



New and rare diatom (Bacillariophyta) species from a mountain lake in Eastern Siberia

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Abstract

The examination of a moss sample collected from a lake in a remote mountainous region of Eastern Siberia revealed a diverse diatom flora that included four new species: *Eunotia frigida*, *Brachysira subtilis*, *Encyonopsis vasilievae*, and *Neidium rugosum*. *N. rugosum* has been previously illustrated from several locations in the arctic and subarctic and is widely distributed across the circumpolar Arctic. The distribution of three other species is likely more limited. Besides these species, a number of rare diatoms were also found in the moss community. These include *Neidium boyeri* and *Stauroneis crassula* previously known only from North America; *Encyonema sibericum* so far only reported from Western Siberia, *Encyonema lunatum* var. *borealis* earlier found in Finland, and *Eunotia ferefalcata*, *Pinnularia angustarea*, and *Naviculadicta mongolica* so far reported only from Mongolia. This study contributes to the understanding of biogeographic patterns of diatom distribution.

Key words: *Brachysira*, *Encyonopsis*, *Eunotia*, *Neidium*, diatoms, new species, Siberia

Introduction

Although a considerable number of publications exist on recent diatom communities from Eastern Siberia, which is the area east for the Yenisei River, most studies have focused either on charismatic ancient lakes, such as Lake Baikal (e.g., Jasnitsky 1936, Skabichevsky 1936, 1952, 1987, Skvortzow 1937, Foged 1993, Popovskaya *et al.* 2002, Flower 2005, Kulikovskiy *et al.* 2012 and Lake Elgygytyn (Sechkina 1956, Jouse & Sechkina 1960, Kharitonov 1980, Genkal & Kharitonov 1996, Cremer *et al.* 2005, Stachura-Suchoples *et al.* 2008, Kharitonov & Genkal 2010, 2012) or did not include high-quality photographic voucher documentation of species occurrences. As a result, diatoms of this extensive geographic region are still poorly known. Only recently a number of floristic studies on diatoms from smaller water bodies in Eastern Siberia accompanied by photographic evidence have been published (Genkal *et al.* 2007, 2011, Bondarenko & Genkal 2010, Genkal & Bondarenko 2010, 2011). In order to further document regional diatom biodiversity, we examine here diatoms in a single sample collected from a small mountain lake located in Sakha (Yakutia) Republic and document a number of new and rare species.

Material and Methods

Material used for this study was a moss sample from an unnamed lake located in the watershed of the river Vostochnaya Khandyga in the Sakha (Yakutia) Autonomous Republic, Russia. This location is near the so-called “Pole of Cold” of the northern hemisphere characterized by the continental subarctic dry climate with extremely

