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RED DATA LISTED HEPATICS OF SCANDINAVIA IN A REGIONAL AND WORLD-WIDE PERSPECTIVE – A PRELIMINARY STUDY

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SUMMARY— The distribution patterns, both within Scandinavia and on a world basis, of the hepatic species on the Red Data Lists of Sweden and Norway are analysed. Separate analyses are made for different habitat types (forests, anthropogenic environments, wetlands, cliffs and outcrops and alpine environments) and distribution types (arctic, alpine, montane, boreal, mediterranean, oceanic and temperate). Most of the hepatics have a wide distribution outside Scandinavia and they are rare in this region only because they represent marginal populations. This is also shown by the occurrence in Scandinavia of hepatic species on Red Data Lists in the Netherlands and in Switzerland.

KEYWORDS— Rarity, habitat type, distribution type, liverworts

ZUSAMMENFASSUNG — Lebermoose der Roten Listen Skandinaviens in regionaler und globaler Sicht – Eine vorläufige Studie

Die Verbreitungsmuster der Lebermoosarten der Roten Listen Schwedens und Norwegens, sowohl in Skandinavien als auch weltweit, werden analysiert. Verschiedene Lebensraumtypen (Wälder, anthropogene Standorte, Feuchtgebiete, Felswände und anstehendes Gestein und alpine Standorte) und Verbreitungstypen (arktisch, alpin, montan, boreal, mediterran, ozeanisch und gemässigt) werden separat abgehandelt. Die meisten Lebermoose haben eine weite Verbreitung ausserhalb Skandinaviens, und sie sind im Gebiet nur deswegen selten, weil es sich um Populationen am Rande des Art-Areals handelt. Dies zeigt sich auch bei skandinavischen Vorkommen von Lebermoosen der Roten Listen der Niederlande und der Schweiz.

Introduction

The majority of the published Red Data Lists are made from a narrow local or national perspective, with little or no attention paid to occurrences in other regions. Often, occurrences in neighbouring regions are not even considered. This has started a debate about which species should be targeted to receive our limited resources, in order to secure their survival (Sjöberg 1993). There are two main views. One view is that we should first try to save the most threatened and the rarest species in each region. These may represent marginal populations that are genetically different from the main population due to genetic drift. Another view is that we should try to save the species that are threatened and/or rare in an international perspective, but which occur with fairly large populations in the particular region, in order to ensure that the species will survive on a world-wide basis. The strategy chosen depends of course on the resources available for conservation. When resources are limited and conservationists have to choose strategies, knowledge of the status and the biology of individual species is needed, both on a local/national level and on a world-wide level.

The aim of this study is to illustrate how the species within two national Red Data Lists are distributed throughout the world, and how frequent they are in different areas. We also attempt to illustrate how Scandinavian hepatics occur on Red Data Lists in nearby areas and the degree to which species of those Red Data lists are rare and/or threatened within Scandinavia. The main questions are: How threatened/rare are the species on the Swedish and Norwegian Red Data Lists in a regional or world-wide perspective? In which habitat types occur species that are rare throughout their range? Which distribution types are best represented among species that are rare throughout their range? How threatened/rare in Scandinavia are species on Red

Data Lists from nearby areas? Is there any difference in which habitat types most of the Red Data Listed species occur in Scandinavia and in nearby areas?

Methods

The hepatics on the Red Data Lists of Scandinavia, i.e. Sweden (Databanken för hotade arter & Naturvårdsverket 1991) and mainland Norway (Frisvoll & Blom 1992) were analysed with respect to world distribution and habitat occurrences. The species are classified into the threat categories Extinct, Endangered, Vulnerable, Care-demanding (species that are not yet rare but dramatically declining and may move into the Vulnerable category if causal factors continue operating) and Rare (species that are not at present Endangered or Vulnerable but are at risk due to stochastic events to the small total populations) following the two Red Data Lists. Note that 'Rare' is here a threat category. In the following text we use the term rare in a loose way including species that are rare both by natural and man-made reasons. See Söderström (1995) for a discussion on the use of the term rare.

A classification into five 'General Rarity Groups' was made. **Rare throughout their range** are those species which we consider rare all over their distribution area. **Not rare in Scandinavia** are species Red Data Listed in one of the two Scandinavian countries, but not in the other, although the species occur in both countries. However, a few species are classified by us as rare in both countries although they are not Red Data Listed in both countries. Most of these are so recently discovered in one of the countries that they were not considered when the Red Data List was prepared. **Not rare in Europe** are those species which are Red Data Listed in Scandinavia but not threatened or rare in some parts of Europe outside Scandinavia. **Not rare outside Europe** are species that are Red Data Listed in Scandinavia and threatened, rare or absent in the rest of Europe but not in some other parts of the world. **Probably not rare in some areas** are species that are Red Data Listed in Scandinavia and of which we had great difficulty to assess the rarity from the literature. They may seem rare everywhere but can also be assumed not to be rare due to insufficient knowledge. Most of these occur in areas not covered by any flora or comparable publication.

