

## Successful establishment of the Asian cyclopoid copepod *Thermocyclops taihokuensis* in Ukrainian waters

by

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### Abstract

*Thermocyclops taihokuensis* (Harada, 1931) was recorded for the first time in Ukraine (Kyiv region). The species was found in the Bucha River and the Sovki River in 2020, and from 2021 to 2025 it was continuously present in high numbers and was the dominant zooplankton taxon in the warm seasons in Nyvky Park pond (Syrets River), indicating successful establishment of this Asian *Thermocyclops* species in the ponds of the right-bank tributaries of the Dnieper River. Of the three species of the genus native to Ukraine, *Thermocyclops oithonoides* (Sars G.O., 1863) is most similar to *T. taihokuensis* morphologically. Distinguishing features between the Asian *Thermocyclops* and native congeners, as well as the ecology of *T. taihokuensis* in its native range, are discussed. No native *Thermocyclops* species co-occurred with *T. taihokuensis* in the studied water bodies, which may indicate competitive replacement of the local species by the new non-native invasive one.

**Key words:** Crustacea, Europe, invasive species, non-indigenous species, rivers, ponds

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## 1. Introduction

Biological invasions have become a global problem. The consequences of new species entering alien habitats are not always predictable and clear, while invasive species are one of the main factors changing the structure and functioning of hydrobiocenoses in all environments, be it marine, estuarine or freshwater (Bollens et al., 2002). Non-native species may have high phenotypic and ecological plasticity and are capable of unbalancing entire ecosystems. The increased northward spread of tropical species into temperate waters of Europe is seemingly associated with both human activity (Duggan & Pullan, 2017; Turbelin et al., 2017) and the expansion of their geographic range caused by climate warming (Dexter & Bollens, 2020). Invasive invertebrate species have been shown to have higher growth rates, higher energy metabolism, and higher food requirements than native ones (Isinibilir et al., 2016; Lagos et al., 2017).

The native geographic range of *T. taihokuensis* (Harada, 1931) is likely restricted to East and Central Asia, as well as to some tropical regions (Fig. 1). It has been found in Taiwan (terra typica), the Philippines, Thailand, Vietnam, China, Korea, Japan, the Russian Far East, Tajikistan, Uzbekistan, and Kazakhstan (Guo, 1999; Harada, 1931; Mirabdullayev & Kuzmetov, 1997; Mirabdullayev et al., 2003; Sługocki & Hołyńska, 2024). The species inhabits various habitats, including eutrophic lakes, ponds, reservoirs, fish ponds, and rice paddies (Chang, 2013; Guo, 1999; Lopez et al., 2017; Mirabdullayev & Kuzmetov, 1997). Based on the occurrence of *T. taihokuensis* in lakes in the ancient bed of the Uzboy River, which once connected the Caspian Sea with the Aral Sea, Monchenko (2008) concluded that the south of the Aral Sea is the most western limit of the species range. This geographic barrier has been overcome in recent decades. In August 2011, several adult specimens of *T. taihokuensis* were found in zooplankton samples from an artificial pond fed by a stream in the catchment area of the Drava River (Hungary), a tributary of the Danube River (Sługocki & Hołyńska, 2024). *Thermocyclops taihokuensis* appeared in the Tsimlyansk Reservoir of the Don River (South-West Russia) in 2012 and was present in large numbers in the Volga River basin in the late 2010s (Lazareva, 2021; Zhikharev et al., 2020). In August 2023, *T. taihokuensis* was recorded in Poland for the first time in the lower section of the Oder River (Sługocki & Hołyńska, 2024).

This paper presents the first report of the occurrence of *T. taihokuensis* and documents its successful establishment and seasonal dominance in ponds of the right-bank tributaries of the Dnieper River in the Kyiv region between 2020 and 2025. The morphology of the Ukrainian population of *T.*

*taihokuensis* is compared to the native Ukrainian congeners with special emphasis on *T. oithonoides*. Finally, we place these findings in the context of current knowledge of the ecology of *T. taihokuensis* in its native range and its invasion history in Europe.

