

ARE THERE ENDEMIC VASCULAR PLANTS IN WET HABITATS OF EUROPE?

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ABSTRACT

We extracted a list of vascular plant taxa associated with damp, wet and inundated environments from the database EvaplantE. At least 339 taxa which are endemic to Europe occur regularly in wet habitats. 103 of these are relatively closely associated and 236 are less closely associated with such habitats. 80 taxa are mainly associated with other habitat types but a minority of their populations also occurs under wet conditions. Only a few of the 339 taxa are hydrophytes which live in lakes or rivers. Far more taxa occur in habitats such as river banks or slopes in the surroundings of springs or waterfalls.

The distribution patterns of endemics associated with wet habitats show a relatively high diversity in Central and Western Mediterranean regions, the Alps and Atlantic regions and small numbers of endemics to the East of Europe. We did not find a clear north-south gradient with high numbers of endemics in the Canaries, Madeira Archipelago and Mediterranean and low numbers in Scandinavia and northern Russia.

Compared to rocks and screes, grassland, scrubs and heaths, or forests the number of endemics associated with wet habitats in Europe is low. We assume that this is due to the separation of water bodies in combination with the young age of wetlands and the low ecological continuity across wetland localities.

Absolute numbers of endemics in a region can be used as a measure for the responsibility in the framework of international nature conservation policies.

ZUSAMMENFASSUNG: Gibt es endemische Gefäßpflanzen in europäischen Feuchtgebieten?

Die hier vorgelegte Analyse bezieht sich auf für Europa endemische Gefäßpflanzen, die eine Affinität zu Süßwasserhabitaten oder anderen nassen bzw. feuchten Standorten aufweisen, oder auf diese beschränkt sind. Eine aktuelle Auswertung von EvaplantE ergab, dass mindestens 339 Taxa zu den für Europa endemischen Pflanzen nasser oder (wechsel) feuchter Standorte gehören. Etwa 103 von ihnen weisen eine enge Bindung, 236 eine weniger enge Bindung an derartige Standorte auf. 80 Taxa erscheinen zwar regelmäßig auch an feuchten Standorten, diese Sippen haben jedoch ihren Verbreitungsschwerpunkt in anderen terrestrischen Lebensräumen. Nur bei wenigen Taxa handelt es sich um Hydrophyten im engeren Sinne, d.h. um Besiedler der Wasserkörper von Flüssen oder Seen.

Das Bild der geographischen Verbreitung von Endemiten mit Affinität zu Feuchtstandorten im weitesten Sinne zeigt eine relativ große Diversität in den Regionen des zentralen und westlichen Mittelmeerraumes, den Alpen und in den atlantischen Gebieten.

Beide Gruppen weisen einen weniger ausgeprägten Nord-Süd-Gradienten auf als die Vertreter anderer Habitatgruppen, bei denen erwartungsgemäß das Zentrum der Endemiten im Mittelmeerraum, bzw. auf den Kanaren und den Inseln des Madeira-Archipels liegt.

Im Vergleich zu den Bewohnern von Fels- und Schuttfluren, Grasland, Gebüsch und Heiden, oder auch Wäldern in Europa ist die Zahl der Endemiten mit einer Affinität zu Feuchtgebieten vergleichsweise gering. Dies hängt möglicherweise mit der starken Isolation der einzelnen Feuchtgebiete in Kombination mit dem niedrigen Alter der meisten Still- und Fließgewässer in Europa und der geringen ökologischen Kontinuität innerhalb der Feuchtgebiete zusammen.

Die absolute Zahl der Endemiten kann als Maßstab für die relative Bedeutung einer Region und die Verantwortung der Zuständigen im Zusammenhang mit internationalen Naturschutzbestrebungen verwendet werden.

REZUMAT: Există oare plante vasculare endemice în zonele umede ale Europei?

Am extras o listă de plante vasculare care prezintă o afinitate spre habitate de apă dulce sau alte stațiuni umede, prin baza de date EvaplantE. Cel puțin 339 taxoni ai plantelor endemice din Europa aparțin celor legate de habitate de stațiuni umede. Dintre acestea aproximativ 103 taxoni sunt relativ strâns legați de zone umede, iar 236 au o afinitate mai puțin strânsă spre astfel de stațiuni. 80 de taxoni apar în mod frecvent și în astfel de locuri, având însă punctul de greutate în răspândirea lor în alte habitate terestre. Doar la un număr redus de taxoni este vorba de hidrofitie în sens strict, adică de plante legate de corpul apelor curgătoare sau de lacuri. De departe mai mulți taxoni apar în habitate cum ar fi malurile râurilor sau pantele din jurul izvoarelor sau cascadelelor.

