

## A critical taxonomic analysis of the *Hydrellia pakistanae* species group (Diptera: Ephydriidae)

D.L. Deonier  
c/o U.S.D.A. BioControl Laboratory  
P.O. Box 147100  
Gainesville, FL 32614-7100 U.S.A.

### Abstract

Critical taxonomic analysis of the *Hydrellia pakistanae* species group yielded *H. pakistanae* Deonier, *H. sarahae*, n.sp. (composed of *H. sarahae sarahae*, n.ssp. in China and *H. sarahae laticapsula*, n.ssp. in India and Pakistan), *H. balciunasi* Bock known only from Australia, and a related species, *H. bogorae*, n.sp. from Java, Indonesia. These species all have the same primary host-plant species, i.e., *Hydrilla verticillata*, a fact making them all potential biocontrol agents for this aquatic plant pest in North America and other areas where it has pest status. Morphology is summarized as well as perceived synapomorphies of this species group.

### Introduction

Presently, the genus *Hydrellia* Robineau-Desvoidy in the tribe Hydrelliini of the subfamily Hydrelliinae is the largest known genus of Ephydriidae and because the larvae of all known member species are parasites (leaf- and stem-miners) of aquatic plants, it has considerable economic importance, i.e., some member species have potential for pest status and others for biocontrol of pest plant species. The latter aspect was apparent to some workers several years ago, especially regarding biomanaging the introduced aquatic plant pest, *Hydrilla verticillata*. Although most of my field observations indicate that native *Hydrellia* species are so ecointegrated as to be seldom, if ever, energy limited (Deonier, 1971, 1979), the natural (intrinsic) rate of increase is sufficiently high that, with several key mortality factors reduced or removed, species introduced from native *Hydrilla* regions might indeed function efficiently as part of a multiagent management plan.

### Methods

The methods used in this study are similar to those in Deonier (1971). However, to obtain the best preparations of both male and female abdomina, entire specimens were boiled in 5-10% KOH solution for about 10 minutes to remove all or nearly all soft

internal abdominal tissues. Because this treatment seldom yielded very much clearing of the exoskeleton, several drops of 3% H<sub>2</sub>O<sub>2</sub> were pipetted into the hot, but no longer boiling, solution to obtain the desired degree of cuticular clearing (in most cases, a light yellow, or straw color). After neutralization with glacial acetic acid, the specimens were boiled for about 1 minute in alcohol (preferably 95% ethanol) to remove all gas bubbles from the abdomen. Specimens were then transferred into glycerol on a cavity, or depression, microscope slide for dissection, examination, and illustration.

The most frequently used measurements and indices are defined as follows: *Body length* = Distance between most prominent part of face and posterior end of abdomen as measured in lateral view and as if head and abdomen were aligned horizontally. *Color* = Descriptions of color apply to views perpendicular to the sclerite concerned unless otherwise stated. Color designations are according to the ISCC-NBS method. *Wing length* = Distance between the apex of the tegula and the wing tip. *Epistomal index* = Quotient of the epistomal width, or breadth, divided by minimum interocular distance on the face. *Mesofacial index* = Quotient of the mesofacial height, as measured from epistoma to ptilinal suture, divided by the minimum interocular distance on the face. *Ocular index* = Quotient of the nearly vertical ocular height divided by the subocular height (minimum distance between

compound eye and edge of subcranial cavity). *Subcranial index* = Quotient of the subcranial cavity width, or breadth, divided by the width of the anteclypeus (clypeus of some authors). *Vertex index* = Quotient of the vertex width, or breadth, as measured between compound eyes at level of lateral ocelli, divided by the antecellar distance (between median ocellus and ptilinal suture).

The material consisted almost entirely of specimens preserved in 70% isopropanol and stored in glass vials. Although such specimens can be dry mounted onto paper points, it is time consuming and the color factor is sometimes altered. For this reason as well as for future chemical analyses, I strongly recommend that all facilities and agencies begin to deepfreeze or dry-pack at least some of their voucher specimens of most, if not all, insect species. Depositories for type material are: National Museum of Natural History (USNM), Florida State Collection of Arthropods (FSCA), and the Shanghai Entomological Institute, Academia Sinica. Only material bearing my holotype, paratype, or determination label was seen by me (not any material bearing label: *Fide* D. L. Deonier).

## Morphological Interpretations

In respect to the male (and perhaps female) external genitalia, this group has unquestionably evolved to a greater level of divergence from the generic norm than any of the numerous other species groups (compare to Deonier, 1971: Figs. 4, 5, 10, 12-13, and 136-137). My interpretation of the male external genitalia in this group is that the copulobi of sternum 5 and the postgonites have become encapsulated by anterior expansion and partial fusion of the gonial arches and, perhaps, some dorsal expansion of the anteromedial part of sternum 5. The most difficult of these changes to analyze and interpret was the postgonite because the only evidence of a postgonite uncus (nearly universal except perhaps in some the *H. prudens* species group) seems to be 1 or 2 minute microtrichoid structures projecting from the posterior part (heel) of what I have termed the postgonite process (PP in Figs. 1, 10, 16, and 26). *H. balciunasi* lacks even microtrichoid structures. This postgonite

process appears to be the product of the fusion of a posterior structure whose sclerotization consistency can be traced dorsad to the gonial arch (and which most probably represents the postgonite) with an anterior part of separate, but undiscerned, origin. Bock (1990) used the terms hypandrium and internal genitalia, but did not offer any explanation of the anatomical situation in this group.

## Synapomorphies of *H. pakistanae* Species Group

Although geographic distribution data are insufficient and at least one other new species (for adequate study and description of which additional material is required) exists in Korea, I offer the following apparent group synapomorphies:

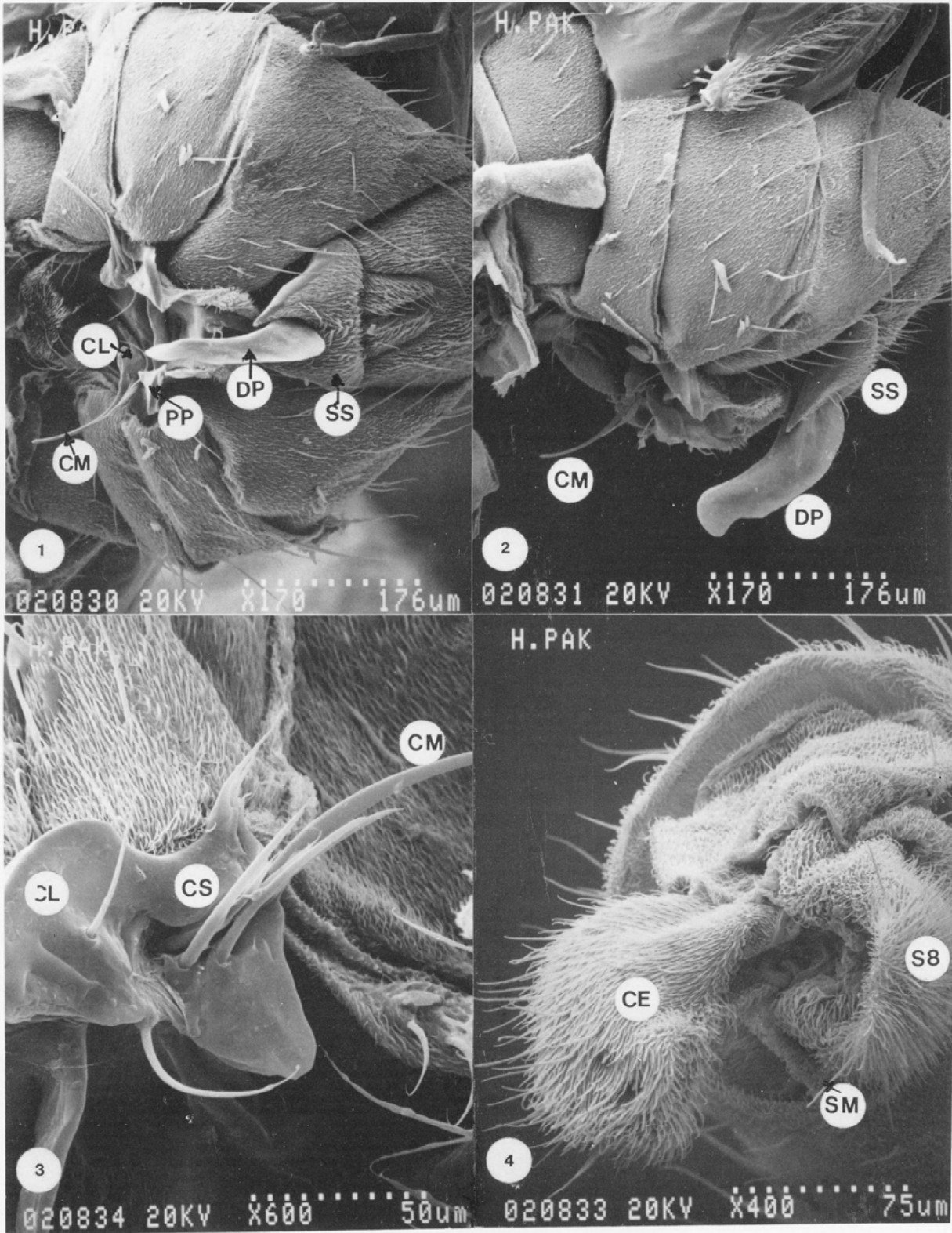
1. Planate face receding (sharply in males) in profile
2. Dilated male profemora
3. Anterodorsal setae of male probasitarsus elongated (slightly to greatly)
4. Copulobi (sternum 5) and postgonites encapsulated by expansion of gonial arches
5. Copulobi bearing pair of posteromedial cruciate macrochaetae
6. Copulobi followed posteriorly by greatly modified postgonites
7. Pregonites relatively minute and deeply situated
8. Distiphallus cultriform (plow-shaped), with sharply acute midventral carina
9. Female sternum 8 with 1-3 pairs of long, hairlike setulae projecting far from posterior margin.

Of these, characters 1, 2, and 3 are shared with the *H. bilobifera* species group. At the present, there are not enough data available to determine the cladistic significance of these characters and I am uncertain about the relationship of these two species groups.

Within the *pakistanae* group, it can be discerned that 2 character states exist for character 5 (cruciate copulobic macrochaetae): styliform and spatulate. One could speculate that since the latter is shared only by *H. balciunasi* Bock, found only in Australia, and *H. bogorae*, n. sp., from Indonesia, that the spatulate state is somehow connected with island isolation

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**Figures 1-4.** *Hydrellia pakistanae* Deonier. 1) male abdomen (copulobi exerted), ventral view; 2) male abdomen, left lateral view; 3) right copulobus of male abdomen; 4) female external genitalia, posterolateral view (right cercus twisted 90° from sternum 8. Abbr.: CE = distiphallus; CM = pulobic macrochaeta; CS = copulobic comb setae; DP = distiphallus; PP = postgonite process; S8 = sternum 8; SM = long, hairlike posteromediolateral microsetula; SS = fused surstyli.



effect, but insufficient distribution data precludes such a conclusion.

*Hydrellia pakistanae* Deonier  
(Figs. 1-5, 12, 15-18, 25-28, 32-33, 37-40)

*Hydrellia pakistanae* Deonier 1978: 195-196.

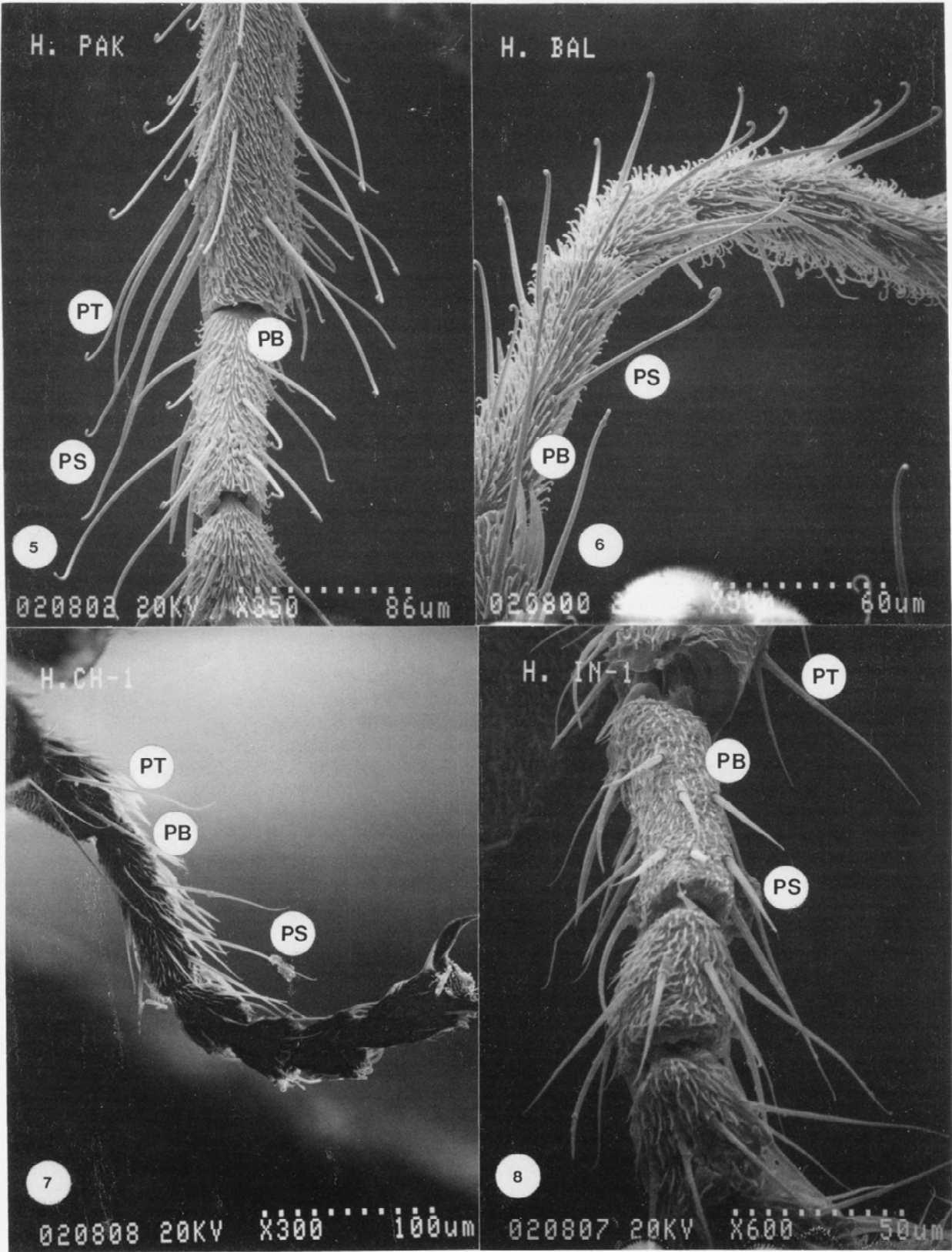
**Diagnosis:** Maxillary palpus light to dark yellow; palpus smoothly spatulate (angles slightly more pronounced in female); antenna dark brown except antennomere III varying from dark yellow or orange to sometimes entirely dark brown (more commonly yellow, orange, or dark brown spotted with orange); 4-7 (usually 5) dorsal arisal rays; lower 0.5-0.7 of male face and lower 0.3-0.5 of female face usually planate and receding in profile, but infrequently hardly planate in either sex and usually not as distinctly so as in *H. sarahae*, n.sp.; face shining sericeous golden [metallic light yellow to very slightly bronzed golden or silvery golden (silvery or dulled silvery occasionally)]; upper 0.3-0.5 with slight antennal foveae separated by slight median elevation; these foveae often with very slight bluish-gray or green reflection; lunule mostly silvery pruinose; 4-6 (usually 5) primary facial setae and 0-2 (usually 1) ventroclinate secondary facial setula above primary facial row (often offset nearly to orbit); mesonotum mostly light bluish-gray pruinose; mesonotal disc often with reddish or golden-brown overtone; male profemur dilated, maximum diameter about 0.25 length and about 2 times maximum tibial diameter; male protibia not noticeably expanded distally, with usually 1-2 anterodorsal and 1 posterior preapical setae subequal to or longer than probasitarsus; male protibiae noticeably more "bristly or hairy" than those of others in species group, with usually 5 posterodorsals and 1 posterior preapical subequal to or longer than probasitarsus (about 1.5-2.0 times as long as dorsals and often curved, or curled, distally); male probasitarsus with 2-4 (usually 3) long, curled anterodorsal setae subequal to or longer than probasitarsus; male mesotibia moderately dilated, with 1 posterodorsal preapical and 2-3 distal posterior setae conspicuous (only as strongly developed as in *H. sarahae sarahae*, n.sp., n.ssp.); cleared female cercus, in lateral view, distinctly pendulous and L-shaped (distal 0.5 directed ventrad) and

