Grubbs, Scott A. 2016. Taxonomic notes on the eggs of eastern Nearctic *Isoperla* (Plecoptera: Perlodidae: Isoperlinae). *Illiesia,* 12(08):35-41. Available online: http://illiesia.speciesfile.org/papers/Illiesia12-08.pdf

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TAXONOMIC NOTES ON THE EGGS OF EASTERN NEARCTIC *ISOPERLA* (PLECOPTERA: PERLODIDAE: ISOPERLINAE)

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ABSTRACT

The eggs of *Isoperla burksi* Frison, 1942 and *I. sandbergi* Szczytko and Kondratieff, 2015 are described and illustrated with scanning electron microscopy for the first time. *Isoperla montana* (Banks, 1898) and *I. zuelligi* Szczytko and Kondratieff, 2015 are reported from Alabama for the first time and additional scanning micrographs are presented for *I. zuelligei*.

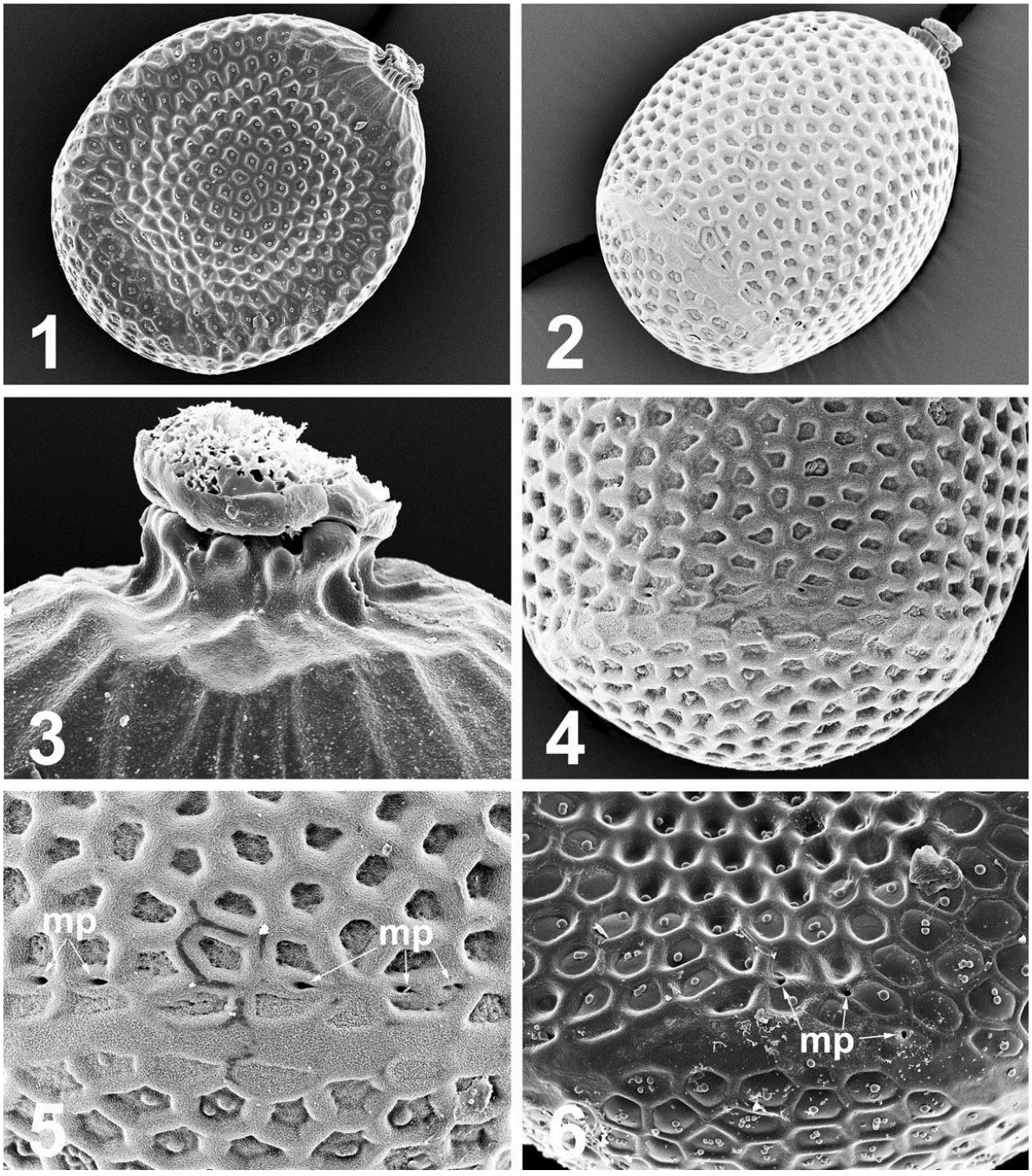
Keywords: Plecoptera, Perlodidae, *Isoperla*, Nearctic, eggs

