

Database on distribution and ecology of silica-scaled chrysophytes from Siberia

Anna Bessudova¹, Evgeniy Dolid¹, Yelena Likhoshway¹

1 *Limnological Institute, Siberian Branch of the Russian Academy of Sciences, 3 Ulan-Batorskaya St., Irkutsk, 664033, Russia*

Corresponding authors: Anna Bessudova (annabessudova@mail.ru)

Academic editor: R. Yakovlev | Received 3 September 2026 | Accepted 12 October 2026 | Published 31 October 2026

<http://zoobank.org/14FCF0EE-60B6-46AA-A17D-5B71C8BF03CE>

Citation: Bessudova A, Dolid E, Likhoshway Y (2026) Database on distribution and ecology of silica-scaled chrysophytes from Siberia. *Acta Biologica Sibirica* 12: 1395–1406. <https://doi.org/10.5281/zenodo.23771944>

Abstract

Silica-scaled chrysophytes include algae within the class Chrysophyceae that are characterized by species-specific silica elements covering the cell. For this group, a well-established species concept based on the ultrastructure of these elements, studied through electron microscopy, has been developed. These organisms are widely distributed in freshwater ecosystems, where they form an important component of phytoplankton. Because individual scales can be used for species identification and remain preserved in sediments, silica-scaled chrysophytes are increasingly recognized as valuable indicators for monitoring freshwater ecosystems and as promising subjects for paleolimnological and biogeographic research. They also provide important material for investigating biodiversity and the processes underlying its formation. To support this work, an online database has been established documenting 194 species and intraspecific taxa of silica-scaled chrysophytes recorded from Siberian water bodies. Each species record includes original electron micrographs, sampling-site information with geographical coordinates linked to an online map, the sampling date, and key water-quality parameters, including temperature, pH, and electrical conductivity. The database is freely accessible to all interested researchers.

Keywords

Silica-scaled chrysophytes, Siberia, distribution, ecology, internet database

Introduction

Silica-scaled chrysophytes belong to the phylum Ochrophyta and the class Chrysophyceae (golden algae). This distinctive group comprises approximately 440 species of unicellular heterokont flagellates exhibiting diverse nutritional strategies, including autotrophy, mixotrophy, and heterotrophy. These organisms may occur singly or form colonies. They convert silicic acid dissolved in water into species-specific silica scales, ranging from 0.2 to 85 μm in size, which form a dynamic shell around the cell surface. The ultrastructure of these silica scales, observable through electron microscopy (EM), constitutes the primary taxonomic criterion for defining species among scale-bearing chrysophytes (Škaloud et al. 2013; Siver et al. 2015). As with other members of the class Chrysophyceae, scale-bearing chrysophytes possess the unique ability to form silica-based dormant structures known as stomatocysts endogenously, either at the end of their life cycle or in response to abrupt environmental changes (Sandgren 1981; Holen 2014). These stomatocysts are also species-specific (Duff et al. 1995; Bessudova et al. 2024a; 2025b; Firsova et al. 2026). To date, approximately 2000 different stomatocysts morphotypes have been described (Pang and Vijver 2021). However, only 38 morphotypes described in accordance with the recommendations of the International Group on the Description of Statorspores (ISWG) have been linked to the species silica-scaled chrysophytes that produce them (Bessudova et al. 2024a-c; 2025b, c; Firsova et al. 2026). The formation of stomatocysts facilitates the successful colonization of different biotopes. Because these organisms can be identified by their individual scales, they are promising subjects for monitoring freshwaters, investigating biological diversity, and performing paleolimnological and biogeographic research. Two online databases have already been established for these purposes. One, entitled “Silica Secchi Disk” is available at: https://fmp.conncoll.edu/Silicasecchidisk/Center_Chrysophyte_Home_Page.html. This database focuses on silica-scaled chrysophytes found in North American waters and was developed under the supervision of Dr. Peter A. Siver at the Freshwater Ecology Laboratory of Connecticut College in North America. The second database, “Silica-scaled chrysophytes of Europe: distribution, morphology, and ecology,” is available at <https://chrysophytes.eu/>. This database was developed under the supervision of Pavel Škaloud in the Department of Botany at Charles University in Prague, Czech Republic. It contains records of silica-scaled chrysophytes found in European waters (Škaloud et al. 2013).

We have developed an online database documenting silica-scaled chrysophytes found in Siberian water bodies. It includes original micrographs, collection-site information, geographical coordinates linked to an online map, sampling dates, and key water parameters such as temperature, pH, and electrical conductivity.

