure 4.19

Hydropsyche leonardi Ross1938a: 145, fig. 73 [phallus apex].

Type locality: Michigan, Crawford Co., along north branch Au Sable River, two miles above Lovells, 02 May 1936, J.W. Leonard, male holotype (INHS).

Hydropsyche leonardi Ross; Ross 1944: 294 [checklist].

Hydropsyche leonardi Ross; Fischer 1963: 53; 1972a: 114 [bibliography].

Hydropsyche hageni Banks; Hilsenhoff et al, 1972 [misidentified according to Schmude and Hilsenhoff, 1986].

Hydropsyche hageni Banks; Longridge and Hilsenhoff 1973 [misidentified according to Schmude and Hilsenhoff, 1986].

Hydropsyche leonardi Ross; Schuster and Etnier 1978: 100, fig. 48A, B. [larva, biological notes].

Hydropsyche leonardi Ross; Flint, Voshell, and Parker 1979: 851, map 4.

Hydropsyche leonardi Ross; Schmude and Hilsenhoff 1986: 139, fig. 11 [larval habitat and biology].

Hydropsyche leonardi Ross; Nimmo 1987: 86, figs. 194-198, map 39. [male genitalia].

Description. Male (n=7). Forewing length 9.3-11.3 mm, 10.2 mm; brown, irrorate pattern on wing membrane; hind wing length 6.7-7.9 mm, 7.3 mm. Interocular distance 0.74-0.8 mm, 0.76 mm; cephalic width 1.8-2.0 mm, 1.9 mm; interocular distance:cephalic width ratio 0.39-0.42, 0.41. Occiputal setal wart width 0.33-0.4 mm, 0.35 mm; eye width 0.48-0.55 mm, 0.52 mm; occiputal setal wart width:eye width ratio 0.6-0.75, 0.68. Antennal length (n=7) 9.9-10.3 mm, 10.1 mm, each with oblique, sclerotized bands on basal 7-9 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.3 times as tall as greatest length; posterolateral projection truncate or obliquely truncate in lateral view; Tergite X subtriangular to subrectangular in lateral view with distal margin rounded, emarginate apicomesally. Inferior appendages each clavate with elongate setae distally; harpago intorted, apex with dorsoanterior excision in lateral view; intorsely falcate in ventral view. Phallic apparatus with apicolateral lobes dorsoventrally depressed; extending posterad beyond subapicomesal cavity 1.5 to 2 times length of subapicomesal cavity, lateral margin lobed or entire in ventral view; apicodorsal roof convex or declivous, without carina; ventrodistal opening of subapicomesal cavity obpyriform; subapicomesal cavity orbicular in ventral.

Etymology. Named in honor of Dr. Justin W. Leonard, University of Michigan.

Diagnosis. Similar to *H. hoffmani* and *H. hageni* in having the apicolateral lobes extending posterad beyond subapicomesal cavity 1 to 2 times the length of the subapicomesal cavity. Differs from *H. hoffmani* in having harpagones falcate in ventral view. Differs from *H. hageni* in having the interocular distance greater than the eye width and the subapicomesal cavity opening of the phallic apparatus obpyriform.

Distribution.

MD/VA (Flint and Butler, 1983);

DE (Lake, 1984);

MI (Ross, 1938; Leonard and Leonard, 1949; Schuster and Etnier, 1978; Nugen and Tarter, 1983; Nimmo, 1987);

NY (Bilger, 1986);

ON (Nimmo, 1987);

PA (Masteller and Flint, 1992);

VA (Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981; Nugen and Tarter, 1983; Nimmo, 1987);

WI (Hilsenhoff et al, 1972; Longridge and Hilsenhoff 1973; Schmude and Hilsenhoff, 1986; Hilsenhoff, 1995);

WV (Nugen and Tarter, 1983; Tarter, 1990).

Material Examined. OHIO: [**Lake Co**.], Painesville, July 1941, Neiswonder? 2 males (CAS). ONTARIO: **Hastings Co**., Latta, Moira River, 25 May 1973, Yamamoto and Frania, 1 male metamorphotype (ROM). Latta, Moira River, 25 May 1973, Yamamoto and Frania, 2 males (ROM). Moira River at Hwy 401, 25 May 1976, Yamamoto and Avruch., 1 male (ROM). Moira River at Hwy 401 near Belleville, 05 June 1979, #790008 Schefter and Stewart 1 male metamorphotype (ROM). Nipissing Distr., Samuel de Champlain Prov. Pk., Route 17 w., Mattawa, 27 June 1971, #710488 ROM Field Party 3 males (ROM). PENNSYLVANIA: **Bucks Co**., Delaware River, 09 July 1989, Masteller 1 male [Fig. 4.19] (NMNH). WEST VIRGINIA: **Summers Co**., Bluestone Dam near Hinton, New River, 21 August 1980, Kirchner and Phillips 7 males (NMNH).

Notes. Schmude and Hilsenhoff (1986) reported the larva of *H. leonardi* as sensitive to organic pollution and inhabiting only unpolluted streams in Wisconsin. They considered the species univoltine and reported emergence from 28 May to 17 August.

Female, pupa, and egg unknown.

Hydropsyche mississippiensis Flint

Figure 4.20

Hydropsyche mississippiensis Flint 1972a: 80, fig. 5-6 [male genitalia].

Type locality: Mississippi, Wayne Co., Waynesboro, 02 August 1969, C. Bryson, male holotype 71753 (NMNH).

Hydropsyche mississippiensis Schuster and Etnier 1978: 95, fig. 45 [larva, biological notes].

Description. Male (n=12) Forewing length 7.8-9.3 mm, 8.7 mm; hindwing length 5.7-6.8 mm, 6.2 mm. Interocular distance 0.6-0.75 mm, 0.67 mm; cephalic width 1.5-1.8 mm, 1.6 mm; interocular distance:cephalic width ratio 0.38-0.44, 0.41. Eye width 0.4-0.5 mm, 0.46 mm; occipital setal wart width 0.3-0.33 mm, 0.33 mm; occipital setal wart width:eye width ratio 0.63-0.83, 0.72. Coxopodite 0.47-0.6 mm, 0.52 mm; harpago 0.16-0.19 mm, 0.18 mm; coxopodite:harpago 0.28-0.38, 0.34. Antennal length (n=9) 12.1-14.0 mm, 13.0 mm, each with obliquely sclerotized bands on basal 7-9 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.2 times as tall as greatest length; posterolateral projection truncate, occasionally rounded. Tergum X apicomesally emarginate with V-shaped or U-shaped notch, incised approximately half length of tergum X; in lateral view distal margin of tergum X rounded, margin occasionally declivous. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago saber-shaped in lateral view; apex obliquely truncate in ventral view, with base wider than tip, mesal margin slightly concave. Phallic apparatus with apicodorsal roof convex and carinate; ventrodistal opening of subapicomesal cavity obovate to obpyriform; subapicomesal cavity ovaliform.

Etymology. Named for the state of Mississippi.

Diagnosis. Phallic apparatus similar to *H. scalaris*, *H. rossi*, *H. franclemonti,* and *H. catawba*. Differs from *H. rossi* in having tergum X with distal margin rounded and apicodorsal roof of phallobase convex. Differs from *H. franclemonti* in having the interocular distance greater than eye width, occipital setal warts transverse. Differs from *H. catawba* in having tergum X longer than wide and harpagones with apex obliquely truncate in ventral view. Differs from *H. scalaris* in having the phallic apparatus with the opening of subapicomesal cavity obpyriform, subapicomesal cavity ovaliform, and apicolateral lobes extending posterad of subapicomesal cavity approximately 0.25 times as long as the subapicomesal cavity.

Distribution.

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Harris, O'Neil, and Lago, 1991; Hicks and Haynes, 2000a; Hicks and Haynes, 2000b);

FL (Pescador and Harris, 1995);

LA (Flint, Voshell, and Parker, 1979; Lago, Holzenthal, and Harris, 1982);

MS (Flint, 1972; Schuster and Etnier, 1978; Lago, Holzenthal, and Harris, 1982);

NC (Penrose, Lenat, and Eagleson, 1982);

SC (Flint, Voshell, and Parker, 1979);

TN (Etnier, and Schuster, 1979);

TX (Abbott, Stewart, and Moulton, 1997);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981).

Material Examined. LOUISIANA: Tangipanoa park, Chapepeela creek at Hwy 16, 2.5 miles E Holton, 31 May1979, Holzenthal and Poirrier, 4 males (CUAC). **St. Tammany Par**., St Tammany Park, Tchefuncte River at Hwy 40, 4.4. miles West of Folsom, 04 April 1979, R.W. Holzenthal, 1 male (CUAC). **Washington Par.**, Tchefuncte River at Parish road 19, 1.1 miles West Hwy 450, 8.2 miles NW Folsom, 08 April 1979, Holzenthal and Levy, 5 males (CUAC). MISSISSIPPI: **Amite Co**., W. fork of Amite River at unmarked gravel rd. 14.5 air km SSW Liberty, 23 May 1979, Holzenthal, 1 male (CUAC). **Covington Co**., Ocatoma creek, 0.3 km W of Sanford, 30 Aug. 1979, Holzenthal, 6 males (CUAC). **Lincoln Co**., E fork of Amite River at Hwy 98, near Auburn, 14 June 1979, Holzenthal, 2 males (CUAC). Homochitto River at MS Hwy 550, 6.8 km W Caseyville, 01 Aug. 1979, Holzenthal, 5 males (CUAC). **Perry Co**., Cypress creek at Hwy 29, 1.2 miles E of Janice, 15 Sep. 1979, Holzenthal, 13 males (CUAC). **Pike Co**., Topisaw creek at MS Hwy 44, 0.6km W of Pricedale, 29 Sep. 1979, Holzenthal, 2 males (CUAC). Percy Quin Lake, Percy Quin State Park, 23 Oct. 1979, Holzenthal, 1 male (CUAC). **Stone Co**., Flint creek at MS Hwy 26, 7.9km E of Wiggins, 07 June 1979, Holzenthal, 1 male (CUAC). Red creek at Hwy 26, 8.0km W of Wiggins, 07 June 1979, Holzenthal, 6 males (CUAC). NORTH CAROLINA: **Hoke/Scotland**

Co., Lumber River, US 401 bridge, 1 mile NE of Wagram, 01 May 2003, Kondratieff and Kirchner, 26 males (D. Ruiter pers. coll.). Lumber River, US 401 bridge, 1 mile NE of Wagram, 01 May 2003, Kondratieff and Kirchner, 9 males (CUAC) NORTH CAROLINA: **Hoke/Moore Co**., Little River, Morrison Bridge Road, 1 mile east of Southern Pines, 18 May 2004, D. Lenat, 8 males (D. Ruiter pers. coll.). Little River, Morrison Bridge Road, 1 mile east of Southern Pines, 18 May 2004, D. Lenat, 1 male (CUAC). SOUTH CAROLINA: **Aiken Co**., Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 07 September 1989, Floyd, 1 male (CUAC). **Barnwell Co**., Meyers brook, Savannah River Site, 11 June 1983, Kondratieff, 2 males (CSU).

Female, pupa, and egg unknown.

Hydropsyche NA1

Figure 4.21

Description. Male (n=1). Forewing length 10.0 mm; hind wing length 7.3 mm. Interocular distance 0.75 mm; cephalic width 1.4 mm; interocular distance:cephalic width ratio 0..53. Eye width 0.33 mm; occiputal setal wart width 0.3; occiputal setal wart width:eye width ratio 0.91. Antennal length 10.5 mm, each with obliquely sclerotized bands on basal 7 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.3 times as tall as greatest length; posterolateral projection subtriangular, apex rounded. Tergum X with dorsal posteromesal lobes that project posterodorsad; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, clavate with distal tip rounded in lateral view, tip truncate or rounded in ventral view. Phallic apparatus with ventrodistal opening of subapicomesal cavity and subapicomesal cavity both orbicular in ventral view; apicodorsal roof of phallobase not projecting above plane of proximal phallobase.

Diagnosis. Tergum X with dorsal posteromesal lobes that project posterodorsad. Phallic apparatus with phallobase subapically swollen, apicodorsal roof depressed.

Material Examined. Utah: **Sevier Co.**, Quitchupah Creek, Convulsion Canyon, SW [of] Emory, 14 July 1999, G. Brown, 1 male (USNM).

Notes. Possible new species based on a single exemplar that doesn't match any currently described species in the *Hydropsyche scalaris* Group. The apex of the phallic apparatus has the apicodorsal roof flat and is similar to *H. auricolor*, *H. californica*, and *H. winema* but tergum X has the dorsal posteromesal lobes projecting posterodorsad as in *H. aerata*, *H. alabama*, *H. brunneipennis*, and *H. phalerata*.

Female and immature stages unknown.

Hydropsyche occidentalis Banks

Figure 4.22

Hydropsyche occidentalis Banks 1900a: 258 [no holotype designated].

Hydropsyche novamexicana Banks 1904a: 110, fig. 12 [male genitalia] [synonym according to Ross1938c: 17].

Hydropsyche novamexicana Banks; Milne 1934-36: 73.

Hydropsyche occidentalis Banks; Ross 1938c: 17, fig. 27 [apex of phallus].

Lectotype locality: Roswell, New Mexico, 22 August, Cockerell, No. 11505, male lectotype (MCZ).

Hydropsyche occidentalis Banks; Denning 1956a: 253 [male genitalia].

Hydropsyche occidentalis Banks; Fischer 1963: 58; 1972a: 117 [bibliography].

Hydropsyche occidentalis Banks; Alstad 1980: 167 [larva; biology].

Hydropsyche occidentalis Banks; Hauer and Stanford 1982b: 18 [biology].

Hydropsyche occidentalis Banks; Nimmo 1987: 87, map 40, fig. 241-245, 246-247 [male and female genitalia].

<u>Description</u>. Male (n=12). Forewing length 8.9-11.5 mm, 9.8 mm; hind wing length 6.6-8.3 mm, 7 mm. Interocular distance 0.83-0.98 mm, 0.88 mm; cephalic width 1.5-1.8 mm, 1.6 mm; interocular distance:cephalic width ratio 0.53-0.57, 0.55. Eye width 0.28-0.38 mm, 0.32 mm; occiputal setal wart width 0.33-0.45 mm, 0.37 mm; occiputal setal wart width:eye width ratio 1.0-1.3, 1.2. Antennal length 10.6-13.5 mm, 11.7 mm, each with obliquely sclerotized bands on basal 8-10 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.75 times as tall as greatest length; posterolateral projection rounded. Tergum X with scattered setae; apicomesal emargination shallow; distal margin of tergum X truncate in lateral view. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted; quadrate in lateral view; mesal margin deeply concave and forming subapical scoop. Phallic apparatus with apicodorsal roof declivous; ventrodistal opening of subapicomesal cavity linear; subapicomesal cavity ovaliform in ventral view; apicolateral lobes with lateral margin subapically emarginate in ventral view.

Etymology. Latin "*occidentalis*" ("of the west").

Diagnosis. Tergum X with scattered setae, distal margin truncate. Harpagones quadrate in lateral view, mesal margin concave, forming scoop. Phallic apparatus with apicodorsal roof declivous; ventrodistal opening of subapicomesal cavity linear.

Distribution.

AB (Nimmo, 1987);

AZ (Nimmo, 1987; Moulton, Stewart, and Young, 1994);

BC (Ulmer, 1907; Ross and Spencer, 1952; Nimmo and Scudder, 1978; Nimmo, 1987);

CA (Simmons, 1942; Resh, and Sorg, 1978; Nimmo, 1987; McElravy and Resh, 1987; Erman, 1989);

CO (Dodds and Hisaw, 1925; Mecom, 1970; Canton and Ward, 1981; Herrmann, Ruiter, and Unzicker, 1986; Ward, 1986; Nimmo, 1987);

ID (Nimmo, 1987);

MT (Newell, 1970; Newell and Potter, 1973; Roemhild, 1982; Nimmo, 1987);

NE (Harris, Kondratieff, and Boyle, 2000);

NM (Banks, 1904, Ross, 1941; Nimmo, 1987);

OR (Anderson, 1976; Nimmo, 1987);

SK (Nimmo, 1987);

UT (Knowlton and Harmston, 1939; Baumann and Unzicker, 1981; Nimmo, 1987);

WA (Banks, 1900; Nimmo, 1987);

WY (Gore, 1980; Ruiter and Lavigne, 1985; Nimmo, 1987);

Mexico (Knowlton and Harmston, 1939; Nimmo, 1987).

Material Examined. ARIZONA: **Yavapai Co**., Verde River at Rt. 179 near Camp verde, 05 July 1966, G. G. Wiggins, 23 males (CSU). CALIFORNIA: **Fresno Co**., Dry Creek, 14 May 1982, R. F. Gill, 6 males (CUAC). COLORADO: **Eagle Co**., Deep Creek at Colorado River, 6400 ft., 28 June 2003, C. Slater, 117 males (CSU). Deep Creek bridge, Deep Creek at Colorado River, 6400 ft., 28 June 2003, at light, C. Slater, 55 males (CSU). MONTANA: **Missoula Co.**, 22-VII-1988, blacklight, P. Skelley, 10 males (CUAC).

Pupa, and eggs unknown.

Hydropsyche opthalmica Flint

Figure 4.23

Hydropsyche opthalmica Flint 1965: 169 [male genitalia].

Type locality: West Virginia, along Cacapon River about 2 miles south of Capon Bridge, at black light, 13 May 1963, W.D. Field and O.S. Flint, Jr., male holotype 47411 (NMNH).

Description. Male (n=10). Forewing length 7.5-8 mm, 7.8 mm, hind wing length 5.4-5.7 mm, 5.6 mm. Interocular distance 0.4-0.5 mm, 0.46 mm; cephalic width 1.6-1.8 mm, 1.7 mm; interocular distance:cephalic width ratio 0.24-0.29, 0.27. Eye width 0.56-0.7 mm, 0.65 mm; occipital setal wart width 0.22-0.25 mm, 0.24 mm; occipital setal wart width:eye width ratio 0.34-0.41, 0.36. Antennal length 7.6-8.2 mm, 7.8 mm, each with obliquely sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.2 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subtriangular with dorsal margin declivous; apicomesally emarginate; distal margin of tergum X rounded in lateral view. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted; saber-shaped in lateral view; apex ogival to obliquely truncate in ventral view. Phallic apparatus with ventrodistal opening of subapicomesal cavity and subapicomesal cavity both orbicular; apicodorsal roof of phallobase declivous; apicolateral phallobase lobes turned posterodorsad.

Etymology. "Opthalm" latin for eye.

Diagnosis. Interocular distance less than eye width. Occipital setal warts longer than wide, less than half as wide as eye width. Tergum X subtriangular. Subapicomesal cavity opening obpyriform.

Distribution.

DE (Lake, 1984);

PA (Masteller and Flint, 1992);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981);

WV (Flint, 1965; Tarter, 1990).

Material Examined. VIRGINIA: **Warren Co.**, So. Fk. Shenandoah R., 3.5 air miles S. Front Royal, 38º54.1'N, 78º15.3'W, 02 August 2003, CM and OS Flint Jr., 19 males (NMNH). **Clark Co.**, Shenandoah River, Rt. 621, 16 July 1980, B.C. Kondratieff, 6 males (ROM).

Notes. Lake (1984) reported adult activity May-August at a trap site in New Castle Co., Delaware.

Female and immature stages unknown.

Hydropsyche patera Schuster and Etnier

Figure 4.24

Hydropsyche patera Schuster and Etnier 1978: 218, fig. A-C, E-F [male and female genitalia].

Type locality: Harpeth River, at county road 7338, 1.3 mi. north of its junction with U.S. Hwy. 70, approximately 10 mi east of White Bluff, Tennessee, 02 May 1975, male holotpye (NMNH).

Hydropsyche patera Schuster and Etnier; Schuster and Etnier 1978: 104, fig. 50 [larva, biological notes].

Description. Male (n=4). Forewing length 9.6-10.3 mm, 10.0 mm; hindwing length 6.4-8.1 mm, 7.3 mm. Interocular distance 0.53-0.58 mm, 0.55 mm; cephalic width 1.8-2.0 mm, 1.9 mm; interocular distance:cephalic width ratio 0.28-0.31, 0.27. Eye width 0.61-0.73 mm, 0.66 mm; occiputal setal wart width 0.28-0.31 mm, 0.24 mm; occiputal setal wart width:eye width ratio 0.42-0.48, 0.45. Antennal length 9.3-10.5 mm, 10.0 mm, each with obliquely sclerotized bands on basal 7-9 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.4 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X apicomesally emarginate; dorsal margin slightly declivous in lateral view, distal margin rounded. Inferior appendages each with coxopodite clavate, distally bearing elongate setae; harpago intorted; saber-shaped in lateral view; apex rounded in ventral view. Phallic apparatus with phallobase swollen subapically; ventrodistal opening of subapicomesal cavity oblong, 2 to 3 times as long as wide, occasionally obovate; subapicomesal cavity orbicular; ventral margin of apicolateral lobes tapering caudodorsad.

Etymology. Latin feminine noun "*patera*" ("plate").

Diagnosis. Similar to *H. scalaris*, *H. bassi* and *H. placoda*. Differs from *H. scalaris* in having the interocular distance less than the eye width, occipital setal warts approximately as long as wide, and phallobase subapically swollen. Differs from *H. bassi* and *H. placoda* in having phallobase subapically swollen and harpagones with tip rounded in ventral view.

Distribution.

TN (Schuster and Etnier, 1978; Morse et al, 1997).

Material Examined. TENNESSEE: **Cheatham Co**., Harpeth River 1.3 miles N. Shacklett, 29 May 1990, C. M. and O. S. Flint Jr., 1 male [Fig. 4.24] (NMNH). Harpeth River on Co. Rd. on East side of bridge at U.S. 70, 10 Sept. 1975, Schuster and Etnier 2 male metamorphotypes, paratype (NMNH). **Williamson Co**., Little Harpeth River at Granny White Pike, Nashville, 13 May 1970, #700333 Wiggins and Yamamoto, 1 male (ROM).

Pupa and egg unknown.

Hydropsyche phalerata Hagen

Figure 4.25

Hydropsyche phalerata Hagen 1861: 287 [holotype not designated].

Hydropsyche sp. 3 Betten 1934 [identified by Ross (1944)].

Hydropsyche phalerata Hagen; Milne 1934-36: 73 [as synonym of *H. morosa*].

Hydropsyche phalerata Hagen; Banks 1936b: 126 [lectotype, male genitalia].

Lectotype locality: Washington, Sacken, male lectotyype (MCZ).

Hydropsyche phalerata Hagen; Ross 1938c: 18, fig. 25 [male allotype (MCZ), male genitalia].

Hydropsyche phalerata Hagen; Denning 1943: 113, fig. 4 [female allotype, female genitalia].

Allotype locality: Morrison Co. Minnesota, 16 August 1938, at light, D. G. Denning, specimen code UMSP000005190, female allotype (University of Minnesota).

Hydropsyche phalerata Hagen; Ross 1944:102, fig 371, 347[male and female genitalia, larval head and pronotum].

Hydropsyche phalerata Hagen; Fischer 1963: 77; 1972a: 121 [bibliography].

Hydropsyche phalerata Hagen; Schuster and Etnier 1978: 78, fig. 38 [larva, biological notes].

Hydropsyche phalerata Hagen; Deutsch 1985: 37 [male and female midtibiae and tarsi].

Hydropsyche phalerata Hagen; Schmude and Hilsenhoff 1986: 139, fig. 11 [larva].

Hydropsyche phalerata Hagen; Nimmo 1987: 88, fig. 255-259, 260-261 [male and female genitalia].

<u>Description</u>. Male (n=15). Forewing length 7.2-8.6 mm, 7.8 mm; hindwing length 5.3-6.4 mm, 5.7 mm. Interocular distance 0.55-0.7 mm, 0.64 mm; cephalic width 1.5-1.7 mm, 1.6 mm; interocular distance:cephalic width ratio 0.37-0.44, 0.41. Eye width 0.38-0.48 mm, 0.44 mm; occiputal setal wart width 0.28-0.37 mm, 0.33 mm; occiputal setal

wart width:eye width ratio 0.69-0.9, 0.75. Antennal length 9.5-10.6 mm, 9.8 mm, each with obliquely sclerotized bands on basal 7-8 flagellomeres. Abdominal sternum V gland ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.4 times as tall as greatest length; posterolateral projection obliquely truncate, occasionally rounded. Tergum X with dorsal posteromesal lobes that project postero-dorsad; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, distal tip with dorsoanterior edge shallowly and broadly excised in lateral view; subtriangular with ogival apex in ventral view, mesal margin occasionally concave in ventral view. Phallic apparatus with ventral opening of subapicomesla cavity obpyriform; subapicomesal cavity orbicular in ventral view; apicodorsal roof of phallobase convex; apicolateral lobes of phallobase with ventral margin tapering caudodorsad.

Etymology. Latin "*phalerata*" ("with a disk or boss of metal used as an ornament").

Diagnosis. Similar to other species with tergum X having the dorsal posteromesal lobes projecting posterodorsad. Most similar to *H. alabama* and differs in having the harpagones with the mesal margin concave, occasionally straight in ventral view. Eye width 0.38-0.48 mm, .44 mm; Interocular width:cephalic width 0.37-0.44, .41. Occipital wart:eye width 0.69-0.9, 0.76.

Distribution.

MD/VA (Flint and Butler, 1983);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Harris, 1987; Lago and Harris, 1987; Harris, O'Neil, and Lago, 1991);

DC (Hagen, 1861);

DE (Lake, 1984);

FL (Flint, Voshell, and Parker, 1979; Nimmo, 1987; Pescador and Harris, 1995);

GA (Ross, 1944; Schuster and Etnier, 1978; Nimmo, 1987);

IL (Ross, 1944; Schuster and Etnier, 1978; Nimmo, 1987);

IN (Ross, 1944; Schuster and Etnier, 1978; Waltz and McCafferty, 1983; Nimmo, 1987);

KY (Ross, 1944; Resh, 1975; Schuster and Etnier, 1978; Nimmo, 1987);

KS (Banks, 1894, not this species, Hamilton, Schuster, and DuBois, 1983; Schuster and Etnier, 1978; Nimmo, 1987);

MA (Neves, 1979; Nimmo, 1987);

MD (Flint, Voshell, and Parker, 1979; Nimmo, 1987);

MI (Ross, 1944; Leonard and Leonard, 1949; Schuster and Etnier, 1978; Nimmo, 1987; Davis, Hudson, and Armitage, 1991);

MN (Denning, 1943; Etnier, 1965; Schuster and Etnier, 1978; Nimmo, 1987);

MS (Lago, Holzenthal, and Harris, 1982);

NC (Ross, 1944; Schuster and Etnier, 1978; Nimmo, 1987);

NJ (Smith, 1890; Smith, 1900; Smith, 1910; Schuster and Etnier, 1978; Nimmo, 1987);

NY (Banks, 1892; Schuster and Etnier, 1978; Bilger, 1986; Nimmo, 1987);

OH (Ross, 1944; Schuster and Etnier, 1978; Huryn and Foote, 1983; Usis and MacLean, 1986; Nimmo, 1987);

ON (Nimmo, 1987);PA (Hagen, 1861; Schuster and Etnier, 1978; Deutsch, 1984; Nimmo, 1987;Masteller and Flint, 1992);

PQ (Roy and Harper, 1979; Nimmo, 1987);

TN (Ross, 1944; Schuster and Etnier, 1978; Etnier and Schuster, 1979; Nimmo, 1987);

VA (Ross, 1938; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981; Nimmo, 1987);

WI (Ross, 1944; Longridge and Hilsenhoff, 1973; Hilsenhoff, 1975; Schuster and Etnier, 1978; Schmude and Hilsenhoff, 1986; Nimmo, 1987; Hilsenhoff, 1995);

WV (Nugen and Tarter, 1983; Tarter, 1990).

Material Examined. GEORGIA: **Floyd Co**., 6 miles south of Rome on Route 27, 07 August 1968, Yamamoto and Kohalmi, 2 males (ROM). MARYLAND: **Washington Co**., clear spring, 09 July 1982, R. S. Zack, 1 male (ROM). MISSISSIPPI: **Clarke Co**., Enterprise, Chunky Creek at dirt road 7.1 km northwest of US Hwy 11, 13 October 1979, Holzenthal, 1 male (CUAC). NORTH CAROLINA: **Alleghany Co**., 10 km N. Sparta on US21, New River at New R. Cpgrd., 21 October 1984, ROM Field Party 840231, numerous males and females, 1 pair *in copula* (ROM). ONTARIO: Essex Co., Windsor, 16 August 1952, Wiggins, 3 males (ROM). VIRGINIA: **Giles Co**., New River at Route 460, 24 July 1996, Glyn Lyn, Kondratieff and Kirchner, 1♂ (CSU). **Montgomery Co**., Little River, Route 787, 05 August 1980, 2 males (ROM). **Radford Co**., 15 June 1968, A. B. Gurney, 15 males [Fig. 4.25] (NMNH). [**Rockbridge Co**.], Cave Mountain Lake near Natural Bridge, 08 July 1958, Flint, 3 males (ROM). PENNSYLVANIA: [**Perry Co**.], Amity Hall, 05 June 1957, Flint, 2 males (ROM).

Pupa and egg unknown.

Hydropsyche philo Ross

Figure 4.26

Hydropsyche philo Ross 1941a: 90 [male genitalia, female allotype designated].

Type locality: Hastings Natural History Reservation, Monterey Co., California, 24 May 1938; male holotype (INHS), female allotype (INHS).

Hydropsyche philo Ross; Denning 1956a: 253 [male genitalia].

Hydropsyche philo Ross; Fischer 1963: 78; 1972a: 121 [bibliography].

Description. Male (n=10). Forewing length 9.3-10.5 mm, 9.8 mm; hind wing length 6.9-7.7 mm, 7.2 mm. Interocular distance 0.8-0.93 mm, 0.89 mm; cephalic width 1.5-1.7 mm, 1.6 mm; interocular distance:cephalic width ratio 0.52-0.58, 0.54. Eye width 0.33-0.4 mm, 0.35 mm; occiputal setal wart width 0.35-0.45 mm, 0.42 mm; occiputal setal wart width:eye width ratio 1.1-1.4, 1.2. Antennal length (n=5) 8.7-11.8 mm, 10.3 mm, each with obliquely sclerotized bands on basal 8-9 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.4 times as tall as greatest length; posterolateral projection rounded. Tergum X subrectangular in lateral view with scattered setae dorsally; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, sickle-shaped with distal tip rounded in lateral view; half as long as coxopodite. Phallic apparatus with both ventrodistal opening of subapicomesal cavity u-shaped and subapicomesal cavity u-shaped in ventral view; apicolateral phallobase lobes dorsoventrally depressed.

Etymology. Probably from Latin "philos" ("beloved," "dear").

Diagnosis. Harpagones sickle-shaped in lateral view, approximately half as long as coxopodites. Tergum X with scattered setae dorsally. Phallobase subapically swollen and opening of subapicomesal cavity u-shaped.

Distribution.

CA (Ross, 1941; Ross, 1951; McElravy and Resh, 1987;Jackson and Resh, 1989);

UT (Baumann and Unzicker, 1981);

Mexico (Ross, 1951; Bueno-Soria and Flint, 1978).

Material Examined. CALIFORNIA: **Fresno Co**., Marshall Station, 01 June 1983, 1 male (CUAC). Marshall Station, 23 June 1983, D. J. Burdick, 5 males (CAS); Marshall Sta., 25 August 1983, D. J. Burdick, 1 male (CUAC); Marshall Station, 12 Aug. 1983, 19 males (CAS). [**San Benito Co**.] Pinnacles National Monument, 23 June 1967, E. Evans, 1 male (ROM). **Madera Co**., Cascadel Woods, 31 July-02 August 1983, J. Aotoki, 6 males [Fig. 4.26C.1] (CAS). **Santa Clara Co**., Alum Rock Park, 11 September 1960, S. D. Smith, 1 male [Figs. 4.26C.2] (NMNH). **San Diego Co**., San Luis Rey Creek, 3 mi. w. Henshaw Lake, 25 Aug. 1962, G. E. Ball, 2 males (ROM). **San Diego Co**., 1 mile w. of Lake Henshaw, 28 July 1962, D. R. Smith, 2 males (ROM). **Stanislaus Co**., Adobe Creek, 22 October 1950, J. E. Gillaspy, 1 male metamorphotype (ROM).

Notes. The pupal case of a single male metamorphotype was constructed of a loose assemblage of small pebbles, two abandoned gastropod shells, organic debris, and two empty Trichoptera cases. Several larvae that were collected along with the metamorphotype might be *H. philo*.

Female and immature stages unknown.

Hydropsyche placoda Ross

Figure 4.27

Hydropsyche placoda Ross 1941a: 87, plate IX, fig. 69 [male genitalia].

Type locality: along Namakagon River, Spooner, Wisconsin, 5-6 June 1936, Frison and Ross, male holotype (INHS), female allotype (INHS).

Hydropsyche placoda Ross; Denning 1943: 115, plate XVIII, fig. 5 [female genitalia].

Hydropsyche placoda Ross; Ross 1944: 103 [male and female genitalia].

Hydropsyche placoda Ross; Fischer 1963: 78; 1972a:122 [bibliography]

Hydropsyche placoda Ross; Hilsenhoff 1982: 15 [larva?].

Hydropsyche placoda Ross; Schmude and Hilsenhoff 1986: 136, figs. 12, 13 [larval head, A9 sternum, anal legs].

Hydropsyche placoda Ross; Nimmo 1987:88 map 43, figs. 262-268 [male and female genitalia].

Description. Male (n=5). Forewing length 7.8-8.9 mm, 8.5 mm, hindwing length 5.7-6.5 mm, 6.2 mm. Interocular distance 0.48-0.53 mm, 0.5 mm; cephalic width 1.7-1.9 mm, 1.8 mm; interocular distance:cephalic width ratio 0.26-0.29, 0.28. Eye width 0.63-0.68 mm, 0.65 mm; occiputal setal wart width 0.25-0.31 mm, 0.28 mm; occipital setal wart width:eye width ratio 0.38-0.49, 0.43. Antennal length (n=3) 7.3-8.5 mm, 8.1 mm, each with obliquely sclerotized bands on basal 8 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.3 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subrectangular with dorsal margin slightly declivous in lateral view; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view; subtriangular in ventral view. Phallic apparatus with ventrodistal opening of subapicomesal cavity oblong, 2 to 3 times as long as wide; subapicomesal cavity ovaliform in ventral view, occasionally orbicular; apicolateral lobes of phallobase with ventral margin tapering caudodorsad.

Etymology. Greek "*placoda*" ("flat").

Diagnosis. Interocular distance less than eye width, occipital setal warts approximately as long as wide. Harpgones subtriangular in ventral view. Phallic apparatus with supapicomesal cavity opening oblong, 2 to 3 times as long as wide.

Distribution.

AB (Nimmo, 1987);

IL (Ross, 1941; Nimmo, 1987);

IN (Waltz and McCafferty, 1983);

MB (Nimmo, 1987);

MN (Ross, 1941; Etnier, 1965; Nimmo, 1987);

MT (Ross, 1944; Roemhild, 1982; Nimmo, 1987);

NY (Ross, 1941; Nimmo, 1987);

OH (Garono and MacLean, 1988);

ON (Ross, 1941; Munroe, 1951; Nimmo, 1987);

PA (Masteller and Flint, 1992);

PQ (Nimmo, 1966; Corbet, Schmid, and Augustin, 1966; Roy and Harper, 1975; Roy and Harper, 1979; Nimmo, 1987);

SD (Ross, 1941; Nimmo, 1987);

SK (Nimmo, 1987);

TN (Edwards, 1966, uncertain record according to Etnier and Schuster, 1979);

WI (Ross 1938a, misidentified as *H. valanis* according to Schmude and Hilsenhoff, 1986; Ross, 1941; Hilsenhoff et al, 1972; Longridge and Hilsenhoff, 1973; Schmude and Hilsenhoff, 1986; Nimmo, 1987; Hilsenhoff, 1995).

Material Examined. ALBERTA: Pembina River, Prov. Pk. nr. Edson, UVL, 19 July 1961, 1 male [Fig. 4.27] (ROM). MANITOBA: The Pas, 09 July 1953, Walter Krivda, 1 male (ROM). NEW YORK: **Erie Co**., Grand Island, 31 July, 1957, L. L. Pechuman, 2 males [Fig. 4.27] (ROM). WISCONSIN: **Marathon Co**., Wisconsin River at Hwy 51 bridge, 22 May 1985, K.L. Schmude, 1 male metamorphotype (ROM). Wisconsin River at Hwy 51 bridge, 29 June 1985, K.L. Schmude, 1 male (ROM).

Pupa and egg unknown.

Hydropsyche scalaris Hagen

Figure 4.29

Hydropsyche scalaris Hagen 1861: 286 [holotype not designated].

Hydropsyche scalaris Hagen; Banks 1936b: 127 [lectotype].

