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Synura korshikovii sp. nov. (Chrysophyceae, Synurales), a new species from Ukraine

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Abstract

A new species, *Synura korshikovii sp. nov.*, is described from water reservoirs in the vicinities of Polisky Nature Reserve, Northern Ukraine, based on scale morphology studied by means of transmission and scanning electron microscopy. This species has three types of scales: spine-bearing oval body scales, spine-bearing prolonged transition scales and spineless ovate or circular caudal scales. All scale types are covered with hexagonal reticulum. The spine is clavate or cylindrical with flat apex terminating in a few rows of papillae-like teeth.

Key words: chrysophytes, scales, Polisky Nature Reserve, Ukraine

Introduction

The genus *Synura* Ehrenberg (1835: 314) comprises colonial chrysophytes with cells covered with siliceous scales. The genus was divided into three Sections: *Synura*, *Peterseniae* Petersen et Hansen ex Balonov et Kuzmin (1974: 1682) and *Lapponicae* Balonov et Kuzmin (1974: 1685). This infrageneric classification is included in the current taxonomic treatment of synurophytes (Kristiansen & Preisig 2007). After the transfer of *Synura lapponica* Skuja (1956: 275), the type of the section *Lapponicae*, into the genus *Tessellaria* Playfair (1918: 508) (Škaloud, Kristiansen & Škaloudová 2013) this Section became taxonomically invalid. Based on morphological and molecular data Škaloud *et al.* (Škaloud, Kristiansen & Škaloudová 2013) suggested that the genus *Synura* be split into five sections: *Echinulatae*, *Peterseniae*, *Spinosae*, *Splendidae* and *Synura*. Unfortunately, no formal descriptions of these sections were provided. Currently, there are 37 accepted taxa of *Synura* based on descriptions made with a combination of light and electron microscopy (Kristiansen & Preisig 2007; Němcová *et al.* 2008; Pang & Wang 2013; Siver 2013; Škaloud *et al.* 2012, 2014; Škaloud, Kristiansen & Škaloudová 2013).

Recent molecular reconstructions by Siver *et al.* (2015) supported the distinction between Sections *Synura* and *Peterseniae*, which represented two subclades on the tree. Interestingly, *S. uvella* Ehrenberg (1835: 315), the generitype, has an ancestral position relative to other *Synura* species (Siver *et al.*, 2015).

Ten species of *Synura* have been recorded from Ukraine (Korshikov 1929, 1942; Matvienko 1952; Kapustin & Tsarenko 2013; Kapustin & Gusev unpublished). The purpose of this paper is to describe a new species of *Synura*, *S. korshikovii*, from Ukraine based on scale morphology studied by means of transmission and scanning electron microscopy.

Materials and Methods

Polisky Nature Reserve (PNR) is situated in the northwestern part of the Zhytomyr Region (Ukraine). Its area consists of 20,104 hectares. The vegetation is dominated by forests (73%), together with swamps and bogs (22%) (Andrienko & Orlov 2012). The hydrographic network of the PNR includes the Ubort river (the tributary of the Pripyat river) and its tributaries: Perha, Bolotnytsya, and Zholobnytsya.

Plankton samples were collected from two sites: from the pond “Hrybove Lake” situated in the buffer zone of

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PNR and from the pond on the Bolotnysya river. Coordinates, collection date, water temperature, pH and conductivity of each site are shown in Table 1.

For electron microscopy studies an aliquot of each sample was washed by repeated centrifugation in deionized water. Drops of the washed sample were dried or digested in sulfuric acid with potassium dichromate. For SEM studies samples were placed on the SEM stub and coated with gold for 10 minutes. SEM observations were carried out with JEOL 6510 LV scanning electron microscope. For TEM studies Formvar-coated grids (EMS FF200-Cu-50, Electron Microscopy Sciences, Hatfield, PA, USA) were used and observations were made on JEM-1011. Water mineralization, pH and temperature measurements were performed using the Hanna Combo (HI 98129) device (Hanna Instruments, Inc., Ann Arbor, Michigan, USA).

TABLE 1. Coordinates, collection date and environmental variables of each site.

