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Article

www.chrysophytes.eu – a database on distribution and ecology of silica-scaled chrysophytes in Europe

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With 16 figures

Abstract: Members of the silica-scaled chrysophytes are important components of the freshwater phytoplankton. Knowledge of the occurrence of chrysophytes and of their ecological ranges can be useful for many types of studies, for example for monitoring water quality or for paleolimnological and biogeographical studies. An internet database of the European silica-scaled chrysophytes has been developed to store microphotographs and sampling data (including geographical coordinates, pH, conductivity and temperature values), and to provide access to the data to all people who are interested. The database currently includes data from almost 170 published papers and holds information about the distribution and ecology of 194 species, based on more than 7000 entries. For each species listed in the database, a photo gallery, a list of all records, and a distribution map are provided, and are automatically updated with each new entry. For those species with more than 20 records, their distribution frequencies in relation to gradients in pH, conductivity, and temperature are also shown. Continual addition of newly published and as yet unpublished data is planned. Join us and insert your own records or EM photographs from Europe into the database!

Key words: distribution, ecology, Europe, internet database, silica-scaled chrysophytes

Introduction

The silica-scaled chrysophytes are solitary or colonial flagellates occurring in all types of freshwater bodies. These organisms have species-specific silica structures, which are formed in silica deposition vesicles (SDVs) derived from the Golgi apparatus. The scales do not form a static armour, but rather a dynamic structure that adjusts to the addition of new scales during both cell growth and division. The scales vary in size from around 1–10 µm. For accurate identification at the species level, the use of Electron Microscopy (EM) is essential (Kristiansen & Preisig 2007). Silica-scaled chrysophytes are very special among protists in that they adhere to a morphological species concept, which extends beyond standard protist cell structure; the silica scales give us extra morphological criteria on which to base taxonomy. Members of the silica-scaled chrysophytes are important components of the freshwater phytoplankton. They may form the majority

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of phytoplankton in oligotrophic freshwater lakes and ponds. Knowledge of the occurrence of chrysophytes and of their ecological ranges is useful for monitoring the status of water bodies and changes in their water quality. Paleolimnological studies have focused mainly on monitoring eutrophication, acidification and trends in climatic changes (Smol 1995). Due to well-established concepts of species identification, and their wide distribution and narrow occurrence spectra, the silica-scaled chrysophytes are excellent paleoecological indicators. The opportunity arises to estimate, with more precision, distribution patterns and ecological preferences of particular chrysophyte species. To achieve this, comprehensive records of the occurrence of silica-scaled chrysophytes still need to be collected.

We have established an online database where all records dealing with the European silica-scaled chrysophytes can be simply stored and catalogued for reference and use in any subsequent investigations. The database has been developed to store data about each collection made (including the geographical coordinates, temperature, pH, and conductivity values), and to store a collection of Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), or Light Microscopy (LM) microphotographs.

