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THE LARVAE OF FOUR *HYDROPSYCHE* SPECIES WITH THE CHECKERBOARD
HEAD PATTERN (TRICHOPTERA: HYDROPSYCHIDAE)

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ABSTRACT

Diagnostic characters to distinguish among larvae of four species of Hydropsyche from Saskatchewan (H. bifida Banks, H. recurvata Banks, H. walkeri Betten and Mosely, and H. bronta Ross) with checkerboard pattern of light and dark areas on the dorsum of the head include: differences in color of head and pronotum, body proportions, and secondary setation. A key is provided to larvae of these four species.

Les larves de quatre espèces d'Hydropsyche de la Saskatchewan, caractérisées par un motif en damier de taches pâles et foncées sur la surface dorsale de la tête, se distinguent les unes des autres par des différences dans la coloration de la tête et du pronotum, dans les proportions du corps, et dans la chétotaxie secondaire. On présente une clé d'identification des larves de ces quatre espèces.

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INTRODUCTION

Larvae of six hydropsychid species, *Hydropsyche bifida* Banks, *Hydropsyche recurvata* Banks, *Hydropsyche walkeri* Betten and Mosely, *Hydropsyche bronta* Ross, *Hydropsyche*

cheilonis Ross, and *Hydropsyche morosa* Hagen, have a characteristic checkerboard pattern of light and dark areas on the dorsum of the head (Figs. 3, 5a). Some individuals have a slightly modified version of the pattern characteristic of their species (Figs. 5b, 6). Larvae of these six species are difficult to distinguish and previous taxonomic studies (Ross, 1944; Schuster and Etnier, 1978) failed to effectively separate them.

Schuster and Etnier, (1978) wrote that three small light spots at the posterior end of the frontoclypeal apotome distinguish larvae of *H. morosa* from larvae of the other five species with the checkerboard head pattern, which either have no light spots, or a single large light spot at the posterior end of the frontoclypeal apotome. It is doubtful that three spots on the frontoclypeal apotome is diagnostic, since Mackay (1978) illustrated an *H. morosa* larva with a single large light spot.

Mackay (1978) distinguished larvae of *H. bronta* and *H. morosa* by differences in head widths of each instar of the two species, those of *H. morosa* having a consistently larger mean head width at each instar. This method is of limited use in normal taxonomic work as it requires measurement of many specimens from each locality studied. Also, this method may fail to discriminate between larvae from the same locality if more than two species with the checkerboard head pattern are represented in the collections.

In Saskatchewan four species of *Hydropsyche* larvae with checkerboard head pattern were collected: *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri*. In this paper we report results of our study of those taxa.

METHODS

Larval sclerites from pupal cases of reared specimens of *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri* were mounted on slides. We found consistent differences, and used them to identify larvae. Identified larvae were then studied for additional diagnostic features. Detailed study of body setation was facilitated by clearing specimens and mounting various body parts on slides for study with a compound microscope.

Several measurements were made of heads of larvae of each species. Widths of heads and measurements of the frontoclypeal apotome (Figure 7) were determined as follows:

- 1 aa width of apotome at level of anterolateral lobe
- 2 bb width of apotome just posterad of anterolateral lobe
- 3 cc width of apotome at level of tentorial pits
- 4 dd width of apotome at widest portion of posterior part
- 5 ee width of apotome at level of the pits in posterior part
- 6 g distance from anterior margin of apotome to lateral pit
- 7 h distance from lateral pit to anterior margin of tentorial pit
- 8 k distance from anterior margin of apotome to medial pit *H. bifida* the anterior margin gradually bends posterolaterad to meet the anterolateral corner (Figs. 1, 2 & 11). In *H. walkeri* the anterior margin projects anterolaterad as a small rectangular lobe (Figs. 3, 4, & 12).