Materials and methods

The “Silica-scaled chrysophytes from Siberia” database was developed at the Limnological Institute of the Siberian Branch of the Russian Academy of Sciences in Irkutsk. It is implemented as a modern web application using the Next.js framework, the React library, and the TypeScript programming language. The data are stored in a PostgreSQL relational database and processed with the Prisma ORM.

The database compiles taxonomic data on genera and species, bibliographic references, physicochemical characteristics of the environment, the geographical coordinates of sampling stations, regional information, and species micrographs. The locations of recorded finds are visualized through an interactive map implemented with OpenLayers, an open-source JavaScript library.

The system comprises pages featuring catalogs of genera and species, reference lists, and sampling stations. The public application allows users to search the catalogs, view detailed profiles of individual species and genera, and access information about published sources and collection sites. Authorized users with administrator or editor privileges have access to tools for adding and deleting records, uploading and organizing images, and editing text blocks through a rich-text editor. The web application interface is available in both Russian and English.

The database contains scanning (SEM) and/or transmission (TEM) electron microscopy materials obtained from 30 published papers. Of these, 25 are copyrighted (Firsova et al. 2015; Bessudova et al. 2017; Bessudova and Likhoshway 2017; Bessudova et al. 2018a-c; 2019; 2020; 2021; 2022a, b; 2023a-g; 2024a, d; 2025a, b, d, e; Bashenkhayeva et al. 2025), while the remaining five were contributed by scientists who, at various times, studied silica-scaled chrysophytes in Siberian water bodies (Balonov and Kuzmina 1986; Kristiansen et al. 1997; Gusev 2016; Gusev et al. 2018; Gusev et al. 2022).

The original micrographs in the database were obtained from research performed between 2017 and 2026 in Siberian reservoirs, lakes and rivers. The study sites included the mouths of large and small rivers, bays, large and small lakes, and unnamed reservoirs. Specifically, the mouths of the following large rivers were examined: the Yenisei, Anabar, Olenek, Yana, Indigirka, Kolyma, Ob, Verkhnyaya Angara, Barguzin, Selenga, and Angara. The mouths of the small rivers include Temnik, Chikoy, Dzhizha, Irkut, Kuda, Kitoy, Belaya, and Ida. The large lakes are Baikal, Labyntyr, Bolshoe Toko, Vorota, Engelhardt, Taimyr, and Frolikha. Small lakes and unnamed water bodies include unnamed lakes in the Lower Yenisei basin, unnamed tundra lakes near the village of Tiksi, and unnamed lakes on Kotelny Island. The reservoirs are Khantayskoye, Kolymskoye, Irkutsk, Bratskoye, Ust-Ilimskoye, and Boguchanskoye.

Sampling for the early studies (through 2022) was performed with either a bathometer or a conventional container, collecting 1–1.3 L from the surface-water horizon. The samples were immediately fixed with Lugol’s solution. After settling and siphoning (concentration) (Utermöl 1958), they were prepared for EM analysis. In

later studies (2022–2026), bathometric samples were filtered through 3- μm polyethylene terephthalate filters (Vladipor, Vladimir) using a filtration unit (Reatrek Filter, Obninsk). The material retained on the filter was rinsed off with 5 mL of the unfiltered sample, transferred to a 50-mL Falcon tube, and fixed with glutaraldehyde (final concentration, 2.5%), Lugol's solution, or formaldehyde (final concentration, 3.7%–4%). The fixed samples were then processed for analysis using EM methods.

Samples were collected from the mouths of the Anabar, Olenek, Yana, Indigirka, and Kolyma rivers, as well as from unnamed tundra lakes near the village of Tiksi, using a plankton net with a mesh size of 15–30 μm . The samples were fixed with glutaraldehyde (final concentration, 2.5%), Lugol's solution, or formaldehyde (final concentration, 3.7%–4%) and then prepared for EM.

For EM, 1 mL samples were transferred to 1.5 mL Eppendorf tubes and centrifuged in a MiniSpin centrifuge (Eppendorf, Germany) at a maximum speed of 13,400 rpm for 10 min. The supernatant was then removed by pipetting, and the precipitate was resuspended in distilled water and centrifuged three times. Next, 30% hydrogen peroxide (H_2O_2) was added to the washed precipitate, which was incubated in a thermostat at 80 °C for 2–4 h. The precipitate was then washed with distilled water to remove the H_2O_2 and centrifuged three additional times. Finally, the washed sample was prepared for examination by SEM or TEM.

