

Pier Luigi Nimis

Towards a checklist of Mediterranean lichens

Abstract

Nimis, P. L.: Towards a checklist of Mediterranean lichens. — *Boccone 6*: 5-17. 1996. — ISSN 1120-4060.

The OPTIMA Commission For Lichens is supporting an international project for a compilation of a general checklist of lichens of the Mediterranean region. This paper describes the history of the project and the present State of the Art, with some critical considerations about the delimitation of the Mediterranean area for a lichen checklist, and a short outline of the main phytogeographic features of southern Europe, as far as lichens are concerned. It is suggested that the national checklist produced in the framework of the project should become available on the Internet, with a possibility of continuous updating by the international lichenological community.

Introduction

In the last years, mainly as a consequence of the UNESCO Conference of Rio and of the associated increase in research funding, biodiversity has become a focal issue in environmental research, its estimate being recognized as essential for managing ecosystems on a global scale. As it often happens when a scientific term becomes popular and vulgarized, the term “biodiversity” - which, incidentally, was already difficult to define within his original context - is often used in a rather vague sense, without a strict operational definition. The most widespread acception is to consider it as equivalent to the number of taxa occurring in a given Operational Geographic Unit (OGU, see Crovello 1981), i.e. a site, a particular area, a country, a continent... Such a definition, however, is far from being satisfactory. Once it is known that in a given OGU there is a given number of certain organisms, the question arises: is the biodiversity of this OGU high or low ? Thus, the quantification of “biodiversity” implies a quantitative comparison with areas of more or less equal size and similar ecological conditions. This is a controversial and interesting field, in which much more research and basic data are needed. The relations between number of species, latitude, area size, ecological complexity, etc. have been the object of study since the beginnings of this century (Arrhenius 1921, Gleason 1922); the problem, however, being exceedingly complex, is far from being fully resolved (see e.g. Preston 1962, Johnson & Raven 1970, Malyshev & al. 1994). The difficulties are exacerbated by the widespread lack of accurate and comprehensive data on the number of organisms occurring in OGUs of different surface.

In botany and mycology, comparative biodiversity estimates are usually based on national, regional or local floras, which are more or less accurate inventories of the organisms occurring in a given area. The quality of the available information, however, differs strongly among taxonomic groups. Vascular plants were studied more thoroughly, while for other groups of organisms basic information is often scanty, and sound biodiversity estimates are practically impossible. This is the case of lichenized and lichenicolous fungi in most of the world, including southern Europe, even though Europe is certainly the lichenologically best known part of the world. Spain, France and Italy, in particular, have witnessed a dramatic increase in the intensity of lichenological exploration in the last 20 years. Nevertheless, the knowledge of the south European and Mediterranean lichen floras was and still is largely insufficient. There is a huge number of papers dealing with lichens of this region, but no effort towards a general synthesis was ever attempted, several taxa still await critical revision, and large areas remain virtually unexplored by lichenologists. Considering this state of affairs, any attempt towards a general assessment of lichen biodiversity in the Mediterranean region is premature. The reader can easily imagine what is the situation in other parts of the world, and for many other groups of organisms. Real advances in biodiversity research can be only achieved by intensified work along three lines: a) syntheses of the hitherto available data, b) taxonomic research, c) exploration of poorly known areas.

The present volume of Bocconea, published under the auspices of the OPTIMA Commission for Lichens, is the second contribution, after the checklist of the lichens of Italy (Nimis 1993), towards a synthesis of available data on lichen biodiversity in the Mediterranean region and southern Europe. It presents checklists of lichens (some including lichenicolous fungi) for four extra European, Mediterranean countries: Morocco, Tunisia, Israel, Mediterranean Turkey, and for a south European country that has many lichens in common with the Mediterranean, the Ukraine. Further checklists will be issued in the next future. The principal aim of these publications is to provide a solid starting point for further taxonomic and floristic research, and a foundation for a better understanding of the south European and Mediterranean lichen flora.

Activity within OPTIMA: 1989-1993

The checklists published in this volume are the product of an international project by the OPTIMA Commission for Lichens, aiming at the compilation of an inventory of biodiversity of lichens and lichenicolous fungi in the Mediterranean area. The idea of producing a checklist of Mediterranean lichens was first put forward by Josef Poelt during a lichenological excursion to Sardinia in 1986. Two years later I was asked to organize a lichen session in the framework of the VI OPTIMA symposium, held in Delphi (Greece) in September 1989. The session was entirely devoted to floristic and phytogeographical problems concerning Mediterranean lichens, and all invited speakers, while trying to present the best possible syntheses in their respective fields, underlined the extreme need for further synthetic work, and for ongoing taxonomic and floristic research (Barreno 1991, Egea & Llimona 1991, Roux 1991, Scheidegger 1991). On that occasion, Poelt's idea was first presented in public, and discussed by a large group of lichenologists. It was then decided to create a Commission for Lichens within OPTIMA, with the main task of promoting and coordinating efforts toward the compilation of a checklist. Members of the Commission were E. Barreno (Valencia), J. M. Egea (Murcia), X. Llimona (Barcelona), H. Mayrhofer (Graz), D. Ottonello (Palermo), J. Poelt (Graz), C. Roux (Marseille), C. Scheidegger (Bern), and I myself acting as the secretary. Thanks to funds obtained from the University of Trieste, the Commission held its first official meeting there on 20-21

April 1990. The participants agreed on a practical approach to the lichen Med-Checklist, an open process involving several stages with increasing levels of sophistication. The original idea was to prepare, in a relatively short time, a "first approximation checklist", to be followed by a series of updated, more complete versions. This checklist was supposed to contain a complete list of taxa with relevant synonymy, notes on ecology and distribution, and references to relevant literature. Critical, or imperfectly known taxa were to be included, with their special status flagged. The checklist was to reflect the present state of knowledge, which of course was uneven for the various taxonomic groups and geographical subdivisions, to pinpoint open problems, and to highlight areas in which further research was most urgently needed.