Imaginea răspândirii geografice a endemitelor cu afinitate spre stațiuni umede în sens larg prezintă o diversitate relativ mare în regiuni ale spațiului mediteranean central și vestic, în Alpi și în zonele atlantice și o diversitate redusă a endemitelor în partea de est a Europei. Nu am găsit un gradient nord-sud clar, cu un număr mare de endemite în Canare, Madeira și zona mediteraneană și un număr redus în Scandinavia și nordul Rusiei.

În comparație cu habitate de stâncării și grohotișuri, de pajiști, tufărișuri sau de păduri din Europa, numărul endemitelor cu afinitate spre zone umede este relativ redus. Acest fapt ar putea fi în legătură cu izolarea diferitelor habitate umede în combinație cu vârsta scăzută a majorității habitatelor umede și a continuității ecologice reduse în zonele umede.

Numărul absolut al endemitelor într-o regiune poate să servească drept reper pentru responsabilitatea factorilor de decizie în relație cu strădaniile politicilor internaționale de conservare a naturii.

INTRODUCTION

Since De Candolle (1820; cf. also Rabitsch and Essl 2007) defined the term endemism in a biogeographical context, growing attention has been paid to the phenomenon and the meaning of endemism, in the international nature conservation policies. However, the relationship between endemism and habitat is a relatively new topic in vegetation science.

Perhaps Rikli (1943, 1946) was the first biogeographer who wrote a chapter about the habitats of endemic vascular plants. For the Mediterranean Basin and the surrounding regions, he described plant endemism in relation to rocky habitats, coastal habitats, garigue, semi-desert and desert, but not freshwater habitats, swamps or other wet habitats.

Few publications were found which dealt exclusively with endemics of wet habitats. Davis et al. (1997), for example, examined the Vernal Pools of California which harbor around 140 endemics in ephemeral freshwater communities and related vegetation types.

In Europe, at least 101 endemic vascular plant taxa inhabit bogs, mires, and fens, 255 occur on the lake shores, on river banks and in other freshwater-connected habitats (Hobohm and Bruchmann, 2009). 42 of the endemic vascular plant species or subspecies are relatively closely associated with mires. They comprise calciphilous and acidophilous taxa and representatives of lowlands and mountain areas (Hobohm, 2008b). In contrast to the distribution of endemic vascular plants of Europe as a whole (with high concentrations in the Mediterranean and only a few taxa in the north), inhabitants of moors are concentrated in the west of Europe.

For New Zealand, a figure of 264 endemic species is given for wetlands (McGlone et al., 2001). This relatively high number for an area which is much smaller than Europe might be explained by less marked effects of Pleistocene glaciations, higher precipitation rates, and the higher proportion of wetland areas in New Zealand in general (Davis et al., 1994, 1995). For the swamp habitats and other freshwater wetlands of the Nile Delta in Egypt, McGinley (2008) gives eight endemic species (of a total of 553 plant species).

Information about single endemic plants and their habitats can be found on some websites (cf. Red List data of the IUCN, www.iucnredlist.org) and many regional floras.

However, only few comprehensive analyses on endemic vascular plant taxa deal with lakes, rivers, bogs, mires, swamps, or other aquatic habitats. We hypothesize that the proportion of endemics in wetlands is indeed relatively low because of the natural vulnerability of the habitats which can still be considered almost young.

Here, we focus on the endemic vascular plants of standing and running water, including e.g. ponds, springs, wet stream sides, river-banks (also those with summer-dry pioneer-vegetation on sandy or gravelly banks), bogs, mires and fens, including moorland, swamps, etc.

The aim of our analysis is to give an overview of endemic vascular plant taxa in wetlands and other wet habitats in Europe, to estimate the number of wetland endemics in Europe, and to characterize the ecology and distribution patterns of these plants in comparison with endemics of other habitat types. Furthermore, we want to underline the need to relate nature conservation efforts in Europe.

