The Great Lakes Entomologist

Volume 19
Number 3 - Fall 1986 *Number 3 - Fall 1986*

Article 1

October 1986

Biology. Ecology, Larval Taxonomy, and Distribution of Hydropsychidae (Trichoptera) in Wisconsin

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BIOLOGY, ECOLOGY, LARVAL TAXONOMY, AND DISTRIBUTION OF HYDROPSYCHIDAE (TRICHOPTERA) IN WISCONSIN[1]

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ABSTRACT

About 43,000 larvae and 1800 adults of Hydropsychidae from Wisconsin were studied. These included *Diplectrona modesta*, *Macrostemum zebratum*, *Parapsyche apicalis*, *Potamyia flava*, eight species of *Ceratopsyche*, and 11 species of *Hydropsyche*, but because their larvae cannot be identified the nine species of *Cheumatopsyche* known from Wisconsin were not included. Keys were developed to separate larvae of species of *Ceratopsyche* and *Hydropsyche* that were collected in Wisconsin or are likely to occur here, and notes are provided to facilitate identification of closely related species. Two forms of *Ceratopsyche morosa* are distinguished, and the larva of *Hydropsyche placoda* is described. Most species have univoltine or bivoltine life cycles in Wisconsin, but *D. modesta* probably has a semivoltine life cycle. The various species inhabit a wide range of lotic habitats, and *Ceratopsyche alternans* also inhabits lakeshores. Larvae of *Hydropsyche orris*, *H. phalerata*, and *P. flava* occur only in large rivers; those of *Ceratopsyche alhedra*, *C. bronta*, *D. modesta*, and *Hydropsyche arinale* occur only in small streams. Tolerance to organic pollution varied widely, with *C. morosa* (morosa form), *C. walkeri*, *D. modesta*, *Hydropsyche leonardi*, and *P. apicalis* being found only in unpolluted streams, while *C. morosa* (bifida form) and *Hydropsyche betteni* abounded in streams with significant organic enrichment. Larvae of some species were always associated with sandy substrates, others were found only in rocky or silt-bottomed streams, and species such as *Hydropsyche bidens*, *H. orris*, *H. phalerata*, *H. placoda*, *H. simulans*, and *P. flava* often burrowed into decaying wood.

Larvae of the net-spinning family Hydropsychidae inhabit most streams and are often the most abundant caddisfly, if not the most abundant insect. For this reason they are important in biological monitoring and ecological studies. They are also important in systematic considerations (Wiggins 1981). But larval identification has often been a problem. In Wisconsin *Diplectrona*, *Macrostemum*, *Parapsyche*, and *Potamyia* are monotypic and larvae are easily identified (Wiggins 1977, Hilsenhoff 1981, Merritt and Cummins 1984), but larvae of the nine species of *Cheumatopsyche* in Wisconsin (Longridge and Hilsenhoff 1973) remain unidentifiable. Identification of *Hydropsyche* and *Ceratopsyche* larvae had been a serious problem until a 1978 publication by Schuster and Etnier on *Hydropsyche* and a M.S. thesis by Patricia Schefter in 1982 on the *Hydropsyche morosa* species group (*Ceratopsyche*) made it possible to identify most species. These two significant studies, along with those by Ross (1944), Flint (1961), Mackay (1978), Smith (1979), and Smith and Lehmkuhl (1980), make it possible to identify almost all species from Wisconsin. Species of adult Hydropsychidae can be

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[1]Research supported by the College of Agricultural and Life Sciences, University of Wisconsin-Madison and by Hatch Research Project 2785.

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identified using Betten (1934), Ross (1938a,b, 1939, 1941, 1944, 1947, 1962), Denning (1942, 1943, 1949), Schmid (1968), Gordon (1974), Flint, Voshell, and Parker (1979), and Flint and Butler (1983).

Longridge and Hilsenhoff (1973) were the first to survey the caddisflies of Wisconsin, and Hilsenhoff updated these records in 1981. Other studies of Wisconsin caddisflies were restricted to particular streams or areas (Vorhies 1909, Longridge and Hilsenhoff 1972, Karl and Hilsenhoff 1979, Hilsenhoff 1982a, Steven and Hilsenhoff 1984). These studies, along with a study of 53 streams by Hilsenhoff (1977) and a cooperative study with the Wisconsin Department of Natural Resources (DNR) of 1018 stream sites throughout Wisconsin, provided most of the hydropsychid larvae and ecological data used in this study. Larval distribution, abundance, habitat, and biology of Wisconsin species are discussed below and regional keys to mature larvae of *Ceratopsyche* and *Hydropsyche* with notes on their identification are provided. Most third and fourth instar larvae can also be identified by characters in these keys.

Collections made during the last 28 years contain 43,778 Hydropsychidae larvae (exclusive of *Cheumatopsyche*) from at least 1200 different lotic and semilotic sites (Table 1). Most were collected from riffles or runs of streams by disturbing substrates upstream from a D-frame net. Several species, however, often live and construct their catchnets in partially decayed wood with cracks and crevices. These include *Hydropsyche bidens*, *H. orris*, *H. placoda*, *H. simulans*, and *Potamyia flava*. Our minimal efforts to sample wood were mostly carried out in the past year, and resulted in a several-fold increase in our collection of these species. Other species that we collected from wood in lesser numbers were *Ceratopsyche alternans*, *C. bronta*, *C. morosa* (both forms), *Hydropsyche phalerata*, *H. scalaris*, and *Macrostemum zebratum*. The wood was found lodged in the current of rocky riffles and runs, along the banks in slow and fast current, or embedded in sand. Larvae were removed with a forceps or collected after they had crawled out of the wood as it dried. Up to two hours were needed to remove larvae from large pieces of wood. Also listed in Table 1 are 1875 adults we reexamined, most of them from a study by Longridge and Hilsenhoff (1973). Adult females for several species of *Ceratopsyche* and *Hydropsyche* cannot be reliably distinguished, and are not included in the table.

Relative abundance of species in four regions of Wisconsin that are similar in area, drainage, and geology (Fig. 1) is reported in Table 1. Inevitably sampling bias has occurred. Large deep rivers, shorelines of large lakes, and wood are all undersampled. Species collected in the restricted studies mentioned above and those collected by the DNR from streams in three priority watershed surveys are overrepresented. But because extensive statewide sampling has occurred, we believe a reasonably uniform and adequate collection of hydropsychid larvae was obtained. Habitat and apparent tolerance to organic pollution are tabulated for each species in Table 2, and adult emergences and voltinism are summarized in Table 3. Life cycles were determined by examining one or more series of collections of a species made throughout the year from a single stream, but this was not possible for several species. Species that may occur in Wisconsin, but which have not yet been found here, are also mentioned. Synonymies are included for species that have been referred to by more than one name. All specimens are preserved in the University of Wisconsin Insect Collection in 70% ethanol with 3% glycerine.

Arctopsyche McLachlan, 1868

Arctopsyche ladogensis (Kolenati, 1859)

Synonymy. *Aphelocheira ladogensis* Kolenati (1859:201)

This is the only species in the western Great Lakes region, and we have larvae from the Elm River, Houghton County, and the Ontonagon River, Ontonagon County, in Michigan's Upper Peninsula. Many unsuccessful attempts were made to collect it in Wisconsin, but we still believe it may be found. Larvae inhabit cold, fairly large streams with a strong current (Flint 1961, Wiggins 1977).

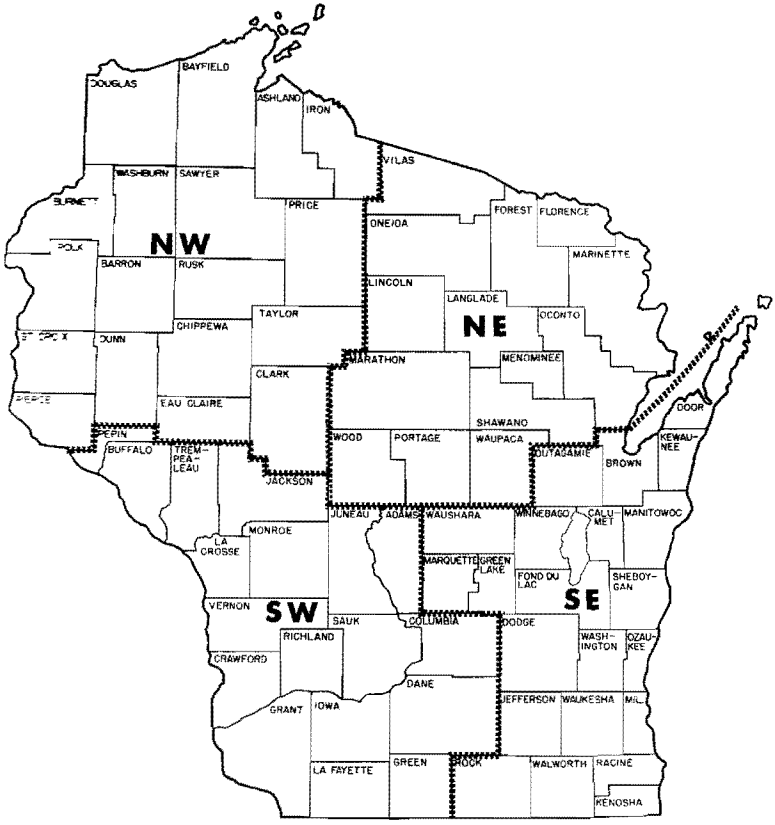


Fig. 1. Four regions of Wisconsin similar in area, drainage, and geology.