At that time most of the participants agreed that the "first approximation checklist" was to be limited to southern Europe, excluding Africa and Asia, the reason being that lichenological knowledge of most non-European areas was exceedingly poor. The subdivision of the checklist area was to be based on practical criteria, such as the degree of lichenological knowledge, and the presence of active lichenologists in each area. The following subdivisions were then agreed upon: Portugal (Lu), Spain (Hs), Balears (Bl), Southern France (Ga), Corsica (Co), Peninsular Italy (It), Sicily (Si), Sardinia (Sa), Yugoslavia (Yu), Albania (Al), Greece (Gr, including the eastern islands - AE), Crete (Cr, including the Karpathos group), and European Turkey (Tu). The participants to the Trieste meeting saw no point in limiting the check-list to areas with truly Mediterranean vegetation, considering that many lichens have very broad distributional ranges, and that the lichens of sub-Mediterranean regions are also poorly known in a general way. The Alps were deliberately excluded for practical reasons: a lichen checklist for the Alps would by itself have been worthy of an independent project.

In Trieste a provisional list of Regional Advisers was drawn up. Their role was to check all informations relative to their region, propose additions or emendations, and contact, if necessary, other lichenologists from the same area. A second provisional list was prepared, including specialists of various taxonomic groups: they were to provide, for the groups in which they were specialized, a preliminary list of all species known to occur within the checklist area. Many proposed advisers and specialists were contacted by members of the Commission during the International Mycological Congress held in Regensburg (Germany) in August 1990, and most agreed to collaborate in the project.

Back from Regensburg, in September 1990, I began to work on a provisional list for Italy (including Sardinia and Sicily). The amount of taxonomic and floristic problems that arose in the very first stages of this process was so huge, that the prospects of rapidly producing an albeit "first approximation" checklist for all of southern Europe came to appear as utterly unrealistic. I had to cope with a literature which, at the end, summed up to more than 1,500 titles, with a plethora of forgotten names, and with taxonomic groups whose intricated taxonomy was far from being solved. Furthermore, different authors had - as usual - different species concepts, some authors were - of course - more reliable than others, and I was forced to make many delicate choices in accepting or rejecting given records. Finally, many problems could be solved only by the direct examination of herbarium specimens, and the old Italian herbaria were full of invaluable material which, since one century, patiently awaited revision.

The compilation of a kind of "first approximation checklist" for Italy alone took me two full years of hard work, and resulted in a bulky volume of 897 pages (Nimis 1993). This trial run, however, was useful to test the system of specialists and regional advisers, which proved to work very well.

Activity within OPTIMA: after 1993

Steady contacts with members of the OPTIMA Commission for Lichens during the compilation of the checklist of Italy, brought about a radical change of the original project framework. The main modifications, informally agreed among the Commission members, were as follows:

- The general checklist would be preceded by regional lists, summarizing in a critical form the information available for the different regions.
- The authors of the regional checklists would be free to adopt, for the time being, the nomenclature and species concept they like best. Attempts towards uniformization would have to await a later stage, when more national checklists would be available.
- The area covered by regional checklists would not be limited to Mediterranean Europe. Mediterranean Asia, Northern Africa and Macaronesia were to be included as well. Furthermore, other southern European, not strictly Mediterranean countries, should be also considered, if and when authors willing to compile a checklist were available.

The reasons for these decisions will be discussed in the next two chapters.

During the VIII OPTIMA Meeting, held in Sevilla in September 1995, another Lichen Symposium was organized, which was fully devoted to the presentation of some new checklists that are published in the present volume of *Bocconea*. On that occasion, a new Commission for Lichens was appointed for the period 1995-2001. The new Commission is composed by the following members: P. L. Nimis (Trieste, secretary), E. Barreno (Valencia), A. Crespo (Madrid), J. M. Egea (Murcia), M. Galun (Tel-Aviv), V. John (Bad Durkheim), X. Llimona (Barcelona), H. Mayrhofer (Graz), D. Ottonello (Palermo), C Roux (Marseille) and M. R. D. Seaward (Bradford).

The first five checklists compiled according to the general considerations discussed above are presented in this volume. The state of the art of the Med-checklist project in 1996 is the following:

Albania. — This is one of the least-known parts of Mediterranean Europe. The University of Trieste has financed a project aiming at the production, after a period of field-work in 1997, of a checklist for Albania by the end of 1998, produced by J. Hafellner (Graz) and M. Tretiach (Trieste).

