
Chironomidae of the Upper Saint Croix River, Wisconsin

Authors: Alexander T. Egan, and Leonard C. Ferrington Jr.

Source: Transactions of the American Entomological Society, 145(3) : 353-384

Published By: The American Entomological Society

URL: <https://doi.org/10.3157/061.145.0307>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-o-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Chironomidae of the Upper Saint Croix River, Wisconsin

ALEXANDER T. EGAN^{1*}, LEONARD C. FERRINGTON, JR.²

¹Alexander T. Egan

National Park Service – Great Lakes Inventory & Monitoring Network
Ashland, WI 54806 USA

* Corresponding author: alex_egan@nps.gov

²Leonard C. Ferrington, Jr.

Department of Entomology, University of Minnesota
St. Paul, MN 55108 USA
ferri016@umn.edu

ABSTRACT

Chironomid communities of the upper St. Croix River, Wisconsin, were sampled for pupal exuviae at four locations monthly from April to October, 2007. Species richness was very high, with 252 species from 73 genera, dominated by the subfamilies Chironominae and Orthocladiinae. Most studies of lotic systems find fewer than 150 chironomid taxa, and often less than 100. The high richness may be due to regional conditions that support diverse aquatic communities, such as thermal regime, typical landscape patterns such as elevated mid-order stream diversity or increased β -diversity in headwaters, or the collection method which can detect species from adjacent habitats. There were 35 species that are atypical of lotic systems and some may have occupied microhabitats or adjacent habitat that more closely matches their preferences. Twenty-one species, mostly in Orthocladiinae, had range expansions into the western Great Lakes region or appear to be previously undescribed for the Nearctic. Sixty morphotypes, dominated by 41 Chironominae, did not fit any published exuviae descriptions.

Key words: Chironomidae, Diptera, Taxonomy, Diversity, Richness, Saint Croix River

INTRODUCTION

The Saint Croix National Scenic Riverway (SACN) is part of the U.S. National Park system, encompassing a narrow ribbon of protected lands adjacent to the St. Croix and Namekagon rivers in western Wisconsin and eastern Minnesota. The landscape of the upper St. Croix and its tributaries consists of dense Laurentian mixed forest (conifer, mixed hardwood and conifer, bogs and swamps), riparian floodplains and sandy soils, with limited agriculture or development (Kraft et al. 2015). The riparian corridor is relatively intact and natural for most of the river, especially in the upper portion of the basin.

One of the primary goals of research in national parks is to provide information regarding the health and structure of natural resources within these protected areas. Resource inventories help both individual parks and the entire national park system understand baseline conditions and how to effectively monitor or manage landscapes, giving a reference for comparisons through time or across landscapes (Fancy et al. 2009).

Chironomidae are typically the most diverse and abundant macroinvertebrates in fresh waters and occupy important positions in the food web as consumers, predators, and prey (Armitage et al. 1995). Individual species may have habitat and chemical preferences for water quality, becoming

either absent or abundant under impacted conditions. In a water-based park like SACN, having a strong reference point for chironomids will help managers understand the ecological complexity at the base of the river's food web.

Prior studies in the park that included Chironomidae at the genus-level found a healthy and diverse community, particularly in low-order streams of the upper Riverway, with a median of about 15-16 genera per sample site (Niemela et al. 2004). The principal chironomid genera were *Cricotopus*, *Polypedilum*, *Conchapelopia*, *Rheotanytarsus* and *Tanytarsus* (Niemela et al. 2004), which is a common result in part due to the high species richness within these genera. A general guideline has been that mid-order streams have higher diversity than lower or higher orders (Vannote et al. 1980), and this result is often confirmed in longitudinal studies where 3rd-5th order streams have the maximum richness (Clarke et al. 2008). This pattern appears to hold for species richness of Chironomidae in mid-latitude streams and rivers (Coffman 1989). The St. Croix and Namekagon rivers are 5th order above their confluence and 6th order below. Along with the relatively intact and protected status of riparian areas, this suggests the Riverway should have a high diversity.

This is the first comprehensive, species-level study on Chironomidae of the St. Croix River mainstem, and is part of an on-going assessment of longitudinal patterns of community diversity. The geographic scope of the study consists of 17 sample sites extending across more than 170 miles of river from the Gordon Dam near the headwaters to its confluence with the Mississippi River. Due to the large geographic scope and high volume of sample material, our current focus is on the four upper-most river sites in Wisconsin above the confluence of the Namekagon and the St. Croix (Figure 1). Our goals are to define the general community, including novel species for the region or habitat, and briefly discuss important traits of undescribed pupal exuviae.

MATERIALS AND METHODS

Four sites on the upper St. Croix were sampled. Each site was defined as a 50 meter stretch of river and collections of surface-floating pupal exuviae (SFPE) were constrained within the 50 meters. Latitude and

Longitude coordinates mark the approximate mid-length of each site location. Sites were located just downstream of Gordon Dam (Site 17; 46° 15' 16" N LAT, 91° 55' 43" W LONG), Scott Bridge (Site 16; 46° 15' 19" N LAT, 91° 57' 40" W LONG), County Road T landing (Site 15; 46° 11' 34" N LAT, 92° 04' 16" W LONG), and CCC Bridge landing (Site 14; 46° 07' 01" N LAT, 92° 07' 54" W LONG).

Collections of SFPE occurred approximately monthly from April 28th to October 26th, 2007. Depending on subsampling regime, monthly sampling from spring to early autumn has been found to return a large proportion (e.g. 60-80% or more) of the available taxa within a single year (Raunio & Muotka 2005, Bouchard & Ferrington 2011). Although winter-emerging cold-stenotherms may be underrepresented during the months sampled, the earliest samples were collected within 28 days of ice break-up and it is expected that some of the cold-stenotherms were detected.

Chironomid pupal exuviae offer numerous advantages over other life stages, including taxonomic resolution that is often as good as the adult stage, enhanced detection of species that are rare or occupy cryptic or difficult-to-sample niches, and ease of collection where the floating exuviae accumulate along shorelines. Although SFPE collections generally have an unambiguous association to target habitats, one drawback is the chance that exuviae from adjacent habitats can be included in samples. We used a standard collection protocol as described in Ferrington et al. (1991), with the exception that 20 minutes of sampling effort was expended at each sample site on each collection date.

Two samples of SFPE were collected at each site/date, one from along each bank of the river. On several collection dates the number of SFPE was conspicuously different among the two samples. In cases where both samples had large numbers of SFPE (occasionally exceeding 1,000 SFPE), one sample was randomly chosen and sorted. In cases where one sample appeared to contain few specimens, the sample with the greater number of SFPE was sorted. Samples with more than 300 SFPE were randomly subsampled to 300 specimens, then a scan for rare species was performed. Samples with fewer than 300 SFPE were completely sorted. Sorted specimens were processed and slide mounted as described in

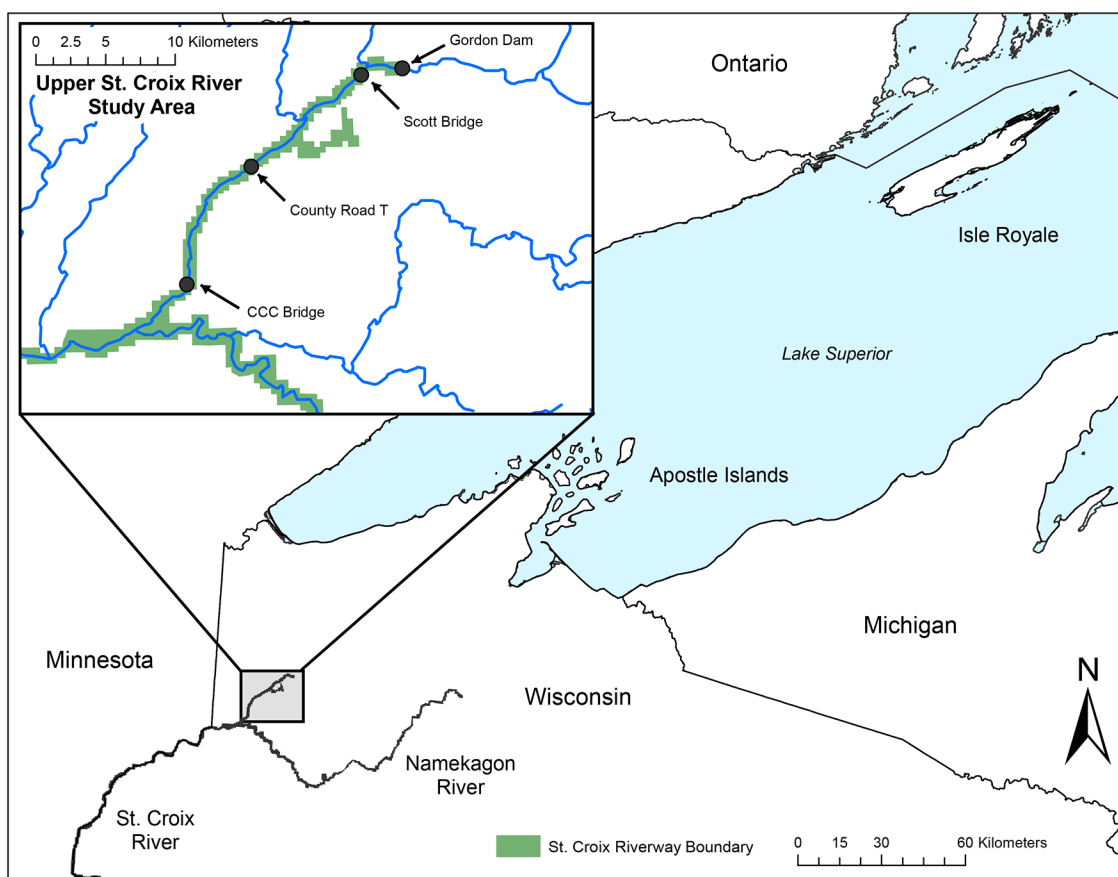


Figure 1. Study area in context of the St. Croix River and regional locations mentioned in the text.

Kranzfelder et al. (2015). Voucher specimens for each species have been selected and deposited in the Insect Collection of the Department of Entomology at the University of Minnesota (UMSP).

Taxonomy and biogeography followed nomenclature and ranges described in Ashe and O'Connor (2009, 2012), unless more recent changes have been made, for all subfamilies except Chironominae. For Chironominae we used Oliver et al. (1990) and more recent or specific publications if available for individual genera or species. Identification of chironomid pupal exuviae to genus has become more accessible and relatively simple in recent decades (Ferrington et al. 2008, Wiederholm 1986). However, species-level identification for most genera can still be an arduous and challenging process, particularly since some genera contain

many undescribed or poorly defined species. We used sources cited in Tables 1-5 for species-level identifications.

Annotations from the species lists include details of interest, such as range expansions, ecology, unique morphological variants, and brief descriptions of putative undescribed exuviae. Some genera and species listed in the tables are not mentioned in the text because their presence was unsurprising (i.e., river-dwellers known from the Midwestern U.S. Species listed as "IR" were initially found at Isle Royale National Park, Michigan (Egan and Ferrington, 2015 and Egan, unpublished data), and species listed as "SC" were initially found in samples collected at St. Croix National Scenic Riverway.

RESULTS

Species with an asterisk (*) have not previously been described from lotic habitats. Those with a range that did not previously include the western Great Lakes region, or have plausible inclusion based on prior locations, are designated with a pound sign (#). Specimens that were a good match with a species description but have not been previously found in the Nearctic as adults were labelled “cf.” since we do not have association with the adult stage for confirmation.

Subfamily Tanypodinae

A total of 34 species in 16 genera were from the subfamily Tanypodinae (Table 1).

Ablabesmyia includes many species that are widespread in the Nearctic. The species “nr. *aspera*” is discussed in Roback (1985) as a possible hybrid population between *aspera* and *hauberi*, with both found at SACN, although taxonomy remains unresolved for this designation. Only a single specimen from SACN material fits the description by Roback, but other material from Isle Royale, Michigan (Egan, unpublished), supports this morphological distinction. Specimens representing the *janta/ramphe* group could not be separated and Roback (1985) discusses variations that are known or likely in both species. The presence of *simpsoni* represents a range expansion into the central Nearctic. Both *mallochi* variants I and II are present. Designations of *monilis* require some caution; we have found many traits among similar morphotypes from different locations in the central Nearctic (Minnesota, Wisconsin, Michigan) to be variable, including shape of the aeropyle tube, reticulation of the thoracic horn, wing sheath vein strength and breadth, and T IV pattern. Both Roback (1985) and Saether (2011) use wing sheath vein strength, along with an incomplete M vein, as key traits for *monilis* and most of our specimens fit this condition. However, variability can make some specimens appear closer to *aspera* Roback or nr. *aspera* Roback, with thinner wing sheath veins, and all specimens have an undefined T IV color pattern. In addition, Stur et al. (2019) note that the similar *americana* Fittkau cannot be distinguished from most other species as a pupal

exuviae. Variation can occur within a single sample, so seasonal differences for *monilis* are not obvious factors. Morphological differences in *basalis* support Saether’s (2011) separation from *monilis*. Specimens from SACN and Isle Royale (Egan, unpublished data) of *idei* have wide variation in wing sheath spotting, ranging from (1) dense and dark spots on a clear wing sheath to (2) weak spots with a light brown background to (3) no discernable spots and brown color across the entire wing sheath with weak venation. This range of conditions can occur in specimens from a single sample, and while Roback (1985) mentions variation in wing sheath spotting and veins, he does not mention a plain brown color variant. Species SC 1 did not fit any described pupal exuviae, with key features including: thoracic horn of the *sensu stricto* type with a conical aeropyle tube apex; tergite IV sometimes with a dark anteromedial patch (similar to *parajanta*); and the distinctive wing sheath veins are faint, restricted to the area basal to the cross vein (no veins in distal ½ of wing sheath), and are arranged as two parallel curving veins (these are the same as “sp. E” in Jacobsen [2008] but the dorsal suture lacks a distinct spot).