The habitat types we used originate from the classification in the Red Data Lists of Sweden and Norway (Databanken för hotade arter & Naturvårdsverket 1991, Frisvoll & Blom 1992) with minor modifications. Five different habitat types (forests, cliffs and outcrops, anthropogenic environments, wetlands and alpine environments) are recognised. Forest species are those dependent on forests or woodlands for their ability to grow, i.e. species living on bark, the forest floor, boulders or stones in woods, etc. Cliff and outcrop species are those living on rocks, outside the alpine region, and species associated with such sites, including alvar ground. Species of anthropogenic environments are those found on farmland or cultivated ground in the widest sense, including towns, etc. Species living on bark on isolated trees (not in woodlands) are also included in this habitat type. All species living on bare soil are placed in this category although they may be partly found in more or less natural habitats. Species of alpine environments are those growing above the tree limit or in very open subalpine woodland. Wetland species are those in water, close to the banks of lakes and rivers, on mires, in springs, etc. Note that a species may occur in as many as three of these categories.

Some of the habitat designations are further divided. Forest species are subdivided according to type of forest (coniferous, deciduous or swampy forests) and substrate (terricolous, epixylic, epiphytic or epilithic). Cliff and outcrop species are separated into those on siliceous versus base rich substrates. Species of alpine environments are separated on basis of substrate types (heathlands, wetlands or cliffs) and wetland species are categorised as shore, mire, or water species.

World distribution data were collected from the literature. The general distribution types used in the study were taken from Düll (1983), with some changes that became apparent after studying distribution maps. We grouped related distribution types into arctic, alpine, montane, boreal, mediterranean, oceanic and temperate.

To see how the Red Data Listed hepatics of other parts of Europe occur in Scandinavia, we analysed the species on the Red Data Lists from Switzerland (Urmi & al. 1992) and The Netherlands (Siebel & al. 1992). These lists were chosen since they are recent, of good quality and represent a lowland and a mountainous country. Hepatic species on these lists were classified with regard to the habitat types they occur in, and to their occurrence in Scandinavia, i.e. absent, rare (but not necessarily Red Data Listed), and not rare.

No statistical analyses are made in this preliminary study, partly because some groups include too few species, and partly due to the preliminary classification of some species.

Results

Of the 87 hepatics which are Red Data Listed in Scandinavia (59 in Norway and 53 in Sweden), 72% are not rare on a world basis, and 41% not rare in Europe (Fig. 1). Grouping of the species by threat category and 'General Rarity Group' shows, for both Sweden and Norway, that Care-demanding hepatics have the lowest proportion (8%) of species that are considered rare world-wide. All other threat categories, with at least ten species, have 28-45% of species rare throughout their range (Fig. 1).

Forest habitats have the smallest proportion (17%) of Scandinavian Red Data Listed hepatics rare throughout their range (Fig. 2). None of the species occurring in deciduous forests (n=6) is considered rare world-wide, while 21% of the species in coniferous forests (n=14) and 23% of epixylic species (n=13) are rare throughout their range (Fig. 3). Of the wetland hepatics included in the Scandinavian Red Data Lists (n=25), 36% are rare throughout their range (Fig. 2) and 66% of those occurring in mires (n=6) are rare throughout their range (Fig. 4). Of the Scandinavian Red Data Listed hepatics occurring on cliffs and outcrops (n=29), 31% are rare throughout their range (Fig. 2), with species of siliceous and base rich cliffs showing the same patterns. Of the Scandinavian Red Data Listed hepatics in anthropogenic environments (n=14), 43% are rare throughout their range (Fig. 2). Many of the Scandinavian Red Data Listed hepatics growing in alpine habitats (42%; n=21) seem to be rare on a world-wide basis (Fig. 2), and the category 'probably not rare in some areas' is also rather large (24%). Taxa of heathlands, wetlands and cliffs in alpine environments showed the same general pattern of rarity.

Suboceanic/oceanic, submontane/montane and subarctic/arctic hepatic species are the most common distribution types among the species on the Red Data Lists. No boreal species, and few temperate (11%; n=9), mediterranean (20%; n=10) and montane (15%; n=27) species are rare world-wide, while a large proportion of arctic (42%; n=21), alpine (33%; n=12) and oceanic (24%; n=46) hepatics are rare throughout their range (Fig. 5).

Only 9% (i.e. six species, *Cephaloziella baumgartneri*, *Cololejeunea minutissima*, *Metzgeria temperata*, *Riccia crozalsii*, *Sphaerocarpos michelii* and *Targionia hypophylla*; nomenclature follows Grolle 1983) of the hepatic species on the Dutch Red Data List (n=67) do not occur in Scandinavia, and 18% of the species are included in the Scandinavian Red Data Lists or considered rare, but as much as 73% are not rare in Scandinavia (Fig. 6). Of the 105 hepatics on the Swiss Red Data List, 28% do not occur in Scandinavia, e.g., *Asterella saccata*, *Lophozia turbinata*, *Oxymitra paleacea* and *Scapania verrucosa*, 28% are Red Data Listed or considered rare, and 44% are not rare in Scandinavia (Fig. 7). In both Switzerland and The Netherlands the anthropogenic environments contain the largest proportion of Red Data Listed hepatics that are rare also in Scandinavia, as well as a large proportion of species absent from Scandinavia. Of the Dutch Red Data Listed hepatics, 85% of the forest species, 74% of the wetland species and 81% of the species on cliffs and outcrops are more or less common in Scandinavia (Fig. 6). Of the Swiss Red Data Listed hepatics, about half the number of species from forests, wetlands and alpine environments (48%, 52% and 48%, respectively) are more or less common in Scandinavia, while many species of cliffs and outcrops (39%) do not occur in Sweden or Norway (Fig. 7).