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References

- Antoniades, D., Hamilton, P.B., Douglas, M.S.V. & Smol, J.P. (2008) Diatoms of North America: The freshwater floras of Prince Patrick, Ellef Ringnes and northern Ellesmere Islands from the Canadian Arctic Archipelago. *Iconographia Diatomologica* 17: 1–649.
- Bessey, C. (1907) A synopsis of plant phyla. *Nebraska University Studies* 7: 275–373.
- Bondarenko, N.A. & Genkal, S.I. (2010) *Pennatophyceae (Bacillariophyta) from the mountain lakes of the Vitim-Lena rivers basin*. *Russian Botanical Journal* 95: 924–929.
- Bory de Saint-Vincent, J.B.M. (1822) Dictionnaire Classique d'Histoire Naturelle. Volume 2. Rey & Gravier, libraires-éditeurs; Baudouin Frères, libraires-éditeurs. Paris.
- Bukhtiyarova, L. & Round, F.E. (1996) Revision of the genus *Achnanthes* sensu lato. *Psammothidium*, a new genus based on *A. marginulatum*. *Diatom Research* 11: 1–30.
<http://dx.doi.org/10.1080/0269249x.1996.9705361>
- Chown, S.L., Sinclair, B.J., Leonaas, H.P. & Gaston, K.J. (2004) Hemispherical asymmetries in biodiversity—a serious matter of ecology. *PLoS Biology* 2: e406.
<http://dx.doi.org/10.1371/journal.pbio.0020406>
- Cleve, A. (1895) On recent freshwater Diatoms from Lule Lappmark in Sweden. Bihang till Kongliga Svenska Vetenskaps-Akademiens Handlingar, Vol: 21, 44 pp.
- Cleve, P.T. (1894) Synopsis of the Naviculoid Diatoms, Part I. *Kongliga Svenska-Vetenskaps Akademiens Handlingar* 26: 1–194.
- Compère, P. (1886) Algues récoltées par J. Léonard dans le désert de Libye. *Bulletin du Jardin Botanique National de Belgique* 56: 9–50.
<http://dx.doi.org/10.2307/3667756>
- Cremer, H., Wagner, B., Lushus, O. & Melles, M. (2005) A microscopical study of diatom phytoplankton in deep crater Lake El'gygytgyn, Northeast Siberia. *Algological Studies* 116: 147–169.
<http://dx.doi.org/10.1127/1864-1318/2005/0116-0147>
- Desmazières, J.B.H.T. (1825) *Plantes cryptogames de la France*. Ed. 1. Lille, 1825.
- Ehrenberg, C.G. (1837) Über ein aus fossilen Infusorien bestehendes, 1832 zu Brod verbacknes Bergmehl von der Grenzen Lapplands in Schweden Bericht über die zur Bekanntmachung geeigneten. *Verhandlungen der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* 1837: 43–45.
- Ehrenberg, C.G. (1838) *Die Infusionsthierchen als vollkommene Organismen. Ein Blick in das tiefere organische Leben der Natur*. Verlag von Leopold Voss, Leipzig, pp. 548.
<http://dx.doi.org/10.5962/bhl.title.58475>
- Ehrenberg, C.G. (1854) Mikrogeologie. Einundvierzig Tafeln mit über viertausend grossentheils colorirten Figuren, Gezeichnet vom Verfasser. [Atlas]. Leopold Voss, Leipzig, 40 pls.
- Flower, R.J. (2005) *A review of diversification trends in diatom research with species references to taxonomy and environmental applications using examples from Lake Baikal and elsewhere*. *Proceedings of the California Academy of Sciences* 56: 107–128.
- Foged, N. (1981) Diatoms in Alaska. *Bibliotheca Phycologica* 53: 1–317.
- Foged, N. (1993) Some diatoms from Siberia especially from Lake Baikal. *Diatom Research* 8: 231–279.
<http://dx.doi.org/10.1080/0269249x.1993.9705262>
- Gaston, K.J. (2000) Global patterns in biodiversity. *Nature* 405: 220–227.
<http://dx.doi.org/10.1038/35012228>
- Genkal, S.I. & Bondarenko, N.A. (2010) *Cyclotella melnikae* sp. nov., a new diatom from the mountain lakes of Pribaikalie, Russia. *Diatom Research* 25: 281–291.
<http://dx.doi.org/10.1080/0269249x.2010.9705850>
- Genkal, S.I. & Bondarenko, N.A. (2011) Diatom algae in mountain lakes of the Dzherginskiy reserve (the Baikal area). 1. Centrophyceae. *Povolzhskiy ekologicheskiy zhurnal* 2: 127–136.
- Genkal, S.I., Bondarenko, N.A. & Popovskaya, G.I. (2007) New representative of the genus *Discostella* Houck et Klee (Bacillariophyta) from the Eastern Baikal area (Russia). *International Journal on Algae* 9: 359–364.
<http://dx.doi.org/10.1615/interjalgae.v9.i4.50>
- Genkal, S.I., Bondarenko, N.A. & Schur, L.A. (2011) *Diatoms in the lakes of the Southern and Northern Eastern Siberia*. Rybinsky Dom Pechati, Rybinsk, 71 pp.
- Genkal, S.I. & Kharitonov, V.G. (1996) *Cyclotella arctica* (Bacillariophyta)- a new species from Lake El'gygytgyn (Chukotka