Site	Coordinates	Date	Temperature, °C	pH	Conductivity, µS
Pond "Hrybove lake"	51.500867 N, 28.106525 E	25 March 2015	9	6,67	64
Pond on Bolotnytsya river	51.536074 N, 28.103102 E	25 March 2015	11	6,12	59

Results

Synura korshikovii D. Kapustin et E.S. Gusev *sp. nov.* (Figs. 1–25)

Colony dimensions unknown. Body scales oval, 4.0–4.9 × 2.4–3.1 µm, with an upturned edge encircling approximately ¾ of scale perimeter. Spine clavate or cylindrical, 1.5–2.0 × 0.57–0.79 µm, with flat apex terminating in 2–3 rows of rounded teeth. Whole scale covered with meshwork and each mesh includes a pore. The secondary layer surrounds the base of the spine and consists of numerous struts. Transition scales similar to the body scales but narrower (2.3–5.5 × 1.1–2.5 µm). Caudal scales ovate, elliptical to roundish, surrounded by uninterrupted upturned edge (2.3–4.1 × 2.1–3.1 µm); basal plate covered in a meshwork with pores. Stomatocysts unknown.

Type (designed here): SEM stub PPZ-7 (**holotype:** Fig. 2) deposited at the I.D. *Papanin Institute for Biology of Inland Waters Russian Academy of Sciences, Russia.*

Type locality: UKRAINE: Zhytomyr Region, Ovruch District, Polisky Nature Reserve, env. of Selezivka, pond on Bolotnytsya river. 51.536074 N, 28.103102 E, 25 March 2015, *leg. D.A. Kapustin*.

Etymology. The epithet is dedicated in honour of the prominent Ukrainian phycologist Alexander A. Korshikov (1889–1945) who made the first revision of the genus *Synura*.

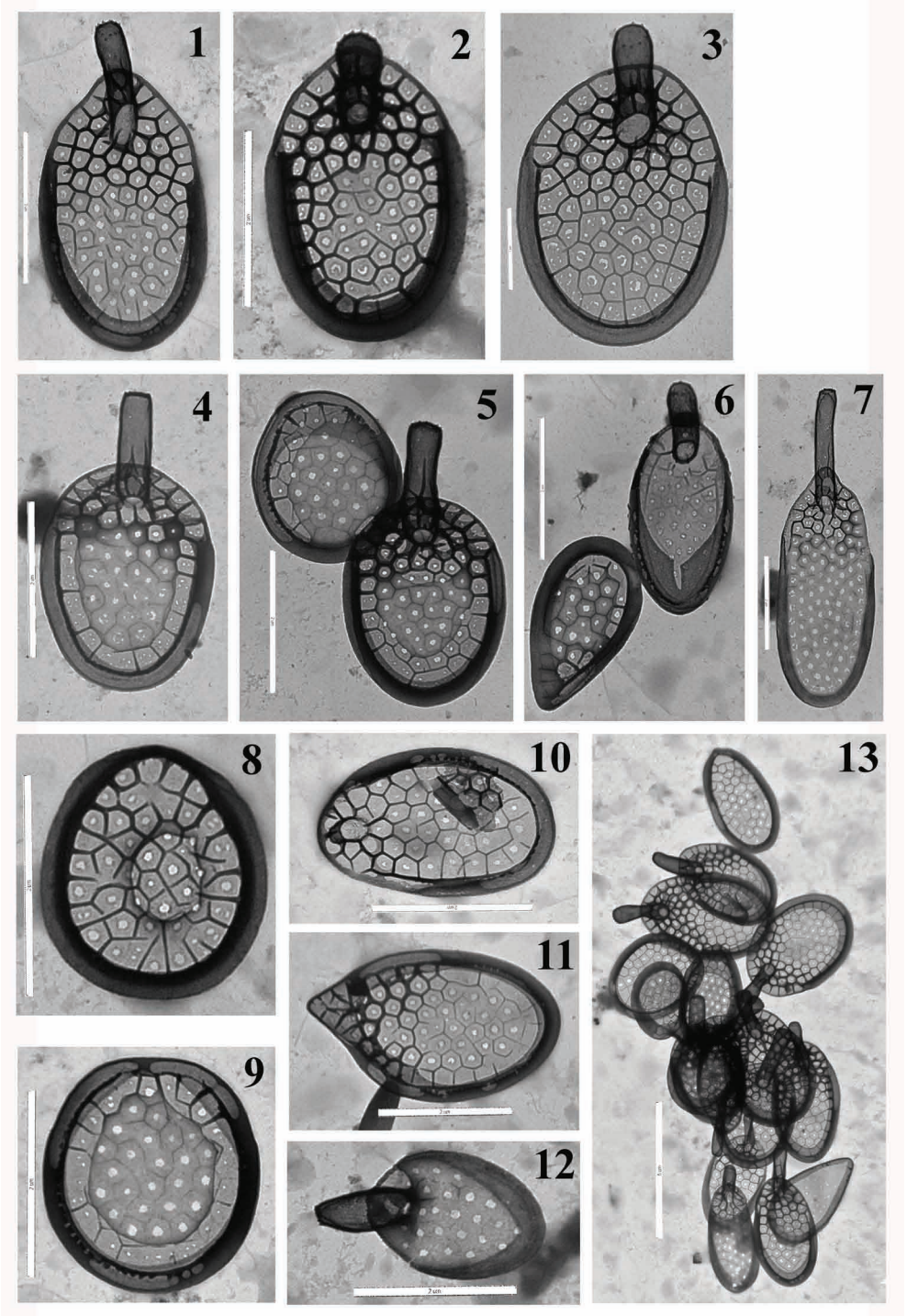
Occurrence. Besides the type locality, *S. korshikovii* also occurs in the pond "Hrybove Lake" situated in the buffer zone of PNR.

