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Short Communication

Plants of Mongolia – A Virtual Approach: E-taxonomy, Virtual Herbarium and Digital Key

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Abstract

This work is based on the long-term research experience between Mongolia and Germany, which resulted in extensive plant collections in both countries. One goal is to provide information access via the Internet to the herbarium specimens available in German plant collections. Up to now, 16,403 records (a finding of a species documented by images and/or vouchers) for 1,533 out of 2879 Mongolian vascular plant species are included in the database. For half of the species described for Mongolia scans of herbarium specimens are available. The plant database is searchable for family, scientific name, habitat, growth form as well as distribution, and other parameters such as the red list status or the endemic status.

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Reliable determination of plants is a basis of ecological research

Long dichotomous keys are a valuable resource for botanists, but they are difficult to use for non-specialists and often unsuitable for field work. However, often comprehensive plant identification skills are needed for applied projects that can be compensated by a variety of selected plant images as demonstrated in FloraGREIF – the Internet-based plant database for Mongolia.

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Plant Determination online

Species descriptions are more and more available online (Flora of China, 2013; Australian Virtual Herbarium, 2013). Virtual Herbaria (specimens and photos online) are being developed in several countries, for example BGBM (Digital specimen images at the Herbarium Berolinense, 2013), NYBG (The C.V. Starr Virtual Herbarium), AVH (Australian Virtual Herbarium) and others. Digital interactive keys for plant determination online, such as Visual Plants online (Visual Plants online, 2013), are not widespread yet and often refer only to a limited set of taxa only (e.g. a genus or a family).

A plant information system including a digital key to the species is useful for scientists in applied

projects, to teach biology students, but is attractive as well for amateur botanists, tourists and people excited about the living environment in nature and images. Moreover, digitalized herbarium sheets are valuable resources for taxonomists being in preparation monographs or revisions of a plant species or larger groups.

Information system and digital key for Mongolia

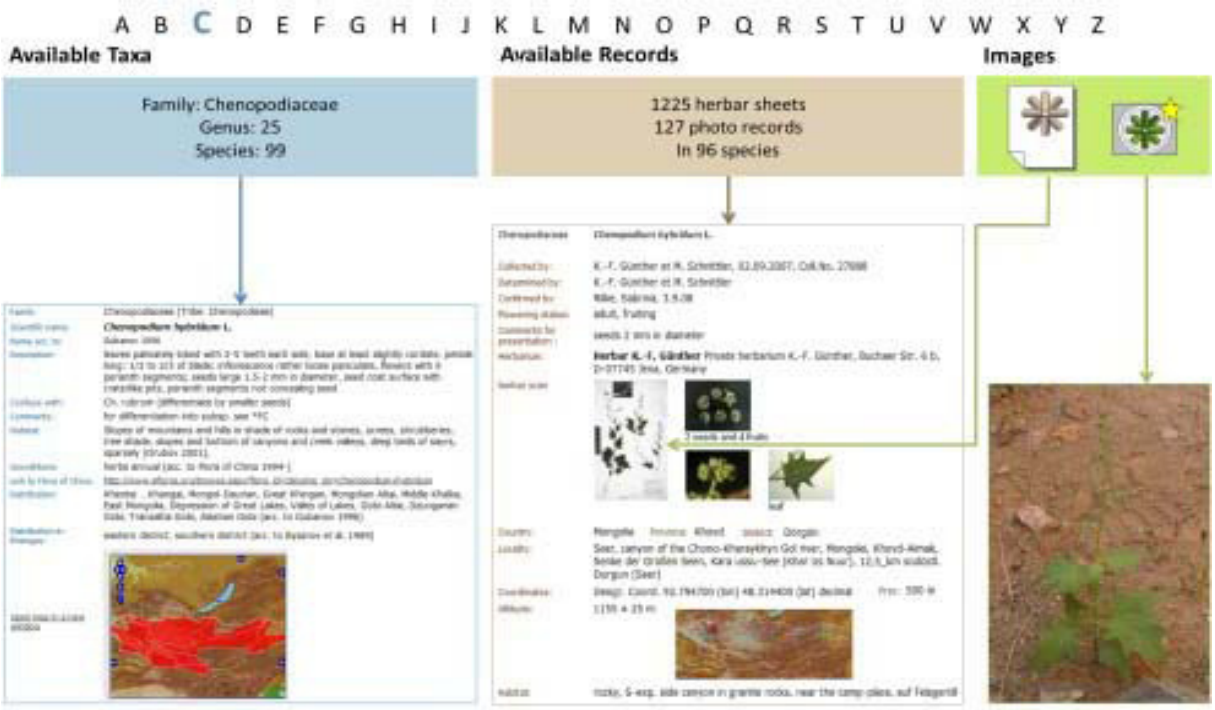
The project "FloraGREIF – The Virtual Guide to the Flora of Mongolia" has been founded by German Science Foundation (DFG) between 2007 and 2010. Since 2008 the internet database FloraGREIF (FloraGREIF) is online under http://greif.uni-greifswald.de/floragreif.