For SEM examination, the washed precipitate (50 μL) was thoroughly mixed, and a drop was placed on an alcohol-pretreated SEM stub. The stub number was recorded in the work log. The sample was air-dried, sputter-coated with gold using an SCD 004 vacuum sputter coater (Balzers, Liechtenstein), and examined using a Quanta 200 scanning electron microscope (FEI Company, USA).

For TEM examination, the sample was deposited onto a prepared 3-mm-diameter mesh coated with a Formvar film substrate, dried at room temperature, and analyzed using a LEO 906E transmission electron microscope (Carl Zeiss, Germany).

Results and discussion

As a result of research performed in the freshwaters, lakes and rivers of Eastern Siberia, an extensive information on silica-scaled chrysophytes has been compiled. This information needed to be cataloged and systematically organized to make it accessible to all interested users. To address this need, the database “Silica-scaled chrysophytes from Siberia” was developed and made available online at <https://lin.irk.ru/chrysophytes-siberia>. The database is designed to facilitate analysis of the distribution and ecology of silica-scaled chrysophytes in Siberian water bodies. The database contains distributional and ecological data based on more than 3,500 records extracted from 30 published papers. For each genus represented in the database, a concise description outlines its principal diagnostic features and the morphological terminology used for its silica elements, and is supplemented by a structural diagram. The taxa assigned to each genus are arranged alphabetically.

Each taxon entry includes links to the authors and the publication containing its original description, the original electron micrographs, discovery-site information with geographical coordinates linked to an online map, the sampling date, and key water parameters, including temperature, pH, and electrical conductivity (Fig. 1).

Currently, the online database includes records for 151 described species and intraspecific taxa representing seven genera: *Chrysosphaerella* (7 species), *Spiniferomonas* (18), *Paraphysomonas* (15), *Lepidochromonas* (13), *Polylepidomonas* (1), *Mallomonas* (62), and *Synura* (35). The database also contains information on 43 potentially new species whose silica scales differ from those of previously described species, although insufficient material is available for their complete characterization. Of these, 11 species belong to the genus *Mallomonas*, 10 to *Synura*, 15 to *Paraphysomonas*, 3 to *Lepidochromonas*, 2 to *Spiniferomonas*, and 2 to *Chrysosphaerella*. These records further highlight the significant potential diversity of silica-scaled chrysophytes inhabiting Siberian water bodies. In the future, these specimens may help characterize the species more comprehensively and advance studies of their ecology and biogeography. Among the potentially new species are unique specimens, including *Mallomonas* sp. 8 from the subglacial samples of Lake Baikal. Its posterior scales bear a feature unique within the genus: an opening at the base of the dome. Only two of the approximately 250 species known worldwide exhibit this distinctive ultrastructural feature, including the extant species *Mallomonas paludosa* Fott and the fossil *M. aperturae* Siver, described from sedimentary rocks dating to the Middle Eocene (approximately 47.8 Ma) (Siver 2018).

The database contains original electron micrographs of most species, acquired using both SEM and TEM. Because these complementary techniques reveal different aspects of morphology, their combined use provides the most comprehensive view of scale ultrastructure (Fig. 1). The micrographs presented depict scales, bristles, or spines. For most species, the micrographs show cells, whereas for 12 species they show stomatocysts: *Chrysosphaerella baikalensis* Popovskaya (Stomatocyst 507 Firsova et Bessudova 2024), *C. coronacircumspina* Wujek et Kristiansen (Stomatocyst 156 Zeeb et Smol 1993), *Spiniferomonas abrupta* Nielsen (Stomatocyst 513 Firsova et Bessudova 2025) (Fig. 1), *S. minuta* Nicholls (Stomatocyst 331 Firsova et Likhoshway 2006), *S. septispina* Nicholls (Stomatocyst 302 (Firsova 2006) Firsova et Bessudova 2024), *S. bourrellyi* Takahashi (Stomatocyst 180 Zeeb et Smol 1993), *S. trioralis* Takahashi (Stomatocyst 111 Zeeb et al. 1990), *Paraphysomonas corynephora* Preisig et Hibberd (Stomatocyst 52 (Duff et Smol 1991) Duff et al. 1995), *P. circumvallata* Thomsen (Stomatocyst 514 Firsova et Bessudova 2026), *Mallomonas akrokomos* Ruttner (Stomatocyst 118 Zeeb et al. 1990), *M. crassisquama* (Asmund) Fott, and *Mallomonas* sp. 5 (Stomatocyst 166 Zeeb et Smol 1993). Identifying known stomatocyst morphotypes, or discovering new ones and correlating them with the species that produce them, enables their use in monitoring modern water bodies and as paleoindicators for reconstructing the geological past. Moreover, stomatocyst morphotypes may provide an additional criterion for defining species of silica-scaled chrysophytes.