MATERIALS AND METHODS

For the purposes of assessing endemism, Fontain et al. (2007) and Tutin et al. (1996) divided Europe into regions which represent nations, groups of small nations or, in the case of Russia, parts of a nation, islands or groups of islands (Hobohm and Bruchmann, 2009; Figs. 1 and 2). Using a GIS analysis Bruchmann (2011) found the following area sizes for the 42 respective regions: Albania (28,657 km²), Austria with Liechtenstein (84,128 km²), the Azores (2,569 km²), Belgium with Luxembourg (33,235 km²), the Balearic Islands (5,100 km²), Great Britain with the Orkneys, Zetland and the Isle of Man (230,790 km²) and excluding Northern Ireland and the Channel Islands, Bulgaria (111,024 km²), Canary Islands (7,556 km²), Corsica (8,780 km²), Crete with Karpathos, Kasos and Gavdhos (8,508 km²), Cyprus (9,138 km²), former Czechoslovakia (127,692 km²), Denmark (42,714 km²), the Faroe Islands (1,484 km²), Finland including Aaland Islands (335,313 km²), France with the Channel Islands (539,527 km²) and excluding Corsica, Germany (357,251 km²), Greece without Crete (121,564 km²), Ireland (the whole island; 83,924 km²), Switzerland (41,493 km²), The Netherlands (35,549 km²), Spain with Gibraltar and Andorra (excluding the Balearic Islands; 494,053 km²),

Hungary (93,002 km²), Iceland (102,962 km²), Italy without Sardinia and Sicily (25,0631 km²), former Yugoslavia (255,252 km²), Portugal (88,573 km²), Madeira (774 km²), Switzerland (41,493 km²), Norway (excluding Svalbard and Jan Mayen; 320,915 km²), Poland (311,695 km²), Romania (237,396 km²), the northern division of European Russia (1,463,824 km²), the Baltic division (189,125 km²), the central division of Russia (1,625,765 km²), the south-western division (605,414 km²), Ukraine the Crimean Peninsula (25,831 km²) and the south-east of European Russia (953, 366 km²), Sardinia (24,099 km²), Svalbard comprising Bear Island and Jan Mayen (62,912 km²), Sicily plus Malta (25,726 km²), Sweden with Öland and Gotland (446,070 km²) and the European part of Turkey at Imroz (23,877 km²).

The database (EvaplantE; cf. Bruchmann and Hobohm, 2010; Hobohm and Bruchmann, 2009; Hobohm, 2008a) contains information about most endemic vascular plant taxa in Europe. Like a phone-book, such a list will never be complete and changes are still in progress. In general, we use a relatively broad term of what a species or subspecies is.

The database distinguishes between eight habitat groups, two of which contain most plants which live under more or less wet conditions: 1. freshwater habitats, comprising standing and running waters, including e.g. ponds, minerogene springs, wet stream sides, river banks and also wet to dry pioneer-vegetation on river banks etc. (in the following we call this group freshwater habitats s. l.), 2. bogs, mires, fens, swamps, including moorland, swamp-springs, wet or regularly inundated grassland etc. (in the following: mires s. l.). There is a wide overlap between both groups and therefore, many taxa are listed in both groups. Coastal habitats, like salt marshes or rocky habitats near the ocean, were excluded from this analysis.

We reduced and analyzed the recent version of the database (EvaplantE; version 12/2010) with a focus on plants living under wet conditions or in the succession stages following inundation. The analysis is founded on descriptive statistics. As a first step, we summed up numbers of families, species and subspecies for the whole of Europe, and numbers of species and subspecies per region. The number of endemics can be used as an important indicator or measure for international nature conservation policies and efforts (cf. Convention on Biological Diversity, Mittermeier et al., 2005).

Because the regions vary in size certain statistical methods cannot be applied. On the other hand, it is currently impossible to obtain serious numbers of European endemic vascular plant taxa per artificially defined grid cell.

Several regions are of similar size with a difference of less than 10% between the smaller and the larger region. This is the case for the central and northern part of European Russia, mainland France and mainland Spain, Finland, Norway and Poland, the states of former Yugoslavia, Italy, Romania and Britain, Czechia plus Slovak Republik and Greece (without Crete), Greece and Bulgaria, Bulgaria and Iceland, Iceland and Hungary, Hungary and Portugal, Austria and Ireland, Denmark and Switzerland, the Netherlands and Belgium plus Luxemburg, Ukraine in the Crimean Peninsula, Sicily plus Malta, Sardinia and the European part of Turkey, with Cyprus, Crete and Corsica. If we compare the number of regions with a similar area size or the same number of taxa, we can use these values as direct measurements for the density of endemics. The density of endemics in a particular region is also higher than in another one if the region is smaller and the number of endemics higher; we can thus make direct comparisons for very many pairs of regions. To estimate distribution patterns and altitudinal ranges we calculated absolute numbers and median values.

We then compared, qualitatively and semi-quantitatively, ecological conditions and distribution patterns for freshwater and wetland endemics in Europe with numbers of taxa associated with other habitats.