Ceratopsyche Ross and Unzicker, 1977

The literature refers to this genus as the *Hydropsyche bifida* species group (Ross 1944), the *Hydropsyche morosa* species group (Schefter and Unzicker 1984), or as *Symphitopsyche* subgenus *Ceratopsyche* (Ross and Unzicker 1977). Nielsen (1981) and Schuster (1984) discussed reasons why they believe *Ceratopsyche* is a valid genus apart from *Hydropsyche* and *Symphitopsyche*, and Morse and Holzenthal (1984) agreed, but their opinions have not been accepted by everyone. Schmid (1979) discussed reasons why *Hydropsyche sens. lat.* should be retained, and Schefter (1982), Schefter and Unzicker (1984), and Wiggins (1984) believe more study is needed to support this name change. Thus, all three generic names appear in recent literature. Although the matter still needs to be resolved to everyone's accord, we will follow Nielsen and Schuster.

KEY TO MATURE LARVAE OF *CERATOPSYCHE* IN WISCONSIN

1. Ventral portion of anal prolegs with spine-like setae similar to those on sternum of abdominal segment IX 2
1'. Ventral portion of anal prolegs without spine-like setae 6

Table 1. Numbers of larvae of each species of Hydropsychidae collected in four areas of Wisconsin (Fig. 1) and numbers of adults of each species collected overall between 1956 and 1984.

	South		North		Total larvae	Adult males	Adult females
	West	East	West	East			
Ceratopsyche alhedra	1418	54	431	324	2227	39	
C. alternans	0	52	326	716	1094	23	
C. bronta	1592	1005	1251	1374	5222	181	
C. morosa bifida form	1191	1409	1022	738	4360	373	
C. morosa morosa form	0	0	216	1148	1364	31	
C. slossonae	6888	2172	2093	1356	12509	550	
C. sparna	1565	421	476	1339	3801	126	
C. vexa	0	57	60	737	854	43	
C. walkeri	0	2	379	620	1001	24	
Diplectrona modesta	253	6	91	81	431	28	4
Hydropsyche arinale	0	30	0	0	30	1	
H. betteni	2196	3080	1182	1271	7729	189	
H. bidens	56	11	15	0	82	9	
H. cuanis	50	82	0	16	148	9	
H. dicantha	30	0	101	204	335	5	
H. leonardi	0	0	9	111	120	4	
H. orris	555	3	1	10	569	48	
H. phalerata	0	0	24	17	41	4	
H. placoda	0	37	175	175	387	25	
H. scalaris	22	44	46	97	209	3	
H. simulans	255	134	252	8	649	8	
Macrostemum zebratum	0	8	112	145	265	9	9
Parapsyche apicalis	51	5	91	82	229	2	4
Potamyia flava	118	3	1	0	122	67	64
TOTAL	16240	8615	8354	10569	43778	1801	81

2(1). Paired, mid-dorsal, primary setae on pronotum 1/2 mid-dorsal length of pronotum and dark; secondary pronotal setae mostly pale with an infuscation around point of insertion giving pronotum a freckled appearance..... *vexa*

2′. Paired, mid-dorsal, primary setae on pronotum less than 1/3 mid-dorsal length of pronotum and usually pale; pronotum without distinct infuscation around points of insertion of secondary setae..... 3

3(2′). Secondary setae laterad of frontoclypeal suture truncate, of equal length, and pale (rarely dark) ..... *alternans*

3′. Secondary setae laterad of frontoclypeal suture mostly acuminate, unequal in length, and dark 4

4(3′). Dark marks on venter of head, if present, arranged as 2 or 3 pairs, one pair halfway back embracing gular suture, a second pair halfway back and lateral to each stridulatory area (Fig. 2), and sometimes a third pair on anterior of stridulatory areas that may coalesce with lateral pair (Fig. 3); posterior half of frontoclypeus with several black, bristle-like setae; posterior angle of frontoclypeus with a pale spot, never with 3 smaller spots or only muscle scars..... *bronta*

4′. Dark marks on venter of head, if present, never as above (Figs. 4,5,9); posterior half of frontoclypeus with or without black, bristle-like setae; posterior angle of frontoclypeus with a single pale spot, 3 smaller spots, or only muscle scars..... 5

Table 2. Physical characteristics of Wisconsin streams in which Hydropsychidae species occur and the tolerance of species to organic pollution. Parentheses indicate uncommon occurrence.

Species	Maximum temp. °C	Width (m)	Current[a]	Substrate[b]	Pollution[c] tolerance
Ceratopsyche alhedra	22–28	0.5–15	M–F(VF)	P,C,B,Be	N,S
C. alternans	26–28	3–75	(M)F–VF	(S,P),C,B,(Be)	N,S,(M)
C. bronta	23–30	2–18(36)	M–F	S,G,P,C,(B)	(N),S,M,(H)
C. morosa bifida form	25–30	3–76	M–F	Si,S,G,P,C,(B)	(N),S,M,H
C. morosa morosa form	21–29	6–36	F–VF	(S),P,C,B,(Be)	N,(S)
C. slossonae	15–25(28)	(0.5)2–25(76)	M–VF	S,G,P,C,B	N,S,M
C. sparna	16–26	0.5–21	(S)M–F	S,G,P,C	N,S
C. vexa	23–28	3–50	M–F	Si,S,G,P,C	N,S,(M)
C. walkeri	21–28	4–36	M–F	S,G,P,C,B,Be	N,(S)
Diplectrona modesta	16–20	0.5–8	M	S,G,P,C	N,(S)
Hydropsyche arinale	26	6–12	S–M	Si,S,G,P,C	S,(M)
H. beneni	19–30	2–76	S–F	Si,S,G,P,C,B	N,S,M,H
H. bidens	29	25–(320)	M–F	Si,S,G,P,C	(N),S,M
H. cuanis	26–30	5–45	(S)M–F	Si,S,G,P,C	S,(M)
H. dicantha	24–29	3–24	M–F	Si,G,P,C,B	N,S
H. leonardi	20–24	10–35	M–F	P,C,B	N
H. orris	29	(73)–320	M–F	Si,S,G,P	S,M
H. phalerata	25–28	80–110	M–VF	S,G,P,C	N,S,M,(H)
H. placoda	25–28	14–100	F–VF	S,G,P,C,B	N,S,(M)
H. scalaris	25–30	10–30	M	Si,S,G,P,C	N,S,(M)
H. simulans	24–29	8–320	S–F	Si,S,G,P,C	N,S,M
Macrostemum zebratum	(21)27–29	9–80	M–F	Si,G,P,C	N,S,(M)
Parapsyche apicalis	15–18	0.5–27	S–VF	S,G,P,C	N
Psilomyia flava	29	150–320	M–F	Si,S,G,P	S,M

[a]Current: S = < 0.15 m/sec, M = 0.15–0.45 m/sec, F = 0.45–0.75 m/sec, VF = > 0.75 m/sec.
[b]Substrate: Si = silt, S = sand, G = gravel, P = pebbles, C = cobbles, B = boulders, Be = bedrock (Cummins 1962).
[c]Pollution Tolerance: N = none, S = slight, M = moderate, H = high.