[Главная](#) • [Виды](#) • [Локации](#) • [Литература](#) • [Контакты](#)

[EN](#) [RU](#) [Вход](#)

Вид *Spiniferomonas abrupta*

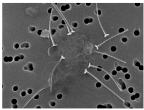
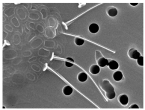
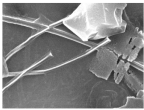
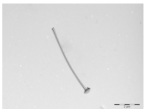
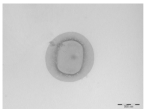
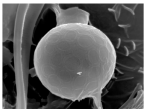
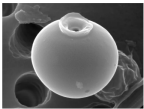
Информация

Автор
Nielsen 1994: 478

Описание
Nielsen, Y. (1994): *Spiniferomonas abrupta*, sp. nov. and some rare species of Synurophyceae and Chrysophyceae, not formerly recorded from Denmark. *Nordic Journal of Botany* 14(4): 473–480.

Фотографии

Всего фотографий: 7.



Отборы

Всего отборов: 23.

Регион	Станция	Координаты	pH	T	Ес	Дата отбора	Литература
Иркутское водохранилище	станция 14, напротив залива Еловый, центр	52.141920 104.458080	8.47	15.37	107	12.08.2024	Bessudova et al. 2025a
Богучанское водохранилище	станция 41, устье реки Проспихина	58.608330 99.391930	7.5	7.6	180	09.06.2024	Bessudova et al. 2025a
река Ангара	станция 10	53.170620 103.357140	7.9	8.2	110	19.05.2024	Bessudova et al. 2025b
устье реки Ида	станция 11	53.178940 103.376630	8.4	11.3	278	19.05.2024	Bessudova et al. 2025b
озеро Байкал	центральная станция 7 разреза мыс Кадейный - посёлок Мешка	51.778850 105.375460	7.5	5.1	-	17.10.2023	Bessudova et al. 2024a
Иркутское водохранилище	станция 15, напротив залива Ершовский, центр	52.218080 104.367420	8.1	17.3	-	20.08.2023	Bessudova et al. 2024a
река Ангара	станция 10, парк Бурдугуз	52.046970 104.584930	7.9	11.3	-	19.08.2023	Bessudova et al. 2024a
озеро Байкал	центральная станция 5 разреза мыс Толстый - река Снежная	51.606700 104.735780	8.4	10.2	-	18.08.2023	Bessudova et al. 2024a
озеро Байкал	центральная станция 8 разреза посёлок Лястевка - посёлок Талой	51.704360 105.012000	8.2	13.4	-	18.08.2023	Bessudova et al. 2024a
Иркутское водохранилище	станция 12, напротив залива Курманской, центр	52.109480 104.486230	8.3	7.6	-	25.06.2023	Bessudova et al. 2023b

«

1

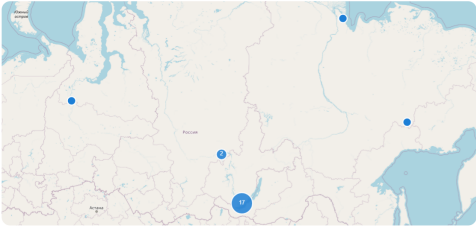
2

3

»

Карта станций

На карте отмечены станции, где найден данный вид.



© 2026 Федеральное государственное бюджетное учреждение науки Линнейский институт Сибирского отделения Российской академии наук

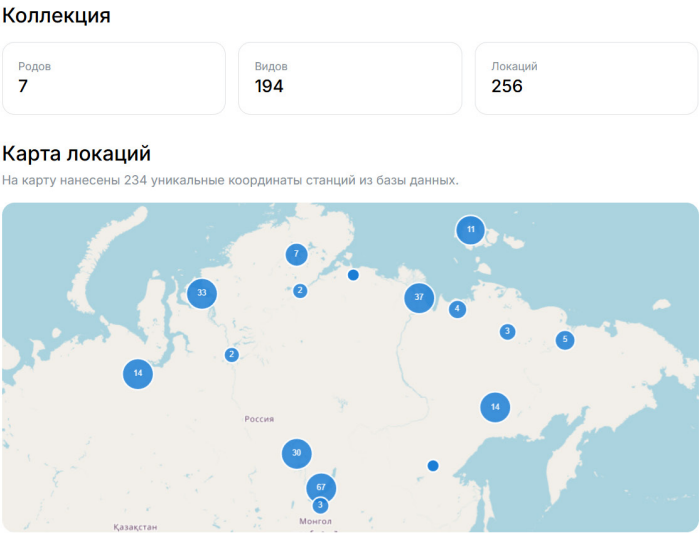
Figure 1. Screenshot illustrating the design of a species card.