RESULTS AND DISCUSSION

The database EvaplantE comprises at least 339 plant taxa – species and subspecies – which occur more or less regularly in wetland communities (appendix). All of these are restricted to the boundaries of Europe, as defined in Fontain et al. (2007). This number is a minimum value because more than 20% of the listed taxa in EvaplantE have not yet been characterized in relation to ecological conditions and habitat.

However, some 103 taxa on the list are more or less closely associated with wetlands. This means that they do not normally occur in other habitat types such as rocky habitats, grasslands, scrub or heath communities, forests, saline habitats, ruderal places, urban habitats or arable land. Only few of them are hydrophytes living in standing or running waters. The other 236 taxa occur in both wetlands and other habitats. Some (c. 80) live secondarily in wetlands and primarily in other terrestrial habitats (appendix and Tab. 1).

Table number 1 illustrates the range of wet habitat types with examples of endemic vascular plants in different parts of Europe. The lists in the appendix and in the table number 1 show that hydrophytes associated with shallow standing or running waters are a minority. Most plant taxa are hemicryptophytes with a more or less strong affinity to wet conditions but not absolutely connected to open water bodies.

The largest systematic group is the family Asteraceae with 49 endemic taxa. This family is one of the two largest families in the world. The other is Orchidaceae, which has its main distribution in the tropics and subtropics; Asteraceae species occur mainly in the subtropical and temperate zones. Both families are characterized by a large proportion of wind-dispersed and insect-pollinated taxa. Further large families are Rosaceae (22), Brassicaceae (21), Scrophulariaceae (20), Apiaceae (19), Ranunculaceae (18), Poaceae (17), Cyperaceae (16), Caryophyllaceae (14), Orchidaceae (13), Liliaceae (12). All other families comprise only 10 or fewer endemic taxa.

Figure number 1 shows distribution patterns of endemic vascular plants associated with freshwater habitats s. l., figure number 2 shows patterns of endemics associated with mires s. l.; the numbers in the south-west of Europe are higher than in the north-east. For taxa associated with freshwater habitats, s. l. the numbers in a triangle-shaped region between Spain, former Yugoslavia and Germany are much higher than in the rest of Europe. The highest absolute numbers of taxa associated with freshwater habitats s. l. were found in France and Spain. Austria, Italy and Germany also have high numbers (Fig. 1). The highest numbers of taxa associated with mires s. l. were found for France, Germany, Spain and Italy. Austria, former Yugoslavia and Great Britain all have the same number of taxa (Fig. 2). The numbers for freshwater-associated taxa are normally higher than for mires (Fig. 2). Some Atlantic, Baltic and northern regions such as the Faroe Islands, Azores, Ireland, the Baltic countries, Finland and northern Russia present similar values for both groups.

The comparison of regions with a similar area or number of taxa or with different area sizes but obviously higher densities shows that the concentration of endemism increases in most cases from the north-east to the south-west, but also from the Atlantic islands in the west to a region comprising France and neighboring countries, with the highest values for freshwater-related taxa s. l. more to the SE of Europe and for mires-associated taxa s. l. more to the temperate and Atlantic zone of the mainland in West Europe.

Table 1: Examples of European vascular plants which occur in wetlands.