Algeria. — Work is in progress by several authors in Algeria, France and Spain to produce a checklist of lichens of Algeria by the end of 1997, which will also include the revision of many of the taxa described by Werner.

Italy. — The checklist of Italian lichens was the first to be published (Nimis 1993). It included 2,145 infrageneric taxa, with a geographical breakdown into 20 different administrative regions, including Sicily and Sardinia. An abridged version, without the critical notes on the taxa and with the references limited to post-1993 papers, is being continuously updated, and will be available on the Internet, probably by the end of 1996. By May 1996 the number of accepted infrageneric taxa (excluding most lichenicolous fungi) has risen to 2,200. A catalogue of the lichenicolous fungi of Italy, by Triebel and Nimis, is in preparation, and will probably be published in the first half of 1997.

Iberian Peninsula (Spain and Portugal). — The Spanish Lichen Society has, with the main aim of producing a lichen flora of Spain and Portugal, elaborated a checklist in the form of a guide to the bibliographical sources of published floristic information. The data are stored in a FoxPro database, designed by N. L. Hladun (Barcelona). Each entry (usually a species name) is followed by the citation, in chronological order, of the sources

(authors, date of publication, page and number of references). Up to now, data from 1,466 sources have been incorporated (170 with data from Portugal only, 824 limited to Spain). Altogether, 41,576 data were entered, usually corresponding to 1-10 records each. A more detailed list for Portugal is planned for the next future by Palmira Carvalho (University of Lisboa). The checklist for the Iberian Peninsula will be ready by the end of 1996. The number of hitherto accepted infrageneric taxa is about 1,900 (Llimona, pers. comm.).

Israel. — A checklist is published in this volume by Galun & Mukhtar. It contains a list of references, and includes unpublished records of the lichens hitherto known from Israel. The total number of infrageneric taxa is 234.

Morocco. — The checklist of lichens and lichenicolous fungi of Morocco is also published in this volume by Egea. It is based on literature data, and on the results of original investigations of that area. For each taxon, the following informations are included: accepted name, most relevant synonyms, and bibliographical references, given separately for 9 geographical subdivisions of the country. The checklist includes 1,100 infrageneric taxa, 1,058 of lichenized, 42 of lichenicolous fungi.

Tunisia. — This checklist too is published in this volume, by Mark Seaward. A previous inventory of the Tunisian lichen flora, dating back to the 1950s, recorded 186 species from fragmentary and widely scattered published sources. The new, detailed literature survey, supplemented by herbarium studies, and the collections made by the author in 1973, has shown the currently known Tunisian lichen flora to comprise 415 infrageneric taxa.

Turkey. — The checklist published in this volume by V. John is limited to the Mediterranean part of Turkey, and covers both lichenized and lichenicolous fungi. This area covers nine provinces directly adjoining the Mediterranean sea, and two bordering provinces. The checklist is based on literature records, herbarium specimens, and original field work. The total number of accepted infrageneric taxa is 459.

Southern France — The author responsible for the checklist of the lichens of southern France is Claude Roux (Marseille), the co-author of one of the most important identification books for European lichens that appeared in this century (Clauzade & Roux 1985). Both authors provided further fundamental contributions to the knowledge of the Mediterranean lichen flora, and published a comprehensive key to lichenicolous fungi worldwide (Clauzade & Roux 1989). Both works are presently being updated, which may somehow justify the slow progress in the compilation of a checklist for southern France, originally planned as one of the first to be issued within the project. That checklist, however, is of fundamental importance for the project, since southern France is one of the best-known parts of the Mediterranean region. It will be probably available in c. one year.

Slovenia. — A checklist Slovenian lichens is being compiled by H. Mayrhofer and collaborators (Graz), jointly with A. Batic (Ljubljana). It will be based on literature records and on a conspicuous body of original collections made in different parts of the country, and will be ready before the end of 1996.

Ukraine — Although this is definitely a non-Mediterranean country, the Ukraine includes a large portion of the Black Sea coast, and notably the Crimea, with its quasi-Mediterranean climate. For this reason, the checklist of Ukrainian lichens is relevant for the project. This checklist is published in this volume by Kondratyuk and co-workers, and includes reference to 1,259 infrageneric taxa.

Macaronesia. — A checklist of the lichens and lichenicolous fungi of Macaronesia (Canary Islands, Madeira and Azores) has been published by Hafellner (1995). It will be continuously updated by the author within the framework of the OPTIMA project.

Other countries. — For the following countries no new checklist is in sight, although older checklists, or more or less complete bibliographical lists sometimes exist that could serve as a basis for an updated inventory: Bulgaria, Croatia (an old checklist available: Kusan 1953), Cyprus (contacts with potential authors already taken), Egypt, Greece, including Crete (a modern literature survey available: Christensen 1989, contacts with potential authors are in progress), Lebanon, Lybia, F.Y.R. Makedonija (an old checklist available: Kusan 1953), Malta, Romania, Yugoslavia (Serbia and Montenegro: an old checklist available: Kusan 1953).