Six ratios calculated from these measurements were used to describe shapes and proportions statistically, as follows:

1. Head width/length of frontoclypeal apotome (HW/FL).

2. Width of frontoclypeal apotome at level of tentorial pits/length of frontoclypeal apotome (FW/FL).
3. Width of frontoclypeal apotome just posterad of anterolateral lobes/width of frontoclypeal apotome at level of anterolateral lobes (BL/L).
4. Distance from anterior margin of frontoclypeal apotome to mesal pit on anterior part of frontoclypeal apotome/distance from anterior margin of frontoclypeal apotome to lateral pit on anterior part of frontoclypeal apotome;
5. Distance from lateral pit on anterior surface of frontoclypeal apotome to anterior edge of tentorial pit/length of frontoclypeal apotome.
6. Width of frontoclypeal apotome at level of pits on posterior part of frontoclypeal apotome/width of frontoclypeal apotome at level of widest part of posterior part of apotome.

Only the first three ratios are discussed further, because they are useful for discrimination of species. Measurements for ratios BL/L and FW/FL were taken from mature (fourth and fifth instar) larvae, and from sclerites extracted from cases of reared pupae. Measurements for the ratio HW/FL were taken only from mature larvae. All specimens measured are from Saskatchewan. Range, mean, 1.5 standard deviations (SD) and 95% confidence limits (CL) were determined for each ratio for each species (Tables 1-3); these data are illustrated in Figs. 15-17.

RESULTS

We treat features diagnostic for larvae of the four species examined in this study. For more complete descriptions consult Schuster and Etnier, Etnier (1978).

Color Pattern

Coloration must be used cautiously as a diagnostic feature for larvae of species with checkerboard head pattern because of variability and overlap.

H. bifida Banks. – Head coloration of *H. bifida* larvae is quite distinctive compared to head coloration of larvae of the other three species. In *H. bifida*, ground color of venter and dorsum of the head is dark brown in almost all specimens, these dark regions contiguous posterolaterally (Fig. 11) in most specimens. Most specimens of the other three species have a lateral light area between the dark dorsal and ventral regions of the head (Figs. 12, 13), if indeed these regions are dark. *H. bifida* larvae have distinct light spots on sides of the head (Fig. 11), these spots contrasting with the dark lateral surface. Larvae of the three other species lack spots on side of head, which contrast as noticeably with ground color of head (Figs. 12, 13) as in *H. bifida*. There are also one to three white spots on the dorsal surface of each parietal sclerite just anterad of seta 17 (Fig. 1). The light region around the eye of most specimens does not extend posterodorsad towards the margin of the parietal sclerite (Fig. 1), as in *H. recurvata* (Fig. 5a), *H. bronta* (Fig. 6), and most *H. walkeri* larvae (Fig. 3).

Schuster and Etnier (1978) noted that many *H. bifida* larvae are without anterior and posterior spots on the dorsum of the head. Many Saskatchewan *H. bifida* larvae lack these

spots and when the large single spot is absent from the posterior end of the frontoclypeal apotome, several smaller light spots are evident (Fig. 1).

TABLE I

Variation in the ratio HW/FL for *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri*

	N	Mean	Range	1.5 SD	CL
<i>H. recurvata</i>	29	1.139	0.986–1.260	0.071	1.121–1.157
<i>H. bifida</i>	33	1.108	1.055–1.175	0.051	1.096–1.121
<i>H. walkeri</i>	42	1.149	1.060–1.300	0.071	1.133–1.164
<i>H. bronta</i>	21	0.959	0.882–1.000	0.047	0.945–0.974

The pronotum has numerous small white spots on each lateral surface (Fig. 14).

H. walkeri Betten and Mosely. – Schuster and Etnier (1978) reported *H. walkeri* larvae with heads almost entirely light in color (as in Fig. 5b), but larvae examined by us have dark heads with checkerboard pattern on the frontoclypeal apotome (Fig. 3). Some individuals have, some lack, (Fig. 12) light spots on sides of head; these spots do not contrast as markedly with ground color of the head as in *H. bifida*. *H. walkeri* larvae have a light area at the posterior end of the frontoclypeal apotome, and there is a distinctive light spot laterad of seta 16 (Fig. 3). Light spots are lacking from the region of the head just anterad of seta 17, and most specimens have a light area directed posterodorsad from the region around the eye. Most specimens have a broad, dark stripe along the coronal suture (Fig. 3); this stripe is absent from or less well developed in larvae of the other three species. Most specimens with the dorsal and ventral regions of the head dark, have these regions separated by a light lateral area.