- Peninsula). *Botanicheskij Zhurnal (Russian Botanical Journal)* 81: 69–73.
- Gregory, W. (1854) Notice of the new forms and varieties of known forms occurring in the diatomaceous earth of Mull; with remarks on the classification of the Diatomaceae. *Quarterly Journal of Microscopical Science* 2: 90 0150100.
- Greville, R.K. (1833) Diatomaceae. In: William Jackson Hooker (ed.), *The English Flora of Sir J.E. Smith*. Longman, Rees, Orme, Brown, Green and Longman. London. 1824–1836., Vol: 5, 401–415, pl. 1
- Haeckel, E. (1878) *Das Protistenreich. Eine Populäre Uebersicht über das Formengebiet der Niedersten Lebewesen*. Ernst Günther's Verlag, Leipzig, 104 pp.
<http://dx.doi.org/10.5962/bhl.title.58542>
- Hamilton, P.B., Poulin, M. & Kingston, J.C. (1993) A taxonomic and morphological study of an acidobiontic diatom, *Neidium holstii* (Cleve) Krammer from North America and Greenland. *Nova Hedwigia Beiheft* 106: 109–119.
- Hartley, B., Ross, R. & Williams, D.M. (1986) A check-list of the freshwater, brackish and marine diatoms of the British Isles and adjoining coastal waters. *Journal of the Marine Biological Association of the United Kingdom* 66: 531–610.
<http://dx.doi.org/10.1017/s0025315400042235>
- Jasnitsky, V. (1936) Neue und interessante Arten der Diatomeen aus dem Baikalsee. *Journal Botanique de l'URSS* 21: 689–703.
- Jouse, A.P. & Sechkina, T.V. (1960) Diatoms in bottom sediments of Lake Elgygytyn (Anadyr Plateau). *Proceedings of the Limnology Laboratory, USSR Academy of Sciences*, 10: 55–62.
- Kharitonov, V.G. (1980) Diatoms of Lake El'gygytyn (Anadyr District). *Botanicheskij Zhurnal (USSR Botanical Journal)*: 65: 1622–1628.
- Kharitonov, V.G. & Genkal S.I. (2010) Centric diatom algae (Centrophyceae) of ultraoligotrophic Lake Elgygytyn and water bodies of its basin (Chukotka, Russia). *Inland Water Biology* 3: 1–10.
<http://dx.doi.org/10.1134/s1995082910010013>
- Kharitonov, V.G. & Genkal S.I. (2012) *Diatoms of the Elgygytyn Lake and its vicinity (Chukotka)*. Far-Eastern Branch of the Russian Academy of Sciences, Magadan, 402 pp.
- Krammer, K. (1991) Morphology and taxonomy of some taxa in the genus *Aulacoseira* Thwaites (Bacillariophyceae). I. *Aulacoseira distans* and similar taxa. *Nova Hedwigia* 52: 89–112.
- Krammer, K. (1997) Die cymbelloiden Diatomeen. Eine Monographie der weltweit bekannten Taxa. Teil 1. Allgemeines und *Encyonema*. *Bibliotheca Diatomologica* 36: 1–382.
- Krammer, K. (2000) The genus *Pinnularia*. *The Diatoms of Europe. Diatoms of Inland Waters and Comparable Habitats* 1: 1–703.
- Krammer, K. (2003) *Cymbopleura, Delicata, Navicymbula, Gomphocymbellopsis, Afrocybella*. *Diatoms of Europe, Diatoms of the European Inland waters and comparable habitats* 4: 1–529.
