Chironomids (Insecta, Diptera, Chironomidae) from alpine lakes in the Eastern Carpathians with comments on newly-recorded species from Ukraine

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Abstract

Background

The first summarising checklist of Ukrainian Chironomidae (Insecta, Diptera) consisted of 302 species. Compared to other European countries, it is obvious that the real chironomid diversity of Ukraine has not been fully documented and greater effort is needed to discover the actual richness of this family. Thus, our survey focused on the chironomid fauna of some alpine lakes situated above the treeline in the Ukrainian Carpathians (a part of the Eastern Carpathians) aiming to contribute to the knowledge of the Ukrainian chironomid fauna and create the basis for more comprehensive neo- and palaeolimnological studies of these, regionally, little-known ecosystems.

New information

In total, 34 species/taxa, belonging to 22 genera and 4 subfamilies were collected in June 2019. Ten species were recorded for the first time in Ukraine: *Zavrelimyia melanura*, *Acamptocladius reissi, Cricotopus speciosus, Cricotopus curtus, Heterotrissocladius marcidus*, *Orthocladius dentifer*, *Psectrocladius oligosetus, Polypedilum uncinatum, Paratanytarsus laccophilus* and *Tanytarsus bathophilus*. The occurrence of six species previously considered as “doubtfully present” in Ukraine was finally confirmed. Generally, the surveyed lakes have a unique composition of chironomids consisting of a mixture of species typical for cold alpine lakes and acidic ponds situated at lower altitudes.

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Keywords

Non-biting midges, alpine ponds, pupal exuviae, new records, Ukrainian Carpathians

Introduction

The Chironomidae family is a group of holometabolous insects distributed with the widest range of any family of insects, with individual species occurring from Antarctica and sub-Antarctic islands to Ellesmere Island in the Canadian Arctic. In this respect, chironomids are exceeded only by a few collembolan and mite species (Cranston 1995). Chironomids are common inhabitants of most aquatic habitats and regularly dominate aquatic insect communities in both abundance and species richness, often approaching 80 or more species and occasionally exceeding 100 species per site (Ferrington 2007).

Due to their ecological diversity, ubiquity and critical position in food webs, chironomids have been important components of biomonitoring and conservation programmes (see Nicacio and Juen 2015 for review). In addition to being important for understanding contemporary, mainly anthropogenic impacts, chironomid subfossil remains represent a tool for reconstructing past environmental changes (e.g. Langdon et al. 2010).

From the estimated more than 10,000 species worldwide (Cranston 1995), nearly 1300 species have been recorded in Europe (Spies and Sæther 2013). Naturally, there are considerable differences in knowledge of regional chironomid faunas, with Western Europe having the most comprehensive knowledge as a result of higher concentration of specialists and longer history of the chironomid investigation relative to other regions (e.g. Ferrington 2007.

According to the first summarising checklist, 302 Chironomidae species have been recorded from Ukraine (Baranov 2011a). However, as the author of that publication stated, most of the data are probably based on identifications of larval stages only and, thus, often not reliable. The expansion of knowledge on Ukrainian chironomids has continued in the last decade, evidenced by the discovery of new regional records and even several new species (Lietytska and Baranov 2009, Baranov 2011b, Baranov 2013, Baranov 2015, Baranov and Ferrington Jr. 2013, Baranov and Przhiboro 2014, Moubayed-Breil and Baranov 2018 and citations therein).

Here, we provide the first inventory of the family Chironomidae from some alpine lakes of the Eastern Carpathians located in Ukraine. Out of the several thousand natural and artificial lakes in Ukraine (Polishchuk and Igumnova 1983), mountain lakes located in the Carpathians represent a tiny fraction in both number and size. Nevertheless, these alpine lakes are particularly suitable for studying ecosystem responses to environmental impacts both global (e.g. climate change, atmospheric pollution) and regional (e.g. land use change, species introductions; Catalan and Donato Rondón 2016). Our survey not only expands the knowledge on the Ukrainian chironomid fauna, but can also serve as the first

step to more comprehensive neo- and palaeolimnological studies of these unique and, in Ukraine, so far largely unknown ecosystems.

Materials and methods

Study area and sampling sites

The part of the Eastern Carpathians located in Ukraine (Ukrainian Carpathians) represents medium altitude mountains with only few peaks slightly exceeding 2000 m a.s.l. The highest massifs, Chornohora and Svydovets, show direct glacial imprints of past glaciations (Matoshko 2011). The glacial cirques and glacial valleys, usually separated by a rock step, are the most remarkable signs of glacier activity. In some cirques, lakes of glacial origin formed, although most of them are in advanced terrestrial phase or have turned to peat bogs. The present study was performed at eight lakes in Chornohora and Svydovets Massifs (Fig. 1, Fig. 2) between 23th and 26th June 2019. In case we were not aware of official lake names, we named the lakes for adjacent hills (Breskul 1, Breskul 2, Dantsyzh) or nearby named lakes (Vorozheska 2, Vorozheska 3). Due to their small size (< 2 ha, max depth < 2.2 m) and high elevation (above the upper tree line), all the study sites can be considered alpine ponds (Céréghino et al. 2007, Hamerlík et al. 2013).

