



MICHIGAN PLECOPTERA (STONEFLIES): DISTRIBUTION PATTERNS AND AN UPDATED SPECIES LIST

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ABSTRACT

The stonefly fauna of Michigan is updated, increasing the number of species verified from the state to 68. Twelve species are reported for the first time while two species of *Isogenoides* and *Taeniopteryx maura* (Pictet) are removed. Eight of the nine Nearctic families are represented. Peltoperlidae is the sole family not present in Michigan. Perlodidae (18 species) and Perlidae (17 species) were the most speciose families in the state, and *Isoperla* (Perlodidae) was easily the most species-rich genus (11). Within the Michigan portion of the four Great Lakes bordering the state, eight species have been obtained from Lake Superior compared to none from Lake Erie and two species total collected from Lake Huron and Lake Michigan. Half (34 species) of the state fauna appears to be distributed only in the northern Lower Peninsula and Upper Peninsula, while 27 species are broadly distributed throughout the state. We discuss, in detail, 25 species that appear to be rare or uncommon and sparsely-distributed. This group includes four species known only from historical records (prior to 1950) and two that are presumably extirpated from the state (*Helopicus nalatus* (Frison) and *Attaneuria ruralis* (Hagen)).

Keywords: Plecoptera, stoneflies, Nearctic, Michigan, extirpation

INTRODUCTION

The stonefly fauna of Michigan was first summarized by Grubbs & Bright (2001). Previously, Michigan stonefly records had been scattered throughout several published papers, namely in Frison (1942), Ricker (1952), Stout & Rondinelli (1995), Bright (1996), and Yanoviak & McCafferty (1996). Historically the most prolific collectors in Michigan were Theodore H. Frison and Herbert H.

Ross of the Illinois Natural History Survey, and Justin W. Leonard of the University of Michigan, all working during the 1930's and 1940's. Frison and Ross collected mainly from river basins draining west to Lake Michigan in the northern half of the Lower Peninsula. Leonard's sampling was more widespread, working across the Upper Peninsula and the northern half of the Lower Peninsula. Due in part to the collective efforts of these three

individuals, plus F.E. Lyman (also from the University of Michigan), four species combined were described from Michigan type localities in Frison (1942) and Ricker (1952) (Table 1). One species (*Amphinemura linda* (Ricker)), however, is now a junior synonym of *A. palmeni* (Koponen) (Boumans & Baumann 2012). No species have since been described from the state.

Grubbs & Bright (2001) added several new state records and included a checklist of 58 species. *Paragnetina media* (Walker), however, was

erroneously listed as “new or potential” and should have been included in their list. The senior author began collecting in Michigan during the mid-1990’s, working mainly in the Upper Peninsula. As part of a broader study of the stonefly fauna of the Midwest, the authors began a statewide collecting effort in 2006. The intent of this paper is to provide an update of the Michigan stonefly fauna, report new state records, and discuss species that appear to be rare or uncommon and sparsely-distributed.

Table 1. Valid stonefly species with Michigan type localities.

Family	Species	County, Stream	Reference
Chloroperlidae	<i>Alloperla leonarda</i> Ricker	Houghton Co, North Branch of Otter River	Ricker (1952)
Perlodidae	<i>Helopicus nalatus</i> (Frison)	Washtenaw Co., Huron River	Frison (1942)
	<i>Isogenoides doratus</i> (Frison)	Lake Co., Pere Marquette River	Frison (1942)

METHODS

Freshly-obtained specimens and museum material were used in this study. Data were also included from reliable literature sources. Fresh adult specimens were collected with beating sheets, sweep nets, by hand-picking from rocks, tree trunks and bridges, and through rearing of nymphs. Mature nymphs that could be identified to species were also included. Location data for each specimen record were recorded either directly with hand-held GPS units or georeferenced from museum label data. Specimens were examined from the following institutions: Brigham Young University, Provo, UT (BYU), Canadian National Collection, Ottawa, ONT, Canada (CNC), Field Museum of Natural History, Chicago, IL, Illinois Natural History Survey, Champaign, IL (INHS), Iowa State University, Ames, IA, Michigan State University, East Lansing, MI (MSUC), Notre Dame University, South Bend, IN, Ohio Biological Survey, Columbus, OH, Ohio State University, Columbus, OH, Purdue University, West Lafayette, IN (PURC), Southern Illinois University, Carbondale, IL, University of Michigan Museum of Zoology, Ann Arbor, MI (UMMZ), University of Wisconsin, Madison, WI (UWIRC), and Western

Kentucky University, Bowling Green, KY (WKU).

Nearctic-scale distribution categories were assigned for all species based on an established and rapidly-growing literature base of U.S. state and Canadian province records (e.g. Stewart & Stark 2002; DeWalt et al. 2012a). Distribution categorization has been performed at the state level by Kondratieff & Kirchner (1987, Virginia), Grubbs (1997, Maryland), and Grubbs & Bright (2001, Michigan). We have modified previous categories to include: Appalachian (AP), eastern Nearctic – glaciated (ENG), eastern Nearctic – unglaciated (ENU), eastern Nearctic - widespread (ENW), Northern Holarctic (H), and Nearctic - widespread (NW). We have also included state-level distribution categories to assist Michigan aquatic biologists, conservation biologists, and land managers with a deeper understanding of the state fauna. Three state categories were applied: Upper Peninsula (UP), northern Lower Peninsula (NLP), and southern Lower Peninsula (SLP).

