



A new species of *Setodes* Rambur (Trichoptera: Leptoceridae) from northern Michigan, USA

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Abstract

Setodes truncatus n. sp. is illustrated and described herein based on specimens collected from 2 adjacent watersheds of the Huron Mountains in northern Michigan (USA). Both known populations inhabit undisturbed sandy rivers. Males of *S. truncatus* appear most similar to those of *S. incertus* (Walker) but can be separated based on their short and truncate inferior appendages and by other differences in the genitalia. The larva and female both remain unknown. A revised key to males of the 10 North American species of *Setodes* is provided.

Key words: Caddisfly, caddisflies, Upper Peninsula, Huron Mountains

Introduction

The caddisflies of the northcentral US are fairly well known. Michigan, Minnesota, and Ohio, in particular, all have undergone extensive recent faunal inventories (Armitage et al. 2011, Houghton 2012, Houghton et al. 2018). Despite this effort, however, new state records continue to be found in under-collected areas (Houghton 2020).

The genus *Setodes* Rambur comprises 344 extant species worldwide (Morse 2021), with >95% found in the eastern hemisphere (Schmid (1987). The western hemisphere fauna contains 9 described species from the eastern US (Rasmussen & Morse 2020), and 1 from the Dominican Republic (Flint & Sykora 2004). The genus appears absent from western North America as well as Central and South America (Holzenthal & Calor 2017). Holzenthal (1982) revised the genus for North America and described 2 new species. Rasmussen et al. (2008) described an additional species from northern Florida. Females of all 9 species have been described by Holzenthal (1982), Holzenthal and Harris (1985), and Rasmussen et al. (2008). Larvae of 8 species were described by Nations (1994), with a subsequent key compiled by Morse et al. (2017). The larva of the 9th species, *S. chipolanus* Rasmussen and Harris 2008 (in Rasmussen et al. 2008), remains unknown.

Two widespread species of *Setodes*: *S. incertus* (Walker 1852) and *S. oligius* (Ross 1938), are known from the northcentral US states of Michigan, Minnesota, and Wisconsin (Fig. 1). The former species is moderately common throughout forested regions of all 3 states where it can reach high abundance in undisturbed sandy-bottomed streams. The latter is less common and rarely abundant. In this paper, a new species of *Setodes* is described from 2 rivers of northern Michigan (Fig. 1).

Materials and methods

The new species was discovered during a caddisfly survey of the Huron Mountain Club, a ~6,000 ha private conservation area in the Upper Peninsula of Michigan. One male specimen was collected in 2015. In 2019, a rigorous effort was undertaken to find additional specimens, including sampling 6 lakes and 12 stream sites of the property once each during June, July, August, and September. Specimens were collected using a 10-watt portable ultraviolet