Lateral spots on the pronotum are only slightly lighter than ground color.

H. recurvata Banks. – Head coloration of *H. recurvata* larvae is extremely varied, from almost entirely dark to almost entirely light (Fig. 5b) (Ross, 1944; Schuster and Etnier, 1978). Most *H. recurvata* larvae lack light spots anterad of seta 17 as this area is occupied by a light area which extends dorsad and posterad from the light region around the eye (Fig. 5a). In dark specimens of *H. recurvata* light spots are not evident on the lateral and dorso-lateral regions of the posterior part of the head (Fig. 13). In lighter larvae some yellow spots are evident but they do not contrast markedly with ground color of the head. If dorsal and ventral regions of the head are both dark, they are separated laterally by a light area (Fig. 13) in most specimens.

Pronotal spots, if evident laterally, are darker than the ground color.

TABLE II

Variation in the ratio FW/FL for *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri*

	N	Mean	Range	1.5 SD	CL
<i>H. recurvata</i>	39	0.662	0.608–0.713	0.038	0.654–0.671
<i>H. bifida</i>	38	0.651	0.608–0.700	0.032	0.644–0.657
<i>H. walkeri</i>	42	0.647	0.602–0.695	0.035	0.640–0.655
<i>H. bronta</i>	29	0.558	0.522–0.595	0.027	0.551–0.565

H. bronta Ross. – Schuster and Etnier (1978) described two forms of *H. bronta*, based on differences in larval head patterns, from different regions of their study area. The Central Form has the typical checkerboard head pattern, but the Appalachian Form has a transverse striped head pattern (Fig. 6). Adults associated with the two larval forms are indistinguishable. In Saskatchewan both larval forms were collected, often from the same river. It is likely these two color forms are conspecific variants.

Small light spots are evident laterally on heads of some *H. bronta* larvae, but most larvae lack them. The light area around the eyes of most larvae is extended posterodorsad to the region anterad of seta 17 (Fig. 6). Ventral and lateral surfaces of the head are predominantly light. On each parietal sclerite of many larvae is a brown spot near the ventral ecdysial line and another on the ventrolateral surface in the vicinity of the stridulatory surface.

Pronotal sclerites lack contrasting dark or light spots laterally.

Head Setation

Head setation is most readily observed on cleared specimens mounted on slides. Head capsules of hydropsychid larvae possess a rich secondary setation, these setae being greatly modified in many species. The *Hydropsyche* larvae examined in this study have three main types of secondary setae on the head. The first is stout, dark, peg-like setae prominent on much of the dorsal and posterolateral regions of the parietal sclerites, and also on the frontoclypeal apotome of larvae of some species. The second type is fine setae present for most specimens on anterodorsal and posterodorsal regions of the parietal sclerites and on the frontoclypeal apotome. Larvae of some *Hydropsyche* species have setae intermediate between these first two types. The third type of secondary setae is along the anterior margin of the frontoclypeal apotome. These setae are extremely small with their blunt apical ends minutely divided.

Information about setation for abraded heads can be gained by determining size and number of sockets left where setae were attached. Sockets at bases of peg-like setae are larger

TABLE III

Variation in the ratio BL/L for *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri*

	N	Mean	Range	1.5 SD	CL
<i>H. recurvata</i>	46	0.93	0.889–0.959	0.026	0.925–0.935
<i>H. bifida</i>	39	0.892	0.84–0.944	0.036	0.884–0.900
<i>H. walkeri</i>	42	0.903	0.857–0.943	0.029	0.897–0.909
<i>H. bronta</i>	28	0.857	0.814–0.89	0.03	0.849–0.864

than those of the fine setae. Number of sockets in the rubbed area indicate number of setae previously present in that region.

H. bifida Banks. – Larvae of *H. bifida* have many long, fine setae on the posterior part of the frontoclypeal apotome, and on the region of each parietal sclerite laterad of the posterior end of the frontoclypeal apotome (Figs. 8, 11). Peg-like setae are absent from the posterior part of the frontoclypeal apotome (Figs. 1, 8).

