The Great Lakes Entomologist

Volume 34
Number 2 - Fall/Winter 2001 *Number 2 - Fall/ Winter 2001*

Article 10

October 2001

Arcynopteryx Compacta (Plecoptera: Perlodidae), A Holarctic Stonefly Confirmed From Lake Superior, With a Review and First Checklist of the Stoneflies of Michigan

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ARCYNOPTERYX COMPACTA (PLECOPTERA: PERLODIDAE), A HOLARCTIC STONEFLY CONFIRMED FROM LAKE SUPERIOR, WITH A REVIEW AND FIRST CHECKLIST OF THE STONEFLIES OF MICHIGAN

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ABSTRACT

Arcynopteryx compacta, a northern Holarctic species, is confirmed from Lake Superior along the Keweenaw Peninsula of Michigan's Upper Peninsula. A checklist of stoneflies of Michigan is provided, reporting 58 species plus a list of an additional 19 species that are likely to occur in the state.

Arcynopteryx compacta (McLachlan) is included in a small group of stoneflies that can be described as circumpolar. This species is broadly distributed throughout the northern Holarctic region in a circular manner mainly south of the Arctic Circle. The other members of this group are *Diura bicaudata* (Linnaeus), *Nemoura arctica* Ebsen-Peterson, *Plumiperla diversa* (Frison), and *Podmosta weberi* (Ricker) (Stewart and Ricker 1997). Aside from North America, *A. compacta* is locally distributed across Siberia and the Russia Far-Eastern region (Levanidova and Zhiltzova 1979), Scandinavia (Lillehammer 1985), and high-altitude habitats in the French Pyrenees (Lavendier 1979). *Arcynopteryx compacta* inhabits streams and can be a dominant predator along the rocky shorelines of lakes (Stewart and Stark 1988).

In North America, *A. compacta* is found along a wide latitudinal band at higher latitudes and altitudes (Ricker 1944, 1964; Hynes 1988). *Arcynopteryx compacta* is distributed in Alaska (Stewart et al. 1990), Yukon (Stewart and Ricker 1997), Saskatchewan (Stewart and Stark 1988), lakes of the Canadian Rockies (Donald and Anderson 1980) south to isolated patches in Montana, Colorado and Wyoming (Baumann et al. 1977), and east to highly-localized populations in Maine, New Hampshire, and possibly New York (Hanson 1942, Mingo 1983). Ricker (1964) provided a distribution map for this species in North America and noted that *A. compacta* exuviae were collected from boulders along the Lake Superior shoreline of the Keweenaw Peninsula in the Upper Peninsula of Michigan. This nominal collection provided the basis for inclusion of Lake Superior as a distribution point in Ricker's (1952) treatment of Perlodinae.

During recent collecting trips to Michigan's Upper Peninsula, the senior author collected fresh material of *A. compacta* from habitats similar to that described by Ricker (1964). Collecting trips were made to this region in May 1995, June 1996, and June 2001. Nymphs were hand-picked from boulders along a wave-swept shoreline and adults were located by searching among driftwood and associated rubble. Additional stonefly species collected with *A. compacta* included *Capnia vernalis* (Newport), *Paracapnia angulata* Hanson, *Isogenoides frontalis* (Newman), *Isoperla bilineata* (Say), *I. cotta* Ricker, and immature chloroperlid nymphs.

To date, there has not been a published comprehensive treatment of Michigan's stonefly fauna. Only 39 species were listed by Stark et al. (1986),

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followed by 42 (Stewart and Stark 1988), and 40 (Stark 2001) species, respectively (Table 1). This paper reports 16 "new" state records, which are listed below. Six novel records are noted based on material obtained by the senior author (detailed records limited to two occurrences where males, if obtained, were collected), three records solely from literature (only one record listed), including electronic resources (i.e., Illinois Natural History Survey (INHS 2001)), and an additional seven records based on a combination of the authors' collections, literature, and/or museum holdings.