with distinct fenestrate (windowlike), discal depression; mediobasal cercal micro-onychial (hooklets) minute, similar to others of species group except *H. bogorae*. Male postabdomen as in Figs. 1-3, 12, 15-18, 25-28, 32-33; female postabdomen as in Figs. 37-40.

**Description:** **Head:** Face shining sericeous golden (metallic light yellow) to very very slightly bronzed golden or silvery golden (silvery or dulled silver occasionally); lower 0.5-0.7 of male face and lower 0.3-0.5 of female face usually planate and receding in profile, but infrequently hardly planate in either sex and usually not as distinctly so as in *H. sarahae*, n.sp.; upper 0.3-0.5 with slight antennal foveae separated by slight median elevation; foveae often with very slight bluish-gray or green reflection; lunule mostly silvery pruinose; epistoma deeply concave (often appearing notched in male); 4-6 (usually 5) primary facial setae and 0-2 (usually 1) ventroclinate secondary facial setula above primary row (often offset nearly to orbit); antenna dark brown except antennomere III varying from dark yellow or orange to sometimes entirely dark brown (more commonly yellow, orange, or dark brown spotted with orange), with dense, usually light brown or orange dorsomedial micropubescence; 4-7 (usually 5) dorsal arisal rays; frons moderately to steeply sloping; frontal vitta, in anterior view, semiglossy dark grayish-brown, dark brown, or dark reddish-brown; ocellar area often sparsely light-gray pruinose; parafrontale and posterior fronto-orbital area often velvety lightly yellowish-brown (golden brown) pruinose; anterior fronto-orbital area often light-gray pruinose; posterior fronto-orbital seta about 2 times as long as anterior; 20-30 postocular setae with usually 1 somewhat regular row of 14-20 setae near orbit (especially in female); maxillary palpus variable, light to dark yellow and spatulate (smoothly angular and relatively small blade). Epistomal index 1.4-2.4; mesofacial index 1.6-2.4; vertex index 4.5-7.0; ocular index 5.5-8.5; subcranial index 1.5-2.4; head width/ head height 1.1-1.6.

**Thorax:** Postpronotum mostly light bluish-gray pruinose; mesonotum mostly light bluish-gray pruinose with noticeable bluish-gray or bluish-green iridescence or reflections except disc sparsely light-gray pruinose with light yellowish or reddish overtones; 3-4 (1 macrochaetous) antesutural and 2 (1

**Figures 5-8.** *Hydrellia* spp. protarsi, male. 5) *H. pakistanae*, left protibia and probasitarsus, dorsal view; 6) *H. balciunasi* Bock, left protarsus, anterodorsal view; 7) *H. sarahae*, n.sp., right protarsus, anterodorsal view; 8) *H. bogorae*, n.sp., right protarsus, dorsal view. Abbr.: PB = probasitarsus (protarsomere 1); PS = anterodorsal probasitarsal setae; PT = anterodorsal preapical tibial setae.



macrochaetous) postsutural dorsocentral setae; 1 mesokatepisternal seta; coxae mostly light-gray pruinose laterally (metacoxa yellow or orange laterally) and light to moderate yellow anteriorly; femora light-gray pruinose over dark grayish brown; male profemur dilated, but not as much as in *H. bogorae*, n.sp. (maximum diameter about 0.25 length and about 2 times tibial diameter); profemur with anteroventral row of about 17 minute black microspinules on distal 0.5; tibiae somewhat variable in color, with pro- and metatibiae light-gray pruinose except distal 0.25-0.30 (and often basal 0.10) light to dark yellow; mesotibia similar except only distal and basal 0.10-0.15 light to dark yellow; male protibia not noticeably expanded distally, with usually 1-2 anterodorsal and 1 posterior preapical setae subequal to or longer than probasitarsus; male protibiae noticeably more "bristly or hairy" than those of others in species group, with usually 5 posterodorsals and 1 posterior preapical subequal to or longer than probasitarsus (about 1.5-2.0 times as long as dorsals and often curved, or curled, distally); male probasitarsus with 2-4 (usually 3) long, curled anterodorsal setae subequal to or longer than probasitarsus; male mesotibia moderately dilated, with 1 posterodorsal preapical and 2-3 distal posterior setae conspicuous (only as strongly developed as in *H. sarahae sarahae*, n.sp., n.ssp.). Wing length 1.20-1.90 mm; wing veins light yellow to light to moderate brown; 4-8 dorsal and 8-11 anterior interfractural costal setae; costal-section indices: II/I 1.4-2.5; III/IV 2.4-4.0; V/IV 2.4-4.5;  $M_{1+2}$  index 1.3-1.9.

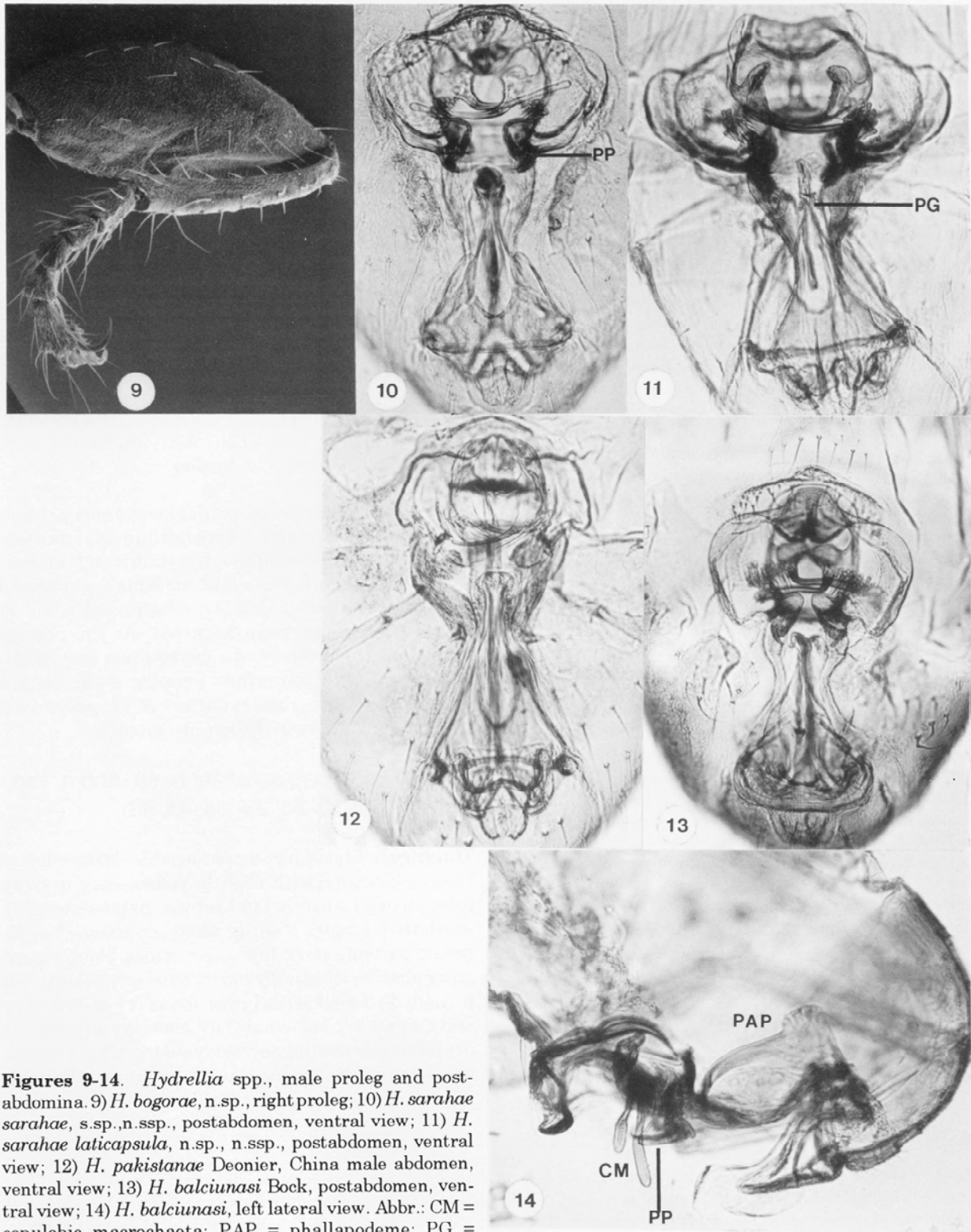
**Abdomen:** Terga semiglossy light-gray or bluish-gray pruinose except discal area of 1-2 or 1-3 commonly very glossy (and iridescent) bluish-gray or bluish-green, sometimes only semiglossy reddish- or grayish-brown. Male postabdomen: sternum 5 encapsulated within pouch formed by gonial arch expansion and fusion, partially overlain anteriorly by sternum 4; capsule spreading laterad to aliform margins with obtusangular shoulders (Figs. 12, 15, 17, 25, 26); capsule subequal in width to sternum 4; encapsulated copulobi incurved and bearing paired posteromedial cruciate, styliform macrochaetae each bordered laterally by a comb of 3-8 incurved setae (Indian males commonly have 5 in a range of 5-8 comb setae whereas China males commonly have 3 in a range of 3-5, but 2 China males had 7 comb setae); capsule without apparent patches of microsensilla. Postgonite process, in ventral view, nearly truncate or slightly incurved, heavily sclerotized lobe with 1-2 posteriorly directed microtrichoid structures (discrimination into Indian form with obvious heel-like projection bearing 2 microtrichoid structures as in Fig. 16B versus China

form with no heel and bearing only 1 microtrichoid structure as in Fig. 18B failed); pregonite microscopic, apparently nonfurcate and bearing 4 microtrichoid structures, and situated dorsolaterad of distiphallus (at about 0.3 length proximad or basad from apex) as in Figs. 15-18 and 25-26); distiphallus, in ventral view, cultriform, medially carinate, and with an acute apex; in lateral view, projecting from curved, shanklike basiphallus anteriorly to variably formed (but commonly downcurved from a slight to deep preapical notch) apex (Figs. 16, 18, 27B, E, and 28B); other variants of less frequency are depicted in Figs. 27-28. Phallapodeme, in lateral view, with variable prominent, crestlike posterodorsal process (condyle scar inapparent; most common variants Figs. 32A, E among Indian specimens and Figs. 33D, F for China specimens with other variants for India (Fig. 32) and China (Fig. 33) less frequent. Fused surstyli relatively short, tapering distally to anteromedial notch (commonly narrow V- or narrow U-shaped), mostly yellow or light yellowish-brown and bearing 2-3 pairs of microsetulae around notch; fused surstyli length: cercus length 1.8-2.2. Syntergum 9+10 usually smoothly rounded and apparently more setose in China than in Indian specimens. Female postabdomen: sternum 8 about as wide as long, but wider than sternum 4-7 and shorter than 6 and 7; sternum 8 with dense covering of mostly long hairlike and fewer spinular microsetulae and usual single pair of long, posteromediolateral hairlike microsetulae; cercus orange to brownish-orange and distinctly pendulous; cleared cercus, in lateral view, distinctly L-shaped with distal 0.5 directed ventrad and with distinct fenestrate (windowlike) discal depression; mediobasal cercal micro-onychial (hooklets) minute, similar to other of species group except *H. bogorae*. Cercus shape, in lateral view, somewhat variable as in Fig. 40 with B and C predominant in Indian specimens and A much less frequent in contrast to China specimens with Fig. 40A almost exclusive. Ventral receptacle cupuliform, about as deep as wide.