Delimitation of the “Mediterranean Region”

In planning a checklist of “Mediterranean” lichens we had to face the question of defining the term “Mediterranean”, and delimiting the corresponding geographic area. For this purpose, different criteria - climatic, vegetational, biogeographic - can be used, jointly or individually, resulting in various, sometimes widely different delimitations (see e.g. Margaris & Mooney 1981, Kruger & al. 1983, Quézel 1985, Rivas-Martinez 1987). A widespread view considers as truly “Mediterranean” all areas with an evergreen sclerophyllous vegetation dominated by *Quercus ilex*, or, in the eastern Mediterranean region, by *Q. calliprinos* (see, however, the objections by Emberger 1943); the so-called *Oleo-Ceratonion* vegetation is included as a marker of the warmest and driest Mediterranean climate conditions. A different criterion for “Mediterranean” climatic conditions is the present, cultivated distribution of the Olive tree (*Olea sativa*). Several climatic indexes were also proposed to define the “Mediterraneity” of a given area (e.g. by Daget 1977a-b, Tukhanen 1980, Box 1982). However, the regions bordering the Mediterranean Sea have such wide temperatures and rainfall ranges (from 100 mm in pre-desert zones to more than 3000 mm on some mountains), as to render any kind of quantitative climatic definition very problematic (Quézel 1985). All such definitions are of scant interest for our planned lichen checklists. One of their common, drawbacks is that it is extremely difficult, in practice, to delimit truly “Mediterranean” OGUs due to the complicated geomorphological and orographical situation of the countries surrounding the Mediterranean Basin. Even if all authors were to agree on an uniform set of criteria for classifying an OGU as “Mediterranean”, the evaluation of literature records would be far from easy: for every locality one would have to check whether or not it falls within a “Mediterranean” OGU, when the required information is likely missing in most of the relevant literature.

Apart from the difficulties of geographic delimitation, there are other good reasons for adopting a broad concept of the term “Mediterranean” for a lichen checklist. One such reason is that lichens, as most cryptogams, have far broader distributional ranges, on average, than higher plants. Phytogeographical subdivisions based on lichen data differ from those based on the distribution of higher plants. Lichens, being excellent indicators of climatic parameters such as temperature and air humidity, can provide valuable information on the phytoclimatic characteristics of a region. Also, as will be discussed in the next chapter, the number of lichens with truly “Mediterranean” range is extremely small when compared to that of animals or vascular plants. Lichen checklists covering a broad area will be much more informative, with respect to distribution patterns of taxa,

than those limited to narrow areas. Another reason has to do with the biogeographic peculiarities of southern Europe. The highest peaks of the Mediterranean mountains do neither have a truly Mediterranean climate, nor do they host a sclerophyllous vegetation. However, they are biogeographically so peculiar that the existence of an "Oromediterranean" vegetation belt is accepted by most authors, albeit under different denominations. Similar considerations apply to intermediate vegetation belts, such as the *Cedrus* forests of the mountains of Mediterranean Asia and North Africa. They show little affinity to evergreen sclerophyllous vegetation, yet they are a typical, unique feature of the Mediterranean region in the wide sense. The floristic, phytogeographical and historical affinities of the Macaronesian flora with that of the Mediterranean proper are so obvious that Macaronesia must not be ignored in a comprehensive treatment of Mediterranean biodiversity. Finally, in the northern part of the Mediterranean region deciduous forests form a belt just above the sclerophyllous vegetation, and the two biota often intermingle. Italy is a good example, where deciduous oaks are much more frequent, sometimes even at low elevations, than evergreen vegetation, and where beech (*Fagus sylvatica*) forms the tree-line from the northern Apennines down to the mountains of Sicily. Deciduous woods, and especially beech forests, are admittedly not the most characteristic examples of "Mediterranean" vegetation. Yet, southern Europe was the principal refugial area, during the glacial period, for the temperate nemoral flora of Europe (Nimis & Bolognini 1993, Bolognini & Nimis 1993). What may now appear to be a typical example of "Central European" vegetation, such as a German beech forest, is in reality a very much impoverished version of a type of biome that has its roots, and maintains its maximum diversity in the mountains of the Mediterranean region. This holds true for vascular plants and for lichens alike. Many species of the deciduous forest belt - "Central European" or "submediterranean" species, as they are often called - colonized Central and northern Europe from the south. To my mind, one of the prime reasons not to limit our lichen checklists to "truly Mediterranean" areas is, that information on the distribution of lichens throughout southern Europe and in different altitudinal belts of the Mediterranean is paramount for understanding the post-glacial recolonization of more northern areas.

Phytogeographical patterns in the "Mediterranean" lichen flora

In the lichenological literature the term "Mediterranean" has often been used exactly as for vascular plants. Many authors (e.g. Nimis & Poelt 1987) implicitly assumed the existence of a "Mediterranean element" in lichens, whose distribution patterns would be consistent with those of steno- or eurimediterranean vascular plants. Barreno (1991) was one of the first to question this assumption, suggesting that examples of truly "Mediterranean" distribution are far less frequent in lichens than in vascular plants. She pointed out that many terricolous "Mediterranean" lichens are distributed far beyond the Mediterranean region, some of them extending throughout the Mediterranean, Irano-Turanian and Saharo-Arabian floristic provinces, a range that corresponds well with the Isoclimatic Mediterranean Area proposed by Daget (1977a,b), and with the "Mesogean Subempire" of Quezel (1978). The puzzling paucity, among lichens, of cases of truly "Mediterranean" distribution patterns was confirmed by the phytoclimatic analysis of the Italian lichen flora of Nimis (1993) and Nimis & Tretiach (1995). To date, Italy is the only country of southern Europe for which it is possible to attempt an albeit preliminary phytogeographic synthesis for lichens. The lichen flora of Italy is composed by three main elements:

- A mainly temperate element linked to the deciduous forest belt, without particular suboceanic affinities (38% of the total flora), which is well represented in all regions, but scarcely penetrates eu-Mediterranean vegetation (e.g. several species of *Parmelia* and *Phaeophyscia*, or otherwise common temperate lichens such as *Candelaria concolor* or *Candelariella reflexa* are quite rare in the southern Mediterranean region, where they are mostly confined to the “submediterranean” vegetation belt).
- A suboceanic to oceanic element with more or less evident subtropical to tropical affinities, confined to humid climates which, in Italy, is most frequent along the western side of the Peninsula, in Liguria and in Sardegna (c. 20% of the total flora); this element is more important in western Europe, while in southern Europe and the Mediterranean region it is tied to areas with suboceanic climatic conditions (humid mountains, Tyrrhenian and Dalmatian coasts, Colchis, etc.).
- A northern element, restricted to the highest mountains, most frequent in the Alps and becoming progressively rarer southwards (c. 25%); in the Mediterranean region this element, which in northern and central Europe is generally bound to the arctic-alpine or boreal-oroboreal vegetation belts and which includes many species with a northern, holarctic distribution, reaches far more southern latitudes than the corresponding element in vascular plants, especially on siliceous substrata. Many “northern” species are still present on e.g. Tenerife, in the Atlas Mountains, and the siliceous mountains of Turkey. On the whole, there is a sharp phytogeographical difference between siliceous and calcareous substrata in Europe: the northern element tends to prevail on the former, whereas on calcareous rocks there is a higher incidence of “southern” species (Nimis & Tretiach 1995). A satisfactory interpretation of this fact will require further, intensive taxonomic research, and a much better knowledge of the lichen flora of the Himalayas, supposedly one of the main areas of origin and differentiation of the “southern” calcicolous flora.

The remaining 16% of the Italian lichen flora can be distributed among three smaller elements, each with peculiar distribution:

- South European orophytes (7%) a group including several poorly-known, “endemic” taxa.
- Widespread xerophytic species (2%), an element including the “Mesogean” element of Barreno (1991), which in Italy is scarcely represented due to the rarity of truly arid types of climate, but that has a stronger presence in N Africa, SW Asia and parts of the Iberian Peninsula.
- “Mediterranean” species (8%), an element whose incidence is quite low, when compared to the proportion of Mediterranean vascular plant species in the Italian vascular flora. For example, steno- plus eurimediterranean species account for 28.5% of the vascular flora of Sicily (Nimis 1984), whereas the corresponding figure for lichens is only 8.9 % (Nimis & Tretiach 1995). The “Mediterranean” lichen element is difficult to define and quite heterogeneous, as it includes: (a) several, often not very well-known, coastal species restricted to the Mediterranean region, (b) those species with a Macaronesian-Mediterranean distribution not bound to a particularly humid climate, (c) a few species extending into other parts of the world with a Mediterranean climate, especially California, (d) some species restricted to the humid belt of the Mediterranean mountains. Perhaps the richest habitat for truly “Mediterranean” lichens are humid rock outcrops, both siliceous and calcareous, along the coasts, which host a very peculiar and often geographically differentiated flora (see e.g. Roux 1991). The epiphytic vegetation, on the contrary, is much more homogeneous throughout the Mediterranean region. According to Nimis (1993) the scarcity of truly “Mediterranean” lichens might be explained by two main reasons: (a) a summer

drought period does not result in a sufficient strong selective pressure for the evolution of a truly Mediterranean lichen flora, many lichens being anyhow able to withstand long periods of drought, (b) the evolution of a Mediterranean-type climate in southern Europe is too recent to permit the differentiation of a specialized flora in a group of organisms such as lichens which, supposedly, have a very low rate of evolution.

