

CHAPTER 3

LARVA AND ADULT ASSOCIATION OF HYDROPSYCHID SPECIES

Introduction

Various studies (Dohet, 2002; Lenat and Resh, 2001; Resh, 1992; Resh, 1973) pointed out that the need for keys to identify the immature stages of caddisflies has become increasingly important with regard to understanding their potential as water quality indicators. Very common genera, such as *Cheumatopsyche* and *Hydropsyche* of the family Hydropsychidae are almost totally unknown in the aquatic stages (Ross, 1944). Studies on caddisfly larval taxonomy are not only important for the realization of their potential as water quality indicator organisms, but are also vital for a number of other reasons. First, such studies may be used as a starting point from which natural history and a wide spectrum of ecological associations may be based. Any such studies hinge on correct species determination. Second, and most important from the trichopterologist's point of view, such studies give a new dimension (the larva) from which data may be gleaned. A knowledge of the immature stages may enable a greater understanding of the systematics and phylogenetic relationships within Trichoptera. Ultimately, these may give rise to a better understanding of the entire order Trichoptera (reviewed by Schuster and Etnier, 1978).

In Europe and North America, the knowledge of taxonomy and biology of family Hydropsychidae are well known in both the adult and larval stages.

Although discrimination of species among the adult stages has developed with growing precision, identification of the larvae is problem of long standing. Taxonomy of larvae based largely on markings of the head color pattern was introduced by Ross (1944) for a number of eastern North American species, and a major advance in larval identification was made by Schuster and Etnier (1978) with diagnoses for 39 eastern North American species based mainly on markings with some characters of setal condition. Mackay (1978) used characters of anterolateral pronotal setae to distinguish among *Cheumatopsyche* larvae, *Hydropsyche sparna*, and the other hydropsychid species in her study area. Smith and Lehmkuhl (1980) distinguished four *morosa* group species using color patterns, morphometric comparisons, and secondary setation of the head capsule. Williams and Wiggins (1981) have re-examined existing setal nomenclature for the Trichoptera, proposing a new and unified system incorporating primary setae and sensory pits of all body parts, homologizing them among the caddisfly taxa. Scheffer and Wiggins (1986) developed and applied primary and secondary setae taxonomic characters to identification of larvae of the *Hydropsyche morosa* species group known in North America. Other characters that are used to identify the *Hydropsyche morosa* group is a constant number and arrangement of abdominal gill trunks, although the number of filaments on each branch may be distinctive for certain species.

Although most southeast Asian species cannot yet be identified in the larval stage, Morse (2004) has provided keys for known genera of southeast Asian hydropsychid larvae and Dudgeon (1999) has reviewed the taxonomic knowledge of larvae of these genera. Also, Tanida (1987) used primarily the shape of the anterior margin of the head capsule to distinguish among species of Japanese hydropsychids.

The purpose of this study is to associate unknown larvae with identifiable adults of Hydropsychidae in southern Thailand by means of field rearing, laboratory rearing, and molecular analysis and to describe larvae of hydropsychid species in southern Thailand. The procedure in molecular analysis is presented separately in Chapter 4.

Materials and methods

Specimen collection

Initially, it was intended that many species of hydropsychid larvae and adults would be associated by larval rearing in the field. However, because the running water level was inconsistent, this method was abandoned so that all the investigative efforts and time could be employed collecting metamorphotypes.

The metamorphotype, or pharate adult, is a stage of great importance to the study of Trichoptera. It represents a period in the life cycle in which features of all three post-egg stages of the holometabolous insect are available for study—larva, pupa, and developing adult.

Mature pupae of Hydropsychidae can be used to associate identifiable adults with yet-unidentified larvae. Species whose diagnostic genitalia are evident after cuticular separation beneath the loose pupal skin can be identified by those genitalia. In Hydropsychidae, the pupal cocoon retains shed larval sclerites from the last instar. Therefore, the distinctive color, shape, and setation characters of larval sclerites can be linked confidently to particular species. The limitations of this

technique are that it requires collecting the pupae at precisely the appropriate time of year, a few hours before adult emergence, and generally it requires capture of a male pupa.

Laboratory rearing

Some live pupal specimens from the field were reared in separate rearing cages (aquaria) and aerated and maintained at 20°C with a natural photoperiod. The bottom of the cages were covered with sand and small gravel to a depth of 1 cm. The water and substrate were brought from the study sites. The insects in the cages were observed until adult emergence.

Preparation of specimens

Upon return from the field, hydropsychids were sorted to morpho-species. Generally, the morphological structures that are used to identify the mature larvae of caddisflies preserve well as long as proper preserving procedures are followed. Newly collected benthic samples must be preserved in 95% EtOH. The preservative must be replaced with the same concentration within 24 hours if the samples are not processed or sorted immediately, or else the integrity of the insect tissues is destroyed because of dilution.

Details of head color pattern, setal characters, and shape of the anterior margin of the head capsule were discerned using a dissecting microscope with camera lucida attachment for preparation of line drawings.

Some mature larvae were dissected and prepared for photography in glycerine. The pupal integument was peeled from metamorphotypes and mounted on

a microscope slide in glycerine. Pupal mandibles were removed for photography in glycerine. All slide mounts were labeled with complete locality information. Specimens were studied with a Wild M3B dissecting microscope or compound microscope. Images were captured with a digital camera mounted to either the dissecting or compound microscope. Images were enhanced and modified using Auto Montage and Adobe PhotoShop. Care was taken to enhance or darken characters that were already on the images. Plates were constructed in Adobe Illustrator.

For detailed examination of larval characters, selected specimens were freeze dried, sputter coated with gold and viewed using a Joel JSM 5200 scanning electron microscope. A selection of these structures is being used to demonstrate the value of larval morphology for resolving the generic classification of closely related species.

Terminology for larvae follows Scheffer and Wiggins (1986) and Wiggins (1996). Voucher specimens were deposited in the Department of Pest Management, Faculty of Natural Resources, Prince of Songkla University; and Enns Entomology Museum, University of Missouri-Columbia, U.S.A.

Results and discussion

From the results of this study, 23 species of unknown hydropsychid larvae could be associated with identifiable adults of Hydropsychidae. The 23 species of hydropsychid larvae comprise of 9 genera: *Diplectrona* (*D. gombak*); *Cheumatopsyche* (*C. charites*, *C. copia*, and *C. tramota*); *Potamyia* (*P. chaos* and *P. phaidra*); *Hydropsyche* (*H. assarakos*, *H. brontes*, *H. butes*, *H. camillus*, *H. dolosa*,

and *H. pallipenne*); *Hydatomanius* (*H. adonis* and *H. klanklini*); *Hydromanius* (*H. abiud*, *H. inferior*, and *H. serubabel*); *Macrostemum* (*M. dohrni*, *M. hestia*, and *M. fenestratum*); *Pseudoleptonema* (*P. quinquefasciatum* and *P. supalak*); and *Trichomacronema* (*T. tamdao*). Three of 23 species of hydroptychid larvae, *Hydatomanius adonis*, *H. klanklini*, and *Macrostemum dohrni*, were reared from pupae to the adult stage. A summary of the number of species and specimens identified from each site is presented in Table 2.4.

Larval descriptions and discussion

GENUS *Diplectrona* Westwood, 1839

Diagnosis: Larvae have the typical characteristics of the family. Larvae of *Diplectrona* are distinguished from those of other hydroptychid genera by the shape of the ventral apotome (posterior part is as long as the anterior part), the arrangement and number of abdominal gills (scattered along central stalk and fewer than 10), and the abdomen sometimes bears numerous spear-shaped conical hairs.

From the results of this study, one species of an unknown *Diplectrona* larva was associated with an identifiable adult; *Diplectrona gombak*. Details of this species are described as below:

***Diplectrona gombak* Oläh, 1993**

Larva: Total length 11.5-12.5 mm (n=10). Overall body shape as in Hydropsychidae. Head yellowish to brown, with muscle scars on posterior one fifth. Notal sclerites yellowish.

Head: Head capsule length, 1.02-1.16 mm; width, 0.90-0.97 mm. Dorsum of head yellowish in anterior portion and becoming lighter in posterior portion and around eyes. Posterior one fifth of dorsum with group of darker muscle scars (Fig. 3.1). Frontoclypeus with anterior margin evenly straight, lateral broadened at mid-length to level of eyes (Figs. 3.1-3.2). Head covered with numerous, long, dark, erect, truncate peg-like setae and tapered setae dorsally; lateral regions with medium long, dark, erect acuminate peg-like setae and tapered setae in anterior three-quarters (Fig. 3.19). Frontoclypeus with long setae projecting beyond anterior margin. Ventral surface yellow, with stridulatory lines in anterior half (Fig. 3.3). Labrum light-brown, semicircular in dorsal view, bearing well-developed, lateral, light brown brushes; anteromedian margin of labrum with group of long setae, remainder of anterior half with short setae (Fig. 3.4). Mandibles reddish-brown; right mandible with 2 apical and 2 mesal teeth, left mandible with 2 apical and 3 mesal teeth and well-developed dorsomesal brush; outer surface of both mandibles with scattered setae (Fig. 3.5). Submentum broad at posterior part; anterior part narrow with shallow concavity, laterally with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome quite large, shorter than in length to ecdysial line

linking it with anterior ventral apotome (Figs. 3.3, 3.6).

Thorax: Nota yellow with a dense covering of dark-brown setae. Pronotum with median ecdysial line, with numerous, dark-brown, moderately long, erect, acuminate peg-like setae and long, tapered setae projecting beyond anterior margin; muscle scars midway between midline and lateral margin in posterior half (Figs. 3.7, 3.20). Meso- and metanotum each with transverse ecdysial line, with numerous, dark-brown, long, erect and inclined truncate peg-like setae projecting beyond anterior margin; lateral margin of each notum with group of muscle scars (Figs. 3.8-3.9, 3.21). Prosternite broadly large, lateral at mid-length concavity, anterior portion wider than posterior portion (Fig. 3.13). Foretrochantin acuminate, with stout setae (Fig. 3.10). Forelegs with numerous long spike-like setae and tapered setae on external surface and ventral margin of coxa, with feather-like setae on ventral margin of coxa and on trochanter and femur; tibia and tarsus each with tapered setae and with spike-like setae on ventral margin (Fig. 3.10). Mid- and hindlegs similar in size, shape, and structure; with spike-like setae and tapered setae on coxa to tarsus; femur, tibia and tarsus with a row of long spike-like setae and feather-like setae on ventral margin (Figs. 3.11-3.12, 3.22). Mesosternum with one pair of gills; metasternum with 3 gills; gills consisting of central stem bearing numerous lateral filaments.

Abdomen: Abdominal segments covered with densely, appressed, dark-brown, elongate, spear-shaped conical hairs and hair-like setae (Fig. 3.23). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills and one pair of lateral gills; each gill arising from a common base (Fig. 3.24). Segment VI with one pair of lateral gills. Sternum VIII with pair of spine-

bearing plates; posterior margin with 2 or 3 black setae. Sternum IX with pair of ovoid plates covered with spines emanating from prominent sockets; posterior margin with row of setae. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.14). Anal prolegs with bent claw and cluster of long bristles, without spike-like setae on ventral surface (Fig. 3.15).

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing several long setae; anterior region with many dark setae. Mandibles enlarged basally, with posterior surface bearing long, black setae; lateral surface of both mandibles with scattered setae; left mandible bearing 4 teeth, right mandible with 3 teeth, margin of both inner body of mandibles serrate (Fig. 3.16). Dorsal surface with one pair of anterior hook plates on segments II-VII and one pair of posterior hook plates on segments III-IV, plate broadly oval-shaped (Fig. 3.17); segment VIII covered with long, black, slender setae. Apex of apical processes forked, fork arms with scaly surface; long, bristle-like setae on inner branch of fork and 2 areas anterior to the anal appendages (Fig. 3.18).

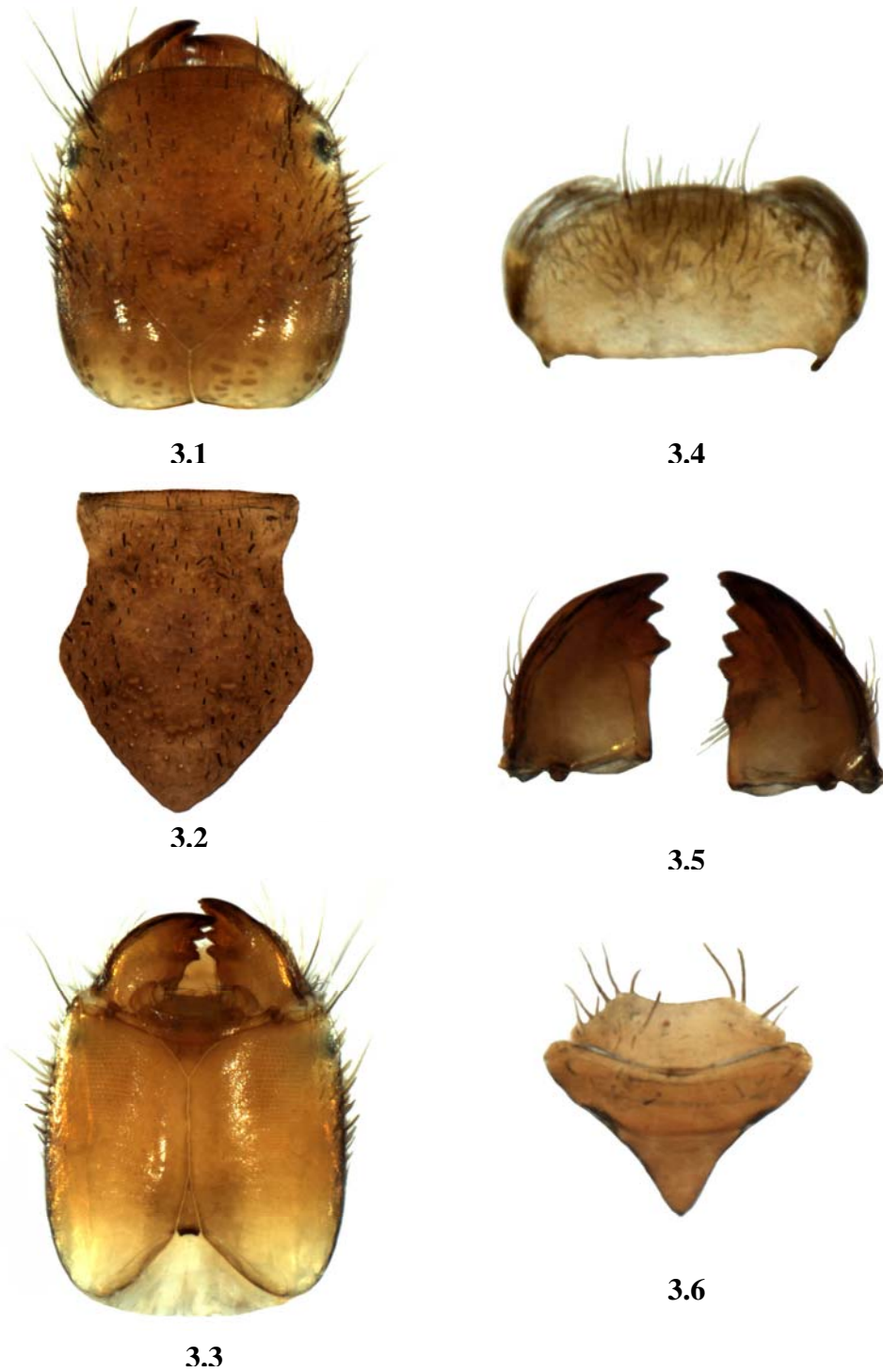
Diagnosis: This species may be recognized on the basis of the following characteristics: The anterior margin of the frontoclypeus is evenly straight and the lateral margin is broadened at mid-length to the level of the eyes. The posterior ventral apotome is quite large, but shorter in length than ecdysial line linking it with the anterior ventral apotome. Many long truncate peg-like setae are present on the dorsum of the head; heavy, elongate, spear-shape conical hairs and hair-like setae are present on the abdominal segments.

Material examined: SURAT THANI Prov.: Tai Rom Yen National Park, stream

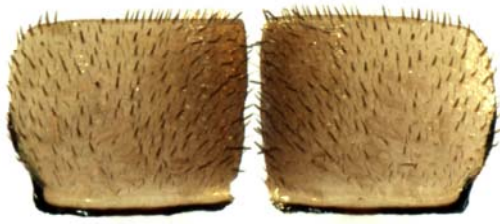
from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 9-viii-2004, Prommi, 1 male mmt.; same locality, 10-x-2004, Prommi, 4 larvae; same locality, 10-iv-2005, Prommi, 2 larvae; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 7-x-2004, Prommi, 6 larvae, 1 pupa; same locality, 4-iv-2005, Prommi, 1 larva; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall 68 m. 08°58' N, 98°27' E, 3-iv-2005, Prommi, 1 larva; SATUN Prov.: Tarutao National Park, stream from Ludoo Waterfall, 6-iii-2005, Prommi, 10 larvae; KRABI Prov.: Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-viii-2004, Prommi, 4 larvae; same locality, 6-x-2004, Prommi, 2 larvae; NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-viii-2004, Prommi, 4 larvae; same locality, 11-x-2004, 6 larvae; same locality, 6-iv-2005, Prommi, 4 larvae, 1 pupa; Pliew Waterfall, 110 m. 08°29' N, 99°45' E, 6-iv-2005, Prommi, 1 larva; Khao Luang National Park, stream from Yord Luang Waterfall, 78 m. 08°38' N, 99°44' E, 7-iv-2005, Prommi, 1 larva; Sununtha National Park, Sunantha Waterfall; 166 m. 08°46' N, 99°48' E, 8-iv-2005, Prommi, 1 larva; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 1 larva; same locality, 5-x-2004, Prommi, 6 larvae; PATTHALUNG Prov.: Khaobantad Wildlife Sanctuary, stream from Momjui Waterfall, 95 m. 07°15' N, 100°02' E, 4-x-2004, Prommi, 1 larva, 1 pupa; same locality, 25-ii-2005, Prommi, 7 larvae; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 3-x-2004, Prommi, 2 larvae; same locality, 1-xii-2004, Prommi, 5 larvae; same locality, 1-ii-2005, Prommi, 3 larvae; same locality, 13-v-2005, Prommi, 16 larvae, 4 pupae; same locality, 17-vi-2005, Prommi, 1 larva;

NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 2 larvae, 1 pupa.

Discussion: Eight species of adult male *Diplectrona* known from Thailand (Malicky, 2002). Of 8 species, 4 species were collected in this study, including *D. pseudofasciata* Ulmer which was newly recorded from Thailand, and has also been recorded from Malaysia and Philippines. Two morphospecies of larvae were collected from this study. One morphospecies of them was *Diplectrona gombak* which was widespread known from neighbor countries, i.e. Malaysia, Vietnam, and Philippines (Malicky, 2002). Larvae of *D. gombak* constructs a sandgrain or organic materials retreat and capture net. This species was commonly collected in medium-sized to large stream. Microhabitats varied from depositional pools to riffle areas. The flight period of the adult was year-long.



Figures 3.1-3.6. Larval features of *Diplectrona gombak*: 3.1, dorsal view of head; 3.2, frontoclypeal apotome; 3.3, ventral view of head; 3.4, dorsal view of labrum; 3.5, ventral view of mandibles; 3.6, submentum and anterior ventral apotome.



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Figures 3.7-3.12. Larval features of *Diplectrona gombak*: 3.7, pronotum; 3.8, mesonotum; 3.9, metanotum; 3.10, outer face of right foreleg; 3.11, inner face of left midleg; 3.12, inner face of left hindleg.



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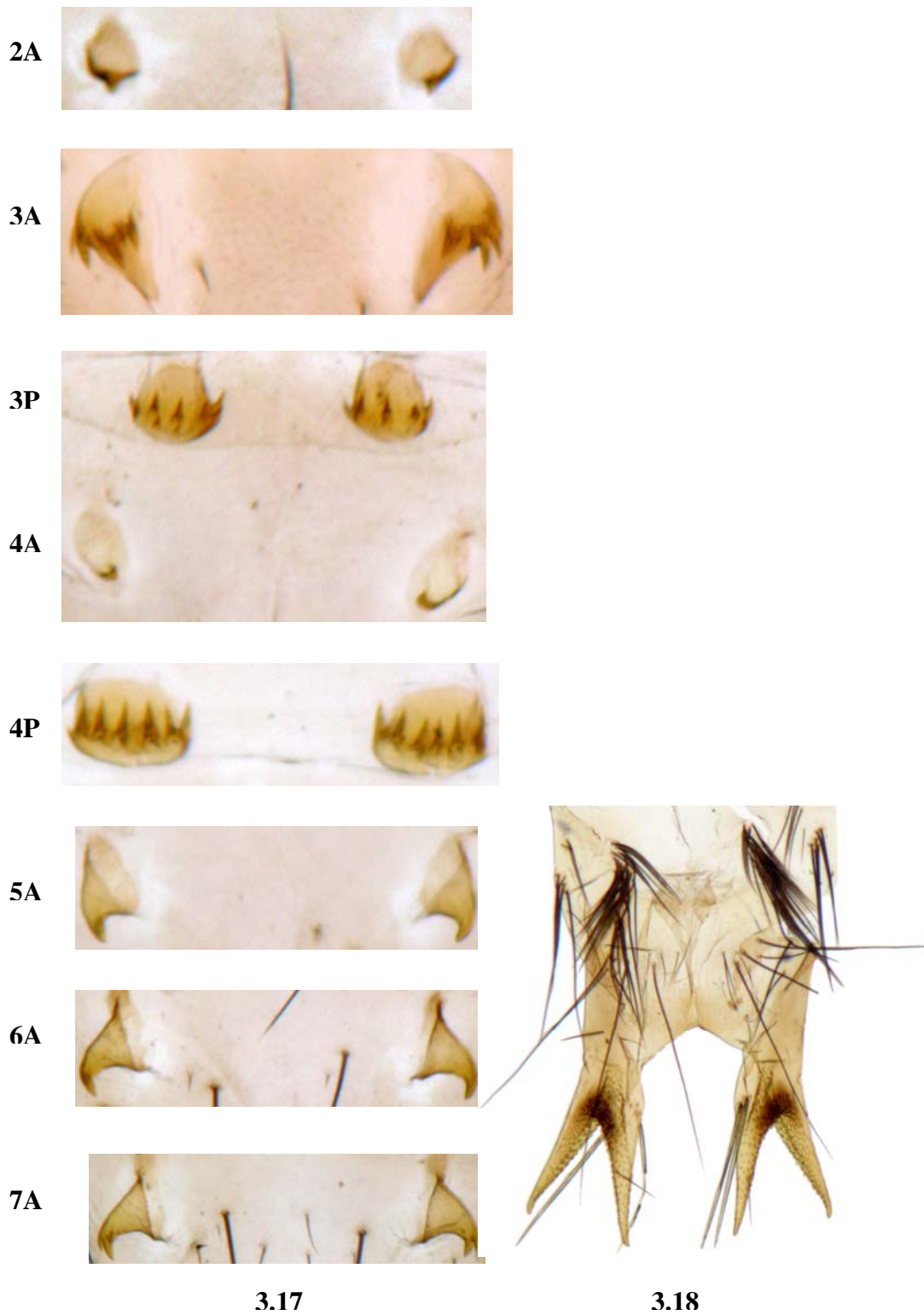


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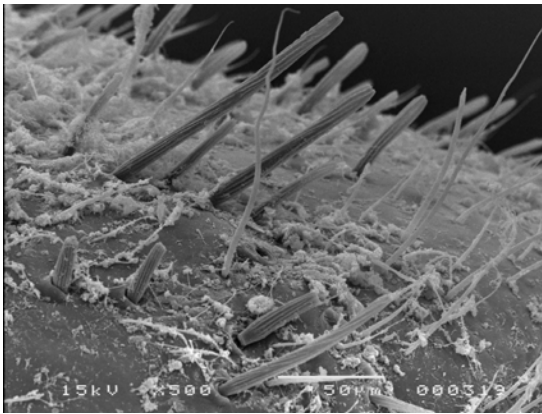


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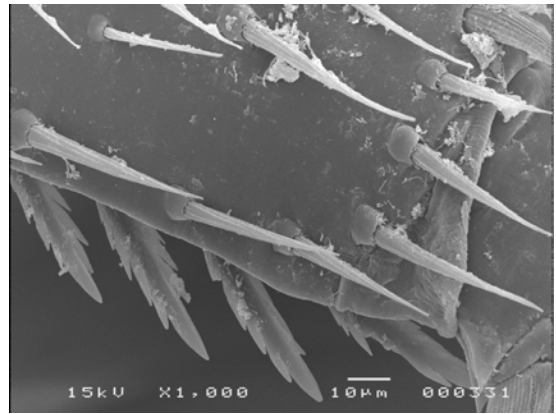
Figures 3.13-3.16. *Diplectrona gombak*: 3.13, prosternum; 3.14, sterna VIII and IX; 3.15, lateral view of anal claw; 3.16, dorsal view of pupal mandibles.



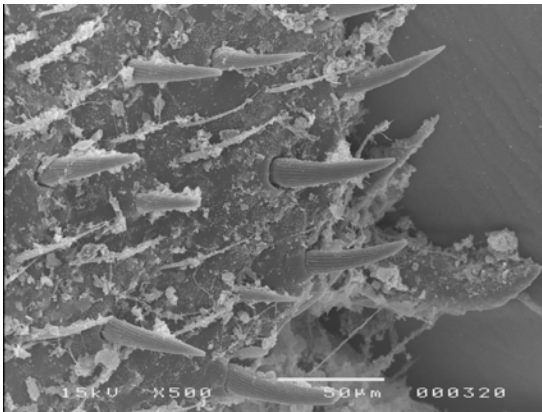
Figures 3.17-3.18. *Diplotrona gombak*: 3.17, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.18, pupal apical abdominal appendages.



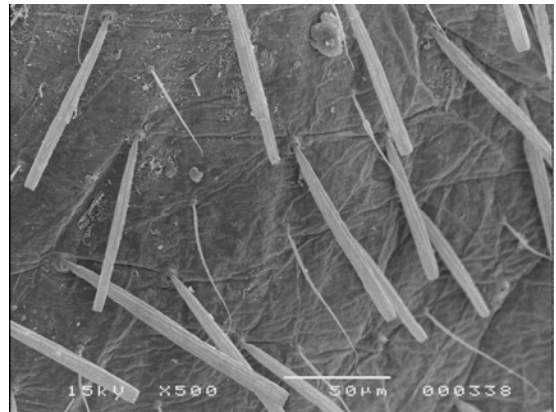
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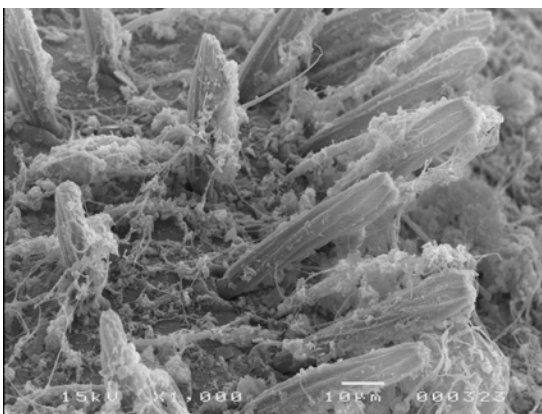
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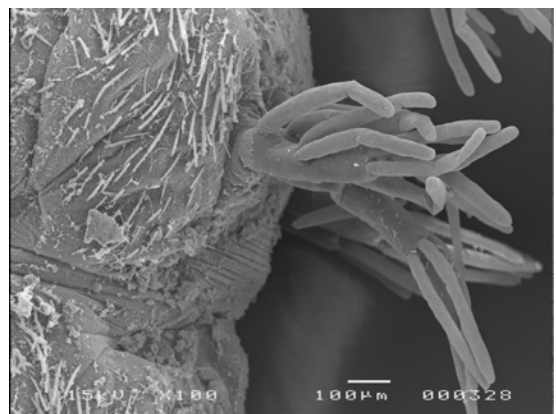
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Figures 3.19-3.24. *Diplectrona gombak*: 3.19, setae on dorsum of head; 3.20, setae on pronotum; 3.21, setae on meso- and metanotum; 3.22, setae on ventral margin of femur through tarsi of mid- and hind legs; 3.23, setae on abdominal segments; 3.24, abdominal gills.

GENUS *Cheumatopsyche* Wallengren, 1891

Diagnosis: Larvae have the typical characteristics of the family. Larvae of *Cheumatopsyche* are distinguished from those of other hydropsychid genera by the following combination of characteristics: Absence of an anteromedian projection on the anterior ventral apotome of the head; median notch in the anterior margin of frontoclypeus; notched posterior margin of each sclerite on abdominal sternum IX; inconspicuous posterior ventral apotome; tiny posterior sclerites on the prosternum; forked trochantin; the mandibles are not flanged; the mesosternum has two and metasternum has three gill tufts; and abdominal segments I-VII bear ventral gills.

From the results of this study, 3 species of unknown *Cheumatopsyche* larvae could be associated with identifiable adults; *C. charites*, *C. copia*, *C. tramota*. Details of each species are described as follows:

Cheumatopsyche charites Malicky & Chantaramongkol, 1997

Larva: Total length 6.5-7.5 mm (n=10). Head and thoracic sclerites yellow to brownish.

Head: Head capsule length, 0.71-0.77 mm; width, 0.54-0.65 mm. Dorsum of head brownish except frontoclypeus darker. Frontoclypeus with median concavity in anterior margin; coarsely crenulate with about 24 lobes; mid-lateral and posterior corner with small black, areas (Fig. 3.25). Head covered with numerous brush of setae, mingled with stout setae on dorsal and lateral regions in anterior three-

quarter (Fig. 3.38). Frontoclypeus also covered with brush of setae, lacking stout setae; anterior margin bearing brush of setae. Head ventrally light-brown, with stridulatory lines in anterior half; posterior half paler with group of muscle scars (Fig. 3.26). Labrum golden-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-brown pectinate setae; dorsal surface with moderately long setae; with pair of long anteromesal setae; anterior margin hairy (Fig. 3.27). Mandibles reddish-brown, short, with 2 apical and 3 mesal teeth, left mandible with well developed setal brush, outer surface of both mandibles with scattered setae (Fig. 3.28). Submentum reddish-brown, with anterior margin broadly V-shaped with median cleft; cleft with sides parallel, anterior margin and lateral area with short and long setae (Fig. 3.29). Anterior ventral apotome broadly triangular (Fig. 3.30), posterior ventral apotome small and triangular.

Thorax: Pronotum yellow, with lateral and most of posterior margins black; densely covered with setae of various forms: simple, bifid, trifid, or with four or five filaments; anterior margin also with setae (Figs. 3.31, 3.39). Meso- and metanotum light-yellow, muscle scars darker; posteromesal crescentic black mark; lateral margins black; each notum covered with same setae as pronotum; anterior margins bearing same setae (Figs. 3.32-3.33). Posterior prosternites reduced to small flecks, one adjacent to each posterolateral angle of anterior prosternite (Fig. 3.34). Foretrochantin forked. Foreleg with surface of coxa covered with short setae and dense feather-like setae on posterior region; anterior and posterior margin with row of stout setae; trochanter through tibia adorned with long and spike-like setae on anterior surface and ventral margin, mingled with a row of feather-like setae on ventral margin; tarsi with spike-like setae. Mid- and hindlegs similar in size, shape,

and structure; with dense spike-like setae and stout setae on inner surface of coxa through tarsi; mingled with a row of feather-like setae on ventral margin. Mesosternum with 1 pair of gills and metasternum with 3 gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments covered with recumbent, hair-like setae. First sternum with 2 pairs of gills with adjacent bases. Sternum II-VI each with 2 pairs of lateral gills and 1 pair of median gills (Fig. 3.40). Sternum VII with only 2 pairs of lateral gills (Fig. 3.30). Sternum VIII with pair of moderately sclerites plates bearing spike-like setae, posterior margin of each plate with long setae. Sternum IX with pair of large, triangular sclerotized plates bearing with spike-like setae emanating from prominent sockets; posterior margin of each plate with long setae; inner margin of each sclerite of abdominal sternum IX notched at posterior corners. Tergum IX with pair of small lateral and moderately dorsolateral sclerites (Fig. 3.41). Anal prolegs with bent claw and cluster of long bristles, spike-like setae on dorsal surface.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing a few long setae; middle region with many dark setae. Mandibles enlarged at bases, with posterior face bearing about 7 long, black basal setae; left mandible bearing 4 teeth, right mandible with 3 teeth (Fig. 3.35). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.36). Apical processes of abdomen with tips concave; outer margin of each process fringed with long, black, setae (Fig. 3.37).

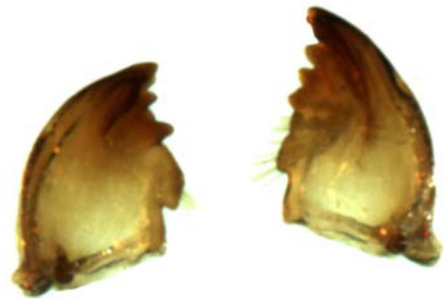
Diagnosis: The larva of *Cheumatopsyche charites* can be distinguished from those

of congeners by the following combination of characteristics: The anterior margin of the frontoclypeus is concave in the median region and it is coarsely crenulate with about 24 lobes. Many brush of setae and stout setae are located on the dorsum of head, and the stout setae are also located on lateral part of the head. A variety of setae are present on the thoracic nota: simple, bifid, trifid, or with four or five filaments.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 8-viii-2004, Prommi, 1 larva; same locality, 2-iv-2005, Prommi, 3 larvae; SURAT THANI Prov.: Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 6-viii-2004, Prommi, 11 larvae, 1 pupa; same locality, 7-x-2004, Prommi, 5 larvae; same locality, 4-iv-2005, Prommi, 1 larva; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall 68 m. 08°58' N, 98°27' E, 3-iv-2005, Prommi, 8 larvae; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 7-iv-2004, Prommi, 1 male mmt.



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Figures 3.25-3.30. Larval features of *Cheumatopsyche charites*: 3.25, frontoclypeal apotome; 3.26, ventral view of head; 3.27, dorsal view of labrum; 3.28, ventral view of mandibles; 3.29 submentum; 3.30, anterior ventral apotome.



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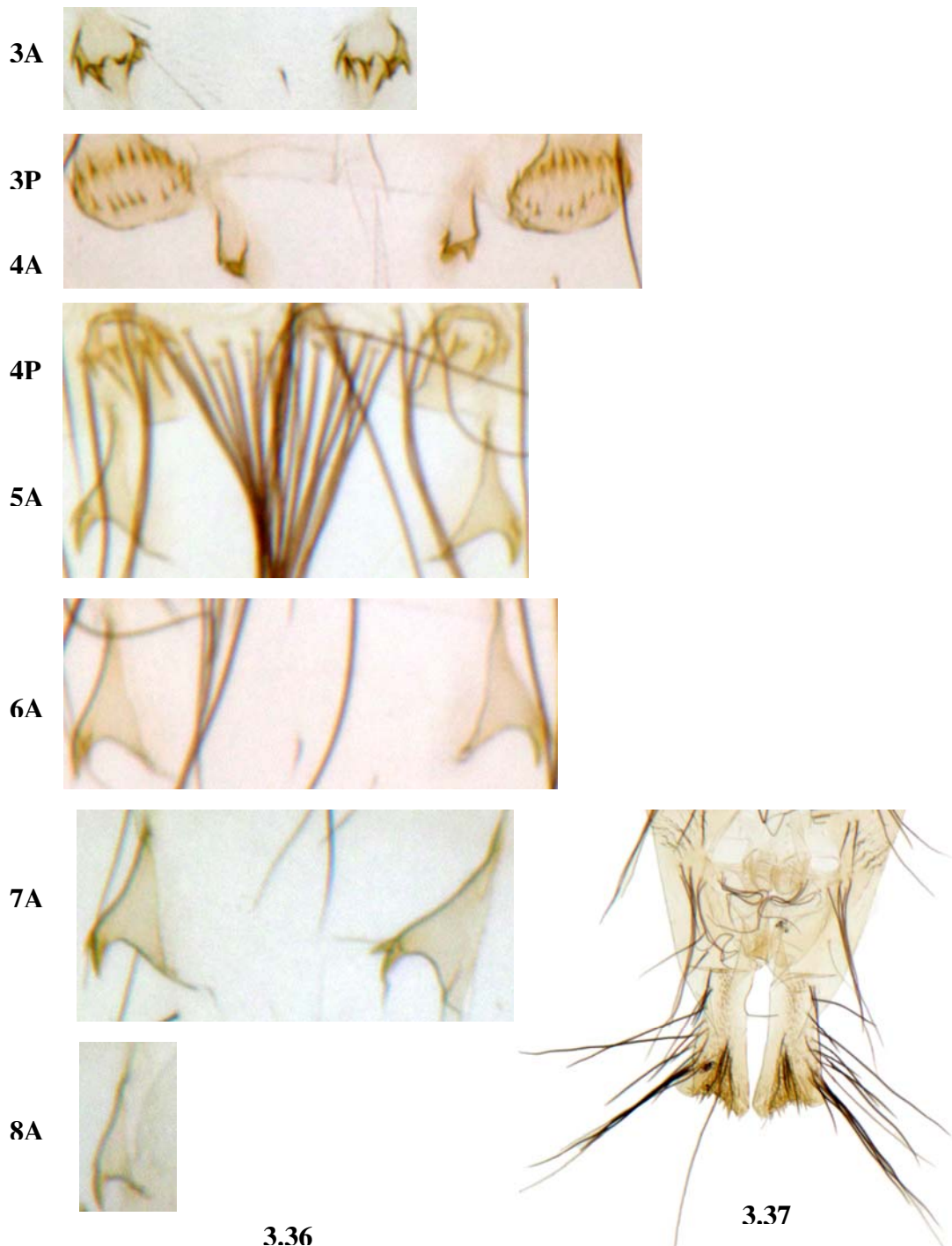


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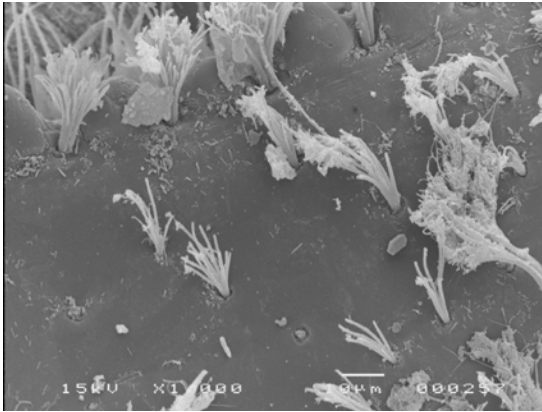


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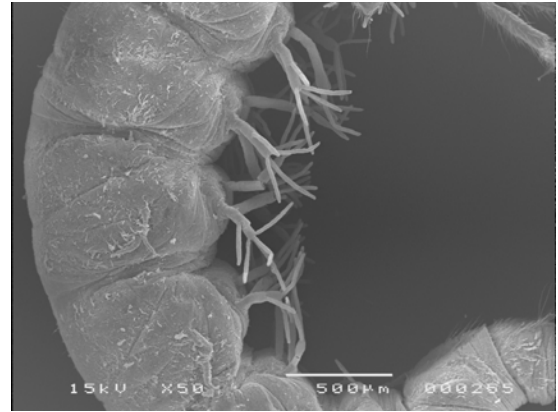
Figures 3.31-3.35. *Cheumatopsyche charites*: 3.31, pronotum; 3.32, mesonotum; 3.33, metanotum; 3.34, prosternum; 3.35, ventral view of pupal mandibles.



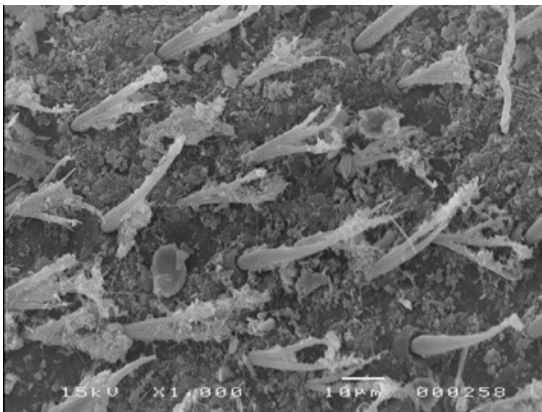
Figures 3.36-3.37. *Cheumatopsyche charites*: 3.36, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.37, pupal apical abdominal appendages.



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Figures 3.38-3.41. *Cheumatopsyche charites*: 3.38, setae on dorsum of head; 3.39, setae on pronotum; 3.40, abdominal gills; 3.41, sterna VIII and IX.

***Cheumatopsyche copia* Malicky & Chantaramongkol, 1997**

Larva: Total length 6.5-7.0 mm (n=10). Head and thoracic sclerites light-brown to dark-brown (Fig. 3.42).

Head: Head capsule length, 0.68-0.71 mm; width, 0.51-0.59 mm. Dorsum of head dark-brown in frontoclypeus area; remainder becoming lighter (Fig. 3.43). Frontoclypeus with deep anteromedian notch, coarsely crenulate with about 16 lobes (Figs. 3.43-3.44). Dorsal and lateral surface of head covered with numerous, simple, hair-like setae (Figs. 3.60-3.61). Frontoclypeus with scattered hair-like setae of various forms (simple, bifid, trifid), a few brush of setae scattered on the lateral corner and anterior margin (Figs. 3.60-3.61). Head ventrally dark-brown, with stridulatory lines in anterior half; posterolaterally paler with a group of muscle scars (Fig. 3.45). Labrum golden-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-brown brushes; dorsal surface with setae; with pair of long anteromesal setae (Fig. 3.46). Mandibles reddish-brown, short, with 2 apical and 3 mesal teeth; left mandible with well-developed setal brush; lateral surface of both mandibles with scattered setae (Fig. 3.47). Submentum brown, with anterior margin broadly V-shaped with median cleft; cleft with sides parallel, anterior margin and lateral area with both short and long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small and triangular (Figs. 3.45, 3.48).

Thorax: Pronotum brownish, muscle scars darker; lateral and most of posterior margins black. Pronotum densely covered with long, appressed, tapered setae; anterior margin bearing same setae (Figs. 3.49, 3.62). Meso- and metanotum

brown, muscle scars darker; posteromesal crescentic black mark, lateral margins black, each notum densely covered with long, appressed, tapered setae; anterior margins bearing with same setae (Figs. 3.50-3.51). Posterior prosternites reduced to small flecks, one adjacent to each posterolateral angle of anterior prosternite (Fig. 3.55). Foretrochantin deeply forked, with dorsal ramus slightly shorter than ventral ramus; the ventral ramus with spike-like setae (Fig. 3.52). Foreleg with coxa through femur densely covered with feather-like setae on posterior margin; femur and tibia with long and spike-like setae in anterior surface and ventral margin; tarsi with only spike-like setae (Fig. 3.52). Mid- and hindlegs similar in size, shape, and structure; with dense spike-like setae and stout setae on inner surface of coxa through tarsi; with a row of feather-like setae on ventral margin (Figs. 3.53-3.54). Mesosternum with one pair of gills; metasternum with 3 gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments covered with club-like hairs (Fig. 3.63). First sternum with 2 pairs of gills with adjacent bases. Segments II-VI each with 2 pairs of lateral gills and one pair of median gills. Segment VII with 2 pairs of lateral gills. Sternum VIII with pair of sclerites bearing with spike-like setae. Sternum IX with pair of large, triangular sclerites bearing spike-like setae emanating from prominent sockets; inner margin of each sclerite of sternum IX notched at posterior corners. Tergum IX with pair of small lateral and larger dorsolateral sclerites (Fig. 3.56). Anal prolegs with bent claw and cluster of long bristles; spike-like setae on dorsal surface.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing a few long setae; middle region with groups of dark setae. Mandibles enlarged at bases, with

posterior surface bearing approximately 7 long, black setae; mandibles bearing 2 teeth (Fig. 3.57). Dorsal surface with one pair anterior hook plates on segments III-VIII and one pair posterior hook plates on segments III-IV (Fig. 3.58). Apical processes of abdomen with tips concave; outer margin of each process fringed with long, black setae (Fig. 3.59).

Diagnosis: This species may be recognized on the basis of the following characteristics: The anterior margin of frontoclypeus is deeply notched medially and it is coarsely crenulate with approximately 16 lobes. Many simple hair-like setae are on the dorsal and lateral parts of the head. A variety of setae (simple, bifid, trifid) are present on frontoclypeus, and a few brush of setae are also present in the lateral corner. Many stout, tapered setae are present on the entire nota.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 9-x-2004, Prommi, 1 larva; same locality, 2-iv-2005, Prommi, 2 larvae; SURAT THANI Prov.: Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 6-viii-2004, Prommi, 1 larva, 1 male mmt.; same locality, 7-x-2004, Prommi, 2 larvae; Mae Yai waterfall, 287 m. 08°53' N, 98°29' E, 4-iv-2005, Prommi, 4 larvae; Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 10-x-2004, Prommi, 10 larvae; same locality, 10-iv-2005, Prommi, 4 larvae; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall 68 m. 08°58' N, 98°27' E, 7-viii-2004, Prommi, 4 larvae; KRABI Prov.: Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-viii-2004, Prommi, 5 larvae; same locality, 5-iv-2005, Prommi, 4 larvae, 1 pupa; NAKHON SI THAMMARAT Prov.: Khao Luang National Park, stream from Yord Luang Waterfall, 78 m. 08°38' N,

99°44' E, 7-iv-2005, Prommi, 5 larvae; Sununtha National Park, Sunantha Waterfall; 166 m. 08°46' N, 99°48' E, 8-viii-2005, Prommi, 6 larvae, 1 pupa; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 59 m. 07°32' N, 99°47' E, 12-iv-2005, Prommi, 1 larva; PATTHALUNG Prov.: Khaobantad Wildlife Sanctuary, stream from Momjui Waterfall, 95 m. 07°15' N, 100°02' E, 4-x-2004, Prommi, 7 larvae, 1 pupa; same locality, 25-ii-2005, Prommi, 8 larvae, 2 female mmts.; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 7-iv-2004, 1 male mmt.; NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 12 larvae.



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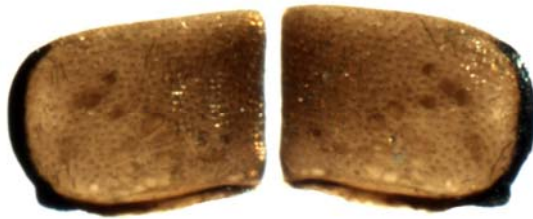


3.44



3.48

Figures 3.42-3.48. Larval features of *Cheumatopsyche copia*: 3.42, larva; 3.43, dorsal view of head; 3.44, frontoclypeal apotome; 3.45, ventral view of head; 3.46, dorsal view of labrum; 3.47, ventral view of mandibles; 3.48, submentum and anterior ventral apotome.



3.49



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3.53



3.51



3.54

Figures 3.49-3.54. Larval features of *Cheumatopsyche copia*: 3.49, pronotum; 3.50, mesonotum; 3.51, metanotum; 3.52, outer face of right foreleg and trochantin; 3.53, inner face of left midleg; 3.54, inner face of left hindleg.



3.55

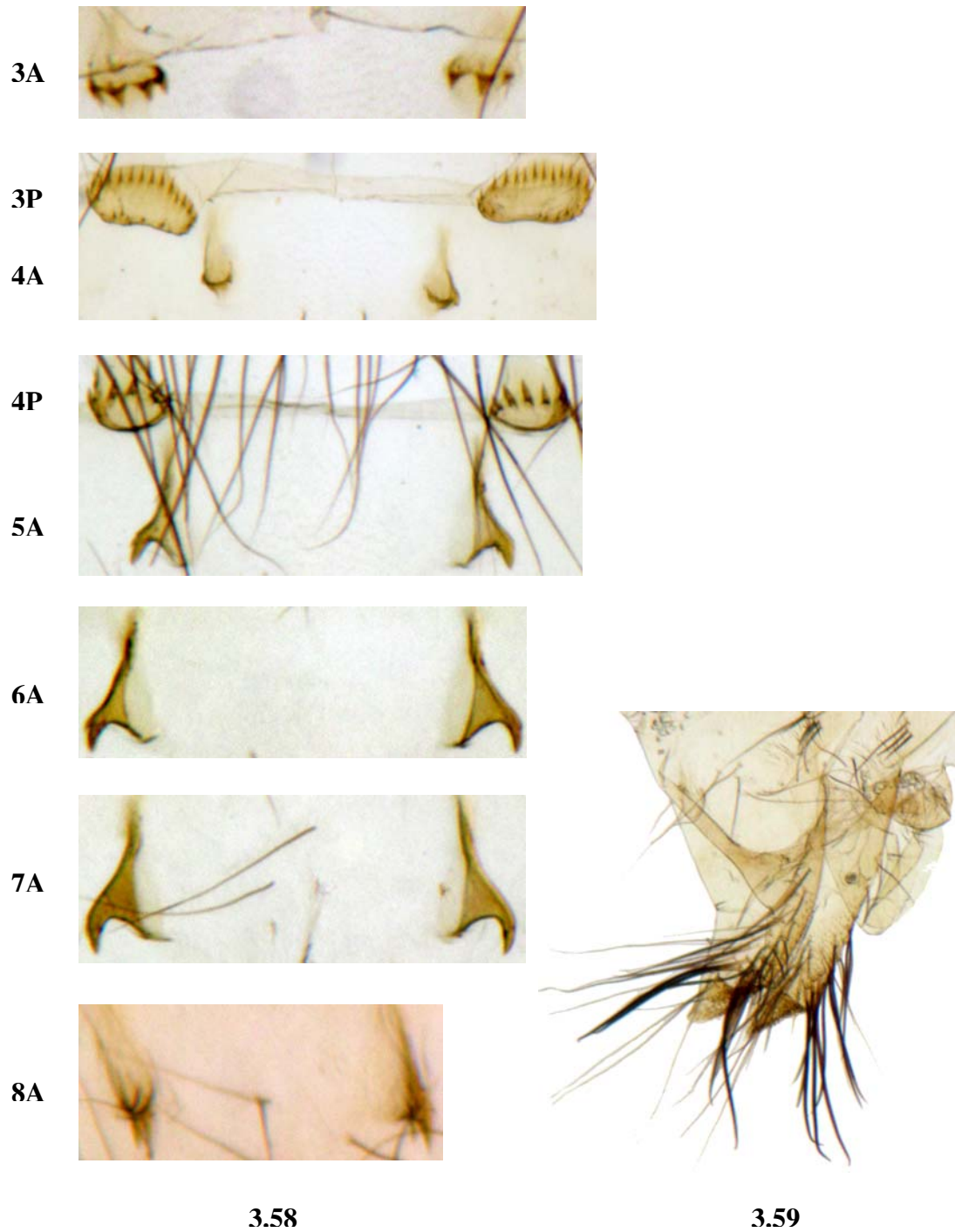


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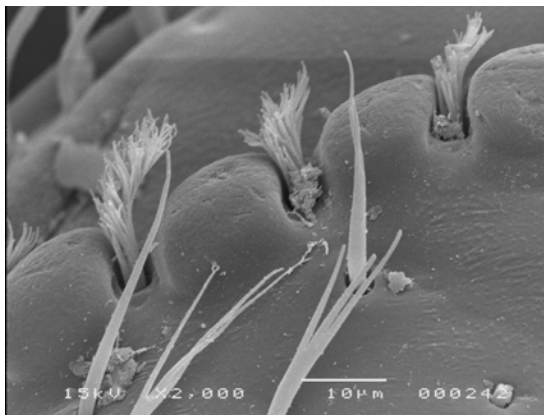


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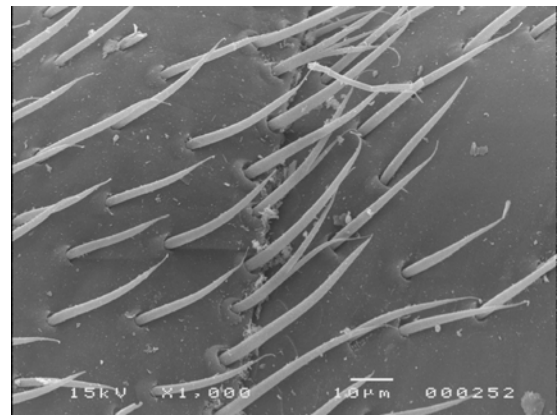
Figures 3.55-3.57. *Cheumatopsyche copia*: 3.55, prosternum; 3.56, sterna VIII and IX; 3.57, ventral view of pupal mandibles.