The location data identify the water body from which the samples were collected, the station number for large water bodies, and the corresponding geographical coordinates. Based on the sampling stations, the online database contains records for 256 locations and 234 unique station coordinates (Fig. 2).

The sampling date is essential for monitoring and investigating seasonal and interannual changes in the region’s water bodies.

The selection of three key water parameters (temperature, pH, and electrical conductivity) was based on laboratory and field studies demonstrating the particular sensitivity of silica-scaled chrysophytes to these characteristics (Gutowski 1989; Siver and Hamer 1989; 1992; Cumming et al. 1992; Siver and Lott 2010; 2012; Hyatt et al. 2010). Gradients in these parameters play an important role in determining species distributions in the environment (Siver and Lott 2010; 2012; Siver 2015; Bessudova et al. 2024d).

The online database is freely available to all interested researchers seeking information on the distribution and ecological ranges of these species across Siberian reservoirs, lakes and rivers. It will support monitoring, paleolimnological and biogeographic research, biodiversity studies, and investigations into the processes shaping biodiversity.



© 2026 Федеральное государственное бюджетное учреждение науки Лимнологический институт Сибирского отделения Российской академии наук

Figure 2. Screenshot showing the numbers of genera, species, and intraspecific taxa, along with an interactive online map displaying the selected sampling locations.

Acknowledgments

The microscopy studies were performed at the Electron Microscopy Center of the Shared Research Facilities “Ultramicroanalysis” of the Limnological Institute, <https://www.lin.irk.ru/copp/>, accessed on 5 March 2025. The study was supported by the Ministry of Science and Higher Education of the Russian Federation in the frames of Agreements FWSR-2026-0001 project, theme No. 1023032700153-7.6.17.

References

- Balonov IM, Kuzmina AE (1986) Chrysophyta. In: Hydrochemical and hydrological studies on the Khantay Reservoir, Nauka, Novosibirsk, 59–70. [In Russian]
- Bashenkhaeva M, Zakharova Y, Galachyants Y, Petrova D, Makarov M, Sakirko M, Bessudova A, Smolin I, Khanaev I, Fedotov A, Likhoshway YV (2025) Massive development of flagellates under the ice of Lake Baikal: combining microscopy and metabarcoding methods. *Journal of Great Lakes Research* 51(3): 102545.
- Bessudova A, Domysheva VM, Firsova AD, Likhoshway YV (2017) Silica-scaled chrysophytes of Lake Baikal. *Acta Biologica Sibirica* 3(3): 47–56. <https://doi.org/10.14258/abs.v3i3.3615>
- Bessudova AY, Likhoshway YV (2017) Scaled chrysophytes (Chrysophytes) of the Boguchany Reservoir. *Modern Science: actual problems of theory and practice. Series "Natural & Technical Sciences"* 11: 4–11. [In Russian]
- Bessudova A, Sorokovikova LM, Tomberg IV, Likhoshway YV (2018a) Silica-scaled chrysophytes in large tributaries of Lake Baikal. *Cryptogamie Algologie* 39(2): 1–21. <https://doi.org/10.7872/crya/v39.iss2.2018.145>
- Bessudova A, Bukin YS, Sorokovikova LM, Firsova AD, Tomberg IV (2018b) Silica-scaled chrysophytes in small lakes of the Lower Yenisei basin, the Arctic. *Nova Hedwigia* 107(3–4): 315–336. https://doi.org/10.1127/nova_hedwigia/2018/0473
- Bessudova A, Firsova AD, Tomberg IV, Sorokovikova LM, Likhoshway YV (2018c) Biodiversity of silica-scaled chrysophytes in tributaries of northern limit of Lake Baikal. *Acta Biologica Sibirica* 4(3): 75–84. <https://doi.org/10.14258/abs.v4i3.4411>
- Bessudova A, Tomberg IV, Firsova AD, Kopyrina LI, Likhoshway YV (2019) Silica-scaled chrysophytes in lakes Labyntyr and Vorota of the Sakha (Yakutia) Republic, Russia. *Nova Hedwigia, Beihefte* 148: 35–48. <https://doi.org/10.1127/nova-suppl/2019/049>
- Bessudova AY, Sorokovikova LM, Sinyukovich VN, Firsova AD, Tomberg IV, Likhoshway YV (2020) Effects of water levels on species diversity of silica-scaled chrysophytes in large tributaries of Lake Baikal. *Acta Biologica Sibirica* 55: 7–22. <https://doi.org/10.3897/abs.6.e52840>
- Bessudova AY, Gabyshev VA, Firsova AD, Gabysheva OI, Bukin YS, Likhoshway YV (2021) Diversity of silica-scaled chrysophytes and physicochemical parameters of their environment in the estuaries of rivers in the Arctic watershed of Yakutia, Russia. *Sustainability* 13: 13768. <https://doi.org/10.3390/su132413768>