**Type:** Holotype male, USNM Type No. 75480.

**Type locality:** PAKISTAN: Jhelum C.I.B.C. 1133 (7-X-1972, Hyd. 10/72-16, larva mining leaves of *Hydrilla verticillata*).

**Paratypes:** Same data as holotype, 8 males, 7 females; Pakistan C.I.B.C., Rawalpindi, Pakistan (1407: Larvae mining leaves of *Hydrilla verticillata*; lab.reared), 7 males, 8 females; Pakistan C.I.B.C., Rawal Dam (29-VI-71, in *Hydrilla verticillata*, C.I.E.



**Figures 9-14.** *Hydrellia* spp., male proleg and post-abdomina. 9) *H. bogorae*, n.sp., right proleg; 10) *H. sarahae sarahae*, s.sp., n.ssp., postabdomen, ventral view; 11) *H. sarahae laticapsula*, n.sp., n.ssp., postabdomen, ventral view; 12) *H. pakistanae* Deonier, China male abdomen, ventral view; 13) *H. balciunasi* Bock, postabdomen, ventral view; 14) *H. balciunasi*, left lateral view. Abbr.: CM = copulobitic macrochaeta; PAM = phallapodeme; PG = pregonite; PP = postgonite process.

A4880, 988-92), 1 male; Lahore (17-X-71; C.I.B.C. Hyd. 10/71-13; larva mining leaves of *Hydrilla verticillata*, 1099), 1 female. These paratypes deposited as indicated in Deonier (1978).

**Other Specimens Examined:** **INDIA:** Parents coll: Bangalore, Karnataka State (reared III-1987 on *Hydrilla* in quarantine, FL: Alachua Co., Gainesville, D.P.I., G. R. Buckingham), 12 males, 20 females; same (IV-1987), 6 males, 11 females; same (VIII-1989), 2 males, 4 females; Bangalore, Karnataka State (June 1986), 42 males, 62 females; (2-XI-1990, G. R. Buckingham; Lab. reared, USDA Lab, Gainesville, FL), 33 males, 61 females; (8-VIII-1991, Lab. reared, USDA Lab, Gainesville, FL), 33 males, 63 females; Kumbaleogoda, Bangalore, Karnataka State (VIII-18-19-1990, G. R. Buckingham; Voucher FBCL 90-1045; *Hydrilla verticillata*), 8 males, 11 females; Bangalore, Karnataka State (21-V-1986, S. Krishnaswamy), 21 males, 19 females; (V-1982-20, reared from *Hydrilla verticillata*, J. K. Balciunas and M. Minno), 1 female; Karnataka State, Dasappaddodi Pond, 35.5 km WSW of Bangalore (V-17-1982, at Uv light, J. K. Balciunas and M. Minno, Coll. no. KAR82BL1), 1 female; Dasappadodi Pond (V-28-1982, at Uv light, J. K. Balciunas and M. Minno, Coll. no. KAR82BL4), 3 females; Bangalore (14-X-1990, reared from USDA Lab colony, Gainesville, FL), 2 males, 10 females; (V-1985, Ex *Hydrilla* lab reared, Gainesville, FL, original coll: C. A. Bennett, G. R. Buckingham, and S. Krishnaswamy), 11 males, 7 females. **PAKISTAN:** Rawalpindi (30-VIII-1990, reared from USDA Lab colony in *Hydrilla verticillata*, original coll: Riaz Mahmood, Voucher FBCL 90-1047), 14 males, 17 females; (18-X-1990, reared from USDA Lab colony in *Hydrilla verticillata*, original coll: Riaz Mahmood), 6 males, 6 females; (8-VIII-1991, reared from USDA Lab colony, Gainesville, FL, original coll: Riaz Mahmood), 55 males, 79 females. **CHINA:** Beijing: San Jia Dian Reservoir (30-VII-1992, adults on floating leaves *Hydrocharis dubia*, Chen, Z. Q. and C. A. Bennett), 1 male, 1 female; Beijing, August 1st Lake (3-VIII-1992, larvae and puparia on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 2 males, 2 females; (10-VIII-1992, larvae and puparia on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 1 male; (20-VIII-1991, Ex larvae in *Hydrilla*, G. R. Buckingham), 5 males, 5 females; Beijing, Qiao Zhuang (23-VII-1992, larvae and puparia on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 1 male; (30-VII-1992, larvae and puparia on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 1 male; (6-VIII-1992, larvae on *Hydrilla*, C. A. Bennett), 1 female; Beijing, Sleeping Buddha Park, Cherry Blossom Valley (24-VIII-1991, Ex larvae in *Hydrilla*, G. R. Buckingham), 1 female; Beijing, Hsing Hua University (22-VIII-1991, adults on leaves *Hydrocharis dubia* and

*Potamogeton natans*, G. R. Buckingham), 1 male, 2 females; (22-VIII-1991, Ex puparia in *Hydrilla* leafmines, G. R. Buckingham), 2 males, 4 females; (22-VIII-1991, Ex larvae in *Hydrilla* leafmines, G. R. Buckingham), 7 males, 1 female; (22-VIII-1991, adults in flowers *Hydrocharis dubia*, G. R. Buckingham), 1 male, 3 females; Beijing, nonspecific (VIII-1991, Sino-American BioControl Laboratory, Wang, Y.), 3 males, 14 females; (VIII-IX-1991, reared from *Hydrilla*, USDA Lab, Gainesville, FL, original coll: G. R. Buckingham), 19 males, 52 females; (IX-1990, Jing, H. and G. R. Buckingham), 2 females; (VII-VIII-1992, reared from *Hydrilla*, USDA Lab, Gainesville, FL, original coll: C. A. Bennett), 53 males, 113 females; Beijing, mixed sites (IX-1991, reared from *Hydrilla*, USDA Lab, Gainesville, FL, original coll: G. R. Buckingham, Voucher FBCL 91-1024), 1 female. Heilongjiang Province: Harbin, Shier Li Piao Marsh, Lat 46.5°N, Long 125. 2° E (8-VIII-1991, on *Myriophyllum spicatum*, J. K. Balciunas, Coll. no. HEL9(V001) 3 females. Liaoning Province: Shenyang (12-13-1990, Ex *Hydrilla*, G. R. Buckingham, emerged FL BioControl Lab, Gainesville), 10 males, 1 female; (VIII-1991, Ex *Hydrilla*, USDA Lab colony, original coll: G. R. Buckingham), 14 males, 24 females.

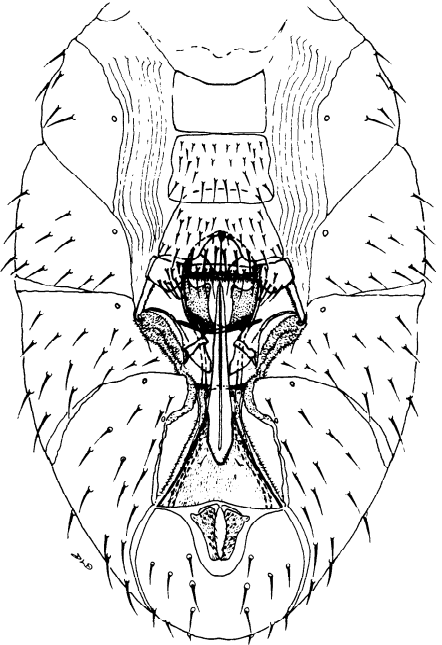
**Remarks:** This intensive study showed no consistent evidence of subspeciation between Indian, Pakistan, or China populations although certain trends in characters, e.g., slightly more bulbous female cercus and darker curled anterodorsal probasitarsal setae in China populations were apparent. At the present time, this broad conspecific distribution may point, along with the somewhat simpler male genital anatomy, to an earlier evolution of *H. pakistanae* compared to others in the species group.

*Hydrellia sarahae sarahae*, n. sp. and n. ssp.  
(Figs. 7, 10, 23-24, 29, 34, 41-43)

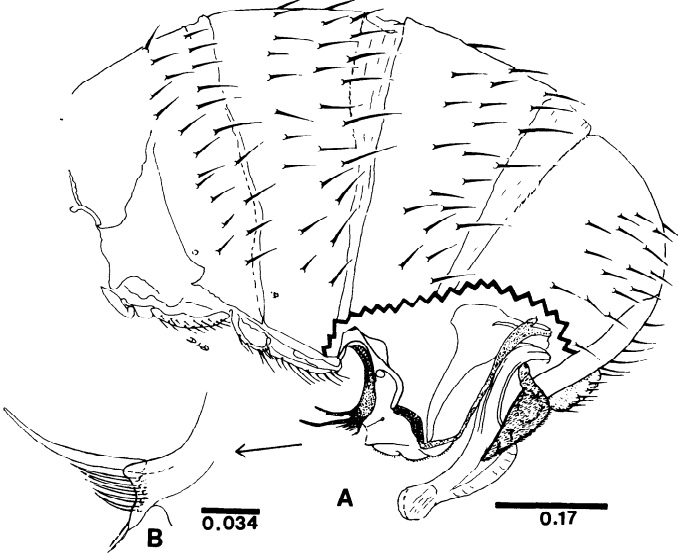
**Diagnosis:** Maxillary palpus variable, dark yellow to brownish-orange with slightly yellow apex to (very infrequently) entirely light brown; palpus smoothly spatulate (angles slightly more pronounced in female); antenna dark brown or nearly black except antennomere III usually partly to mostly orange; 3-6 (usually 5) dorsal aristal rays; lower 0.7 of male face and lower 0.3-0.5 of female face planate and receding in profile; face shining sericeous golden to light bronze (metallic moderate yellow) pruinose (occasionally sil-

**Figures 15-18.** *Hydrellia* spp., male abdomina. 15) *H. pakistanae* Deonier, Indian male abdomen, ventral view; 16A) same, left lateral view; 16B) same, left lateral view, postgonite process, copulobic macrochaeta and copulobic comb; 17) *H. pakistanae*, China male abdomen, ventral view; 18A) same, left lateral view; 18B) same, left lateral view, postgonite process, copulobic macrochaeta and copulobic comb.

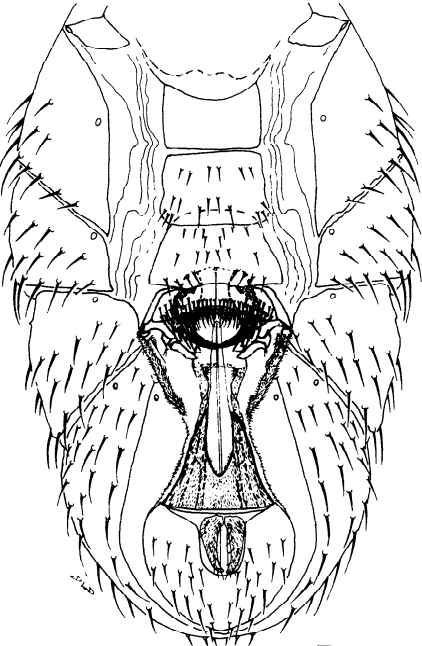




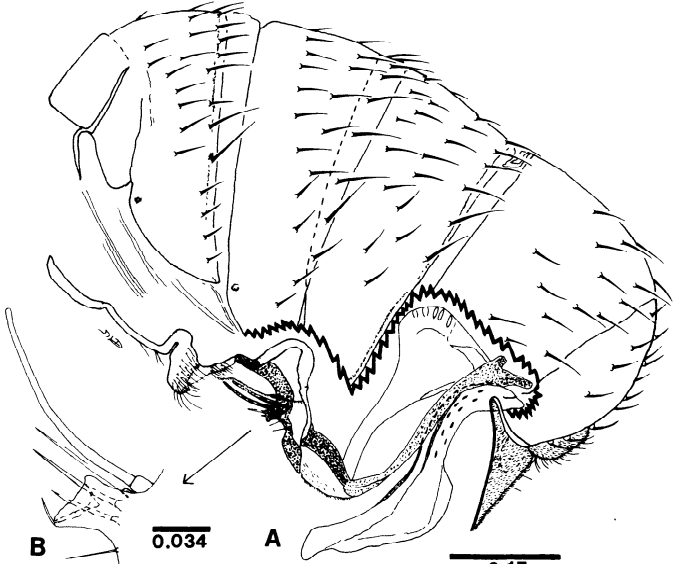
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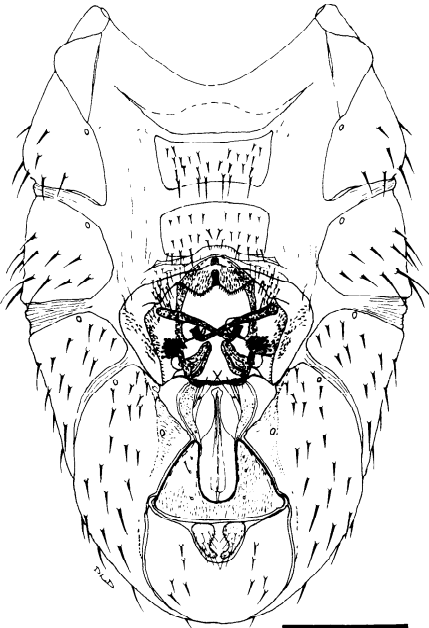
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very) in male; shining sericeous silvery pruinose in female (infrequently golden); 4-6 primary facial setae with 1 secondary facial setula above primary row, but offset nearly to orbit; mesonotum and pleuron often nearly unicolorous, semiglossy light bluish-gray pruinose except mesonotal disc semiglossy light to dark grayish-brown pruinose with slight reddish overtone; male profemur slightly to moderately dilated, maximum diameter 0.2-0.3 length and about 2 times maximum diameter of protibia; male protibia very slightly expanded distally with 1-2 of 3 anterodorsal preapical setae often subequal to length of probasitarsus; male probasitarsus with usually 3 mostly straight anterodorsal setae 0.5-0.8 as long as probasitarsus (few specimens with these setae subequal to probasitarsus, but not curling as in *H. pakistanae*); female cercus nearly always pendulous in dead specimens with nib of flange pointed downward; cercus and sternum 8 nearly always black; cleared female cercus, in lateral view, definitely malliform with terminal flange usually wider than in Indian form and with long ellipsoid fenestrate, or windowlike, discal depression distinct; mediobasal micro-onychia of cerci minute and similar in size to others of species group except *H. bogorae*. Male length 1.00-1.80 mm; female 1.30-2.20 mm. Male postabdomen as in Figs. 10, 23-24, 29, 34; female postabdomen as in Figs. 41-43.