INTRODUCTION

The use of scanning electron microscopy (SEM) by stonefly workers starting in the 1970s provided a novel opportunity to study fine chorionic features of eggs that were only incompletely seen with standard light microscopy (e.g., Hynes 1941, Knight et al. 1965). Since that time, eggs have been described and illustrated with SEM for a high proportion of Nearctic Perlodidae and often provide more diagnostic value than the associated female. The eggs of 42 of 61 (=69%) eastern Nearctic species of Isoperlinae have been described and illustrated with SEM (Szczytko & Kondratieff 2015). In this paper the eggs of *Isoperla burksi* Frison, 1942 and *I. sandbergi* Szczytko and Kondratieff, 2015 are described and illustrated with SEM for the first time. In addition, *I. montana* (Banks, 1898) and *I. zuelligi* Szczytko and Kondratieff, 2015 are reported from Alabama for the first time based largely on SEM analyses of mature eggs. SEM images of eggs of *I. zuelligi* are provided herein.

METHODS

All *Isoperla* eggs examined in this study were obtained from specimens deposited at Western Kentucky University, Bowling Green, Kentucky (WKUC). Other specimens studied were those from the Illinois Natural History Survey, Champaign, Illinois (INHS), Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZC), and United States National Museum, Washington, D.C. (USNM). Eggs for SEM analyses were dehydrated through a series of 95% and 100% ethanol for 10 minutes each and placed in hexamethyldisilizane for 30 minutes. Dehydrated eggs were attached to aluminum stubs with double-stick tape and coated with gold-palladium using an Emscope SC500. Eggs were examined using a Jeol JSM-6510LV scanning electron microscope and digital images were captured with an IXRF system. Terminology followed that of Szczytko & Kondratieff (2015).



Figs. 1–6. *Isoperla burksi*. 1–5, Indiana, Little Salt Creek; 6, Kentucky, Big Brush Creek. 1, egg, concave profile, 300X; 2, egg, convex profile, 300X; 3, egg, details of collar, 500X; 4, egg, anterior half, 500X; 5, egg, details of eclosion line and micropyles, 900X; 6, egg, details of eclosion line and micropyles, 750X. mp = micropyles.

RESULTS AND DISCUSSION

Isoperla burksi Frison, 1942
Banded Stripetail
(Figs. 1–6)

http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:468714

Isoperla burksi Frison, 1942:332. Holotype ♂ (INHS), Lusk Creek, Eddyville, Pope Co., Illinois
Isoperla burksi: Illies 1966:392, 397.
Isoperla burksi: Poulton & Stewart 1991:47.
Isoperla burksi: Szczytko & Kondratieff 2015:52.

Egg. General shape oblong, cross-section concave (Figs. 1–2), anterior and posterior poles broadly-rounded (Figs. 2–4). Color pale brown. Collar well-developed, with irregular longitudinal ridges, slightly flared apically (Fig. 3). Follicle cell impressions near collar ranging from elongate to hexagonal (Figs. 1, 3). Chorion covered mostly with irregular-shaped pentagonal or hexagonal follicle cell impressions with thickened elevated ridges (Figs. 4–6); floors with numerous shallow pits (Fig. 5–6). Eclosion line present (Figs. 4–6). Micropyles located along ridges near eclosion line in anterior ¼ (Figs. 5–6).

