

EARLY LAND PLANTS TODAY – A COMMUNITY-DRIVEN APPROACH

L. SÖDERSTRÖM¹, M. VON KONRAT², A. HAGBORG² and A. SÉNECA^{1,3}

¹*Department of Biology, Norwegian University of Science and Technology
N-7491 Trondheim, Norway; lars.soderstrom@bio.ntnu.no, aseneca@bio.ntnu.no*

²*Department of Botany, The Field Museum, 1400 South Lake Shore Drive, Chicago
IL-60605-2496, USA; mvonkonrat@fieldmuseum.org, ahagborg@fieldmuseum.org*

³*Department of Biology, FCUP, University of Porto
Rua Campo Alegre S/N, P-4169-007 Porto, Portugal; aseneca@fc.up.pt*

Early Land Plants Today (ELPT) aims to combine existing data on nomenclature, taxonomy and distribution for liverworts and hornworts. At the moment the databases includes about 40,000 names of about 9,500 ‘accepted’ taxa and about 500,000 distribution records. The data is used for a forthcoming world checklist of liverworts and hornworts, several regional checklists, and nomenclature summaries of individual families. The data is made available for other databasing and conservation initiatives.

Key words: distribution, hornworts, liverworts, nomenclature, taxonomy

INTRODUCTION

Background

Data on liverwort and hornwort taxonomy, nomenclature and distribution are widely scattered in the literature and sometimes not very accessible. This also means that some sources are easily overlooked, causing instability, for example in nomenclature.

Data on taxonomy, nomenclature, and distribution exist in literature that dates all the way back to Linnaeus’ time, i.e. over 250 years. Many of the older publications are rare and difficult to access, even if increasingly many now are becoming available electronically through various library initiatives, e.g., the Biodiversity Heritage Library. Another problem is that the older publications are written before the International Code of Botanical Nomenclature (ICBN; now being renamed to *International Code of Nomenclature for algae, fungi, and plants*, ICN; MCNEILL and TURLAND 2011) was adopted, and it is sometimes difficult to apply the old concepts in a modern standard, causing varying and often erroneous interpretation of a taxon or a name. Further, during the last 20 years alone, nomenclatural novelties (new species and new combinations) have been published in over 90 journals or books, making an overview of them challenging.

Distribution data are even more scattered (in hundreds of publications) and much of it is in local journals not widely distributed and therefore difficult to access for other than locals. The fact that many are written in local languages is another hurdle. A third problem is that different nomenclature, and even different taxonomic concepts, are used in the distribution reports, making comparisons between regions more difficult.

There is no central source that provides a synthesis of the nomenclature, taxonomy, and distribution on a global scale for liverworts and hornworts.

What is ELPT

Early Land Plants Today (ELPT) is an initiative to collect data on liverwort and hornwort taxonomy, nomenclature, and distribution. This project started when Matt von Konrat and Anders Hagborg in Chicago and Lars Söderström in Trondheim discovered that they had two rather large databases covering liverwort taxonomy, nomenclature and distribution. The project then took form in a hotel room in Kuala Lumpur during the IAB meeting in 2007. From there it has progressed rapidly and started to involve many colleagues around the world into an ambitious project to collect as much of the existing information as possible and make it widely available. We see no limitation in how the data can be used.

The principal objectives of the ELPT project (VON KONRAT *et al.* 2008, 2010a) are:

- To unite nomenclature and distribution data on a global scale.
- Synthesize the taxonomy, systematics, and nomenclature on a group by group basis.
- Develop a global worldwide taxonomic checklist of liverwort and hornwort taxa.
- Map the distribution of liverworts and hornworts, locally and globally.
- Contribute to targets set by the Global Strategy for Plant Conservation (GSPC).
- Solicit as much participation as possible.
- Share information with the biological and broader communities.

Summary of the ELPT data sets

ELPT is currently sitting in two different databases, on two different platforms, with partly overlapping, partly complimentary data, that we are working to merge into a single database. However, the principal idea with both databases is much the same.

The databases have basically 3 segments, nomenclature, taxonomy, and distribution.

