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ФЛОРИСТИЧЕСКИЕ НАХОДКИ

NOVEL RECORDS OF CHAROPHYTA SPECIES FOR THE SOUTH OF WEST SIBERIA FROM KOLYVANSKOE LAKE

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Nitella hyalina and *Coleochaete nitellarum* were found for the first time in the Siberia. *Nitella wahlbergiana*, a new species record for Altai Territory, was spotted in one of the southernmost localities of the species distribution range. All species were growing together with *Chara braunii*, *C. virgata* and *Nitella syncarpa*, rare species in Siberia. This association of rare species allowed recognition of Kolyvanskoe Lake as one of important plant areas for charophytes in North Asia.

Keywords: Altai Territory, charophytes, important plant area, rare species, novel records, *Chara braunii*, *Chara virgata*, *Coleochaete nitellarum*, *Nitella hyalina*, *Nitella syncarpa*, *Nitella wahlbergiana*, hotspot

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Numerous important plant areas, key for plant protection, were suggested for Altay-Sayan Region (Important Plant Areas..., 2009). All of them are recognized based on species richness of vascular plants, and characters of plant communities. Easily spottable macroscopic algae, mostly charophytes (Charophyta, Characeae), can be helpful in suggestion and evaluation of important plant areas too. The charophytes can be keystone species in some aquatic ecosystems maintaining stable environment, reducing or preventing negative impact of nutrient influx (Schubert et al., 2018 and references herein; Dombrowski et al., 2023). Some important charophyte areas were already suggested for Altai Mountains (Ilyin, 1984a-c) and Yenisei Siberia (Romanov et al., 2022b). Kolyvanskoe Lake located in piedmont area of Altai Mountains was already recognized as a regional natural monument (Krasnya kniga..., 2009) and one of important plant areas (Important Plant Areas..., 2009) threatened by recreation (Rusanov et al., 2016). We aimed to report new species records for Asian Russia and Altai Territory, highlighting importance of this lake for protection of rare species of plants, including Charophyta.

MATERIALS AND METHODS

The specimens were collected by D. V. Kuzmenkin from the shallows of Kolyvanskoe Lake covered with small gravel on 16 and 17 July 2019. They were partly pressed and partly fixed in 70% ethanol. The vouchers were placed in the collection of algae of the Komarov Botanical Institute of the Russian Academy of Sciences, Saint-Petersburg (LE). The specimens collected by V. V. Ilyin and stored in herbaria of the Institute of Botany, Vilnius (BILAS), LE, and the Gorno-Altaysk State University, Gorno-Altaysk were studied by R. E. Romanov. The specimens were studied at different magnifications without any treatment, with help of a Carl Zeiss Stereo Discovery V12 stereo microscope equipped with an AxioCam MRs-5 digital camera (Carl Zeiss AG, Oberkochen, Germany), stereo microscope Olympus SZ61 and microscope Olympus BH2 (Olympus Corporation, Shinjuku, Tokyo, Japan) equipped with Canon EOS80D digital camera (Canon Inc. Operations, Ohta-ku, Tokyo, Japan), and Zeiss Stemi 305 stereo microscope (Carl Zeiss AG, Oberkochen, Germany). The oospores were prepared for scanning electron microscopy as described elsewhere (Romanov

et al., 2015). The cleaned oospores were coated with gold and studied using a Zeiss EVO 40 scanning electron microscope (Carl Zeiss AG, Oberkochen, Germany).

Kolyvanskoe Lake is a regional natural monument located in forest-steppe near the piedmont of Kolyvansky Ridge in Zmeinogorsk District of Altai Territory at 51°21'46.4"N 82°11'43.1"E, at 330 m a.s.l. Its surface area is 4.7 km². This is a small shallow lake with maximal depth of 2.8 m and average depth of 2.2 m (Gubarev et al., 2023). Current salinity of its water is about 100 mg l^{-1}; pH – 7.7–8.6 (Bezmaternykh, Vdovina, 2024). It is still oligo-mesotrophic to mesotrophic and notably different from other small lakes in northern piedmont area of Altai Mountains by hydro-chemical traits (Bezmaternykh, Vdovina, 2024). During summer its waters are warmed up well. The lake has abundant aquatic vegetation surveyed several times. It supports populations of rare and regionally protected species of aquatic magnoliophytes (Ilyin, 1984a-c, 1987; Durnikin et al., 2005; Important Plant Areas..., 2009; Krasnaya kniga..., 2009, 2016).