In the study area, bedrock is represented by sedimentary rocks of Cretaceous-Paleogene flysch. The dominant vegetation of the lake catchment areas is formed by unique mountain grasslands ("polonyna") chequered, to various extents, by juniper (*Juniperus communis nana* (Willd.) Syme), dwarf pine (*Pinus mugo* Turra) or rhododendrons (*Rhododendron kotschyi* Simonkai) patches at some lakes. The studied lakes are located at altitudes between 1477 and 1745 m. The bottoms of the lakes vary from stony silt to mud and organic depositions.

Coordinates of studied lakes were identified in the field using GPS device Garmin GPSmap 64. Lake area was estimated in Google Earth Pro. Maximum lake depth was estimated in the field, except for one site, where published data were available. Basic characteristics of the studied lakes are presented in Table 1.

Sampling methods

Floating chironomid pupal exuviae and drowned adults were collected along the shores of lakes at stretches by skimming the water surface with a hand net (mesh size 250 μm, frame diameter 25 cm) with a telescopic handle. The collected material was placed into labelled plastic bottles and preserved with 75% ethanol. Sorted exuviae and adult males were mounted on microscopic slides and identified using Schlee (1968), Langton and Visser (2003), Ekrem (2008), Stur and Ekrem (2006), Langton et al. (2013) for pupal exuviae and Langton and Pinder (2007a), Langton and Pinder (2007b) for adults. The nomenclature and distribution of species follow Fauna Europaea (Spies and Sæther 2013). Voucher specimens are deposited in the collections of the Dept. of Biology and Ecology, Faculty of Natural Sciences, Matej Bel University in Banská Bystrica.

Data resources

A total of 1,124 pupal exuviae, 7 pharate adults (males) and 35 adults (males) were identified to 22 genera, 34 species/ taxa and 4 subfamilies: Orthocladiinae were represented with 15 species/ taxa, followed by Chironominae (15), Tanypodinae (3) and Prodiamesinae (1) (Table 2).

The number of species/taxa in a single lake varied from 4 to 13 with the mean diversity being 8.5 taxa per lake. The most frequent taxa were *Chironomus* spp. (6 lakes) followed by *Synendotendipes* sp. (most likely *S. dispar*, as the collected adults, 5 lakes); *Cladotanytarsus* (s. str.) *atridorsum* and *Paratanytarsus laccophilus* were recorded in half of the lakes. Half of the species (17) were recorded in a single lake only.

In some cases, pupal exuviae characteristics allowed identification to morphotypes only that may not correspond to valid species: *Corynoneura* Pe 2a, *Cricotopus* (*Isocladius*) Pe 5, *Chironomus* lob-pe 2a, genus *Synendotendipes*, *Tanytarsus* Pe 4c. Due to identification difficulties, pupal exuviae of *Chironomus* (s.str.) were not analysed further.

Our results confirmed the presence of previously doubtful records for Ukraine, such as *Diplocladius cultriger, Parorthocladius nudipennis, Synendotendipes dispar, Cladotanytarsus atridorsum, Paratanytarsus austriacus* and *Paratanytarsus lauterborni* (Spies and Sæther 2013). Ten species represent first records for the Ukrainian fauna.

List of newly recorded Chironomidae species from Ukraine

Zavrelimyia melanura (Meigen, 1804)

Material

a. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26-06-19; individualCount: 4; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_1; occurrenceID: 33D5962A-4716-5255-9809-1DF7727E5944

Distribution: Palaearctic species distributed in Europe, Far East, Near East and North Africa.

Notes: Larvae of Zavrelimyia are common components of littoral assemblages of mountain lakes in the Alps (Boggero et al. 2006, Lods-Crozet et al. 2012, Boggero 2018), South Carpathians (Tatole 2004) and the Tatra Mountains (Bitušík et al. 2006). The species is cold-stenothermic and, in addition to lakes, it occurs in mountain streams and rivers (e.g. Laville 1980, Casas and Vilchez-Quero 1993, Rossaro et al. 2006).

Acamptocladius reissi Cranston et Saether, 1982

Material

a. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26 -06-19; individualCount: 1; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_2; occurrenceID: 3B58E0A3-F7D1-52AF-8842-AFC2AE10AA49

Distribution: Palaearctic species, sporadically distributed in nine European countries.

Notes: The species is known from mountain peat pools and peatland lakes (Baars et al. 2014); however Ferrarese and Lencioni (2003) found pupae and larvae in the littoral of an alpine lake of glacial origin at an altitude of 1936 m in Central-Eastern Alps. The lake in their study resembled our lake Geryshaska by the Carex-dominated littoral and general character of its surroundings.

Cricotopus (*Isocladius*) *speciosus* Goetghebuer, 1921

Material

a. country: Ukraine; locality: Svydovets, lake Vorozheska 1; verbatimElevation: 1480; eventDate: 26-06-19; individualCount: 12; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_3; occurrenceID: BB0F1A74-6E35-5630-A6F6-F92681019E40

Distribution: Palaearctic species, recently known from seven West European countries, European part of Russia and from East Palaearctic.