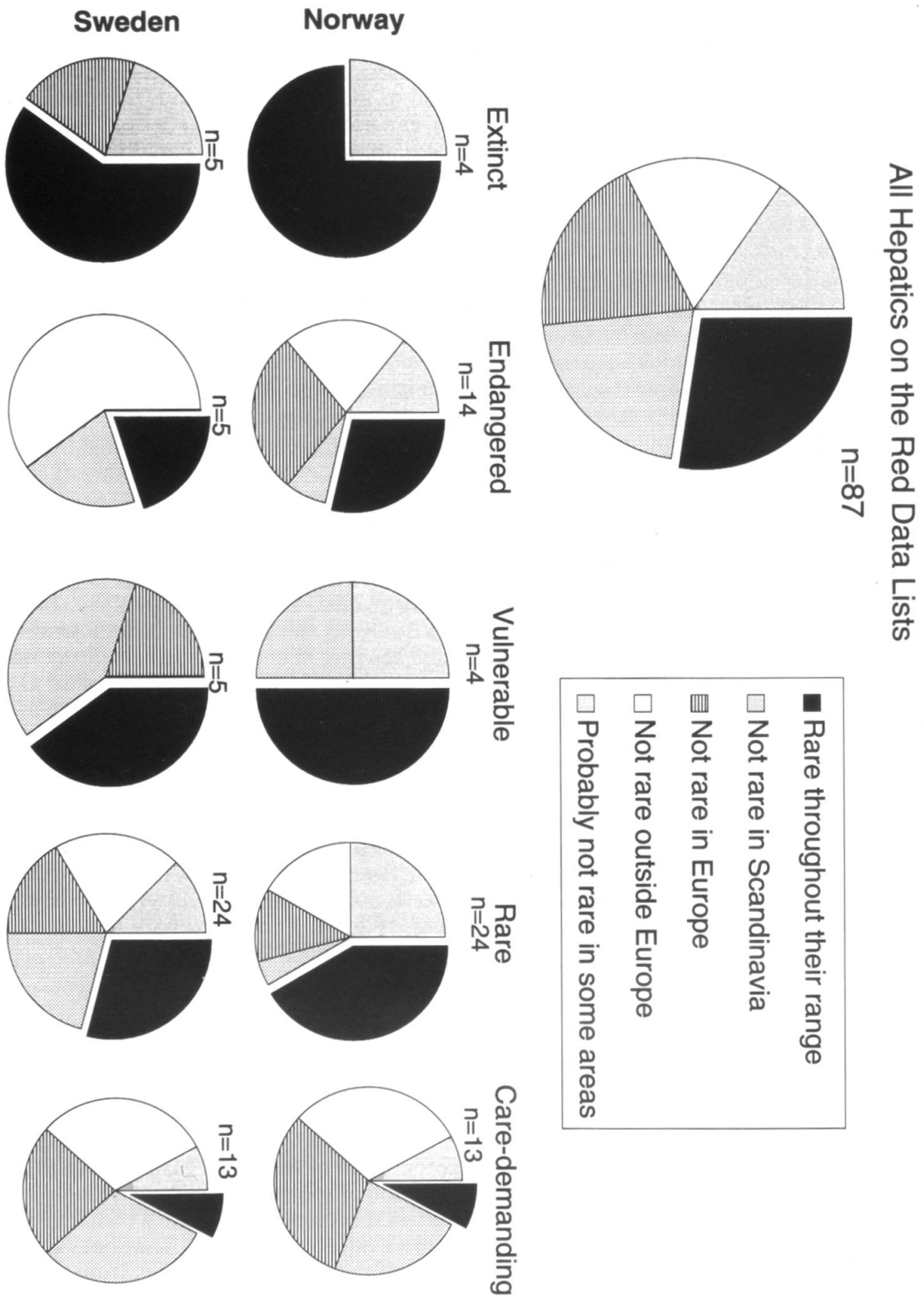


FIGURE 1. Hepatics included in the Scandinavian Red Data Lists classified into 'General Rarity Groups' and compared with their placement in threat categories in Sweden and Norway.