Family Nemouridae

Genus *Ostrocerca*

O. albidipennis (Walker): **Chippewa Co.**, spring into Taqhuamenon River, near Lower Falls, Taqhuamenon Falls State Park, 05/24/95, SAG, 1 ♂. This record indicates a western range extension. *O. albidipennis* is mainly an Appalachian-distributed species that flanks slightly east into the upper Piedmont and Ontario to the west.

Family Taeniopterygidae

Genus *Oemopteryx*

O. glacialis (Newport): **Delta Co.**, Escanaba River, 04/08/49, S. Lievense, 3 ♀♀ (UMMZ).

Genus *Strophopteryx*

S. fasciata (Burmeister): **Berrien Co.**, Dowagiac Creek, Niles, 04/15/95, SAG, 1 ♀; **Calhoun Co.**, South Branch Kalamazoo River, 5.5 km SSW Albion, 03/03/1992, Ethan Bright (EB), 1 larva; **Delta Co.**, Sturgeon River, Nahma Junction, 05/12/41, T. H. Frison (THF), 1 ♂ (INHS 2001).

Genus *Taeniopteryx*

T. burksi Ricker & Ross: **Berrien Co.**, St. Joseph River, Niles, 04/07/96, SAG, 2 ♂♂, 2 ♀♀; Dowagiac Creek, U.S. 31, Niles, 04/07/96, SAG, 2 ♂♂. In their revision of North American *Taeniopteryx*, Ricker and Ross (1968) listed this species from Clinton and Ingham Counties.

T. maura (Pictet): **Cheybogan Co.**, West Branch Sturgeon River, between Wolverine and Vanderbilt, 03/15/35, J. W. Leonard (JWL), 2♂♂, 1 ♀ (INHS 2001).

Family Capniidae

Genus *Capnia*

C. vernalis (Newport): **Keweenaw Co.**, Lake Superior, Keweenaw Peninsula, 8 km E Eagle Harbor, 05/27/95, SAG, 3 ♀♀; **Isle Royale Co.**, Isle Royale, 07/14/05, H. A. Gleason (Needham and Claassen 1925).

Genus *Paracapnia*

P. opis (Newman): **Keweenaw Co.**, Montreal River, 8 km SE Eagle Harbor, 06/04/01, SAG and Dana E. King-Grubbs (DEG), 5 ♂♂, 29 ♀♀.

Family Leuctridae

Genus *Leuctra*

L. ferruginea (Walker): **Alger Co.**, Valley Spur Creek, 3 km SW Munising, 06/05/95, SAG, 4 ♂♂, 1 ♀; **Keweenaw Co.**, Silver River, 06/03/49, J. W. Leonard and F. A. Leonard, 3 ♂♂, 3 ♀♀ (UMMZ).

Family Pteronarcyidae

Genus *Pteronarcys*

P. dorsata (Say): **Berrien Co.**, Dowagiac Creek, Niles, 04/15/95, SAG, 2 ♂♂, 2 ♂♂; **Lake Co.**, Little Manistee River, near Peacock, 05/10/40, THF, 1 ♂ (INHS 2001).

Table 1. Comparison of previous compilations of stoneflies listed from Michigan.