5(4'). Posterior half of frontoclypeus with at most 2–4 inconspicuous, bristle-like setae near lateral margins; posterior angle of frontoclypeus with a single pale spot or 1–3 pairs of muscle scars ..... *morosa* (bifida form)

5'. Posterior half of frontoclypeus with more than 5 conspicuous, dark, bristle-like setae; posterior angle of frontoclypeus with 3 light spots that may coalesce ..... *morosa* (morosa form)

6(1'). Secondary setae laterad of frontoclypeal suture truncate and of equal length; frontoclypeus with 7 distinct pale spots in a checkerboard pattern, or spots coalescing to form large pale areas ..... *walkeri*

6'. Secondary setae laterad of frontoclypeal suture mostly acuminate and unequal in length; frontoclypeus with less than 7 distinct pale spots, spots absent, or rarely with spots coalescing to form large pale areas 7

7(6'). Frontoclypeus usually with a single central pale spot, but sometimes with an additional anterior and/or posterior spot arranged linearly, or spots absent, or spots coalescing to form large pale areas; pigmentation on venter of head variable, usually as in Figs. 6 or 7, never as in Figs. 8 or 9.... *slossonae*

7'. Frontoclypeus either entirely dark or light, or with 2–5 spots anteriorly in a checkerboard pattern; pigmentation on venter of head as in Figs. 8 or 9, or mostly yellow 8

8(7'). Long, anterolateral seta on margin of pronotum usually 4 times length of adjacent marginal setae or longer; venter of head dark with a pale area on

Table 3. Summary of adult emergences and life cycles of Wisconsin Hydropsychidae.

Species	Adult emergence	Life cycle
Ceratopsyche alhedra	5 June–12 Sept.	Apparently univoltine
C. alternans	21 May–18 Aug.	Apparently univoltine
C. bronta	5 May–26 Aug.	Univoltine, probably bivoltine some streams
C. morosa bifida form	3 May–31 Aug.	Bivoltine some southern streams, unclear other streams
C. morosa morosa form	28 May–26 Aug.	Apparently univoltine
C. slossonae	15 May–28 Aug.	Univoltine
C. sparna	7 June–27 Aug.	Apparently univoltine
C. vexa	27 May–15 July	Apparently univoltine
C. walkeri	9 June–12 Aug.	Univoltine
Diplectrona modesta	3 May–9 July	Univoltine or semivoltine
Hydropsyche arinale	19 Aug.	Undetermined
H. betteni	21 May–12 Aug.	Univoltine, probably bivoltine some warmer streams
H. bidens	15 June–17 Aug.	Undetermined
H. cuanis	21 May–10 June	Undetermined
H. dicantha	23 June–19 July	Apparently univoltine
H. leonardi	28 May–17 Aug.	Univoltine
H. orris	21 May–20 Aug.	Bivoltine lower Wisconsin R., major emergences early June and mid-August
H. phalerata	17 Aug.	Undetermined
H. placoda	15 June–19 Aug.	Apparently univoltine
H. scalaris	18 June–10 Aug.	Univoltine
H. simulans	3 May–18 Aug.	Undetermined
Macrostemum zebratum	21 June–16 July	Univoltine
Parapsyche apicalis	30 April–5 Aug.	Univoltine
Potamyia flava	21 May–3 Sept.	Bivoltine lower Wisconsin R., major flights early June and mid-August

each side of gular suture in anterior third (Fig. 8), occasionally like Fig. 9; width of head capsule about 1.25 mm ..... *alhedra*

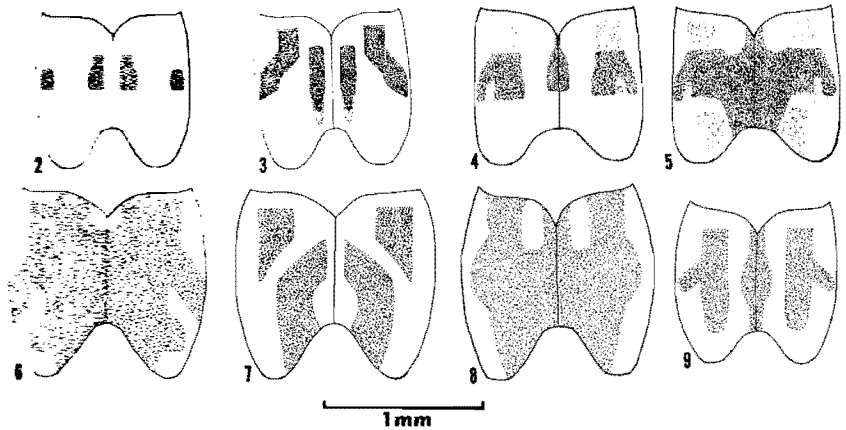
8′. Long, anterolateral seta on margin of pronotum less than 3 times length of adjacent marginal setae, usually 1.5–2 times longer; venter of head with a pale area on each side of gular suture extending entire length of head (Fig. 9), never like Fig. 8; width of head about 1.10 mm ..... *sparna*

Ceratopsyche alhedra (Ross, 1939)

Synonymy. *Hydropsyche alhedra* Ross (1939:67); *Hydropsyche riola* Denning (1942:49); *Symphitopsyche alhedra* and *S. riola* Schuster and Etnier (1978:44,45); *Hydropsyche alhedra* Schefter.

Habitat. Larvae occur statewide, but are most abundant southwest (Fig. 10). Many streams in which they occur are silty with eroded banks and algal mats attached to the substrate, but they also occur in small, cool, clean streams.

Identification. Schefter (pers. comm.) found larvae of *C. alhedra* difficult to separate from *C. sparna* and believes intermediates exist. We found some populations with occasional individuals that had intergrading characters, but usually these species can be



Figs. 2–9. Ventral view of heads of larvae of *Ceratopsyche* from Wisconsin. (2, 3) *C. bronta*; (4, 5) *C. morosa* (bifida form); (6, 7) *C. slossonae*; (8) *C. alhedra*; (9) *C. sparna*.

separated by characters in the key. The long seta on the anterolateral margin of the pronotum is usually 4 times or more the length of adjacent setae, rarely only 2.5 times longer; this seta on *C. sparna* is 1.5–2.0 and only rarely 3 times longer, but there is some overlapping of this character.

The ventral color pattern of the head is mostly dark with a pale, anterior spot on each side of the gular suture, giving the dark mark a wide "W" shape (Fig. 8); *C. sparna* never has this configuration. Occasionally the dark markings are reduced to separated streaks, one on the gular suture and one each on the stridulatory surfaces, similar to *C. sparna* (Fig. 9). The dorsal color pattern of the head is a dark brown, often with two anterolateral light spots, or rarely a checkerboard pattern of 3–5 light spots. The dorsal head color of *C. sparna* is a paler red brown or yellow brown.

Ceratopsyche alternans (Walker, 1852)

Synonymy. *Philopotamus alternans* and *P. indecisus* Walker (1852:104); *Hydropsyche slossonae* var. *recurvata* Banks (1914:253); *Hydropsyche codona* Betten (1934:187); *Hydropsyche recurvata* Betten (1934:190); *Symphitopsyche recurvata* Schuster and Etnier (1978:34); *Hydropsyche alternans* Nimmo (1981:261).

Habitat. Larvae inhabit riffles of small to large streams in northern Wisconsin (Fig. 10). The streams usually flow through woods and have good water quality; normally only slight organic enrichment is tolerated. This species also inhabits the Great Lakes and smaller lakes (Ross 1944, Barton and Hynes 1978, Sykora et al. 1981, Schefter and Wiggins, in press). We collected larvae on rocks in 15 cm of water in Lake Butte des Morts, Winnebago County, a widened portion of the Fox River. This lake exhibits severe cyanobacterial blooms during the summer and extreme physical and chemical variations throughout the year (Sloey 1970). This situation obviously contrasts with its stream habitat, and its ability to adapt to this lake's conditions is remarkable.

Identification. The ventral spine-like setae on the abdominal prolegs, and the pale (seldom dark), truncate, subequal, secondary setae on the parietals are diagnostic.

Ceratopsyche bronta (Ross, 1938)

Synonymy. *Hydropsyche bronta* Ross (1938b:149); *Symphitopsyche bronta* Schuster and Etnier (1978:37).