Habitat types	Examples of endemic vascular plants (area within Europe)
Shallow standing or slow running waters, ponds, ditches, lake margins	<i>Apium inundatum</i> (Central and W Europe), <i>Baldellia alpestris</i> (Iberian Peninsula), <i>Callitriche brutia</i> (S, W and NW Europe), <i>Callitriche hamulata</i> (W, Central and N Europe), <i>Isoetes boryana</i> (France), <i>Isoetes setacea</i> (France, Spain, Portugal), <i>Ranunculus hederaceus</i> (W Europe), <i>Ranunculus revelieri</i> (Corsica, Sardinia, mainland France)
More or less rapid flowing waters, e.g. small rivers or irrigation channels	<i>Isoetes longissima</i> (Spain), <i>Isoetes malinverniana</i> (Italy), <i>Ranunculus fluitans</i> (many regions in Europe)
Banks of tidal rivers	<i>Angelica heterocarpa</i> (France), <i>Oenanthe conioides</i> (Germany), <i>Deschampsia wibeliana</i> (Germany)
Seasonally flooded or wet places, including seasonal pools, wet river banks, lake shores, sands or rocky ground	<i>Agropyron tanaiticum</i> (Central and E Europe), <i>Allium schmitzii</i> (Portugal), <i>Angelica razulii</i> (Iberian Peninsula), <i>Arenaria gothica</i> (Sweden, Switzerland?), <i>Centaurea margaritacea protogerberi</i> (E Europe), <i>Cyperus cyprius</i> (Cyprus), <i>Goniolimon graminifolium</i> (SW of former USSR), <i>Scrophularia trifoliata</i> (Corsica, mainland Italy, Sardegna), <i>Thorella verticillato-inundata</i> (France, Spain, Portugal), <i>Tragopogon floccosus</i> (Central Europe), <i>Verbascum banaticum</i> (E and SE Europe)
Seasonally inundated, wet or moist meadows and pastures	<i>Achillea asplenifolia</i> (Central Europe), <i>Alchemilla coriacea</i> (Alps and Iberian Peninsula), <i>Anthericum baeticum</i> (Spain), <i>Armeria arcuata</i> (Portugal), <i>Asparagus pseudoscaber</i> (Central Europe)
Moors, bogs, fens, swamps, marshes	<i>Allium suaveolens</i> (Central and S Europe), <i>Armoracia macrocarpa</i> (Danube Basin), <i>Aristolochia rotunda insularis</i> (Mediterranean), <i>Calamagrostis scotica</i> (Great Britain), <i>Dactylorhiza incarnata pulchella</i> (Ireland, Great Britain), <i>Dactylorhiza pseudocortigera</i> (Norway, Sweden), <i>Dactylorhiza sphagnicola</i> (W Europe), <i>Tofieldia calyculata</i> (many regions of Europe)
Shaded rocks and slopes near streams, humid and wet places close to springs, waterfalls or crater lakes, damp shady places and watercourses in woods, along orchards or on banks, woodland along rivers	<i>Arabis kennedyae</i> (Cyprus), <i>Carex lowei</i> (Madeira), <i>Centaureum microcalyx</i> (Iberian Peninsula), <i>Chrysosplenium oppositifolium</i> (S and W Europe), <i>Dryopteris aitoniana</i> and <i>D. maderensis</i> (Madeira), <i>Malus praecox</i> (Central and E Europe), <i>Syringa josikaea</i> (Carpathian mountains), <i>Soldanella pindicola</i> (Greece), <i>Trichomanes speciosum</i> (S and W Europe), <i>Veronica dabneyi</i> (Azores), <i>Sibthorpia peregrina</i> (Madeira, Portugal mainland), <i>Vaccinium padifolium</i> (Madeira)

For 203 of the 339 taxa in EvaplantE we obtained values for the altitudinal range. These taxa occur at all altitudes between sea level and the alpine zones. The average of the minima (median) is 300 m a.s.l., the average of the maxima 1,800 m a.s.l. This means that most endemics occur in the montane and not in the alpine zones (cf. Körner, 2002). *Gentiana bavarica* is found in damp places, e.g. moors with spring waters, wet alpine meadows, and snow-patches. This species represents the absolute maximum of 3,600 m a.s.l. in our list.

47 endemics are basiphytes, 39 acidophytes. Many species are indifferent to pH or not yet characterized.