Clinotanypus pinguis is one of two described Nearctic pupal exuviae for this genus, of four known species. Ranges for the other species may suggest southern distributions. Identifications fit with details from four separate sources, although a wide gradient in sizes may indicate two species included in the authors’ material from SACN, Isle Royale and Minnesota (Egan, unpublished data).

Conchapelopia fasciata is the senior synonym of *C. dusena* (Ashe & O’Connor 2009).

Labrundinia ranges are often widespread in the southern Nearctic and the SACN species *becki* and *neopilosella* represent a slightly more western or northern distribution than was previously known. *Labrundinia longipalpis* is the senior synonym of *maculata* (Ashe & O’Connor 2009).

Nilotanypus specimens are in two distinct size and color patterns, including a smaller size with pale brown pigment and larger with golden brown pigment. However, features are consistent and the size and range of the darker specimens, which can be hard to separate from *americanus* Beck & Beck, argues for *fimbriatus*. There can be considerable variation within these species (Roback 1986), so it is

not clear if these represent two species or a gradient.

Pentaneura from SACN generally fit the generic description in Silva & Ferrington (2018). Although proportionally somewhat larger, the SACN species appears to be *inconspicua* based on comparisons with unpublished descriptions of associated specimens of *inyoensis* Sublette (Bilyj, personal communication). A distinctive feature in SACN *inconspicua* specimens not mentioned in Silva & Ferrington (2018) is a constricted anal lobe apex that sometimes resembles a drop of water, which may be a stable local variation.

Procladius of *sublettei-denticulatus* were often inseparable. Some specimens with an enclosing adult were identifiable and both species are present in SACN samples. Variation between these two species (and even some *freemani*) supports Roback's (1980) inability to separate these pupal exuviae in a broad sense, although local populations may be separable as in Saether (2010a). As a result, these two species will be combined during data analyses (Ferrington & Egan, in prep).

Thienemannimyia *senata* was formerly placed in the genus *Hayesomyia*.

Trissopelopia is possibly monotypic in the Nearctic with only *ogemawi* Roback (Roback 1971) described as an adult. The SACN specimens appear to be *ogemawi* based on exuviae-adult associations (Bilyj, pers. comm.).

Zavrelimyia (*Paramerina*) pupal exuviae in the Nearctic are not well described, with *anomala* having only a sparse narrative (Beck & Beck 1966). Our specimen appears to fit associated material for *fragilis* (Bilyj, pers. comm.). *Paramerina* was formerly considered a separate genus.

Subfamily Diamesinae

A total of 4 species in 3 genera were from the subfamily Diamesinae (Table 2).

Diamesa has many undescribed pupal exuviae. Species SC 1 does not fit any description of species known from the Nearctic or Western Palearctic. It has a total length of 6.2 mm, golden brown color, the thoracic horn is 550-580 μ m long with some small apical spinules, one precorneal seta is displaced near the Aps setae, dense shagreen and posterior row of large teeth (<10 large teeth up to 100 μ m long with additional small teeth) on tergites II-VIII,

conjunctives with a broad area of tiny spinules in rows, and anal lobe macrosetae slightly hooked and about 350 μ m long.

Pagastia orthogonia traits from specimens in three regional parks (St. Croix, Apostle Islands, Isle Royale) fit the Lake Superior variant described by Caldwell (2007) with only pigmentation varying.

Subfamily Orthocladiinae

A total of 99 species in 22 genera were from the subfamily Orthocladiinae (Table 3).

Two *Corynoneura* species described from the Russian Far East fit keys and descriptions well: *secunda*, which is not previously known from the Nearctic, and *collaris* was described by Fu & Saether (2012) from Canada's Northwest Territories. Since *secunda* is not described from the Nearctic we include a "cf." designation, even though it has distinctive pupal exuviae (Makarchenko & Makarchenko 2006). It also appears that *secunda* may be "sp. NA 1" in the Fu & Saether key. The *collaris* description (Makarchenko & Makarchenko 2010), which is discussed in Fu & Saether, appears to match "sp. NA 2" in their key. *Corynoneura arctica* and *doriceni* are typically found in lentic systems, suggesting they emerged from locations in the river with reduced flow or above the Gordon Dam, while *disinflata* was originally described from very small streams or trickles and probably originates from a first order stream (Fu & Saether 2012). In the literature *lacustris* is not well described and the frontal setae, a crucial feature that helps separate it from *macula*, are often impossible to observe. As a result, for data analyses we will combine the two into a single *macula-lacustris* category, even though distinctive individuals from both species are present in SACN samples (Ferrington & Egan, in prep).

Cricotopus range expansions include a more northerly distribution for *albiforceps* and *triannulatus*, a more southern distribution for *laricomalis* and *mackenziensis*, while *flavocinctus* was previously known from central Canada. *Cricotopus coronatus*, *laricomalis*, *obnixus* and *tricinctus* are more typical of lakes, ponds or slow-flowing waters, so these individuals presumably emerged from a slow-flowing location in the river or above the Gordon Dam. The separation of *diversus* from *festivellus*

(Kieffer) derives from descriptions in Cuppen et al. (*in press*). Five taxa were morphologically distinct from Holarctic keys and species descriptions and all appear to be in the subgenus *Cricotopus*. Species SC 1 has no PSB and the thoracic horn is oval with distinctive grape-like clusters along the anterior margin. Species SC 2 keys to *bicinctus*, it has distinct PSB on segments II and III, shagreen on segments III-V (VI) is robust and distinctly transverse, and frontal setae are typically absent but sometimes were observed on the frontal apotome. Species SC 3 is similar to *triannulatus* or *tristis*, has a double line of shagreen above the hook row on tergite II, D4 on segment VIII is displaced making the segment appear to have five long and thin lateral setae, and a variable line of bumps along the anterior thoracic suture that are sometimes distinct or may be absent. Species SC 4 is also similar to *tristis* but is notably smaller, paler, and has weaker shagreen. Species SC 5 keys to *caducus* Hirvenoja, which is Palearctic and halobiontic, so this is likely undescribed; thoracic horns are absent.

Heterotrissocladius changi has been found in lakes, often oligotrophic, so its presence in river samples suggests it emerged from above the dam or in a slow-flowing area. River specimens were in good condition and appeared similar to specimens collected in lakes at Isle Royale, Michigan (Egan, unpublished data).

Hydrobaenus species *pilipes* (Malloch) and *scapulapilosus* Saether cannot be separated as pupal exuviae, and Saether (1976) notes that they may be the same species.

Krenosmittia halvorseni has previously been documented in northern Canada and New Brunswick, making northern Wisconsin a connecting southern range expansion.

Limnophyes found in SACN samples are generally not known from lotic systems but probably originated from nearby habitats such as seeps or wet soil. For *pentaplastus*, Wisconsin is a southern range expansion.

Lopescladius hyporheicus in Wisconsin is a northern range expansion. Species SC 1 is very similar to *hyporheicus* except that tiny (1-2 μm) anterior shagreen on tergites III-V are arranged in distinct, tight rows, whereas shagreen in *hyporheicus* is larger (5 μm) and arranged in loose, broken rows.

Nanocladius sp. SC 1 splits the subgenus traits with the hook row on a distinct tubercle (*Nanocladius*) and lacking pedes spurii B (*Plecopteracoluthus*, except in one specimen where PSB are present). This might also be a variant of *crassicornus*, which also lacks PSB in some specimens, making this feature dubious for identifications. However, the thoracic horn in SC 1 gradually tapers and has a more digitiform shape than the broader, ovate *crassicornus* horn.

Orthocladius (*Orthocladius*) sp. SC 1 has PSB on segments 2 and 3, which otherwise only occurs in *carlatus* and *mallochi* in this subgenus, and superficially resembles *Cricotopus bicinctus*. Other features of SC 1 include pale brown pigment, frontal setae on the apotome, thoracic horn 130 μm long and 15-20 μm wide, narrow hook row (150 μm) in three rows, anterior and posterior shagreen separated on T III-VI, and anal lobe macrosetae 120 μm long with 2-3 apical spines on the lobe.

Parakiefferiella are often associated with oligotrophic lakes (Tuiskunen 1986), so it's interesting that *fennica*, *smolandica*, and cf. *gynocera* are present in SACN habitats. Neither *gynocera* nor *scandica* are known from the Nearctic but descriptions of SACN specimens fit both fairly well. One undescribed species, IR 5, has no thoracic horn, elongate anterior and posterior sternites II spinules, and otherwise is very similar to *fennica*. This morphotype has been found in several Lake Superior area parks, including Isle Royale, Apostle Islands, and SACN. Species SC 1 also has no thoracic horn, strong PSB on II and III, and the shagreen on tergites VI and VII is widely broken medially. Species SC 2 has very long thoracic horns for this genus (200 μm , 10-15 μm wide), which are sparsely covered in small spinules, and anal lobe tails with 5-6 large spines apically. Wisconsin is a range connection for *coronata* between British Columbia and the U.S. southeast.

Parametriocnemus vespertinus was previously known from Alberta, Canada, so Wisconsin is a range expansion. Saether suggests that *lundbeckii*, which is highly variable, and *stylatus* (Spärck) are probably inseparable and may be the same species, yet SACN specimens match *lundbeckii* in Saether (1969) and not *stylatus* in Langton (1991). An interesting variant on three possible *lundbeckii* specimens has a pair of

large anteromedial spine patches on tergite II and the male genital sac extends well beyond (25 μm) the end of the anal lobe. Species SC 1 is similar to and co-occurs with *lundbeckii*, but several features are consistently different in both sexes: thorax somewhat rugose, strongest anteriorly; tergite shagreen is anterior, very sparse and weak medially; posterior tergite spines on large lobes on (I) II-VIII, with the row on II of much smaller spines that are not on an enlarged lobe; anal lobe fringe often appears absent, when present setae are narrow-taeniate or hair-like and only in posterior 1/3 of lobe near macrosetae.

Psectrocladius is a diverse genus and Nearctic taxonomy is not always well defined, particularly in the *psilopterus* group. Within this group, several morphotypes can be readily separated from each other but cannot be definitively named: IR 3 and IR 4 (Egan, unpublished data) and SC 1. The most definitive traits between these are size, tergite spine arrangement, and pigmentation: IR 3 is over 4 mm long, has a wider (650-800 μm) abdomen at tergite II, tergite spine patches have more spines in denser clusters, and generally a distinct pigmentation; IR 4 is less than 3.5 mm long, has a narrower (500-550 μm) abdomen at tergite II, tergite spine patches with fewer spines, and much less pigmentation. Species SC 1 appears to be intermediate between IR 3 and IR 4, though it's unclear if this is a variant or a separate species. These three types may represent variants of one or two species. *Psectrocladius brehmi* is not known from the Nearctic, though specimens key well to this species in Langton (1991). Wisconsin is a large range expansion for *sordidellus*, which was previously known in Alaska.

Stilocladius species SC 1 features contradict the first couplet in Makarchenko & Makarchenko (2003), with PSB present and the thoracic horns mostly bare, thus not following either direction in the key. It also does not fit descriptions by Saether (1982) for *clinopecten*, the only described Nearctic species. Additional features include total length of 3 mm, frontal setae 70 μm long, the area around the anteprenotal setae has an odd arrangement of parallel wrinkles ending in peg-like structures, thoracic horn 230-240 μm long and 50 μm wide with rounded serrations along one side and at apex, the anal lobe is subcylindrical and 190 μm long, and the macrosetae are 150 μm long.

Tvetenia tshernovskii is formerly a junior synonym of *vitracies*.

Subfamily Chironominae

A total of 71 species in 22 genera were from the subfamily Chironominae – Tribe Chironomini, and two species from one genus in the Tribe Pseudochironomini (Table 4).

Cladopelma species IR 1 and IR 2 are similar to *galeator* with a parallel-sided segment eight spine. IR 1 has smooth and short (60-70 μm) cephalic tubercles with a subapical seta. IR 2 has cephalic tubercles that are elongate (140-150 μm) with apical spinules giving it a “rough” look. Both of these morphotypes have minute (5-8 μm) medial intersegmental spinule patches on T III-IV and IV-V. These two species are known from both Isle Royale lakes (Egan, unpublished data) and SACN, and may represent variants of *galeator* or of another undescribed species.

Cryptochironomus in western Great Lakes parks appear to have numerous undescribed pupal exuviae. For species with antler-like cephalic tubercles, SC 2 tubercles have a very large, square base (500 x 500 μm) and short “antlers” with a strongly curving main branch 100-150 μm long and stubby, rounded lateral branches 50-100 μm long. Three species have strong reticulation on abdominal segments: *sorex* lacks PSB on segment II and reticulation is distinct on all segments and generally covers entire tergite and pleurite, and has been associated with reared adults (Bilyj, pers. comm); IR 4 also has strong reticulation on all segments that have associated shagreen similar to *crassiforceps* Goetghebuer, with PSB present on segments I and II, and has posterior spine rows on tergites I-VII and sternites I-VIII; SC 1 reticulation is strongest on anterior segments and thoracic horns are an extremely unique form of a large globe 350 μm in diameter with elongate filaments emerging from the surface. Species SC 3 has no abdominal reticulation and keys to either *blarina* Townes or *imitans* Saether, but does not fit descriptions of either species. Habitat for *ponderosus* was initially described as lakes and this specimen may be from above the Gordon Dam, and Wisconsin appears to be a range expansion from Oklahoma and Louisiana (Sublette 1964).