RESULTS AND DISCUSSION

A total of 8,729 specimens from 558 unique localities were accumulated from museum and our modern material. Twelve species are reported here as

new state records (Table 2), represented mostly by Perlidae (eight species) and Nemouridae (two species). Several changes to the Michigan list have occurred since Grubbs & Bright (2001). The new record of *Taeniopteryx maura* (Pictet) reported by Grubbs & Bright (2001) was based on a prior misidentification of *T. burksi* Ricker & Ross and is herein removed from the state list. Sandberg and Stewart (2005) synonymized *Isogenoides krumholzi* (Ricker) with *I. doratus* (Frison) and also indicated that the state records of *I. varians* (Walsh) noted in Needham & Claassen (1925) and Hanson (1943) are not valid. The prior Michigan records of *Perlesta shubuta* Stark now pertain to the recently-described *P. ephelida* (Grubbs & DeWalt 2012), a broadly-distributed eastern Nearctic species. In total, 68 species are now verified from Michigan.

Eight of the nine Nearctic families were represented. Peltoperlidae is not present in Michigan. The most species-rich family was Perlodidae (18 species), followed by Perlidae (17 species) and Nemouridae (10 species). In contrast, Pteronarcyidae was represented by two species of *Pteronarcys* and Leuctridae only by three *Leuctra* species. *Isoperla* was the most speciose genus (11 species) in Michigan, over two-fold higher compared to *Perlesta* (five species), and both *Allocapnia* and *Acroneuria* (four species each). *Paragnetina media* (Walker) and *Acroneuria lycorias* (Newman) were easily the two most common species in collections, obtained from 129 and 70 localities, respectively (Table 2). *Perlesta lagoi* Stark was obtained from 15 localities, mainly in the southern half of the Lower Peninsula. This species and *P. nitida* Banks exhibit similar male and female genitalic features and eggs (Grubbs & Stark 2001; Stark 2004). For this treatment all specimens have been grouped conservatively as *P. lagoi* until we can resolve the identity of both species using modern molecular techniques.

Stoneflies in the Great Lakes

Several species have been collected from three of the four Great Lakes bordering Michigan. There are no Michigan records from Lake Erie. The sole Lake Huron locality pertains to *A. lycorias* and *Isoperla bilineata* (Say) from Port Austin near the tip of the "Thumb" region. *Isoperla bilineata* is the only species collected from the northern portion of Lake Michigan. In contrast, *Capnia vernalis* Newport,

Paracapnia angulata Hanson, *Haploperla brevis* (Banks), *A. lycorias*, *I. bilineata*, *Arcynopteryx dichroa* (McLachlan), *Isogenoides frontalis* (Newman), and *I. olivaceus* (Walker) have been collected from Lake Superior.

Nearctic-scale distribution patterns

The most prominent group of species in Michigan are those that are distributed widely across the eastern Nearctic region (26 species or 38% of total; Table 2). Over half (9 of 17) of the Perlidae recorded from the state are eastern Nearctic species. Eighteen species (26%) are Nearctic-widespread species, including several whose ranges extend west into at least the Rocky Mountain region (e.g. *P. angulata*, *Taeniopteryx nivalis* Fitch, and *Pteronarcys dorsata* (Say)). An additional 16 species (22%) are distributed mainly in the once-glaciated eastern Nearctic region. Most of these species (e.g. *Allocapnia minima* (Barnston), *Oemopteryx glacialis* (Barnston), and *I. olivaceus*) are found primarily across the Upper Peninsula or northern half of the Lower Peninsula.

Although not well represented in the state fauna, there are five species (*Leuctra rickeri* James, *Agnetina flavescens* (Walsh), *Neoperla catharae* Stark and Baumann, *Perlesta golconda* DeWalt and Stark, and *Helopicus nalatus* (Frison)) whose ranges encompass mostly unglaciated landscapes. Most records for these species are from the southern half of the Lower Peninsula. There are two species, *Ostrocerca albidipennis* (Walker) and *Paranemoura perfecta* (Walker), that are distributed throughout the Appalachian Mountains and provide evidence that there are some species that have dispersed westward into the Upper Peninsula through the northern Great Lakes region. Both species have been collected in the Upper Peninsula. It is expected that species with similar distribution patterns (e.g. *Suwallia marginata* (Banks), but not reported for Michigan), will eventually be collected in the Upper Peninsula or the far northern portion of the Lower Peninsula.

State-wide distribution patterns

Several species (27 total) are distributed broadly across both peninsulas (Table 2). Notable examples include *Amphinemura delosa* (Ricker) and *P. media*, of which both have been collected from counties adjacent to the Indiana state line and are widespread throughout the Lower and Upper Peninsulas. Half of

the state fauna (34 total) have been collected either in the northern Lower Peninsula or the Upper Peninsula or both. This group includes the three *Leuctra* species, the five chloroperlid species, the

three *Isogenoides* species, and six of the 10 *Isoperla* species. The remaining seven species are those that have been obtained to date only in the southern Lower Peninsula.

Table 2. List of the stoneflies species reported from Michigan, with new state records (denoted by *), Nearctic-scale distribution categories and state-level distributions.