Notes: Larvae of the subgenus *Isocladius* are widespread in mountain lakes in the Alps (Boggero 2018) and the Tatra Mountains (Bitušík et al. 2006), but species composition is insufficiently known due to identification difficulties. *C.* (*I.*) *speciosus* belongs to the *sylvestris* group, members of which are mostly eurythermic and euryoecious. There is a considerable gap in the knowledge of the species' ecologies. Langton and Visser (2003) mention its occurrence in ponds, lakes and running waters.

Cricotopus (*Cricotopus*) *curtus* Hirvenoja 1973

Material

a. country: Ukraine; locality: Svydovets, lake Vorozheska 1; verbatimElevation: 1480; eventDate: 26-06-19; individualCount: 1; lifeStage: pupal exuviae; recordedBy: M. N; associatedOccurrences: BDJ_13073_4; occurrenceID: A65D314E-97D7-50A4-9D0A-679618C12ACF

Distribution: Holarctic species recorded in most countries in Western and Central Europe. Major gaps in distribution include the Balkans and a belt from Scandinavia to South-European Russia.

Notes: A common rheophilic and polyoxybiontic species. Pupal exuviae could originate both from the inlet and the littoral of the lake, as slow-flow conditions are present along the lake shores.

Heterotrissocladius marcidus Walker, 1856

Materials

a. country: Ukraine; locality: Chornohora, lake Nesamovyte; verbatimElevation: 1745; eventDate: 24-06-19; individualCount: 1; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_5; occurrenceID: 204EF1E9-7888-5B70-8C60-3397024207F9

b. country: Ukraine; locality: Chornohora, lake Dantsyzh; verbatimElevation: 1671; eventDate: 24-06-19; individualCount: 2; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_6; occurrenceID: 587204B1-162B-5A44-ABF7-EE9035B68D3E

Distribution: Holarctic species widespread in Europe with the exception of the Balkans and a belt extending from the Baltics to Ukraine.

Notes: Belongs to the most widespread and often most abundant species in lakes of the Alps (Boggero et al. 2006) and the Tatra Mountains (Bitušík et al. 2006). Cogălniceanu et al. (2009) reported it for several lakes in the Retezat Mts., Romania. We would expect its occurrence in lakes situated at higher altitudes in the Ukrainian part of the Eastern Carpathians.

Orthocladius (*Orthocladius*) *dentifer* Brundin, 1947

Materials

a. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26-06-19; individualCount: 2; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_7; occurrenceID: C5BEA529-A46C-5E38-B693-6CEF2D8CDBC6

b. country: Ukraine; locality: Svydovets, lake Vorozheska 1; verbatimElevation: 1480; eventDate: 26-06-19; individualCount: 16; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_8; occurrenceID: 10A39FDA-39F5-51B7-B0AF-55FC33CD2902

c. country: Ukraine; locality: Svydovets, lake Vorozheska 2; verbatimElevation: 1477; eventDate: 26-06-19; individualCount: 76; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_9; occurrenceID: 978F9B83-FF67-5630-BBCA-02E2093D6F06

d. country: Ukraine; locality: Svydovets, lake Vorozheska 2; verbatimElevation: 1477; eventDate: 26-06-19; individualCount: 3; sex: M; lifeStage: pharate adult; recordedBy: M. N.; associatedOccurrences: BDJ_13073_10; occurrenceID: B6137456-E646-5760-944F-D0A6E58BDCB2

Distribution: Holarctic species, known from Western and Northern Europe but not previously recorded in Central and Eastern Europe.

Notes: Larvae of *Orthocladius* (s. l.) are rheophilic to rheobiontic and poloxybiontic, generally confined to well-aerated flowing waters. They are recorded in the littoral of alpine lakes (Boggero et al. 2006), mostly identified to genus/subgenus level. *Orthocladius dentifer* is known from lakes (Rossaro et al. 2003) and rivers (Murray et al. 2014), even in severely polluted conditions (Loskutova et al. 2015).

Psectrocladius (*Psectrocladius*) *oligosetus* Wuelker, 1956

Materials

a. country: Ukraine; locality: Chornohora, lake Breskul 1; verbatimElevation: 1738; eventDate: 23-06-19; individualCount: 4; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_11; occurrenceID: 78851F60-447D-5CAB-A1B2-450CAD87594B

b. country: Ukraine; locality: Chornohora, lake Breskul 2; verbatimElevation: 1728; eventDate: 23-06-19; individualCount: 5; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_12; occurrenceID: 12BA2BA3-3327-5973-A348-F3E4F520B376

Distribution: West Palaearctic species, in Europe known from western and northern countries, with distribution gaps from the Baltic republics across Poland and Ukraine to the Balkans.

Notes: Apparently a cold-stenothermic species occurring in lakes in mountain regions (e.g. Rieradevall et al. 2007, Bitušík and Svitok 2006, Bitušík et al. 2007, Boggero 2018).

Polypedilum (*Pentapedilum*) *uncinatum* (Goetghebuer, 1921)

Materials

a. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26-06-19; individualCount: 5; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_13; occurrenceID: A2E99A4B-9C97-5318-9E60-B36BE91F9ECF

b. country: Ukraine; locality: Svydovets, lake Vorozheska 2; verbatimElevation: 1477; eventDate: 26-06-19; individualCount: 1; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_14; occurrenceID: FD8B88A3-AAB8-5D91-BBF6-9215DCDA152A

Distribution: Holarctic species recorded from a small number of European countries; however, its distribution from Scandinavia to Greece indicates its potential occurrence all over Europe.