The nomenclatural data includes all data needed to fulfil the requirements of the International Code for Botanical Nomenclature (MCNEILL *et al.* 2006). It includes name, authority, original citation, basionyms, type data (protologue and specimen data), source of information for all elements, and auxiliary nomenclatural data. To highlight problems and to justify interpretations, there are a lot of annotations making it more transparent. This segment still needs some updates, but it is already large and close to be completed. This has been possible due to the Index Hepaticarum ([http:// www.ville-ge.ch/musinfo/bd/cjb/hepatic/](http://www.ville-ge.ch/musinfo/bd/cjb/hepatic/)), which is an important source for old nomenclatural data.

The taxonomic data is based as much as possible on current taxonomic opinions and evidence, mainly in collaboration with experts on various taxonomic groups. The 'precautionary principle' is adopted, i.e. not accepting synonyms immediately if there is conflicting evidence or other doubts as it is easier to merge taxa/names later than to split them again. However, all opinions on synonymisation are fully acknowledged. This segment is as up-to-date as it can be and is being continuously maintained.

The geographical segment will be the largest. All published reports are recorded down to fairly small geopolitical units. Defined geopolitical units, based on BRUMMITT (2001), but slightly modified and often subdivided, are used. The baseline units are countries with larger countries split into their subdivisions (Russia, China, India, Australia, Canada, USA, Mexico, and Brazil) or islands (Indonesia and New Zealand). Some well delimited areas of countries (typical remote islands) are separate units (*e.g.* Svalbard separated from Norway, Madeira separated from Portugal, etc.). Some smaller countries are pooled together with their neighbouring country (Andorra with Spain, Monaco with France, Luxembourg with Belgium, etc.). These units are on one hand grouped into regions (five in Europe, ten in Africa, etc.) and into continents (nine units). On the other hand, they are also split into subunits wherever a base unit is large enough. Up to three levels of subdivisions are used.

The quality of the data in the database depends on two things. First, some areas are explored much better than others and the data in the database can not be better than the current knowledge of the flora. Secondly, for some regions ELPT have not yet been able to capture published data as well as it could. The quality of the ELPT data is however good for most larger geopolitical units (like countries in Europe), but many subdivisions are not yet populated with available data. In addition, some areas are worked more with and are better populated than others. This segment is constantly and rapidly updated, often in collaboration with colleagues.

The strength of the database structure is that all information is integrated, so if the taxonomy changes (new synonyms, etc.) distribution will automatically be updated accordingly.

Summary statistics

The two datasets are not completely merged yet, so the figures of processed and captured data so far are estimates. However, there are enough data to be able to give rather accurate information in most cases.

The total number of publications, international and local, old and new, processed so far is about 7,000. The number of published names (close to 40,000) captured from them is probably a very close estimate.

The number of 'accepted' taxa (*ca* 9,500) is a bit too high because some taxa most likely are synonyms, but of what? Based on the data a calculation (= educated guess) on how many species there are landed around 7,500 (VON KONRAT *et al.* 2010c). This is probably still too low knowing the structure of the data and some estimates point towards 10,000 species.

The database has about half a million geographical detail records, but they are somewhat unevenly distributed. First, rather small geopolitical regions are recognized in some areas while the geopolitical regions in other areas are larger, but it is an aim to split all larger areas into smaller units. Secondly, the knowledge of the bryoflora in the different geopolitical regions differs a lot. Much less is known, for example, about the bryoflora in Moldova than in the Netherlands. Third, for some regions the registration of available data is still poor (mostly subdivisions of countries). Thus the records in the databases are concentrated to regions where ELPT have had special interests (*e.g.* where checklists are produced from the data) or where data are otherwise more efficiently captured.

Application of the data

The data can be used in many different ways as shown here by some examples. It has been used in 1) developing a world checklist with updated nomenclature and taxonomy (*in prep.*), 2) summarising nomenclatural data for some families (VÁŇA *et al.* 2010a, b) and 3) production of regional checklists. It is an aim to also work towards the Global Strategy for Plant Conservation (GSPC) targets.