Species	Number of unique localities	Nearctic-scale distribution	State-level distribution
Family Capniidae			
<i>Allocapnia granulata</i> (Claassen)	54	ENW	SLP, NLP, UP
<i>Allocapnia minima</i> (Barnston)	17	ENG	NLP, UP
<i>Allocapnia pygmaea</i> (Burmeister)	17	ENG	NLP, UP
<i>Allocapnia vivipara</i> (Claassen)	11	ENW	SLP
<i>Capnia vernalis</i> Newport	1	NW	UP
<i>Capnura manitoba</i> (Claassen)	1	ENG	NLP
<i>Paracapnia angulata</i> Hanson	10	NW	NLP, UP
<i>Paracapnia opis</i> (Newman)	2	ENG	UP
Family Leuctridae			
<i>Leuctra ferruginea</i> (Walker)	6	ENW	NLP, UP
* <i>Leuctra rickeri</i> James	1	ENU	UP
<i>Leuctra tenuis</i> (Pictet)	8	ENW	NLP, UP
Family Nemouridae			
<i>Amphinemura delosa</i> (Ricker)	28	ENW	SLP, NLP, UP
* <i>Amphinemura nigrutta</i> (Provancher)	1	ENW	UP
<i>Amphinemura palmeni</i> (Koponen)	5	NW	NLP, UP
<i>Nemoura trispinosa</i> Claassen	18	NW	SLP, NLP, UP
<i>Ostrocerca albidipennis</i> (Walker)	2	AP	UP
* <i>Paranemoura perfecta</i> (Walker)	2	AP	UP
<i>Prostoia completa</i> (Walker)	34	ENW	SLP, NLP, UP
<i>Prostoia similis</i> (Hagen)	3	ENW	UP
<i>Shipsa rotunda</i> (Claassen)	5	NW	NLP, UP
<i>Soyedina vallicularia</i> (Wu)	6	ENG	SLP, NLP, UP
Family Taeniopterygidae			
<i>Oemopteryx glacialis</i> (Barnston)	6	ENG	UP
<i>Strophopteryx fasciata</i> (Burmeister)	13	ENW	SLP, NLP, UP
<i>Taeniopteryx burksi</i> Ricker & Ross	44	NW	SLP, NLP, UP
<i>Taeniopteryx nivalis</i> (Fitch)	49	NW	SLP, NLP, UP
<i>Taeniopteryx parvula</i> Banks	19	NW	SLP, NLP, UP
Family Chloroperlidae			
<i>Alloperla atlantica</i> Baumann	5	ENW	UP
<i>Alloperla banksi</i> Frison	2	ENG	NLP

<i>Alloperla leonarda</i> Ricker	2	ENG	UP
<i>Haploperla brevis</i> (Banks)	28	NW	NLP, UP
<i>Haploperla orpha</i> (Frison)	2	ENG	NLP, UP
Family Perlidae			
<i>Acroneuria abnormis</i> (Newman)	11	NW	SLP, NLP, UP
<i>Acroneuria frisoni</i> Stark & Brown	12	ENW	SLP
<i>Acroneuria internata</i> (Walker)	16	ENW	SLP, UP
<i>Acroneuria lycorias</i> (Newman)	70	NW	SLP, NLP, UP
<i>Agnentina capitata</i> (Pictet)	27	ENW	SLP, NLP, UP
* <i>Agnentina flavescens</i> (Walsh)	8	ENU	SLP, NLP, UP
* <i>Attaneuria ruralis</i> (Hagen)	1	ENW	SLP
* <i>Neoperla catharae</i> Stark & Baumann	1	ENU	SLP
* <i>Neoperla stewarti</i> Stark & Baumann	1	ENW	SLP, UP
<i>Paragnetina media</i> (Walker)	129	NW	SLP, NLP, UP
* <i>Perlesta decipiens</i> (Walsh)	16	NW	SLP, NLP, UP
<i>Perlesta ephelida</i> Grubbs & DeWalt	48	ENW	SLP, NLP, UP
* <i>Perlesta golconda</i> DeWalt & Stark	2	ENU	SLP
* <i>Perlesta lagoi</i> Stark	15	ENW	SLP, NLP, UP
* <i>Perlesta</i> WI-1	1	ENG?	UP
<i>Perlinella drymo</i> (Newman)	5	ENW	SLP, NLP, UP
<i>Perlinella ephyre</i> (Newman)	7	ENW	SLP
Family Perlodidae			
<i>Arcynopteryx dichroa</i> (McLachlan)	2	NH	UP
<i>Clioperla clio</i> (Newman)	21	ENW	SLP, NLP, UP
<i>Cultus decusus decusus</i> (Walker)	13	ENG	NLP
<i>Helopicus nalatus</i> (Frison)	1	ENU	SLP
<i>Isogenoides doratus</i> (Frison)	2	NW	NLP
<i>Isogenoides frontalis</i> (Newman)	27	ENG	NLP, UP
<i>Isogenoides olivaceus</i> (Walker)	13	ENG	NLP, UP
<i>Isoperla bilineata</i> (Say)	31	NW	SLP, NLP, UP
<i>Isoperla cotta</i> Ricker	18	ENG	NLP, UP
<i>Isoperla dicala</i> Frison	57	ENW	SLP, NLP, LP
<i>Isoperla frisoni</i> Illies	41	ENG	NLP, UP
<i>Isoperla lata</i> Frison	13	ENW	NLP, UP
<i>Isoperla marlynia</i> Needham & Claassen	4	NW	NLP, UP
<i>Isoperla nana</i> (Walsh)	12	ENG	SLP, NLP, UP
* <i>Isoperla richardsoni</i> Frison	11	ENW	SLP, NLP, UP
<i>Isoperla signata</i> (Banks)	48	ENW	SLP, NLP, UP
<i>Isoperla slossonae</i> (Banks)	13	ENW	NLP, UP
<i>Isoperla transmarina</i> (Newman)	42	NW	NLP, UP

Family Pteronarcyidae

<i>Pteronarcys dorsata</i> (Say)	31	NW	SLP, NLP, UP
<i>Pteronarcys pictetii</i> Hagen	1	ENW	NLP

New state records and uncommon/rare species

Two of the new state records (*A. flavescens* (Walsh) and *Perlesta decipiens* (Walsh)) are for species that are broadly distributed state-wide, mainly across the Lower Peninsula. The remaining ten new state records, plus an additional 15 that had been previously reported from the state, are noted herein as presumably rare or uncommon and sparsely-distributed, and are discussed in more detail below. This group includes species that are presumably extirpated from Michigan, species known only from historical records (prior to 1950), and those that known only from Lake Superior. There are several additional species, however, that may be markedly more common than presently known but contemporaneous collecting efforts are needed to discern whether these taxa are indeed rare/uncommon or not.