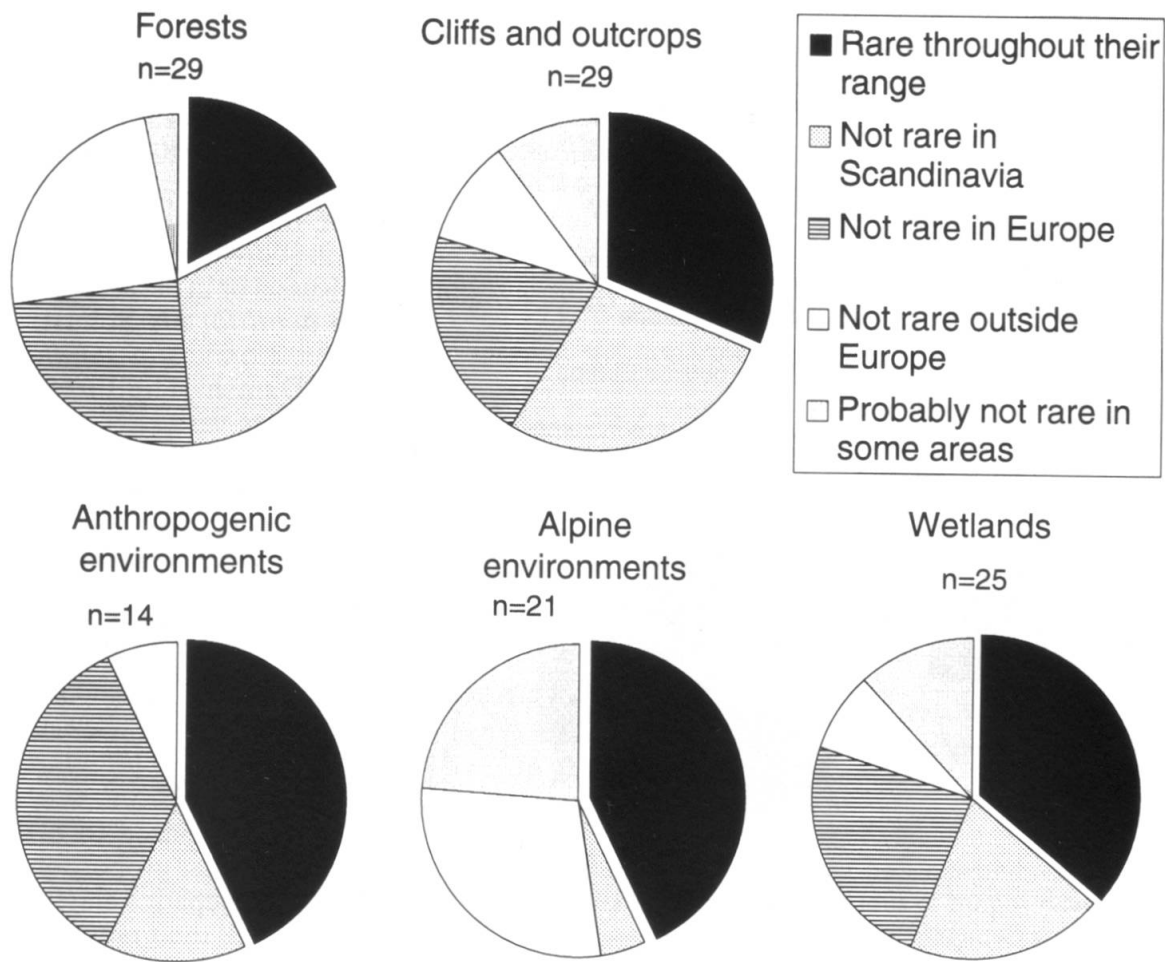


FIGURE 2. Hepatics included in the Scandinavian Red Data Lists separated with regard to their occurrence in habitat types, and classified into 'General Rarity Groups'.

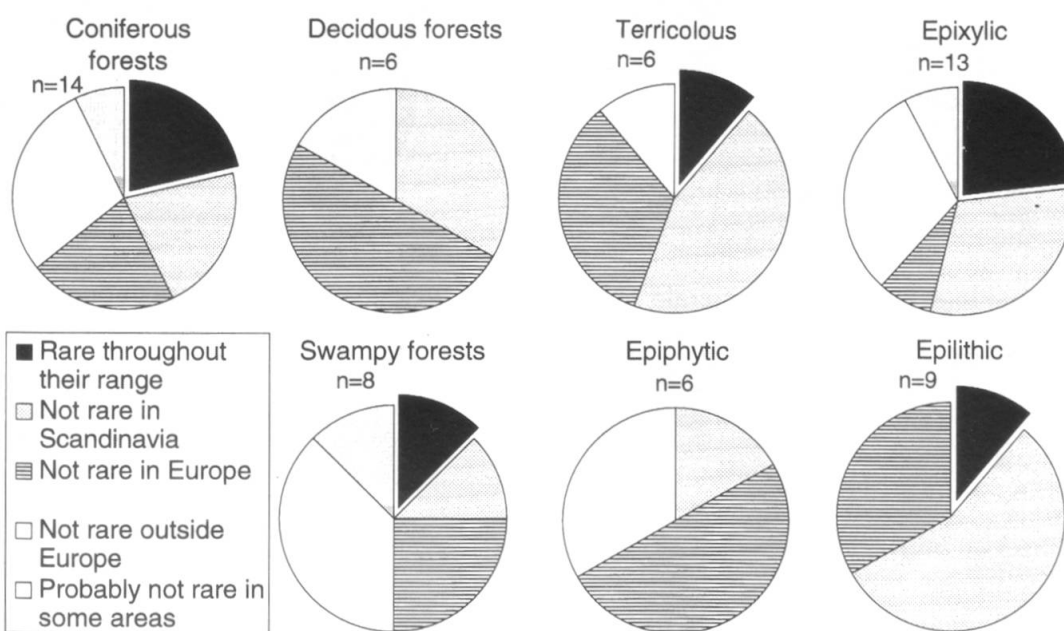


FIGURE 3. Scandinavian Red Data Listed forest hepatics separated with regard to forest types and substrate types, and classified into 'General Rarity Groups'.