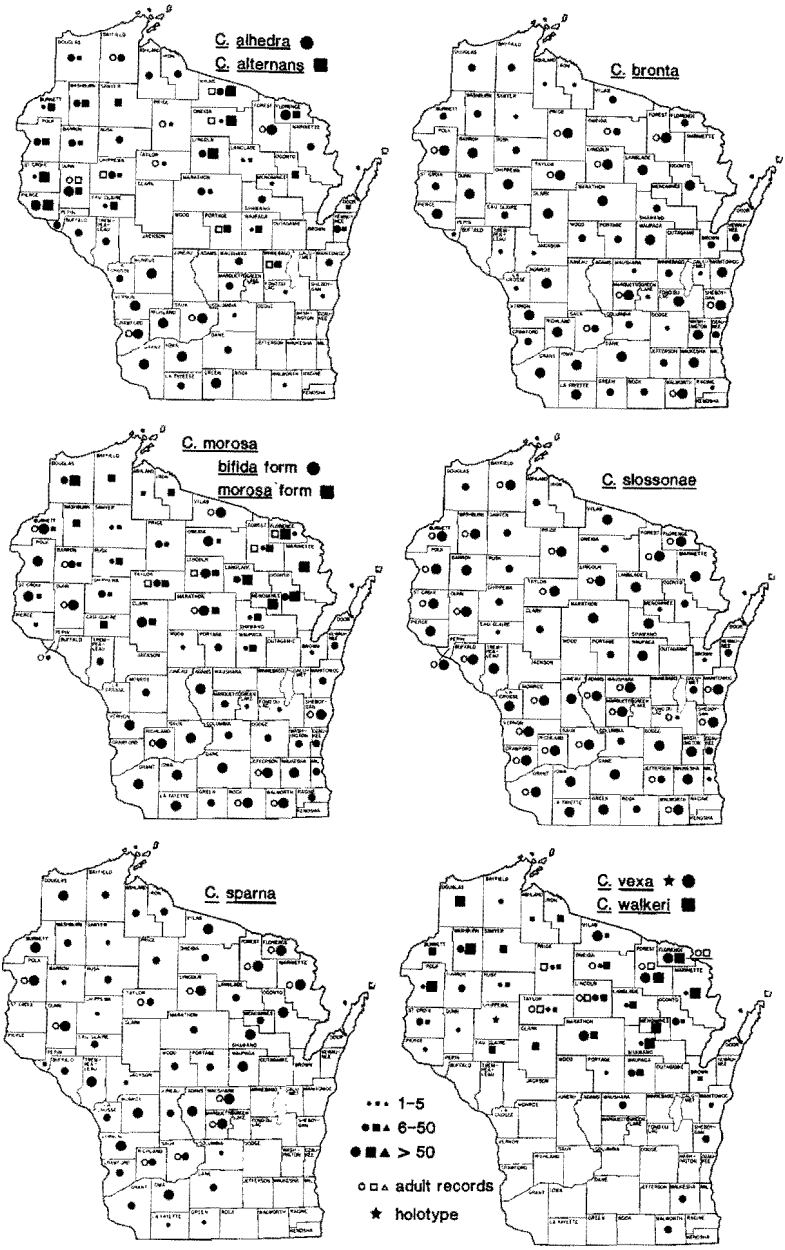


Fig. 10. Distribution and abundance of *Ceratopsyche* species in Wisconsin.

Habitat and Biology. Larvae inhabit silty streams statewide (Fig. 10) that often contain algae and slimes, and are uncommon in cleaner and wooded streams. This species is bivoltine and trivoltine in southern Ontario (Mackay 1984); our life history data are inconclusive.

Identification. Larvae are most similar to *C. morosa* and can be distinguished by the many bristle-like setae on the posterior of the frontoclypeus, and by the typical ventral pattern of the head as mentioned by Smith and Lehmkuhl (1980) and described in the key (Fig. 2). The spots next to the gular suture frequently extend posteriorly, forming dark streaks (Fig. 3). No other species in Wisconsin exhibits this basic pattern. Heads of some *C. bronta* larvae lack ventral pigmentation.

Ceratopsyche cheilonis (Ross, 1938)

Synonymy. *Hydropsyche cheilonis* Ross (1938b:149); *Symphitopsyche cheilonis* Schuster and Etnier (1978:33).

This species was reported from Wisconsin by Longridge and Hilsenhoff (1972, 1973), but all adults were reexamined and found to be *C. bronta*. We have seen adults and larvae from the Salt Fork River in Oakwood, Illinois, but have not collected this species in Wisconsin and believe it does not occur this far north. The larva is described by Schefter and Wiggins (in press).

Ceratopsyche morosa (Hagen, 1861)

Synonymy. *Hydropsyche chlorotica* and *H. morosa* Hagen (1861:287,290); *Hydropsyche bifida* Banks (1905: 15); *Symphitopsyche bifida* and *S. morosa* Schuster and Etnier (1978:30,41).

Schefter and Unzicker (1984) synonymized *C. bifida* with *C. morosa* based on examination of the types, and adult and larval intergradations. Intermediate forms are not found in every area of the overlapping ranges, and occur mostly north and east of the Great Lakes (Schefter, pers. comm.). In Wisconsin we have not found intermediate adult males, and there are consistent setal and color differences between the two forms of larvae, along with a difference in their water quality requirements. Thus, to help refine water quality studies on streams we believe it is necessary to identify both larval forms.

Ceratopsyche morosa (bifida form)

Habitat. Moderate to high amounts of organic enrichment from agricultural runoff and sewage effluent can be tolerated; clean rivers rarely harbor large populations. This form is abundant below impoundments and found statewide (Fig. 10).

Identification. The lack of many dark bristle-like setae on the posterior of the frontoclypeus distinguishes it from *C. morosa* (morosa form) and *C. bronta*. At most there is a total of 2–4 inconspicuous setae near the posterior and (or) posterolateral angles. Dark, ventral areas of the head are variable. The basic pattern is three dark areas halfway back, one each on the posterior half of the stridulatory surfaces, and one mesally on the gular suture (Fig. 4). These can fuse to form a transverse band or be reduced to three small spots. More often the pigmentation is extensive, forming a wide "W" shape (Fig. 5) as in *C. alhedra*; this is never the case with *C. morosa* (morosa form) or *C. bronta*. The three pairs of dorsal muscle scars at the posterior angle of the frontoclypeus are more conspicuous, even when a pale spot covers them, than in *C. morosa* (morosa form) and *C. bronta*.

Ceratopsyche morosa (morosa form)

Habitat. This form is found only in northern Wisconsin (Fig. 10) in fast to very fast streams with a pebble to bedrock bottom. These streams flow primarily through woods and forests and have very good water quality. Larvae can tolerate only slight enrichment.

Identification. Many dark bristle-like setae are scattered over the posterior of the frontoclypeus. The ventral head color can be entirely yellow, pigmented similar to *C. sparna* (Fig. 9), or intermediate. Most often there are uniform, longitudinal, dark streaks on the gular suture and stridulatory surfaces. The frontoclypeus has three small, laterally-elongate light spots covering the posterior muscle scars (Schuster and Etnier 1978). Often these spots coalesce to form one or two larger spots. The remaining dorsal color pattern can vary from a typical checkerboard style to extensive light areas.

Ceratopsyche slossonae (Banks, 1905)

Synonymy. *Hydropsyche slossonae* Banks (1905:14); *Symphitopsyche slossonae* Schuster and Etnier (1978:47).

Habitat and Biology. A wide range of streams are inhabited statewide (Fig. 10). They vary in size and maximum temperature, but larvae are most common in colder, smaller, and shallower streams. They abound in clean streams with shallow (8–45 cm) riffles, but can tolerate moderate amounts of organic enrichment. Some populations in Ontario were bivoltine (Mackay 1979), but in streams we studied this species was univoltine.

Identification. The dorsal head pattern varies considerably (Schefter and Wiggins, in press). The single, mesal, frontoclypeal pale spot is the predominant pattern. Other patterns include an additional anterior and (or) posterior spot arranged linearly, a large anterior and posterior spot that cover most of the frontoclypeus, and an entirely yellow or dark head. Entirely yellow-headed larvae are rare and occur in northern counties; the entirely dark head is also rare and seen mostly in early instars. The two large, pale-spots pattern is more common, with a random, northern distribution.

Ventral head color varies from solid dark to entirely light. The two most common patterns are a dark surface with a small, pale spot anteriorly on the gular suture (Fig. 6), or two slightly curved, posterior dark streaks embracing the gular suture, with or without additional pigmentation (Fig. 7). It never exhibits patterns like *C. alhedra* or *C. sparna* (Figs. 8,9).

Ceratopsyche sparna (Ross, 1938)

Synonymy. *Hydropsyche sparna* Ross (1938b:150); *Symphitopsyche sparna* Schuster and Etnier (1978:52). Ross (1938b) stated that Betten (1934) recorded this species as *Hydropsyche phalerata*.