Materials and methods

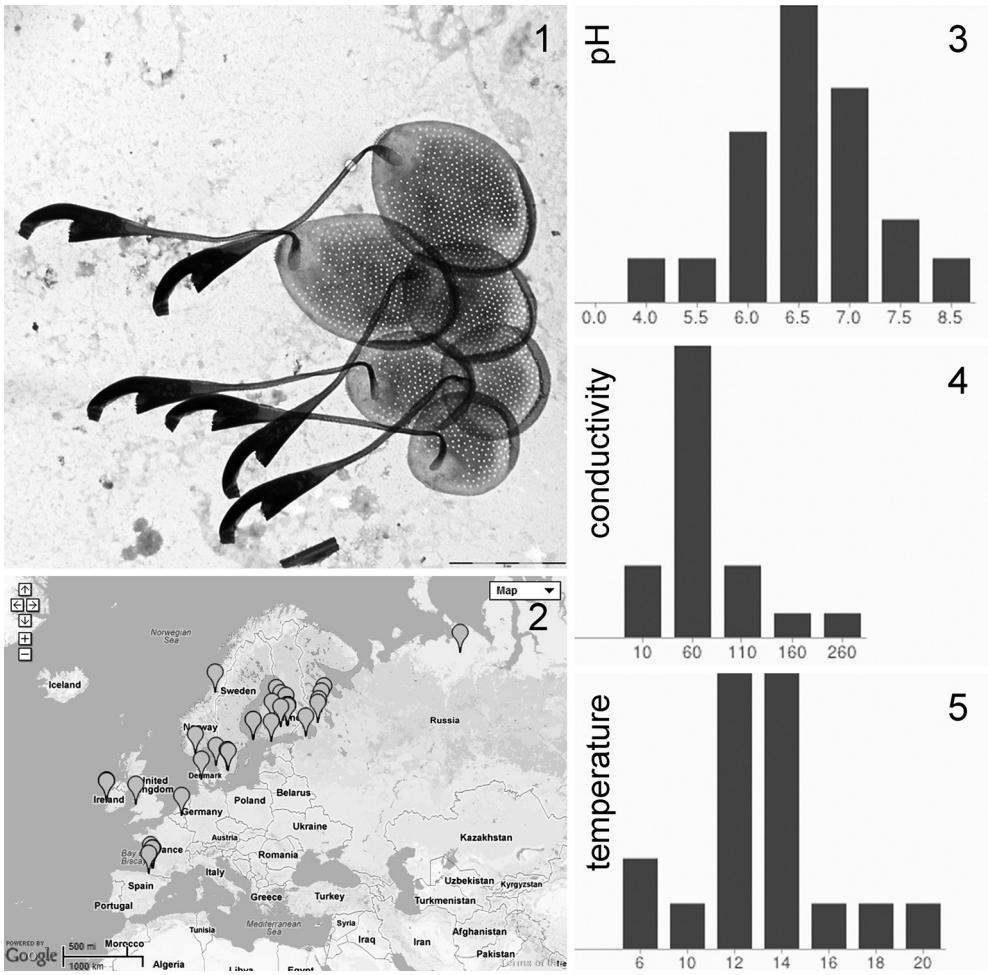
Database websites were made in a content management platform, Drupal 6. Individual web pages of chrysophyte taxa, representing the core of the database, were created using the Panels module integrated with Views. Geographical visualization of sampling sites was enabled using the Java Script plugin for the Google Maps application. All data, including the sampling information, environmental parameters, geographical data and microphotographs, were stored in the MySQL table using the content forms. These data are filtered using the Views and displayed on the pages of the particular taxa. Floristic data were retrieved from 164 publications dealing with the occurrence of silica-scaled chrysophytes in Europe (for the list of references, see the database web page: http://www.chrysophytes.eu/references).

Microphotographs of silica-scaled chrysophytes were taken from material sampled in various localities in the Czech Republic, Austria, Ireland, Finland, France, Norway and Sweden. Light micrographs were taken using an Olympus BX51 with digital camera Olympus E30. The resolution of the microscope was increased by using a Nomarski DIC optics and U-CA magnification changer. To obtain transmission electron microscopic (TEM) micrographs, unfixed drops of each sample were dried onto Formvar-coated grids, which were then washed by repeated transfer into drops of distilled water dispensed onto the hydrophobic surface of a Parafilm® strip. Dried grids were examined with a JEOL 1011TEM. Scanning electron microscopy (SEM) micrographs were obtained by drying drops of each sample on a piece of aluminium foil, mounted onto a SEM stub with double-sided adhesive carbon type. The stubs were coated with gold for 5 minutes with a Bal-Tec SCD 050 sputter coater, and observed with a JEOL 6380LV SEM.

Results and discussion

How to join to the database

The database of silica-scaled chrysophytes is open to all interested scientists and members of the public. Visitors can use the database as guests or as registered users. Users can add, edit and delete their own records, photographs and references. To become a user, it is necessary to obtain permission from the administrator and create a new account by filling in a short form at http://www.chrysophytes.eu/user/register. After creating a password-protected user account, users can insert new data into the database.



Figs 1–5. *Mallomonas hamata* –**1**. Group of scales with helmet bristles. **2**. Map of its distribution in Europe. **3–5**. Diagrams showing its distribution in relation to pH, conductivity (µS.cm^{-1}), and temperature (°C).