Contributing to international databasing initiatives

One of the main strengths of ELPT is that it is a collaboration with many other biodiversity and conservation initiatives and it is now one of the more important sources for data on liverworts and hornworts. There are several other

databases of importance (*e.g.*, Index Hepaticarum, Tropicos, IPNI) that ELPT collaborates with, but none that includes all data combined in the way that ELPT is aiming for.

ELPT is trying to index all new taxa published (VON KONRAT *et al.* 2010*b*, SÖDERSTRÖM *et al.* 2012*b*). Those names are or will be made available to The Plant List, Catalogue of Life, and other third parties.

Towards the first ever worldwide checklist of liverworts and hornworts

An on-going project close to completion is working towards the production of the first ever global checklist of liverworts and hornworts. This is a work together with many colleagues all over the world and the aim is to submit it for publication 2012.

There will never be a consensus on the circumscription of all taxa and the synonymisation is therefore restrictive if there is any doubt about the synonymy. Instead ELPT (inspired by a similar approach by CROSBY *et al.* 1999) introduced a rating system for the taxa indicating confidence level of the taxa (Table 1).

The work with this checklist has uncovered many nomenclatural and taxonomic problems. Those are dealt with in a series of notes to be published in Phytotaxa.

Regional checklists

As the distribution data are so scattered, regional and local checklists (*e.g.* country, island, province) are important tools to quickly summarise information. However, a checklist is often almost outdated as soon as it is published, so they should be updated regularly. Although some parts of the world are well covered

Table 1. Confidence levels of taxa used in the forthcoming world checklist of liverworts and hornworts.

*	serious doubts	There are doubts about the value of the taxon. It can be that there are conflicting views without any substantial evidence in any direction, conflicting views with substantiating evidence supporting one or both positions, or there is evidence pointing towards synonymisation, but it is premature to do it.
**	knowledge problem	The taxon is not well known by the person evaluating it. It may be a newly described species or a species originally not well described and not restudied recently.
***	accepted	A good taxon as currently understood based on personal experience or on a convincing taxonomic revision. Nomenclature and/or taxonomic position may, however, be questioned, <i>e.g.</i> elements may be excluded from the taxon, but the taxon with the current type will still be accepted.

with recent checklists, many parts are still lacking, or have only old checklists (SÖDERSTRÖM *et al.* 2008; Fig. 1). Much of North America has only old checklists and only a few checklists for Mexico, Central America and the Caribbean have been published in the last 100 years. The situation is also alarming for most of Southeast Asia and the Pacific.

The ELPT project has so far, in collaboration with colleagues, produced checklists for Java (SÖDERSTRÖM *et al.* 2010), Jamaica (SÖDERSTRÖM *et al.* 2011b), New Caledonia (THOUVENOT *et al.* 2011), Fiji (SÖDERSTRÖM *et al.* 2011a) and Tonga (SÖDERSTRÖM *et al.* 2012a). Currently a checklist of Cuba is under production and several more are planned. A checklist of *Sphagnum* of the Pacific (SÉNECA and SÖDERSTRÖM 2011) was produced in the same way and with the same methodology.

Conservation initiatives

ELPT also likes to contribute to conservation initiatives, like the Global Strategy for Plant Conservation (GSPC). GSPC has 5 objectives and 16 targets (SHARROCK 2012). Target 1 is “to make a list of the world’s known plant species”. In the absence of a working list of the accepted names of known plant species, completing or even measuring progress towards the other 15 targets is extremely

