Martin Grube & Pier Luigi Nimis

The Med-checklist of Mediterranean lichens on-line: towards a synthesis

Abstract

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During the past two years, considerable progress has been achieved towards the preparation of a checklist of lichens for Mediterranean countries. Checklists for numerous operational geographical units are available and compilations have started for further countries. The existing checklists, which are being continuously updated, are available via the Internet. Standardization of the data and the preparation of databases, some of which are already accessible on the World Wide Web, is part of ongoing activities. An important step towards a synthesis is the development of a thesaurus of synonyms which will facilitate the linking of checklists and databases following different taxonomic concepts into a single information system.

Introduction

In the last decades there has been an increasing interest for lichen biodiversity, due to several reasons: lichens are used as sensitive biomonitors of air pollution and as indicators of ecological continuity, and are important agents of biodeterioration of stone monuments. In southern Europe, biomonitoring studies based on lichens are becoming increasingly numerous; Cislaghi & Nimis (1997), working in NE Italy, found a correlation between the incidence of lung cancer and air pollution levels as indicated by the occurrence of lichens, showing the possibility of shifting from the bioindication of pollution to that of health risk. The Mediterranean area is also extremely rich in stone monuments, and these are often colonized by luxuriant lichen communities. Studies on lichen-induced biodeterioration processes on Mediterranean monuments are therefore numerous, especially in Italy, Spain and S France, but also in Greece and Israel (e.g. Nimis & al. 1992 and references therein). In contrast to northern Europe, matters of ecological continuity are still poorly studied in the Mediterranean region, probably because closed forests are more important in northern landscapes (Rose 1976, Tibell 1991). The Mediterranean area was strongly influenced by man, particularly since Greek-Roman times, when forests were actively destroyed over large areas, resulting in a significant change of available substrata for lichens. Man-made emissions, either directly as air pollution or by means of contributing to long term climatic change, also have an impact on the lichen flora.

A fundamental pre-requisite for a sound development of applied lichenology is a thorough knowledge of lichen floras in the Operational Geographic Units (OGU, Crovello 1981) to be investigated. The first step towards a biodiversity inventory is the preparation of a checklist, which is not only a time-consuming and difficult task, but also a never-ending venture: it needs to be continuously updated following the stream of taxonomic and floristic research (see Nimis 1996).

Available checklists

The initiative aiming at a compilation of an inventory of Mediterranean lichens was started in 1989 by the OPTIMA Commission for Lichens (Nimis 1996). The catalogue of Italian lichens was the initial contribution (Nimis 1993), followed by checklists for several other Mediterranean or adjacent regions: Cyprus (Litterski & Mayrhofer 1999), Israel (Galun & Mukhtar 1996, Kondratyuk & al. 1996a), Macaronesia (Hafellner 1995), Morocco (Egea 1996), Slovenia (Suppan & al. 1998, 2000), Tunisia (Seaward 1996), Turkey (John 1996), and Ukraine (Kondratyuk & al. 1996a). Other checklists are in progress or planned: e.g. for Albania, Algeria, Crete, Greece, Iberian Peninsula, and Syria. We are optimistic to cover the entire range of the Mediterranean with further, still to be planned, checklist projects within the next years.

The currently available checklists vary strongly in the number of species. Italy, with c. 2,300 infrageneric taxa, is the country with the highest number, followed by the Iberian Peninsula, with c. 1,900 species, whereas only 234 species are known from Israel. The total number of species in the Mediterranean region at large is still hard to estimate, but, including lichenicolous fungi, it will certainly exceed 3,000 taxa. Available data from other large regions such as Australia (2,494 species, Grgurinovic 1994), the North American continent excluding Mexico (3,799 species, Esslinger & Egan 1995), and Scandinavia (Norway and Sweden: 2,602 species, Santesson 1993) may be compared with this number.

Lichen biodiversity information on-line

To provide quick access to the available information and to enable the automatic creation of a Med-checklist at a later stage, an information system for the Mediterranean checklists was created on the internet (Grube & Nimis 1997). Existing checklists are already available on the Web as plain text files, which may be searched or printed. The large checklist of Italy is exclusively available via queries to a database. Information on individual countries can be accessed via a 'master' page (http://biobase.kfunigraz.ac.at/medlichens.html). These pages contain links to literature references and to an entry form for short additions or comments into new web pages. The e-mail addresses of individual contributors are included with each comment, so that these pages may serve as small discussion forum. Direct changes in the checklist files are not possible: the checklist author has to filter the newly added information, or to contact the contributors for further details. Large amounts of data cannot processed by the entry forms, and should be sent directly to the checklist authors. At the last meeting of the OPTIMA Commission for Lichens in Paris (May 9, 1998), the authors of the existing checklists have agreed to continuously update their on-line checklists, following some pre-defined standards.

