



AN UPDATE ON THE STONEFLY FAUNA (INSECTA, PLECOPTERA) OF MARYLAND, INCLUDING NEW AND EMENDED STATE RECORDS AND AN UPDATED STATE CHECKLIST

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ABSTRACT

The stonefly fauna of Maryland is updated. An unassociated female of *Perlesta* Banks, 1906 is described under informal designation, complete with light microscopy micrographs of head and pronotal pigmentation patterns plus scanning electron microscopy (SEM) images of eggs. New state records are presented for *Cultus verticalis* (Banks, 1920), *Neoperla catharae* Stark & Baumann, 1978, and *P. mihucorum* Kondratieff & Myers, 2011. Light microscopy and SEM micrographs are also presented for *P. mihucorum*. Published state records of *Isoperla* Banks, 1906 and *Sweltsa onkos* (Ricker, 1952) are emended given recent descriptions in both genera. Distribution maps for *S. onkos* and *S. hoffmani* Kondratieff & Kirchner, 2009, plus for all species of *Isoperla* and *Perlesta* known to occur in the Appalachian Mountain region of western Maryland, are provided. An updated state checklist of 114 species is included.

Keywords: Plecoptera, Perlidae, *Perlesta*, state records, Maryland

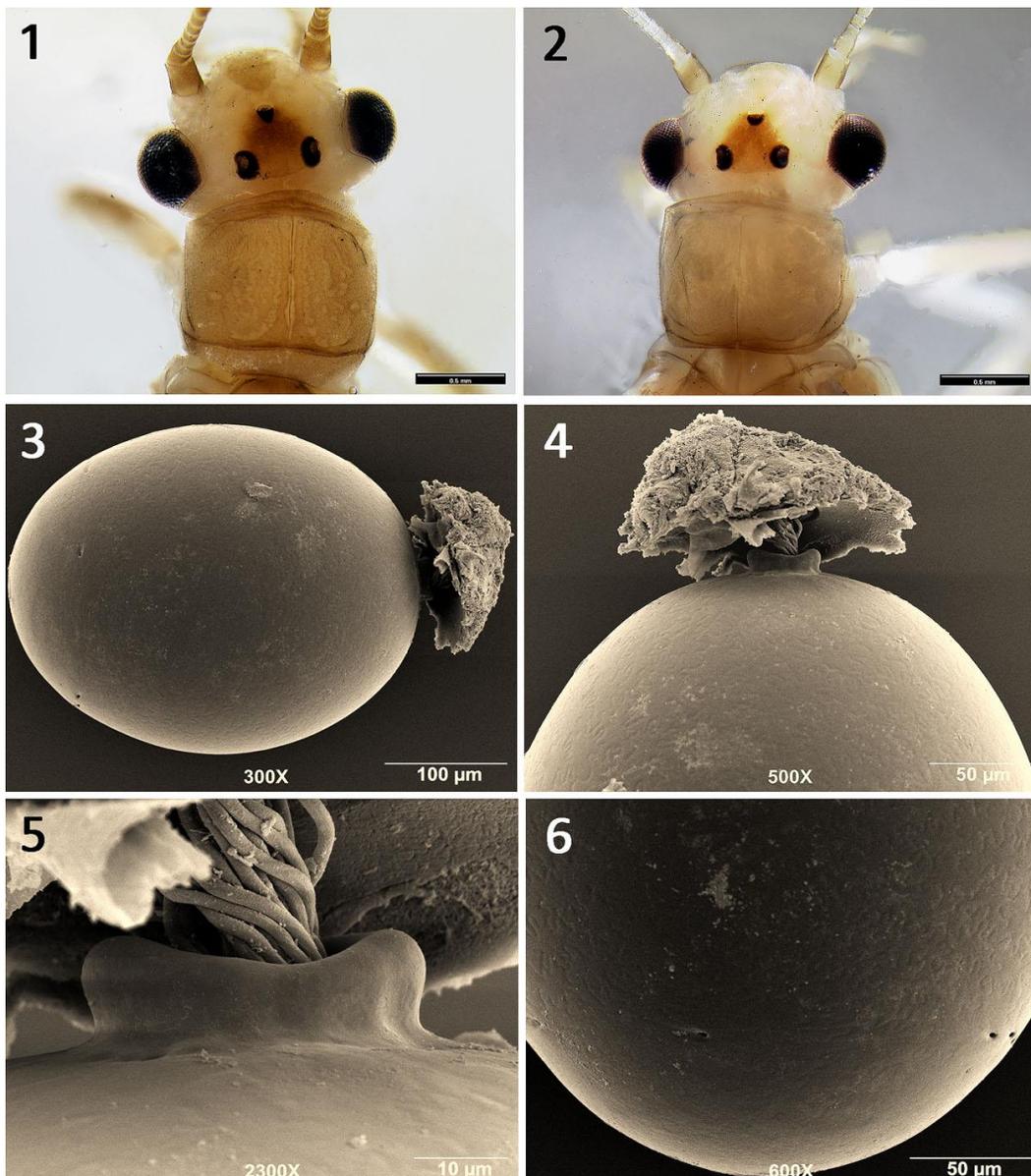
INTRODUCTION

Information on the stonefly fauna of Maryland was based initially on the species lists in Duffield & Nelson (1990) and Grubbs (1997), and now easily searchable as a “Faunal list” in DeWalt et al. (2018). Duffield & Nelson (1990) presented 25 new state records and the first published state checklist of 58 species. Grubbs (1997) reported 36 new state records and an updated checklist of 95 species. Additions and clarifications were subsequently included in Grubbs & Stark (2001), Nelson et al. (2002), Grubbs (2003), and Surdick (2004).

Since 2004, taxonomic and locality information

on the Maryland fauna have been included in systematic treatments of *Allocaupnia* Claassen, 1928 (Grubbs & Sheldon 2008), *Leuctra* Stephens, 1836 (Grubbs 2015, Grubbs & Wei 2017), *Prostoia* Ricker, 1952 (Grubbs et al. 2014), *Soyedina* Ricker, 1952 (Grubbs 2006), *Sweltsa* Ricker, 1943 (Kondratieff & Kirchner 2009, Stark et al. 2011), *Perlesta* Banks, 1906 (Grubbs & DeWalt 2008, 2012), and *Isoperla* Banks, 1906 (Szczytko & Kondratieff 2015).

Stemming from the recent taxonomic treatments of *Sweltsa* and *Isoperla*, several species whose distribution in Maryland were in question, or are now more readily identified, were re-examined.