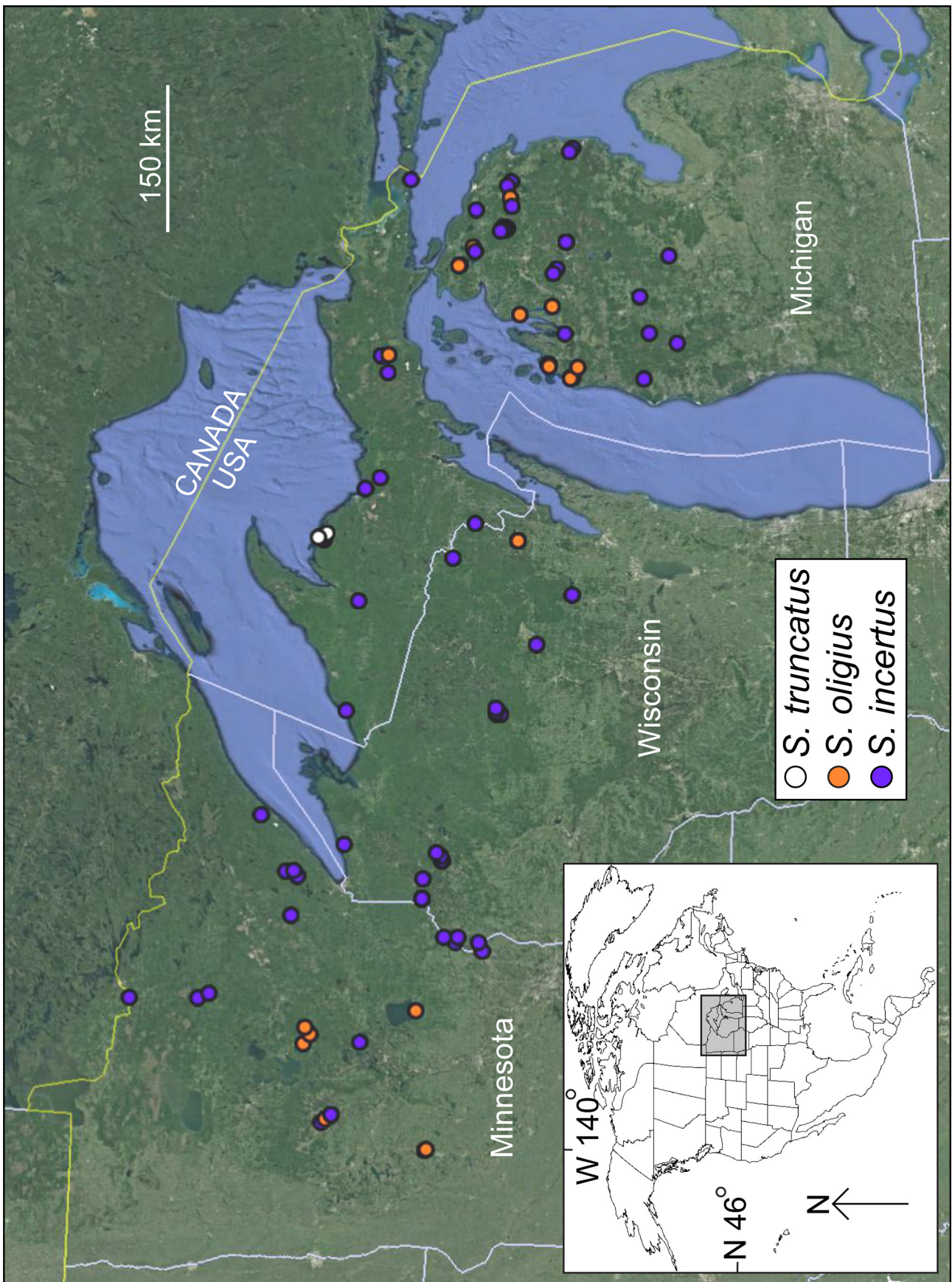


FIGURE 1. Known collections of the 3 *Setodes* species found in the US states of Michigan, Minnesota, and Wisconsin during the last 20 years. Base map © 2021 Google, National Oceanic and Atmospheric Administration.



FIGURE 2. Collecting localities for *S. truncatus* n. sp. 2A, the Pine River; 2B, the Salmon Trout River. Photographs by the author, August 2019.

LED light placed over a white pan filled with 80% ethanol (Zemel & Houghton 2017). Traps were placed adjacent to aquatic habitats at dusk and retrieved ~2 h later (Wright et al. 2013). This sampling regime ultimately yielded 1 additional male from the Pine River (type locality) (Fig. 2A) and 2 males from the Salmon Trout River of the adjacent watershed (Fig. 2B). The 2 sites are separated by ~9 km.

To prepare the holotype for illustration, its abdomen was removed and cleared of soft tissue by soaking for ~24 h in 10% KOH at ~21° C. Removal of remaining degraded viscera was facilitated by an abdominal ethanol injection using a hypodermic syringe. Preliminary illustrations were prepared by rendering structures viewed through a 10x10 square grid ocular microscope eyepiece onto grid paper. These templates were then scanned into Adobe Illustrator CC to produce final illustrations (Holzenthal 2007). Terminology adapted from that of Holzenthal (1982). Type material has been deposited in the University of Michigan Museum of Zoology (UMMZ) and the Hillsdale College Insect Collection (HCIC).