Lectotype locality: St. Lorenz, Canada, Sacken, male lectotype (MCZ).

Hydropsyche scalaris Hagen; Denning 1943: 112, fig. 3 [pupa].

Hydropsyche scalaris Hagen; Fischer 1963: 83; 1972a: 123 [bibliography].

Hydropsyche scalaris Hagen; Schuster and Etnier 1978: 87, fig. 43 [larva, biological notes].

Hydropsyche scalaris Hagen; Schuster 1984: 343, fig. 16 [larva].

Hydropsyche scalaris Hagen; Schmude and Hilsenhoff 1986: 141, fig. 14 [larval habitat and biology].

Hydropsyche scalaris Hagen; Nimmo 1987: 89, map 45, fig. 276-282 [male and female genitalia].

<u>Description</u>. Male (n=46). Forewing length 8.5.-11.6 mm, 10.3 mm; hindwing length 6.0-8.3 mm, 7.2 mm. Interocular distance 0.7-0.95 mm, 0.81 mm; cephalic width 1.7-2.1 mm, 1.9 mm; interocular distance:cephalic width ratio 0.39-0.46., 0.41. Eye width 0.45-0.6 mm, 0.54 mm; occiputal setal wart width 0.35-0.5 mm, 0.42 mm; occiputal setal wart width:eye width ratio 0.66-0.9 mm, 0.77 mm. Antennal length (n=20) 12.0-15.5 mm, 13.8 mm, each with obliquely sclerotized bands on basal 8-10 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.0 times as tall as greatest length; posterolateral projection obliquely truncate, occasionally rounded. Tergum X subrectangular in lateral view with row of setae dorsally; distal margin rounded, apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view; subrectangular in ventral view with tip obliquely truncate. Phallic apparatus with ventrodistal opening of subapicomesal cavity oblong, 2 to 4 times as long as wide; subapicomesal cavity orbicular in ventral view, occasionally ovaliform; apicodorsal phallobase roof convex, usually projecting above plane of proximal phallobase; apicolateral lobes of phallobase variable in ventral view, lateral margin entire, sinuate, or lobed; ventral margin tapering caudodorsad.

Etymology. Latin "*scalaris*" ("of a ladder").

Diagnosis. Interocular distance greater than eye width, occipital setal warts transverse. Harpagones subrectangular with apex obliquely truncate in ventral view. Phallic apparatus with apicodorsal roof convex, subapicomesal cavity opening oblong, 2 to 4 times as long as wide.

Distribution.

MD/VA (Flint and Butler, 1983);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Harris, Lago, and O'Neil, 1984; Lago and Harris, 1987; Harris, 1990; Harris, O'Neil, and Lago, 1991; Moulton and Stewart, 1996);

AR (Unzicker, Aggus, and Warren, 1970; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Bowles and Mathis, 1989; Moulton and Stewart, 1996);

CO (Dodds and Hisaw, 1925, record suspect; Nimmo, 1987);

CT (Britton, 1938; Nelson and Downs, 1995);

DC (Hagen, 1861; Moulton and Stewart, 1996);

DE (Lake, 1984; Moulton and Stewart, 1996);

FL (Betten, 1934, record suspect;

GA (Ross, 1944; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979;

Hamilton and Schuster, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

IL (Nimmo, 1987; Moulton and Stewart, 1996);

IN (Ross, 1944; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Waltz and McCafferty, 1983; Nimmo, 1987; Moulton and Stewart, 1996);

KS (Banks, 1892, record suspect; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

MB (Neave, 1934, record suspect; Flannagan, 1978, record suspect; Flannagan and Flannagan, 1982, record suspect; Nimmo, 1987; Moulton and Stewart, 1996);

MD (Banks, 1904, record suspect; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

ME (Blickle and Morse, 1966; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

MN (Denning, 1943, record suspect; Etnier, 1965; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

MO (Ross, 1944; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Mathis and Bowles, 1992; Moulton and Stewart, 1996);

NC (Banks, 1908, record suspect; Nimmo, 1987; Moulton and Stewart, 1996); NE (Harris, Kondratieff, and Boyle, 2000);

NJ (Smith, 1890; Smith, 1900, Smith, 1910, records suspect; Nimmo, 1987; Moulton and Stewart, 1996);

NM (Banks, 1904, record suspect; Nimmo, 1987);

NY (Betten, 1901, Betten, 1926, records suspect; Bilger, 1986, record suspect; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

OH (Masteller and Flint, 1979; Huryn and Foote, 1983; Nimmo, 1987; Garono and MacLean, 1988; Moulton and Stewart, 1996);

OK (Ross, 1944; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Bowles and Mathis, 1992; Moulton and Stewart, 1996);

ON (Ross, 1944; Schuster and Etnier, 1978; Mackay, 1979; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987);

PA (Masteller and Flint, 1979; Nimmo, 1987; Masteller and Flint, 1992; Moulton and Stewart, 1996);

PQ (Robert, 1958; Nimmo, 1966; Corbet, 1966; Corbet, Schmid, and Augustin, 1966; Schuster and Etnier, 1978; Roy and Harper, 1979; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

TN (Edwards, 1956; Edwards, 1966, records suspect; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

TX (Edwards, 1973; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

VA (Banks, 1904, record suspect; Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981; Nimmo, 1987; Moulton and Stewart, 1996);

VT (Wimmer, 1979);

WI (Ross, 1944; Hilsenhoff et al, 1972; Longridge and Hilsenhoff, 1973; Hilsenhoff, 1975; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Hamilton and Schuster, 1979; Schmude and Hilsenhoff, 1986; Nimmo, 1987; Lillie and Hilsenhoff, 1992; Hilsenhoff, 1995; Moulton and Stewart, 1996);

WV (Tarter and Hill, 1979; Nugen and Tarter, 1983; Tarter, 1990; Moulton and Stewart, 1996);

WY (Muttkowski, 1929, record suspect; Moulton and Stewart, 1996).

Material Examined.

Form 1. MISSOURI: **Franklin Co**., Meramac State Park, 01 June 1990, B. Kondratieff, 1 male [Fig. 4.29, C.1] (CSU). VIRGINIA: **Russell Co**., Clinch River, County Road 641, 1 mile north of VA 80, 21 May 1993, Kondratieff and Kirchner, 1 male (CSU). ONTARIO: **Hastings Co**., Moira River at Hwy. 401, May 1979, P. W. Schefter, 2 male metamorphotypes (fig 4.29C.1).

Form 2. St Lorenz, Canada, Sacken, 1 male [lectotype, Fig. 4.29 A-B, C.2, D-E] (MCZ). ONTARIO: **Halton Co**., Norval, Credit River, 14 July 1952, G. B. Wiggins, 14 males (ROM). **Hastings Co**., Moira River at Hwy. 401 nr. Belleville, 05 June 1979, #790008, P. W. Schefter and W. Stewart, 1 male metamorphotype (ROM). **Peel Co**., Churchville, Credit River, 14 July 1952, G. B. Wiggins, 2 males (ROM). MISSOURI: **McDonald Co**., 23 July 1988, M. Mathis, 1 male (CUAC). VIRGINIA: **Montgomery Co**., Radford Arsenal, 23-29 Aug. 1955, at light, R. L. Hoffman, INHS Trichop. #34226, 1 male (INHS). WISCONSIN: [**Lincoln Co**.], Merril, 24 July 1937, at light, Frison and Ross, INHS Trichop #34238, 1 male [Fig. 4.29C.2] (INHS). GEORGIA: **Habersham Co**., Clarkesville, Soque River, 7-1-39, P. W. Fattig, INHS Trichop. #34236, 1 male (INHS).

Form 3. GEORGIA: [**Habersham Co**.], Clarkesville, Soque River, 7-1-39, P. W. Fattig, INHS Trichop. #34236, 1 male (INHS). MISSOURI: [**Phelps Co**.], Stony Dell, 27 Sept. 1938, Frison and Yeager, INHS Trichop. #34240, 1 male (INHS). SOUTH CAROLINA: **Aiken Co**., Savannah River Plant, Upper Three Runs Creek @ SRP 8-1, 03 May 1977, 1 male (CUAC). ONTARIO: **Halton Co**., Norval, Credit River, 14 July 1952, G. B. Wiggins, 1 male [Fig. 4.29, C.3] (ROM). **Hastings Co**., Moira R. at Hwy. 401, 05 June 1979, #790008, P. Schefter and W. Stewart, 1 male metamorphotype (ROM). **Peel Co**., Churchville, Credit River, 14 July 1952, G. B. Wiggins, 3 males (ROM). WISCONSIN: [**Lincoln Co**.], Wisconsin River, 01-02 July 1933, Frison and Mohr, INHS Trichop. #34234, 1 male (INHS). [**Lincoln Co**.], Merril, 24 July 1937, at light, Frison and Ross, INHS Trichop #34238, 1 males (INHS). VIRGINIA: **Montgomery Co**., Radford Arsenal, 23-29 Aug. 1955, at light, R. L. Hoffman, INHS Trichop. #34226, 1 male (INHS).

Form 4. ARKANSAS: **Montgomery Co**., L. Missouri River, Albert Pike, LM-3S, 28 August 1980, 1 male (CUAC). MISSOURI: **Crawford Co**., Huzzah creek, Hwy. K, 21 August 2000, B. Zuellig, 1 male (CSU). VIRGINIA: **Montgomery Co**., Radford Arsenal, late June 1957, at light, R. L. Hoffman, INHS Trichop.

#34237, 1male (INHS). WISCONSIN: [**Lincoln Co**.], Merril, 24 July 1937, at light, Frison and Ross, INHS Trichop #34238, 3 males [Fig. 4.29, C.4] (INHS).

Form 5. ARKANSAS: **Montgomery Co**., L. Missouri River, Albert Pike, LM-3S, 28 August 1980, 1 male [Fig. 4.29, C.5] (CUAC). WISCONSIN: [**Lincoln Co**.], Merril, 24 July 1937, at light, Frison and Ross, INHS Trichop #34238, 1 male (INHS).

Form 6. MISSOURI: **McDonald Co**., 23 July 1988, M. Mathis, 1 male [Fig. 4.29, C.6] (CUAC). ARKANSAS: **Marion Co**., 2 miles NW Yellville, 06 June 1967, H. B. Leech, 1 male (CAS).

Notes. Forms 2-5 were represented in material identified by H. H. Ross. The lectotype designated by Banks (1936) appears to be of form 2. Form 2 was the most commonly encountered form in this study: form 1 (n=4), form 2 (n=23), form 3 (n=11), form 4 (n=6), form 5 (n=2), and form 6 (n=2). Some variation existed in the size of the harpagones in relation to the coxopodites, the harpagones of form 6 appeared longer than in other specimens.

Egg unknown.

Hydropsyche simulans Ross

Figure 4.28; 4.30

Hydropsyche simulans Ross 1938a: 139, fig. 64-65 [adult, male genitalia].

Type locality: Mount Carmel, Illinois, 11 September 1937, along Wabash River, H. H. Ross, male holotype (INHS), female allotype (INHS).

Hydropsyche simulans Ross; Denning 1943: 117, fig. 7 [female genitalia].

Hydropsyche simulans Ross; Ross 1944: 104, figs. 393, 377, 386, 352 [adult, male and female genitalia, larval head and pronotum].

Hydropsyche incommoda sensu Ross 1944: 106, fig. 381 [male and female genitalia, misidentified according to Flint et al., 1979].

Hydropsyche simulans Ross; Fischer 1963: 86; 1972a: 124 [bibliography].

Hydropsyche simulans Ross; Rhame and Stewart 1976: 65 [net, biology].

Hydropsyche simulans Ross; Ross and Unzicker 1977: 310, fig. 9 [male genitalia].

Hydropsyche simulans Ross; Schuster and Etnier 1978: 90, fig. 2-6, 9-10, 44 [larva, biological notes].

Hydropysche incommoda sensu Schuster and Etnier 1978: 92 [larva, misidentified according to Schmude and Hilsenhoff 1986].

Hydropsyche rossi Flint, Voshell and Parker 1979: 854, fig. 14-18 [male genitalia] **NEW SYNONYMY**

Hydropsyche rossi Flint, Voshell and Parker; Cudney and Wallace 1980: 169 [biology].

Hydropsyche simulans Ross; Schuster 1984: 341, figs. 12, 3, 9 [forewing margin, male genitalia].

Hydrospche simulans Ross; Schmude and Hilsenhoff 1986: 141, fig. 11 [larval habitat].

Hydropsyche simulans Ross; Nimmo 1987: 90, map 46, figs. 283-289 [male and female genitalia].

Hydropsyche rossi Flint, Voshell and Parker; Nimmo 1987: 89, map 44, figs. 269-275 [male and female genitalia].

Hydropsyche fenestra Lago and Harris 2006: 560, fig. 1 [male genitalia] **NEW SYNONYMY**

Description. Male (n=24). Forewing length 9.0.-11.7 mm, 10.6 mm; hindwing length 6.3-8.0 mm, 7.4 mm. Interocular distance 0.73-0.83 mm, 0.77 mm; cephalic width 1.7-2.0 mm, 1.9 mm; interocular distance:cephalic width ratio 0.38-0.43., 0.41. Eye width 0.45-0.59 mm, 0.52 mm; occipital setal wart width 0.33-0.43 mm, 0.37 mm; occipital setal wart width:eye width ratio 0.64-0.8, 0.72. Coxopodite 0.56-0.7 mm, 0.64 mm; harpago 0.23-0.29 mm, 0.26 mm; coxopodite:harpago ratio 0.35-0.45, 0.4. Antennal length (n=15) 15.2-18.4 mm, 16.6 mm, each with obliquely sclerotized bands on basal 8-11 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.0 to 2.4 times as tall as greatest length; posterolateral projection obliquely truncate or rounded. Tergum X subrectangular in lateral view with row of setae dorsally, distal margin obliquely truncate or truncate; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view; variable in ventral view with tip obliquely truncate to ogival. Phallic apparatus with ventrodistal opening of subapicomesal cavity oblong, 2 to 4 times as long as wide, rarely lanceolate (Fig. 4.30, C.1), obovate or obpyriform (Figs. 4.28, A.2, B.1-B.2); subapicomesal cavity orbicular to ovaliform in ventral view; apicodorsal phallobase roof carinate, convex and projecting above plane of proximal phallobase, weakly convex and not projecting above plane of proximal phallobase, or flat; apicolateral lobes of phallobase variable in ventral view, lateral margin entire or lobed; ventral margin tapering caudodorsad in lateral view.

Etymology. Latin "*simulans*" ("imitating," "copying").

Diagnosis. Interocular distance greater than eye width, occipital setal warts transverse. Tergum X subrectangular with distal margin truncate or obliquely truncate. Phallic apparatus with carina on apicodorsal roof. Harpago 0.23-0.29 mm, 0.26 mm.

Distribution.

AL (Harris et al, 1983; Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Harris, 1990; Harris, O'Neil, and Lago, 1991; Moulton and Stewart, 1996; Hicks and Haynes, 2000a; Hicks and Haynes 2000b);

AR (Unzicker, Aggus and Warren, 1970; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Bowles and Mathis, 1989; Moulton and Stewart, 1996);

CO (Herrmann, Ruiter, and Unzicker, 1986; Moulton and Stewart, 1996);

FL (Ross, 1944; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Pescador and Harris, 1995; Mattson, Epler, and Hein, 1995; Moulton and Stewart 1996);

IA (Ross, 1938; Schuster and Etnier, 1978; Moulton and Stewart, 1996);

IL (Ross, 1938; Ross, 1944; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

IN (Ross, 1938; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Waltz and McCafferty, 1983; Nimmo, 1987; Moulton and Stewart, 1996);

KS (Ross, 1944; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

KY (Ross, 1944; Resh, 1975; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

LA (Banks, 1907, uncertain record; Flint, Voshell, and Parker, 1979; Lago, Holzenthal, and Harris, 1982; Moulton and Stewart, 1996);

MA (Bilger, 1986, probably erroneous, Flint, pers comm; Moulton and Stewart, 1996);

MB (Harris and Lawrence, 1978; Moulton and Stewart, 1996);

MI (Harris, O'Neil, and Lago, 1991; Moulton and Stewart, 1996);

MN (Denning, 1943; Etnier, 1965; Schuster and Etnier, 1978; Lager, Johnson, Williams, and McCullough, 1979; Hamilton Schuster, 1979; Moulton and Stewart, 1996);

MO (Ross, 1944; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Flint, Voshell, and Parker, 1979; Mathis and Bowles, 1992; Moulton and Stewart, 1996);

MS (Flint, Voshell, and Parker, 1979; Lago, Holzenthal, and Harris, 1982; Nimmo, 1987; Moulton and Stewart, 1996);

MT (Roemhild, 1982; Nimmo, 1987; Moulton and Stewart, 1996);

NC (Ross, 1944; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 1996);

ND (Harris and Carlson, 1978; Nimmo, 1987; Moulton and Stewart, 1996);

NE (Nimmo, 1987; Moulton and Stewart, 1996; Harris, Kondratieff, and Boyle, 2000);

NY (Betten 1936, unlikely record; Moulton and Stewart, 1996);

OH (Denning, 1943; Schuster and Etnier, 1978; Hamilton and Schuster, 1979;

Huryn and Foote, 1983; Usis and MacLean, 1986; Nimmo, 1987; Garono and MacLean, 1988; Moulton and Stewart, 1996);

OK (Denning, 1943; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Nimmo, 1987; Bowles and Mathis, 1992; Moulton and Stewart, 1996);

ON (Nimmo, 1987; Moulton and Stewart, 1996);

SC (Flint, Voshell, and Parker, 1979; Cudney and Wallace, 1980; Nimmo, 1987; Moulton and Stewartm, 1996);

TN (Ross, 1944; Edwards, 1955; Edwards, 1956; Edwards, 1966; Schuster and Etnier, 1978; Etnier and Schuster, 1979; Hamilton and Schuster, 1979; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton and Stewart, 996; Abbot, Stewart, and Moulton, 1997);

TX (Cloud and Stewart, 1974; Rhame and Stewart, 1976; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Flint, Voshell, and Parker, 1979; Nimmo, 1987; Moulton, Beitinger, Stewart, and Currie, 1993; Moulton and Stewart, 1996);

VA (Flint, Voshell, and Parker, 1979; Parker and Voshell, 1981; Nimmo, 1987; Hoffman and Parker, 1997; Moulton and Stewart, 1996);

WI (Ross, 1938; Longridge and Hilsenhoff, 1973; Hilsenhoff, 1975;Shapas and Hilsenhoff, 1976; Schuster and Etnier, 1978; Hamilton and Schuster, 1979; Schmude and Hilsenhoff, 1986; Narf, 1985; Lillie and Hilsenhoff, 1992; Hilsenhoff, 1995; Moulton and Stewart, 1996);

WV (Nugen and Tarter, 1983; Tarter, 1990; Moulton and Stewart, 1996);

WY (Ross, 1963; Ruiter and Lavigne, 1985; Moulton and Stewart, 1996).

Material Examined. ARKANSAS: Hot Springs, 19 June 1943, T. H. Frison, 1 male #33074 (INHS); **Arkansas Co**., India Bayou at AR Hwy 1, White River National Wildlife Refuge, 04 September 1990, Chordas, 10 males (CUAC). Randolph Co., Black River at Old Davidsonville State Park, 10.3 miles South of Pocahontus, 08 April 1978, #780048, Yamamoto and Stewart, 1 male (ROM); **Pike Co.**, Arlie Moore Rec. Area, DeGray Lake, 30 May 1978, M. Kopek, 3 males (CUAC). COLORADO: **Weld Co.**, Wiggins, 03 August 1986, D. Thompson, 1 male (CSU). FLORIDA: **Marion Co**., Ocklawaha River, Route 40, 19 August 1988, Kondratieff and Welch, 2 males (CSU). ILLINOIS: Freeport, 28 June 1935, 1 male, paratype #23824 (INHS); Golconda, 13 May 1943, Frison and Sanderson, 1 male #33075 (INHS); Grafton, 18 September 1937, 12 males, #33051 (INHS); Grafton, 05 JULY 1985, 2 males #33052 (INHS); Havana, Quiver Cr., 15 April 1935, 2 males, paratype #23817 and #23821 (INHS); Havana, Quiver Cr., 25 April 1935, Ross and Mohr, 2 males, paratype #23818 and #23820 (INHS); Mommence, Kankakee R., 05 May 1938, Ross and Burks, 1 male #33058 (INHS); Mommence, 16 August 1938, Ross and Burks, 2 males #33063 (INHS); Mt. Carmel, 25 June 1936, 10 males, paratypes #23822, #23823, and #23825 (INHS); Rock Island, 07 June 1939, Burks and Riegel, 2 males #32638 (INHS); Rockton, 02 July 1931, Frison, Betten and Ross, 1 male, paratype #23819 (INHS); Shawneetown, 28 May 1935, Ross and Mohr, 2 males, paratypes #23826 (INHS); **Champaign Co**., 3.5 miles NE of Mahomet in mixed forest, 40°15’N 88°29’W, 31 May 1985, #850100b ROM field party, 3 males (ROM). KANSAS: Clay Center, Republican R., 14 August 1943, 1 male #33073 (INHS). LOUISIANA: **West Feliciana Parish**., Little Bayou Sara at LA Hwy 66, 3.1mi. NNW of Weyanoke, 20 October 1979, Holzenthal 1 males (CUAC). **St.**

Tammany Parish, Talisheek creek at LA Hwy 435 spur in Talisheek, 17 October 1979, Holzenthal, 6 males (CUAC). Talisheek creek at LA Hwy 41, RWH 172, 01 October 1979, Holzenthal 1 male (CUAC). MISSISSIPPI: **Amite Co**., East fork of Amite river at unmarked gravel road, 14.6 km South of Liberty, 23 June 1979, Holzenthal, 32 males (CUAC). **Clairborne Co**., Bayou Pierre at Carlisle, 09 July 1979, Holzenthal 1 male (CUAC). **Pearl River Co**., Chinquapin creek at MS Hwy 43, 1.0 km South of Crossroads, 03 July 1979, Holzenthal 8 males (CUAC). **Simpson Co**., Strong River at MS Hwy 28, 3.7km West of Pinola, 20 June 1979, Holzenthal 5 males (CUAC). MISSOURI: **Pulaski Co.**, Gasconade River, T-Hwy, 28 July 1985, Mathis, 1 male, (CUAC); Gasconade River, 26 June 1987, M. Mathis, 3 males (CUAC). MONTANNA: Glasgow, Milk R., 13 July 1940, 2 males #33077 (INHS). NORTH CAROLINA: **Hoke/Scotland Co**., Lumber river, US 401 bridge, 1 mile NE of Wagram, 01 May 2003, Kondratieff and Kirchner, 2 males (D. Ruiter pers. coll.). **Robeson Co**., Lumber river, Chicken road bridge, 2 miles SE of Pembroke, 02 May 2003, Kondratieff and Kirchner, 1 male (D. Ruiter pers. coll.). NEBRASKA: **Brown Co.**, Calamus river, Hwy 7, 13 June 2000, Kondratieff and Zuellig, 2 males [Fig. 4.30, A-B, C.2, D.1, E] (D. Ruiter pers. coll.); **Dawson Co.**, roadside park on Rt. 80, nr. Cozad, 09 September 1966, 12 males (ROM); **Knox Co.**, Missouri River, Niobrara, N Hwy 12, 25 July 2001, 13 males (CSU). OKLAHOMA: Turner Falls S.P., Honey cr., 02 June 1937, Ross, 3 males, #32633 (INHS); **Comanche Co.**, Fort Sill, East Range, Natural Resources Bldg., 31 March 2003, 2 males (CSU). SOUTH CAROLINA: **Aiken Co**., Savannah River Plant, Upper Three Runs Creek at SRP Road 8-1, 12-13 April 1979, McEwan and Powell, 1 male (CUAC). Savannah River Plant, Upper Three Runs Creek at SRP Road 8-1, 28 May 1984, Morse, 1 male (CUAC). Savannah River Plant, Upper Three Runs Creek at SRP Road 8-1, 28 May1984, Kelley and McEwan, 1 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 26 June 1990, Floyd, 34 males (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 10 August 1990, Floyd, 1male (CUAC). Upper Three Runs Creek, at Road C br. crossing, Savannah River site, 08 May 1990, Floyd, 1 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 18 April 1990, Floyd, 1 male (CUAC). Upper Three Runs Creek, at Road C br. crossing, Savannah River site, 18 April 1990, Floyd, 1 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 12 July 1990, Floyd, 2 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 06 June 1990, Floyd, 25 males (CUAC). Upper Three Runs Creek, at Road C br. crossing, Savannah River site, 06 June 1990, Floyd, 5 males (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 27 July 1990, Floyd, 18 males (CUAC). Upper Three Runs Creek, at Road C br. crossing, Savannah River site, 26 June 1990, Floyd, 16 males (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 08 May 1990, Floyd, 1 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River Site, 07 September 1989, Floyd, 8 males (CUAC). Upper Three Runs Creek, at Road C br. crossing, Savannah River site, 27 July 1990, Floyd, 1 male (CUAC). Savannah River Plant, Upper Three Runs Creek at SRP Road 8-1, 23-24 July 1979, McEwan and Powell, 1 male (CUAC). Upper Three Runs Creek, approximately 2km downstream of SC 125, Savannah River

Site, 26 June 1990, Floyd, 32 males (CUAC). Upper Three Runs Creek, SREL, 30 June 1975, Stirewalt, 7 males (ROM). TEXAS: **Bandera Co.**, Medina River, 4 mi. N [of] Medina on Hwy. 16, 30 June 1988, 1 male, ROM 881210 (ROM).

Notes. Abdominal segment IX and tergum X are identical in *Hydropsyche rossi* and *H. simulans* slight differences of the harpagones in ventral view are subtle and variable. Apparent differences that have been used for diagnosing these two species are restricted to the phallobase apex, a character not without problems. The apicodorsal roof of *H. simulans* and *H. rossi* both contain a tubular extension of the proximal phallobase (i.e., carina). The apicodorsal roof varies from strongly convex to flat and the ventral opening of the subapicomeal cavity is variable with no consistent morphological patterns useful for species delineations. Figure 4.28 is the most commonly encountered form in the Southeastern United States. PCA analysis of *H. rossi* and *H. simulans* showed no distinction between the two species (Fig. 4.38). *Hydropsyche fenestra* Lago and Harris is identical to *H. simulans*. Because the apex of the phallic apparatus is variable and no other features supported treatment of H. rossi and H. fenestra as distinct species they are treated as junior subjective synonyms of *H. simulans*. To avoid unnecessary taxonomic inflation, caution should be used in describing new species based soley on variation in the apex of the phallic apparatus.

Pupa and egg unknown.

Hydropsyche valanis Ross

Figure 4.31

Hydropsyche valanis Ross 1938a: 144, fig. 70 [male genitalia].

Type locality: Rockton, Illinois, 02 July 1931, along Rock River, male holotype (INHS).

Hydropsyche valanis Ross; Ross 1944: 105, fig. 378 [male and female genitalia].

Allotype locality: Noblesville, Indiana, 10 August 1938, Ross and Burks, female allotype (INHS).

Hydropsyche valanis Ross; Fischer 1963: 89 [bibliography].

Hydropsyche valanis Ross; Schuster and Etnier 1978: 85, fig. 41 [larva, biological notes].

Hydropsyche valanis Ross; Nimmo 1987: 90, map 47, fig. 290-296 [male and female genitalia].

Description. Male (n=11). Forewing length 7.4.-8.7 mm, 8.1 mm, hind wing length 5.0-6.4 mm, 5.8 mm. Interocular distance 0.48-0.5 mm, 0.49 mm; cephalic width 1.6-1.8 mm, 1.7 mm; interocular distance:cephalic width ratio 0.27-0.3., 0.28. Eye width 0.58-0.68 mm, 0.64 mm; occipital setal wart width 0.2-0.25 mm, 0.24 mm; occipital setal wart width:eye width ratio 0.32-0.4, 0.37. Antennal length (n=10) 7.0-8.1 mm, 7.8 mm, each with obliquely sclerotized bands on basal 7-9 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.3 times as tall as greatest length; posterolateral projection obliquely truncate or rounded. Tergum X subrectangular in lateral view with row of setae dorsally; distal margin rounded, apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view; in ventral view with tip rounded. Phallic apparatus with ventrodistal opening of subapicomesal cavity U-shaped, 2 times as long as wide; subapicomesal cavity rounded basally in ventral view;

apicodorsal phallobase roof convex or declivous, not projecting above plane of proximal phallobase; apicolateral lobes of phallobase dorsoventrally depressed; cleft phallobase in ventral view forming apicolateral lobes with lateral margin entire (Fig. 4.31, E.1) or subquadrate with sinuate lateral margins (Fig. 4.31, E.2); ventral margin tapering caudodorsad in lateral view.

Etymology. Probably from Latin "*valens*" ("strong") and suffix "*-anus*" ("having"), as in "having strength."

Diagnosis. Interocular distance less than eye width, occipital setal warts approximately as long as wide. Phallic apparatus with subapicomesal cavity opening U-shaped, 2 times as long as wide, apicodorsal roof with diamond-shaped notch.

Distribution.

IA (Ross, 1938; Schuster and Etnier, 1978; Nimmo, 1987);

IL (Ross, 1938; Harris, 1971; Schuster and Etnier, 1978; Nimmo, 1987);

IN (Ross, 1938; Schuster and Etnier, 1978; Waltz and McCafferty, 1983; Nimmo, 1987);

KS (Hamilton, Schuster, and DuBois, 1983);

KY (Resh, 1975; Schuster and Etnier, 1978; Nimmo, 1987);

MI (Davis, Hudson, and Armitage, 1991);

MN (Ross, 1944; Etnier, 1965; Schuster and Etnier, 1978; Nimmo, 1987);

NY (Bilger, 1986, record suspect, Flint, pers comm);

OH (Schuster and Etnier, 1978; Huryn and Foote, 1983; MacLean and MacLean, 1984; Usis and MacLean, 1986; Nimmo, 1987; Garono and MacLean, 1988);

PA (Masteller and Flint, 1992);

VT (Bilger, 1986, record suspect, Flint, pers comm);

WI (Ross 1938a incorrectly identified 1 male *H. valanis* and subsequently Schuster and Etnier, 1978, and Nimmo, 1987, reported this species from Wisconsin; According to Schmude and Hilsenhoff, 1986, *H. valanis* is likely to occur in Wisconsin but the male specimen identified by Ross 1938a is actually *H. placoda*).

Material Examined. GEORGIA/SOUTH CAROLINA: **Rabun Co./Oconee Co.**, Chattooga River at Rt. 28, 34°55'N, 83°10'W, 28 June 1991, M. Floyd and B. Nichol, 11 males [fig. 4.31E.1] (CUAC). NORTH CAROLINA: **Transylvania Co./Jackson Co.**, Whitewater R. at 35°02'N, 83°01'W, 03 July 1991, D. Loch, 1 male [fig. 4.31E.2] (CUAC).

Pupa and egg unknown.

Hydropsyche venularis Banks

Figure 4.32

Hydropsyche venularis Banks 1914: 252, fig. 62 [male genitalia].

Hydropsyche scalaris sensu Milne 1934-36: 73 *nec* Hagen, 1861.

Hydropsyche venularis Banks; Ross 1938c: 19, fig. 28 [lectotype, male genitalia].

Lectotype locality: Washington D. C., June 22. No. 11508, male lectotype (MCZ).

Hydropsyche venularis Banks; Fischer 1963: 90 [bibliography].

Hydropsyche venularis Banks; Wallace 1975: 466 [net].

Hydropsyche venularis Banks; Schuster and Etnier 1978: 96, fig. 46 [larva, biological notes].

Hydropsyche venularis Banks; Parker and Voshell 1982: 1734 [biology].

Hydropsyche venularis Banks; Parker and Voshell 1983: 70 [biology].

Hydropsyche venularis Banks; Nimmo 1987: 90, map 48, figs. 297-303 [male and female genitalia].

Description. Male (n=10). Forewing length 9.3-11.3 mm, 10.5 mm; hind wing length 6.3-8 mm, 7.4 mm. Interocular distance 0.54-0.59 mm, 0.57 mm; cephalic width 1.9-2.2 mm, 2 mm; interocular distance:cephalic width ratio 0.26-0.29, 0.28. Eye width 0.68-0.76 mm, 0.72 mm; occiputal setal wart width 0.28-0.33 mm, 0.30 mm; occiputal setal wart width:eye width ratio 0.39-0.44, 0.41. Antennal length 12.1-14.6 mm, 13.5 mm, each with obliquely sclerotized bands on basal 9-11 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.3 times as tall as greatest length; posterolateral projection obliquely truncate. Tergum X subtriangular in lateral view with row of setae dorsally, distal margin rounded; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, furcate in lateral view; in ventral view subtriangular with tip blunt or acute. Phallic apparatus with ventrodistal opening of subapicomesal cavity oblong or ovaliform, 2.5 to 3 times as long as wide, occasionally obpyriform; subapicomesal cavity ovaliform in ventral view; apicodorsal phallobase roof convex with carina projecting above plane of proximal phallobase; cleft phallobase in ventral view forming apicolateral lobes with lateral margins sinuate (Fig. 4.32, B); ventral margin tapering caudodorsad in lateral view.

Etymology. Probably from Latin "*venula*" ("little vein").

Diagnosis. Interocular distance less than eye width, occipital setal warts approximately as long as wide. Harpagones subtriangular in ventral view. Phallic apparatus with subapicomesal cavity ovaliform in ventral view.

Distribution.

GA/NC/SC (Gordon and Wallace, 1975);

GA/SC (Wallace, 1975; Hudson and Nichols, 1986);

NC/SC (Unzicker, Resh, and Morse, 1982);

AL (Harris, Lago, and O'Neil, 1984; Harris, 1987; Lago and Harris, 1987; Frazer, Harris, and Ward, 1991; Harris, O'Neil, and Lago, 1991; Hicks and Haynes, 2000a);

CT (Bilger, 1986, record suspect, Flint, pers comm);

DC (Banks, 1914; Schuster and Etnier, 1978);

GA (Wallace, 1975; Nimmo, 1987);

IL (Bright, 1986);

KY (Resh, 1975; Schuster and Etnier, 1978; Nimmo, 1987);

MD (Nimmo, 1987);

MO (Banks, 1914, record suspect; Schuster and Etnier, 1978; Nimmo, 1987);

NC (Etnier, 1973; Schuster and Etnier, 1978; Nimmo, 1987);

NY (Betten, 1926, record suspect; Schuster and Etnier, 1978; Bilger, 1986; Nimmo, 1987);

PA (Masteller and Flint, 1992);

SC (Flint, Voshell, and Parker 1979; Nimmo, 1987; Morse, Hamilton, and Hoffman, 1989);

TN (Etnier, 1973; Schuster and Etnier, 1978; Nimmo, 1987);

VA (Banks, 1914, record suspect; Schuster and Etnier, 1978; Flint, Voshell, and Parker, 1979; Parker and Voshell, 1979; Parker and Voshell, 1981; Parker and Voshell, 1982; Parker and Voshell, 1983; Nimmo, 1987; Hoffman and Parker, 1997);

VT (Bilger, 1986, record suspect, Flint, pers comm);

WI (Banks, 1914, record suspect; Schuster and Etnier, 1978; Nimmo, 1987);

WV (Tarter, 1990).

Material Examined. GEORGIA: Pinola Shoals, Pantherville, 13 June 1945, R. H. Dodge, 1 male (CAS). **Crawford Co**., Spring Cr. 5 miles SSE of Roberta, UV light trap, 11 May 1983, S. Hamilton and R. Holzenthal, 1 male [Figs. 4.32, A-B, C.1, D.1, E] (CUAC). SOUTH CAROLINA: **Aiken Co**., Upper Three Runs Creek at Road C br. crossing, Savannah River Site, 07 September 1989, M.A. Floyd, 2 males (CUAC). Upper Three Runs Creek at Road C br. crossing, Savannah River Site, 20 September 1990, M.A. Floyd, 1 male (CUAC). **Oconee Co**., Little River at Rt. 24, 18 April 1989, E. Chen, 11 males (CUAC). VIRGINIA: **Culpeper Co**., Hazel River at Rt. 707, 03 July 1981, B. Kondratieff, 3 males (ROM). **Grayson Co**., New River, 3 miles west of Galax, Route 94 bridge, 18 May 1994, Kondratieff and Kirchner, 1 male (CSU). **Montgomery Co**., Little River at Rt. 787, 04 March 1983, Kondratieff, 5 males (CSU). Little River at Rt.

787, 05 August 1980, Kondratieff, 5 males [Fig. 4.32, C.2] (ROM). Poverty Creek, Poverty Hollow, 16 June 1987, K. Stein, 1 male [Fig. 4.32, D.2] (CSU).

Pupa and egg unknown.

Hydropsyche winema Denning

Figure 4.33

Hydropsyche winema Denning 1965: 80, fig. 9 [male genitalia].