Figs. 1–6. *Perlesta* sp. MD-5, Maryland, Sideling Hill Creek. 1–2, female, head + pronotum, dorsal profile; 3, entire egg, 300X; 4, egg, posterior pole, 500X; 5, egg, posterior pole and collar, 2300X; 6, egg, anterior pole and micropyles, 600X.

Perlesta was also examined closely, revealing unassociated females with potentially unique egg characteristics plus a surprising range extension for *P. mihucorum* Kondratieff & Myers, 2011 were present in material collected by the author during the 1990's. Scanning electron and light microscopy micrographs are included to further facilitate

identification of these two species. In addition, two additional new state records, several species emendations, and an updated state checklist is provided.

METHODS

Specimens examined for this project were obtained from Western Kentucky University, Bowling Green (WKUC). Locality data for all specimen records, in decimal degrees, were obtained either directly on site with GPS units or georeferenced from museum label data (if possible) using Acme Mapper 2.1 (<http://mapper.acme.com>). All specimen data are available as a comma separate values file prepared in Darwin Core Archive file format

(http://illiesia.speciesfile.org/Papers/MarylandPlecopteraProject_DwC-A.csv). Specimens for scanning electron microscopy (SEM) were serially dehydrated in 75%, 95%, and 100% ethanol for 10 minutes each and placed in hexamethyldisilazane for 30 minutes. Dehydrated specimens were attached to aluminum stubs with double-stick tape and coated with gold-palladium in an Emscope SC500. Coated specimens were examined using a Jeol JSM-6510LV scanning electron microscope and digital images were captured with an IXRF system. Digital images were also obtained using Auto-Montage software with a Leica MZ16 stereomicroscope equipped with a JVC KY-F75U digital camera.

RESULTS

Taxonomy

Perlesta MD-5 (Figs. 1–6, 21)

Female. Forewing length 9.5–11.0 mm (n = 3). Head light pale yellow with a golden brown intraocellar patch that is slightly open anteriorly, plus a light golden-brown triangular patch anterior to the anterior ocellus; m-line indistinguishable (Figs. 1–2). Pronotum light golden brown with no medial stripe (Figs. 1–2). Subgenital plate ca. ½ width of 8th abdominal sternum, lacking pigmentation. Lobes distinct, rounded laterally, bordered by a v-shaped notch.

Egg. Oval (Fig. 3). Collar small and straight-sided, raised about chorionic surface, flange lacking (Figs. 4–5); chorion covered by a patchwork of amoeboid-like polygons (Figs. 4, 6); micropyles present in

anterior ¼ (Fig. 6).

Material examined. USA, Maryland, Allegany Co., Sideling Hill Creek, near Bellegrove, at light, 39.70443, -78.32840, 3 August 1996, S.A. Grubbs, 2♀ (WKUC); same but 14 July 1998, S.A. Grubbs, ♀ (WKUC).

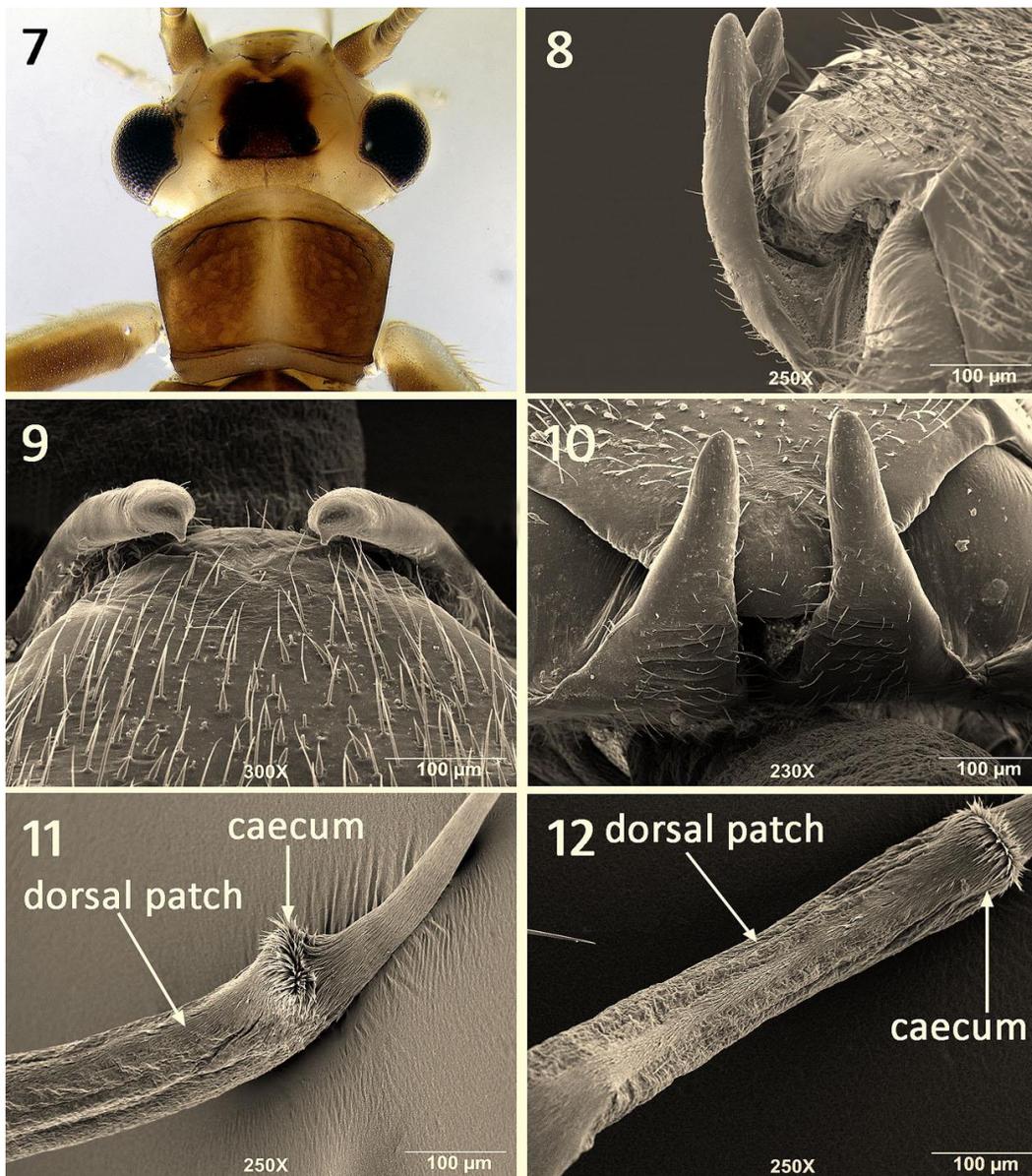
Remarks. The eggs appear different from all other species of eastern Nearctic *Perlesta*. A brief description was provided here in hope that females can be associated with males at some point in the future. These eggs may pertain to one of three *Perlesta* species whose eggs are unknown and found along the Atlantic Coastal Plain region of Virginia and North Carolina: *P. beatyi* Kondratieff, Zuellig & Lenat, 2011, *P. bjostadi* Kondratieff & Kirchner, 2006, and *P. durfeeii* Kondratieff, Zuellig & Kirchner, 2008. The egg of *P. leathermani* Kondratieff & Zuellig, 2006 also has a small, “button-like” collar (their Fig. 8.). The light head pigmentation of MD-5 (Figs. 1–2), however, appears different from the darker *P. leathermani* (Kondratieff et al. 2006, their Fig. 1).