Demicryptochironomus vulneratus is not known as adults in the Nearctic and Oliver et al. (1990) list it as not Nearctic, but features from SACN specimens fit figures in Saether (1977) and Langton (1991) well. Species SC 1 features include tergite II shagreen of small dark points near the hook row; tergites III-VI with dark shagreen posteriorly, lighter shagreen medial and anteriorly; and 0-3 segment VIII spurs that are small and pale. Species IR 1 has an interesting thoracic horn with a single elliptical basal ring and 4-5 very thick, long trunks basally before narrower branching occurs; it also has PSB on I and II, along with stout shagreen on tergites II-V where points are not pigmented but the tergite anterior to the points has a gray wash.

Dicrotendipes hurlburti is known from Florida and Panama. The SACN specimen needs to be viewed with caution since it was not in good condition and *hurlburti* can be hard to separate from other species (Epler 2016). Important features include the segment VIII spur is single and only slightly sinuate, and tergites II-VI have small median shagreen with patches smallest on II and VI and shagreen largest in the center of the patch. It is unclear if *tritonus* from SACN (and Isle Royale) are an undescribed Nearctic taxon, but specimens work well for *tritonus* in Langton (1991). Several species were previously known only from lentic habitats, including *leucoscelis*, *lobiger*, *milleri* and *tritonus*, and these may have emerged from adjacent habitats.

Einfeldia natchitochae taxonomy is currently unresolved but we will retain it in *Einfeldia*. The species is known from Louisiana and South Carolina, making Wisconsin a large range expansion. Features fit Sublette's (1964) description well, except for the presence of frontal warts, suggesting this may be in the genus *Benthalia* (Martin, pers. comm.). Rivers appear to be an atypical habitat for *pagana*.

Glyptotendipes subgeneric designations are based on updates in Spies & Saether (2004). Species IR 1 has been found at Isle Royale and SACN, and although it keys to either *imbecillis* in Langton (1991) or *viridis* in Contreras-Lichtenberg (2001), it appears to be neither species. Key features include epaulettes on tergites III-VI that are small, oval, and do not get distinctly larger on posterior segments; cephalic tubercles are short and conical with a broad base and short apical setae; and shagreen on tergites II-VI that

generally has many small, circular gaps. The known range of *signatus* appears to be Palearctic.

Lauterborniella agrayloides is typically found in small bodies of standing water (Pinder & Reiss 1986), suggesting SACN specimens washed into the river or emerged from slow-flowing areas.

Microtendipes rydalensis may be a new species for the Nearctic fauna, or this may be *caelum* Townes which belongs to the same group (Bilyj pers. comm.). Species NA3 was determined from an unpublished draft of Nearctic Chironominae by Peter Langton, who noted a "very unusual" condition for this genus with tergite II-V shagreen completely fused to anterior transverse rows. Both *rydalensis* and *caducus* were also identified with the draft key so should be taken with caution. Species IR 1, from Isle Royale and SACN, is large (9 mm) and most similar to *chloris* in Langton (1991) or *pedellus* (De Geer), and species IR 2 is similar but distinctly smaller (6.2-6.8 mm) and with weaker shagreen and most closely fits Langton's (unpublished) species NA2.

Parachironomus has at least three undescribed pupal exuviae at SACN. Species SC 1 does not have a vortex (a posterior whorl of spines on the parasternite of segment IV); the prealar tubercle has a low anterior mound and elongate, strongly hooked posterior mound; sternites I has paired, spinose tubercles; tergite VI has posterior spinules that are distinctly larger than other shagreen and slightly hooked; and the anal comb is absent. Species SC 2 and SC 3 have a vortex. SC 2 keys to *vitiosus*/Pe 2 in Langton (1991) but it is highly variable in total length and sternite II spinule size, and has a prealar tubercle with a large posterior lobe. SC 3 does not fit any described species yet has no distinct features to differentiate from others in this genus.

Phaenopsectra flavipes is not well described, making this species determination difficult to conclude with certainty.

Polypedilum is a species-rich and difficult genus taxonomically, with apparently 16 undescribed species, based on pupal exuviae, from SACN samples. Specimens of *albinodus-scalaenum* are most similar to these two species based on Vårdal et al. (2002). The species nr. *nymphaeorum* cannot clearly be placed in a subgenus but is similar to *nymphaeorum* (Maschwitz & Cook 2000). Several species have small or absent cephalic tubercles and

conjunctives III-IV without spinule rows:

- SC 1 (anterior transverse shagreen strong on tergites III-VI, hook row $\frac{1}{2}$ or more of segment width, medial shagreen with large fenestrations, fringe with 55-68 taeniae, dorsal anal lobe setae near apex) should be *Tripodura* based on anal lobe setae (which are often not present) but overall features suggest *Uresipedium* and these may be *P. U. obtusum*.
- SC 2 (narrow hook row only $\frac{1}{3}$ of segment width, anterior transverse shagreen similar in size to other shagreen and with large fenestrations, segment VIII comb weak with one primary and a couple accessory spines, fringe with about 22 taeniae, dorsal anal lobe setae near apex [but often missing]) is in *Tripodura*.
- SC 8 (pale overall, anterior transverse shagreen on II-VI is only slightly larger than other shagreen, shagreen with large fenestrations, comb weak, no dorsal anal lobe setae) is in *Uresipedium* and keys to the African *lehmanni* (Saether & Oyewo 2008), though is unlikely to be that species.

Species with small or absent cephalic tubercles and conjunctives III-IV have spinule rows:

- IR 8 (strong anterior shagreen on tergites II-VI with spinules larger than hooks in hook row, conjunctives III-IV and IV-V have two or three rows of spinules are often in the form of large hooks, conjunctives sometimes have weak lateral dark spots) may be *Uresipedium*.
- IR 11 is similar to *Tripodura griseopunctatum* but shagreen is generally very weak and widespread and the fringe has 17-18 taeniae.
- SC 3 (total length 2.6 mm, tergite II-V with strong shagreen overall, fringe with 14-15 taeniae, dorsal anal lobe setae taeniate) is in *Tripodura*.
- SC 4 (total length 2.8 mm, tergites II-V with strong anterior transverse shagreen and connected shagreen is much weaker, fringe with 24 taeniae, dorsal anal lobe setae taeniate) is in *Tripodura*.
- SC 5 (short frontal tubercles with apical setae, tergite II-VI with strong anterior transverse shagreen and II-V with distinctly separated shagreen and fenestrations, dorsal anal lobe setae thin) is in *Tripodura*.
- SC 7 (low frontal warts, tergites III-V with very

sparse shagreen that is almost absent medially, dorsal anal lobe setae thin) is in *Tripodura*.

- SC 9 (anterior transverse shagreen row only a little larger than other shagreen which covers most of tergite and has fenestrations) is in *Uresipedium*.
- SC 10 (keys to *illinoense/angulum* in Maschowitz & Cook [2000] but shagreen not the same as in description and figures) is in *Polypedium*.
- SC 11 (similar to the *falciforme* group with an elongate and pointed prealar spur) is in *Polypedium*.
- SC 12 (total length over 7 mm, segment VIII spurs in a row of six separate spurs that are progressively smaller anteriorly, fringe with about 75 taeniae in double rows) is possibly in *Uresipedium*.
- SC 13 (frontal apotome with an unusual domed shape, anterior transverse shagreen on tergites II-VII, medial shagreen completely separate on patches III-VII) is in *Uresipedium*.
- SC 14 (similar to SC 1, shagreen broadly distributed and has fenestrations, PSB absent, on segment VIII with one primary spur with many flattened accessory points that are closely appressed to the spur) is in *Polypedium*.

Stenochironomus poecilopterus cannot be separated from *pulchripennis* or *colei* as pupal exuviae. However, Borkent (1984) suggested that *poecilopterus* was more typical of lotic systems, *pulchripennis* may prefer lentic, and *colei* is a western Nearctic species, thus our designation here.

Pseudochironomus anas is not described as a pupal exuviae. One pharate adult from SACN was compared to Saether (1977) and Townes (1945) and found to be this species, which will be described in another publication. The range of *anas* is at least from western Ontario, where it is a common lake species (Bilyj pers. comm.), to New York (Townes 1945).

A total of 42 species in 9 genera were from the subfamily Chironominae – Tribe Tanytarsini (Table 5).

Cladotanytarsus specimens that key to Palearctic *lepidocalcar* in Langton (1991) and Bilyj & Davies (1989) are smaller, and the comb (9 large marginal teeth, 3-6 small teeth) and fringe (29

taeniae) are unlike *lepidocalcar*.

Micropsectra logani specimens have some features that do not fit the description in Stur & Ekrem (2006), making it unclear if these are variants or a similar species.

Paratanytarsus species MN 1 was also collected by the authors at Pearl Lake, Minnesota, and it keys to *austriacus* in Langton (1991) but is noticeably smaller with a thoracic horn only 100 μm long. Species SC 1 is in the *bituberculatus* group, has a large thoracic horn (460 μm long) with 30 μm spinules along most of the horn except the base, tergites IV-V have median patches of short, golden-brown spines that are elongate (50-70 μm long) posteriorly (these patches vary between a single oval and two patches with a narrow connection), and the same tergites also have separate elongate rows of 40-50 μm long spines laterally. A single specimen keys to *intricatus* in Langton (1991) but features do not fit that species. The range of *dissimilis* was previously in the southeastern US.

Rheotanytarsus diversity is largely undescribed, even for common species. The *exiguus* specimens have enough variation that they may encompass 2-3 species or one highly variable species since some intermediate specimens occur; tergites II-VI have paired, anterior, circular spine patches; tergite VI has no shagreen; and the anal lobe has 20-25 taeniae in the fringe. Species SC 1 is very similar to *pellucidus* (Walker), particularly with posterior shagreen on pointed tubercles of tergite II, but only tergites II-V have circular spine patches. Species SC 2 is similar to SC 1 except tergite VI also has paired circular spine patches, and both of these may be variants of *pellucidus*. Species SC 3 has paired spine patches on tergites II-VI, anterior shagreen on IV, 12-14 taeniae in the fringe, and the anal lobe is strongly truncated and oval.

Stempellina of the Nearctic are in need of a revision, particularly for immature stages. The *bausei* specimens are a very good fit with descriptions and figures in Langton (1991), except for unique abdominal pigmentation which is not mentioned by Langton, and *bausei* is not known from the Nearctic. At least four morphotypes have been found at Isle Royale (Egan, unpublished data) and SACN, all comparable to *almi* Brundin but dissimilar enough to suggest they may be different species. Only one type

matches pupal-adult associations, with the thoracic horn 150 μm long and three posterolateral spines on segment VIII (Bilyj, pers. comm.). Morphotype SC 1 has a narrow thoracic horn 390-420 μm long with spinules that are large in the basal half and small and sparse anteriorly, and segment VIII has one posterolateral large, pale, curving spine and one smaller, pale, curved spine anterior to it (rarely a third small spine occurs near the anterior part of the segment).

Stempellinella nr. *chambiensis* is similar to that species, which is widespread in the southern hemisphere but not known from the Nearctic.

Tanytarsus from SACN samples that have not been described from the Nearctic include *recurvatus*, *lactescens*, and *smolandicus*. However, associated material of *recurvatus* (Bilyj, pers. comm.), along with SACN and Isle Royale material, fits the description in Langton (1991). As a very diverse genus, there are numerous undescribed species, with five apparently undescribed pupal exuviae from SACN. Species IR 8 keys to Pe 15 in Langton (1991), with four lateral taeniae on segment VIII, small and oval darkened point patches on tergites III-VI with no additional shagreen, and Dc4 on the cephalothorax is very large (180 μm long) and taeniate. The other four exuviae have four lateral taeniae on segment VIII and elongate spines on tergites III and/or IV. In addition, species SC 1 keys to *gibbosiceps* Kieffer in Langton (1991) but the thoracic horn (150 μm long and very thin) is too small. SC 1 also has elongate spines (70 μm) on tergite III that curve medially. Species IR 3 also keys to *gibbosiceps* but differs in general size (2.8-3 mm total length), armament (tergite III spines large and 75 μm long, angled laterally, with tergite IV spines slightly smaller and also angled), and lateral taeniae (segments V-VI have no lateral taeniae); there is some variation within this designation suggesting it may represent multiple species. Both species IR 6 and IR 7 key to *buchonius* Reiss & Fittkau or Pe 14 in Langton, but neither fit those species. IR 6 has conical cephalic tubercles, rugose thorax, no thoracic horn and tergites IV-VI with spine patches instead of points. IR 7 has frontal tubercles that are very small and bead-like, tergite III spines long (50 μm) and covers half or more of the segment, tergite IV spines are small but the row is elongate.