Habitat and Biology. Larvae occur almost exclusively in streams containing sand, which may comprise as much as 90% of the substrate. This may explain why it is absent from the east (Fig. 10) where the bedrock is predominantly dolomite; the rest of the state has mostly sand-forming bedrocks (Martin 1965). This same distribution was observed for *Baetisca* mayflies (Hilsenhoff 1984) and brachycentrid caddisflies (Hilsenhoff 1985). Larvae mostly inhabit clean, woodland streams, and can tolerate only slight enrichment from agricultural runoff. We have not collected larvae from large or organically rich rivers as reported by Schuster and Etnier (1978). Mackay (1979) found univoltine and bivoltine populations in Ontario, and Parker and Voshell (1982) reported trivoltinism in Virginia. In the few streams we studied this species was univoltine.

Identification. As stated earlier, *C. sparna* is difficult to consistently separate from *C. alhedra* and hybrids may exist. Separation of the two species is discussed under *C. alhedra*. The dorsal head color is usually a light red brown or yellow brown. When frontoclypeal light spots are present there are two anterolaterally, with an occasional central spot.

Ceratopsyche vexa (Ross, 1938)

Synonymy. *Hydropsyche vexa* Ross (1938b:148); *Symphitopsyche vexa* Schuster and Etnier (1978:127).

Habitat. Larvae occur in streams of varying water quality that flow through woods, agricultural land, wetland, and residential areas of northern and southeastern Wisconsin (Fig. 10).

Identification. The ventral, spine-like setae on the anal prolegs, the pair of long, mid-dorsal setae on the pronotum, and the infuscation around the points of insertion of the secondary pronotal setae are distinctive.

Ceratopsyche walkeri (Betten and Mosely, 1940)

Synonymy. *Hydropsyche maculicornis* Walker (1852:113); *Hydropsyche walkeri* (includes *Hydropsyche* sp. 1 from Betten [1934]) Betten and Mosely (1940:23); *Symphitopsyche walkeri* Schuster and Etnier (1978:35).

Habitat. Larvae inhabit cool, fast, northern (Fig. 10) streams with a rocky substrate. Almost all of the streams flow through heavily wooded areas and have excellent water quality. Schuster and Etnier (1978) and Schefter and Wiggins (in press) state that this species can tolerate some organic enrichment, but we rarely found it in streams with even slight organic enrichment.

Identification. Larvae are easily identified by the lack of ventral, spine-like setae on the anal prolegs, the lack of bristle-like setae on the frontoclypeus, and by the dark, truncate and subequal, bristle-like setae on the parietals. The dorsal head pattern is of two types as described in the key (also Schuster and Etnier 1978, Schefter and Wiggins, in press); both are common in Wisconsin.

Diplectrona Westwood, 1840

Diplectrona modesta Banks, 1908

Habitat and Biology. Larvae occur statewide (Fig. 11) in small, cold, spring-fed streams with a moderate current and many shallow, rocky riffles. The life cycle is reported to be univoltine with a single late-spring to early-summer emergence (Ross 1944, Wiggins 1977), or with two major flight periods produced by spring and summer cohorts (Cushman et al. 1977, Masteller and Flint 1980). We collected adults only from 3 May to 9 July, but Karl and Hilsenhoff (1979) found fifth instar larvae, along with several other instars, during every month they sampled a southern Wisconsin stream (February–November). This also appears to be the situation in Chemical Creek, Marinette County, in northern Wisconsin. These populations may be univoltine with adults of the summer cohort having escaped detection, but we believe this species is semivoltine in Wisconsin, with larvae growing only during the summer months and adults emerging during a relatively short period in late spring and early summer.

Hydropsyche Pictet, 1834

Eleven of the approximately 40 North American species were collected in Wisconsin. A twelfth species was reported from Wisconsin by Ross (1938b), but it had been misidentified. We believe that three or more additional species may be found, and all species that may occur in Wisconsin are discussed below. A key to larvae that have been collected or are likely to be collected in Wisconsin follows, updating an earlier key by Hilsenhoff (1982b).

There are two types of setae or hairs that occur on the dorsum of most abdominal segments of *Hydropsyche* larvae and we refer to them as "hair-like setae" or "scale-like setae." They are illustrated by Schuster and Etnier (1978) along with the club setae or club hairs that occur on *Ceratopsyche* in place of the broader scale-like setae.

KEY TO MATURE LARVAE OF *HYDROPSYCHE* IN WISCONSIN

1. Frontoclypeus with 2 large tubercles on anterior margin 2
1'. Frontoclypeus without 2 large tubercles on anterior margin 3

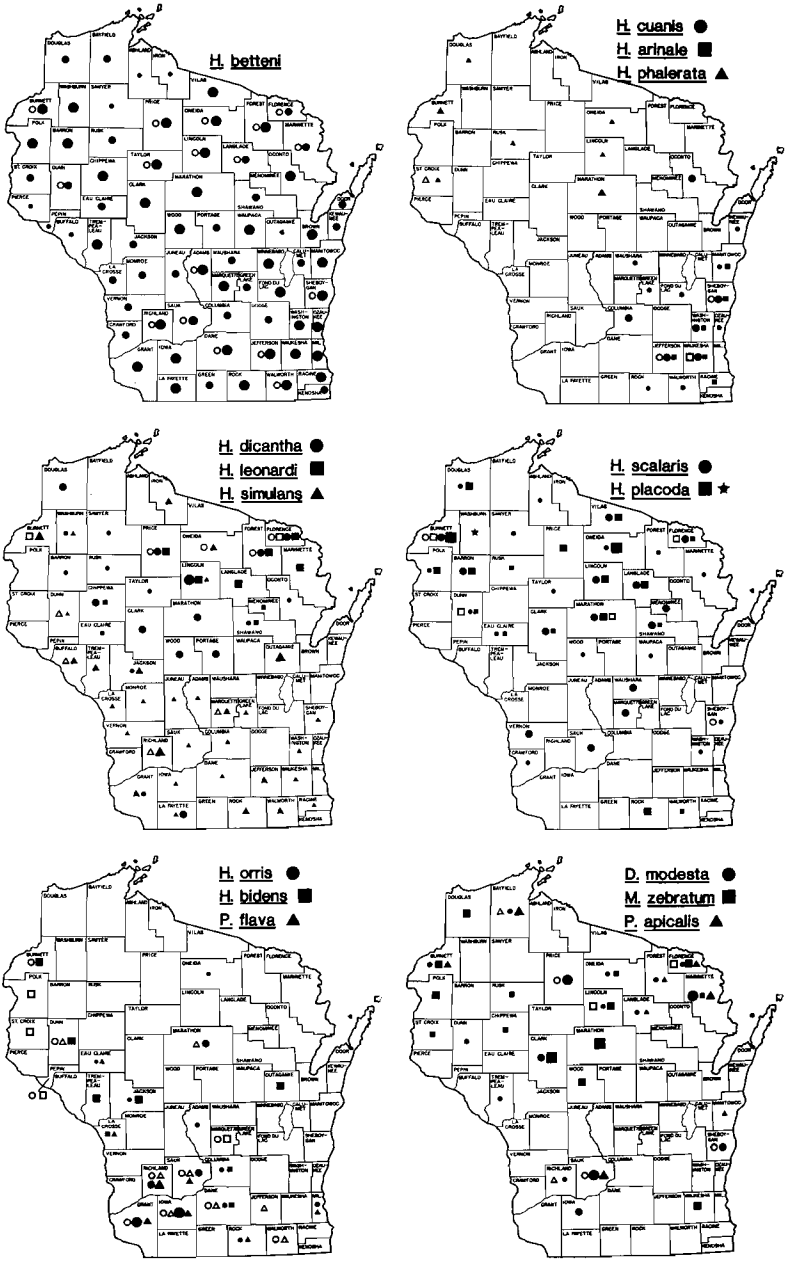


Fig. 11. Distribution and abundance of *Hydropsyche* species, *Diplectrona modesta*, *Macrostemum zebratum*, *Parapsyche apicalis*, and *Potamyia flava* in Wisconsin.