New state records

Neoperla catharae Stark & Baumann, 1978 is known from several central and eastern US states (DeWalt et al. 2018). The new records are near the eastern end of this species range.

Perlesta mihucorum Kondratieff & Myers, 2011 was described from upstate New York and has been collected from large streams and small rivers. This is a common species across the panhandle region of western Maryland plus one additional record in the upper Piedmont region.

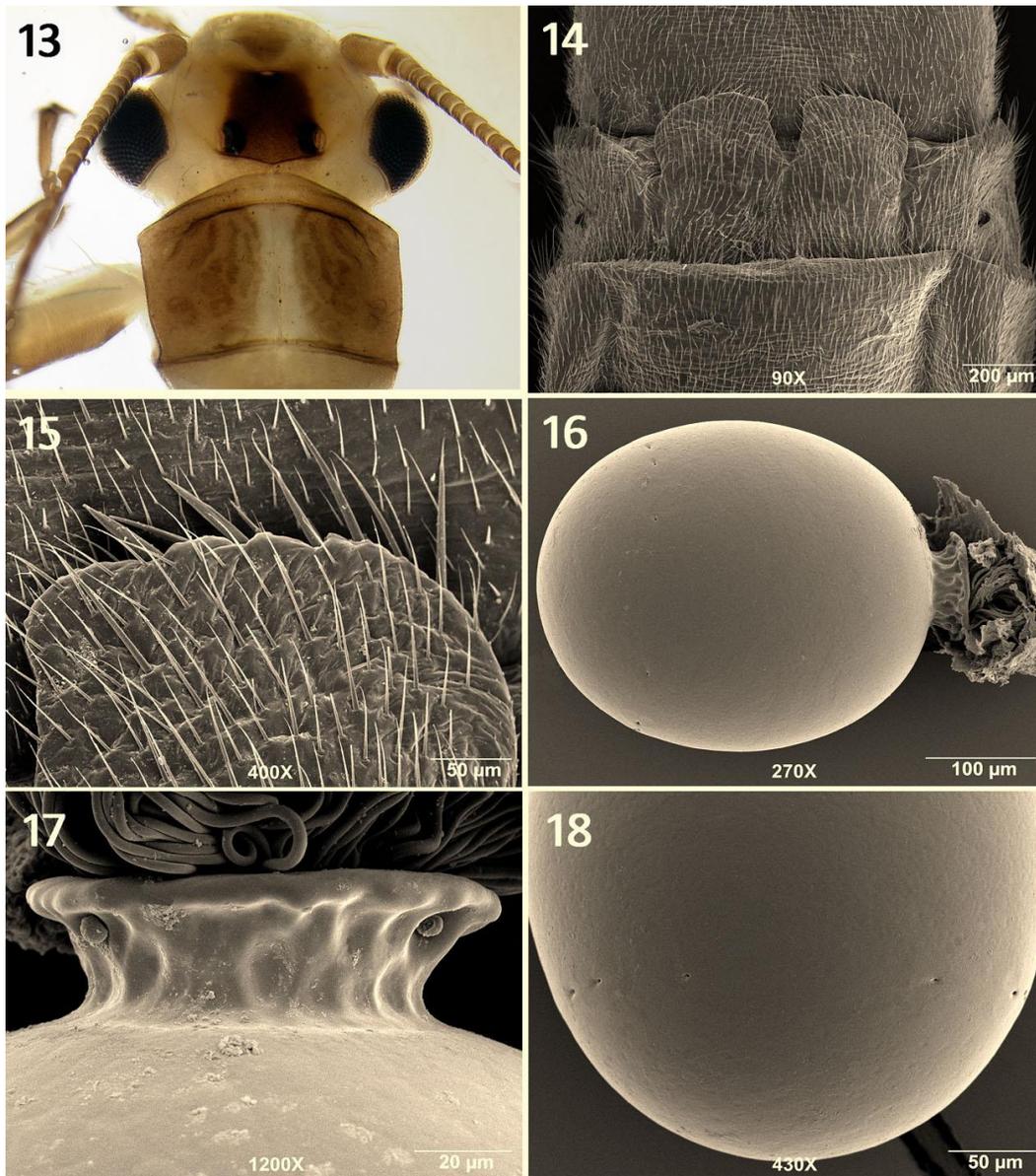
Remarks. Males of *P. mihucorum* are readily identified by the combination of paraprocts with subapical tooth mostly anteriorly-directed and not visible in caudal view (Figs. 8–10) and aedeagus with small caecum ca. as long as wide and narrow dorsal patch (Figs. 11–12). Males from Maryland and West Virginia examined in this study were keyed to couplet 12 in Stark (2004), mainly because of the first choice in couplet 10 (“Paraproct spine distinct in lateral aspect”). This is in contrast to Kondratieff & Myers (2011), who illustrated (their Fig. 4) and stated “...tooth inconspicuous in lateral view”. This initially led this author to conclude



Figs. 7–12. *Perlesta mihucorum*, male, Maryland, Conococheague Creek; 7, head + pronotum, dorsal profile; 8, paraprocts, lateral view, 250X; 9, paraprocts, dorsal view, 300X; 10, paraprocts, caudal view, 230X; 11, aedeagus, dorsolateral view, 250X; 12, aedeagus, dorsal view, 250X.

that the Maryland and West Virginia specimens represented an undescribed species. However, paraproct tooth aspect is herein considered interspecific variability, especially since characteristics of the male caecum, female subgenital plate, and egg align well with the definition of *P. mihucorum* from New York.