Notes: The species belongs to typical chironomid generalists for temporary wetlands, with adaptation to survive dry periods in moist soil (Dettinger-Klemm 2003).

Paratanytarsus laccophilus (Edwards, 1929)

Materials

a. country: Ukraine; locality: Chornohora, lake Breskul 1; verbatimElevation: 1738; eventDate: 23-06-19; individualCount: 31; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_15; occurrenceID: 0F42D106-D9CD-550B-BC49-E109E6C728D5

b. country: Ukraine; locality: Chornohora, lake Nesamovyte; verbatimElevation: 1745; eventDate: 24-06-19; individualCount: 23; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_16; occurrenceID: BF903AA5-08CA-53FD-9E60-E3C27404E1B9

c. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26-06-19; individualCount: 155; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_17; occurrenceID: 65A9FC8F-C5EF-5A8E-BD40-88F70962E2DB

d. country: Ukraine; locality: Svydovets, lake Geryshaska; verbatimElevation: 1584; eventDate: 26-06-19; individualCount: 2; sex: M; lifeStage: pharate adult; recordedBy: M. N.; associatedOccurrences: BDJ_13073_18; occurrenceID: B0217F6C-F6D8-573C-B937-EE1D1BA08DFC

e. country: Ukraine; locality: Svydovets, lake Vorozheska 1; verbatimElevation: 1480; eventDate: 26-06-19; individualCount: 1; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_19; occurrenceID: 119660A0-8886-58DA-8809-4E90DD087499

Distribution: Holarctic species, primarily distributed in northern and Western Europe, records are lacking from the southern and eastern part of the continent.

Notes: Euryoecious species occurring in ponds and lakes (Langton and Visser 2003). It belongs to typical colonisers of both natural (Lencioni et al. 2018) and artificial water bodies (Bukvová and Hamerlík 2015). However, the species is not characteristic for high mountain lakes. While Boggero (2018) considered *P. laccophilus* to be rare in lakes of the southern side of the Central-Eastern Alps, it has not been found in the Tatra Mountains at all.

Tanytarsus bathophilus Kieffer, 1911

Materials

a. country: Ukraine; locality: Svydovets, lake Vorozheska 1; verbatimElevation: 1480; eventDate: 26-06-19; individualCount: 12; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_20; occurrenceID: 5A6E06D2-C0E4-527C-BDC8-D51370C9AAF1

b. country: Ukraine; locality: Svydovets, lake Vorozheska 2; verbatimElevation: 1477; eventDate: 26-06-19; individualCount: 2; lifeStage: pupal exuviae; recordedBy: M. N.; associatedOccurrences: BDJ_13073_21; occurrenceID: 38DAFB99-2262-5F3C-9AB9-31583EA4A402

Distribution: Palaearctic species widespread in Europe, but with a major gap in occurrence extending from the Baltic Republics to Southern Europe (apart from Romania) and the Balkans.

Notes: Larvae live mainly in lakes but also in flowing waters (e.g. Rossaro et al. 2006). It is the most commonly encountered species of the genus in alpine lakes in the Tatra Mountains (Bitušík et al. 2006), but apparently missing in alpine lakes of the South Carpathians (Tatole 2004, Cogălniceanu et al. 2009).

Discussion

Our study contributes to the knowledge of the chironomid fauna of alpine lakes in the Ukrainian part of the Eastern Carpathians. We report a total of 34 species/taxa, while almost one third (10 species) of them were recorded for the first time in Ukraine. We are aware that this inventory is far from complete, as evidenced by the comparison with data from the Tatra Mountains (Western Carpathians) and the South Carpathians (Tatole 2004, Bitušík et al. 2006, Cogălniceanu et al. 2009).

The most common species of the Tatra Mts. lakes (Western Carpathians, Bitušík et al. 2006) and the Retezat Mts. (South Carpathians, Cogălniceanu et al. 2009), *Heterotrissocladius marcidus* and *Paratanytarsus austriacus* were found only in a few of the Ukrainian lakes. On the other hand, the most characteristic species of the surveyed lakes were either not present in the Tatra Mts. lakes (e.g. *Cladotanytarsus atridorsum* and *Paratanytarsus laccophilus*) or were very rare (e.g. *Chironomus* spp., *Synendotendipes* sp.) (Bitušík et al. 2006). Nevertheless, the last two taxa can be common in acidic Tatra Mts. ponds situated in lower altitudes (Novikmec et al. 2015, Hamerlík et al. 2016). Absence of the members of the Diamesinae subfamily, typical for cold, nutrient-poor alpine lakes, from the Ukrainian samples is also interesting; however, it does not necessarily mean that they are not present in the lakes; their absence was most likely caused by spring emergence of the adults (e.g. Raunio et al. 2010). In general, chironomid communities of Ukrainian alpine lakes represent a mixture of species typical for cold alpine lakes and acidic ponds situated in lower altitudes.

