SHORT NOTE

Observations on morphology of *Anabaena sedovii* Kossinsk. (Nostocales, Cyanobacteria) isolated from the Yenissei River (East Siberia, Russia)

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Abstract: For the first time *Anabaena sedovii* Kossinsk. (Nostocales, Cyanobacteria) is recorded from the lower of Yenissei River near Igarka city (East Siberia) and isolated to monospecific culture. Morphological studies were performed on short-term cultures. The size and shape of vegetative cells, size akinetes and heterocytes as well as position of akinetes of our isolate under culture conditions almost correspond to features of nature populations as described by Kosinskaya. New further diacritical features such as double and triple adjacent intercalar heterocytes, terminal heterocytes, short distance between heterocytes and occurrence of gas vesicles observed in this study extended our knowledge on taxonomy and distribution of the member of subgenera *Dolichospermum*.

Key words: *Anabaena sedovii*, cyanobacteria, morphology, taxonomy, East Siberia

The species *Anabaena sedovii* has been described for the first time by Kosinskaya (1933) from nature populations from stream floods of Francis Joseph's Land an archipelago located in the far north of Russia, Arctic Ocean. Furthermore, this species has been recorded mainly from northern regions of Siberia and Europe, exhibiting North-Alpine range of distribution (Kukk 1961). In East Siberia *A. sedovii* has been recorder from plankton of glacial Lake of Yakutiya (Komarenko & Vasilieva 1975), Delingde Lake and Bol'shaya Kheta River located in the north of Krasnoyarsk Region (Bondarenko & Schure 2007). According to Kosinskaya (1933) trichomes are solitary, short, fragile and bright blue coloration, 3–3.6–4.8 µm (more frequently 3.6) in width. Cells are spherical or short barrel-shaped 3–3.6–4.8 µm in length. Heterocytes are spherical, usually similar to vegetative cells in diameter (rarely slightly larger). Akinetes are cylindrical in shape with rounded ends and smooth colorless wall, 3.6–5.4 µm in width and 7.2–16.8 µm long, solitary or 2–3 in rows, aside of heterocytes or more often distant from them (Hollerbakh et al. 1953).

To date, *A. sedovii* was observed only in natural populations, but not in culture. Short-term cultivation can help to study morphological variability under various growth conditions and influence of different factors on particular morphological features (Komárek & Zapomělová 2007).

The strain *A. sedovii* was isolated from phytoplankton samples of the Yenissei River (Karskoe See basin) near Igarka city located in North of East Siberia. Isolation was carry out by repeated transfers of single trichomes on solid or liquid BG_{11} medium without nitrogen (Rippka et al. 1979) under a continuous light (30-40 µmol m^{-2} s^{-1}) and temperature range 22–25 °C. This strain (not axenic) is maintained in culture collection of the Siberian Federal University in Krasnoyarsk, Russia, under the number ACCS058. Morphological studies were performed on cultures after 1-3 months after isolation from nature using Meiji ML2000 light microscope (Meiji Techno, Japan). Microphotographs were captured using Infiniti I camera (Luminera, Canada).

Anabaena sedovii strain was growing as free-floating slightly arcuate curved or straight trichomes, without mucilaginous envelopes (Fig. 1a–j). The trichomes were uniserial, metameric, slightly narrowed to the ends, colorless, short (from a few cells to 50–60), very fragile. The vegetative cells were spherical or short barrel-shaped, blue, containing aerotopes. The cell size ranged between 4–5 µm in width and 3–5 µm in length. Terminal cells were spherical, sometimes slightly shorter than wide. Heterocytes developed