Discussion

A surprisingly large portion (28%) of the Scandinavian Red Data Listed hepatics are considered rare throughout their range, e.g., *Anastrophyllum sphenoloboides*, *Cephaloziella phyllacantha* and *Haplomitrium hookeri*. Some of these may, however, turn out to be more common when further investigations are made, especially those occurring in poorly investigated parts of boreal Russia or in the arctic, e.g., *Lophozia debiliformis* Schust. & Damsh. and *Marsupella spiniloba* Schust. & Damsh. The threat to different species varies with threat category but there is no clear linear correlation between degree of threat and threat category. However, Care-demanding species are normally the least rare and those with the least immediate threat of the Red Data Listed species and it is therefore not surprising that many of them occur more commonly in other areas, e.g., *Anastrophyllum hellerianum* and *Cephalozia catenulata*.

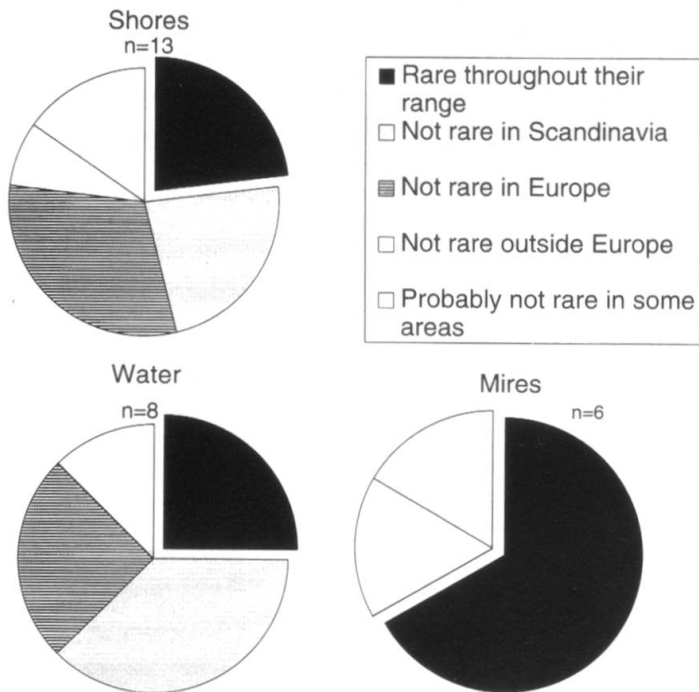


FIGURE 4. Scandinavian Red Data Listed wetland hepatics separated with regard to substrate types, and classified into 'General Rarity Groups'.

Forests have, compared to other habitats, the smallest proportion of Red Data Listed hepatics classified as rare throughout their range. This