Presumed extirpated

Attaneuria ruralis (Hagen)

Collection records. USA, Michigan: Kalamazoo Co., Augusta Creek, Gull Lake Biological Station, 42.3633, -85.3535, 3.VII.1957, R.L. Fischer, ♂ (MSUC).

Comments. The sole state record for this large river species is from the southwestern Lower Peninsula, coincidentally from the same locality as for *P. golconda*. Within the midwestern U.S., however, this species has been extirpated from Illinois (DeWalt et al. 2005), Indiana (DeWalt & Grubbs 2011) and Ohio (DeWalt et al. 2012b). Collecting efforts are needed to assess if *A. ruralis* is still present in Michigan.

Helopicus nalatus (Frison)

Collection records. USA, Michigan: Washtenaw Co., Huron River, T2S, R5E, Sec2, 42.3338, -83.8093, 29.I.1937, F.E. Lyman, nymph (INHS); same but 4.II.1937, 2 nymphs (INHS), same by 20.II.1937, nymph (INHS); same but 4.IV.1937, 2 nymphs (INHS); same but 9.IV.1937, 3 nymphs (INHS); same but 28.IV.1937, 2 nymphs (INHS); same but 6.V.1937, 2 nymphs (INHS); same but 31.V.1937, 2♂ (INHS); Huron River, 42.3299, -83.8199, 31.V.1937, F.E. Lyman, ♂ (CNC); same but 10.IV.1938, 4 nymphs

(CNC).

Comments. The only known state records for *H. nalatus* are from, or near, the type locality in southeastern Michigan. Several independent collecting efforts by the authors in 2006 and 2008 failed to produce fresh adults or nymphs, suggesting this species may no longer inhabit the Huron River.

Historical species

Capnura manitoba (Claassen)

Collection records. USA, Michigan: Montmorency Co., Hunt Creek, 44.8640, -84.1555, 4.IV.1939, J.W. Leonard, ♂, 2 nymphs (INHS).

Comments. This is the only member of this genus that is distributed east of the Great Plains region, known from Manitoba east to Atlantic Canada (Nelson & Baumann 1987, DeWalt et al. 2012a). This historical record still represents one of only two known localities for this species in Michigan. A second locality is listed in Nelson & Baumann (1987) from Ogemaw County. Both counties are located in the northern tier of the Lower Peninsula.

Alloperla banksi Frison

Collection records. USA, Michigan: Grand Traverse Co., Boardman River, Mayfield, 44.6371, -85.5182, 28.V.1939, T.H. Frison and H.H. Ross, ♂ (INHS); Boardman River, T26N, R10W, Sec.21, 44.6424, -85.3332, 11.VI.1947, J.W. Leonard and F.A. Leonard, ♂ (UMMZ).

Comments. This uncommon species mainly occupies prior glaciated portions of eastern North America, with scattered records across the northern Great Lakes and St. Lawrence River region plus a disjunct southern distribution in Virginia (Kondratieff and Kirchner 1987, Surdick 2004, DeWalt et al. 2012a). The only Michigan records are from the Boardman River in the northwest Lower Peninsula.

Haploperla orpha (Frison)

Collection records. USA, Michigan: Marquette Co., Laughing Whitefish River, E of Marquette, 18.VIII.1949, H.H. Ross, ♀ (INHS); **Oscoda Co., Au**

Sable River, Mio, 44.6601, -84.1292, 29.V.1937, T.H. Frison, ♂, ♀ (INHS).

Comments. Reported from North Dakota east to Atlantic Canada (Surdick 2004, DeWalt et al. 2012a), the only Michigan localities for this northern species refers to two historical records. Several independent collecting efforts during late May and early June have failed to locate new populations.

Pteronarcys pictetii Hagen

Collection records. USA, Michigan: Crawford Co., Manistee River, near Grayling, 17.VI.1935, T.H. Frison 3♂ (INHS).

Comments. The sole Michigan locality for this broadly-distributed Nearctic species (DeWalt et al. 2012a) refers to a single historical record from the northern Lower Peninsula. More populations should be found with additional rearing of the nymphs, which at this time cannot be identified specifically.

Lake Superior species

Capnia vernalis Newport

Collection records. USA, Michigan: Keweenaw Co., Lake Superior, M-26, MDOT Esrey Roadside Park, 5 mi E Eagle Harbor, 47.4688, -88.0577, 27.V.1995, S.A. Grubbs, 3♀ (WKU); Isle Royale, 14.VII.1905, H.A. Gleason (Needham and Claassen 1925).

Comments. This is a very broadly-distributed Nearctic species known from Atlantic Canada west to Alaska and south within the Rocky Mountain region to Colorado and New Mexico (Nelson & Baumann 1989, DeWalt et al. 2012a). This is one of two species in Michigan, *A. dichroa* being the second, which is known only from rocky coastline habitat along Lake Superior.

Arcynopteryx dichroa (McLachlan)

Collection records. USA, Michigan: Keweenaw Co., Lake Superior, Isle Royale, 47.9163, -89.2090, 5.V.1959, B.A. Mech, ♀, nymph (PURC); same but 15.V.1959, 3♂, ♀ (PURC); Lake Superior, M-26, MDOT Esrey Roadside Park, 5 mi E Eagle Harbor, 47.4688, -88.0577, 27.V.1995, S.A. Grubbs, ♂, 10 nymphs (WKU); same but 9.VI.1996, 3♂, 2♀ (WKU); Lake Superior, 3.5 km W Copper Harbor along MI-26, 47.4793, -87.9363, 30.V.2010, R.E. DeWalt, M. Pessino, M.M. Brown, and E.W. Hernandez, 10♂, 18♀, 16 nymphs (INHS).