Type locality: Branch of Little Deschutes River, near Crescent, Oregon, 30 August 1954, D. G. Denning, male holotype (CAS).

Description. Male (n=2). Forewing length 8.5-9.0 mm, 8.75 mm, hind wing length 6.3-6.9 mm, 6.6 mm. Interocular distance 0.75 mm; cephalic width 1.5-1.6 mm, 1.55 mm; interocular distance:cephalic width ratio 0.47-0.5, 0.49. Eye width 0.3-0.33 mm, 0.32 mm; occipital setal wart width 0.35-0.4 mm, 0.38 mm; occipital setal wart width:eye width ratio 1.2. Antennal length 6.7-7.0 mm, 6.9 mm, each with obliquely sclerotized bands on basal 7 flagellomeres. Abdominal sternum V glands ampulliform.

Abdominal segment IX with dorsal carina, segment about 2.6 times as tall as greatest length; posterolateral projection rounded. Tergum X subrectangular in lateral view with row of setae dorsally; distal margin obliquely truncate; apicomesally emarginate. Inferior appendages each with coxopodite clavate, bearing elongate setae distally; harpago intorted, saber-shaped in lateral view; in ventral view with tip ogival. Phallic apparatus with proximal phallobase subapically swollen; ventrodistal opening of subapicomesal cavity and subapicomesal cavity both orbicular in ventral view; apicodorsal phallobase roof flat and not projecting above plane of proximal phallobase.

Etymology. Unknown.

Diagnosis. This species is only known from Oregon and is nearly identical to *H. californica*. *Hydropsyche winema* has a narrower head capsule with a cephalic width of 1.5 mm to 1.6 mm and *H. californica* has a broader head capsule with a cephalic width of 1.7 mm to 1.8 mm. *Hydropsyche winema* has a greater interocular distance:cephalic width ratio (0.47-0.50) than *H. californica* (0.40-0.44). *Hydropsyche winema* has a narrower eye width (0.3-0.33) mm than *H. californica*, (0.4-0.49 mm) and the postoccipital setal wart is wider than the eye (narrower than the width of the eye in *H. californica*). Thus, the postoccipital setal wart width:eye width ratio for *H. winema* (1.2) is much greater than that for *H. californica* (0.80-0.98, 0.88). Apparent differences in the apex of the phallus also help to distinguish *H. winema* and *H. californica*. In *H. winema*, the subapical phallobase is swollen, forming spatulate margins that converge distally in ventral view [Fig. 4.33, D]. In *H. californica*, the subapical phallotheca is more nearly moniliform in ventral view [Fig. 4.7, B] and may have sharply angled corners or rounded margins, occasionally both on a single specimen. In a few specimens of *H. californica*, the moniliform phallotheca appears closer to the spatulate condition of *H. winema* but the distance between the distal edge of the phallobase and the basal margin of the subapicomesal cavity in *H. winema* is 0.14-0.16 mm and in *H. californica* 0.17-0.2 mm.

Distribution.

OR (Denning, 1965; Anderson, 1976).

Material Examined. OREGON: [**Klamath Co**.], near Crescent, Branch of Little Deschutes River, 30 August 1954, D. G. Denning, 1 male [holotype] [Figs. 4.33]; 1 male [paratype], same data as holotype (CAS).

Notes. Although apparent differences between *H. winema* and *H. californica* have been provided, the limited number of exemplars for each species made it difficult to assess the variability of morphological characters. Because measurements of the cephallic width, eye width, interocular distance:cephalic width ratio and postocciputal setal wart width:eye width ratio show no overlap, these forms are recognized as two distinct species, but these characters differ merely by tenths or hundredths of a millimeter and additional material may not support recognizing two distinct species.

CHAPTER 5: CONCLUSIONS

Species placed in the *Hydropsyche scalaris* Group have been difficult and at times impossible to identify. Subtle differences of the apicolateral lobes, apicodorsal roof, and subapicomesal cavity of the phallic apparatus are variable. Caution should be used in describing new species based soley on variation in the apex of the phallic apparatus.

Species have been recognized when consistent differences can be found in the morphology of the phallic apparatus and some other feature of the terminalia or body. The phallic apparatus of *Hydropsyche scalaris* and *Hydropsyche bassi* is nearly identical but the two species differ consistently in the morphology of the head (Figs. 4.5A; 4.29A). Species were synonymized when descriptions were based only on subtle differences in the apex of the phallic apparatus, and no other feature of the terminalia or body supported treatment as a separate species. *Hydropsyche bidens*, *H. orris*, and *H. alvata* are considered junior subjective synonyms of *H. incommoda. Hydropsyche rossi* and *H. fenestra* Lago and Harris are considered junior subjective synonyms of *H. simulans.*

Subtle intraspecific differences of the phallic apparatus are widespread within the *H. scalaris* Group, and provide weak morphological support for species delineations. New species descriptions based on subtle morphology, limited exemplars, and no understanding of intraspecific or geographic variation have caused numerous problems. The inevitable result is an unnecessary inflation of nomenclature that leads to taxonomic confusion and an impossible diagnostic puzzle.

Difficulties in species delineation are accentuated by new species descriptions based on a single life stage, the adult male. Females (14 of 31) and larvae (12 of 31) remain unassociated for nearly half of the species (Table IV). Ignoring synonymies, a total of 38 names have been proposed in the *H. scalaris* Group, 26 of which fail to consider any other life stage in the original description. Even the most recent species descriptions of *H. alabama*, *H. franclemonti*, and *H. fenestra* Lago and Harris persist in ignoring the egg, larva, pupa, and adult female life stages (Lago and Harris, 1991; Flint, 1992; Lago and Harris, 2006). *Hydropsyche scalaris* and *H. dicantha* are the only species for which the larva, pupa, adult female, and adult male have all been described. Although it is possible to describe new species based only on the adult male, additional life stages can help distinguish between intraspecific and interspecific variation, a daunting task when limited to a single life stage or a single specimen of one life stage.

The problem is not limited to the descriptive taxonomic practices of Trichoptera systematists of the 1800's and early 1900's. Neither is the problem restricted to those who have worked with the *H. scalaris* Group. A search of the database for the Trichoptera World Checklist showed a total of 166 caddifly species described worldwide as new to science in 2005. Approximately 92% (153 of 166) of the original descriptions were based only on adult males and 8% (13 of 166) included additional life stages. As long as new species are described based on a single life stage, Trichoptera workers will continue to be inundated with a taxonomic backlog that limits further progress in understanding caddisfly biology (Wiggins, 1966). Missing life history information restricts the taxonomists ability to utilize species concepts other than typological. Current taxonomic practices are a hinderance to both basic and applied science in

Trichopterology. Given the importance of larval caddisflies in water quality monitoring, concentrated effort to describe all life stages as part of an original description is imperative. Less time and effort can be spent correcting other taxonomists' work and more effort put into documenting caddisfly diversity and solving water quality problems.

Further study is needed to associate all life stages of species in the *Hydropsyche scalaris* Group. A detailed morphological and molecular analysis of all life stages of *Hydropsyche incommoda* and *Hydropsyche simulans* that incorporates material across the full geographic range of these species might help to elucidate species boundaries undetectable using only adult males. Differences in the interocular distance, length of the occipital setal wart, and eye size of the adult male head indicate different life history or mating strategies within the *H. scalaris* Group, an area of research needing more attention.

APPENDICES

Appendix A

Table II, III, IV

Figs. 3.1-3.12

Table II. List of Morphological Abbreviations.

Head.
antf. Antennifer
ant.s.a. Antennal setal area
a.tent.p. Anterior tentorial pit
ad.par.sc. Anterodorsal parietal sclerite
cd. Cardo
cvx. Cervix
com. e. Compound eye
cor. su. Coronal suture
d.par.su. Dorsoparietal suture
fla. Flagellum
fron.s.a. Frontal setal area
fron.su. Frontal suture
frclp. Frontoclypeus
frclp.s.a. Frontoclypeal setal area
ge. Gena
lab.p. Labial palp
labr. Labrum
md. Mandible
mx.p. Maxillary Palp
ob.sc. Oblique sclerotization
ocl.s.a. Ocellar setal area
ocl.tub. Ocellar tubercle
occ. Occiput
occ.frm. Occipital foramen
occ.s.w. Occipital setal wart
occ.su. Occipital suture
ped. Pedicel
pge. Postgena
pge.su. Postgenal suture
pocc.cn. Postocciputal condyle
pd.par.sc. Posterodorsal parietal sclerite
p.tent.p. Posterior tentorial pit
porb.s.w. Postorbital setal wart
sca. Scape
st. Stipes
sge. Subgena
sge.su. Subgenal suture
tmp.dpn. Temporal depression
tmp.sc. Temporal sclerite
tmp.mb. Temporal membrane
tent.br. Tentorial bridge
ve. Vertex

Thorax.
frw.bs. Forewing base
hdw.bs. Hind wing base
lt.prnt.sw. Lateral pronotal setal wart
md.prnt.sw. Medial pronotal setal wart
ms.sct. Mesoscutum
ms.sctl. Mesoscutellum
ms.ntm. Mesonotum
mt.sct. Metascutum
mt.sctl. Metascutellum
mt.ntm. Metanotum
pms.sctl. Postmesoscutellum
prtx.p.epst. Prothoracic pre-episternum
tgl. Tegula

Wing venation.
A. Anal vein
arcl. Arculus
C. Costal vein
Cu. Cubital vein
cu Cubital crossvein
cu-a Cubital-anal crossvein
dsc.cl. Discoidal cell
fk.1-5. Forks 1 through 5
hml.v. Humeral crossvein
jgl.br. Jugal bar
M. Medial vein
m Medial crossvein
m-cu Medial-cubital crossvein
Nygma
R. Radial vein
r Radial crossvein
r-m Radial-medial crossvein
r_3-r_4 [or s] Sectoral crossvein
Sc. Subcostal vein
Stigma

Musculature.
ilt.mu. Internal longitudinal phallic muscle
itv.mu. Internal transverse phallic muscle
it.mu.8-9 Intersegmental tergal muscle
is.mu.8-9 Intersegmental sternal muscle
ed.cxpdt.mu. External dorsolateral coxopodite muscle
ev.cxpdt.mu. External ventromedial coxopodite muscle
ep.ph.mu. External posterior phallic muscle
ea.ph.mu. External anterior phallic muscle
im.mu. Internal medial coxopodite muscle

Table II (continued)

Terminalia.
IX. Abdominal segment IX
X. Abdominal tergite X
IX/X.su. Dorsolateral suture at boundary of abdominal segments IX and X
antc. Antecosta
apdm.rdg. Phallic apodeme ridge
av.phcrpt. Anteroventral inverted phallocrpyt
bsl.pl. Basal plate
cv.wl. Subapicomesal cavity wall of phallobase
cxpdt. Coxopodite
d.kl. Dorsal keel
edth. Endotheca
ej.dct. Ejaculatory duct
gnpr. Gonopore
hrpg. Harpago
inf.ap. Inferior appendage/Clasper
iv.phct. Inverted phallicata
lb.phlbs. Apicolateral lobes of phallobase
pd.phcrpt. Posterodorsal everted phallocrypt
ph.apdm. Phallic apodeme
ph.aprt. Phallic apparatus
phcrpt.fl. Phallocrypt floor
phct.rd. Ventral sclerotized rod of phallicata
phcrpt.wl. Sclerotized phallocrypt wall
ph.frmn. Phallic foramen
phlbs. Phallobase
phlbs.rf. Apicodorsal phallobase roof
sub.sc. Apical sclerite at base of inverted phallicata (subapicomesal sclerite)
s.m. Setal mound of tergum X

Table III. Two-letter postal abbreviations for states and provinces of North America.

United States

(AL) Alabama
(AK) Alaska
(AZ) Arizona
(AK) Arkansas
(CA) California
(CO) Colorado
(CT) Connecticut
(DE) Delaware
(FL) Florida
(GA) Georgia
(HI) Hawaii
(ID) Idaho
(IL) Illinois
(IN) Indiana
(IA) Iowa
(KS) Kansas
(KY) Kentucky
(LA) Louisiana
(ME) Maine
(MD) Maryland
(MA) Massachusetts
(MI) Michigan
(MN) Minnesota
(MS) Mississippi
(MO) Missouri
(MT) Montana
(NE) Nebraska
(NV) Nevada
(NH) New Hampshire
(NJ) New Jersey
(NM) New Mexico
(NY) New York
(NC) North Carolina
(ND) North Dakota
(OH) Ohio
(OK) Oklahoma
(OR) Oregon
(PA) Pennsylvania
(RI) Rhode Island
(SC) South Carolina
(SD) South Dakota
(TN) Tennessee
(TX) Texas
(UT) Utah
(VT) Vermont
(VA) Virginia
(WI) Wisconsin
(WY) Wyoming

Canada

(AB) Alberta
(BC) British Columbia
(MB) Manitoba
(NB) New Brunswick
(NF) Newfoundland
(NS) Nova Scotia
(ON) Ontario
(PE) Prince Edward Island
(PQ) Quebec
(SK) Saskatchewan

Table IV. Associated life stages for the North American species of the *Hydropsyche scalaris* Group. No eggs described. See synonymies for bibliographic information.

Species	Larva	Pupa	Adult Female	Adult Male
aerata	X		X	X
alabama				X
arinale	X		X	X
auricolor			X	X
bassi				X
brunneipennis	X			X
californica			X	X
catawba				X
delrio			*X	X
demora	X			X
dicantha	X	X	X	X
fattigi				X
franclemonti				X
frisoni	X		X	X
hageni	X		X	X
hoffmani	X	X		X
impula				X
incommoda	X		X	X
leonardi	X			X
mississippiensis	X			X
occidentalis	X[?]		X	X
opthalmica				X
patera	X		X	X
phalerata	X		X	X
philo				X
placoda	X		X	X
scalaris	X	X	X	X
simulans	X		X	X
valanis	X		X	X
venularis	X		X	X
winema				X

* Specimen deposited [INHS]; no illustrations or description of genitalia.

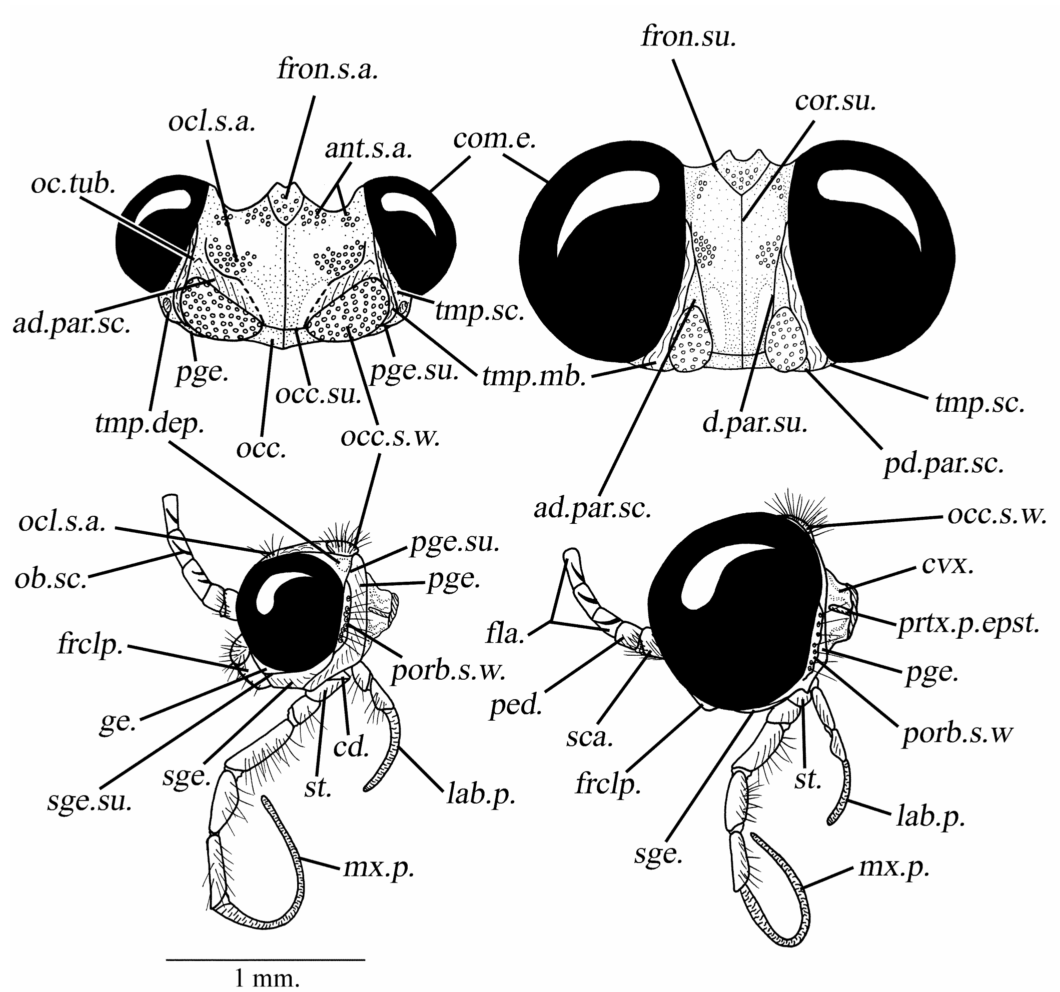


Figure 3.1. Morphology of the adult male head. Antennae not shown. Dashed lines indicate suture occasionally absent. A) Dorsal view of *H. occidentalis*, B) left lateral view of *H. occidentalis*, C) dorsal view of *H. aerata*, antennae not shown, D) left lateral view of *H. aerata*.

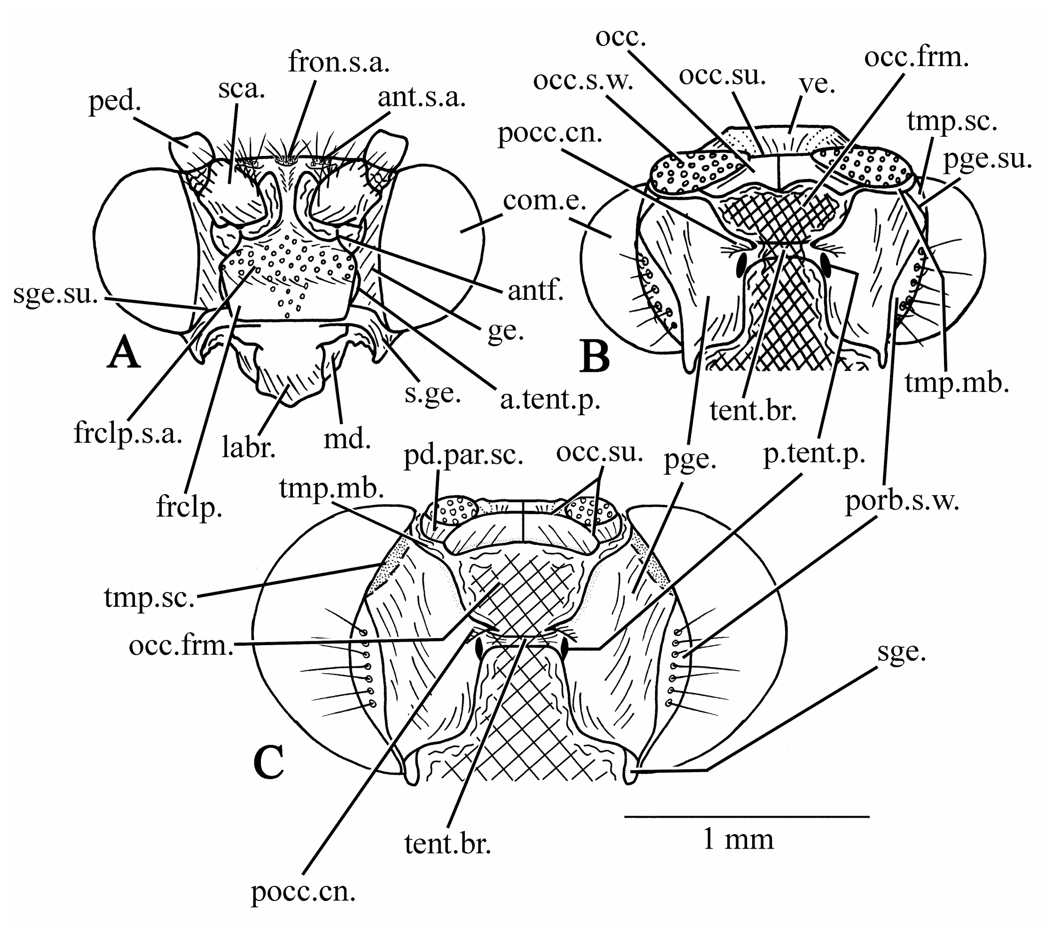


Figure 3.2. Morphology of adult male head (continued). A) Anterocaudal view of *H. occidentalis*, B) posterocaudal view of *H. occidentalis*, C) posterocaudal view of *H. aerata*.

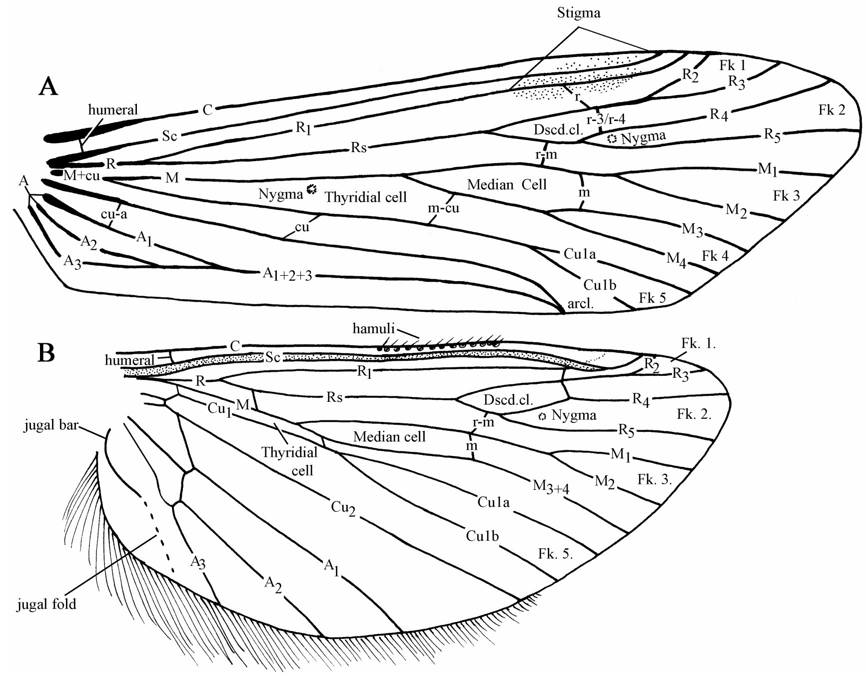


Figure 3.3. *Hydropsyche occidentalis* wing. A) Dorsal view of forewing, B) dorsal view of hind wing.

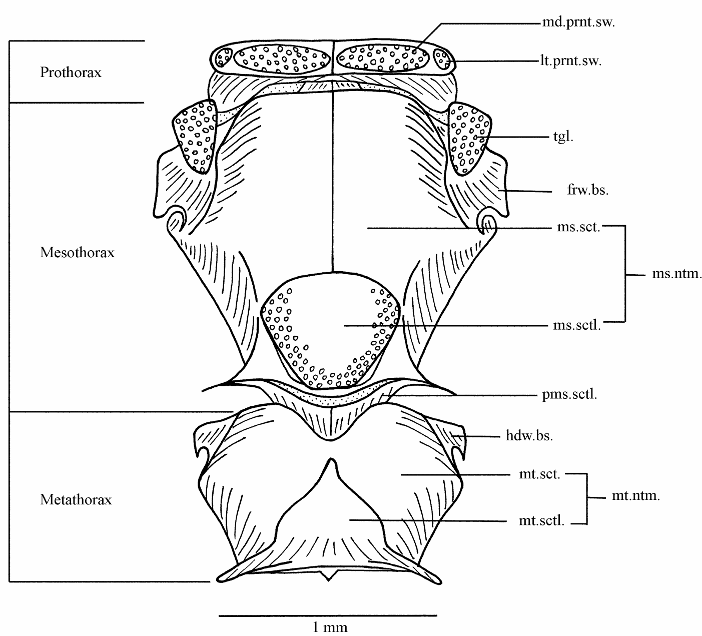


Figure 3.4. Thorax of *H. scalaris*, dorsal view.

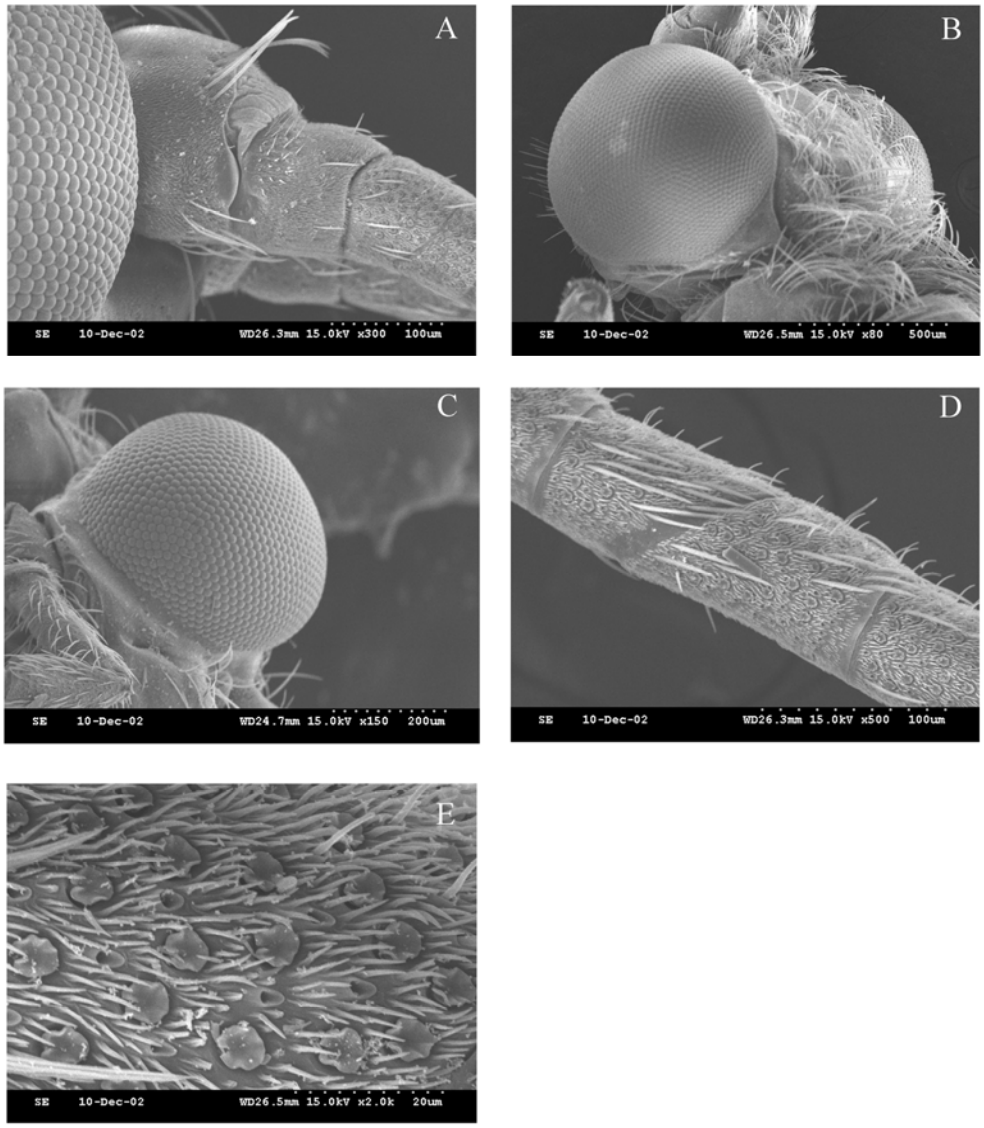


Figure 3.5. Scanning electron microscopy of *H. incommoda* head. A) left lateral view of scape and pedicel, B) posterolateral view of head, C) compound eye, D) antennal flagellomere with sclerotized band, E) sensilla of the antennae.

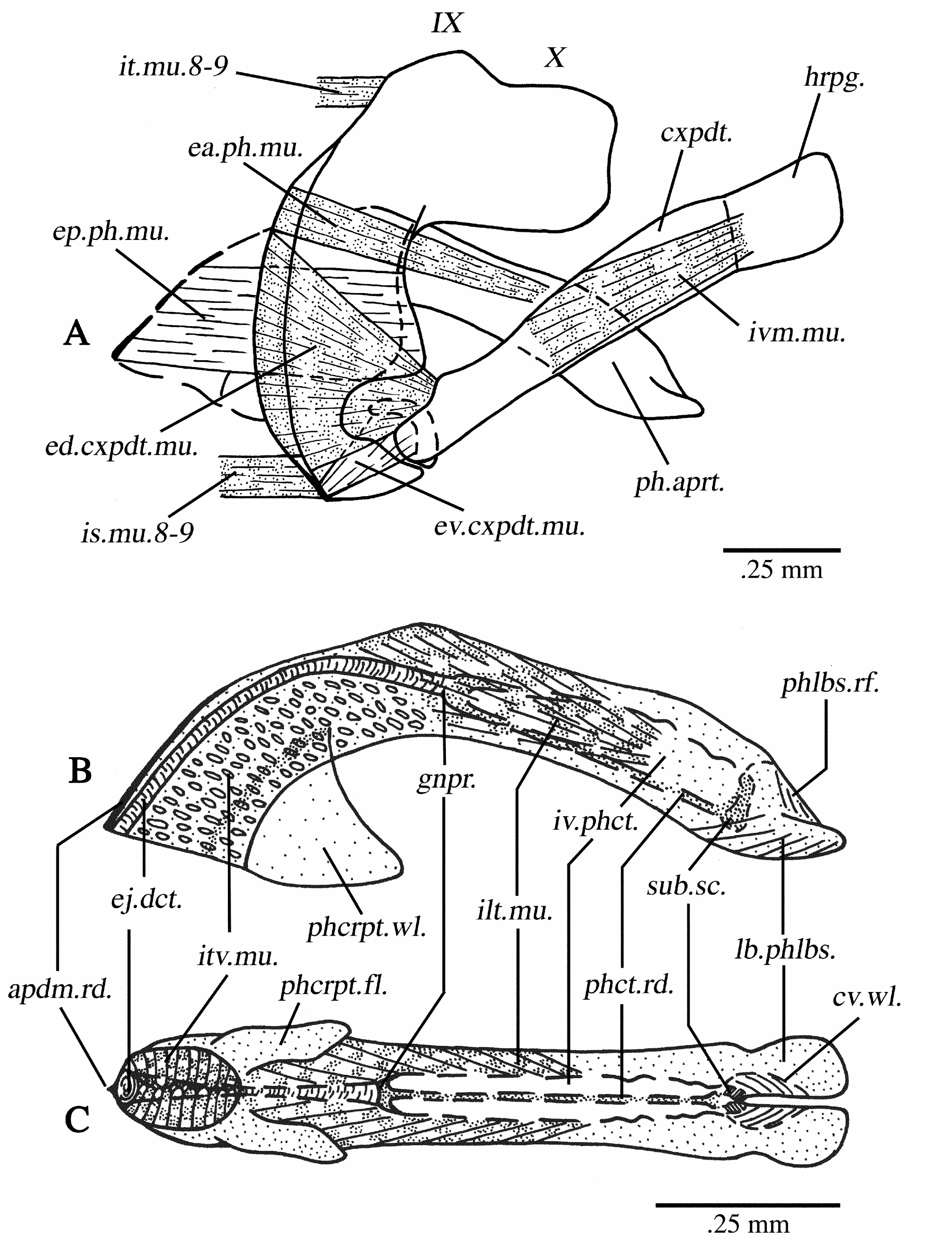


Figure 3.6. Terminalia of *Hydropsyche occidentalis*. A) Left lateral view of terminalia and associated musculature, B) left lateral view of phallic apparatus, C) ventral view of phallic apparatus.

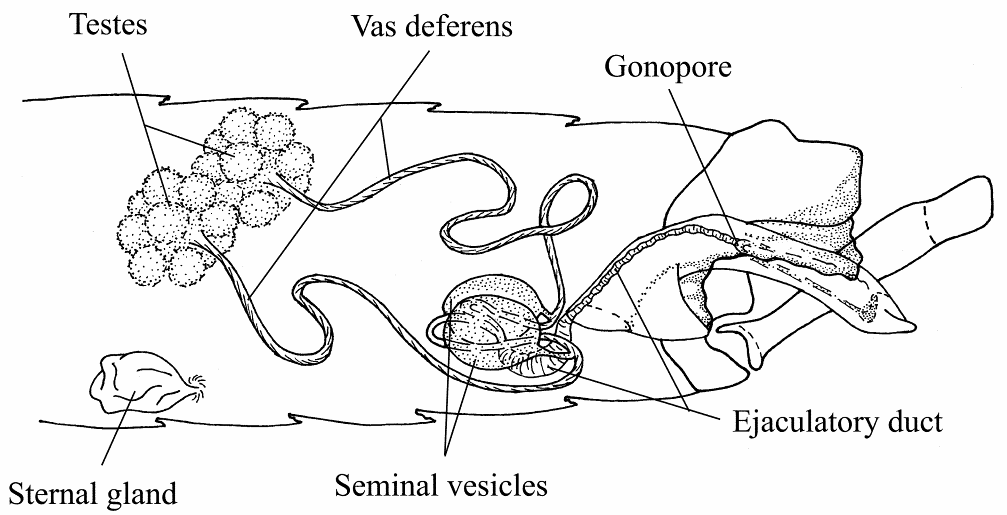


Figure 3.7. Reproductive tract of *H. occidentalis*, left lateral view.

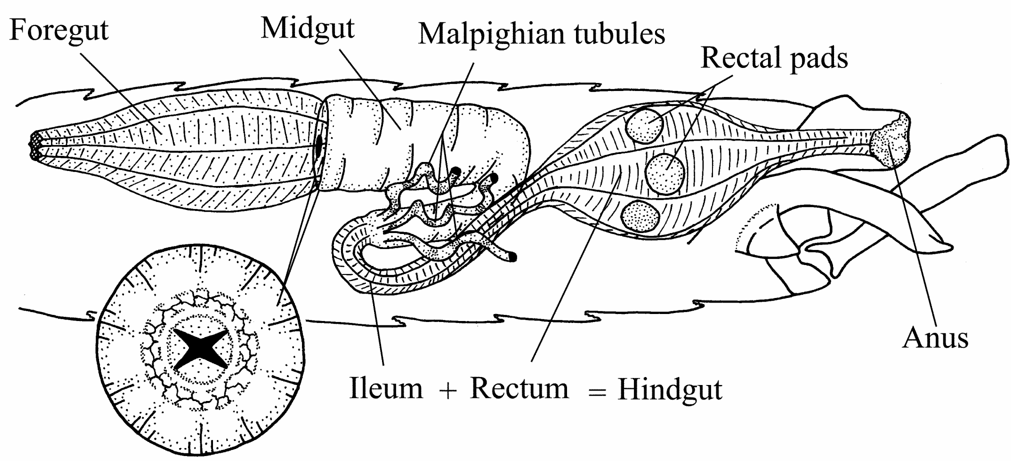


Figure 3.8. Digestive tract of *H. occidentalis*, left lateral view.