- Bessudova A, Gabyshev V, Likhoshway YV (2022a) Record of two rare taxa from *Synura* genus (Chrysophyceae) with a description of a new species (*Synura tiksienensis* sp. nov.) near the arctic settlement of Tiksi, Yakutia, Russia. *Phytotaxa* 560(2): 247–253. <https://doi.org/10.11646/phytotaxa.560.2.8>
- Bessudova A, Gabyshev V, Bukin Yu, Gabysheva O, Likhoshway YeV (2022b) Species richness of scaled Chrysophytes in arctic waters in the Tiksi Region (Yakutia, Russia). *Acta Biologica Sibirica* 8: 431–459. <https://doi.org/10.5281/zenodo.7710355>
- Bessudova A, Likhosway YV (2023a) New observations on *Mallomonas getseniae* comb. et stat. nov. (Chrysophyceae, Synurales). *Phytotaxa* 626(3): 213–216. <https://doi.org/10.11646/phytotaxa.626.3.8>
- Bessudova AY, Gabyshev V, Firsova AD, Likhoshway YeV (2023b) Silica-scaled protists (Chrysophyceae, Centroplasthelida, Thaumatomnadida and Rotosphaerida) in waters bodies of Kotelny Island, Russian Arctic. *Polar Biology* 46: 895–913. <https://doi.org/10.1007/s00300-023-03173-1>
- Bessudova A, Firsova A, Bukin Y, Kopyrina L, Zakharova Y, Likhoshway Y (2023c) Under-ice development of silica-scaled chrysophytes with different trophic mode in two ultraoligotrophic lakes of Yakutia. *Diversity* 15(3): 326. <https://doi.org/10.3390/d15030326>
- Bessudova A, Likhoshway YeV, Firsova AD, Mitrofanova E, Koveshnikov M, Soromotin AV, Khoroshavin V, Kirillov V (2023d) Small organisms in a large river: what provides the high diversity of scaled chrysophytes in the Ob River? *Water* 15: 3054. <https://doi.org/10.3390/w15173054>
- Bessudova A, Galachyants Y, Firsova A, Hilkanova D, Nalimova M, Marchenkov A, Mikhailov I, Sakirko M, Likhoshway Y (2023e) Changes in diversity of silica-scaled chrysophytes during lake–river–reservoir transition (Baikal–Angara–Irkutsk reservoir). *Life* 13: 2052. <https://doi.org/10.3390/life13102052>
- Bessudova A, Firsova A, Hilkanova D, Makarov M, Sakirko M, Bashenkhaeva M, Khanaev I, Zakharova Y, Likhoshway Y (2023f) Two new species, *Mallomonas baicalensis* sp. nov. and *M. grachevii* sp. nov. (Synurales Chrysophyceae), found under the ice of Lake Baikal. *Water* 15(12): 2250. <https://doi.org/10.3390/w15122250>
- Bessudova A, Firsova AD, Tomberg IV, Bayramova E, Hilkanova D, Bedoshvili YD, Bashenkhaeva M, Kopyrina L, Zakharova Y, Likhoshway YeV (2023g) Two new species of silica-scaled chrysophytes (Chrysophyceae, Synurales) *Mallomonas kicherica* and *M. sibirica* water bodies of Eastern Siberia, Russia. *Phytotaxa* 620(1): 59–69. <https://doi.org/10.11646/phytotaxa.620.1.5>
- Bessudova A, Firsova AD, Likhoshway YV (2024a) Redescription of *Chrysosphaerella baikalensis* (Chrysophyceae, Chromulinales) with new data on the ultrastructure of its stomatocysts. *Phytotaxa* 669(1): 67–74. <https://doi.org/10.11646/phytotaxa.669.1.7>
- Bessudova A, Firsova AD, Likhoshway YV (2024b) New data on the ultrastructure of stomatocysts, plate and spines scales of *Chrysosphaerella coronacircumspina* (Chrysophyceae, Chromulinales). *Acta Biologica Sibirica* 10: 1259–1267. <https://doi.org/10.5281/zenodo.14027780>