- Krammer, K. & Lange-Bertalot, H. (1985) Naviculaceae Neue und wenig bekannte Taxa, neue Kombinationen und Synonyme sowie Bemerkungen zu einigen Gattungen. *Bibliotheca Diatomologica* 9: 5–230.
- Kulikovskiy, M.S., Lange-Bertalot, H., Metzeltin, D. & Witkowski, A. (2012) Lake Baikal: Hotspot of endemic diatoms. *Iconographia Diatomologica* 23: 1–861.
- Kulikovskiy, M.S., Lange-Bertalot, H., Witkowski, A., Dorofeyuk, N.I. & Genkal, S.I. (2010) Diatom assemblages from Sphagnum bogs of the world. I. Nur bog in northern Mongolia. *Bibliotheca Diatomologica* 55: 1–326.
- Kützing, F.T. (1833) Synopsis Diatomacearum oder Versuch einer systematischer Zusammensrellung der Diatomeen. *Linnaea* 8: 529–520, Taf. 13–19
- Kützing, F.T. (1836) *Algarum Aquae Dulcis Germanicarum*. Decas XVI. Collegit Fridericus Traugott Kutzing, Soc. Bot. Ratisbon. Sodalis. Halis Saxonum in Commissis C.A. Schwetschkii et Fil., Vol: 16, 4 pp.
- Kützing, F.T. (1844) *Die Kieselschaligen. Bacillarien oder Diatomeen*. Nordhausen. 152 pp.
<http://dx.doi.org/10.5962/bhl.title.64360>
- Lange-Bertalot, H. (1993) 85 neue taxa und über 100 weitere neu definierte Taxa ergänzend zur Süßwasserflora von Mitteleuropa, Vol. 2/1-4. *Bibliotheca Diatomologica* 27: 1–164.
- Lange-Bertalot, H. (2001) *Navicula sensu stricto*, 10 genera separated from *Navicula sensu lato*, *Frustulia*. *Diatoms of Europe* 2: 1–526.
- Lange-Bertalot, H., Bak, M., Witkowski, A. & Tagliaventi, N. (2011) *Eunotia* and some related genera. *Diatoms of the European Inland Waters and Comparable Habitats* 6: 1–747.
- Lange-Bertalot, H. & Genkal, S.I. (1999) Diatoms from Siberia I. Islands in the Arctic Ocean (Yugorsky-Shar Strait). *Iconographia Diatomologica* 6: 1–292.
- Lange-Bertalot, H. & Metzeltin, D. (1996) Indicators of oligotrophy - 800 taxa representative of three ecologically distinct lake types, Carbonate buffered - Oligodystrophic - Weakly buffered soft water. *Iconographia Diatomologica* 2: 1–390.
- Lange-Bertalot, H. & Moser, G. (1994) *Brachysira* Monographie der Gattung. *Bibliotheca Diatomologica* 29: 1–212.
- Lazarus, D. & Jahn, R. (1998) Using the Ehrenberg Collection. *Diatom Research* 13: 273–291.
<http://dx.doi.org/10.1080/0269249x.1998.9705451>
- Mayer, A. (1947) Die bayerischen *Encyonema* und *Cymbella* Arten mit ihren Formen. *Berichte der Bayerischen Botanischen Gesellschaft (zur Erforschung der heimischen Flora)* 27: 226–239.
- McKnight, T. L. & Hess, D. (2007) *Physical Geography: A Landscape Appreciation*. Prentice Hall, New Jersey, 720 pp.
- Metzeltin, D. & Lange-Bertalot, H. (1998) Tropical diatoms of South America I: About 700 predominantly rarely known or