Comments. The prior records of *A. compacta* from Michigan (Grubbs & Bright 2001) now refer to *A. dichroa* (Teslenko 2012). This only Michigan records for this Holarctic-distributed species are from Lake Superior. The large series that the authors have recently collected have been from boulder habitats along the northern coast of the Keweenaw Peninsula.

Rarity status unknown

Paracapnia opis (Newman)

Collection records. USA, Michigan: Keweenaw Co., Montreal River, 8 km SE Eagle Harbor, 47.4214, -88.0759, 4.vi.2001, S.A. Grubbs, 5♂, 29♀ (WKU); Marquette Co., Middle Branch Escanaba River, SW Clarksburg at CR-496, 46.4896, -87.8580, 23.III.2011, R.E. DeWalt and M. Pessino, ♂, ♀ (INHS).

Comments. This species is known from the northern Great Lakes region east to Atlantic Canada (Stark & Baumann 2004, DeWalt et al. 2012a). First reported from Michigan by Grubbs & Bright (2001) from the Keweenaw County locality noted above, a second population has since been obtained and more are expected with collecting efforts during early-mid spring.

Leuctra rickeri James

Collection records. USA, Michigan: Mackinac Co., 46.0234, -84.9963, 8.VI.1957, W.E. Ricker, ♂ (CNC).

Comments. This species is mainly associated with small, upland streams in unglaciated regions (DeWalt et al. 2012a). A single Michigan record is now available, surprisingly from the southern tip of the Upper Peninsula.

Amphinemura nigrifera (Provancher)

Collection records. USA, Michigan: Chippewa Co., Sault Ste. Marie, 46.4899, -84.3993, 1.VI.1960, Kelton and Whitney, ♂ (CNC).

Comments. This is the sole record for this widespread species from Michigan, based on a determination by Dr. William Ricker in 1965. There are, however, several series of collections from northern Michigan (Alger, Keweenaw, and Otsego Cos.) with only females that may be of this species or *A. varshava* (Ricker). The females of the two species are similar and difficult to separate, and males are needed for verification. We expect *A. varshava* to be present in Michigan, especially since the type locality

is in northern Indiana ca. 60 km south of the Michigan border. We have recent material of *A. varshava* from both northeastern Wisconsin and northern Indiana.

Ostrocerca albidipennis (Walker)

Collection records. USA, Michigan: Chippewa Co., spring into Taquamenon River, near Lower Falls, Taquamenon Falls State Park, 46.6053, -85.2074, 24.V.1995, S.A. Grubbs, ♂(WKU); Marquette Co., Lily Pond Drain, Huron Mountain Club, 46.8479, -87.8295, 26.VI.1986, 3♀ (PURC).

Comments. This is one of two Appalachian-distributed species that has dispersed west across Ontario to Michigan's Upper Peninsula (Table 2), and known mainly from Atlantic Canada south to Maryland and West Virginia (DeWalt et al. 2012a). Both records for this species are from small upland streams. Additional records are anticipated from similar habitat types in forested systems, including intermittent streams.

Paranemoura perfecta (Walker)

Collection records. USA, Michigan: Alger Co., spring into Lake Superior, along North Country National Scenic Trail, Pictured Rocks National Lakeshore, 46.5528, -86.4241, 21.V.2009, S.A. Grubbs, 5♂, 10♀ (WKU). Marquette Co., T47N, R23W, S24, Tributary Sand River, 46.4599, -87.1187, 10.V.1980, M. Arduser, 2♂, 16♀ (MSUC).

Comments. Similar to *O. albidipennis*, this is an Appalachian species reported mainly from Atlantic Canada south to eastern Tennessee (Baumann 1996, DeWalt et al. 2012a). Focused collecting efforts in forested upland streams should also reveal additional populations of this species.

Prostoia similis (Hagen)

Collection records. USA, Michigan: Baraga Co., Tracy Creek, 46.4408, -88.5116, 17.III.1935, J.W. Leonard, 12♂, 27♀, 5 nymphs (INHS); same but 17.V.1935, J.W. Leonard, 2♂, 2♀ (CNC); Delta Co., Big River, Rte. 503, 45.8291, -86.7996, 26.V.1995, S.A. Grubbs, ♀ (WKU); Marquette Co., Mountain Stream, 46.8748, -87.8778, 17.V.1993, S.P. Yanoviak, 2 nymphs (PURC).

Comments. This species is very broadly distributed across the eastern Nearctic region (DeWalt et al.

2012a), but in Michigan is known from only three localities in the Upper Peninsula. Several additional populations across the state are anticipated from forested upland streams.

Shipsa rotunda (Claassen)

Collection records. USA, Michigan: Delta Co., Sturgeon River, Nahma Junction, 45.8953, -86.7036, 12.V.1940, T.H. Frison and H.H. Ross, 28♂, 44♀, 3 nymphs (CNC); Keweenaw Co., Montreal River, 8 km SE Eagle Harbor, 47.4214, -88.0759, 4.VI.2001, S.A. Grubbs, 5♀ (WKU); Manganese Creek, 1.5 km SE Copper Harbor, 47.4606, -87.8784, 30.V.2010, R.E. DeWalt, M. Pessino, E.W. Hernandez, and M.M. Brown, ♀ (INHS); Mackinac Co., Carp River, 20 km N St. Ignace, 46.0340, -84.7202, 2.VI.2001, S.A. Grubbs, ♀ (WKU); Schoolcraft Co., Manistique River, Germfask at MI-77, 46.2321, -85.9288, 24.III.2011, R.E. DeWalt and M. Pessino, ♀ (INHS).