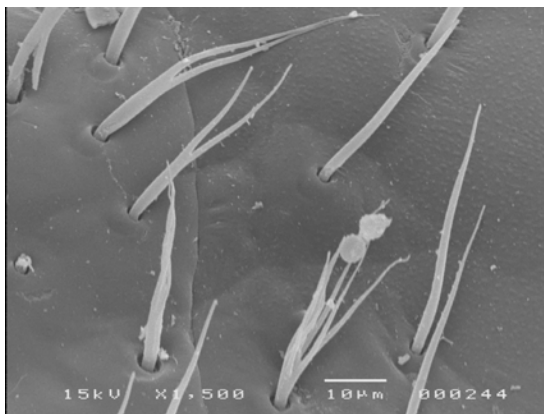
Figures 3.58-3.59. *Cheumatopsyche copia*: 3.58, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.59, pupal apical abdominal appendages.



3.60



3.62



3.61



3.63

Figures 3.60-3.63. *Cheumatopsyche copia*: 3.60-3.61, setae on dorsum of head; 3.62, setae on pronotum; 3.63, setae on abdominal segments.

***Cheumatopsyche tramota* Malicky & Chantaramongkol, 1997**

Larva: Total length 7.5-8.0 mm (n=10). Head and thoracic sclerites yellow to dark-brown (Fig. 3.64).

Head: Head capsule length, 0.71-0.77 mm; width, 0.54-0.65 mm. Dorsum of head yellow except lateral and posterior half of frontoclypeus dark-brown (Fig. 3.65). Frontoclypeus with wide, deep median notch in anterior margin, coarsely crenulate with about 12 lobes; posterior corner with group of paler muscle scars (Fig. 3.66). Head covered with numerous, long, hair-like setae and tapered setae on dorsal and lateral regions in anterior three-quarters. Frontoclypeus also covered with same setae of various forms (simple, bifid, trifid); scattered brush of setae in lateral area of frontoclypeus; anterior margin of frontoclypeus bearing brush of setae (Figs. 3.81-3.82). Head ventrally yellow, with stridulatory lines in anterior half (Fig. 3.67). Labrum golden-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-brown pectinate setae; dorsal surface with moderately long setae; with pair of long anteromesal setae (Fig. 3.68). Mandibles reddish-brown, short; right mandible with 2 apical and 3 mesal teeth; left mandible with 2 apical and 4 mesal teeth, with well-developed setal brush; lateral surface of both mandibles with scattered setae (Fig. 3.69). Submentum brown, with anterior margin broadly V-shaped with median cleft; cleft with sides parallel, anterior margin and lateral area with short and long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small triangular (Fig. 3.67).

Thorax: Pronotum brown, muscle scars paler; lateral and posterior

margin mostly black. Pronotum densely covered with long, recumbent, tapered setae; anterior margin bearing same setae (Figs. 3.70, 3.83). Meso- and metanotum light-brown, muscle scars darker; posteromesal crescentic black mark, lateral margins black, each notum densely covered with long, recumbent, tapered setae; anterior margins bearing same setae (Figs. 3.71-3.72). Posterior prosternites reduced to small flecks, one adjacent to each posterolateral angle of anterior prosternite (Fig. 3.76). Foretrochantin deeply forked, with dorsal ramus slightly shorter than ventral ramus; ventral ramus robust, with some spike-like setae (Fig. 3.73). Foreleg with surface of coxa densely covered with feather-like setae on posterior region; trochanter through tibia adorned with long and spike-like setae on anterior surface and ventral margin, mingled with row of feather-like setae on ventral margin; tarsi with spike-like setae (Figs. 3.73, 3.84). Mid- and hindlegs similar in size, shape, and structure; with dense spike-like setae and stout setae on mesal surface of coxa through tarsi; mingled with row of feather-like setae on ventral margin (Figs. 3.74-3.75). Mesosternum with one pair of gills; metasternum with 3 gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments covered with recumbent, hair-like setae. First sternum with 2 pairs of gills with adjacent bases. Segments II-VI each with 2 pairs lateral gills and 1 pair median gills. Segment VII with 2 pairs lateral gills. Sternum VIII with pair of moderately sclerites plates, bearing spike-like setae; posterior margin of each plate with long setae. Sternum IX with pair of large, triangular sclerites plates, bearing spike-like setae emanating from prominent sockets; posterior margin of each plate with long setae; inner margin of each sclerite of sternum IX notched at posterior corners. Tergum IX with pair of small lateral and

moderately dorsolateral sclerites (Fig. 3.77). Anal prolegs with bent claw and cluster of long bristles, spike-like setae on dorsal surface.

Pupa: Labrum semicircular with basolateral lobes, each bearing long setae, anterior region with many dark setae. Mandibles enlarged at bases, with posterior surface bearing ca. 4 long, black setae; right mandible bearing 4 teeth, left mandible with 3 teeth (Fig. 3.78). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.79). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by small, hooked setae; outer margin and inner face of each process fringed with long, black setae; inner surface of base with same setae (Fig. 3.80).

Diagnosis: This species may be distinguished on the basis of the frontoclypeus color pattern of light-brown in the anterior half. The anterior margin of frontoclypeus has a deep, wide median notch and it is coarsely crenulate with ca. 12 lobes. Heavy simple hair-like setae on the dorsal and lateral areas of the head. Various setal types are present on frontoclypeus (i.e. simple, bifid, trifid), and a few brush of setae are also present in lateral corners. Many stout, long, tapered setae on all nota.

Material examined: NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 6-iv-2004, Prommi, 1 male mmt.; same locality, 10-viii-2004, Prommi, 31 larvae; same locality, 11-x-2004, 6 larvae, 4pupae, 1 female mmt.; KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-iv-2005, Prommi, 15 larvae; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 3 larvae, 1 pupa;

same locality, 12-iv-2005, Prommi, 3 larvae; NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 3 larvae.

Discussion: *Cheumatopsyche* is a large genus represented on all continents except South America (Wiggins, 1996). Twenty-two species of *Cheumatopsyche* are now reported in Thailand and are known only from the adult stages (Malicky and Chantaramongkol, 1999). Of these 15 were found in this study. *Cheumatopsyche carna* and *C. musiana* were each represented by only a single specimen. Three immature larvae and pupae of this genus could be associated with adult stages from this study (Table 2.4). Larvae were collected from a wide variety of habitats ranging from small to large streams with flowing water and co-occured on the same rock with species of *Hydropsyche*. Larvae of *Cheumatopsyche* construct a sandgrain retreat and capture net. The flight period of these adult was year-long.



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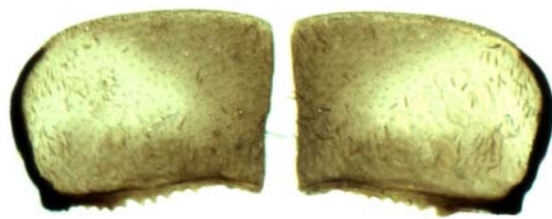


3.66



3.69

Figures 3.64-3.69. Larval features of *Cheumatopsyche tramota*: 3.64, larva; 3.65, dorsal view of head; 3.66, frontoclypeal apotome; 3.67, ventral view of head; 3.68, dorsal view of labrum; 3.69, ventral view of mandibles.



3.70



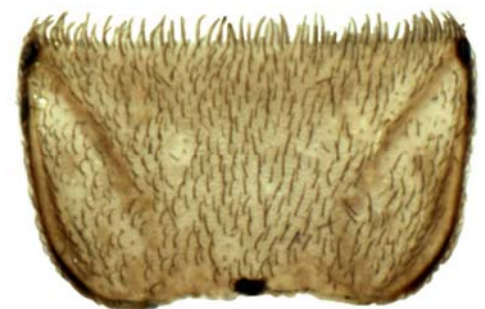
3.73



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Figures 3.70-3.75. Larval features of *Cheumatopsyche tramota*: 3.70, pronotum; 3.71, mesonotum; 3.72, metanotum; 3.73, inner face of left foreleg; 3.74, inner face of left midleg; 3.75, inner face of left hindleg.



3.76

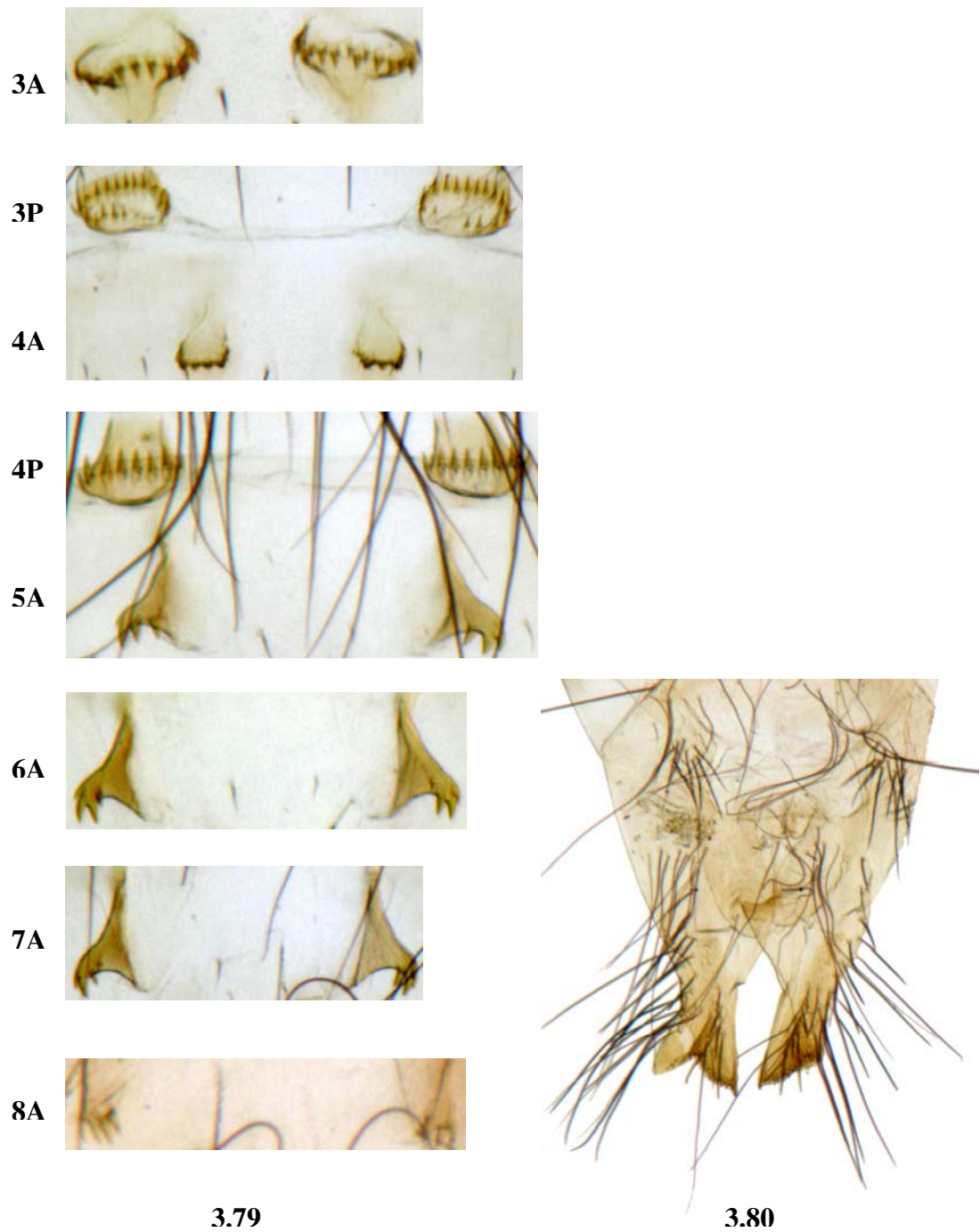


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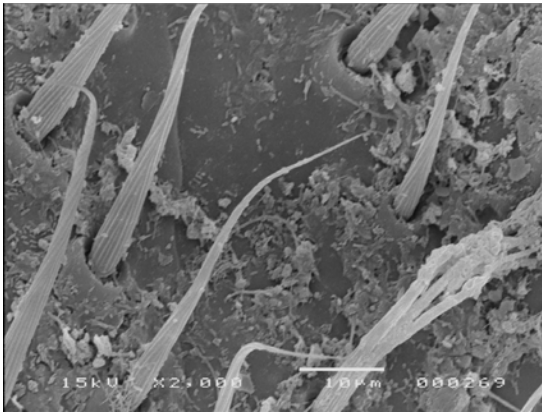


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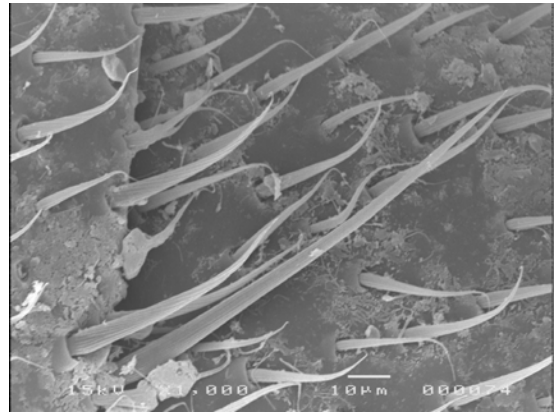
Figures 3.76-3.78. *Cheumatopsyche tramota*: 3.76, prosternum; 3.77, sterna VIII and IX; 3.78, ventral view of pupal mandibles.



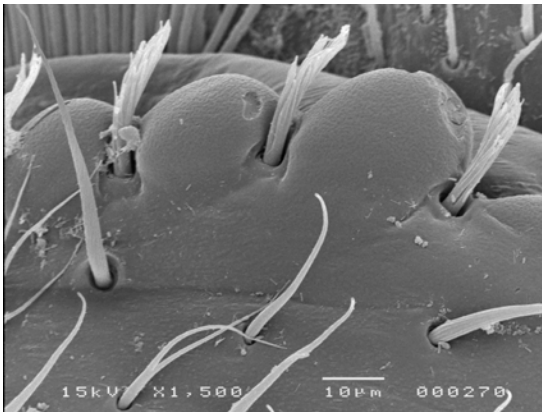
Figures 3.79-3.80. *Cheumatopsyche tramota*: 3.79, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.80, pupal apical abdominal appendages.



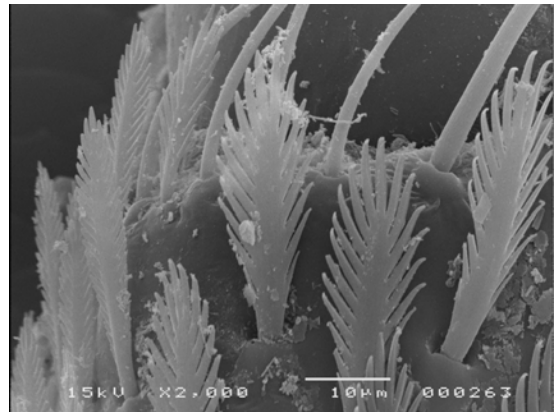
3.81



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3.84

Figures 3.81-3.84. *Cheumatopsyche tramota*: 3.81-3.82, setae on dorsum of head; 3.83, setae on pronotum; 3.84, setae on ventral margin of foreleg.

GENUS *Hydatomanicus* Ulmer, 1951

Diagnosis: Larvae have the typical characteristics of the family and are distinguished from other hydropsychid genera by the present of cone-like hairs typically located on the dorsum of the abdominal segments. Also, the posterior corners of frontoclypeus have a cluster of three spots.

From the results of this study, 2 species of unknown *Hydatomanicus* larvae could be associated with identifiable adult species: *Hydatomanicus adonis* and *H. klanklini*. Details of each species are described as follows:

***Hydatomanicus adonis* Malicky and Chantaramongkol, 1996**

Larva: Total length 11.5-12.0 mm (n=10). Overall body shape as usual Hydropsychidae. Head dark-brown to black. Notal sclerites dark-brown.

Head: Head capsule length, 1.29-1.33 mm; width, 1.19-1.22 mm. Dorsum of head dark-brown to black with three yellow areas on midline of frontoclypeus; areas around each eye yellow; posterior one-fifth of head with dark muscle scars (Fig. 3.85). Anterior three-fourths dorsolaterally covered with moderately long, black, truncate peg setae and acuminate peg setae; mingled with tapered setae and some brush of setae to corner of frontoclypeus (Fig. 3.106). Frontoclypeus devoid of same setae except in anterolateral corners. Anterior margin of frontoclypeus slightly convex and finely crenulate; frontoclypeus slightly broadened just posterior to mid-length; posterior corner of frontoclypeus with a

cluster of 3 large, dark spots (Figs. 3.85-3.86). Head ventrally dark brown to black with group of darker muscle scars covering stridulatory surfaces (Fig. 3.87). Labrum dark-brown; elliptical in dorsal view; bearing well-developed, lateral, brown brushes; anterior half with stout setae and anteromesal pair of long, dark, setae; anterior margin hairy (Fig. 3.88). Mandibles dark reddish-brown with a lateral trough, numerous, long, black setae along base of trough; left mandible with mesal tuft of hairs (Fig. 3.89). Submentum with cleft; anterior margin of each cleft with long, black setae (Fig. 3.90). Anterior ventral apotome broadly triangular; posterior ventral apotome small, triangular (Fig. 3.87).

Thorax: Nota dark-brown, with darker spots on lateral margins. Each notum covered with same setae as in dorsum of head, but lacking brush of setae; anterior margin each bearing same setae (Figs. 3.91-3.93, 3.107). Prosternum transverse, with dark band on the anterior and posterior margins, paler mesally, with a pair of dark posterolateral plates (Fig. 3.98). Propleuron ventrally with black setae; trochantin forked, with stout setae (Fig. 3.97). Foreleg with coxa and trochanter densely covered with feather-like setae on posterior surface; femur with long, stout, black setae on ventral margin (Figs. 3.94, 3.108). Mid- and hindlegs similar in size, shape, midleg without stout, spike-like setae on lateral surface of femur and tibia; hindleg with stout, spike-like setae on lateral surface of femur and tibia emanating from prominent sockets (Figs. 3.95-3.96). Mesosternum with one pair of lateral gills, each with central stalk decorated with numerous lateral filaments; metasternum with 2 pairs of gills, one lateral and one mesal.

Abdomen: Abdominal segments covered with black, cone-like hairs, mingled with club-like hairs (Fig. 3.109). Segments I-VI each with 2 pairs of lateral

gills arising from a common base (Fig. 3.110). Segments II-V each with one pair of mesal gills with a single stalk. Segment VII with one pair of lateral gills. Sterna VIII and IX each with pair of spine-bearing plates with numerous, brown, stout setae emanating from prominent sockets; posterior margin of sclerites with long, black setae. Each sclerite of sterna entire and triangular. Tergum IX with moderately lateral sclerite and pair of dorsal sclerites; posterior margin of each sclerite with long, black setae (Fig. 3.99). Anal prolegs with dark setae on each side of lateral sclerites, with bent claw and cluster of long bristles (Fig. 3.100).

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing numerous long setae; anterior region with many dark setae (Fig. 3.102). Mandibles with 4-5 strong teeth, basolateral surface with 4 long setae, mesal surface with 5 longer setae (Fig. 3.103). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segment III; anterior plates on segments II-IV very broad, with a single row of hooks, plates on segments V-VIII very narrow, with small cluster of hooks on raised mesal portion of plates; posterior plate of segment III broadly transverse with 2 rows of hooks (Fig. 3.104). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by short setae and hooked setae; outer margin of each process fringed with long, black setae (Fig. 3.105).

Diagnosis: This species may be recognized on the basis of the following combination of characteristics. First, the color pattern of the head and thoracic nota are much darker than *H. klanklini* and the frontoclypeus has three yellow areas on the midline. Finally, the abdominal segments are densely covered with cone-like hairs and club-like hairs. In general, *Hydatomanicus adonis* is more robust and larger than

H. klanklini.

Material examined: KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall, 5-viii-2004, 5 larvae, 2 pupae; same locality, 6-x-2004, 3 larvae, 1 pupa; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 11-i-2004, Prommi, 5 larvae, 1 pupa; same locality, 12-ii-2004, Prommi, 8 larvae, 3 pupae; same locality, 10-iii-2004, Prommi, 6 larvae, 3 pupae; same locality, 7-iv-2004, 10 larvae, 4 pupae; same locality, 1-v-2004, Prommi, 13 larvae, 8 pupae; same locality, 8-vi-2004, 7 larvae, 2 pupae; same locality, 1-vii-2004, Prommi, 8 larvae, 3 pupae; same locality, 4-viii-2004, Prommi, 10 larvae, 4 pupae; same locality, 1-ix-2004, Prommi, 6 larvae, 2 pupae; same locality, 3-x-2004, Prommi, 13 larvae, 5 pupae; same locality, 6-xi-2004, Prommi, 9 larvae, 3 pupae; same locality, 1-xii-2004, Prommi, 6 larvae, 2 pupae; same locality, 1-i-2005, Prommi, 8 larvae, 2 pupae; same locality, 1-ii-2005, Prommi, 8 larvae, 3 pupae; same locality, 2-iii-2005, Prommi, 11 larvae, 5 pupae; same locality, 12-iv-2005, Prommi, 12 larvae, 5 pupae; same locality, 13-v-2005, Prommi, 7 larvae, 2 pupae; same locality, 30-vi-2005, 8 larvae, 3 pupae.



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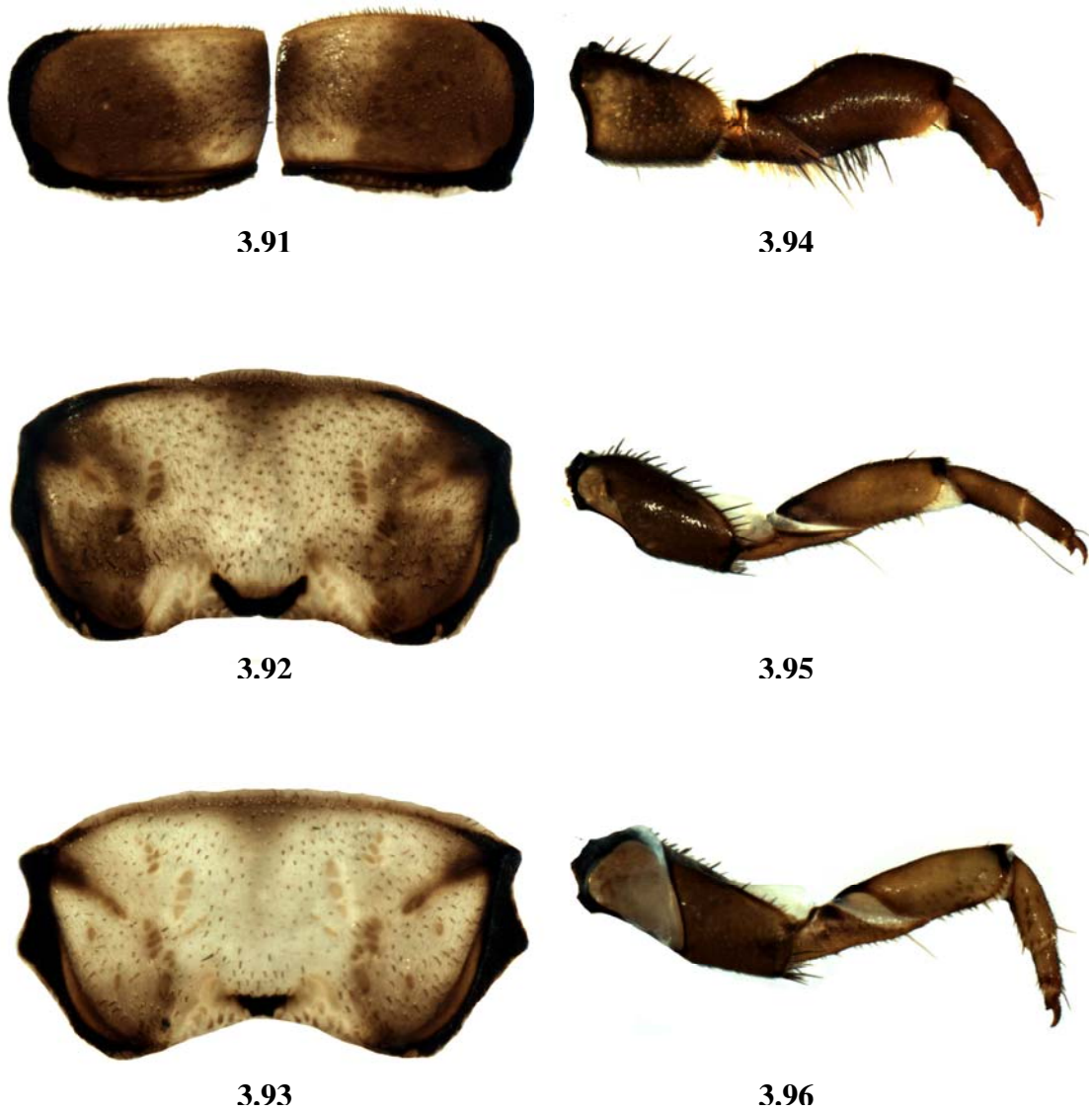


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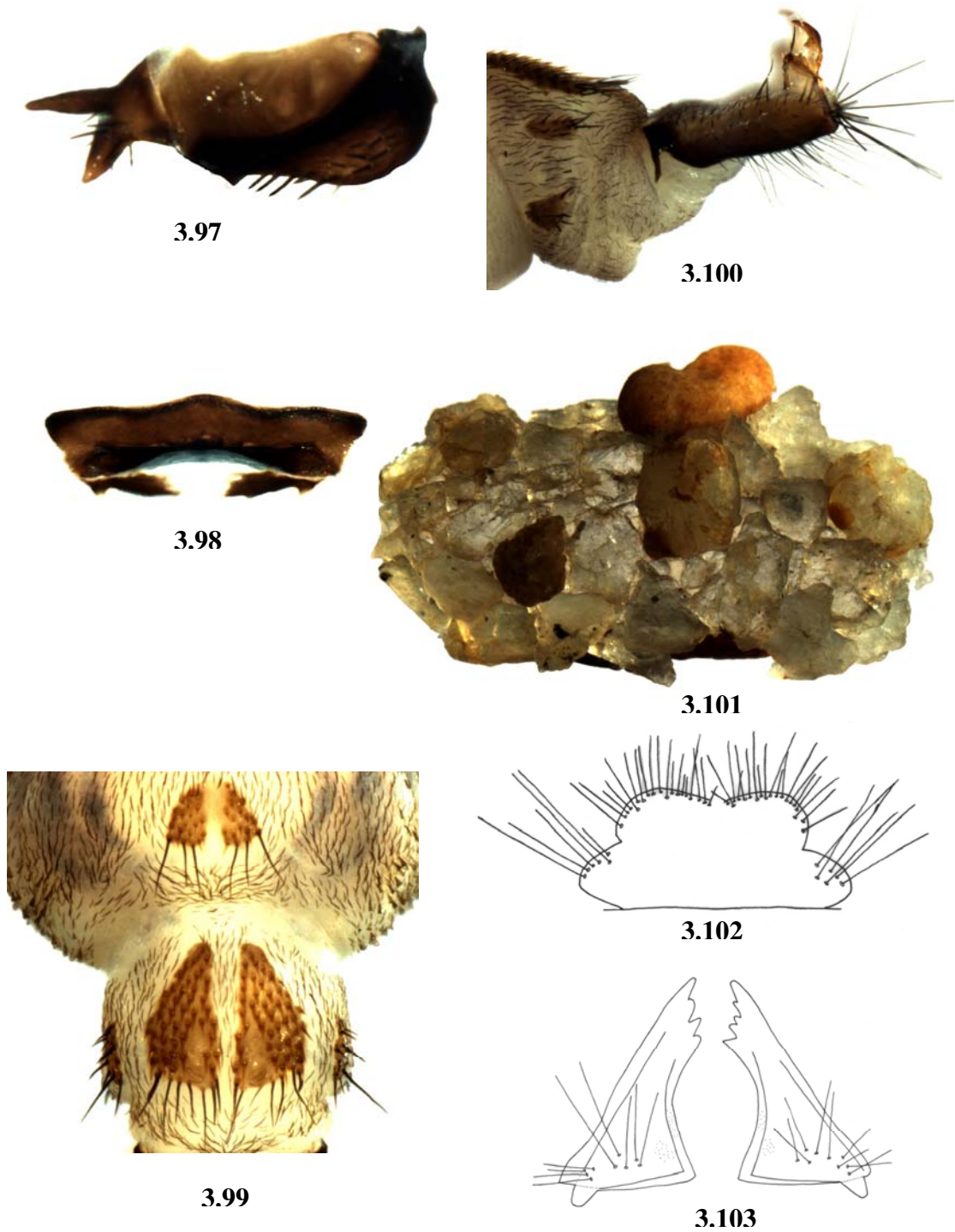


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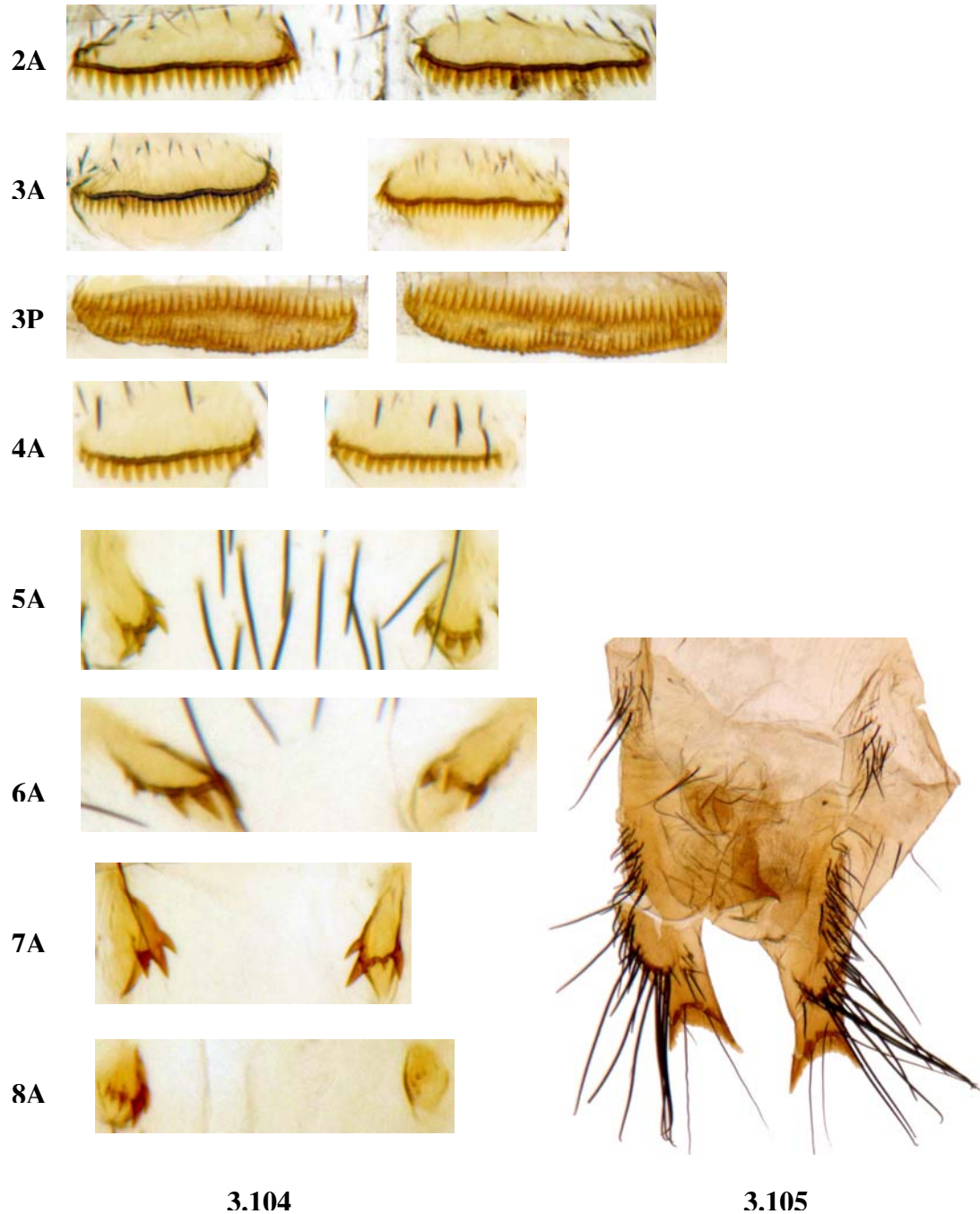
Figures 3.85-3.90. Larval features of *Hydatomanicus adonis*: 3.85, dorsal view of head; 3.86, frontoclypeal apotome; 3.87, ventral view of head; 3.88, dorsal view of labrum; 3.89, ventral view of mandibles; 3.90, submentum and anterior ventral apotome.



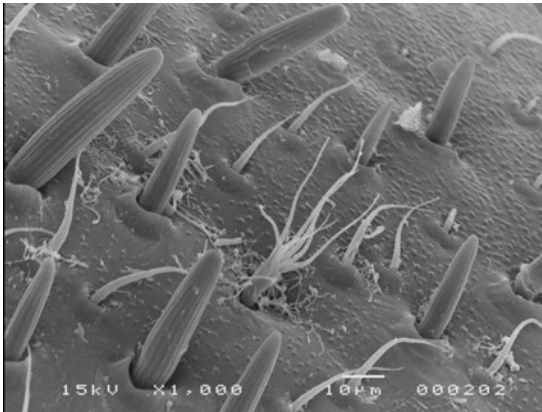
Figures 3.91-3.96. Larval features of *Hydatomanicus adonis*: 3.91, pronotum; 3.92, mesonotum; 3.93, metanotum; 3.94 outer face of left foreleg; 3.95, inner face of left midleg; 3.96, inner face of left hindleg.



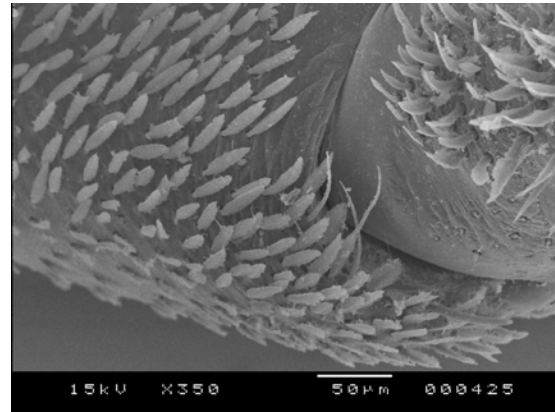
Figures 3.97-3.103. *Hydatomanicus adonis*: 3.97, foretrochantin; 3.98, prosternum; 3.99, sterna VIII and IX; 3.100, lateral view of anal claw; 3.101, larval and pupal case constructed from sand and small gravels; 3.102, dorsal view of pupal labrum; 3.103, dorsal view of pupal mandibles.



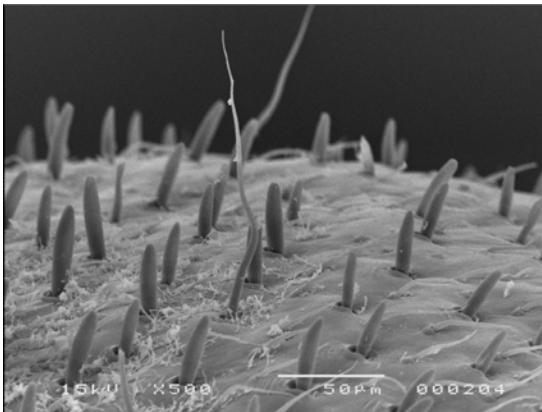
Figures 3.104-3.105. *Hydatomanicus adonis*: 3.104, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.105, pupal apical abdominal appendages.



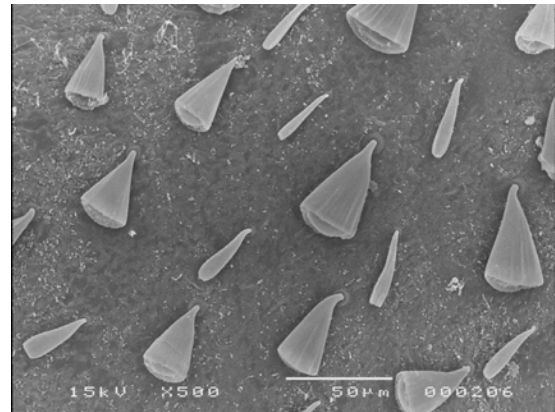
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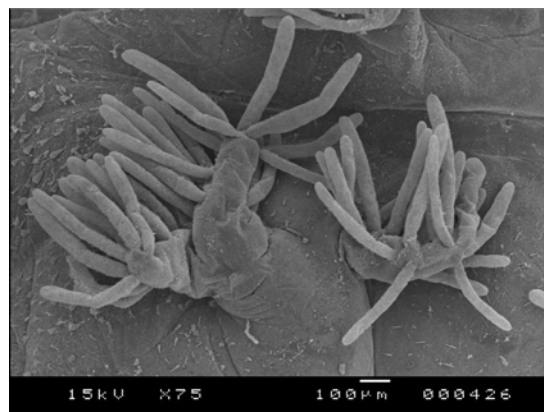
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Figures 3.106-3.110. *Hydatomanicus adonis*: 3.106, setae on dorsolateral surface of head; 3.107, setae on pronotum; 3.108, setae on fore-coxa and trochanter; 3.109, setae on abdominal segments; 3.110, abdominal gills.

***Hydatomanicus klanklini* Malicky and Chantaramongkol, 1993**

Larva: Total length 7.5-8.5 mm (n=10). Overall body shape as usual in Hydropsychidae (Fig. 3.111). Head yellow to brown. Notal sclerites brown to brownish.

Head: Head capsule length, 1.16-1.19 mm; width, 1.12-1.16 mm. Dorsum of head brown with wide longitudinal yellow band on frontoclypeus; areas around and below each eye yellow; posterior one-fifth of head with dark-brown muscle scars. (Fig. 3.112). Dorsolaterally and frontoclypeus dark-brown. Anterior three-fourths of head dorsolaterally covered with moderately long, black, truncate peg setae; mingled with tapered setae to corner of frontoclypeus (Fig. 3.130). Frontoclypeus devoid of same setae except for anterolateral corners. Anterior margin of frontoclypeus slightly convex and finely crenulate; frontoclypeus slightly broadened just posterior to mid-length; posterior corner of frontoclypeus with cluster of 3 large dark spots (Figs. 3.112-3.113). Head ventrally dark-brown with group of large, darker, muscle scars covering stridulatory surfaces (Fig. 3.114). Labrum yellow-brown; elliptical in dorsal view; bearing well-developed, lateral, golden brushes; anterior half with stout setae and anteromesal pair of long, dark setae; anterior margin hairy (Fig. 3.115). Mandibles reddish-brown with lateral trough; numerous, long, black setae along base of trough; left mandible with mesal tuft of hairs (Fig. 3.116). Submentum with cleft; anterior margin of cleft with long, black setae (Fig. 3.123). Anterior ventral apotome broadly triangular; posterior ventral apotome small, triangular (Figs. 3.114, 3.123).

Thorax: Nota yellow to brown, darker on lateral margins. Each notum covered with same setae as dorsum of head; anterior margin each bearing same setae; large black U-shaped mark posteriorly on mesonotum with 4-5, round muscle scars (Figs. 3.117-3.119, 3.131). Prosternum transverse, with dark band on anterior and posterior margins, paler mesally, with pair of dark posterolateral plates (Fig. 3.124). Propleuron ventrally with black setae; trochantin forked, with stout setae (Fig. 3.120). Foreleg with coxa and trochanter densely covered with feather-like setae on posterior surface; femur with long, stout, black, setae on ventral margin (Fig. 3.120). Mid- and hindlegs similar in size, shape; midleg without stout, spike-like setae on lateral surface of femur and tibia; hindleg with stout, spike-like setae on lateral surface of femur and tibia emanating from prominent sockets (Figs. 3.121-3.122). Mesosternum with one pair of lateral gills, each with central stalk with numerous lateral filaments; metasternum with 2 pairs of gills; one lateral and one mesal.

Abdomen: Segments dorsolaterally covered with black, cone-like hairs varying in size (Fig. 3.132). Segments I-V each with 2 pairs lateral gills arising from common base (Fig. 3.133). Segments II-IV each with one pair mesal gills with a single stalk. Segments VI-VII each with one pair lateral gills. Sterna VIII and IX each with pair of spine-bearing plates with numerous golden-brown, stout setae emanating from prominent sockets; posterior margin of sclerites with long, black setae. Each sclerite of sterna entire, triangular. Tergum IX with small lateral sclerite and pair of larger dorsal sclerites; posterior margin of each sclerite with long, black setae. Anal prolegs with dark setae on each side of lateral sclerites, with bent claw and cluster of long bristles.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing numerous

setae, anterior region with many long, dark setae (Fig. 3.126). Mandibles with 4-5 strong teeth, basolateral surface with 7 long setae, mesal surface with 4 long setae (Fig. 3.127). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segment III; anterior plates on segments II-IV very broad, with a single row of hooks, plates on segments V-VIII very narrow, with a small cluster of hooks on a raised mesal portion of plates; posterior plate of segment III broadly transverse with 2 rows of hooks (Fig. 3.128). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface, covered by short setae and hooked setae; outer margin of each process fringed with long, black setae (Fig. 3.129).

Diagnosis: This species may be distinguished from *Hydatomanicus adonis* on the basis of the following combination of characteristics. First, the color pattern of the head and thoracic nota are much paler the yellow band on the midline of the frontoclypeus is wider. The ventral surface of the head is brown; whereas, the venter of *Hydatomanicus adonis* has dark-brown to black areas. Second, the abdominal segments are densely covered with black, cone-like hairs varying in size. The abdominal segments of *Hydatomanicus adonis* are densely covered with the same size of black, cone-like hairs and club-like hairs.

Material examined: KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall, 5-viii-2004, 8 larvae, 5 Pupae; same locality, 6-x-2004, 6 larvae, 3 pupae; TRANG Prov.: NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 11-x-2004, Prommi, 5 larvae; Pliew Waterfall, 6-iv-2005, Prommi, 28 larvae, 10 pupae; Khao Luang National Park; Promlok Waterfall, 3-xii-2004, Prommi, 8 larvae; stream from Yord Luang Waterfall, 3-xii-2004,

Prommi, 3 larvae; Sununtha National Park, Sunantha Waterfall, 8-iv-2005, 21 larvae, 15 pupae; Si Khit National Park, stream from Si Khit Waterfall, 9-iv-2005, Prommi, 12 larvae, 5 pupae; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall, 7-viii-2004, Prommi, 1 larva; PATTHALUNG Prov.: Khaobantad Wildlife Sanctuary, stream from Momjui Waterfall, 4-x-2004, Prommi, 3 larvae; same locality, 12-iv-2005, Prommi, 5 larvae; Praiwan Waterfall, 4-x-2004, Prommi, 8 larvae, 3 pupae; RANONG Prov.: Ngao Waterfall National Park, Ngao Waterfall, 8-viii-2004, Prommi, 4 larvae; same locality, 9-x-2004, Prommi, 3 larvae; Tungraya-nasak Wildlife Sanctuary, Bok Krai Waterfall, 2-iv-2005, Prommi, 15 larvae, 8 pupae; same locality, 15-viii-2005, Prommi, 12 larvae, 8 pupae; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 11-i-2004, Prommi, 3 larvae, 1 pupa; same locality, 12-ii-2004, Prommi, 2 larvae; same locality, 10-iii-2004, Prommi, 3 larvae, 1 pupa; same locality, 7-iv-2004, 5 larvae, 2 pupae; same locality, 1-v-2004, Prommi, 4 larvae, 2 pupae; same locality, 8-vi-2004, 3 larvae; same locality, 1-vii-2004, Prommi, 4 larvae, 2 pupae; same locality, 4-viii-2004, Prommi, 3 larvae, 1 pupa; same locality, 1-ix-2004, Prommi, 5 larvae, 2 pupae; same locality, 3-x-2004, Prommi, 8 larvae, 2 pupae; same locality, 6-xi-2004, Prommi, 6 larvae, 1 pupa; same locality, 1-xii-2004, Prommi, 4 larvae, 2 pupae; same locality, 1-i-2005, Prommi, 5 larvae, 1 pupa; same locality, 1-ii-2005, Prommi, 4 larvae; same locality, 2-iii-2005, Prommi, 6 larvae, 2 pupae; same locality, 12-iv-2005, Prommi, 8 larvae, 3 pupae, 1 adult; same locality, 13-v-2005, Prommi, 4 larvae, 1 pupa; same locality, 30-vi-2005, 5 larvae, 2 pupae; SATUN Prov.: Thaleban National Park, Yaroi Waterfall, 12-xi-2004, Prommi, 17 larvae, 10 pupae; same locality, 15-iii-2005, Prommi, 12 larvae, 8 pupae; SURAT THANI Prov.: Khao Sok

National Park, Mae Yai Waterfall, 4-iv-2005, Prommi, 10 larvae, 6 pupae; Tai Rom Yen National Park, Dad Fah Waterfall, 9-viii-2004, Prommi, 10 larvae, 4 pupae.

Discussion: *Hydatomanius* is a small genus in the subfamily Hydropsychinae, containing only 3 species; *Hydatomanius adonis*, *H. scotosius*, and *H. klanklini*, known from Thailand. All of these have been found in northern Thailand, and only *H. klanklini* has been found in southern Thailand (Malicky and Chantaramongkol, 1999). The immature larvae, pupae, and adult stages of two species from this genus were collected from this study, *Hydatomanius adonis* and *H. klanklini*. Larvae of *Hydatomanius* were collected from the surface of bedrock and large boulders. Larvae construct a sandgrain retreat and capture net (Figs. 3.101, 3.125). The case and net are adapted for life in high water velocity. These larvae were found year round, and the adults were not attracted to black lights.



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Figures 3.111-3.116. Larval features of *Hydatomanicus klanklini*: 3.111, larva; 3.112, dorsal view of head; 3.113, frontoclypeal apotome; 3.114, ventral view of head; 3.115, dorsal view of labrum; 3.116, dorsal view of mandibles.



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Figures 3.117-3.122. Larval features of *Hydatomanicus klanklini*: 3.117, pronotum; 3.118, mesonotum; 3.119, metanotum; 3.120 outer face of left foreleg; 3.121, inner face of left midleg; 3.122, inner face of left hindleg.



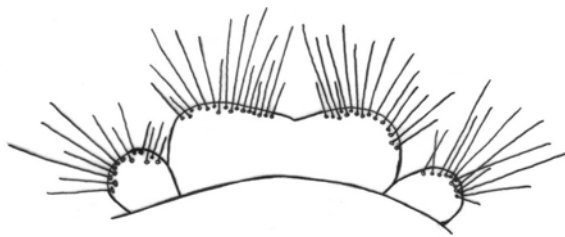
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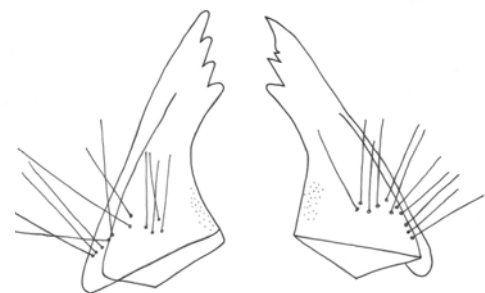
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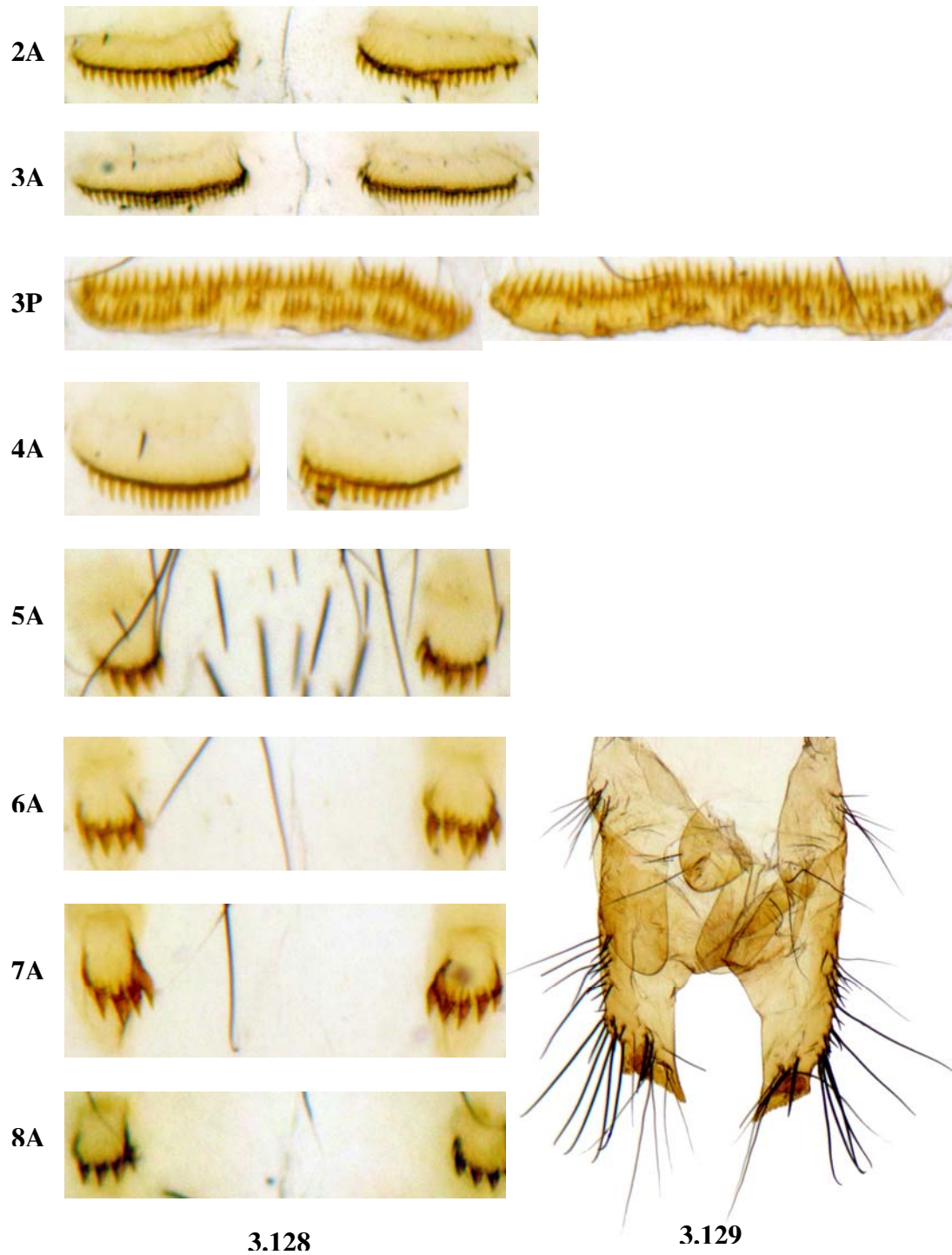


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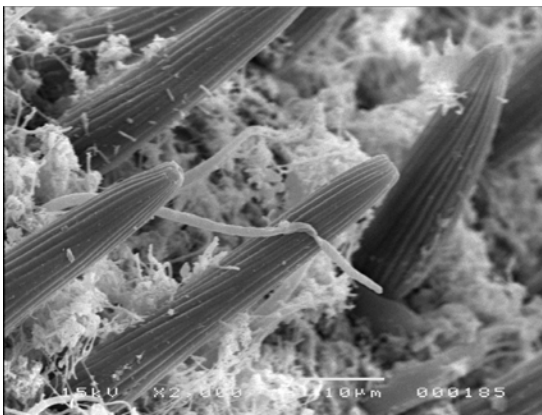


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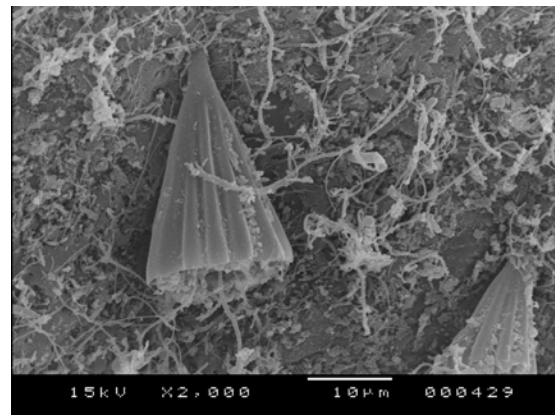
Figures 3.123-3.127. *Hydatomanicus klanklini*: 3.123, submentum and anterior ventral apotome; 3.124, prosternum; 3.125, larval and pupal case constructed from sand and small gravels; 3.126, dorsal view of pupal labrum; 3.127, dorsal view of pupal mandibles.