Summing up, the lichen flora of the Mediterranean region appears to be mainly constituted of four broadly defined phytoclimatic elements: a northern element, a temperate element, a humid subtropical element, and an arid subtropical element. The "Mediterranean" or "Mediterranean-Macaronesian" element, while an interesting, probably very old relic of Tertiary times, is not, at least in sheer number, the most peculiar feature of the Mediterranean lichen flora. Its relationships with the humid subtropical and the arid subtropical floras still await full elucidation, both at the taxonomic and biological-ecological level. A characteristic feature shared by "Mediterranean" and arid subtropical lichens is the high frequency in these phytogeographic groups of parasitic, or parasymbiotic species (Poelt & Doppelbauer 1956), perhaps linked to the scarcity of free-living photobionts in arid areas. In my opinion, and contrary to the prevailing view, another biologically and phytogeographically very interesting element is the temperate one. All other elements - with the exception, of course, of the few typically Mediterranean lichens - have their main center of origin outside the Mediterranean region, whereas many temperate species have once migrated towards the north (and east) from areas bordering the Mediterranean Sea. This migration has left several traces in the lichen flora of the southern areas, and many more probably await discovery. One peculiarity of the Mediterranean flora was highlighted by Poelt (1970) in his classic *Theorie der Artenpaare*: he demonstrated that in the European flora there are several cases of species closely related pair-wise, one reproducing sexually, the other asexually. The members of these "species pairs" often have different distributions, the "primary", sexually reproducing species being more frequent at southern latitudes, the "secondary", asexual species tending to be more widespread, and hence more northerly. This tendency is most probably related to the post-glacial colonization of central and northern Europe by populations coming from the south. Another, related feature of the Mediterranean lichen flora is the north-to-south increase of genetic diversity found in several groups of temperate lichens. According to Leuckert & Poelt (1978) chemically heterogeneous groups tend to be distributed along a north-to-south gradient: in the south there are more numerous and more complex chemotypes. This situation is found in widely different families and genera, at least among saxicolous, sexually reproducing species, and is interpreted as a result of recent impoverishment in northern regions, due to the effects of glaciation. The higher genetic diversity of the southern flora is also evident at the morphological level. A typical example is *Lecanora muralis*, one of the most common saxicolous species of Europe, extending to the Arctic, and well into large urban agglomerations of Central Europe. The species is very variable, and several morphs have been distinguished (Seaward 1976); in the north, however, most of the variability is environmentally induced. In the Mediterranean area, on the contrary, *Lecanora muralis* consists of many morphologically, ecologically and probably also chemically different taxa, that still await thorough taxonomic revision. Examples of this kind are numerous, and often concern very widespread and common temperate lichens such as *Lecidea fuscoatra*, the *Lecanora dispersa* complex, the *Lecanora rupicola* complex, etc. The lichen flora of the countries bordering the Mediterranean sea appears as a kind of reservoir of genetic diversity for the development of the temperate lichen flora,

from which only a few representatives managed to migrate northwards in post-glacial times. These considerations suggest that it would be very short-sighted to focus our attention only on truly "Mediterranean" lichen floras.

Some considerations about the checklists

Checklists, generally, summarize in a more or less critical way the hitherto known information on the biodiversity of a given group of organisms in a given area. They may differ greatly in scope and content: in some cases they appear as simple lists of names, in others they provide detailed literature records for all listed taxa. All checklists presented in this volume are based on properly cited literature records, thus providing detailed bibliographical guidance to the lichenological exploration of each country. This option was preferred in view of the fact that most checklists are the first ever to be published for their respective countries, but it resulted in two major, critical problems: the reliability assessment of literature data, and the selection of sources. It is obvious that not all literature records can be accepted uncritically: the circumscription of taxa may differ among authors, recent taxonomic revisions might have demonstrated that a given taxon actually includes several taxa of the corresponding rank, some authors may be more reliable than others, etc. The author of a checklist is often forced to make difficult decisions, since in most cases it is not possible to check directly all identifications cited in the literature. Identifications in the Spanish literature were checked by Giralt (in litt.) for the case of two genera: *Ochrolechia* and *Rinodina*. The number of misidentifications, even by "thrustworthy" authors, proved to be very high. In the checklists of the present volume a pragmatic approach was taken: they should all be considered as the result of a series of "educated guesses" for which their authors take full responsibility. Eventually, however, it will be up to the reader to judge the reliability of literature data. The essential scope of a checklist is that to give the reader a means of doing just that. The selection of sources is a delicate task as well: should only properly published records be accepted, or should unpublished sources and "grey literature", such as theses, private reports, excursion guides etc, also be taken into consideration? In this respect, too, the author of the checklist is responsible for the mode of selection: the only cogent criterion which all authors were requested to adopt is that the material on which the records are based must be retrievable. Unpublished theses may often contain extremely valuable information, provided that vouchers are deposited in the herbarium of the institution at which the thesis was carried out. If such information is considered as important and valid, it is included in the checklist.

Checklists might differ also on account of the degree of exploration of the area they cover. For well-explored areas they often represent a basis for future updates and a kind of prodromus for a real flora; in the case of poorly explored areas they summarize the current state of knowledge, but cannot pretend to be exhaustive. The latter is, beyond doubt, the case of most checklists of the present volume. The lichenologically best explored areas of southern Europe are Italy and the Iberian Peninsula. The numbers of known infrageneric taxa are c. 2,200 for Italy (Nimis 1993, and later additions), and c. 1,900 for the Iberian Peninsula (Llimona, in litt.). Taking into consideration the surface area of the countries covered, the only checklist in this volume that may be comparably complete is, perhaps, that of the Ukraine. All others should be considered as mere starting points for further research.

The degree of taxonomic knowledge often parallels that of floristic exploration. In well-studied areas most infrageneric taxa are likely to be relatively well-delimited taxonomically. At the other extreme, a checklist may include several names referring to

very poorly-known taxa in need of critical revision. Thus, the total number of taxa accepted in a checklist does not always reflect the actual species diversity of that area, not only because of gaps in the floristic investigation, but also due to inadequate taxonomic knowledge. Incidentally, further taxonomic research will often reduce rather than increase the number of accepted taxa. The checklist of Morocco in the present volume accepts several taxa described by Werner that were largely forgotten by subsequent authors; many will certainly be reduced to synonymy in the future. Their citation in the checklist is, however, important, because it will bring these potentially correct names, often published in long-forgotten papers, to the attention of specialists.