- new taxa representative of the neotropical flora. *Iconographia Diatomologica* 5: 1–695.
- Metzeltin, D., Lange-Bertalot, H. & Nergui, S. (2009) Diatoms in Mongolia. *Iconographia Diatomologica* 20: 3–686.
- Østrup, E. (1910) *Danske Diatoméer*. C.A. Reitzels Boghandel, Kjøbenhavn. 323 pp.
<http://dx.doi.org/10.5962/bhl.title.1044>
- Patrick, R.M. & Freese, L.R. (1961) Diatoms (Bacillariophyceae) from Northern Alaska. *Proceedings of the Academy of Natural Sciences of Philadelphia* 112: 129–293.
- Petersen, J.B. (1924) Freshwater algae from the north coast of Greenland collected by the late Dr. Th. Wulff. Den II Thule Expedition til Groenlands Nordskyst (1916-18) Nr. 13. *Meddelelser om Grønland* 64: 307–319.
- Pfitzer, E. (1871) Untersuchungen über Bau und Entwicklung der Bacillariaceen (Diatomaceen). *Botanische Abhandlungen aus dem Gebiet der Morphologie und Physiologie* 2: 1–189.
- Popovskaya, G.I., Genkal, S.I., & Likhoshway, Y.V. (2002) *Diatoms of the plankton of Lake Baikal: Atlas and key*. Siberian Branch of the Russian Academy of Sciences, Novosibirsk, 168 pp.
- Reichardt, E. (1999) Zur Revision der Gattung *Gomphonema*. *Iconographia Diatomologica* 8: 1–203.
- Reimer, C.W. (1959) The diatom genus *Neidium*. I. New species, new records and taxonomic revisions. *Proceedings of the Academy of Natural Sciences of Philadelphia* 111: 1–35.
- Round, F.E., Crawford, R.M., & Mann, D.G. (1990) *The Diatoms: Biology & Morphology of the Genera*. Cambridge University Press, Cambridge, 747 pp.
- Round, F.E. & Mann, D.G. (1981) The diatom genus *Brachysira*. I. Typification and separation from *Anomoeoneis*. *Archiv für Protistenkunde* 124: 221–231.
[http://dx.doi.org/10.1016/s0003-9365\(81\)80014-0](http://dx.doi.org/10.1016/s0003-9365(81)80014-0)
- Sechkina, T.V. (1956) New diatoms from the bottom sediments of Lake Elgygytyn of the Anadyr District. *Botanical materials of the Lower Plants Department of the Botanical Institute of the USSR Academy of Sciences* 11: 42–49.
- Skabichevsky, A.P. (1936) New and interesting diatoms from Northern Baikal. *Botanical Journal of USSR* 21: 706–722.
- Skabichevsky, A.P. (1952) On the taxonomy of the Lake Baikal diatoms. *Notulae systematicae Academiae scientiarum URSS, Instituti Botanici, Sectione Cryptogamica* 8: 36–42.
- Skabichevsky, A.P. (1987) Materies ad floram Bacillariophytorum zonae sublitoralis Lacus Baical. *News of the systematics of lower plants* 21: 51–62.
- Skvortzow, B.W. (1937) Bottom diatoms from Olchon gate of Baikal lake, Siberia. *Philippine Journal of Science* 62: 293–377.
- Stachura-Suchoples, K., Genkal, S. & Khursevich, G. (2008) *Pliocaenicus sezkiniae* sp. nov., from Lake El'gygytyn in Chukotka (NE Russia). *Diatom Research* 23: 171–184.
<http://dx.doi.org/10.1080/0269249x.2008.9705745>
- Van de Vijver, B., Beyens, L. and Lange-Bertalot, H. (2004) The genus *Stauroneis* in Arctic and Antarctic Regions. *Bibliotheca Diatomologica* 50: 1–312.
- Vyverman W., Verleyen E., Sabbe K., Vanhoutte K., Sterken M., Hodgson D.A., Mann D.G., Juggins S., Van de Vijver B., Jones V., Flower R., Roberts D., Chepurnov V.A., Kilroy C., Vanormelingen P. & De Wever A. (2007) Historical processes constrain patterns in global diatom diversity. *Ecology* 88: 1924–1931.
<http://dx.doi.org/10.1890/06-1564.1>
- Werum, M. & Lange-Bertalot, H. (2004) Diatoms in Springs from Central Europe and elsewhere under the influence of hydrogeology and anthropogenic impacts. *Iconographia Diatomologica* 13: 3–417.