Material examined. **Alabama**, DeKalb Co., South Sauty Creek, 6 km N Rainsville, 34.5484, -85.8543, 7 May 2008, S.A. Grubbs, ♂, ♀ (WKUC). **Indiana**, Jackson Co., Little Salt Creek, 7 km NNW Freetown, 39.0375, -86.1494, 25 May 2002, S.A. Grubbs, 2♀ (WKUC). **Kentucky**, Edmonson Co., Bear Creek, 3 km NW Bee Spring, 37.3029, -86.3204, 6 May 2013, S.A. Grubbs, ♀ (WKUC); Green Co., Big Brush Creek, Bloyd, 37.4049, -85.5758, 27 April 2002, S.A. Grubbs, ♀ (WKUC).

Distribution. USA: AL, AR, IL, IN, KY, MD, MO, NC, SC, NJ, OH, OK, SC, VA, WV (DeWalt et al. 2016).

Diagnosis. Szczytko & Kondratieff (2015) placed this species in the *I. burksi* group with *I. cotta* Ricker, 1952 and *I. orata* Frison, 1942. Egg characteristics uniting these species include a concave cross-section, well-developed collar, distinct ridges offsetting the cell impressions, and lack of an eclosion line (Szczytko & Kondratieff 2015). Eggs of *I. burksi* from Indiana and Kentucky, however, possess a distinct eclosion line (Figs. 4–6) that easily distinguishes this species from *I. cotta* (Szczytko & Kondratieff 2015, figs. 10.14, 10.18) and *I. orata* (Szczytko & Kondratieff 2015, figs. 37.9, 37.12). Each of the other three characteristics listed above are exhibited by *I. burksi*.

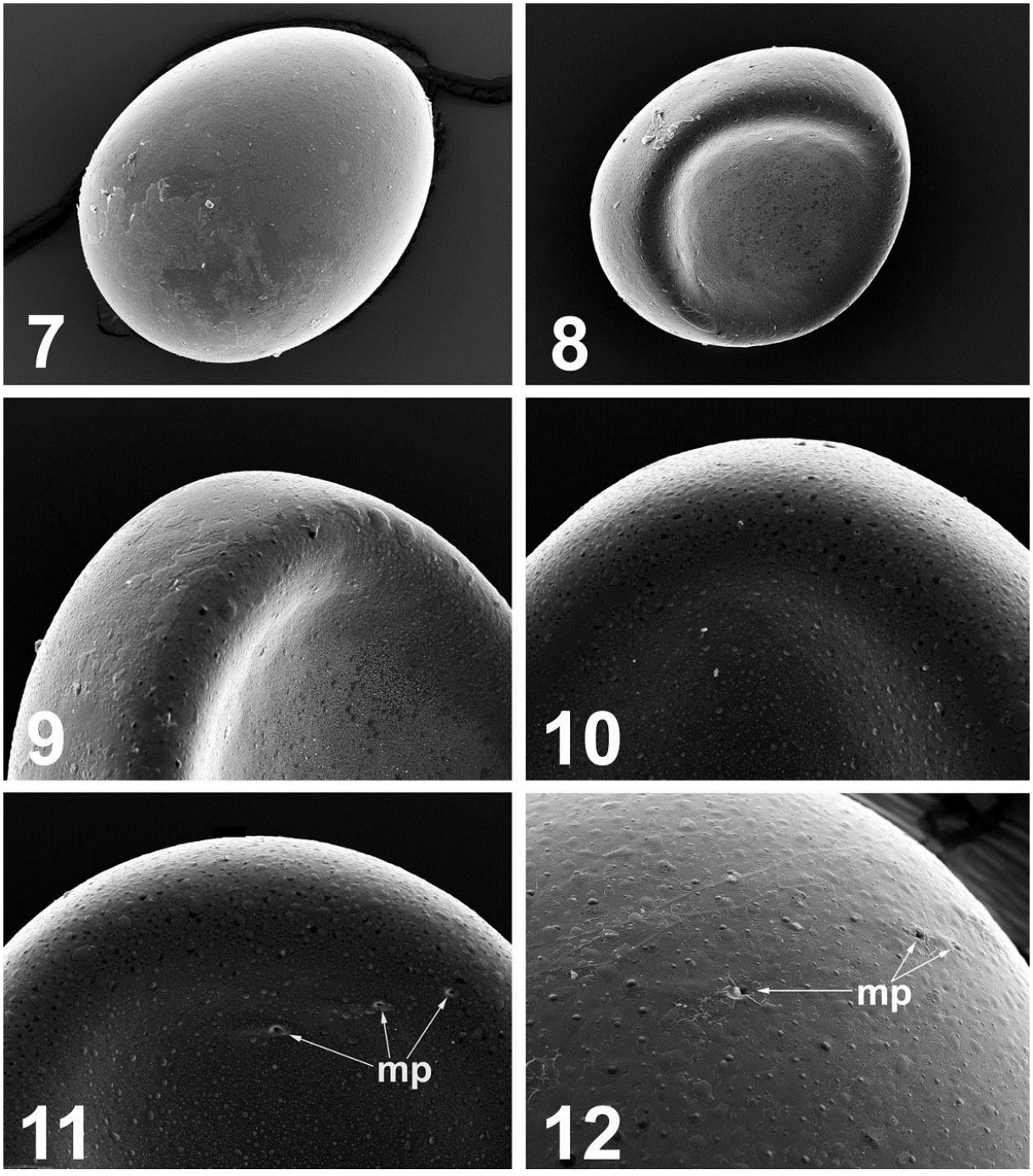
Isoperla montana (Banks, 1898)
Montane Stripetail