The results of this “snap-shot” survey are important for at least two reasons: 1) it is the first insight into species composition of chironomid assemblages of Ukrainian alpine lakes in the context of the whole Carpathians and 2) the data can be useful in determining the ecological conditions in the alpine lakes and can create a basis for future (paleo)limnological studies extended to the whole „alpine lake district“ in the Ukrainian Carpathians.

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Author contributions

PB identified Chironomidae pupal exuviae and adults and wrote the text, MN collected the data, prepared the map, tables and wrote part of the text, LH prepared figures and wrote part of the text.

References

- Baars J-R, Murray DA, Hannigan E, Kelly-Quinn M (2014) Macroinvertebrate assemblages of small upland peatland lakes in Ireland. Biology and Environment: Proceedings of the Royal Irish Academy 114B (3): 233-248. https://doi.org/10.3318/bioe.2014.31
- Baranov V (2011a) A preliminary annotated cheklist of non-biting midges (Diptera, Chironomidae) of Ukraine. Ukrainska Entomofaunistyka 2 (1): 7-24. [In Ukrainian].
- Baranov V (2011b) New and rare species of Orthocladiinae (Diptera, Chironomidae) from the Crimea, Ukraine. Vestnik Zoologii 45 (5): e7-e12. https://doi.org/10.2478/v10058-011-0026-1
- Baranov V (2013) First records of several tanypodinae species (Diptera, Chironomidae) from Ukraine. Vestnik Zoologii 47 (3): 59-62. https://doi.org/10.2478/vzoo-2013-0027
- Baranov V, Ferrington Jr. L (2013) Hibernal emergence of Chironomidae in Ukraine. Chironomus 26 https://doi.org/10.5324/cjcr.v0i26.1616
- Baranov V, Przhiboro A (2014) New records of non-biting midges (Diptera: Chironomidae) from springs and streams of the Ukrainian Carpathians (Gorgany Massif). Zoosystematica Rossica 23 (1): 150-157. https://doi.org/10.31610/zsr/2014.23.1.150
- Baranov V (2015) Adult female of *Chaetocladius insolitus* Caspers, 1987 (Diptera: Chironomidae) with notes on species distribution. Aquatic Insects 36 (1): 9-14. https://doi.org/10.1080/01650424.2015.1007071
- Bitušík P, Svitok M (2006) Structure of chironomid assemblages along environmental and geographical gradients in the Bohemian Forest lakes (Central Europe): An exploratory analysis. Biologia 61 (20): S467-S476. https://doi.org/10.2478/s11756-007-0063-y
- Bitušík P, Svitok M, Kološta P, Hubková M (2006) Classification of the Tatra Mountain lakes (Slovakia) using chironomids (Diptera, Chironomidae). Biologia 61 (18): S191-S201. https://doi.org/10.2478/s11756-006-0131-8
- Bitušík P, Svitok M, Bačík J (2007) Chironomids (Diptera: Chironomidae) of man-made reservoirs in the Banská Štiavnica mining region (Slovakia). Acta Zoologica Universitatis Comenianae 47 (2): 115-126.
- Boggero A, Füreder L, Lencioni V, Simcic T, Thaler B, Ferrarese U, Lotter AF, Ettinger R (2006) Littoral chironomid communities of Alpine lakes in relation to environmental factors. Hydrobiologia 562 (1): 145-165. https://doi.org/10.1007/s10750-005-1809-6

- Boggero A (2018) Macroinvertebrates of Italian mountainlakes. Redia 101: 35-45. https://doi.org/10.19263/redia-101.18.06
- Bukvová D, Hamerlík L (2015) Non-biting midges (Diptera, Chironomidae) in the fountains of Lund, SW Sweden. Entomologisk Tidskrift 136 (3): 87-92.
- Casas JJ, Vilchez-Quero A (1993) Altitudinal distribution of lotic chironomid (Diptera) communities in the Sierra Nevada mountains (Southern Spain). Annales de Limnologie 29 (2): 175-187. https://doi.org/10.1051/limn/1993016
- Catalan J, Donato Rondón JC (2016) Perspectives for an integrated understanding of tropical and temperate high-mountain lakes. Journal of Limnology 75: 215-234. https://doi.org/10.4081/jlimnol.2016.1372
- Céréghino R, Biggs J, Oertli B, Declerck S (2007) The ecology of European ponds: defining the characteristics of a neglected freshwater habitat. Pond Conservation in Europe 210: 1-6. https://doi.org/10.1007/978-90-481-9088-1_1
- Cogălniceanu D, Tudorancea M, Preda E, Gâldean N (2009) Evaluating diversity of chironomid (Insecta: Diptera) communities in alpine lakes, Retezat National Park (Romania). Advances in Limnology 62: 191-213.
- Cranston PS (1995) Introduction. In: Armitage PD, Cranston PS, Pinder LCV (Eds) The Chironomidae: Biology and ecology of non–biting midges. Chapman & Hall, London, 1-7 pp.
- Dettinger-Klemm PA (2003) Chironomids (Diptera, Nematocera) of temporary pools – an ecological case study. University Heidelberg, Heidelberg.
- Ekrem T (2008) Immature stages of European *Tanytarsus* species I. The *eminulus*-, *gregarius*-, *lugens*- and *mendax* species groups (Diptera, Chironomidae). Deutsche Entomologische Zeitschrift 51 (1): 97-146. https://doi.org/10.1002/mmnd.20040510110
- Ferrarese U, Lencioni V (2003) *Acamptocladius reissi* Cranston & Sæther, 1982 (Diptera, Chironomidae): the first Italian records. Lavori Societa Venezia di Scienze Naturali 28: 77-78.
- Ferrington L (2007) Global diversity of non-biting midges (Chironomidae; Insecta-Diptera) in freshwater. Hydrobiologia 595 (1): 447-455. https://doi.org/10.1007/s10750-007-9130-1
- Hamerlík L, Svitok M, Novikmec M, Očadlík M, Bitušík P (2013) Local, among-site, and regional diversity patterns of benthic macroinvertebrates in high altitude waterbodies: do ponds differ from lakes? Hydrobiologia 723 (1): 41-52. https://doi.org/10.1007/s10750-013-1621-7
- Hamerlík L, Svitok M, Novikmec M, Veselská M, Bitušík P (2016) Weak altitudinal pattern of overall chironomid richness is a result of contrasting trends of subfamilies in high-altitude ponds. Hydrobiologia 793 (1): 67-81. https://doi.org/10.1007/s10750-016-2992-3
- Langdon P, Ruiz Z, Wynne S, Sayer C, Davidson T (2010) Ecological influences on larval chironomid communities in shallow lakes: implications for palaeolimnological interpretations. Freshwater Biology 55 (3): 531-545. https://doi.org/10.1111/j.1365-2427.2009.02345.x
- Langton P, Bitusik P, Mitterova J (2013) A contribution towards a revision of West Palaearctic Procladius Skuse (Diptera: Chironomidae). Chironomus 26: 41-44. https://doi.org/10.5324/cjcr.v0i26.1620