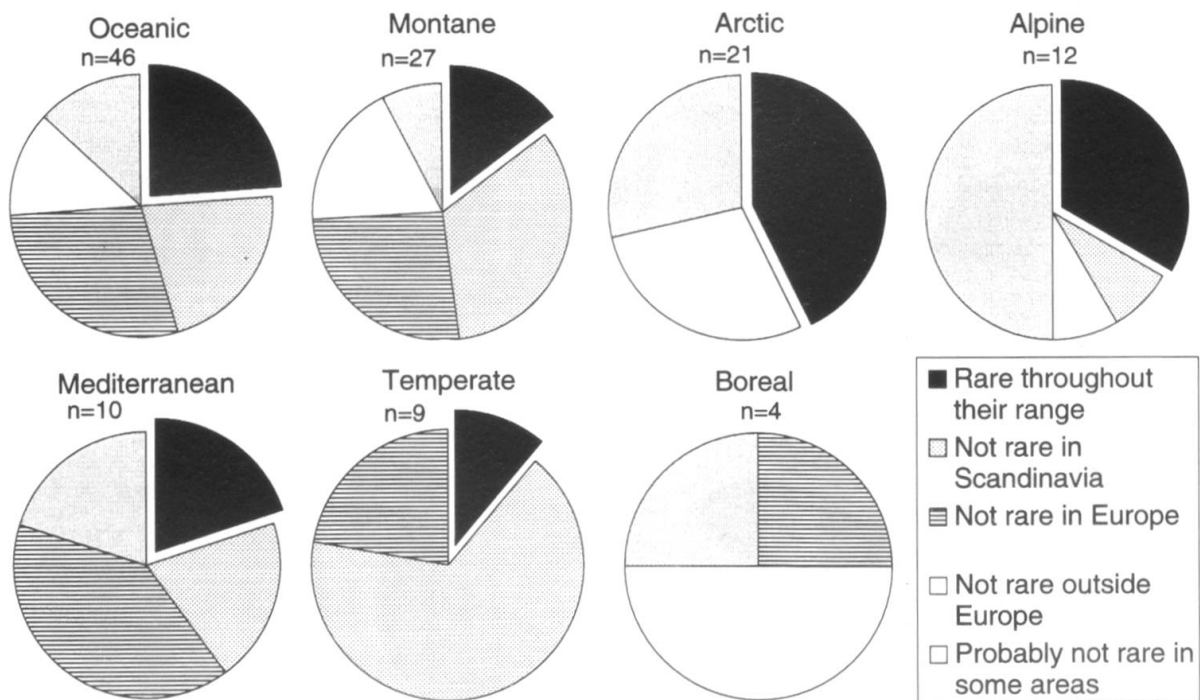
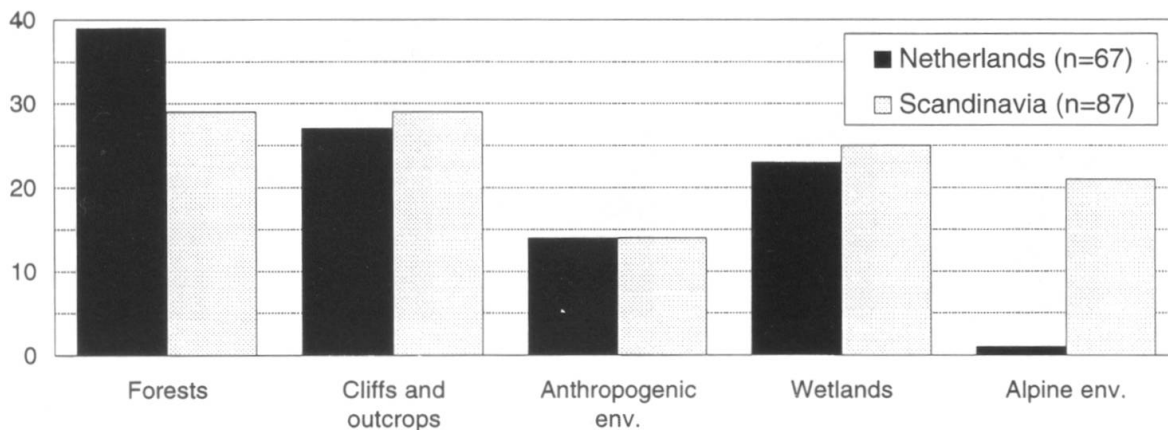


FIGURE 5. Scandinavian Red Data Listed Hepatic species separated with regard to main distribution types and classified into 'General Rarity Groups'.

category consists almost entirely of epixylic species, e.g., *Cephalozia macounii* and *Scapania massalongi*, that are confined to coniferous forests. The most obvious explanation of this is the large forested areas of North America and Russia with similar types of forests and where the remaining natural forests cover much larger areas than in Scandinavia.

Wetlands, especially arctic wetlands, are insufficiently investigated in an international perspective, and therefore the large number of Scandinavian Red Data Listed hepatics considered rare throughout their range might decrease when such habitats are further investigated, e.g., *Jamesoniella undulifolia*, *Lophozia laxa* and *L. elongata*. On the other hand, mires have been