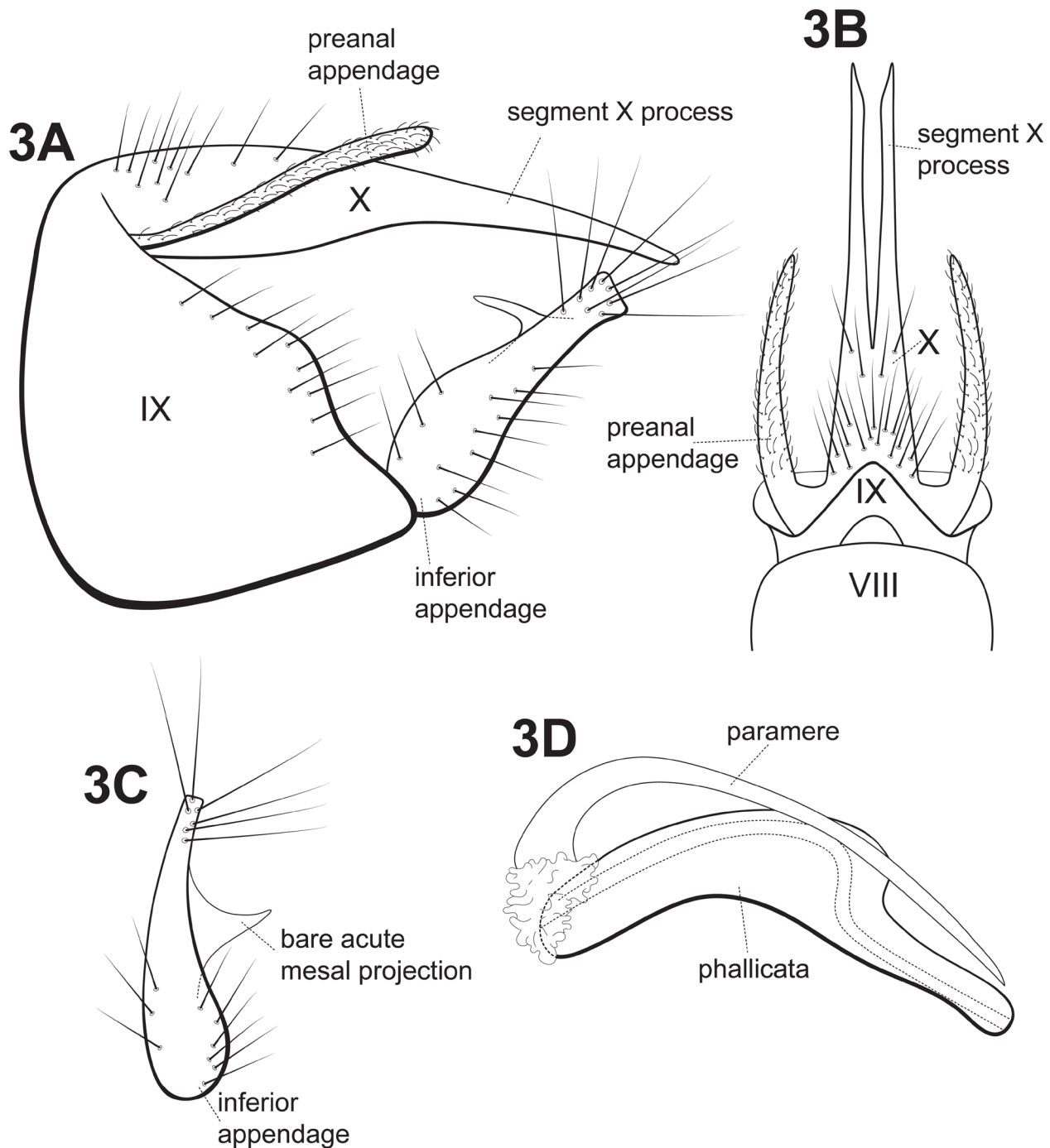


FIGURE 3. *Setodes truncatus*, n. sp., male genitalia. 3A, segments IX–X, left lateral; 3B, terga VIII–X, dorsal; 3C, left inferior appendage, caudal; 3D, phallic apparatus, left lateral.

Species description

Setodes truncatus Houghton, new species

Figs 3A–3D

The male of *S. truncatus* n. sp. appears most similar to that of *S. incertus* within the *S. incertus* species group (Schmid 1987). It is easily separable from that species by having short and truncate inferior appendages in lateral view, long and parallel processes of segment X in dorsal view, and in its pronounced, bare, acute, mesal projection being distinct at mid-length on each inferior appendage.

Male. General appearance typical of genus. Length of each forewing 6.0–6.3 mm ($n = 4$) and with venation typical of genus. In ethanol, body uniformly straw-colored with brown sutures between most thoracic sclerites. Legs pale straw-colored. Wings uniformly straw-colored with sparse dark brown setae. Head with pronounced epicranial stem and dorsal triangle. Abdomen pale with dark brown terminal segments.

Male genitalia as in Fig. 3. Segment VIII pale in color. Segment IX darkly sclerotized, broad and longitudinally long ventrally, longitudinally short and forming narrow V-shaped transverse bridge dorsally and fused with segment X. Pair of slender preanal appendages covered with short appressed setae, together lyrate in dorsal view. Segment X divided at $\sim 1/3$ length into pair of slender processes, extending beyond tips of preanal appendages; separated and approximately parallel for most of their length in dorsal view. Inferior appendages approximately as long as preanal appendages; not extending beyond tips of segment X processes, abruptly truncate and quadrate at apices in lateral view, and covered with long setae; each with bare, acute, mesal projection distinct at mid-length in lateral and, especially, in caudal views. Phallic apparatus reduced, consisting of endothecal membranes basally supporting pair of elongate parameres curving slightly ventrad and tubular phallicata approximating shape of duck's head in lateral view, with small, longitudinal, dorsomesal flange at mid-length.

