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Short communication

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# New records of *Vaucheria* (Xanthophyceae) from the Lake Baikal region

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**ABSTRACT.** As a result of the field studies (2019-2021), new data were obtained on the *Vaucheria*, a genus of yellow-green algae, of the Lake Baikal region. After the studying of 30 fertile specimens from new localities, most of them from close vicinities of Lake Baikal, we identified 10 species. The new records improve the species distributional ranges within the Lake Baikal region, which is particularly important for rare species that were previously known from a few localities, e.g. *V. alaskana*, *V. birostris*, *V. cruciata*, *V. megalaversa*, and *V. prona*. *Vaucheria uncinata* was first recorded from Lake Baikal being occurred in the Pokoinitski bay. A check-list is established for all *Vaucheria* species, ever discovered in the Lake Baikal region.

***Keywords***: *Vaucheria*, Siberia, Lake Baikal, new species records, check-list

## 1. Introduction

*Vaucheria* DC. is among the richest genera of yellow-green algae (Xanthophyceae, *Vaucheria*ceae) that can be delineated through filamentous coenocytic thalli and oogamous reproduction. The species of *Vaucheria* can be easily discovered by the naked eye; however, precise species identification requires thorough microscopic observations to detect reproductive structures. The species of *Vaucheria* occur over a wide range of marine, freshwater, and moist terrestrial habitats worldwide. In the Lake Baikal region (LBR) in Siberia, the studies of *Vaucheria* have a very brief history. There were only a few studies where these algae are identified at a species rank. Dorogostaisky (1904) first reported 3 species, *V. terrestris* Lyngb., *V. racemosa* (Vauch.) DC. sensu Götz and *V. sessilis* (Vauch.) DC., from some tributaries of Lake Baikal and vicinities of Irkutsk. Many years later, Bochka (2000) additionally published new records of *V. terrestris* and *V. aversa* Hass. from small waterbodies of Barguzinsky biosphere reserve, eastern shore of Lake Baikal. All these records lack descriptions or pictures that could confirm identifications, and the voucher specimens have not survived. The author of the present report has studied the genus *Vaucheria* in LBR. As a result, 15 species were identified, including *V. megalaversa* Vishnyakov, a new species described from the region (Vishnyakov, 2019a; 2019b; 2021; Vishnyakov et al., 2020; for more references see these publications). Although species of *Vaucheria* were revealed among the commonest algae in small lakes, rivers, streams, springs, and wet soils of LBR, none registered in Lake Baikal (cf. Izhboldina, 2007), which is the world's largest freshwater lake. Very little is known yet on *Vaucheria* species inhabiting tributaries of Lake Baikal and various waterbodies of the nearshore zone.

This report presents new records of *Vaucheria* from LBR, mostly from close vicinities of Lake Baikal, with a special focus on *V. uncinata* Kütz., a species first recorded from the lake.

## 2. Materials and methods

The specimens originate from various aquatic, semi-terrestrial, and terrestrial habitats. These were collected during the fieldwork in the Irkutsk region and the Republic of Buryatia in 2019-2021. In particular, for the first time, Barguzinski, Eravninski, and Khorinski districts were surveyed. The specimens were studied alive, where possible, or preserved in 95% alcohol or 4% formalin in vials. Some parts of abundant specimens were air-dried on cardboard sheets. For light microscopy (LM), several small pieces of each specimen were rinsed with tap water in Petri dishes and then transferred to microscope slides. LM was done using a CNOEC laboratory microscope (Opto-Edu Co. Ltd, Beijing, China) equipped with a digital camera. The voucher specimens were deposited in *Vaucheria*

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collection, which is currently housed at the Papanin Institute for Biology of Inland Waters, RAS (Borok). A single access number V-n was affixed to each specimen. In total, 35 specimens have been studied, of which 30 specimens consist of fertile filaments and are listed below.

