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ORCHIDS AND EMONOCOT – ASSEMBLING RESEARCH RESOURCES AND FACILITATING COLLABORATIVE TAXONOMY ONLINE

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ABSTRACT. The Orchidaceae is one of the eight families targeted for in-depth treatment in the groundbreaking eMonocot project. A consortium formed by RBG Kew, the Natural History Museum (London), and Oxford University, and funded by NERC, eMonocot is an e-taxonomy initiative that will provide the first web-based treatment for the world's monocot plants (constituting approximately 20% of all higher plants, some 70,000 species, and including numerous groups of the highest conservation, ecological, and economic importance). eMonocot will revolutionize the way taxonomic data are organized and accessed by both the practitioners and users of taxonomy, targeted at biodiversity and environmental scientists but also available to other users including volunteer biologists, horticulturists, schools, and the general public. Available information will include nomenclature, taxonomic descriptions, images, identification guides, as well as geographical, ecological, DNA sequence, and conservation data structured around a taxonomy derived from the World Checklist of Monocotyledons. As part of the eMonocot project, identification guides, and taxon pages to all Orchidaceae genera will be produced, alongside an interactive key and taxon pages for all Cyripedioideae (slipper orchid) species and infra-specific taxa. Researchers may upload content (such as images and species descriptions) to the taxon pages, edit the classification as taxa are described and revised, and access original publications for names and much more.

KEY WORDS: Orchidaceae, eTaxonomy, eMonocot, data sharing, web revision, collaboration

In an age of molecular data revolutionizing the classification of groups of plants such as Orchidaceae, taxonomy is as important as ever. Increasingly, plant taxonomists are working collaboratively with colleagues around the world and need to access and share resources such as checklists, original publications, herbarium records and specimens, bibliographic references, illustrations, photograph libraries, datasets, and distribution maps. Historically such resources have been held by institutions and ultimately accessible to the public or individuals working on the taxa only under carefully controlled conditions.

The distributed resources, online resources, and access for all

Resources that document species' distribution, ecology, and evolution are scattered and often restricted to the world's major scientific libraries and specimen collections, most of which are located in Europe, the USA, and Australia. Consequently researchers

studying particular plant groups may need to travel extensively to access specimens and literature and collaborate with colleagues around the world. Several global initiatives have been addressing this issue by digitizing literature, specimens, and illustrations in collections and making them freely available on the Internet (e.g. Biodiversity Heritage Library, Global Plant Initiatives (GPI), Reflora Project). Other taxonomic resources, such as the International Plant Names Index (IPNI), Index Herbariorum (IH), and the World Checklist of Selected Plant Families (WCSP), are now available electronically and are continuously updated. While this shift to online platforms means that data are increasingly accessible, resources for particular taxonomic groups nevertheless remain diffuse.

The eMonocot project

In order to facilitate the aggregation of these dispersed data, the eMonocot project is developing a freely accessible online information portal (www.eMonocot.org).

eMonocot.org) that provides a synthesis of high-quality scientific information about the world's monocot plants. Monocots were chosen for the focus of this project because they comprise some 70,000 species and represent 20% of all flowering plants, many of which are commercially and nutritionally important. Funded by the Natural Environment Research Council (NERC) via a consortium grant to the Royal Botanic Gardens, Kew, Oxford University, and the Natural History Museum (NHM), the eMonocot Portal is fast becoming a media-rich, interactive tool of discovery, education, and research for a broad audience from the biodiversity research disciplines to the interested public and is accessible free of charge to anyone with access to an Internet connection. Features include nomenclatural information, identification tools (including interactive keys), and informative taxon pages (including species descriptions, ecological data, images, and distribution maps), all brought together from reliable scientific resources.

Entering data into eMonocot – classification, existing sources of data, and Scratchpads

The initial 'backbone' classification for eMonocot is based on the WCSP, which provides taxonomic, nomenclatural, and geographic information for the ca. 90,000 accepted taxa included in the project (ca. 70,000 species plus intraspecific taxa). Additional data are brought together and displayed in the Portal from other source systems, which cover particular taxonomic groups in greater depth or provide different types of data. These include biodiversity data from Global Biodiversity Information Facility (GBIF) and e-taxonomy resources such as efloras, CATE-Araceae, GrassBase, and Palmweb. Importantly, eMonocot is pioneering the development and use of new interactive, web-based e-taxonomy community research tools with Scratchpads websites (www.scratchpads.eu) which enable researchers to manage, share and publish taxonomic data online while participating in virtual research communities in order to work collaboratively on the groups of organisms they study.

