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CHIRONOMIDAE (INSECTA, DIPTERA) FAUNA OF THE LOWER DNIPRO. PART 2: SUBFAMILY ORTHOCLADIINAE

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The current work is the second part of a series of articles intended to describe the state of Chironomidae (Insecta, Diptera) fauna of the Lower Dnipro, based on the long-term studies of this family as part of the benthic, plankton and zoophytos communities and widely represented in the different types of water bodies of this area. This part of research is focused on the subfamily Orthocladiinae. The research was conducted on following water bodies, both the flowing and the standing waters, located in the delta and pre-delta areas of the Lower Dnipro: the Dnipro River, the Koshova River, the Viryovchyna River, the strait into Lake Bobrove, the strait into Lake Kruhle, the Hadiuchka Strait, the Chaika River, the Kozak River, Lake Liahushache, Lake Chychkuvate, Lake Skadovsk-Pohorile, Lake Stebliivskyi Liman, Lake Nazarove-Pohorile, Lake Zakitne, Lake Bobrove, Lake Kruhle, Lake Kardashynskyi Liman and Lake Sabetskyi Liman. Based on larval and pupal specimens, 14 species/taxa of the subfamily Orthocladiinae are recorded and described: Corynoneura scutellata Winnertz, 1846, Cricotopus (Cricotopus) bicinctus (Meigen, 1818), Cricotopus (Cricotopus) sp., Cricotopus (Isocladius) intersectus (Staeger, 1839), Cricotopus (Isocladius) cf. sylvestris (Fabricius, 1794), Hydrobaenus lugubris Fries, 1830, Limnophyes sp., Nanocladius (Nanocladius) dichromus (Kieffer, 1906), Orthocladius (Euorthocladius) sp., Propsilocerus lacustris Kieffer, 1923, Psectrocladius (Psectrocladius) cf. psilopterus (Kieffer, 1906), Psectrocladius (Psectrocladius) cf. sordidellus (Zetterstedt, 1838), Psectrocladius (Psectrocladius) cf. zetterstedti Brundin, 1949, Psectrocladius (Psectrocladius) sp. The biological and ecological characteristics of the Orthocladiinae species were given, including frequency indexes, indicators of quantitative development, seasonality, habitats, macrophytes association and abiotic factors. The distribution of widespread, common and rare species of the subfamily Orthocladiinae in the water bodies of the Lower Dnipro area have been determined.

***Key words**: chironomids, non-biting midges, larvae, macrozoobenthos, hydrobiology, the Dnipro River, Ukraine.*

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ФАУНА CHIRONOMIDAE (INSECTA, DIPTERA) ПОНИЗЗЯ ДНІПРА. ЧАСТИНА 2: ПІДРОДИНА ORTHOCLADIINAE

Представлена робота є другою у серії статей, покликаних описати фауну двокрилих комах родини Chironomidae (Insecta, Diptera) пониззя Дніпра на основі багаторічних досліджень цієї групи, як частини бентосних, планктонних та зоофітосних угруповань, і широко представлену у різнотипних водних об'єктах вищезазначеного регіону. Дана частина дослідження присвячена представникам підродини Orthocladiinae.