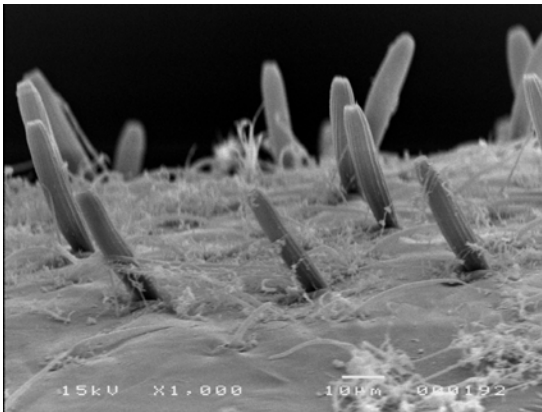
Figures 3.128-3.129. *Hydatomanicus klanklini*: 3.128, pupal hookplates, dorsal view showing abdominal segment number and anterior (A) or posterior (P) position; 3.129, pupal apical abdominal appendages.



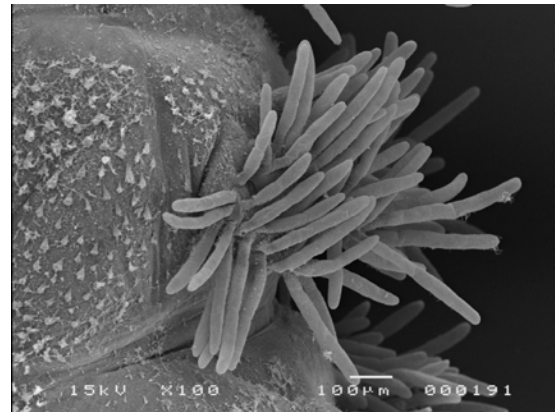
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3.133

Figures 3.130-3.133. *Hydatomanius klanklini*: 3.130, setae on dorsolateral region of head; 3.131, setae on pronotum; 3.132, setae on abdominal segments; 3.133, abdominal gills.

GENUS *Hydromanicus* Brauer, 1865

Diagnosis: Larvae have the typical characteristics of the family. Larvae of *Hydromanicus* can be distinguished from those of other hydropsychid genera by the following combination of characteristics: head with few hairs or setae and a glossy sheen; the upper branch of the forked fore-trochantin about 50% longer than the lower branch (which bears bristles) and wide basally; the anterior margin of the submentum is concave, not cleft; mesosternum has one pair of gills; the metasternum has two pairs of gills; abdominal segments 1 to 6 bear ventral gills; and segment VII lacks gills.

From the results of this study, 3 species of unknown *Hydromanicus* larvae could be associated with identifiable adult species; *Hydromanicus abiud*, *H. inferior*, and *H. serubabel*. Details of each species are described as follows:

***Hydromanicus abiud* Malicky & Chantaramogkol, 1997**

Larva: Total length 17.0-17.5 mm (n=10). Overall body shape as in Hydropsychidae. Head and nota nearly concolorous brownish.

Head: Head capsule length, 1.53-1.62 mm; width, 1.36-1.45 mm. Dorsum of head brownish, with yellow ring around eyes (Fig. 3.134). Dorsal and lateral portions of head densely covered with long, black, inclined and erect truncate peg setae, with tapered setae in anterior three-fourths (Fig. 3.151). Entire frontoclypeus covered with same setae and these setae project beyond anterior

margin. Frontoclypeus with anterior margin strongly convex (Fig. 3.135). Ventral surface of head brownish, with stridulatory lines in anterior half; posterolaterally paler with group of muscle scars (Fig. 3.136). Labrum brown; rounded in dorsal view; bearing well-developed, lateral, golden-yellow, pectinate setae and dorsal long, stout, dark setae, with one pair of longer, dark anteromesal setae (Fig. 3.137). Mandibles dark-brown to black with 2 apical and 3 mesal teeth, left mandible with well developed setal brush; lateral surface of both mandibles with scattered setae (Fig. 3.138). Submentum dark-brown; lacking anteromesal cleft; anterior margin concave; anterior margin and lateral area with short and long, dark setae. Anterior ventral apotome broadly triangular; posterior ventral apotome small triangular (Figs. 3.136, 3.139).

Thorax: Nota brownish, covered with same setae as on dorsum of head (Figs. 3.140-3.142, 3.152). Pronotum with weak posterior sulcus. Prosternite brown; broadly transverse; dark band along posterior margin; with pair of large, paler sclerites posterolaterally (Fig. 3.146). Foretrochantin forked; dorsal branch as long as ventral branch with stout setae on ventral branch (Fig. 3.143). Foreleg stouter than other legs, with femur widened; posteromesal surface of coxa, trochanter, and femur densely covered with feather-like setae; femur with long and spike-like setae on anterior surface and ventral margin; tibia and tarsus with rows of short, stout setae (Figs. 3.143, 3.153-3.154). Mid- and hindlegs similar in size, shape, and structure; with dense spike-like setae and stout setae on mesal surface of coxa through tarsi; with a row of feather-like setae on ventral margin (Figs. 3.144-3.145). Mesosternum with one pair of gills; metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

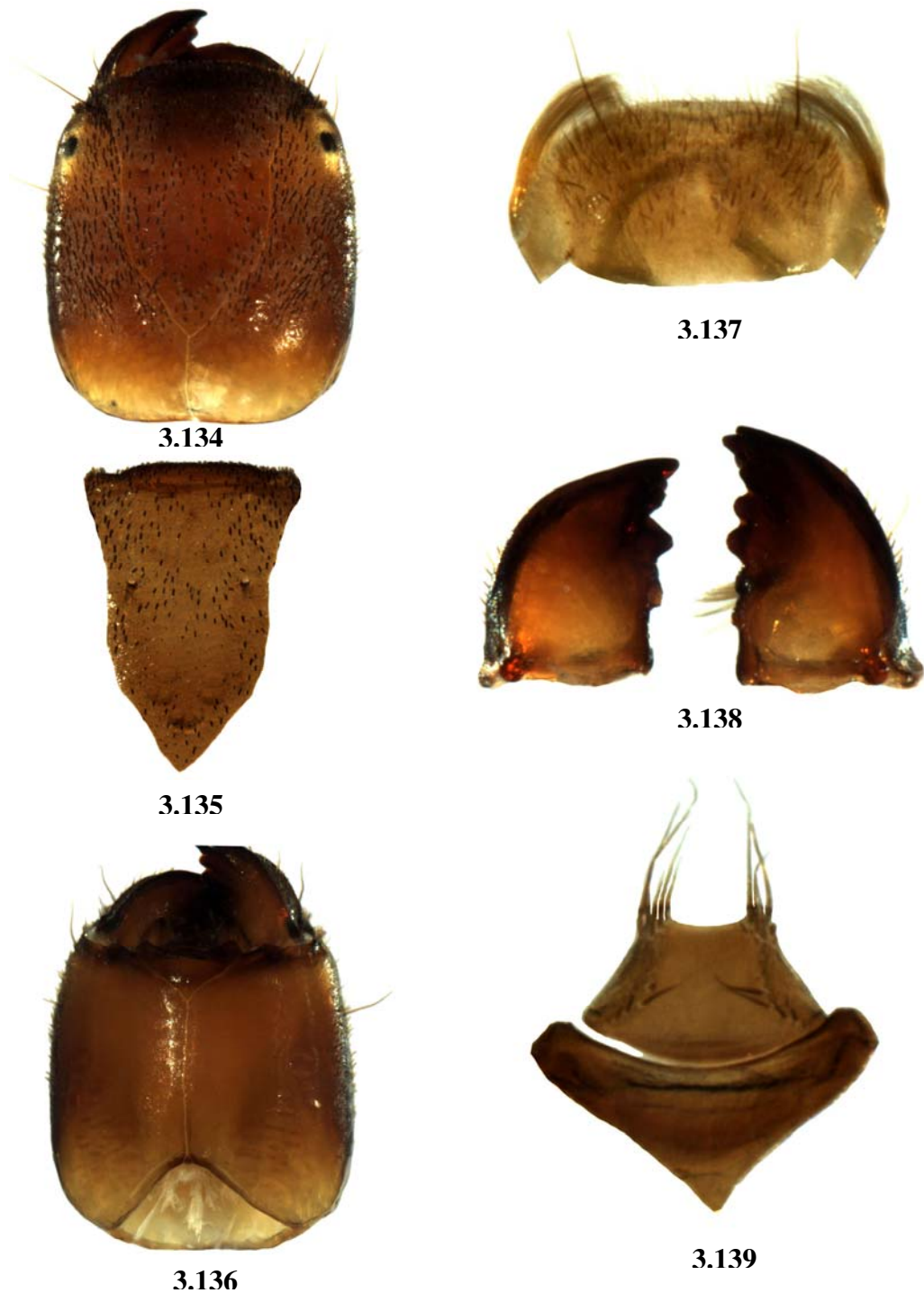
Abdomen: Abdominal segments with dense dark, club-like hairs of various shapes (Fig. 3.155). First sternum with 2 pairs of gills with adjacent bases. Segments II-VI each with 2 pairs of lateral gills and 1 pair of median gills (Fig. 3.156). Sternum VIII with pair of small, subtriangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites shaped, bearing with spike-like setae emanating from prominent sockets. Tergum IX with pair of small lateral and dorsolateral sclerites. Anal prolegs with bent claw and cluster of long bristles, spike-like setae present on dorsal surface.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing numerous long setae; anteriorly with many dark setae (Fig. 3.148). Mandibles with tubular widening at bases, posterior surface bearing approximately 9 long, black setae; left mandible bearing 4 teeth, right mandible with 3 teeth, margins of both mandibles minutely serrate between teeth (Fig. 3.147). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.149). Apical processes elongate, posteriorly with hooked setae, inner margin with short setae, outer margin bearing elongate setae (Fig. 3.150).

Diagnosis: This species may be recognized by the following combination of characteristics. First, the frontoclypeus is triangular and anterior margin strongly convex. Second, there are many long, black, truncate peg setae and tapered setae over the entire dorsal and lateral surfaces of the head and frontoclypeus. Third, the nota are covered with same setae as on the head, and the pronotum has a weak posterior sulcus. Fourth, many club-like hairs of various shapes are present on the abdominal segments. Finally, the prosternite is broadly transverse with a pair of large paler

sclerites posterolaterally.

Material examined: RANONG Prov.: Ngao National Park, Ngao Waterfall; 50 m. 09°51' N, 98°37' E, 9-x-04, Prommi, 2 larvae; same locality, 2-iv-05, Prommi, 18 larvae; KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 6-x-2004, Prommi, 2 larvae; SATUN Prov.: Thaleban National Park, Ranee Waterfall, 94 m. 06°42' N, 100°10' E, 12-xi-2004, Prommi, 10 larvae, 1 pupa, 2 male mmts.



Figures 3.134-3.139. Larval features of *Hydromanicus abiud*: 3.134, dorsal view of head; 3.135, frontoclypeal apotome; 3.136, ventral view of head; 3.137, dorsal view of labrum; 3.138, ventral view of mandibles; 3.139, submentum and anterior ventral apotome.



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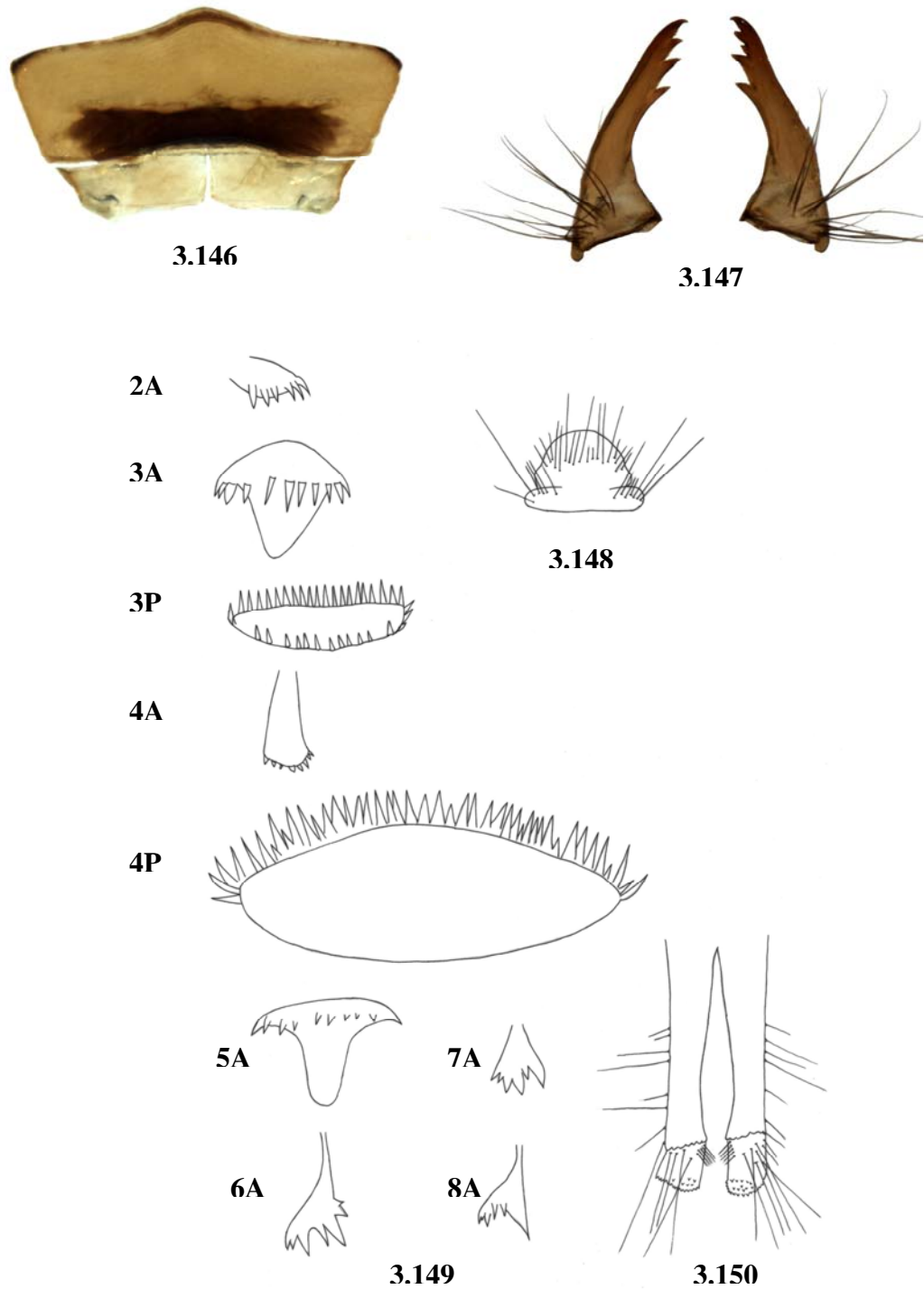


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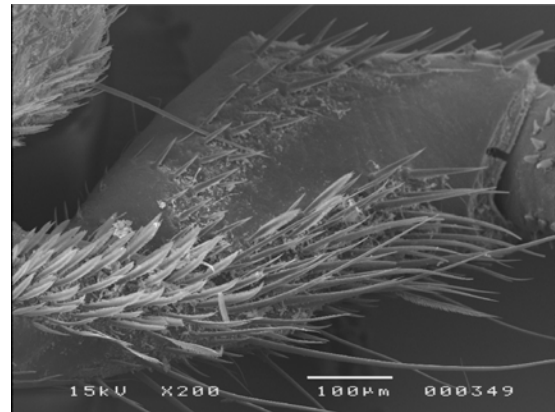
Figures 3.140-3.145. Larval features of *Hydromanicus abiud*: 3.140, pronotum; 3.141, mesonotum; 3.142, metanotum; 3.143, foretrochantin and outer face of right foreleg; 3.144, inner face of left midleg; 3.145, inner face of left hindleg.



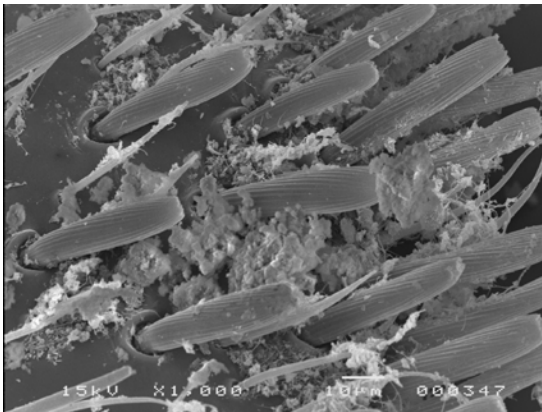
Figures 3.146-3.150. *Hydromanicus abiud*: 3.146, prosternum; 3.147, ventral view of pupal mandibles; 3.148, dorsal view of pupal labrum; 3.149, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.150, pupal apical abdominal appendages



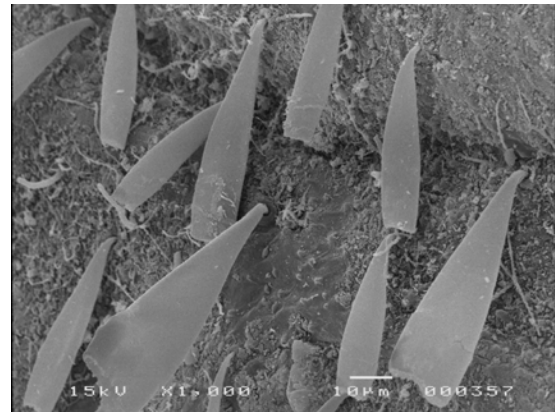
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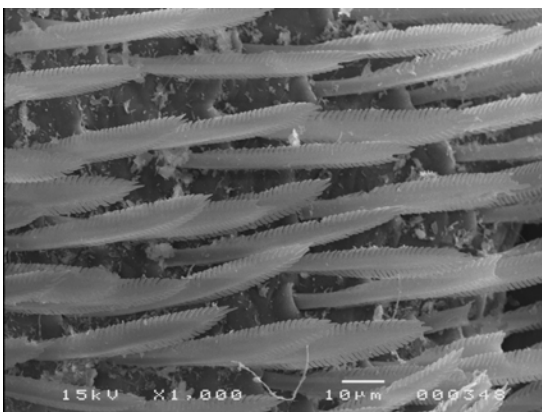
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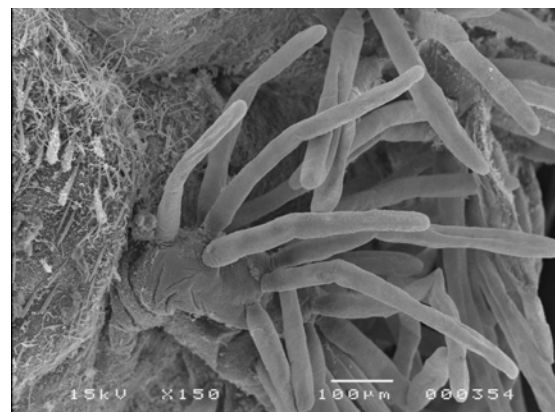
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3.156

Figures 3.151-3.156. *Hydromanicus abiud*: 3.151, setae on dorsum of head; 3.152, setae on pronotum; 3.153, setae on fore-coxa; 3.154, inner face of forelegs; 3.155, setae on abdominal segments; 3.156, abdominal gills.

***Hydromanicus inferior* Malicky & Chantaramongkol, 1997**

Larva: Total length 11.5-13 mm (n=10). Overall body shape as in Hydropsychidae. Head dark brown and nota brown.

Head: Head capsule length, 1.33-1.36 mm; width, 1.16-1.19 mm. Dorsum of head dark-brown except around eyes and posterior one-fifths yellowish (Fig. 3.157). Dorsal and lateral portions of head covered with long, black, erect, truncate peg setae, with tapered setae in anterior three-fourths (Fig. 3.176). Frontoclypeus lacking same setae except for anterolateral corners; setae projecting beyond anterior margin. Frontoclypeus with anterior margin slightly concave, posterior half with darker muscle scars; lateral margins wider at mid-length (Figs. 3.157-3.158). Head ventrally brownish, with stridulatory lines in anterior half; posterolaterally paler with group of muscle scars (Fig. 3.159). Labrum golden-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-brown brushes and dorsal short setae; with pair of long anteromesal setae; posteromedially slightly convex (Fig. 3.160). Mandibles dark-brown with 2 apical and 3 mesal teeth, left mandible with well-developed setal brush; lateral surface of both mandibles with scattered setae (Fig. 3.161). Submentum brown; lacking anteromesal cleft; anterior margin concave; anterior margin and lateral areas with short and long setae (Fig. 3.162). Anterior ventral apotome broadly triangular; posterior ventral apotome small, triangular (Figs. 3.159, 3.162).

Thorax: Pronotum dark-brown, muscle scars paler (Fig. 3.163); densely covered with long, erect, truncate peg setae and tapered setae; anterior margin

bears same setae (Fig. 3.177). Meso- and metanotum brown, muscle scars concolorous; crescentic black mark posteromesally, lateral margins black; mesonotum with small black band near posteromesal crescentic black mark; each covered with long, dense scale hairs and long, inclined truncate peg setae; anterior margins bears same setae (Figs. 3.164-3.165, 3.178-3.179). Prosternite brown; narrow transverse; broad dark band along posterior margin; with pair of large, paler sclerites posterolaterally (Fig. 3.169). Foretrochantin deeply forked, with dorsal ramus slightly longer than ventral ramus; ventral ramus with spike-like setae (Fig. 3.166). Foreleg stouter than other legs; posteromesal surface of coxa and trochanter densely covered with feather-like setae and stout setae; femur with long and spike-like setae on anterior surface and ventral margin; tibia and tarsus with rows of short, stout setae (Fig. 3.166). Mid- and hindlegs similar in size, shape, and structure; with dense spike-like setae and stout setae on mesal surface of coxa through tarsi; with a row of feather-like setae on ventral margin (Figs. 3.167-3.168). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments densely covered with dark, club-like hairs (Fig. 3.180). First sternum with 2 pairs of gills with adjacent bases. Segments II-VI each with 2 pairs of lateral and one pair of median gills (Fig. 3.181). Sternum VIII with pair of large, subtriangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites bearing with spike-like setae emanating from prominent sockets. Tergum IX with pair of small lateral and dorsolateral sclerites (Fig. 3.170). Anal prolegs with bent claw and cluster of long bristles, spike-like setae present on dorsal surface (Fig. 3.171).

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing numerous long setae, surface with many dark setae (Fig. 3.173). Mandibles enlarged at bases, posterior surface bearing black setae; left mandible bearing 4 teeth, right mandible with 3 teeth, margins of both mandibles minutely serrate between teeth (Fig. 3.172). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.174). Apical appendages with tip concavity covered by hooked setae and long setae; posteriorly with elongate row of hooked setae (Fig. 3.175).

Diagnosis: This species may be recognized by the following combination of characteristics. First, the frontoclypeus is lacking truncate peg setae except for anterolateral corners and anterior margin of frontoclypeus is slightly concave and lateral margins of clypeus is widening at mid-length. Second, there are many long, black, truncate peg setae and tapered setae over the entire dorsal and lateral surfaces of the head. Third, the nota are covered with many scale-hairs setae and truncate peg setae. Fourth, heavy club-like hairs are present on the abdominal segments. Lastly, sclerites of segments VIII is large subtriangular.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 8-viii-2004, Prommi, 2 larvae; same locality, 9-x-2004, Prommi, 8 larvae, 1 male mmt; same locality, 22-v-2005, Prommi, 1 pupa; RANONG Prov.: Tungraya-nasak Wildlife Sanctuary, Bokkrai Waterfall, 10°22' N, 98°51' E, 15-viii-2005, Prommi, 1 female mmt; RANONG Prov.: Ngao National Park, Ngao Waterfall; 50 m. 09°51' N, 98°37' E, 8-viii-2004, Prommi, 34 larvae, 1 pupa; same locality, 9-x-2004, Prommi,

38 larvae, 4 pupae; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall, 7-viii-2004, Prommi, 2 larvae, 1 pupa; same locality, 3-iv-2005, Prommi, 1 larva; KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall, 5-viii-2004, Prommi, 8 larvae; same locality, 6-x-2004, Prommi, 8 larvae; same locality, 5-iv-2005, Prommi, 1 larva.



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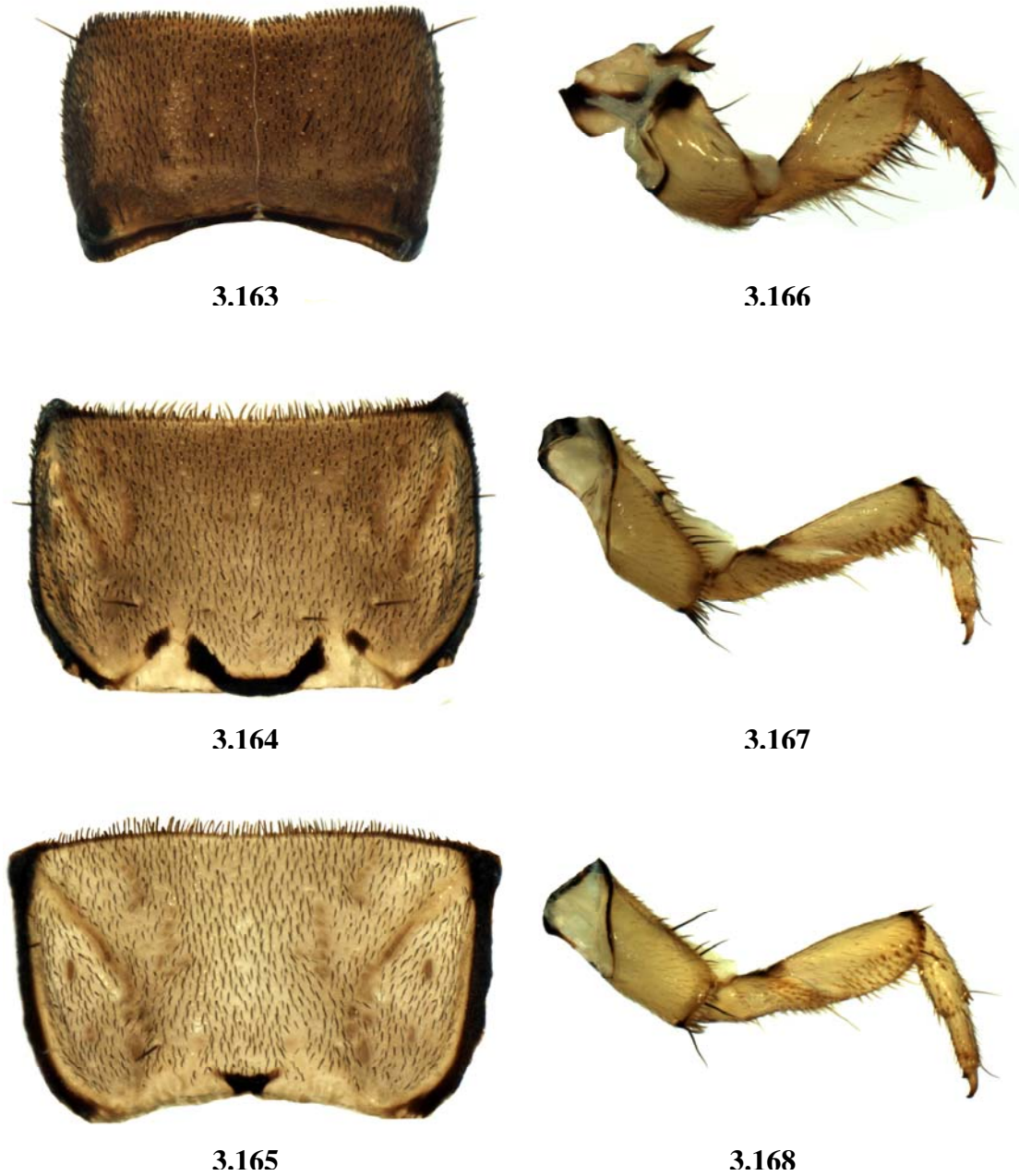


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3.162

Figures 3.157-3.162. Larval features of *Hydromanicus inferior*: 3.157, dorsal view of head; 3.158, frontoclypeal apotome; 3.159, ventral view of head; 3.160, dorsal view of labrum; 3.161, ventral view of mandibles; 3.162, submentum and anterior ventral apotome.



Figures 3.163-3.168. Larval features of *Hydromanicus inferior*: 3.163, pronotum; 3.164, mesonotum; 3.165, metanotum; 3.166, foretrochantin and inner face of left foreleg; 3.167, inner face of left midleg; 3.168, inner face of left hindleg.



3.169



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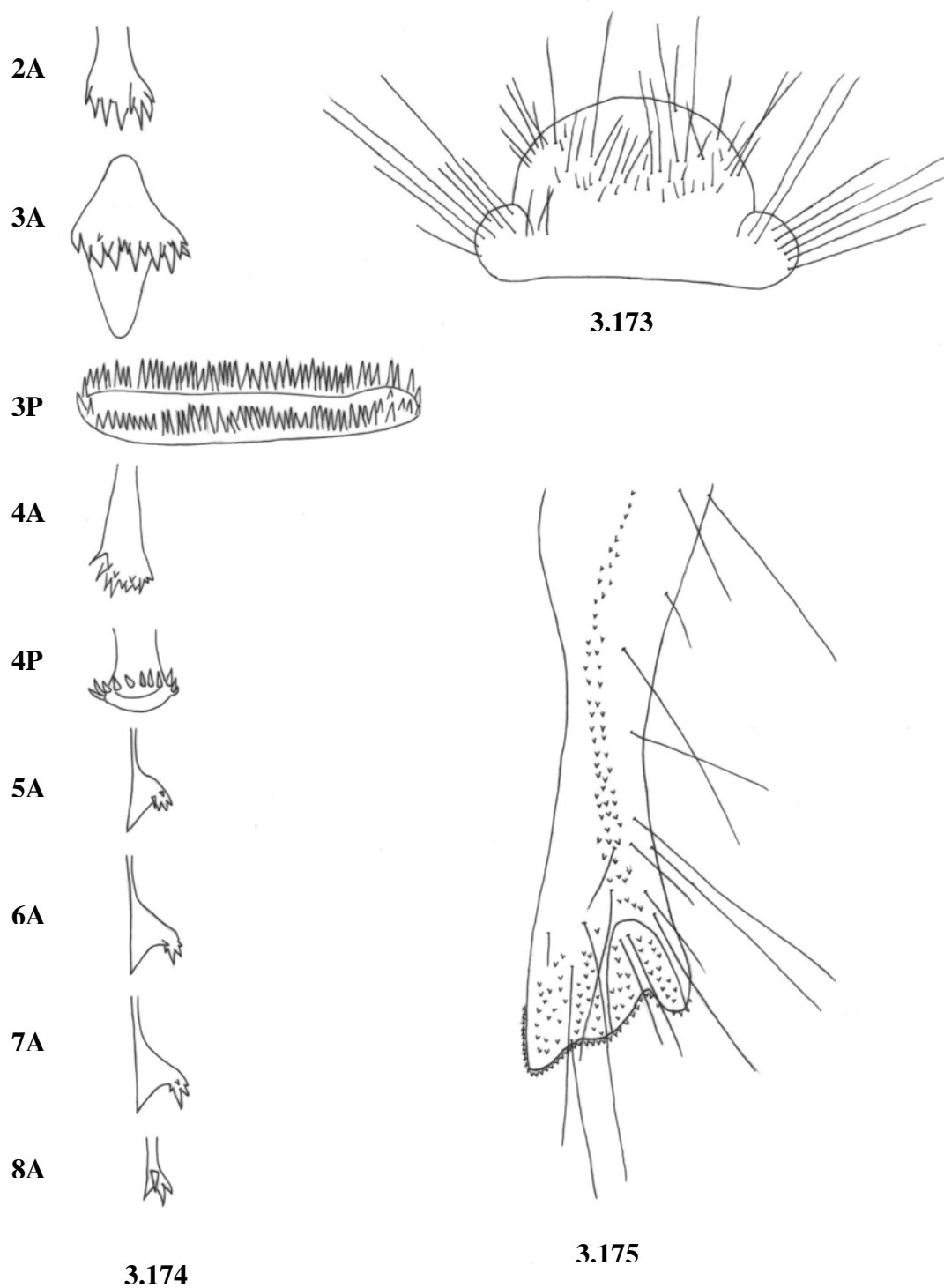


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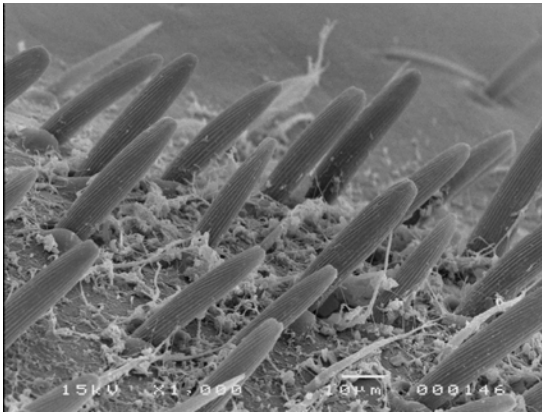


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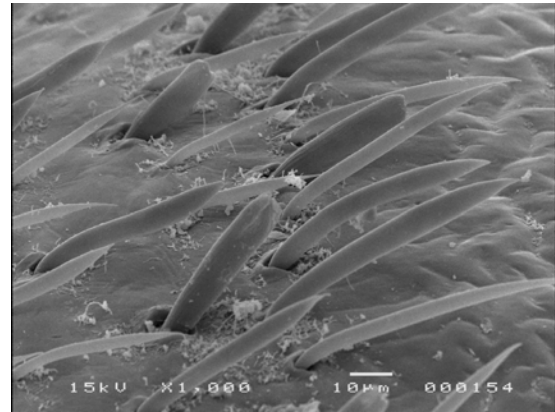
Figures 3.169-3.172. *Hydromanicus inferior*: 3.169, prosternum; 3.170, sterna VIII and IX; 3.171, lateral view of anal claw; 3.172, ventral view of pupal mandibles.



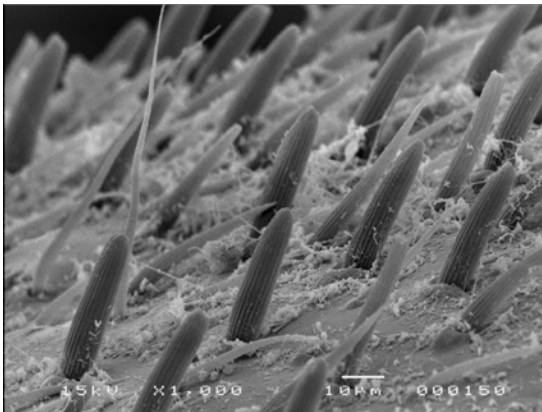
Figures 3.173-3.175. *Hydromanicus inferior*: 3.173, dorsal view of pupal labrum; 3.174, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.175, pupal apical abdominal appendages.



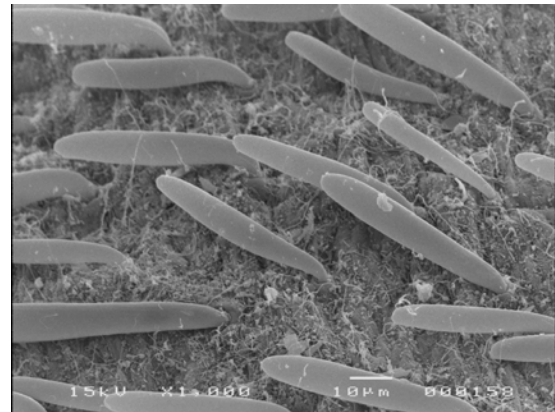
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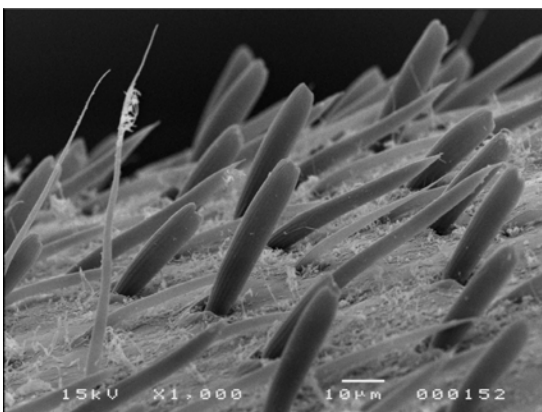
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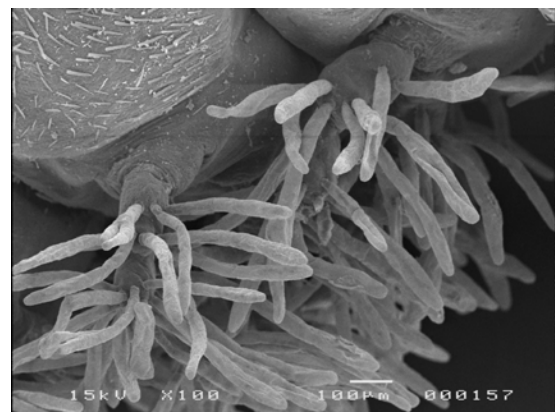
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Figures 3.176-3.181. *Hydromanicus inferior*: 3.176, setae on dorsolateral region of head; 3.177, setae on pronotum; 3.178, setae on mesonotum; 3.179, setae on metanotum; 3.180, setae on abdominal segments; 3.181, abdominal gills.

***Hydromanicus serubabel* Malicky & Chantaramongkol, 1997**

Larva: Total length 11.0-12.0 mm (n=2). Overall body shape as in Hydropsychidae (Fig. 3.182). Head dark-brown and nota sclerites brown.

Head: Head capsule length, 1.19-1.22 mm; width, 0.94-1.02 mm. Dorsum of head dark brown on anterior and becoming lighter on posterior, with yellowish ring around each eye. Anterior three-fourth of head dorsolaterally covered with long, black, erect, truncate peg setae and tapered setae. Frontoclypeus lacking of same setae except for anterolateral corners and same setae project beyond anterior margin. Frontoclypeus with anterior margin slightly concave; lateral margins slightly widening at mid-length (Fig. 3.183). Head ventrally brownish, with stridulatory lines in anterior half; posterolaterally paler with group of muscle scars (Fig. 3.184). Labrum golden-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-brown brushes and dorsal stout setae, with pair of long anteromesal setae; posterior margin slightly convex medially. Mandibles dark-brown with 2 apical and 3 mesal teeth, left mandible with well-developed setal brush; lateral surface of both mandibles with scattered setae. Submentum brown; lacking anteromesal cleft; anterior margin concave; anterior margin and lateral areas with short and long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular (Fig. 3.184).

Thorax: Pronotum dark-brown, muscle scars paler, densely covered with long, erect and truncate peg setae, with long, tapered setae; anterior margin bearing with same setae (Figs. 3.185, 3.189). Meso- and metanotum brown, muscle

scars concolorous; posteromesal crescentic black mark, lateral margins black, mesonotum with small black band near posteromesal crescentic black mark, each densely covered with long, scale hairs and long truncate peg setae; anterior margins bearing with same setae (Figs. 3.186-187, 3.190). Prosternite brown; narrow transverse; dark band along posterior margin; with pair of large, paler sclerites posterolaterally (Fig. 3.188). Foretrochantin deeply forked; dorsal branch slightly as long as ventral branch with stout setae on ventral branch. Foreleg stouter than other legs; posteromesal surface of coxa and trochanter densely covered with feather-like setae (Fig. 3.191); femur with long and spike-like setae on anterior surface and ventral margin; tibia and tarsus with rows of short, stout setae. Mid- and hindlegs similar in size, shape, and structure; with dense spike-like setae and stout setae on mesal surface of coxa through tarsi; with a row of feather-like setae on ventral margin. Mesosternum with one pair of gills; metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments densely covered with dark, club-like hairs (Fig. 3.192). First sternum with 2 pairs of gills with adjacent bases. Segments II-VI each with 2 pairs of lateral gills and 1 pair of median gills (Fig. 3.187). Sternum VIII with pair of small, subtriangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites bearing spike-like setae emanating from prominent sockets. Tergum IX with pair of small lateral and dorsolateral sclerites. Anal prolegs with bent claw and cluster of long bristles, spike-like setae present on dorsal surface.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing numerous long setae, anteriorly with many dark setae. Mandibles enlarged at bases, posterior

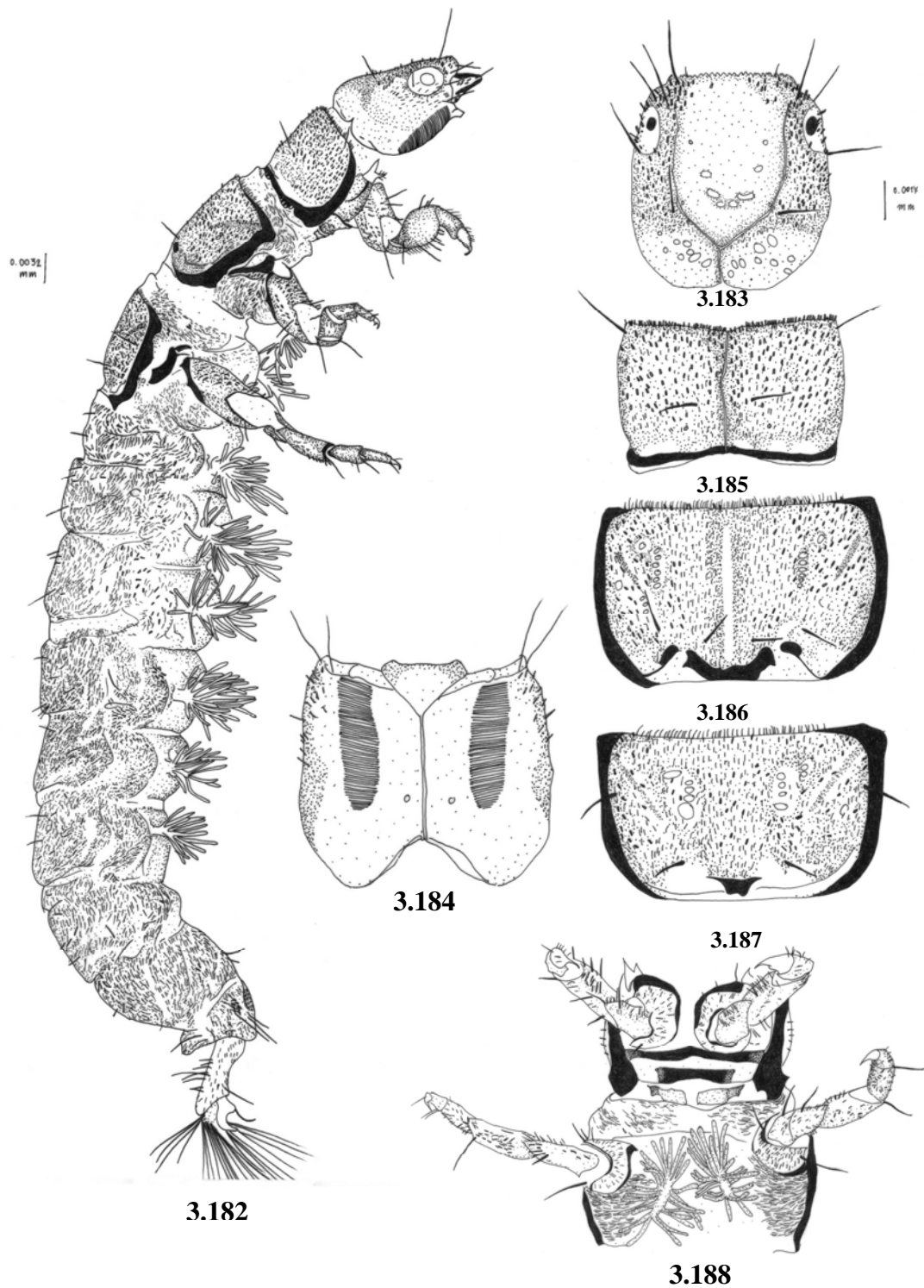
surface bearing black setae; left mandible bearing 4 teeth, right mandible with 3 teeth, margins of both mandibles minutely serrate between teeth. Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV; posterior hook plate of segment IV covered with a row of long setae (Fig. 3.194). Apical processes with tip concavity covered by hooked and long setae, posteriorly with elongate rows of hooked setae (Fig. 3.195).

Diagnosis: Larvae of *Hydromanicus serubabel* most nearly resembles of *H. inferior* to which it is most closely related. However, these two species can be separated by the following combination of characters: anterior margin of frontoclypeus is slightly concave and lateral margins is slightly widening at mid-length. The sclerites on sternum of segment VIII is moderately subtriangular shaped.

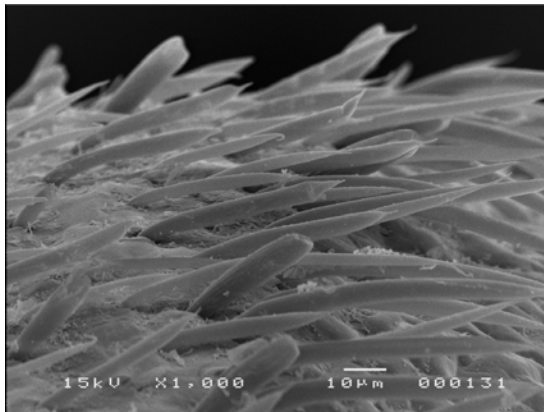
Material examined: SURAT THANI Prov.: Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 6-viii-2004, Prommi, 1 larva; same locality, 7-x-2004, Prommi, 1 larva, 6 pupae, 1 male mmt.

Discussion: *Hydromanicus* is a genus in subfamily Hydropsychinae. They are widespread throughout in Oriental region, but this genera contain fewer than *Hydropsyche* species (Dudgeon, 1999). Eight species of adult *Hydromanicus* have been recorded in Thailand (Malicky and Chantaramongkol, 1999). Three species of adult *Hydromanicus* were collected by a black light trap; *H. abiud*, *H. serubabel*, and *H. inferior*. The first two species have been found in southern Thailand. Three immature larvae and pupae of this genus could be associated with adult stage from this study (Table 2.4). Larvae of *Hydromanicus* were collected from surface of a

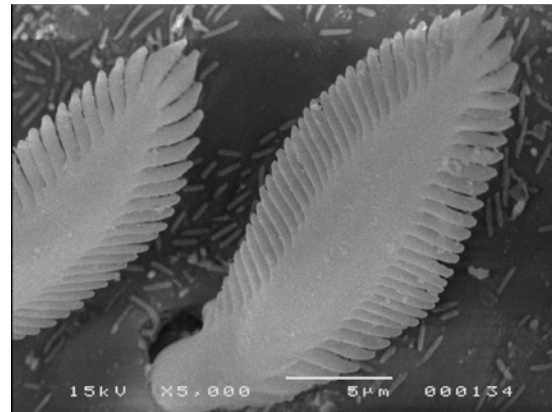
bedrock and large boulders where the root of vegetation occurs. They sometimes prefer location with more rapid current. Larvae construct a sandgrain and organic materials retreat and capture net.



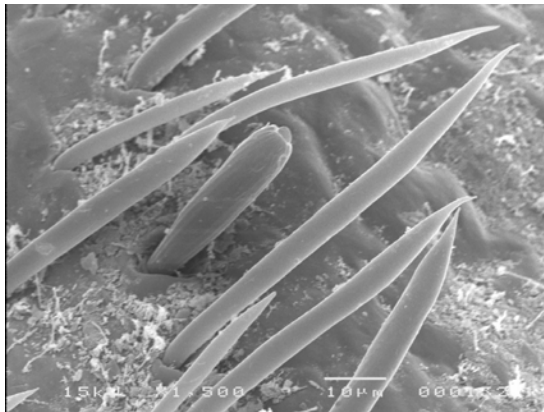
Figures 3.182-3.188. Larval features of *Hydromanicus serubabel*: 3.182, larva; 3.183, dorsal view of head; 3.184, ventral view of head; 3.185, pronotum; 3.186, mesonotum; 3.187, metanotum; 3.188, ventral view of thoracic nota showing prosternum



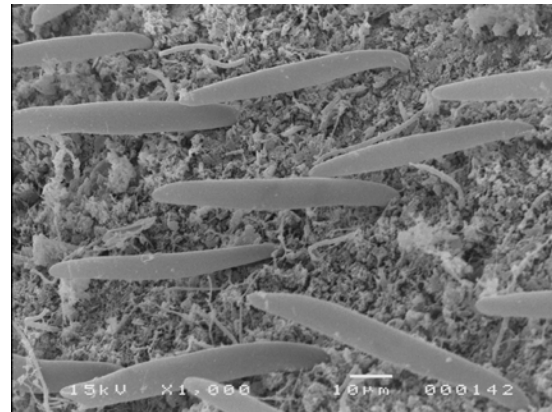
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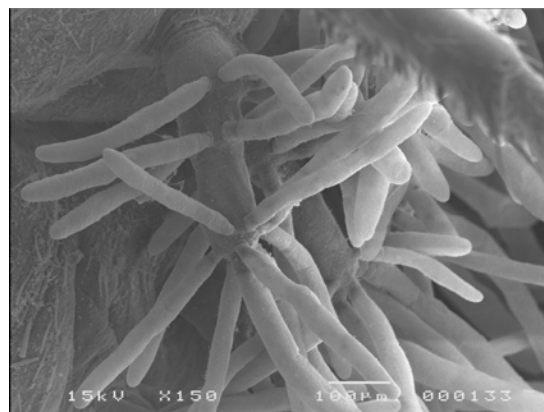
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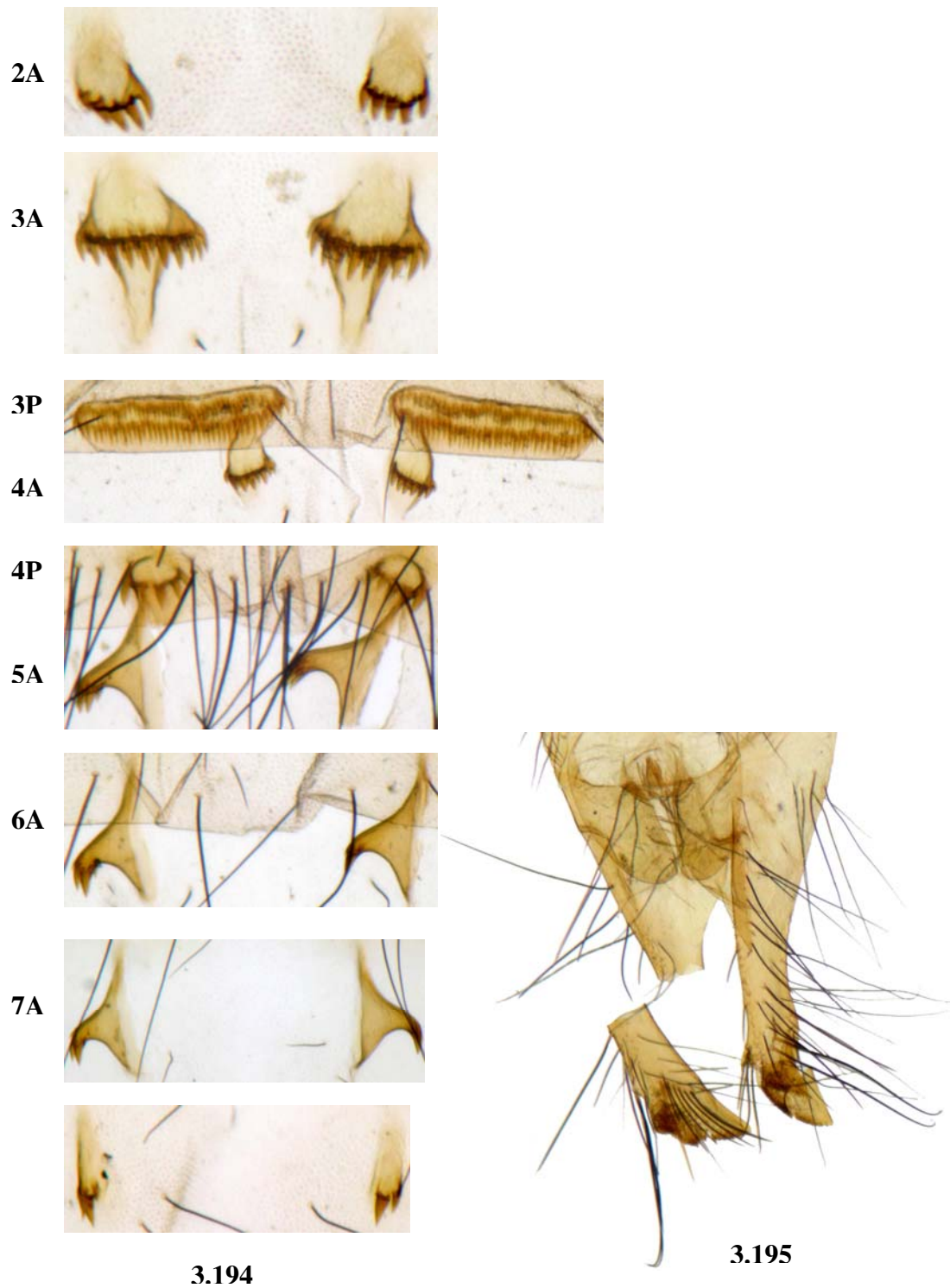


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3.193

Figures 3.189-3.193. *Hydromanicus serubabel*: 3.189, setae on pronotum; 3.190, setae on mesonotum; 3.191, setae on fore-coxa and trochanter; 3.192, setae on abdominal segments; 3.193, abdominal gills.