2(1). Posterior of head yellow with at most a narrow dark band on coronal suture; pale area around eye connected to posterior pale area laterally by a broad pale band ..... *orris*

2'. Posterior of head with a broad dark band along coronal suture; pale area around eye separated from posterior pale area or connected to it laterally by a narrow pale band ..... *bidens*

3(1'). Anterior edge of frontoclypeus distinctly produced mesally ..... *phalerata*

3'. Anterior edge of frontoclypeus straight or broadly rounded 4

4(3'). Venter of anal prolegs with large spine-like setae similar to those on sternum of abdominal segment IX 5

4'. Venter of anal prolegs without large spine-like setae 9

5(4). Frontoclypeus dark brown with 2 pairs of small, anterior pale spots; numerous black, bristle-like setae on posterior of frontoclypeus ..... *valanis*

5'. Frontoclypeus mottled reddish brown or with extensive, anterior light areas; frontoclypeus bare or with small pale setae..... 6

6(5'). Scale-like setae absent or widely scattered on abdominal tergum II 7

6'. Scale-like setae numerous on abdominal tergum II 8

7(6). Head with a brown patch on coronal suture; dark areas of frontoclypeus contiguous; spine-like setae on anal prolegs same size as those on abdominal sternum IX ..... *aerata*

7'. Back of head entirely pale; dark areas of frontoclypeus separated by pale areas; spine-like setae on anal prolegs much smaller and weaker than those on abdominal sternum IX..... *frisoni*

8(6'). Scale-like setae on abdominal tergum I at least 1/2 as numerous as on tergum II; about 13 basal, spine-like setae on venter of each anal proleg (Fig. 13) ..... *placoda*

8'. Scale-like setae on abdominal tergum I sparse, less than 1/4 number on tergum II; about 25 spine-like setae on venter of each anal proleg, covering most of ventral area (Fig. 14)..... *scalaris*

9(4'). Frontoclypeus with a distinct elevated mound at extreme posterior; entire head usually dark brown except for a pale area around each eye, occasionally with anterolateral pale spots on frontoclypeus ..... *betteni*

9'. Frontoclypeus without an elevated mound; head with distinct dorsal pale markings in addition to those around eyes..... 10

10(9'). Frontoclypeus with numerous dark, bristle-like setae on posterior half; head dark brown with 1 or 2 distinct pairs of pale anterior spots on frontoclypeus 11

10'. Frontoclypeus with at most a few dark, bristle-like setae on posterior half; head mottled reddish brown or with extensive pale areas, if head is dark, pairs of small pale spots are absent..... 12

11(10). Frontoclypeus with 4 distinct anterior pale spots and often a less distinct posterior spot; bristle-like setae scattered over much of frontoclypeus; width of head about 1.1mm ..... *dicantha*

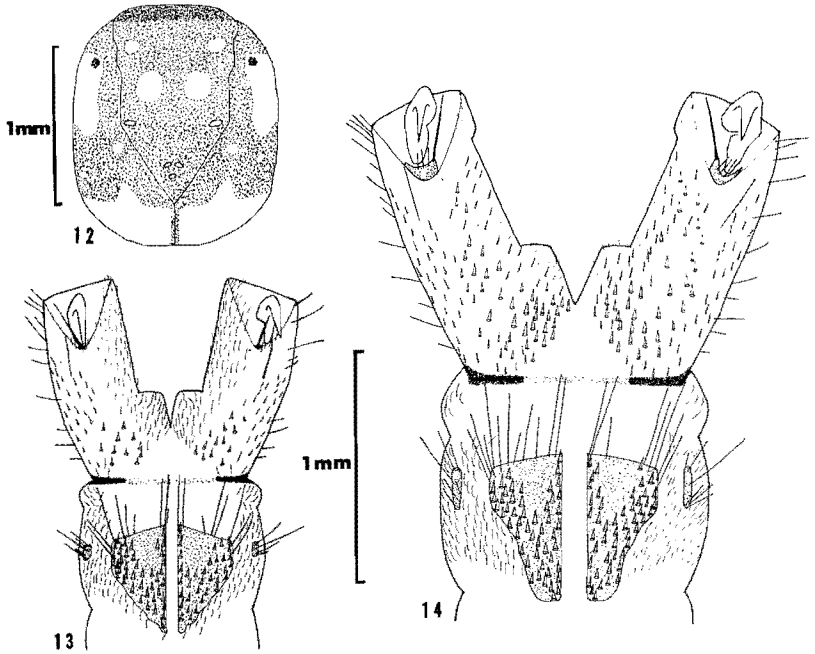
11'. Frontoclypeus with at most 1 pair of small, mesal pale spots; bristle-like setae dense and confined to posterior half of frontoclypeus; width of head about 1.6mm..... *leonardi*

12(10'). Pair of long, mid-dorsal setae on pronotum at least 1/2 mid- dorsal length of pronotum; setae on abdominal terga sparse, with scale-like setae thin and club shaped ..... *cuanis*

12'. Pair of long, mid-dorsal setae on pronotum less than 1/3 mid- dorsal length of pronotum; setae on abdominal terga numerous, with scale-like setae broad or club shaped 13

13(12'). Scale-like setae less than 1/5 as numerous as hair-like setae on abdominal terga II–V ..... *arinale*

13'. Scale-like setae at least 1/2 as numerous as hair-like setae on abdominal terga II–V 14



Figs. 12–14. (12) Dorsal view of head of *Hydropsyche placoda* larva; (13–14) Ventral view of abdominal segment IX and anal prolegs of *Hydropsyche* larvae. Apical setal tufts are omitted and some long setae are longer than shown; (13) *H. placoda*; (14) *H. scalaris*.

14(13′). Scale-like setae distinctly longer than broad and about 1/2 as numerous as hair-like setae on abdominal terga II–V ..... *hageni*

14′. Scale-like setae almost as broad as long and at least as numerous as hair-like setae on abdominal terga II–V ..... *simulans*

Hydropsyche aerata Ross, 1938

We have seen larvae from the Kankakee River in northeastern Illinois, but have not collected this species in Wisconsin. It probably does not occur here, but a thorough study of large rivers in the south may prove us wrong. The larva was illustrated by Ross (1944) and Schuster and Etnier (1978).

Hydropsyche alvata Denning, 1949

The larvae are unknown. Adults of this apparently southern species are closely related to *H. bidens* and *H. orris* and have been collected as far north as Illinois and Michigan (Denning 1949); we have not collected any in Wisconsin. Flint et al. (1979) treated differences between adults of *H. alvata* and *H. orris*; differences between *H. alvata* and *H. bidens* appear more subtle and need clarification. Until additional taxonomic studies are completed and larvae are associated with adults, the status of this species and its possible occurrence in Wisconsin remain uncertain.

Hydropsyche arinale Ross, 1938

Habitat. We have only one male and 30 larvae. The larvae were found in shallow riffles of small, southeastern (Fig. 11), warm-water streams with a slow to moderate current and slight or moderate organic enrichment.

Identification. Larvae lack ventral, spine-like setae on the anal prolegs, and have many hair-like setae but few scale-like setae on the dorsum of the abdomen. The two long, mid-dorsal, pronotal setae are less than 1/3 the mid-dorsal length of that sclerite.

Hydropsyche betteni Ross, 1938

Ross (1938b) stated that this species was identified as *H. incommoda* by Betten (1934).

Habitat and Biology. This ubiquitous species inhabits small springbrooks to large rivers statewide (Fig. 11), but is uncommon in the latter and absent in very large rivers. It occurs in cold streams, but is most abundant in warm streams, and can tolerate organic pollution. Some populations were bivoltine in Ontario (Mackay 1979) and our collections indicate it is probably bivoltine in warmer streams.

Identification. Larvae lack ventral, spine-like setae on the anal prolegs, and setae on the posterior of the frontoclypeus. The posterior, frontoclypeal mound on a dark head is distinctive. We have some mature larvae and many early instars that have two anterolateral pale spots on the frontoclypeus as described by Schuster and Etnier (1978).

Hydropsyche bidens Ross, 1938

Habitat. This species is closely related to *H. orris*, and Schuster and Etnier (1978) stated that when the larvae occur together, *H. bidens* is never as abundant. Both species are restricted to large rivers, but it appears that *H. bidens* is more common in somewhat smaller rivers in southern and western counties (Fig. 11). We collected *H. bidens* and *H. orris* together only in the lower Wisconsin River, where *H. orris* far outnumbered *H. bidens*, and in the Black River in Jackson County, where *H. bidens* was more abundant. Larvae of both species were collected mostly from submerged wood.

Identification. The tubercles on the anterolateral margin of the frontoclypeus, the broad, dark pigmentation on the coronal suture, and the narrow or absent lateral pale area between the eye and the back of the head identify larvae of this species (Schuster and Etnier 1978). Intermediate larvae, similar to *H. orris*, also occur and are discussed under *H. orris*.