**V-584** 24.08.2019 Irkutsk region. Slyudyanski district, 123 km of the Circum-Baikal Railway, 51.776023°N, 104.180452°E, waterfall on the Kirkirey stream, on wet soil. **V-585** 24.08.2019 Irkutsk region. Slyudyanski district. 123 km of the Circum-Baikal Railway, tunnel of Kirkirey, 51.776067°N, 104.180327°E, on wet soil. **V-586** 24.08.2019 Irkutsk region. Slyudyanski district, the Medlyanka River downstream in Kultuk, 51.725567°N, 103.713176°E, in water on mosses and *Montia fontana*, abundantly, 60 ppm, pH 8.5. **V-588** 28.08.2019 Republic of Buryatia. Pribaikalski district, Goryachinsk, 52.987237°N, 108.307435°E, bank of the thermal spring, on wet soil. **V-589** 29.08.2019 Republic of Buryatia. Barguzinski district, the Maksimikha River downstream, 53.263396°N, 108.741017°E, rapids near the rock, on mosses, water depth 0–5 cm, abundantly. **V-592** 04.09.2019 Irkutsk region. Ekhirit-Bulagatski district, karst lake near Gushit, 52.888631°N, 104.975398°E, on wet soil. **V-593** 04.09.2019 Irkutsk, flowerbed near "Angara" hotel, on wet soil. **V-594** 06.09.2019 Irkutsk, 52.291696°N, 104.280019°E, flowerbed near Beloborodov's monument. **V-595** 04.09.2019 Irkutsk region. Ekhirit-Bulagatski district, reservoir on the Ordushka River, 52.816101°N, 104.801734°E, on wet soil in *Typha laxmannii* community. **V-876** 04.07.2020 Irkutsk region. Bayandaevski district, ephemeral pond in Bayandai, 53°03'13.4"N 105°30'33.5"E, in water with *Zannichellia* and *Halerpestes salsuginosa*, electrical conductivity 2.4 mS, abundantly. **V-877** 01.08.2020 Irkutsk, bank of the Angara River channel, along Polarnaya Street, 52.354473°N, 104.267525°E, on wet soil. **V-878** 26.07.2020 Irkutsk region. Irkutski district, bank of the Krestovka River in Listvyanka, 51°51'21.6"N 104°51'39.9"E. **V-879** 12.08.2020 Irkutsk region. Shelekhovski district, right channel of the Olkha River in Olkha, 52°09'27.6"N 104°06'12.6"E, springs. **V-881** 06.07.2020 Irkutsk region. Olkhonski district, Olkhon Island (Lake Baikal), small lake near Shebetski Bay, 53°08'37.1"N 107°07'02.4"E, on depth 30 cm, electrical conductivity 1.5 mS. **V-883** 05.07.2020 Irkutsk region. Olkhonski district, Sakhyurta, wet meadow near Bazarnaya Bay, 53°01'05.9"N 106°53'04.6"E, ephemeral lake, in water of hoofprints and on wet soil. **V-884** 04.07.2020 Irkutsk region. Olkhonski district, oxbow of the Anga River near Ust-Anga, 52°46'28.2"N 106°33'24.0"E, electrical conductivity 446 μS. **V-885** 12.07.2020 Republic of Buryatia. Eravninski district, the Domnaya River, 52°37'10.1"N 111°40'18.1"E, in water under the bridge, electrical conductivity 258 μS. **V-886** 13.07.2020 Republic of Buryatia. Eravninski district, oxbow of the Egita River near Mozhaika, 52°23'58.4"N 110°45'58.6"E, on wet soil trodden up by cattle. **V-887** 11.07.2020 Republic of Buryatia. Khorinski district, oxbow in right floodplain of the Uda River, 52°21'14.8"N 110°23'26.6"E, on wet soil trodden up by cattle. **V-888** 08.08.2020 Republic of Buryatia. Tunkinski district, oxbow of the Irkut River in Tory, 51°47'15.8"N 103°00'03.0"E, on wet soil trodden up by cattle. **V-890** 07.08.2020 Republic of Buryatia. Tunkinski district, left branch of the Kyngarga River in Arshan, 51°55'20.9"N 102°25'32.6"E, in slow water, electrical conductivity 226 μS, t 8.2°C, abundantly. **V-904** 12.06.2021 Irkutsk region. Irkutski district, Bolshoe Goloustnoe, 52.027611°N, 105.413775°E, dried ephemeral lake, on wet soil and *Carex* leaves. **V-905** 09.06.2021 Irkutsk, floodplain of the Angara River, near "Polyana" park, 52.253184°N, 104.276419°E, on wet soil. **V-906** 12.06.2021 Irkutsk region. Irkutski district, right tributary of the Pravaya Ushakovka River, 52.290°N, 104.962°E, near road, in water, electrical conductivity 72 μS. **V-907** 20.06.2021 Irkutsk, Selivanikha, 52.293871°N, 104.234588°E, oxbow of the Irkut River, electrical conductivity 1085 μS, t 17.8°C. **V-911** 03.08.2021 Irkutsk region. Olkhonski district, Baikal, Zunduk cape, 53.392259°N, 107.426535°E, bank of small lake. **V-912** 04.08.2021 Irkutsk region. Olkhonski district, Lake Baikal, Pokoiniki cape, bay (Pokoinitski bay), 54.011713°N 108.241753°E, on 20-30 depth, gravel, electrical conductivity 168 μS. **V-913** 08.08.2021 Republic of Buryatia. Severo-Baikalski district, bank of the Ayaya River, 55.456668°N, 109.915777°E, on sand. **V-914** 08.08.2021 Republic of Buryatia. Severo-Baikalski district, bog in the Ayaya River valley, 55.456359°N 109.9231°E, water pool. **V-916** 13.08.2021 Irkutsk region. Irkutski district, spring near the Bolshaya Kotinka River downstream, 51.904698°N, 105.073809°E, electrical conductivity 0.1 mS, t 11.5°C.