Discussion

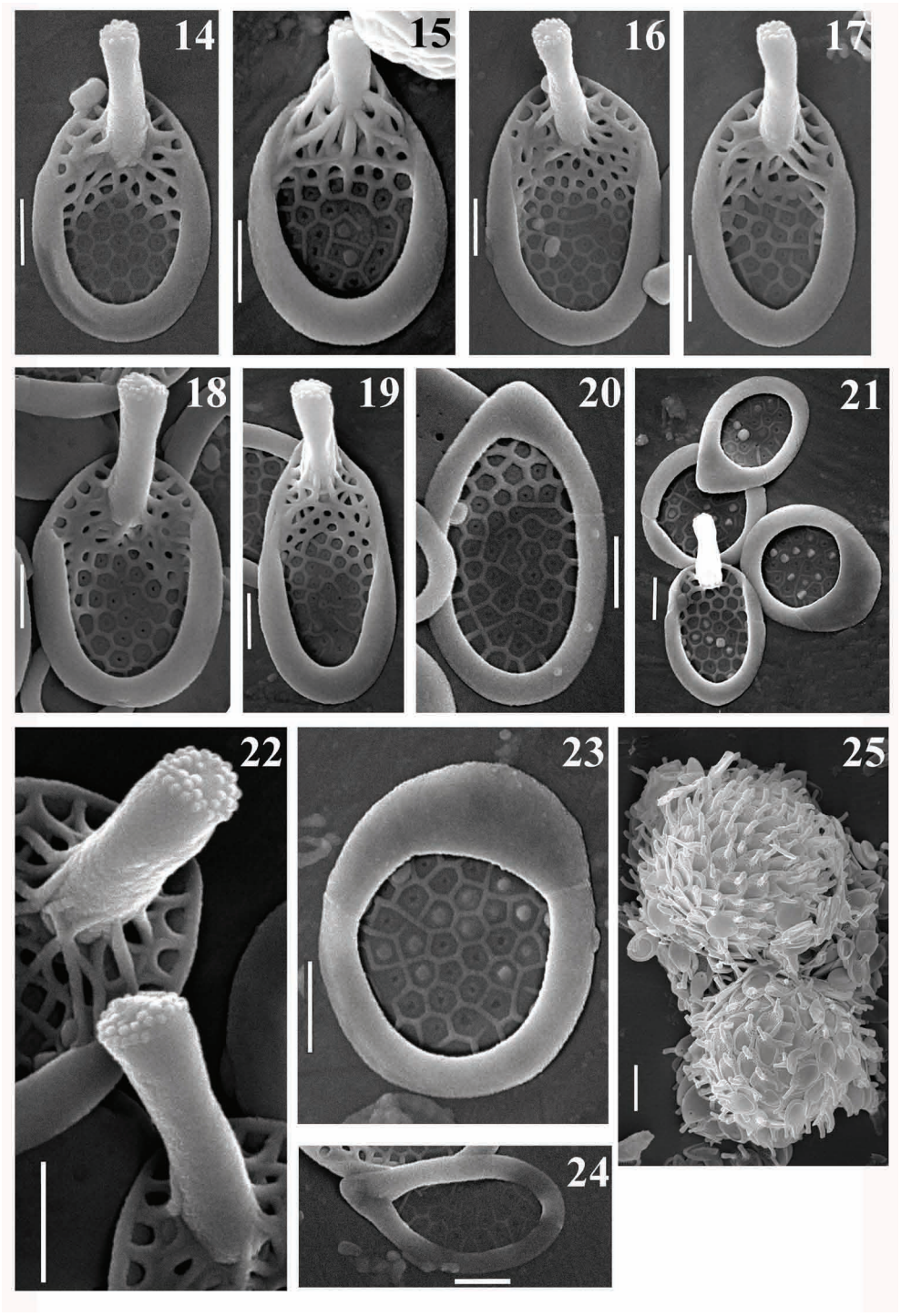
Our new species clearly belongs to the Section *Synura* (Balonov & Kuzmin 1974; Kristiansen & Preisig 2007) based on the presence of distal spine and the structure of the basal plate.