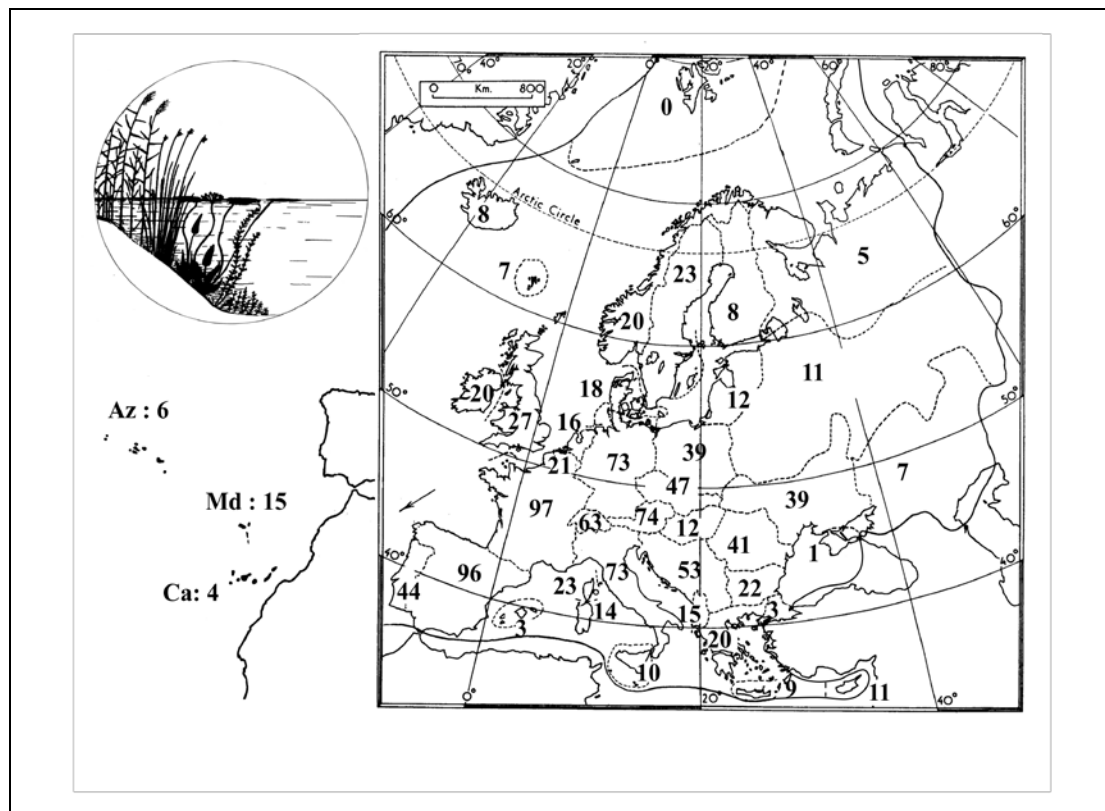


Figure 1: Numbers of European endemic vascular plants which are associated with freshwater habitats s. l. in different regions of Europe (see text).

Our database is still incomplete. Approximately 20% of the taxa in EvaplantE are not characterized with respect to ecological conditions or habitat type. This means that the number of wetland endemics which we present here is a minimum number. We do not yet have all minimum and maximum for the altitudinal ranges, and we also assume that further information will alter our knowledge of the geographical distribution in some cases. Furthermore, molecular-genetic analyses have caused many systematic-taxonomical corrections in recent years. On the other hand, we do not have in present any indications or information from the scientific literature that could contradict the described tendencies.

The number of endemics in wetlands (339) is relatively low compared to endemics of rocky habitats and screes (2,756), grasslands (1,293), scrubs and heaths (1,107), or forests (761) (Bruchmann and Hobohm, 2010). The high endemism is generally related to the size of the respective area, age of the geological surface, ecological continuity, habitat diversity and richness of the species pool. Other parameters such as light, warmth or low productivity has also been discussed as factors promoting the richness of endemics in tropical rainforests, Mediterranean regions and high mountain zones (Jansson, 2003; Körner, 2002; Gaston, 1996; Huston, 1994; Latham and Recklefs, 1993). The separation-isolation factor both promotes and limits endemism. Genetic isolation is the precondition for speciation, and geographical separation promotes genetic isolation. On the other hand,

the richness of the species pool is also a precondition for speciation processes. The more the species in a region the more opportunities for speciation process. Distance and boundaries reduce dispersal opportunities, with the effect that islands at a far distant from the continents have relatively small numbers of species (cf. Kreft and Jetz, 2007; Kreft et al., 2007; Hobohm, 2000).

We assume that the relatively small number of endemics of wet habitats compared to other habitat types in Europe is due to the small total area size of the relating habitats, to the separation in combination with the young age of most habitats and low ecological continuity during different climate periods within the late Pleistocene and Holocene (Pott, 2010; Hobohm and Bruchmann, 2009).

The highest numbers, in absolute terms, of vascular plant endemics with an affinity to wet habitats (both groups) are found in France, with high concentrations of endemics in France and/or neighboring countries. We assume that this fact reflects a combination of conditions which favor endemism in general but especially in wet habitats. The area size of mainland France is much larger than e.g. Great Britain, Belgium plus Luxembourg, the Netherlands or Denmark. France is located within and between two high mountain ranges, the Pyrenees and the Alps. The country is also located between two marine environments which influence and stabilize climate. Therefore, three major climate regimes occur in France: Mediterranean, Atlantic and high-mountain climate. The mainland of France is connected with other species-rich regions – e.g. Iberian Peninsula, the Alps, Italy and some of the relict areas of glaciations periods are either part of the country or not far away.

All these factors together might explain the high numbers of European endemic vascular plant taxa associated with wet habitats in France and neighboring countries (Rull, 2004; Rosenzweig, 1995). However, this cannot easily be verified at the moment.

CONCLUSIONS

The distribution patterns of endemic vascular plant taxa in Europe differ depending on the habitat group to which they belong. Endemics associated with wetlands occur all over Europe with higher numbers to the west and south-west and at altitudes between sea level and 3,600 m a.s.l. As compared to the rocky habitats, grassland and forest, the wet habitats harbor a relatively small number of endemics.