H. walkeri Betten and Mosely. – Numerous long, fine setae are on the posterior part of the frontoclypeal apotome, and on the region of each parietal sclerite laterad of the posterior end of the frontoclypeal apotome (Figs. 8, 12). Peg-like setae are absent from the posterior part of the frontoclypeal apotome (Fig. 3).

H. recurvata Banks. –

The central portion of the posterior part of the frontoclypeal apotome has few, fine, very short setae (Figs. 9, 13). Fine setae are more abundant on the parietal sclerites laterad of the posterior end of the frontoclypeal apotome. A few peg-like setae are present on the posterior part of the frontoclypeal apotome (Figs. 5a, 5b, 9).

H. bronta Ross. – Like *H. bifida* larvae, those of *H. bronta* have numerous fine setae on the posterior part of the frontoclypeal apotome (Fig. 10), although these setae are shorter in *H. bronta*. There are also peg-like setae, and setae which are intermediate in thickness between the fine and peg-like setae, on this region of the frontoclypeal apotome, and on the parietal sclerites in the region laterad of the posterior end of the frontoclypeal apotome. Most peg-like setae on heads of *H. bronta* larvae are more acuminate than in the other three species.

Shape of Head and Head Sclerites

Based on shape of head and frontoclypeal apotome, the four species considered in this study are arranged in two groups. In Group I head width of almost all specimens is greater than frontoclypeal apotome length, and the frontoclypeal apotome is much wider in relation to its length than in Group II. In Group II width of head is equal to or less than length of the frontoclypeal apotome, and the latter is much narrower in relation to its length than in Group I. Larvae of these four species differ in values for ratios HW/FL (Fig. 15) and FW/FL (Fig. 16).

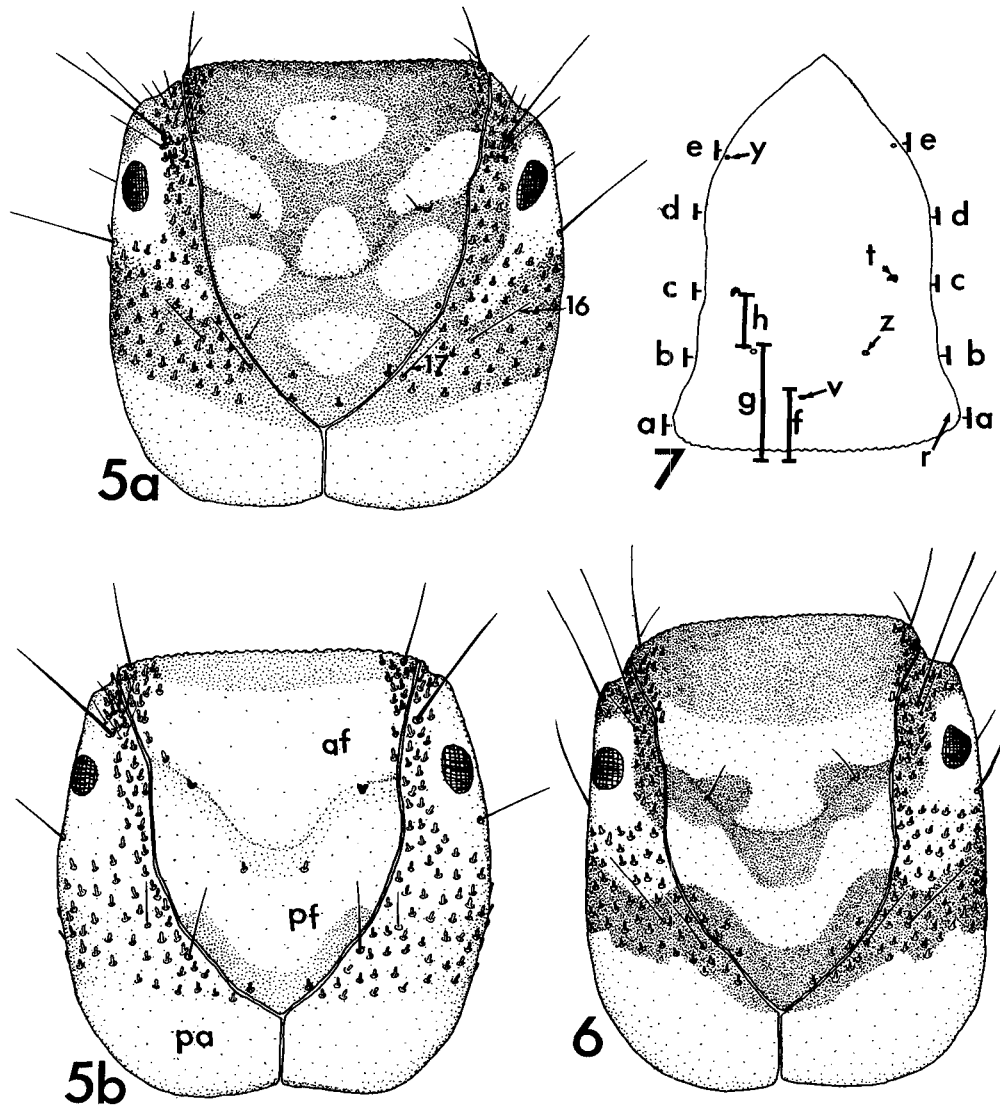
The ratio HW/FL (Fig. 15) shows that heads of *H. bronta* larvae are much narrower in relation to length of frontoclypeal apotome than are heads of the other three species. The ratio FW/FL (Fig. 16) indicates that *H. bronta* larvae have much longer, narrower frontoclypeal apotomes than do larvae of the other three species. Based on these ratios it is clear that three of the four species studied, *H. bifida*, *H. walkeri*, and *H. recurvata*, belong to Group I while only *H. bronta* belongs to Group II. We calculated values for ratios HW/FL and FW/FL from a drawing of the larva of *H. morosa* in Mackay (1978). Values obtained indicate that *H. morosa* probably belongs in Group II, if the drawing accurately represents the species.