- Langton PH, Visser H (2003) Chironomidae exuviae. A key to pupal exuviae of the West Palaearctic Region. Interactive identification system for the European limnofauna (IISEL). World Biodiversity Database, CD–ROM Series.
- Langton PH, Pinder LCV (2007a) Keys to the adult male Chironomidae of Britain and Ireland. 1. Freshwater Biological Association, Scientific Publication, 1-239 pp.
- Langton PH, Pinder LCV (2007b) Keys to the adult male Chironomidae of Britain and Ireland. 2. Freshwater Biological Association, Scientific Publication, 1-168 pp.
- Laville H (1980) Inventaire 1980 des chironomides (Diptera) connus des Pyrénées. Annales de Limnologie 16 (3): 211-223. https://doi.org/10.1051/limn/1980010
- Lencioni V, Fattori D, Nardi G, Latella L (2018) Insights into spatio-temporal dynamics of invertebrate communities from two alpine pasture ponds. Figshare https://doi.org/10.6084/M9.FIGSHARE.7315658
- Lietytska OM, Baranov VO (2009) Bottom communities structure as factor for ecological status determination in zone of Svalyava resort complexes. Zoocenosis66-67. [In Ukrainian]. URL: http://eprints.zu.edu.ua/15366/1/%D0%A1%D0%A2%D0%A0%D0%A3%D0%9A%D0%A2%D0%A3%D0%A0%D0%90%20%
- Lods-Crozet B, Oertli B, Robinson CT (2012) Long-term patterns of chironomid assemblages in a high elevation stream/lake network (Switzerland) – Implications to global change. Fauna Norvegica 31 https://doi.org/10.5324/fn.v31i0.1361
- Loskutova OA, Zelentsov NI, Shcherbina GK (2015) Fauna of chironomids (Diptera, Chironomidae) of the Kolva River (Pechora basin) in conditions of oil pollution. Inland Water Biology 8 (3): 276-286. https://doi.org/10.1134/s1995082915030104
- Matoshko AV (2011) Limits of the Pleistocene glaciations in the Ukraine. Developments in Quaternary Sciences 15: 405-418. https://doi.org/10.1016/b978-0-444-53447-7.00031-3
- Moubayed-Breil J, Baranov V (2018) Taxonomic notes on the genus *Hydrobaenus* with description of *H. simferopolus* sp. nov. from Crimea (Diptera: Chironomidae). Acta Entomologica Musei Nationalis Pragae 58 (2): 347-355. https://doi.org/10.2478/aemnp-2018-0029
- Murray DA, Langton PH, O'Connor JP, Ashe P (2014) Distribution records of Irish Chironomidae (Diptera): Part 2 – Orthocladiinae. Bulletin of the Irish Biogeographical Society 38: 61-246.
- Nicacio G, Juen L (2015) Chironomids as indicators in freshwater ecosystems: an assessment of the literature. Insect Conservation and Diversity 8 (5): 393-403. https://doi.org/10.1111/icad.12123
- Novikmec M, Veselská M, Bitušík P, Hamerlík L, Matúšová Z, Reduciendo Klementová B, Svitok M (2015) Checklist of benthic macroinvertebrates of high altitude ponds of the Tatra Mountains (Central Europe) with new records of two species for Slovakia. Check List 11 (1): 1-12. https://doi.org/10.15560/11.1.1522
- Polishchuk VV, Igumnova LV (1983) On the classification of lakes and lake-like water bodies of the Ukraine. Gidrobiologicheskii Zhurnal 19 (2): 100-101. [In Russian].
- Raunio J, Paasivirta L, Hämäläinen H (2010) Assessing lake trophic status using spring-emerging chironomid pupal exuviae. Fundamental and Applied Limnology 176 (1): 61-73. https://doi.org/10.1127/1863-9135/2010/0176-0061
- Rieradevall M, Chaves ML, Prat N (2007) High altitude Chironomidae (Diptera) of Serra da Estrela (Portugal): Additions to the Portuguese and Iberian Peninsula fauna. Graellsia 63 (2): 273-278. https://doi.org/10.3989/graellsia.2007.v63.i2.94