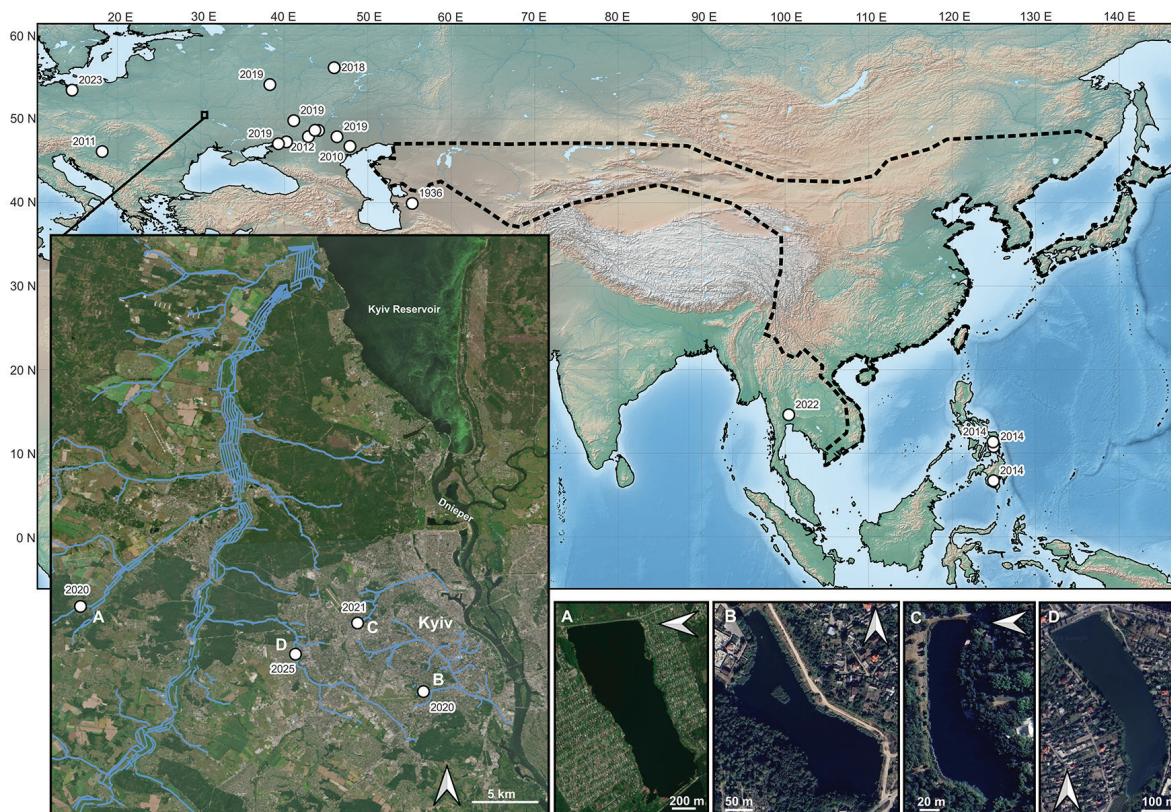
## 2. Materials and methods

Specimens of the *Thermocyclops* species examined in this study were collected in Kyiv and nearby localities in Ukraine (Fig. 1, Table 1). The original alcohol-preserved samples and microscope slides containing *T. taihokuensis* and *T. oithonoides* from Ukraine (except the sample collected in the Bucha River catchment area on 15 August 2020) were deposited at the I.I. Schmalhausen Institute of Zoology of the National Academy of Sciences of Ukraine (Kyiv, Ukraine).

To verify the species-specific characters, a few specimens of *T. oithonoides* from different geographic regions of Europe (Poland and Norway; two and one adult female, respectively) were also examined (Table 1). These specimens, along with several of *T. taihokuensis* from Nyvky Park, collected on 4 April 2021, were deposited as alcohol-preserved material and microscope slides at the Museum and Institute of Zoology of the Polish Academy of Sciences (Warsaw, Poland) [MIZ CRU 001316-001324].

Zooplankton samples in Ukraine were collected by horizontal tows in the subsurface layer (approximately 0–50 cm) using a conical zooplankton net (mouth diameter 30 cm, mesh size 100 µm). The concentrated samples were then placed in 5 L plastic containers filled with clean water. Approximately 1 h after sampling, they were concentrated to 0.5 L and screened in portions of 50–100 mL to select at least 10 specimens of adult *Thermocyclops* females. To facilitate the selection of the desired specimens, organisms were immobilized with carbonated water in the subsamples. The females collected with a pipette were placed in clean filtered water, where they quickly recovered before photography and taxonomic study. The remaining part of the sample was concentrated in 100 mL containers and fixed with 96.6% alcohol, twice completely changing its content in the sample by the sedimentation method. Species abundance in the fixed samples was estimated by the standard method using a dissecting microscope and a Bogorov chamber (Harris et al., 2000). Anesthetized copepods were photographed using the Fujifilm X-S10 camera mounted on a Biolam C11 microscope (Lomo, Leningrad, USSR) by macro rings and equipped with objectives with a magnification of





**Figure 1**

Map showing the presumed native range (dashed line) and published occurrence records (white circles with years – see Introduction) assumed to be outside the range of *T. taihokuensis*. Dates of the species discovery were taken from Monchenko (2008); Dela Paz et al. (2016a, 2016b); Zhikharev et al. (2020); Lazareva (2022); Lazareva et al. (2022); Maiphae et al. (2023); Lazareva and Sabitova (2024); Sługocki and Hołyńska (2024). The new Ukrainian records from Kyiv and its surroundings are shown in the satellite insets. Sampling sites: **(A)** Pond of the Bucha River, **(B)** Sovki pond of the Sovki River, **(C)** pond of the Syrets River, **(D)** pond of the Borshchahivka River. Blue lines indicate the local river network.

6.3–90×. To photograph the diagnostic features, *Thermocyclops* specimens were stored for 24 h in glycerol and dissected.

For light microscope examinations, the selected specimens were dissected in glycerol and preserved as semipermanent microscope slides sealed with nail polish. Pencil drawings were made using a camera lucida attached to Olympus BX 50 (Olympus Optical Co., Ltd., Tokyo, Japan) compound microscope.