Family	Species	Stark et al. (1986)	Stewart & Stark (1988)	Stark (2001)
Nemouridae	*Amphinemura delosa*	X	X	X
	A. linda	X	X	X
	Nemoura trispinosa		X	
	Prostoia completa	X	X	X
	P. similis	X	X	X
	Shipsa rotunda	X	X	X
	Soyedina vallicularia	X	X	X
Taeniopterygidae	*Taeniopteryx nivalis*		X	
	T. parvula	X	X	X
Capniidae	*Allocapnia granulata*	X	X	X
	A. minima	X	X	X
	A. pygmaea	X	X	X
	A. vivipara	X	X	X
	Capnura manitoba			X
	Paracapnia angulata	X	X	X
Leuctridae	*Leuctra tenuis*	X	X	
Perlodidae	*Clioperla clio*	X	X	X
	Cultus decisus decisus	X[1]	X[1]	X
	Helopicus nalatus	X	X	X
	Isogenoides doratus	X	X	X
	I. frontalis	X	X	X
	I. krumholzi	X	X	X
	I. olivaceus	X	X	X
	I. varians	X	X	X
	Isoperla bilineata	X	X	X
	I. cotta	X	X	X
	I. dicala	X	X	X
	I. lata	X	X	X
	I. marlynia	X	X	X
	I. signata	X	X	X
	I. slossonae	X	X	X
	I. transmarina	X	X	X
Chloroperlidae	*Alloperla atlantica*	X	X	X
	A. banksi	X	X	X
	A. leonarda	X	X	X
	Haploperla brevis	X	X	X
Perlidae	*Acroneuria abnormis*	X	X	X
	A. frisoni	X[2]	X[2]	X
	A. internata	X	X	X
	A. lycorias	X	X	X
	Agnetina capitata		X	X
	Paragnetina media	X	X	X
	Perlinella drymo	X	X	X

[1] listed as *Cultus decisus*, but Stark et al. (1988) split this species into three taxonomic units, *C. d. decisus*, *C. d. isolatus*, and *C. verticalis*.

[2] listed as *A. evoluta*, but Stark & Brown (1991) described *A. frisoni*, replacing *A. evoluta*, which replaced *A. mela*.

P. pictetti Hagen: **Crawford Co.**, Manistee River, near Grayling, 06/17/35, THF, 3 ♂♂ (INHS 2001).

Family Perlodidae

Genus *Arcynopteryx*

A. compacta (McLachlan): **Keweenaw Co.**, Lake Superior, Keweenaw Peninsula, 8 km E Eagle Harbor, 05/27/95, SAG, 1 ♂, 10 nymphs; 06/09/96, SAG, 3 ♂♂, 2 ♀♀.

Genus *Isoperla*

I. frisoni Illies: **Crawford Co.**, North Branch AuSable River, 06/16/35, JWL, 2 ♂♂, 3 ♀♀ (INHS 2001); **Luce Co.**, Two Hearted River, 36 km E Grand Marais, Lake Superior State Forest, 06/02/01, SAG and DEG, 5 ♂♂, 1 ♀; **Wexford Co.**, Manistee River, 9 km N Manton, 06/01/01, SAG and DEG, 1 ♂.

I. nana (Walsh): **Mason Co.**, Big South Branch Pere Marquette River, 9 km S Walhalla, Manistee National Forest, 05/26/98, SAG, 2 ♂♂, 1 ♀.

Family Chloroperlidae

Genus *Haploperla*

H. orpha (Frison): **Oscoda Co.**, Mio, 05/29/37, THF, 1 ♂, 1 ♀, (INHS 2001). Frison determined these specimens in 1942. Both abdomens are clipped and cleared, but do not appear to bear a central abdominal stripe. In addition, both specimens are discolored such that pronotal pigmentation was indistinguishable. The quadrate epiproct tip is apparent and very similar to fresh material obtained during the course of this study that clearly lack both abdominal and pronotal coloration. All *Haploperla* specimens obtained during this study, regardless of variation in epiproctal shape, have been conservatively assigned to *H. brevis* (Banks).

Family Perlidae

Genus *Perlesta*

P. shubuta Stark: **Berrien Co.**, Dowagiac Creek, Niles, 06/30/94, SAG, 5 ♂♂, 4 ♀♀; 06/07/01, SAG and DEG, 4♂♂, 2 ♀♀.

Genus *Perlinella*

P. ephyre (Newman): **Berrien Co.**, St. Joseph River, Niles, 06/08/01, SAG, 3 ♂♂, 8 ♀♀; Dowagiac Creek, Niles, 05/25/98, SAG, 1 ♀.