Scratchpads have been developed in partnership with the eMonocot project since 2010, having been funded since 2006 through the FP7 European

Union projects EDIT and ViBRANT. Scratchpad websites are modular content management systems, specifically designed to handle biodiversity content, including a wide range of file types (such as literature references, data sets such as DNA or morphological character matrices, and media, including photographs, video and audio, and specimen data). Scratchpads are free to set up and use, free for users to access, and are already being created and maintained by a wide variety of individuals and groups such as specialist taxonomic research groups, natural history societies, and biodiversity related projects such as the Sampled Red List Index (SRLI) and GPI.

Specifically eMonocot-themed Scratchpads have been created so that individuals and groups of individuals interested in contributing to eMonocot can create taxon-focused websites. These sites will bring together authoritative taxonomic expertise and resources and feed into the eMonocot Portal while also facilitating international collaboration and communication among scientists. The eMonocot Portal will display all of the data being fed into it from these Scratchpads, enabling all monocot data to be searched, analyzed, and downloaded from a single site (the Portal) using a range of additional tools and resources provided. A number of eMonocot Scratchpads have been established by the eMonocot project, supplemented by training workshops to enable monocot taxonomists to collate and share their research materials and data.

Orchids and eMonocot

Because of its sheer size and importance in terms of ecology and conservation, Orchidaceae is one of the eight families of monocots being targeted for in-depth treatment by the eMonocot project team. The Cyripedioideae Scratchpad (<http://cyripedioideae.e-monocot.org>) was among the first to be developed by the project (Fig. 1). Based on data extracted from published monographs of the subfamily written by Phil Cribb and enhanced with additional content gathered by members of the eMonocot project team, the site provides illustrated taxon pages for over 150 taxa in the subfamily (Fig. 2) and is complemented by an interactive key to all species, which was created using Lucid software (Fig. 3).

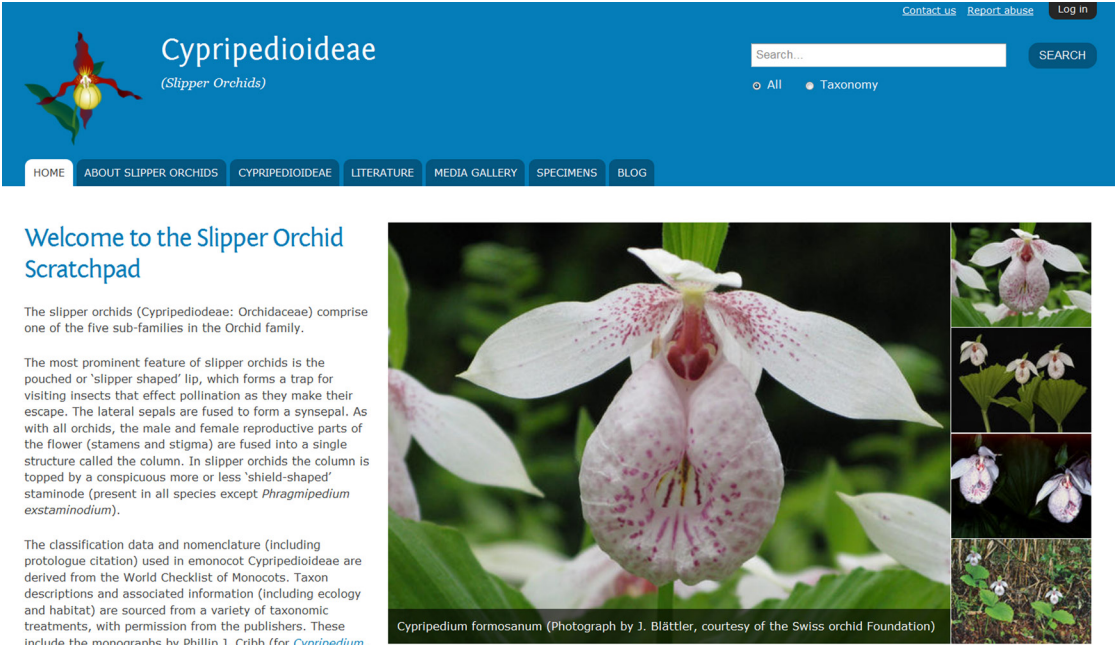


FIGURE 1. A screenshot of the Slipper Orchid Scratchpad homepage (www.cyripedioideae.e-monocot.org) displaying background information and media relating to the slipper orchids.



FIGURE 2. Example of a taxon page from the Slipper Orchid Scratchpad. A classification tree (A) allows the user to explore and navigate to a particular taxon. A series of tabs (B) on each taxon page allows the user to explore the different data pertaining to that taxon. For example, the overview page (C) provides nomenclatural information, including a link to the original description, media, and a summarized taxonomic description.