In the morphological comparisons and species identification we followed the publications by Harada (1931); Monchenko (1974, 2008); Mirabdullayev et al. (2003); Lazareva and Zhdanova (2023) and Sługocki and Hołyńska (2024). The total body length, and length and width of the prosome and urosome were measured with an accuracy of 0.005 mm in 10–13 individuals at each study site.

## 3. Results and discussion

### 3.1. Species diagnostics based on morphology

In Ukraine, *T. taihokuensis* was found for the first time in the Bucha River of the Kyiv region on 15 August 2020 (Fig. 2A) and then in the Sovka River on 11 October 2020. The species, however, was initially misidentified as *T. oithonoides* (Svetlichny et al., 2022), as specimens from those ponds have appeared highly morphologically similar to the description of *T. oithonoides* in the identification key of Monchenko (1974) (see also Fig. 2). Monchenko's monographic work on the fauna of Cyclopoida in Ukraine includes the only three species of the genus, *T. oithonoides*, *T. crassus* (Fischer, 1853), and *T. dybowskii* (Lande 1890), known at that time for the country. Some late faunal studies

Table 1

Sampling sites, coordinates, and collection details for *T. taihokuensis* and *T. oithonoides* examined in this study

Species	Date(s)	Type of water	Area of water body (ha)	Water temp. (°C)	Sampling site	Coordinates	Collector(s)
<i>T. taihokuensis</i>	15.08.2020; 21.06.2025	Pond	75.8	21–23	Bucha River catchment area near Kyiv (Ukraine)	50° 28' 18.1" N 30° 06' 50.6" E	L. Svetlichny
	11.10.2020	Pond	3.7	12	Sovki River catchment area, Kyiv (Ukraine)	50° 24' 26.9" N 30° 28' 54.1" E	L. Svetlichny
	04.04.2021	Pond	0.9	9	Syrets River catchment area in Nyvky Park, Kyiv (Ukraine)	50° 27' 38.2" N 30° 24' 38.0" E	L. Svetlichny
	05.06.2025	Pond	0.9	19	Syrets River catchment area in Nyvky Park, Kyiv (Ukraine)	50° 27' 38.2" N 30° 24' 38.0" E	L. Svetlichny
	21.06.2025	Pond	7.4	21	'Velyke Ozero' of the Borshchahivka River catchment area, Kyiv (Ukraine)	50° 26' 06.7" N 30° 20' 48.6" E	L. Svetlichny
<i>T. oithonoides</i>	21.06.2025	River	-	22	Dnieper River, riverbed, Kyiv (Ukraine)	50° 26' 37.6" N 30° 33' 27.4" E	L. Svetlichny
	16.08.2006	Lake	2170	-	Lake Wigry (Poland)	54° 02' 12" N 23° 05' 54" E	G. Wyngaard; M. Hołyńska
	16.08.2006	Lake	101.9	-	Lake Białe Wigierskie (Poland)	54° 01' 56.9" N 23° 05' 33.9" E	G. Wyngaard; M. Hołyńska
	22.06.2010	Lake	116	-	Lake Storbørja (Norway)	60° 05' 38.5" N 11° 54' 21.2" E	I. Dimante-Deimantovica

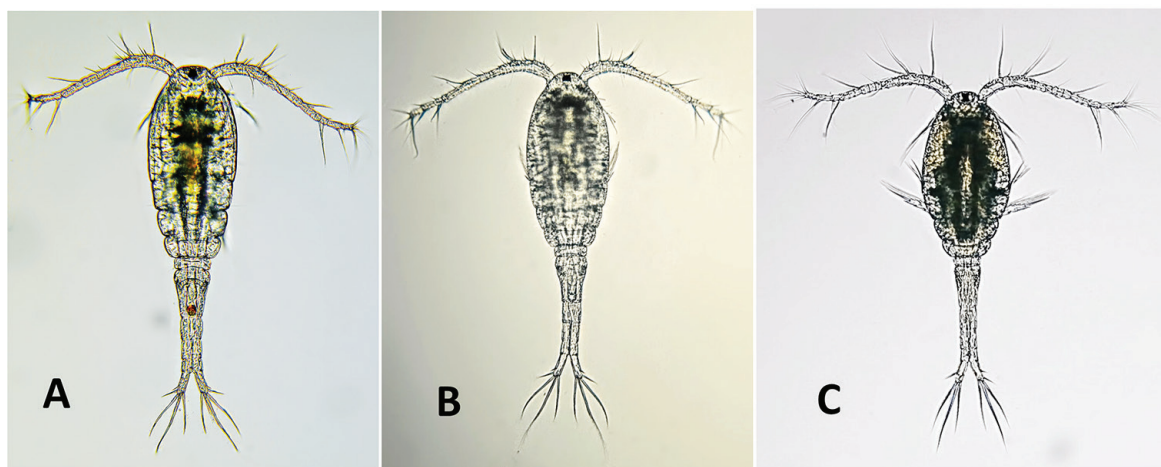
of the ponds in the Kyiv region (Gaponova, 2014, 2016) also did not report the occurrence of any non-native *Thermocyclops* until at least 2016.