Figures 3.194-3.195. *Hydromanicus serubabel*: 3.194, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.195, pupal apical abdominal appendages.

GENUS *Hydropsyche* Pictet, 1834

Diagnosis: Larvae of *Hydropsyche* have the typical characteristics of the family. *Hydropsyche* can be distinguished from other genera of the Hydropsychinae by a pair of large sclerites in the intersegmental fold posterior to the prosternal plate, the frontoclypeus never has an anteromedian notch, and scale hairs and hair-like setae are present on the abdominal segments.

From the results of this study, 6 species of unknown *Hydropsyche* larvae could be associated with identifiable adult species; *Hydropsyche assarakos*, *H. brontes*, *H. butes*, *H. camillus*, *H. dolosa*, *H. pallipenne*. Details of each species are described as follows:

Hydropsyche assarakos Malicky & Chantaramongkol, 2000

Larva: Total length 9.5-11.0 mm (n=10). Overall body shape as usual in Hydropsychidae. Head yellow to brown, with few paler muscle scars in posterolateral half of frontoclypeus. Nota yellow, each with posterolateral muscle scars.

Head: Head capsule length, 1.11-1.16 mm; width, 1.02-1.05 mm. Head yellow, except anterior margin and posterolateral corner of frontoclypeus dark-brown, with a few paler muscle scars. Parietal area of head brownish. Frontoclypeus with anterior margin convex, slightly crenulate, with brush of setae extending beyond anterior margin (Fig. 3.196). Head with long, clear, erect, acuminate peg setae; with long, tapered setae on dorsal and lateral regions in anterior three-quarters (Fig. 3.209).

Frontoclypeus devoid of same setae, except scattered along anterolateral margins. Head ventrally yellow with brown on stridulatory surface; stridulatory lines present ventrally near middle (Fig. 3.197). Labrum light-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-yellow, pectinate setae and stout setae on dorsal surface (Fig. 3.198). Mandibles dark-brown, right mandible with 2 apical and 2 mesal teeth, left mandible with 2 apical and 3 mesal teeth and well-developed setal hairs (Fig. 3.199). Submentum light-brown, with deep anteromesal cleft, anterolateral margins of cleft with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular (Fig. 3.200).

Thorax: Pronotum yellow, densely covered with long, erect, truncate peg setae and tapered setae; darker muscle scars midway between midline and lateral margin in posterior half (Figs. 3.201, 3.210). Meso- and metanotum yellow with same setae as in pronotum, lateral margins with darker muscle scars (Figs. 3.202-3.203). Prosternite yellow, transverse, narrow, with broad dark band along posterior margin; with pair of large, brown, posterolateral sclerites. Foretrochantin deeply forked (Fig. 3.204). Foreleg with numerous feather-like setae on posterior surface of coxa; trochanter with long, feather-like setae on ventral margin; femur with a row of long, dark, spike-like setae, mingled with feather-like setae on ventral margin and few, short, dark, setae on external surface (Figs. 3.204, 3.211). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae on posterior surface of femur (Figs. 3.205-3.206). Mesosternum with one pair of gills; metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments with many club-like hairs and scale hairs (Fig. 3.212). First sternum with 2 pairs of gills with adjacent bases. Segments

II-V each with 1 pair of median gills. Segments II-VII each with one pair of lateral gills, each arising from a common base (Fig. 3.213). Sternum VIII with pair of small, triangular sclerites, bearing spike-like setae. Sternum IX with pair of large, triangular sclerites, bearing spike-like setae emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.214). Anal prolegs with bent claw and cluster of long bristles. Venter of anal proleg lacking spike-like setae on caudal lobes; outer sclerites with long, black setae.

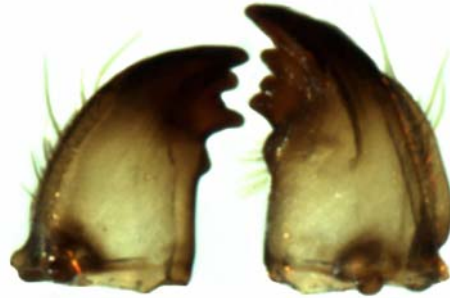
Pupa: Labrum semicircular with rounded basolateral lobes, each bearing a few short and long setae; surface with many, dark, short setae. Mandibles enlarged basally, with posterior surface bearing short and long, black setae; left mandible bearing 4 teeth, right mandible with 3 teeth. Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.207). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by short setae and hooked setae; outer margin of each process fringed with long, black setae; inner margin with row of hooked setae (Fig. 3.208).

Diagnosis: This species is most closely related to *Hydropsyche pallipenne*. It may be confused with *H. pallipenne* since the color pattern of the head of these two species is similar. *H. assarakos* may be distinguished on the basis of the following characteristics. First, the frontoclypeus is slightly convex. The genae possess many clear, acuminate peg setae and tapered setae whereas the frontoclypeus lacks these setae except scattered along the anterior and lateral margins. Finally, many long, clear, truncate peg setae are present on the nota, and dark muscle scars are present midway between the midline and lateral margin in the posterior part of the pronotum.

Material examined: NAKHON SI THAMMARAT Prov.: Namtok Si Khit National Park, stream from Si Khit Waterfall, 192 m. 09°00' N, 99°46' E, 9-iv-2005, Prommi, 38 larvae, 1 male mmt.



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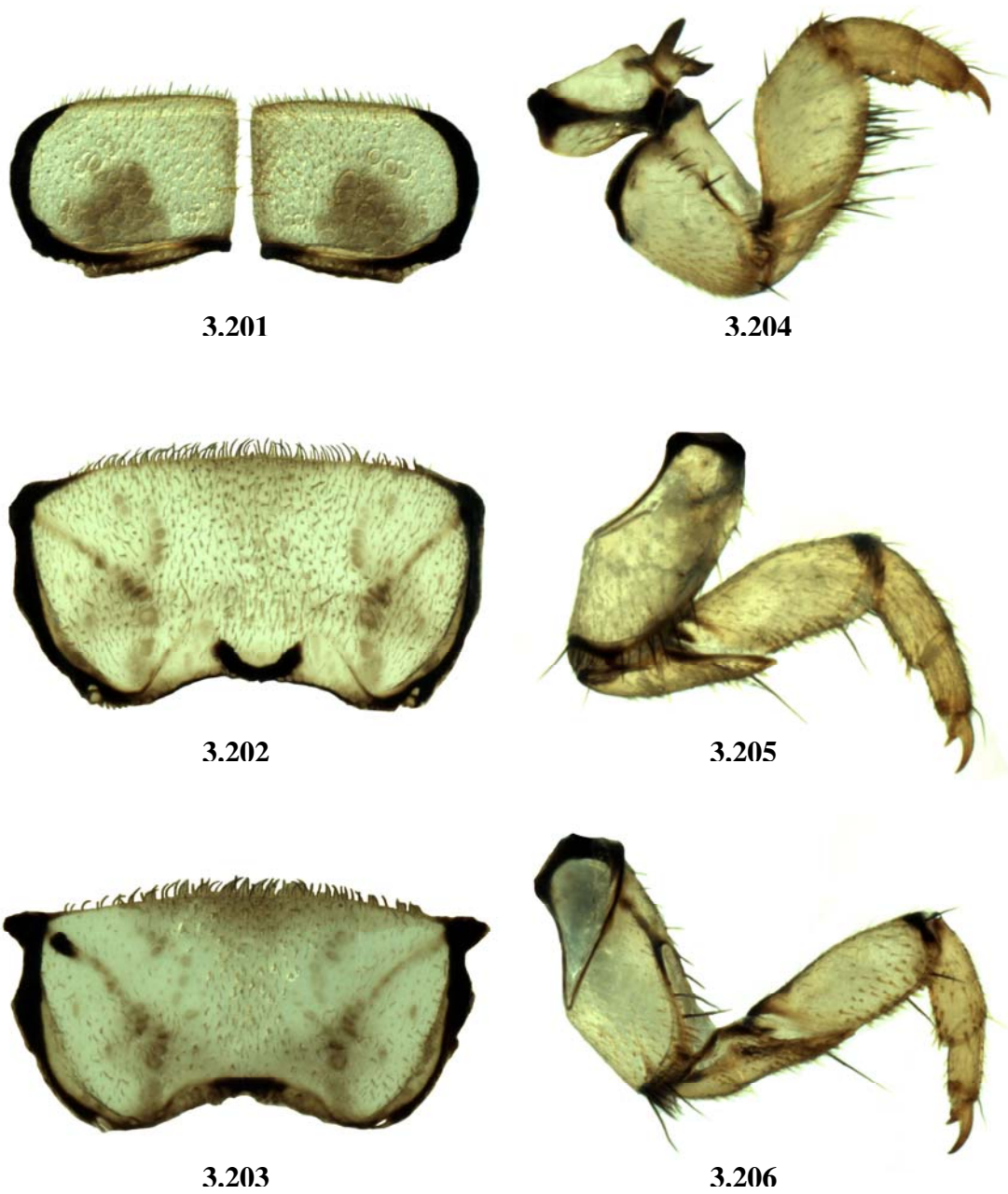


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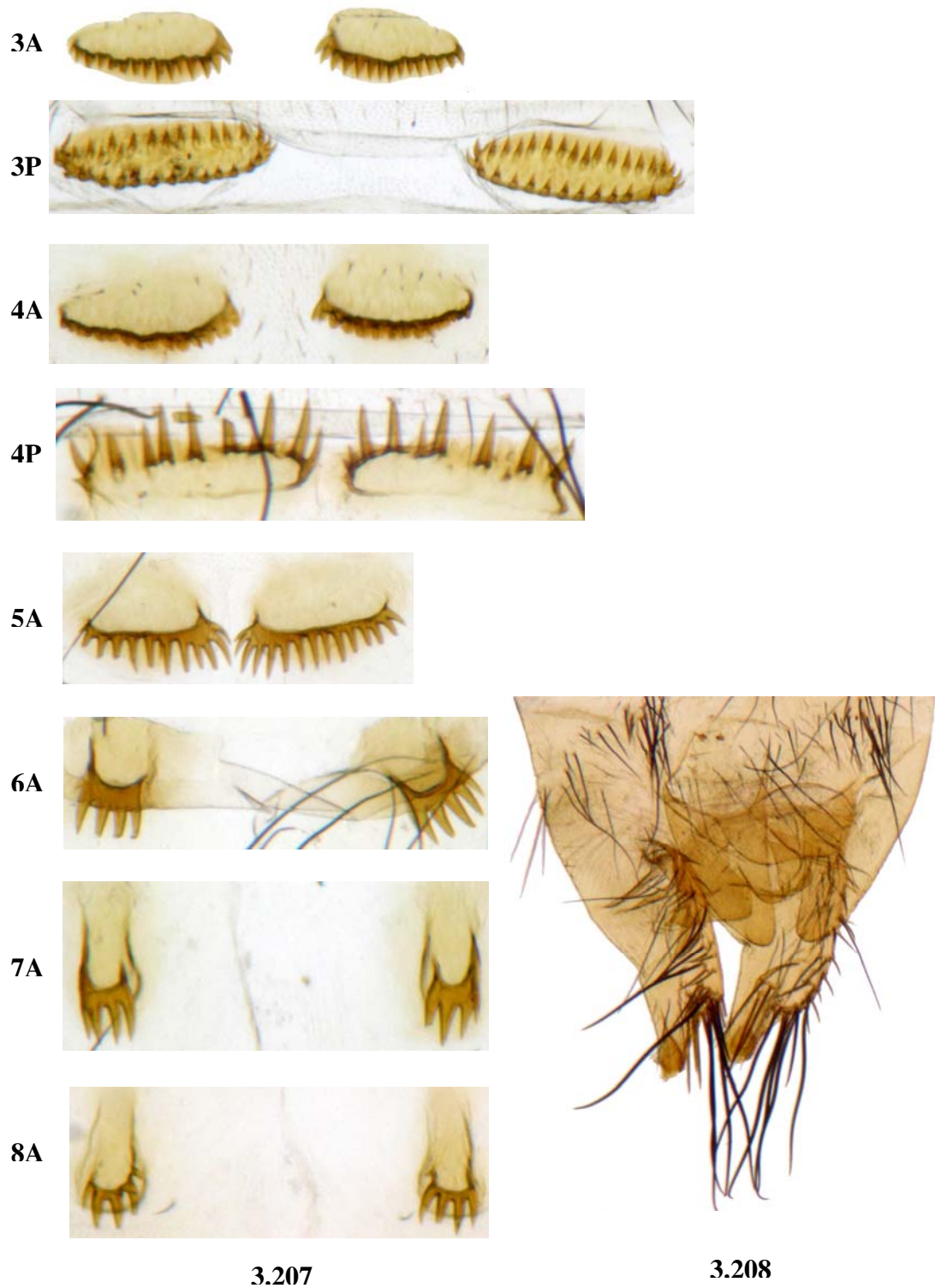


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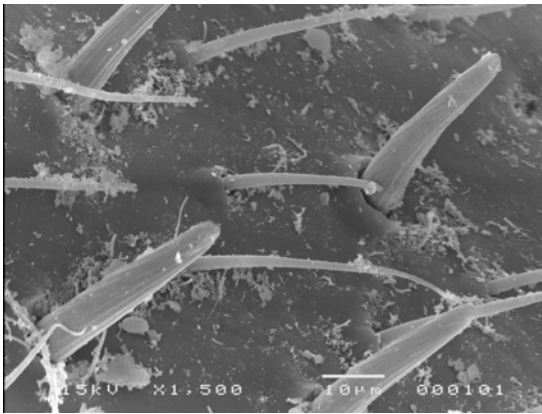
Figures 3.196-3.200. Larval features of *Hydropsyche assarakos*: 3.196, frontoclypeal apotome; 3.197, ventral view of head; 3.198, dorsal view of labrum; 3.199, ventral view of mandibles; 3.200, submentum and anterior ventral apotome.



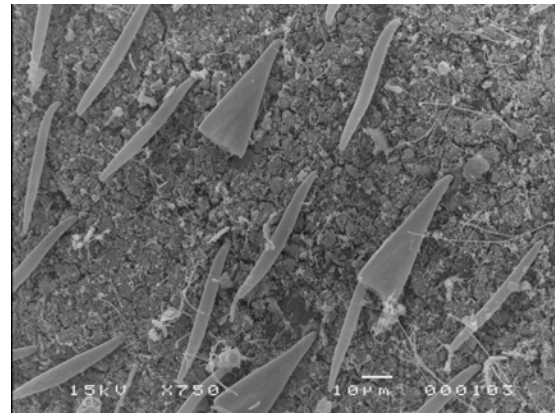
Figures 3.201-3.206. Larval features of *Hydropsyche assarakos*: 3.201, pronotum; 3.202, mesonotum; 3.203, metanotum; 3.204, foretrochantin and outer face of right foreleg; 3.205, inner face of left midleg; 3.206, inner face of left hindleg.



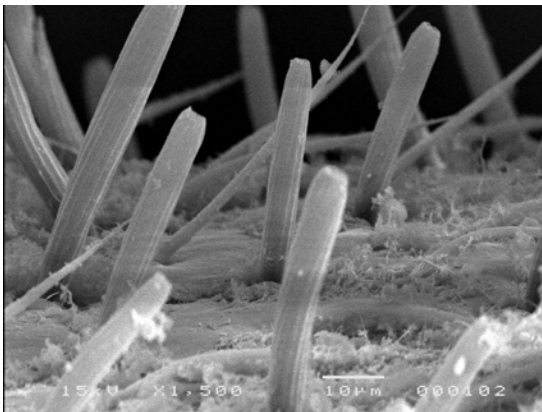
Figures 3.207-3.208. *Hydropsyche assarakos*: 3.207, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.208, pupal apical abdominal appendages.



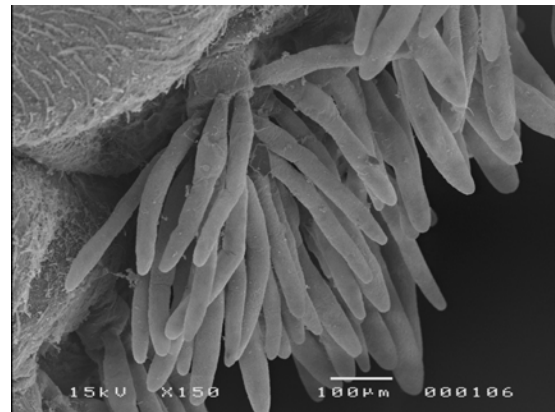
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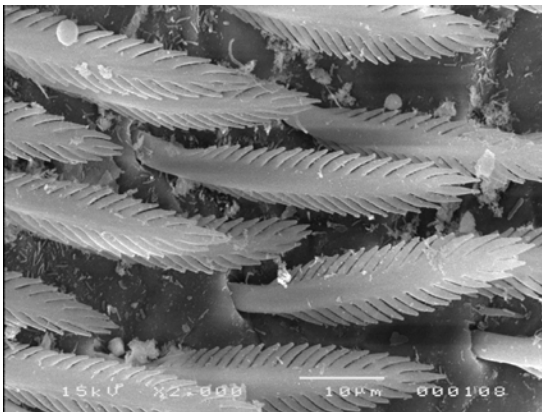
3.212



3.210



3.213



3.211



3.214

Figures 3.209-3.214. *Hydropsyche assarakos*: 3.209, setae on dorsum of head; 3.210, setae on pronotum; 3.211, setae on fore-coxa; 3.212, setae on abdominal segments; 3.213, abdominal gills; 3.214, sterna VIII and IX.

***Hydropsyche brontes* Malicky & Chantaramongkol, 2000**

Larva: Total length 10.0-11.0 mm (n=10). Overall body shape as usual in Hydropsychidae. Head yellow to dark-brown, with dark muscle scars in posterior one fifth. Nota light-brown, each with posterolateral muscle scars.

Head: Head capsule length, 1.02-1.05 mm; width, 0.85-0.94 mm. Dorsum of head dark-brown with two distinct yellow marks on frontoclypeus; T-shaped mark anteriorly and circular shaped mark posteriorly. Areas around each eye and posterior one fifth of head yellow with dark muscle scars (Fig. 3.215). Frontoclypeus with anterior margin convex, slightly crenulate, with brush of setae extending beyond anterior margin (Fig. 3.216). Head with moderately long, erect, acuminate peg setae; with brush of setae, tapered setae on dorsal and lateral regions in anterior three-quarters (Fig. 3.230). Frontoclypeus devoid acuminate peg setae and tapered setae. Head ventrally dark-brown with stridulatory lines present anterior half near middle (Fig. 3.217). Labrum brown; elliptical in dorsal view; bearing well-developed, lateral, golden-yellow, pectinate setae and stout setae on dorsal surface (Fig. 3.218). Mandibles dark-brown, with 2 apical and 3 mesal teeth, left mandible with well-developed setal hairs; lateral surface of both mandibles with scattered setae (Fig. 3.219). Submentum light-brown, with deep anteromesal cleft, anterior margins of cleft with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular (Fig. 3.217).

Thorax: Nota brown, with posterolateral darker muscle scars. Pronotum with numerous, erect, acuminate peg setae and long, appressed scale hairs;

dark muscle scars midway between midline and lateral margin in posterior half (Fig. 3.221). Meso- and metanotum with numerous, long, appressed scale hairs, with scattered, erect, acuminate peg setae; posterolateral margins of meso- and metanotum each with dark muscle scars (Figs. 3.222-3.223, 3.231). Prosternite brown, transverse, narrow, with broad dark band along posterior margin; with pair of large, paler, posterolateral sclerites (Fig. 3.220). Foretrochantin deeply forked (Fig. 3.224). Foreleg with numerous feather-like setae on posterior surface of coxa; trochanter with long, feather-like setae on ventral margin; femur with a row of long, dark, spike-like setae on ventral margin and few, short, dark, setae on external surface (Fig. 3.224). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae on posterior surface of femur (Figs. 3.225-3.226). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments with dark, recumbent setae (Fig. 3.232). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills, each arising from a common base. Sternum VIII with pair of small, subtriangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites bearing spike-like setae emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.227). Anal prolegs with bent claw and cluster of long bristles. Venter of anal proleg with spike-like setae on caudal lobes; outer sclerites with same setae (Figs. 3.227-3.228).

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing short and long setae; surface with many dark, short, setae. Mandibles enlarged basally, with

posterior surface bearing short and long, black setae; left and right mandibles bearing with 4 and 3 teeth (Fig. 3.229). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV; posterior hook plate of segment IV covered with row of long setae (Fig. 3.233). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by long setae and hooked setae; outer margin of each process fringed with long, black, setae (Fig. 3.234).

Diagnosis: This species is easily recognized by its yellow dark-brown coloration and two distinct yellow marks on frontoclypeus. However, some species may have these two yellow marks on frontoclypeus which may lead to some confusion between this species, *Hydropsyche butes* and *H. camillus*. This species may be distinguished on the basis of the following characteristics: First, the frontoclypeus is large and lateral margin is strongly broadened at the mid-length, and many brush of setae are scattered on surface, and a few or no acuminate peg setae and tapered setae are present on surface. Second, many truncate peg setae and tapered setae are present on pronotum, and heavy scale hairs and sparse acuminate peg setae are present on meso- and metanotum.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 8-viii-2004, Prommi, 2 larvae; same locality, 22-v-2005, Prommi, 4 larvae; same locality, 7-vi-2006, Prommi, 1 male mmt.; RANONG Prov.: Tungraya-nasak Wildlife Sanctuary, Bok Krai Waterfall, 10°22' N, 98°51' E, 15-viii-2005, Prommi, 8 larvae, 2 pupae, 1 male mmt., 1 female mmt.; SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 9-viii-2004, Prommi, 7

larvae, 2 pupae; same locality, 10-x-2004, Prommi, 2 larvae; same locality, 10-iv-2005, Prommi, 12 larvae; NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-ii-2004, Prommi, 5 male mmts.; same locality, 10-viii-2004, Prommi, 3 larvae, 1 male mmt., 1 female mmt.; same locality, 11-x-2004, 18 larvae, 2 pupae; Pliew Waterfall, 110 m. 08°29' N, 99°45' E, 6-iv-2005, Prommi, 8 larvae, 2 pupae, 2 male mmts.; Khao Luang National Park, stream from Ai Khaew Waterfall, 127 m. 08°33' N, 99°46' E, 3-xii-2004, Prommi, 2 larvae; stream from Yord Luang Waterfall, 78 m. 08°38' N, 99°44' E, 3-xii-2004, Prommi, 3 larvae, 1 pupa; same locality, 7-iv-2005, Prommi, 10 larvae, 1 pupa; Promlok Waterfall, 138 m. 08°31' N, 99°46' E, 3-xii-2004, Prommi, 3 larvae; Sununtha National Park, Sunantha Waterfall; 166 m. 08°46' N, 99°48' E, 8-viii-2005, Prommi, 4 larvae, 1 male mmt.; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 1 larva; same locality, 12-iv-2005, Prommi, 2 larvae; PATTHALUNG Prov.: Khaobantad Wildlife Sanctuary, stream from Momjui Waterfall, 95 m. 07°15' N, 100°02' E, 4-x-2004, Prommi, 42 larvae, 1 male mmt., 6 female mmts.; same locality, 25-ii-2005, Prommi, 27 larvae, 4 pupae, 2 female mmts., 3 male mmts.; same locality, 12-iv-2005, Prommi, 20 larvae, 6 pupae, 6 male mmts.; Praiswan Waterfall, 73 m. 07°21' N, 99°57' E, 4-x-2004, Prommi, 10 larvae, 10 pupae, 1 male mmt.; SATUN Prov.: Thalebun National Park, Yaroi Waterfall, 66 m. 06°45' N, 100°09' E, 15-iii-2005, Prommi, 74 larvae, 10 pupae, 2 female mmts., 4 male mmts.; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 12-ii-2004, Prommi, 1 male mmt.; same locality, 10-iii-2004, Prommi, 1 male mmt.; same locality, 7-iv-2004, 23 larvae, 5 male mmts.; same locality, 4-viii-

2004, Prommi, 1 larva, 2 pupae, 2 male mmts.; same locality, 3-x-2004, Prommi, 5 larvae, 1 pupa; same locality, 1-i-2005, Prommi, 3 larvae, 1 pupa, 1 male mmt., 1 female mmt.; same locality, 1-ii-2005, Prommi, 10 larvae, 3 male mmts., 2 female mmts.; same locality, 13-v-2005, Prommi, 5 larvae, 2 male mmts.; same locality, 17-vi-2005, Prommi, 1 male mmt.; NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 11 larvae, 1 pupa.



3.215



3.218



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3.217



3.220

Figures 3.215-3.220. Larval features of *Hydropsyche brontes*: 3.215, dorsal view of head; 3.216, frontoclypeal apotome; 3.217, ventral view of head; 3.218, dorsal view of labrum; 3.219, ventral view of mandibles; 3.220, prosternum.



3.221



3.224



3.222



3.225



3.223

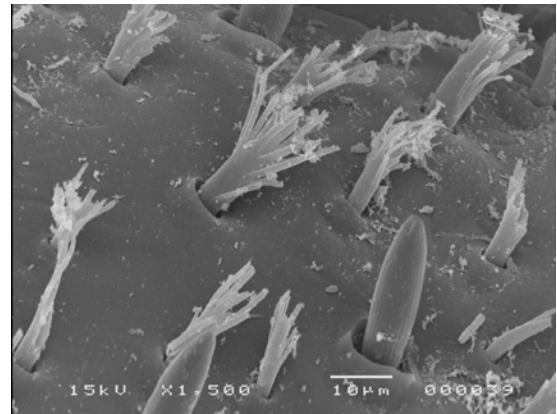


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Figures 3.221-3.226. Larval features of *Hydropsyche brontes*: 3.221, pronotum; 3.222, mesonotum; 3.223, metanotum; 3.224, inner face of left foreleg; 3.225, inner face of left midleg; 3.226, inner face of left hindleg.



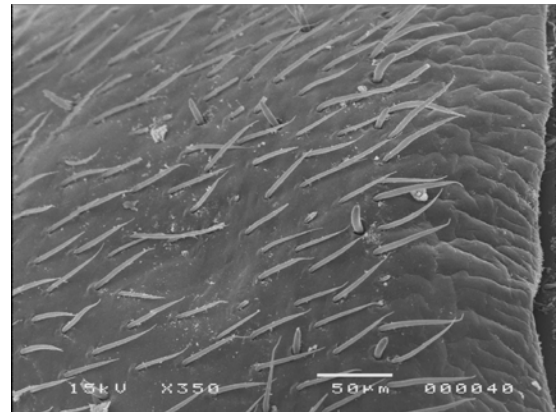
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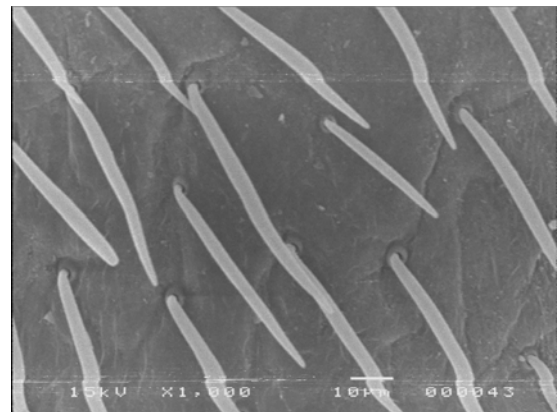
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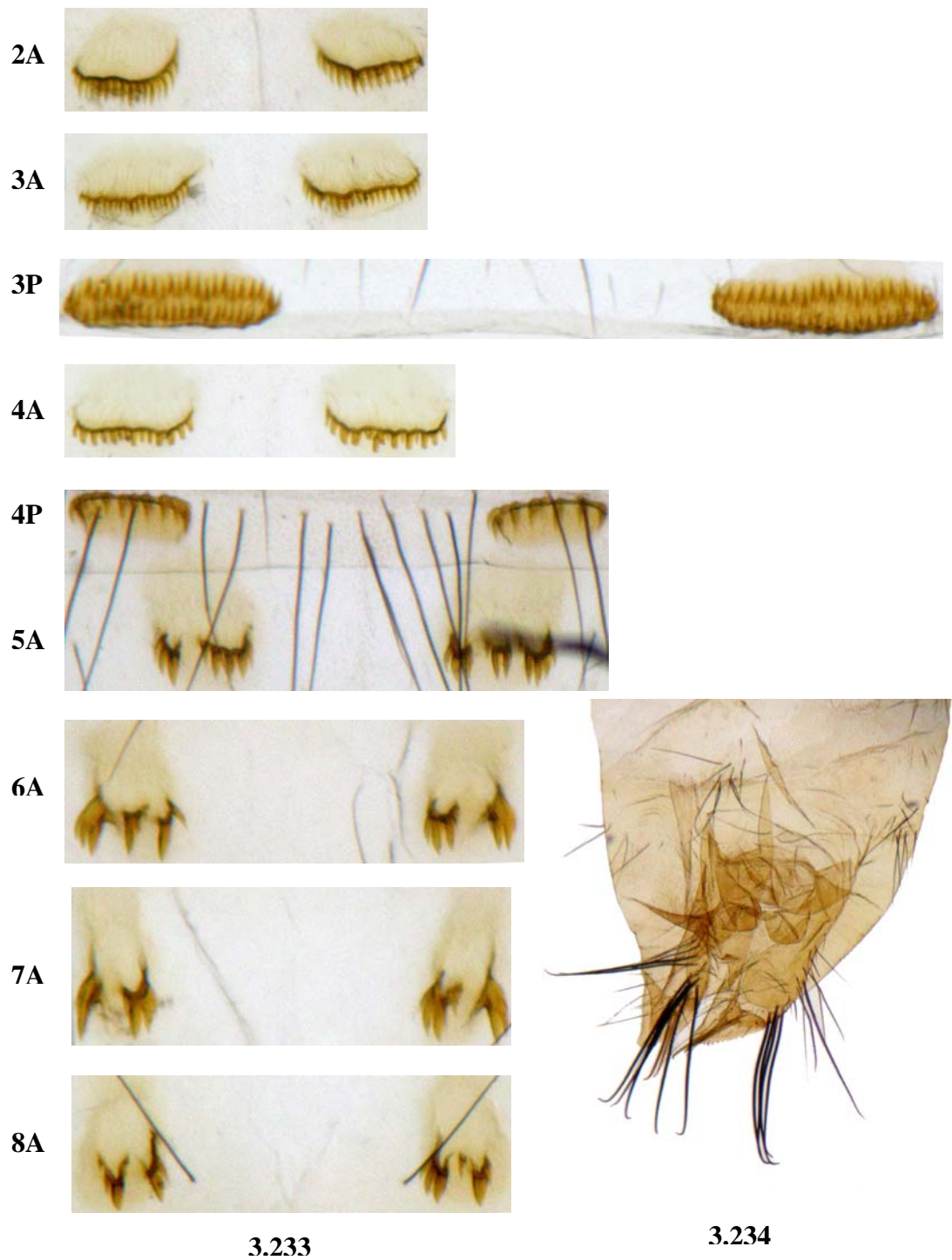


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Figures 3.227-3.232. *Hydropsyche brontes*: 3.227, sterna VIII and IX; 3.228, lateral view of anal claw; 3.229, ventral view of pupal mandibles; 3.230, setae on head; 3.231, setae on mesonotum; 3.232, setae on abdominal segments.



Figures 3.233-3.234. *Hydropsyche brontes*: 3.233, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.234, pupal apical abdominal appendages.

***Hydropsyche butes* Malicky & Chantaramongkol, 2000**

Larva: Total length 8.0-9.0 mm (n=10). Overall body shape as usual in Hydropsychidae. Head yellow to dark-brown, with muscle scars on posterior one fifth. Notae brown, each with posterolateral muscle scars.

Head: Head capsule length, 1.11-1.16 mm; width, 1.02-1.06 mm. Dorsum of head yellow to dark-brown, with two distinct yellow marks on frontoclypeus; large, diamond-shaped mark anteriorly and small circular shaped on posteriorly (Figs. 3.235-3.236). Parietal area of head and areas around eyes yellow with darker muscle scars. Frontoclypeus with anterior margin strongly convex, slightly crenulate, with brush of setae extending beyond anterior margin; anterolaterally with scattered brush of setae, appressed, tapered setae and erect, truncate peg setae (Fig. 3.247). Head with same setae but no brush of setae on dorsal and lateral regions in anterior three-quarters. Head ventrally dark-brown with dark on stridulatory surface; stridulatory lines present ventrally near middle (Fig. 3.238). Labrum brown; elliptical in dorsal view; bearing well-developed, lateral, golden-yellow, pectinate setae and stout setae on dorsal surface. Mandibles dark-brown, with 2 apical and 3 mesal teeth, left mandible with well-developed setal hairs; lateral surface of both mandibles with scattered setae (Fig. 3.237). Submentum light-brown, with deep anteromesal cleft, anterior margins of cleft with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small (Fig. 3.238).

Thorax: Notae brown with darker muscle scars posterolaterally. Pronotum with numerous, erect, truncate peg setae and long, appressed setae; muscle

scars midway between midline and lateral margin in posterior half (Figs. 3.240, 3.248). Meso- and metanotum with numerous, long, scale hairs, and scattered, erect truncate peg setae; dark muscle scars on meso- and metanotum posterolaterally (Figs. 3.241-3.242, 3.249). Prosternite brown, transverse, narrow, with broad dark band along posterior margin; with pair of large, pale, posterolateral sclerites (Fig. 3.233). Foretrochantin deeply forked (Fig. 3.239). Foreleg with numerous, feather-like setae on posterior surface of coxa; trochanter with long, feather-like setae in ventral margin; femur with a row of long, dark, spike-like setae on ventral margin and few, short, dark, setae on external surface (Fig. 3.243). Mid- and hindlegs similar in size, shape, and structure; decorated with a row of feather-like setae and stout setae on posterior surface of femur (Fig. 3.250). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing a series of lateral filaments.

Abdomen: Abdominal segments densely with dark, club-like hairs (Fig. 3.251). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills, each arising from a common base (Fig. 3.252). Sternum VIII with pair of small, subtriangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites bearing with spike-like setae emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites. Anal prolegs with bent claw and cluster of long bristles. Venter of anal proleg with spike-like setae on caudal lobes; outer sclerites with same setae.

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing long setae; anterior half with many, dark setae. Mandibles enlarged basally, with posterior face

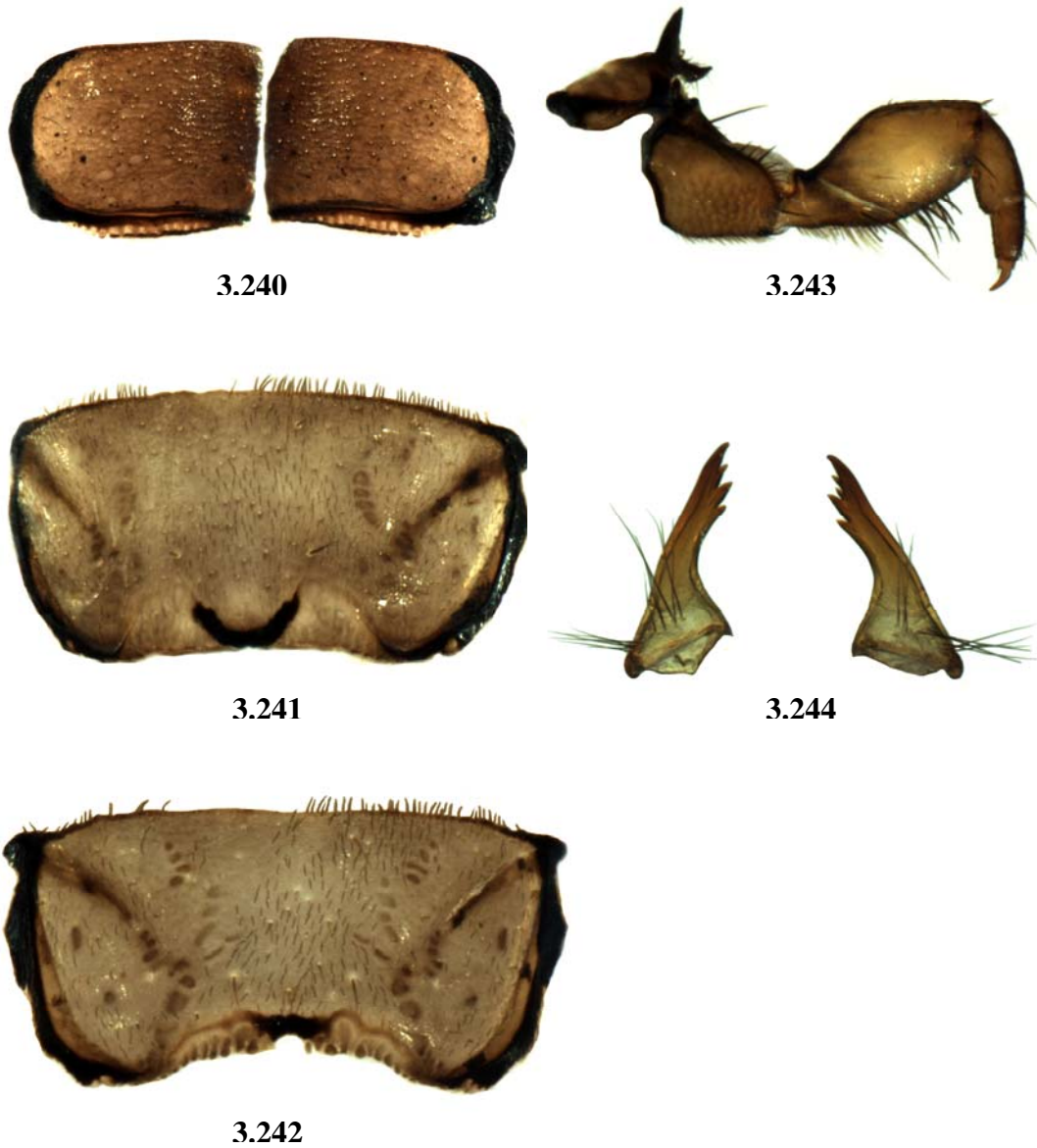
bearing short and long, black setae; left mandible bearing 4 teeth, right mandible with only 3 teeth (Fig. 3.244). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV, posterior hook plate of segment IV covered with a row of long setae (Fig. 3.245). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by short setae and hooked setae; outer margin of each process fringed with long, black setae; inner margin with row of hooked setae (Fig 3.246).

Diagnosis: The larva of *Hydropsyche butes* is closely resemble to *Hydropsyche camillus* with which it may be confused. Both species have distinct yellow marks on frontoclypeus. This species may be separated on the basis of the following characteristics: (1) The shape of frontoclypeus is triangular and lateral margin is evenly straight and point at apex. Many brush of setae and tapered setae are scattered on surface, and a few truncate peg setae are present on anterolateral surface of frontoclypeus, (2) Many truncate peg setae and tapered setae are present on pronotum, and heavy scale hairs and sparse truncate peg setae are present on mesonotum and metanotum.

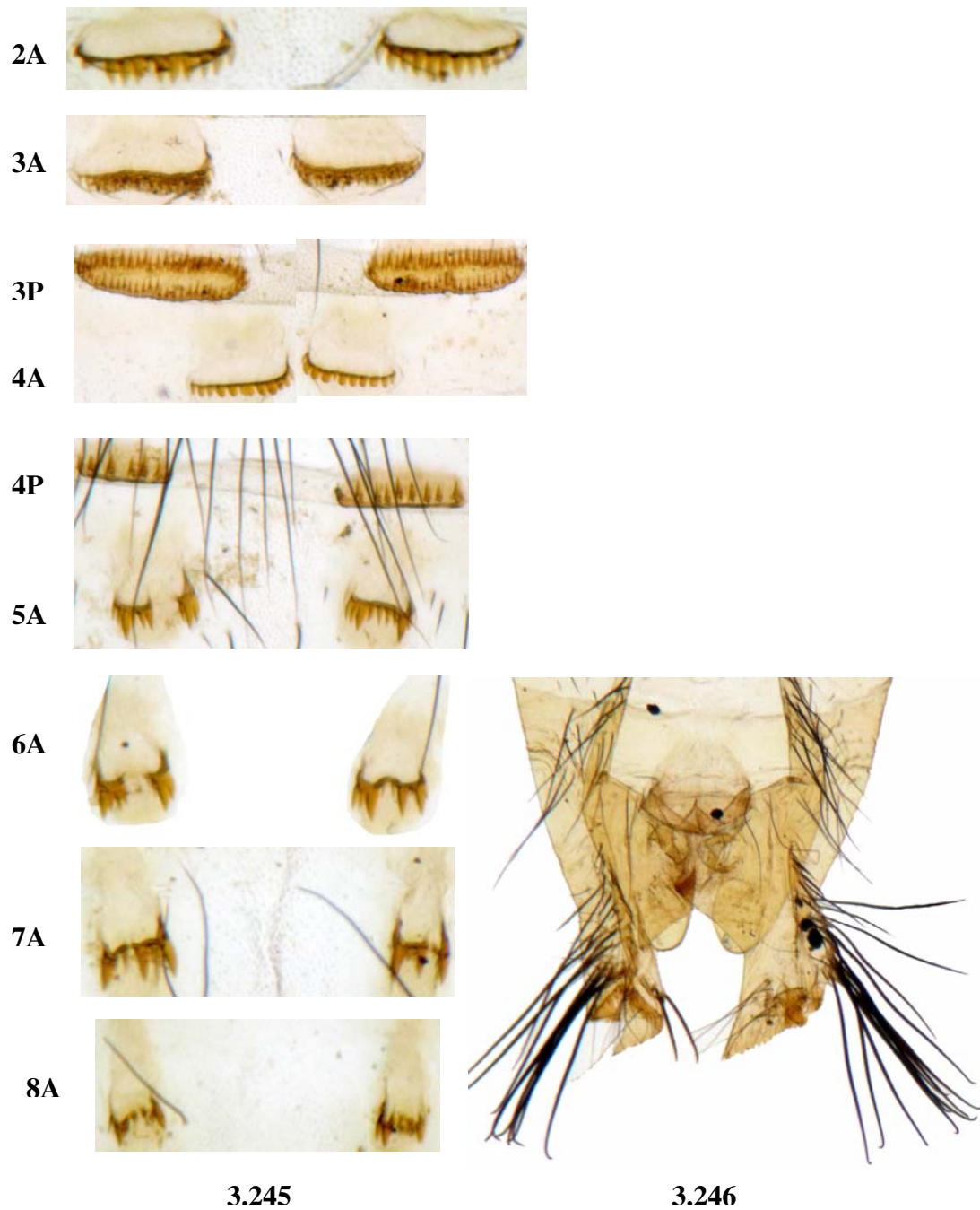
Material examined: SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 2-x-2004, Prommi, 18 larvae, 1 male mmt.; Khao Nam Kang National Park, stream from Ton Lard Waterfall, 26-ii-2005, Prommi, 2 larvae, 1 male mmt.; stream from Ton Dad Fah Waterfall, 26-ii-2005, Prommi, 6 larvae, 1 male mmt.



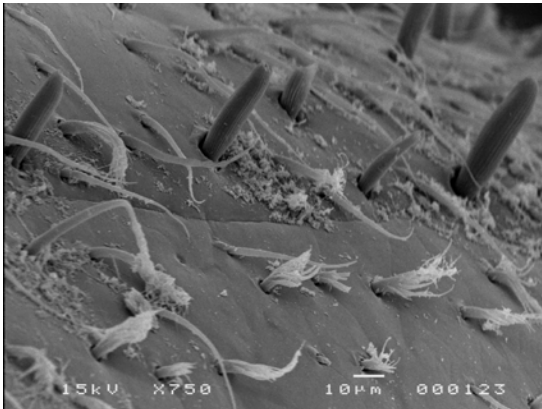
Figures 3.235-3.239. Larval features of *Hydropsyche butes*: 3.235, dorsal view of head; 3.236, frontoclypeal apotome 3.237, ventral view of head; 3.238, ventral view of mandibles; 3.239, prosternum.



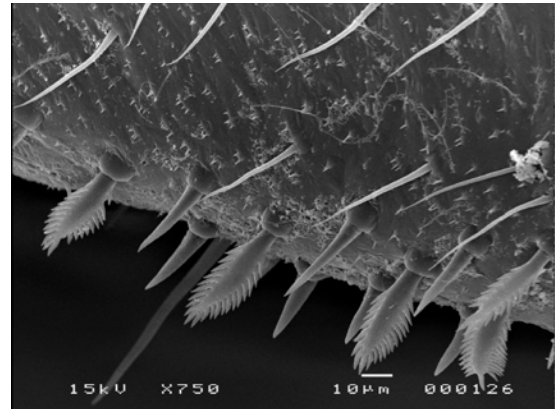
Figures 3.240-3.244. Larval features of *Hydropsyche butes*: 3.240, pronotum; 3.241, mesonotum; 3.242, metanotum; 3.243, outer face of right foreleg; 3.244, ventral view of pupal mandibles.



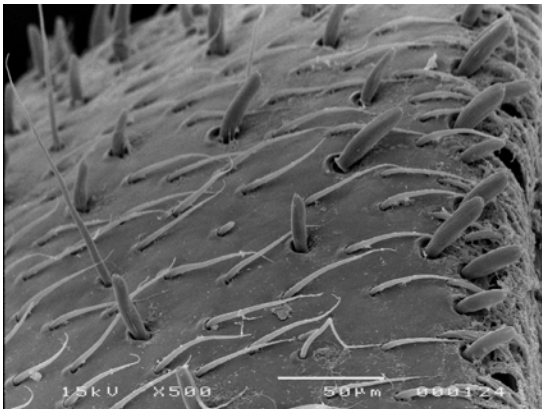
Figures 3.245-3.246. *Hydropsyche butes*: 3.245, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.246, pupal apical abdominal appendages.



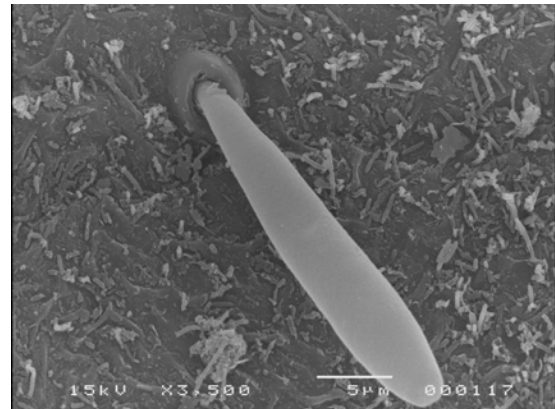
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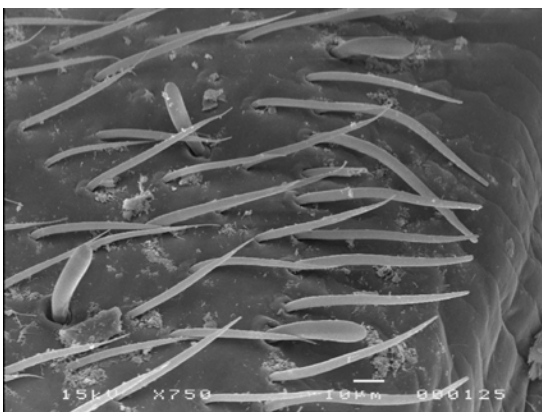
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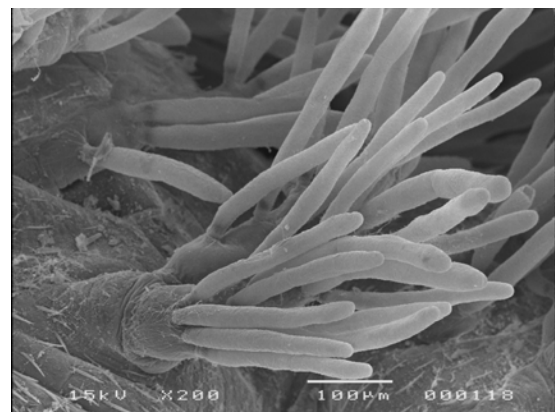
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3.251



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Figures 3.247-3.252. *Hydropsyche butes*: 3.247, setae on surface of head; 3.248, setae on pronotum; 3.249, setae on mesonotum; 3.250, setae on mid- and hind femur; 3.251; setae on abdominal segments; 3.252, abdominal gills.

***Hydropsyche camillus* Malicky & Chantaramongkol, 2000**

Larva: Total length 10.0-11.0 mm (n=10). Overall body shape as usual in Hydropsychidae (Fig. 3.253). Head yellow to dark-brown, with dark muscle scars in posterior one fifth. Nota light-brown, each with posterolateral muscle scars.

Head: Head capsule length, 1.02-1.05 mm; width, 0.85-0.94 mm. Dorsum of head dark-brown, with two distinct yellow marks on frontoclypeus; T-shaped mark anteriorly and circular shaped mark posteriorly (Fig. 3.254). Frontoclypeus with anterior margin strongly convex, slightly crenulate, with brush of setae extending beyond anterior margin (Figs. 3.254-3.255). Head with moderately long, erect, truncate peg setae; with tapered setae on dorsal and lateral regions of anterior three-quarters (Fig. 3.272). Frontoclypeus with a few or no brush of setae; with truncate peg setae anterolaterally. Head ventrally dark-brown with stridulatory lines in the anterior half (Fig. 3.256). Labrum light-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-yellow pectinate setae and stout setae on dorsal surface (Fig. 3.257). Mandibles dark-brown, right mandible with 2 apical and 2 mesal teeth, left mandible with 2 apical and 3 mesal teeth and well-developed setal hairs (Fig. 3.258). Submentum light-brown, with deep anteromesal cleft, anterior margins of cleft with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular (Fig. 3.256).

Thorax: Nota brown with darker muscle scars laterally. Pronotum with numerous, erect, truncate peg setae and long, tapered setae; muscle scars midway between midline and lateral margin in posterior half (Figs. 3.259, 3.273). Meso- and

metanotum with numerous scale hairs, with scattered truncate peg setae; dark muscle scars laterally (Figs. 3.260-3.261). Prosternite brown, transverse, narrow, with broad dark band along posterior margin; with pair of large, brown, posterolateral sclerites (Fig. 3.265). Foretrochantin deeply forked (Fig. 3.262). Foreleg with numerous feather-like setae on posterior surface of coxa; trochanter with long, feather-like setae in ventral margin; femur with a row of long, dark, spike-like setae, mingled with feather-like setae on ventral margin and few, short, dark, setae on external surface (Fig. 3.262). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae on posterior surface of femur (Figs. 3.263-3.264). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments dense with dark, club-like hairs (Fig. 3.274). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills arising from a common base (Fig. 3.275). Sternum VIII with pair of small, triangular sclerites bearing spike-like setae. Sternum IX with pair of large, triangular sclerites bearing spike-like setae emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.266). Anal prolegs with bent claw and cluster of long bristles, spike-like setae present on dorsal and ventral surface (Figs. 3.266-3.267).