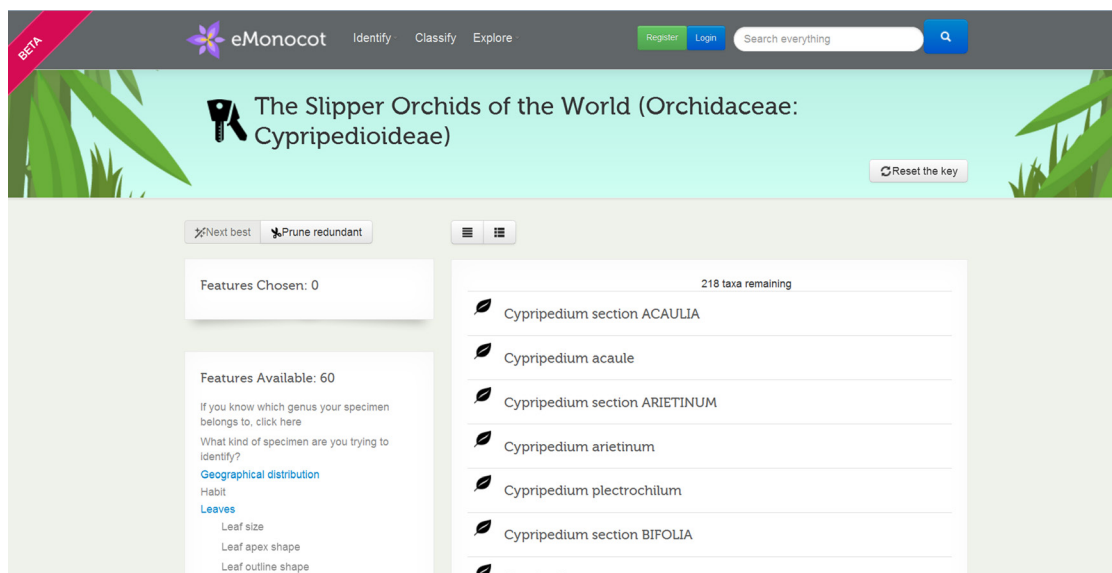


FIGURE 3. An interactive identification key to Cyripedioideae, created in Lucid and published in the eMonocot Portal.

With the support of Kew Publishing, Oxford University Press, and the editors of the series, eMonocot is also creating individual taxon pages for each orchid genus in the family based on descriptions published in *Genera Orchidacearum*. Taxon pages are being illustrated using images of digitized specimens, illustrations, and slides streamed directly from the World Orchid Iconography database of the Swiss Orchid Foundation – a collaborator of the project via a bespoke web service. Additional images can be added to any taxon page by registered users, allowing the display of personal and institutional photo galleries, subject to Creative Commons licensing (<http://creativecommons.org>) as chosen by the copyright owners.

Developing new orchid Scratchpads

A new research community Scratchpad site for Eulophiinae has been created by Ruth Bone (<http://eulophiinae.e-monocot.org>), who is actively seeking to engage researchers and field botanists working in Madagascar and southern and eastern Africa. The site is being used to lay a foundation for the taxonomic revision of the genus *Eulophia* and allied genera through compilation of protologues, eflora data (Flora Zambesiaca and Flora of Tropical East Africa), images, and specimen data. An associated research

project in collaboration with the Swiss Orchid Foundation is underway to develop a phylogenetic hypothesis for the group, and as work progresses the site will be used to document the research project via blogs and social media and make the project bibliography available. Scratchpads also integrate the new Pensoft writing tool that allows users to compile and publish taxonomic papers via the e-journals Phytokeys and the Biodiversity Data Journal; it is hoped that the Eulophiinae project will use these new tools. Another recently established eMonocot Orchidaceae Scratchpad is one for Aeridinae, which is being supplied with content (concentrating initially on descriptions, pdfs of original publications, and images) by Lauren Gardiner.

How eMonocot can help you – and how you can help be part of eMonocot

The eMonocot Project would like to encourage members of the orchid community to set up and maintain more Orchidaceae Scratchpads. Scratchpads can cover different levels of taxonomic groups depending on user interests and expertise and the needs of the communities involved at the level of subfamily (Cyripedioideae Scratchpad), tribe, subtribe (such as the Eulophiinae and Aeridinae Scratchpads) or genus. Scratchpad users

can manage their orchid data and resources, aiding their own research, while contributing data to the eMonocot project. If you would like to get involved with the eMonocot Project by joining or forming a scratchpad community, or wish to find out more about the project, please contact enquiries@e-monocot.org.

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