Regarding females, this is the only species of *Perlesta* with the combination of a subgenital plate with well-developed lobes and deep v-shaped notch (Fig. 14–15) and egg with a smooth chorion and a wide collar that is distinctly stalked, ribbed, and flanged apically (Figs. 16–18). Both males and females have prominent pale yellow median bands



Figs. 13–18. *Perlesta mihucorum*, Maryland, Conococheague Creek; 13, female, head + pronotum, dorsal profile; 14, female, subgenital plate, ventral view, 90X; 15, female, subgenital plate, details of left lobe, ventral view, 400X; 16, entire egg, 270X; 17, egg, posterior pole and collar, 1200X; 18, egg, anterior pole and micropyles, 430X.

on the pronotum (Figs. 7, 13). The eggs shown with SEM appear inseparable as in Kondratieff & Myers 2011 (their Figs. 9–14).

The known disparate ranges of *P. mihucorum* as reported from New York (Kondratieff & Myers 2011) and herein from Maryland and West Virginia

(Fig. 19) are due to incomplete understanding of the distribution of this species. The new state records were unexpected yet not completely surprising considering how little is still known about *Perlesta* taxonomy and biogeography. Examination of material from the adjacent or intervening states of

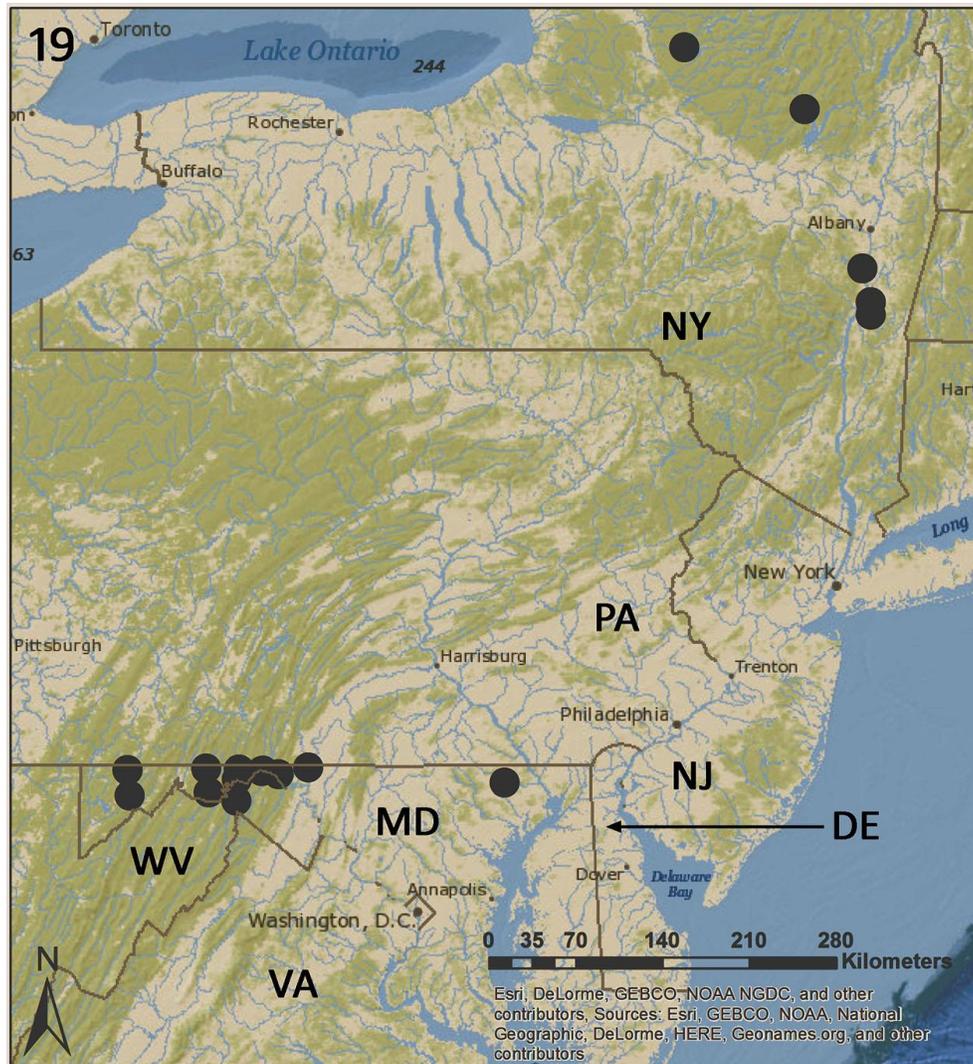
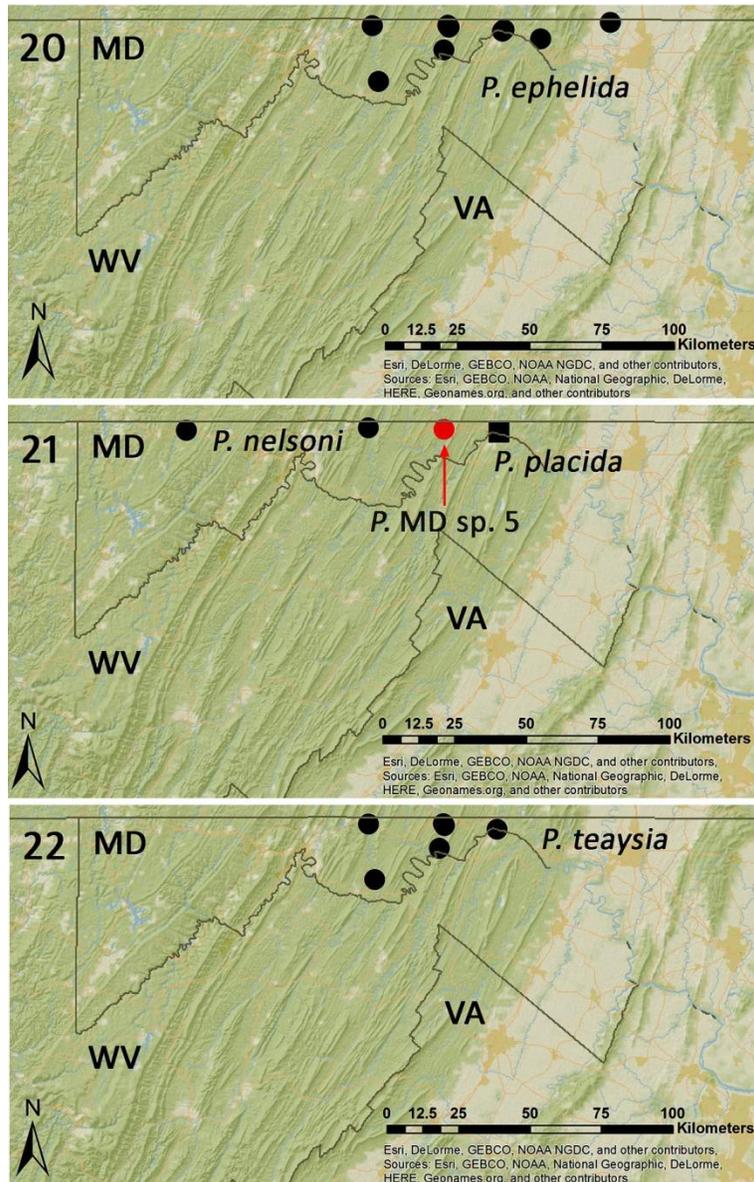