Among the four species studied there are differences in relative size of anterolateral lobe of frontoclypeal apotome. In *H. bronta* these lobes are prominent while in *H. recurvata* they are only slightly developed. In *H. bifida* and *H. walkeri* development of these lobes is intermediate between those of *H. bronta* and *H. recurvata*. The ratio BL/L (Fig. 17) illustrates the difference in development of the anterolateral lobes of the frontoclypeal apotome among the four species.

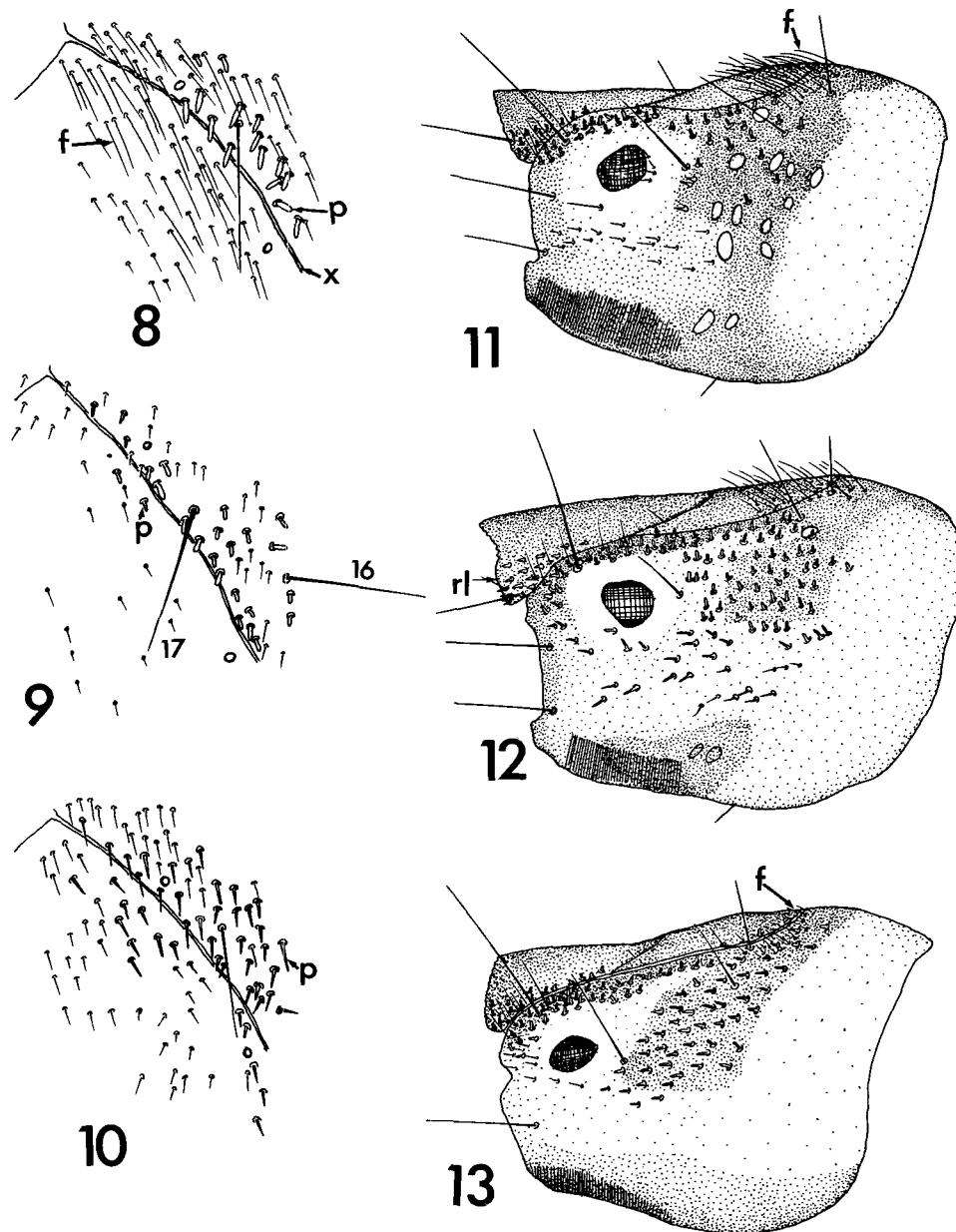
Hydropsyche bifida and *H. walkeri* larvae differ in shape of the anterior part of the frontoclypeal apotome. In *H. walkeri* larvae each lateral margin of the anterior part bulges outward (Figs. 3, 4), while in most, but not all *H. bifida* larvae the margin is straight (Figs. 1, 2). Larvae of these species also differ in the shape of anterior margin of the frontoclypeal apotome. In *H. bifida* the anterior margin gradually bends posterolaterad to meet the anterolateral corner (Figs. 1, 2 & 11). In *H. walkeri* the anterior margin projects anterolaterad as a small rectangular lobe (Figs. 3, 4, & 12).

Key to Species

- | | | |
|----|---|---------------------|
| 1a | Ratio FW/FL 0.522–0.595 | <i>H. bronta</i> |
| 1b | Ratio FW/FL 0.602–0.713 | 2 |