The absolute number of endemics can be used as a measure for the responsibility in the framework of the international nature conservation policies.

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APPENDIX

Preliminary list of plants which are endemic to Europe and associated with wet habitats (according to the recent version of EvaplantE, December 2010).

<i>Achillea asplenifolia</i>	<i>Bellis bernardii</i>
<i>Achillea oxyloba</i>	<i>Bellium bellidioides</i>
<i>Aconitum napellus</i>	<i>Betula pubescens celtiberica</i>
<i>Aconitum variegatum variegatum</i>	<i>Brachypodium firmifolium</i>
<i>Agropyron tanaiticum</i>	<i>Brassica glabrescens</i>
<i>Alchemilla anisiaca</i>	<i>Bupthalmum salicifolium</i>
<i>Alchemilla coriacea</i>	<i>Calamagrostis purpurea pseudopurpurea</i>
<i>Alchemilla decumbens</i>	<i>Calamagrostis scotica</i>
<i>Alchemilla demissa</i>	<i>Callitriche brutia</i>
<i>Alchemilla filicaulis</i>	<i>Callitriche hamulata</i>
<i>Alchemilla fissa</i>	<i>Callitriche lusitanica</i>
<i>Alchemilla incisa</i>	<i>Callitriche platycarpa</i>
<i>Alchemilla inconcinna</i>	<i>Callitriche truncata</i>
<i>Alchemilla pallens</i>	<i>Calycocorsus stipitatus</i>
<i>Alchemilla pseudincisa</i>	<i>Campanula herminii</i>
<i>Alchemilla pyrenaica</i>	<i>Campanula pulla</i>
<i>Alchemilla reniformis</i>	<i>Cardamine asarifolia</i>
<i>Alchemilla straminea</i>	<i>Cardamine pratensis crassifolia</i>
<i>Alchemilla tenuis</i>	<i>Cardamine pratensis granulosa</i>
<i>Alchemilla undulata</i>	<i>Cardamine pratensis rivularis</i>
<i>Alchemilla versipila</i>	<i>Cardamine raphanifolia raphanifolia</i>
<i>Alchemilla xantho-chlora</i>	<i>Cardaria navasii</i>
<i>Allium pendulinum</i>	<i>Carduus crispus multiflorus</i>
<i>Allium schmitzii</i>	<i>Carduus personata</i>
<i>Allium scorzoneri-folium</i>	<i>Carduus platypus</i>
<i>Allium suaveolens</i>	<i>Carex arenaria</i>
<i>Alyssum wulfenianum</i>	<i>Carex bergrothii</i>
<i>Angelica heterocarpa</i>	<i>Carex camposii</i>
<i>Angelica razulii</i>	<i>Carex cretica</i>
<i>Anthericum baeticum</i>	<i>Carex durieui</i>
<i>Apium inundatum</i>	<i>Carex frigida</i>
<i>Arabis kennedyae</i>	<i>Carex fuliginosa fuliginosa</i>
<i>Arabis soyeri</i>	<i>Carex jemtlandica</i>
<i>Arenaria gothica</i>	<i>Carex lainzii</i>
<i>Aristolochia rotunda insularis</i>	<i>Carex lowei</i>
<i>Armeria arcuata</i>	<i>Carex nevadensis</i>
<i>Armeria maritima purpurea</i>	<i>Carex pulicaris</i>
<i>Armoracia macrocarpa</i>	<i>Carex randalpina</i>
<i>Asparagus pseudoscaber</i>	<i>Carex serotina pulchella</i>
<i>Atractylis cancellata gaditana</i>	<i>Carex trinervis</i>
<i>Baldellia alpestris</i>	<i>Carum verticillatum</i>