A more flexible access to the data was made possible by converting the checklists into relational databases. Various software products already allows a great functionality of on-line databases (Grube 2000). In our project, we are using the database system Oracle 8 with the Oracle Web Application server 4.0. The Web Request Broker as the central component of the Web server handles the incoming requests and interfaces them with various back-end technologies called cartridges. These execute the requests, e.g. by processing PL/SQL routines which also dynamically generate the HTML output. The web request broker has an better performance than the traditional CGI scripts due to its inherent multi-process architecture.

Lichenological information for Cyprus, Israel, Italy, Morocco, Slovenia, and Turkey is already in the database and can be accessed directly via the World Wide Web. A link to the database query form is included in the country-specific page. At the moment, it is possible to retrieve information about the geographic distribution of a taxon in the countries. Other data such as synonyms, remarks, ecological indices, specimens in TSB (Nimis 1999b) and Northern Europe (Timdal 2000), or information on genus name and recent literature on queried genus, are available. In the more complex database tables of Italy (Nimis 1999a), data on synonymy, ecological parameters and other remarks can also be retrieved and a Java program was included to plot the geographic distribution of a taxon. The simple routine receives data about the geographic distribution from the database as a string parameter and uses the data to draw points representating regions in Italy on a map.

Taxonomic concepts in these five databased floristic tables are not homogeneous. For example, the generic splitting of *Parmelia* s.l. was accepted in the checklist of Turkey (John 1996) but in the checklist of Italy (Nimis 1993). This makes it difficult to directly extract data for the automatic generation of a joint checklist from the database. To circumvent problems caused by taxonomic inconsistencies, a thesaurus of synonyms was introduced. This is a simple table which contains information on the synonymy by associating synonyms with accepted names. All names are linked to a reference. Basically, this is a partial implementation of the "potential taxon" concept proposed by Berendsohn (1995, 1997). For practical reasons, the names accepted in the tables will be those accepted in the continuously updated checklist of Italy, which contains the highest number of species. The thesaurus table is automatically invoked to look up the accepted name whenever a name entered by the client is not found. The thesaurus, however, will later also permit the user to choose the taxonomic concept to be applied in his own output. While this is easily feasible at the genus level, the thesaurus is difficult to apply at the species level and changing species concepts cannot be covered by the thesaurus so far, because the data included are based on reference rather than on individual specimens. Therefore, the integration of specimen-based information systems such as herbarium databases will be our long term goal, started by the already available links to the lichen herbarium of Trieste. A full integration of this information, which may follow the model by Berendsohn & al. (1999), will make it possible to fully adopt the potential taxon concept at the species level, to create accurate distribution maps, etc.

A further step: non-geographic information

Non-geographic information is available in the database of Italy since 1998. For every infrageneric taxon, seven additional fields are now available in a database format:

1) *Growth-form*: F: non-lichenized, non-lichenicolous fungus (belonging to genera including also lichenized species); LF: lichenicolous fungus, Cr: crustose, Cr.end: crustose endolithic, Cr.pl: crustose placodiomorph, Sq: squamulose, Fol: foliose, Fol.b: foliose broad-lobed (*Parmelia*-type), Fol.n: foliose narrow-lobed (*Physcia*-type), Frut: fruticose, Frut.f: fruticose filamentous. This system is still provisional, and rather rough: work is in progress for developing a new system of morpho-functional categories, more sensitive to ecological variation.

2) *Photobiont*: Ch: green algae other than Trentepohlia, Tr: Trentepohlia, Cy.h: cyanobacteria, filamentous forms (e.g. *Nostoc*, *Scytonema*), Cy.c: cyanobacteria, coccaceous forms (e.g. *Gloeocapsa*, *Xanthocapsa*).

3) *Reproductive strategy*: S: mainly sexual, A.s: mainly asexual, by soredia, or soredia-like structures (e.g. blastidia), A.i: mainly asexual, by isidia, or isidia-like structures (e.g. schizidia), A.f: mainly asexual, by thallus fragmentation.

4) *Substrata*: Sax: Saxicolous, Lign: On Lignum, Epiph: Epiphytic, Terr: On soil, terriculous mosses, plant debris.

5) *Altitudinal range*: This information is mainly based to the presence of a given taxon in 5 main vegetation belts. 1: eu-Mediterranean belt, potential vegetation: evergreen *Quercus ilex* forest, 2: submediterranean belt, potential vegetation: deciduous *Quercus-Carpinus* forests, 3: Mediterranean-montane belt, potential vegetation: *Fagus*-forests, 4: Oroboreal belt of the Alps (incl. *Picea abies*, *Larix decidua* and *Pinus cembra* stands), 5: vegetation above treeline (incl. Alpine tundras and eu-Oromediterranean vegetation).