DISCUSSION

A total of 252 species or morphotypes in 73 genera were found from 5416 individual specimens in the upper St. Croix River, dominated numerically and in terms of richness by Chironominae and Orthocladiinae. For a single year of collections (late April to late October) this is a very high richness compared to similar studies. Most temperate stream or small river studies from a single locality find fewer than 100 chironomid species, even when collecting biweekly for an entire year. In a review by Clarke et al. (2008), individual low-order (about 0-2nd) permanent streams generally had up to 100 macroinvertebrate species (including other groups besides Chironomidae). This is similar to or lower than many chironomid-specific studies and may reflect taxonomic expertise among chironomid specialists. An important caveat to these numbers is study design, with pupal exuviae studies able to detect species that emerge from adjacent habitats where exuviae can enter the study area, while methods that target larval stages (e.g. benthic dredges or stream samplers) are unlikely to collect species from other habitats. Most studies we compare below utilized SFPE collections or used a combination of methods to target multiple life stages.

Richness across biomes generally shows fewer taxa in alpine, arctic or plains sites, while richness is higher in montane or temperate forested areas (Vinson & Hawkins 1998). Among studies by chironomid specialists, Aagaard et al. (1987) found 26 species in a short snow-free season of an arctic-alpine stream, Hayes & Murray (1987) found 20 species in three Canadian high arctic streams, and Lencioni & Rossaro (2005) during a three year study on 5 alpine streams had 53 taxa, so multiple years at multiple sites generally increases the proportion of the community detected. On the Kenai River in Alaska, 88 species were found in two years of collection (Wartinbee 2010) and in two rivers of southern Finland there were 162 species identified (Raunio et al. 2007).

In more temperate locations there is a wide range of reported richness, from 48 species in an Indiana stream (Berg & Hellenthal 1991), 84 species in a single stream riffle from North Carolina (Lenat 1987), 112 species from an Alberta stream (Boerger 1981),

and 127 species from 22 sites on the Arkansas River in Colorado (Ruse et al. 2000). Two studies with a higher richness than usual found 141 taxa from 22 catchments along the Spanish Mediterranean coast (Punti et al. 2009) and 143 taxa from a single creek in Pennsylvania (Coffman 1973). Many of these studies were approximately one year in length.

Compared to our data, the only study we found that had a higher species richness for lotic systems was on small, wadeable streams along or near the Minnesota-Wisconsin border, which had 261 taxa from 12 study sites during biweekly collections across one year (Bouchard & Ferrington 2011). When viewed as a network, headwater streams often have high β -diversity and mid-order streams generally have the highest richness in lotic systems (Clarke et al. 2008). The prediction from Vannote et al. (1980) of higher diversity in mid-order streams has been found in many studies. These two riverine patterns, based on local conditions and habitat heterogeneity with greater niche availability (Vinson & Hawkins 1998), are likely important factors in the high richness found in both Bouchard & Ferrington (2011) and our study. This pattern appears to also occur in other taxonomic groups, as observed in the high mussel diversity of the St. Croix River (Wisconsin DNR 2019). Clarke et al. (2008) found that high variability occurs between regions, so the forested upper Midwest may have particular factors leading to higher taxonomic richness, such as thermal variability (Bouchard 2007).

According to the U.S. Environmental Protection Agency ecoregions, all four sites in our study occurred within the Northern Forests (a broad continental scale), Mixed Wood Shield and Northern Lakes and Forests (nested regional scales) ecoregions, but are adjacent to other ecoregions (EPA 2016). Bouchard & Ferrington's (2011) study occurred to the south, in transition zones between several ecoregions including Eastern Temperate Forests and Great Plains. Transitioning across or being in close proximity to these ecological zones may offer another explanatory factor in high species diversity of the St. Croix River region.

The distribution of individuals followed a standard pattern for chironomids with 91 species (36%) having only one or two specimens and only 14 species (5%) having over 100 specimens. The

four most common species were *Synorthocladius semivirens* with 420 specimens, *Thienemannimyia lobapodema* with 249, *Corynoneura collaris* with 225 and *Nanocladius* sp. SC 1 with 201.

Sixty morphotypes, including 41 in Chironominae and 16 in Orthocladiinae, did not fit any published species description. It is typical for a handful of genera such as *Polypedilum*, *Cricotopus*, *Cryptochironomus* and *Tanytarsus* to have many unknown pupal exuviae, particularly in studies with a high richness (Coffman 1973, Bouchard 2007). Few unknowns occurred in Tanypodinae and Diamesinae. In Orthocladiinae, *Psectrocladius* and *Parakiefferiella* also had numerous unknown species. *Psectrocladius* is a complex genus that needs a revision and *Parakiefferiella* is also complicated and requires a Nearctic revision since many species from the Palearctic appear to be present in North America, based on species that fit well with descriptions in Tuiskunen (1986) and Makarchenko & Makarchenko (2010b). In Chironominae, *Cryptochironomus*, *Demicryptochironomus*, *Microtendipes*, *Parachironomus*, *Paratanytarsus*, *Polypedilum* and *Rheotanytarsus* all had at least half of their richness as unknown exuviae. Most of these genera are diverse, with much of the Nearctic diversity undescribed or unassociated with pupal exuviae, so it's not surprising to encounter many unknown morphotypes.

When habitat is described in the literature, the majority of species we found are dwellers of lotic habitats. The 35 species from this study that were previously unknown from lotic systems are likely either uncommon residents of rivers and streams, occur in slow-flow areas off the main channel of the river, occupy hygropetric or riparian areas, or may have originated from above or near the Gordon Dam. A couple of these species were in Tanypodinae (2), but most were split between Orthocladiinae (14) and Chironominae (19). Microhabitats can play an interesting role in local diversity (e.g. Ferrington 1984), which we also found in freshwater coastal pool habitats of Lake Superior where lotic species were found low on the shore where consistent wave action mimics flowing water (Egan & Ferrington 2015).

We believe that few specimens from the Gordon Dam site originated from the impoundment since

specimens found directly below the dam were often broken, presumably due to mechanical action of passing over the dam. Specimens from our collection site 150+ meters downstream generally included whole individuals, which may have emerged from the area of altered hydrology directly below the dam. Above the riffles at the Scott Bridge site there is a wide, shallow area where lentic-preference species may have developed and emerged.

We found 21 species with range expansions that include either a broader Nearctic extent into the western Great Lakes or that appear to be previously unknown to the Nearctic. Particularly useful have been recent revisions with new species descriptions from the Russian Far East (e.g. Makarchenko & Makarchenko 2006, 2010a, 2010b). Most of these new range expansions were in Orthocladiinae (15), with only a handful in Chironominae (3) and Tanypodinae (3).

Overall, there was a higher richness than we would have expected from only four sites on the upper St. Croix River. Only one similar study (Bouchard 2007), on headwater streams in eastern Minnesota, had a comparable richness, suggesting that conditions in the region may play a role in supporting a particularly diverse aquatic invertebrate community. Our discovery of novel habitat associations and range expansions argues for the utility of identifying Chironomidae to the species level when possible.

ACKNOWLEDGEMENTS

An excellent review and conversation with Bohdan Bilyj resulted in important and valuable improvements to the manuscript, including numerous life-stage associations. Thanks also to Rick Damstra, Byron Karns and David VanderMeulen for additional comments. Initial support for this research was provided through a grant from the National Park Service to LCF. Additional support was provided by a grant from the Minnesota Agricultural Experiment Station, MAES Project # 17-031, also to LCF. Permission for field work and sample retention was provided by the St. Croix Falls, WI office of the St. Croix National Scenic Riverway. Research staff of the Chironomidae Research Group within the Department of Entomology at the University of

Minnesota participated in sample collection, sorting, slide mounting and labeling of specimens, and their diligent efforts are appreciated and valued. Mr. Byron Karns, Ranger and Natural Resources Manager of the National Scenic Riverway, provided substantial assistance and guidance in the planning and execution of this project, both in terms of involvement in site selection and field work. His assistance was essential for the successful completion of this report. Additional clerical and administrative support was provided by the Department of Entomology, College of Foods, Agricultural and Natural Resources Sciences at the University of Minnesota. Interpretation of these data reflect the views of the authors and do not represent those of the U.S. National Park Service.

LITERATURE CITED

- Aagaard K, Olsen A, Solem JO (1987) Chironomids of Blesbekken, an alpine tundra stream at Dovrefjell national park, Norway. *Entomologica Scandinavica* Supplement 29: 349-354.
- Andersen T, Cranston PS, Epler JH (eds) (2013) Chironomidae of the Holarctic Region: keys and diagnoses. Part 1. Larvae. *Insect Systematics and Evolution Supplements* 66: 1-571.
- Anderson AM, Stur E, Ekrem T (2013) Molecular and morphological methods reveal cryptic diversity and three new species of Nearctic *Micropsectra* (Diptera: Chironomidae). *Freshwater Science* 32: 892-921.
- Armitage PD, Cranston PS, Pinder LCV (1995) *The Chironomidae: biology and ecology of non-biting midges*. Chapman & Hall, London, UK. 572 pp.
- Ashe P, O'Connor JP (2009) *A world catalogue of Chironomidae (Diptera)*. Part 1. Buchonomyiinae, Chilenomyiinae, Podonominae, Aphroteniinae, Tanypodinae, Usambaromyiinae, Diamesinae, Prodiamesinae and Telmatogetoninae. Irish Biogeographical Society & National Museum of Ireland, Dublin. 445 pp.
- Ashe P, O'Connor JP (2012) *A world catalogue of Chironomidae (Diptera)*. Part 2. Orthoclaadiinae. Irish Biogeographical Society & National Museum of Ireland, Dublin. 968 pp.
- Beck WM, Beck EC (1966) Chironomidae (Diptera) of Florida I. Pentaneurini (Tanypodinae). *Bulletin of the Florida State Museum* 10: 303-379.
- Beck EC, Beck WM (1969) Chironomidae (Diptera) of Florida III. The *Harnischia* complex (Chironomidae). *Bulletin of the Florida State Museum* 13: 277-313.
- Beck WM, Beck EC (1970) The immature stages of some Chironomini (Chironomidae). *Quarterly Journal of the Florida Academy of Sciences* 33: 29-42.
- Berg MB, Hellenthal RA (1991) Secondary production of Chironomidae (Diptera) in a north temperate stream. *Freshwater Biology* 25: 497-505.
- Bilyj B (1984) Descriptions of two new species of Tanypodinae (Diptera: Chironomidae) from southern Indian Lake, Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 659-671.
- Bilyj B (1988) A taxonomic review of *Guttipelopia* (Diptera: Chironomidae). *Entomologica Scandinavica* 19: 1-26.
- Bilyj B, Davies IJ (1989) Descriptions and ecological notes on seven new species of *Cladotanytarsus* (Chironomidae: Diptera) collected from an experimentally acidified lake. *Canadian Journal of Zoology* 67: 948-962.
- Boerger H (1981) Species composition, abundance and emergence phylogeny of midges (Diptera: Chironomidae) in a brown-water stream of West-Central Alberta, Canada. *Hydrobiologia* 80: 7-30.
- Borkent A (1984) The systematics and phylogeny of the *Stenochironomus* complex (*Xestochironomus*, *Harrisius*, and *Stenochironomus*) (Diptera: Chironomidae). *Memoirs of the Entomological Society of Canada* 1-270.
- Bouchard, Jr RW (2007) *Phenology and taxonomic composition of lotic Chironomidae (Diptera) communities in contrasting thermal regimes*. Ph.D. dissertation, University of Minnesota. 411 pp.
- Bouchard, Jr RW, Ferrington, Jr LC (2011) The effects of subsampling and sampling frequency on the use of surface-floating pupal exuviae to measure Chironomidae (Diptera) communities in wadeable temperate streams. *Environmental Monitoring and Assessment* 181: 205-223.
- Caldwell BA (1997) A new species of *Omisus* Townes (Diptera: Chironomidae) from Georgia and the