- Bessudova A, Firsova AD, Likhoshway YV (2024c) New data on the stomatocysts of *Spiniferomonas septispina* Nicholls (Chrysophyceae, Chromulinales). Phytotaxa 670 (1): 072–076. <https://doi.org/10.11646/phytotaxa.670.1.7>
- Bessudova A, Galachyants Y, Firsova A, Hilkanova D, Marchenkov A, Nalimova M, Sakirko M, Likhoshway Y (2024d) Seasonal dynamics of the silica-scaled chrysophytes as potential markers of climate change in natural model: deep cold lake – shallow warmer reservoir. Sustainability 16: 7299. <https://doi.org/10.3390/su16177299>
- Bessudova AY, Firsova AD, Likhoshway YV (2025a) *Spiniferomonas sibirica* sp. nov. (Chrysophyceae, Chromulinales), a new silica-scaled freshwater flagellate. Phytotaxa 722(1): 087–091. <https://doi.org/10.11646/phytotaxa.722.1.9>
- Bessudova AY, Firsova AD, Likhoshway YV (2025b) Stomatocyst of *Spiniferomonas minuta* Nicholls and the extent of morphological diversity of stomatocysts among species of the genus *Spiniferomonas* E. Takahashi (Chrysophyceae). Phytotaxa 725(1): 101–108. <https://doi.org/10.11646/phytotaxa.725.1.9>
- Bessudova AY, Firsova AD, Likhoshway YV (2025c) New data on the stomatocyst of *Spiniferomonas abrupta* Y. Nielsen (Chrysophyceae, Chromulinales). Phytotaxa 728 (3): 294–300. <https://doi.org/10.11646/phytotaxa.728.3.5>
- Bessudova A, Galachyants Y, Firsova A, Marchenkov A, Tanichev A, Petrova D, Likhoshway Y (2025d) High diversity and spatiotemporal dynamics of silica-scaled chrysophytes (class Chrysophyceae) in reservoirs of the Angara Cascade of hydroelectric dams. Biology 14: 1325. <https://doi.org/10.3390/biology14101325>
- Bessudova AY, Firsova AD, Galachyants YP, Petrova DP, Nalimova MA, Sakirko MV, Likhoshway YV (2025e) Influence of tributaries on the species richness of silica-scaled chrysophytes in the Angara River (Russia, Eastern Siberia). Acta Biologica Sibirica 11: 937–967. <https://doi.org/10.5281/zenodo.17132371>
- Cumming BF, Smol JP, Birks HJB (1992) Scaled chrysophytes (Chrysophyceae and Synurophyceae) from Adirondack drainage lakes and their relationship to environmental variables. Journal of Phycology 28: 162–178. <https://doi.org/10.1111/j.0022-3646.1992.00162.x>
- Firsova AD, Bessudova A, Sorokovikova LM, Tomberg IV, Likhoshway YV (2015) The diversity of chrysophycean algae in an arctic zone of river and sea water mixing, Russia. American Journal of Plant Sciences 6: 2439–2452. <https://doi.org/10.4236/ajps.2015.615246>
- Firsova AD, Bessudova AY, Likhoshway YV (2026) Ultrastructural data on stomatocysts of the genus *Paraphysomonas* (Chrysophyceae, Paraphysomonadales), including description of one new morphotype and identification of a new producer of Stomatocyst 52. European Journal of Protistology 102: 1–6. <https://doi.org/10.1016/j.ejop.2025.126173>
- Gusev ES (2016) Contribution to the flora of silica-scaled chrysophytes of Frolikha Lake (North transbaikal area). Proceeding of IBIW RAS 76(79): 25–30. <https://doi.org/10.24411/0320-3557-2016-10026> [In Russian]
- Gusev ES, Guseva EE, Gabyshev VA (2018) Taxonomic composition of silica-scaled chrysophytes in rivers and lakes of Yakutia and Magadanskaya oblast (Russia). Nova Hedwigia Beiheft 147: 105–117. <https://doi.org/10.1127/nova-suppl/2018/009>