RESULTS AND DISCUSSION

Chara aspera Willd. var. *subinermis* Kütz., *C. braunii* C. C. Gmel., *C. virgata* Kütz., *Nitella hyalina* (DC.) C. Agardh, *N. syncarpa* (Thuill.) Chev., and *N. wahlbergiana* Wallm. (Fig. 1) were growing together at eastern and northern shallows of Kolyvanskoe Lake, 51°22'23.42" N, 82°12'34.79" E and 51°23'28.22" N, 82°12'36.64" E, at depth of 0.1–0.4 m. Ecorticated species of charophytes harbored abundant thalli of *Coleochaete nitellarum* Jost (Charophyta, Coleochaetophyceae), an endophytic species associated with host species of Characeae only (Fig. 1,*d*). The specimens collected by V. V. Ilyin in 1973 and 1974 contain *Chara aspera* var. *subinermis*, *C. globularis* Thuill. and *Nitella* sp. (sterile plants from the section *Nitella R. D.* Wood, probably *Nitella flexilis* (L.) C. Agardh). It allows exclusion of *C. connivens* Salzm. ex A. Braun reported from this lake (Ilyin, 1984a-c, 1987), from the list of algae of the Altai Mountains because those vouchers belong to *C. aspera* var. *subinermis* (our data). It appears impossible to estimate expected changes of species richness of charophytes because of difference between surveys in charophyte collection efforts. In 1973 and 1974, the charophytes were collected by grapnel for mapping of aquatic communities (Ilyin, 1984a-c, 1987), whereas we collected them from nearshore shallows by hand.

This combination of species is really rare in Siberia because of rarity of most species (cf. Ilyin, 1984a-c; Safonova, 2003; Romanov, Kipriyanova, 2010; Kipriyanova, Romanov, 2013; Sviridenko, Sviridenko, 2016; Romanov, 2017; Romanov et al., unpubl. data). *Nitella hyalina* is a new species for the Siberia, considering that some part of West Siberia (West-Siberian Plain) is situated in Kazakhstan. It was indicated as known from the Altai Mountains (Ilyin, 1984a), but this record seems to be based on old specimens collected in Kazakhstan by Politov (Politow, Politoff) in 1835 from the River Narym, i.e. this record actually belongs to the northern slope of the Tarbagatai Mountains (Tarbağatai jotasy) in South-East Kazakhstan (Romanov, 2021). Few close contemporary localities are situated in the Pavlodar Region of Kazakhstan (Sviridenko, Sviridenko, 2016; Romanov, Zhamangara, unpubl. data). *Nitella hyalina* was reliably known in Asian Russia from South Ural only (Veisberg, Isakova, 2018). *Nitella wahlbergiana* has very few records from Siberia, namely from Kemerovo and Tomsk regions, Altai, Krasnoyarsk and Trans-Baikal territories (Romanov, 2017; Romanov et al., 2024; this study). The new record from Kolyvanskoe Lake is one of southernmost in the species distribution range (see map in Romanov et al., 2024). *Nitella syncarpa* is known from very few localities at south of West Siberia. They are situated in Republic of Altai (Ilyin, 1982; Anissimova, Belyakova, 1997; Zarubina, Sokolova, 2016), Altai Territory: small water body in Volchikha District near the village of Ust-Volchikha, 2000, coll. R. E. Romanov (Romanov, 2011, 2017; Romanov, unpubl. data), as well as in Kurgan, Omsk and Tomsk regions (Sviridenko, Sviridenko, 2016; Romanov, 2017). *Chara braunii* was found in very few scattered localities in Altai Territory, Kemerovo, Omsk and Novosibirsk regions (Romanov, Kipriyanova, 2010; Sviridenko, Sviridenko, 2016; Romanov, 2017) as well as from Tyumen and Irkutsk regions, Khanty-Mansi Autonomous Okrug – Yugra, Republic of Khakasia, Krasnoyarsk Territory (Romanov et al., 2022a, b). *Chara virgata* is known from very few localities in Altai Territory (Romanov, Kipriyanova, 2010; Romanov, 2017), Kemerovo, Novosibirsk, Omsk and Tyumen regions, Republic of Khakasia, Tuva Republic, Krasnoyarsk Territory (Romanov, 2017; Romanov et al., 2022a, b). The same association of species found in Kolyvanskoe Lake in 2019 was not spotted elsewhere in Siberia.