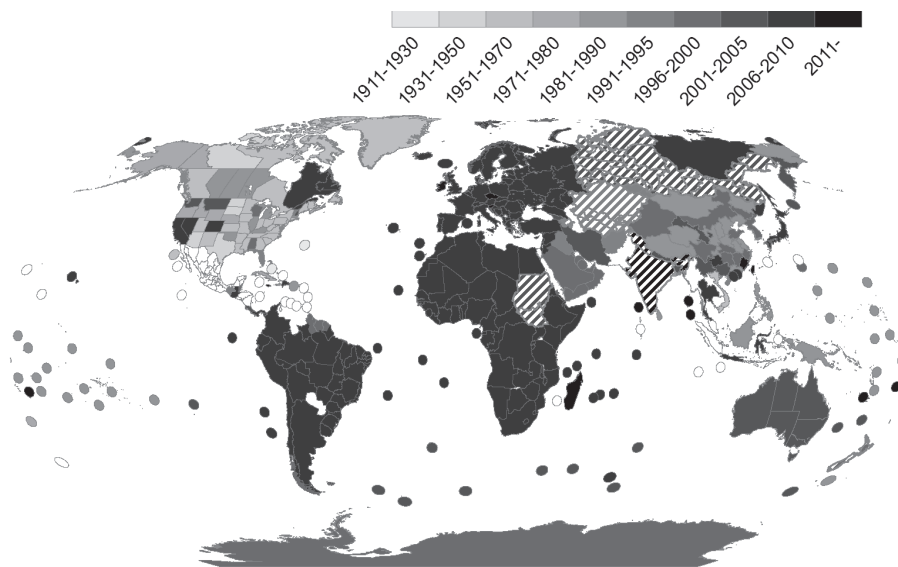


Fig. 1. Map showing existence and age of liverwort and hornwort checklists (updated from SÖDERSTRÖM *et al.* 2008) using baseline units. Hatched areas have checklists, but are not using the same geopolitical regions as ELPT.

difficult or impossible. For example, target 2, “An assessment of the conservation status of all known plant species, as far as possible, to guide conservation action”, can be tackled on the basis of current knowledge, but a comprehensive assessment cannot be achieved without a backbone list of those species to be assessed, given the high levels of synonymy. Without this backbone to clarify synonymy, inaccuracies in assessment are likely as it will be difficult to establish whether all relevant information concerning a particular species has been traced and taken into consideration. One instance of this would be when decisions made at a national level fail to take into account what is known about a species at a global or regional level.

Number of liverwort species and distribution of species

The ELPT database is fairly complete on the occurrence of species in the base line units. Thus, the map of species richness of the world (Fig. 2) should be close to the actual knowledge today.

In Europe the ELPT database does have rather good data on the baseline (country) level (Fig. 3) and for some countries, also subdivisions of the country (Fig. 4). However, for some countries data is not yet very good. For instance, the knowledge of the liverwort flora of Moldova is still very poor. In additions, for some of the larger areas (*e.g.* Belarus) the scoring on is not yet good for subdivision (Fig. 5).

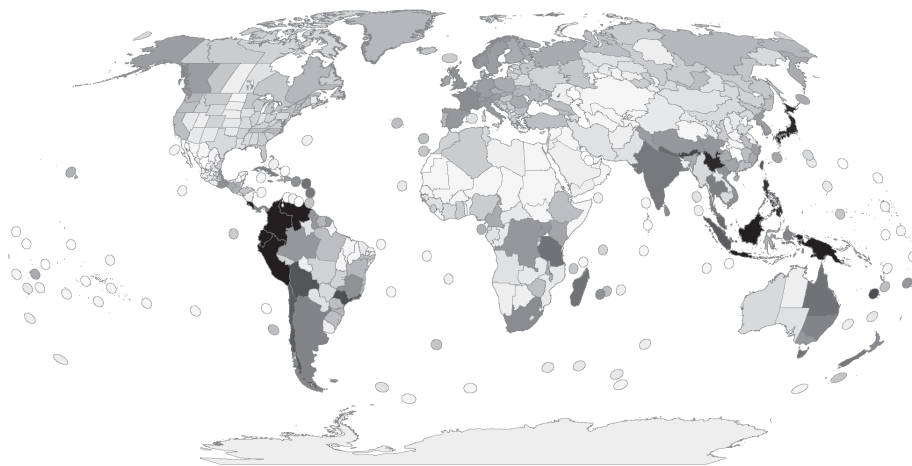


Fig. 2. Number of species in each base level region. The darker the more species. White means no species registered and the darkest, Colombia, have 861 species registered.