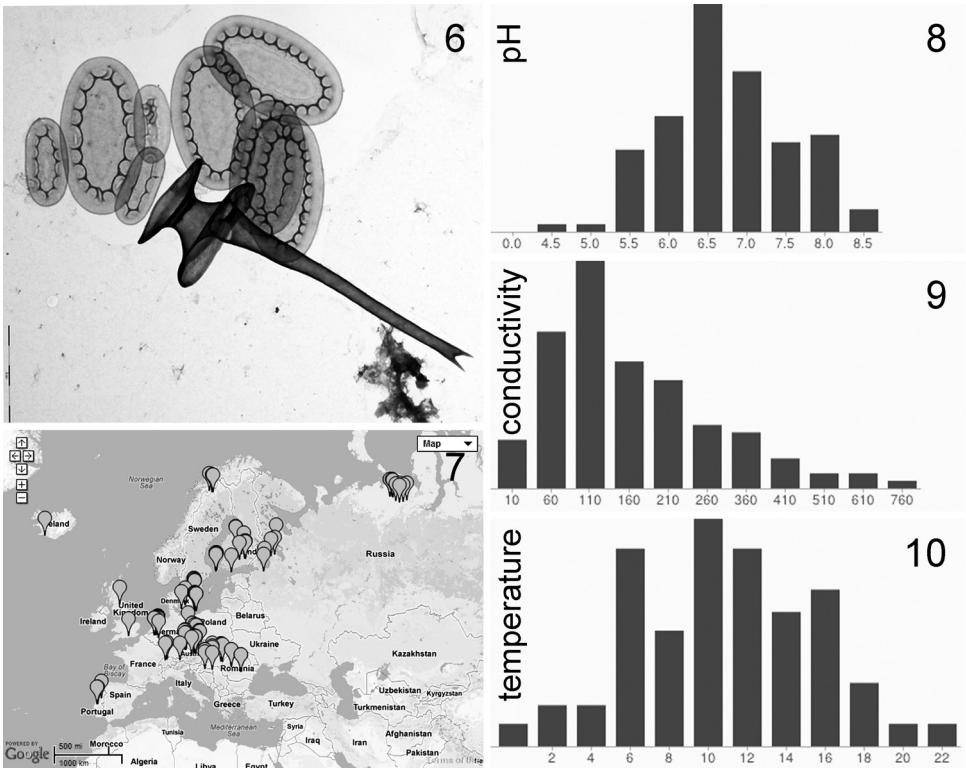
To insert a new record, the user simply selects one or more species, by means of the Ctrl button, from the list (if a species is missing from the list, the user must contact the administrator and ask him to add a new taxon). The user then inputs the citation abbreviation in one of the proposed formats: Fott (1964), Fott & Kalina (1964), Fott et al. (1964). If the record is not published, it should be cited in this format: Fott (unpubl.). In addition, each new record may contain sampling data (year of sampling, values for pH, conductivity, and temperature), and location coordinates. The place of sampling can be pinpointed on maps with terrain or satellite views, or inserted directly as coordinates, derived for example from a GPS navigation device. The user should also add the full citation of the published reference in the following format: Fott, B. & Ludvik, J. (1956): Elektronmikroskopische Untersuchung der Kieselstrukturen bei *Chrysosphaerella*. – Preslia 28: 276–278.

Similarly, to insert a new microphotograph, the user selects the particular taxon from the list and uploads the picture. To insert a microphotograph into the image gallery, the file must be in

a supported format (jpg, jpeg, png, gif) and no larger than 1 MB. After uploading the image, the name of the sampling location should be given.

Current and future database utilization

At the time of writing this paper, the database holds 430 microphotographs and information about the distribution and ecology of 194 species and infraspecific taxa within seven genera (*Chrysodidymus, Chrysosphaerella, Mallomonas, Paraphysomonas, Polylepidomonas, Spiniferomonas,* and *Synura*). The vast majority of the taxa fall within the genera *Mallomonas, Paraphysomonas, Spiniferomonas* and *Synura*; the other three genera are represented only by single or several taxa. The distributional and ecological data are based on more than 7000 database entries, retrieved from 164 published papers. Every genus included in the database is briefly characterized in terms of its main characteristic features and the morphological terminology of scales and bristles. Individual taxa are listed alphabetically and, for each taxon, brief information about its ecology and distribution in the world is provided. In addition, a photo gallery, list of records, and distribution map are provided, and are automatically updated with every new entry. The microphotographs were taken using mainly TEM (Fig. 1), but also using SEM and LM. All microphotographs may be freely used as long as they are properly cited. The list of European records contains basic en-