Therefore, species richness of Characeae in this lake can be estimated at eight species, but this number could increase if further studies of the lake will be implemented. Anyway, this number already makes Kolyvanskoe Lake one of key areas for charophytes in Siberia comparable with Chany Lake in Novosibirsk

Region with six species (Romanov, 2009), Tarangul Lake in North Kazakhstan with nine species (Sviridenko, Sviridenko, 2016), and Ingol Lake in Krasnoyarsk Territory with seven species (Romanov et al., 2022b).

Coleochaete nitellarum is a new species record for Asian Russia. Its closest locality is known from North Kazakhstan, where it was spotted at *Chara baueri* A. Braun in small temporary water body (Langangen, Sviridenko, 1995). It is recorded in Russia from Moscow and North-West of European part (Moschkova, Hollerbach, 1986). This species is infrequently reported elsewhere (see references in: Guiry, Guiry,

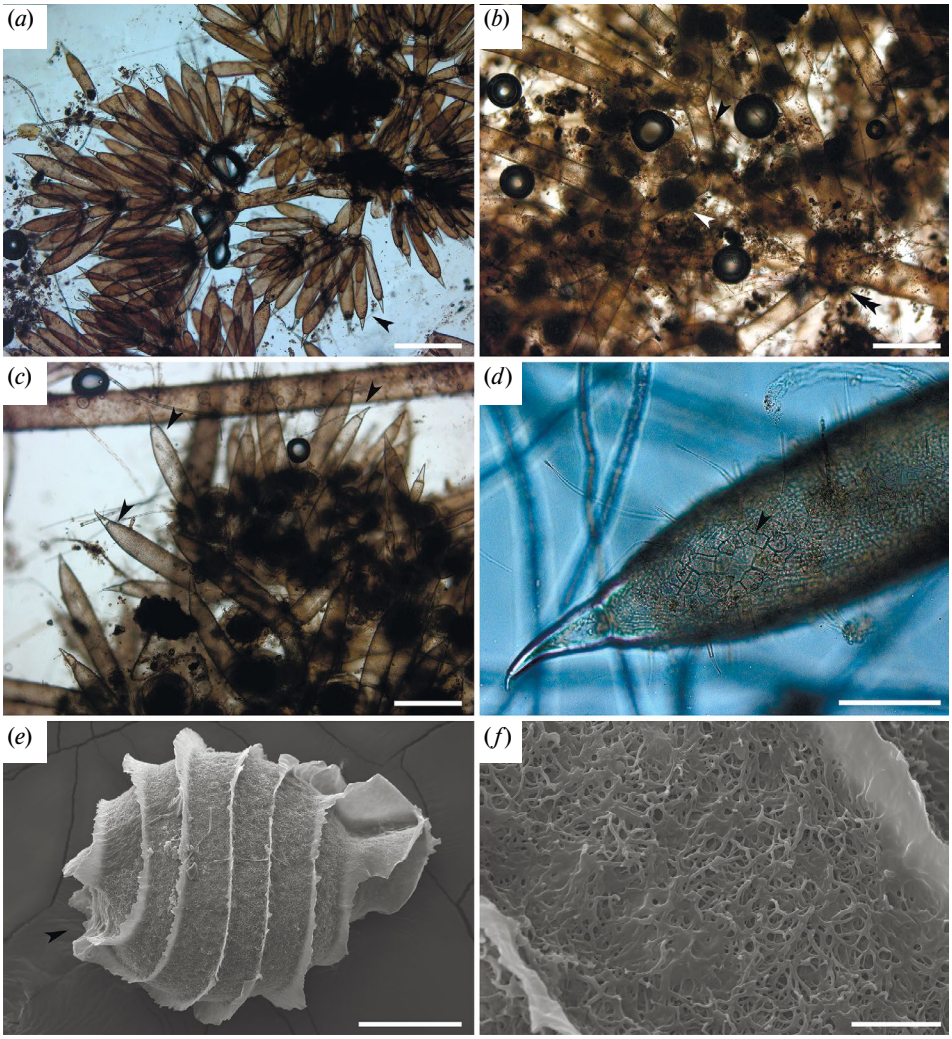

Fig. 1. Key morphological traits of *Nitella hyalina* (*a*), *N. wahlbergiana* (*b*, *c*, *e*, *f*), general appearance of *Coleochaete nitellarum* (*d*) from Kolyvanskoe Lake, Altai Territory: *a* – heteroclemous whorl of branchlets (accessory branchlets indicated with arrowhead); *b* – shortened fertile branchlets with shortened secondary rays (arrowheads), double arrowhead indicates axial node; *c* – two-celled dactyls of shortened fertile branchlets (arrowheads); *d* – thallus of *C. nitellarum* (arrowhead) inside cell wall of dactyl of lax sterile branchlet of *N. wahlbergiana*; *e* – general appearance of oospore with strongly flanged spiral ridges forming a crest at the top (arrowhead indicates basal pole); *f* – roughly spongy surface of oospore. Scale bars: (*a*–*c*) – 0.4 mm; (*d*, *e*) – 0.1 mm; (*f*) – 10 μm.