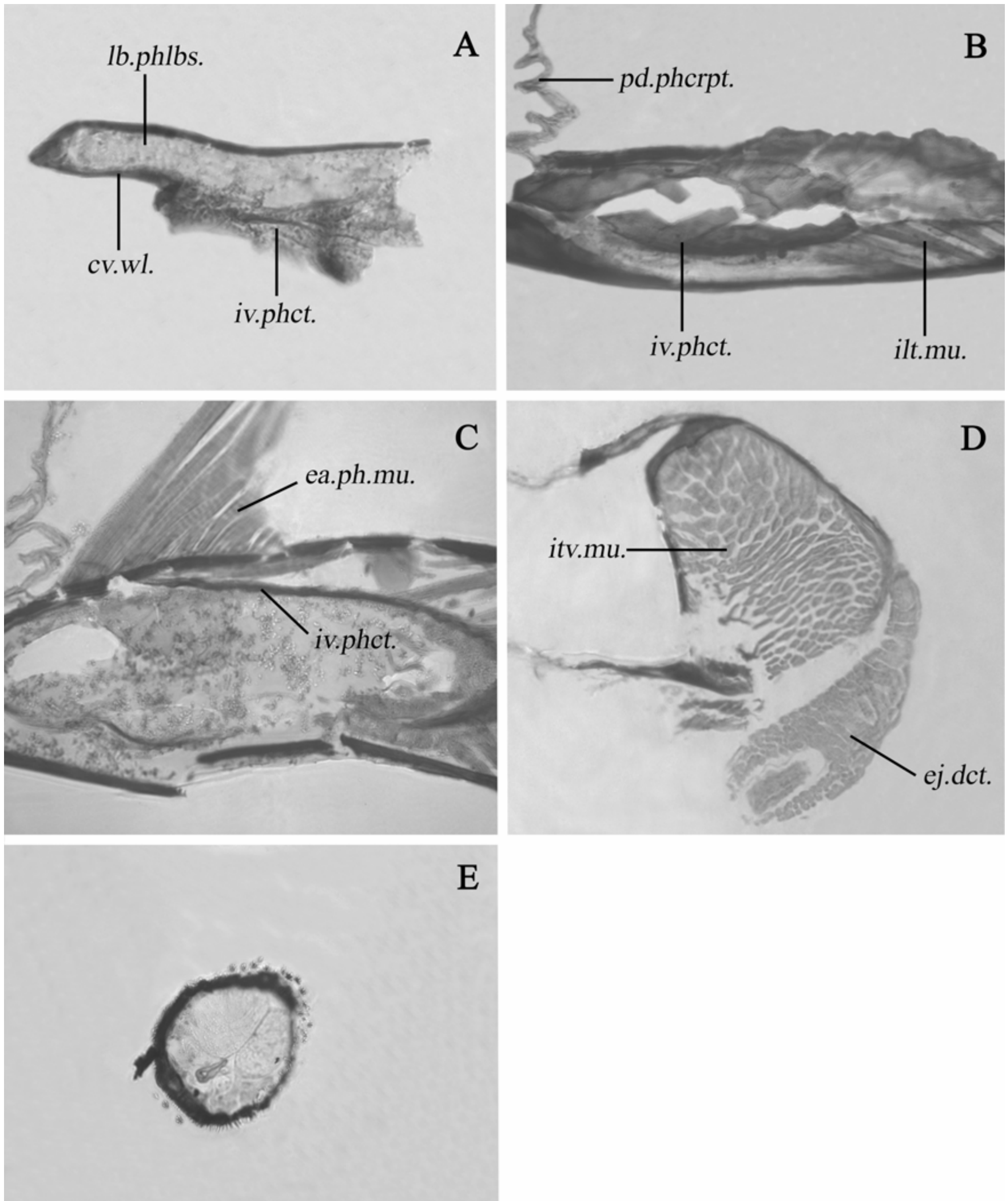


Figure 3.9 Cross sections of *Hydropsyche incommoda* phallic apparatus (fig. 4.18, B.6). A) Orientation uncertain, incomplete section of distal phallic apparatus B-D) longitudinal cross sections E) transverse cross section of antennal flagellomere.

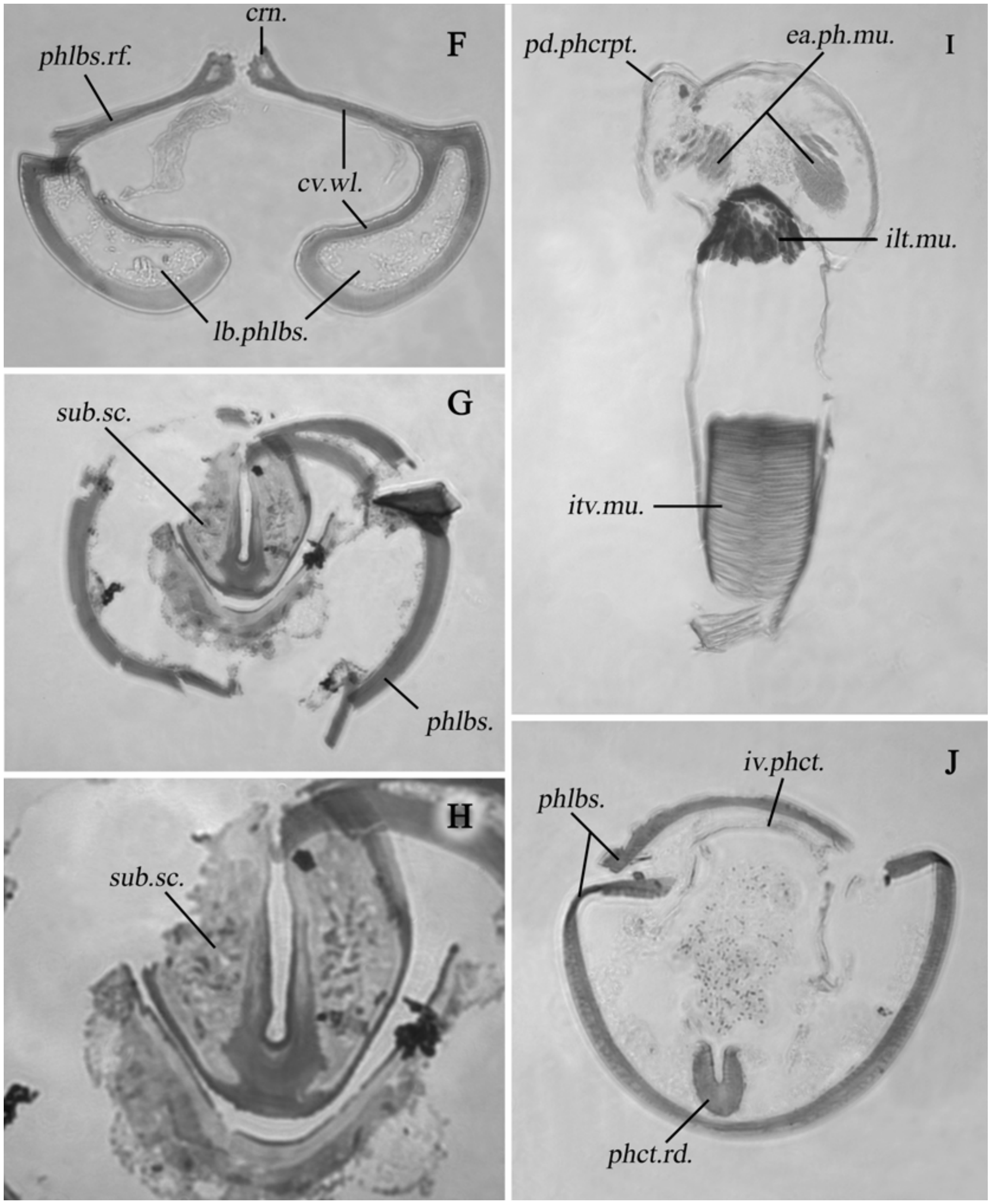


Fig. 3.9 (continued) Cross sections of *Hydropsyche incommoda* phallic apparatus (Fig. 4.18, B.5). F) Transverse cross section of subapicomesal cavity G-H) transverse cross section of subapical sclerite I) transverse cross section of proximal phallic apparatus, some material missing J) transverse cross section of inverted phallicata.

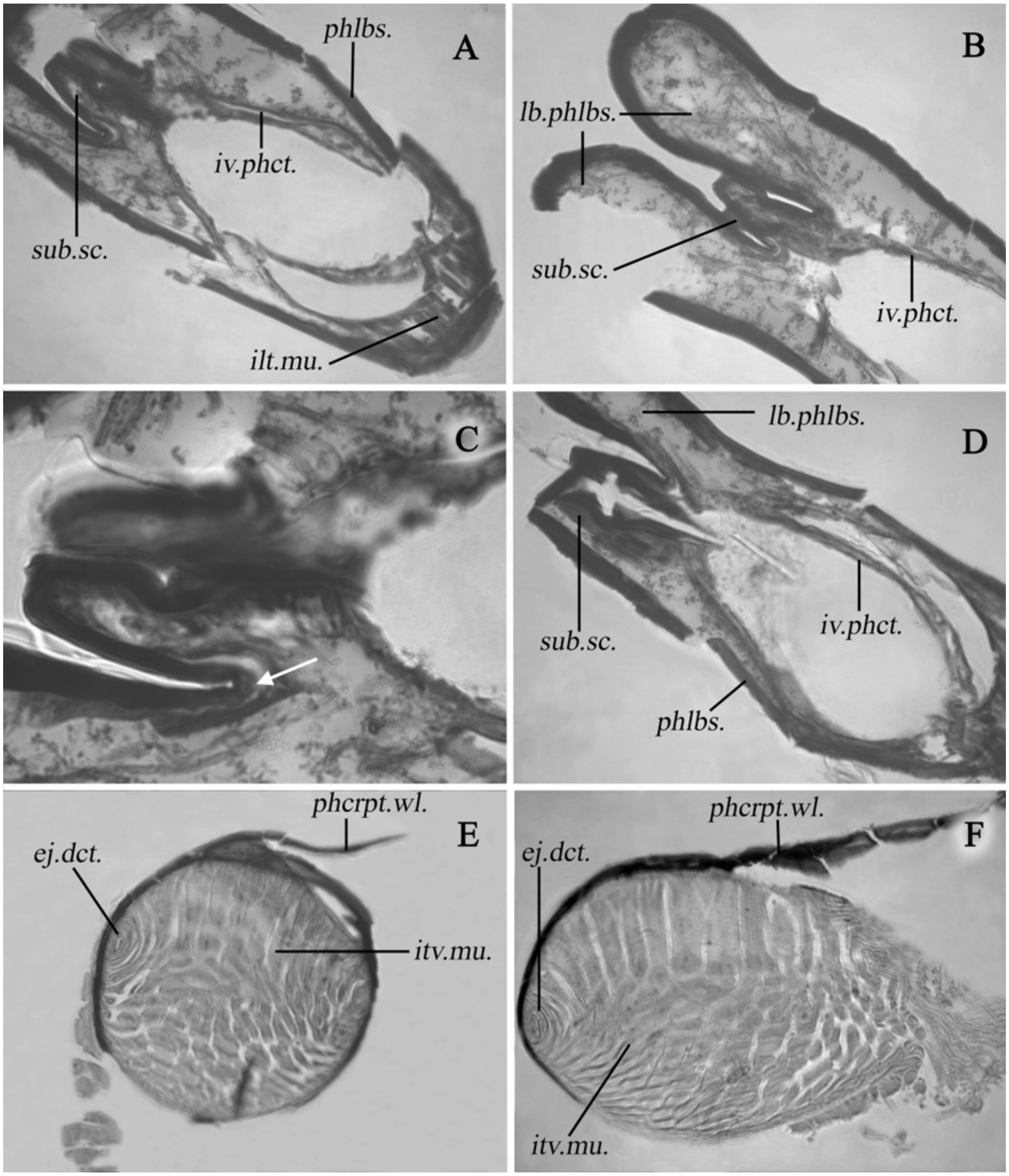
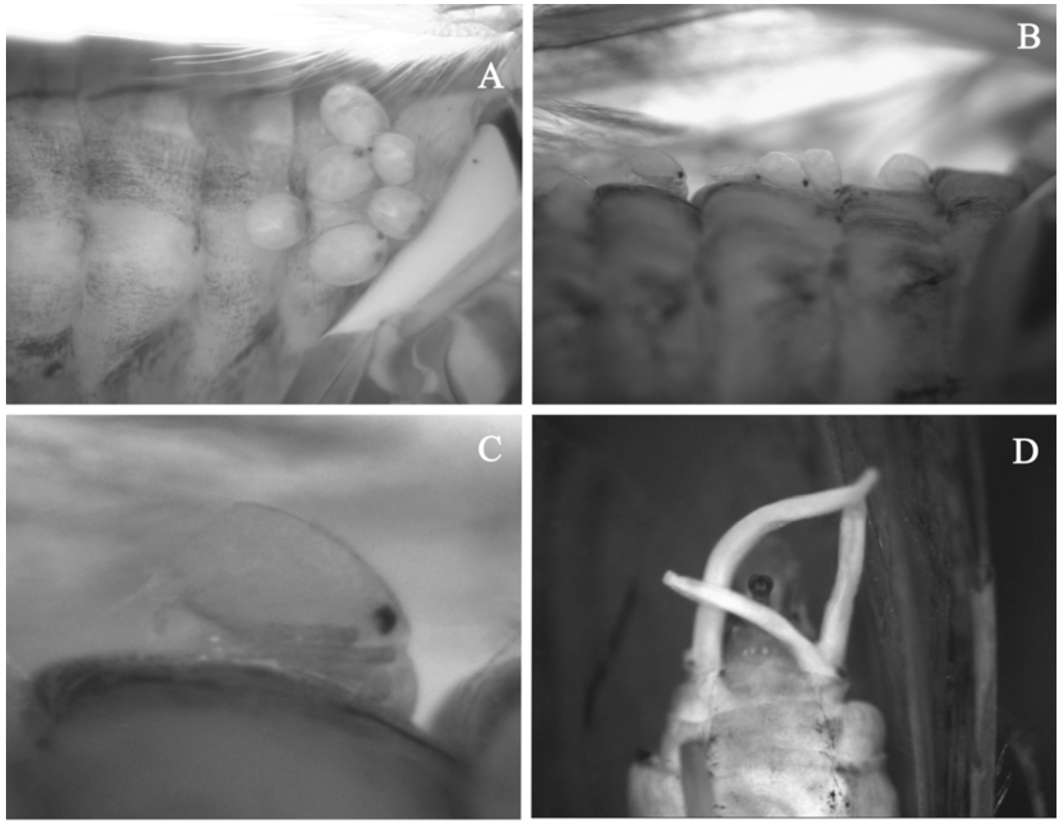


Figure 3.10 Cross sections of *Hydropsyche occidentalis* phallic apparatus.



Figurer 3.11. Abdominal parasites of adult *Hydropsyche*. A-C) Undetermined mites attached to *Hydropsyche mississippiensis*, D) nematode protruding from the abdomen of *Hydropsyche rossi*, ventral view.

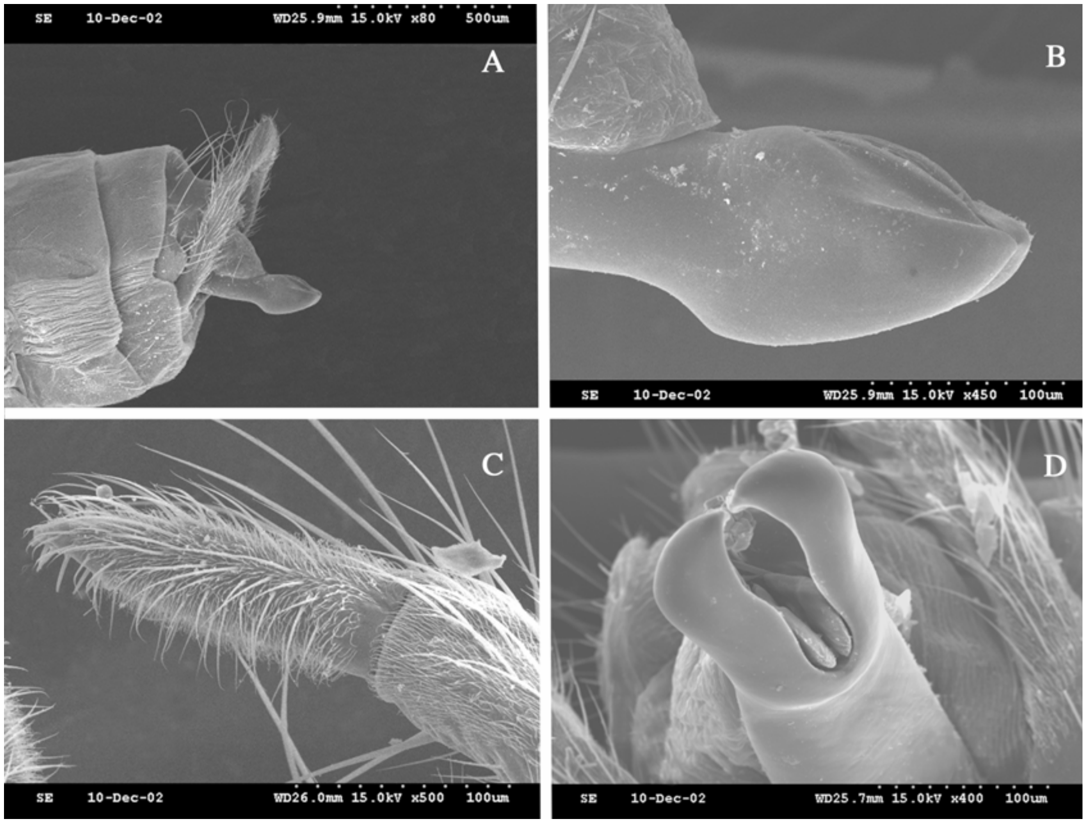


Figure 3.12. Scanning electron microscopy of *Hydrospyche incommoda* terminalia. A) Left lateral view of terminalia, B) left lateral view of phallobase apex, C) harpago of left inferior appendage, D) ventrocaudal view of phallobase apex.

Appendix B

Species illustration plates.

Figures 4.1-4.33

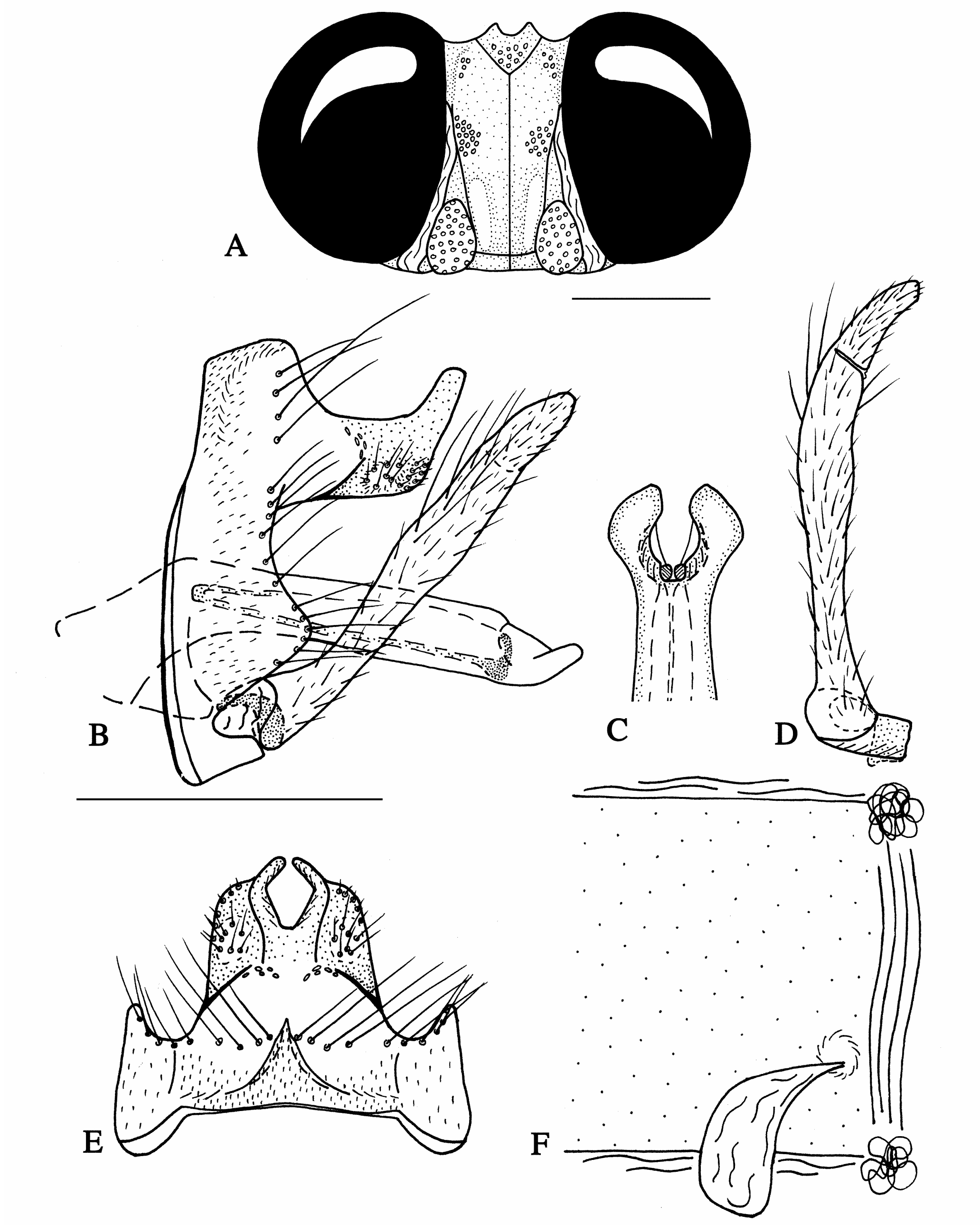


Figure 4.1. Adult male *Hydropsyche aerata*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

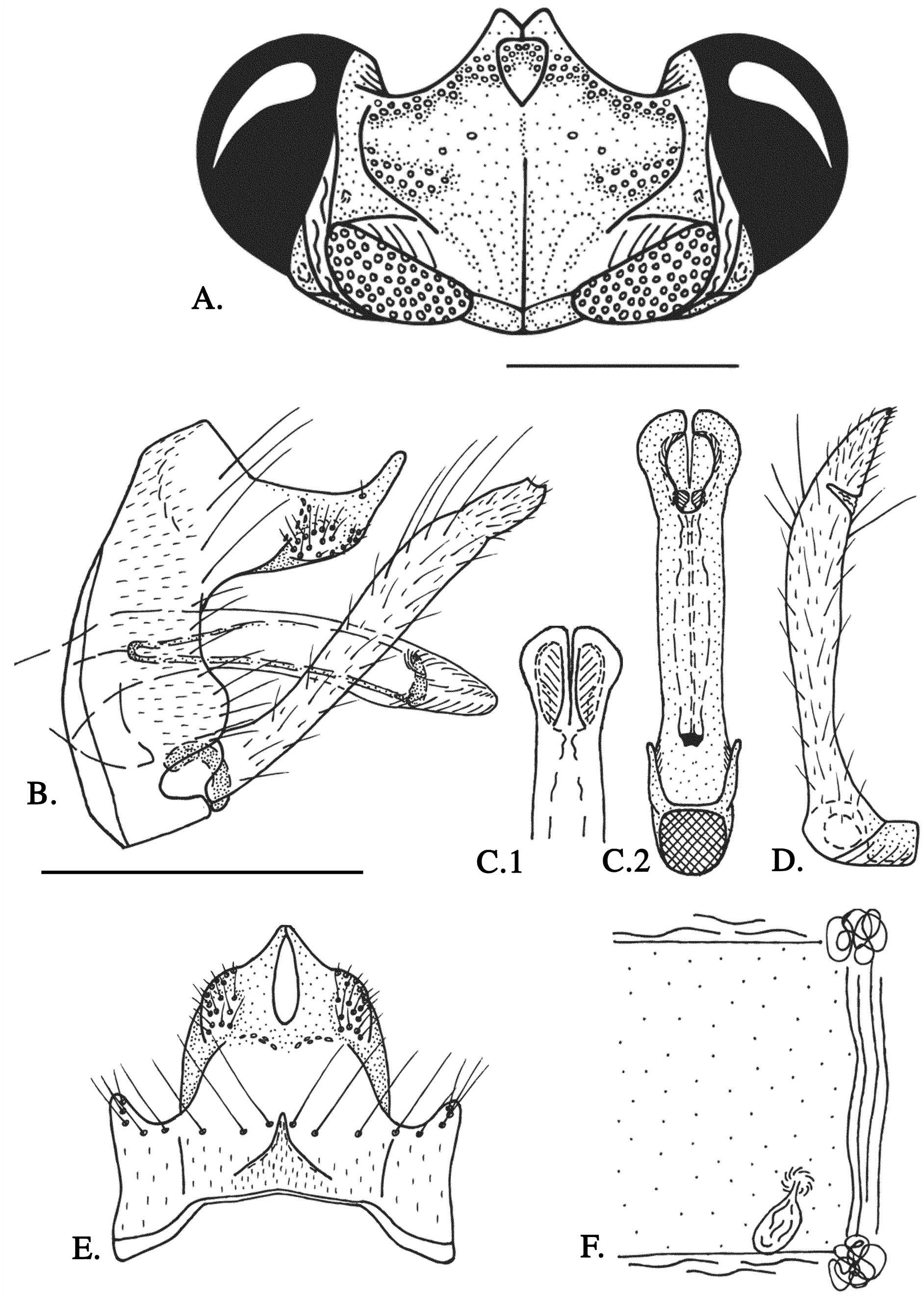


Figure 4.2. Adult male of *Hydropsyche alabama*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1) dorsal view of phallobase apex, C.2) ventral view of phallobase, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

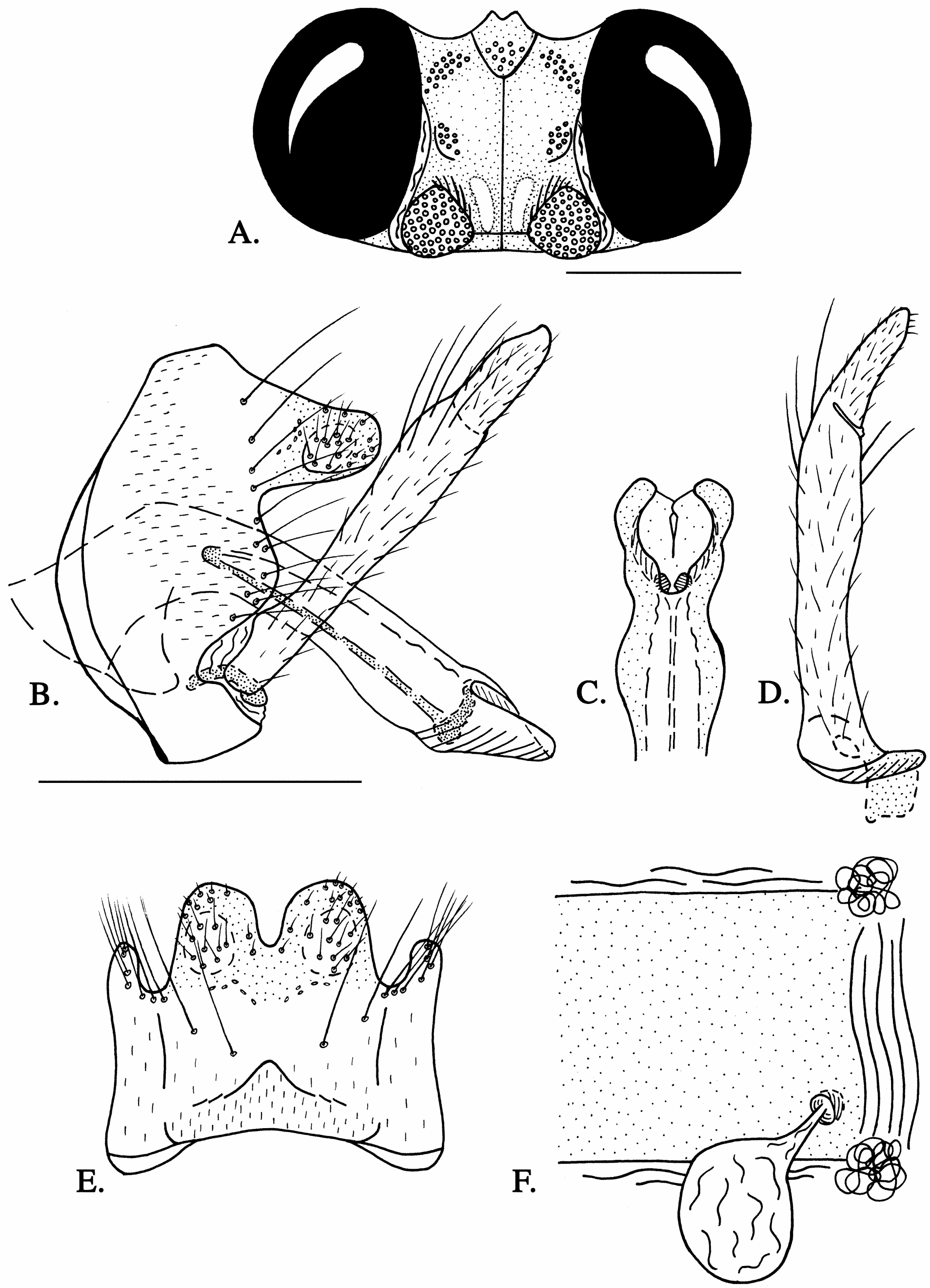


Figure 4.3. Adult male of *Hydropsyche arinale*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

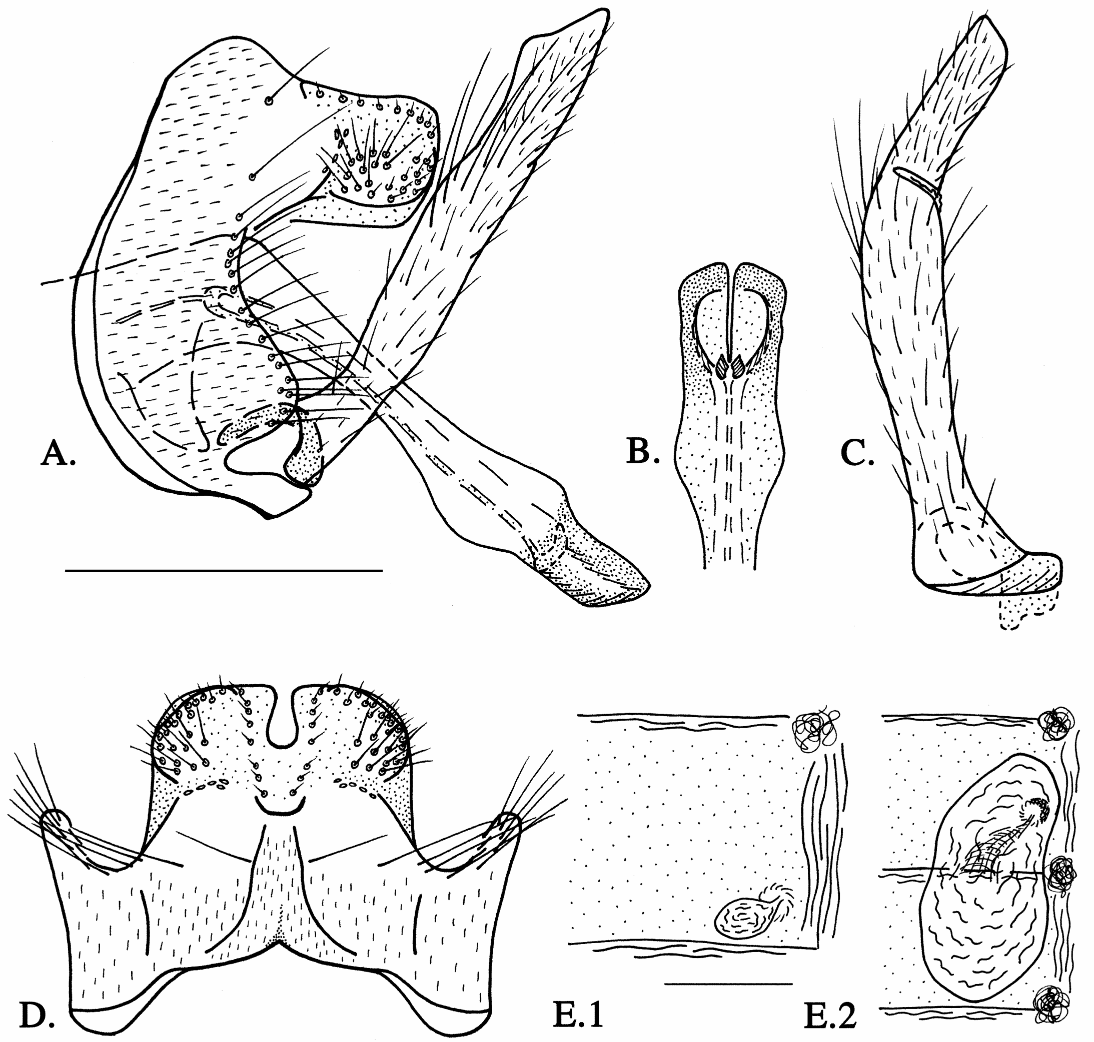


Figure 4.4. Adult male of *Hydropsyche auricolor*. Scale bars, 0.5 mm. A) Left lateral view of terminalia, B) ventral view of phallobase apex, C) ventral view of left inferior appendage, D) dorsal view of terga IX and X, E.1) dorsal view of female abdominal sternum V left gland, E.2) dorsal view of male abdominal sternum V left gland.