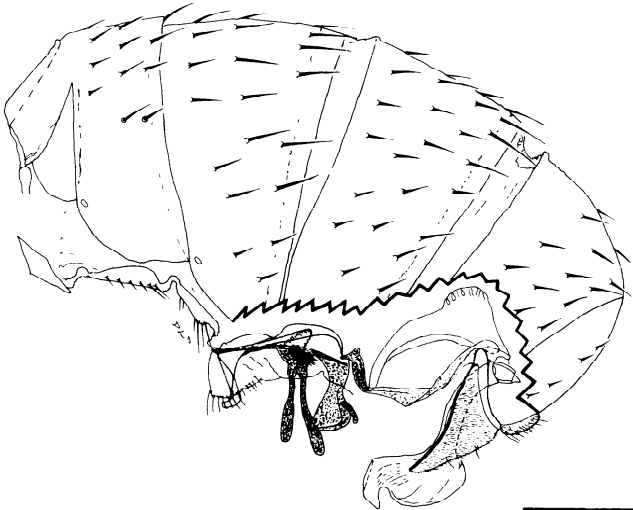
**Description: Head:** Face and lunule shining sericeous golden to light bronze (metallic moderate yellow) pruinose in anterior view in male (only occasionally silvery); shining sericeous silvery pruinose in female (infrequently golden, or metallic moderate yellow); lower 0.7 of male face and lower 0.3 of female face planate and receding in profile (distinctly in male); male face, in anterior view, flaring laterad from epistoma into extremely flattened subocular areas; female face usually with slight median elevation on lower 0.3 and slightly more prominent transverse convexity on upper 0.3 above planate zone; parafaciale inconspicuous; epistoma smoothly concave (deeply in male, shallowly in most females); 4-6 primary facial setae with 1 secondary facial setula above primary row, but offset nearly to orbit (appearing as a parafacial); antenna dark brown or nearly black except antennomere III partly (spotted) to mostly orange, with dense, usually light brown or orange dorsomedial micropubesence; 3-6 (usually 5) dorsal arisal rays; frons steeply sloping; frontal vitta, in anterior view, semiglossy dark grayish-brown (ocellar area occasionally light-gray pruinose); parafrontale usually with moderately dense light yellowish-brown (golden brown) pruinosity and fronto-orbital area

light grayish-brown pruinose; posterior fronto-orbital seta usually 2.5-3.0 times as long as anterior seta (male) and 1.2-2.0 times as long as anterior fronto-orbital seta in female; 20-30 postocular setae with 1 somewhat regular row of 14-17 setae near orbit common in female; maxillary palpus variable, dark yellow to brownish-orange with slightly yellow apex to (very infrequently) entirely light brown; palpus smoothly spatulate, without sharp angles (slightly more pronounced in female) and with relatively small blade. Epistomal index 1.5-2.4; mesofacial index 1.9-3.0; vertex index 4.2-7.5; ocular index 5.5-8.5; subcranial index 1.4-1.9; head width/head height 1.1-1.4.

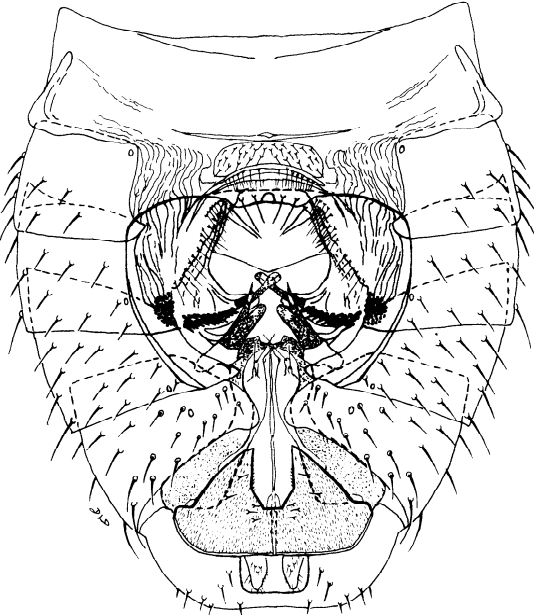
**Thorax:** Mesonotum and pleuron often nearly unicolorous, semiglossy light bluish-gray pruinose except mesonotal disc semiglossy light to dark grayish-brown pruinose with slight reddish overtone in dorsolateral view; notopleuron of mesonotum, in contrast to Indian form, uniformly light bluish-gray pruinose, without light-brown pruinosity; 2-4 (often 1 macrochaetous in female) antesutural and 2 (1 distinctly macrochaetous in both sexes) postsutural dorsocentral setae; 1 mesokatepisternal seta; coxae mostly light-gray pruinose laterally and partly to wholly yellow anteriorly; femora light-gray pruinose over dark grayish-brown; male profemur dilated slightly to moderately, maximum diameter 0.2-0.3 length and about 2 times maximum diameter of protibia; profemur with anteroventral row of 14-20 black microspinules on distal 0.5; male protibia mostly moderate yellow to orange; female protibia moderate yellow to orange except basal 0.3 often sparsely light-gray pruinose; male protibia only slightly expanded distally with 1-2 of 3 anterodorsal preapical setae often subequal to length of probasitarsus; male probasitarsus with usually 3 mostly straight anterodorsal setae 0.5-0.8 as long as probasitarsus (few specimens with these setae subequal to probasitarsus, but not curling as in *H. pakistanae*); male probasitarsus subequal to next 2-3 tarsomeres; protarsus (both sexes) usually dark brown except light to moderate yellow basitarsus; meso- and metatarsi light to moderate yellow except dark-brown tarsomere 5; mesotibia (both sexes) sparsely light-gray pruinose over dark grayish-brown except distal 0.15 and basal 0.10 dark yellow; male mesotibia moderately dilated with 1 dorsal preapical and distal 2-3 posterior setae only slightly to moderately developed (in contrast to usually strongly developed state in Indian subspecies); metatibia (both sexes) with distal 0.4 and basal 0.15 dark yellow, sparsely light-gray pruinose over dark grayish-brown between. Wing length 1.40-1.90 mm; wing veins light to moder-



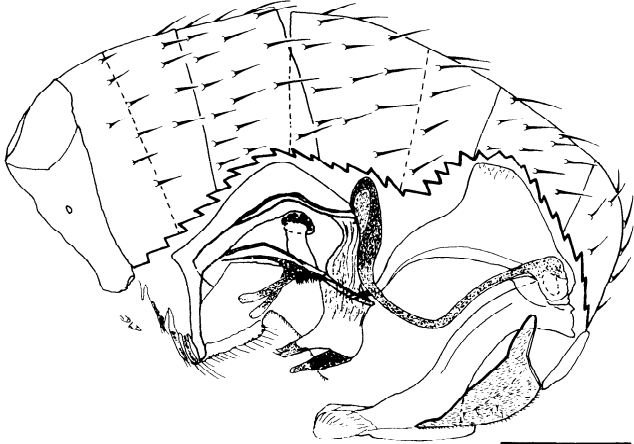
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22

Figures 19-22. *Hydrellia* spp., male abdomina. 19) *H. balciunasi* Bock, male abdomen, ventral view; 20) same, left lateral view; 21) *H. bogorae*, n.sp., male abdomen, ventral view; 22) same, left lateral view.

ate brown; 5-8 dorsal and 6-10 anterior interfractural costal setae (apparent tendency to greater number of both in females); costal-section indices: II/I 1.7-2.2; III/IV 3.0-4.7; V/IV 3.4-5.0;  $M_{1+2}$  index 1.6-2.2.

**Abdomen:** Terga semiglossy light bluish-gray pruinose except discal areas of 1-3 or 4 mostly shining (or glossy) dark grayish-brown in posterodorsal view (posterior margins infrequently defined as light brown); sides and ventral lobes of 1 and 2 (occasionally anteroventral part of 3) often light reddish-brown (nonpruinose). Male postabdomen: sternum 5 encapsulated within pouch formed by gonial arch expansion and fusion, overlain anteriorly and laterally by sterna 4 and 3; capsule widely spreading into obtusely incised anterolateral corners (sides appear to have narrow, more or less rectangular extensions in contrast to more flaring, rounded extensions in Indian subspecies); encapsulated copulobi incurved and bearing paired posteromedial cruciate, styliform macrochaetae and posterior somewhat ovoid clusters of 12-20 spinular microsetulae each; nearly entire capsule with numerous, regularly spaced microsensilla. Postgonite process, in ventral view, composed of heavily sclerotized, anteriorly projecting, broadly rounded lobe with 2 microtrichoid structures on posterior heel-like edge; postgonite process, in lateral view, somewhat variable, but mostly with obvious posteriorly projecting heel bearing the 2 microtrichoid structures (as in Fig. 24A, B); pregonite microscopic, apparently nonfurcate, with 1 pair of microtrichoid structures, and situated dorsolaterad of distiphallus just posterior to postgonite process (Figs. 10, 23, 24A); distiphallus, in ventral view, cultriform, medially carinate, and with expanded apex; in lateral view, projecting from curved, shanklike basiphallus anteriorly to variably formed, but commonly downcurved apex (Fig. 24A, 29A, C, D); apex occasionally with almost no downcurvature (Fig. 29B), but nearly always microstriated in lateral view; phallapodeme, in lateral view, with variable prominent, crestlike posterodorsal process (condyle scar inapparent; most common variants Fig. 34D, F with A-C variants very much less frequent). Fused surstyli relatively short, tapering distally to anteromedial notch (commonly narrow U-shaped, but infrequently nearly V-shaped),

mostly yellow or light yellowish-brown and bearing usually 3-4 pairs of microsetulae near notch and often 1 basal pair; fused surstyli length: cercus length 1.8-2-3. Syntergum 9+10 usually smoothly rounded posteriorly. Female postabdomen: sternum 8 about 0.25 wider than long, about same length as but 0.4 wider than sternum 7; sterna 7 and 8 obviously wider than 5 and 6; sternum 8 with dense covering of both spinular and long hairlike microsetulae and usual single pair of long, posteromediolateral hairlike microsetulae; cercus nearly always pendulous in dead specimens with nib (apex) of flange pointing ventrad; cercus and sternum 8 nearly always black; cleared cercus, in lateral view, definitely malliform with terminal flange usually wider than in Indian subspecies and with long ellipsoid fenestrate, or windowlike discal depression distinct; mediolateral micro-onychium (hooklet) of cercus minute and similar in size to others of species group except *H. bogorae*; cercus with 6-9 longer marginal setulae and 4-5 longer lateral setulae borne discally; cercus 2.0-2.4 times as long as wide in lateral view. Ventral receptacle cupuliform, about 1.3 times as deep as wide.

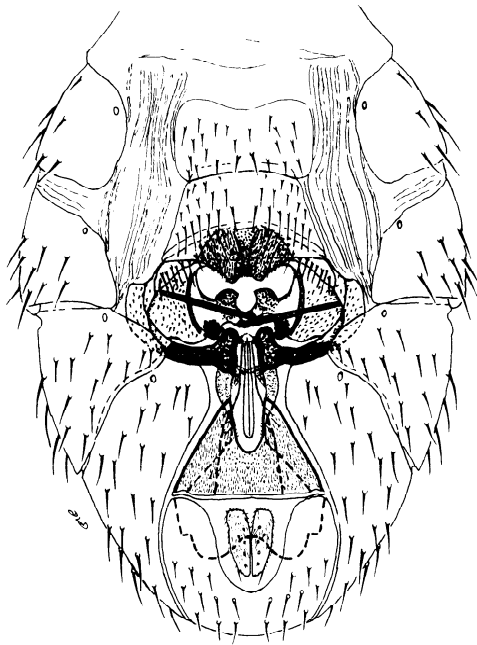
**Etymology:** The specific epithet, *sarahae*, is used to honor my daughter, Sarah E. Deonier, who has helped me sustain my entomological efforts.

**Type:** Holotype male, Shanghai Entomological Research Institute, Academia Sinica, Shanghai, China.

**Type locality:** CHINA: Beijing, San Jia Dian Reservoir (29-VIII-1990, GRB 90-4.1, on floating plants, G. Buckingham, Wang, Y., and Jiang, H.).

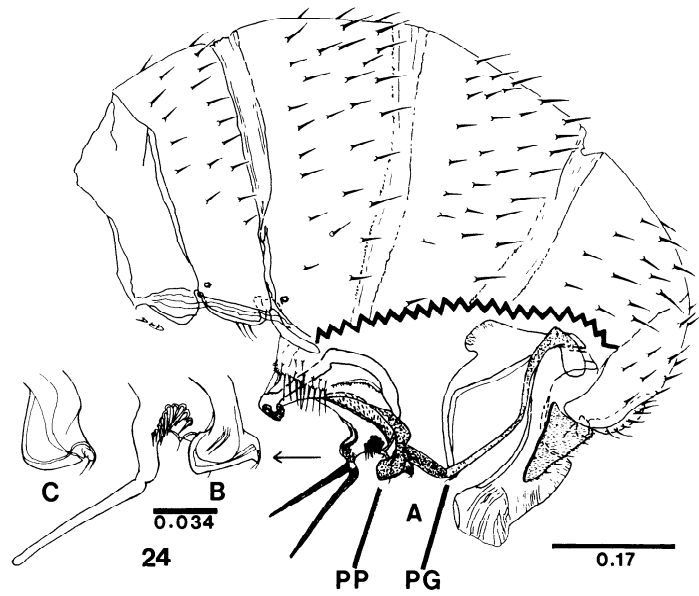
**Paratypes:** CHINA: same data as holotype, 1 male, 2 females; Beijing: San Jia Dian Reservoir (11-9-1991, G. R. Buckingham, adult on *Hydrocharis dubia* leaf), 1 male; (6-VIII-1992, adults on floating leaves *Hydrocharis dubia*, Chen, Z. Q. and C. A. Bennett), 2 males, 19 females; (30-VII-1992, adults on floating leaves *Hydrocharis dubia*, Chen, Z. Q. and C. A. Bennett), 2 males, 3 females; (30-VII-1992, larvae on *Potamogeton crispus*, Chen, Z. Q. and C. A. Bennett), 2 males; August 1st Lake (3-VIII-1992, 10-VIII-1992, larvae and pupar. on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 2 males, 3 females; (20-VIII-1991, Ex larvae in

**Figures 23-27.** *Hydrellia* spp., male abdomina and phalli. 23) *H. sarahae sarahae*, n.sp., n.ssp., male abdomen, ventral view; 24A) same, left lateral view; 24B) same, left lateral view, postgonite process, copulobitic macrochaeta and microsetular cluster; 24C) same, left lateral view, variant of postgonite process; 25A) *H. pakistanae* Deonier, China male abdomen, ventral view with copulobi exerted; 25B) same, distal 0.5 of distiphallus showing microscopic pregonites each bearing 4 microtrichoid structures; 26) *H. pakistanae*, genital capsule of China male, ventral view; 27A-E) *H. pakistanae*, variants in Indian phallus shapes, left lateral view.