http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:468740

Chloroperla montana Banks, 1898:199. Holotype ♂ (MCZC), Mount Washington, (Coos Co.), New Hampshire
Isoperla montana: Banks 1906:175.
Isoperla montana: Illies 1966:410.
Isoperla montana: Zwick 1973:247, 293.
Isoperla montana: Szczytko & Kondratieff 2015:155.

Material examined. Alabama, Clay Co., tributary to Cheaha Creek, 33.4401, -85.8382, 8 April 2008, A.L. Sheldon, 1♀ (WKUC); Enitachopco Creek, 9 km ESE Millersville, 33.1600, -85.8351, 8 April 2010, S.A. Grubbs, 1♂, 2♀ (WKUC); Tallaseehatchie Creek, 13 km ENE Sylacauga, 33.2058, -86.1194, 8 April 2010, S.A. Grubbs, 1♀ (WKUC); tributary to Tallaseehatchie Creek, 33.1912, -86.1018, 9 April 2012, A.L. Sheldon, 1♀ (WKUC); same but 18 May 2012, A.L. Sheldon, 2♀ (WKUC); Mill Shoals Creek, 33.4197, -85.8071, 11 April 2012, A.L. Sheldon, 1♀ (WKUC); tributary to Tallaseehatchie Creek, 33.1858, -86.0989, 18 May 2012, A.L. Sheldon, 1♀ (WKUC); tributary to Tallaseehatchie Creek, 33.1864, -86.0982, 18 May 2012, A.L. Sheldon, 1♀ (WKUC); Cleburne Co., Shoal Creek, 33.7249, -85.6007, 9 April 2008, A.L. Sheldon, 1♂ (WKUC); tributary to Shoal Creek, 33.7255, -85.6008, 13 April 2012, S.A. Grubbs, 1♀ (WKUC); Talladega Co., Dry Creek, 33.3715, -86.0926, 7 April 2008, A.L. Sheldon, 2♂, 2♀ (WKUC).

Distribution. **Canada**: NS, ON, PQ. **USA**: CT, DE, IN, KY, ME, MN, NC, NH, NJ, NY, OH, PA, SC, VA, WV (DeWalt et al. 2016), AL (new state record).