Fig. 19. Distribution map of *Perlesta mihucorum* in eastern North America. The New York localities were plotted using the coordinates provided in Kondratieff & Myers (2011).

Delaware, New Jersey, and Pennsylvania should enhance understanding of the distribution of this species. This species is also probably in northern Virginia, more widespread in West Virginia, and likely present in several New England states. Six species of *Perlesta* in total, including the three females conditionally determined as MD-5, are now known from Maryland. All six species are distributed in the small Appalachian region of western Maryland (Figs. 19–22).

Cultus verticalis (Banks, 1920) is a widespread Appalachian species known from Georgia northeastward to New Hampshire and Quebec (DeWalt et al. 2018). The females reported here were gravid and eggs of *C. verticalis* are distinct from *C. decisus* (Walker, 1852) (Kondratieff 2004). This state record is not surprising.



Figs. 20–22. Distribution maps of five *Perlesta* species in western Maryland, USA, based on material examined during this study. 20, *P. ephelida*; 21, *P. nelsoni*, *P. placida*, and *P. MD sp. 5*; 22, *P. teaysia*. MD = Maryland, VA = Virginia, WV = West Virginia.

Species emendations and updates

Sweltsa hoffmani Kondratieff & Kirchner, 2009 and *Sweltsa onkos* (Ricker, 1936).

A total of 59 vials of material collected and determined as *S. onkos* by the first author in the 1990s from western Maryland were reexamined. Specimens of 55 vials, all from the Appalachian Plateau and Ridge and Valley Physiographic

Provinces, now pertain to *S. hoffmani* (Fig. 23). Only three series from the Blue Ridge Physiographic Province (Frederick Co.) are of *S. onkos* (Fig. 23). Kondratieff & Kirchner (2009, their pp. 297) likewise listed a single series of *S. onkos* from Frederick County (Fig. 23). The *S. onkos* collections presented in Duffield & Nelson (1990, their Fig. 1) may also refer to “true” *S. onkos*.

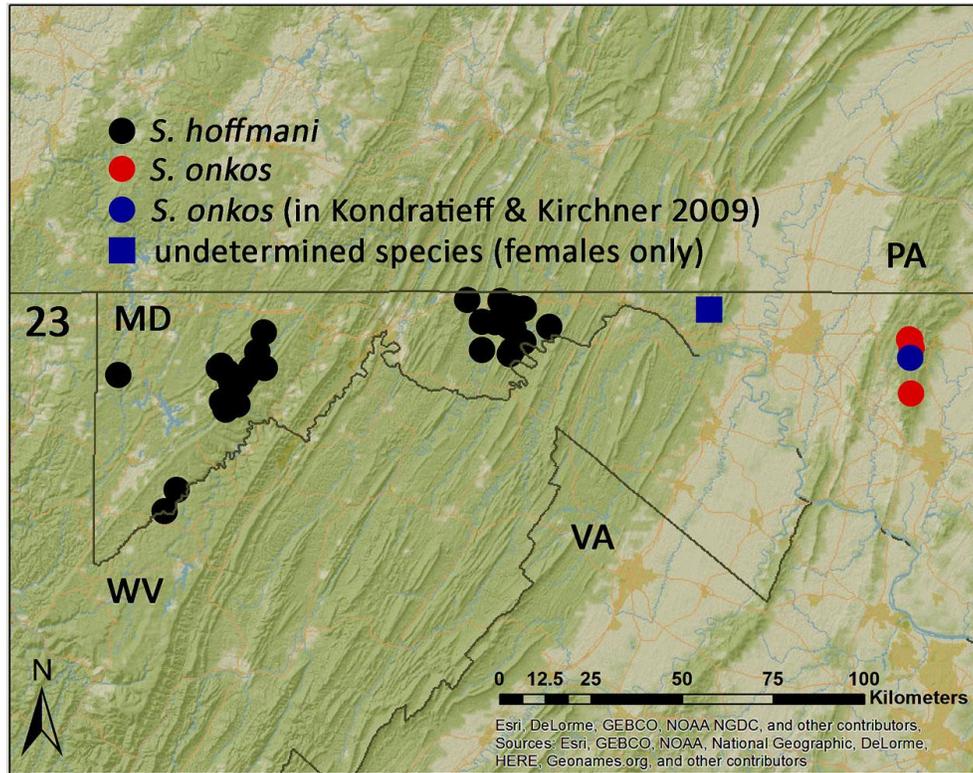


Fig. 23. Distribution map of *Sweltsa hoffmani* and *S. onkos* in western Maryland, USA, based on material examined during this study plus one record in Kondratieff & Kirchner (2009). MD = Maryland, PA = Pennsylvania, VA = Virginia, WV = West Virginia.