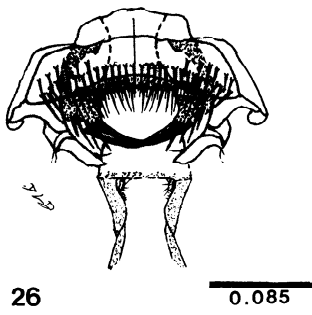
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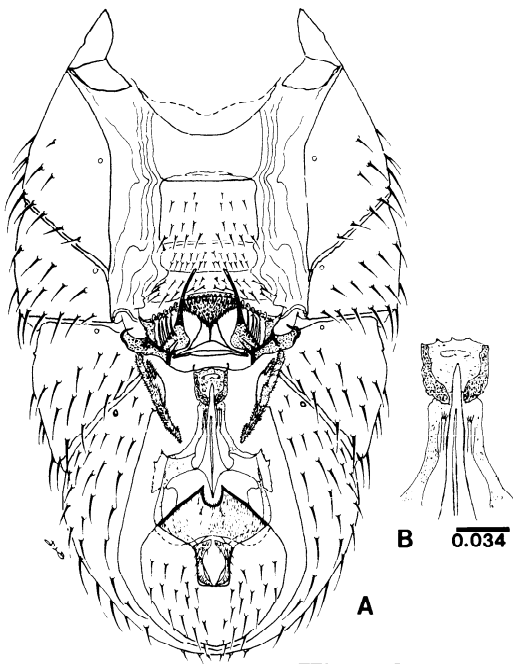


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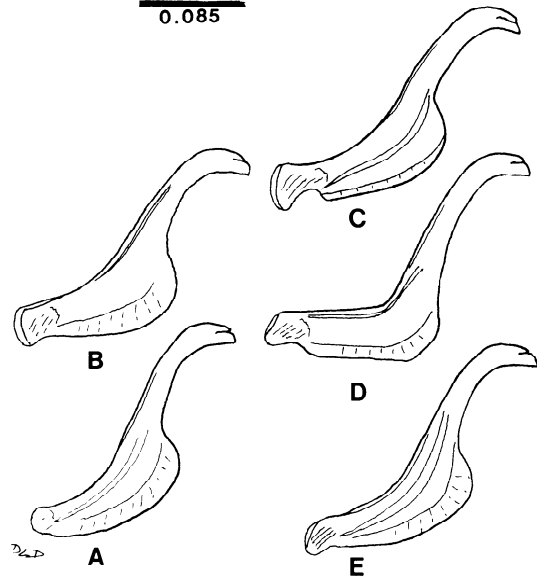
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0.17

*Hydrilla*, G. R. Buckingham), 2 males, 4 females; (20-VIII-1991, Ex puparia in stem and larvae in leafmines *Potamogeton crispus*, G. R. Buckingham), 1 female; (20-VIII-1991, puparium in *Hydrilla* leafmine, G. R. Buckingham), 1 female; Beijing [nonspecific] (IX-1990, G. R. Buckingham) 10 males; (IX-1990 Ex *Hydrilla*, G. R. Buckingham and Jiang, H.), 4 males, 11 females; (VIII-IX-1991, reared 29-IV-1992 from USDA Lab colony), 1 male, 9 females; (VIII-1991 reared on *Hydrilla* at Sino-American BioControl Lab, Wang, Y.), 11 males, 31 females; Beijing [nonspecific] (22-VIII-1991, adults on leaves, anon.), 19 males, 24 females; (IX-X-1992, reared from USDA Lab colony, Gainesville, FL), 16 males, 3 females; MuXudi Canal in Beijing (22-IX-1989, J. K. Balciunas, BEJ89 M002), 1 male, 1 female; Qiao Zhuang (VIII-29-1990, G. R. Buckingham), 2 males, 8 females; (4-IX-1990, Ex *Hydrilla*, G. Buckingham, Wang, Y., Jiang, H.), 1 male, 1 female; (23-VII-1992, larvae and puparia on *Potamogeton cristatus*, Chen, Z. Q. and C. A. Bennett), 2 males, 1 female; (23-VII-1992, larvae and puparia on *Hydrilla*, Chen, Z. Q. and C. A. Bennett), 40 males, 95 females; (30-VII-1992 larvae and puparia on *Hydrilla* Chen Z. Q. and C. A. Bennett), 8 males, 12 females; (6-VIII-1992, larvae on *Hydrilla*, Chen Z. Q. and C. A. Bennett) 8 males, 12 females; (6-VIII-1992, larvae on *Hydrilla*, Chen Z. Q. and C. A. Bennett), 10 males, 10 females; (9-IX-1991, puparium in leaf *Potamogeton pusillus*), 1 male, 1 female; Sleeping Buddha Park (23-VII-1992, eggs laid in flowers of *Potamogeton pusillus*/larvae fed *Potamogeton cristatus*, Chen, Z. Q. and C. B. Bennett), 2 females; (23-VII-1992, larvae and puparia on *Potamogeton pusillus*), 1 male, 2 females; Hsing Hua Univ. Canal (22-VIII-1991, adults in flowers *Hydrocharis dubia*, G. R. Buckingham), 1 female; (22-VIII-1991, Ex puparia in *Hydrilla* leafmines, G. R. Buckingham), 8 males, 10 females; (VIII-1991, reared on *Hydrilla*, Wang, Y. BEJ91FO47-49), 1 male; (23-VII-1992, larvae in *Potamogeton crispus*, Chen, Z. Q. and C. A. Bennett), 1 male, 2 females; (23-VII-1992, larvae and puparia in *Potamogeton natans*, Chen, Z. Q. and C. A. Bennett), 1 male; (23-VII-1992, adults on leaves *Potamogeton natans* and *Hydrocharis dubia*, C. A. Bennett), 2 females. Jiangsu Province: Jian Hu Lake (12-X-1990, emerged from *Hydrilla*, Wang, Y. and G. R. Buckingham), 1 male. Liaoning Province: Shenyang, Shi Miao Qiao Bridge (13-IX-1990, adult on *Hydrilla*, G. Buckingham, Wang, Y.), 4 males, 3 females; [nonspecific] (12-13-IX-1990, G. R. Buckingham), 1 male.

Paratypes are deposited at: Shanghai Entomological Research Institute, U. S. National Museum of Natural History, and Florida State Collection of Arthropods.

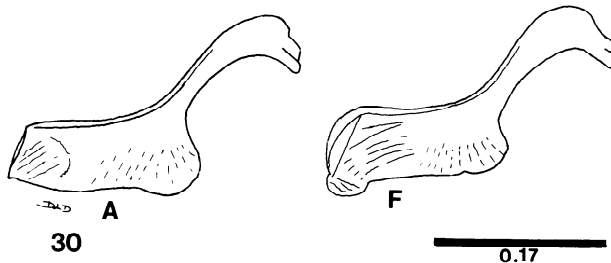
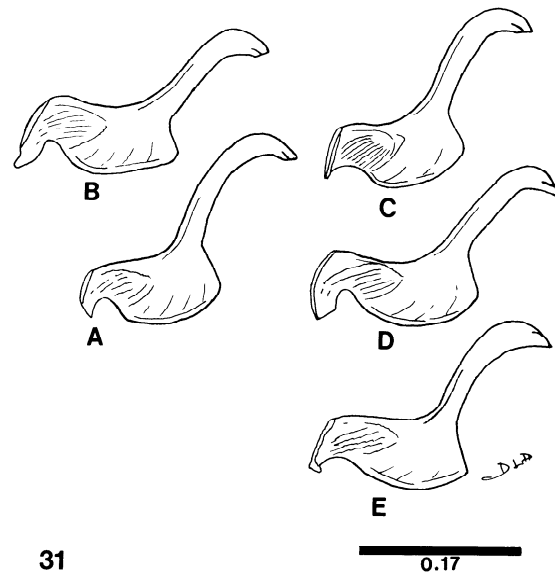
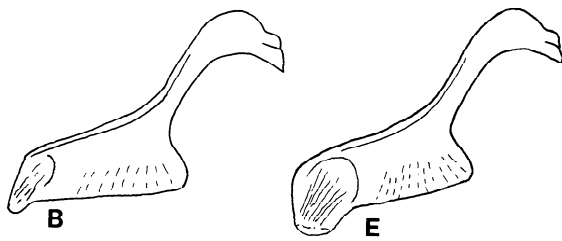
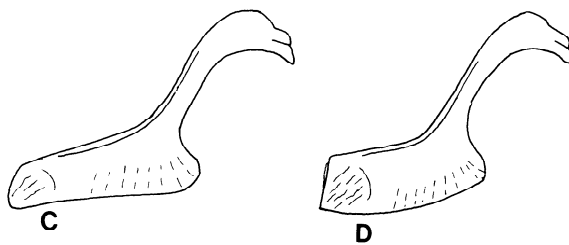
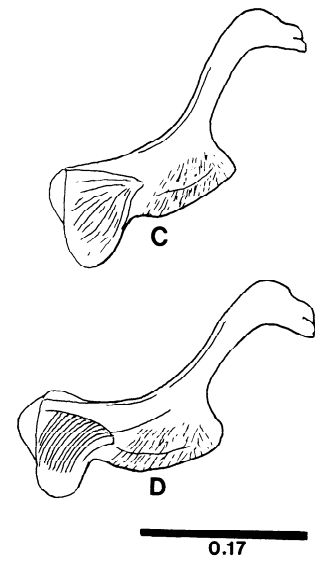
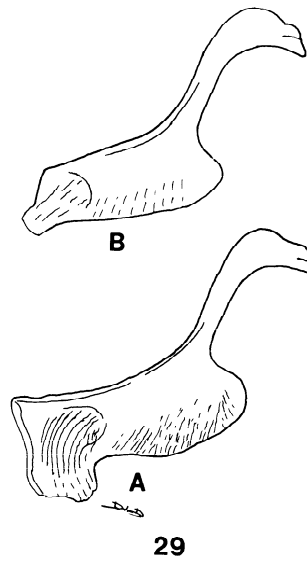
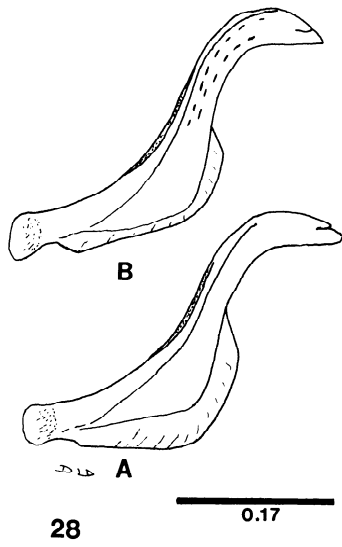
**Remarks:** Although I have not been able to study this species in the field and despite the very large area of distribution that remains unsampled, successful cross-mating experiments carried through 2 generations in Dr. Buckingham's laboratory forced me to conclude that the China and India-Pakistan population aggregates each represent subspecies and not separate species.

As can be seen in the records above, *H. sarahae sarahae*, n.sp., n.ssp. has, in contrast to *H. sarahae laticapsula*, n.sp., n.ssp. (India-Pakistan), some rearing records from host-plant species other than *Hydrilla*. These were species of *Potamogeton* and some, at least, represent actual feeding hosts and not simply puparia hosts.

*Hydrellia sarahae laticapsula*, n. sp. n. ssp.  
(Figs. 7, 11, 23-24, 30, 36, 41-44)

**Diagnosis:** Closely similar to *H. sarahae sarahae*, n.sp., n.ssp. Maxillary palpus variable, dark yellow to brownish-orange to (very infrequently) entirely moderate to dark brown; palpus smoothly spatulate (angles slightly more pronounced in female); antenna dark brown or nearly black except antennomere III occasionally appears in anterior and anterolateral views with very slight orange usually basally (may, in some cases, be orange or reddish-brown dorsomedial micropubescence); 4-7 (usually 5) dorsal arisal rays; face as in China subspecies except male with darker bronzing; 4-6 primary facials with 1 secondary facial setula apparently offset only 0.5 distance to orbit; mesonotum usually with less light bluish-gray pruinosity, mostly semiglossy dark grayish-brown with light-brown pruinosity having some reddish overtone in dorsolateral view; male protibia and probasitarsus as in China subspecies except with anterodorsal preapical setae (usually 2) more strongly developed; male mesotibia slightly more expanded, with 1 dorsal preapical and distal 2-3 posterior setae more strongly developed than in China subspecies; leg coloration as in China subspecies; female cercus nearly always porrect (projecting nearly straight backward) in dead specimens; cercus and sternum 8

**Figures 28-31.** *Hydrellia* spp., phalli. 28A-B) *H. pakistanae* Deonier, variants of phallus shapes in China males; 29A-D) *H. sarahae sarahae*, n.sp., n.ssp., variants in phallus shape, left lateral view; 30A-F) *H. sarahae laticapsula*, n.sp., n.ssp., variants in phallus shapes, left lateral view; 31A-E) *H. balciunasi* Bock, variants in phallus shapes, left lateral view.



orange to light grayish-brown pruinose (dark brown in 2 specimens); cleared female cercus, in lateral view, as in *H. sarahae sarahae*, n.sp., n.ssp. except terminal flange usually not as conspicuous. Male length 1.00-1.80; female 1.36-2.20 mm. Male postabdomen as in Figs. 11, 23-24, 30, 36; female postabdomen as in Figs. 41-44.