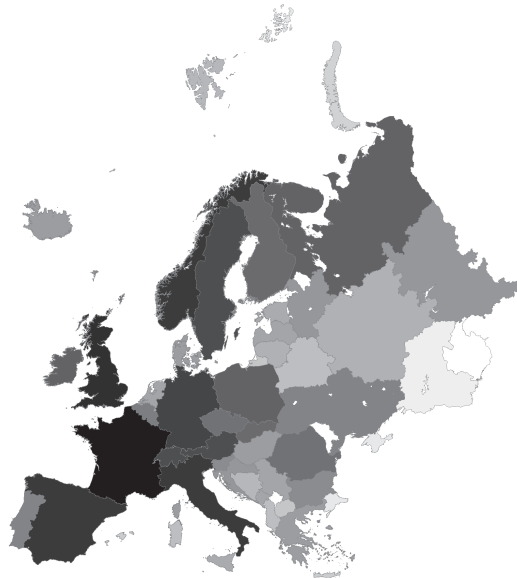


Fig. 3. Number of species in each base level region of Europe. The darker the more species. White means no species registered and the darkest, France, have 323 species registered.

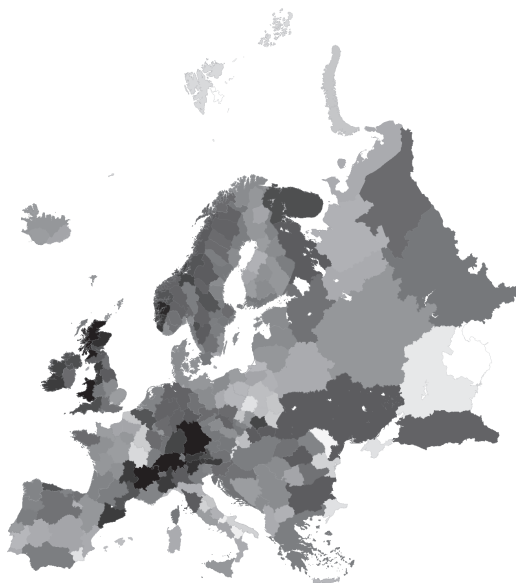


Fig. 4. Number of species in geopolitical units of Europe where the number of species in the ELPT database is estimated to be close to the actually recorded number of species. The darker the more species.

The ELPT database can also be used to map taxa individually. An example of a globally very disjunct species is *Anastrepta orcadensis* (Fig. 6) that occurs in oceanic parts of Europe, major European mountain ranges, the Himalayas, China, Japan, Hawaii and northeastern North America.

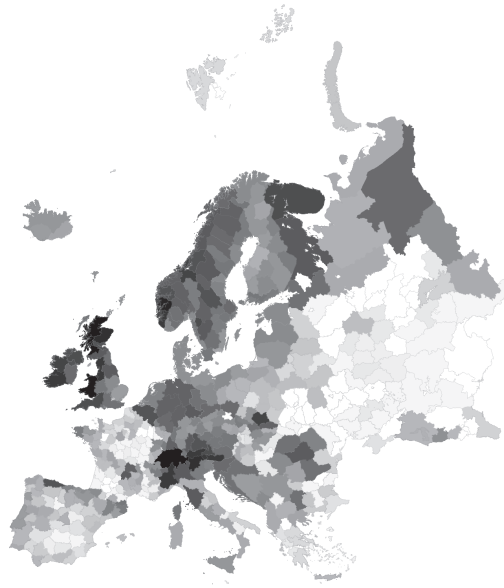


Fig. 5. Number of species in geopolitical units of Europe that ELPT is currently working with. The darker the more species.