Дослідження проводились на наступних водних об'єктах, як водотоках, так і водоймах, розташованих у дельтовій та придельтовій ділянках пониззя Дніпра: ріка Дніпро, рукав Кошова, ріка Вірьовчина, протока у озеро Боброве, протока у озеро Кругле, протока Гадючка, протока Чайка, протока Козак, озеро Лягушаче, озеро Чичкувате, озеро Скадовськ-Погоріле, Стебліївський лиман, озеро Назарове-Погоріле, озеро Закітне, озеро Боброве, озеро Кругле, Кардашинський лиман та Сабецький лиман. На основі матеріалу, представленого личинковими та лялечковими стадіями хірономід, було виявлено та описано 14 видів/таксонів підродини Orthocladiinae: Corynoneura scutellata Winnertz, 1846, Cricotopus (Cricotopus) bicinctus (Meigen, 1818), Cricotopus (Cricotopus) sp., Cricotopus (Isocladius) intersectus (Staeger, 1839), Cricotopus (Isocladius) cf. sylvestris (Fabricius, 1794), Hydrobaenus lugubris Fries, 1830, Limnophyes sp., Nanocladius (Nanocladius) dichromus (Kieffer, 1906), Orthocladius (Euorthocladius) sp., Propsilocerus lacustris Kieffer, 1923, Psectrocladius (Psectrocladius) cf. psilopterus (Kieffer, 1906), Psectrocladius (Psectrocladius) cf. sordidellus (Zetterstedt, 1838), Psectrocladius (Psectrocladius) cf. zetterstedti Brundin, 1949, Psectrocladius (Psectrocladius) sp. Було надано біологічну та екологічну характеристику виявлених видів Orthocladiinae, що включає індекси трапляння, показники кількісного розвитку, сезонність, асоційованість знахідок з угрупованнями макрофітів, типи донних відкладень та абіотичні фактори середовища. Визначено масові, типові та рідкісні види підродини Orthocladiinae та їх розповсюдженість у водних об'єктах пониззя Дніпра.

Ключові слова: *хірономіди, комарі-дзвінці, личинки, макрозообентос, гідробіологія, Дніпро, Україна.*

Larvae and pupae of the Diptera insects of the family Chironomidae are permanent components of the benthic fauna of lowland rivers, in particular the Dnipro River, and also represented in the plankton (primarily associated with macrophytes) and zoophytos communities. As noted in the previous works, chironomids occupy a significant and sometimes leading role as part of macrozoobenthos in flowing and standing waters of the Lower Dnipro, both in the past and at the present time [7, 13]. Despite the long-term studies of Dnipro-Buh estuarine region [4, 6, 12, 17], the data relating to the Chironomidae fauna are general and extremely fragmentary [2, 13]. Followed by the previous article [14], this work is intended to provide a comprehensive description of the Chironomidae fauna in the Lower Dnipro at the time of the research. The second article in this series is focused on the fauna of the subfamily Orthocladiinae, one of the three subfamilies of Chironomidae, widely represented in the researched aquatic ecosystem.

The destruction of the Kakhovka Dam and Kakhovka Reservoir by the Russian military in June 2023 caused irreversible changes in the delta and pre-delta areas of the Lower Dnipro [5], which is why the materials presented below have a particular value as basis for further research in the region and analysis of changes caused by this ecological catastrophe.

MATERIALS AND METHODS

The studies were conducted within the Dnipro-Buh estuarine region. The delta and pre-delta areas of the Lower Dnipro were covered. For the delta area, the

following water bodies and floodplain areas were researched: the Dnipro River, the Viryovchyna River, Holoprystanskyi floodplain area (Lake Liahushache), Kherson-Bilozerskyi floodplain area (the Koshova River, Lake Chychkuvate, Lake Skadovsk-Pohorile and Lake Stebliivskyi Liman), Velykyi Potyomkinskyi floodplain area (Lake Nazarove-Pohorile and Lake Zakitne), Kardashynskyi floodplain area (the strait into Lake Bobrove, the strait into Lake Kruhle, the Hadiuchka Strait, the Chaika River, Lake Bobrove, Lake Kruhle and Lake Kardashynskyi Liman). For the pre-delta area, the Dnipro River, the Kozak River and Lake Sabetskyi Liman were researched. The list with characteristics of the researched water bodies are presented in Table 1. The code abbreviations are **R** for rivers/straits, **L** for lakes and **A** for artificial water micro-reservoir. As coordinates of water bodies, the most typical locations of sampling sites were given. Most of the sampling sites were located in the Nyzhniodniprovskyi National Nature Park or relatively close to its borders.