Detailed morphological comparisons revealed that despite superficial similarities between *T. oithonoides* and *T. taihokuensis*, the specimens of *Thermocyclops* found in 2020, 2021, and 2025 in Ukraine (Table 1) are conspecific with *T. taihokuensis*, but not with *T. oithonoides*. Both species differ from *T. crassus* and *T. dybowskii* by a markedly greater difference in the relative lengths of the apical spines on the third endopodite segment of leg 4 (inner spine/outer spine = 3.0–5.0) (Figs 3G and 4D,E). Those apical spines are subequal in *T. dybowskii*, while in *T. crassus*, the inner apical spine is twice as long as the outer one.

*Thermocyclops taihokuensis* can be distinguished from *T. oithonoides* by several qualitative and meristic characters occurring on leg 4 and the urosome. Thus, the hairs on the posterior surface

of the intercoxal sclerite of leg 4 (Fig. 3F, arrow) do not reach beyond the distal margin of the sclerite in *T. taihokuensis*, while they are longer and reach beyond the distal margin of the intercoxal sclerite in *T. oithonoides*. The coxopodite seta of leg 4 is plumose (with long setules) in *T. taihokuensis* (Fig. 3F, arrowed), while in *T. oithonoides* it bears very short, hardly noticeable setules (verified in specimens from Lakes Wigry and Białe Wigierskie in Poland and Lake Storbørja in Norway). The medial expansion of leg 4 basipodite has an acute apical tip, and small spinules are present on the posterior surface (Fig. 3F, arrows), yet both the acute tip and posterior spinules are absent in *T. oithonoides* (Lakes Wigry and Białe Wigierskie in Poland and Lake Storbørja in Norway). Lateral arms of the seminal receptacle are strongly curved posteriorly in *T. taihokuensis* (Figs 3A and 4A) vs nearly straight (perpendicular to longitudinal axis) in *T. oithonoides* (Mirabdullayev et al., 2003).



**Figure 2**

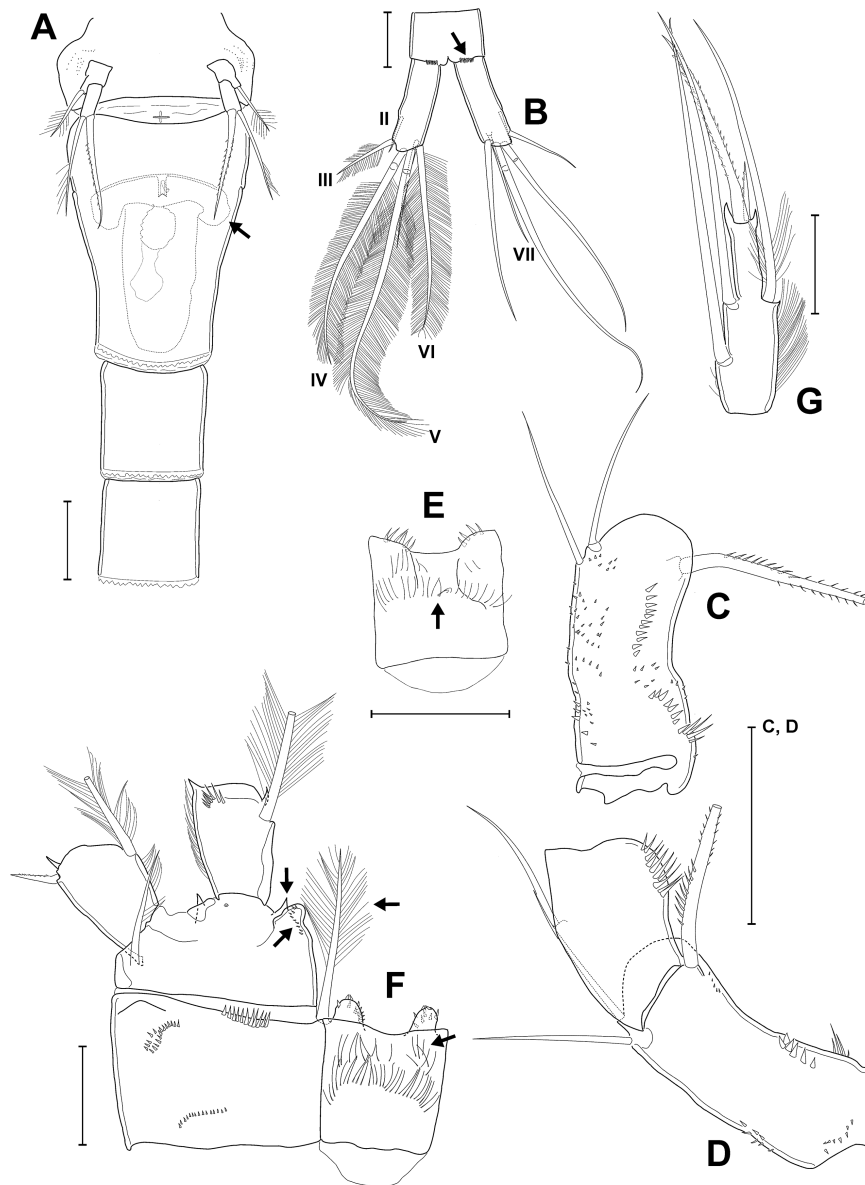
Habitus of *T. taihokuensis* (Harada, 1931) collected in a pond of the Bucha River on 15 August 2020 (**A**) and on 21 June 2025 (**B**), and *T. oithonoides* collected in the Dnieper River on 21 June 2025 (**C**).