Female and larva. Unknown. Like the male, the larva and female of *S. truncatus* will probably be similar to those of *S. incertus*.

Holotype male. Michigan: Marquette County: Pine River at Entrance Road, Huron Mountain Club, 46.8828, -87.8687, 184 m, 25 June 2019, DC Houghton, uv light, HCIC2100358. Deposited in the UMMZ (Catalog #UM-MZI-159435).

Paratypes: Same data as holotype except 28 June 2015, 1 ♂, HCIC2100175 (HCIC). **Michigan: Marquette County:** Salmon Trout River, Middle Falls, Huron Mountain Club, 46.8100, -87.8245, 225 m, 26 June 2019, DC Houghton, uv light, 2 ♂, HCIC2100359 (HCIC).

Etymology. Named for the truncate appearance of the inferior appendages.

Key to North American *Setodes* Rambur males

Ten species of *Setodes* are now known from the USA and Canada (Rasmussen & Morse 2020).

S. arenatus Holzenthal 1982 (NC, SC)

S. chipolanus Rasmussen & Harris 2008 (in Rasmussen et al. 2008) (FL)

S. dixiensis Holzenthal 1982 (AL, LA, MS)

S. epicampes Edwards 1956 (AL, KY, TN)

S. guttatus (Banks 1900) (AL, CT, DC, FL, MD, ME, NJ, PA, QC, VA, WV)

S. incertus (Walker 1852) (AL, CT, GA, KY, MA, MD, ME, MI, MN, NC, NH, NJ, NY, ON, PA, QC, SC, TN, VA, WI, WV)

S. oligius (Ross 1938) (IL, IN, ME, MI, MN, NY, ON, PA, QC, TN, WI)

S. oxapius (Ross 1938) (AR, MO, OK, PA)

S. stehri (Ross 1941) (AL, GA, NC, SC, TN)

S. truncatus Houghton, n. sp. (MI)

This key is adapted from those of Holzenthal (1982) and Rasmussen et al. (2008), incorporating *Setodes truncatus*.

1. Preanal appendages together lyrate in dorsal view and covered with short, appressed setae (Fig. 3A, 3B) 2
 - Preanal appendages absent (Holzenthal 1982, Figs. 9A, 14A), or fused to segment X and represented only by pair of patches of short setae (Holzenthal 1982, Fig. 11A) 8
2. Segment X processes long and slender in dorsal view, extending to or beyond tips of preanal appendages (Fig. 3B) 3
 - Segment X processes short in dorsal view, not as long as preanal appendages (Holzenthal 1982, Figs 7B, 16B) 6
3. Segment X processes long and curved upwards in lateral view, each tip bifid; phallicata with prominent dorsal flange; lateral parameres short (Holzenthal 1982, Fig. 5A) *S. arenatus*
 - Segment X processes in lateral view straight with pointed tips (Fig 3A), or slightly rounded apically (Holzenthal 1982, Fig. 18A); lateral parameres long and slender (Fig. 3D) 4
4. Segment X processes short and foot-shaped in lateral view, extending only to tips of preanal appendages (Holzenthal 1982, Fig. 18A) *S. stehri*
 - Segment X processes narrow and pointed in lateral view, extending well beyond tips of preanal appendages (Fig. 3A) 5
5. Inferior appendages in lateral view shorter than segment X processes (Fig. 3A); segment X in dorsal view with processes fused nearer to base than to tips, elongate, and parallel for most of their length (Fig. 3B) *S. truncatus*
 - Inferior appendages in lateral view longer than segment X processes (Holzenthal 1982, Fig. 12A); segment X in dorsal view with processes fused nearer to tips than to base (Holzenthal 1982, Fig. 12 B) *S. incertus*
6. Segment X processes broadly triangular in dorsal view (Holzenthal 1982, Fig. 7B) *S. dixiensis*
 - Segment X processes narrow in dorsal view (Holzenthal 1982, Fig. 16B; Rasmussen et al. 2008, Fig. 2B) 7
7. Segment X processes very short, bullet-shaped in lateral view (Holzenthal 1982, Fig. 16A), with shallow apical incision between them in dorsal view (Holzenthal 1982, Fig 16B); inferior appendages without bare, mesal, acute projections (Holzenthal, 1982, Fig 16A) *S. oxapius*
 - Segment X processes hatchet-shaped in lateral view (Rasmussen et al. 2008, Fig. 2A), with deep apical incision between them in dorsal view (Rasmussen et al. 2008, Fig. 2B); inferior appendages each with bare, mesal, acute projection (Rasmussen et al. 2008, Fig. 2A) *S. chipolanus*
8. Phallicata in lateral view with prominent dorsal flange; parameres short (Holzenthal 1982, Fig. 9A); inferior appendages very narrow and pointed in ventral view and each with prominent, bare, mesal, acute projection (Holzenthal 1982, Fig. 9C) *S. epicampes*
 - Phallicata in lateral view without dorsal flange; parameres very long and slender (Holzenthal 1982, Fig. 11A); inferior appendages finger-shaped in ventral view and without mesal projections, each with apical portion turned mesad and bifid (Holzenthal 1982, Fig. 11C) 9
9. Segment X processes long and filamentous, gradually tapering along their entire length; inferior appendages each with 2 setose, baso-ventral projections (Holzenthal 1982, Fig. 11A) *S. guttatus*
 - Segment X processes broad basally but abruptly narrowing at about 1/6 their length beyond separation to form pair of filamentous processes; inferior appendages each with single setose, baso-ventral projection (Holzenthal 1982, Fig. 14A) *S. oligius*