Pupa: Labrum semicircular with rounded basolateral lobes, each bearing a few, short and long setae; surface with many dark, short, setae. Mandibles enlarged basally, with posterior surface bearing short and long, black setae; left mandible bearing 4 teeth, right mandible with 3 teeth (Fig. 3.268). Dorsal surface with one pair

of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV; posterior hook plate of segment IV covered with a row of long setae (Fig. 3.270). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by numerous short setae and hooked setae; outer margin of each process fringed with long, black, setae; inner margin with row of hooked setae (Fig. 3.271).

Diagnosis: The larva of *Hydropsyche camillus* is closely resemble to *Hydropsyche butes* with which it may be confused. Both species have distinct yellow marks on frontoclypeus. This species may be separated on the basis of the following characteristics: (1) The shape of frontoclypeus is triangular and lateral margin is slightly broadened at mid-length, and a few or no brush of setae are present on surface. A few truncate peg setae are present on anterior and lateral surface of frontoclypeus, (2) Pronotum are covered with many truncate peg setae and tapered setae, and heavy scale hairs and sparse truncate peg setae are present on mesonotum and metanotum.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 9-x-2004, Prommi, 4 larvae; same locality, 2-iv-2005, Prommi, 2 larvae; SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 17-vi-2004, Prommi, 5 larvae, 1 female mmt.; same locality, 9-viii-2004, Prommi, 2 larvae; same locality, 10-iv-2005, Prommi, 14 larvae, 1 male mmt., 1 female mmt.; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 7-x-2004, Prommi, 1 larva; KRABI Prov.: Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-viii-2004, Prommi, 14 larvae, 1 male mmt.; same locality, 6-x-2004,

Prommi, 15 larvae, 1 pupa; same locality, 5-iv-2005, Prommi, 44 larvae, 6 pupae;
NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from
Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-viii-2004, Prommi, 1 larva; same
locality, 11-x-2004, 11 larvae, 4 pupae; TRANG Prov.: Khao Chong Wildlife
Management Station, stream from Ka Chong Waterfall, 5-viii-2004, Prommi, 4 larva;
SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall,
12-iv-2005, Prommi, 1 larva.



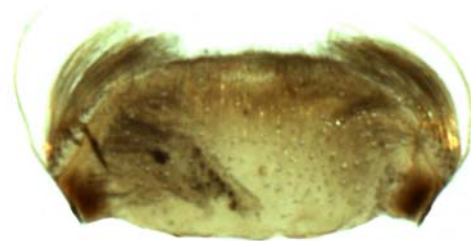
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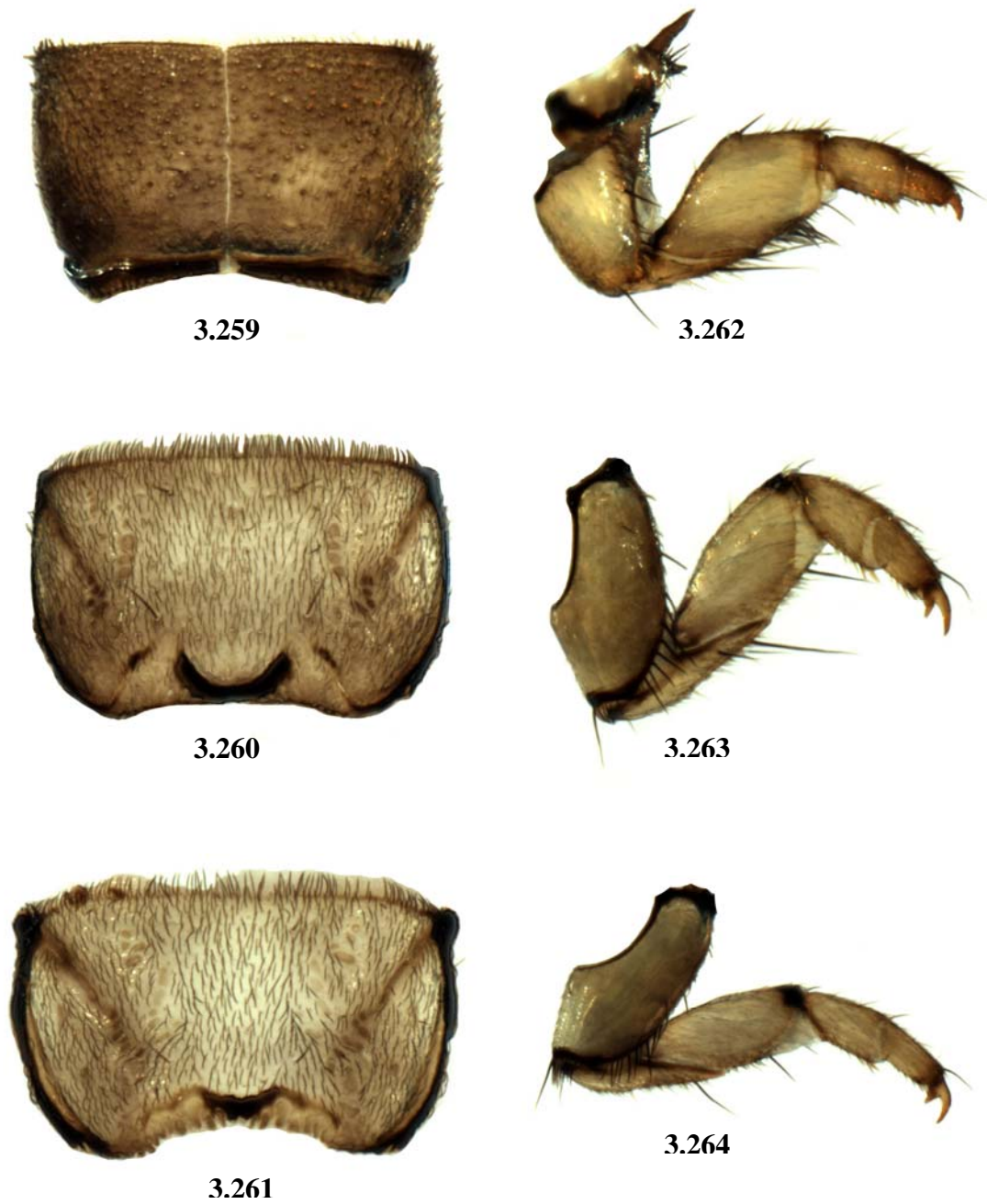


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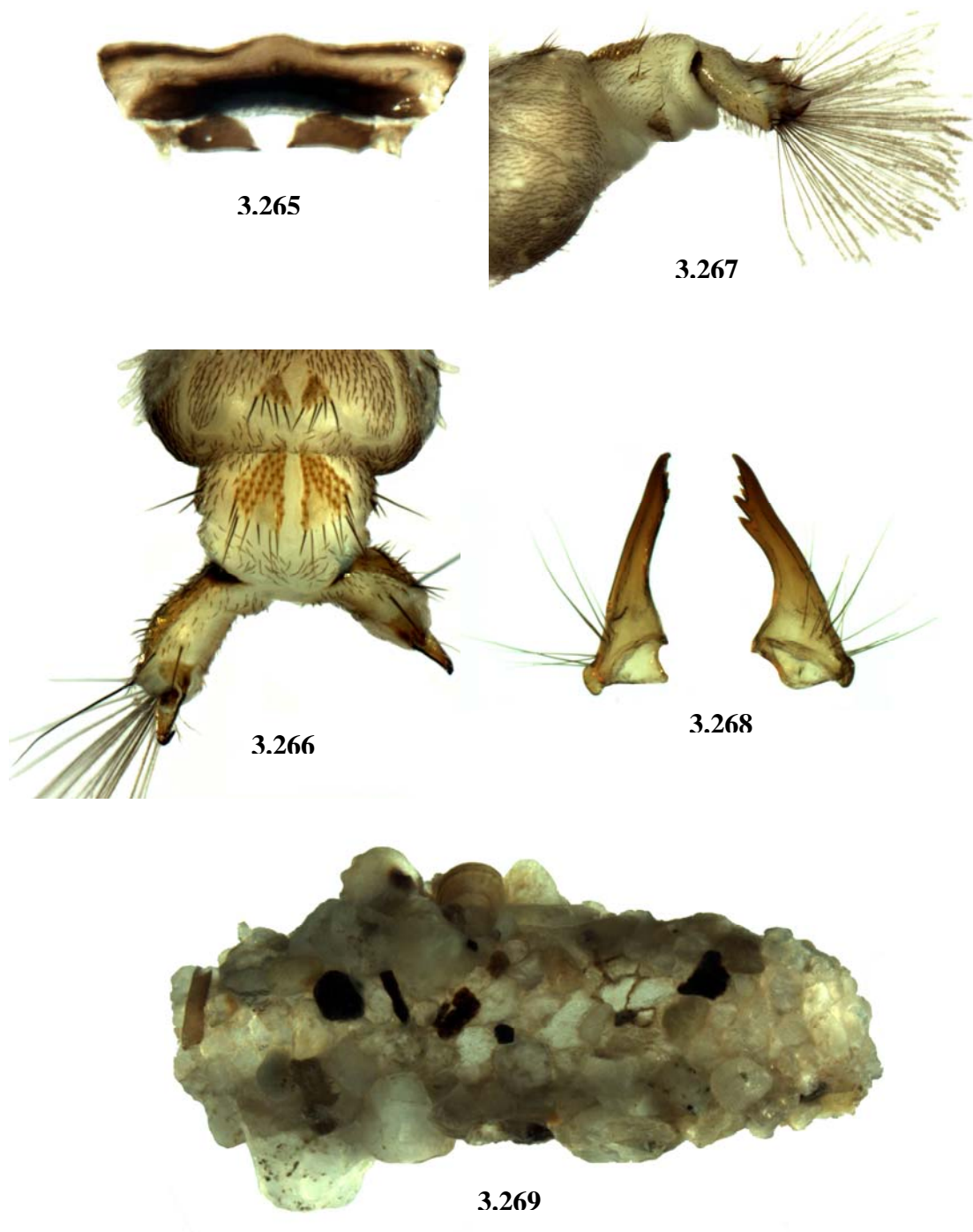


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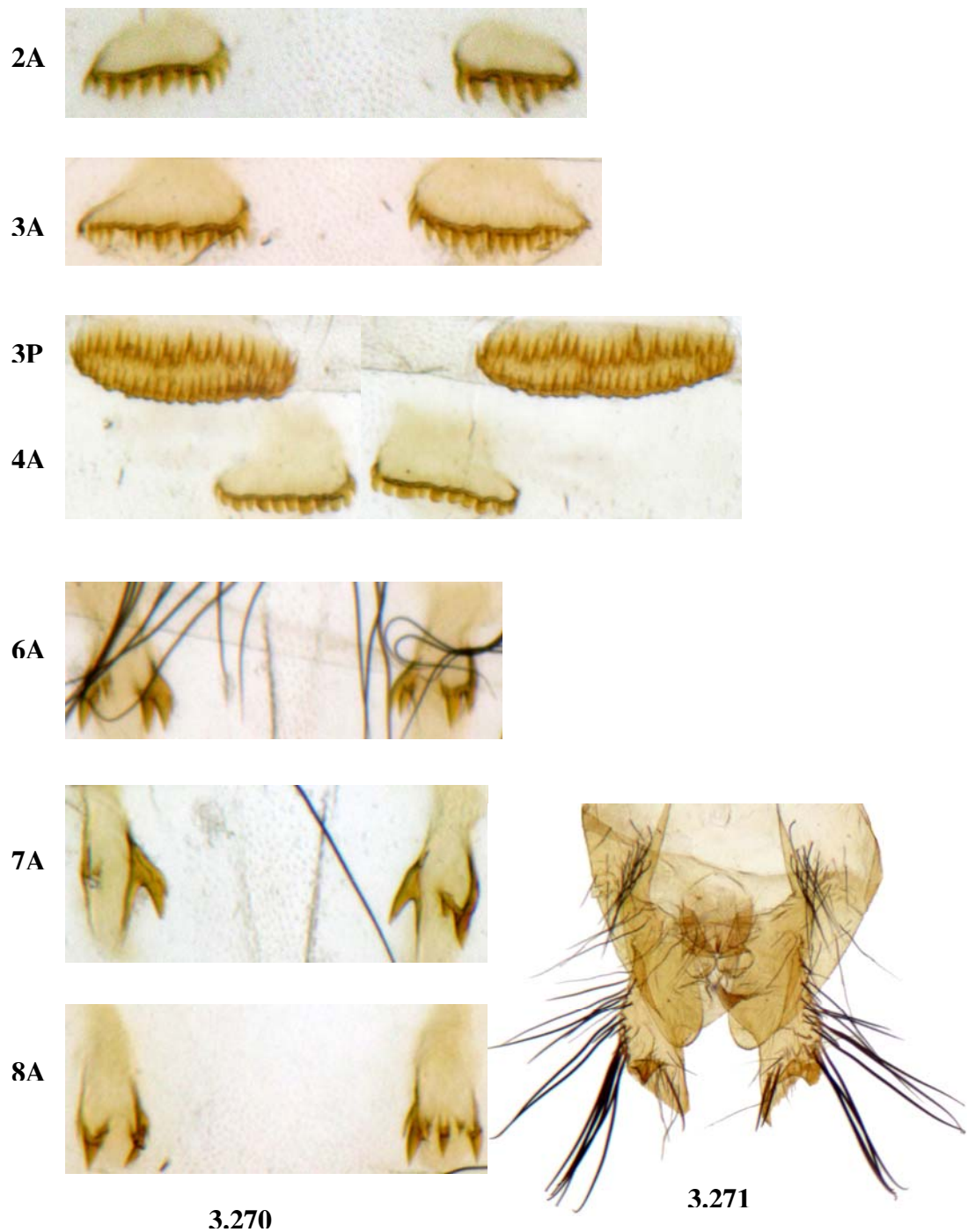
Figures 3.253-3.258. Larval features of *Hydropsyche camillus*: 3.253, larva; 3.254, dorsal view of head; 3.255, frontoclypeal apotome; 3.256, ventral view of head; 3.257, dorsal view of labrum; 3.258, ventral view of mandibles.



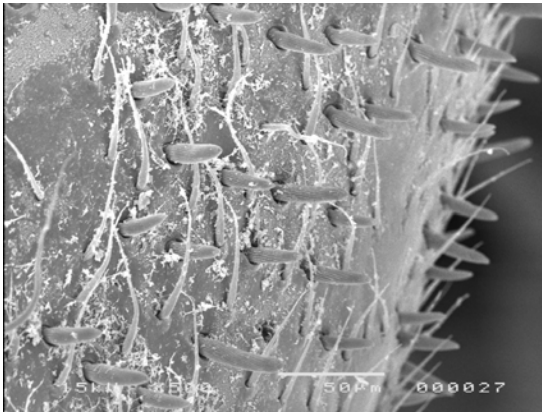
Figures 3.259-3.264. Larval features of *Hydropsyche camillus*: 3.259, pronotum; 3.260, mesonotum; 3.261, metanotum; 3.262, outer face of right foreleg; 3.263, inner face of left midleg; 3.264, inner face of left hindleg.



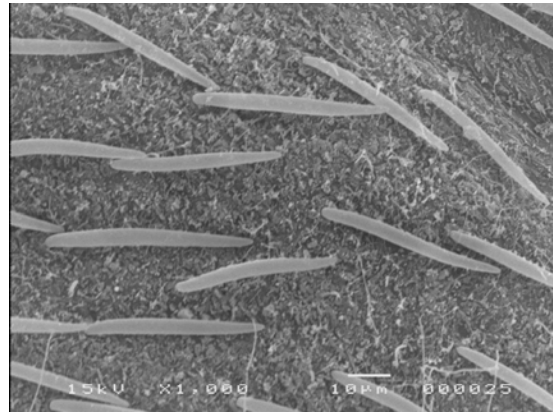
Figures 3.265-3.269. *Hydropsyche camillus*: 3.265, prosternum; 3.266, sterna VIII and IX; 3.267, lateral view of anal claw; 3.268, ventral view of pupal mandibles; 3.269, larval and pupal case constructed from sand and small gravels.



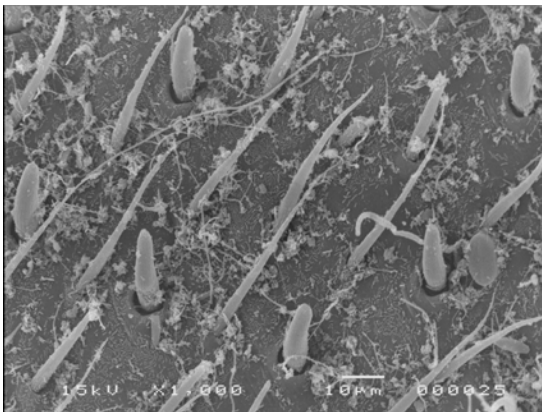
Figures 3.270-3.271. *Hydropsyche camillus*: 3.270, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.271, pupal apical abdominal appendages.



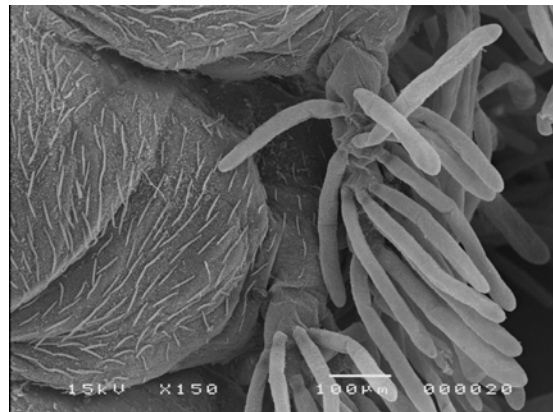
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Figures 3.272-3.275. *Hydropsyche camillus*: 3.272, setae on head; 3.273, setae on pronotum; 3.274, setae on abdominal segments; 3.275, abdominal gills.

***Hydropsyche dolosa* Banks, 1939**

Larva: Total length 13.0-14.0 mm (n=10). Overall body shape as usual in Hydropsychidae. Head dark-brown with a yellow stripe on the midline appears to be a continuation of longitudinal stripe on the thoracic plates.

Head: Head capsule length, 1.19-1.33 mm; width, 1.02-1.05 mm. Dorsum of head light-brown with a yellow stripe on the midline wider anteriorly (Fig. 3.276). Lateral aspect of head with yellow band connecting yellow areas around eyes reach to back of head; light-brown muscle scars mesolaterally. Head anterior three-fourth dorsolaterally and frontoclypeus anterolaterally covered with scattered moderately long, black, erect, truncate peg setae, with appressed hair-like setae (Fig. 3.295). Frontoclypeus with anterior margin slightly concave, with brush of setae extending beyond anterior margin; mesolaterally with light, muscle scars (Figs. 3.277, 3.296). Head ventrally with stridulatory lines in anterior half (Fig. 3.278). Labrum light brown; bearing well-developed, lateral, golden-brown, pectinate setae and stout setae on dorsal surface; slightly convex posteriorly (Fig. 3.279). Mandibles golden-brown, with 2 apical and 3 mesal teeth, left mandible with tuft of hairs; lateral surface of mandibles with scattered, long, setae (Fig. 3.280). Submentum with shallowly median cleft, anterior margins of cleft with long, black setae; stout setae laterobasally (Fig. 3.281). Anterior ventral apotome broadly triangular, posterior ventral apotome minute triangular (Figs. 3.278, 3.281).

Thorax: Nota brown with a very conspicuous yellow stripe in the midline appears to be a continuing of longitudinal stripe on the head. Nota covered

with long, dark and clear, erect, truncate peg setae; with tapered setae, anterior margin of each notum bearing same setae (Figs. 3.282-3.284, 3.297). Prosternite light-brown, transverse, narrow, with broad dark band posteromesally; with pair of large, light-brown, posterolateral sclerites (Fig. 3.289). Foretrochantin deeply forked (Fig. 3.288). Foreleg with feather-like setae on the posterior surface of coxa; trochanter and femur with long feather-like setae on ventral surface, with long setae; tibia and tarsus with stout setae (Fig. 3.285). Mid- and hindlegs similar in size, shape, and structure; with stout setae on posterior surface of femur; tibia and tarsus with scattered setae on ventral margin (Figs. 3.286-3.287). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments densely covered with dark, hair-like setae and club-like hairs (Fig. 3.298). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills arising from a common base (Fig. 3.299). Sternum VIII with pair of half-moon sclerites. Sternum IX with pair of spines-bearing plates emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.290). Anal prolegs with bent claw and cluster of long bristles, without spike-like setae on the ventral surface.

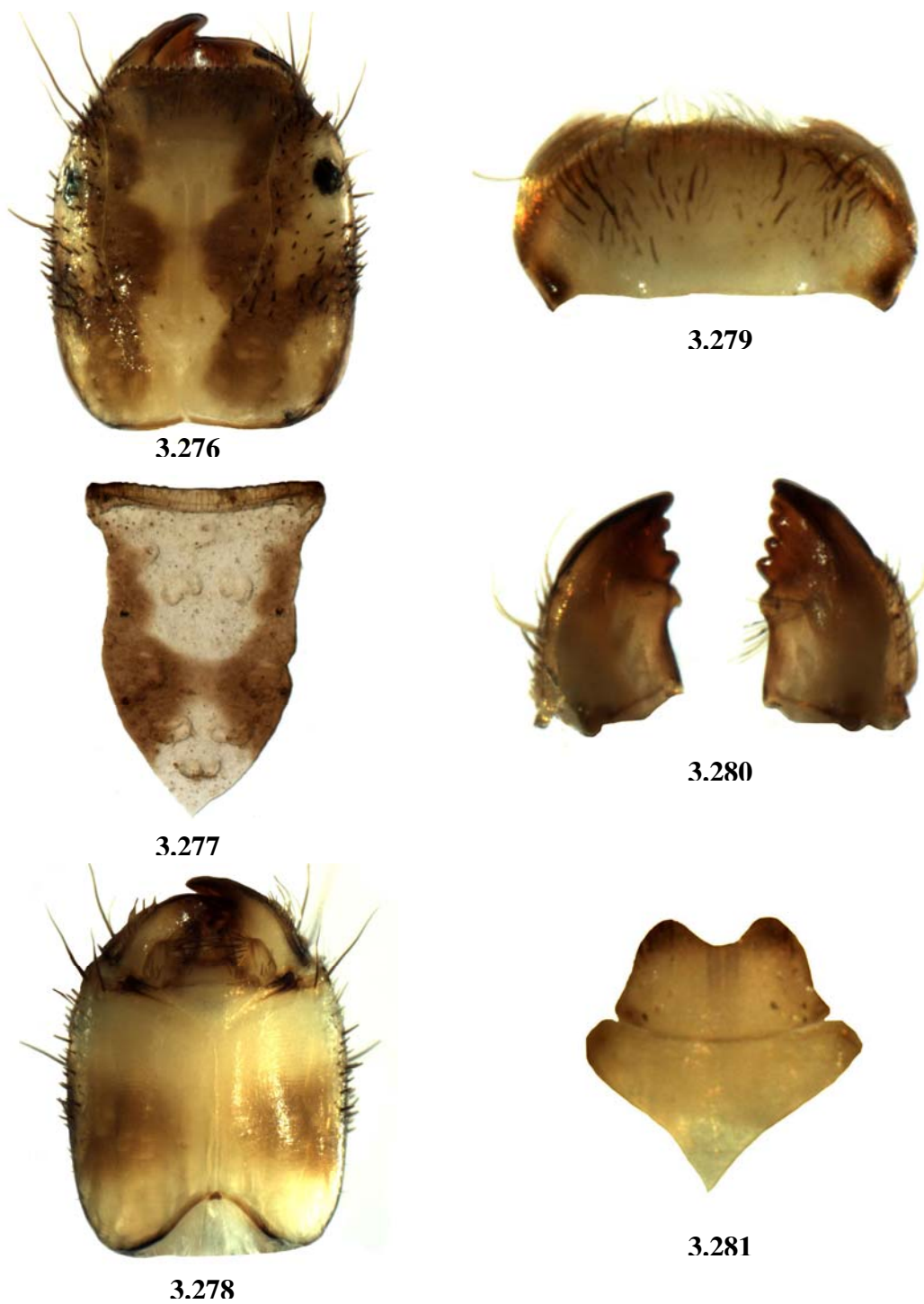
Pupa: Labrum semicircular with rounded basolateral lobes, each bearing short and long setae; surface with many dark, short, setae. Mandibles enlarged basally, with posterior surface bearing short and long, black, setae; left mandible bearing 4 teeth, right mandible with 3 teeth (Fig. 3.291). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV;

posterior hook plate of segment IV covered with a row of long setae (Fig. 3.293). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by long setae and hooked setae; lateral margin of each process fringed with long, black setae (Fig. 3.294).

Diagnosis: At first glance, this species is easily and quickly recognized by a very conspicuous longitudinal yellow stripe in the midline appears to be a continuing of longitudinal stripe on the head. There is no other known *Hydropsyche* larvae that exhibits this type of pattern. However, this larva may be distinguished from all other *Hydropsyche* species by the following characteristics. First, many long, dark, truncate peg setae are present on genae and frontoclypeus is lacking same setae except are scattered along anterolateral margin. Second, heavy dark and clear, long, truncate peg setae are covered on nota. Finally, the median cleft of submentum is shallow in anterior margin.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 9-x-2004, Prommi, 5 larvae; same locality, 2-iv-2005, Prommi, 1 larva; same locality, 22-v-2005, Prommi, 2 larvae; SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 9-viii-2004, Prommi, 5 larvae; same locality, 10-x-2004, Prommi, 1 larva; same locality, 10-iv-2005, Prommi, 1 larva; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 6-viii-2004, Prommi, 1 larva; same locality, 7-x-2004, Prommi, 4 larvae; same locality, 4-iv-2005, Prommi, 13 larvae; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall 68 m. 08°58' N, 98°27' E, 7-viii-2004, Prommi, 1 larva; NAKHON SI THAMMARAT Prov.: Yong Waterfall

National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-viii-2004, Prommi, 6 larvae; same locality, 11-x-2004, 11 larvae, 1 pupa; same locality, 6-iv-2005, Prommi, 19 larvae; Khao Luang National Park, stream from Ai Khaew Waterfall, 127 m. 08°33' N, 99°46' E, 3-xii-2004, Prommi, 1 larva; stream from Yord Luang Waterfall, 78 m. 08°38' N, 99°44' E, 7-iv-2005, Prommi, 3 larvae; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 30 larvae, 10 pupae, 2 male mmts., 4 female mmts.; same locality, 5-x-2007, Prommi, 22 larvae, 3 pupae, 3 female mmts.; same locality, 12-iv-2005, Prommi, 26 larvae, 1 pupa, 1 female mmt.; NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 1 larva.



Figures 3.276-3.281. Larval features of *Hydropsyche dolosa*: 3.276, dorsal view of head; 3.277, frontoclypeal apotome; 3.278, ventral view of head; 3.279, dorsal view of labrum; 3.280, ventral view of mandibles; 3.281, submentum and anterior ventral apotome.



3.282



3.285



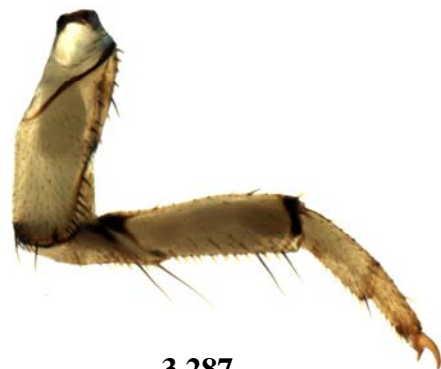
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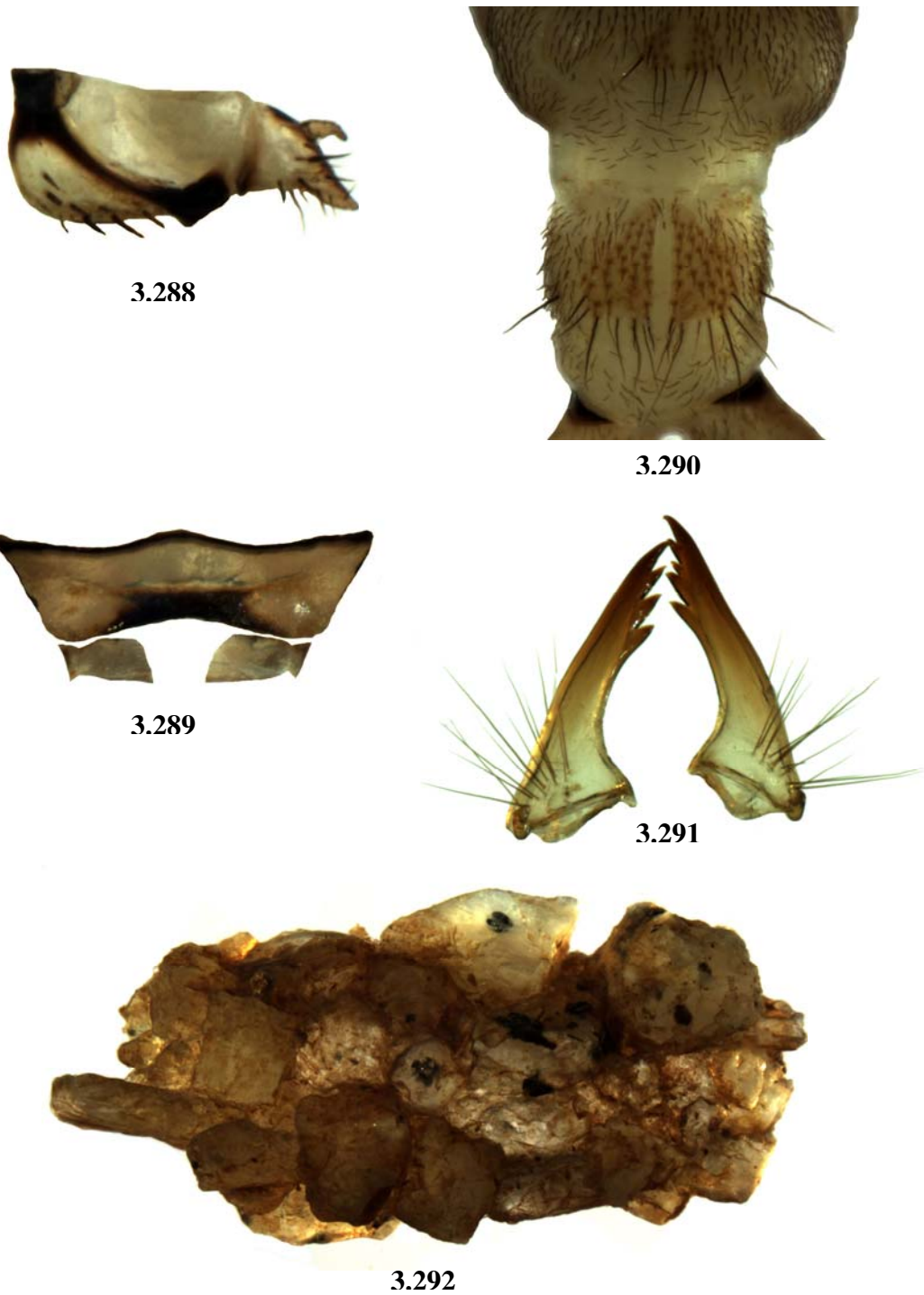


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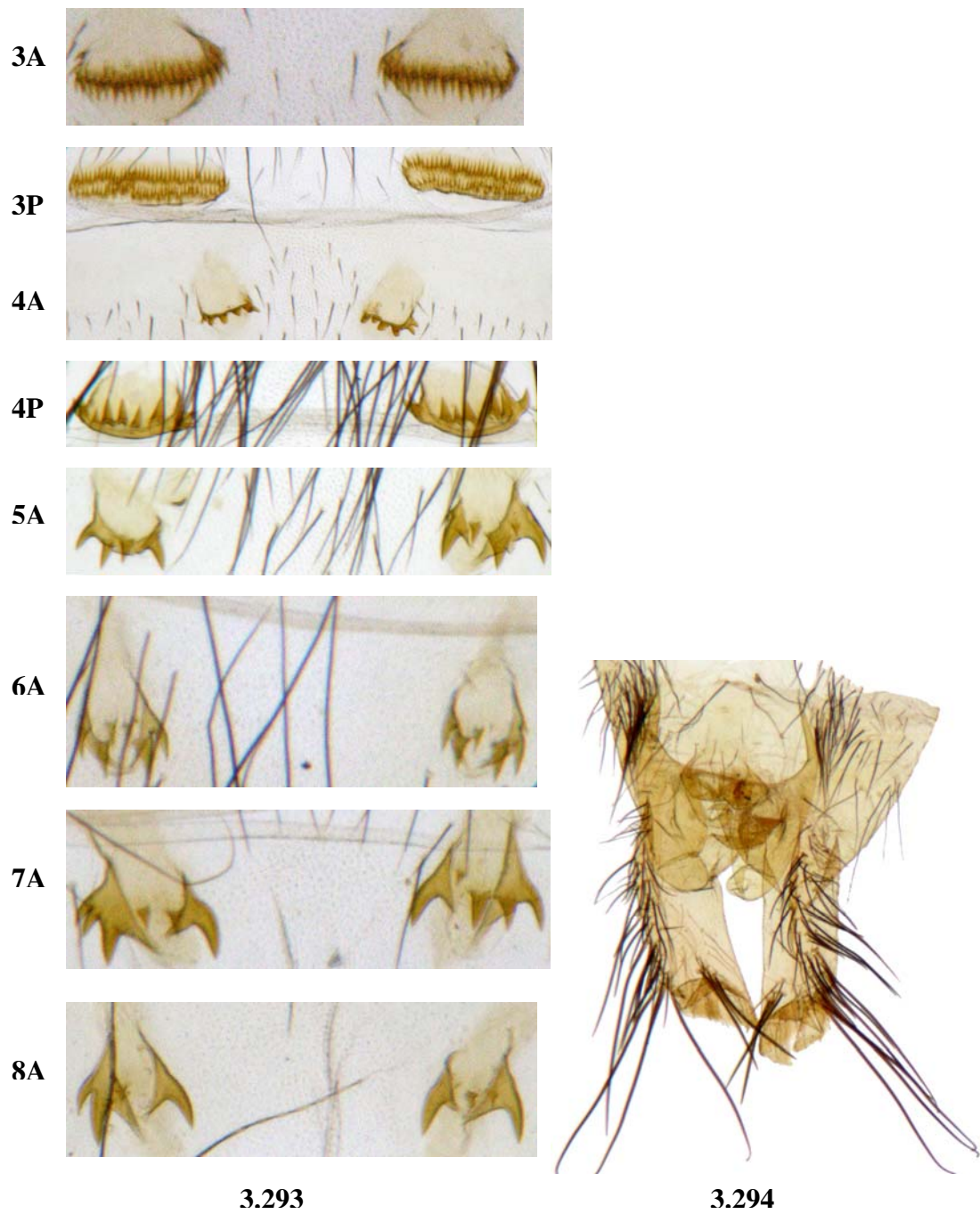


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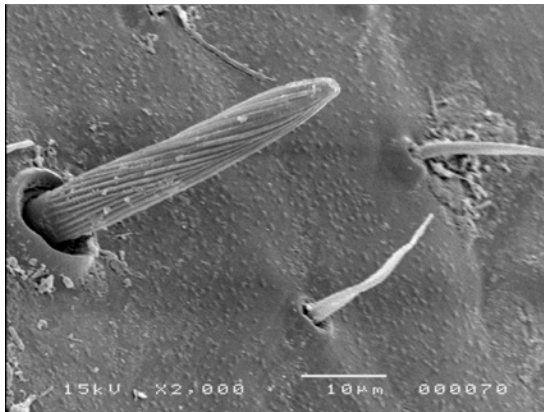
Figures 3.282-3.287. Larval features of *Hydropsyche dolosa*: 3.282, pronotum; 3.283, mesonotum; 3.284, metanotum; 3.285, outer face of right foreleg; 3.286, inner face of left midleg; 3.287, inner face of left hindleg.



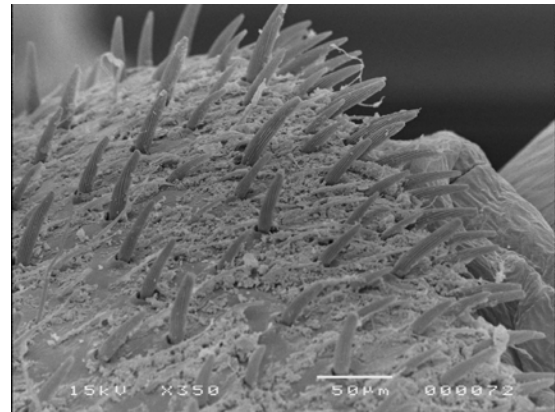
Figures 3.288-3.292. *Hydropsyche dolosa*: 3.288, foretrochantin; 3.289, prosternum; 3.290, sterna VIII and IX; 3.291, ventral view of pupal mandibles; 3.292, larval and pupal case constructed from sand and small gravels.



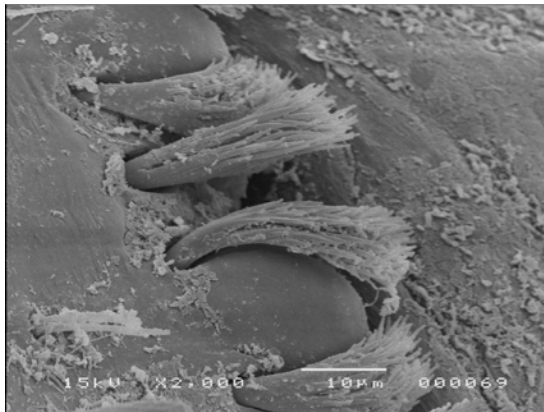
Figures 3.293-3.294. *Hydropsyche dolosa*: 3.293, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.294, pupal apical abdominal appendages.



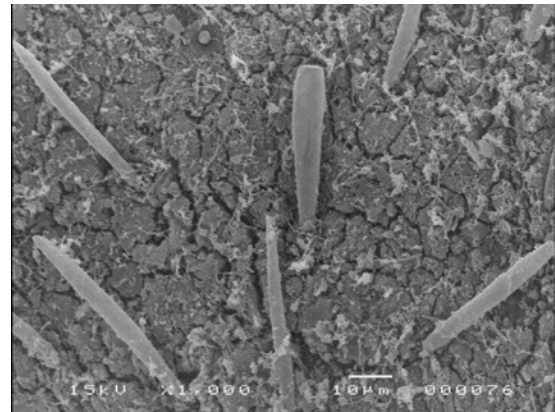
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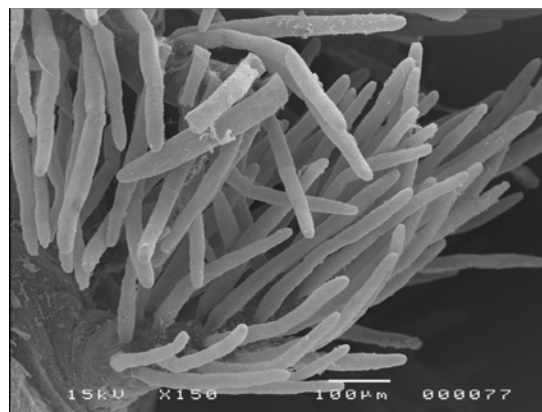
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Figures 3.295-3.299. *Hydropsyche dolosa*: 3.295, setae on head; 3.296, setae bear in anterior margin of frontoclypeus; 3.297, setae on pronotum; 3.298, setae on abdominal segments; 3.299, abdominal gills.

***Hydropsyche pallipenne* Banks, 1938**

Larva: Total length 9.0-10.0 mm (n=10). Overall body shape generally, as described in Hydropsychidae. Head yellow, except brown in posterolateral half of frontoclypeus. Nota yellow, each with laterally muscle scars.

Head: Head capsule length, 0.88-0.97 mm; width, 0.82-0.85 mm. Dorsum of head yellow, with two distinct yellow marks on frontoclypeus; V-shaped mark at anteriorly and circular shaped mark posteriorly; posterolateral half of frontoclypeus brown. Frontoclypeus with anterior margin concave, slightly crenulate, with brush of setae extending beyond anterior margin (Fig. 3.300). Head with long, black, erect, truncate peg setae, with tapered setae on dorsal and lateral regions in anterior three-quarters. Frontoclypeus with same setae on anterolateral margins (Fig. 3.317). Head ventrally yellow with brown on stridulatory surface; stridulatory lines present ventrally near middle (Fig. 3.301). Labrum light-brown; elliptical in dorsal view; bearing well-developed, lateral, golden-light brown, pectinate setae and stout setae on anterior half of dorsal surface (Fig. 3.302). Mandibles dark-brown with 2 apical and 3 mesal teeth, left mandible with well-developed setal hairs (Fig. 3.303). Submentum light-brown, with anteromesal cleft, anterior margins of cleft with long setae. Anterior ventral apotome broadly triangular, posterior ventral apotome small, triangular (Fig. 3.304).

Thorax: Nota yellow with darker muscle scars laterally. Nota densely covered with long, erect, truncate peg setae and tapered setae, same setae projecting beyond anterior margin. Pronotum with muscle scars midway between

midline and lateral margin in posterior half; meso- and metanotum with muscle scars laterally (Figs. 3.306-3.308, 3.318). Prosternite light brown, transverse, narrow, with broad dark band along posterior margin, with pair of large, brown, posterolateral sclerites (Fig. 3.305). Foretrochantin deeply forked, ventral fork with long, black setae (Fig. 3.309). Foreleg with numerous, feather-like setae on posterior surface of coxa; trochanter with feather-like setae on ventral margin; femur with a row of long, dark, spike-like setae on ventral margin and short, dark, setae on external surface (Fig. 3.309). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae on posterior surface of trochanter and femur (Figs. 3.310-3.311). Mesosternum with one pair of gills and metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments with various shaped of setae: simple club-like hairs, hair with the distal pore crenulate and wide distally, distal pore crenulate (Fig. 3.319). First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills arising from a common base (Fig. 3.320). Sternum VIII with pair of small, triangular sclerites bearing spike-like setae. Sternum IX with pair of large triangular sclerites bearing spike-like setae emanating from prominent sockets. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.312). Anal prolegs with bent claw and cluster of long bristles; lateral sclerites with black, long setae (Figs. 3.312-3.313).

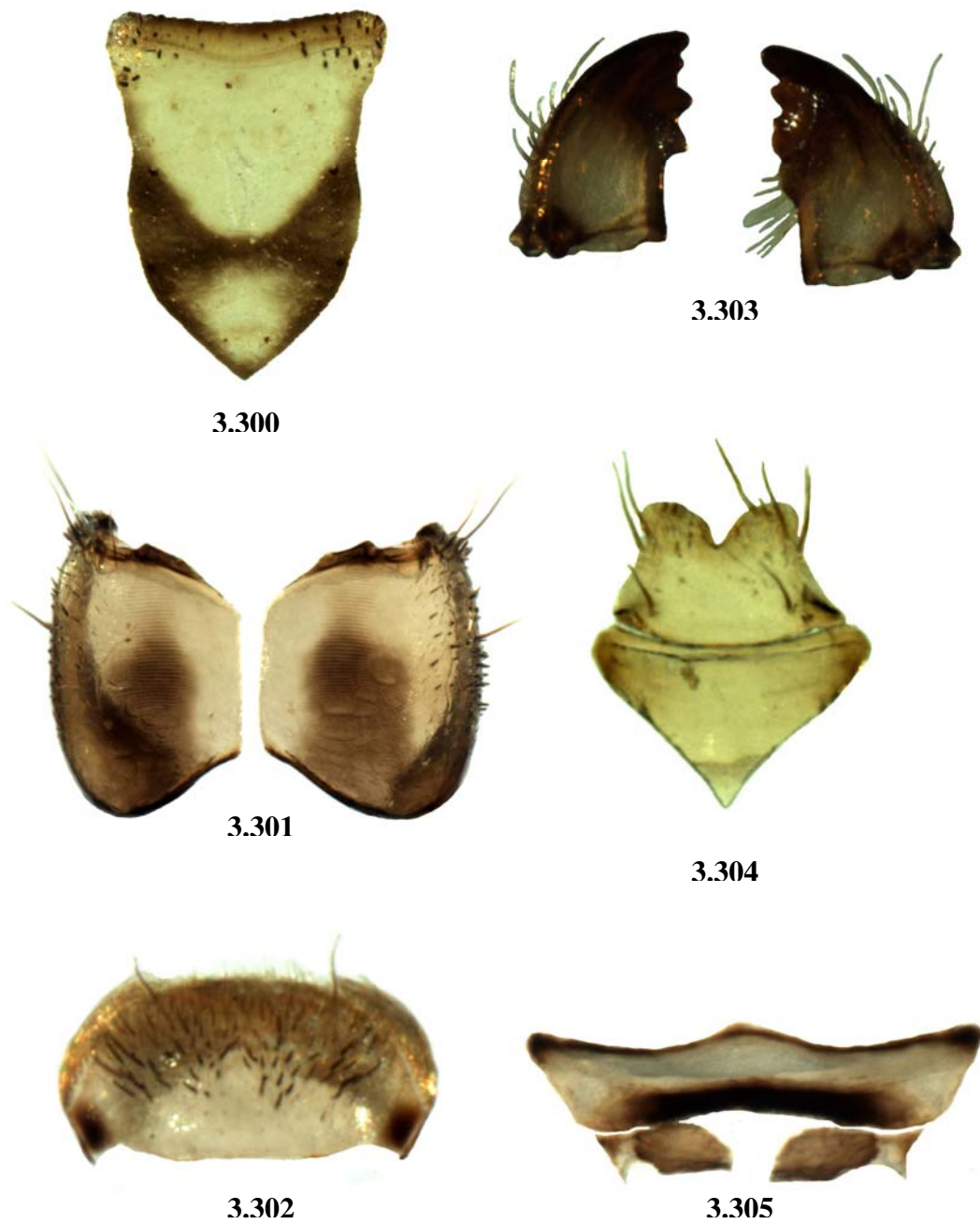
Pupa: Labrum semicircular with rounded basolateral lobes, each bearing a few short and long, setae; surface with many dark, short, setae. Mandibles enlarged basally, with posterior surface bearing moderately long, black setae; left mandible bearing 4

teeth, right mandible with 3 teeth (Fig. 3.314). Dorsal surface with one pair of anterior hook plates on segments II-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.315). Apical processes of abdomen with apicolateral angles acute, separated by shallowly concave surface covered by long setae and hooked setae; lateral margin of each process fringed with long, black setae (Fig. 3.316).

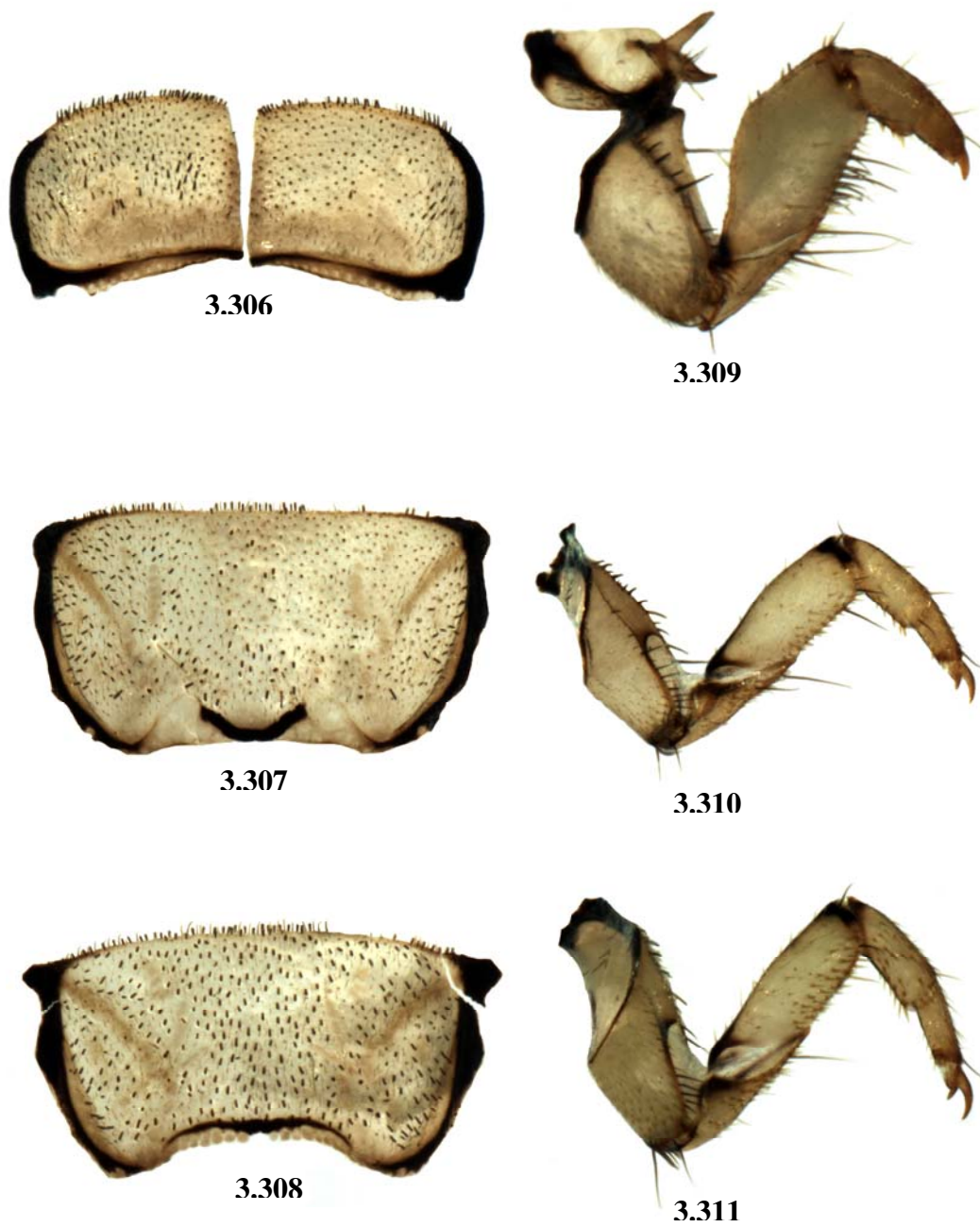
Diagnosis: This species is most closely related to *Hydropsyche assarakos*. It may be confused with *H. assarakos* since the color pattern of the head of these two species are similar. *H. pallipennes* may be separated on the basis of the following characters. First, the frontoclypeus is slightly concave. The genae possesses many dark, truncate peg setae and tapered setae, and frontoclypeus is lacking these setae except are scattered along anterior and lateral margin. Lastly, many long, dark, truncate peg setae are present on nota.

Material examined: SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 10-x-2004, Prommi, 14 larvae; same locality, 10-iv-2004, Prommi, 2 larvae; KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-viii-2004, Prommi, 3 larvae, 1 male mmt.; same locality, 6-x-2004, Prommi, 3 larvae, 1 male mmt.; NAKHON SI THAMMARAT Prov.: Khao Luang National Park, Promlok Waterfall, 138 m. 08°31' N, 99°46' E, 3-xii-2004, Prommi, 1 larva.

Discussion: *Hydropsyche*, the largest genus in the family, occurs on all landmass of the globe except South America and Antarctic (Wigging, 1996; Scheffer, 2005), with more than 250 described species (Mey, 2003). Twenty-seven species of *Hydropsyche* have been recorded from Thailand (Malicky and Chantaramongkol, 2000). Nine species of adults *Hydropsyche* were collected by black light trap. Of the 9 species collected, 3 were new recorded in Thailand; *Hydropsyche assarakos*, *H. biton*, and *H. butes*. These species have been recorded from Malaysia, Philippines, and Nepal (Malicky and Chantaramongkol, 2000). Six immature larvae and pupae of this genus could be associated with adult stage from this study (Table 2.4). Larvae of *Hydropsyche* are uniform in habit and appearance. Microhabitats vary from depositional pools to riffles areas. They sometimes prefer locations with more rapid flow, usually being concentrated around riffles, spillways and rapids. The larvae make a retreat from sandgrain or organic materials (Figs. 3.269, 3.292). In front of this retreat they build a capture net with which they strains food from the current.



Figures 3.300-3.305. Larval features of *Hydropsyche pallipenne*: 3.300, frontoclypeal apotome; 3.301, ventral view of head; 3.302, dorsal view of labrum; 3.303, ventral view of mandibles; 3.304, submentum and anterior ventral apotome; 3.305, prosternum.