Figs. 7–12. *Isoperla sandbergi*. Alabama, spring into Cottaquilla Creek. 7, egg, convex profile, 370X; 8, egg, concave profile, 330X; 9, egg, posterior pole, concave profile, 700X; 10, egg, anterior pole, concave profile, 1000X; 11, egg, anterior pole, concave profile, details of micropyles, 900X; 12, egg, anterior pole, convex profile, details of micropyles, 1400X. mp = micropyles.

Comments. *Isoperla montana* is distributed broadly along the Appalachian Mountains west to Indiana and Minnesota (Szczytko & Kondratieff 2015). The Talladega Mountain region in eastern Alabama marks the known southern limit of the distribution of this common species.

Isoperla sandbergi Szczytko and Kondratieff, 2015

Cheaha Stripetail
(Figs. 7–12)

http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:468960

Isoperla sandbergi Szczytko & Kondratieff, 2015:229. Holotype ♂ (USNM), Dry Creek, above Cheaha Lake, Cheaha State Park, Cleburne Co., Alabama

Egg. General shape oblong, cross-section concave (Figs. 7–8); anterior and posterior poles broadly-rounded (Figs. 9–10). Color pale yellow. Collar absent (Fig. 9). Hexagonal follicle cell impressions not visible; chorionic surface covered with small pits; eclosion line absent; micropyles with thickened openings, arranged in a row of 3 near anterior 1/3 of egg (Figs. 11–12).

Material examined. **Alabama**, Calhoun Co., spring into Cottaquilla Creek, 33.7656, -85.7166, 9 April 2010, S.A. Grubbs, 10♂, 8♀ (WKUC); same but 7 March 2012, S.A. Grubbs, 1♂ (WKUC); Jones Branch, 33.8570, -85.6187, 13 April 2012, A.L. Sheldon, 2♂, 1♀ (WKUC); Jones Branch, 33.8454, -85.6273, 13 April 2012, A.L. Sheldon, 1♂, 2♀ (WKUC); tributary to Jones Branch, 33.8457, -85.6280, 13 April 2012, A.L. Sheldon, 1♀ (WKUC); tributary to Jones Branch, 33.8572, -85.6184, 13 April 2012, A.L. Sheldon, 1♀ (WKUC); Clay Co., tributary to West Fork Hatchett Creek, 33.2945, -86.0615, 8 May 2005, A.L. Sheldon, 2♂, 1♀ (WKUC); tributary to Talladega Creek, 33.3971, -85.8653, 9 May 2005, A.L. Sheldon, 1♂ (WKUC); Talladega Creek, 33.4023, -85.8572; 9 May 2005, A.L. Sheldon, 3♂, 1♀ (WKUC); same but 8 April 2008, A.L. Sheldon, 5♂, 10♀ (WKUC); Talladega Creek, 33.4061, -85.8502; 9 May 2005, A.L. Sheldon, 1♂, 1♀ (WKUC); same but 8 April 2008, A.L. Sheldon, 3♂ (WKUC); tributary to Talladega Creek, 33.4009, -85.8559, 9 May 2005, A.L. Sheldon, 1♂ (WKUC); tributary to Cheaha Creek, 33.4065, -85.8496, 8 April 2008, A.L. Sheldon, 1♂, 1♀ (WKUC); tributary to Cheaha Creek, 33.4401, -85.8382, 8 April 2008, A.L. Sheldon, 4♂, 6♀ (WKUC); tributary to Cheaha Creek, 33.4402, -85.8328, 12 April 2012, A.L. Sheldon, 1♂ (WKUC); tributary to Cheaha Creek, 33.4398, -85.8376, 12 April 2012, A.L. Sheldon, 1♂, 1♀ (WKUC); tributary to Cheaha Creek, 33.4398, -85.8389, 12 April 2012, A.L. Sheldon, 1♂ (WKUC); Cleburne Co., tributary to Terrapin Creek, 33.8775, -85.5658, 22 May 2006, A.L. Sheldon, 1♂ (WKUC); tributary to Terrapin Creek, 33.8777, -85.5700, 22 May 2006, A.L. Sheldon, 1♀ (WKUC); tributary to Terrapin Creek, 33.8784, -85.5510, 9 April 2008, A.L. Sheldon, 1♂, (WKUC).