Comments. This large stream and riverine species has been recorded from Alaska east to Atlantic Canada and south to South Carolina (DeWalt et al. 2012a). There are several recent records from localities scattered across the Upper Peninsula and several more are anticipated, including from the northern tier of the Lower Peninsula.

Oemopteryx glacialis (Barnston)

Collection records. USA, Michigan: Alger Co., Laughing Whitefish River, E Marquette at MI-28, 46.4938, -87.0511, 23.III.2011, R.E. DeWalt and M. Pessino, 2♂, ♀ (INHS); Baraga Co., Sturgeon River, 3km SSE Alberta at US-41, 46.6314, -88.4712, 23.III.2011, R.E. DeWalt and M. Pessino, 21♀ (INHS); Delta Co., Rapid River, Rapid River at US-2, 45.9266, -86.9637, 24.III.2011, R.E. DeWalt and M. Pessino, ♂, 2♀ (INHS); Escanaba River, 8.IV.1949, S. Lievens, 3♀ (UMMZ); Iron Co., Hemlock River, 46.2058, -88.5119, 14.IV.1963, no collector information, nymph (UWIRC).

Comments. This northern species is currently known from several localities scattered across the Upper Peninsula.

Alloperla leonarda Ricker

Collection records. USA, Michigan: Houghton Co., North Branch Otter River, T52N, R35W, Sec 25, 46.8741, -88.6863, 2.VI.1949, J.W. Leonard and F.A.

Leonard, ♂ (INHS); same but 18.VI.1949, 4♀ (CNC, INHS); same but 28.VI.1949, 26♀ (CNC); **Ontonagon Co.**, Middle Branch Escanaba River, 4.6 km SSE Rockland at US-45, 46.6993, -89.1594, 29.V.2010, R.E. DeWalt, M. Pessino, M.M. Brown, and E.W. Hernandez, ♂ (INHS).

Comments. This species has been reported from Atlantic Canada east to Minnesota with also an unusual glacial relictual population in southern Missouri (Poulton & Stewart 1991, Surdick 2004, DeWalt et al. 2012a). Two locality records exist for Michigan, both in the western portion of the Upper Peninsula that includes a small series that was recently collected.

Neoperla catharae Stark & Baumann

Collection records. USA, Michigan: **St. Joseph Co.**, St. Joseph River, Mottville, U.S. 12, 41.8001, -85.7572, 21.VII.2006, S.A. Grubbs, 5♂, 4♀ (WKU).

Comments. This species is distributed very broadly across the unglaciated eastern Nearctic region (Stark 2004, DeWalt et al. 2012a). This record is from the far southern portion of the Lower Peninsula.

Neoperla stewarti Stark & Baumann

Collection records. USA, Michigan: **Kalamazoo Co.**, Augusta Creek, Gull Lake Biological Station, 42.3633, -85.3535, 19.VII.1957, R.L. Fischer, ♂ (MSUC); **Menominee Co.**, Little Cedar River, 6 km W Carney at G18, 45.5799, -87.6332, 9.VII.2011, R.E. DeWalt, ♀ (INHS).

Comments. This widespread eastern Nearctic species (Stark 2004, DeWalt et al. 2012b) is represented in Michigan only by two records. The recent record from 2011 suggests additional records will accrue with summer collecting efforts, but likely mainly from the northern Lower Peninsula and Upper Peninsula. The collecting trip in June-July 2006 by the first author across the southern half of the Lower Peninsula did not produce material of this species.

Perlesta golconda DeWalt & Stark

Collection records. USA, Michigan: **Kalamazoo Co.**, Augusta Creek, Gull Lake Biological Station, 42.3633, -85.3535, 28.VI.1958, R.L. Fischer, ♂, ♀ (MSUC); same 27.VI.1959, R.L. Fischer, ♂, ♀ (MSUC).

Comments. This species occupies a narrow band in the central and eastern Nearctic region from

Nebraska and Missouri east to Ohio (DeWalt et al. 2012a). These new records for Michigan are from the southwestern Lower Peninsula. We anticipate that additional populations will be located in the state's larger river systems (e.g., Grand, St. Joseph, Menominee).

Perlesta WI-1

Comments. This is an undescribed species resembling *P. golconda* but distinctive according to unique aedeagal characteristics. Our material has been collected from the Menominee River along the Michigan-Wisconsin border, yet on the Wisconsin side. We consider this a valid Michigan record. Formal description will follow once gravid females are obtained to permit scanning electron microscopy of mature eggs.

Perlinella drymo (Newman)

Collection records. USA, Michigan: **Arenac Co.**, Rifle River, Omer, 44.0478, -83.8561, 21.V.1936, T.H. Frison and H.H. Ross, ♀ (INHS); **Baraga Co.**, Sturgeon River, at U.S. 41, 46.6253, -88.4702, 14.VI.1967, A.V. Nebeker, H. Bell, and V. Mattson, ♂ (BYU); **Berrien Co.**, St. Joseph River, Niles, Bond St., 41.8199, -86.2568, 30.IV.1999, S.A. Grubbs, ♂, ♀ (WKU); **Ingham Co.**, Red Cedar River, at Grand River Hwy, 42.7296, -84.4663, 15.IV.2000, E.D.E., 2 nymphs (MSUC).

Comments. This widespread large stream and riverine species (DeWalt et al. 2012a) is known from only four Michigan localities, yet distributed from the Upper Peninsula south to the far southwestern Lower Peninsula. Several additional localities are expected.