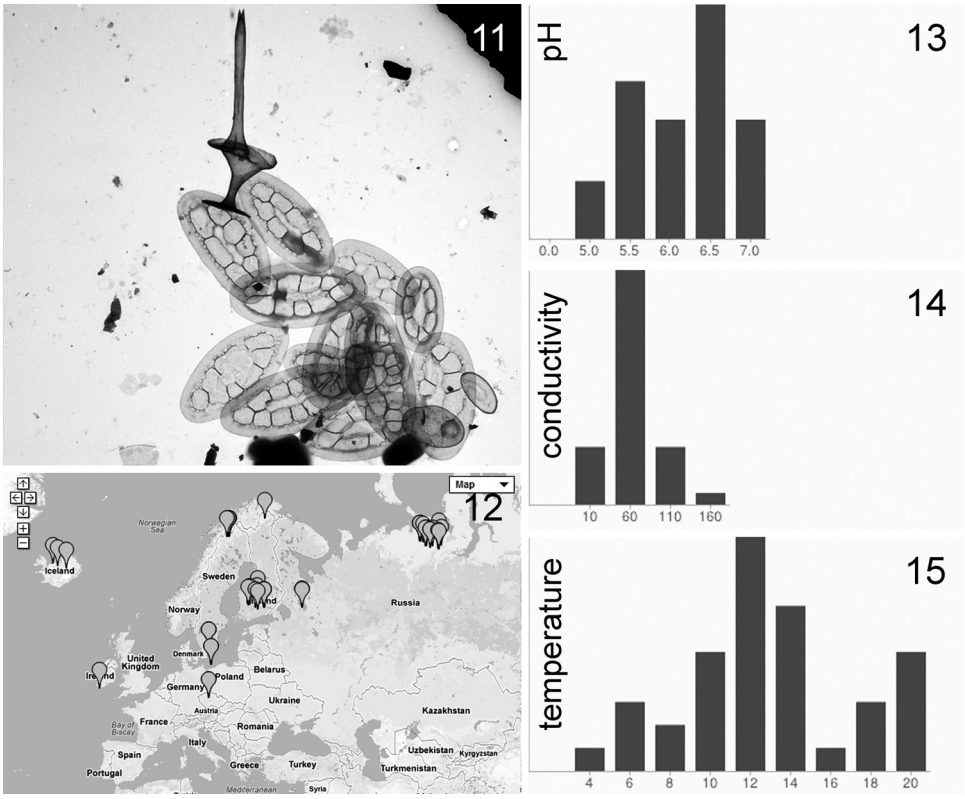


Figs 6–10. *Chrysosphaerella brevispina* –**6**. Scales and spine. **7**. Map of its distribution in Europe. **8–10**. Diagrams showing its distribution in relation to pH, conductivity (μS.cm^{-1}), and temperature (°C).

vironmental variables: values of pH, conductivity and temperature. The coordinates of localities are given and are linked directly with the distribution map (Fig. 2). For those species with more than 20 records, their distribution frequencies in relation to gradients in pH, conductivity, and temperature gradients are also shown (Figs 3–5).

The purpose of this database is not only to store data, but also to serve as a resource to provide information for the formulation of different biogeographical and ecological hypotheses. Its utilization in paleolimnological studies is also envisaged. For example, Fig. 2 shows a peculiar European distribution of *Mallomonas hamata,* a species that seems to be restricted to areas with oceanic climate. Despite extensive sampling in inland European waters, the species has never been found in areas with a more continental climate. Interesting conclusions can also be drawn from the comparison of the distribution patterns of *Chrysosphaerella brevispina* and *C. longispina* (Figs 6–15). The latter species is apparently not able to tolerate waters with high conductivity values, which could explain its limited distribution in many parts of Europe.