The posterior margin of the anal somite ventrally has two rows of spinules (6–8 in each row) in *T. taihokuensis* (Ukraine) (Fig. 3B, arrow), vs the number of spinules is less (3–5) in *T. oithonoides* (verified in specimens from Lakes Wigry and Białe Wigierskie, Poland, and Lake Storbørja in Norway; Mirabdullayev et al., 2003). Other distinguishing features which however may show intraspecific variation are: i. the posterior surface of the intercoxal sclerite of leg 3 (and sometimes leg 2 as well) with one (middle) or two (middle and distal) rows of hairs in *T. taihokuensis* (Fig. 3E), vs hairs are absent or reduced to single row (distal) on leg 3 in *T. oithonoides* (Lake Wigry in Poland and Lake Storbørja in Norway); and ii. caudal setae V are curved in *T. taihokuensis* (Fig. 3B) vs straight in *T. oithonoides* (Fig. 4C).

Concerning the morphometric traits, the relative length of the inner apical spine on the third endopodite of leg 4 clearly separates the species: the ratio of the spine length to the segment length is 1.1–1.2 in *T. taihokuensis* (Ukraine) vs 1.5–1.8 in *T. oithonoides* (Lakes Wigry and Białe Wigierskie Poland, and Lake Storbørja in Norway; Mirabdullayev et al., 2003; Ukrainian sites) (Figs 4D,E). Position of the lateral caudal seta (II) on the caudal ramus is also informative: the seta is inserted near posterior third in *T. taihokuensis* (Figs 3B and 4B) while in *T. oithonoides* it is inserted near middle length of the caudal ramus (Fig. 4C). The total body length in *T. taihokuensis* varied from  $0.970 \pm 0.079$  mm (Bucha River, 15 August 2020) to  $1.125 \pm 0.054$  mm (Syrets River, 5 June 2025) and it was significantly ( $p < 0.05$ ) greater than in *T. oithonoides* ( $0.727 \pm 0.043$  mm in the

Dnieper River) (Table 2). The relative length and width of the urosome also differed between the species, i.e. the urosome is shorter and wider in *T. taihokuensis* than in *T. oithonoides* (Table 2).