Checklists are also expected to be a means of achieving nomenclatural stability, at least for some years. In this respect, however, those contained in this volume will likely fail. All of course update the nomenclature, although with different standards. Lichen taxonomy has recently witnessed a dramatic increase in the creation of new genera, on many of which the international lichenological community is far from having formed a consensus. Thus, the checklist of the Ukraine accepts an extreme generic splitting of *Parmelia*, while the other checklists follow a more conservative approach. Many further changes, especially at generic level, are to be expected in the near future. It would have made little sense to strive at uniformizing nomenclature at this stage. The consensus problem, however will present itself anew in a few years' time, in the context of the compilation of an overall checklist of Mediterranean lichens, and will require further discussions at the international level. In this volume, the only attempt at uniformization was adherence to the standard for authors' abbreviations proposed by Brummitt & Powell (1994).

To sum up, checklists can have different nature, scope and contents, and they should be always judged while considering the situation of floristic and taxonomic research that they reflect. In any case, they are a valuable tool for retrieving and accessing the enormous amount of information which has accumulated during centuries of biological research. They offer an indispensable basis for specimen revision, for the critical re-appraisal of poorly-known taxa, and for the further exploration of under-investigated areas. In this sense, checklists may and should be catalysts for new, more intensive investigations. The best criterion for a checklist to have accomplished its task as a facility to the scientific community is the speed of its becoming outdated. Their ephemeral value, which is what I paradoxically wish to all checklists of the present volume, has an interesting implication, to be discussed in the next chapter.

Biodiversity on-line

Checklists are never-ending ventures, subject to continuous updating following the developments of current research. In the past, it was customary to issue, at certain intervals, checklists with increasing "degrees of approximation", but always in the traditional, paper-bound form. Recent progress in the fields of interactive data access and retrieval now provides scientists with new, powerful tools which can bring about a true revolution in data availability. The expansion of the Internet, the advent of the World Wide Web, and the development of Web servers and browsers that include HTML, have virtually eliminated past obstacles to the creation of on-line databases. With a Web server acting as a buffer between the database and the network, and Web browsers functioning as platform-independent "front ends", network-based database publishing is now an easy, cheap and efficient option. Continuous on-line interaction among different centres is now possible, a fact that leads on to the "publication" of a product that is updated on-line by a continuous stream of new information, filtered by the responsible(s) for a given checklist.

This is exactly what is needed for biodiversity inventories, and what is envisaged as the future destiny of the checklists published in this volume.

The simplest approach to database publishing on the Word-Wide-Web is to export database views to ASCII text files, marked up as HTML documents, and to place them on a Web server for remote access. It is also possible to build single-level or multi-level indexes by exporting subsets of the data. A slightly more complex approach is to export database views to ASCII text files, and access them with the aid of a Wide Area Information Server. Even the possibility of remote accessing of simple, flat text files is an enormous advance with respect to the past: using the devices of any word processing programme, it is possible to search them as a kind of simple, limited database.

Although checklists have been and will continue to be published in the traditional form, their continuous updating on the Web provides the possibility of a new type of "publication", one that would have not been possible in the past and that is particularly adapted for open-ended works such as gene-banks and biodiversity inventories. The creation of a working space on the Internet for the lichen Med-checklist project will have two advantages: (a) facilitating the exchange of information among specialists from different countries, (b) making immediately available to the scientific community the most up-to-date information on lichen biodiversity in southern Europe and the Mediterranean region. The hitherto available checklists could be made available in hypertext format in the near future and with a relatively minor financial input. The main issue to be solved is standardizing the information deriving from different sources, so as to allow interaction among different database units, following the proposals of the Taxonomic Databases Working Group (TDWG). The biogeographic databases originated from our project could be linked with the morphologic-taxonomical data handled in the framework of the LIAS project. This is a DELTA-based taxonomic database edited by the Botanische Staatssammlung München, in collaboration with several international centres. This link will eventually permit the production of computerized identification keys for any list of lichen species produced from the Lichen Med-Checklist databases, which will considerably increase the number of potential users of the products of the OPTIMA project.

There are good possibilities for the checklists of the present volume, and those to follow, not merely to be important sources of information published in the traditional way, but to become the starting point for a wholly new kind of product: continuously updated biodiversity inventories available on-line world-wide.

Acknowledgements

I am indebted to Prof. W. Greuter (Berlin) for his thorough revision of the manuscript.

References

- Arrhenius, O. 1921: Species and area. — *J. Ecol.* **9**: 95-99.
- Barreno, E. 1991: Phytogeography of terricolous lichens in the Iberian Peninsula and the Canary Islands. — *Bot. Chron.* **10**: 199-210.
- Bolognini, G. & Nimis, P. L. 1993: Phytogeography of Italian deciduous oak woods based on numerical classification of plant distribution ranges. — *J. Veg. Sci.* **4**: 847-860.
- Box, E. O. 1982: Life-form composition of Mediterranean terrestrial vegetation in relation with climatic factors. — *Ecol. Medit.* **8**: 173-181.
- Brummitt, R. K. & Powell, C. E. 1994: Authors of plant names. — Kew.
- Christensen, S. N. 1989: The lichen flora on *Ulmus* in a north Greek mountain village with an introduction to the literature of Greek lichens. — *Graphis Scripta* **2**: 107-113.