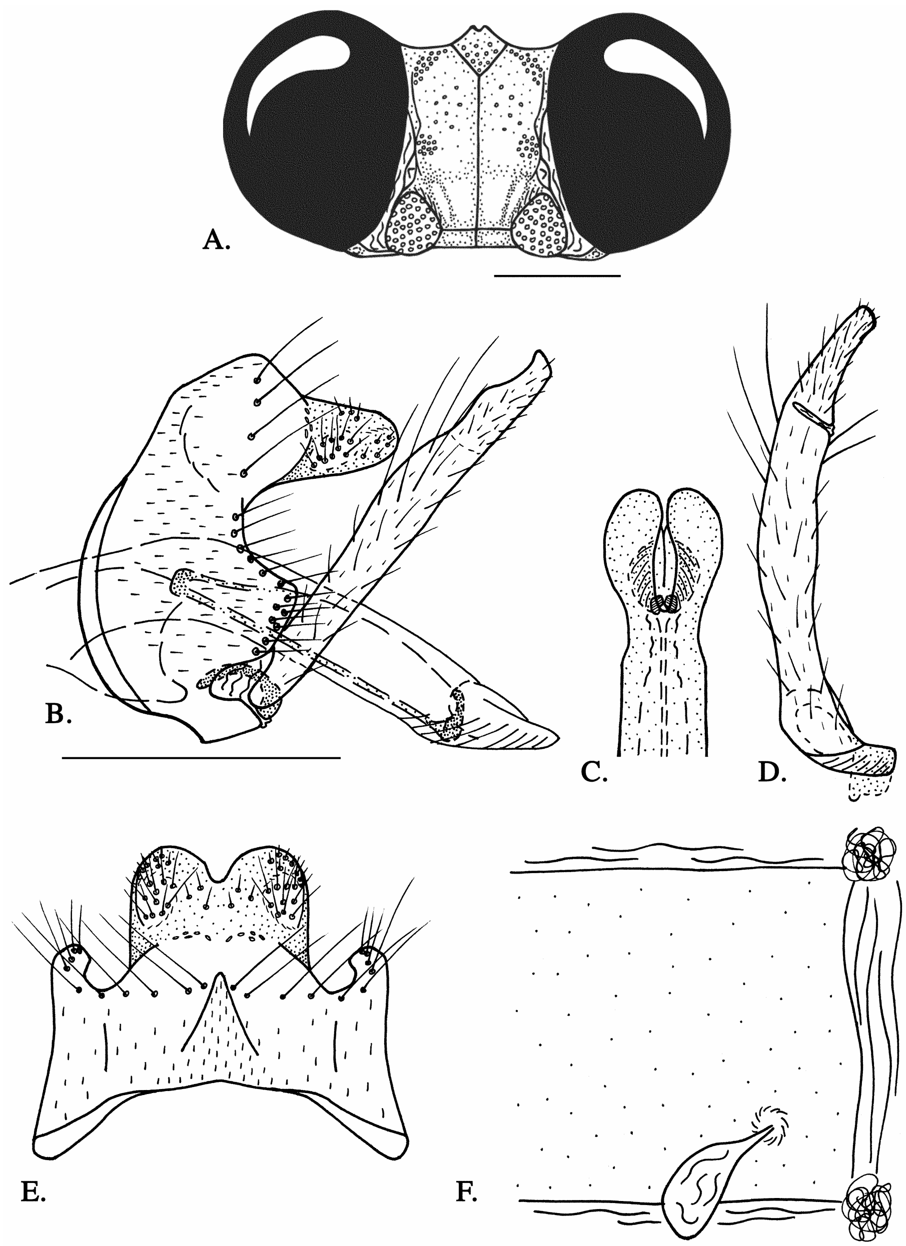


Figure 4.5. Adult male of *Hydropsyche bassi*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

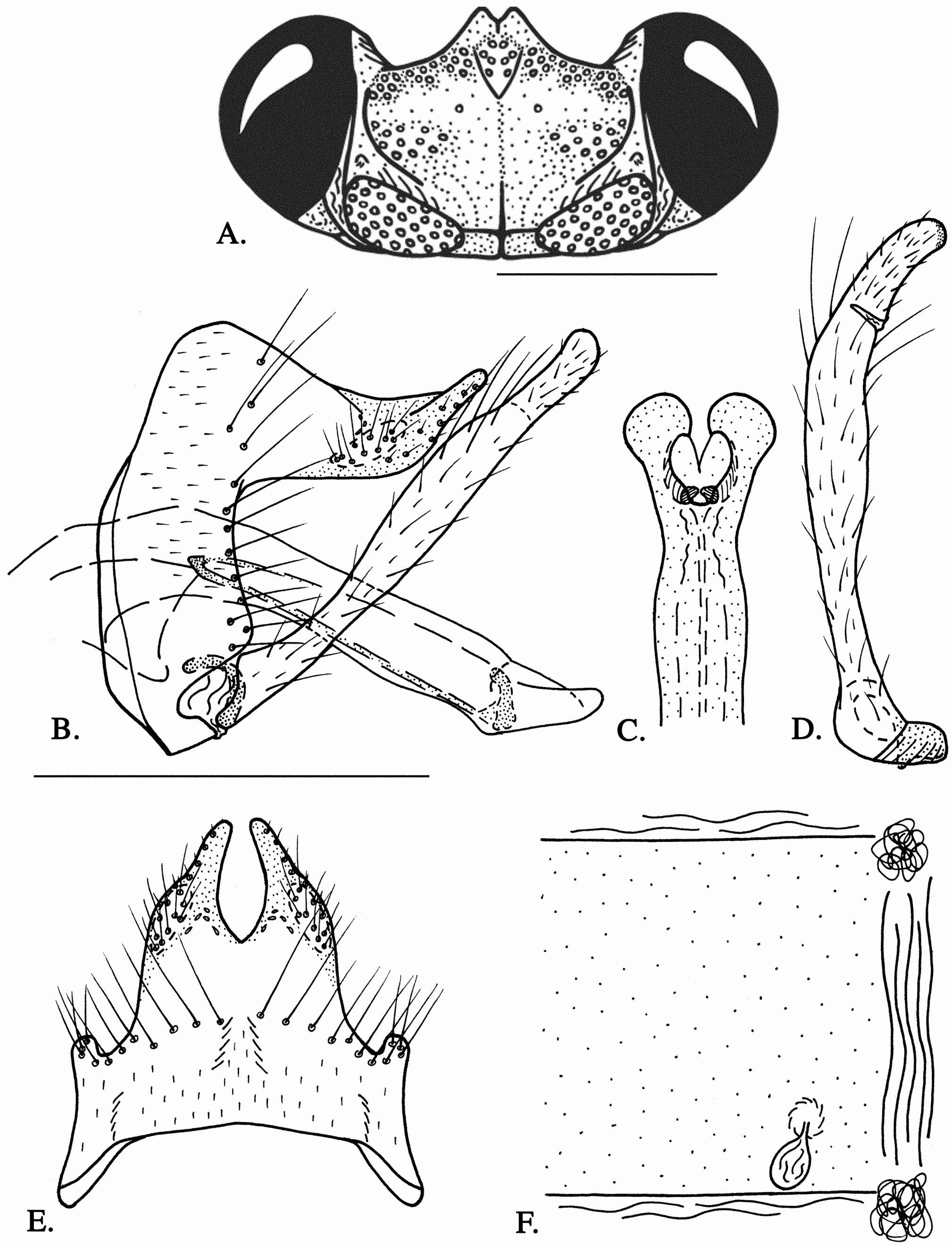


Figure 4.6. Adult male of *Hydropsyche brunneipennis*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

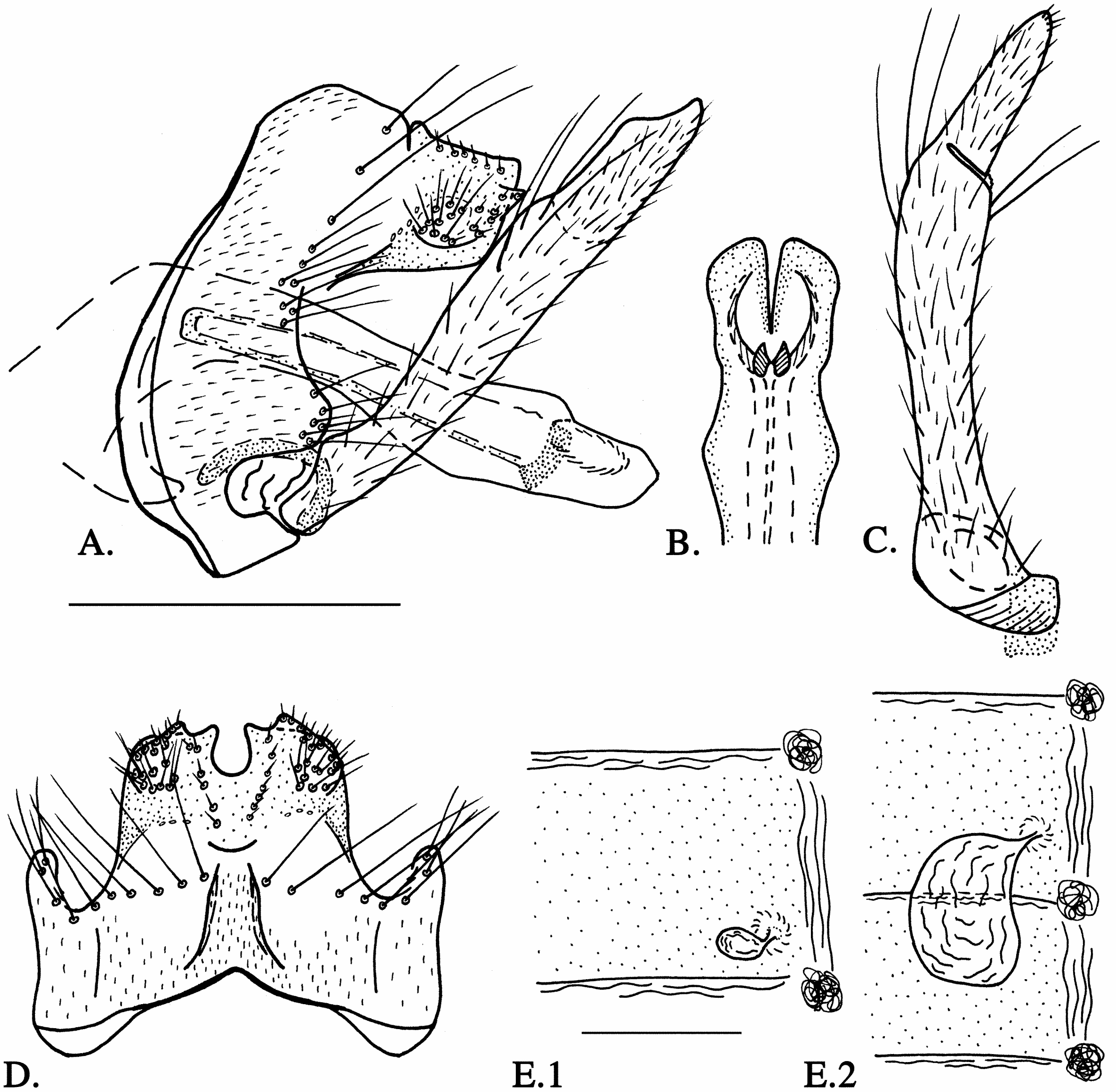


Figure 4.7. Adult male of *Hydropsyche californica*. Scale bars, 0.5 mm. A) left lateral view of terminalia, B) ventral view of phallobase apex, C) ventral view of left inferior appendage, D) dorsal view of terga IX and X, E.1) dorsal view of female abdominal sternum V left gland, E.2) dorsal view of male abdominal sternum V left gland

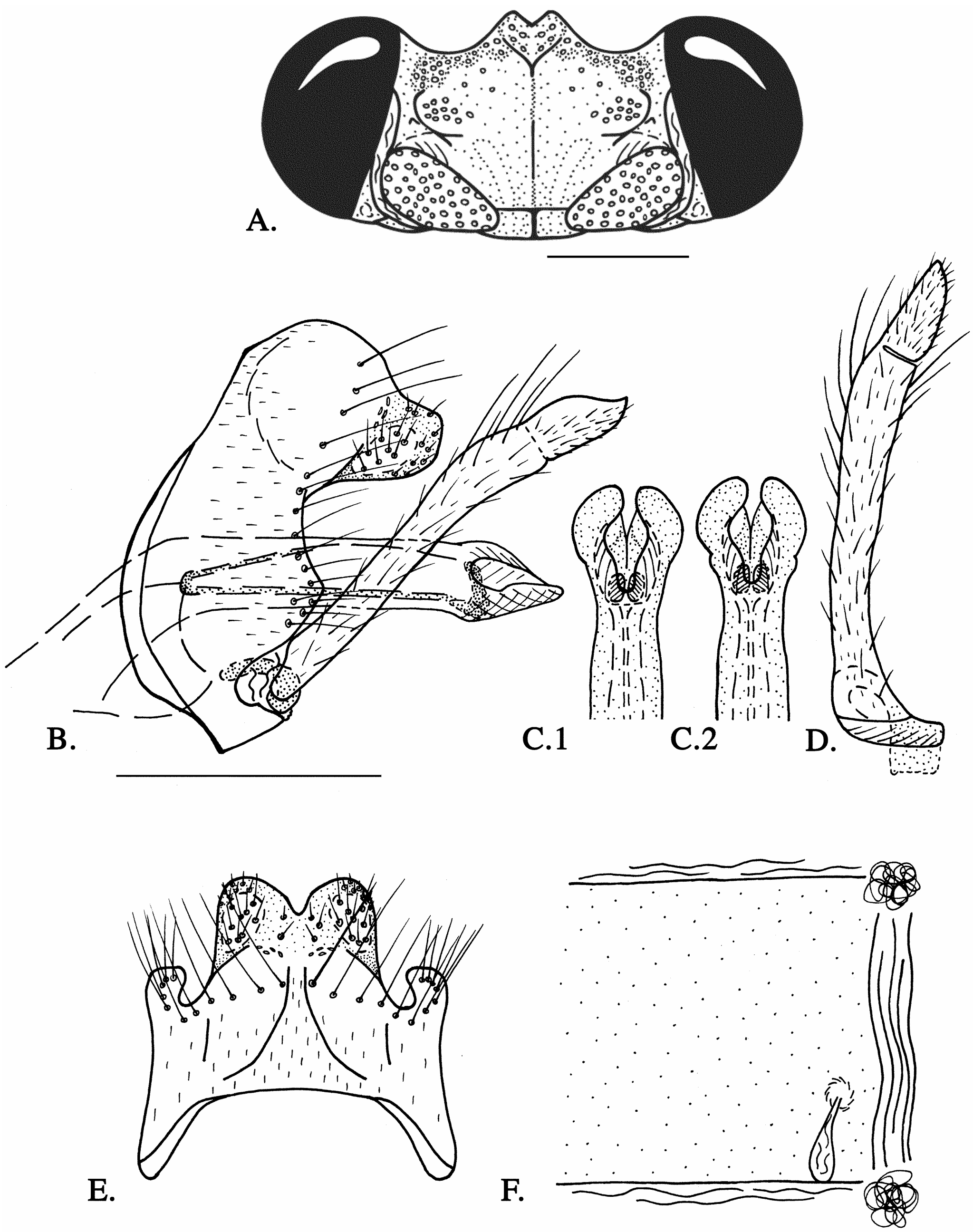


Figure 4.8. Adult male of *Hydropsyche catawba*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1-C.2) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

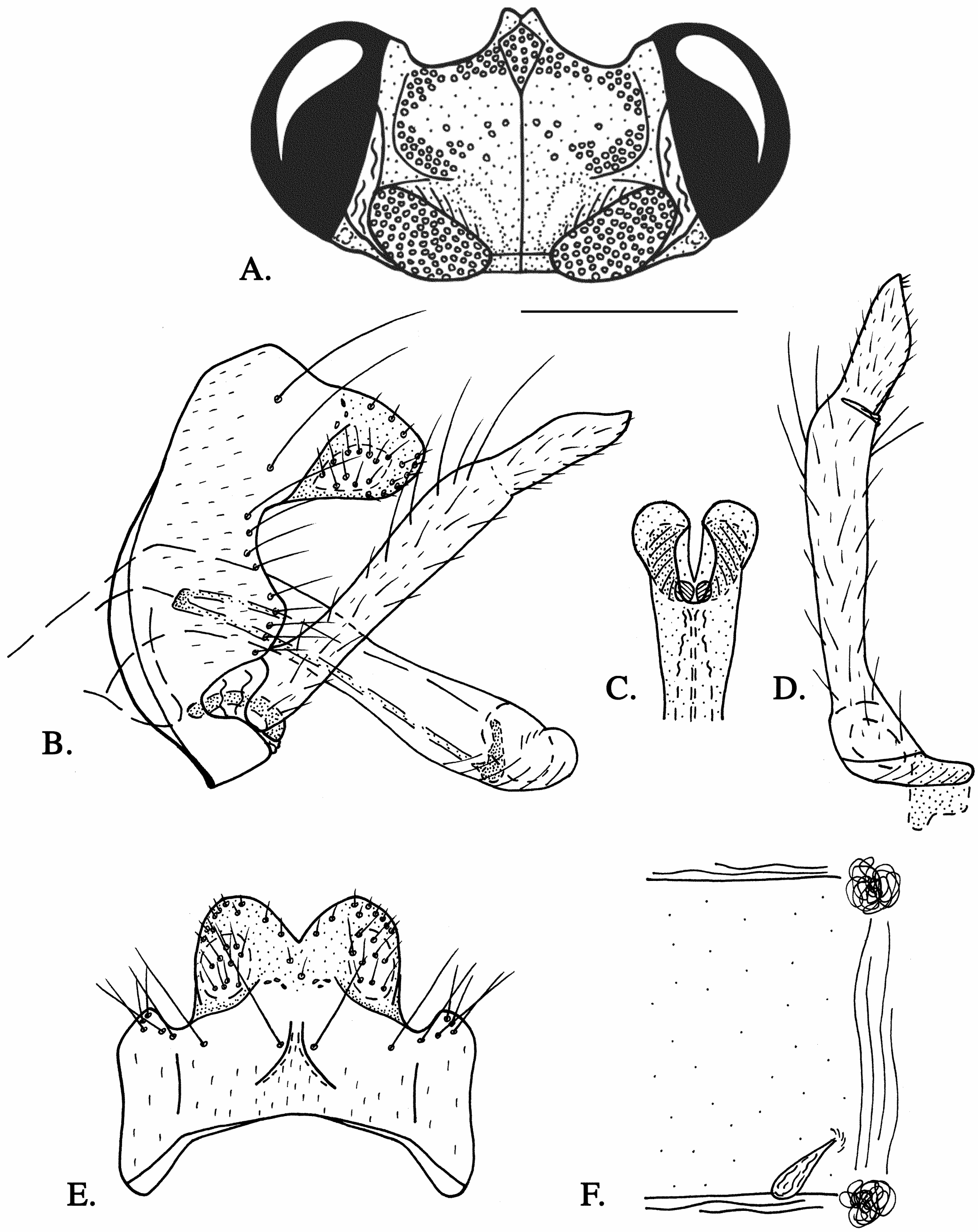


Figure 4.9. Adult male of *Hydropsyche delrio*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

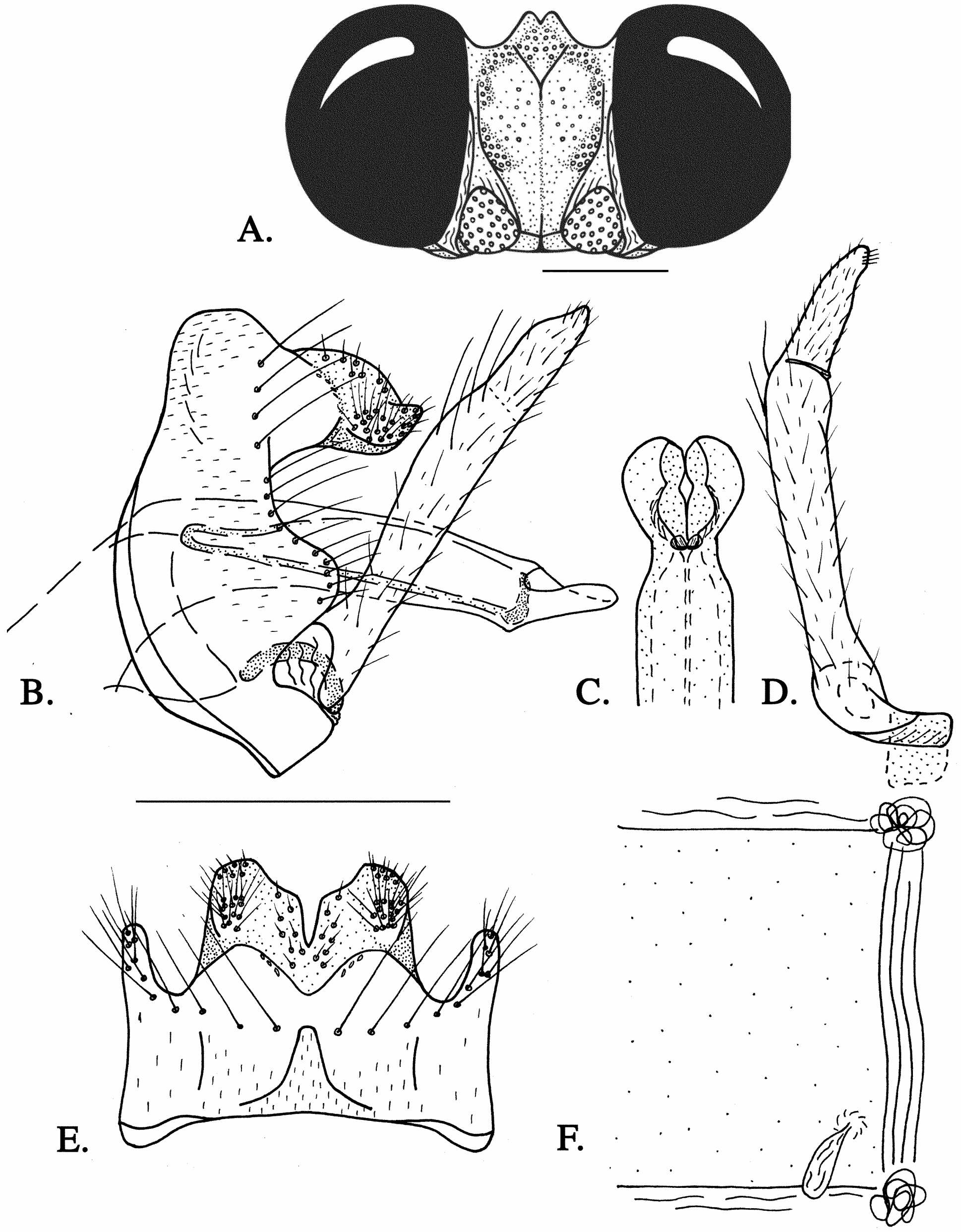


Figure 4.10. Adult male of *Hydropsyche demora*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

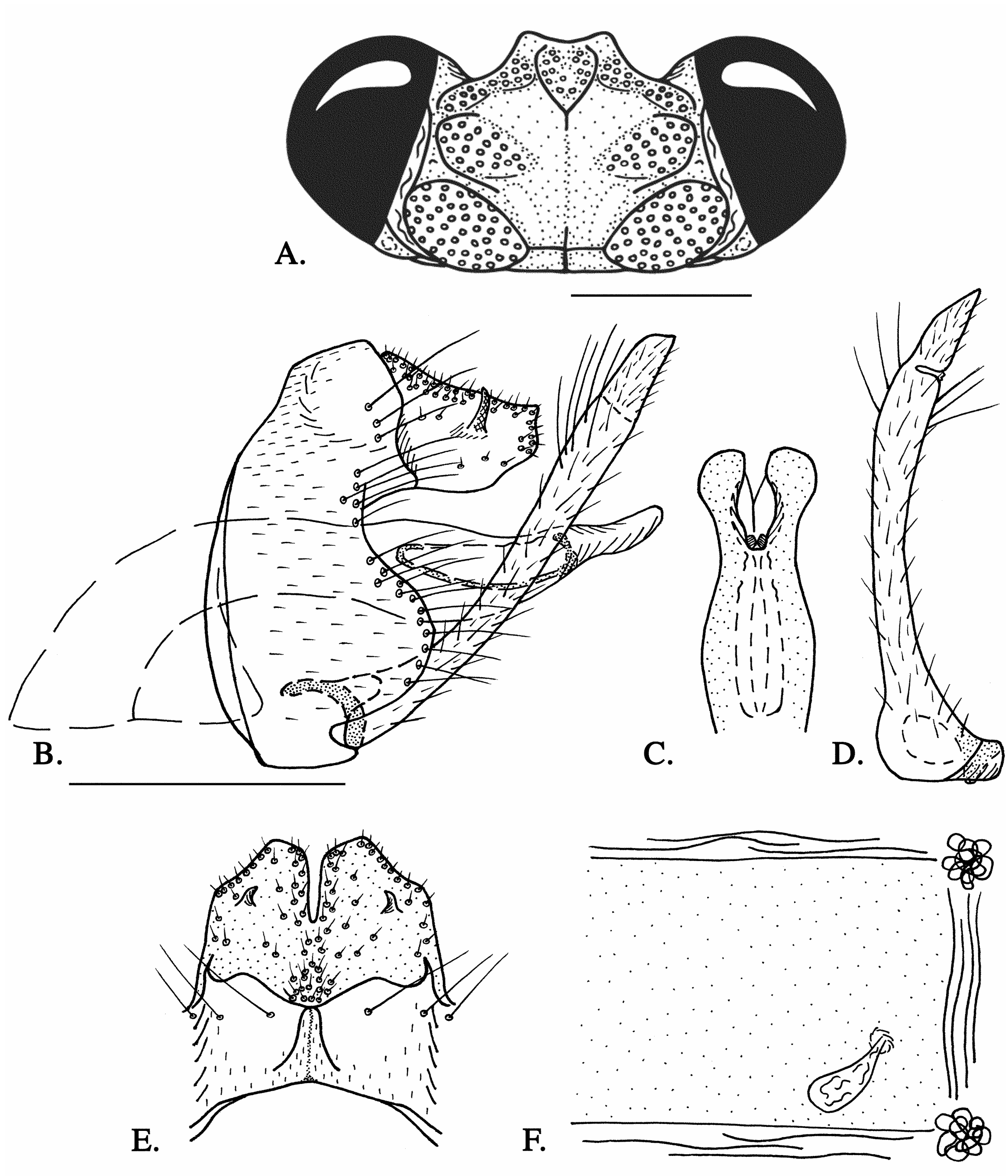


Figure 4.11. Adult male of *Hydropsyche dicantha*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

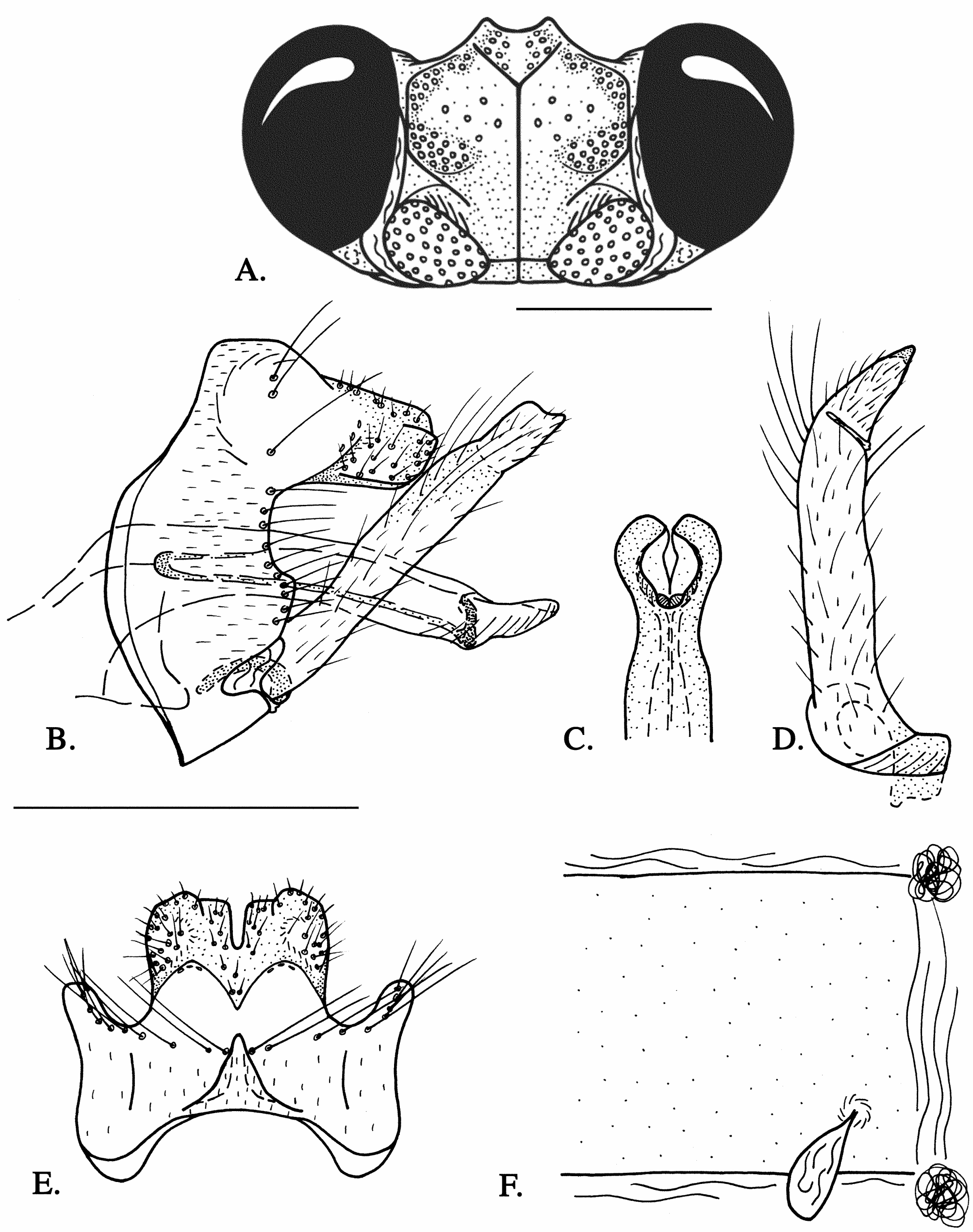


Figure 4.12. Adult male of *Hydropsyche fattigi*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

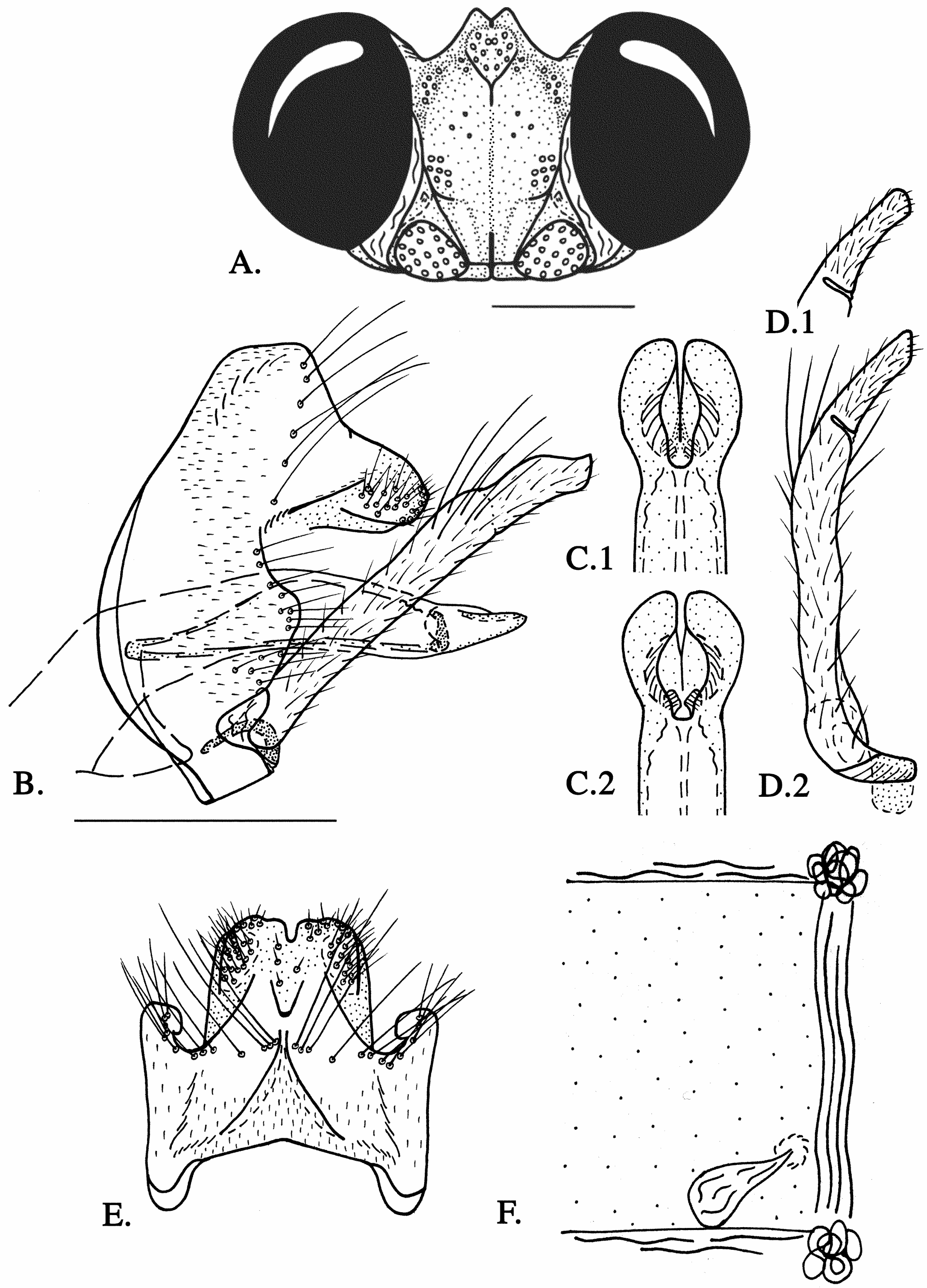


Figure 4.13. Adult male of *Hydropsyche franclemonti*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1-C.2) ventral view of phallobase apex, D.1-D.2) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

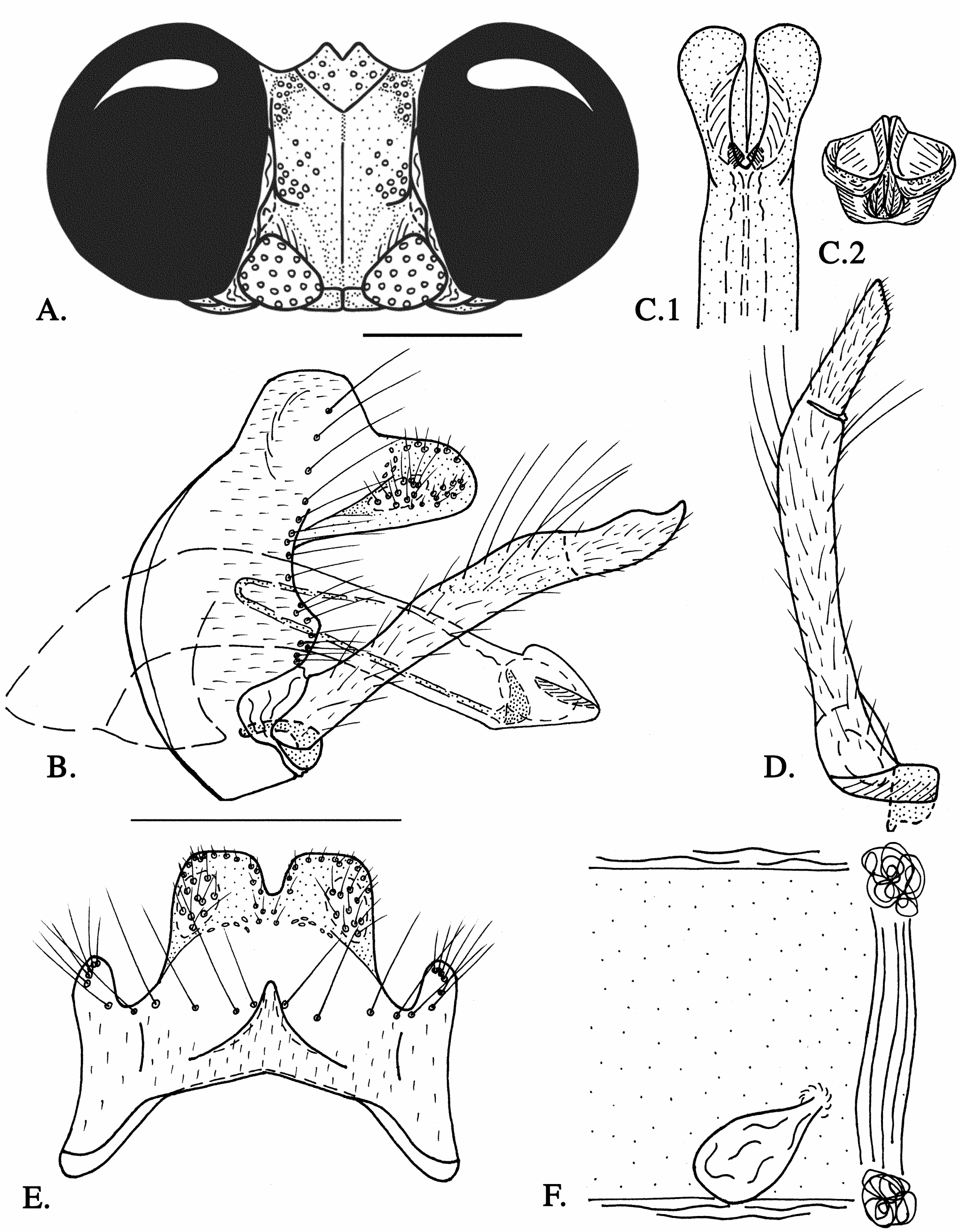


Figure 4.14. Adult male of *Hydropsyche frisoni*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1) ventral view of phallobase apex, C.2) Caudal view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

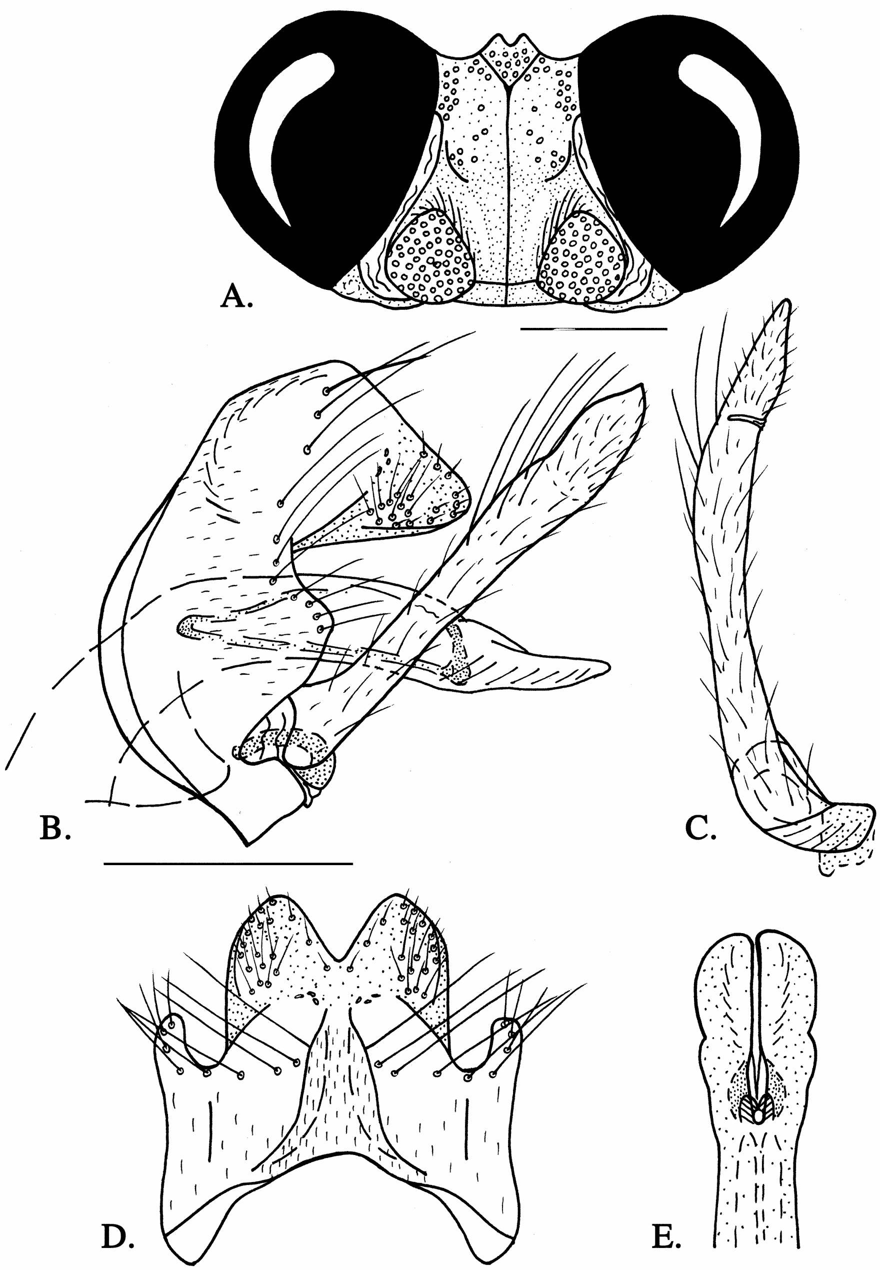


Figure 4.15. Adult male of *Hydropsyche hageni*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of left inferior appendage, D) dorsal view of terga IX and X, E) ventral view of phallobase apex.