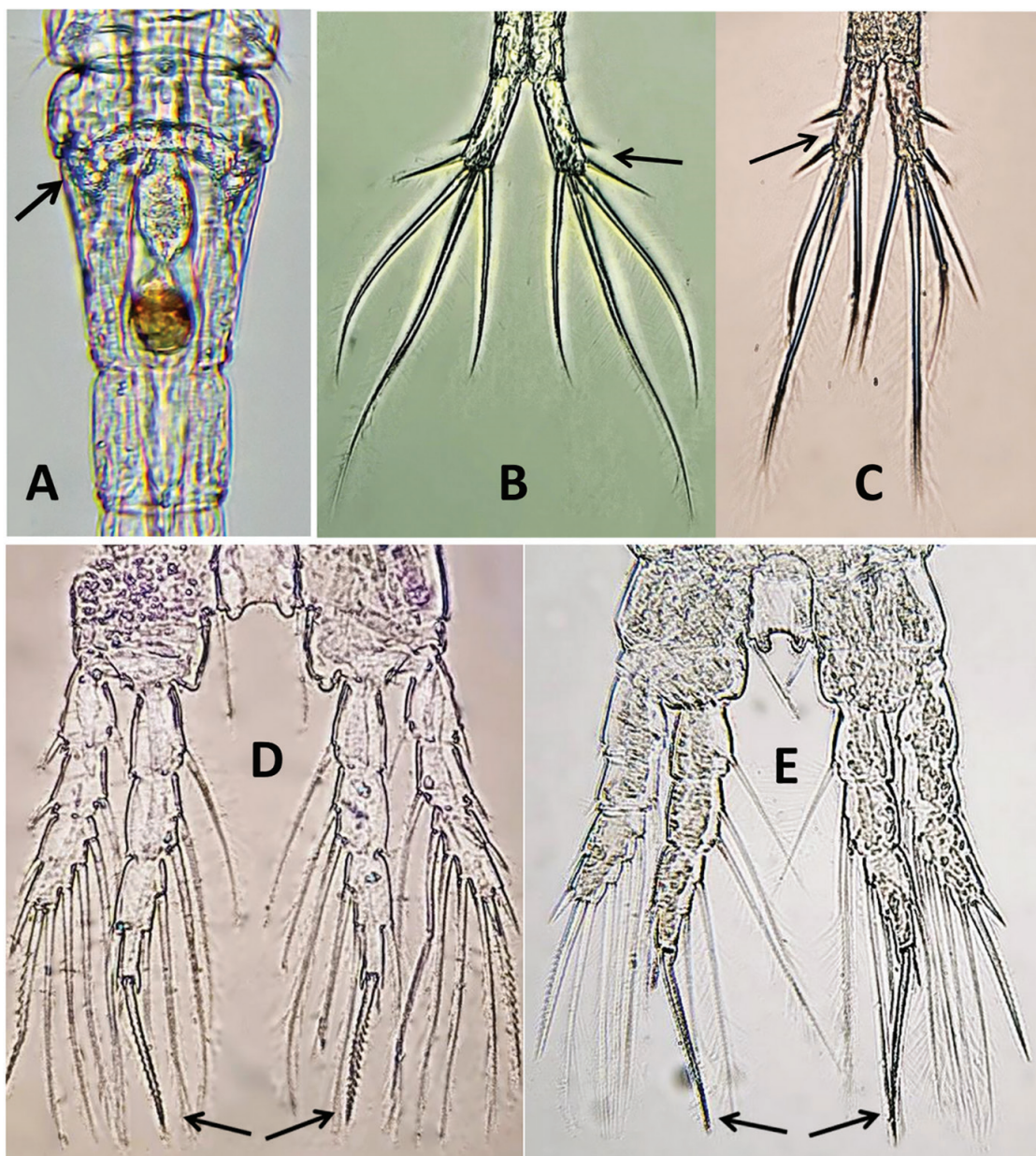
Setal armature of the antenna and the surface ornamentation pattern of the antennal coxobasipodite provide numerous morphological features that are successfully used in species diagnostics in the Cyclopidae (Mirabdullayev et al., 2003). Monchenko (2008) (Uzboy River, Turkmenistan) and Zhikharev et al. (2020) (Sura River in west-central Russia) described the antennal coxobasipodite having two exopodite setae in *T. taihokuensis*, a character state never reported in the family Cyclopidae, and interpreted by Sługocki and Hołyńska (2024) as a developmental aberrancy (atavism) in these local populations. The specimens in the Kyiv region (verified in the material from Nyvky pond) had the typical setation of the antennal coxobasipodite, i.e. two medial and one long lateral (exopodite) setae at the mediodistal and laterodistal angle of the segment, respectively (Figs 3C,D). Posterior surface ornamentation of the antennal coxobasipodite (Fig. 3C) (Nyvky pond) is the same as that in the population in southern Hungary (Égervölgyi tó, Baranya County; see Sługocki & Hołyńska, 2024). This character is rarely reported in *Thermocyclops* species, and its diagnostic value for species identification still needs to be verified within the genus. The only published drawing of the posterior surface ornamentation of the antennal coxobasipodite in the native range of the species known to us is that one provided by Chang (2013). In contrast to the Ukrainian/Hungarian populations, the specimens from South Korea have no spinules in the medial half of the segment.



**Figure 3**

Diagnostic characters of *T. taihokuensis* (Harada, 1931), female (Nyvky pond, Kyiv, Ukraine). **(A)** Pediger 5, genital double-somite and urosomites 3 and 4 (ventral view)—arrow shows posteriorly curved lateral arm of the seminal receptacle. **(B)** Anal somite and caudal rami with caudal setae coded by Roman numerals in the text (ventral view), setulation of the caudal setae is shown only on one side of the rami—arrow shows the spinules along the posterior margin of the anal somite. **(C,D)** Antenna: **(C)** coxobasipodite (posterior view); **(D)** coxobasipodite and first endopodite (anterior view). **(E)** Leg 3 intercoxal sclerite (posterior view)—arrow shows hairs. **(F,G)** Leg 4: **(F)** protopodite, first exopodite and first endopodite (posterior view)—arrows show the morphological features (intercoxal sclerite with short hairs; coxopodite seta with plumose setulation; medial expansion of the basipodite with a row of spinules and with acute tip distally) distinguishing the species from *T. oithonoides*; **(G)** third endopodite, homonomous setulation of setae is shown only on proximal section of the lateral seta. Scale bars show 50  $\mu\text{m}$ . **A–B** show ♀-1 [MIZ CRU 001316], **C–D** show ♀-4 [MIZ CRU 001319], and **E–G** show ♀-2 [MIZ CRU 001317].





**Figure 4**

Photos of the diagnostic characters in *Thermocyclops* species. **(A)** Genital double-somite with seminal receptacle (shown by arrow) in *T. taihokuensis*. **(B,C)** Anal somite and caudal rami with caudal setae, note the difference in the site of the insertion of the lateral caudal (II) seta on the caudal ramus between **(B)** *T. taihokuensis* and **(C)** *T. oithonoides*. **(D,E)** Leg 4, note the difference in the proportional length of the inner apical spine (indicated by arrows) in relation to the length of the segment between **(D)** *T. taihokuensis*; and **(E)** *T. oithonoides*.