Table 1

Basic characteristics of researched water bodies of the Lower Dnipro

Water body	Code	Coordinates	Depth (m)	
			Avg	Max
Dnipro River	R1	46.593333N 32.590000E	4,4	10,0
Koshova River	R2	46.626909N 32.568573E	2,7	4,9
Viryovchyna River	R3	46.628469N 32.549996E	0,8	1,2
Strait into Lake Bobrove	R4	46.547036N 32.561017E	1,5	1,5
Strait into Lake Kruhle	R5	46.597810N 32.600446E	2,0	2,0
Hadiuchka Strait	R6	46.584272N 32.601484E	1,6	1,8
Chaika River	R7	46.595270N 32.639557E	1,9	2,3
Kozak River	R8	46.782528N 33.260611E	1,0	1,2
Lake Liahushache	L1	46.521591N 32.395952E	1,4	2,2
Lake Chychkuvate	L2	46.605155N 32.493031E	1,4	1,8
Lake Skadovsk-Pohorile	L3	46.599722N 32.517222E	0,8	1,0
Lake Stebliivskyi Liman	L4	46.609722N 32.533056E	3,1	6,1
Lake Nazarove-Pohorile	L5	46.566209N 32.546378E	0,8	1,1
Lake Zakitne	L6	46.588889N 32.573333N	0,6	1,1
Lake Bobrove	L7	46.547156N 32.553760E	0,9	1,4
Lake Kruhle	L8	46.594167N 32.603889E	1,2	2,0
Lake Kardashynskyi Liman	L9	46.581667N 32.628056E	1,6	2,3
Lake Sabetskyi Liman	L10	46.770972N 33.251028E	1,0	1,5
Artificial water micro-reservoir	A1	46.602717N 32.582764E	0,1	0,1

The larvae and pupae of non-biting midges of the subfamily Orthocladiinae, found in samples of macrozoobenthos and zooplankton, were the material of this study. The single specimens were found in the zoophytos samples. Sampling was carried out three times a year in the spring, summer and autumn seasons during the years 2012-2021. In some research years, monthly sampling was provided (except for the winter seasons). Hydrological and hydrobiological samples were collected according to generally accepted methods [8, 10]. Benthic samples were collected using the Petersen grab (small and medium models) and washed through №19 nylon mesh sieve. Plankton samples were collected by filtering a certain volume of water through the Apstein net made of №68 nylon mesh. In all cases plankton sampling sites were associated with macrophytes. Zoophytos samples were qualitative and collected by washing specimens from the macrophytes into a №19 nylon mesh sieve. Samples were fixed with 4% formalin solution, primary processing and further identification were carried out in laboratory conditions. Species identification was done on slide-mounted material using following literature [1, 9, 11, 15, 16]. Species nomenclature follows Fauna Europaea [3]. The term species was used for both Linnaean and interim names.

RESULTS AND DISCUSSION

Like the other members of the Chironomidae family, the body of larvae of the subfamily Orthocladiinae is worm-like, consisting of a well-developed head, 3 thoracic and 10 abdominal segments. The thoracic and abdominal segments bear setae of various shapes and degrees of development. The larvae feed mainly on algae (primarily diatoms), but predation also occurs (feed on small oligochaetes, chironomids larvae, etc.). In particular, members of the genera *Cricotopus* and *Psectrocladius* are able to predatory. Larvae of this subfamily inhabit a wide variety of water bodies and moist substrates, the littoral zones of seas and oceans. In the cold streams and mountain rivers, members of this subfamily are the dominant group of chironomids. The lake fauna of Orthocladiinae is often characterized by phytophilicity.

A total of 427 samples of macrozoobenthos and 39 samples of zooplankton were processed during the research. In the researched water bodies of the Lower Dnipro, 14 species/taxa of the subfamily Orthocladiinae were recorded and represented in 8 genera: *Corynoneura, Cricotopus, Hydrobaenus, Limnophyes, Nanocladius, Orthocladius, Propsilocerus* and *Psectrocladius*. The list of species is provided below with sampling site codes for the records.