- Rossaro B, Lencioni V, Casalegno C (2003) Revision of West Palaearctic species of *Orthocladius* s. str. van der Wulp, 1874 (Diptera: Chironomidae: Orthocladiinae), with a new key to species. Studi Trentini di Scienze Naturali, Acta Biologica 79: 213-241.
- Rossaro B, Lencioni V, Boggero A, Marziali L (2006) Chironomids from Southern Alpine running waters: Ecology, Biogeography. Hydrobiologia 562 (1): 231-246. https://doi.org/10.1007/s10750-005-1813-x
- Schlee D (1968) Vergleichende Merkmalsanalyse zur Morphologie und Phylogenie der *Corynoneura*-Gruppe (Diptera: Chironomidae). Zugleich eine allgemeine Morphologie der Chironomiden-Image (♂). Stuttgarter Beiträge zur Naturkunde 180: 1-150.
- Spies M, Sæther OA (2013) Chironomidae. Fauna Europaea: In: Beuk P, Pape T (Eds) Fauna Europaea: Diptera, Nematocera. Fauna Europaea version 2.6. http://www.faunaeur.org. Accessed on: 2019-11-10.
- Stur E, Ekrem T (2006) A revision of West Palaearctic species of the *Micropsectra atrofasciata* species group (Diptera: Chironomidae). Zoological Journal of the Linnean Society 146 (2): 165-225. https://doi.org/10.1111/j.1096-3642.2006.00198.x
- Tatole V (2004) Comparation of the taxonomical structure of the chironomid fauna from six Carpathian Massifs of Southern Romania. Travaux du Museum National d´Histoire Naturelle “Grigore Antipa” 46: 211-226.
- Tsarenko P, Wołowski K, Lenarczyk J, Bilous O, Lilitska H (2019) Green and charophytic algae of the high-mountain Nesamovyte and Brebeneskul lakes (Eastern Carpathians, Ukraine). Plant and Fungal Systematics 64 (1): 53-64. https://doi.org/10.2478/pfs-2019-0007

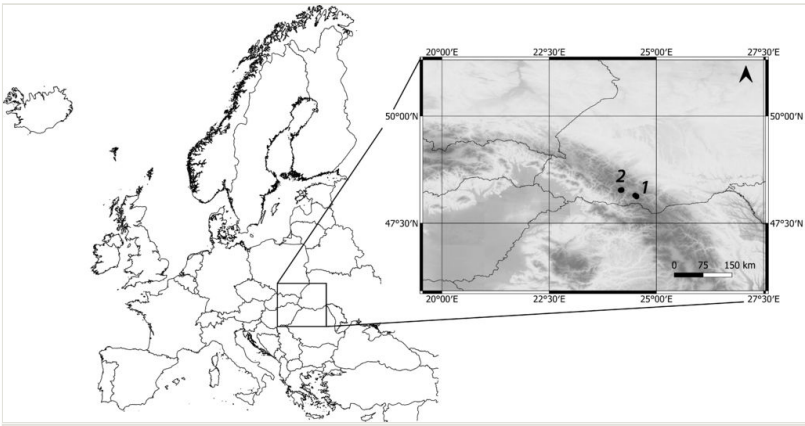


Figure 1.

Geographical location of the studied area and and the position of sampling sites in the Eastern Carpathians (1 – Chornohora lakes: Breskul 1, Breskul 2, Nesamovyte, Dantsyzh; 2 – Svydovets lakes: Geryshaska, Vorozheska 1, Vorozheska 2, Vorozheska 3).



Figure 2.

View of the study lakes. **a.** Nesamovyte; **b.** Breskul 1; **c.** Breskul 2; **d.** Dantsyzh; **e.** Geryshaska; **f.** Vorozheska 1; **g.** Vorozheska 2; **h.** Vorozheska 3. For basic characteristics and coordinates, see Table 1.

Table 1.

Basic characteristics of the studied lakes. [a]Tsarenko et al. (2019)

Lake name	Location	Altitude (m)	Max. depth (m)	Area (ha)
Nesamovyte	48.12238 N, 24.53945 E	1745	2.0[a]	0.35
Breskul 1	48.14943 N, 24.50369 E	1738	1.1	0.04
Breskul 2	48.14813 N, 24.50411 E	1728	1.6	0.01
Dantsyzh	48.13129 N, 24.53715 E	1671	0.9	0.05
Geryshaska	48.26978 N, 24.16531 E	1584	2.0	1.90
Vorozheska 1	48.27612 N, 24.19274 E	1480	2.2	0.54
Vorozheska 2	48.27746 N, 24.19270 E	1477	0.8	0.12
Vorozheska 3	48.27748 N, 24.19331 E	1469	0.3	0.01

Table 2.