While our records are supported by detailed morphological comparison, future molecular analyses would provide valuable additional confirmation of the identity of *T. taihokuensis* across its introduced range and help to assess genetic divergence between native and invasive populations.

### 3.2. On the European occurrences of *T. taihokuensis*

In Europe, *T. taihokuensis* was first found in the early 2010s in the southern part of European Russia and Hungary (Lazareva et al., 2022; Sługocki & Hołyńska, 2024), which may suggest that the species

**Table 2**  
Morphometric characteristics and abundance of *Thermocyclops* species in the right-bank tributaries of the Dnieper River and its main riverbed in the Kyiv region

Parameters	<i>T. taihokuensis</i>						<i>T. oithonoides</i>	
	Bucha		Sovki	Syrets		Borshchahivka	Dnieper River	
	15.08.2020	21.06.2025	11.10.2020	04.04.2021	05.06.2025	21.06.2025	21.06.2025	
Total body length, mm	0.970 ± 0.079 (10)	1.058 ± 0.076 (10)	1.054 ± 0.038 (13)	1.088 ± 0.047 (12)	1.125 ± 0.054 (13)	1.079 ± 0.038 (13)	0.727 ± 0.043 (10)	0.727 ± 0.043 (10)
Length of urosome/total body length ratio	0.408 ± 0.009 (10)	0.381 ± 0.024 (10)	-	0.38–0.40 (4)	-	-	0.439 ± 0.012 (10)	0.439 ± 0.012 (10)
Urosome width/prosome width ratio	0.390 ± 0.009 (10)	0.398 ± 0.024 (10)	-	0.37–0.42 (4)	-	-	0.304 ± 0.009 (10)	0.304 ± 0.009 (10)
Total abundance of copepodids and adults, ind. m <sup>-3</sup>	5624.3	1828.6	1236.8	4333.3	12592.6	428.5	7.2	

The number of measured individuals is given in parentheses. Sampling site names correspond to river catchments and their associated ponds (see Table 1).

was present but overlooked at that time in Ukraine. A geographically broad-scale study and verification of *Thermocyclops* samples collected before 2020 could test this hypothesis. The Dnieper River is artificially connected to the Don River basin via water-transfer channels, which may facilitate the spread of *T. taihokuensis*. Zooplankton studies conducted in the Dnieper–Donbas Channel in the spring of 2020 reported the presence of *T. oithonoides* (Novitskyi et al., 2020), a species common in northern Ukraine and morphologically highly similar to *T. taihokuensis*. Therefore, revising the identification of those specimens may correct the occurrence records.

Nevertheless, the rate of expansion and certain occurrence records outside the major waterways suggest additional vectors, such as unintentional introductions through fish aquaculture, ballast water, and potentially birds. Passive dispersal by migratory waterbirds has been documented for copepods and other invertebrates, as eggs or cysts can be transported on feathers, feet, or via gut passage (Bilton et al., 2001; Hessen et al., 2019).

The high abundance of *T. taihokuensis* in 2020 in the ponds in the Bucha and Sovka Rivers, located about 30 km apart, may indicate that this Asian species had by then successfully established itself in the ponds of the right-bank tributaries of the Dnieper River. *Thermocyclops taihokuensis* co-occurs with other congeners (*T. oithonoides* and *T. crassus*) in the large river systems such as the Volga, Don, and Oder (Lazareva, 2022; Lazareva et al., 2022; Sługocki & Holyńska, 2024), but it was the only representative of the genus in smaller water bodies around Kyiv. *Thermocyclops taihokuensis* was the dominant species in the zooplankton of all studied sites of the right-bank tributaries of the Dnieper River with an abundance varied between 430 and 12 600 ind. · m<sup>-3</sup>, but *T. oithonoides* was found only in the Dnieper riverbed, where calanoid copepods were dominant (Table 2).

Experimental studies on the thermal biology of *T. taihokuensis* (adult female) collected from the Bucha River in August 2020 and initially misidentified as *T. oithonoides* (Svetlichny et al., 2022) showed that under new conditions, this species exhibits a warm-water but eurythermal response to temperature changes. *Thermocyclops taihokuensis* females entered a lethargic state after 24 h at a temperature around 4°C. Their activity resumed between 7 and 27°C, and the recorded swimming speed increased synchronic with temperature, consistent with the linear temperature dependence of activity, a characteristic of the eurytherms. Field observations of the long breeding period of the species, lasting until October in the Shat Reservoir (Oka River basin, 54° N) in Russia, also



confirm the eurythermic character of *T. taihokuensis* (Lazareva, 2021). Although the surface of most water bodies in Kyiv freezes in winter, the temperature in the lower layers does not fall below zero. *Thermocyclops taihokuensis* may have adapted its life cycle to low temperatures through diapause in bottom sediments.