Orthocladiinae

Corynoneura scutellata Winnertz, 1846: R1, R2, R3, R8, L3, L6, L8

Cricotopus (Cricotopus) bicinctus (Meigen, 1818): R1, R5, R8, L8, L9, L10
Cricotopus (Cricotopus) sp.: R1, R2, R5, L3, L4, L8
Cricotopus (Isocladius) intersectus (Staeger, 1839): R1, R2, L3
Cricotopus (Isocladius) cf. *sylvestris* (Fabricius, 1794): R1, R2, R3, R5, R7, R8, L3, L4, L6, L8, L9, L10

Hydrobaenus lugubris Fries, 1830: R1, R2, R3, R6, R7, R8, L1, L3, L8, L9

Limnophyes sp.: A1

Nanocladius (Nanocladius) dichromus (Kieffer, 1906): R1, R2

Orthocladius (Euorthocladius) sp.: R3

Propsilocerus lacustris Kieffer, 1923: R1, R2, R4, R8, L2, L3, L4, L5, L6, L7, L8, L9, L10

Psectrocladius (Psectrocladius) cf. *psilopterus* (Kieffer, 1906): L3
Psectrocladius (Psectrocladius) cf. *sordidellus* (Zetterstedt, 1838): R1, R4, R8, L3, L5, L6, L8, L9, L10
Psectrocladius (Psectrocladius) cf. *zetterstedti* Brundin, 1949: L8
Psectrocladius (Psectrocladius) sp.: R1, L9

Based on the material of macrozoobenthos samples the biological and ecological characteristics of the Orthocladiinae fauna were determined and presented in Table 2. The frequency index is the ratio of the number of samples, in which certain species was detected, to the total number of samples taken for the group of water bodies, expressed as a percentage. For density and biomass, only maximum values are given, since the minimum values were non-representative and similar for almost all detected species. In the absence of variability in data for a certain indicator, its value is given as maximum.

Table 2

Biological and ecological characteristics of Orthocladiinae in the water bodies of the Lower Dnipro

Species/taxa	Frequency index (%)			Density (ind./m^2)		Biomass (g/m^2)		Seasonality (%)			Macrophytes association (%)	Temperature (°C)			Bottom depth (m)		
	Lower Dnipro	Flowing waters	Standing waters	Avg	Max	Avg	Max	Spring	Summer	Autumn		Avg	Min	Max	Avg	Min	Max
Corynoneura scutellata	0,7	0,5	0,9	133±44	200	0,05±0,02	0,09	67	–	33	100	15,1	10,3	19,0	0,9	0,5	1,1
Cricotopus bicinctus	3,0	4,3	1,8	125±30	350	0,15±0,04	0,39	75	17	8	58	15,6	8,0	24,9	2,0	0,9	3,7
Cricotopus sp.	2,2	2,7	1,8	119±62	1400	0,18±0,10	0,78	44	–	56	78	13,4	10,1	16,0	1,9	1,0	3,4
Cricotopus intersectus	0,7	1,1	0,5	50±0	50	0,09±0,06	0,21	67	–	33	67	10,3	8,5	13,0	2,4	0,6	3,5
Cricotopus cf. *sylvestris*	9,1	9,1	9,1	184±37	1100	0,20±0,04	1,03	60	24	16	73	16,7	8,0	26,0	1,4	0,2	3,4
Hydrobaenus lugubris	5,7	6,5	5,0	186±43	850	0,31±0,09	1,61	59	18	23	18	16,1	8,0	27,0	1,6	0,6	3,4
Nanocladius dichromus	0,7	1,6	–	100±50	200	0,12±0,08	0,28	100	–	–	67	10,5	10,1	11,0	2,2	1,0	3,4
Orthocladius sp.	0,2	0,5	–	–	50	–	0,03	100	–	–	–	–	–	14,5	–	–	1,0
Propsilocerus lacustris	9,4	3,8	14,2	283±64	1550	0,11±0,02	0,70	45	33	20	40	18,9	10,1	28,0	1,6	0,2	9,0
Psectrocladius cf. *psilopterus*	0,2	–	0,5	–	200	–	0,08	100	–	–	100	–	–	20,1	–	–	0,8
Psectrocladius cf. *sordidellus*	9,1	3,2	14,2	217±43	1150	0,25±0,05	1,29	67	19	14	81	18,4	10,9	25,9	1,2	0,4	3,4
Psectrocladius cf. *zetterstedti*	0,7	–	1,4	250±104	400	0,29±0,16	0,62	100	–	–	67	–	–	16,9	1,1	1,0	1,3
Psectrocladius sp.	0,5	0,5	0,5	50±0	50	0,06±0,01	0,07	50	–	50	–	–	–	20,4	1,2	0,6	1,8

Below are comments on the detected species, supplemented by diagrams of preferences for substrate (bottom sediment) types of habitats of each species (Figures 1-10). For *Corynoneura scutellata* and species detected only in individual samples, the figures are not given due to their non-representativeness. Based on frequency indexes in benthic samples for the Lower Dnipro in general, the following status of species was used: <2% – rare species, 2-8% – common species, 9-14% – widespread species, >15% – dominant species.