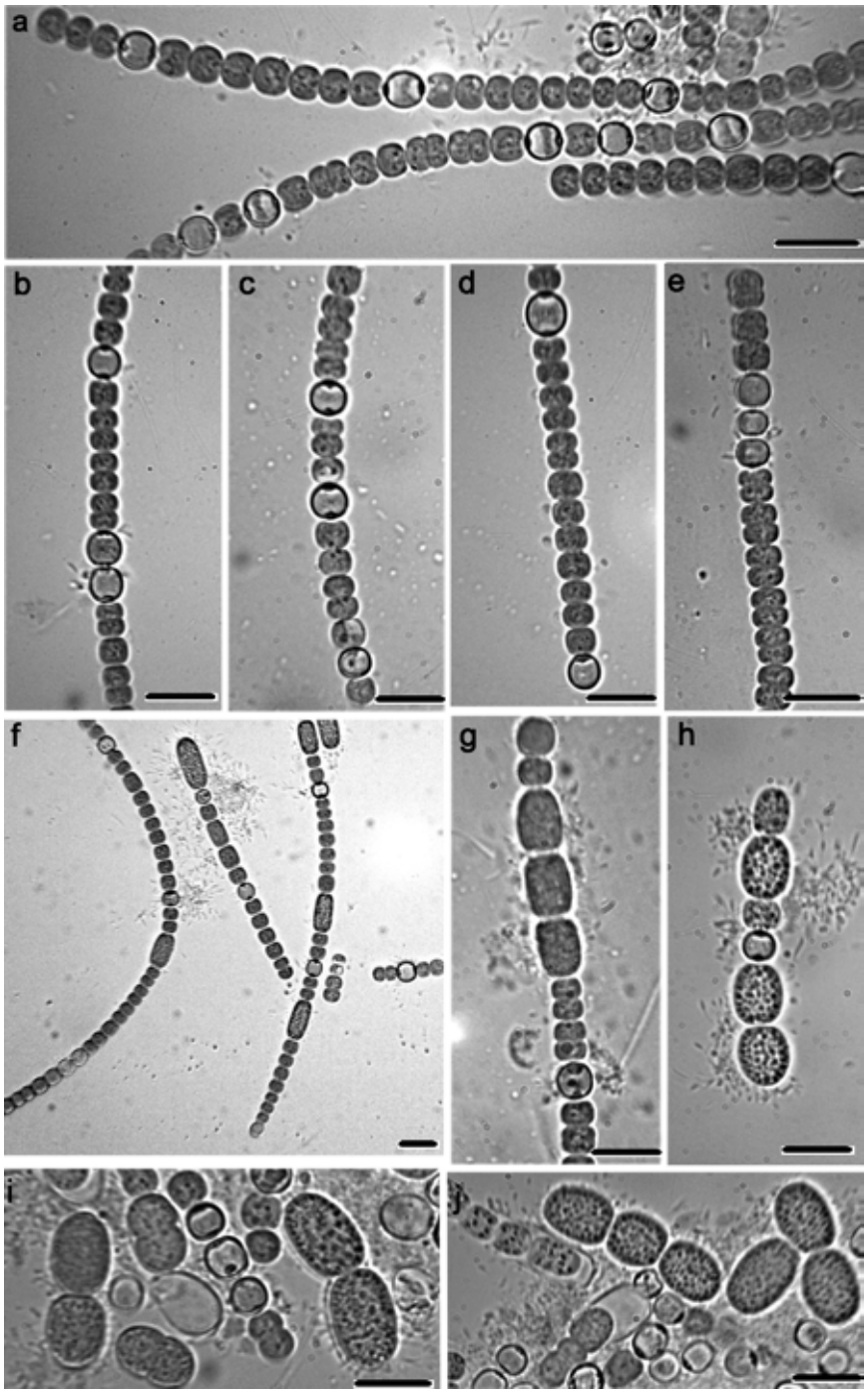

Fig. 1. Microphotographs of *Anabaena sedovii* strain ACCS058, showing important morphological features: (a) metameric structure of trichomes; (b) double adjacent arrangement of heterocytes; (c) intercalar heterocytes; (d) terminal heterocyte; (e) triple adjacent heterocytes; (f–h) different positions of akinetes; (i–j) ripe akinetes and their germination. Scale bars 10 μm.

intercalary or rarely terminally (with one pore), solitary or in pairs (frequently) or occasionally with three adjacent; 1–8 heterocytes per trichome, usually in a short distance separated by 1–10 vegetative cells, rarely up to 18 cells. Heterocytes were spherical, sometimes elongated or barrel-shaped, usually similar to vegetative cells in size or slightly larger than vegetative cells, 5–6.5 μm in diameter. Akinetes were cylindrical at an early age and oval at a mature age, frequently with blunted end and granular content; smooth colorless coat; solitary or 2–3 in a row, intercalar, developing always paraheterocytic, close to heterocytes from their both sides, or more frequently slightly distant from them (2–4 cells), 5.8–9 x 10–15 μm in size. Cell halves perpendicular to the trichome axis.

Reproduction occurs by fragmentation of trichomes and germination of akinetes after dormancy under low temperature or dark conditions.

The occurrence of paired and triple intercalary heterocytes in *Anabaena sedovii* observed in our study correspond to observations on *Anabaena nathii* Vasishta as described for populations from India and Africa (Vasishta1960, Komárek & Zapomělová 2008) and *Anabenopsis* morphotypes (Komárek 2005). The distribution, narrower trichomes and position of akinetes distinguish *A. sedovii* from the *A. nathii* (trichomes 5.6–8 μm wide; akinetes cf. Fig. 13 in Komárek & Zapomělová 2008). By contrast, the members of the genus *Anabaenopsis* are characterized by disintegration of trichomes between two intercalar heterocytes, it means by formation of fragments with terminal solitary heterocytes.

Thus, our results show new taxonomic features of *A. sedovii*: double and triple adjacent intercalar heterocytes, terminal heterocyte, short distance between heterocytes and formation of gas vesicles. The size and shape of vegetative cells, akinetes and heterocytes as well as position of akinetes of our isolate under culture conditions corresponded to features described previously by Kosinskaya (1933) from natural populations.

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