Synura korsikovii is most closely related to the *S. spinosa* Korshikov (1929: 281) species complex, especially to *S. mollispina* (J.B. Petersen et J.B. Hansen) L.Ș. Péterfi et Momeu (1977: 17). The basal plate of scales in both species is completely covered with a hexagonal reticulum, and each mesh encloses a pore. *Synura curtispina* f. *reticulata* Asmund (1968: 508) and *S. favus* D.E. Bradley (1966: 147) also have a similar structure of body scales but both taxa are currently regarded as synonyms of *S. curtispina* (J.B. Petersen et J.B. Hansen) Asmund (1968: 506) (Kristiansen & Lind 1995). The upturned edge in *S. mollispina* surrounds approximately 50% of the scale perimeter whereas in *S. korshikovii* it encircles approximately 75% of the scale perimeter. Additionally, both species differs in spine structure. *Synura mollispina* has a longer and thinner conical spine ending in two teeth whereas there is a clavate or cylindrical spine with a flat apex terminating in 2–3 rows of rounded teeth in *S. korshikovii*. The differences between these species become most evident when comparing the structure of the transition and caudal scales. The transition scales of *S. mollispina* are spineless or have a reduced spine (Wawrzyniak & Andersen 1985; Škaloud *et al.* 2013) that is prolonged and somewhat acuminate, and the basal plate is covered with hexagonal reticulum (Kristiansen & Preisig 2007). Caudal scales of *S. mollispina* are very long and narrow, and have an acuminate distal part; they are completely

surrounded by an upturned edge (Kristiansen & Preisig 2007). Interestingly, there were no descriptions of the transition and caudal scales in the protologue of *S. spinosa* f. *mollispina* J.B. Petersen et J.B. Hansen (1956: 20). Transition scales of *S. korshikovii* vary significantly in shape (Figs. 6, 7, 10, 12, 13, 19), but typically they are more prolonged than the body scales and have a similar structure. Some transition scales have a longer spine and a thickened, upturned edge (Figs. 6, 7, 12). Caudal scales of *S. korshikovii* are elliptical to roundish with a meshwork (Figs. 5, 6, 8, 9, 11, 20, 21, 23, 24). The upturned edge encircled the scales completely. The distal part of the upturned edge is thickened (Fig. 23) and somewhat pointed (in elliptical and ovate scales only; Figs. 11, 20, 21, 24). Ovate caudal scales of *S. korshikovii* resemble those of *S. spinosa* and *S. sphagnicola* (Korshikov) Korshikov (1929: 287), but the basal plate of the caudal scales of these species lacks a meshwork.



FIGURES 1–13. *Synura korshikovii*. TEM images of scales of different types. Figs. 1–4. Body scales. Fig. 5. Roundish caudal (top left corner) and body (bottom right corner) scales. Fig. 6. Ovate caudal (bottom left corner) and transition (top right corner) scales. Fig. 7. Transition scale with long spine. Figs. 8, 9. Roundish caudal scales. Fig. 10. Transition scale with reduce spine. Fig. 11. Elliptical caudal scale. Fig. 12. Transition scale. Fig. 13. Group of scales of different types. Scale bars: Figs. 1, 2, 4–12: 2 µm; Fig. 3: 1 µm; Fig. 13: 5 µm.