Corynoneura scutellata Winnertz, 1846

A common species with regards to the frequency index in plankton samples (15%). In benthic samples the species was rare, which is why the revealed preferences for substrate (detritus and mud) are not indicative. All records of the species were associated with macrophytes and attributed to the spring and autumn seasons.

Cricotopus (Cricotopus) bicinctus (Meigen, 1818)

A common species, previously identified as *Cricotopus algarum* (Kieffer, 1911) [6, 12]. The species show a preference for flowing waters. Significant number of records connected with spring season. Unlike other species of the genus, it often occurred on muddy sands instead of mud.

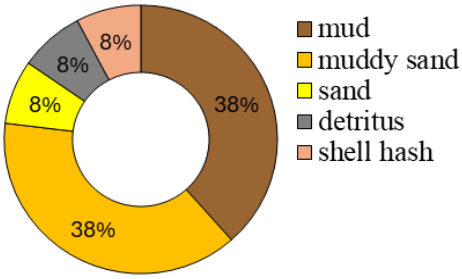

Fig. 1. *Cricotopus bicinctus* substrat preferences

Cricotopus (Cricotopus) sp.

Another common species. A member of *Cricotopus (Cricotopus) bicinctus* species group. Can create a high density (up to 1400 ind./m^2). Among all other orthoclads, the records are most assigned to muddy sediments.

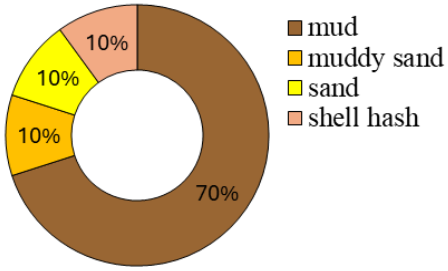

Fig. 2. *Cricotopus* sp. substrat preferences

Cricotopus (Isocladius) intersectus (Staeger, 1839)

A rare species. Occurrences connected with low water temperatures (the spring and autumn seasons).

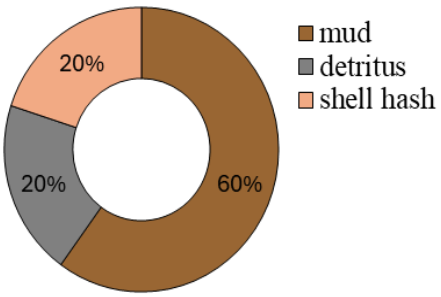

Fig. 3. *Cricotopus intersectus*

substrat preferences

Cricotopus (Isocladius) cf. *sylvestris* (Fabricius, 1794)

A widespread species. Able to create high density (up to 1100 ind./m^2) and biomass (up to 1,03 g/m^2). Show preference for muddy sediments, but regularly occurred on the other substrates. Inhabited of both flowing and standing waters equally.

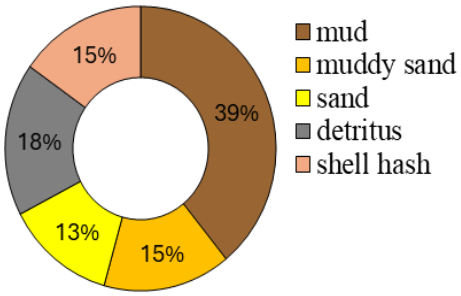

Fig. 4. *Cricotopus* cf. *sylvestris* substrat preferences

Hydrobaenus lugubris Fries, 1830

A common species with a tendency to widespread status. The highest indicators of biomass among subfamily were noted for this species: up to 1,61 g/m^2 and 0,31±0,09 g/m^2 on average. Assigned to various types of bottom sediments. Unlike the most of orthoclads of the Lower Dnipro, the records of *Hydrobaenus lugubris* were not associated with macrophytes, which noticeably distinguished it from other members of the subfamily.