Overall, 58 species have been confirmed from Michigan (Table 2). Yanoviak and McCafferty (1996) included records for *Leuctra tenella* Provancher and *Isoperla richardsoni* Frison from the Huron Mountain region of the Upper Peninsula. We have omitted these records as new because both determinations were based on nymphs, although both species may occur in Michigan. Nymphs of *Leuctra* are difficult to identify to species (Stewart and Stark 1988), despite the taxonomic treatment by Harper and Hynes (1971), and examination of the nymphs identified as *L. tenella* proved inconclusive. Nymphal material of *I. richardsoni* was not available for study. Adult material determined as *L. tenella* by J. W. Leonard in the University of Michigan Museum of Zoology was available for study, but all adults were misidentifications of either *Leuctra tenuis* or *L. ferruginea*.

Stout and Rondinelli (1995) reported the occurrence of *Suwallia*, *Paranemoura*, and *Oemopteryx glacialis* from the Ford River, also in the Upper Peninsula. Identical to Yanoviak and McCafferty (1996), however, these determinations were made from nymphs and material was not available for study. *Suwallia* (as *S. marginata* (Banks)) is expected to occur in Michigan, especially in the Upper Peninsula or the northern tier of the Lower Peninsula. Although the presence of *Paranemoura* is unlikely, the occurrence of *Ostrocerca albidipennis* (Walker) in the eastern portion of the Upper Peninsula raises the

Table 2. Revised checklist of stoneflies reported from Michigan. ** "new" state records, + potential additions based on known occurrences from adjacent state(s) or Ontario.

Family	Species	New or potential state Record	Known locations	Biogeographic distribution
Nemouridae	*Amphinemura delosa* (Ricker)			EB
	A. linda (Ricker)			EB
	Nemoura trispinosa Claassen			WB
	Ostrocerca albidipennis (Walker)	**		AP
	Prostoia completa (Walker)			EB
	P. similis (Hagen)			EB
	Shipsa rotunda (Claassen)			WB
	Soyedina vallicularia (Wu)			EB
Taeniopterygidae	*Oemopteryx glacialis* (Newport)	**		NB
	Strophopteryx fasciata (Burmeister)	**		EB
	Taeniopteryx burksi Ricker and Ross	**		EB
	T. maura (Pictet)	**		EB
	T. nivalis (Fitch)			WB
	T. parvula Banks			WB
Capniidae	*Allocapnia frisoni* Ricker and Ross	+	OH, WI	EB
	A. granulata (Claassen)			EB
	A. illinoensis Frison	+	IL, IN, MN, OH, WI	EB
	A. minima (Newport)			EB
	A. nivicola (Fitch)	+	IL, IN, OH, WI	EB
	A. pygmaea (Burmeister)			EB
	A. recta (Claassen)	+	IL, IN, OH, ON, WI	EB
	A. rickeri Frison	+	IN, MN, OH, ON, WI	EB
	A. vivipara (Claassen)			EB
	Capnia vernalis (Newport)	**		WB
	Capnura manitoba Claassen			NB
	Paracapnia angulata Hanson			WB
	P. opis (Newman)	**		NB
Leuctridae	*Leuctra ferruginea* (Walker)	**		EB
	L. sibleyi Claassen	+	IL, IN, OH, MN, ON, WI	EB
	L. tenella Provancher	+	IN, MN, ON, WI	EB
	L. tenuis (Pictet)			EB
Pteronarcyidae	*Pteronarcys dorsata* (Say)	**		WB
	P. pictetti Hagen	**		EB
Perlodidae	*Arcynopteryx compacta* (McLachlan)	**		NH
	Clioperla clio (Newman)			EB
	Cultus decisus decisus (Walker)			NB
	Helopicus nalatus (Frison)			EB
	Isogenoides doratus (Frison)			NB
	I. frontalis (Newman)			NB
	I. krumholzi (Ricker)			NB
	I. olivaceus (Walker)			NB
	I. varians (Walsh)			EB
	Isoperla bilineata (Say)			EB
	I. cotta Ricker			NB
	I. dicala Frison			EB
	I. frisoni Illies	**		EB
	I. lata Frison			EB
	I. marlynia (Needham and Claassen)			WB
	I. montana (Banks)	+	MN	EB
	I. nana (Walsh)	**		EB
	I. orata Frison	+	MN	EB
	I. richardsoni Frison	+	MN, WI	EB
	I. signata (Banks)			EB
	I. slossonae (Banks)			EB
	I. transmarina (Newman)			WB

Table 2. Continued.