| 2a | (1b) Dorsum of head with numerous long, fine setae on middle of posterior part of frontoclypeal apotome (Figs. 8, 11, 12); no peg-like setae on posterior part of frontoclypeal apotome (Figs. 1, 3, & 8); side of head with (Fig. 11) or without (Fig. 12) light spots | 3 |
| 2b | Middle of posterior part of frontoclypeal apotome with few short, fine setae (Figs. 9, 13); peg-like setae on posterior part of frontoclypeal apotome (Fig. 5b); side of head without contrasting light spots (Fig. 13) | <i>H. recurvata</i> |
| 3a | (2a) Anterolateral margin of frontoclypeal apotome gradually curved posterad to anterolateral corner of apotome (Figs. 1, 2, 11) | <i>H. bifida</i> |
| 3b | Anterior margin of frontoclypeal apotome projected forward as small rectangular lobe near each anterolateral corner of apotome (Figs. 3, 4, & 12) ... | <i>H. walkeri</i> |



Figs. 5-7. Fig. 5a. *H. recurvata* head, dorsal aspect; Fig. 5b. *H. recurvata* head, dorsal aspect, showing anterior part of frontoclypeal apotome (af), posterior part of frontoclypeal apotome (pf) and parietal sclerite (pa); Fig. 6. *H. bronta* head, dorsal aspect; Fig. 7. *Hydropsyche* frontoclypeal apotome (schematic) showing locations where measurements were taken; also anterolateral lobe (r), tentorial pit (t), medial pit on anterior part (v), lateral pit on anterior part (z) and pit on posterior part (y).