Up to now, 16,403 records (a finding of a species documented by images and/or vouchers) for 1,533 out of 2879 Mongolian vascular plant species are included in the database. For half of the species described for Mongolia (Grubov, 1982; Gubanov, 1996, 1999) scans of herbarium specimens are available.

The plant database is searchable for family, scientific name, habitat, growth form as well as distribution, and other parameters such as the red list status or the endemic status. See for example *Chenopodium hybridum*:

Information about the distribution of plant species can be found via the WebGIS application. Topographical maps, satellite images, and hypsometric tints give basic information about the region of interest within Mongolia. Floristic units and vegetation zones were digitised and are provided as map layers (Zemmrich *et al*., 2013). FloraGREIF is dealing with the WebGIS application in two ways: it is used to display distribution maps inside taxon and record descriptions and as standalone WebGIS application embedded in a website, which creates dynamic maps according to the content currently available in the data base.

Plant Species and Records*
2879 Mongolian vascular plant species listed
1533 species listed with a total of 16403 records, thereof: • 1401 species / 3198 records with at least one scan of a herbarium specimen • 765 species / 6088 records represented by photos or macro images • 627 species / 734 records with both kinds of information available • 369 species / 780 records with corresponding habitat images
** Status as effective from October 2013*



Sources: http://greif.uni-greifswald.de/floragreif/?flora_search=Taxon&taxon_id=241, http://greif.uni-greifswald.de/floragreif/?flora_search=Record&record_id=4762).

Since 2011, we complete the information system by a trait data base and an interactive digital key, founded by the German Science Foundation (DFG) until 2014. The interactive key is based on the trait data base, where status values can be assigned to different taxa ranks like families, genera or species. Assigned values are inherited from higher to lower rank. According to the phenology status of a particular plant, and the tools available for determination, as well the user's previous knowledge, the user can choose the available traits for the multi access key, or skip others (e.g., for a non-flowering individual). Nevertheless, the digital key will still work, but may result in a longer list of potential taxa which have to be compared by the user with the information (digital vouchers, images) in the system. In contrast to traditional keys, our approach is not systematic, i.e. keying out first families, than genera etc., but focuses on easily accessible characteristic traits like leaf shape or growth form, therefore the result list may cross the borders of families. Illustrations and notes will guide the user to understand the relevant features and scientific terms. The character database can be edited by authorized users.

Within the duration of the ongoing project, a general digital key will be filled with trait data for larger plant groups. Taxa with many similar species and special differential traits (like sedges or umbellifers) will be treated later in special keys.

The FloraGREIF Information System can be adapted to other regions. Cooperation with partners is the fundamental basis to enhance taxa descriptions, and to provide and add plant and photo records.

Cooperation

The Virtual Guide to the Flora of Mongolia is a cooperative project. Partners are: Academy of Sciences of Mongolia, State University of Khovd, Herbaria of HAL, GAT, JE, GFW, B, KAS, LE, WU, OSBU.

A current issue is to provide the collections of Mongolian plants within German herbarium collections online. K. Ungethüm at HAL is going to complete the data input to FloraGREIF online for the Mongolian Plant Collection at the University of Halle (approx. 10,000 herbarium sheets) in 2014.

The Mongolian project partners work in parallel to digitize herbarium specimens and the corresponding record data. We thus see good chances for a joint future project.

Next Steps

Currently 53% of Mongolian vascular plant species are covered by records. The herbaria HAL and GFW continuously increase the coverage rate of species by record data.

The digital key will be filled with data up to genus and species level.

The WebGIS application will be upgraded: A gazetteer (or geographical dictionary) is developed. It connects regional and local toponyms to geographic coordinates and will allow to search places by name and display their location on the map. The implemented information system is an open source software and can be used on demand by interested project partners for online presentation of herbarium specimens including digital key.

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