A. Number of hepatic species occurring in different habitat types



B. Occurrence and rarity in Scandinavia of Dutch Red Data Listed hepatics

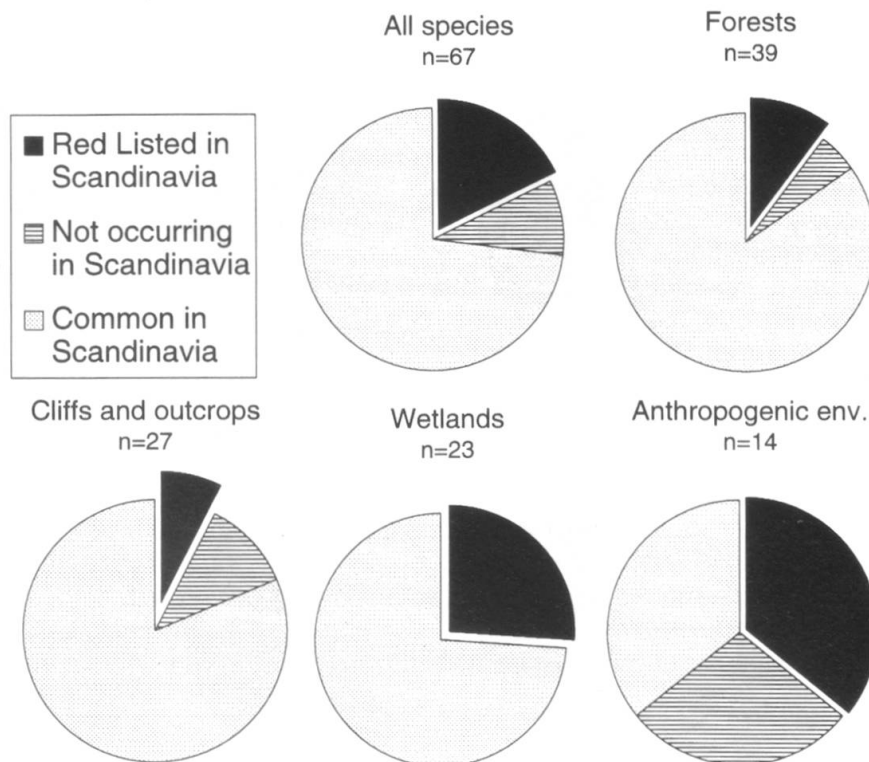
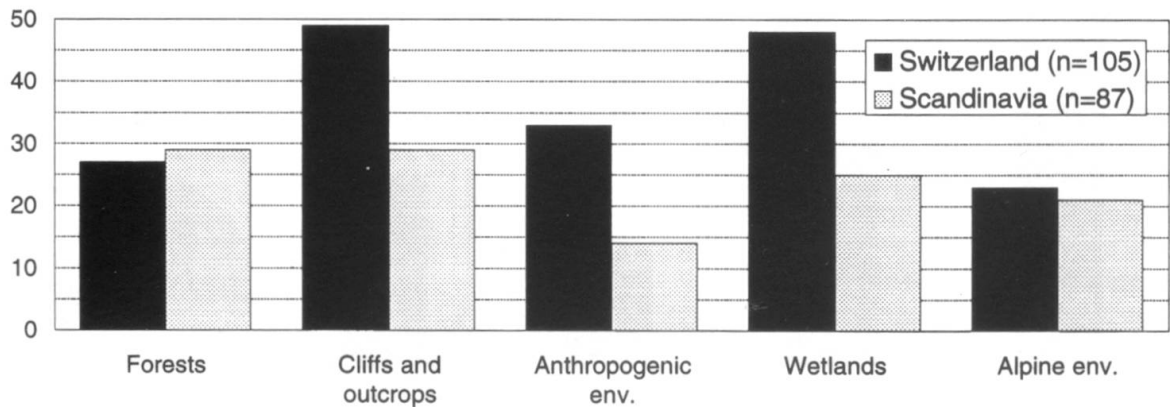


FIGURE 6. A) Number of hepatics included in Red Data Lists of the Netherlands and of Scandinavia, separated with regard to habitat types. B) The occurrence and rarity in Scandinavia of the Dutch Red Data Listed hepatics with regard to habitat types.

cultivated to a very large extent in densely populated areas of Europe and in Central and Western Europe, and the apparent rarity may therefore be a reality for the majority of mire species. Most of the wetland hepatics categorised as 'water species' are connected with waterfalls, e.g., *Herbertus stramineus* and *Kurzia trichoclados*.

Anthropogenic and alpine environments have a larger proportion of species that are rare worldwide than other habitat types. Red Data Listed hepatics of anthropogenic environments are often annual or ephemeral, and have a life cycle with dormant diaspores (sexually or asexually produced) which may serve as potential gametophytes, e.g., *Mannia sibirica*, *Riccia ciliata*