Figures 3.306-3.311. Larval features of *Hydropsyche pallipenne*: 3.306, pronotum; 3.307, mesonotum; 3.308, metanotum; 3.309, outer face of right foreleg; 3.310, inner face of left midleg; 3.311, inner face of left hindleg.



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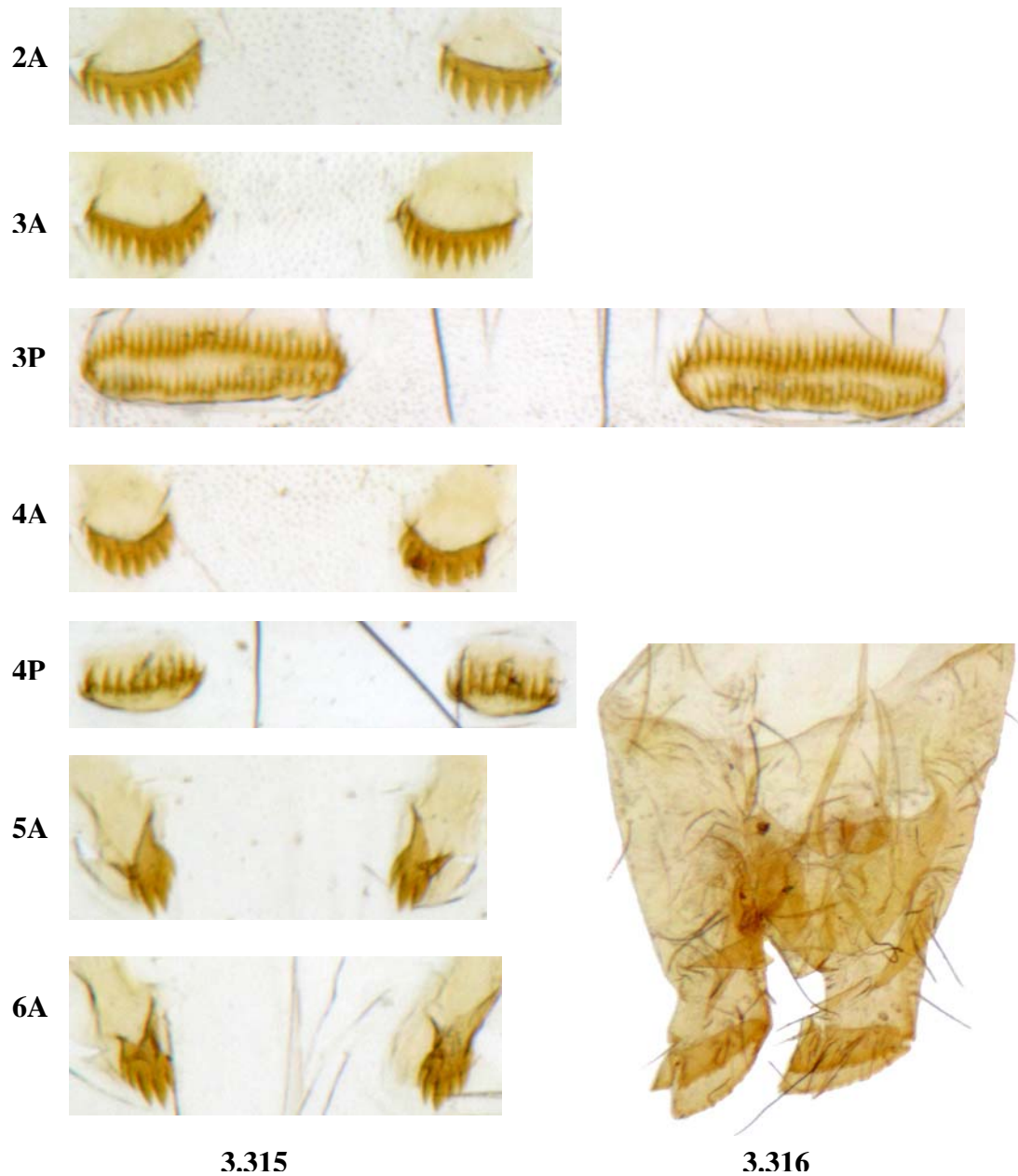


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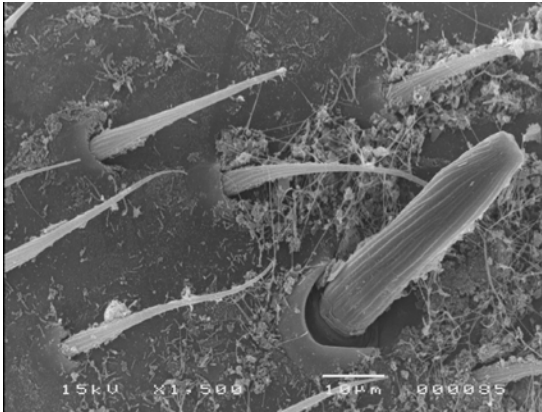


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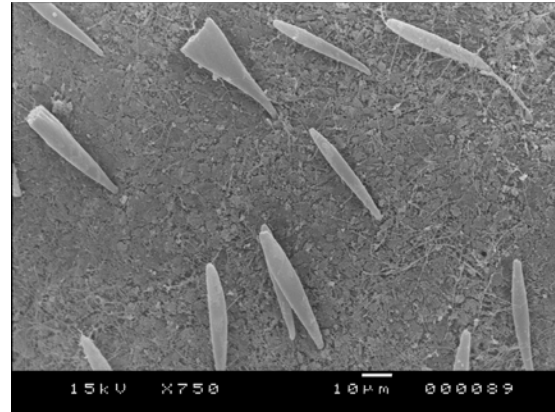
Figures 3.312-3.314. *Hydropsyche pallipenne*: 3.312, sterna VIII and IX; 3.313, lateral view of anal claw; 3.314, ventral aspect of pupal mandibles.



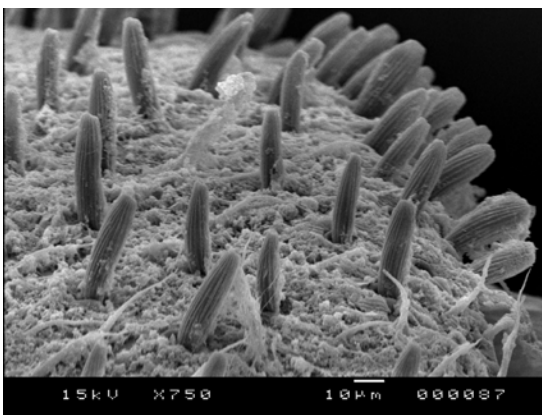
Figures 3.315-3.316. *Hydropsyche pallipenne*: 3.315, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.316, pupal apical abdominal appendages.



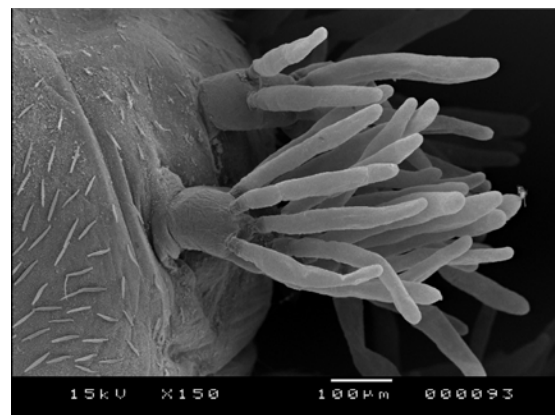
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Figures 3.317-3.320. *Hydropsyche pallipenne*: 3.317, setae on head; 3.318, setae on pronotum; 3.319, setae on abdominal segments; 3.320, abdominal gills.

GENUS *Potamyia* Banks, 1900

Diagnosis: Larvae of *Potamyia* have the typical characteristics of the family as described above. *Potamyia* can be distinguished from other genera of the Hydropsychinae by the anterior ventral apotome of the head with a prominent anteromedian tubercle; the posterior margin of the sclerites on abdominal sternum IX are entire; the lateral margin of each mandible is flanged; and the fore trochantin is forked or not.

From the results of this study, 2 species of unknown *Potamyia* larvae could be associated with identifiable adult species, *Potamyia chaos* and *P. phaidra*. Details of each species are described as follows:

***Potamyia chaos* Malicky and Thani, 2000**

Larva: Total length 9.5-10.5 mm (n=10). Body shape typically as usual in Hydropsychidae. Almost head and notal sclerites yellow.

Head: Head capsule length, 1.02-1.05 mm; width, 0.82-0.85 mm. Entire head light-yellow (Fig. 3.321). Frontoclypeus with anterior margin concave, slightly crenulate; posteromedian portion with pair of small, pale, muscle scars (Fig. 3.322). Head covered with numerous, long, inclined truncate peg setae, mingled with tapered setae on dorsal and lateral regions in anterior three-quarters (Fig. 3.338). Entire frontoclypeus also covered with same setae; anterior margin of frontoclypeus bearing with brush of setae (Fig. 3.339). Head ventrally with stridulatory lines in

anterior half (Fig. 3.323). Labrum light-brown; elliptical in dorsal view; bearing well-developed, lateral, brown pectinate setae and setae on dorsal surface, posterior margin slightly concave in middle (Fig. 3.324). Mandibles with prominent lateral flanges, each with a row of setae along lateral groove. Each mandible with 2 apical and 4 mesal teeth, left mandible with tuft of hairs (Fig. 3.325). Submentum with posterolateral corner broadly rounded; anterior margin broadly V-shaped with median cleft; cleft with parallel sides, lateral areas with setae (Fig. 3.326). Anterior ventral apotome without or with weakly prominent anteromedian tubercle, lateral arms long, narrow; posterior ventral apotome small (Figs. 3.323, 3.326).

Thorax: Nota yellow with a dense covering of dark brown setae. Pronotum covered with numerous, long, truncate peg setae, mingled with tapered setae, same setae projecting beyond anterior margin (Figs. 3.327, 3.340). Meso- and metanotum each covered with numerous, inclined, long, scale hairs; same setae projecting beyond anterior margin (Figs. 3.328-3.329, 3.341). Prosternite broadly transverse, with broad dark band along posterior margin, with pair of small sclerites in posterolateral margins (Fig. 3.333). Propleuron ventrally with stout setae; trochantin unforked with vestigial dorsal ramus (Fig. 3.330). Foreleg with feather-like setae, mingled with palmate setae on mesal and lateral surfaces of coxa; trochanter and femur with long, feather-like setae on ventral surface, mingled with long setae (Fig. 3.330). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae mingled with spike-like setae on posterior surface of trochanter, femur, and tibia (Figs. 3.331-3.332). Mesosternum with one pair of gills; metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments covered with long, dark, club-like

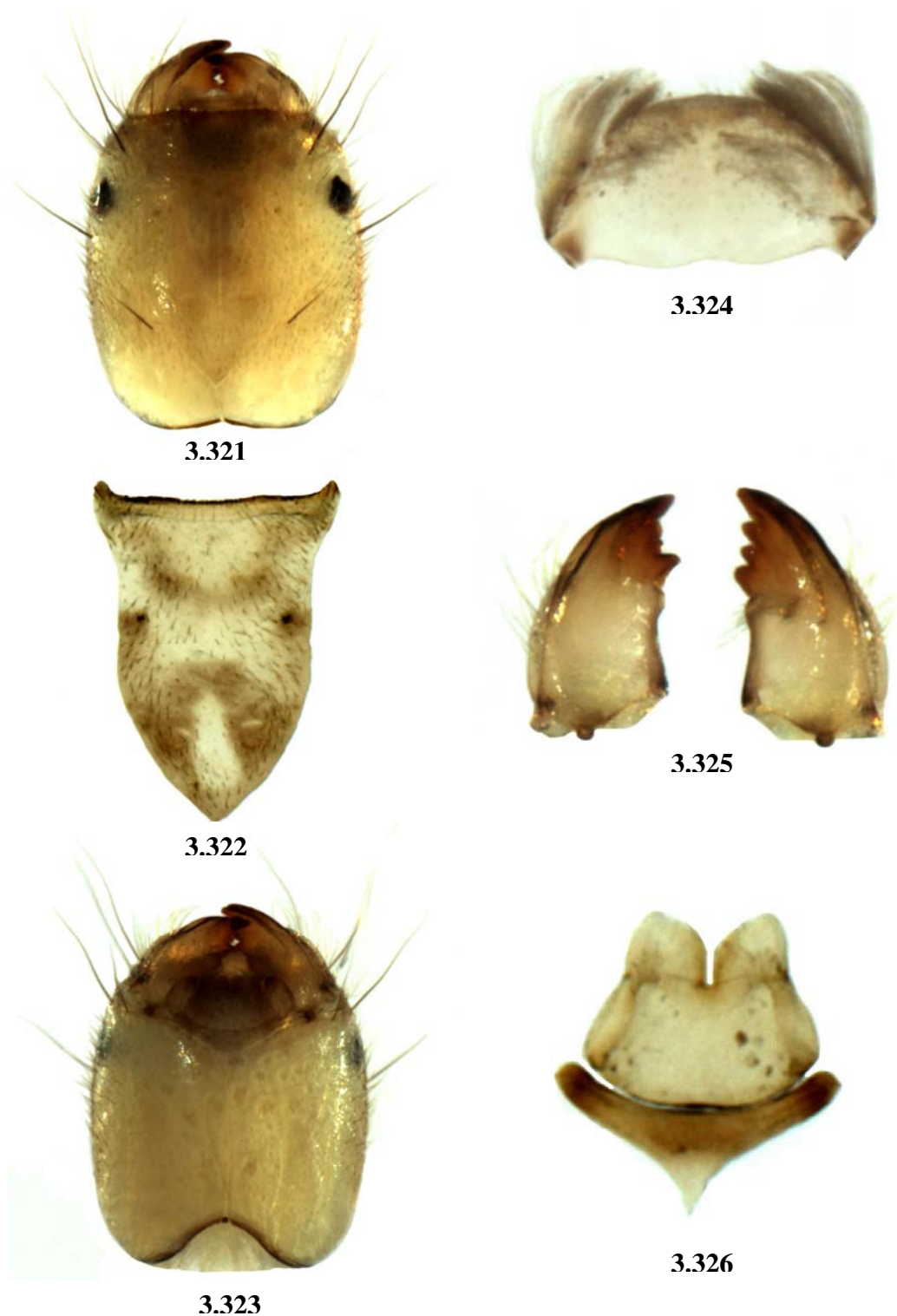
hairs that spiral with wide distal pore, mingled with appressed branched hair-like setae (Fig. 3.342). First sternum with 2 pairs of gills with adjacent bases (Fig. 3.343). Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills arising from a common base. Sterna VIII and IX each with pair of spike-bearing plates, sternum IX with spikes emanating from prominent sockets. Each sclerite of sternum IX entirely triangular. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.334). Anal prolegs with bent claw and cluster of long bristles, dorsal surface with spike-like setae, ventral surface without spike-like setae (Fig. 3.335).

Pupa: Labrum semicircular in dorsal view, with basolateral lobes, each lobe with group of dark, long setae; anteriorly with many moderately long, dark setae (Fig. 3.344). Mandibles widened at bases, with 2 groups of elongate setae on lateral and ventral surfaces; left mandible bearing 3 teeth, right mandible with 4 teeth (Fig. 3.336). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV (Fig. 3.345). Apical appendages with wide base narrowing to apex; tip oblique, highest on inner margin, with apex serrate between edges; posterior face with 4 large, pale subapical setae; ventral and lateral surfaces bearing long, black, slightly hooked setae from well-developed tubercles (Fig. 3.337).

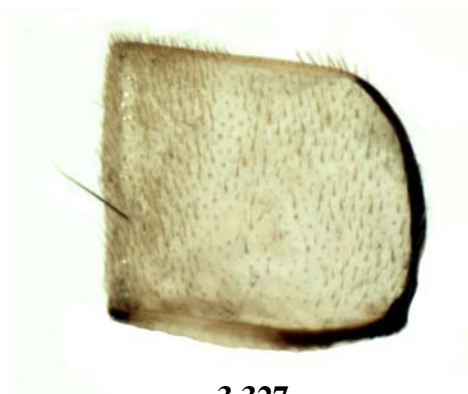
Diagnosis: The larval of *P. chaos* is easily recognized by its yellow coloration of the entire head and nota. However, this species can be distinguished from other species of *Potamyia* by the following characteristics: The anterior ventral apotome has a weakly-developed anteromedian tubercle and the apices are not cleft. The ventral sclerites of abdominal sternum IX are large and triangular. The lateral margin

of the mandible is strongly flanged, and the foretrochantin has a vestigial dorsal ramus.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 8-viii-2004, Prommi, 1 larva; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 3-viii-2004, Prommi, 1 pupa; same locality, 2-x-2004, Prommi, 2 larvae, 4 pupae; same locality, 20-iii-2004, Prommi, 1 larva; same locality, 13-v-2005, Prommi, 8 larvae; same locality, 6-ii-2006, Prommi, 6 larvae, 1 male mmt., 1 female mmt.



Figures 3.321-3.326. Larval features of *Potamyia chaos*: 3.321, dorsal view of head; 3.322, frontoclypeal apotome; 3.323, ventral view of head; 3.324, dorsal view of labrum; 3.325, ventral view of mandibles; 3.326, submentum and anterior ventral apotome.



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Figures 3.327-3.342. Larval features of *Potamyia chaos*: 3.327, semi-pronotum (right portion); 3.328, mesonotum; 3.329, metanotum; 3.330, foretrochantin and outer face of right foreleg; 3.331, inner face of left midleg; 3.332, inner face of left hindleg.



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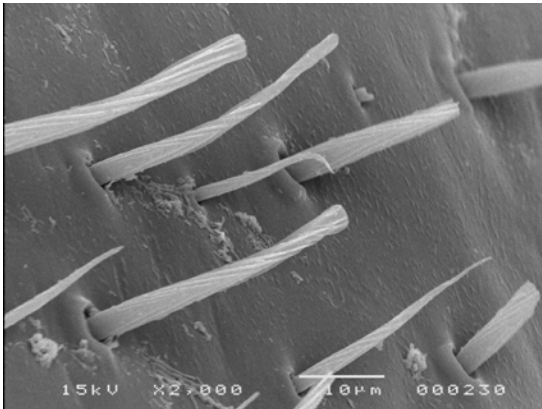


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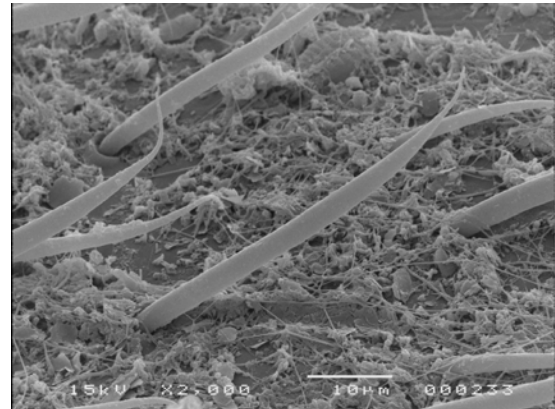


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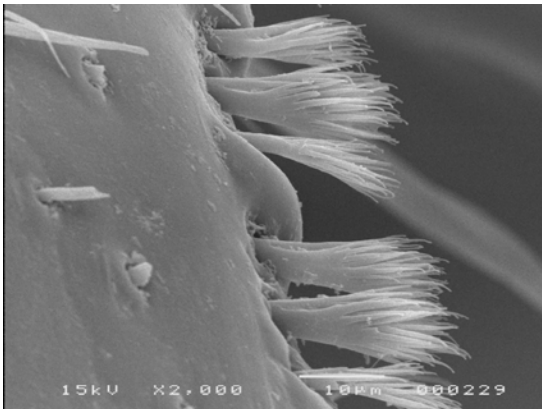
Figures 3.333-3.337. *Potamyia chaos*: 3.333, prosternum; 3.334, sterna VIII and IX; 3.335, lateral view of anal claw; 3.336, ventral view of pupal mandibles; 3.337, pupal apical abdominal appendages.



3.338



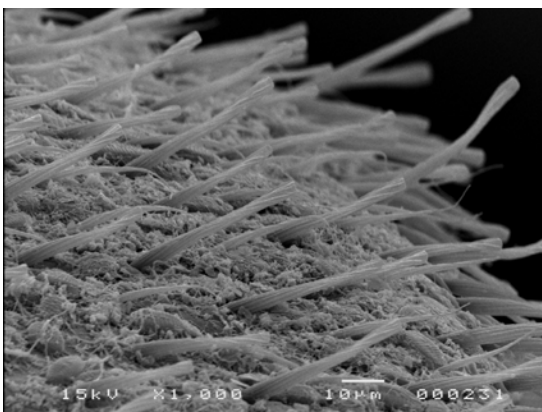
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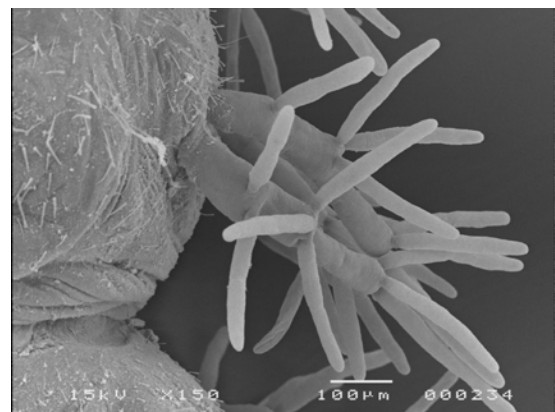
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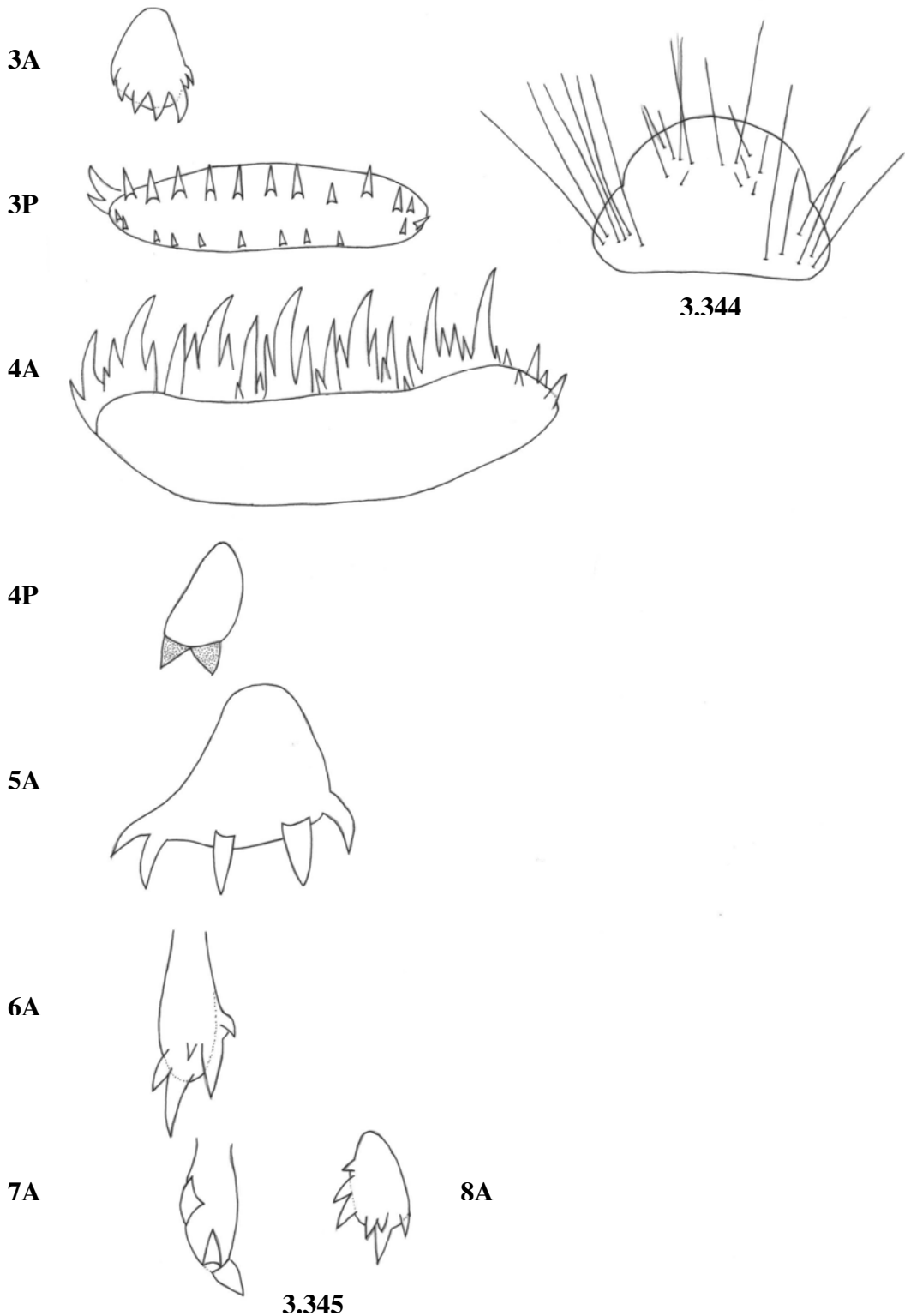


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Figures 3.338-3.343. *Potamyia chaos*: 3.338, setae on dorsum of head; 3.339, setae bear in anterior margin of frontoclypeus; 3.340, setae on pronotum; 3.341, setae on mesonotum; 3.342, setae on abdominal segments; 3.343, abdominal gills.



Figures 3.344-3.345. *Potamyia chaos*: 3.344. dorsal view of pupal labrum; 3.345, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position.

***Potamyia phaidra* Malicky and Chantaramongkol, 1997**

Larva: Total length 10.86-13.03 mm (n=10). Overall body shape as usual in Hydropsychidae (Fig. 3.346). Head yellowish to brown, with muscle scars on posterior half. Notal sclerites yellowish to brown, with muscle scars on posterior half of pronotum.

Head: Head capsule length, 1.02-1.16 mm; width, 1.00-1.16 mm. Dorsum of head dark-brown on anterior and becoming lighter on posterior, with yellowish ring around each eye. Posterior half of dorsum and areas near eyes with numerous muscle scars (Fig. 3.347). Frontoclypeus with anterior margin concave, slightly crenulate; posteromedian portion with pair of large and small muscle scars (Figs. 3.347-3.348). Head with numerous moderately long, truncate peg setae and tapered setae on dorsal and lateral regions in anterior three-quarters (Fig. 3.365). Head ventrally with stridulatory lines in anterior half (Fig. 3.350). Labrum elliptical in dorsal view; bearing well-developed, lateral, reddish-brown brushes and stout setae on dorsal surface, posterior margin slightly convex medially (Fig. 3.351). Mandibles with prominent lateral flanges, each with a row of setae along lateral groove. Each mandible with 3-5 apical and subapical teeth (Fig. 3.349). Submentum with posterolateral corner broadly rounded; anterior margin broadly V-shaped with median cleft; the cleft with parallel sided (Fig. 3.352). Anterior ventral apotome with prominent anteromedian tubercle, lateral arms long, narrow, slightly enlarged at apex; each apex usually cleft (Fig. 3.352); posterior ventral apotome small and triangular.

Thorax: Notal yellow to brown with a dense covering of dark-brown

setae. Pronotum with setae as in dorsum of head; muscle scars approximately at midway between midline and lateral margin in posterior half (Figs. 3.357, 3.366). Meso- and metanotum each densely covered with scale hairs; anterior margin of each notum bearing similar setae (Figs. 3.358-3.359, 3.367). Prosternite transverse, narrow, with broad dark band along posterior margin, with pair of small sclerites on posterolateral margin (Fig. 3.353). Propleuron ventrally with stout setae, trochantin acuminate with stout setae. Foreleg with long setae on anterior surface of coxa, posterior surface possess feather-like setae; femur with long setae on ventral surface (Figs. 3.360, 3.368). Mid- and hindlegs similar in size, shape, and structure; with feather-like setae only on posterior surface of femur; no feather-like setae on tibia or tarsus (Figs. 3.361-3.362). Mesosternum with one pair of gills; metasternum with 2 pairs of gills; gills consisting of central stem bearing many lateral filaments.

Abdomen: Abdominal segments with dark, scale hairs, more dense on ventral surface. First sternum with 2 pairs of gills with adjacent bases. Segments II-V each with one pair of median gills. Segments II-VII each with one pair of lateral gills arising from a common base (Fig. 3.369). Sterna VIII and IX each with pair of spike-bearing plates, sternum IX with spikes emanating from prominent sockets. Each sclerite of sternum IX entire triangular. Tergum IX with small lateral sclerite and pair of large dorsal sclerites (Fig. 3.354). Anal prolegs with bent claw and cluster of long bristles, ventral surface without spike-like setae (Fig. 3.355).

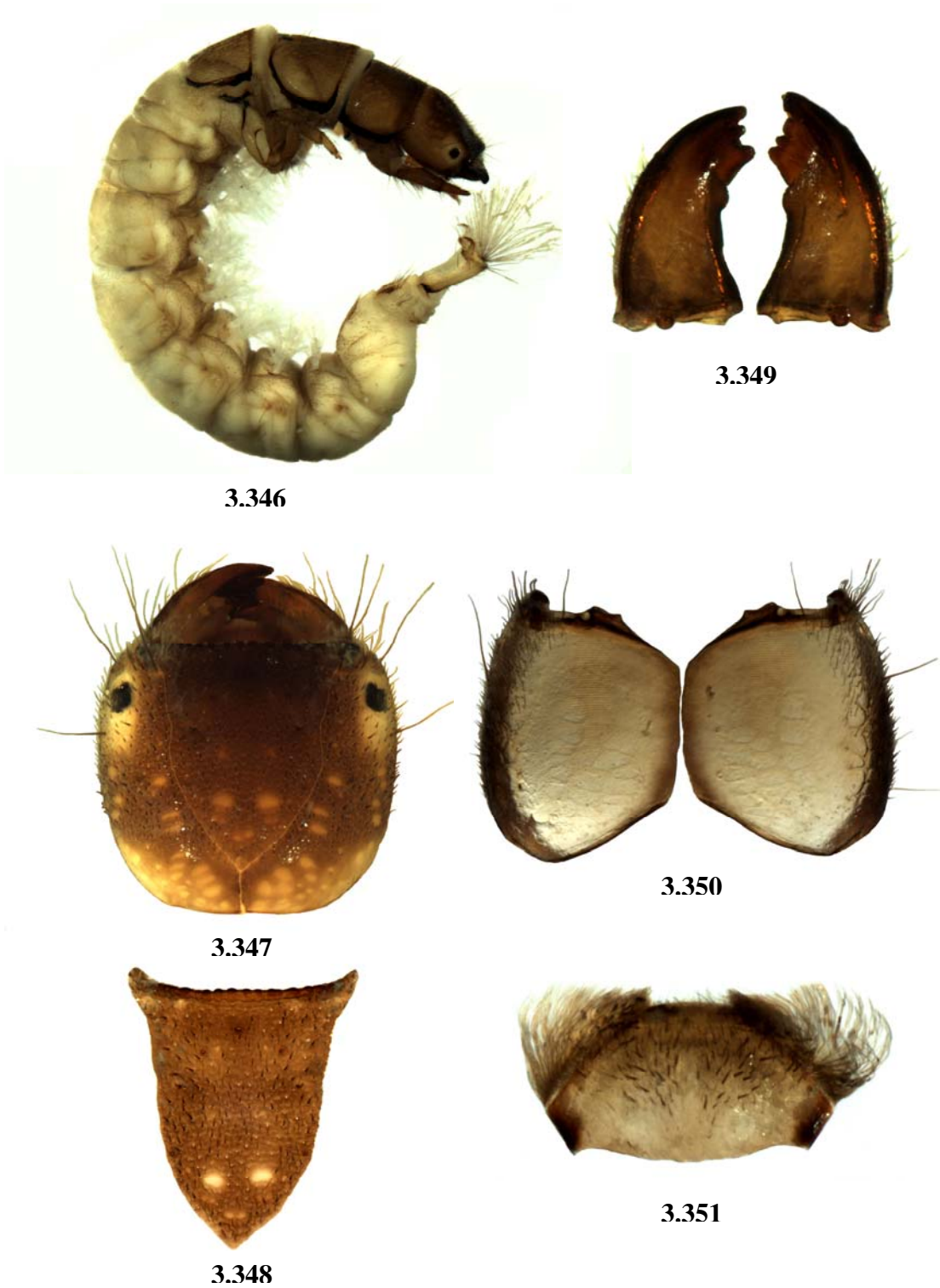
Pupa: Labrum semicircular in dorsal view, with basolateral lobes; each lobe with group of dark, long setae; anteriorly with many moderately-long, dark setae. Mandibles tapering regularly to pointed apex; inner margin with 2 large teeth; widened at bases, with 2 groups of elongate setae on lateral and ventral surfaces (Fig.

3.356). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III-IV, posterior hook plate of segment IV covered with a row of long setae (Fig. 3.363). Apical processes with wide base narrowing to apex; ventral surface and lateral margins bearing elongate setae (Fig. 3.364).

Diagnosis: The most distinctive larval characteristics of *P. phaidra* are the anterior ventral apotome with a prominent anteromedian tubercle and cleft apices, ventral sclerites of abdominal sternum IX distinct and separate, lateral margin of each mandible weakly flanged, the fore-trochantin not forked, and many muscle scars on the posterior half of the head and posterior half of the pronotum.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 2-iv-2005, Prommi, 17 larvae, 2 pupae; NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 10-viii-2004, Prommi, 28 larvae, 5 pupae; same locality, 11-x-2004, 15 larvae, 4 pupae; Khao Luang National Park, stream from Ai Khaew Waterfall, 3-xii-2004, Prommi, 13 larvae; stream from Yord Luang Waterfall, 7-iv-2005, Prommi, 35 larvae, 2 pupae; same locality, 26-v-2005, 57 larvae, 4 pupae; SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 9-viii-2004, Prommi, 53 larvae, 4 pupae, 6 adults; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 7-x-2004, Prommi, 10 larvae, 2 pupae; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 5-viii-2004, Prommi, 4 larvae; same locality, 5-x-2004, 2 larvae.

Discussion: Of the 13 species of *Potamyia* known from Thailand, *P. phaidra* and *P. flavata* have the most widespread distribution (Malicky & Chantaramongkol, 1999). Of these 3 were collected by light trapping from this study (Table 2.3). The other 10 species known to occur in Thailand appear to have more restricted distributions. Two immature larvae and pupae of this genus could be associated with adult stage from this study (Table 2.4). Larvae of *Potamyia* are found in mid-stream where microhabitats vary from depositional pools to riffles areas. The larvae make a retreat from sandgrains.



Figures 3.346-3.351. Larval features of *Potamyia phaidra*: 3.346, larva; 3.347, dorsal view of head; 3.348, frontoclypeal apotome; 3.349, ventral view of mandibles; 3.350, ventral view of head; 3.351, dorsal view of labrum.



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3.353

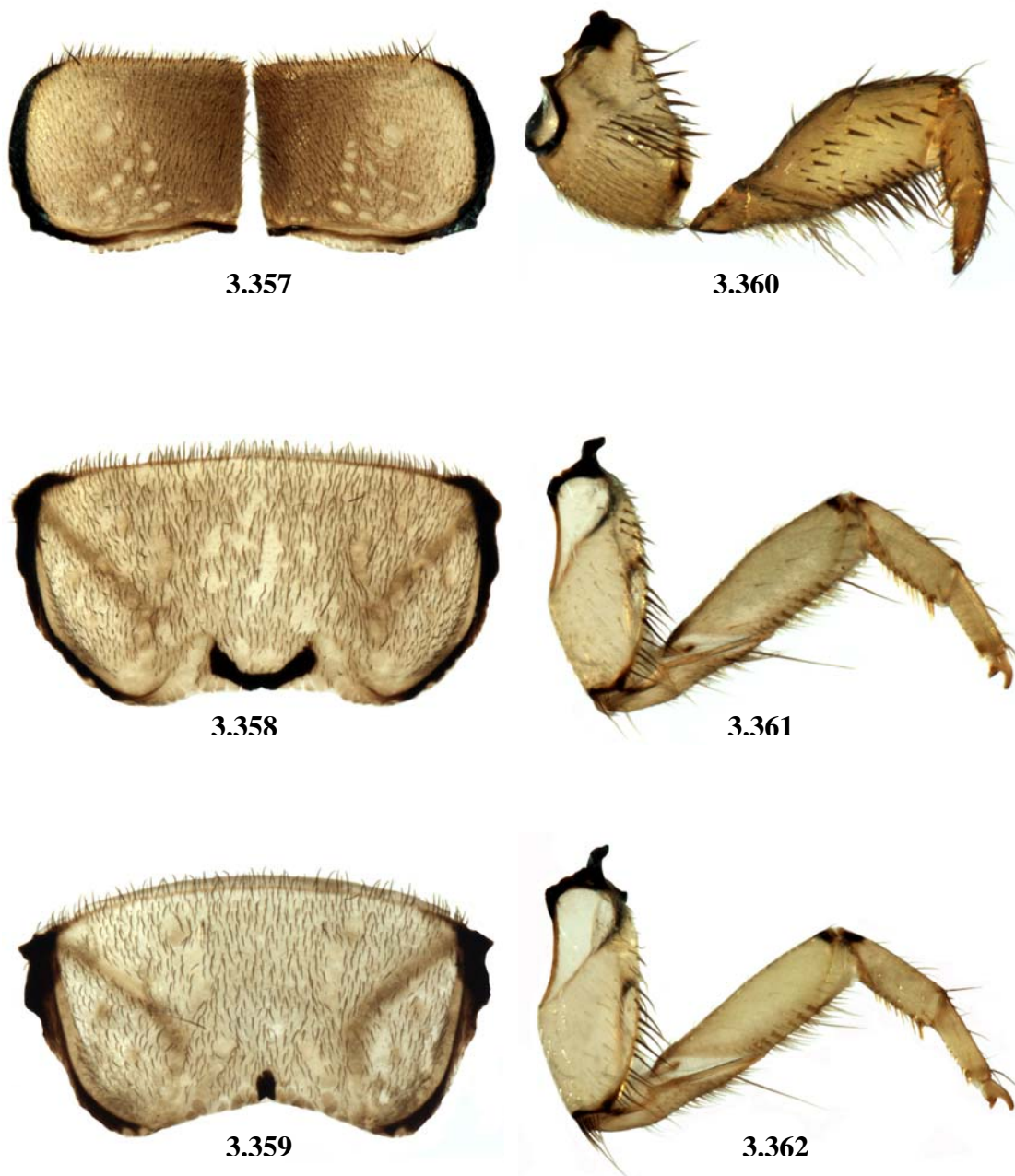


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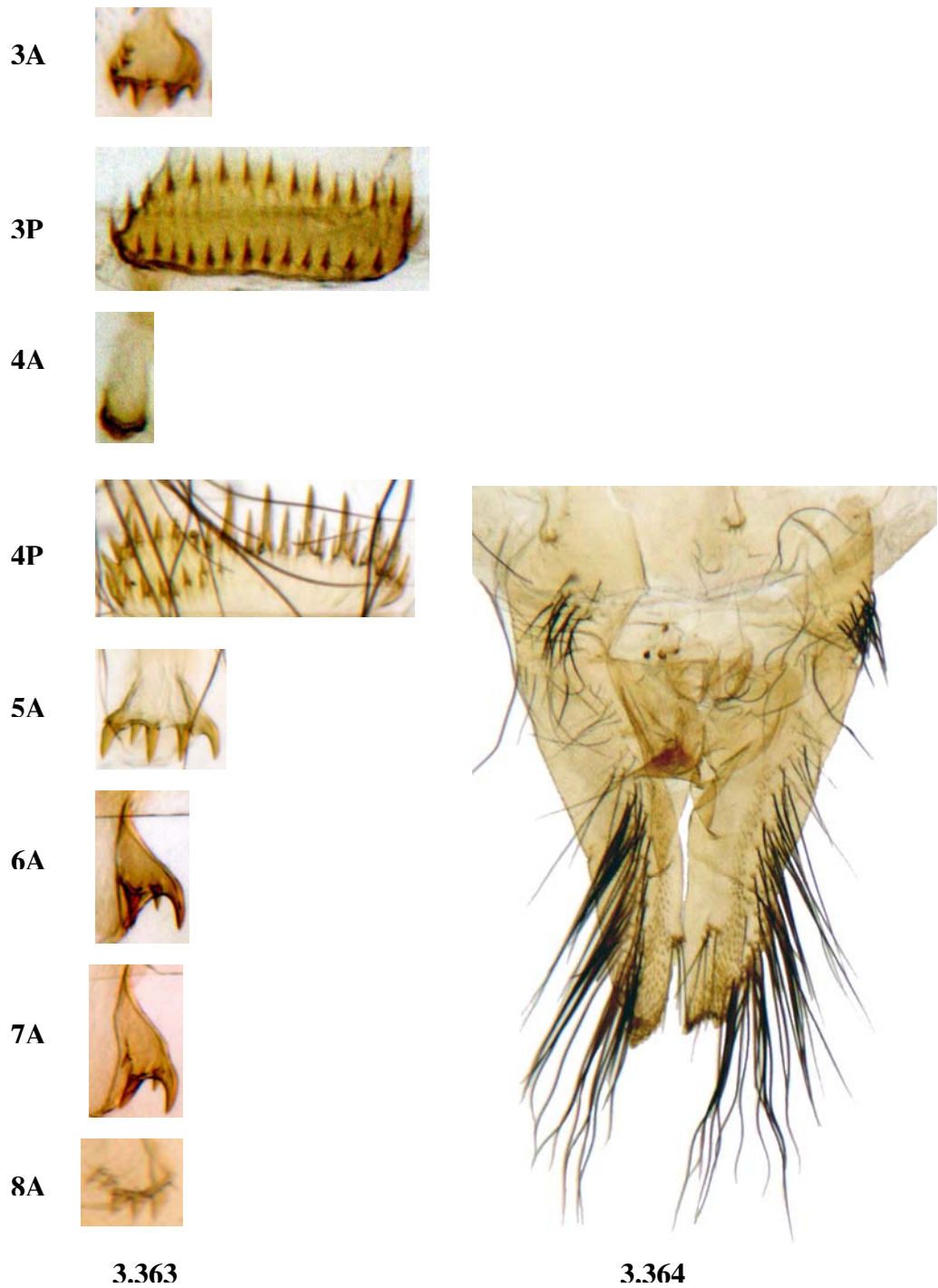


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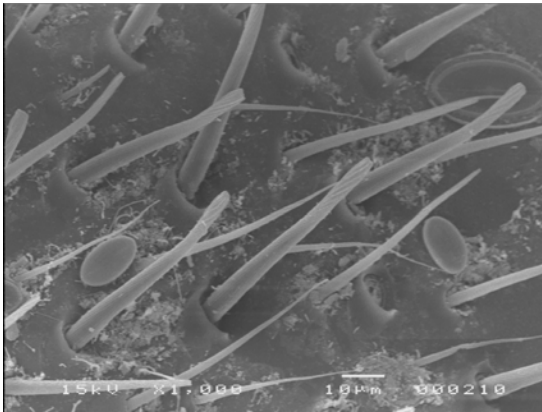
Figures 3.352-3.356. *Potamyia phaidra*: 3.352, submentum and anterior ventral apotome; 3.353, prosternum; 3.354, sterna VIII and IX; 3.355, lateral view of anal claw; 3.356, ventral view of pupal mandibles.



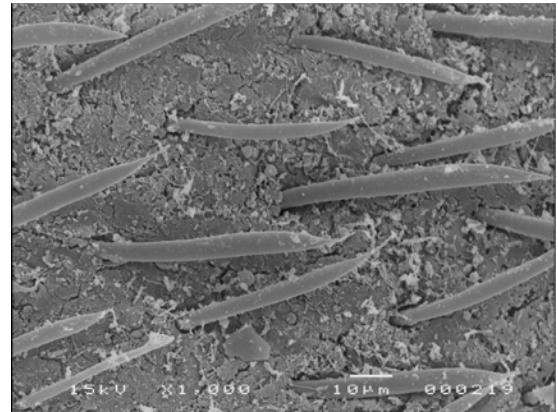
Figures 3.357-3.362. Larval features of *Potamyia phaidra*: 3.357, pronotum; 3.358, mesonotum; 3.359, metanotum; 3.360, outer face of right foreleg; 3.361, inner face of left midleg; 3.362, inner face of left hindleg.



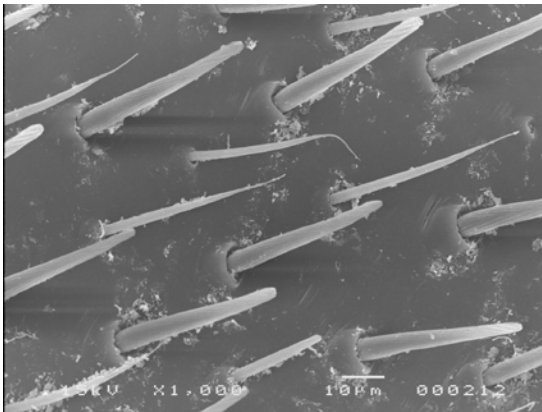
Figures 3.363-3.364. *Potamyia phaidra*: 3.363, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.364, pupal apical abdominal appendages.



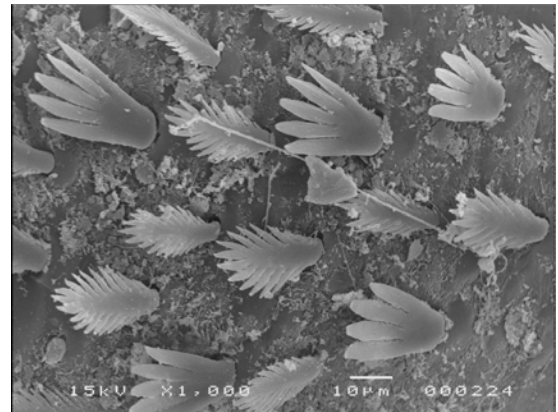
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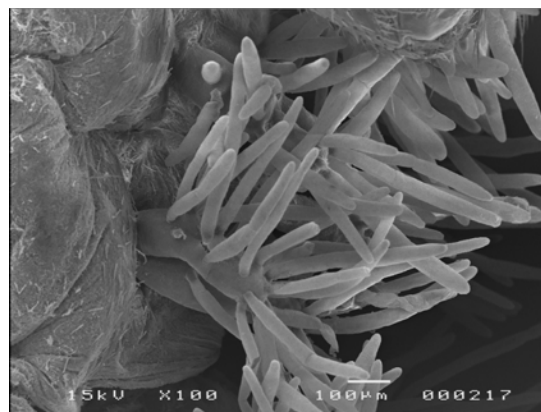
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Figures 3.365-3.369. *Potamyia phaidra*: 3.365, setae on dorsum of head; 3.366, setae on pronotum; 3.367, setae on mesonotum; 3.368, setae on fore-coxa; 3.369, abdominal gills.

GENUS *Macrostemum* Kolenati, 1859

Diagnosis: Larvae of *Macrostemum* have typical characteristics of the family. Dorsally, the head is flattened, and has a prominent carina. The anteclypeus is membranous and bears a pair of sclerites at base. The posterior ventral apotome is very small and the anterior ventral ecdysial line is lacking on one side, thus anterior ventral apotome is only half delimited. The foretrochantin is simple. The foreleg has a dense setal tuft on the lateral surface of the tibia and tarsus. The mesosternum with one pair of branched gills and the metasternum has 2 pairs. Gills are present on abdominal segments I-VII.

From the results of this study, 3 species of unknown *Macrostemum* larvae could be associated with identifiable adult species, *Macrostemum dohrni*, *M. fenestratum*, and *M. hestia*. Details of each species are described as follows:

Macrostemum dohrni Ulmer, 1905

Larva: Total length 16.5-17.5 mm (n=10). Sclerites light-brown to dark-brown, muscle scars paler.

Head: Head capsule length, 1.53-1.67 mm; width, 1.53-1.67 mm. Head dark-brown except small, circular, light-brown around eyes. Genae with dorsolateral a carina passing above eyes; carina with few short and long setae (Fig. 3.385). Lateral aspect of head with 2 groups of scattered setae near eyes and posterior angles (Fig. 3.386). Frontoclypeus with anterior margin concave. Lateral margin of

clypeus near pretentorinae slightly constricted; posteriorly triangular and extending beyond carina (Fig. 3.370). Head ventrally with anterior most 6 stridulatory lines widely separated, the transition to closely-spaced posterior lines very abrupt; muscle scars midway between midline and lateral margin in posterior half (Fig. 3.371). Labrum golden-brown, with large membranous basal region bearing 2 transverse sclerites adjacent to frontoclypeus; with large lateral brushes on lobes; anterior margin with dense fringe of hairs and rows of short, erect, clavate setae; dorsal surface with scattered pale setae and pair of long dark setae on anteromesal portion; posteromedially protrude medially (Fig. 3.373). Mandibles dark-brown, strongly asymmetrical, with 2 apical and 2 mesal teeth; without mesal tuft of hairs; lateral margin with ridge and scattered setae (Fig. 3.372). Submentum large, wider at base; anterior margin slightly concave; anterior angle bearing long setae (Fig. 3.374). Anterior ventral ecdysial line absent from right side; posterior ventral apotome very small (Fig. 3.371).

Thorax: Pronotum dark-brown in anterior half; light-brown in posterior half, with short and long setae on anterior margin; muscle scars midway between midline and lateral margin in posterior half (Fig. 3.377). Prosternum broadly transverse; with triangular, posteromesal sclerite (Fig. 3.375). Mesonotum light-brown, with 3 pairs of long setae on anterior margin; 3 pairs of long setae and scattered hair-like setae; same setae on anterior margin (Fig. 3.378). Metanotum with 2 pairs of long setae; lateral margin with 2 pairs of long setae, mingled with scattered hair-like setae (Fig. 3.379). Foretrochantin pointed upward, with few setae. Coxa of foreleg with pad of short, spiniform setae on posteromesal surface; trochanter and femur of forelegs with long, slender hairs on ventral margins; femur bearing a slender,

digitate basomesal process; tibia and tarsus with dense fringe of long, silky hairs primarily on lateral surface; ventral margin with moderately long hairs (Fig. 3.380). Mid- and hindlegs similar; with scattered long setae; apex of tibia with 4-5 stout and broad setae; spiniform setae on anterior margin (Figs. 3.381-3.382). Mesosternum with one pair of gills; metasternum with 2 pairs of gills.

Abdomen: Gills ventrally, laterally, and dorsolaterally as in Figs. 3.387, 3.390. Abdominal segments bears numerous with long, flexible hair-like setae. Sternum VIII with pair of long, dark setae and group of shorter, dark setae. Tergum IX divided into pair of small, lateral plates; each plate bearing row of long setae. Sternum IX with pair of ovoid plates covered with pale spiniform setae and 2 or 3 long, black setae on posterior portion; dorsolateral regions with pair of moderate, pale, plates each bearing a few, long setae (Fig. 3.388). Anal proleg with lateral sclerites bearing row of long, black setae on lateral margin; anal claw curved ventrad with cluster of long bristles; with 2 pale ventrobasal setae (Fig. 3.389).

Pupa: Labrum small and rounded, with 2-3 basolateral setae. Mandibles tapering regularly to a pointed apex; inner margin of left mandible with 4 teeth; right mandible with 3 teeth; inflated at bases, with group of setae on outer face; each distal tooth serrated (Fig. 3.376). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segment III (Fig. 3.383). Apical processes tapering to blunt points, with apical hooked setae; lateral surface bearing long, black setae (Fig. 3.384).

			S	S	S	S	S	S	
			D	D					
	S	S	D	S	D	D	S	S	
S	S								
Meso	Meta	1	2	3	4	5	6	7	8

Figure 3.390. *Macrostemum dohrni*. Schematic gill diagrams of the lateral aspect of the meso- and metathorax and first 8 abdominal segments. S = a single long central stalk with numerous lateral filaments; D = 2 S-type filaments with adjacent bases.

Diagnosis: This species may be distinguished on the basis of the frontoclypeus color pattern. The frontoclypeus is unicolored dark-brown, wide anteriorly, slightly narrowed at mid-length, and triangular posteriorly extending beyond the carina. Ventrally the head has anterior 6 widely separated stridulatory lines, with an abrupt transition to the closely spaced posterior stridulatory lines. Abdominal segments III and VI have 2 pairs (dorsal and lateral) of gills with a single long central stalk with numerous lateral filaments. Sternum VIII has a pair of long, dark setae, and a group of shorter, dark setae.