Survival at higher latitudes may also be facilitated by the rising winter temperatures due to global warming, as indicated by the spread of other warm-water *Thermocyclops* species to the northern regions in Europe (Nowakowski & Stugocki, 2024) and Canada (Campbell et al., 2024). It should be noted that in the same year, we discovered another non-native Asian copepod, *Sinodiaptomus sarsi* (Rylov, 1923) in the Nyvky Park (Syrets River) (Svetlichny & Samchyshyna, 2021). In the warm season, *T. taihokuensis* and *S. sarsi* dominated the zooplankton in the Nyvky pond, and on 21 June 2025 *S. sarsi* was present in high numbers in the Borshchahivka River (unpublished). Interestingly, another invader *Eucyclops roseus* Ishida, 1997 was discovered in the Holosiivski and Orekhovatski ponds of Kyiv in 2020 (Gaponova & Hołyńska, 2022; Kostenko et al., 2021). All three newcomers in Ukraine, *T. taihokuensis*, *E. roseus*, and *S. sarsi* are thermophilic species with native distribution in Eastern and Central Asia.

### 3.3. Ecology of the species in the native range

In its native range, *T. taihokuensis* inhabits diverse water bodies, including ditches, small pools, fish ponds, rice fields, rivers, reservoirs, lakes, and water bodies in highly urbanized areas (Chen et al., 2012; Dela Paz et al., 2018; Guo et al., 2013; Li et al., 2010; Xie & Takamura, 1997). It occurs in both continental and island water bodies, such as those on Hainan Island (Li et al., 2011). The species primarily lives in freshwater environments, but was also found as a dominant component of the zooplankton in saline–alkaline ponds with a salinity ranging from  $1.36 \text{ g} \cdot \text{L}^{-1}$  to  $20 \text{ g} \cdot \text{L}^{-1}$  (Zhao et al., 2001). In Asia, *T. taihokuensis* often co-occurs with other *Thermocyclops* and *Mesocyclops* species and is a frequent and abundant taxon of the copepod communities (Wei et al., 2024; Zhao et al., 2007). The species was also found in water bodies of diverse trophic conditions, varying from oligotrophic to eutrophic (Li et al., 2010; Wei et al., 2024). Some authors suggest that *T. taihokuensis* may serve as an indicator for a high level of nutrients in the water (Dela Paz et al., 2018). Furthermore, Wu et al. (2018) reported a strong relationship ( $R = 0.87$ , Pearson correlation) between its abundance and chlorophyll *a* concentration in the Huangpu River, indicating a close link with the primary productivity. Along with the observations from turbid habitats such as the

Huaihe River (transparency 0.40–0.43 m; Deng et al., 2013) and Chinese soft-shelled turtle (*Trionyx sinensis*) aquaculture ponds (Secchi depth 0.13–0.50 m, oxygen 1.36–7.06 mg/L; Wei et al., 2020), these findings suggest that *T. taihokuensis* is particularly well adapted to eutrophic and environmentally dynamic waters.

As a warm-adapted species, *T. taihokuensis* reaches its highest abundance in the warmest months. In the zooplankton communities of rivers and lakes in China, the highest densities were observed from June to August (Deng et al., 2013; Wu et al., 2018; Zhao et al., 2007). Its development rate is strongly temperature-dependent, with a total development time (egg to adult) ranging from 16.4 days (females) and 13.2 days (males) at 20°C to 9.3 days (females) and 6.8 days (males) at 30°C (Chen, 1985). The species exhibits marked sexual dimorphism in the rate of development, with males consistently reaching maturity faster than females, primarily due to the shorter copepodid stages. At lower temperatures (~20°C), the development slows significantly, more than doubling the maturation time compared to the summer peak. This slower development limits the population turnover in spring and autumn, while the very rapid development during warmer periods allows the species to exploit the seasonal productivity peaks. These traits indicate strong adaptation to eutrophic and thermally dynamic environments, with a high reproductive potential during summer and reduced growth activity in the cooler months. We speculate that the higher reproductive rate of *T. taihokuensis* compared to native species (Maier, 1989) may facilitate its competitive advantage in warm, food-rich environments, which are especially common in small water bodies during the summer.

Long-term studies also indicate its opportunistic strategy. Lu and Xie (2002) reported that in Lake Donghu (China), between the 1960s and 1990s, substantial changes occurred in the zooplankton community structure, following the introduction of filter-feeding fishes. As a consequence, the large-bodied *Daphnia* and calanoid copepods became rare, while *T. taihokuensis* and *Diaphanosoma brachyurum* (Liévin, 1848) increased in dominance. This demonstrates the capacity of *T. taihokuensis* to take advantage of altered community structures or newly constructed water bodies.

## 4. Conclusions

The morphological characteristics of *T. taihokuensis* from Ukraine correspond to those previously described for Eurasian populations, confirming its taxonomic identity and indicating morphological stability across

regions. The species shows clear signs of successful establishment in Kyiv water bodies, demonstrating ecological adaptability to local thermal conditions and likely persistence through winter diapause. Its eurythermal and euryhaline traits, together with a preference for eutrophic, shallow waters with pronounced seasonal temperature fluctuations, such as urban ponds receiving warm and nutrient-rich inflows, have likely facilitated its spread from Asia into Europe. The presence of *T. taihokuensis* alongside other thermophilic non-native copepods suggests ongoing faunal shifts in aquatic ecosystems driven by climate warming.

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