Distribution. USA: AL (DeWalt et al. 2016).

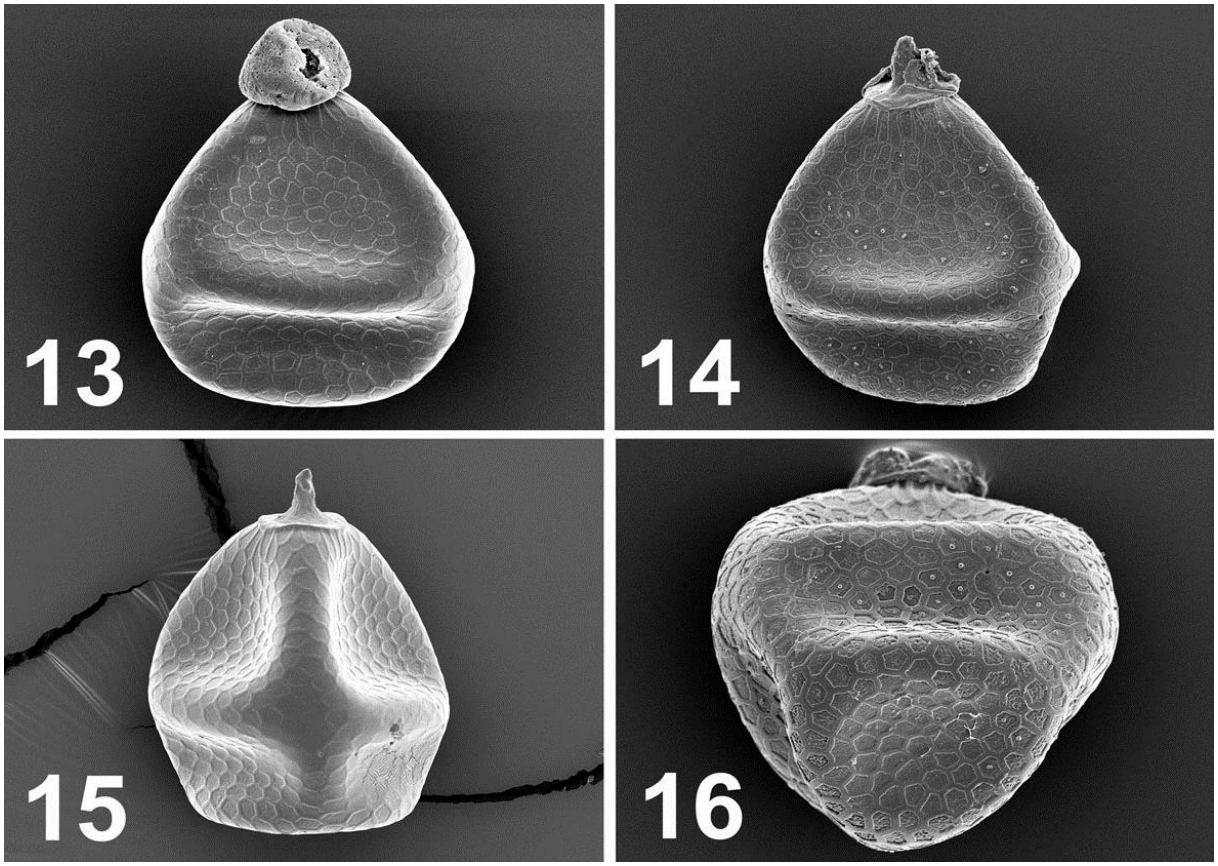
Diagnosis. Szczytko & Kondratieff (2015) placed *I. sandbergi* in the *I. similis* (Hagen, 1861) Group with *I. bellona* Banks, 1911, *I. cherokee* Szczytko and Kondratieff, 2015, *I. distincta* Nelson, 1976, *I. major* Nelson and Kondratieff, 1983, *I. similis*, and *I. starki* Szczytko and Kondratieff, 2015. The eggs of *I. bellona* and *I. distincta* remain undescribed. The combination of a concave profile and lack of a collar easily distinguishes the eggs of *I. sandbergi* from *I. cherokee*, *I. major*, *I. similis*, and *I. starki*. The eggs of *I. major* and *I. similis* are round in cross-section, possess a low raised collar, and lack a concavity (Szczytko & Kondratieff 2015, figs. 29.7, 51.15). The eggs of *I. cherokee* and *I. starki* have a concave profile but possess either a low, button-like collar (*I. cherokee*; Szczytko & Kondratieff 2015, Figs. 7.24–7.25) or a distinct, elevated collar (*I. starki*; Szczytko & Kondratieff 2015, Fig. 55.21).