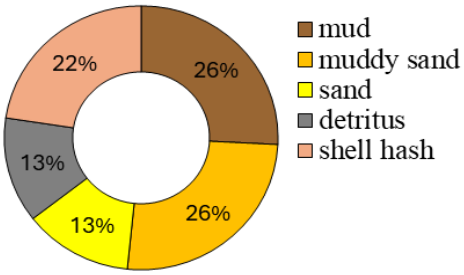

Fig. 5. *Hydrobaenus lugubris* substrat preferences

Limnophyes sp.

The species was found only once in an artificial micro-reservoir (a rubber tire, filled with water). This aspect, as well as the absence of this genus in benthic samples (the nearest regular sampling site was located in 70 m from the micro-reservoir), indicates that the species is assigned to semiterrestrial biotopes, common for some members of the genus *Limnophyes*. Several characters refer to belonging of the specimen to *Limnophyes minimus* (Meigen, 1818), but the lack of materials requires further research for validation. The frequency status of the species is unclear.

Nanocladius (Nanocladius) dichromus (Kieffer, 1906)

A rare species. The species have strong preference for flowing waters with sandy bottom sediments and shell hash. As for *Cricotopus (Isocladius) intersectus*, the occurrences were connected with low water temperatures (the spring season only).

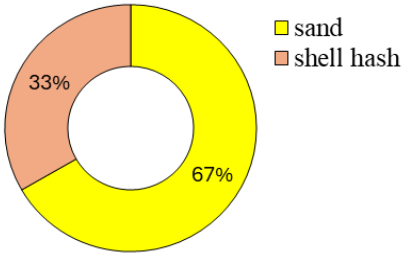

Fig. 6. *Nanocladius dichromus* substrat preferences

Orthocladius (Euorthocladius) sp.

A rare species, discovered in the anthropogenically polluted Viryovchyna River. The single occurrence does not give a good argument to connect the record of this species with water pollution, uncommon for the members of the genus. The bottom sediments were represented by mud and detritus.

Propsilocerus lacustris Kieffer, 1923

A widespread species. It has the widest area of distribution: 13 water bodies with preference for standing waters. Among all othoclads of the researched area, it shows the highest indicators of density: up to 1550 ind./m^2 and 283±64 ind./m^2 on average. Assigned to muddy sediments, but often found on shell hush. Similar to *Hydrobaenus lugubris*, the records of the species were not strongly associated with macrophytes. Can be found in the deep waters (up to 9 m).

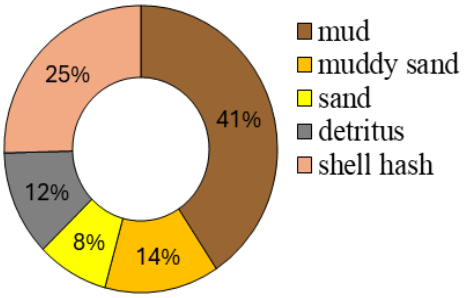

Fig. 7. *Propsilocerus lacustris* substrat preferences

Psectrocladius (Psectrocladius) cf. *psilopterus* (Kieffer, 1906)

A rare species, despite the previous numerous recordings (see comments for *Psectrocladius (Psectrocladius)* cf. *sordidellus*). Found only once in Lake Skadovsk-Pohorile. The habitat is characterized by muddy bottom sediments with detritus and macrophytes.

Psectrocladius (Psectrocladius) cf. *sordidellus* (Zetterstedt, 1838)

A widespread species. Previously identified as *Psectrocladius psilopterus* (Kieffer, 1906) [6, 12]. Similar to *Propsilocerus lacustris*, it prefers standing waters, but differs in preferences of substrate (inhabits muddy sediments and detritus). Among the common and widespread species, it has one of the highest associations with macrophytes (after *Corynoneura scutellata*).