Discussion

Setodes truncatus appears to be uncommon, even at its known collecting localities. Both localities are medium-sized rivers of sand and cobble substrate and with low habitat disturbance throughout their entire watersheds (Yanoviak and McCafferty 1996). The Salmon Trout River has considerably faster current velocity (\bar{x} = 1.7 m/s, n = 12) than the Pine River (\bar{x} = 0.4 m/s, n = 12), based on a series of measurements taken within 2 h of each other on a single day in August 2019. Summer temperature of the Pine (\bar{x} = 17.2° C) is warmer than that of the Salmon Trout (\bar{x} = 15.7° C), based on the US Environmental Protection Agency StreamCat Database (<https://www.epa.gov/waterdata>), accessed 14 November 2020. Sampling 2 other sites of the Salmon Trout during June–September 2019, including 1 of slower current velocity and sandier substrate, failed to find additional specimens of *S. truncatus*. No female of *Setodes* was collected from either site.

Larval specimens of *S. truncatus* also remain elusive. Larvae of *Setodes* are known for burrowing in sandy deposits within depositional areas of fast-moving sandy rivers (Merrill & Wiggins 1971). Despite Hess sampling, hand-picking, and sand sieving during summers of both 2015 and 2019, no larvae of *Setodes* were found at either collecting site. A single subterminal-instar specimen of *Setodes*, collected ~250 m upstream of the Pine River site in 1993 (Yanoviak & McCafferty 1996), was located in the Purdue Entomology Research Collection (PERC) and examined as a possible candidate for *S. truncatus*. The specimen, however, was indistinguishable from both descriptions and specimens of *S. incertus*, probably due to any potential diagnostic differences in head and pronotum coloration (Merrill & Wiggins 1971; Nations 1994; Morse et al. 2017) having faded during the interim ~28 years stored

in ethanol. While *S. incertus* adults have not been collected from either collecting site of *S. truncatus*, the species has been found within ~10 km of the sites, so the larval specimen could belong to either species.

Setodes truncatus joins *Plectrocnemia sabulosa* (Leonard and Leonard 1949) (Polycentropodidae) as the only known caddisflies endemic to Michigan. Interestingly, the only collections of *P. sabulosa* since the 1950s were from 3 sites along the Salmon Trout River (Houghton 2020), including the same ultraviolet light collection that yielded paratypes of *S. truncatus*. It is possible that both species may be found in northern Wisconsin, given its proximity to the Upper Peninsula of Michigan and the large number of sandy and undisturbed rivers in the northern portion of that state.

Setodes truncatus is the first caddisfly described as new to science from a Michigan specimen in >70 years. Throughout the 1930s and 1940s, many caddisflies were described from the northcentral US states of Illinois, Michigan, and Minnesota, predominantly by Denning (1941, 1942, 1947), Leonard and Leonard (1949), and, especially, Ross (1938, 1944). Only a few species have been described from the region since then (Etnier 1965, 1968; Wiggins 1975; Monson & Holzenthal 1993; Blahnik & Holzenthal 2014). The states of Michigan, Minnesota, and Wisconsin, however, all contain undisturbed watersheds which may serve as refuge habitats for other rare and unique species (Houghton 2021). Future research should investigate such habitats for additional specimens of *S. truncatus* and other potentially undiscovered caddisflies.

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