- Clauzade, G. & Roux, C. 1985: Likenøj de Okcidenta Europo. Ilustrita Determinlibro. — Bull. Soc. Bot. Centre-Ouest, nouv. sér., num. spéc. 7: 1-893.
- & — 1989: Nelikenigintaj Fungoj Likenogaj. Ilustrita Determinlibro. — Bull. Soc. linn. Provence, num. spéc. 1: 1-142.
- Crovello, T. J. 1981: Quantitative biogeography: an overview. — *Taxon* 30: 563-575.
- Daget, Ph. 1977a: Le bioclimat Méditerranéen, caractères généraux, modes de caractérisation. — *Vegetatio* 34: 1-20.
- 1977b: Le bioclimat Méditerranéen: analyse des formes climatiques par le système d'Emberger. — *Vegetatio* 34: 87-104.
- Egea, J. M. & Llimona, X. 1991: Phytogeography of silicolous lichens in Mediterranean Europe and NW Africa — *Bot. Chron.* 10: 179-198.
- Emberger, L. 1943: Les limites de l'aire de végétation Méditerranéenne en France. — *Bull. Soc. Hist. Nat. Toulouse* 78: 159-180.
- Gleason, H. A. 1922: On the relation between species and area. — *Ecology* 3: 158-162.
- Hafellner, J. 1995: A new checklist of lichens and lichenicolous fungi of insular Laurimacaronesia including a lichenological bibliography for the area. — *Fritschiana* 5: 1-132.
- Johnson, M. P. & Raven, P. H. 1970: Natural regulation of plant species diversity. — *Evol. Biol.* 4: 127-162.
- Kruger, F. J., Mitchell, D. T. & Jarvis, J. U. M. (eds.) 1983: Mediterranean Type Ecosystems. — *Ecol. Stud.* 43.
- Kusan, F. 1953: *Prodromus Flore Lisaja Jugoslavije*. — Jug. Akad. Znanosti i Umjetnosti, Zagreb, 595 pp.
- Leuckert, Ch. & Poelt J. 1978: Über Nord-Süd Gradienten von Chemotypen europäischer Flechten. — *Pl. Syst. Evol.* 130: 53-77.
- Malyshev, L., Nimis, P. L. & Bolognini, G. 1994: Essays on the modelling of spatial floristic diversity in Europe: British Isles, West Germany and East Europe. — *Flora* 189: 79-88.
- Margaris, N. S. & Mooney, H. A. (ed.) 1981: Components of productivity of Mediterranean-climate regions. Basic and applied aspects. — *Tasks Veg. Sci.* 4.
- Nimis, P. L. 1984: Contributions to quantitative phytogeography of Sicily. I. Correlation between phytogeographical categories and environment-types. — *Webbia* 38: 123-137.
- 1993: The Lichens of Italy. An Annotated Catalogue. — *Mus. Reg. Sci. Nat. Torino, Monogr.* 12: 1-897.
- & Bolognini, G. 1993: Quantitative phytogeography of Italian beech forests. — *Vegetatio* 109: 125-143.
- & Poelt, J. 1987: The lichens and lichenicolous fungi of Sardinia (Italy). An annotated list. — *Studia Geobot.* 7, suppl. 1: 1-269.
- & Tretiach, M. 1995: The lichens of Italy. A phytoclimatical outline. — *Cryptog. Bot.* 5: 199-208.
- Poelt, J. 1970: Das Konzept der Artenpaaren bei den Flechten. — *Vortr. Gesamtgeb. Bot.* 4: 187-198.
- & Doppelbauer, H. 1956: Über parasitische Flechten. — *Planta* 46: 467-480.
- Preston, F. W. 1962: The canonical distribution of commonness and rarity. — *Ecology* 43: 186-215.
- Quézel, P. 1978: Analysis of the Flora of Mediterranean and Saharan Africa. — *Ann. Missouri Bot. Gard.* 65: 479-534.
- 1985: Definition of the Mediterranean region and the origin of its flora. — In: Gomez-Campo, C. (ed.): *Plant Conservation in the Mediterranean Area*. — Dordrecht.
- Rivas-Martinez, S. 1987: Memoria del mapa de series de vegetación de España. — Madrid.
- Roux, C. 1991: Phytogéographie des lichens saxicoles-calcicoles d'Europe méditerranéenne. — *Bot. Chron.* 10: 163-178.
- Scheidegger, Ch. 1991: Phytogeography of the genus *Buellia* (*Physciaceae*, *Lecanorales*) in Mediterranean Europe. — *Bot. Chron.* 10: 211-220.
- Seaward, M. R. D. 1976: Performance of *Lecanora muralis* in an urban environment. — In: Brown, D. H., Hawksworth, D. L. & Bailey, R. H. (eds.): *Lichenology, Progress and Problems*. London and New York.
- Tukhanen, S. 1980: Climatic parameters and indices in plant geography. — *Acta Phytogeogr. Suec.* 67.

Address of the author:

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