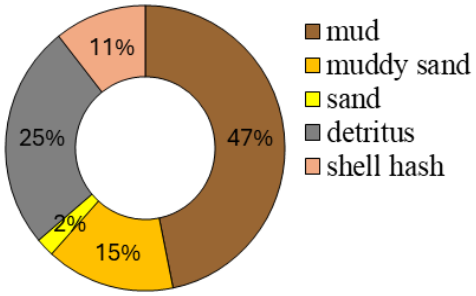

Fig. 8. *Psectrocladius* cf. *sordidellus* substrat preferences

Psectrocladius (Psectrocladius) cf. *zetterstedti* Brundin, 1949

A rare species. Recorded in Lake Kruhle only with preference to the ecotone area (close to the straits) of the lake. This aspect is indicated in the habitat assignments.

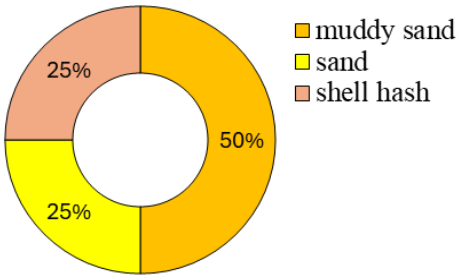

Fig. 9. *Psectrocladius* cf. *zetterstedti* substrat preferences

Psectrocladius (Psectrocladius) sp.

A rare species. A member of *Psectrocladius (Psectrocladius) sordidellus* species group. Single records were made for the Dnipro River and Lake Kardashynskyi Liman.

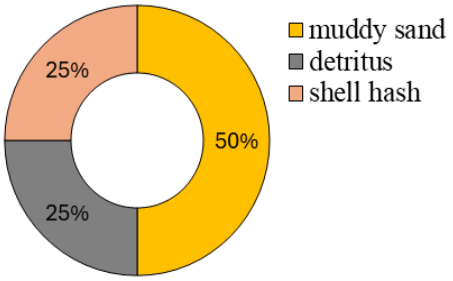

Fig. 10. *Psectrocladius* sp. substrat preferences

CONCLUSIONS

During the long-term studies of the Lower Dnipro water bodies 14 species of the subfamily Orthocladiinae, represented in 8 genera, were recorded. The following species were common/widespread for the fauna of the region: *Corynoneura scutellata*, *Cricotopus (Cricotopus) bicinctus*, *Cricotopus (Cricotopus)* sp., *Cricotopus (Isocladius)* cf. *sylvestris*, *Hydrobaenus lugubris*, *Propsilocerus lacustris* and *Psectrocladius (Psectrocladius)* cf. *sordidellus*. However, none of these species belong to the dominant species of Chironomidae of the Lower Dnipro with the frequency indexes close to 9% for widespread species *C. (I.)* cf. *sylvestris*, *P. lacustris* and *P. (P.)* cf. *sordidellus*, based on benthic samples. Other species of the subfamily were rare. The indicators of quantitative development were not so high as for the other subfamilies of Chironomidae. Average density was 50±0 – 283±64 ind./m^2, while maximum value was 1550 ind./m^2 (*P. lacustris*). As for biomass, average values were 0,05±0,02 – 0,31±0,09 g/m^2, maximum – 1,61 g/m^2 (*H. lugubris).*

The larvae of Orthocladiinae showed strong assigning to the macrophytes-associated habitats, except for *P. lacustris* and especially *H. lugubris*. The bottom sediments of habitats were widely ranged with general preference for mud/muddy sand, except for *C. scutellata* (part of zoophytos) and *Nanocladius (Nanocladius) dichromus* (psammophilic). *C. (I.)* cf. *sylvestris* and *H. lugubris* have no preferences for the types of water bodies, while *P. lacustris* and *P. (P.)* cf. *sordidellus* were

strongly limnophilic. *N. (N.) dichromus* was the only undoubtedly rheophilic species. Most of the records were dedicated to the spring season, typically for the aquatic entomofauna of researched region.

The species of subfamily Orthocladiinae were discovered in almost every water body of the Lower Dnipro, included in the general research of Chironomidae fauna, and took the second place (after the subfamily Chironominae) for the number of the recorded species.

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