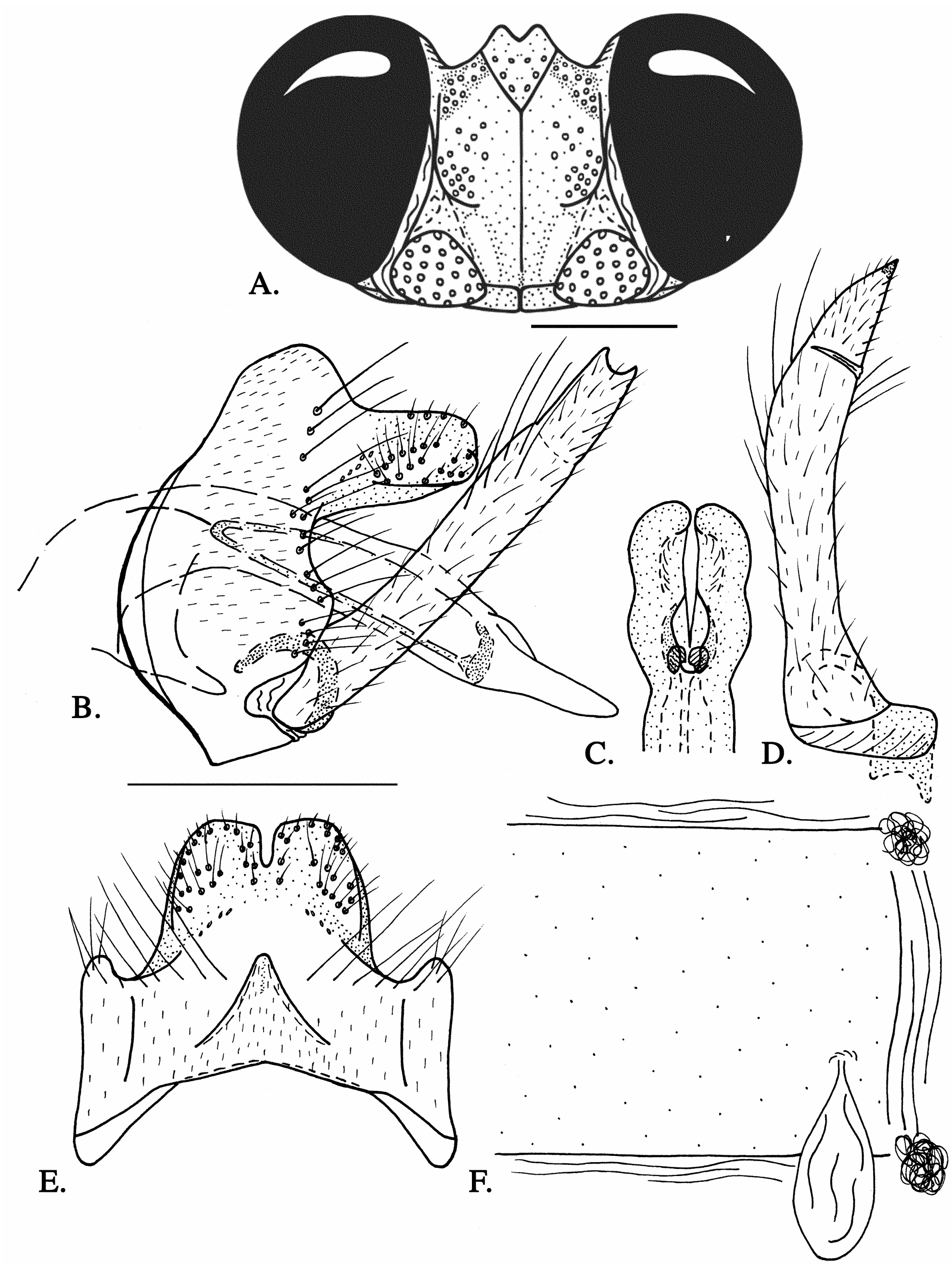


Figure 4.16. Adult male of *Hydropsyche hoffmani*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

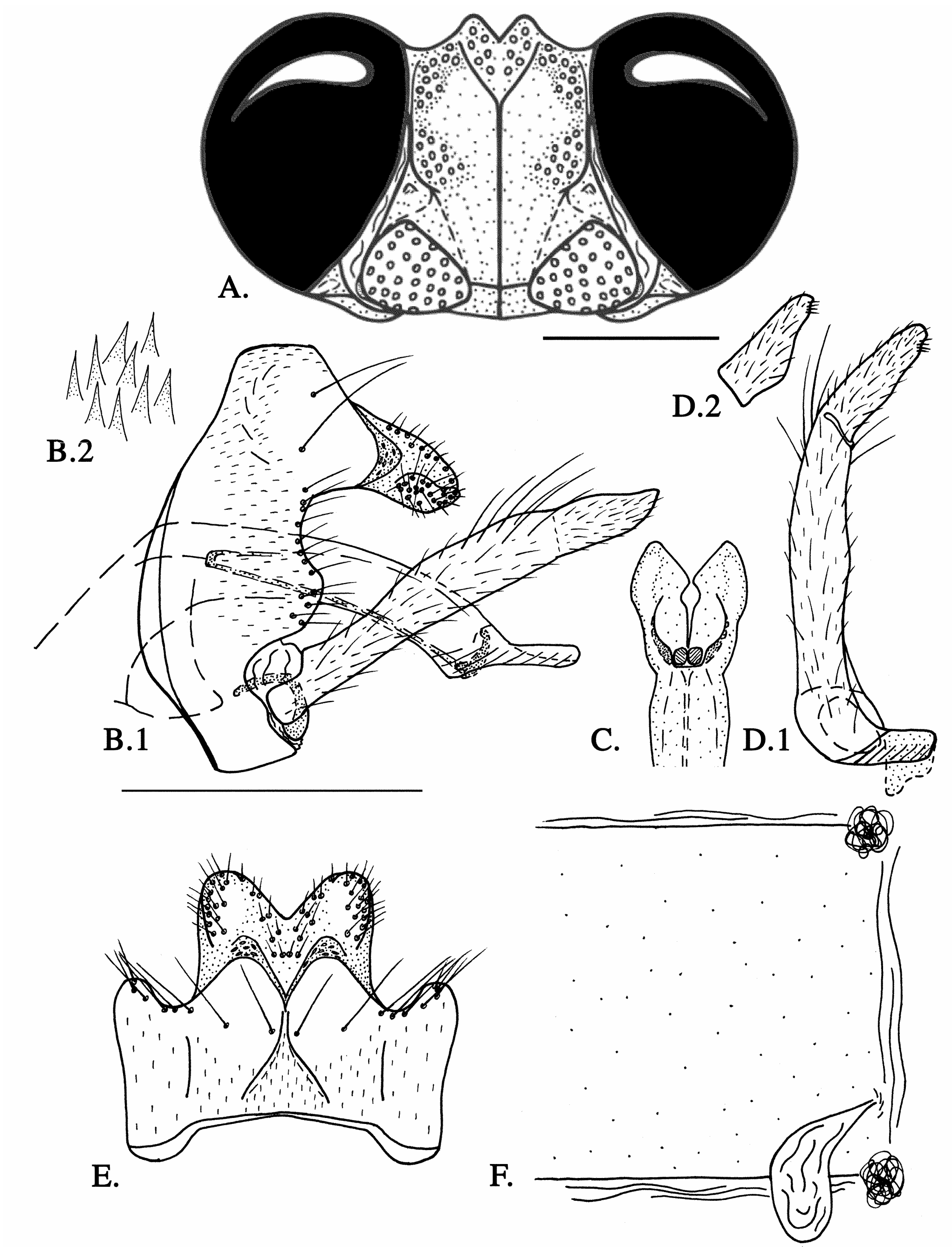


Figure 4.17. Adult male of *Hydropsyche impula*. Scale bars, 0.5 mm. A) Dorsal view of head, B.1) left lateral view of terminalia, B.2) microsculpturing of abdominal segment IX, C) ventral view of phallobase apex, D.1-D.2) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

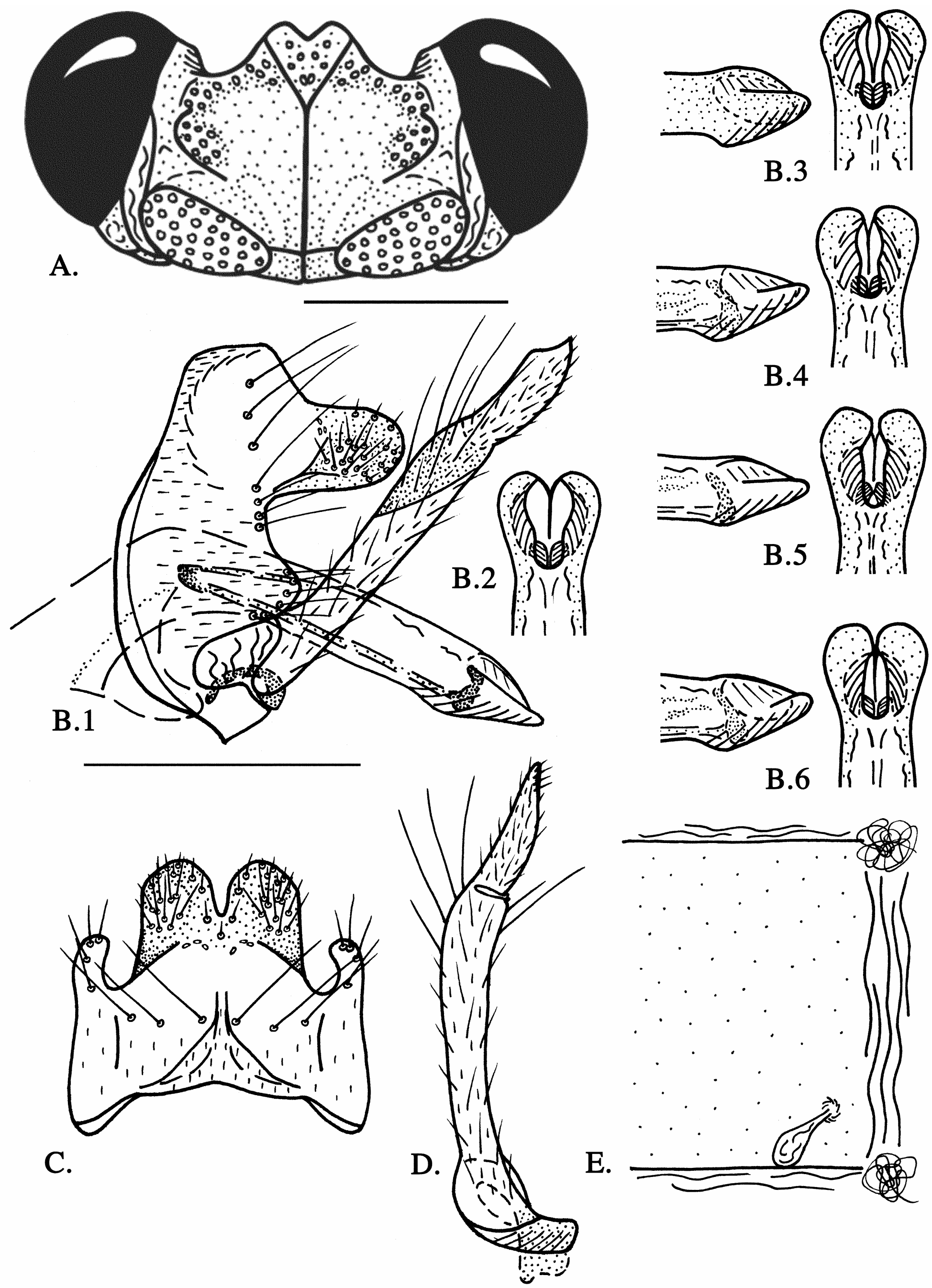


Figure 4.18. Adult male of *Hydropsyche incommoda*. Scale bars, 0.5 mm. A) Dorsal view of head, B.1) left lateral view of terminalia, B.2-B.6) variations of phallobase apex, C) dorsal view of terga IX and X, D) ventral view of left inferior appendage, E) dorsal view of abdominal sternum V left gland.

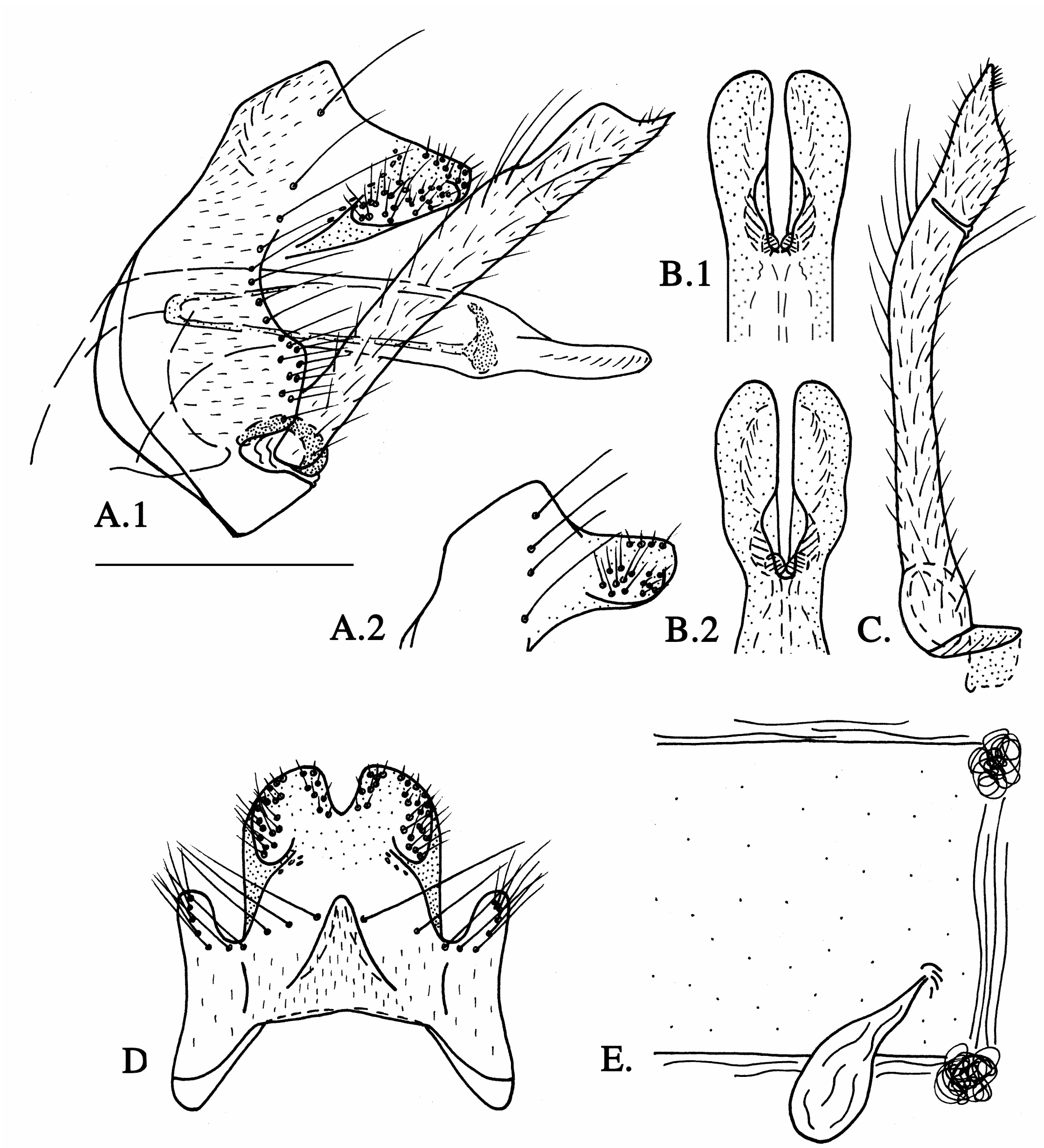


Figure 4.19. Adult male of *Hydropsyche leonardi*. Scale bars, 0.5 mm. A.1) left lateral view of terminalia, A.2) left lateral view of terga IX/X, B.1- B.2) ventral view of phallobase apex, C) ventral view of left inferior appendage , D) dorsal view of terga IX and X, E) dorsal view of abdominal sternum V left gland.

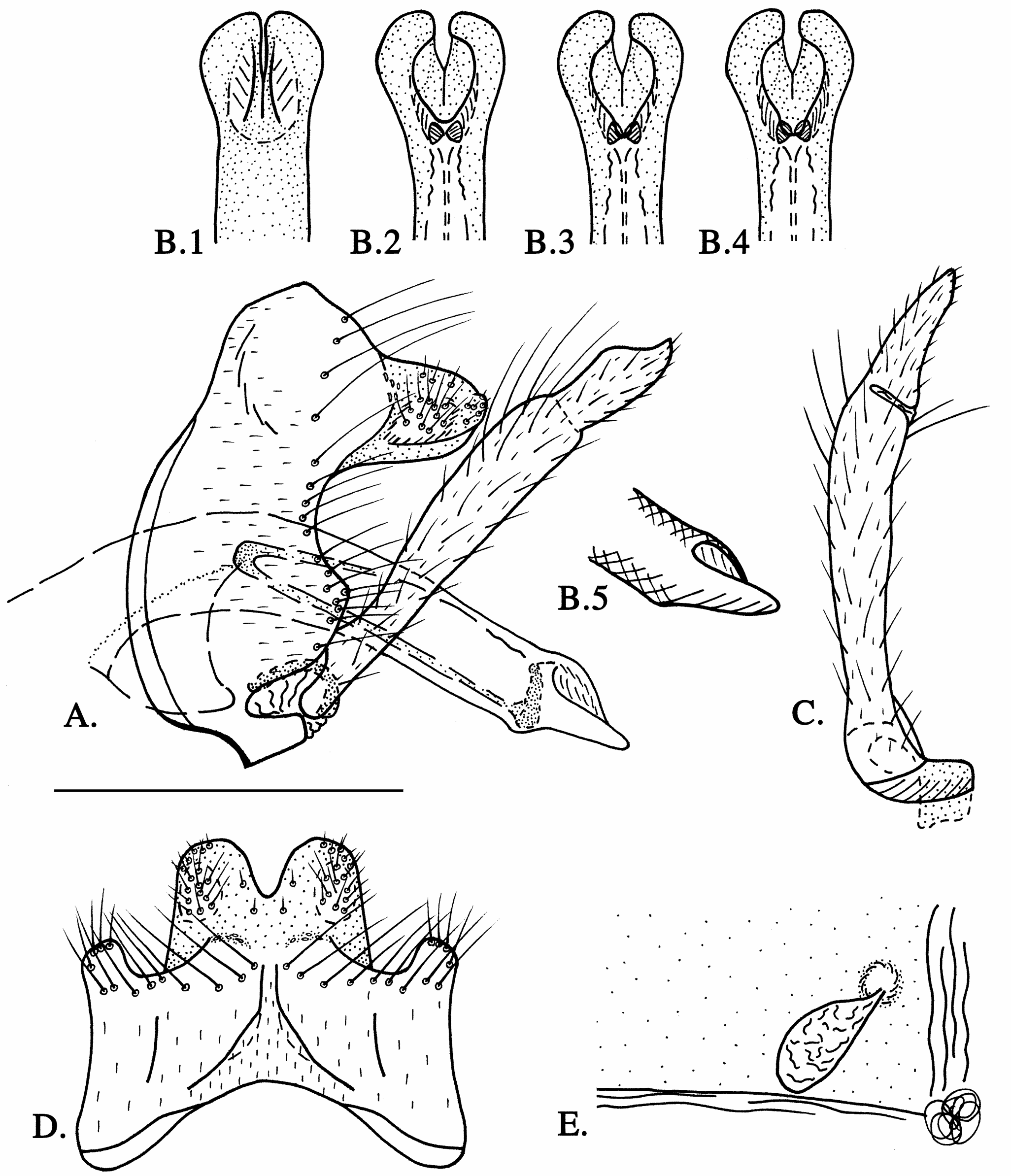


Figure 4.20. Adult male of *Hydropsyche mississippiensis*. Scale bars, 0.5 mm. A) left lateral view of terminalia, B.1) dorsal view of phallobase apex, B.2-B.4) ventral view of phallobase apex, B.5) left lateral view of phallus apex, C) ventral view of left inferior appendage , D) dorsal view of terga IX and X, E) dorsal view of abdominal sternum V left gland.

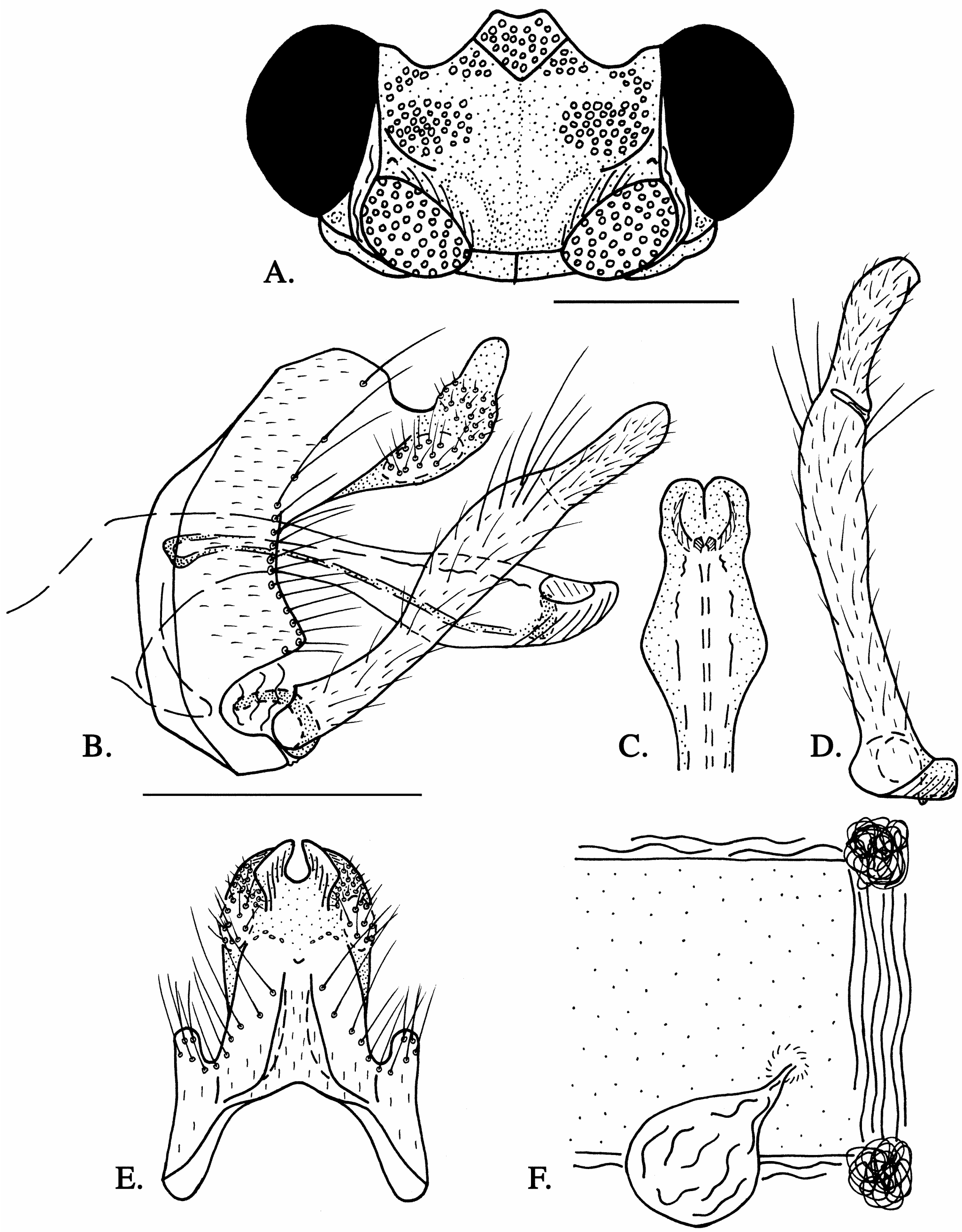


Figure 4.21. Adult male of *Hydropsyche* NA1. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

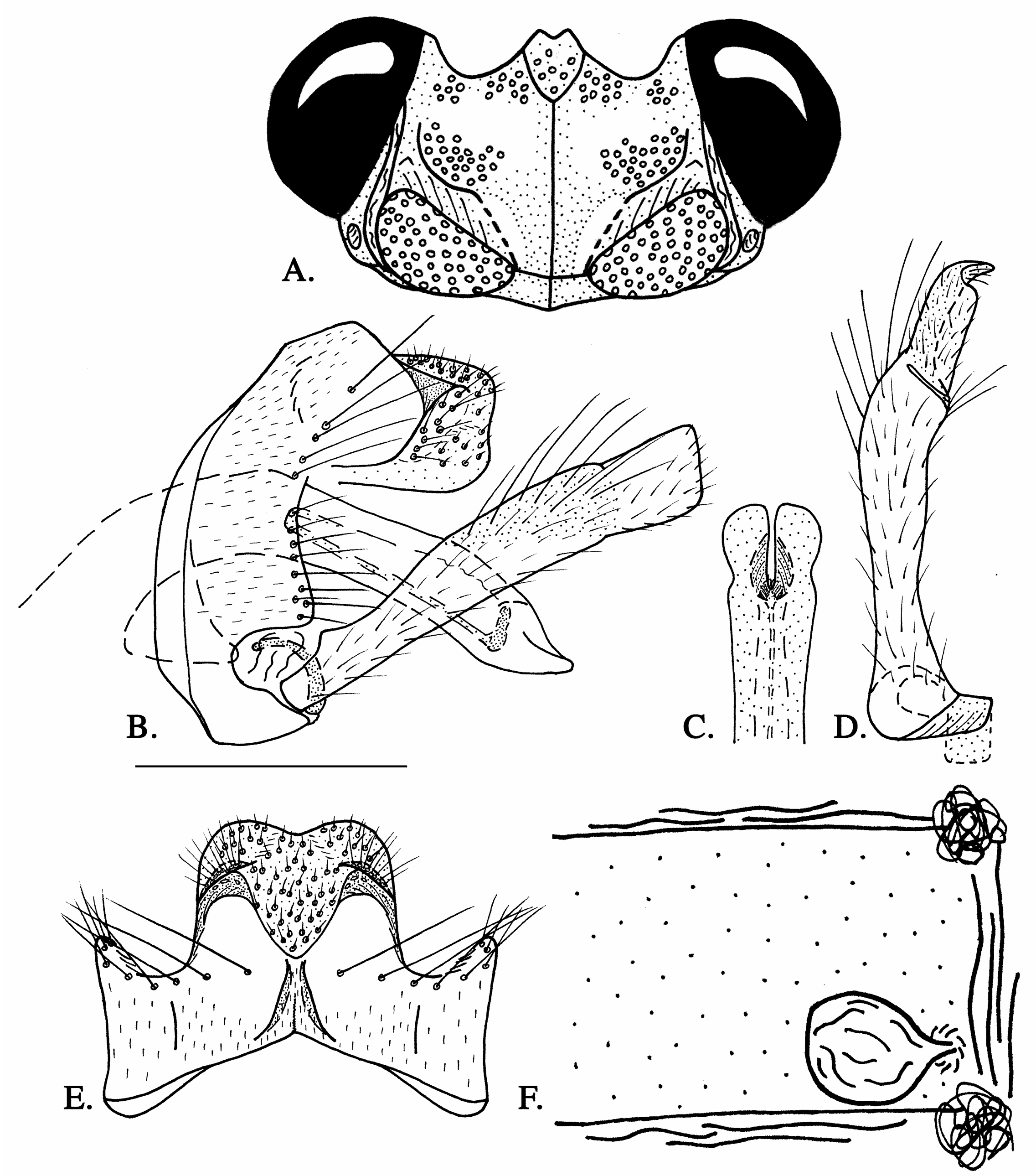


Figure 4.22. Adult male of *Hydropsyche occidentalis*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

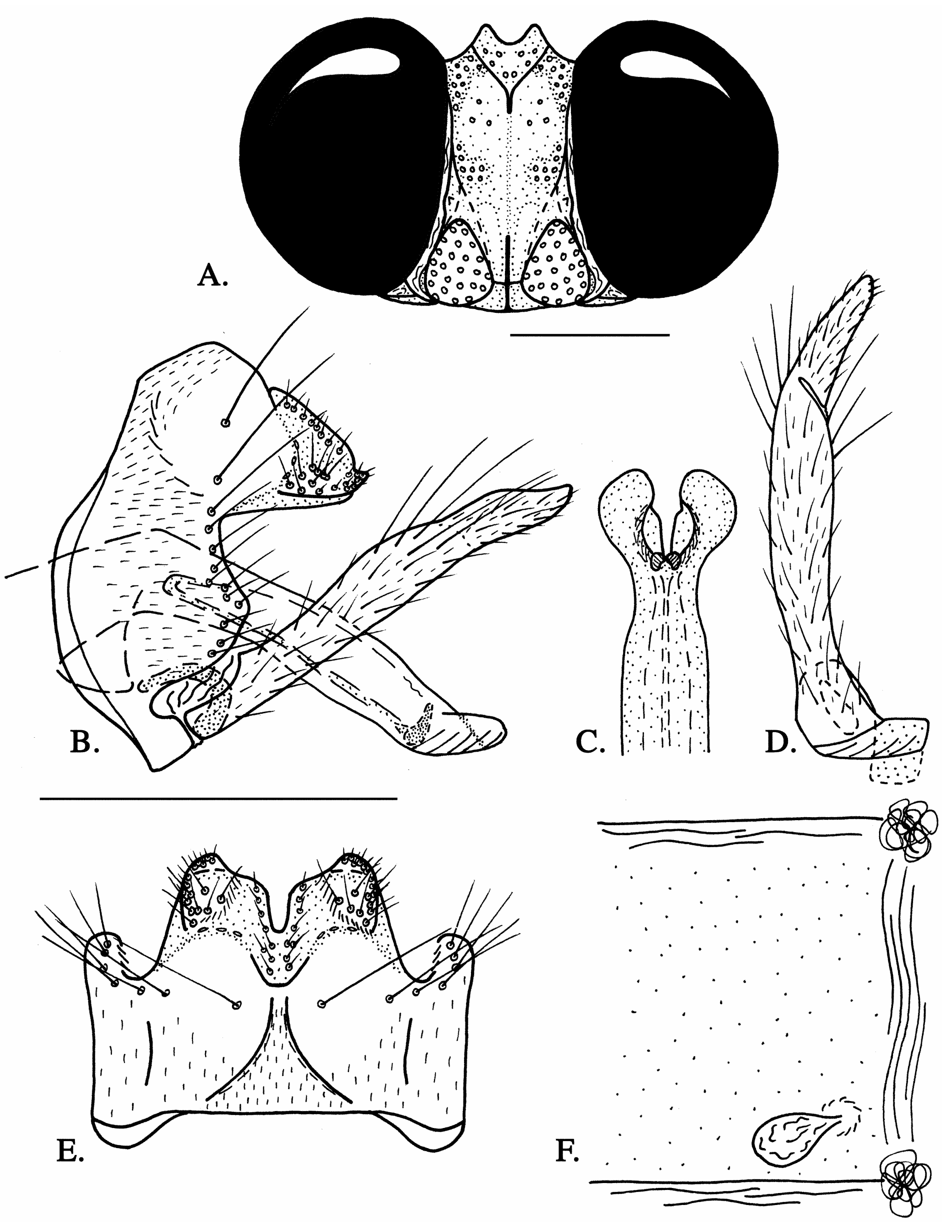


Figure 4.23. Adult male of *Hydropsyche opthalmica*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

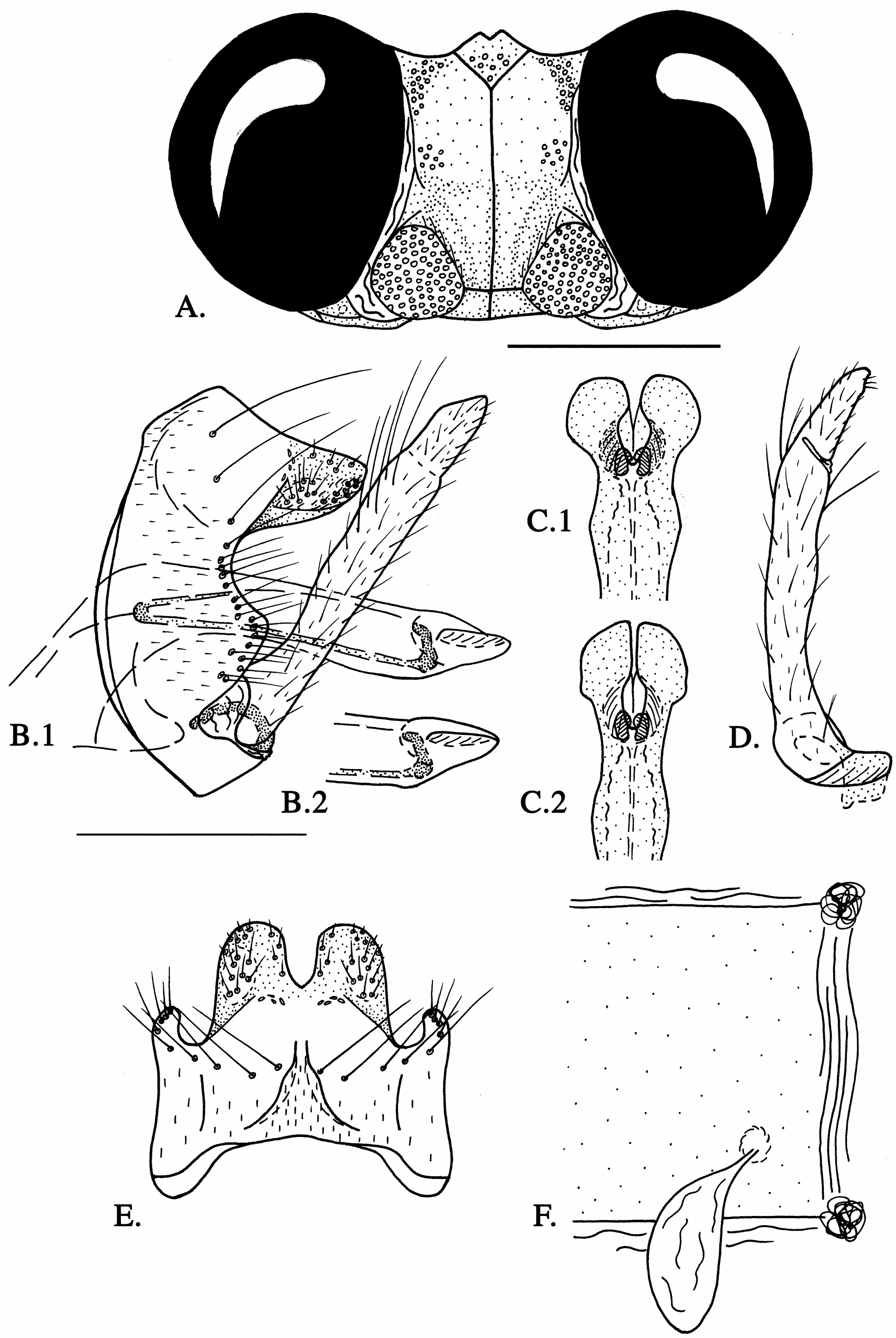


Figure 4.24. Adult male of *Hydropsyche patera*. Scale bars, 0.5 mm. A) Dorsal view of head, B.1) left lateral view of terminalia, B.2) left lateral view of phallus apex, C.1-C.2) ventral view of phallobase apex, D) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