FIGURES 14–25. *Synura korshikovii*. SEM images of scales of different types. Figs. 14–18. Body scales. Fig. 19. Transition scale. Fig. 20. Elliptical caudal scale. Fig. 21. Body scale (bottom left corner) and three caudal scales of different shape. Figs. 23, 24. Caudal scales. Fig. 25. Two cells with the scales on the surface. Scale bars: Figs. 14–24: 1 μm; Fig. 25: 5 μm.

Our new species shares some features with *S. nygaardii* (J.B. Petersen et J.B. Hansen) Kristiansen in Kristiansen *et al.* (1997: 348). The shape of the body scales in both species are similar with rather broad upturned edge. However, in *S. nygaardii* the scales are covered by a meshwork only distally whereas it covers entire scale surface in *S. korshikovii*. Interestingly, Siver *et al.* (2013, fig. 3) showed the scales of the fossil *S. nygaardii* as being almost entirely covered with a meshwork. The spine of *S. nygaardii* has 7 teeth and there are a few rows of numerous papillae-like teeth in *S. korshikovii*. Similarly, *S. korshikovii* differs from other species in *S. spinosa* complex.

A further distinctive feature of *S. korshikovii* is the spine structure. The spine is clavate to cylindrical with flat apex terminating in 2–3 rows of rounded teeth (Fig. 22). Usually the spines in *Synura* species are conical and have

a few acute teeth or a ring of cylindrical teeth as in *S. morusimila* W. Pang et Q. Wang (2013: 57). The spine bases are often supported by short struts. In *S. korshikovii* the struts are long, well developed (Figs. 14–19) and connected with secondary layer which forms the hexagonal reticulum onto the distal part of the scale. *Synura spinosa* f. *striata* Cronberg (1989: 220) has the spine with parallel ridges along it, however the spine of *S. korshikovii* is smooth. Morphological features of *Synura korshikovii* and other similar taxa are summarized in Table 2.

We suggest that *S. korshikovii* is an acidophilous species that prefers cold humic waters with low conductivity. This species may be rather rare and may have a short vegetative period. This may explain why we did not find it in our previous studies (Kapustin, Gusev, unpublished). It occurred in the locations sampled together with *S. spinosa* and *S. petersenii* Korshikov *emend*. Škaloud et Kynčlová in Škaloud *et al.* (2012: 319). Currently, the known distribution of *S. korshikovii* is only two locations in the Northern Ukraine but it may occur in other water bodies outside Ukraine.

TABLE 2. Morphological and morphometric comparisons among *Synura korshikovii sp. nov.* and other taxa from *Synura spinosa* complex.

	S. korshikovii	*S. mollispina*[1]	*S. nygaardii*[1]	*S. favus*[2]	*S. curtispina f. curtispina*[3]	*S. curtispina f. reticulata*[3]	*S. spinosa f. spinosa*[1]	*S. spinosa f. striata*[4]
Body scale length	4.0–4.9 µm	4.9 µm	4.8–5.2 µm	4.5–5 µm	3.9–4.3 µm	3–4 µm	3.7–5.2	5–5.5 µm
Body scale width	2.4–3.1 µm	3.3 µm	3.1–3.4 µm	3.4 µm	2.9–3.1 µm	–	2.3–3.8	2.5–2.7 µm
Spine length	1.5–2.0 µm	2.8 µm	2.3–3 µm	1.2–1.7 µm	1.9–2.4 µm	1.3–1.7 µm	2.8–5.0	2.2 µm
Form of teeth	rounded							
Number of teeth	numerous in 2–3 rows	2	up to 7	2–3	2–3	–	2	6–8
Hexagonal reticulum on the distal part of body scales	present	present	absent	absent	absent	present	absent	absent
Caudal scales	ovate, elliptical to roundish	long and narrow	oval	slipper-like	slipper-like	–	ovate	ovoid
Hexagonal reticulum on the distal part of caudal scales	present	present	absent	absent	absent	absent	absent	absent

[1]Kristiansen & Preisig (2007), [2]Bradley (1966), [3]Kristiansen & Lind (1995), [4]Cronberg (1989)

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