Hydropsyche californica Banks, 1899

Denning (1943) captured two males and one female in St. Louis County, Minnesota. This record is a considerable eastward extension of its range and only 100 km north of Wisconsin. There are no other records from Minnesota, and we believe it will not be found in Wisconsin.

Hydropsyche confusa (Walker, 1852)

Synonymy. *Philopotamus confusus* Walker (1852:103); *Hydropsyche separata* Banks (1936:129); *Hydropsyche guttata* Ross and Spencer (1952:46); *Hydropsyche corbeti* Nimmo (1966:688); *Hydropsyche confusa* Nimmo (1981:259).

It has not been found in Wisconsin and probably does not occur here. Its distribution is Canada, northern Great Plains states, and lakes Erie, Huron, and Ontario of the Great Lakes (Denning, 1943, Sykora et al. 1981). The larva was described by Smith (1979).

Hydropsyche cuanis Ross, 1938

Habitat. Larvae inhabit warm rivers of the southeast (Fig. 11) that usually have a sand and silt substrate, and moderate organic enrichment.

Identification. Abdominal setae are sparse, with dorsal scale-like setae elongate and hair-like setae extremely thin. Also, the two long, mid-dorsal setae on the pronotum are at least 1/2 the mid-dorsal length of that sclerite. In general, all the primary setae of the pronotum and head are longer than those of other Wisconsin species in this genus.

Hydropsyche dicantha Ross, 1938

Ross (1938b) stated that Betten (1934) identified this species as *H. venularis*.

Habitat and Biology. Larvae occur primarily in shallow (10–50 cm), fast riffles of clean, northern streams (Fig. 11). Isolated populations in the southwest live in silty, algae-ridden streams that pass through agricultural lands or woodlands. Populations in Ontario are bivoltine (Mackay 1978); our records are not conclusive.

Identification. Larvae are distinguished by their relatively small size, numerous, bristle-like setae scattered over the entire frontoclypeus, and two pairs of round, pale spots on the anterior of the frontoclypeus (Schuster and Etnier 1978). A posteromedial pale spot on the frontoclypeus is also usually present.

Hydropsyche frisoni Ross, 1938

Hydropsyche frisoni has not been found in Wisconsin, but undoubtedly occurs here since it has been collected only a few kilometers to the northwest in Minnesota; we have seen larvae from that area and they are distinctive (Schuster and Etnier 1978). These authors stated that it occurs in small, warm-water rivers and may be intolerant of habitat alteration.

Hydropsyche hageni Banks, 1905

This species was reported from Wisconsin by Longridge and Hilsenhoff (1972, 1973), but examination of the adults and larvae revealed they were *H. leonardi*. Denning (1943) recorded *H. hageni* from Minnesota and Manitoba based on one female and one male respectively, and admits that "the association of this female with *hageni* is problematical." Since *H. hageni* has not been found in Wisconsin and is similar in appearance to *H. leonardi*, it is possible Denning's specimens may have been *H. leonardi*. Except for Denning's two specimens, the reported distribution of *H. hageni* is Alabama, Illinois, Kentucky, Maryland, North Carolina, Tennessee, Virginia and West Virginia (Flint et al. 1979, Harris et al. 1984, Nugen and Tarter 1983). Illinois records of adults are from the Kankakee and the Rock rivers (Ross 1944). The Rock River collection was made just to the south of Wisconsin, so the species may occur in southern Wisconsin. Larvae apparently inhabit larger and much warmer streams than *H. leonardi*.

We have seen a male *H. hageni* from Rockford, Illinois, that Ross compared with the holotype from Virginia, and also adults and larvae from the Kankakee River at Momence, Illinois. We compared these larvae with larvae from Tennessee (Schuster and Etnier 1978) and found them to differ in head color. The Illinois larvae are not dark headed as described by Schuster and Etnier (1978) and will not key out to *H. hageni* in their key. Since the type of larva likely to be found in Wisconsin would be like the lighter-headed Illinois specimens, it is this type of larva that will key to *H. hageni* in our key. Larvae are similar to *H. simulans*, but lack large, pale spots on the anterolateral portion of the frontoclypeus and have a reduced number of scale hairs on the abdominal terga. In *H. simulans* scale-like setae on abdominal terga II–V are usually as broad as long and at least as numerous as the hair-like setae, while in *H. hageni* these scale-like setae are distinctly longer than broad and at most only half as numerous as hair-like setae. Dark-headed larvae, like those from Tennessee, appear similar to *H. leonardi*, but lack the numerous bristle-like setae on the frontoclypeus.

Hydropsyche leonardi Ross, 1938

Habitat and Biology. Larvae occur in cold, fast-flowing, northern streams (Fig. 11) with excellent water quality. This species is univoltine, with emergence in late May to early June (one male 17 August). Early instar larvae appear in late July, overwinter mostly as fifth instar larvae, and pupate the following spring.

Identification. This large larva has a dark brown head with two small, pale, mesolateral spots on the frontoclypeus. It is easily distinguished by the numerous, bristle-like setae on the posterior of the frontoclypeus, which are best seen in lateral view.

Hydropsyche orris Ross, 1938

Synonymy. *Hydropsyche cornuta* Ross (1938b:141).

Habitat. Larvae are abundant in the lower Wisconsin River, and only a few larvae were collected elsewhere (Fig. 11). Adult collections indicate it probably occurs in the large, western rivers (Mississippi R., Chippewa R., St. Croix R.). The lower Wisconsin River is very large with warm water, a powerful current, moderate organic enrichment, and a sandy substrate with some rocks and silt. Few riffles exist and collecting has been restricted to shallow (1 m), accessible areas. Larvae were found on rocks or burrowing into wood. Numbers of larvae we have collected do not compare with the large swarms we have observed. Fremling (1960) gave an excellent account of the life history.

Identification. Larvae are identified by the anterolateral tubercles on the frontoclypeal margin, by the narrow dark band on the coronal suture, and the broad pale area laterally between the eye and the back of the head. A few intermediate larvae have been found, where the pigmentation on the head is asymmetrical; one half looks like *H. orris* and the other half like *H. bidens*.

Hydropsyche phalerata Hagen, 1861

Ross (1944) stated that Betten (1934) identified this species as *Hydropsyche* sp. 3.

Habitat. Our minimal larval collections are from wide, fast, northern rivers (Fig. 11). Most sites had slight to significant enrichment.

Identification. Larvae are easily separated by the produced, anterior margin of the frontoclypeus, and their distinctive head pattern, which has large pale areas at the anterolateral margins of the frontoclypeus and a broad, dark band across the back of the head just anterior to the coronal suture (Schuster and Etnier 1978).

Hydropsyche placoda Ross, 1941

This is the only previously unassociated species known to occur in Wisconsin. Adults were collected in Burnett, Dunn, and Florence counties, and Ross (1941) described the species from specimens caught in Burnett County (Fig. 11). He also provided insight to the characteristics of the larva by stating that the adult is closely related to *H. scalaris*. Hilsenhoff (1982b) tentatively identified larvae as this species and included them in his key to Wisconsin species. We have reared larvae and now have positive associations.

Description of Mature Larva. Head capsule length 1.38–1.58 mm, width 1.09–1.31 mm (85 larvae). Dorsum of head predominately reddish brown to brown on yellow background, appearing mottled due to dark infuscation around yellow points of insertion of setae. Pigmentation covers most of frontoclypeus, extending laterally to light area encompassing each eye (Fig. 12). A pair of light spots always present on frontoclypeus slightly posterior to level of eyes, and usually another smaller pair at anterolateral corners that can be indistinct when portion of frontoclypeus anterior to level of eye is mostly light. Venter of head yellow except for a longitudinally elongate patch of infuscations around points of setal insertions, directly ventrad to lateral dark band. Several longitudinal rows of many yellow muscles scars run posterad from eyes.

Posterior half of frontoclypeus with numerous, scattered, very small (but distinct), yellowish setae; anterolateral margins with yellowish, but slightly more robust setae.

Parietals also with numerous, small, yellowish setae on dorsal and lateral regions of anterior 5/6 of head, but including scattered dark, stiff, bristle-like setae that are twice as long, and a few yellowish, stiff, bristle-like setae that are four to five times as long as small yellowish setae.

Thoracic nota brown to light brown with pronotum darker than mesonotum, which in turn is slightly darker than metanotum. Infuscation around setal insertions prominent on pronotum, less so on mesonotum and almost absent on metanotum. Pronotum with numerous small, yellowish setae and scattered dark, stiff, bristle-like setae; both types of setae become successively less numerous on meso- and metanotum. Pair of long mid-dorsal setae and pair of long anterolateral setae on pronotum either light or dark and at least 1/4 but less than 1/2 mid-dorsal length of sclerite.