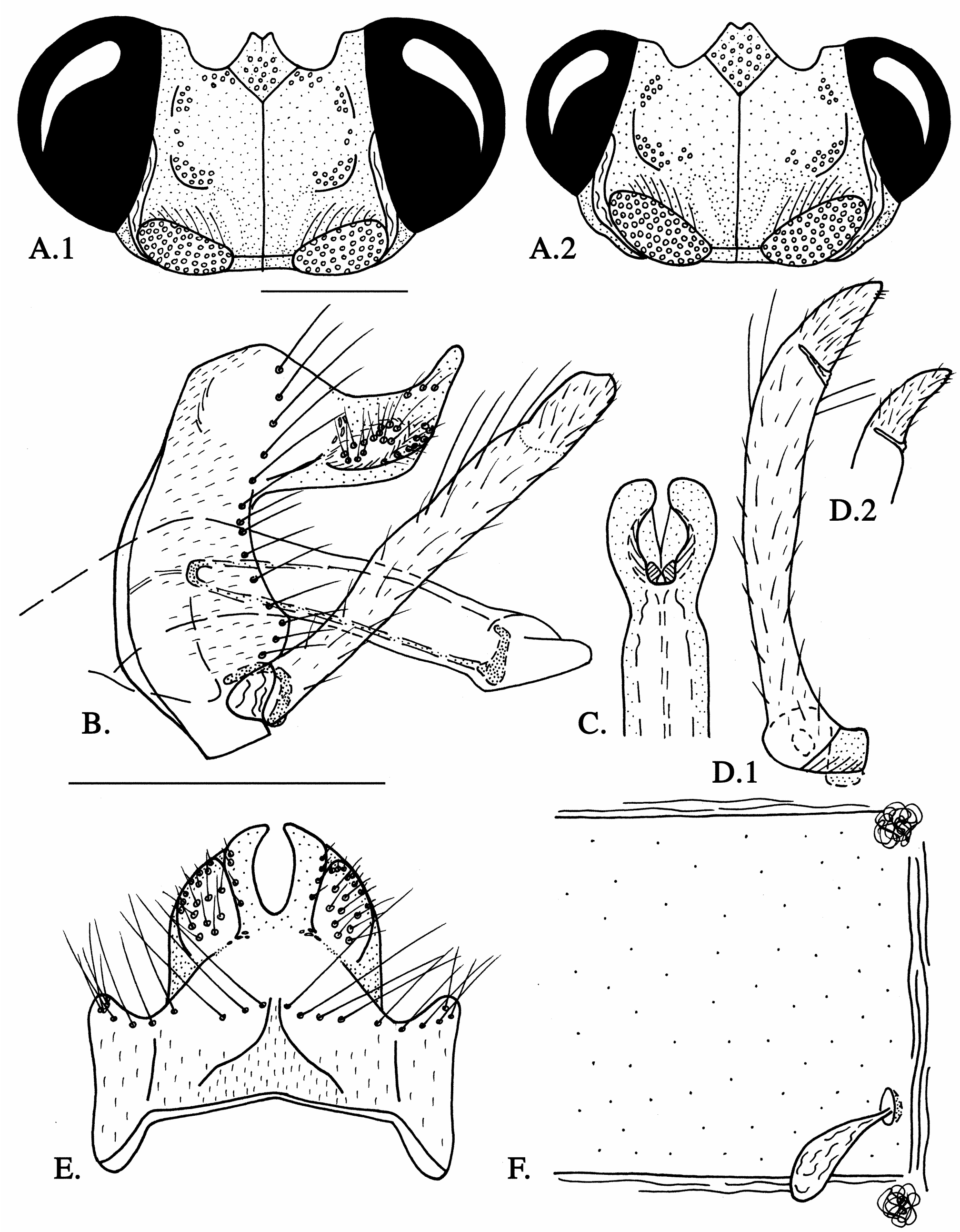


Figure 4.25. Adult male of *Hydropsyche phalerata*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of phallobase apex, D.1-D.2) ventral view of left inferior appendage, E) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

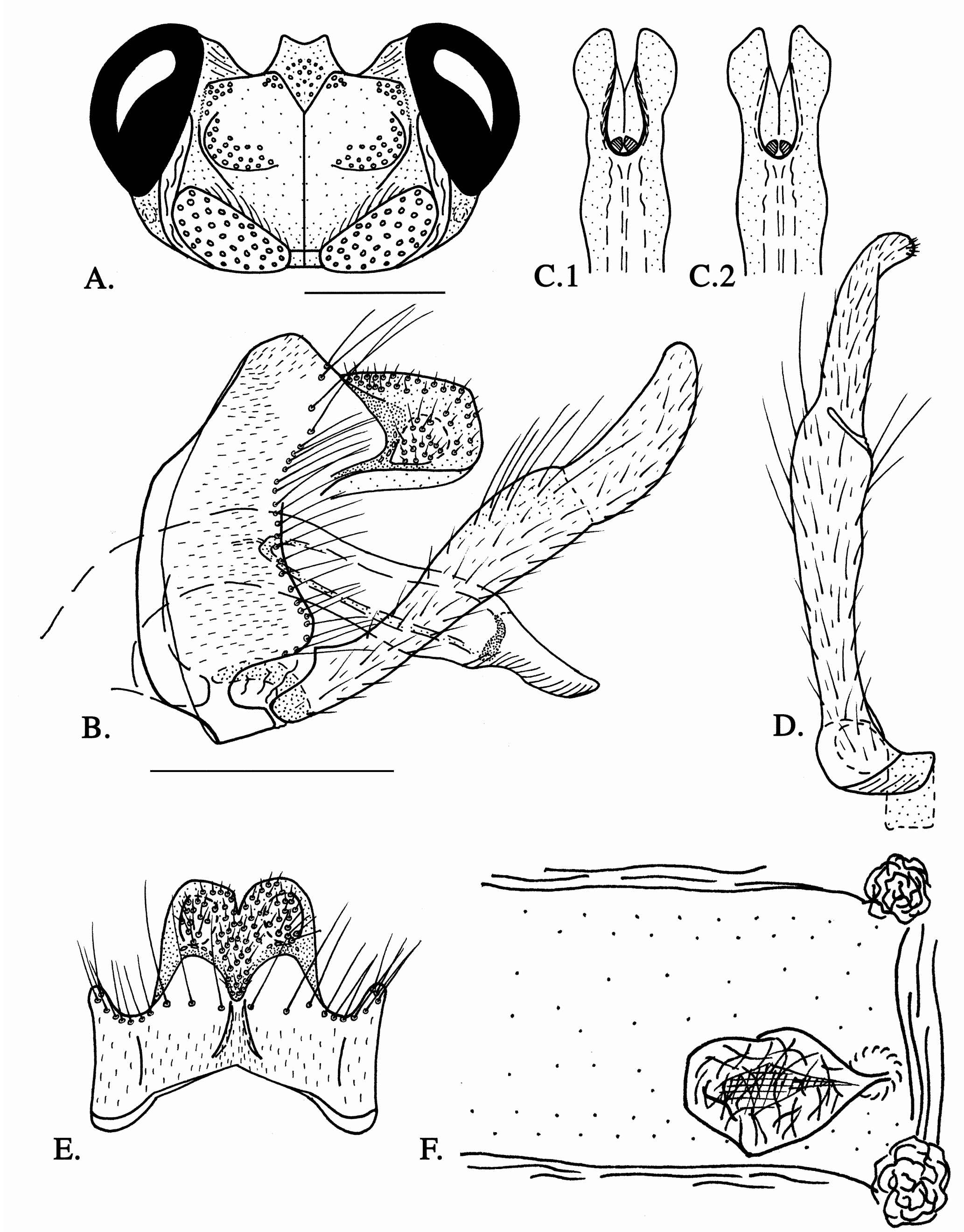


Figure 4.26. Adult male of *Hydropsyche philo*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1-C.2) ventral view of phallobase apex , D) ventral view of left inferior appendage, E)) dorsal view of terga IX and X, F) dorsal view of abdominal sternum V left gland.

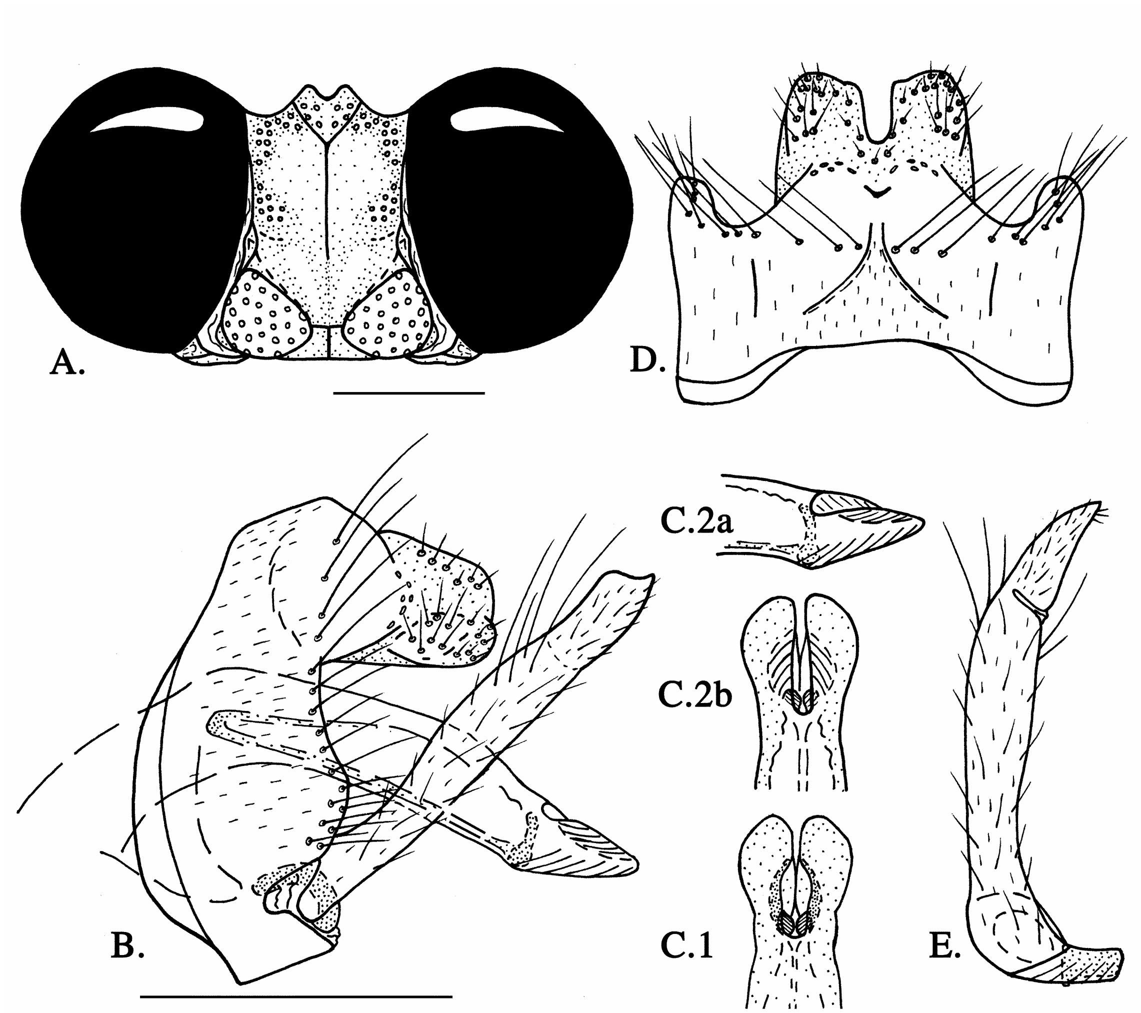


Figure 4.27. Adult male of *Hydropsyche placoda*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C.1-C.2) ventral view of phallobase apex , D) dorsal view of terga IX and X, E) ventral view of left inferior appendage.

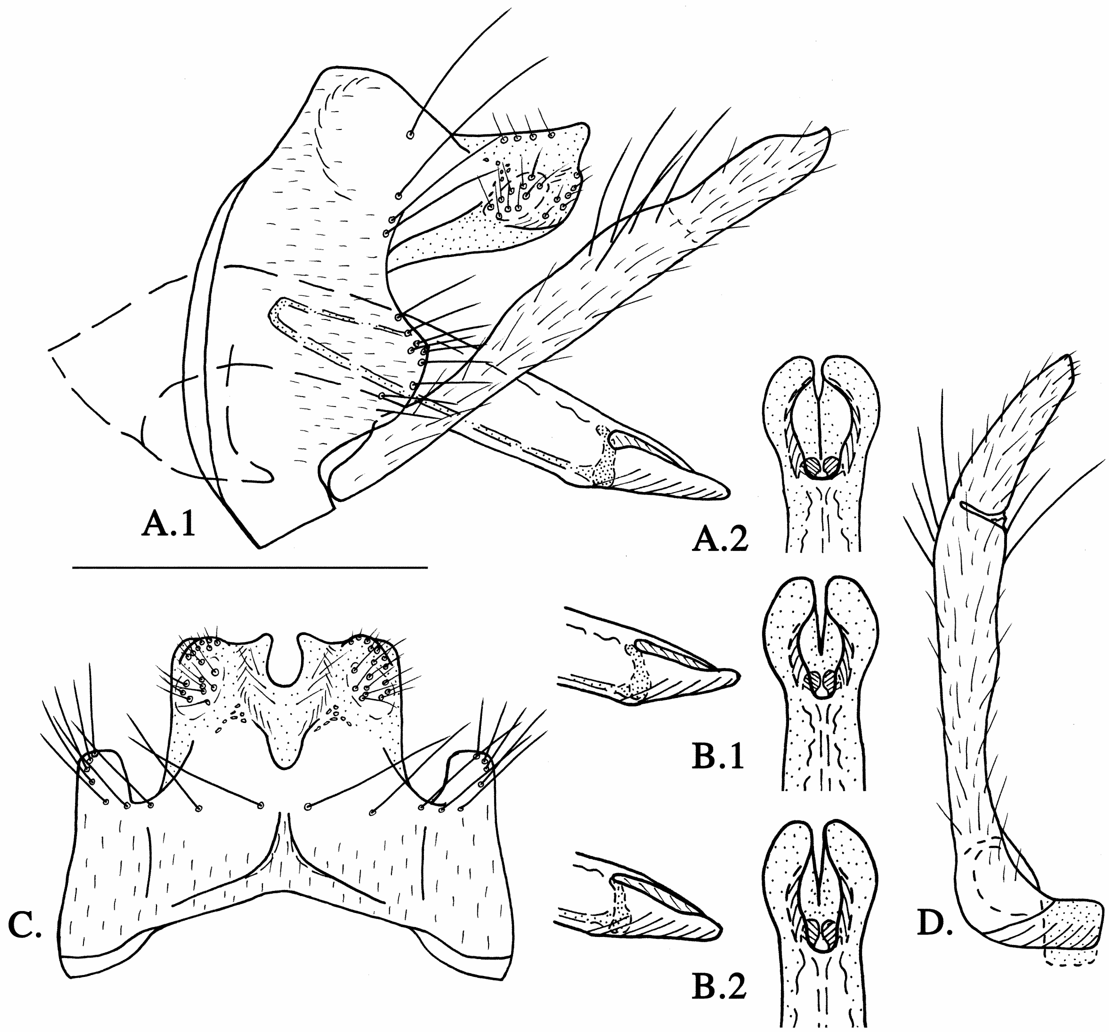


Figure 4.28. Adult male of *Hydropsyche simulans*. Scale bar, 0.5 mm. A.1) left lateral view of terminalia, A.2) ventral view of terminalia, B.1-B.2) ventral view of phallobase apex , D) ventral view of left inferior appendage, E) dorsal view of terga IX and X.

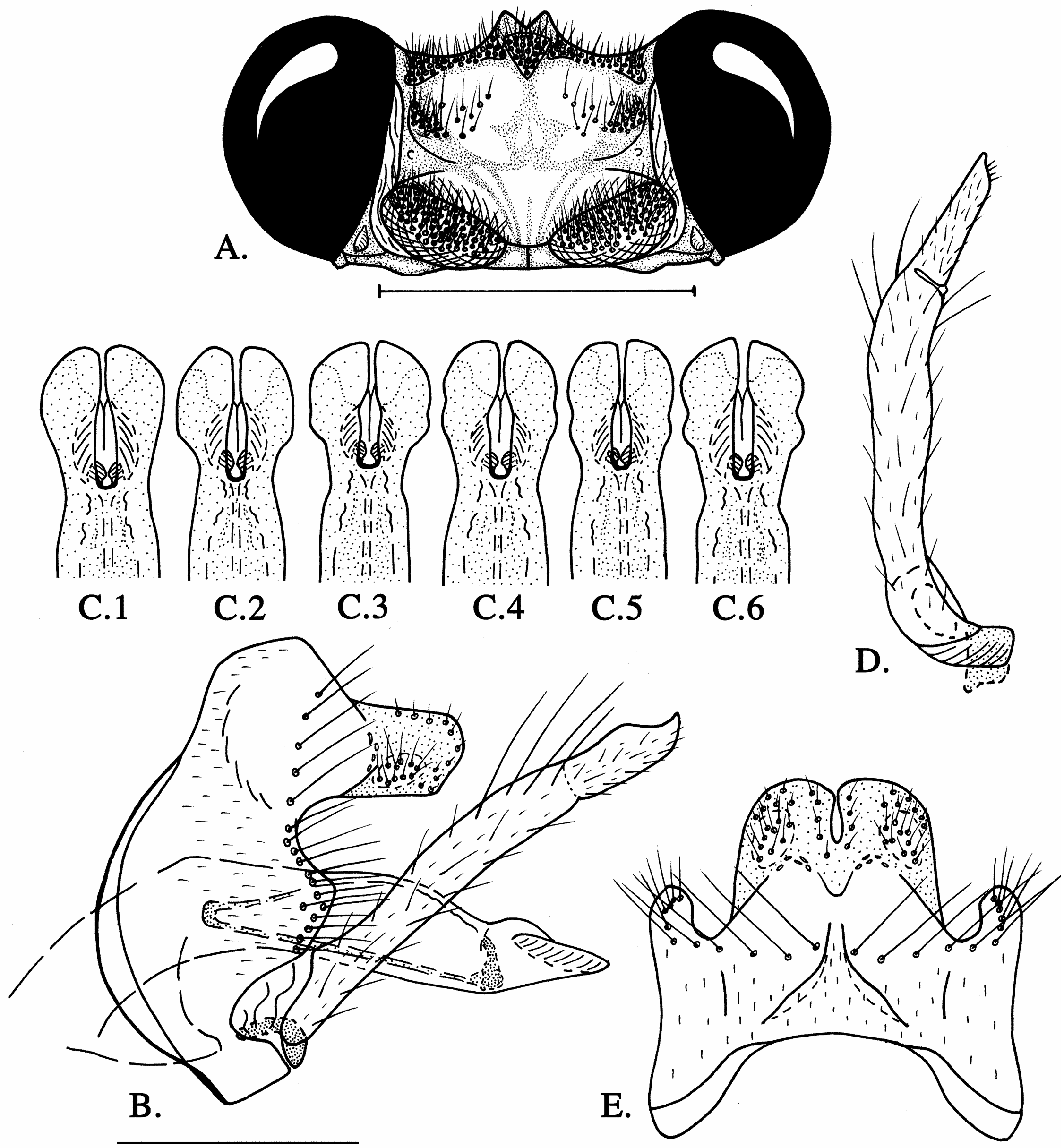


Figure 4.29. Adult male of *Hydropsyche scalaris*. Scale bar, 0.5 mm. A.) Dorsal view of head, B) left lateral view of terminalia, C.1-C.6) ventral view of phallobase apex D) ventral view of left inferior appendage, E) dorsal view of terga IX and X.

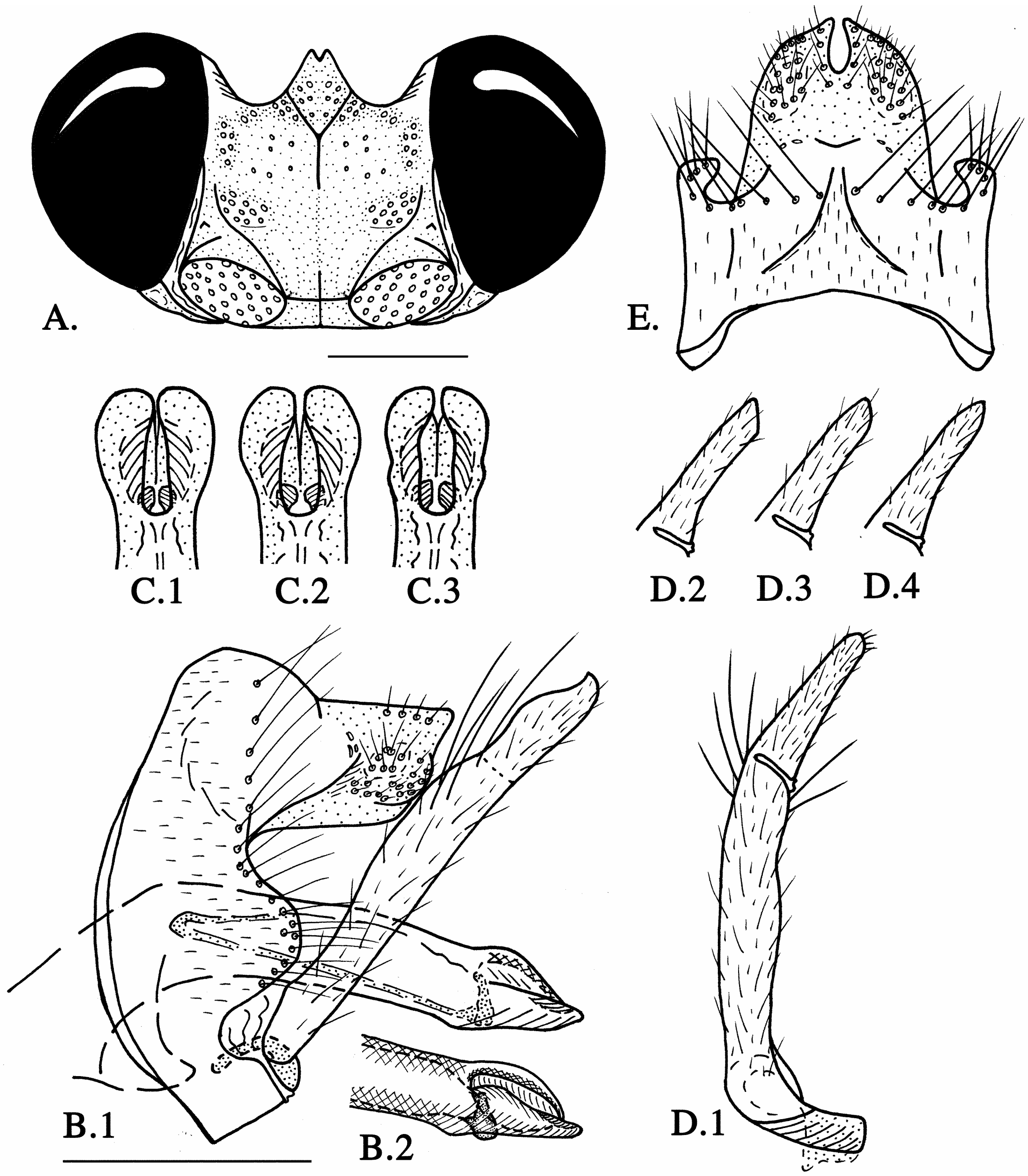


Figure 4.30. Adult male of *Hydropsyche simulans*. Scale bars, 0.5 mm. A) Dorsal view of head B.1-2) left lateral view of terminalia, C.1-C.3) ventral view of phallobase apex, D.1-D.4) ventral view of left inferior appendage, E) dorsal view of terga IX and X.

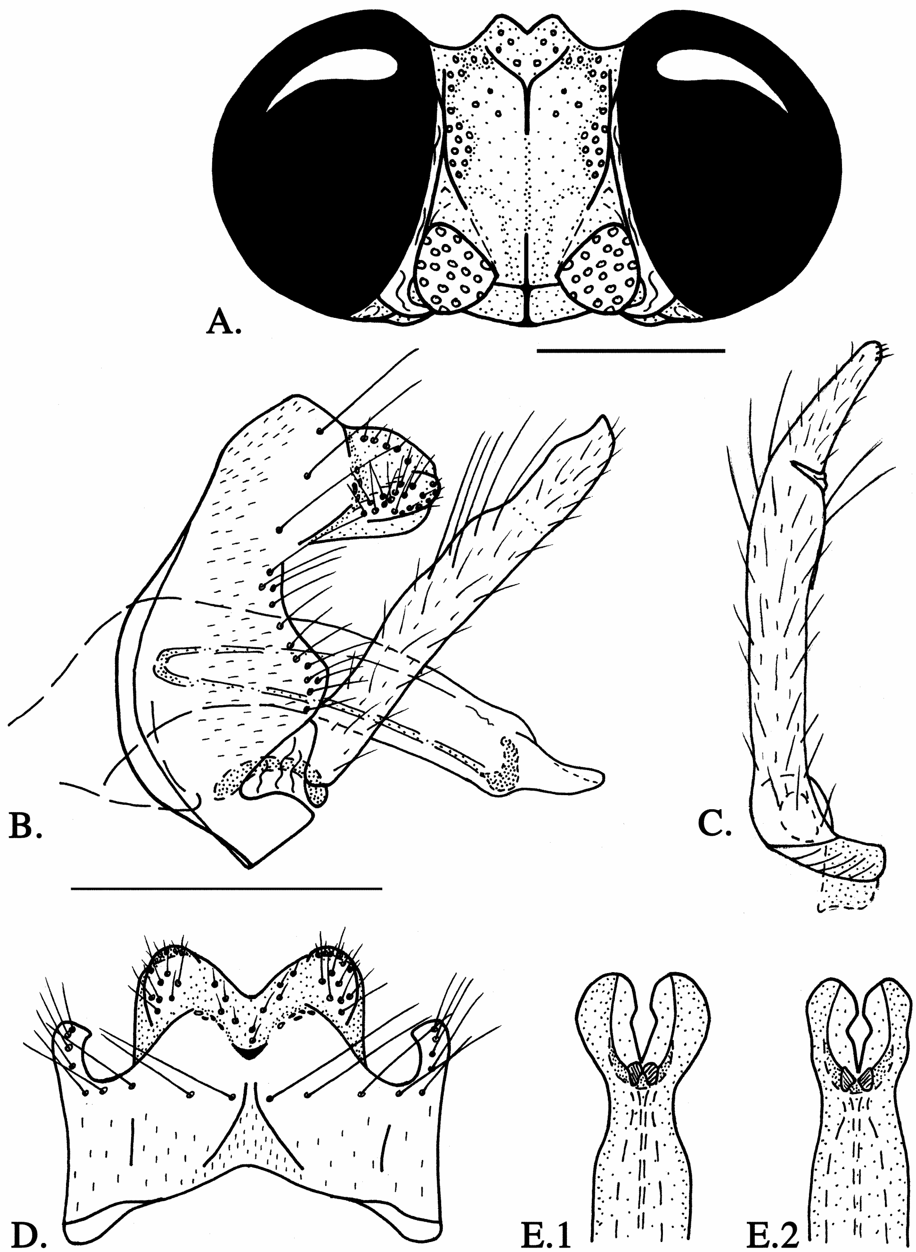


Figure 4.31. Adult male of *Hydropsyche valanis*. Scale bars, 0.5 mm. A) Dorsal view of head, B) left lateral view of terminalia, C) ventral view of left inferior appendage, D) dorsal view of terga IX and X, E.1-E.2) ventral view of phallobase apex.

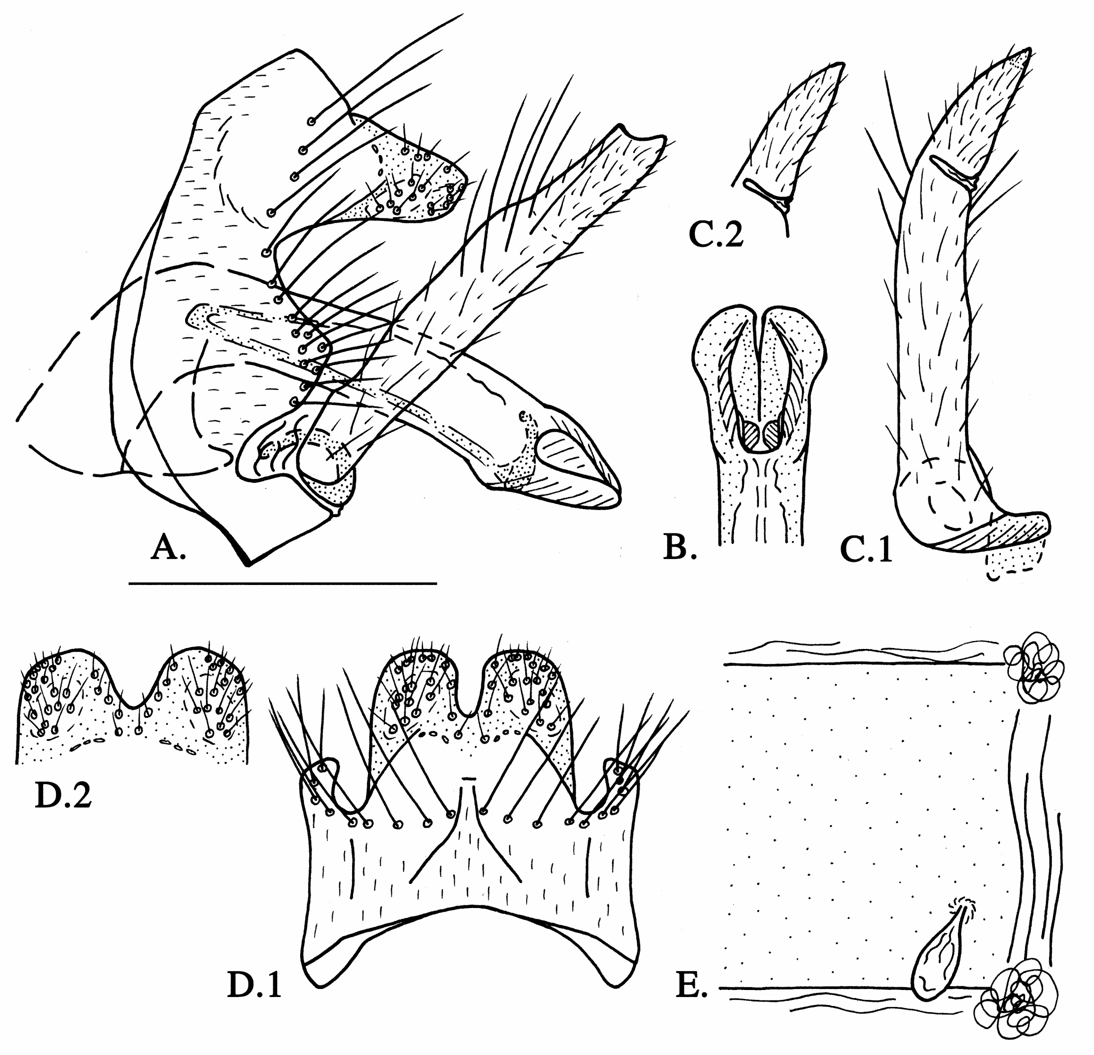


Figure 4.32. Adult male of *Hydropsyche venularis*. Scale bars, 0.5 mm. A) left lateral view of terminalia, B) ventral view of phallobase apex, C.1-C.2) ventral view of left inferior appendage, D.1) dorsal view of terga IX and X, D.2) dorsal view of tergum X, E) dorsal view of abdominal sternum V left gland.

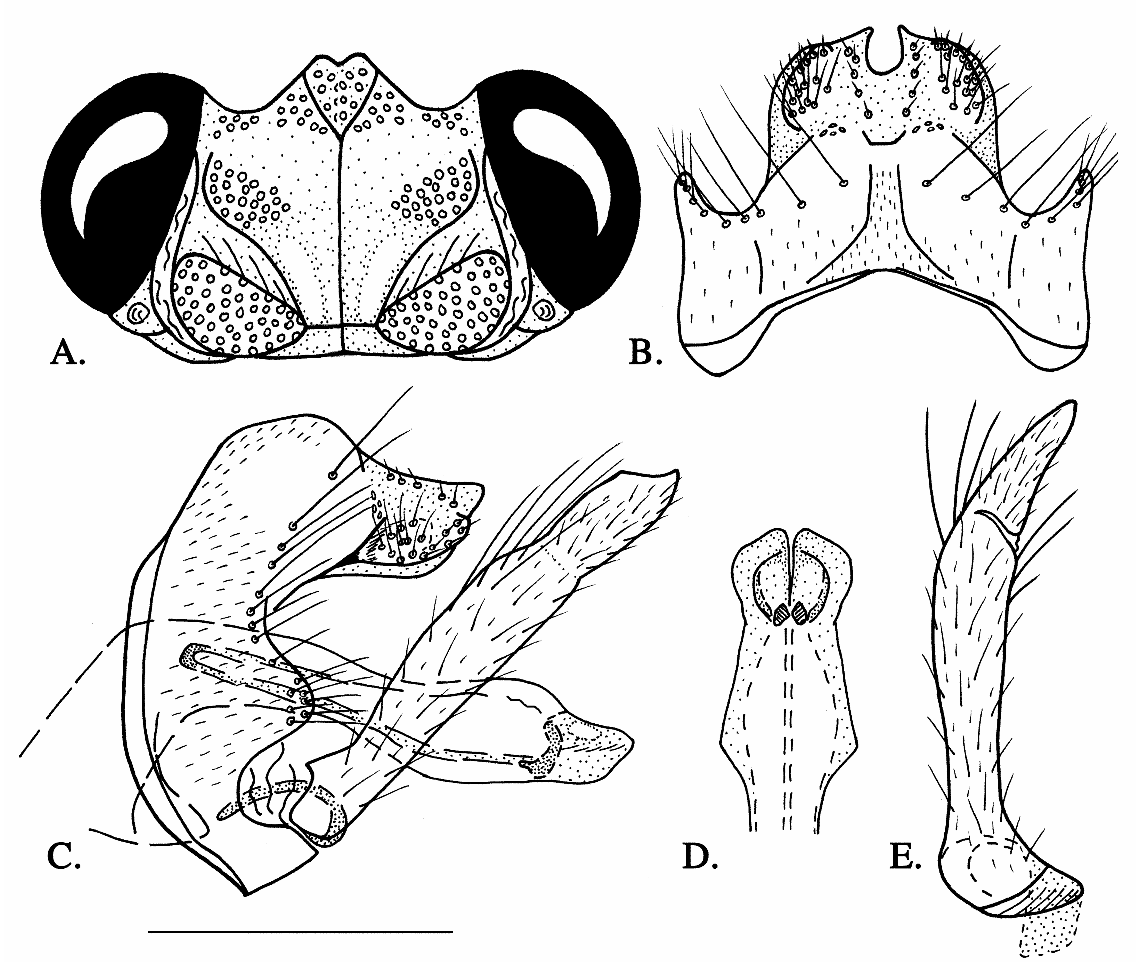


Figure 4.33. Adult male of *Hydropsyche winema*. Scale bars, 0.5 mm. A) Dorsal view of head, B) dorsal view of terga IX and X, C) left lateral view of terminalia, D) ventral view of phallobase apex, E) ventral view of left inferior appendage.