**Description: Head:** Differing mainly from *H. sarahae sarahae*, n.sp., n.ssp. in: slightly darker bronze color of male face; nearly unicolorous dark brown or nearly black antenna (III only infrequently with any orange); 4-7 (usually 5) dorsal arisal rays; epistomal index 1.4-2.1; mesofacial index 1.7-2.2; vertex index 4.0-6.4; ocular index 4.8-6.5; subcranial index 1.4-2.1; head width/head height 1.2-1.5.

**Thorax:** Mainly differing in: mesonotum mostly semiglossy dark grayish-brown with light-brown pruinosity having some reddish overtone in dorsolateral view; notopleuron of mesonotum often partly brown; male protibia with anterodorsal preapical setae (usually 2) more strongly developed; male mesotibia slightly more dilated, with dorsal preapical and distal 2-3 posterodorsal setae more strongly developed; wing length 1.42-1.93 mm; 5-10 dorsal and 7-12 anterior interfurcular costals (tendency to greater number of both and smaller size of anteriors in female); costal-section indices: II/I 1.6-2.2; III/IV 3.0-4.0; V/IV 3.0-4.5;  $M_{1+2}$  index 1.6-2.0.

**Abdomen:** Terga closely similar to those of *H. sarahae sarahae*, n.sp., n.ssp. Male postabdomen differing mainly in: capsule with flaring rounded lateral extensions and appearing noticeably wider than fused surstyli (nearly 2 times as wide versus about 1.5 times in most *H. sarahae sarahae*); 14-22 spinular microsetulae in ovoid posterior cluster; innermost copulobus process just anterior to copulobus macrochaeta apparently longer than in China subspecies (Fig. 11); postgonite process often with less obvious heel in lateral view (Fig. 24C); distiphallus (Fig. 30) often with less downcurvature of apex in lateral view (3 common variants, Fig. 30B, E, F, showed less downcurvature than in China subspecies and 3 less frequent variants, A, C, D, had no downcurvature); phallapodeme, in lateral view, quite variable in posterodorsal process (Fig. 36: A, B, E most common forms with C, D, F, G much less frequent). Fused surstyli often with sides slightly more arched

than in China subspecies. Female postabdomen differing mainly in: female cercus nearly always porrect (projecting nearly straight backward) in dead specimens; cercus and sternum 8 orange to light grayish-brown pruinose; cleared cercus, in lateral view, with less conspicuous, narrower terminal flange.

**Etymology:** The subspecific epithet, *laticapsula*, is used in reference to the broader genital capsule in the male.

**Type:** Holotype male, USNM.

**Type locality:** INDIA: Bangalore, Karnataka State (reared X-8-1992 from *Hydrilla*, USDA Lab colony, Gainesville, FL, Exp. code HSI-92-34).

**Paratypes: INDIA:** same data as holotype, 54 males, 34 females; Bangalore (Ex *Hydrilla* in Quar., 20-III-1991, FL: Alachua Co., Gainesville D.P.I.), 9 males, 40 females; (29-VI-1992), 9 males, 22 females; (15-II-1991), 72 males, 210 females; Kumbaleogoda, Bangalore, Karnataka State (18-19-VIII-1990, G. Buckingham, Voucher FBCL 90-1045), 18 males, 37 females. **PAKISTAN:** Rawalpindi (30-VIII-1990, *Hydrilla verticillata*, Riaz Mahmood, Voucher FBCL 90-1047), 1 male.

Paratypes are deposited at U.S. National Museum and Florida State Collection of Arthropods.

**Remarks:** See this section under *H. sarahae sarahae*, n.sp., n.ssp. This subspecies obviously has a broad north-south distribution (Bangalore to Rawalpindi) in the Indian subcontinent, but its east-west distribution is completely unknown.

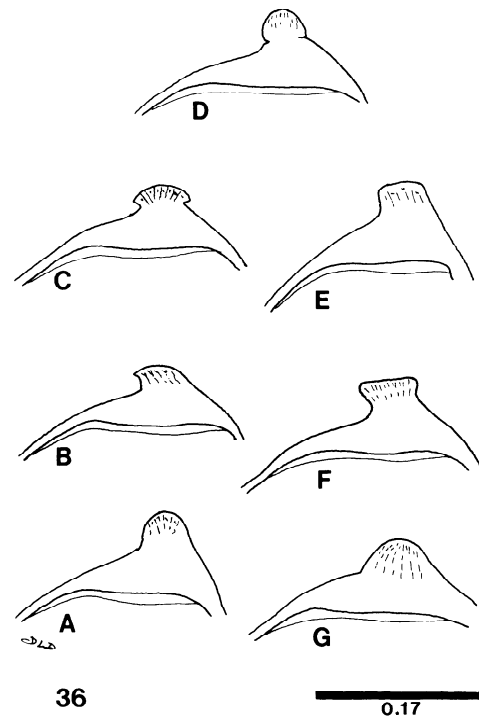
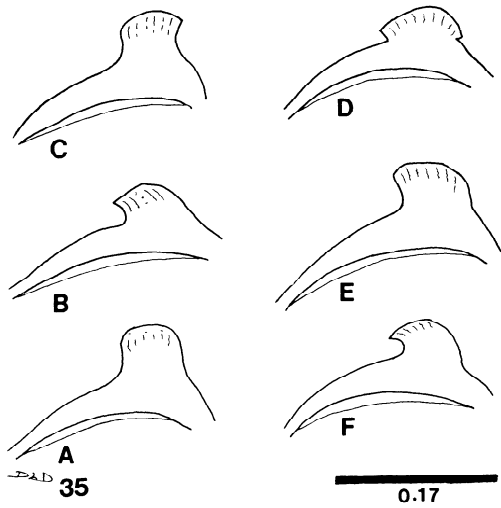
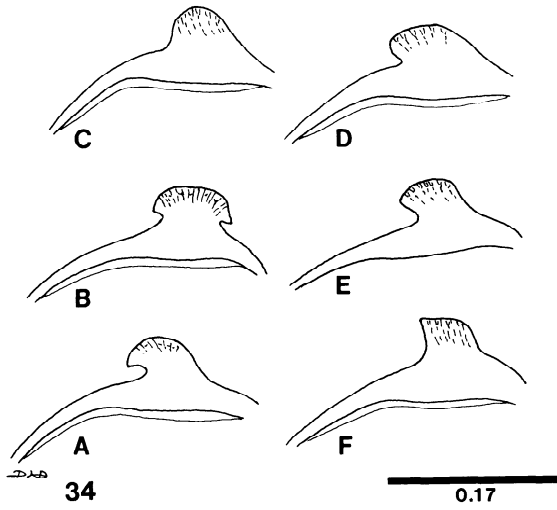
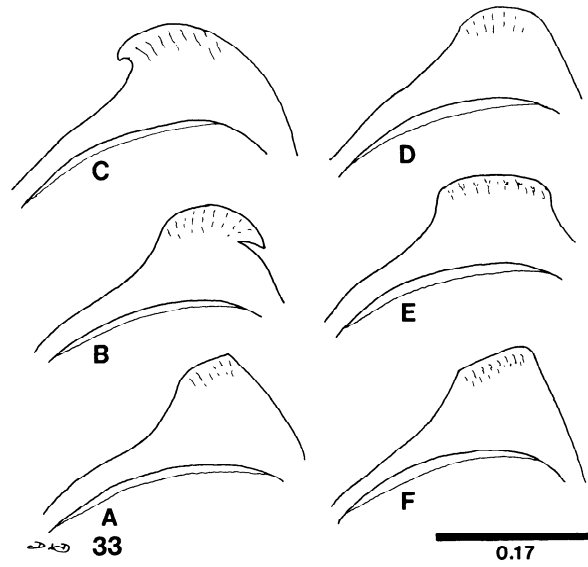
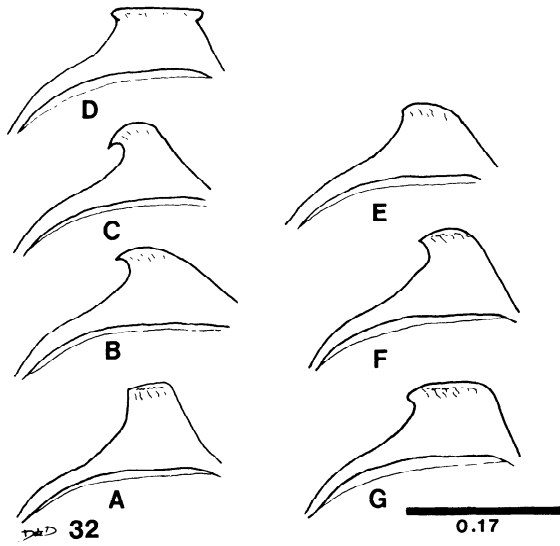
*Hydrellia balciunasi* Bock  
(Figs. 6, 13, 14, 19-20, 31, 35, 49-52)

*Hydrellia balciunasi* Bock 1990: 987-989.

**Diagnosis:** Maxillary palpus variable, moderate yellow to dark yellowish-brown; palpus spatulate with smoothly rounded angles (female with 3-4 ventral palpal setae conspicuously black and larger than in male); antenna dark brown or nearly black except antennomere III mostly moderate to dark yellow and slightly infuscated (spotched with brown or brownish-orange); 4-7 (usually 5) dorsal arisal rays; lower

**Figures 32-36.** *Hydrellia* spp., variants phallapodeme shapes, left lateral view. 32A-G) *H. pakistanae* Deonier, Indian males; 33A-F) *H. pakistanae*, China males; 34A-F) *H. sarahae sarahae*, n.sp., n.ssp.; 35A-F) *H. balciunasi* Bock; 36A-G) *H. sarahae laticapsula*.





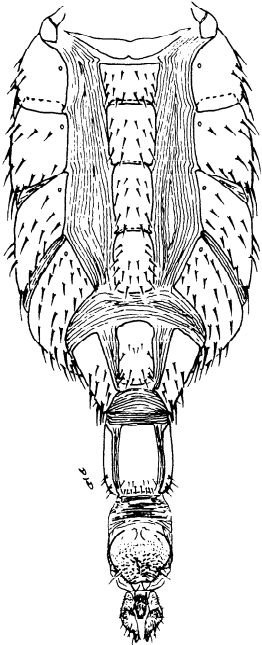
0.7 of male face and lower 0.3-0.5 of female face planate and receding in profile (distinctly so in male); face shining sericeous golden (metallic light yellow) to bronzed (metallic light brownish-yellow) pruinose; lunule mostly silvery pruinose; 4-5 primary facial setae with usually 1 secondary facial setula above primary row; mesonotum semiglossy moderate grayish-brown to light yellowish-brown (golden brown) pruinose with reddish reflections in dorsolateral view; notopleuron of mesonotum mostly and pleuron except more brownish anatergite and anterior part of mesokatepisternum sparsely to densely light bluish-gray pruinose; male profemur slightly dilated, maximum diameter about 0.2 length and about 2 times maximum diameter of protibia; male protibia not noticeably expanded distally, with 1 of 2 anterodorsal but no posterodorsal preapical setae subequal in length to probasitarsus; male probasitarsus with 1-2 straight anterior setae 0.5-0.8 probasitarsal length; cleared female cercus, in lateral view, often somewhat malliform with slight terminal flange and with slight fenestrate (windowlike) discal depression; mediobasal cercal micro-onychia (hooklets) minute, similar in size to others of species group except *H. bogorae*. Male length 1.00-1.70 mm (to 2.10 fide Bock, 1990); female 1.25-2.10 mm. Male postabdomen as in Figs. 13, 14, 19-20, 31, 35); female postabdomen as in Figs. 49-52.

**Description: Head:** Face shining sericeous golden (metallic light yellow) to bronzed (light brownish-yellow) pruinose; lunule mostly silvery pruinose; lower 0.7 of male face and lower 0.3 of female face planate and receding in profile (distinctly so in male); male face, in anterior view, flaring laterad from epistoma into extremely flattened subocular areas; female face often with very slight median elevation on lower 0.3 and slightly more prominent median convexity on upper 0.3 above planate zone; parafaciale inconspicuous; epistoma moderate to deeply concave (apparently deeper and less smoothly concave in male than in female); 4-5 primary facial setae with usually 1 secondary facial setula above primary row; antenna dark brown or nearly black except antennomere III mostly moderate to dark yellow and slightly splotched with brown or brownish-orange; antennomere III with relatively dense yellow dorsomedial micropubescence; 4-7 (usually 5) dorsal arisal rays; frons moderately to

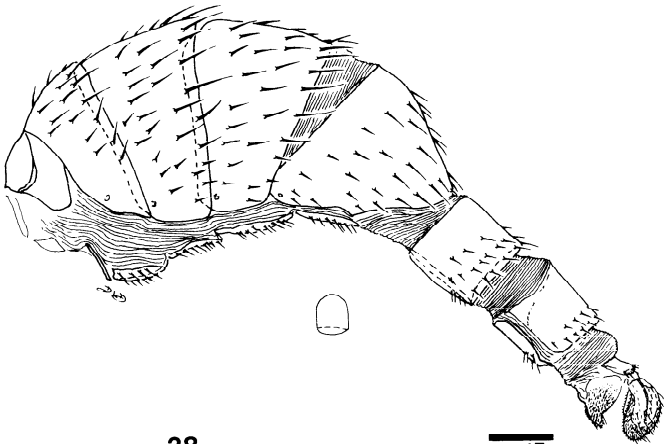
steeply sloping; frontal vitta, in anterodorsal view, semiglossy dark grayish-brown with parafrontale and fronto-orbital area with slightly more light grayish- or yellowish-brown pruinosity; posterior fronto-orbital seta variably 2-3 times as long as anterior seta (sexual dimorphism inapparent); 18-26 postocular setae with 1 irregular row of about 14 somewhat near orbit in female; maxillary palpus moderate yellow to yellowish-brown (often dark yellowish-brown); palpus spatulate with smoothly rounded angles; female palpus often somewhat larger and with larger, more conspicuous black ventral setae than in male. Epistomal index 1.9-3.3; mesofacial index 1.7-2.9; vertex index 3.0-7.8; ocular index 4.2-8.4; subcranial index 1.5-2.7; head width/head height 1.1-1.4.