6) *Eutrophication*: 1: no eutrophication, 2: very weak eutrophication, 3: weak eutrophication, 4: rather high eutrophication, 5: very high eutrophication.

7) *Water requirements*: Mainly referring to air humidity, but sometimes utilized also for the humidity of the substrata. 1: hygrophytic, 2: rather hygrophytic, 3: mesophytic, 4: xerophytic (in dry situations, but absent from extremely arid stands), 5: very xerophytic (rarely applied to Italian lichens for the scarcity of sub-desertic habitats).

8) *Light requirements*: 1: in very shaded situations (e.g. deep gorges, closed evergreen forests), 2: in shaded situations (e.g. north exposed faces in closed deciduous forests), 3: in sites with diffuse light but scarce direct solar irradiation (e.g. horizontal surfaces in rather open deciduous woodlands), 4: in sun-exposed sites, but avoiding extreme solar irradiation (e.g. horizontal or weakly inclined surfaces in more or less open stands), 5: in sites with very high direct solar irradiation (e.g. steeply inclined to vertical south-exposed surfaces in completely open stands).

9) *pH of the substratum*: 1: on very acid substrata (e.g. acid lignum, acid peaty soil, very acid, non eutrophicated siliceous rocks), 2: intermediate between 1 and 3, 3: on subneutral substrata (e.g. on base-rich siliceous rocks, and soil, on trees with eutrophic bark), 4: intermediate between 3 and 5, 5: on basic substrata (e.g. pure limestone).

Such and further non-geographical data permit much more complex queries. For example, somebody interested in endolithic lichens occurring on the Temples of Agrigento can ask for the list of endolithic calcicolous species occurring in the Mediterranean belt of Sicily; people carrying out a biomonitoring study using epiphytic lichens near Vicenza can rapidly obtain a list of epiphytic species occurring in the sub-mediterranean belt of Veneto; material for lichens and forest continuity in the montane belt of the Gran Sasso National Park can be obtained from, e.g. a list of epiphytic macrolichens with a suboceanic distribution occurring in the beech belt of Abruzzo. When phenotypic data on lichens become available in DELTA format (Dallwitz 1993, Rambold 1996-2000), indicidual keys to species occurring under these ecological conditions will be available. More complex cross-queries will also provide a consistent base of data for biogeographical comparisons, on the line of that provided for the whole of Italy by Nimis & Tretiach (1995).

Discussion and prospects

Work on lichens is especially suited for serving as a model for similar international initiatives concerning other taxonomic groups. Lichens are relatively few in number, they are sufficiently well-known, particularly in the Mediterranean region, and information on lichen biodiversity is of potential interest for a wide range of users.

The progress of national checklist projects directly stems from the activities of the OPTIMA Commission for Lichens. Their coordination is supported by the on-line representation of the available data, and databased biodiversity information offers to individual authors a consistent "added value" to their data, provided by the links to many different data sources. Considering the increasing speed in the accomplishment of the projects aims witnessed during the last few years, we are optimistic to be able to present a fully computerized general checklist for all hitherto investigated countries in a very near future.

Once the questions of standardization are solved, incorporated databased herbarium information, will have a great impact for environmental studies: the potential distribution of a species, according to the distribution of preferred ecological conditions (Nimis & Martellos 2000), can be compared with the actual distribution to asses the rarity of a species. This will be important in lichen conservation and the creation of Red-Lists. When properly analysed, information from historic collections can be used to document changes in biodiversity (Shaffer & al. 1998). For well-investigated OGUs, it will be also possible to quantify more rigorously floristic similarities among climatically similar, but geographically distant areas. Reports on "similar" lichen floras in "Mediterranean" areas of the World are often based on a few selected species only (Tretiach 1998). When larger species sets will be compared, these affinities could prove to be less significant, and the differences may provide relevant information for further research. To date, phytogeographical evaluations are only possible within Italy, which is the best investigated country. However, international coordination and the database approach provided by the OPTIMA Commission for Lichens will soon permit to include several other countries in quantitative studies of lichen phytogeography in the Mediterranean region.

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Addresses of the authors:

Dr. Martin Grube, Institut für Botanik, Karl-Franzens-Universität, Holteigasse 6, 8010 Graz, Austria.

Prof. Pier Luigi Nimis, Dipartimento di Biologia, Università di Trieste, Via Giorgeri 10, I-34127 Trieste, Italy.