Appendix C

Key to the adult males of the North American

Hydropsyche scalaris Group

KEY TO THE ADULT MALES OF THE NORTH AMERICAN *Hydropsyche scalaris* GROUP

1. Interocular width broad, greater than eye width. Occipital setal warts transverse, greater than half eye width, often equal to or greater than width of eye (fig. 4.22A; fig. 4.29A; fig. 4.30A) 2

1'. Interocular width narrow, less than or equal to eye width. Occipital setal warts variable, usually ovaliform or subglobose; width less than half diameter of the eye (fig. 4.1A; fig. 4.3A; fig. 4.27A) 22

2(1). Tergum X with posteromesal lobes that project posterodorsad (fig. 4.2B; fig. 4.6B; fig. 4.21B)..3

2'. Tergum X with distal margin truncate or rounded, without posteromesal lobes that project posterodorsad (fig. 4.26B; fig. 4.12B) 7

3(2). Harpagones with apex acute, tip pointed or ogival in ventral view; Dorsoanterior margin excised in dorsolateral view (fig. 4.2D,B; fig. 4.25D, B) 4

3'. Harpagones with apex obtuse, tip rounded or truncate in ventral view; rounded in lateral view (fig. 4.6D,B; fig. 4.21D,B) 6

4(3). Eye width 0.38-0.48 mm, 0.44 mm. Interocular width:cephalic width 0.37-0.44, 0.41. Occipital wart:eye width 0.69-0.9, 0.76 ....*H. phalerata*

4'. Eye width 0.25-0.33mm, 0.32 mm. Interocular width:cephalic width 0.53-0.58, 0.54. Occipital wart:eye width 1.0-1.2, 1.1 ....*H. alabama*

6(3'). Phallobase constricted proximally, subapically swollen. Subapicomesal cavity opening orbicular. Sternal gland enlarged, one half as long as abdominal segment V (fig. 4.21)..*H.* NA1

6'. Phallobase of uniform width. Subapicomesal cavity opening of phallobase obpyriform. Sternal gland small, one fourth as long as abdominal segment V (fig. 4.6)..*H. brunneipennis*

7(2'). Phallobase swollen subapically (fig. 4.33C, D; fig. 4.11B, C; fig. 4.26C).........8

7'. Phallobase of uniform width (fig. 4.22C; fig. 4.8C) 14

8(7). Tergum X with distal margin truncate or obliquely truncate (fig. 4.26B; fig. 4.33C). Subapicomesal cavity opening of cleft phallobase orbicular (fig. 4.4B; fig. 4.7B) 9

8'. Tergum X with distal margin rounded or irregular, if truncate then subapicomesal opening of cleft phallobase not orbicular (fig. 4.9B, E; fig. 4.11B, E). Subapicomesal cavity opening of cleft phallobase oblong, obpyriform, or U-shaped (fig. 4.9C; fig. 4.11C; fig. 4.26C)............................11

9(8). Harpagones rectangular in ventral view with tip truncate (fig. 4.4C). Abdominal sternum V glands enlarged, each approximately as long as abdominal segments IV and V (fig. 4.4E.2). Southwestern species ....*H. auricolor*

9'. Harpagones not rectangular in ventral view, tip rounded or ogival (fig. 4.7C; fig. 4.33E). Abdominal sternum V glands approximately as long as abdominal segment V (fig. 4.7E.2). Northwestern species...10

10(9’). Phallobase with subapical swelling moniliform, lateral margins often angled sharply (fig.4.7B). Eye width 0.4-0.49 mm, 0.44 mm. Occipital wart:eye width 0.8-0.98, 0.88 .... *H. californica*

10’. Phallobase with subapical swelling spatulate, proximal phallobase constricted (fig. 4.33D). Eye width 0.3-0.33 mm, 0.32 mm. Occipital wart:eye width 1.2. Oregon .... *H. winema*

11(8’). Tergum X with dorsolateral spines, distal margin irregular (fig. 4.11B, E). Subapicomesal cavity opening of cleft phallobase obpyriform, subapicomesal cavity ovaliform. Inverted phallicata less than half as long as phallobase (fig. 4.11B,C) .... *H. dicantha*

11’. Tergum X without dorsolateral spines, distal margin rounded or truncate (fig. 4.9B, E; fig. 4.26B, E). Subapicomesal cavity opening of cleft phallobase obpyriform, oblong or U-shaped. Subapicomesal cavity orbicular or U-shaped. Inverted phallicata greater than half as long as phallobase 12

12(11’). Harpagones saber-shaped in lateral view, approximately one third as long as coxopodites (fig 4.3B; fig. 4.8B). Tergum X with dorsum sparsely setose, setae usually forming a single row (fig. 4.3E; fig. 4.9E). Subapicomesal cavity opening of cleft phallobase obpyriform or oblong. Subapicomesal cavity orbicular (fig. 4.3C; fig. 4.9C) 13

12’. Harpagones sickle-shaped in lateral view, approximately half as long as coxopodites (fig. 4.26B). Tergum X with dorsum densely setose, setae scattered (fig. 4.26B, E). Subapicomesal cavity opening of cleft phallobase and subapicomesal cavity U-shaped .... *H. philo*

13(12). Harpagones falcate with mesal margin convex in ventral view (Fig. 4.18D). Phallobase with subapical swelling moniliform. Subapicomesal cavity opening of cleft phallobase oblong, 2 to 2.5 times as long as wide (Fig. 4.9C); occasionally similar to Fig. 4.18B.4. Apicolateral lobes of cleft phallobase subglobose (fig.4.18B). Texas and Mexico.. *H. delrio*

13'. Harpagones not falcate, mesal margin straight or concave in ventral view. Phallobase with subapical swelling subquadrate. Subapicomesal cavity opening of cleft phallobase obpyriform. Apicolateral lobes of cleft phallobase wedge shaped. Carina present on apicodorsal roof (fig. 4.3)............. *H. arinale*

14(7'). Harpagones subtriangular or falcate in ventral view; mesal margin concave, occasionally straight; tip pointed forming acute angle (Fig. 4.8D; Fig. 4.12D; fig. 4.18 D; fig. 4.19C)...15

14'. Harpagones variable, rectangular, sub-rectangular, or scoop-shaped; mesal margin concave or straight, not convex; tip obliquely truncate, truncate, ogival, or rounded (fig. 4.20C; fig. 4.22D; fig. 4.30D)..18

15(14). Harpagones falcate...16

15'. Harpagones subtriangular...17

16(15). Phallobase with apicolateral lobes elongate, extending posterad beyond subapicomesal cavity 1.5 to 2 times length of subapicomesal cavity; dorsoventrally depressed (fig. 4.19).. *H. leonardi*

16'. Phallobase with apicolateral lobes not elongate, extending posterad beyond subapicomesal cavity 0.5 times the length of subapicomesal cavity or less;

wedge-shaped. Subapicomesal cavity opening of phallobase variable, linear to obpyriform (fig. 4.18)..*H. incommoda*

17(14'). Apicodorsal roof convex, dorsal carina present. Tergum X short, approximately as long as wide. Abdominal segment IX with dorsal profile rounded in lateral view. Phallobase with subapicomesal cavity ovaliform (fig. 4.8)..*H. catawba*

17'. Apicodorsal roof declivous, dorsal carina absent. Tergum X subrectangular, longer than wide. Abdominal segment IX with dorsal profile not rounded in lateral view. Phallobase with suapicomesal cavity orbicular (fig. 4.12)............. ....*H. fattigi*

18(14'). Harpagones appearing truncate in lateral view, mesal margin deeply concave and forming subapical scoop (fig. 4.22B). Tergum X with scattered setae (fig. 4.22E). Cleft phallobase with subapicomesal opening linear; apicolateral lobes with lateral margin subapically emarginate in ventral view (Fig. 4.22C)............ ....*H. occidentalis*

18'. Harpagones saber-shaped in lateral view, mesal margin not forming subapical scoop (fig. 4.29B; fig. 4.30B). Tergum X with setae forming a single row (fig. 4.29E; fig. 4.30E). Cleft phallobase with subapicomesal cavity opening oblong, obpyriform, or obovate; apicolateral lobes with lateral margin smooth or sinuate in ventral view (fig. 4.20B; fig. 4.28B; fig. 4.29C; fig. 4.30C)........19

19(18'). Tergum X subrectangular with distal margin truncate or obliquely truncate (fig. 4.28A,C; fig. 4.30B)..*H. simulans*

19'. Tergum X subrectangular with distal margin rounded..................................21

21(19’). Subapicomesal cavity opening of cleft phallobase oblong, 2 to 4.5 times as long as wide. Subapicomesal cavity orbicular. Apicolateral lobes extending posterad beyond subapicomesal cavity 0.5 to 1 times length of subapicomesal cavity (fig. 4.29) .... *H. scalaris*

21’. Subapicomesal cavity opening of cleft phallobase obovate to obpyriform. Subapicomesal cavity ovaliform. Apicolateral lobes extending posterad beyond subapicomesal cavity approximately 0.25 times length of subapicomesal cavity (fig. 4.20) .... *H. mississippiensis*

22(1’). Tergum X with posteromesal lobes that project posterodorsad (Fig. 4.1, B). Subapicomesal cavity opening of cleft phallobase obpyriform (Fig. 4.1, C)........ .... *H. aerata*

22’. Tergum X with distal margin rounded or truncate, not projecting posterodorsad (Fig. 4.14, B; Fig. 4.15, B; Fig. 4.27, B). Subapicomesal cavity opening variable 23

23(22’). Apicolateral lobes of phallobase elongate, extending posterad beyond subapicomesal cavity 1 to 2 times length of subapicomesal cavity; dorsoventrally depressed. Phallobase with apicodorsal roof with carina absent 24

23’. Apicolateral lobes of phallobase not elongate, extending posterad beyond subapicomesal cavity less than 1 times the length of the subapicomesal cavity; if dorsoventrally depressed then distal margin of apicolateral lobes subtriangular (fig. 4.17C) 25

24(23). Harpagones with apex bifurcate in lateral view (fig. 4.16B), subtriangular with lateral margin convex in ventral view (fig. 4.16D). Tergum X subrectangular .... *H. hoffmani*

24'. Harpagones saber-shaped in lateral view, apex not bifurcate (fig. 4.15B), falcate with mesal margin convex in ventral view (fig. 4.15C). Tergum X subtriangular...*H. hageni*

25(22'). Phallobase with subapicomesal cavity opening pandurate or U-shaped (fig. 4.10C; fig. 4.31E). Phallobase with apicodorsal roof declivous, carina absent (fig. 4.10B; fig. 4.31B)..26

25'. Phallobase with subapicomesal cavity opening obpyriform, orbicular, oblong, or oblanceolate. Phallobase with apicodorsal roof dorsoventrally depressed, declivous, or convex; carina present or absent...27

26(25). Phallobase with subapicomesal cavity opening pandurate (fig. 4.10C). Tergum X with dorsal margin convex, distal margin irregular in dorsal view (fig. 4.10B,E) .... *H. demora*

26'. Phallobase with subapicomesal cavity opening U-shaped (fig. 4.31E). Tergum X with dorsal margin straight or convex, distal margin entire; notch v-shaped to u-shaped (fig. 4.31B,D)..*H. valanis*

27(25'). Phallobase swollen proximally (fig.4.3C; fig. 4.24C) 28

27'. Phallobase of uniform width. 29

28(27). Phallobase with subapicomesal cavity opening obpyriform, apicolateral margin sinuate in ventral view; Apicodorsal roof carinate, with diamond-shaped notch (fig. 4.3)..*H. arinale*

28’. Phallobase with subapicomesal cavity opening oblong, 2 to 3 times as long as wide, apicolateral margin smoothly rounded or angled proximally; Apicodorsal roof without diamond-shaped notch (fig. 4.24).................................... *H. patera*

29(27’). Phallobase with subapicomesal cavity opening oblong, oblanceolate, or linear; if obpyriform then subapicomesal cavity ovaliform (fig. 4.5C; fig. 4.14C; fig. 4.27C; fig. 4.32B)..30

29’. Phallobase with subapicomesal cavity opening obpyriform or orbicular. Subapicomesal cavity orbicular (fig. 4.13C; fig. 4.17C; fig. 4.23C) 33

30(29). Carina present on apicodorsal roof of cleft phallobase (fig. 4.14C; fig. 4.32A), usually projecting above plane of proximal phallobase 31

30’. Carina absent on apicodorsal roof of cleft phallobase (fig. 4.5C; fig. 4.27B), apicodorsal roof not projecting above plane of proximal phallobase 32

31(30). Harpagones subrectangular in ventral view, with tip obliquely truncate. Phallobase with subapicomesal cavity opening oblanceolate; subapicomesal cavity orbicular (fig. 4.14)... *H. frisoni*

31’. Harpagones subtriangular in ventral view, with tip forming an acute point. Phallobase with subapicomesal cavity opening oblong, 3 to 4 times as long as wide, occasionally appearing obpyriform; subapicomesal cavity ovaliform (Fig. 4.32)... *H. venularis*

32(30’). Tergum X subrectangular with distal margin truncate in lateral view. Harpagones subtriangular in ventral view, with distal tip forming an acute point (Fig. 4.27)... *H. placoda*

32’. Tergum X subrectangular with distal margin rounded in lateral view. Harpagones subrectangular with distal tip truncate .... *H. bassi*

33(29’). Phallobase with apicodorsal roof declivous or flattened, with diamond-shaped notch along mesal margin (Fig. 4.17 B,C; Fig. 4.23B,C) 34

33’. Phallobase with apicodorsal roof convex, not projecting above plane of proximal phallobase, without diamond-shaped notch along mesal margin; ventrodistal opening obpyriform.. *H. franclemonti*

34(32). Phallobase with apicolateral lobes dorsoventrally depressed with apex subtriangular in ventral view. Harpagones with mesal protuberance (Fig. 4.17) ....*H. impula*

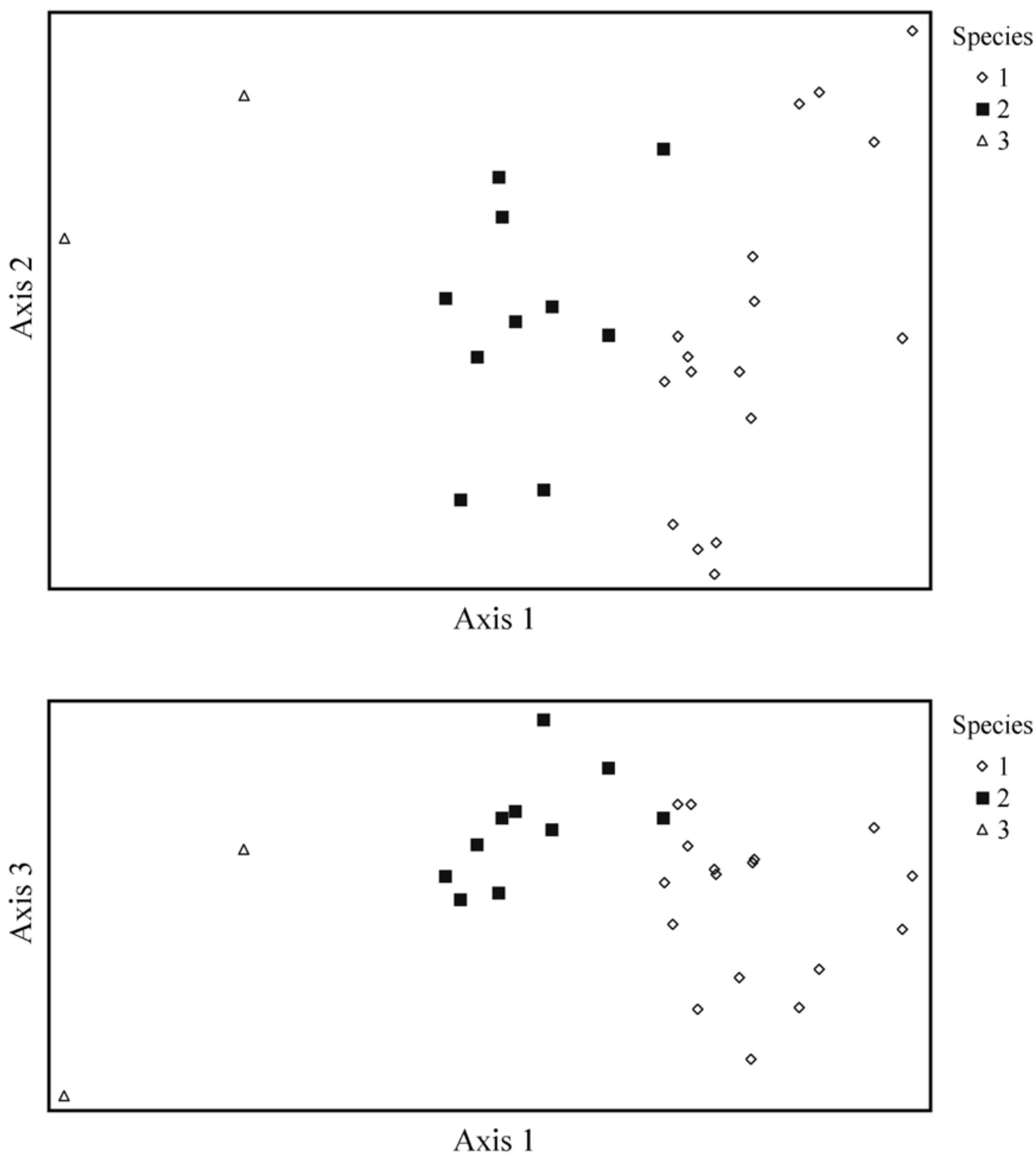
34’. Phallobase with apicolateral lobes projecting posterodorsad with apex rounded in ventral view. Harpagones without mesal protuberance. Tergum X subtriangular (Fig.4.23)...*H. opthalmica*

Appendix D

Principal Component Analysis Graphs

Table V-XVI

Figures 4.34-4.39



Multi-Response Permutation Procedures (MRRP) for groups
Chance corrected within-group agreement, A = 0.10056811
Probability of a smaller or equal delta, p = 0.02031054

Fig. 4.34 Plot of individual scores obtained from the principal components analysis for *H. auricolor* (1), *H. californica* (2), and *H. winema* (3).

Table V. Variance extracted, first 3 axes of principal components analysis of *H. auricolor*, *H. californica*, and *H. winema*.

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	3.533	44.166	44.166	2.718
2	2.511	31.392	75.558	1.718
3	1.262	15.776	91.334	1.218

Table VI. First 6 eigenvectors of principal components analysis of *H. auricolor*, *H. californica*, and *H. winema*.

	Eigenvector		
Traits	1	2	3
FOR	0.3463	0.4105	-0.0994
HIN	0.2819	0.4704	-0.0683
IOW	0.1604	0.5239	-0.2588
CEW	0.4879	-0.0211	0.1648
ICR	-0.3670	0.3321	-0.3593
EYE	0.4472	-0.1870	0.0056
WAR	-0.0774	0.3483	0.8649
PER	-0.4429	0.2620	0.1189

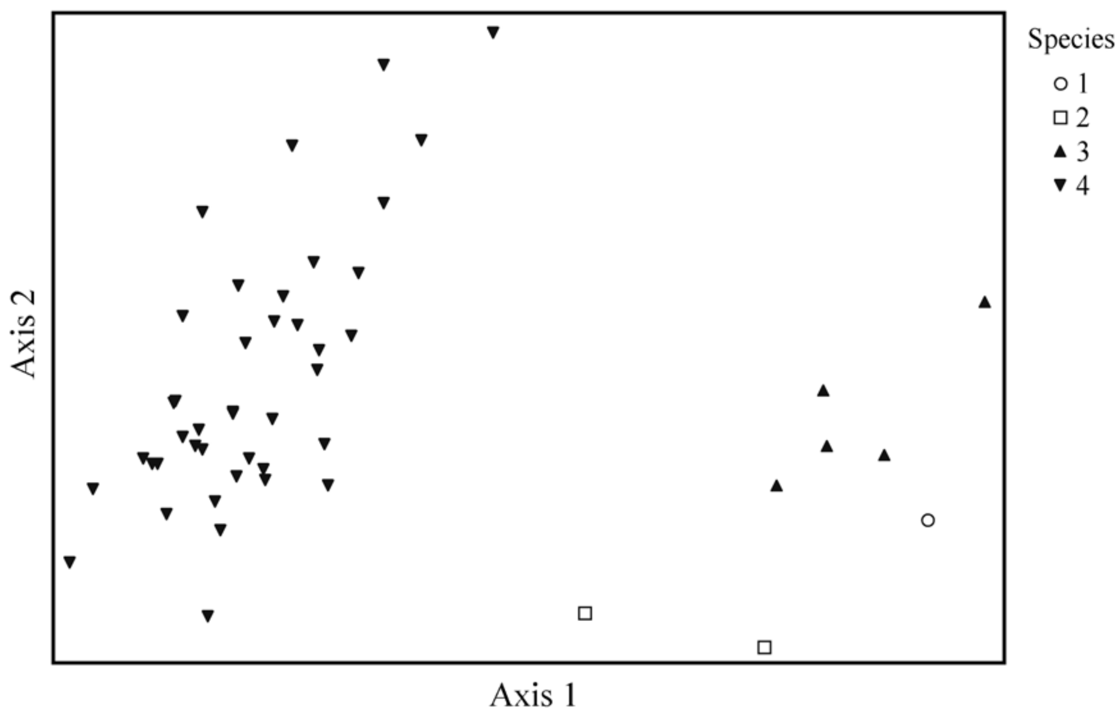


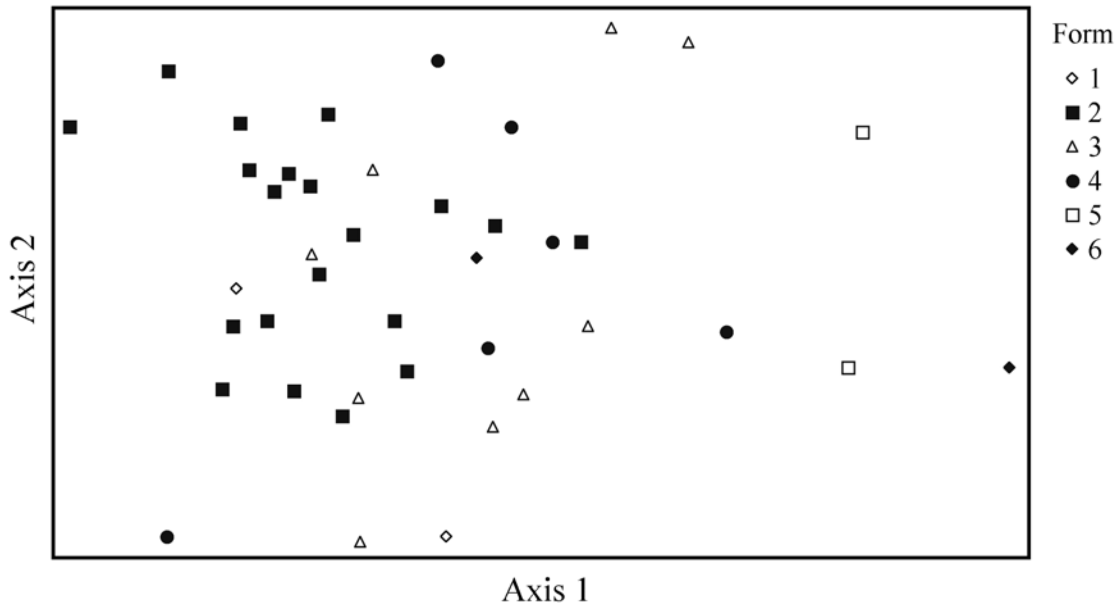
Fig. 4.35 Plot of individual scores obtained from the principal components analysis for *H. bassi* (1), *H. patera* (2), *H. placoda* (3), and *H. scalaris* (4).

Table VII. Variance extracted, first 2 axes of principal components analysis of *H. bassi* (1), *H. patera* (2), *H. placoda* (3), and *H. scalaris* (4).

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	5.488	68.600	68.600	2.718
2	1.795	22.437	91.037	1.718

Table VIII. First 6 eigenvectors of principal components analysis of *H. bassi* (1), *H. patera* (2), *H. placoda* (3), and *H. scalaris* (4).

Trait	Eigenvector 1	Eigenvector 2
FOR	-0.3484	-0.3879
HIN	-0.3146	-0.3762
IOW	-0.4164	0.0631
CEW	-0.2452	-0.5629
ICR	-0.3792	0.2961
EYE	0.2984	-0.4836
WAR	-0.4000	0.0216
PER	-0.3915	0.2553



Multi-Response Permutation Procedures (MRRP) for groups
Chance-corrected within-group agreement, A = 0.15418384
Probability of a smaller or equal delta, p = 0.00209628

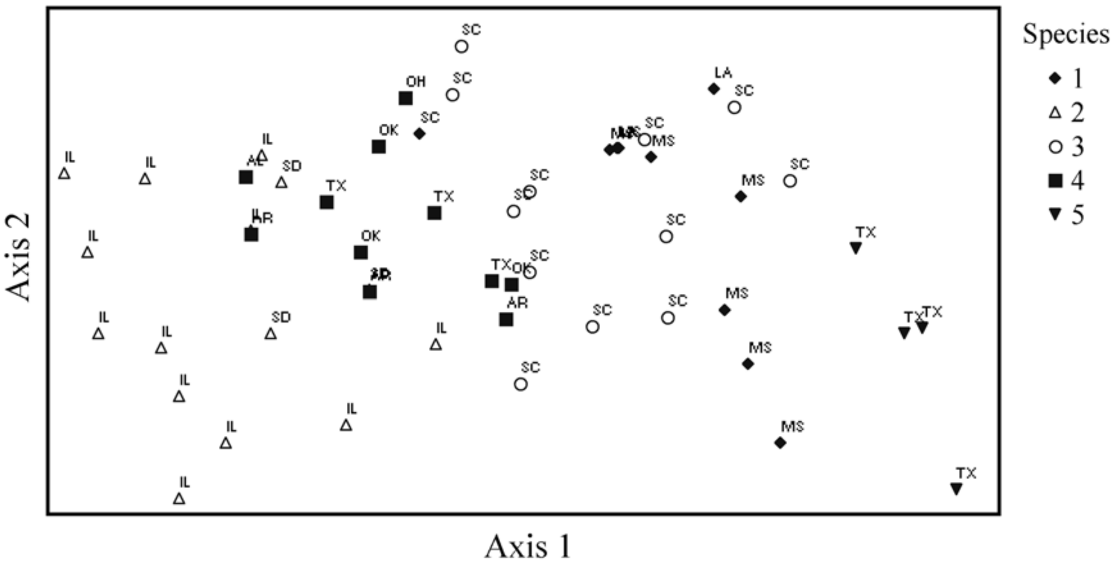
Fig. 4.36 Plot of individual scores obtained from the principal components analysis for *H. scalaris* forms 1-6.

Table IX. Variance extracted, first 2 axes of principal components analysis of *H. scalaris* forms 1-6.

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	4.235	52.934	52.934	2.718
2	1.911	23.891	76.825	1.718

Table X. First 2 eigenvectors of principal components analysis of *H. scalaris* forms 1-6.

Traits	Eigenvector 1	2
FOR	-0.4509	0.0343
HIN	-0.4127	-0.0675
IOW	-0.3660	0.3061
CEW	-0.4583	-0.0685
ICR	0.1895	0.4663
EYE	-0.3744	-0.2945
WAR	-0.3261	0.4042
PER	0.0021	0.6545



Multi-Response Permutation Procedures (MRRP) for groups
Chance-corrected within-group agreement, A = 0.54165729
Probability of a smaller or equal delta, p = 0.000000001

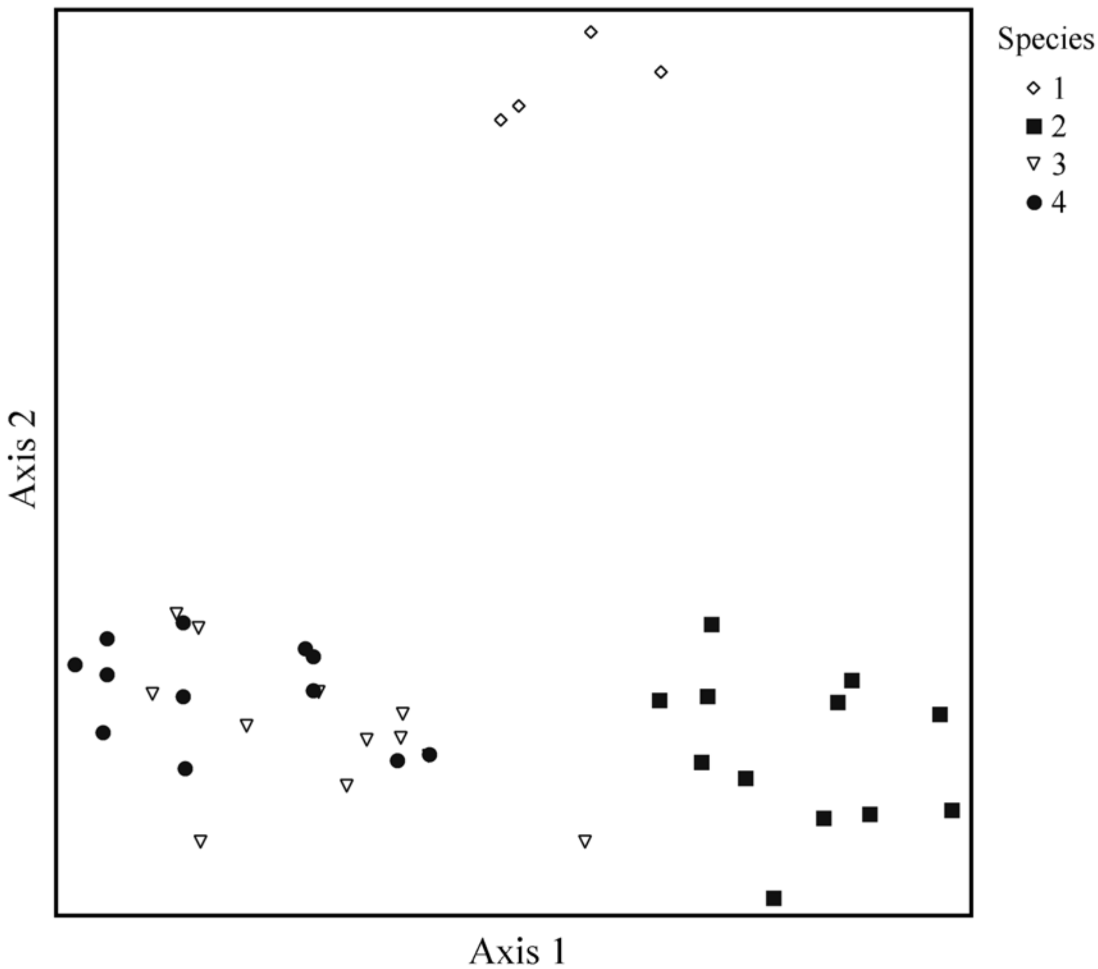
Fig. 4.37 Plot of individual scores obtained from the principal components analysis for *H. alvata* (1), *H. bidens* (2), *H. incommoda* (3), *H. orris* (4), and *H. delrio* (5).

Table XI. Variance extracted, first 2 axes of principal components analysis of *H. alvata* (1), *H. bidens* (2), *H. incommoda* (3), *H. orris* (4), and *H. delrio* (5).

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	5.624	70.302	70.302	2.718
2	1.220	15.246	85.548	1.718

Table XII. First 2 eigenvectors of principal components analysis of *H. alvata* (1), *H. bidens* (2), *H. incommoda* (3), *H. orris* (4), and *H. delrio* (5).

	Eigenvector	
Traits	1	2
FOR	-0.4018	-0.1676
HIN	-0.3986	-0.1309
IOW	-0.3790	-0.3429
CEW	-0.4093	-0.0806
ICR	0.1861	-0.6255
EYE	-0.3815	0.2375
WAR	-0.3655	-0.1734
PER	0.2337	-0.5942



Multi-Response Permutation Procedures A = 0.38367633
Probability of a smaller or equal delta, p = 0.00000047

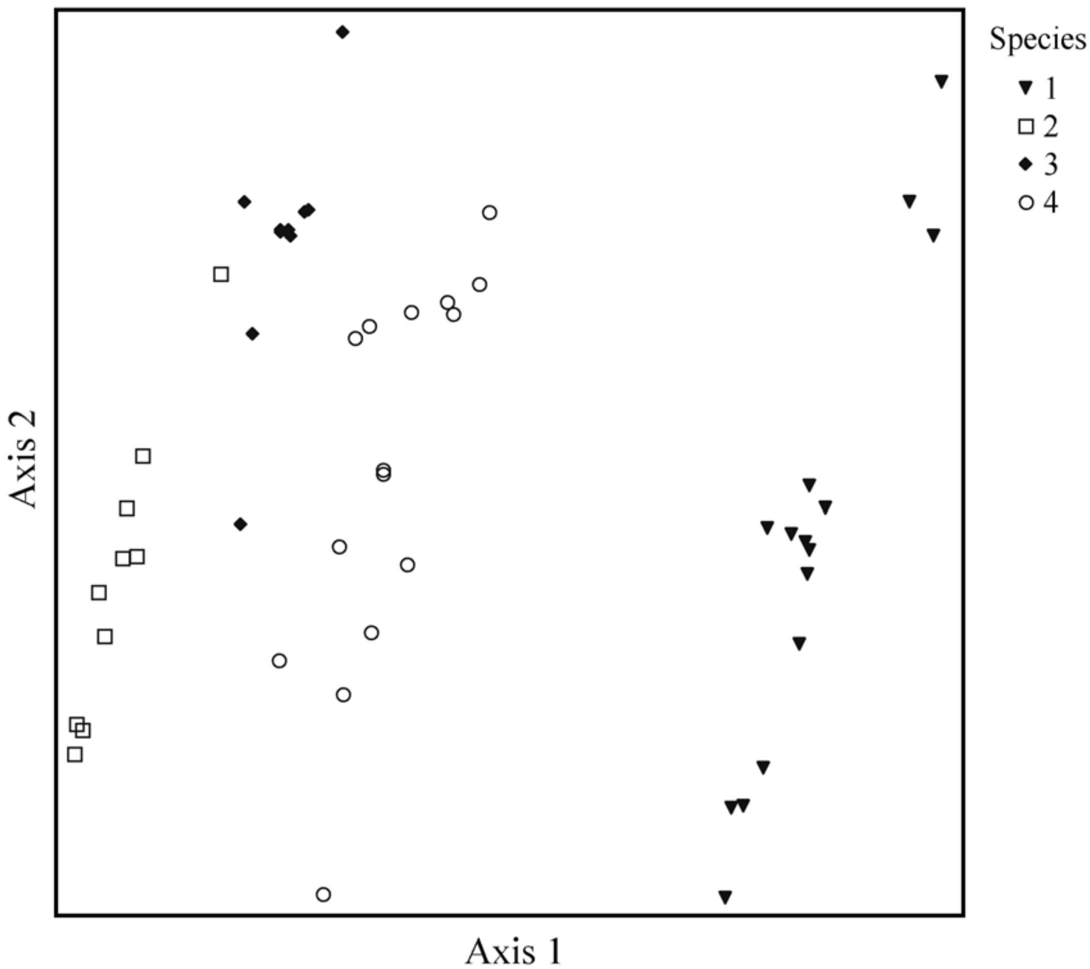
Fig. 4.38 Plot of individual scores obtained from the principal component analysis for *H. franclemonti* (1), *H. mississippiensis* (2), *H. rossi* (3), and *H. simulans* (4).

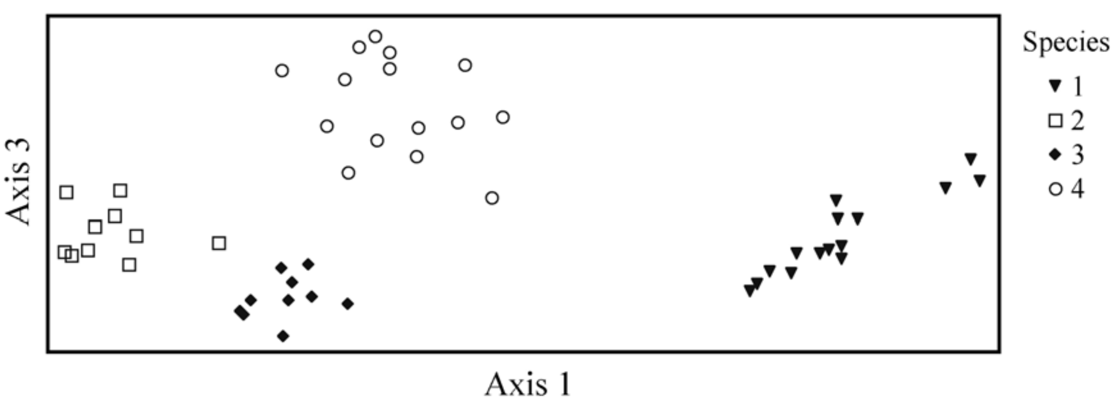
Table XIII. Variance extracted, first 2 axes of principal components analysis of *H. franclemonti* (1), *H. mississippiensis* (2), *H. rossi* (3), and *H. simulans* (4).

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	5.823	52.933	52.933	3.020
2	3.485	31.682	84.615	2.020

Table XIV. First 2 eigenvectors of principal components analysis of *H. franclemonti* (1), *H. mississippiensis* (2), *H. rossi* (3), and *H. simulans* (4).

	Eigenvector	
Traits	1	2
FOR	-0.3951	0.0653
HIN	-0.3769	0.0599
IOW	-0.2920	-0.3533
CEW	-0.3964	-0.0132
ICR	0.0269	-0.5014
EYE	-0.2394	0.4092
WAR	-0.2834	-0.3255
PER	-0.0472	-0.5012
COX	-0.2924	0.2630
HAR	-0.3802	0.0699
HCR	-0.2981	-0.1309





Multi-Response Permutation Procedures A = 0.37112708
Probability of a smaller or equal delta, p = 0.00000001

Fig. 4.39 Plot of individual scores from the principal component analysis for *H. aerata* (1), *H. alabama* (2), *H. brunneipennis* (3), *H. phalerata* (4).

Table XV. Variance extracted, first 3 axes of principal components analysis of *H. aerata* (1), *H. alabama* (2), *H. brunneipennis* (3), *H. phalerata* (4).

AXIS	Eigenvalue	% of Variance	Cum.% of Var.	Broken-stick Eigenvalue
1	5.704	71.295	71.295	2.718
2	1.653	20.667	91.962	1.718
3	0.491	6.139	98.101	1.218

Table XVI. First 3 eigenvectors of principal components analysis of *H. aerata* (1), *H. alabama* (2), *H. brunneipennis* (3), *H. phalerata* (4).

	Eigenvector		
Traits	1	2	3
FOR	-0.2604	-0.5725	0.2876
HIN	-0.1987	-0.6695	0.0637
IOW	-0.4081	-0.0902	-0.2068
CEW	0.3362	-0.3754	-0.4541
ICR	-0.4109	0.0989	0.1469
EYE	0.3969	-0.2131	-0.1399
WAR	-0.3481	0.0344	-0.7893
PER	-0.4070	0.1364	0.0075

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