- Southeast USA. In: Hoffrichter O (editor): *Late 20th Century Research on Chironomidae: An Anthology from the 13th International Symposium on Chironomidae*: 59-67.
- Caldwell BA (1985) *Paracricotopus millrockensis*, a new species of Orthocladiinae (Diptera: Chironomidae) from the Southeastern United States. *Brimleyana* 11: 161-168.
- Caldwell BA (2000) First Nearctic record of *Neostempellina* Reiss, with description of a new species. *Spixiana* 23: 163-166.
- Caldwell BA (2007) Morphological variation, additional distribution records, and notes on ecology of *Pagastia orthogonia* Oliver (Diptera: Chironomidae). In, Andersen T (editor), *Contributions to the Systematics and Ecology of Aquatic Diptera – A Tribute to Ole A. Saether*. The Caddis Press: 69-72.
- Caldwell BA, Bode RW, Smith AJ (2010) Description of the immature stages and adult female of *Neostempellina reissi* Caldwell (Diptera: Chironomidae). In, Ferrington LC (editor) *Proceedings of the XV International Symposium on Chironomidae*: 272-284.
- Clarke A, Mac Nally R, Bond N, Lake PS (2008) Macroinvertebrate diversity in headwater streams: a review. *Freshwater Biology* 53: 1707-1721.
- Coffman WP (1973) Energy flow in a woodland stream ecosystem: II. The taxonomic composition and phenology of the Chironomidae as determined by the collection of pupal exuviae. *Archiv für Hydrobiologie* 71: 281-322.
- Coffman WP (1989) Factors that determine the species richness of lotic communities of Chironomidae. *Acta Biologica Debrecina, Supplementum Oecologica Hungarica* 3: 95-100.
- Coffman WP, Roback SS (1984) *Lopescladius* (*Cordiella*) *hyporheicus*, a new subgenus and species (Diptera: Chironomidae: Orthocladiinae). *Proceedings of the Academy of Natural Sciences of Philadelphia* 136: 130-144.
- Coffman WP, Cranston PS, Oliver DR, Saether OA (1986) The pupae of Orthocladiinae (Diptera: Chironomidae) of the Holarctic region – Keys and diagnoses. *Entomologica Scandinavica Supplement* 28: 147-296.
- Contreras-Lichtenberg R (1999) Revision der westpaläarktischen Arten des Genus *Glyptotendipes* Kieffer, 1913 (Insecta: Diptera: Chironomidae). Teil 1: Subgenus *Phytotendipes* Goetghebuer, 1937. *Annalen des Naturhistorischen Museums in Wien* 101 B: 359-403.
- Contreras-Lichtenberg R (2001) Revision der westpaläarktischen Arten des Genus *Glyptotendipes* Kieffer, 1913 (Insecta: Diptera, Nematocera, Chironomidae). Teil 2: Sg. *Glyptotendipes* s.str. Kieffer, 1913 und Sg. *Trichotendipes* Heyn, 1993. *Annalen des Naturhistorischen Museums in Wien* 103 B: 417-451.
- Cuppen H, Gresens SE, Tempelman D (*in press*) Description of the larvae of *Cricotopus festivellus* (Kieffer 1906) and *Cricotopus diversus* (Boesel 1983) with keys to discrimination of larval, pupal and adult stages (Diptera: Chironomidae). *CHIRONOMUS Journal of Chironomidae Research*.
- Curry LL (1958) Larvae and pupae of the species of *Cryptochironomus* (Diptera) of Michigan. *Limnology and Oceanography* 3: 427-442.
- Dendy JS, Sublette JE (1959) The Chironomidae (= Tendipedidae: Diptera) of Alabama with descriptions of six new species. *Annals of the Entomological Society of America* 52: 506-519.
- Doughman JS (1985) *Annotated keys to the genera of the tribe Diamesini (Diptera: Chironomidae), descriptions of the female and immatures of Potthastia iberica Tosio, and keys to the known species of Potthastia*. Institute of Water Resources/Engineering Experiment Station, Report IWR-107, University of Alaska-Fairbanks 50 pp.
- Egan AT, Ferrington, Jr LC (2015) Chironomidae (Diptera) in freshwater coastal rock pools at Isle Royale, Michigan. *Transactions of the American Entomological Society* 141: 1-25.
- Egan AT, Langton PH (2018) Descriptions of four Nearctic *Procladius* Skuse pupal exuviae. *Chironomus Journal of Chironomidae Research* 31: 30-36.
- Ekrem T (2004) Immature stages of European *Tanytarsus* species I. The *eminulus*-, *gregarius*-, *lugens*- and *mendax* species groups (Diptera, Chironomidae). *Deutsche Entomologische*

- Zeitschrift* 51: 97-146.
- Ekrem T (2007) A taxonomic revision of the genus *Stempellinella* (Diptera: Chironomidae). *Journal of Natural History* 41: 1367-1465.
- Ekrem T, Sublette MF, Sublette JE (2003) North American *Tanytarsus* I. Descriptions and keys to species in the *eminulus*, *gregarius*, *lugens* and *mendax* species groups (Diptera: Chironomidae). *Annals of the Entomological Society of America* 96: 265-328.
- Environmental Protection Agency (2016). Available from: <https://www.epa.gov/eco-research/ecoregions-north-america> (accessed August 2019).
- Epler JH (1988) Biosystematics of the genus *Dicrotendipes* Kieffer, 1913 (Diptera: Chironomidae: Chironominae) of the world. *Memoirs of the American Entomological Society* 36: 1-214.
- Epler JH (2016) A new species of *Dicrotendipes* (Diptera: Chironomidae) from Florida. *Zootaxa* 4208: 077-083.
- Epler JH (2018) The genus *Cryptotendipes* Beck et Beck in Florida, with the description of a new species (Diptera: Chironomidae: Chironominae). *Zootaxa* 4433: 583-594.
- Fancy SG, Gross JE, Carter SL (2009) Monitoring the condition of natural resources in US National Parks. *Environmental Monitoring and Assessment* 151: 161-174.
- Ferrington Jr LC (1984) Evidence for the hyporheic zone as a microhabitat of *Krenosmittia* spp. Larvae (Diptera: Chironomidae). *Journal of Freshwater Ecology* 2: 353-358.
- Ferrington Jr LC, Blackwood MA, Wright CA, Crisp NH, Kavanaugh JL, Schmidt FJ (1991) A protocol for using surface-floating pupal exuviae of Chironomidae for rapid bio assessment of changing water quality. In: *Sediment and Stream Water Quality in a Changing Environment: Trends and Explanations*. IAHS Publ. 203: 181-190.
- Ferrington Jr LC, Coffman WP, Berg MB (2008) *Chironomidae*. In: R. W. Merritt, K. W. Cummins and M. B. Berg (editors). An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Co., Dubuque, IA 1214 pp.
- Fu Y, Saether OA (2012) *Corynoneura* Winnertz and *Thienemanniella* Kieffer from the Nearctic region (Diptera: Chironomidae: Orthocladiinae). *Zootaxa* 3536: 1-61.
- Fu, Y, Fang X, Wang X (2019) Taxonomy of *Corynoneura* Winnertz (Diptera: Chironomidae). Academic Press, UK 343 pp.
- Fusari LM, Oliveira Roque F, Hamada N (2013) Review of *Xenochironomus* Kieffer, 1921 (Diptera: Chironomidae) with description of six new species. *Zootaxa* 3646: 101-126.
- Gilka W (2005) A systematic review of European *Stempellina* Thienemann et Bause, 1913 (Diptera: Chironomidae) with description of a new species from Fennoscandia. *Annales Zoologici* 55: 413-419.
- Gilka W (2011) Six unusual *Cladotanytarsus* Kieffer: towards a systematics of the genus and resurrection of *Lenziella* Kieffer (Diptera: Chironomidae: Tanytarsini). *Zootaxa* 3100: 1-34.
- Grodhaus G (1976) Two species of *Phaenopsectra* with drought-resistant larvae (Diptera: Chironomidae). *Journal of the Kansas Entomological Society* 49: 405-418.
- Grodhaus G (1987a) *Phaenopsectra mortonsoni* n. sp. and its relationship to other Chironomidae (Diptera) of temporary pools. *Entomologica Scandinica Supplement* 29: 137-145.
- Grodhaus G (1987b) *Endochironomus* Kieffer, *Tribelos* Townes, *Synendotendipes*, n. gen., and *Endotribelos*, n. gen. (Diptera: Chironomidae) of the Nearctic region. *Journal of the Kansas Entomological Society* 60: 167-247.
- Hansen DC, Cook EF (1976) The systematics and morphology of the Nearctic species of *Diamesa* Meigen, 1835 (Diptera: Chironomidae). *Memoirs of the American Entomological Society* 30: 1-203.
- Hayes BP, Murray DA (1987) Species composition and emergence of Chironomidae (Diptera) from three high arctic streams on Bathurst Island, Northwest Territories, Canada. *Entomologica Scandinavica Supplement* 29: 355-360.
- Hayford B (1998) A systematic revision of *Paratendipes* (Diptera: Chironomidae) with special emphasis on the evolution of thermophily. Ph.D. dissertation, University of Kansas. 274 pp.
- Hestenes TC, Saether OA (2000) Three new Nearctic

- Thienemanniella* Kieffer species with a review of the Nearctic species. In: Hoffrichter O (editor): *Late 20th Century research on Chironomidae: an anthology from the 13th international symposium on Chironomidae*, Shaker Verlag, Aachen: 103-127.
- Hirvenoja M (1973) Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera: Chironomidae). *Annales Zoologici Fennici* 10: 1-363.
- Hirvenoja M, Hirvenoja E (1988) *Corynoneura brundini* spec. nov. Ein Beitrag zur Systematik der Gattung *Corynoneura*. *Spixiana* 14: 213-238
- Jackson GA (1977) Nearctic and Palearctic *Paracladopelma* Harnisch and *Saetheria* n. gen. (Diptera: Chironomidae). *Journal of the Fisheries Research Board of Canada* 34: 1321-1359.
- Jackson JK, Battle JM, White BP, Pilgrim EM, Stein ED, Miller PE, Sweeney BW (2014) Cryptic biodiversity in streams: a comparison of macroinvertebrate communities based on morphological and DNA barcode identifications. *Freshwater Science* 33: 312-324.
- Jacobsen RE (2008) *A key to the pupal exuviae of the midges (Diptera: Chironomidae) of Everglades National Park, Florida*. Scientific Investigations Report 2008-5082. U.S. Geological Survey, Reston, VA. 119 pp.
- Johannsen OA (1937) *Aquatic Diptera*. Part III. Chironomidae: subfamilies Tanypodinae, Diamesinae, and Orthocladiinae. Memoir 205. Cornell University Agricultural Experiment Station. 84 pp.
- Kraft GJ, Mechenich C, Mechenich DJ, Cook JE, McNelly JL (2015) *Natural resource condition assessment: Saint Croix National Scenic Riverway*. Natural Resource Report NPS/SACN/NRR-2015/1003. National Park Service, Fort Collins, Colorado. 221 pp.
- Kranzfelder P, Anderson AM, Egan AT, Mazack JE, Bouchard Jr RW, Rufer MM, Ferrington Jr LC (2015) Use of Chironomidae (Diptera) surface-floating pupal exuviae as a rapid bioassessment protocol for water bodies. *Journal of Visualized Experiments* 101: 1-9.
- Kyerematen RA, Saether OA, Andersen T (2000) A review of the *Rheotanytarsus pellucidus* group (Diptera: Chironomidae). Late 20th Century Research on Chironomidae: an Anthology from the 13th International Symposium on Chironomidae, pp. 147-170 (ed. O. Hoffrichter).
- Kyerematen RA, Andersen T (2002) *Rheotanytarsus* Thienemann et Bause (Diptera: Chironomidae) from Central America and Mexico. *Studies on Neotropical Fauna and Environment* 37: 23-51.
- Langton PH (1991) *A key to pupal exuviae of West Palearctic Chironomidae*. Cambridgeshire, UK. 386 pp.
- Lehman J (1969) Die europäischen Arten der Gattung *Rheocricotopus* THIEN. und HARN. Und drei neue Artvertreter dieser Gattung aus der Orientalis (Diptera, Chironomidae). *Archiv für Hydrobiologie* 66: 348-381.
- Lehman J (1972) Revision der europäischen Arten (Puppen und Imagines) der Gattung *Eukiefferiella* Thienemann. *Beiträge zur Entomologie* 22: 347-405.
- Lenat D (1987) The macroinvertebrate fauna of the Little River, North Carolina: taxa list and seasonal trends. *Archiv für Hydrobiologie* 110: 19-43.
- Lencioni V, Rossaro B (2005) Microdistribution of chironomids (Diptera: Chironomidae) in alpine streams: an autecological perspective. *Hydrobiologia* 533: 61-76.
- LeSage L, Harrison AD (1980) Taxonomy of *Cricotopus* species (Diptera: Chironomidae) from Salem Creek, Ontario. *Proceedings of the Entomological Society of Ontario* 111: 57-114.
- Lin X, Stur E, Ekrem T (2017) DNA barcodes and morphology reveal unrecognized species in Chironomidae (Diptera). *Insect Systematics & Evolution* (2017): 1-70.
- Makarchenko EA, Makarchenko MA (2000) Revision of *Pagastia* Oliver, 1959 (Diptera, Chironomidae) of the Holarctic region. In: Hoffrichter O (editor): *Late 20th Century Research on Chironomidae: an Anthology from the 13th International Symposium on Chironomidae*: 171-176.
- Makarchenko EA, Makarchenko MA (2003) A new and little known species of *Stilocladius* Rossaro, 1979 (Diptera: Chironomidae: Orthocladiinae) from the Russian Far East. *Euroasian Entomological Journal* 2: 135-140.