Isogenoides doratus (Frison)

Collection records. USA, Michigan: **Lake Co.**, Pere Marquette River, near Baldwin, 43.8574, -85.8518, 9.V.1940, T.H. Frison and H.H. Ross, nymph, exuviae (INHS); same but 10.V.1940, 2♂, ♀ (INHS); Pine River, Walker Bridge, Manistee National Forest, 44.1126, -85.6831, 31.V.1938, O.H. Clark, ♂ (INHS), same but 10.IV.1999, B.C. Kondratieff and J.B. Sandberg, ♂, ♀ (reared) (Sandberg and Stewart 2005); Pine River, Lincoln Bridge Campground, Manistee National Forest, 44.1336, -85.6960, 27.V.1998, S.A. Grubbs, 2♀ (WKU).

Comments. This sporadically-distributed species is known from British Columbia east to Quebec (Sandberg & Stewart 2005, DeWalt et al. 2012a). The few records from Michigan are from the southern edge of the northern Lower Peninsula. The relatively-recent records (1998 and 1999) from the Pine River provided ample evidence this uncommon species still persists in the state.

Isoperla marlynia Needham & Claassen

Collection records. USA, Michigan: Crawford Co., Au Sable River, T26N, R2W, Sec.12, 44.6557, -84.4945, 26.VII.1950, J.W. Leonard and F.W. Leonard, ♀ (UMMZ); **Delta Co.,** Sturgeon River, Nahma Junction, 45.8953, -86.7036, 20.V.1940, T.H. Frison and H.H. Ross, ♂, ♀ (CNC); **Houghton Co.,** Sturgeon River, Chassell, 47.0177, -88.5061, 20.VIII.1937, H.H. Ross, exuvium (INHS); **Wexford Co.,** Manistee River, nr. U.S. 131, 8.5 km N Manton, 44.4843, -85.4063, 1.VI.2001, S.A. Grubbs, ♀ (WKU).

Comments. *Isoperla marlynia* has been reported from Saskatchewan east to Atlantic Canada and south to Oklahoma, Kentucky and South Carolina (DeWalt et al. 2012a). Within Michigan, however, this is easily the most uncommon *Isoperla* species and presently known only from four localities scattered across the northern Lower Peninsula and Upper Peninsula.

Isoperla richardsoni Frison

Collection records. USA, Michigan: Arenac Co., Rifle River, Omer, 44.0477, -83.8561, 21.V.1936, T.H. Frison and H.H. Ross, 7♂, 10♀ (CNC); **Benzie Co.,** Betsie River, Benzonia, 44.6214, -86.0992, 27.V.1939, T.H. Frison and H.H. Ross, ♀ (CNC); **Crawford Co.,** North Branch Au Sable River, 2 mi upstream Lovells, 44.8276, -84.4910, 2.V.1936, J.W. Leonard, ♂ (CNC); **Ingham Co.,** Red Cedar River, 42.7316, -84.4869, 21.V.1891, no collector information, 8♂, 1♀ (MSUC); **Lake Co.,** Pine River, near Skookum, 44.0794, -85.6430, 27.VI.1938, R.P. Bohland, 3♀ (CNC); **Mason Co.,** Big Sable River, Free Soil, 44.1146, -86.2084, 26.V.1939, T.H. Frison and H.H. Ross, ♀ (CNC); **Mecosta Co.,** Muskegon River, Big Rapids, 43.6987, -85.4771, 22.V.1936, T.H. Frison and H.H. Ross, 2♂, 3♀, 1 nymph (CNC, INHS); **Schoolcraft Co.,** Manistique River, Germfask at MI-77, 46.2321, -85.9288, 1.VI.2010, R.E. DeWalt, M. Pessino, M.M. Brown, and E.W. Hernandez, 2 exuviae (INHS);

Washtenaw Co., Huron River, Ann Arbor, 42.2887, -83.7405, 18.V.1919, T.H. Hubbell, ♀ (UMMZ); same but 15.V.1936, J.A. Oliver, ♀ (CNC); same but 29.V.1939, D.L. Cantrall, 2 nymphs (UMMZ); Huron River, Delhi Mills, 42.3338, -83.8099, 6.V.1937, J. Friouf, nymph (UMMZ); same but 23.V.1938, F.E. Lyman, ♂, 3♀ (UMMZ); Huron River, T2S, R5E, S2, 42.3338, -83.8093, 6.V.1937, F.E. Lyman, 9 nymphs (INHS).

Comments. Although this species has been collected from several localities in the Upper and Lower Peninsulas, with one exception (Schoolcraft Co., Manistique River) all material were obtained prior to 1940. This species appears to have experienced a marked range reduction.

SUMMARY

The results of this paper are part of a broader effort to understand distribution patterns of the stonefly fauna of the midwestern U.S. (Illinois, Indiana, Michigan, Ohio, and Wisconsin) and Ontario. Similar to this study, we have recently updated the Illinois (DeWalt & Grubbs 2011), Indiana (DeWalt & Grubbs 2011), and Ohio (DeWalt et al. 2012b; Grubbs et al. *unpublished data*) faunas, and will follow up with Wisconsin and Ontario. Given that stoneflies are generally intolerant of water and habitat quality degradation (DeWalt et al. 2005) they are undoubtedly being lost from many locations in Michigan. Compared to Illinois, Indiana and Ohio, fewer species are known from Michigan yet this state also appears to have lost one species (*A. ruralis*) and likely a second (*H. nalatus*). A particular emphasis on the regional study is distributional modeling with state and regional occurrence data to assess vulnerability of species to range loss and extirpation. The large dataset accruing for this analysis will help to begin the process of protecting the species and the streams they inhabit from future losses.