In addition to species-specific characteristics, the database very clearly shows the locations and numbers of sampling sites in Europe (Fig. 16). Although the temperate zone, and especially the European region, is considered to be the most intensively investigated area in terms of chrysophyte distribution (Kristiansen 2005), a map of sampling sites (Fig. 16) clearly illustrates how unequal sampling effort has been in different European regions. There are still many countries with no chrysophyte records, mainly in eastern and southern Europe. Therefore, we actively



Figs 11–15. *Chrysosphaerella longispina* –**11**. Scales and spine. **12**. Map of its distribution in Europe. **13–15**. Diagrams showing its distribution in relation to pH, conductivity (μS.cm^{-1}), and temperature (°C).

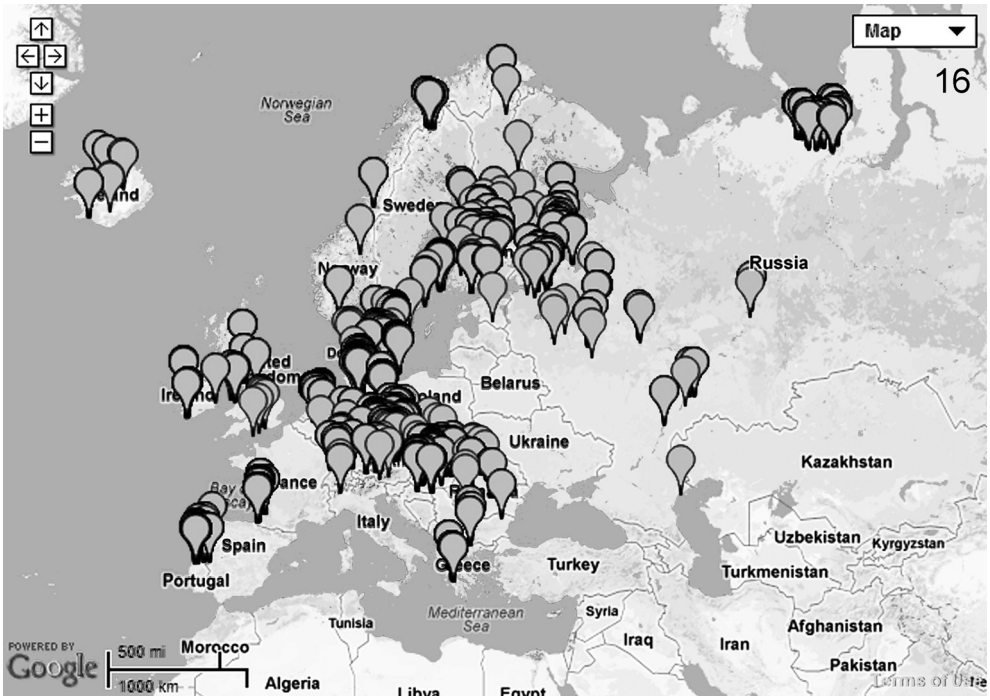


Fig. 16. Map showing the locations of all sampling sites in the silica-scaled chrysophytes database, showing uneven sampling in Europe

invite everybody who is interested in chrysophyte biogeography, ecology and taxonomy to use and contribute to this database. We have already included published records of the occurrence of silica-scaled chrysophytes in Europe, and will continue to add newly published data. However, we will be very grateful to anybody who can include his or her own data, even unpublished, records or EM pictures.

Acknowledgements

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References

Kristiansen, J. (2005): Golden algae. A Biology of Chrysophytes. – Gantner Verlag, pp. 165.

Kristiansen, J. & Preisig, H. R. (2007): Chrysophyte and Haptophyte algae. 2nd part: Synurophyceae. – In: Büdel, B., Gärtner, G., Krienitz, L., Preisig, H. R. & Schagerl, M. (eds): Süsswasserflora von Mitteleuropa 1/2, 2. Aufl. Spektrum Akad. Verlag, Berlin, Heidelberg. 252 pp.

Smol, J. P. (1995): Application of chrysophytes to problems in paleoecology. – In: Sandgren, C., Smol, J. P. & Kristiansen, J. (eds): Chrysophyte Algae: Ecology, Phylogeny and Development. Cambridge Univ. Press, Cambridge, pp. 303–329.