- Makarchenko EA, Makarchenko MA (2006) Chironomids of the genera *Corynoneura* Winnertz, 1846 and *Thinemanniella* Kieffer, 1919 (Diptera, Chironomidae, Orthocladiinae) of the Russian Far East. *Euroasian Entomological Journal* 5: 151-162.
- Makarchenko EA, Makarchenko MA, Yavorskaya NM (2009) New records of chironomids (Diptera, Chironomidae, Orthocladiinae) in Far East and bordering territories. VI. *Hydrobaenus* Fries. *Euroasian Entomological Journal* 1: 33-50.
- Makarchenko EA, Makarchenko MA (2010a) New data on the fauna and taxonomy of *Corynoneura* Winnertz (Diptera, Chironomidae, Orthocladiinae) for the Russian Far East and bordering territories. *Euroasian Entomological Journal* 9: 353-370.
- Makarchenko EA, Makarchenko MA (2010b) A review of *Parakiefferiella* Thienemann (Diptera, Chironomidae, Orthocladiinae) from the Russian Far East. *Euroasian Entomological Journal* 9: 397-410.
- Makarchenko EA, Makarchenko MA, Semenchenko AA (2019) Towards the taxonomy of *Corynoneura* Winnertz (Diptera: Chironomidae: Orthocladiinae) from the Russian Far East and Eastern Siberia. *Zootaxa* 4612: 221-236.
- Martin J. *North American species of the genus Chironomus as recognized by larval cytology and morphology*. <http://www.chironomidae.net/Martin/NACyfiles/NACHiron.html> (accessed May 2019).
- Maschwitz DE, Cook EF (2000) Revision of the Nearctic species of the genus *Polypedilum* Kieffer (Diptera: Chironomidae) in the subgenera *P.* (*Polypedilum*) Kieffer and *P.* (*Uresipedilum*) Oyewo and Saether. *Bulletin of the Ohio Biological Survey* 12: 1-135.
- Morrissey T (1950) Tanypodinae of Iowa (Diptera). III. *American Midland Naturalist* 43 (1): 88-91.
- Moubayed-Breil J, Orsini A (2016) On the genus *Potthastia* Kieffer, 1922 from Corsica and continental France with description of three new species [Diptera, Chironomidae, Diamesinae]. *Ephemera* 17: 1-36.
- Murray DA, Fittkau EJ (1985) *Hayesomyia* a new genus of Tanypodinae from the Holarctic. *Spixiana Supplement* 11: 195-207.
- Neff SE (1955) Studies on a Kentucky Knobs Lake II. Some aquatic Nematocera (Diptera) from Tom Wallace Lake. *Transactions of the Kentucky Academy of Science* 16 (1): 1-13.
- Niemela S, Christopherson D, Genet J, Chirhart J, Feist M (2004) *Condition of rivers and streams in the St. Croix River basin of Minnesota*. Minnesota Pollution Control Agency, Biological Monitoring Program, St. Paul, MN 65 pp.
- Oliveira C, Silva F (2011) Two new species of *Larsia* Fittkau, 1962 (Diptera: Chironomidae: Tanypodinae) from Neotropical Region, with a checklist of *Larsia* species of the world. *Zootaxa* 2786: 27-41.
- Oliver DR (1971) Description of *Einfeldia synchrona* n.sp. (Diptera: Chironomidae). *The Canadian Entomologist* 103: 1591-1595.
- Oliver DR (1976) *Bicinctus*-group of the genus *Cricotopus* Van der Wump (Diptera: Chironomidae) in the Nearctic with a description of a new species. *Journal of the Fisheries Research Board of Canada* 34: 98-104.
- Oliver, DR, Bode RW (1985) Description of the larva and pupa of *Cardiocladius albiplumus* Saether (Diptera: Chironomidae). *The Canadian Entomologist* 117: 803-809.
- Oliver DR, Dillon ME (1988) Review of *Cricotopus* (Diptera: Chironomidae) of the Nearctic Arctic zone with description of two new species. *The Canadian Entomologist* 120: 463-496.
- Oliver DR, Dillon ME, Cranston PS (1990) *A catalog of Nearctic Chironomidae*. Research Branch Agriculture Canada, Publication 1857/B. 89 pp.
- Oliver DR, Dillon ME (1994) Systematics of some species of *Micropsectra* (Diptera: Chironomidae) living in low-order streams in southern Ontario, Canada. *The Canadian Entomologist* 126: 199-217.
- Orel OV (2014) To systematics of the genus *Saetheria* Jackson (Diptera, Chironomidae) from the Russian Far East. *Zootaxa* 3802: 65-74.
- Oyewo EA, Saether OA (2008) Revision of *Polypedilum* (*Pentapedilum*) Kieffer and *Ainuyusurika* Sasa et Shirasaki (Diptera: Chironomidae). *Zootaxa* 1953: 1-145.
- Pagast F (1947) Systematik und Verbreitung der um die Gattung *Diamesa* gruppeirten Chironomiden.

- Archiv für Hydrobiologie* 41: 435-596.
- Pinder LCV, Reiss F (1986) The pupae of Chironominae (Diptera: Chironomidae) of the Holarctic region – Keys and diagnoses. *Entomologica Scandinavica Supplement* 28: 299-456.
- Puchalski M, Gilka W (2017) *Cladotanytarsus* Kieffer (Diptera: Chironomidae): several distinctive species reviewed on the basis of records from Canada and USA. *Zootaxa* 4242: 344-358.
- Punti T, Rieradevall M, Prat N (2009) Environmental factors, spatial variation, and specific requirements of Chironomidae in Mediterranean reference streams. *Journal of the North American Benthological Society* 28: 247-265.
- Raunio J, Muotka T (2005) The use of chironomid pupal exuviae in river biomonitoring: the importance of sampling strategy. *Archiv für Hydrobiologie* 164: 529-545.
- Raunio J, Paavola R, Muotka T (2007) Effects of emergence phenology, taxa tolerances and taxonomic resolution on the use of the Chironomid Pupal Exuvial Technique in river biomonitoring. *Freshwater Biology* 52: 165-176.
- Reiss F (1988) *Irmakia*, ein neues Subgenus von *Demicryptochironomus* Lenz, 1941, mit der Beschreibung von vier neuen Arten. *Spixiana* 11: 1-12.
- Reiss F (1990) Revision der Gattung *Zavreliella* Kieffer, 1920. *Spixiana* 13: 83-115.
- Reiss F, Säwedel L (1981) Key to males and pupae of the Palearctic (excl. Japan) *Paratanytarsus* Thienemann & Bause, 1913, n. comb., with descriptions of three new species (Diptera: Chironomidae). *Entomologica Scandinavica Supplement* 15: 73-104.
- Roback SS (1957) The immature Tendipedids of the Philadelphia area (Diptera: Tendipedidae). *Monographs of the Academy of Natural Sciences of Philadelphia* 9: 152 pp.
- Roback SS (1971) The adults of the subfamily Tanypodinae (= Pelopiinae) in North America (Diptera: Chironomidae). *Monographs of the Academy of Natural Sciences of Philadelphia* 17: 410 pp.
- Roback SS (1972) The immature stages of *Paramerina smithae* (Sublette) (Diptera: Chironomidae: Tanypodinae). *Proceedings of the Academy of Natural Sciences of Philadelphia* 124: 11-15.
- Roback SS (1975a) A new subgenus and species of the genus *Tanytarsus* (Chironomidae: Chironominae: Tanytarsini). *Proceedings of the Academy of Natural Sciences of Philadelphia* 127: 71-80.
- Roback SS (1976a) The immature chironomids of the Eastern United States I: Introduction and Tanypodinae-Coelotanypodini. *Proceedings of the Academy of Natural Sciences of Philadelphia* 127: 147-201.
- Roback SS (1976b) The immature chironomids of the Eastern United States II. Tanypodinae: Tanypodini. *Proceedings of the Academy of Natural Sciences of Philadelphia* 128: 55-88.
- Roback SS (1980) The immature chironomids of the Eastern United States IV. Tanypodinae-Procladiini. *Proceedings of the Academy of Natural Sciences of Philadelphia* 132: 1-63.
- Roback SS (1981) The immature chironomids of the Eastern United States V. Pentaneurini-*Thienemannimyia* group. *Proceedings of the Academy of Natural Sciences of Philadelphia* 133: 73-128.
- Roback SS (1985) The immature chironomids of the Eastern United States VI. Pentaneurini-Genus *Ablabesmyia*. *Proceedings of the Academy of Natural Sciences of Philadelphia* 137: 153-212.
- Roback SS (1986) The immature chironomids of the Eastern United States VIII: Pentaneurini: Genus *Nilotanypus*, with description of a new species from Kansas. *Proceedings of the Academy of Natural Sciences of Philadelphia* 138: 443-465.
- Roback SS (1987) The immature Chironomids of the Eastern United States IX. Pentaneurini – Genus *Labrundinia* with the description of some Neotropical material. *Proceedings of the Academy of Natural Sciences of Philadelphia* 139: 159-209, 1987.
- Roback SS, Tennessen KJ (1978) The immature stages of *Djalmabatista pulcher* [= *Procladius* (*Calotanypus*) *pulcher* (Joh.)]. *Proceedings of the Academy of Natural Sciences of Philadelphia* 130: 11-20.
- Ruse LP, Herrmann SJ, Sublette JE (2000) Chironomidae (Diptera) species distribution

- related to environmental characteristics of the metal-polluted Arkansas River, Colorado. *Western North American Naturalist* 60: 34-56.
- Saether OA (1969) Some Nearctic Pedominae, Diamesinae, and Orthoclaadiinae (Diptera: Chironomidae). *Fisheries Research Board of Canada Bulletin* 170. 154 pp.
- Saether OA (1975) Nearctic and Palearctic *Heterotrissocladius* (Diptera: Chironomidae). *Bulletin of the Fisheries Research Board of Canada* 193. 67 pp.
- Saether OA (1976) Revision of *Hydrobaenus*, *Trissocladius*, *Zalutschia*, *Paratrissocladius*, and some related genera (Diptera: Chironomidae). *Bulletin of the Fisheries Research Board of Canada* 195. 287 pp.
- Saether OA (1977) Taxonomic studies on Chironomidae: *Nanocladius*, *Pseudochironomus*, and the *Harnischia* complex. *Bulletin of the Fisheries Research Board of Canada* 196. 143 pp.
- Saether OA (1980) The females and immatures of *Paracricotopus* Thienemann and Harnisch, 1932, with the description of a new species (Diptera: Chironomidae). *Aquatic Insects* 2: 129-145.
- Saether OA (1981) *Doncricotopus bicaudatus* n. gen. n. sp. (Diptera: Chironomidae, Orthoclaadiinae) from the Northwest Territories, Canada. *Entomologica Scandinavica* 12: 223-229.
- Saether OA (1982) Orthoclaadiinae (Diptera: Chironomidae) from SE U.S.A., with descriptions of *Pludsonia*, *Unniella* and *Platysmittia* n. genera and *Atelopodella* n. subgen. *Entomologica Scandinavica* 13: 465-510.
- Saether OA (1983) Three new species of *Lopescladius* Oliverira, 1967 (syn. "*Cordites*" Brundin 1966, n. syn.), with a phylogeny of the *Parakiefferiella* group. *Memoirs of the American Entomological Society* 34: 279-298.
- Saether OA (1985) A review of the genus *Rheocricotopus* Thienemann & Harnisch, 1932, with the description of three new species. *Spixiana Supplement* 11: 59-108.
- Saether OA (1989) Two new species of *Hydrobaenus* Fries from Massachusetts, U.S.A., and Japan (Diptera: Chironomidae). *Entomologica Scandinavica* 20: 55-63.
- Saether OA (1990) A review of the genus *Limnophyes* Eaton from the Holarctic and Afrotropical regions (Diptera: Chironomidae, Orthoclaadiinae). *Entomologica Scandinavica Supplement* 35: 1-139.
- Saether OA (2003) A review of *Orthoclaadius* subgen. *Symposiocladius* Cranston (Diptera: Chironomidae). *Aquatic Insects* 25: 281-317.
- Saether OA (2005) A new subgenus and new species of *Orthoclaadius* van der Wulp, with a phylogenetic evaluation of the validity of the subgenera of the genus (Diptera: Chironomidae). *Zootaxa* 974: 1-56.
- Saether OA (2009) *Cryptochironomus* Kieffer from Lake Winnipeg, Canada, with a review of Nearctic species (Diptera: Chironomidae). *Zootaxa* 2208: 1-24.
- Saether OA (2010a) *Procladius* Skuse from Lake Winnipeg, Manitoba, Canada, with keys to some females and immature stages of the genus (Diptera: Chironomidae). *Zootaxa* 2726: 34-58.
- Saether OA (2010b) *Cryptotendipes* Lenz from Manitoba, Canada, with keys to known immatures of the genus (Diptera: Chironomidae). *Zootaxa* 2412: 1-20.
- Saether OA (2011) Notes on Canadian *Ablabesmyia* Johannsen, with keys to known Nearctic immatures of the genus (Diptera: Chironomidae). *Zootaxa* 3069: 43-62.
- Saether OA, Halvorsen GA (1981) Diagnoses of *Tvetenia* Kieff. Emend., *Dratnalia* n. gen., and *Eukiefferiella* Thien. emend., with a phylogeny of the *Cardiocladius* group (Diptera: Chironomidae). *Entomologica Scandinavica Supplement* 15: 269-285.
- Saether OA, Schnell OA (1988) Two new species of the *Rheocricotopus* (R.) *effusus* group (Diptera: Chironomidae). *Spixiana Supplement* 14: 54-74.
- Saether OA, Wang X (1995) Revision of the genus *Paraphaenocladius* Thienemann, 1924 of the world (Diptera: Chironomidae, Orthoclaadiinae). *Entomologica Scandinavica Supplement* 48: 1-69.
- Saether OA, Sundal A (1998) *Cerobregma*, a new subgenus of *Polypedilum* Kieffer, with a tentative phylogeny of subgenera and species groups within *Polypedilum* (Diptera: Chironomidae). *Journal of the Kansas Entomological Society* 71:

- 315-382.
- Saether OA, Kyerematen RAK (2001) Towards phylogeny and zoogeography of the genus *Rheotanytarsus* Thienemann et Bause, 1913 (Diptera: Chironomidae). *Tijdschrift voor Entomologie* 144: 73-117.
- Saether OA, Oyewo EA (2008) Keys, phylogenies and biogeography of *Polypedilum* subgenus *Uresipedilum* Oyewo et Saether (Diptera, Chironomidae). *Zootaxa* 1806: 1-34.
- Saether OA, Andersen T, Pinho LC, Mendes HF (2010) The problems with *Polypedilum* Kieffer (Diptera: Chironomidae), with the descriptions of *Probolum* subgen. n. *Zootaxa* 2497: 1-36.
- Saether OA, Langton PH (2011) New Nearctic species of the *Psectrocladius limbatellus* group (Diptera: Chironomidae). *Aquatic Insects* 33: 133-163.
- Säwedäl L (1976) Revision of the *notescens*-group of the genus *Micropsectra* Kieffer, 1909 (Diptera: Chironomidae). *Entomologica Scandinavica* 7: 109-144.
- Silva FL, Fonseca-Gessner AA, Ekrem T (2014) A taxonomic revision of genus *Labrundinia* Fittkau, 1962 (Diptera: Chironomidae: Tanypodinae). *Zootaxa* 3769 (1): 001-185.
- Silva FL, Ferrington Jr LC (2018) Systematics of the new world genus *Pentaneura* Phillip (Diptera: Chironomidae: Tanypodinae): Historical review, new species and phylogeny. *Zoologischer Anzeiger* (2018): 1-30.
- Simpson KW, Bode RW, Albu P (1983) Keys for the genus *Cricotopus* adapted from "Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera: Chironomidae)" by M. Hirvenoja. *New York State Museum, Bulletin No.* 450.
- Soponis AR (1977) A revision of the Nearctic species of *Orthocladius* (*Orthocladius*) Van Der Wulp (Diptera: Chironomidae). *Memoirs of the Entomological Society of Canada* 102: 1-187.
- Soponis AR (1987) Notes on *Orthocladius* (*Orthocladius*) *frigidus* (Zetterstedt) with a redescription of the species (Diptera: Chironomidae). *Entomologica Scandinavica Supplement* 29: 123-131.
- Soponis AR (1990) A revision of the Holarctic species of *Orthocladius* (*Euorthocladius*). *Spixiana Supplement* 13, 68 pp.
- Spies M (2000) A contribution to the knowledge of Holarctic *Parachironomus* Lenz (Diptera: Chironomidae), with two new species and a provisional key to Nearctic adult males. *Tijdschrift voor Entomologie* 143: 125-143.
- Spies M, Saether OA (2004) Notes and recommendations on taxonomy and nomenclature of Chironomidae (Diptera). *Zootaxa* 752:1-90.
- Steffan AW (1965) *Plecoptera coluthus downesi* gen. et sp. nov. (Diptera: Chironomidae), a species whose larvae live phoretically on larvae of Plecoptera. *The Canadian Entomologist* 97: 1323-1344.
- Steiner JW (1983) *Paracricotopus mozleyi* n. sp. from Georgia, U.S.A. (Diptera: Chironomidae). *Memoirs of the American Entomological Society* 34: 331-335.
- Stur E, Ekrem T (2006) A revision of West Palearctic species of the *Micropsectra atrofasciata* species group (Diptera: Chironomidae). *Zoological Journal of the Linnean Society* 146: 165-225.
- Stur E, Silva FL, Ekrem T (2019) Back from the past: DNA barcodes and morphology support *Ablabesmyia americana* Fittkau as a valid species (Diptera: Chironomidae). *Diversity* 11: 1-15.
- Sublette JE (1964) Chironomidae (Diptera) of Louisiana I. Systematics and immature stages of some lentic chironomids of westcentral Louisiana. *Tulane Studies of Zoology* 11: 109-150.
- Sublette JE, Stevens LE, Shannon JP (1998) Chironomidae (Diptera) of the Colorado River, Grand Canyon, Arizona, USA, I: systematics and ecology. *Great Basin Naturalist* 58: 97-146.
- Townes HK (1945) The Nearctic species of Tendipedini [Diptera, Tendipedidae (= Chironomidae)]. *The American Midland Naturalist* 34: 1-206.
- Tuiskunen J, Lindeberg B (1986) Chironomidae (Diptera) from Fennoscandia north of 68°N, with a description of ten new species and two new genera. *Annales Zoologici Fennici* 23: 361-393.
- Tuiskunen J (1986) The Fennoscandian species of *Parakiefferiella* Thienemann (Diptera, Chironomidae, Orthoclaadiinae). *Annales*

- Zoologici Fennici* 23: 175-196.
- Vallenduuk HJ, Morozova E (2005) *Cryptochironomus*. An identification key to the larvae and pupal exuviae in Europe. *Lauterbornia* 55: 1-22.
- Vannote RL, Minshall GW, Cummins KW, Sedell JR, Cushing CE (1980) The river continuum concept. *Canadian Journal of Fisheries and Aquatic Sciences* 37: 130-137.
- Vårdal H, Bjørlo A, Saether OA (2002) Afrotropical *Polypedilum* subgenus *Tripodura*, with a review of the subgenus (Diptera: Chironomidae). *Zoologica Scripta* 31: 331-402.
- Vinson MR, Hawkins CP (1998) Biodiversity of stream insects: variation at local, basin, and regional scales. *Annual Review of Entomology* 43: 271-293.
- Wartinbee DC (2010) Chironomidae of the Kenai River from collections of pupal exuviae. Proceedings of the XV International Symposium on Chironomidae (ed. L. C. Ferrington, Jr.), pp. 196-202.
- Wiederholm T (ed.) (1986) Chironomidae of the Holarctic region. *Entomologica Scandinavica Supplement* 28. 482 pp.
- Wilda TJ (1982) New record of *Tanytarsus* (*Sublettea*) *coffmani* (Diptera: Chironomidae) from North Carolina. *Entomological News* 93: 77-78.
- Wisconsin Department of Natural Resources (2019) *The Clam Chronicle Newsletter*, Spring 2019.
- Wrubleski DA, Roback SS (1987) Two species of *Procladius* (Diptera: Chironomidae) from a northern prairie marsh: descriptions, phenologies and mating behavior. *Journal of the North American Benthological Society* 6: 198-212.
- Wuelker W, Martin J, Kiknadze II, Sublette JE, Michiels S (2009) *Chironomus blaylocki* sp. n. and *C. bifurcatus* sp. n., North American species near the base of the decorus-group (Diptera: Chironomidae). *Zootaxa* 2023: 28-46.
- Wülker W (1956) Zur Kenntnis der Gattung *Psectrocladius* Kieff. (Dipt., Chironom.). *Archiv für Hydrobiologie Supplement* 24: 1-66.

Table 1. Tanypodinae from the Upper St. Croix River, Wisconsin, including counts and taxonomic references.

Taxon	Count	References
<i>Ablabesmyia</i> (<i>Ablabesmyia</i>)		Roback 1985, Saether 2011, Stur et al. 2019
<i>aspera</i> Roback	4	
nr. <i>aspera</i> Roback	1	
<i>basalis</i> (Walley)	34	
<i>hauberi</i> Beck & Beck	2	
<i>janta-ramphe</i>	1	
<i>mallochi</i> (Walley)	51	
<i>monilis</i> (Linnaeus)	24	
<i>simpsoni</i> Roback #	14	
sp. SC 1	5	
<i>Ablabesmyia</i> (<i>Karelia</i>)		Roback 1985, Saether 2011
<i>idei</i> (Walley)	6	
<i>philosphagnos</i> Beck & Beck *	1	
<i>Clinotanypus</i>		Roback 1957, 1976a, Johannsen 1937, Morrissey 1950, Neff 1955, Langton 1991
<i>pinguis</i> (Loew)	2	
<i>Conchapelopia</i>		Roback 1981, Beck & Beck 1966
<i>fasciata</i> Beck & Beck	3	
<i>Djalmabatista</i>		Roback & Tennessen 1978
<i>pulchra</i> (Johannsen)	1	
<i>Guttipelopia</i>		Bilyj 1988
<i>gutipennis</i> (Wulp)	2	
<i>Helopelopia</i>		Roback 1957, 1981
<i>cornuticaudata</i> (Walley)	2	
<i>Labrundinia</i>		Silva et al. 2014, Roback 1987
<i>becki</i> Roback #	4	
<i>longipalpis</i> (Goetghebuer)	21	
<i>neopilosella</i> Beck & Beck #	1	
<i>pilosella</i> (Loew)	19	
<i>Larsia</i>		Beck & Beck 1966, Bilyj 1984, Oliveira & Silva 2011
<i>berneri</i> Beck & Beck	1	
<i>Nilotanypus</i>		Roback 1986
<i>fimbriatus</i> (Walker)	12	
<i>Pentaneura</i>		Silva & Ferrington 2018, Bilyj pers. comm.
<i>inconspicua</i> (Malloch)	40	

Table 1 continued.

Taxon	Count	References
<i>Procladius</i>		Roback 1980, Saether 2010a, Wrubleski & Roback 1987, Egan & Langton 2018
<i>bellus</i> (Loew)	17	
<i>denticulatus</i> Sublette *	12 ¹	
<i>freemani</i> Sublette	3	
<i>sublettei</i> Roback	1	
<i>Rheopelopia</i>		Roback 1981
<i>acra</i> (Roback)	5	
<i>perda</i> (Roback)	4	
sp. 2 (Roback 1981)	17	
<i>Tanypus</i> (<i>Tanypus</i>)		Roback 1976b
<i>punctipennis</i> Meigen	8	
<i>Thienemannimyia</i>		Roback 1981, Murray & Fittkau 1985, Langton 1991, Andersen et al. 2013
<i>senata</i> (Walley)	36	
<i>Trissopelopia</i>		Ferrington et al. 2008, Roback 1971, Bilyj pers. comm.
<i>ogemawi</i> Roback	1	
<i>Zavreliomyia</i> (<i>Paramerina</i>)		Beck & Beck 1966, Roback 1972, Bilyj pers. comm.
<i>fragilis</i> (Walley)	1	

¹ = *Procladius denticulatus* and *P. sublettei* counts combined due to inability to separate some specimens.

Table 2. Diamesinae from the Upper St. Croix River, Wisconsin, including counts and taxonomic references.

Taxon	Count	References
<i>Diamesa</i>		Langton 1991, Pagast 1947, Hansen & Cook 1976
sp. SC 1	1	
<i>Pagastia</i>		Makarchenko & Makerchenko 2000, Caldwell 2007
<i>orthogonia</i> Oliver	1	
<i>Potthastia</i>		Langton 1991, Moubayed-Breil & Orsini 2016, Doughman 1985
<i>gaedii</i> (Meigen)	2	
<i>longimanus</i> Kieffer	8	

Table 3. Orthocladiinae from the Upper St. Croix River, Wisconsin, including counts and taxonomic references.

Taxon	Count	References
<i>Cardiocladius</i>		Langton 1991, Sublette et al. 1998, Oliver & Bode 1985
<i>albiplumus</i> Saether	2	
<i>obscurus</i> (Johannsen)	24	
<i>platypus</i> (Coquillett)	19	
<i>Corynoneura</i>		Fu & Saether 2012, Makarchenko & Makarchenko 2006, 2010a, Langton 1991, Hirvenoja & Hirvenoja 1988, Fu et al. 2019, Makarchenko et al. 2019
<i>arctica</i> Kieffer * #	7	
<i>caudicula</i> Fu & Saether	52	
<i>collaris</i> Makarchenko & Makarchenko #	225	
<i>disinflata</i> Fu & Saether	6	
<i>doriceni</i> Makarchenko & Makarchenko *	83	
<i>edwardsi</i> Brundin	1	
<i>floridaensis</i> Fu & Saether	175	
<i>lacustris</i> Edwards	103 ¹	
<i>lobata</i> Edwards	35	
<i>macula</i> Fu & Saether	1	
cf. <i>secunda</i> Makarchenko & Makarchenko #	32	
<i>Cricotopus</i> (<i>Cricotopus</i>)		Hirvenoja 1973, Langton 1991, Oliver & Dillon 1988, Simpson et al. 1983, Oliver 1976, LeSage & Harrison 1980, Cuppen et al. <i>in press</i>
<i>albiforceps</i> (Kieffer) #	27	
<i>bicinctus</i> (Meigen)	24	
<i>coronatus</i> Hirvenoja *	30	
<i>curtus</i> Hirvenoja	10	
<i>diversus</i> (Boesel)	33	
<i>flavocinctus</i> Kieffer #	11	
<i>fuscus</i> (Kieffer)	3	
<i>mackenziensis</i> Oliver #	12	
<i>tremulus</i> (Linneus)	5	
<i>triannulatus</i> (Macquart) #	5	
<i>trifascia</i> Edwards	141	
<i>tristis</i> Hirvenoja	20	
<i>vierriensis</i> Goetgheguer	112	

Table 3 continued.

Taxon	Count	References
sp. SC 1	1	
sp. SC 2	52	
sp. SC 3	66	
sp. SC 4	1	
sp. SC 5	1	
<i>Cricotopus (Isocladius)</i>		Hirvenoja 1973, Langton 1991, Oliver & Dillon 1988, Simpson et al. 1983
<i>laetus</i> Hirvenoja *	4	
<i>laricomalis</i> Edwards #	3	
<i>obnixus</i> Walker * #	1	
<i>sylvestris</i> (Fabricius)	2	
<i>tricinctus</i> (Meigen)	1	
<i>Doncricotopus</i>		Saether 1981
<i>bicaudatus</i> Saether	3	
<i>Eukiefferiella</i>		Lehman 1972
<i>ilkleyensis</i> (Edwards)	2	
<i>tirolensis</i> Goetghebuer	6	
<i>Heterotrissocladius</i>		Saether 1975
<i>changi</i> Saether *	6	
<i>Hydrobaenus</i>		Saether 1976, Saether 1989, Makarchenko et al. 2009
<i>pilipes-scapulapilosus</i>	1	
<i>Krenosmittia</i>		Langton 1991, Tuiskunen & Lindeberg 1986
<i>halvorseni</i> (Cranston & Saether) #	33	
<i>Limnophyes</i>		Saether 1990, Langton 1991
<i>carolinensis</i> Saether	2	
<i>pentaplastus</i> (Kieffer) * #	1	
<i>pumilio</i> (Holmgren) *	1	
<i>Lopescladius (Cordiella)</i>		Coffman & Roback 1984, Saether 1983
<i>hyporheicus</i> Coffman & Roback #	98	
<i>Lopescladius (Lopescladius)</i>		Coffman & Roback 1984, Saether 1983
<i>verruculosus</i> Saether	65	
sp. SC 1	39	
<i>Nanocladius (Nanocladius)</i>		Saether 1977, Dendy & Sublette 1959
<i>balticus</i> (Palmén) *	10	
<i>crassicornus</i> Saether	109	

Table 3 continued.