Рис. 1. Диагностические признаки *Nitella hyalina* (*a*), *N. wahlbergiana* (*b*, *c*, *e*, *f*), внешний вид *Coleochaete nitellarum* (*d*) из оз. Колыванское, Алтайский край: *a* – мутовка листьев с короткими акцессорными листьями (стрелка); *b* – компактные фертильные листья с укороченными вторичными сегментами (стрелки), двойная стрелка указывает на узел стебля; *c* – двуклеточные последние сегменты компактных фертильных листьев (стрелки); *d* – таллом *C. nitellarum* (стрелка) в клеточной стенке последнего сегмента распростертого стерильного листа *N. wahlbergiana*; *e* – внешний вид ооспоры с резко выступающими ребрами, переходящими в нежную бахрому, образующую на вершине высокий воротничок (стрелка указывает на базальный полюс); *f* – губчатая поверхность ооспоры. Масштаб: (*a*–*c*) – 0.4 мм; (*d*, *e*) – 0.1 мм; (*f*) – 10 мкм.

2024), because it is always associated with species of charophytes (Moschkova, Hollerbach, 1986) and its search requires microscopy of them.

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ФЛОРИСТИЧЕСКИЕ НАХОДКИ CHAROPHYTA ДЛЯ ЮГА ЗАПАДНОЙ СИБИРИ ИЗ ОЗЕРА КОЛЫВАНСКОЕ

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Nitella hyalina и *Coleochaete nitellarum* впервые обнаружены в российской части Сибири. Новый вид для Алтайского края *N. wahlbergiana* найден в одном из наиболее южных местонахождений в ареале. Все виды росли совместно с *Chara braunii*, *C. virgata* и *Nitella syncarpa*, редкими видами в Сибири. Эта ассоциация редких видов позволяет отнести озеро Колыванское к одной из ключевых ботанических территорий для харовых водорослей в Северной Азии.

Ключевые слова: Алтайский край, харовые водоросли, ключевые ботанические территории, редкие виды, флористические находки, *Chara braunii*, *Chara virgata*, *Coleochaete nitellarum*, *Nitella hyalina*, *Nitella syncarpa*, *Nitella wahlbergiana*, очаг разнообразия

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