## 3. Results and discussion

In total, 10 species were identified.

***V. alaskana*** Blum

Specimens: V-884, 887. Rare species, mostly distributed within the Holarctic. In LBR, the species is known from a few localities in the vicinities of Irkutsk, in rivers of the Eastern Sayan Mountains, and Olkhon Island of Lake Baikal (Vishnyakov, 2019a; 2019b). The species primarily occurs in semi-terrestrial habitats, i.e. riverbank or damp soil, become exposed to the air when the water level recedes. However, specimen V-884 originates from aquatic habitat, being collected near the shore.

***V. birostris*** Simons

Specimens: V-888. Rare species with a Holarctic distribution. In LBR, the species is known from a few floodplain localities of the Angara, Kuda, Bolshaya Goloustnaya, and Selenga rivers (Vishnyakov, 2019a; 2019b). The species prefers semi-terrestrial habitats.

***V. bursata*** (O.F. Müll.) C. Agardh

Specimens: V-584, 586, 589, 595, 879, 884, 890, 904, 907, 913, 914, 916. Species with a cosmopolitan distribution, the most common representative of the genus in LBR (Vishnyakov, 2019a; 2019b). This amphibious species can occur in aquatic, semi-terrestrial, and terrestrial habitats.

***V. canalicularis*** (L.) T.A. Chr.

Specimens: 585, 588, 592, 595, 877, 883, 886, 888, 905, 907, 911. Cosmopolitan species, which is one of the commonest in LBR. However, most of the specimens originate from the Irkutsk region, and very rarely from the Republic of Buryatia (Vishnyakov, 2019a; 2019b). The species primarily occurs in aquatic and semi-terrestrial habitats.

***V. cruciata*** (Vauch.) DC.

Specimens: V-905. Cosmopolitan amphibious species, which was rarely recorded from LBR (Vishnyakov, 2019a; 2019b). The species mostly occurs in aquatic and semi-terrestrial habitats of floodplains.