Isoperla Banks, 1906

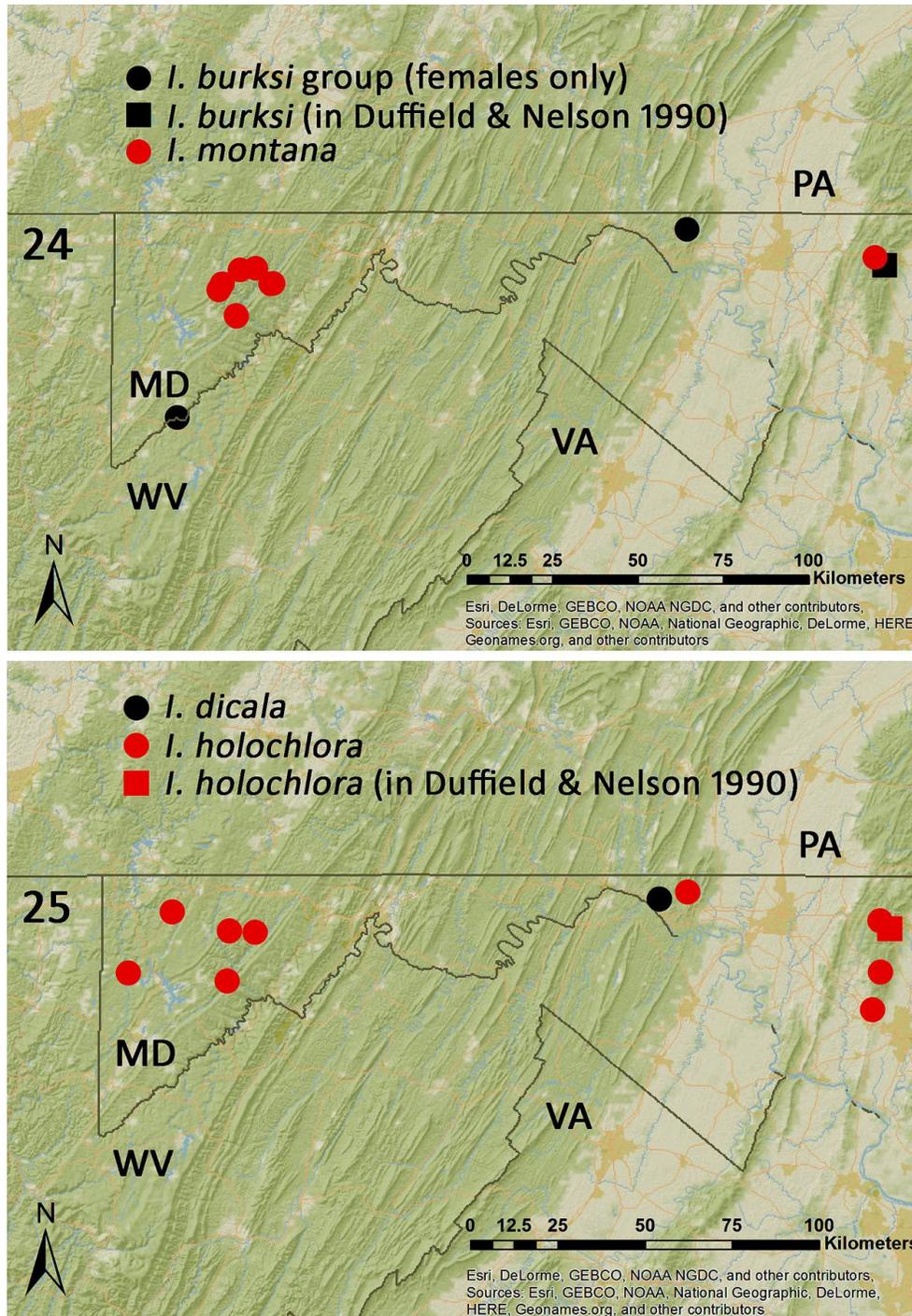
The eastern Nearctic species of *Isoperla* were revised by Szczytko & Kondratieff (2015), resulting in 22 new species descriptions, revised species definitions, and several new state records. Consequently, all *Isoperla* species listed from Maryland by Duffield & Nelson (1990) and Grubbs (1997) require clarification and updates.

Isoperla burksi Frison, 1942 was reported from Maryland by Duffield & Nelson (1990) (Fig. 24). The author has not collected males of this species from western Maryland, although undetermined females that may refer to either *I. burksi* or *I. orata* Frison, 1942 have been found at two localities (Fig. 24). Males with extruded aedeagi or females with mature eggs are needed for positive determination.

Isoperla dicala Frison, 1942 was reported from Maryland by Grubbs (2003) but not included as occurring in the state by Szczytko & Kondratieff (2015). The small series reported in Grubbs (2003) from one location (Fig. 23) were determined as *I. dicala* by Dr. Szczytko ca. 15 years ago.

Isoperla gibbsae Harper, 1971 was reported from Maryland in Duffield & Nelson (1990) (Fig. 26) but not included as occurring in the state by Szczytko & Kondratieff (2015). This species is retained in the Maryland state list pending verification. Szczytko & Kondratieff (2015) similarly noted that the West Virginia record of *I. gibbsae* (Kirchner 1978) requires verification.

Isoperla holochlora Klapálek, 1923 was reported from Maryland by Duffield & Nelson (1990) (Fig. 25).



Figs 24–25. Distribution map of four *Isoperla* species in western Maryland, USA, based on material examined during this study plus records in Duffield & Nelson (1990) and Szczytko & Kondratieff (2015). 24, *I. burksi* and *I. montana*; 25, *I. dicala* and *I. holochlora*. MD = Maryland, PA = Pennsylvania, VA = Virginia, WV = West Virginia.

This species was included by Szczytko & Kondratieff (2015) from the state. The author collected this Appalachian species from western Maryland from several localities during 1995–1997 (Fig. 25).

***Isoperla kirchneri* Szczytko & Kondratieff, 2015** was described from Virginia and is currently known from New York south to North Carolina and Tennessee (DeWalt et al. 2018). The presence of this species in western Maryland is not surprising (Fig. 26). The specimens reported as *I. namata* Frison, 1942 by Grubbs (1997) were identified using Szczytko & Kondratieff (2015) and all now refer to *I. kirchneri*. *Isoperla namata* is herein removed from the Maryland state list.

***Isoperla montana* (Banks, 1898)** was reported from Maryland by Grubbs (1997) and subsequently listed by Szczytko & Kondratieff (2015) as occurring in the state. The author presents several additional localities in western Maryland (Fig. 24).

***Isoperla pseudosimilis* Szczytko & Kondratieff 2015** was described from upstate New York and is currently known from the New England states south to North Carolina and Tennessee (DeWalt et al. 2018). This montane species was likewise expected from Maryland and all material determined by the author in the mid-1990s as *I. similis* (Hagen, 1861) were newly determined as *I. pseudosimilis* using Szczytko & Kondratieff (2015) (Fig. 27).