Family	Species	New or potential state Record	Known locations	Biogeographic distribution
Chloroperlidae	*Alloperla atlantica* Baumann			EB
	A. banksi Frison			NB
	A. leonarda Ricker			NB
	Haploperla brevis (Banks)			WB
	H. orpha (Frison)	**		NB
	Suwallia marginata (Banks)	+	ON, WI	EB
Perlidae	*Acroneuria abnormis* (Newman)			WB
	A. frisoni Stark and Brown			EB
	A. internata (Walker)			EB
	A. lycorias (Newman)			WB
	Agnetina capitata (Pictet)			EB
	A. flavescens (Walsh)	+	IL, IN, MN, OH, WI	EB
	Attaneuria ruralis (Hagen)	+	IL, IN, MN, OH, WI	EB
	Neoperla occipitalis (Pictet)	+	IL, IN, OH, ON, WI	EB
	N. stewarti Stark and Baumann	+	MN, OH, ON, WI	EB
	N. mainensis Banks	+	IL, OH, ON	EB
	Paragnetina media (Walker)	+		EB
	Perlesta adena Stark	+	OH, ON, IL	EB
	P. decipiens (Walsh)	+	IL, OH, WI	WB
	P. shubuta Stark	**		EB
	Perlinella drymo (Newman)			EB
	P. ephyre (Newman)	**		EB

possibility of a Michigan record of *Paranemoura*, as the latter species shares a similar distribution in the northern Appalachians with *P. claasseni* Baumann and *P. perfecta* (Walker).

The presence of *Neoperla* has been confirmed based a nymphal record from the Huron River in Washtenaw County, in the southern part of the Lower Peninsula. Three species are likely to occur in southern Michigan (see table 2). Nymphs are very difficult to identify with confidence, and we prefer to await the collection of adult material before attempting specific-level diagnoses.

The stonefly fauna of Michigan can be conveniently split into five overlapping distributional units (Table 2): (1) widespread boreal (WB), defined as species which occupy portions of both the eastern and western regions of North America, using the Mississippi River and James Bay as approximate dividing lines; (2) eastern boreal (EB), defined as species that range mainly throughout eastern North America; (3) northern boreal (NB), defined as species that only occupy northern regions in eastern North America; (4) northern Holarctic (NH), defined as species distributed as circumpolar; and (5) Appalachian (AP), defined as species that are found primarily in the Appalachian Mountain range. In order of decreasing predominance, the EB group is most common to Michigan (32 species), followed by WB (12 species), NB (12 species), and NH and AP (1 species each).

The landscape of Michigan can be simply divided into two obvious geographic units, the Lower Peninsula and the Upper Peninsula. This dichotomy, however, does not reflect natural boundaries according to climatic, geologic, physiographic, or vegetation units. A basic classification system may follow Bailey and Cushwa (1981), which separates the Upper Peninsula and northern and central portion of the Lower Peninsula from the southern unit of the Lower Peninsula according to mixed coniferous-deciduous ('northern') and deciduous ('southern') geographic units. However, because a systematic collecting effort throughout both peninsulas has not been attempted, a potential grouping of like assemblages of species into the ecosystem classification scheme created by Albert (1995), ecoregions (Omernik 1987, Bailey et al. 1995) and/or U.S.G.S. hydrologic unit codes is not yet possible.

ACKNOWLEDGMENTS

We thank Arwin Provonsha (Purdue University), Colin Favret (Illinois Natural History Survey), and Mark O'Brien (University of Michigan Museum of Zoology) for making material available for study. Boris Kondratieff (Colorado State University), Stan Szczytko (University of Wisconsin Stevens-Point), and Richard Merritt (Michigan State University) improved the quality of this manuscript through pre-publication reviews.

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