List of recorded chironomid species/taxa in the surveyed lakes. Numbers without symbol represent pupal exuviae, symbols # – new record for Ukraine, ⚅ – previously considered doubtful, * – adult male, ** – pharate adult (male). Abbreviations of lake names: Nes – Nesamovyte, Bre1 – Breskul 1, Bre2 – Breskul 2, Dan – Dantsyzh, Ger – Geryshaska, Vor1 – Vorozheska 1, Vor2 – Vorozheska, Vor3 – Vorozheska 3.

Taxa	**Lake name**							
	Nes	**Bre1**	**Bre2**	**Dan**	**Ger**	**Vor1**	**Vor2**	**Vor3**
Tanypodinae	-	-	-	-	-	-	-	-
Procladius (*Holocladius*) *choreus* (Meigen, 1804)	-	7, 1**	-	-	-	45, 1**	19, 1*	-
Macropelopia nebulosa Meigen, 1804	1	-	-	13	-	-	-	-
# *Zavrelimyia melanura* (Meigen, 1804)	-	-	-	-	-	4	-	-
Prodiamesinae	-	-	-	-	-	-	-	-
Prodiamesa olivacea (Meigen, 1818)	-	-	-	1	-	-	-	-
Orthocladiinae	-	-	-	-	-	-	-	-
# *Acamptocladius reissi* Cranston et Saether, 1982	-	-	-	-	1	-	-	-
Corynoneura cf. *coronata* Edwards, 1924	-	3	-	-	-	-	-	-
Corynoneura cf. *fittkaui* Schlee, 1968	2*	3, 3*	3	-	-	-	-	-
Corynoneura Pe2a Langton, 1991	1	-	-	-	18	-	-	-
# *Cricotopus* (*Isocladius*) *speciosus* Goetghebuer, 1921	-	-	-	-	-	12	-	-
Cricotopus (*Isocladius*) *sylvestris* Fabricius, 1794)	-	-	-	-	2, 1**	3	-	-
Cricotopus (*Isocladius*) Pe 5 Langton, 1991	-	-	-	-	1	-	-	-
Cricotopus (*Isocladius*) *intersectus* (Staeger, 1839)	44, 4*	-	-	-	-	-	-	-
# *Cricotopus* (*Cricotopus*) *curtus* Hirvenoja 1973	-	-	-	-	-	1	-	-
⚅ *Diplocladius cultriger* Kieffer, 1908	-	-	-	4, 1**	-	-	-	-
# *Heterotrissocladius marcidus* Walker, 1856	1	-	-	2	-	-	-	-
Nanocladius (*Nanocladius*) *parvulus* (Kieffer, 1909)	-	-	-	-	-	-	2	-
# *Orthocladius* (*Orthocladius*) *dentifer* Brundin, 1947	-	-	-	-	2	16	76, 3**	-
⚅ *Parorthocladius nudipennis* (Kieffer, 1908)	-	-	-	-	-	1	-	-
# *Psectrocladius* (*Psectrocladius*) *oligosetus* Wuelker, 1956	-	4	5	-	-	-	-	-
Chironominae - Chironomini	-	-	-	-	-	-	-	-
Benthalia carbonaria (Meigen, 1804)	-	-	-	-	40	-	-	-
Chironomus (*Chironomus*) spp.	6	9	-	-	9	25	19	21
Chironomus lob-pe 2a Langton & Visser 2003	-	16	33	-	-	-	-	5

Pagastiella orophila (Edwards, 1929)	40, 3*	-	-	-	-	-	-	-
# *Polypedilum* (*Pentapedilum*) *uncinatum* (Goetghebuer, 1921)	-	-	-	-	5, 10*	-	1	-
genus *Synendotendipes* Langton et Visser, 2003	1	14	9	-	2	-	-	5
Synendotendipes dispar (Meigen, 1830)	-	-	-	-	-	-	-	2*
Chironominae - Tanytarsini	-	-	-	-	-	-	-	-
Cladotanytarsus (*Cladotanytarsus*) *atridorsum* Kieffer, 1924	-	-	-	-	50	103, 6*	50, 1*	1
Micropsectra lindrothi Goetghebuer, 1931	-	-	-	5	-	-	-	-
Paratanytarsus austriacus (Kieffer, 1924)	-	-	-	-	-	14	10	-
# *Paratanytarsus laccophilus* (Edwards, 1929)	23	31	-	-	155, 2*	1	-	-
Paratanytarsus lauterborni (Kieffer, 1909)	-	-	-	-	-	2	12	-
# *Tanytarsus bathophilus* Kieffer, 1911	-	-	-	-	-	12	2	-
Tanytarsus gregarius Kieffer, 1909	93, 4*	-	-	-	-	-	-	-
Tanytarsus Pe 4c Langton, 1991	-	-	-	-	6	-	-	-
No of taxa	**10**	**8**	**4**	**5**	**12**	**13**	**9**	**5**