Taxon	Count	References
<i>distinctus</i> (Malloch)	164	
<i>incomptus</i> Saether *	3	
<i>mallochi</i> Sublette	1	
<i>minimus</i> Saether *	2	
<i>rectinervis</i> (Kieffer)	78	
<i>spiniplenus</i> Saether	9	
sp. SC 1	201	
<i>Nanocladius</i> (<i>Plecopteracoluthus</i>)		Saether 1977, Dendy & Sublette 1959, Steffan 1965
<i>downesi</i> (Steffan)	39	
<i>Orthocladius</i> (<i>Orthocladius</i>)		Soponis 1977, 1987, Saether 2005
<i>carlatus</i> (Roback)	80	
<i>dorenus</i> (Roback)	1	
<i>lapponicus</i> Goetghebuer *	5	
<i>mallochi</i> Kieffer	8	
<i>nigritus</i> Malloch	19	
<i>obumbratus</i> Johannsen	149	
sp. SC 1	1	
<i>Orthocladius</i> (<i>Symposiocladius</i>)		Saether 2003, 2005, Soponis 1977
<i>annectens</i> Saether	25	
<i>holsatus</i> Goetghebuer	1	
<i>Orthocladius</i> (<i>Euorthocladius</i>)		Soponis 1990, Saether 2005
<i>rivicola</i> Kieffer	3	
<i>rivulorum</i> Kieffer	12	
<i>Paracricotopus</i>		Caldwell 1985, Saether 1980, Steiner 1983
<i>millrockensis</i> Caldwell	1	
<i>Parakiefferiella</i>		Langton 1991, Tuiskunen 1986, Saether 1969, Makarchenko & Makarchenko 2010b
<i>bathophila</i> (Kieffer)	84	
<i>coronata</i> (Edwards) #	2	
<i>fennica</i> Tuiskunen *	1	
cf. <i>gynocera</i>	1	
cf. <i>scandica</i>	1	
<i>smolandica</i> (Brundin) *	10	
sp. IR 5	4	
sp. SC 1	7	
sp. SC 2	1	

Table 3 continued.

Taxon	Count	References
<i>Parametriocnemus</i>		Saether 1969
<i>lundbeckii</i> (Johannsen)	5	
<i>vespertinus</i> Saether #	1	
sp. SC 1	54	
<i>Paraphaenocladus</i>		Saether 1969, Saether & Wang 1995
<i>nasthecus</i> Saether	1	
<i>Psectrocladius</i> (<i>Psectrocladius</i>)		Langton 1991, Wülker 1956, Saether 1969, Roback 1957, Saether & Langton 2011, Coffman et al. 1986
cf. <i>brehmi</i> Kieffer	1	
<i>dubius</i> Saether & Langton	1	
<i>sordidellus</i> (Zetterstedt) #	1	
sp. IR 3	17	
sp. IR 4	1	
sp. SC 1	8	
<i>Rheocricotopus</i> (<i>Psilocricotopus</i>)		Saether & Schnell 1988, Saether 1985, Lehman 1969
<i>robaki</i> (Beck & Beck)	24	
<i>Stilocladius</i>		Saether 1982, Makarchenko & Makarchenko 2003
sp. SC 1	4	
<i>Synorthocladus</i>		Langton 1991
<i>semivirens</i> (Kieffer)	420	
<i>Thienemanniella</i>		Fu & Saether 2012, Hestenes & Saether 2000
<i>boltoni</i> Hestenes & Saether	26	
<i>lobapodema</i> Hestenes & Saether	249	
<i>taurocapita</i> Hestenes & Saether	74	
<i>xena</i> (Roback)	109	
<i>Tvetenia</i>		Saether 1969, Saether & Halvorsen 1981, Lehman 1972, Langton 1991
<i>calvescens</i> (Edwards)	13	
<i>tshernovskii</i> (Pankratova)	68	

¹= *Corynoneura macula* and *C. lacustris* counts combined due to inability to separate some specimens.

Table 4. Chironominae (Chironomini, Pseudochironomini) from the Upper St. Croix River, Wisconsin, including counts and taxonomic references.

Taxon	Count	References
<i>Chironomus</i> (<i>Chironomus</i>)		Wuelker et al. 2009, Martin 2019, Langton 1991
<i>decorus</i> complex Johannsen	1	
<i>Cladopelma</i>		Beck & Beck 1969
<i>collator</i> (Townes)	2	
<i>edwardsi</i> (Kruseman)	2	
<i>galeator</i> (Townes)	4	
sp. IR 1	2	
sp. IR 2	1	
<i>Cryptochironomus</i>		Saether 2009, Sublette 1964, Curry 1958, Vallenduuk & Morozova 2005
<i>imitans</i> Saether	32	
<i>ponderosus</i> (Sublette) * #	1	
<i>sorex</i> Townes	7	
sp. IR 4	5	
sp. SC 1	12	
sp. SC 2	12	
sp. SC 3	1	
<i>Cryptotendipes</i>		Saether 2010b, Epler 2018
<i>emorsus</i> (Townes)	7	
<i>pseudotener</i> (Goetghebuer)	2	
<i>Demicryptochironomus</i> (<i>Demicryptochironomus</i>)		Saether 1977, Reiss 1988, Langton 1991
cf. <i>vulneratus</i> (Zetterstedt) *	1	
sp. IR 1	2	
sp. SC 1	8	
<i>Dicrotendipes</i>		Epler 1988, Epler 2016, Langton 1991
cf. <i>hurlburti</i> Epler	1	
<i>leucoscelis</i> (Townes) *	1	
<i>lobiger</i> (Kieffer) *	2	
<i>milleri</i> (Townes) *	4	
<i>modestus</i> (Say)	44	
<i>neomodestus</i> (Malloch)	21	
cf. <i>tritonus</i> (Kieffer) *	22	
<i>Einfeldia</i>		Sublette 1964, Oliver 1971, Martin 2019
<i>natchitochaeae</i> (Sublette) #	3	

Table 4. continued.

Taxon	Count	References
<i>pagana</i> (Meigen) *	3	
<i>Glyptotendipes</i> (<i>Glyptotendipes</i>)		Langton 1991, Contreras-Lichtenberg 1999, 2001
cf. <i>signatus</i> (Kieffer) *	12	
sp. IR 1	3	
<i>Lauterborniella</i>		Pinder & Reiss 1986, Langton 1991
<i>agrayloides</i> (Kieffer) *	11	
<i>Microtendipes</i>		Pinder & Reiss 1986, Langton 1991, Langton unpublished data
cf. <i>caducus</i> Townes	2	
cf. <i>rydalensis</i> (Edwards)	1	
NA3 Langton	1	
sp. IR 1	2	
sp. IR 2	2	
<i>Omisus</i>		Caldwell 1997, Beck & Beck 1970
<i>pica</i> Townes	3	
<i>Parachironomus</i>		Langton 1991, Jacobsen 2008, Spies 2000
<i>tenuicaudatus</i> (Malloch)	3	
sp. SC 1	8	
sp. SC 2	28	
sp. SC 3	1	
<i>Paracladopelma</i>		Jackson 1977
<i>loganae</i> Beck & Beck	4	
<i>Paratendipes</i>		Hayford 1998
<i>albimanus</i> (Meigen)	12	
<i>Phaenopsectra</i>		Langton 1991, Grodhaus 1976, Grodhaus 1987a, Roback 1957
cf. <i>flavipes</i> (Meigen)	7	
<i>Polypedilum</i>		Saether et al. 2010, Maschwitz & Cook 2000, Saether & Sundal 1998, Saether & Oyewo 2008, Oyewo & Saether 2008, Vårdal et al. 2002
(<i>Polypedilum</i>) <i>fallax</i> (Johannsen)	3	
nr. <i>nymphaeorum</i> Maschwitz & Cook	2	
(<i>Cerobregma</i>) <i>ontario</i> (Walley)	10	
(<i>Tripodura</i>) cf. <i>albinodus-scalaenum</i>	18	
(<i>Tripodura</i>) <i>simulans</i> Townes	5	
(<i>Pentapedilum</i>) <i>sordens</i> (van der Wulp)	3	
sp. SC 1	64	

Table 4. continued.

Taxon	Count	References
sp. SC 2	15	
sp. SC 3	8	
sp. SC 4	4	
sp. SC 5	1	
sp. SC 7	1	
sp. SC 8	3	
sp. SC 9	9	
sp. SC 10	2	
sp. SC 11	3	
sp. SC 12	1	
sp. SC 13	1	
sp. SC 14	2	
sp. IR 8	47	
sp. IR 11	2	
<i>Robackia</i>		Saether 1977
<i>claviger</i> (Townes)	3	
<i>demeijerei</i> (Kruseman)	36	
<i>Saetheria</i>		Jackson 1977, Orel 2014
<i>tylus</i> (Townes)	5	
<i>Stenochironomus</i> (<i>Stenochironomus</i>)		Borkent 1984
cf. <i>poecilopterus</i> (Mitchell)	3	
<i>hilaris</i> (Walker)	2	
<i>Tribelos</i>		Grodhaus 1987b
<i>jucundum</i> (Walker)	23	
<i>Xenochironomus</i>		Fusari et al. 2013
<i>xenolabis</i> (Kieffer)	4	
<i>Zavreliella</i>		Reiss 1990
<i>marmorata</i> (van der Wulp)	2	
<i>Pseudochironomus</i>		Saether 1977, Townes 1945
<i>anas</i> Townes	15	
<i>fulviventris</i> (Johannsen)	2	

Table 5. Chironominae (Tanytarsini) from the Upper St. Croix River, Wisconsin, including counts and taxonomic references.

Taxon	Count	References
<i>Cladotanytarsus</i> (<i>Cladotanytarsus</i>)		Bilyj & Davies 1989, Gilka 2011, Puchalski & Gilka 2017
<i>daviesi</i> Bilyj *	106	
nr. <i>lepidocalcar</i> Kruger	7	
<i>mancus</i> (Walker) *	1	
<i>muricatus</i> Bilyj	1	
<i>pinnaticornis</i> Bilyj *	1	
<i>Micropsectra</i>		Anderson et al. 2013, Stur & Ekrem 2006, Oliver & Dillon 1994, Säwedäl 1976
<i>apposita</i> (Walker)	2	
<i>geminata</i> Oliver & Dillon	1	
cf. <i>logani</i> (Johannsen)	4	
<i>subletteorum</i> Anderson, Ekrem & Stur	8	
<i>Neostempellina</i>		Caldwell 2000, Caldwell et al. 2010
<i>reissi</i> Caldwell	26	
<i>Paratanytarsus</i>		Reiss & Säwedäl 1981, Langton 1991
<i>dissimilis</i> Johannsen #	2	
nr. <i>intricatus</i> (Goetghebuer)	1	
sp. MN 1	4	
sp. SC 1	3	
<i>Rheotanytarsus</i>		Saether & Kyerematen 2001, Kyerematen et al. 2000, Kyerematen & Andersen 2002
cf. <i>exiguus</i> (Johannsen)	196	
sp. SC 1	23	
sp. SC 2	4	
sp. SC 3	42	
<i>Stempellina</i>		Gilka 2005, Langton 1991, Bilyj pers. comm.
<i>almi</i> Brundin	5	
cf. <i>bausei</i> (Kieffer)	27	
sp. SC 1	3	
<i>Stempellinella</i>		Ekrem 2007
nr. <i>chambiensis</i> (Goetghebuer)	4	
<i>fimbriata</i> Ekrem	128	
<i>Sublettea</i>		Roback 1975, Wilda 1982, Pinder & Reiss 1986

Table 5 continued.

Taxon	Count	References
<i>coffmani</i> (Roback)	7	
<i>Tanytarsus</i>		Pinder & Reiss 1986, Ekrem et al. 2003, Langton 1991, Lin et al. 2017, Ekrem 2004
<i>aigos</i> Ekrem, Sublette, Sublette *	2	
cf. <i>curticornis</i> Kieffer *	13	
<i>debilis</i> (Meigen) *	7	
<i>epleri</i> Ekrem, Sublette, Sublette	3	
<i>guerlus</i> (Roback)	2	
cf. <i>lactescens</i> Edwards *	6	
<i>nearcticus</i> Butler#	4	
<i>nemorosus</i> Edwards *	3	
<i>neoflavellus</i> Malloch	5	
<i>quadridentatus</i> Brundin *	2	
<i>recurvatus</i> Brundin *	3	
<i>sepp</i> Ekrem, Sublette, Sublette	15	
cf. <i>smolandicus</i> Brundin	7	
sp. IR 3	59	
sp. IR 6	2	
sp. IR 7	9	
sp. IR 8	2	
sp. SC 1	1	