Material examined: SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 10-x-2004, Prommi, 1 larva; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31'

E, 4-iv-2005, Prommi, 13 larvae, 8 pupae, 1 male mmt.; KRABI Prov.: Khaopanombenja National Park, Huai To Waterfall; 26 m. 08°14' N, 98°54' E, 5-iv-2005, Prommi, 6 larvae; NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-viii-2004, Prommi, 2 larvae; same locality, 11-x-2004, 1 pupa; same locality, 6-iv-2005, Prommi, 15 larvae; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 11 larvae, 1 pupa, 1 male mmt.; same locality, 5-x-2004, Prommi, 6 larvae, 4 pupae, 1 male mmt.; 12-iv-2005, Prommi, 31 larvae, 9 pupae, 4 male mmts.; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 4-viii-2004, Prommi, 3 larvae, 1 pupa; same locality, 1-xii-2004, Prommi, 6 larvae, 1 pupa, 1 male mmt.; same locality, 1-ii-2005, Prommi, 20 larvae, 2 pupae; same locality, 14-ii-2005, Prommi, 15 larvae, 1 pupa, 1 female mmts.; same locality, 20-iii-2005, Prommi, 39 larvae, 2 pupae, 1 female mmt.; same locality, 17-vi-2005, Prommi, 3 larvae; NARATHIWAT Prov.: Hala-Bala Wildlife Sanctuary, stream from Sirindorn Waterfall; 62 m. 05°48' N, 101°49' E, 4-ix-2004, Prommi, 35 larvae, 23 pupae.



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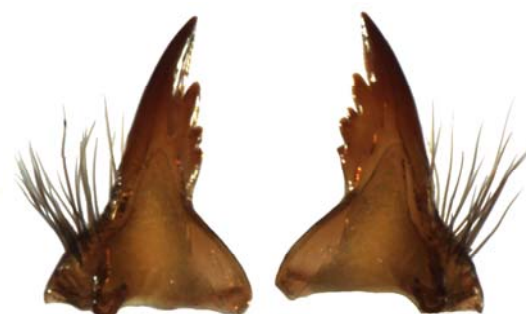
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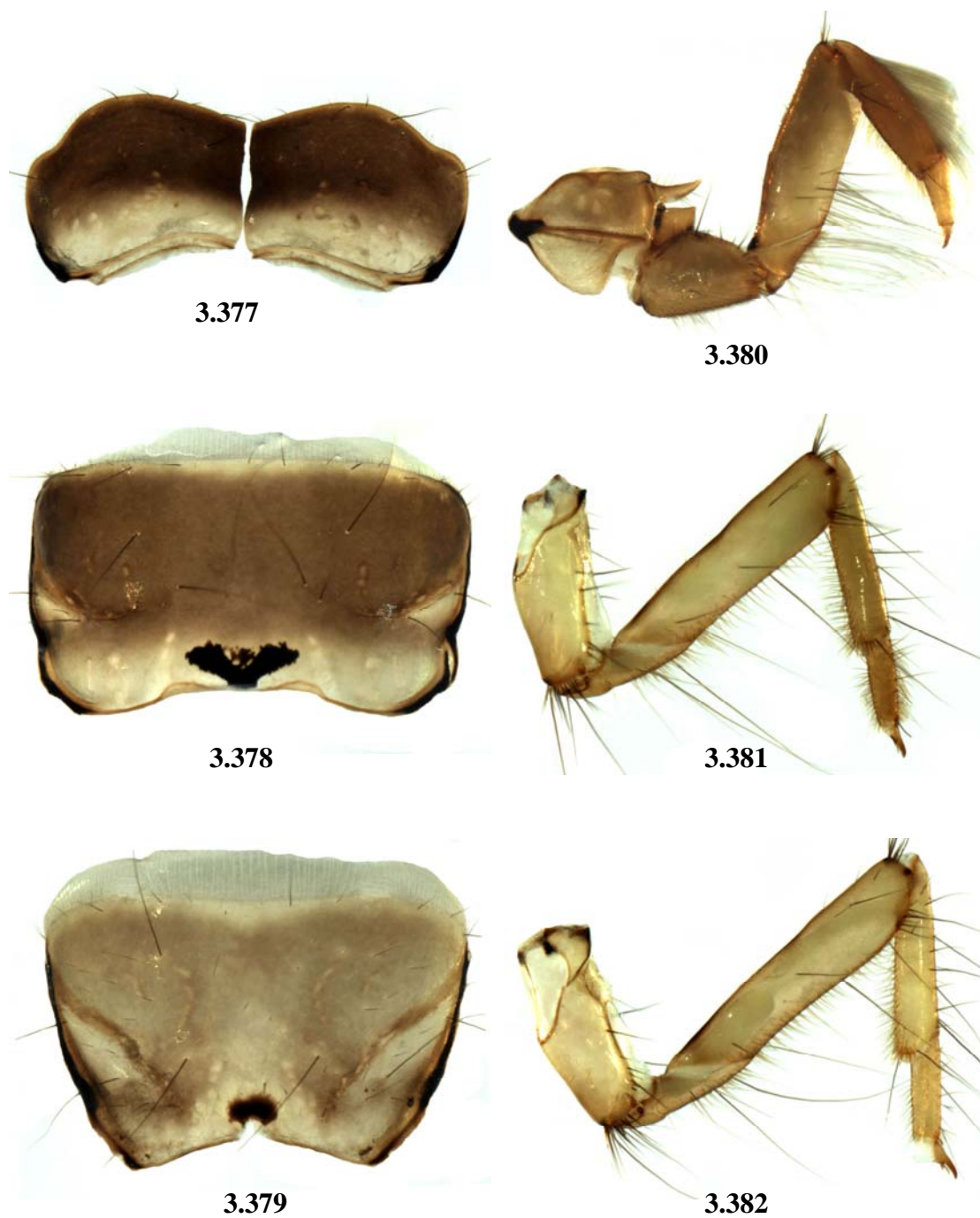


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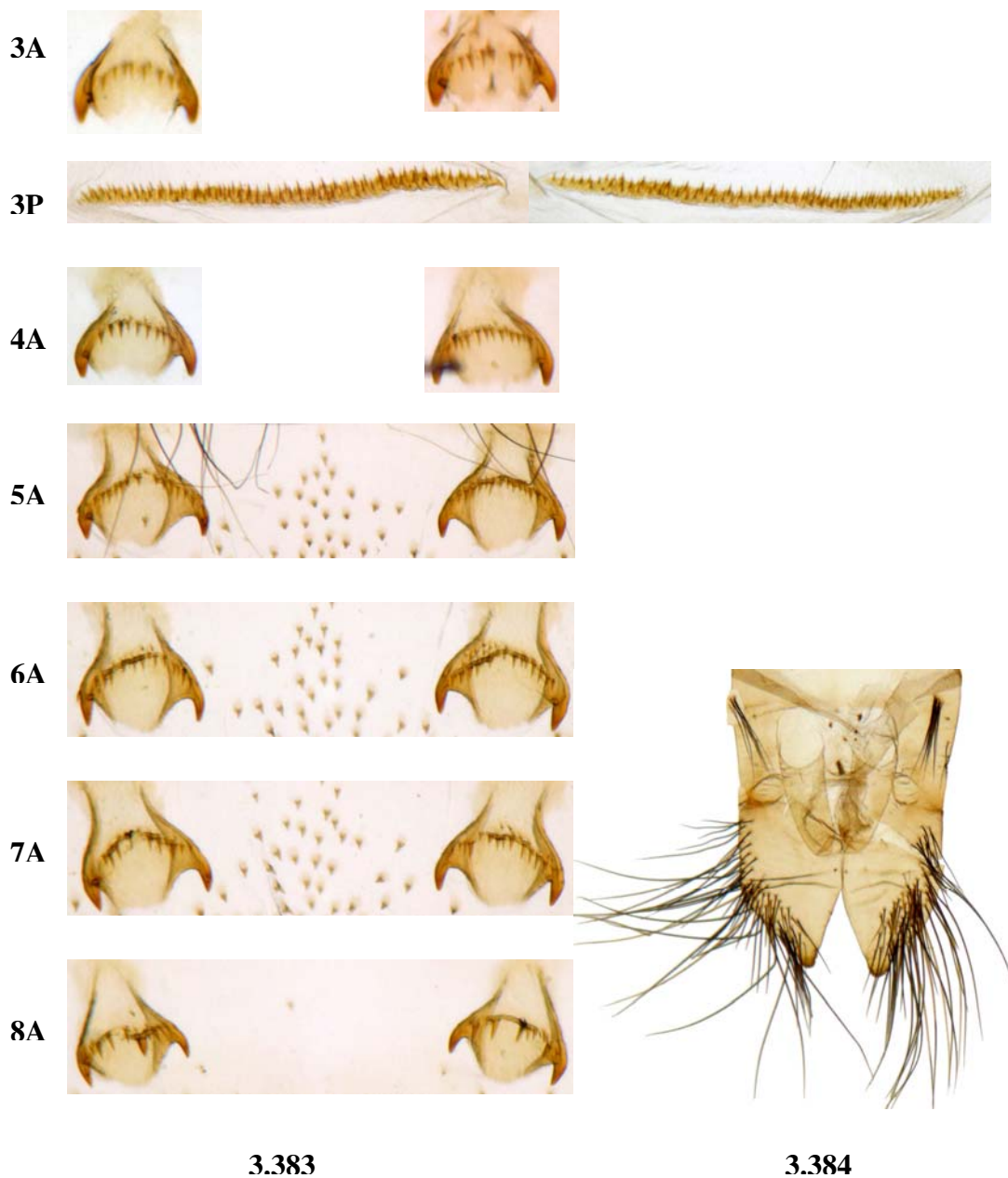


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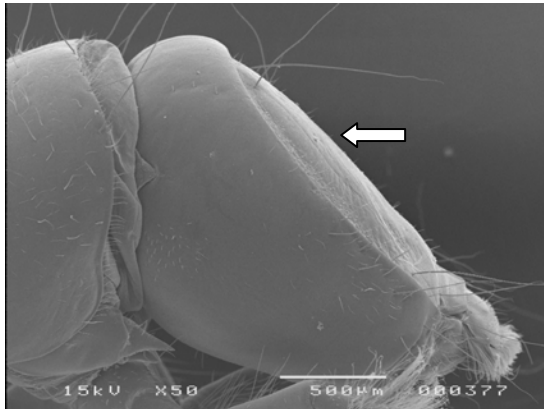
Figures 3.370-3.376. Larval features of *Macrostemum dohrni*: 3.370, frontoclypeal apotome; 3.371, ventral view of head; 3.372, ventral view of mandibles; 3.373, dorsal view of labrum; 3.374, submentum; 3.375, prosternum; 3.376, ventral view of pupal mandibles.



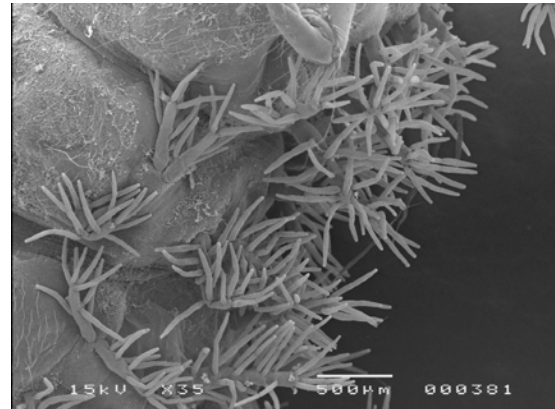
Figures 3.377-3.382. Larval features of *Macrostemum dohrni*: 3.377, pronotum; 3.378, mesonotum; 3.379, metanotum; 3.380, outer face of right foreleg; 3.381, inner face of left midleg; 3.382, inner face of left hindleg.



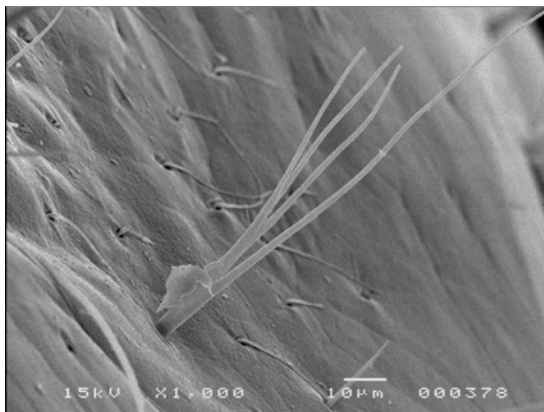
Figures 3.383-3.384. *Macrostemum dohrni*: 3.383, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.384, pupal apical abdominal appendages.



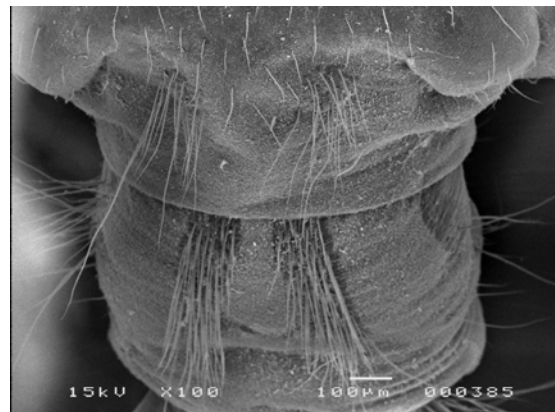
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Figures 3.385-3.389. *Macrostemum dohrni*: 3.385, lateral aspect of head showing a carina (↔); 3.386, setae present on inside a carina; 3.387, abdominal gills; 3.388, sterna VIII and IX; 3.389, anal claw.

***Macrostemum fenestratum* Albarda, 1887**

Larva: Total length 6.5-7.5 mm (n=10). Overall body shape as usual in Hydropsychidae. Sclerites pale reddish-brown to golden-yellow.

Head: Head capsule length, 1.12 mm; width, 1.16 mm. Dorsum of head yellowish, paler around eyes and posterolaterally. Genae with dorsolaterally carina passing above eyes; carina with row of long setae (Fig. 3.391). Ridge anteriorly slightly higher than posteriorly; carina with thin, hair-like setae (3.407). Frontoclypeus with anterior margin concave; posteriorly triangular extending beyond the carina. Lateral margin of clypeus near pretentorinae with 2 pairs of yellow rectangular marks (Figs. 3.391-3.392). Head ventrally with stridulatory lines widely separated in anterior half, the transition to closely-spaced posterior lines very abrupt; muscle scars midway between the midline and lateral margin in posterior half (Fig. 3.393). Labrum with large membranous basal region bearing 2 transverse sclerites adjacent to frontoclypeus; with large lateral brushes on lobes; anterior margin with dense fringe of hairs and rows of short, erect, clavate setae; dorsal surface with scattered pale setae and pair of long dark setae in anteromesal region; posteromedially protrude (Figs. 3.394, 3.408). Mandibles reddish-brown, strongly asymmetrical, without mesal tuft of hairs; lateral margin of mandibles with ridge and scattered setae. Left mandible with 2 apical and 5 mesal teeth; right mandible with 1 apical and 4 mesal teeth (Fig. 3.395). Submentum large, wider at base; anterior margin concave; anterior angle bearing long setae (Fig. 3.396). Anterior ventral ecdysial line absent from right side; posterior ventral apotome very small (Fig. 3.393).

Thorax: Nota light-brown with long setae on anterior margin; muscle scars midway between midline and lateral margin in posterior half (Figs. 3.397-3.399). Prosternum broadly transverse; with triangular, posteromesal sclerite. Each nota with scattered, short, appressed, hair-like setae and erect, hair-like setae with five filaments (Fig. 3.409). Foretrochantin pointed, with few setae (Fig. 3.400). Coxa of foreleg with pad of short, spiniform setae posteromesally. Femur of foreleg bearing a slender, digitate basomesal process; tibia and tarsus with dense fringe, long, silky hairs primarily on lateral surface (Fig. 3.400). Mid- and hindlegs similar; with scattered long setae; apex of tibia with 4-5 stout and broad setae; spiniform setae on anterior margin (Figs. 3.401-3.402). Mesosternum with one pair of gills and metasternum with 2 pairs of gills.

Abdomen: Gills ventrally, laterally, and dorsolaterally as in Figs. 3.411-3.412. Abdominal segments covered with numerous, long, flexible hair-like setae and dense minutely, hook-like setae (Fig. 3.410). Sternum VIII with pair of long setae, and 2 pairs of shorter setae. Tergum IX with 3 pairs of large sclerites; dorsolateral pairs with long setae posteriorly; lateral pairs with row of long, black setae; ventral pairs with pair of ovoid plates covered with pale spiniform setae and 2 or 3 long, black setae posteriorly. Anal proleg short; lateral sclerites with row of long, black setae; anal claw curved ventrad and cluster of long bristles, without spike-like setae on ventral surface; ventrobasal with 2 pale setae (Fig. 3.403).

Pupa: Labrum small and rounded, with 2-3 basolateral setae. Mandibles tapering regularly to a pointed apex; inner margin with 4 teeth; inflated at bases, with group of setae on lateral surface; each distal tooth serrated (Fig. 3.404). Dorsal surface with

one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III (Fig. 3.405). Apical processes tapering to blunt points, with apical hooked setae; lateral surface bearing long, black setae (Fig. 3.406).

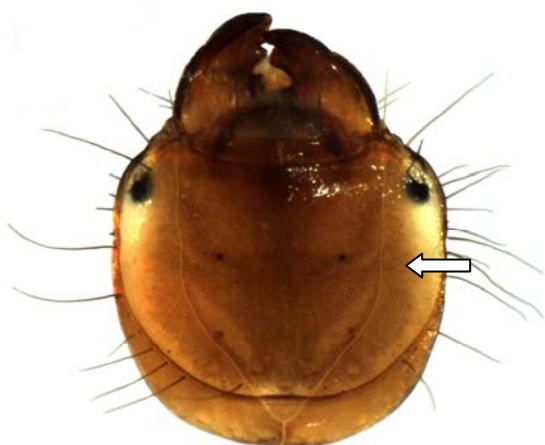
			S	S	S	S	S	S	
			D	D					
	S	S	S	S	D	D	S	S	
S	S	S	S	S	S	S	S		
Meso	Meta	1	2	3	4	5	6	7	8

Figure 3.412. *Macrostemum fenestratum*. Schematic gill diagrams of the lateral aspect of the meso- and metathorax and first 8 abdominal segments. S = a single long central stalk with numerous lateral filaments; D = 2 S-type filaments with adjacent bases.

Diagnosis: This small and distinctive species is easily recognized on the basis of the presence of two pairs of yellow rectangular marks on lateral margin of clypeus near pretentorinae. The anterior section of ridge is slightly higher than posterior in lateral view and anterior margin of frontoclypeus is strongly concave. The abdominal segments II, III, and VI have two pairs dorsal and lateral of gill with a single long central stalk with numerous lateral filaments. The heavy long, flexible hair-like setae and dense minutely, hook-like setae inconspicuous under a dissecting microscope are present on abdominal segments.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 8-viii-2004, Prommi, 1 larva; same locality, 2-iv-2005, Prommi, 12 larvae; RANONG Prov.: Klong Na Kha Wildlife Sanctuary, Klong Bang Mun stream, 50 m. 09°27' N, 98°30' E, 3-iv-2005, Prommi, 4 larvae, 2 pupae; SURAT THANI Prov.: Tai Rom Yen National Park, stream from Dad Fah Waterfall, 236 m. 08°51' N, 99°28' E, 9-viii-2004, Prommi, 3 larvae; Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 4-iv-2005, Prommi, 13 larvae, 1 pupa; SATUN Prov.: Tarutao National Park, stream from Ludoo Waterfall, 6-iii-2005, Prommi, 183 larvae, 5 pupae, 2 male mmts., 1 female mmt.; NAKHON SI THAMMARAT Prov.: Yong Waterfall National Park, stream from Yong Waterfall, 112 m. 08°10' N, 99°44' E, 10-viii-2004, Prommi, 30 larvae, 2 male mmts.; same locality, 11-x-2004, 13 larvae; same locality, 6-iv-2005, Prommi, 15 larvae, 1 female mmt.; Khao Luang National Park, stream from Yord Luang Waterfall, 78 m. 08°38' N, 99°44' E, 26-v-2005, Prommi, 18 larvae, 2 pupae, 1 male mmt.; TRANG Prov.: Khao Chong Wildlife Management Station, stream from Ka Chong Waterfall, 59 m. 07°32' N, 99°47' E, 4-viii-2004, Prommi, 56 larvae, 6 pupae; same locality, 5-x-2004, Prommi, 16 larvae, 3 pupae; same locality, 12-iv-2005, Prommi, 24 larvae, 4 pupae; PATTHALUNG Prov.: Khaobantad Wildlife Sanctuary, stream from Momjui Waterfall, 95 m. 07°15' N, 100°02' E, 4-x-2004, Prommi, 4 larvae; SONGKHLA Prov.: Ton Nga Chang Wildlife Sanctuary, Ton Nga Chang Waterfall, 53 m. 06°56' N, 100°14' E, 4-viii-2004, Prommi, 40 larvae, 3 pupae; same locality, 3-x-2004, Prommi, 29 larvae, 2 pupae, 1 male mmt.; same locality, 1-xii-2004, Prommi, 1 pupa; same locality, 1-ii-2005, Prommi, 2 larvae; same locality, 20-iii-2005, Prommi, 8

larvae; same locality, 12-iv-2005, Prommi, 1 larva; same locality, 17-vi-2005, Prommi, 13 larvae.



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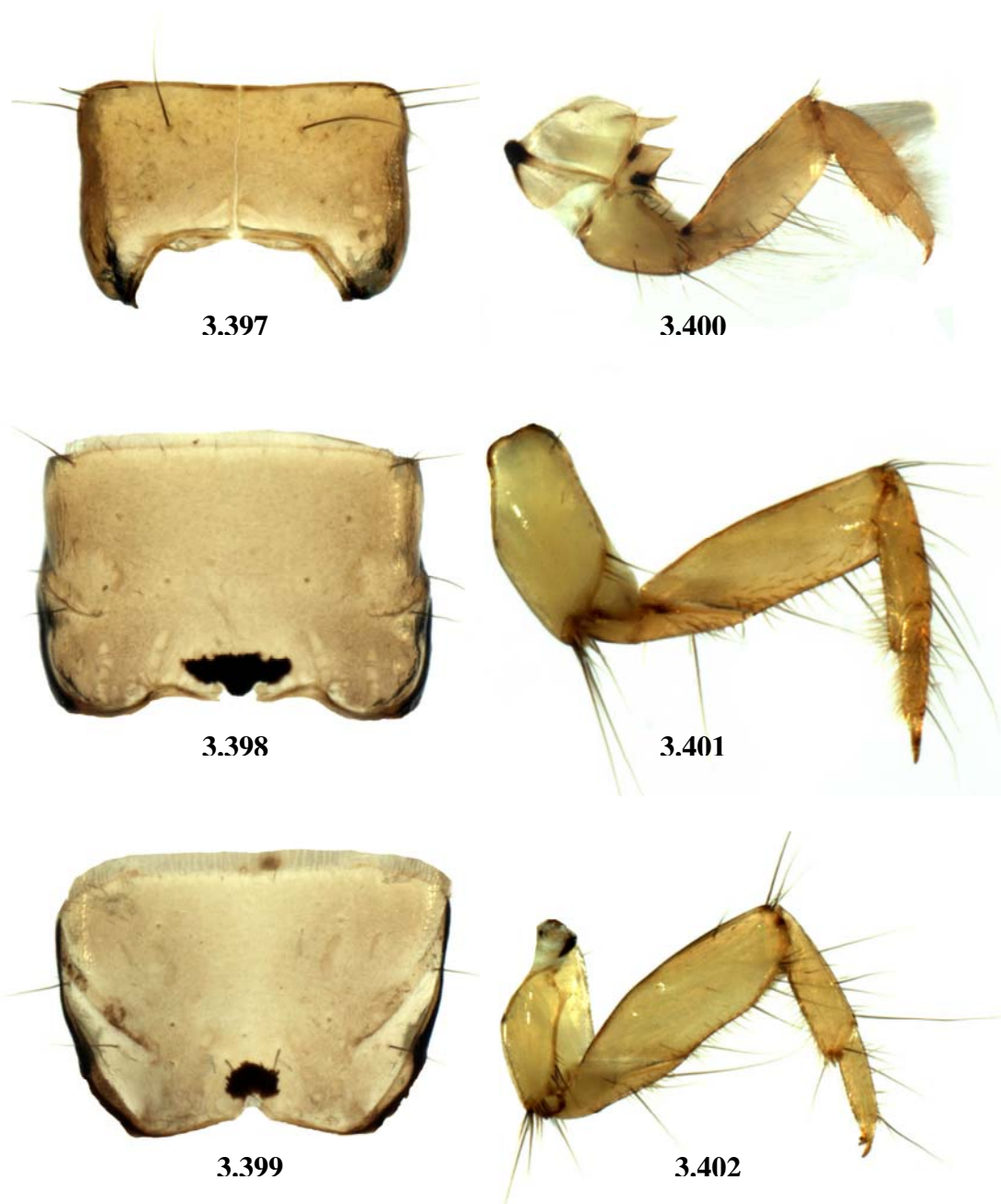


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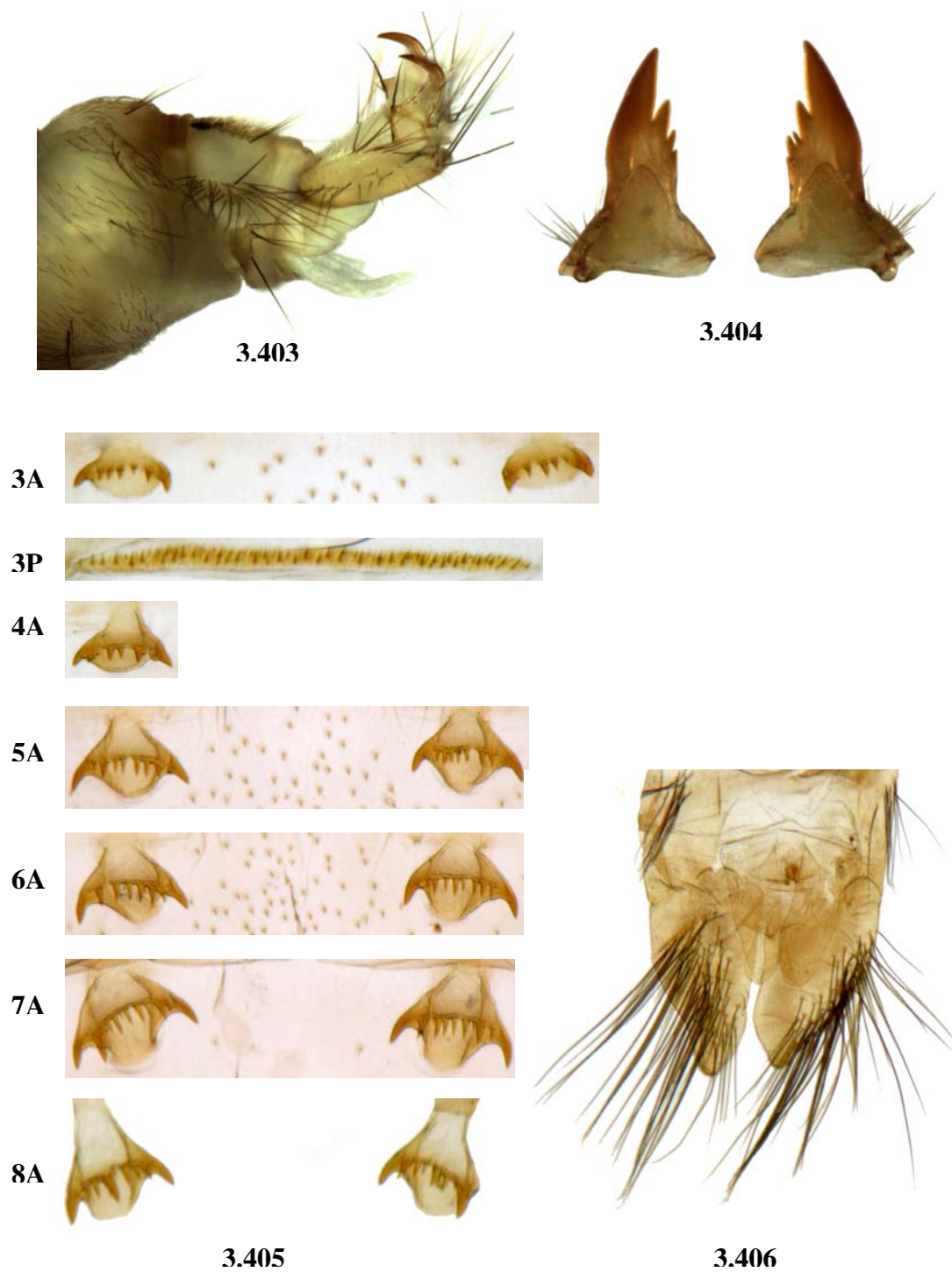


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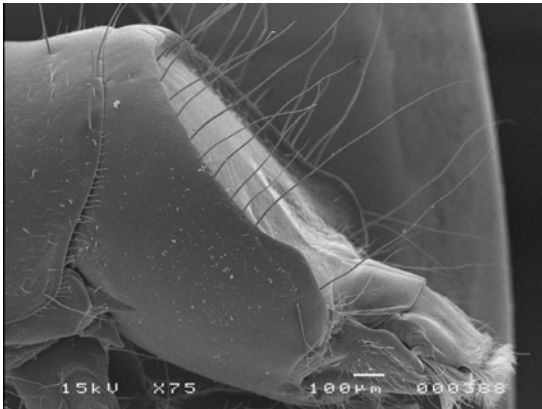
Figures 3.391-3.396. Larval features of *Macrostemum fenestratum*: 3.391, dorsal view of head showing a carina (↔); 3.392, frontoclypeal apotome; 3.393, ventral view of head; 3.394, dorsal view of labrum; 3.395, ventral view of mandibles; 3.396, submentum.



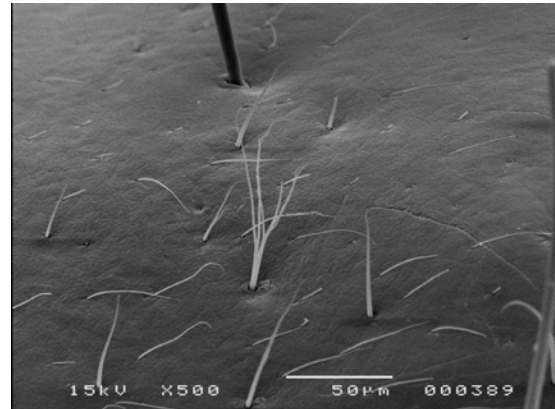
Figures 3.397-3.402. Larval features of *Macrostemum fenestratum*: 3.397, pronotum; 3.398, mesonotum; 3.399, metanotum; 3.400, outer face of right foreleg; 3.401, inner face of left midleg; 3.402, inner face of left hindleg.



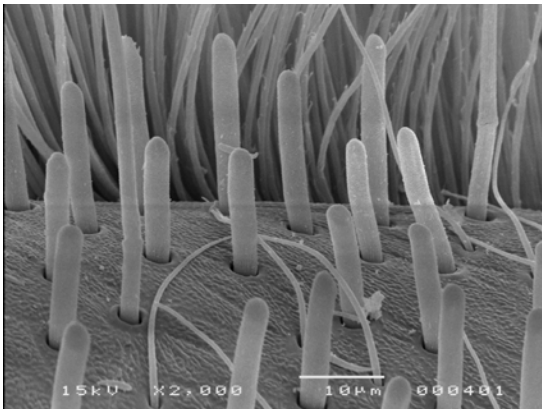
Figures 3.403-3.406. *Macrostemum fenestratum*: 3.403, lateral view of anal claw; 3.404, ventral view of pupal mandibles; 3.405, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.406, pupal apical abdominal appendages.



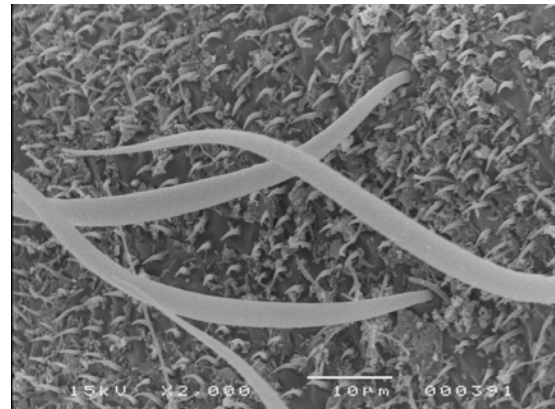
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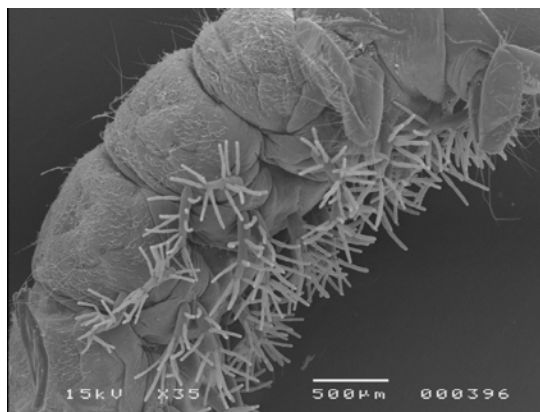
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Figures 3.407-3.411. *Macrostemum fenestratum*: 3.407, lateral aspect of head; 3.408, setae on anterior margin of labrum; 3.409, setae on nota; 3.410, setae on abdominal segments; 3.411, abdominal gills.

***Macrostemum hestia* Malicky & Chantaramongkol, 1998**

Larva: Total length 13.5-14.5 mm (n=10). Sclerites light-brown to dark-brown, muscle scars paler (Fig. 3.413).

Head: Head capsule length, 1.45-1.48 mm; width, 1.36-1.45 mm. Dorsum of head dark-brown, paler around eyes and posterolaterally. Genae with dorsolateral carina passing above eyes; carina with sparsely long setae and thin, hair-like setae (Fig. 3.427). Frontoclypeus with anterior margin concave. Lateral margin of clypeus near pretentorinae constricted and abrupt protrude; posteriorly triangular extending beyond carina (Fig. 3.414). Head ventrally with stridulatory lines widely separated in anterior half, the transition to closely-spaced posterior lines very abrupt; muscle scars midway between midline and lateral margin in posterior half (Fig. 3.415). Labrum with large membranous basal region bearing 2 transverse sclerites adjacent to frontoclypeus; with large lateral brushes on lobes; anterior margin with dense fringe of hairs and rows of short, erect, clavate setae; dorsal surface with scattered pale setae and pair of long dark setae on anteromesal region; posteromedially protrude (Fig. 3.416). Mandibles dark-brown, strongly asymmetrical, without mesal tuft of hairs; lateral margin with ridge and scattered setae. Left mandible with 2 apical and 3 mesal teeth; right mandible with 2 apical and 2 mesal teeth (Fig. 3.417). Submentum large, wider at base; anterior margin prominent anteromedian tubercle; anterior angle bearing long setae (Fig. 3.418). Anterior ventral ecdysial line absent from right side (Fig. 3.415); posterior ventral apotome very small.

Thorax: Pronotum brown in anterior half; light-brown in posterior half, with short and long setae on anterior margin; muscle scars midway between midline and lateral margin in posterior half (Fig. 3.420). Prosternum broadly transverse; with triangular, posteromesal sclerite (Fig. 3.419). Mesonotum light-brown, with 2 pairs of long setae on anterior margin; 3 pairs of long setae and scattered hair-like setae (Fig. 3.421). Metanotum with 2 pairs of long setae; 3 pairs of long setae laterally, with scattered hair-like setae (Fig. 3.422). Foretrochantin pointed upward, with few setae (Fig. 3.423). Coxa of foreleg with pad of short, spiniform setae at posteromesal surface (Fig. 3.428); trochanter and femur of forelegs with long, slender hairs on ventral margins. Foreleg with a femur bearing a slender, digitate basomesal process; tibia and tarsus with dense fringe of long, silky, hairs primarily on lateral surface; ventral margin with moderately long hairs (Fig. 3.423). Mid- and hindlegs similar in general appearance; with scattered long setae; apex of tibia with 4-5 stout and broad setae; spiniform setae on anterior margin (Figs. 3.424-3.425). Mesosternum with one pair of gills and metasternum with 2 pairs of gills.

Abdomen: Gills ventrally, laterally, and dorsolaterally as in Fig. 3.434. Abdominal segments bears numerous long, flexible hair-like setae (Fig. 3.429). Sternum VIII with pair of long setae, and 2 pairs of shorter setae. Tergum IX divided into pair of small, lateral plates; each plate bearing row of long setae. Sternum IX with pair of ovoid plates covered with pale spiniform setae and 3 or 4 long setae on posterior margin (Fig. 3.430). Anal proleg with lateral sclerites bearing row of long, black setae laterally; anal claw curved ventrad with cluster of long bristles; with 2 pale ventrobasal setae (Fig. 3.413).

Pupa: Labrum small and rounded, with basolateral setae (Fig. 3.431). Mandibles

tapering regularly to a pointed apex; inner margin of left mandible with 4 teeth; right mandible with 3 teeth; inflated at bases, with group of setae on lateral surface; each distal tooth serrated (Fig. 3.426). Dorsal surface with one pair of anterior hook plates on segments III-VIII and one pair of posterior hook plates on segments III (Fig. 3.432). Apical processes tapering to blunt points; ventral and lateral surfaces bearing long, pale, slightly hooked setae from well-developed tubercles (Fig. 3.433).

			S	S	S	S	S	S	
			D	D					
	S	S	D	D	D	D	D	S	
			S						
S	S	S	S	S	S	S	S		
Meso	Meta	1	2	3	4	5	6	7	8

Figure 3.434. *Macrostemum hestia*. Schematic gill diagrams of the lateral aspect of the meso- and metathorax and first 8 abdominal segments. S = a single long central stalk with numerous lateral filaments; D = 2 S-type filaments with adjacent bases.

Diagnosis: This species may be distinguished on the basis of the frontoclypeus color pattern. The frontoclypeus is unicolored brown, lateral margin of clypeus near pretentorinae is constricted and abrupt protrude and triangular posteriorly, extending beyond the carina. Submentum is large and wider at base, prominent anteromedian

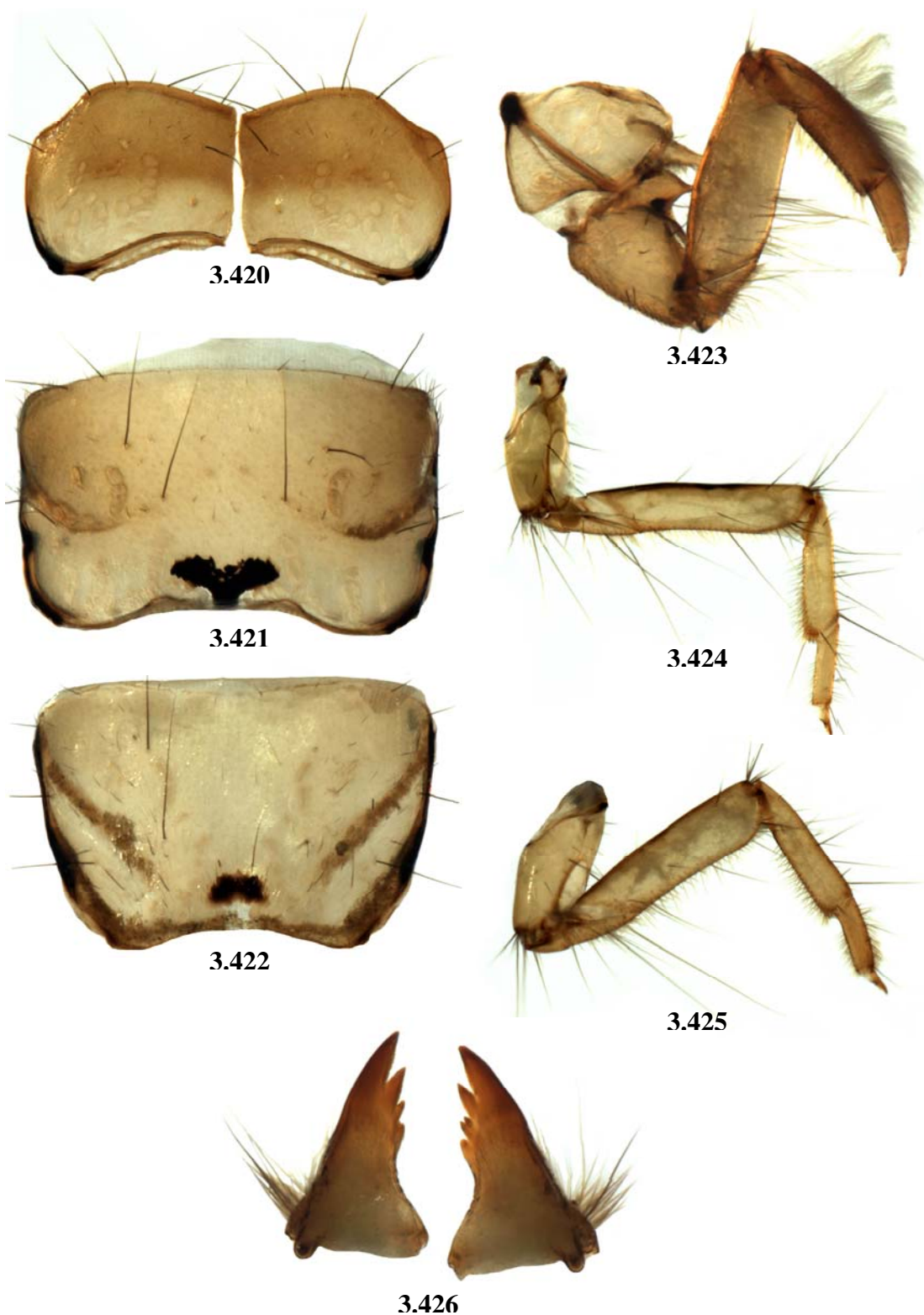
tubercle is present on anterior margin.

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Hawe Lome Waterfall, 122 m. 09°43' N, 98°40' E, 2-iv-2005, Prommi, 4 larvae; SURAT THANI Prov.: Khao Sok National Park, stream from Sib Ed Chan Waterfall, 133 m. 08°55' N, 98°31' E, 6-iv-2004, Prommi, 1 male mmt.; same locality, 6-viii-2004, Prommi, 1 larva; 7-x-2004, Prommi, 4 larvae, 1 pupa; same locality, 4-iv-2005, Prommi, 14 larvae, 3 pupae; RANONG Prov.: Klong Na Kha Wildlife Sanctuary, Klong Bang Mun stream; 50 m. 09°27' N, 98°30' E, 3-iv-2005, Prommi, 8 larvae, 4 pupae; PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall 68 m. 08°58' N, 98°27' E, 7-viii-2004, Prommi, 5 larvae; same locality, 3-iv-2005, Prommi, 24 larvae, 6 pupae, 2 male mmts.

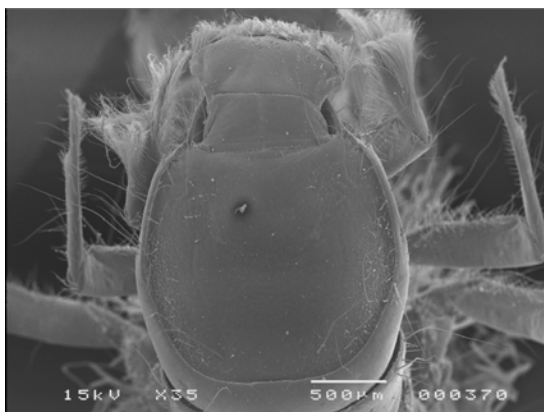
Discussion: The genus *Macrostemum* is speciose and occurs throughout the Old World tropics (Dudgeon, 1999). Ten species of *Macrostemum* have been recorded from Thailand (Malicky and Chantaramongkol, 1999; Malicky and Chantaramongkol, 2003). Of the six species collected, 1 was new recorded in Thailand from this study, *M. albardana* Banks, 1931. Three immature larvae and pupae of this genus could be associated with adult stage from this study (Table 2.4). *Macrostemum* larvae make specialized feeding chambers of fine sand and small stones, under or at the side of rocks. The structure is opened at both ends and water flows through it; food particles are filtered from the current by an exceptionally fine-meshed net stretched across the chamber. The larva rests beside the net in a small antechamber, using the setal fringes on the forelegs to collect food from the net (Wallace & Merritt, 1980).



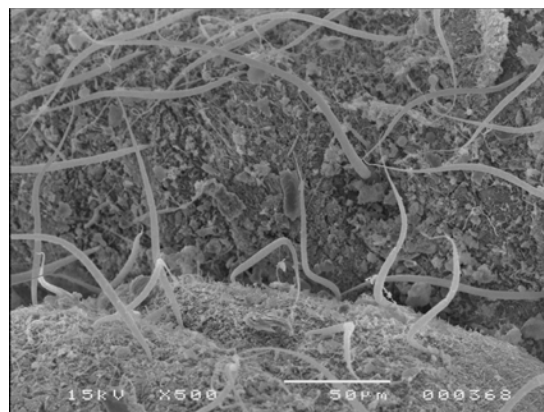
Figures 3.413-3.419. Larval features of *Macrostemum hestia*: 3.413, larva; 3.414 frontoclypeal apotome; 3.415, ventral view of head; 3.416, dorsal view of labrum; 3.417, ventral view of mandibles; 3.418, submentum; 3.419, prosternum.



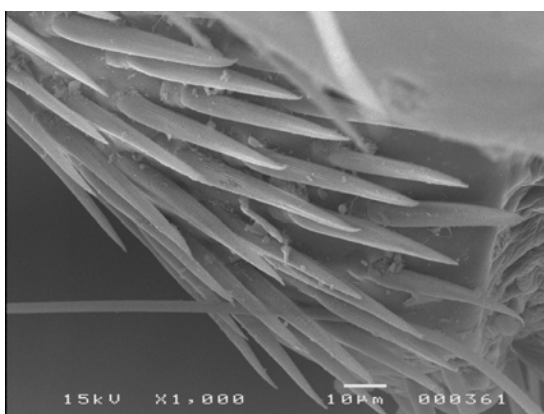
Figures 3.420-3.426. Larval features of *Macrostemum hestia*: 3.420, pronotum; 3.421, mesonotum; 3.422, metanotum; 3.423, outer face of right foreleg; 3.424, inner face of left midleg; 3.425, inner face of left hindleg; 3.426, ventral view of pupal mandibles.



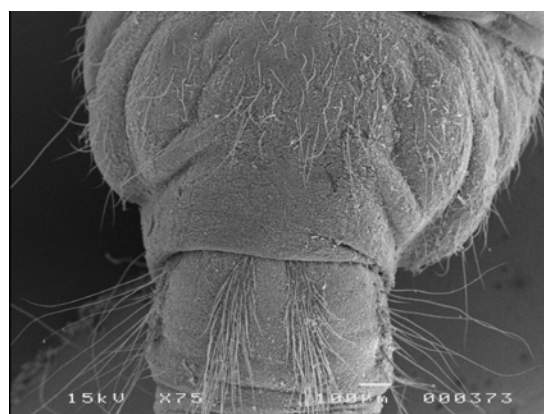
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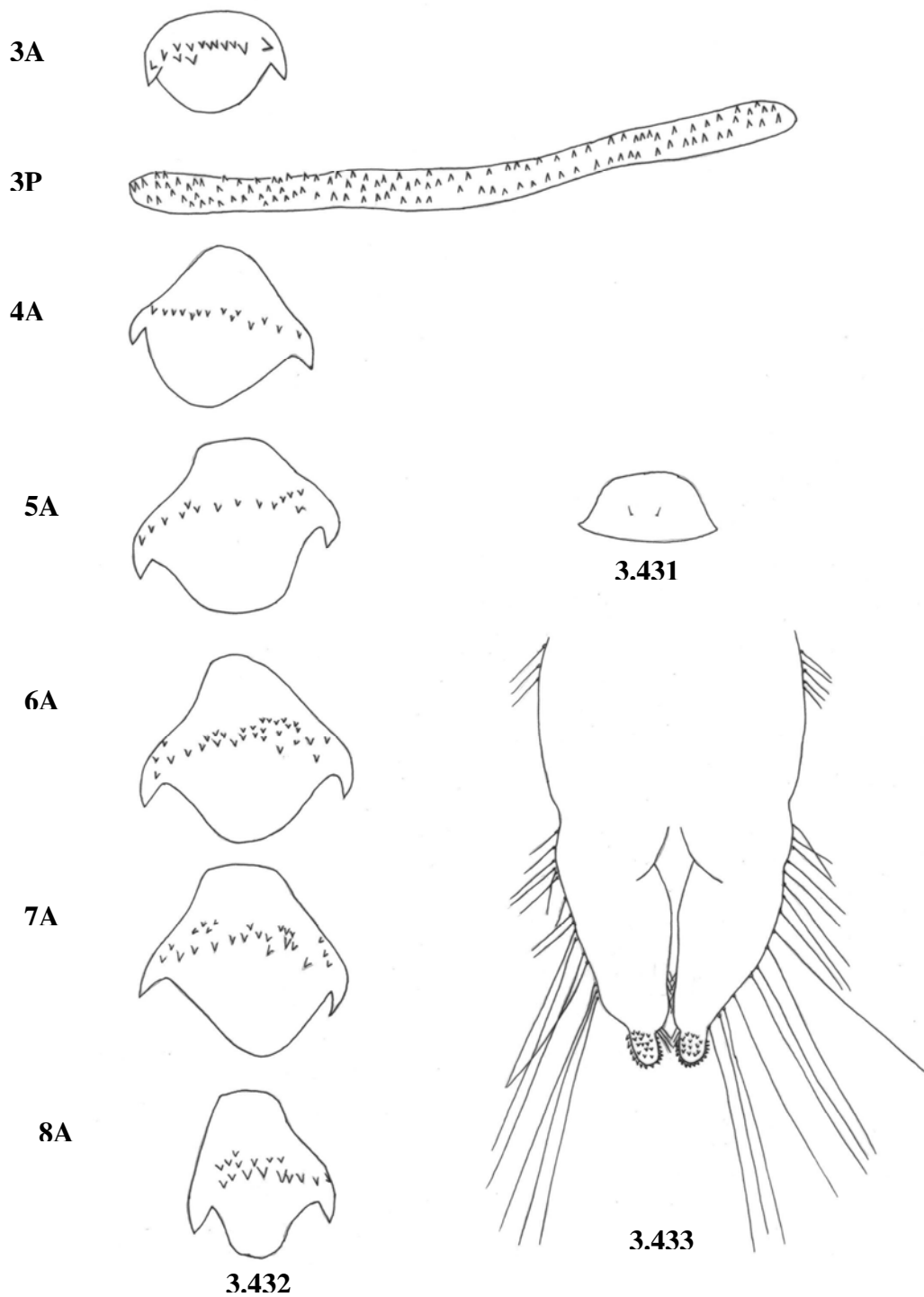


3.428



3.430

Figures 3.427-3.430. *Macrostemum hestia*: 3.427, dorsal view of head; 3.428, setae on fore-coxa; 3.429, setae on abdominal segments; 3.430, sterna VIII and IX.



Figures 3.431-3.433. *Macrostemum hestia*: 3.431, dorsal aspect of pupal labrum; 3.432, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.433, pupal apical abdominal appendages.

GENUS *Pseudoleptonema* Mosely, 1933

Diagnosis: Larvae of *Pseudoleptonema* have the typical characteristics of the family. The dorsum of head is flattened, with or without a prominent carina. The anterior margin of the frontoclypeus notched, and asymmetrical or strongly convex. The anteclypeus is membranous, without a pair of basal sclerites. The posterior ventral apotome is very small and the anterior ventral ecdysial line is lacking on one side, thus anterior ventral apotome is only half delimited. Stridulatory grooves are present. The foretrochantin is simple and the foreleg is without a dense setal tuft on the lateral surface of the tibia and tarsus. The mesosternum with one pair of gills and the metasternum is with or without gills. Gills usually are present on abdominal segments I-VIII.

From the results of this study, 2 species of unknown *Pseudoleptonema* larvae could be associated with identifiable adult species, *Pseudoleptonema quinquefasciatum* and *P. supalak*. Details of each species are described as follows:

Pseudoleptonema quinquefasciatum Martynov, 1935

Larva: Total length 5.0-6.0 mm (n=10). Overall, body shape as usual in Hydropsychidae (Fig. 3.435). Head yellow to brown. Notal sclerites pale yellow-brown.