**Thorax:** Mesonotum except notopleuron slightly variable from semiglossy moderate grayish-brown to light yellowish-brown pruinose with reddish reflections in dorsolateral view; notopleuron mostly and pleuron except more brownish anatergite and anterior part of mesokatepisternum sparsely to densely light bluish-gray pruinose; 2-3 (1 distinctly macrochaetous and often subequal to postsutural) antesutural and 2 (1 macrochaetous) postsutural dorsocentral setae; 1 mesokatepisternal seta; coxae mostly light-gray pruinose laterally, light to dark yellow anteriorly; femora light-gray pruinose over dark grayish-brown; male profemur slightly dilated, maximum diameter about 0.2 length and about 2 times maximum diameter of protibia; profemur with anteroventral row of 14-20 black microspinules on distal 0.5; protibia varying from mostly moderate to dark yellow to sparsely pruinose light to moderate brown on basal 0.7 and moderate yellow on distal 0.3 (sexual dimorphism not confirmed); male protibia not noticeably expanded distally, with 1 of 2 anterodorsal, but no posterodorsal preapical setae subequal in length to probasitarsus; male probasitarsus with 1-2 straight anterior setae 0.5-0.8 probasitarsal length; male probasitarsus subequal to next 2 or 3 tarsomeres; tarsi except dark yellow meso- and metabasitarsomeres mostly dark brown to reddish-brown dorsally; mesotibia (both sexes) sparsely light-gray pruinose over dark grayish-brown except distal 0.2 dark yellow; male mesotibia moderately dilated; metatibia (both sexes) sparsely light-gray pruinose over dark

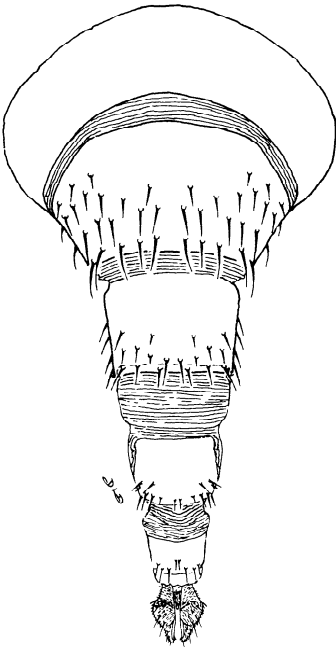
**Figures 37-40.** *H. pakistanae* Deonier, female abdomen, postabdomen, and cerci. 37) abdomen, ventral view; 38) abdomen, lateral view; 39) postabdomen, dorsal view; 40A-C) variants in shapes of female cercus and sternum 8, left lateral view.



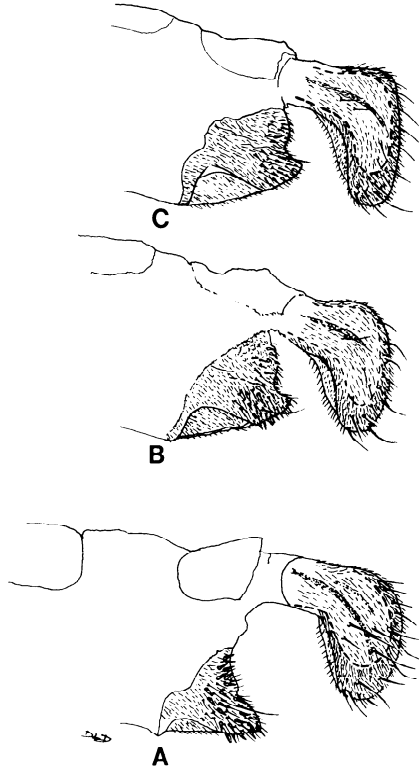
37 0.17



38 0.17



39 0.17



40 0.10

brown except distal 0.3-0.5 and basal 0.1-0.2 dark yellow. Wing length 1.20-2.04 mm; wing veins light yellow to light brown; 5-7 dorsal and 6-7 anterior interfractural costal setae; costal-section indices: II/I 1.6-2.0; III/IV 2.4-4.0; V/IV 3.0-4.4;  $M_{1+2}$  index 1.4-2.0.

**Abdomen:** Terga densely light bluish-gray pruinose over light to dark brown (infrequently with reddish reflections); semiglossy discally in posterodorsal view with posterior margins very light brown (narrow and inconspicuous compared to those of *H. bogorae*, n. sp.); ventral lobes (not sides) of terga 1-3 semiglossy light brown; sides and ventral lobes of terga 4-5 and all of syntergum 9+10 densely light-gray pruinose. Male postabdomen: sternum 5 encapsulated within pouch formed by gonial arch expansion and fusion, overlain anteriorly and laterally by sterna 4 and 3; capsule widely spreading (to over 0.5 width of sternum 2 on each side) to broadly rounded 65° anterolateral corners and narrowing in an arc posteriorly; encapsulated copulobi incurved and bearing a pair of posteromedial, cruciate, spathulate macrochaetae, each bordered laterally by a somewhat ovoid cluster of 18-34 spinular microsetulae (arranged essentially on the mid to posterolateral corner of each copulobus); capsule bordered laterally by densely arranged band of microsensilla. Postgonite process, in ventral view, composed of heavily sclerotized digitiform lobe and a much smaller digitiform lobule (appearing, in lateral view, as posterior polliciform, or thumblike, appendage of the larger shoelike, or hooflike, component of postgonite process; neither lobe with discernible microtrichoid projections as in others of species group. Pregonite microscopic, only slightly bifurcate, bearing 1 pair of microtrichoid structures, and situated dorsolaterad of distiphallus apex; distiphallus, in ventral view, cultriform, medially carinate, and with expanded apex; in lateral view, projecting from long, curved shanklike basiphallus anteriorly to variably formed downcurved hooklike apex preceded by relatively deeply incised emargination; apex often microstriated in lateral view; phallapodeme, in lateral view, with prominent, but variable erect, crestlike posterodorsal process (condyle scar inapparent; most common variants Fig. 35A, E). Fused surstyli relatively short, tapering distally to anteromedial notch (commonly narrow U-shaped, but occasionally more nearly V-shaped), mostly yellow or light yellowish-brown and bearing usually 3 pairs of microsetulae

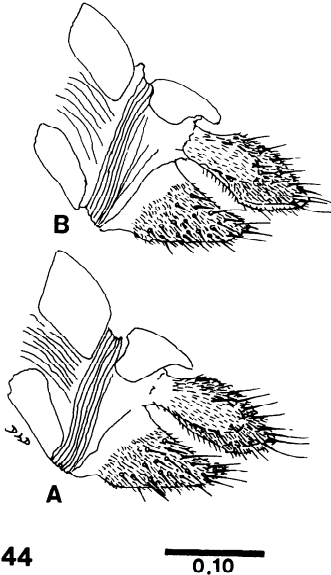
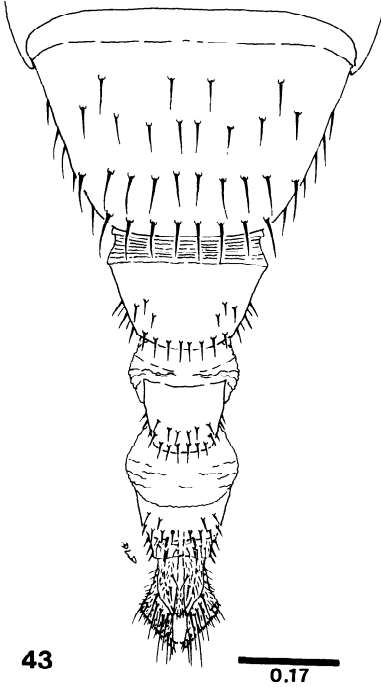
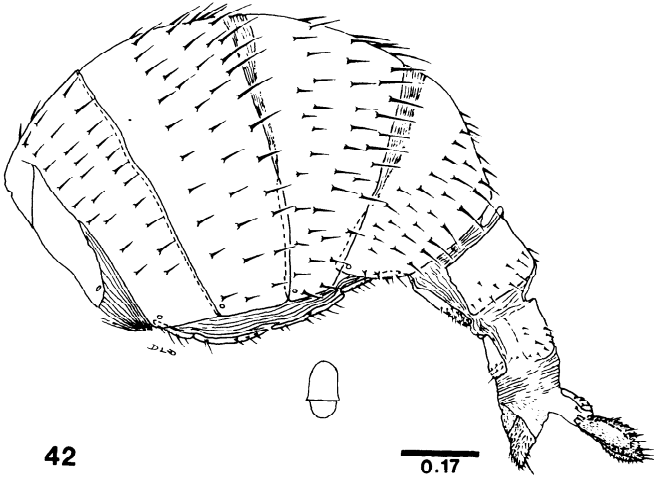
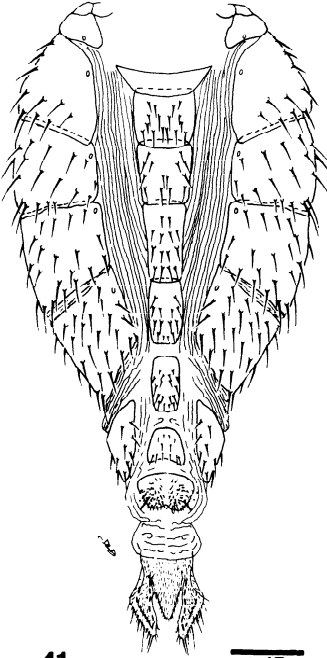
around notch; fused surstyli length: cercus length 2:1. Syntergum 9+10 usually smoothly rounded posteriorly. Female postabdomen: sternum 8, in ventral view, slightly longer than wide, about same width, but noticeably longer than sternum 7; sterna 7 and 8 wider than 5 and 6; sternum 8 with sparser covering of microsetulae than others of species group (some long, hairlike and some spinular microsetulae); contrasting with others of species group in commonly having 2 pairs of long, hairlike posterolateral microsetulae in addition to usual single pair of long, hairlike posteromediolateral microsetulae; sternum 8, and sterna 6-7 often yellow, orange, or light brown; cercus usually yellow to dark yellowish-brown; cercus, in lateral view, commonly malliform, or hammerlike, with small, but noticeable terminal flange and with slight fenestrate (windowlike) discal depression; mediolateral cercal micro-onychium (hooklet) minute, about same size as others of species group except *H. bogorae*, n.sp.; cercus with 8-10 longer marginal setulae and 4-5 longer discal setulae; cercus 1.9-2.2 times as long as wide in lateral view. Ventral receptacle cupuliform, about 1.2 times as deep as wide.

**Type:** Holotype male, Australian National Insect Collection, Canberra.

**Type locality:** Reared from laboratory colony in *Hydrilla verticillata* collected at Alipou Creek on Pacific Highway, 1 km N. of Grafton, New South Wales (VII-20-1987, M. Purcell).

**Specimens Examined:** Holotype and paratypes were not examined, but specimens compared with paratypes from Brisbane, Queensland and Jabiru, Northern Territory were dissected and studied. Northern Territory: Yellow-water Billabong, 55 km SW of Jabiru (Ex: Berlese sample, VIII-11-1983, J. K. Balciunas), 3 males, 7 females; Yellow-water Billabong (VIII-11-1983, J. K. Balciunas), 4 males, 2 females; (VIII-15-1983, J. K. Balciunas), 3 males, 4 females. Queensland: Brisbane (Ex: USDA Lab colony at Gainesville, FL, XI-28-1989, G. R. Buckingham), 3 males, 13 females; Petrie, North Pine Dam (reared from USDA Lab colony in *Hydrilla* originally coll. II-III-1988, M. R. Purcell; extracted V-5-15), 1 male, 13 females; same, North Pine Dam USDA Lab colony, Gainesville, FL (V-18-1988), 5 males, 5 females; (IV-21-1988), 5 males, 3 females; (V-22-1988), 15 males, 10

**Figures 41-44.** *Hydrellia sarahae*, n.sp., female abdomen, postabdomen, and cerci. 41) *H. sarahae*, female abdomen, ventral view; 42) *H. sarahae sarahae*, n.sp., n.ssp., female abdomen, lateral view; 43) same, postabdomen, dorsal view; 44) *H. sarahae laticapsula*, n.sp., n.ssp., variants in shapes of female cercus and sternum 8, left lateral view.



females; (VI-20-1988), 15 males, 15 females; (VII-13-1988), 5 males, 5 females; (V-31-1989), 9 males, 8 females; (VII-1989), 9 males; (III-25-1991), 6 males, 13 females.

**Remarks:** See this section under *H. bogorae*, n.sp. Although Bock's (1990) study was much more extensive than any previous work on Australian *Hydrellia*, it was nevertheless based mostly upon existing collections and did not involve an intensive continental survey. For this reason and because of the vast distances involved with the resultant isolating effect, I suspect that additional members of the *pakistanae* species group remain to be discovered in Australia.

Bock (1990) recorded *H. balciunasi* from *Vallisneria gracilis* F.M. Bailey, *Najas tenuifolia* R. Br., and *Ceratophyllum demersum* Linnaeus in addition to the usual host-plant species, *Hydrilla verticillata* Royle. From the information provided, it is not possible to determine if these other species were feeding hosts or simply incidental pupariation hosts.