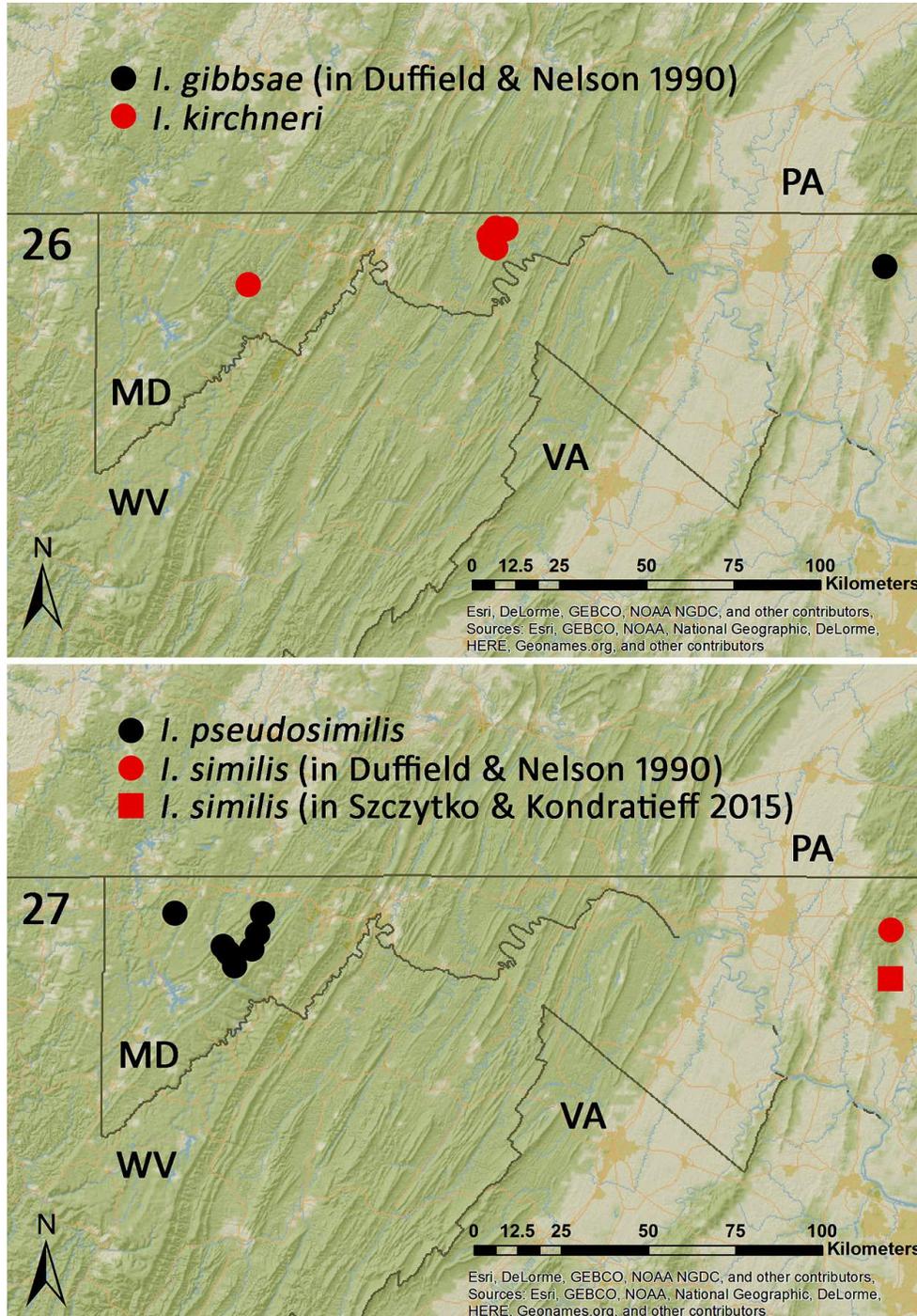
***Isoperla similis* (Hagen, 1861)** was reported from Maryland by Duffield & Nelson (1990) (Fig. 27). This species has since been redefined by Szczytko & Kondratieff (2015) and is now considered a species found mainly along the Piedmont and Atlantic Coastal Plain regions. Szczytko & Kondratieff (2015) included *I. similis* from Maryland based on a single female from the Blue Ridge Physiographic Province (Fig. 27).

DISCUSSION

Although smaller in total land area, the updated species total (n = 114, Table 1) reported here for

Maryland is comparable to that of Alabama (107 species, Grubbs 2011) and Georgia (100 species, Verdone et al. 2017). Maryland is the 9th smallest state in the US with only 21% and 24% of land area compared to Alabama and Georgia, respectively. Furthermore, at least 111 of the 114 species (= 97%) have been collected from the four western panhandle counties (Garrett, Allegany, Washington, and Frederick) that traverse the Appalachian Mountain region of the state. This high proportion suggests that habitat availability and quality is still sufficient to support a diverse regional species pool. Elevations in the Appalachian Plateau, Ridge and Valley, and Blue Ridge Physiographic Provinces in western Maryland range from ca. 60 m (= ca. 200 ft) at the Potomac River to 1024 m (= 3360 ft) on Backbone Mountain. The western panhandle is also sparsely populated compared to central and eastern portions of the state and is home to several protected areas. Notable examples include Savage River State Forest (220 km², Garrett Co.), Green River State Forest (192 km², Allegany Co.), and Catoclin Mountain Park, a National Park Service unit in Frederick Co. (25 km²). There are also several additional state forests, state parks, and wildlife management areas distributed across these four counties. By comparison, there is markedly less surface relief in the Piedmont and Coastal Plain Provinces within the eastern Maryland, ranging from sea level to only 391 m (= 1282 ft) at the summit of Sugarloaf Mountain. This region of the state is also more densely populated.

What is lacking is a broader understanding about statewide distribution patterns of stoneflies across Maryland. For example, how many species with Appalachian distributions are found eastward into the Piedmont region? How many species are restricted in the Coastal Plain region? These questions, and several more, can be addressed following a comprehensive examination of material housed in museums and private collections, a summary of the valid literature, and focused collection efforts in the areas of the state either lightly sampled or supporting species clusters indicative of important biological diversity.



Figs. 26–27. Distribution map of four *Isoperla* species in western Maryland, USA, based on material examined during this study plus records in Duffield & Nelson (1990) and Szczytko & Kondratieff (2015). 26, *I. gibbsae* and *I. kirchneri*; 27, *I. pseudosimilis* and *I. similis*. MD = Maryland, PA = Pennsylvania, VA = Virginia, WV = West Virginia.