Dorsum of abdomen with numerous hair-like setae. Scale-like setae on each segment as abundant as or more abundant than hair-like setae; scale-like setae larger on posterior segments. Scale-like setae on segment I at least 1/2 as numerous as on segment II, usually almost as numerous.

Ventral surface of each anal proleg with 6–14 golden, spine-like setae with prominent sockets, similar to those on sclerites of abdominal sternum IX (Fig. 13). These setae confined mainly to basal and posterolateral portions, with numerous less-robust, socketless, spine-like setae laterally. Numerous black, hair-like setae posteromedially, with a few at base.

Variation. We have seen little variation of the diagnostic characters. The color on the anterior portion of the frontoclypeus is lighter in some individuals, to the extent that the anterolateral light spots are indistinct.

Identification. This species can be easily recognized by its sclerotized, golden, spine-like setae on the venter of the anal prolegs, its mottled, reddish brown to brown dorsal head pattern with many, very small, yellowish setae on the posterior half of the frontoclypeus, and by the numerous scale-like setae on the dorsum of all abdominal segments. It is most closely related to *H. scalaris*, but is much smaller than that species (*H. scalaris* head capsule length 1.95–2.30 mm, width 1.70–1.95 mm). *Hydropsyche placoda* has one to two pairs of light spots on the anterior half of the frontoclypeus; *H. scalaris* has no distinct light spots. Scale-like setae on the dorsum of abdominal segment I of *H. placoda* are at least 1/2 as numerous as on segment II, and they are scattered over the entire surface. Scale-like setae on *H. scalaris* are, at most, only 1/4 as numerous on segment I as on segment II, and are most numerous at the posterior margin. Finally, the spine-like setae on the anal prolegs of *H. scalaris* are heavily sclerotized, reddish brown, and abundantly scattered over the entire ventral surface (Fig. 14), whereas these setae on *H. placoda* are less robust, golden, and less numerous, being confined to the basal and lateral margins (Fig. 13).

Material Examined. Wisconsin River at Hwy 51 bridge, Marathon County, WI, 22-V-85, K.L. Schmude: 7 adults, 14 metamorphotypes, 19 larvae. Also 18 male adults and 368 larvae from other areas of Wisconsin (Table 1, Fig. 11).

Deposition of Material. A male and female metamorphotype, and larval specimens are deposited in the Illinois Natural History Survey, Royal Ontario Museum, and the National Museum of Natural History. The remainder are in the University of Wisconsin Insect Collection.

Habitat. Larvae occur mostly in northern Wisconsin (Fig. 11) in medium to large, warm-water rivers with very fast, shallow (20–50 cm) riffles. They can burrow into submerged wood and tolerate moderate enrichment. Larvae used in associating this species were collected from cracks and crevices in discarded porous concrete blocks in one meter of water.

Hydropsyche rossi Flint, Voshell, and Parker, 1979

This species was described by Flint et al. (1979) based on its misidentification by Ross (1944) as *H. incommoda*, and by the rediscovery of *H. incommoda* Hagen 1861 (lectotype designated by Ross [1938a]) in the southeastern states. Since Ross's 1944 paper, *H.*

incommoda has been consistently misapplied to *H. rossi* by subsequent authors. To complicate matters, Schuster and Etnier (1978) could not distinguish larvae of *H. rossi* (as *H. incommoda*) from *H. simulans*. Since *H. rossi* has been collected from the Kankakee River in northeastern Illinois (Schuster and Etnier 1978), and since *H. simulans* larvae exhibit habitat and morphological variability in Wisconsin, there is a possibility that *H. rossi* occurs in Wisconsin and its larvae are being misidentified as *H. simulans*. Consequently, the status of *H. rossi* in this state is uncertain.

Hydropsyche scalaris Hagen, 1861

Habitat and Biology. It is distributed throughout much of the state (Fig. 11), but larvae were never collected in great numbers. They occur mostly in sandy, medium-sized streams and can tolerate some enrichment. This species is apparently univoltine, as reported by Mackay (1979) in Ontario.

Identification. Numerous, ventral, spine-like setae on the anal prolegs (Fig. 14), a lack of black, bristle-like setae on the frontoclypeus, and numerous, dorsal, scale-like setae on abdominal segment II identify larvae of this species. Separation from the similar *H. placoda* is discussed under that species.

Hydropsyche simulans Ross, 1938

Habitat. Larvae were collected throughout most of the state (Fig. 11) in many types of streams, ranging from small, sluggish streams to very large, fast rivers. Schuster and Etnier (1978) collected them only in large rivers with long, wide riffles where the larvae used mostly large rocks for an anchoring substrate. Harris and Carlson (1978) collected them from undercut streambanks and stickjams in two small (1.3, 2.2-m-wide), slow springbrooks in eastern North Dakota, and did not collect any in the rocky riffles; we have not collected larvae of this species in small springbrooks. We found larvae on rocks in riffles, in debris lodged in the current, and in wood embedded in sand. All were in streams with a significant silt load.

Identification. Abdominal scale-like setae are abundant and usually as wide as long on terga II–V. Two basic head color patterns with various intergradations occur (Schuster and Etnier 1978). These patterns were observed in Wisconsin, occasionally in the same stream. Also, there can be a few distinct, black, bristle-like setae on the posterior half of the frontoclypeus, a character not previously mentioned. Schuster and Etnier (1978) could not distinguish larvae of this species from those of *H. rossi*, and it is possible we identified *H. rossi* larvae as *H. simulans*.

Hydropsyche valanis Ross, 1938

One adult male was reported from northcentral Wisconsin by Ross in 1938(b) and designated as a paratype. We have seen this specimen and it is *H. placoda*. We have not collected *H. valanis*, but have seen larvae from the Greater Miami River in Dayton, Ohio. We have also seen males collected along the Rock River at Rockton, Illinois, only 5 km south of Wisconsin, so its occurrence in southern Wisconsin is likely. Larvae occur in large, warm-water rivers with large riffle areas and suspended organic materials (Ross 1944, Schuster and Etnier 1978).

Macrostemum Kolenati, 1859

Macrostemum zebratum (Hagen, 1861)

Synonymy. *Macronema zebratum* Hagen (1861:285); *Macronemum zebratum* Denning (1943:157); *Macrostemum zebratum* Flint and Bueno-Soria (1982:369).

Habitat and Biology. Larvae were collected in northern and eastern Wisconsin (Fig. 11) in large, swift rivers with a rocky substrate and significant amounts of silt and other

organic material. They also occurred occasionally in smaller, fast streams with excellent water quality. This species is bivoltine in Virginia (Parker and Voshell 1982); our records indicate a one-year life cycle in Wisconsin.

Parapsyche Betten, 1934

Parapsyche apicalis (Banks, 1908)

Synonymy. *Arctopsyche apicalis* Banks (1908:266).

Habitat. Larvae probably occur statewide (Fig. 11) in small, cold, clean streams with a rocky, sandy substrate and usually a fast current (Flint 1961). Such streams are uncommon in Wisconsin, but when found, many larvae can be collected.

Potamyia Banks, 1900

Potamyia flava (Hagen, 1861)

Synonymy. *Macronema flavum* Hagen (1861:285); *Hydropsyche kansensis* Banks (1905:15).

Habitat. A few larvae were taken from rivers in the southeast and westcentral areas (Fig. 11), and it abounds in the lower Wisconsin River. We have collected adults, but no larvae, in Marathon County where this species undoubtedly occurs in the Wisconsin River. Larvae live in very large, silty, sandy, warm- water rivers where they often burrow into submerged wood (Fremling 1960). Larval numbers in our collection do not match our observations of large swarms of adults due to the difficulty in sampling their deep-water habitat.

ACKNOWLEDGMENTS

We thank Drs. David A. Etnier, Guenter A. Schuster, and John D. Unzicker for loaning larval and adult specimens, and Dr. Oliver S. Flint, Jr. for verifying adults of *Hydropsyche placoda*. We are very grateful to Dr. Glenn B. Wiggins and Ms. Patricia W. Schefter for furnishing a preliminary copy of their manuscript on identification of larvae in the *Hydropsyche morosa* species group (*Ceratopsyche*), and especially thank Ms. Schefter for supplying larval specimens, verifying adults, and assisting in identifications through our correspondence. We also thank Mr. Mark Wipfli for assisting in the collecting of larvae of *Hydropsyche placoda*.

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