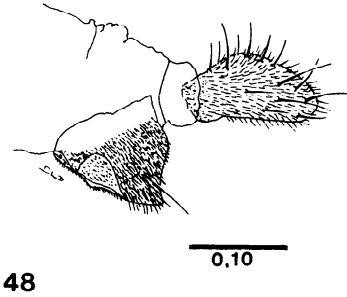
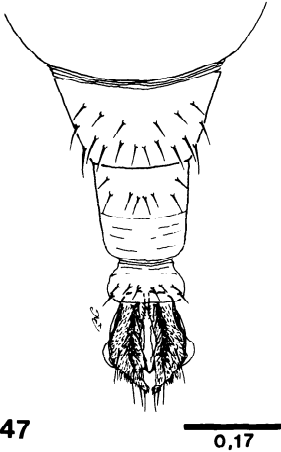
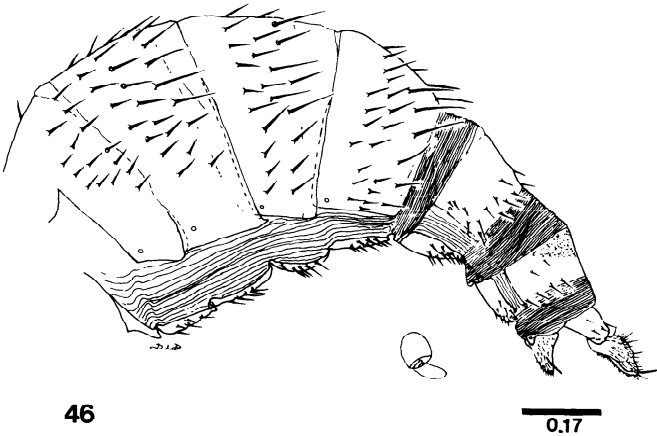
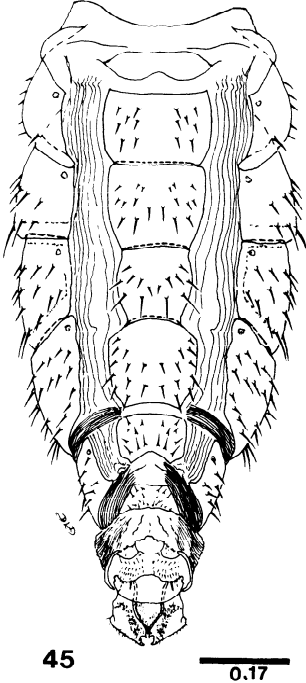
*Hydrellia bogorae*, n. sp.  
(Figs. 8, 9, 21-22, 45-48)

**Diagnosis:** Maxillary palpus light to moderate yellow; palpus smoothly spatulate; antenna dark brown except antennomere III usually light yellow dorsomedially and dark yellow or orange anterolaterally; 4-6 (usually 5) dorsal arisal rays; lower 0.7 of male face and lower 0.3-0.5 of female face planate and receding in profile (distinctly so in male); face shining sericeous silvery pruinose, often with sparse golden (metallic yellow) flecks; 4-5 primary facial setae and 1 secondary facial setula above primary row; mesonotum semiglossy moderate brown pruinose except notopleuron light reddish brown; pleuron light bluish-gray pruinose over dark brown; male profemur dilated, maximum diameter about 0.3 length and about 3 times maximum diameter of protibia (appearing relatively shorter and stouter than in males of other species of this group); male protibia slightly expanded distally, with 1 of 2 anterodorsal, but no posterodorsal preapical setae subequal in length to probasitarsus; male probasitarsus with 1-2 straight anterodorsal setae nearly subequal to (but not longer than) probasitarsus; female cercus, in lateral view, obellipsoid, widest about 0.4 out from base and without obvious fenestrate, or windowlike, discal depression; cercus with mediobasal microonychium (hooklet) stouter than in others of the species group. Male length 0.90-1.10 mm; female 1.00-

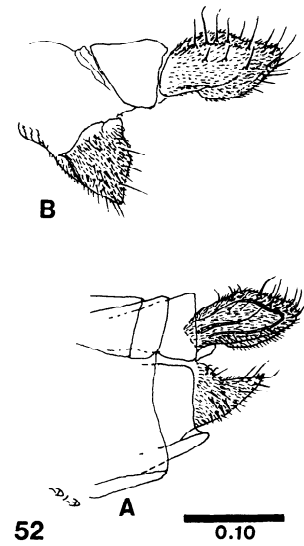
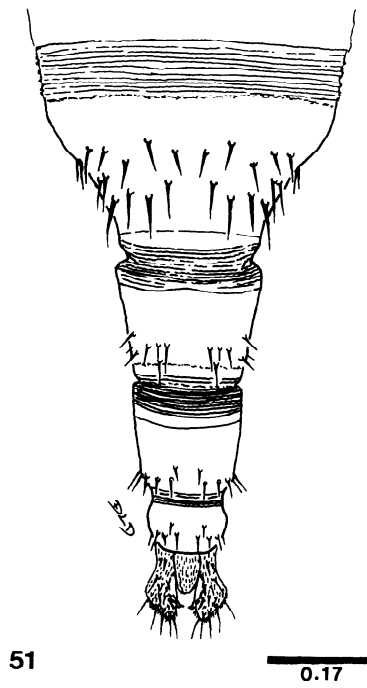
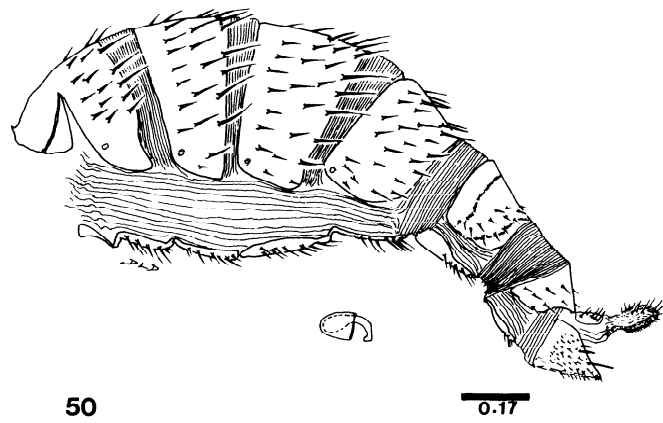
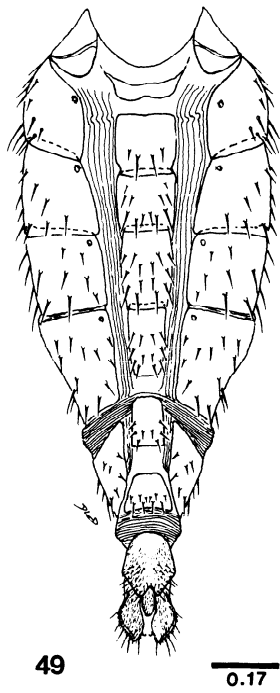
1.70 mm. Male postabdomen as in Figs. 21-22; female postabdomen as in Figs. 45-48.

**Description: Head:** Face and lunule shining sericeous silvery pruinose, often with sparse golden (metallic yellow) flecks; lower 0.7 of male face and lower 0.5 of female face planate and receding in profile (distinctly so in male); male face, in anterior view, flaring laterad from epistoma into extremely flattened subocular areas; female face often with slight convexity or elevation on lower 0.3 and slightly more prominent median convexity on upper 0.3; parafacial inconspicuous; epistoma deeply concave (with slightly notched appearance in male, smoothly concave in female); 4-5 primary facial setae with 1 secondary facial setula above primary row; antenna dark brown except antennomere III usually light yellow dorsomedially and dark yellow or orange anterolaterally with dense yellow dorsomedial micropubescence; 4-6 (usually 5) dorsal arisal rays; frons moderately sloping; frontal vitta dark brown in anterodorsal view (ocellar area slightly more pruinose); parafrontal dark reddish-brown pruinose and fronto-orbital area light grayish-brown pruinose; posterior fronto-orbital seta about 2 times as long as anterior in male and about 3 times as long in female; 20-30 postocular setae with 1 irregular row of 10-14 setae near orbit in female; maxillary palpus light to moderate yellow; palpus smoothly spatulate without sharp angles and with relatively small blade. Epistomal index 2.0-3.0; mesofacial index 2.0-3.0; vertex index 4.2-8.5; ocular index 4.5-8.5; subcranial index 1.6-2.6; head width/head height 1.0-1.5.

**Thorax:** Mesonotum semiglossy moderate brown pruinose except notopleuron light reddish-brown pruinose (dorsolateral view); 2-3 (1 distinctly macrochaetous) antesutural and 2 (1 macrochaetous) postsutural dorsocentrals; 1 mesokatepisternal seta; coxae mostly light-gray pruinose laterally and light to dark yellow anteriorly; femora light-gray pruinose over dark grayish-brown; profemur conspicuously dilated, maximum diameter about 0.3 length and about 3 times maximum diameter of protibia; profemur with anteroventral row of 14-20 black microspinules on distal 0.5; protibia (both sexes) light to dark yellow; male protibia slightly expanded distally, with 1 of 2 anterodorsal but no posterodorsal preapical setae subequal in length to probasitarsus; male probasitarsus with 1-2 straight anterodorsal setae nearly or subequal to (but not longer than) probasitarsal length; probasitarsus (tarsomere 1) and tarsomere 5 light to moderate brown dorsally and yellow laterally; 2-4 light yellowish-brown (in both sexes); meso- and



Figures 45-48. *H. bogorae*, n.sp., female abdomen, postabdomen, and cercus. 45) abdomen, ventral view; 46) same, left lateral view; 47) postabdomen, dorsal view; 48) cercus and sternum 8, left lateral view.



**Figures 49-52.** *H. balciunasi* Bock, female abdomen, postabdomen, and cercus. 49) abdomen, ventral view; 50) same, left lateral view; 51) postabdomen, dorsal view; 52) cercus and sternum 8, left lateral view.



metatibia (both sexes) sparsely light-gray pruinose over dark brown except distal 0.2 yellow; male mesotibia moderately dilated; mesotarsus with coloration as in protarsus; metatarsus with tarsomeres 1-2 light yellow and tarsomeres 3-5 light to moderate brown. Wing length 1.20-1.80 mm; wing veins light yellow to light brown; 4-6 dorsal and 5-8 anterior interfractural costal setae; costalsection indices: II/I 1.7-2.5; III/IV 3.0-4.2; V/IV 3.4-4.6;  $M_{1+2}$  index 1.5-2.2.

**Abdomen:** Terga semiglossy dark grayish-brown pruinose (often with reddish reflections) with light-brown posterior margins and with tergum 5 glossy very dark brown in posterodorsal view; sides and ventral lobes light-gray pruinose over dark reddish-brown. Male postabdomen: sternum 5 entirely encapsulated within pouch formed by expanded and fused gonial arches and overlain by sterna 4 and 3; capsule widely spreading to rounded, nearly 90° anterolateral corners and narrowing in an arc posteriad; encapsulated copulobi (posterolateral lobes of sternum 5) incurved and bearing a pair of posteromedial, cruciate, spathulate macrochaetae, each bordered laterally by a long comb of 24-32 spinnular microsetulae arranged incrementally from 1 seta nearest copulobic macrochaeta to 2 and then 3 rows laterad; copulobic comb bordered laterally by small densely set cluster of microsensilla. Postgonite process composed of heavily sclerotized digitiform lobe and a smaller bifurcate anterolateral lobe bearing 1 microtrichoid structure on 1 furca. Pregonite microscopic, bifurcated, bearing 1 pair of microtrichoid structures, and situated dorsolaterad of distiphallus apex; distiphallus, in ventral view, cultriform, medially carinate, acuminate, but with expanded apex; distiphallus, in lateral view, projecting anteriorly to microstriated apex from relatively narrow, downcurved, shanklike basiphallus (concealed in ventral view by fused surstyli); phallopodeme, in lateral view, with prominent, erect, crestlike posterodorsal process (condyle scar diffuse, inapparent). Fused surstyli short, tapering distally to anteromedial notch (U- or V-shaped), mostly yellow or light yellowish-brown and bearing 5 pairs of microsetulae around notch; fused surstyli length: cercus length 3:1. Syntergum 9+10 roundly truncate posteriorly. Female postabdomen: sternum 8 wider than long, noticeably wider than 7, but about same length and width as 6 and with dense covering of microsetulae (mostly longer hairlike form and few short spinular microsetulae); sternum 5 about 2 times size of 6; sterna 6-8 often yellow or light brown; cercus usually yellow or light reddish-brown; cercus, in lateral view, obellipsoid, widest about 0.4 of length out from base and without obvious fenestrate, or

windowlike, depression and terminal flange; cercus with medial preapical micro-onychium (hooklet) conspicuous and much larger than in others of species group; cercus with about 10 longer marginal setulae and 4-5 longer lateral setulae; cercus 2.0-2.5 times as long as wide in lateral view. Ventral receptacle cupuliform, about 1.2 times as deep as wide.

**Etymology:** The specific epithet, *bogorae*, is used in reference to the type locality of Bogor, Java.

**Type:** Holotype male, USNM.

**Type-locality:** INDONESIA: Bogor, Java (VI-14-1977, Soeprapto; reared from larva mining leaves of *Hydrilla verticillata*).

**Paratypes:** 4 males, 11 females with same data as holotype.

**Remarks:** This species shares with *H. balciunasi* spathulate copulobic macrochaetae, enlarged shoelike postgonite processes, and distinct, but deeply situated pregonites which are directed anteriorly. The relative shortness of the spathulate copulobic macrochaetae and the large size of the postgonite process along with the stout female cerci bearing conspicuous micro-onychial mediodistally are unique characters for this species.

## Acknowledgements

I wish to acknowledge financial assistance for this study from the Aquatic Plant Management Group, Waterways Experiment Station, U. S. Army Corps of Engineers, Vicksburg, MS and facility support from the USDA BioControl Laboratory, the Florida State Collection of Arthropods, and the Department of Entomology and Nematology, University of Florida, all in Gainesville. I want to offer special thanks to Drs. J. F. Butler, H. L. Cromroy, D. W. Hall, and G. C. Smart, Jr. for their assistance with special microscopy problems. Dr. Cromroy and Mr. William Carpenter made the scanning electron micrographs from specimens I provided. Dr. G. R. Buckingham and Ms. C. A. Bennett provided specimens of most of the species included in the study. And, I offer special thanks to Ms. Alice Sanders and Ms. Beverly Pope, Staff Librarians, and to Dr. Nancy Coile and Carlos Artaud, Systematic Botanists, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville.

**Literature cited**

- Bock, I. R.** 1990. The Australian species of *Hydrellia* Robineau-Desvoidy (Diptera: Ephydriidae). *Invertebrate Taxon.* 3: 965-993.
- Deonier, D. L.** 1971. A Systematic and Ecological Study of Nearctic *Hydrellia* (Diptera: Ephydriidae). *Smithsonian Contr. Zool.* 68: 147 pp.
- Deonier, D. L.** 1978. New species of *Hydrellia* reared from aquatic macrophytes in Pakistan (Diptera: Ephydriidae). *Ent. Scand.* 9: 188-197.
- Deonier, D. L.** 1979. Introduction - a prospectus on research in Ephydriidae. *In* D. L. Deonier, ed. First Symposium on the Systematics and Ecology of Ephydriidae (Diptera). North American Benthological Society. Oxford, Ohio.