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Table 1. List of Maryland stoneflies. New and emended records are marked by an asterisk (*)

Family Capniidae

- Allocapnia aurora* Ricker, 1952
- Allocapnia curiosa* Frison, 1942
- Allocapnia frisoni* Ricker & Ross, 1964
- Allocapnia frumi* Kirchner, 1982
- Allocapnia granulata* (Claassen, 1924)
- Allocapnia harperi* Kirchner, 1980
- Allocapnia illinoensis* Frison, 1935
- Allocapnia maria* Hanson, 1942
- Allocapnia nivicola* (Fitch, 1847)
- Allocapnia pygmaea* (Burmeister, 1839)
- Allocapnia recta* (Claassen, 1924)
- Allocapnia rickeri* Frison, 1942
- Allocapnia vivipara* (Claassen, 1924)
- Allocapnia wrayi* Ross, 1964
- Allocapnia zola* Ricker, 1952
- Paracapnia angulata* Hanson, 1961

Family Leuctridae

Subfamily Leuctrinae

- Leuctra alexanderi* Hanson, 1941
- Leuctra carolinensis* Claassen, 1923
- Leuctra duplicata* Claassen, 1923
- Leuctra ferruginea* (Walker, 1852)
- Leuctra grandis* Banks, 1906
- Leuctra rickeri* James, 1976
- Leuctra sibleyi* Claassen, 1923
- Leuctra tenella* Provancher, 1878
- Leuctra tenuis* (Pictet, 1841)
- Leuctra variabilis* Hanson, 1941
- Paraleuctra sara* (Claassen, 1937)

Subfamily Megaleuctrinae

- Megaleuctra flinti* Baumann, 1973

Family Nemouridae

Subfamily Amphinemurinae

- Amphinemura delosa* (Ricker, 1952)
- Amphinemura nigriflora* (Provancher, 1876)
- Amphinemura wui* (Claassen, 1936)

Subfamily Nemourinae

- Ostrocerca albidipennis* (Walker, 1852)
- Ostrocerca complexa* (Claassen, 1937)
- Ostrocerca truncata* (Claassen, 1923)
- Paranemoura perfecta* (Walker, 1852)
- Prostoia completa* (Walker, 1852)
- Prostoia similis* (Hagen, 1861)
- Shipsa rotunda* (Claassen, 1923)
- Soyedina carolinensis* (Claassen, 1923)
- Soyedina kondratieffi* Baumann & Grubbs, 1996
- Soyedina vallicularia* (Wu, 1923)
- Soyedina washingtoni* (Claassen, 1923)

Family Taeniopterygidae

Subfamily Brachypterainae

- Oemopteryx contorta* (Needham & Claassen, 1925)
- Strophopteryx appalachia* Ricker & Ross, 1975
- Strophopteryx fasciata* (Burmeister, 1839)
- Taenionema atlanticum* Ricker & Ross, 1975

Subfamily Taeniopteryginae

- Taeniopteryx burksi* Ricker & Ross, 1968
- Taeniopteryx lonicera* Ricker & Ross, 1968
- Taeniopteryx maura* (Pictet, 1841)
- Taeniopteryx metequi* Ricker & Ross, 1968
- Taeniopteryx nivalis* Fitch, 1847
- Taeniopteryx parvula* Banks, 1918
- Taeniopteryx ugola* Ricker & Ross, 1968

Family Chloroperlidae

Subfamily Chloroperlinae

- Alloperla aracoma* Harper & Kirchner, 1978
- Alloperla atlantica* Baumann, 1974
- Alloperla biserrata* Nelson & Kondratieff, 1980
- Alloperla chloris* Frison, 1934
- Alloperla imbecilla* (Say, 1823)
- Alloperla usa* Ricker, 1952
- Haploperla brevis* (Banks, 1895)
- Suwallia marginata* (Banks, 1897)
- **Sweltsa hoffmani* Kondratieff & Kirchner, 2009
- Sweltsa lateralis* (Banks, 1911)
- **Sweltsa onkos* (Ricker, 1936)
- Sweltsa palearata* Surdick, 2004
- Sweltsa pocahontas* Kirchner & Kondratieff, 1988

Subfamily Paraperlinae

- Utaperla gaspesiana* Harper & Roy, 1975

Family Perlidae

Subfamily Acroneuriinae

- Acroneuria abnormis* (Newman, 1838)
- Acroneuria arenosa* (Pictet, 1841)
- Acroneuria carolinensis* (Banks, 1905)
- Acroneuria filicis* Frison, 1942
- Acroneuria frisoni* Stark & Brown, 1991
- Acroneuria lycorias* (Newman, 1839)
- Attaneuria ruralis* (Hagen, 1861)
- Eccoptura xanthenes* (Newman, 1838)
- Hansonoperla appalachia* Nelson, 1979
- Perlesta ephelida* Grubbs & DeWalt, 2012
- **Perlesta mihucorum* Kondratieff & Myers, 2011
- Perlesta nelsoni* Stark, 1989
- Perlesta placida* (Hagen, 1861)
- Perlesta teaysia* Kirchner & Kondratieff, 1997
- **Perlesta* sp. M-5
- Perlinella drymo* (Newman, 1839)
- Perlinella ephyre* (Newman, 1839)

Subfamily Perlinae

- Agnentina annulipes* (Hagen, 1861)
- Agnentina capitata* (Pictet, 1841)
- Agnentina flavescens* (Walsh, 1862)
- **Neoperla catharae* Stark & Baumann, 1978
- Neoperla robisoni* Poulton & Stewart, 1986
- Neoperla stewarti* Stark & Baumann, 1978
- Paragnetina immarginata* (Say, 1823)
- Paragnetina media* (Walker, 1852)

Family Perlodidae

Subfamily Isoperlinae

- Clioperla clio* (Newman, 1839)
- Isoperla burksi* Frison, 1942
- Isoperla dicala* Frison, 1942
- Isoperla gibbsae* Harper, 1971
- Isoperla holochlora* Klapálek, 1923
- **Isoperla kirchneri* Szczytko & Kondratieff, 2015
- Isoperla montana* (Banks, 1898)
- **Isoperla pseudosimilis* Szczytko & Kondratieff, 2015
- **Isoperla similis* (Hagen, 1861)

Subfamily Perlodinae

- **Cultus verticalis* (Banks, 1920)
- Diploperla duplicata* (Banks, 1920)
- Diploperla robusta* Stark & Gaufin, 1974
- Isogenoides hansonii* (Ricker, 1952)
- Malirekus iroquois* Stark & Szczytko, 1988
- Remenus bilobatus* (Needham & Claassen, 1925)

Yugus kirchneri Nelson, 2001

Family Peltoperlidae

Peltoperla arcuata Needham, 1905

Tallaperla elisa Stark, 1983

Tallaperla maria (Needham & Smith, 1916)

Family Pteronarcyidae

Pteronarcys biloba Newman, 1838

Pteronarcys dorsata (Say, 1823)

Pteronarcys proteus Newman, 1838

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