Figs. 8–13. Fig. 8. *H. bifida* dorsum of head showing fine setae (f), peg-like setae (p), and frontoclypeal suture (x); Fig. 9. *H. recurvata* dorsum of head showing peg-like seta (p); Fig. 10. *H. bronta* dorsum of head showing peg-like seta (p); Fig. 11. *H. bifida* head, lateral aspect, showing fine setae (f); Fig. 12. *H. walkeri* head, lateral aspect showing rectangular lobe (rl); Fig. 13. *H. recurvata* head, lateral aspect, showing fine setae (f);

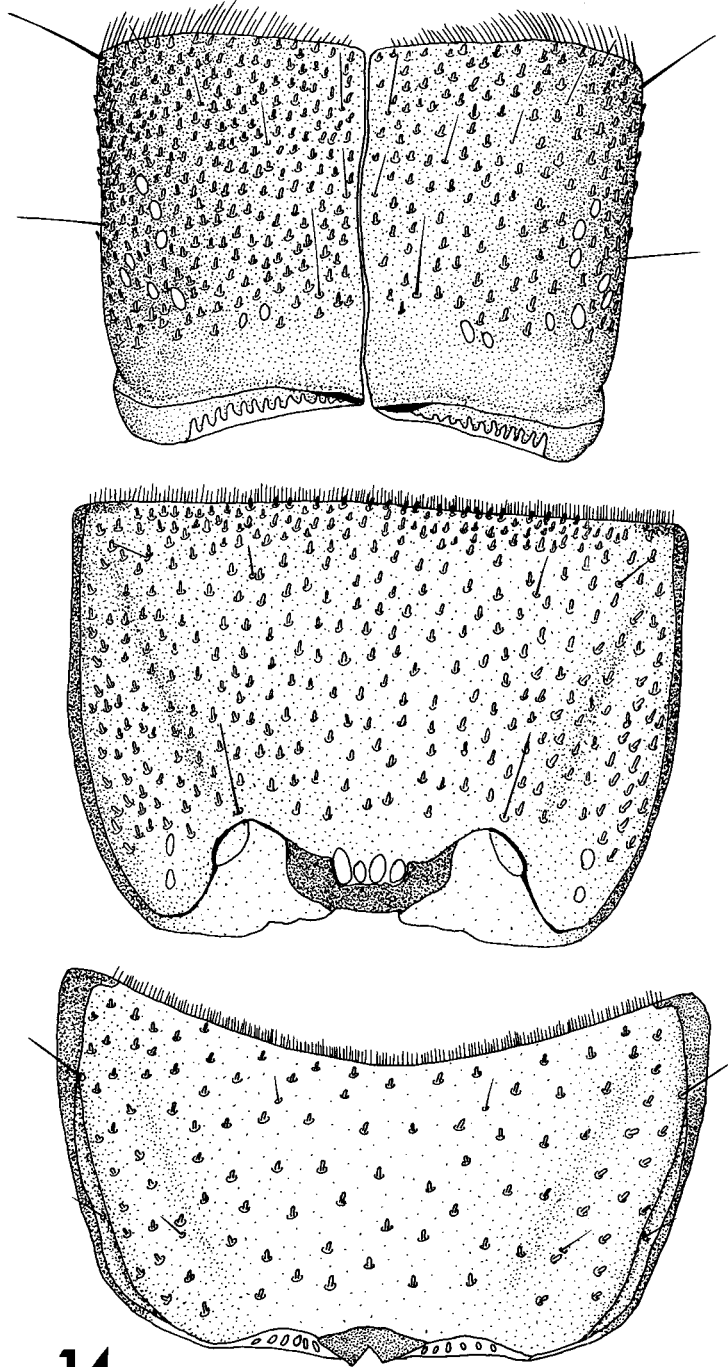
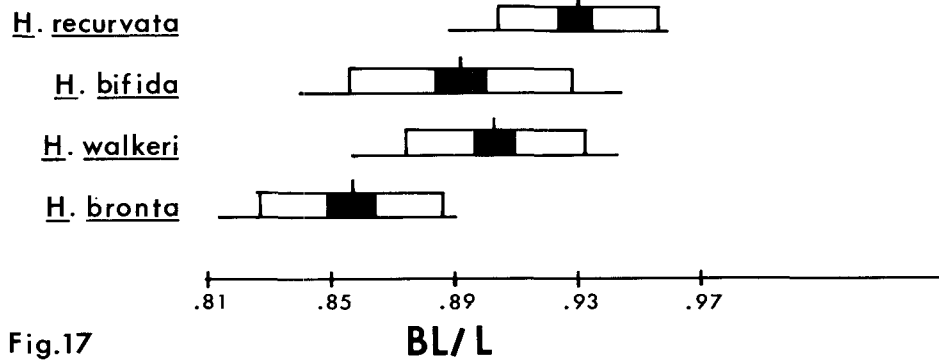
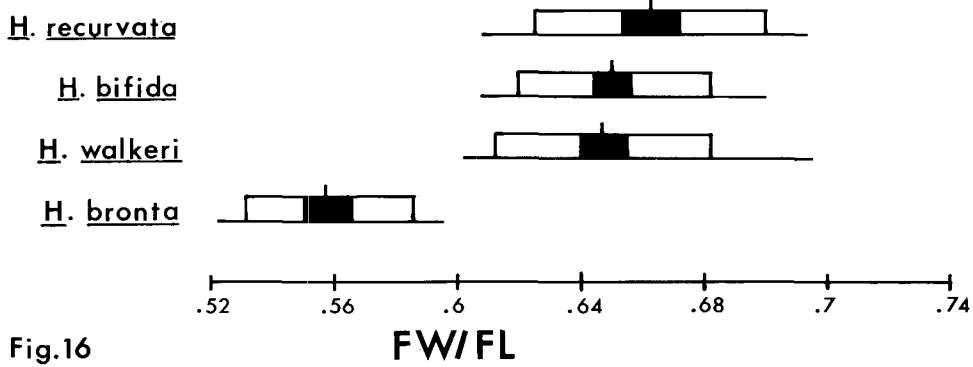
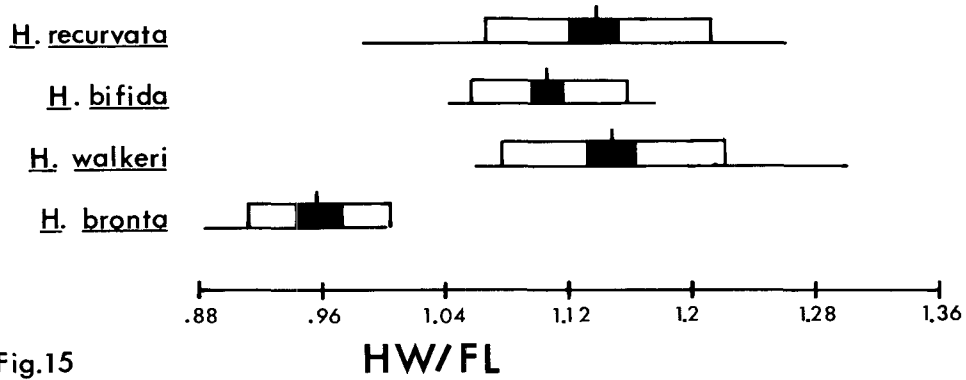
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Fig. 14.—Thoracic sclerites of *Hydropsyche bifida*.



Figs. 15–17. Fig. 15. Variation in the ratio HW/FL for *H. bifida*, *H. recurvata*, *H. bronta*, and *H. walkeri*. Data for each species is represented as follows: range, by basal horizontal line, mean by medial vertical line, confidence limits by dark box and 1.5 standard deviations on each side of the mean by the clear box. Fig. 16. Variation in the ratio FW/FL for *H. bifida*, *H. recurvata*, *H. bronta* and *H. walkeri*; for explanation, see caption of Fig. 15; Fig. 17. Variation in the ratio BL/L for *H. bifida*, *H. recurvata*, *H. bronta* and *H. walkeri*. For explanation see caption of Fig. 15.