***V. frigida*** (Roth) C. Agardh

Specimens: V-905, 906, 914. Cosmopolitan amphibious species. In LBR, it is widely distributed in various aquatic, semi-terrestrial, and terrestrial habitats (Vishnyakov, 2019a; 2019b).

***V. megalaversa*** Vishnyakov

Specimens: V-914, 916. Rare Asian aquatic species. The distribution of *V. megalaversa* appears to be disjunctive between LBR and Ola plateau at the Russian Far East. This was identified previously as a "giant forma of *Vaucheria aversa*" (Vishnyakov, 2019a; 2019b) and accepted as a distinct species only recently (Vishnyakov, 2021). In LBR, the species was previously known from a few riverine localities surrounding Southern Baikal and Tunka rift valley. One new specimen (V-916) originates from a spring associated with *locus typicus*, the Bolshaya Kotinka River, a small tributary of Lake Baikal, another one (V-914) comes from a small minerotrophic bog situated nearby northeastern shore of Lake Baikal. The species prefers clean habitats and is currently known from both stagnant and flowing waters.

***V. prona*** T.A. Chr.

Specimens: V-593, 594. Semi-cosmopolitan species. In LBR, it was previously known from a few localities in Irkutsk and its vicinities, in quarries near Cheremkhovo and in the Selenga River delta (Vishnyakov, 2019a; 2019b). The species prefers terrestrial or semi-terrestrial habitats, which are frequently disturbed by human activity.

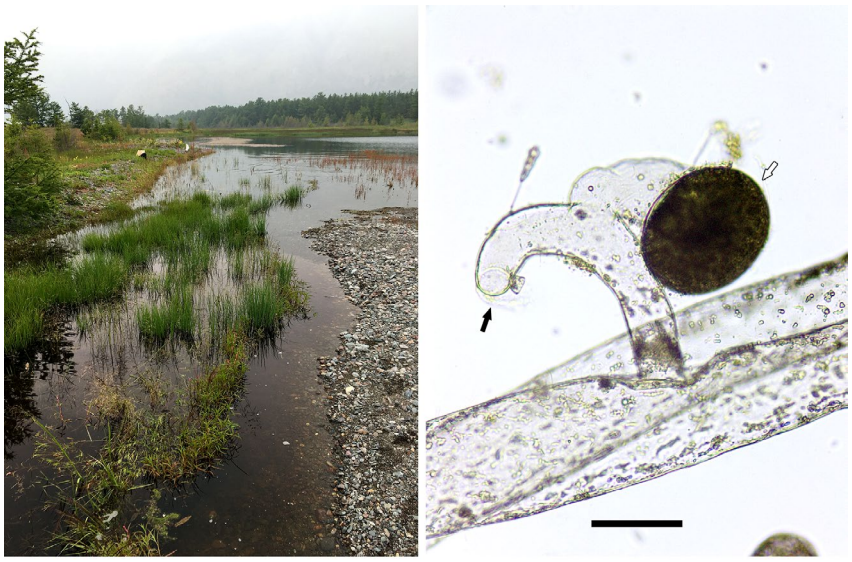
***V. racemosa*** (Vauch.) DC.

Specimens: 589, 876, 878, 881, 883, 885, 888, 914, 916. Semi-cosmopolitan species, one of the commonest in LBR (Vishnyakov, 2019a; 2019b). The species primarily occurs in aquatic habitats, both stagnant and flowing, becoming rare in semi-terrestrial habitats.