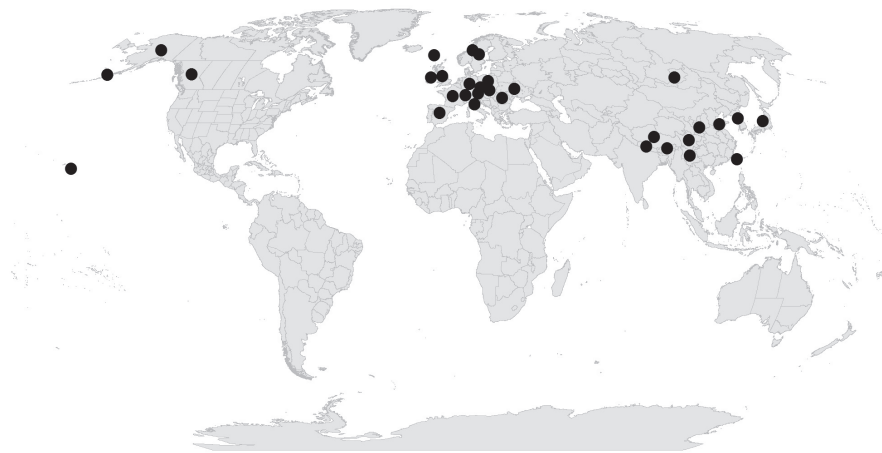


Fig. 6. The world distribution of *Anastrepta orcadensis*. Each dot is an occurrence in a base level unit.

Two examples of distribution data on a European level as the registered data is at present, one for a rare species where we have thorough and detailed data, and one for a common species where we don't have thorough data on the detailed level.

Riccia breidlerii (Fig. 7) is an endemic plant for the Alps just known from 11 of our geopolitical units (first level of subunits to the base unit currently operated with). It is known from several cantons of Switzerland, but the country is not (yet) divided into subregions.

The common species is *Aneura pinguis*, or rather the *Aneura pinguis* complex (Fig. 8). It is registered from all geopolitical provinces with good data in the ELPT database, but *e.g.* France is still problematic as it should be present in most of the provinces, but not yet recorded by ELPT for a number of provinces. Also the occurrence in Eastern Europe is still not satisfactorily recorded in addition that many provinces, especially in northern Russia, are large and should be subdivided further. As an example, the Komi Republic is about the same size as Finland and represented by only one dot here compared with the 20 subdivisions of Finland.

CONCLUSION

ELPT aims to create an open source for information on liverworts and hornworts. This can be done only in collaboration with the bryological world. ELPT



Fig. 7. The distribution of the European endemic liverwort *Riccia breidlerii*. Each dot represents an occurrence in a subunit to ELPT base units except for Switzerland that is not yet subdivided.

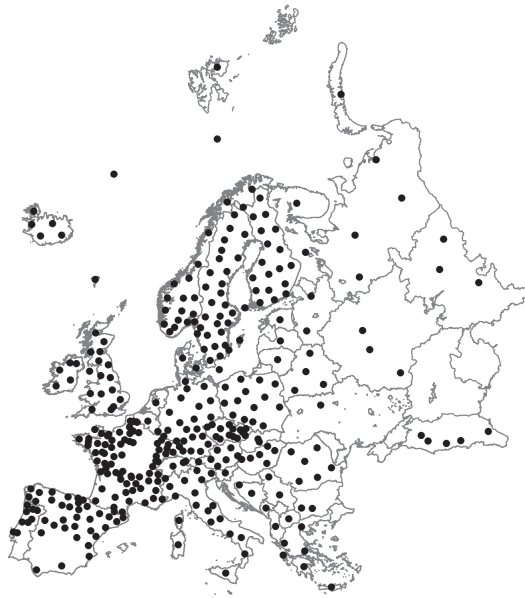


Fig. 8. The distribution of *Aneura pinguis*. Each dot represents an occurrence in a subunit to ELPT base units except for a few areas that are not yet subdivided

is willing to share data for any non-commercial use. It is an on-going project and the data is continuously updated. The ELPT project can be a model for similar attempts in other groups and we are interested in cooperation with any similar projects on other groups.

We like to finish with a quotation from CRANE (2004) showing the state of plant knowledge 130 years after Charles Darwin offered money for a plant list.

“...Charles Darwin wrote of his desire to provide financial support ‘for the formation of a perfect M.S. catalogue of all known plants’ (Darwin 1881, letter 13570). It is a personal embarrassment to me, and should be chastening to us all, that more than 120 years later we still have not delivered on that commitment.”

ELPT is trying to fulfil Darwin’s wish for our plant groups.

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(Received 30 August, 2012)