Head: Head capsule length, 0.85-0.88 mm; width, 0.71-0.77 mm. Dorsum of head brown at vertex, otherwise yellow (Fig. 3.436). Frontoclypeus with

transverse row of three, pale spots at posterior corner. Anterior margin of frontoclypeus notched, asymmetrical (Fig. 3.437). Head with hair-like setae on dorsolateral surface, mingled with brush of setae (inconspicuous with dissecting microscope) (Fig. 3.452). Head ventrally smooth, golden-yellow; part of the head with anterior 6 stridulatory lines widely separated. Anterior ventral ecdysial line absent on right side; posterior ventral apotome small (Fig. 3.438). Submentum with anterior margin entire, not cleft, with a few, black setae at anterior angles (Fig. 3.438). Labrum golden-yellow, broad, anterolateral margin with golden, pectinate setae; dorsal surface of labrum with scattered, moderately long, hair-like setae (Figs. 3.436, 3.453). Mandibles reddish-brown; short; broad at bases; asymmetrical; with lateral trough; long, black setae along base of trough; right mandible with mesal tuft of hairs (Fig. 3.439).

Thorax: Nota pale yellow-brown. Pronotum dark in posteromesal region with pale muscle scars; anterior angle with long, hair-like setae projecting beyond anterior margin; scattered long, hair-like setae at anterior half (Figs. 3.441, 3.454). Meso- and metanotum pale yellow-brown; anterior margin membranous with slender setae projecting beyond margin; scattered hair-like setae; mesonotum with small dark patch on posterolateral corner (Figs. 3.442-3.443). Prosternum transverse, narrow at middle, swollen laterally, with a large Y-shaped sclerites at posteromesal margin (Fig. 3.440). Propleuron with a row of stout setae ventrally; trochantin tapering to point, with a few, long setae (Fig. 3.444). Coxa of foreleg with row of short and medium length, slender setae on ventral margin; with a few spike-like setae on dorsal margin. Ventral margin of femur with long, slender setae. Dorsal margin of tibia and tarsus with scattered, long, slender setae (Fig. 3.444). Mid- and hindlegs

similar in shape, with scattered, long, slender setae. Apex of tibia and tarsus with spike-like setae (Figs. 3.445-3.446). Tarsal claw of forelegs almost straight, claws of mid- and hindlegs curved. Mesosternum with one pair of gills, metasternum without gills.

Abdomen: Abdominal segments covered with long, recumbent, hair-like setae, mingled with dense, very small, hair-like setae (inconspicuous with dissecting microscope) (Fig. 3.455). Three pairs of dorsolateral gills on segments I, II, and VIII. Two pairs of dorsolateral gills on segments III-VII and one pair of lateral gills each on segments I-V. Two pairs of ventral gills on segments II-IV and one pair of ventral gills on segments V-VI. Each gill with short central stalk, with 0-6 filaments arising from central stalk. Apex of central stalk without filaments and some filaments with dark, slender setae extending beyond apex. Sterna VIII and IX each with pair of sclerites, sternum IX with spike-like setae emanating from prominent sockets. Each sclerite subcircular. Tergum IX with large lateral sclerites. Anal prolegs with bent claw and cluster of long, slender setae; lateral sclerites with row of long, black, slender setae at lateral margin (Fig. 3.447).

Pupa: Labrum subtriangular with rounded basolateral lobes. Mandibles broad posteriorly, tapering regularly to a pointed apex; inner margin with 3-4 teeth; laterobasal angle with group of long, slender setae on lateral surface (Fig. 3.448). Dorsal surface with one pair of anterior hook plates on segments II-VIII; plates as long as wide, with teeth on a distinct elevated lobe; 1 pair of posterior hook plates on segment III, plates broadly covered with numerous teeth (Fig. 3.450). Apical processes short, apex broad with group of dorsolateral hooked setae; lateral surface bearing long, dark, slightly hooked setae from well-developed tubercles (Fig. 3.451).

Material examined: CHUMPHON Prov.: Khuan Mae Yai Mhom Wildlife Sanctuary, stream from Haew Lome Waterfall, 2-iv-2005, Prommi, 6 larvae, 2 mature pupae; same locality, 25-v-2005, Prommi, 4 mature pupae.

Diagnosis: This species may be recognized on the basis of the following of characteristics: The anterior margin of the frontoclypeus is strongly notched, dorsum of head is not flattened, and metanotal gills are absent. In addition, segments I, II, and VIII have three pairs of dorsolateral gills on either side of the abdomen. Moreover, small, black posterolateral patches are present on the mesonotum.



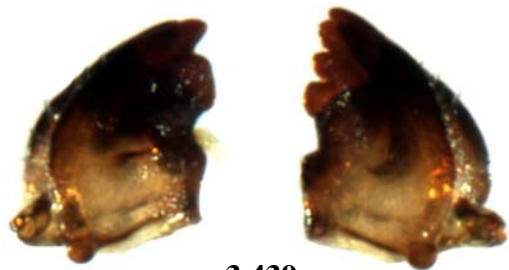
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Figures 3.435-3.440. Larval features of *Pseudoleptonema quinquefasciatum*: 3.435, larva; 3.436, dorsal view of head; 3.437, frontoclypeal apotome; 3.438, ventral view of head; 3.439, ventral view of mandibles; 3.440, prosternum.



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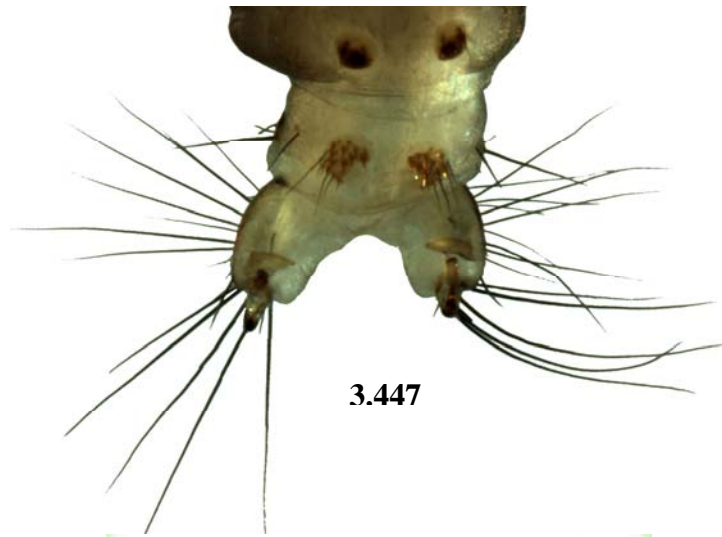


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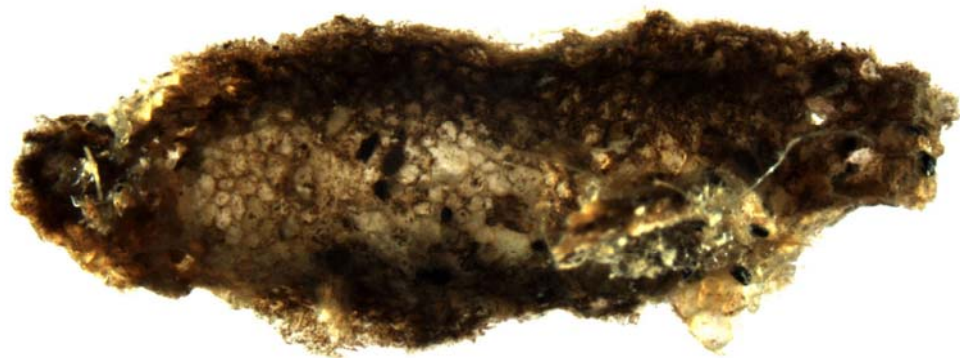
Figures 3.441-3.446. Larval features of *Pseudoleptonema quinquefasciatum*: 3.441, pronotum; 3.442 mesonotum; 3.443, metanotum; 3.444, outer face of right foreleg; 3.445, inner face of left midleg; 3.446, inner face of left hindleg.



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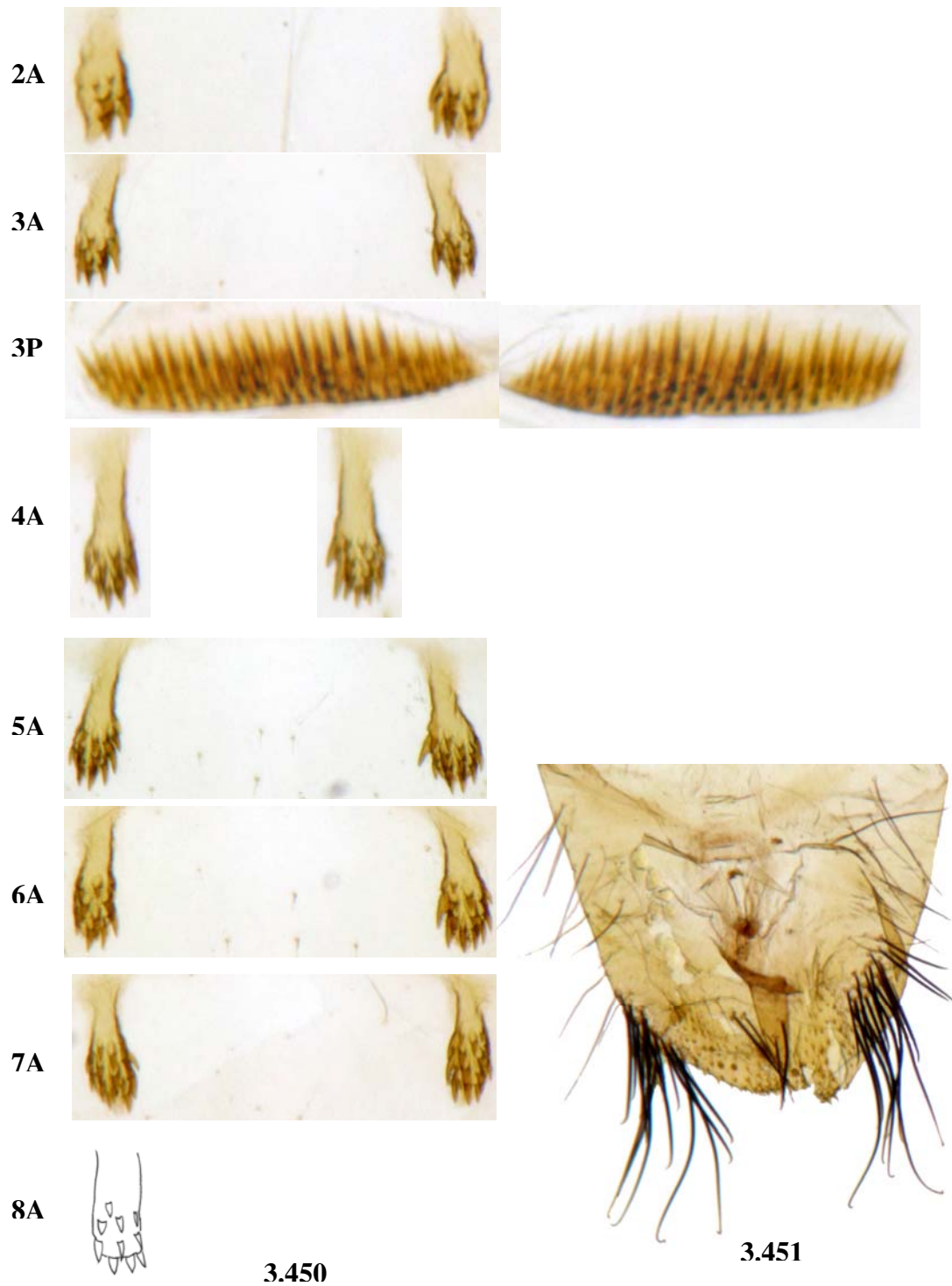


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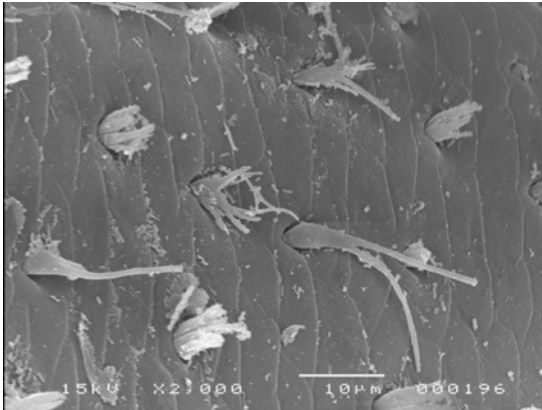


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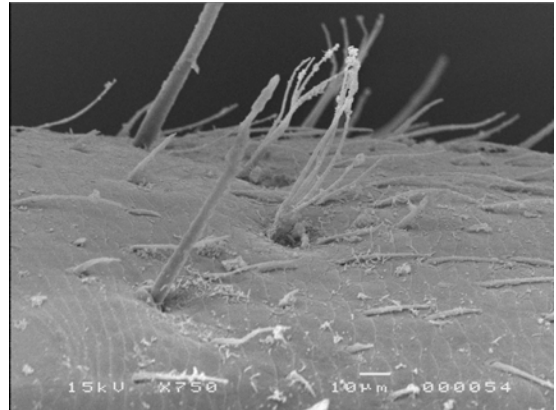
Figures 3.447-3.449. *Pseudoleptonema quinquefasciatum*: 3.447, sternite VIII and IX; 3.448, ventral view of pupal mandibles; 3.4493, larval and pupal case constructed from sand and detritus.



Figures 3.450-3.451. *Pseudoleptonema quinquefasciatum*: 3.450, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.451, pupal apical abdominal appendages.



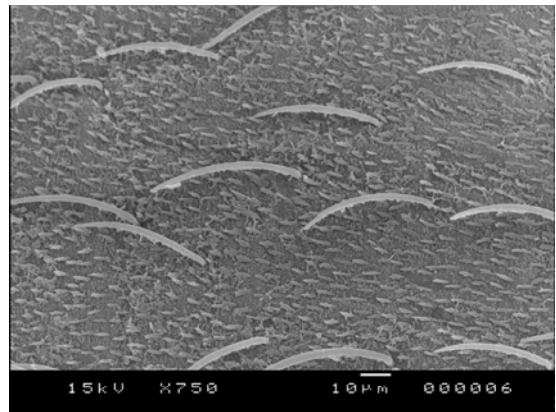
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Figures 3.452-3.455. *Pseudoleptonema quinquefasciatum*: 3.452, setae on dorsum of head; 3.453, pectinate setae on lateral margin of labrum; 3.454, setae on pronotum; 3.455, setae on abdominal segments.

***Pseudoleptonema supalak* Malicky and Chantaramongkol, 1998**

Larva: Total length 4.0-4.5 mm (n=10). Overall, body shape as usual in Hydropsychidae. Head yellow to brown. Notal sclerites pale yellow-brown.

Head: Head capsule length, 0.77 mm; width, 0.68 mm. Dorsal part of head flattened with a U-shaped carina. Anterior half of head yellow, posterior half brown. Frontoclypeus with anterior margin strongly convex; anterior half of frontoclypeus paler than the other portion (Figs. 3.456, 3.469). Head with hair-like setae on dorsolateral surface. Head ventrally yellow except brown mid-laterally, with group of muscle scars. Anterior ventral ecdysial line absent from right side; posterior ventral apotome small (Fig. 3.457). Ventral part of the head with anterior 6 stridulatory lines widely separated. Submentum with anterior margin entire, not cleft, with setae at anterior angles (Fig. 3.457). Labrum light-brown; with brown anterolateral pectinate setae; dorsal surface of labrum with moderately-long, hair-like setae (Fig. 3.456). Mandibles reddish to light-brown; short; with lateral trough; golden setae along base of trough; right mandible with mesal tuft of hairs (Fig. 3.461).

Thorax: Nota yellow to light-brown. Each notum covered with long, hair-like setae, except pronotum same setae covered on anterior half; long, hair-like setae projecting beyond anterior margin (Figs. 3.458, 3.471). Meso- and metanotum membranous with long, hair-like setae projecting beyond anterior margin (Figs. 3.459-3.460, 3.472). Prosternum transverse, narrow at middle, swollen laterally, with a large Y-shaped sclerites at posteromesal margin. Fore trochantin tapering to point, with long setae (Fig. 3.462). Femur of foreleg with long, slender

setae on ventral margin; tibia and tarsus with scattered setae on dorsal margin (Fig. 3.462). Midleg shorter than hindleg and similar in structure, with scattered, long, slender setae. Apex of tibia and tarsus with spike-like setae (Figs. 3.463-3.464). Mesosternum with one pair of gills and metasternum with 2 pairs of gills.

Abdomen: Abdominal segments covered with long, recumbent, hair-like setae, mingled with dense, small, hair-like setae (inconspicuous with dissecting microscope) (Fig. 3.473). Segments I-VIII with 2 pairs of dorsolateral gills with adjacent bases. Segment I with 3 pairs of ventral gills. Segment II with one pair of lateral gills. Segments II-VI with one pair of ventral gills. Each gill with short central stalk, with 0-2 filaments arising from central stalk. Apex of central stalk without filaments with dark, slender, setae extending beyond apex (Figs. 3.469-3.470). Sterna VIII and IX each with pair of sclerites, sternum IX with spike-like setae emanating from prominent sockets. Tergum IX with large lateral sclerites (Fig. 3.474). Anal prolegs with bent claw and cluster of long, slender setae; lateral sclerites with a row of long, black setae at lateral margin.

Pupa: Labrum elliptical (Fig. 3.465). Mandibles broad posteriorly, tapering regularly to a pointed apex; inner margin with 3 teeth; lateral with long setae on lateral surface (Fig. 3.466). Dorsal surface with one pair of anterior hook plates on segments II-VIII; plates as long as wide, with teeth on a distinct elevated lobe; one pair of posterior hook plates on segment III, plates broadly covered with numerous teeth (Fig. 3.467). Apical processes short, apex broad with group of dorsolateral hooked setae; lateral surface bearing long, dark, slightly hooked setae from well-developed tubercles (Fig. 3.478).

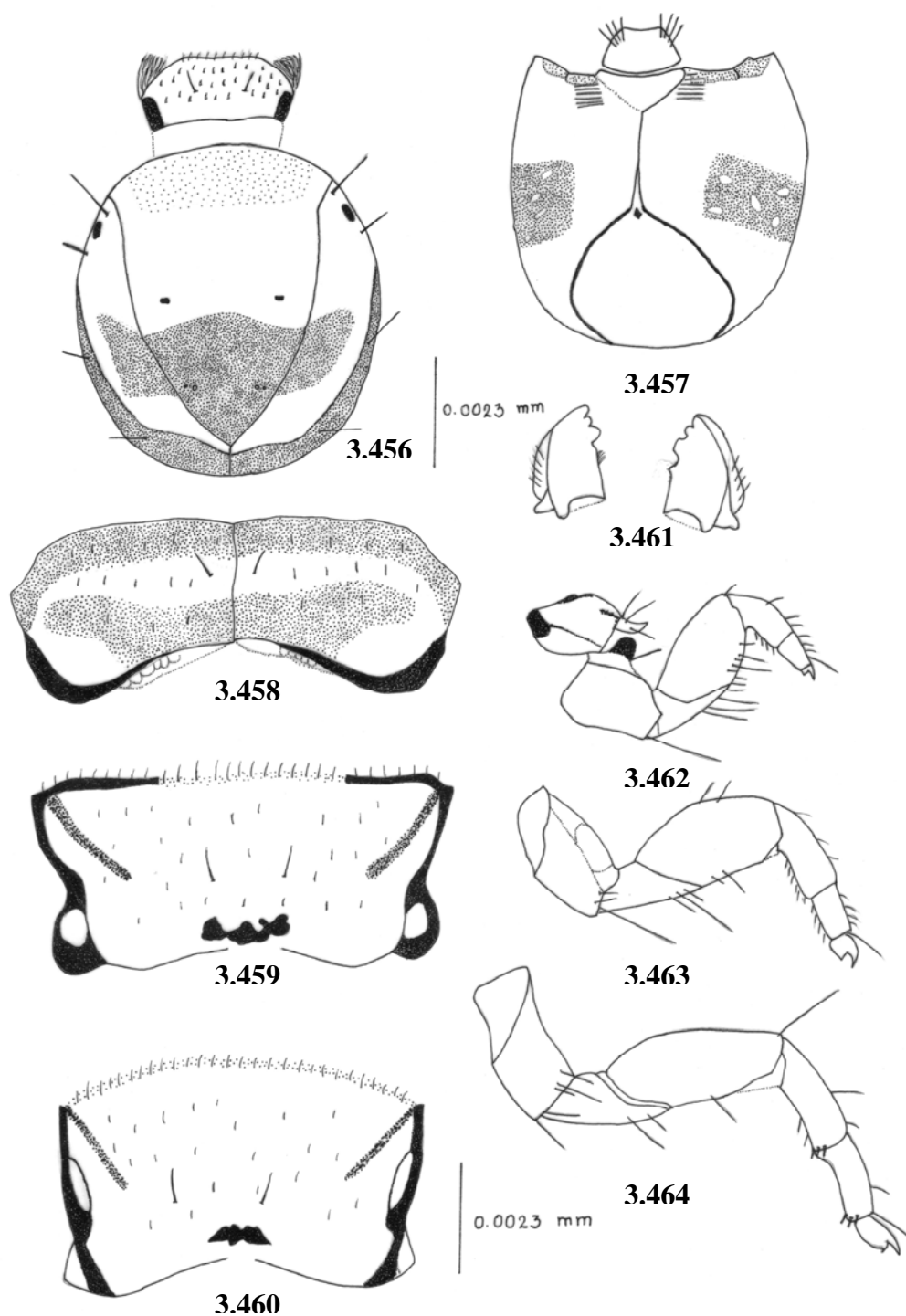
Diagnosis: This small and distinctive species is easily recognized on the basis of

the presence of a wide carina on the head. It is the only known *Pseudoleptonema* larva which has such a carina and, with the present key available, would key *Macrostemum*. However, it is unlikely that anyone familiar with *Macrostemum* would confuse the two genera. There are a number of striking differences between *P. supalak* and *Macrostemum* species. First, the anterior margin of frontoclypeus is strongly convex and the 2 transverse sclerites are absent from frontoclypeus, whereas the anterior margin of frontoclypeus in *Macrostemum* is slightly concave and 2 transverse sclerites are present nearly the frontoclypeus. Second, the number and an arrangement of abdominal gills are differences. In general, *Macrostemum* is more robust and larger than *P. supalak*.

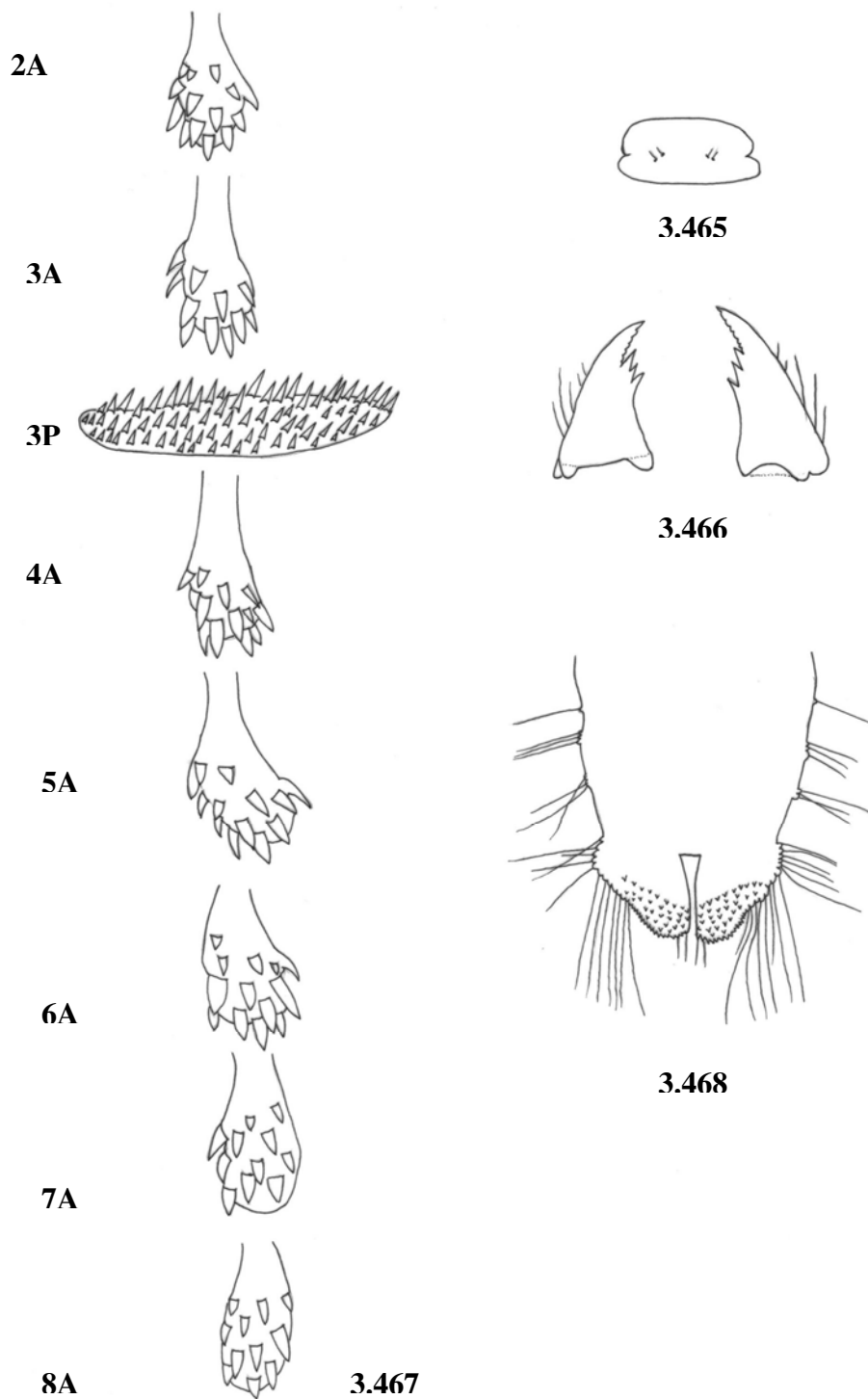
Material examined: PHANG NGA Prov.: Sri Phang Nga National Park, stream from Ton Thon Toey Waterfall, 7-vi-2006, 25 larvae, 2 mature pupae.

Discussion: The genus *Pseudoleptonema* is a small genus in the subfamily Macronematinae. The following species are known: *P. ceylanicum* Hagen 1858, *P. godapitigama* Schmid 1958 and *P. kalukandama* Schmid 1958 from Sri Lanka, *P. supalak* Malicky and Chantaramongkol 1998 and *P. erawan* Malicky and Chantaramongkol 2001 from Thailand and *P. sinuatum* Ulmer 1906 from Borneo. *P. quinquefasciatum* Martynov 1935 is widespread from India and Nepal to Laos and Vietnam (Hoang *et al.*, 2005; Malicky, 1998; Malicky and Chantaramongkol, 1999). The immature larvae, pupae, and adult stages of two species from this genus were collected in this study, *P. supalak* and *P. quinquefasciatum*. Most of the specimens were collected from high turbulence habitats, especially on the rock surfaces in streams. Larval cases were found tightly attached to the substrate. At the collection

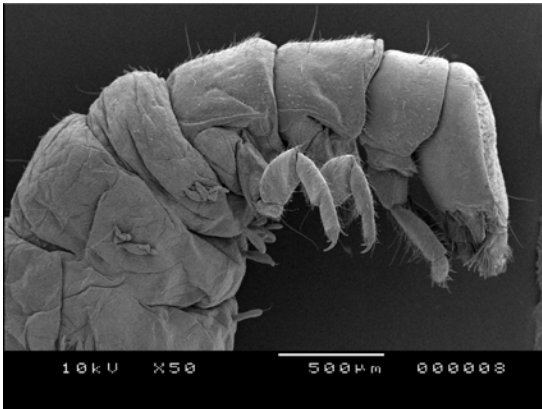
sites, the streams are 4-6 m wide. *P. quinquefasciatum* has been reported from northern Thailand (Chiang Mai and Mae Hong Son Provinces) and its flight period extends from March and April. *P. supalak* has been reported from northeast Thailand (Petchaboon Province) (Malicky, 1998).



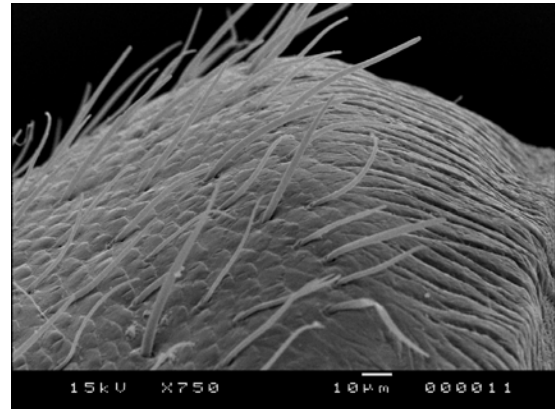
Figures 3.456-3.464. Larval features of *Pseudoleptonema supalak*: 3.456, dorsal view of head; 3.457, ventral view of head; 3.458, pronotum; 3.459, mesonotum; 3.460, metanotum; 3.461, ventral view of mandibles; 3.462, foretrochantin and outer face of right foreleg; 3.463, inner face of left midleg; 3.464, inner face of left hindleg.



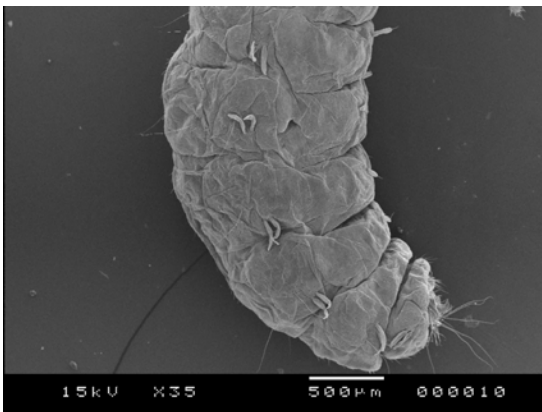
Figures 3.465-3.468. *Pseudoleptonema supalak*: 3.465, dorsal view of pupal labrum; 3.466, ventral view of pupal mandibles; 3.467, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.468, pupal apical abdominal appendages.



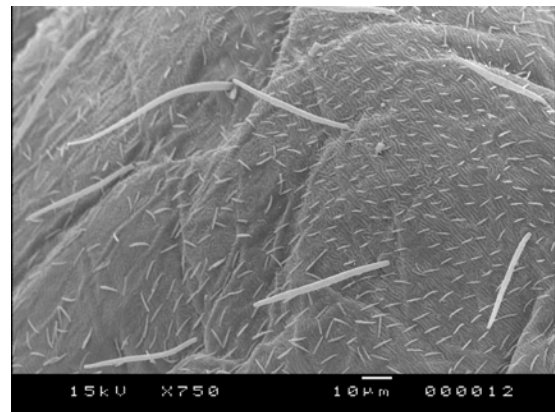
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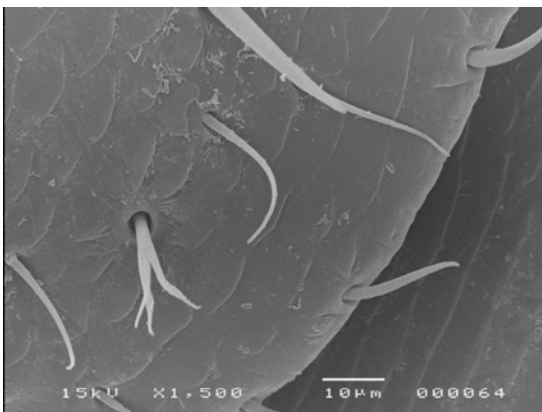
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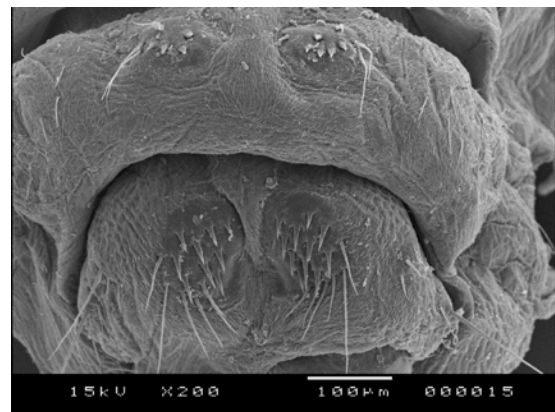
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Figures 3.469-3.474. *Pseudoleptonema supalak*: 3.469-3.470, lateral aspect of larva; 3.471, setae on lateral margin of pronotum; 3.472, setae on mesonotum; 3.473; setae on abdominal segments; 3.474, sterna VIII and IX.

GENUS *Trichomacronema* Schmid, 1964

Diagnosis: Larvae of *Trichomacronema* have the typical characteristics of the family. It differs from other hydropsychids in having a large body that is stout and robust, abdominal gills are short, smaller with filaments mostly on the apex of a central stalk, and the presence of long hair-like setae and small club-like hairs on abdominal segments. The anteclypeus membranous is lacking a pair of sclerites at base. The posterior ventral apotome is moderately and the anterior ventral ecdysial line is lacking on one side, thus anterior ventral apotome is only half delimited. The foretrochantin is simple. The foreleg is without dense setal tuft on lateral surface of tibia and tarsus. The mesosternum has one pair of branched gills and the metasternum has 2 pairs. Abdominal gills usually are present on segments I-VIII.

From the results of this study, one species of unknown *Trichomacronema* larva could be associated with identifiable adult species, *Trichomacronema tamdao*. Details of this species are described as below:

Trichomacronema tamdao Malicky, 1998

Larva: Total length 11.0-11.5 mm (n=7). Overall body shape as usual in Hydropsychidae. Head and nota brown to dark-brown, muscle scars darker.

Head: Head capsule length, 1.36 mm; width, 1.33 mm. Head dark-brown to black except around eyes light-brown; light stripe below eyes beyond posterior margin; posterior tip of frontoclypeus with pair of small, light-brown areas

(Fig. 3.475). Frontoclypeus triangular; anterior margin notch medially, lateral side with lobes (Figs. 3.475-3.476). Head dorsolaterally with small spade-shaped setae and stout setae (conspicuous with scanning electron microscope) (Fig. 3.491). Anterior margin of frontoclypeus bear a few stout setae. Head ventrally with stridulatory lines present near middle (Fig. 3.477). Labrum dark-brown; rounded in dorsal view; anterolateral margin with golden-brown, pectinate setae; dorsal surface of labrum with numerous, stout, moderately-long, setae and pair of long golden-brown setae anteromesally (Fig. 3.478). Mandibles dark; short; broad at base; asymmetrical; with lateral trough; long, black setae along base of trough; right mandible with mesal tuft of hairs (Fig. 3.479). Submentum large, wider at base, with anterior margin concave; mesolaterally with long setae. Anterior ventral ecdysial line absent from right side; posterior ventral apotome large, shorter than in length to ecdysial line linking it with anterior ventral apotome (Fig. 3.477).

Thorax: Nota dark-brown; pronotum slightly darker than others, anterior half paler than posterior half (Fig. 3.481). Meso- and metanotum with light spot above black posterior mark; mesonotum with 3, small, light spots on middle, metanotum with 2 pairs of light spots anteriorly. Lateral margin of each notum with rows of darker muscles (Figs. 3.482-3.483). Each notum covered with various shape of setae; pair of moderately-long, erect, flattened, setae anteriorly; pair of long, erect, flattened, point at tip, setae at middle, mingled with erect, brush of setae (filament spirally) (Figs. 3.488-3.489). Each notum covered with long, appressed, hair-like setae, with scattered, short setae and flattened, grooved spines (Figs. 3.491). Prosternum transverse, narrow at middle, swollen laterally, with a large Y-shaped sclerites at posteromesal margin. Foretrochantin tapering to point, with a few, long

setae (Fig. 3.484). Coxa of foreleg, with scattered short, spade-shaped setae (Fig. 3.491). Trochanter through tarsus densely covered with long, bent downward, setae and short, stout setae; anterior and posterior margin with row of long, stout setae (Figs. 3.484, 3.490). Midleg with coxa through tarsus covered with spade-shaped, adorned with long, bent downward, setae; anterior and posterior margin with row of long, stout setae (Fig. 3.485). Hindleg with coxa through femur covered with spade-shaped, mingled with long setae; apex of tibia with 4-5 stout clavate setae; tibia and tarsus with scattered, long, slender setae (Fig. 3.486). Mesosternum with one pair of gills and metasternum with 2 pairs of gills.

Abdomen: Abdominal segments covered with long, recumbent, hair-like setae, mingled with dense, very small, club-like setae (conspicuous with scanning electron microscope) (Fig. 3.492). Segments I- VII with 4 pairs of lateral gills. Segments I-V with 2 pairs of ventral gills. Segment VIII with 3 pairs of lateral gills with adjacent base. Each gill with short central stalk, 2-12 filaments arising from central stalk. (Fig. 3.493). Sternum VIII with pair of sclerites, ovoid shaped; sclerites with stout, spike-like setae. Sternum IX with one pair of ventral sclerites, subquadrate shaped; sclerites bear with stout, spike-like setae; posterior margin of sclerites with long setae. Tergum IX with pair of large, lateral sclerites; one pair of small, dorsolaterally (Fig. 3.480). Anal prolegs stout, short, with bent claw. Venter of anal proleg with spike-like setae on caudal lobes; inner and outer sclerites with long, black, slender setae (Fig. 3.480).

Pupa: Labrum semicircular with basolateral lobes, anteriorly with scattered, dark setae (Fig. 3.494). Mandibles tapering apically to a sharp point; inner margin of left mandible with 4 teeth; right mandible with 2 teeth; inflated at the bases, with group of

setae on lateral surface (Fig. 3.495). Dorsal surface with one pair of anterior hook plates on segments II-VIII, the plates with teeth on distinct elevated lobe; one pair of posterior hook plates on segment III, plates broadly covered with numerous teeth (Fig. 3.496). Apical processes short, apex narrow rounded with group of dorsolateral hooked setae; lateral surface bearing long, dark, slightly hooked setae from well-developed tubercles (Fig. 3.497).

Diagnosis: Larvae of *Trichomacronema* differs from other hydropsychids in having a large body that is stout and robust, abdominal gills that are short, smaller with filaments mostly on the apex of a central stalk.

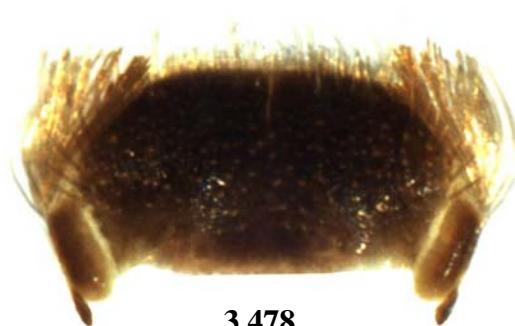
Material examined: RANONG Prov.: Tungraya-nasak Wildlife Sanctuary, Bok Krai Waterfall, 10°22' N, 98°51' E, 2-iv-2005, Prommi, 7 larvae, 2 pupae, 1 male mmt.

Discussion: *Trichomacronema* was established by Schmid, 1964 on the basis of a single Indian species. Two species of adult *Trichomacronema* have been recorded in Thailand; *T. paniae* and *T. tamdao*. *T. tamdao* was firstly described from Vietnam (Malicky, 1998) and has been reported from northern Thailand (Chiang Mai, Mae Hong Son, Nan, and Phrae Provinces) and its flight period extends from March and April. *T. paniae* was described from northern Thailand (Malicky and Chantaramongkol, 1991). Most of the immature stages were collected from high turbulence habitat, especially on the rock surface. Larva case was found tightly attached to the substrate (Fig. 3.487). In this study, adult of *T. tamdao* was not collected by light trapping. Association of the immature and adult was based partly

on cocoons containing larval sclerites with confirms by Malicky (personal communication).



3.475



3.478



3.476



3.479

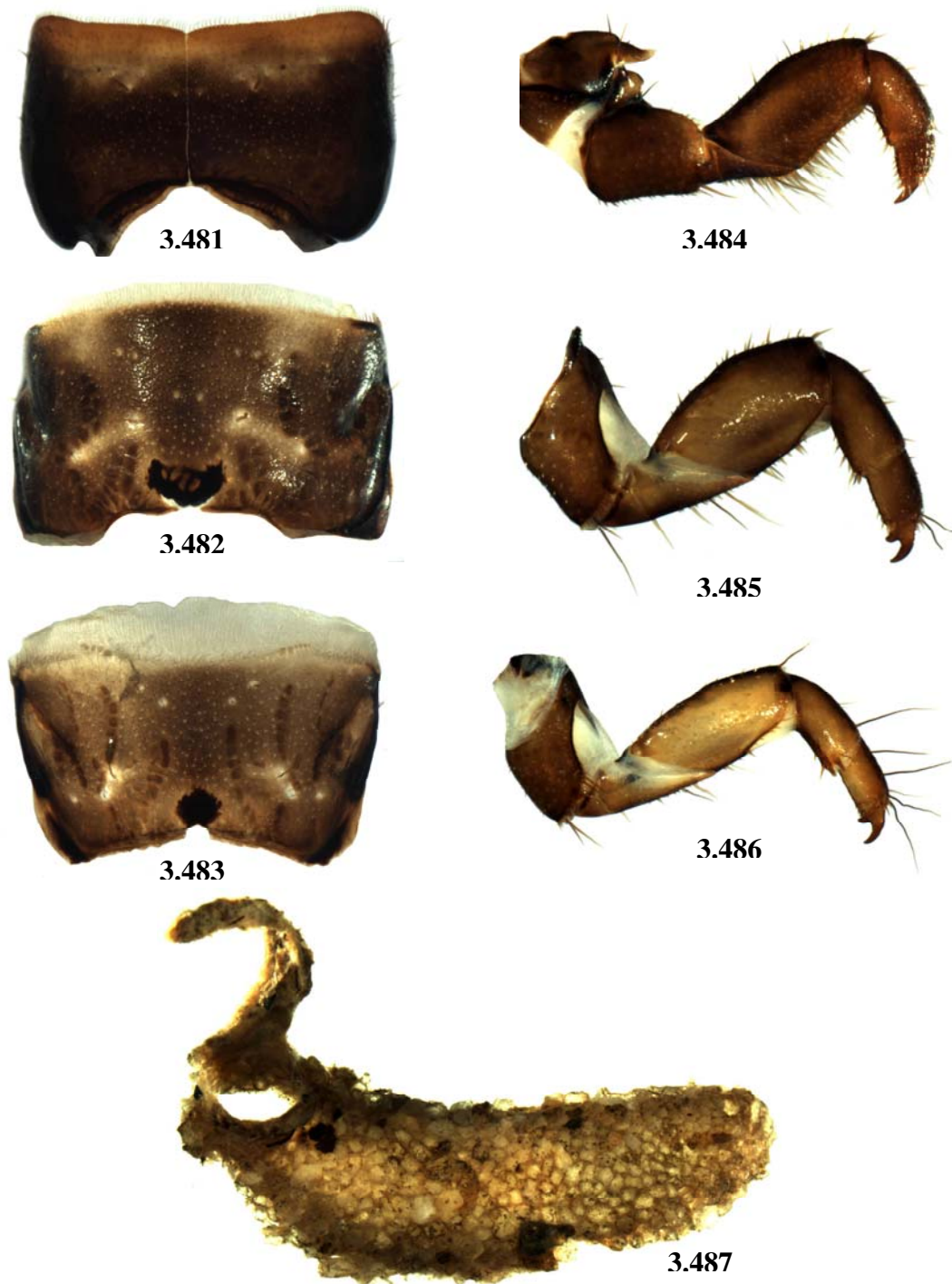


3.477

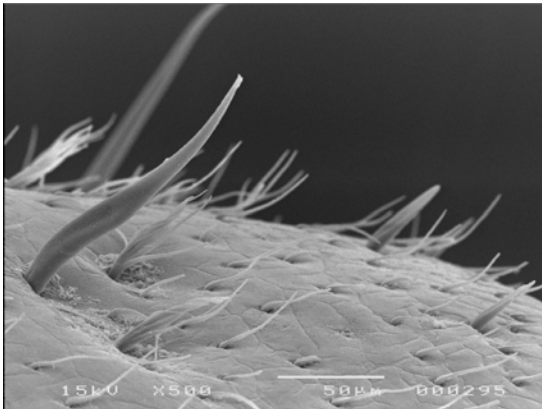


3.480

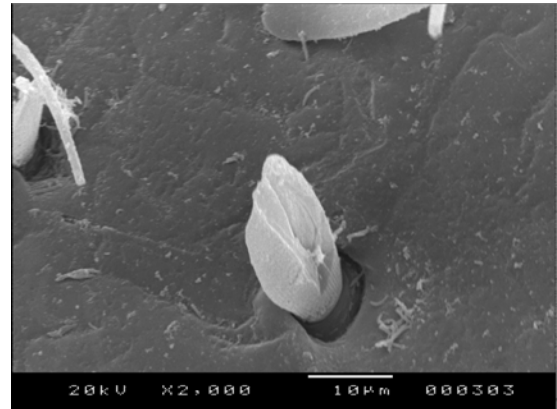
Figures 3.475-3.480. Larval features of *Trichomacronema tamdao*: 3.475, dorsal view of head; 3.476, frontoclypeal apotome; 3.477, ventral view of head; 3.478, dorsal view of labrum; 3.479, ventral view of mandibles; 3.480, sterna VIII and IX.



Figures 3.481-3.487. Larval features of *Trichomacronema tamdao*: 3.481, pronotum; 3.482 mesonotum; 3.483, metanotum; 3.484, foretrochantin and outer face of right foreleg; 3.485, inner face of left midleg; 3.486, inner face of left hindleg; 3.487, larval case constructed from sand and detritus.



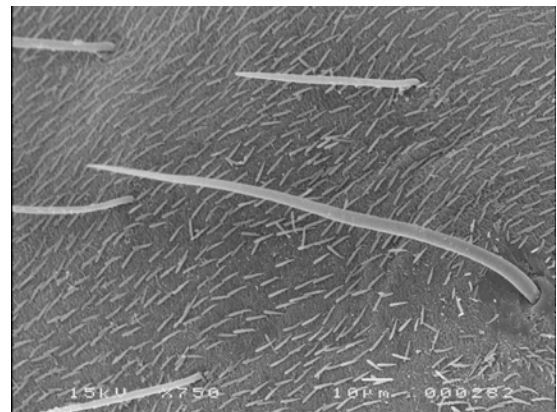
3.488



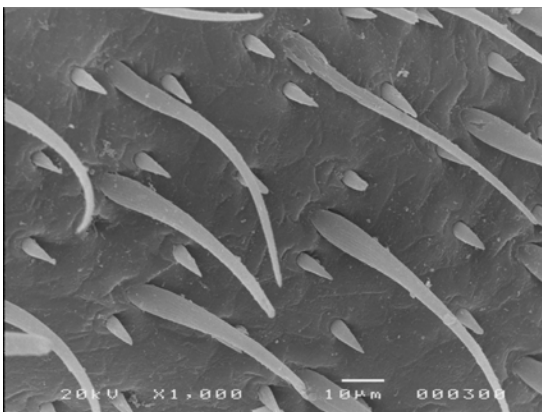
3.491



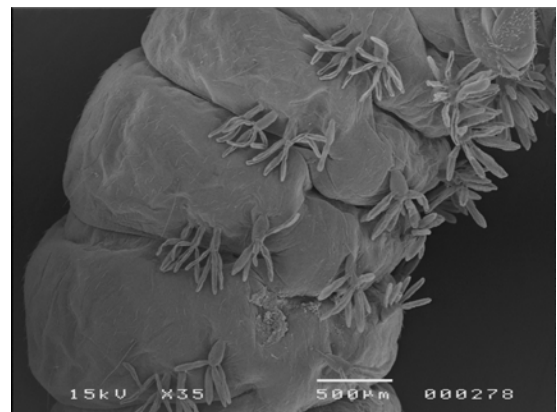
3.489



3.492

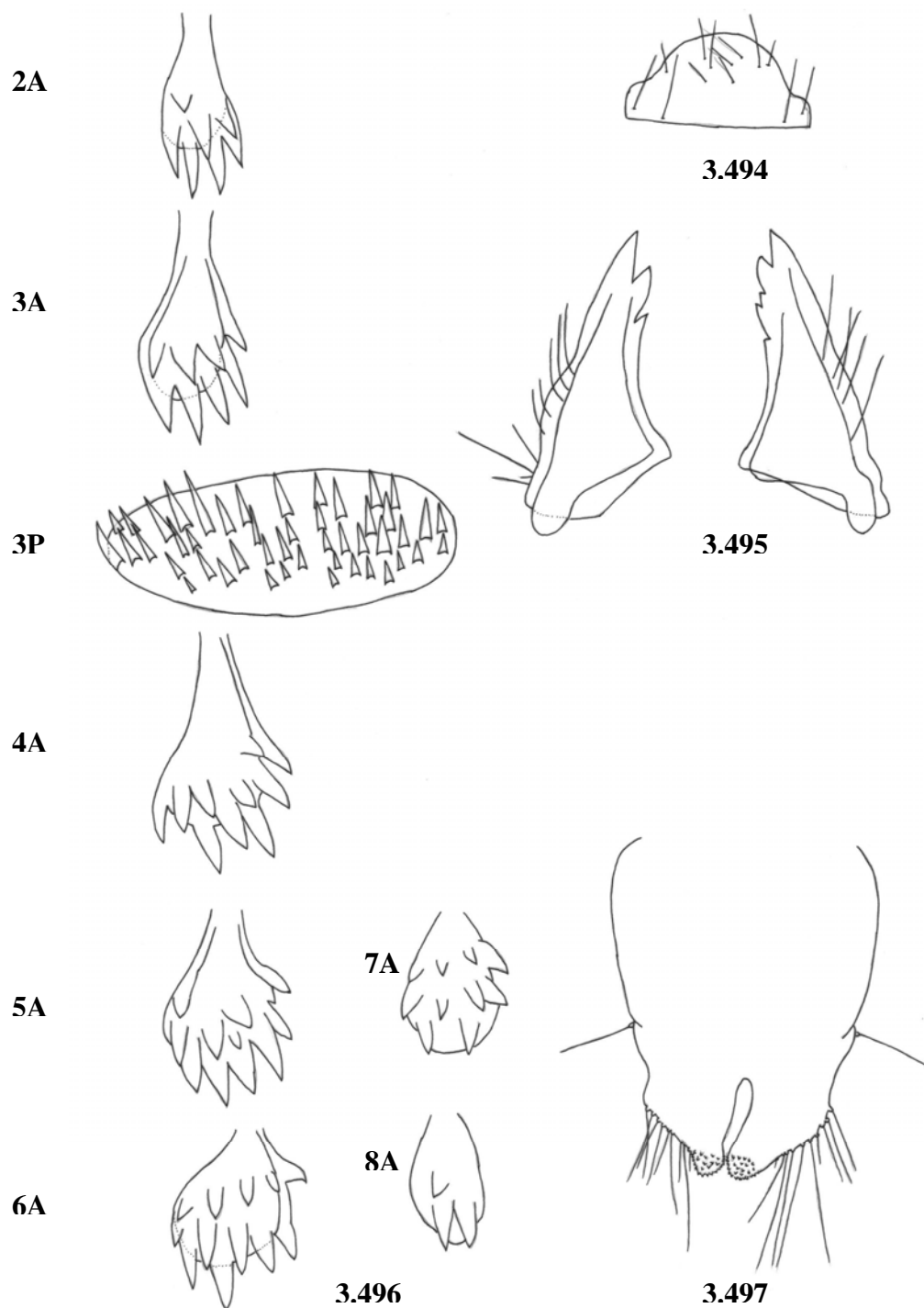


3.490



3.493

Figures 3.488-3.493. *Trichomacronema tamdao*: 3.488-3.489, setae on pronotum; 3.490, setae on thoracic legs; 3.491, setae on dorsum of head, nota, and fore-coxa; 3.492, setae on abdominal segments; 3.493, abdominal gills.



Figures 3.494-3.497. *Trichomacronema tamdao*: 3.494, dorsal view of pupal labrum; 3.495, ventral view of pupal mandibles; 3.496, pupal hookplates, dorsal showing abdominal segment number and anterior (A) or posterior (P) position; 3.497, pupal apical abdominal appendages.