***V. uncinata*** Kütz.

Specimens: V-912. Semi-cosmopolitan amphibious species, which was recorded 5 times from LBR. Previously known localities belong to small tributaries of the Irkutsk reservoir on the Angara, Bolshaya and Burduguz rivers (Vishnyakov, 2019a; 2019b). *V. uncinata* was first discovered in Lake Baikal in 2021. The locality belongs to Pokoinitski bay, the northwestern shore of the lake, where the species was locally abundant in a sparse community of *Persicaria* and *Carex* at the shallowest part (Fig. 1A). The locality is in sharp contrast with an open shore of Lake Baikal, which is exposed to wave activity, deep, and cold, and yet connected directly with it. As is currently known, the coastal zone of Lake Baikal serves as a home for many hydrobionts, both endemics and immigrants from the Holarctic waters, and the latter are commonly restricted to semi-isolated shallowest parts of the lake (Izhboldina, 2007; Timoshkin et al., 2012). In this regard, *V. uncinata* is a species of the Siberian floristic complex that entered the shallow bay. Thorough future investigations of the Lake Baikal coastal zone are needed to determine whether the *Vaucheria* species is more widely distributed or limited to the known locality.

There are only four species among identified, which can be considered common in LBR: *V. bursata*, *V. canalicularis*, *V. frigida*, and *V. racemosa*. The rest are sporadically occurred throughout the region.



A B

**Fig.1.** Locality of V*aucheria uncinata* in Lake Baikal (A) and LM micrograph (B) showing fruiting branch bearing stalked antheridium (disintegrated wall is indicated by black arrow) and oogonium without distinctive fertilization pore (white arrow). Scale bar: 100 μm.

The most of species show broad geographical ranges that often span more than one continent, and there is a single species, *V. megalaversa*, restricted to local habitats in northeastern Asia. The morphology of all studied species was in good agreement with that of previously studied (Vishnyakov, 2019a; 2021). As a new member of the Lake Baikal algal flora, *V. uncinata* is additionally described here. Filaments are 65–140 μm in diameter. Gametangia born on short lateral gametophores. Each gametophore consists of 1 or 2 pendent oogonia and 1 antheridium (Fig. 1B). Oogonia are ellipsoidal, 130–170 μm in diameter. Antheridia are circinate-cylindrical, 32–45 μm in diameter. Asexual reproduction is unknown. An absence of distinctive oogonial fertilization pore allows distinguishing easily *V. uncinata* from all other species in LBR.

Based on the results of our previous studies, we propose here a conspectus of 15 species of the genus *Vaucheria* in LBR. These belong to 6 sections. I. Section *Woroninia* (Solms-Laub.) Heer.: *V. schleicheri* De Wild. (**IR**). II. Section *Corniculatae* (Walz) Heer.: *V. bursata* (O.F. Müll.) C. Agardh (**IR, RB**). III. Section *Tubuligerae* (Walz) Heer.: *V. fontinalis* (L.) T.A. Chr. (**IR**), *V. megalaversa* Vishnyakov (**IR, RB**), *V. pseudaversa* Vishnyakov (**RB**). IV. Section *Vaucheria*: *V. birostris* Simons (**IR, RB**), *V. canalicularis* (L.) T.A. Chr. (**IR, RB**), *V. cruciata* (Vauch.) DC. (**IR, RB**). V. Section *Racemosae* (Walz) Entwisle: *V. alaskana* Blum (**IR, RB**), *V. frigida* (Roth) C. Agardh (**IR, RB**), *V. nuoljae* (Skuja) Vishnyakov (**IR**), *V. prona* T.A. Chr. (**IR, RB**), *V. racemosa* (Vauch.) DC. (**IR, RB**), *V. taylorii* Blum (**RB**). VI. Section *Heeringia* Blum: *V. uncinata* Kütz. (**IR**). Abbreviations: IR – Irkutsk Region, RB – Republic of Buryatia.

## 4. Conclusions

The present report improves significantly the distributional ranges of 10 previously reported species within the Lake Baikal region, which is particularly important for rare species that were previously known from a few localities. One such species is *V. uncinata*, which was first discovered in Lake Baikal.

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## Conflict of interests

The author declares no conflict of interests

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