A. Number of hepatic species occurring in different habitat types



B. Occurrence and rarity in Scandinavia of Swiss Red Data Listed hepatics

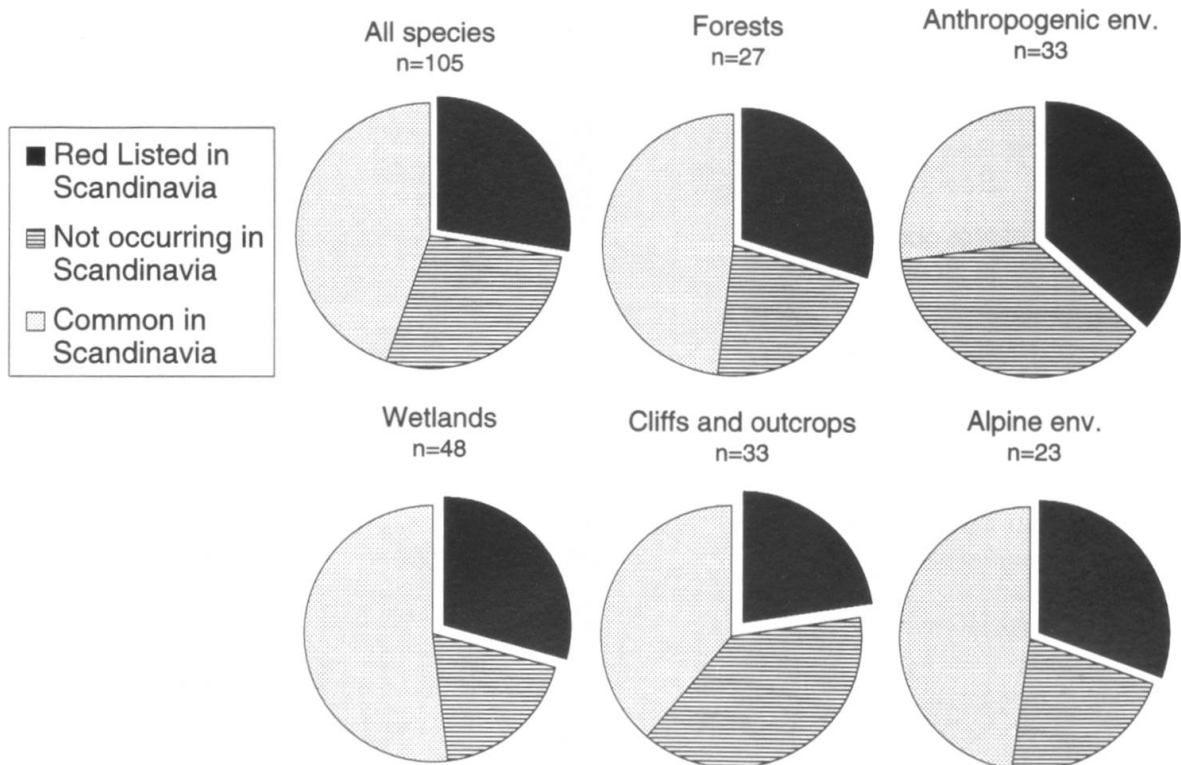


FIGURE 7. A) Number of hepatics included in Red Data Lists of Switzerland and of Scandinavia, separated with regard to habitat types. B) The occurrence and rarity in Scandinavia of the Swiss Red Data Listed hepatics with regard to habitat types.

and *R. huebeneriana*. These species are often difficult to detect due to the short period they occur with mature gametophytes (cf. Söderström 1995). However, in Western Europe and other intensively managed areas, modern management methods, with increased use of pesticides and fertilisers, may be a potential threat to species of this type of environment. Alpine areas are insufficiently investigated and some species may thus turn out to be more common. On the other hand, alpine environments, as well as cliffs and outcrops, consist of more or less small and isolated areas and the populations of species in these habitats are sometimes small. This may be the case for *Cephaloziella grimsulana* and *Lophozia decolorans* in alpine areas, and *Cephaloziella massalongi* and *Lophozia perssonii* on cliffs and outcrops. In smaller habitat patches, species may have disappeared completely and, if dispersal is restricted, recolonisation may not be easily effected. Therefore they will not occur in every patch of potentially suitable environments (cf. the metapopulation dynamic theory, e.g., Hanski & Gilpin 1991).

The oceanic, arctic and montane distribution types are the most well represented ones among Scandinavian Red Data Listed hepatics. Scandinavia (or most of it) lies outside or on the edge of the oceanic and arctic zones and many of the oceanic and arctic species may just barely reach the area, e.g., *Cryptocolea imbricata*, *Fossombronia pusilla* and *Lejeunea ulicina*. Since arctic environments are so poorly investigated, the proportion of arctic species rare throughout their range is comparably large, but it will almost certainly decrease with further investigations, e.g., in arctic Russia. The number of montane species on the Scandinavian Red Data Lists is large, since species regarded as montane in Europe are well represented in Scandinavia. These species also occur quite often in lowland areas of Scandinavia, e.g., *Calypogeia suecica*. The boreal zone covers most of Scandinavia and this is the most probable explanation as to why so few boreal hepatics occur on Red Data Lists of Sweden and Norway (only *Anastrophyllum hellerianum*, *Calypogeia azurea*, *Frullania bolanderi* Aust. and *Gymnocolea acutiloba*). Most of the Scandinavian Red Data Listed hepatics with a temperate distribution type are only on the Norwegian list. The temperate zone is more extensive in Sweden, and the species are therefore usually more or less common there, e.g., *Anthoceros agrestis*, *Mannia fragrans*, *Riccia fluitans* and *Ricciocarpos natans*.

The Scandinavian hepatic flora contains many species that are threatened or rare in other parts of Europe. For example, 91% of the Dutch Red Data Listed species and 72% of the Swiss Red Data Listed species occur in Scandinavia. Many of these species are quite common, or at least not threatened, in Scandinavia. In the Netherlands, forests and cliffs are rare and many of the hepatic species in those habitats may occur in very small populations. A large proportion of the hepatics confined to those habitats are thus Red Data Listed only because the habitat is so rare. Such habitats are much more common in Scandinavia and the species are therefore mostly abundant. In Switzerland, forests and cliffs are rather common and the number of Swiss Red Data Listed hepatics that are not rare in Scandinavia is therefore smaller compared to the Netherlands (45 and 73% respectively). Anthropogenic environments are much more common in Central Europe than in Scandinavia with many species showing a southern distribution. The Red Data Listed anthropogenic hepatics in the Netherlands and Switzerland are therefore mostly rare or lacking in Scandinavia.

In conclusion, this preliminary investigation shows that although many Red Data Listed species are rare all over their distribution range, the majority is not. A common phenomenon is that species are rare in a region (and thus included in Red Data Lists) because this region is at the margin of the species' distribution range and/or their habitats are rare. Such species are common in other areas. This phenomenon is shown both by analysis of world occurrence of Scandinavian Red Data Listed species and of the occurrences in Scandinavia of species Red Data Listed in other regions.

Acknowledgements

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