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REFERENCES

- Baumann, R.W. 1996. A review of the stonefly genus *Paranemoura* (Plecoptera: Nemouridae) and a new species from the northeast. *Proceedings of the Entomological Society of Washington*, 98:818–826.
- Boumans, L. & R.W. Baumann. 2012. *Amphinemura palmeni* is a valid Holarctic stonefly genus (Plecoptera: Nemouridae). *Zootaxa*, 3537:59–75.
- Bright, E. 1996. A new larval record of *Perlinella drymo* (Plecoptera: Perlidae) for Michigan. *The Great Lakes Entomologist*, 29:39–42.
- DeWalt, R.E. & S.A. Grubbs. 2011. Updates to the stonefly fauna of Illinois and Indiana. *Illiesia*, 7:31–50.
- DeWalt, R.E., C. Favret, & D.W. Webb. 2005. Just how imperiled are aquatic insects? A case study of stoneflies (Plecoptera) in Illinois. *Annals of the Entomological Society of America*, 98:941–950.
- DeWalt R.E., U. Neu-Becker, & G. Steuber. 2012. Plecoptera species file online. Version 1.0/4.1 [18 September 2012]. Available online, <http://Plecoptera.SpeciesFile.org>
- DeWalt, R.E., Y. Cao, T. Tweddale, S.A. Grubbs, L. Hinz, & M. Pessino. 2012. Ohio USA stoneflies (Insecta: Plecoptera): species richness estimation, distribution of functional niche traits, drainage affiliations, and relationship to other state faunas. *ZooKeys*, 178:1–26.
- Frison, T.H. 1942. Studies on North American Plecoptera, with special reference to the fauna of Illinois. *Bulletin of the Illinois Natural History Survey*, 22:235–355.
- Grubbs, S.A. 1997. New records, zoogeographic notes, and a revised checklist of stoneflies (Plecoptera) from Maryland. *Transactions of the American Entomological Society*, 123:71–84.
- Grubbs, S.A. & E. Bright. 2001. *Arcynopteryx compacta* (Plecoptera: Perlodidae), a Holarctic stonefly confirmed from Lake Superior, with a review and first checklist of the stoneflies of Michigan. *Great Lakes Entomologist*, 34:77–84.
- Grubbs, S.A. & R.E. DeWalt. 2012. *Perlesta ephelida* (Plecoptera: Perlidae), a new eastern Nearctic stonefly species. *ZooKeys*, 194:1–15.
- Grubbs, S.A. & B.P. Stark. 2001. Notes on *Perlesta* (Plecoptera: Perlidae) from eastern North America. *Aquatic Insects*, 23:119–122.
- Hanson, J.F. 1943. Records and descriptions of North American Plecoptera. Part III. Notes on *Isogenoides*. *American Midland Naturalist*, 29:657–669.
- Kondratieff, B.C. & R.F. Kirchner. 1987. Additions, taxonomic corrections, and faunal affinities of the stoneflies (Plecoptera) of Virginia, U.S.A. *Proceedings of the Entomological Society of Washington*, 89:24–30.
- Needham, J.G. & P.W. Claassen. 1925. A monograph of the Plecoptera or stoneflies of America north of Mexico. Thomas Say Foundation Series, Entomological Society of America, 2:1-397.
- Nelson, C.R. & R.W. Baumann. 1987. The winter stonefly genus *Capnura* (Plecoptera: Capniidae) in North America: systematics, phylogeny, and zoogeography. *Transactions of the American Entomological Society*, 113:1–28.
- Nelson, C.R. & R.W. Baumann. 1989. Systematics and distribution of the winter stonefly genus *Capnia* (Plecoptera: Capniidae) in North America. *Great Basin Naturalist*, 49:289–363.
- Poulton, B.C. & K.W. Stewart. 1991. The stoneflies of the Ozark and Ouachita Mountains (Plecoptera). *Memoirs of the American Entomological Society*, 38:1–116.
- Ricker, W.E. 1952. Systematic studies of Plecoptera. *Indiana University Publication Scientific Series*, 18:1–200.
- Sandberg, J.B. & K.W. Stewart. 2005. Holomorphology and systematic of the stonefly genus *Isogenoides* (Plecoptera: Perlodidae). *Transactions of the American Entomological Society*, 131:269–345.
- Stark, B.P. 2004. Perlidae (The Stones). Pages 61-148. In B.P. Stark & B.J. Armitage, editors. *The Stoneflies (Plecoptera) of Eastern North America. Volume II. Chloroperlidae, Perlidae, and Perlodidae (Perlodinae)*. *Bulletin of the Ohio Biological Survey, New Series Volume 14*, Columbus, Ohio. 192 pp.
- Stark, B.P. & R.W. Baumann. 2004. The winter stonefly genus *Paracapnia* (Plecoptera: Capniidae). *Monographs of the Western North American*

Naturalist, 2:96–108.

Stewart, K.W. & B.P. Stark. 2002. Nymphs of North American Stonefly Genera (Plecoptera), 2nd edition. The Caddis Press, Columbus, Ohio, 510 pp.

Stout, R.J. & M.P. Rondinelli. 1995. Stream-dwelling insects and extremely low frequency electromagnetic fields: a ten year study. *Hydrobiologia*, 302:197–213.

Surdick, R.F. 2004. Chloroperlidae (The Sallflies). Pages 1-60. *In* B.P. Stark & B.J. Armitage, editors. The Stoneflies (Plecoptera) of Eastern North America. Volume II. Chloroperlidae, Perlidae, and Perlodidae (Perlodinae). Bulletin of the Ohio Biological Survey, New Series Volume 14, Columbus, Ohio. 192 pp.

Teslenko, V.A. 2012. A taxonomic revision of the genus *Arcynopteryx* Klapálek, 1904 (Plecoptera, Perlodidae). *Zootaxa*, 3329:1–18.

Yanoviak, S.P. & W.P. McCafferty. 1996. Comparison of macroinvertebrate assemblages inhabiting pristine streams in the Huron Mountains of Michigan, U.S.A. *Hydrobiologia*, 330:195–211.

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