- Gusev E, Němcová Y, Kulikovskiy M (2022) *Mallomonas voloshkoe* sp. nov. (Synurales, Chrysophyceae) and distribution of *M. pechlaneri* in mountain lakes of Siberia. *Phytotaxa* 530 (2): 221–229. <https://doi.org/10.11646/phytotaxa.530.2.9>
- Gutowski A (1989) Seasonal succession of scaled chrysophytes in a small lake in Berlin. In: *Chrysophytes: Developments and Perspectives*. Vol. 95. J. Cramer, Berlin, 159–177.
- Holen DA (2014) Chrysophyte stomatocyst production in laboratory culture and descriptions of seven cyst morphotypes. *Phycologia* 53: 426–432. <https://doi.org/10.2216/14-001.1>
- Hyatt CV, Paterson AM, Cumming BF, Smol JP (2010) Factors related to regional and temporal variation in the distribution of scaled chrysophytes in north-eastern North America: evidence from lake sediments. *Nova Hedwigia Beihefte* 136: 87–102. <https://doi.org/10.1127/1438-9134/2010/0136-0087>
- Kristiansen J, Düvel L, Wwgwberg S (1997) Silica-scaled chrysophytes from the Taymir Peninsula, Northern Siberia. *Nova Hedwigia* 65: 337–351.
- Pang W, van De Vijver B (2021) Freshwater chrysophycean stomatocysts from Monte Lauro (Buccheri, Sicily, Italy). *Phytotaxa* 494 (2): 177–192. <https://doi.org/10.11646/phytotaxa.494.2.1>
- Sandgren CD (1981) Characteristics of sexual and asexual resting cyst (statospore) formation in *Dinobryon cylindricum* Imhof (Chrysophyta). *Journal of Phycology* 17: 199–210. <https://doi.org/10.1111/j.1529-8817.1981.tb00840.x>
- Siver PA, Hamer JS (1989) Multivariate statistical analysis of the factors controlling the distribution of scaled chrysophytes. *Limnology and Oceanography* 34: 368–381.
- Siver PA, Hamer JS (1992) Seasonal periodicity of Chrysophyceae and Synurophyceae in a small New England lake: implications for paleolimnological research. *Journal of Phycology* 28: 186–198.
- Siver PA, Lott AM (2010) The scaled chrysophyte flora from the Pinelands National Preserve of southern New Jersey, USA. *Nova Hedwigia Beihefte* 136: 167–180. <https://doi.org/10.1127/1438-9134/2010/0136-0167>
- Siver PA, Lott AM (2012) Biogeographic patterns in scaled chrysophytes from east coast of North America. *Freshwater Biology* 57: 451–466. <https://doi.org/10.1111/j.1365-2427.2011.02711.x>
- Siver PA (2015) Synurophyte algae. In: *Freshwater algae of North America: ecology and classification*. Second edition. USA, Boston, Academic Press, 607–651.
- Siver PA, Jo BY, Kim JI, Shin W, Lott AM, Wolfe AP (2015) Assessing the Evolutionary History of the Class Synurophyceae (Heterokonta) Using Molecular, Morphometric, and Paleobiological Approaches. *American Journal of Botany* 102: 921–941. <https://doi.org/10.3732/ajb.1500004>
- Siver PA (2018) *Mallomonas aperturae* sp. nov. (Synurophyceae) reveals that the complex cell architecture observed on modern synurophytes was well established by the middle Eocene. *Phycologia* 57(3): 273–279. <https://doi.org/10.2216/17-112.1>
- Škaloud P, Kristiansen J, Škaloudová M (2013) Developments in the taxonomy of silica-scaled chrysophytes—from morphological and ultrastructural to molecular approaches. *Nordic Journal of Botany* 31: 385–402. <https://doi.org/10.1111/j.1756-1051.2013.00119.x>

- Škaloud P, Škaloudová M, Pichrtová M, Němcová Y, Kreidlová J, Pusztai M (2013) www.chrysophytes.eu – a database on distribution and ecology of silica-scaled chrysophytes in Europe. *Nova Hedwigia*, Beiheft 142: 141–146.
- Utermöhl H (1958) Vervollkommung der quantitativen Phytoplankton-Methodik. *Mitteilungen Internationale Vereinigung für Theoretische und Angewandte Limnologie* 9: 1–39.