Comments. This species appears to be the most common headwater *Isoperla* in the Talladega Mountain region (Sheldon & Grubbs unpublished data).

Isoperla zuelligi Szczytko and Kondratieff, 2015

Uwharrie Stripetail
(Figs. 13–16)

http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:468712



Figs. 13–16. *Isoperla zuelligi*. 13, 15, Alabama, Terrapin Creek; 14, 16, Alabama, South Sauty Creek. 13, egg, biconcave profile, 270X; 14, egg, biconcave profile, 270X; 15, egg, cross-ridged profile, 270X; 16, egg, anterior pole, 350X.

Isoperla zuelligi Szczytko & Kondratieff, 2015:277. Holotype ♂ (USNM), Barnes Creek, Ophir Road, south of Ophir, Uwharrie National Forest, Montgomery Co., North Carolina

Material examined. **Alabama**, Calhoun Co., Terrapin Creek, 4 km NE Piedmont, 33.9550, -85.5715, 17 May 2008, ♀ (WKUC); same locality but 7 April 2010, S.A. Grubbs, 5♂, 7♀ (WKUC); Clay Co., Swept Creek, 33.2591, -86.1047, 7 April 2008, A.L. Sheldon, ♂, ♀ (WKUC); Cleburne Co., Terrapin Creek, 33.8774, -85.5546, 13 April 2012, S.A. Grubbs, 2♂, 2♀ (WKUC); Coosa Co., Hatchet Creek, 6 km N Rockford, 32.9439, -86.2034, 8 April 2010, S.A. Grubbs, ♂ (WKUC); DeKalb Co., South Sauty Creek, 4 km N Rainsville, 34.5213, -85.8897, 7 May 2008, S.A. Grubbs, 2♂, 6♀ (WKUC); South Sauty Creek, 6 km N Rainsville, 34.5484, -85.8543, 7 May 2008, S.A. Grubbs, 2♀ (WKUC).

Distribution. USA: AL (new state record), NC (DeWalt et al. 2016).

Diagnosis. Egg as described in Szczytko & Kondratieff (2015, figs. 61.11–61.14) from the Uwharrie Mountains in North Carolina. In addition, the egg has a biconcave profile with a lateral ridge (Figs. 13–14) opposite of the profile with the cross-shaped ridges (Fig. 15) and the anterior pole is slightly concave (Fig. 16).

Comments. This is a new Alabama state record.

This species is common in mid-order streams draining the Talladega Mountain region. *Isoperla zuelligi* should be found in the intervening states of Georgia and South Carolina.

ACKNOWLEDGEMENTS

Andy L. Sheldon (Crawfordville, Florida) has provided an immense amount of adult *Isoperla* material from the Talladega Mountain region. John Andersland (Western Kentucky University, Bowling Green) assisted with SEM preparation.

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Submitted 13 July 2016, Accepted 24 August 2016, Published 6 September 2016

Hosted and published at the University of Illinois, Illinois Natural History Survey, Champaign, Illinois, U.S.A.

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Digitale Literatur/Digital Literature

Zeitschrift/Journal: Illiesia

Jahr/Year: 2016

Band/Volume: 12

Autor(en)/Author(s): Grubbs Scott A.

Artikel/Article: Taxonomic notes on the eggs of eastern Nearctic Isoperla (Plecoptera: Perlodidae: Isoperlinae). 35-41