<i>Centaurea arenaria sophiae</i>	<i>Deschampsia wibeliana</i>
<i>Centaurea macroptilon</i>	<i>Diphasiastrum madeirense</i>
<i>Centaurea margaritacea appendiculata</i>	<i>Doronicum cataractarum</i>
<i>Centaurea margaritacea donetzica</i>	<i>Dryopteris aitoniana</i>
<i>Centaurea margaritacea konkae</i>	<i>Dryopteris maderensis</i>
<i>Centaurea margaritacea paczoskii</i>	<i>Ebingeria elegans</i>
<i>Centaurea margaritacea protogerberi</i>	<i>Elymus alaskanus scandicus</i>
<i>Centaurea rhenana savranica</i>	<i>Elymus alaskanus subalpinus</i>
<i>Centaurium microcalyx</i>	<i>Epilobium alsinifolium</i>
<i>Cephalaria litvinovii</i>	<i>Epilobium fleischeri</i>
<i>Cephalorhynchus cyprius</i>	<i>Epilobium nutans</i>
<i>Cerastium azoricum</i>	<i>Erica tetralix</i>
<i>Cerastium brachypetalum doerfleri</i>	<i>Erucastrum palustre</i>
<i>Cerastium fontanum lucorum</i>	<i>Eryngium viviparum</i>
<i>Ceterach lolegnamense</i>	<i>Erysimum creticum</i>
<i>Chaerophyllum elegans</i>	<i>Euphorbia uliginosa</i>
<i>Chondrilla chondrilloides</i>	<i>Euphrasia calida</i>
<i>Chrysosplenium alpinum</i>	<i>Euphrasia scottica</i>
<i>Chrysosplenium oppositifolium</i>	<i>Festuca arundinacea uechtriziana</i>
<i>Cirsium bourgaeum</i>	<i>Festuca nitida</i>
<i>Cirsium brachycephalum</i>	<i>Festuca rivularis</i>
<i>Cirsium creticum triumfetti</i>	<i>Festuca rubra thessalica</i>
<i>Cirsium dissectum</i>	<i>Fraxinus pallisiae</i>
<i>Cirsium glabrum</i>	<i>Gagea julia</i>
<i>Cirsium rivulare</i>	<i>Galanthus nivalis</i>
<i>Cirsium spinosissimum</i>	<i>Galeopsis pyrenaica</i>
<i>Cirsium tymphaeum</i>	<i>Galium viridiflorum</i>
<i>Cirsium waldsteinii</i>	<i>Genista berberidea</i>
<i>Cochlearia glastifolia</i>	<i>Gentiana bavarica</i>
<i>Cochlearia officinalis pyrenaica</i>	<i>Gentiana clusii</i>
<i>Coronilla globosa</i>	<i>Gentianella ramosa</i>
<i>Cymbalaria hepaticifolia</i>	<i>Geranium palmatum</i>
<i>Cyperus cyprius</i>	<i>Geranium rubescens</i>
<i>Cytisus multiflorus</i>	<i>Geum rhodopeum</i>
<i>Daboecia azorica</i>	<i>Goniolimon graminifolium</i>
<i>Dactylorhiza cordigera siculorum</i>	<i>Gratiola linifolia</i>
<i>Dactylorhiza incarnata coccinea</i>	<i>Gypsophila repens</i>
<i>Dactylorhiza incarnata pulchella</i>	<i>Hemerocallis lilioasphodelus</i>
<i>Dactylorhiza maculata islandica</i>	<i>Herniaria ciliolata</i>
<i>Dactylorhiza maculata schurii</i>	<i>Hierochloe hirta hirta</i>
<i>Dactylorhiza majalis alpestris</i>	<i>Hierochloe odorata baltica</i>
<i>Dactylorhiza majalis occidentalis</i>	<i>Huperzia dentata</i>
<i>Dactylorhiza majalis praetermissa</i>	<i>Hypericum elodes</i>
<i>Dactylorhiza majalis purpurella</i>	<i>Inula helvetica</i>
<i>Dactylorhiza pseudocordigera</i>	<i>Iris spuria spuria</i>
<i>Dactylorhiza sphagnicola</i>	<i>Isoetes azorica</i>
<i>Dactylorhiza traunsteineri lapponica</i>	<i>Isoetes boryana</i>
<i>Deschampsia littoralis</i>	<i>Isoetes heldreichii</i>

<i>Isoetes longissima</i>	<i>Paradisea lusitanica</i>
<i>Isoetes malinverniana</i>	<i>Pastinaca latifolia</i>
<i>Isoetes setacea</i>	<i>Pedicularis foliosa</i>
<i>Isoetes velata asturicense</i>	<i>Pedicularis limnogenae</i>
<i>Isoetes velata tenuissima</i>	<i>Pedicularis pyrenaica</i>
<i>Jasonia tuberosa</i>	<i>Pedicularis recutita</i>
<i>Juncus jacquinii</i>	<i>Pedicularis sylvatica hibernica</i>
<i>Juncus requienii</i>	<i>Pedicularis sylvatica sylvatica</i>
<i>Juncus thomasii</i>	<i>Petagnia saniculifolia</i>
<i>Knautia godetii</i>	<i>Petasites kablikianus</i>
<i>Lathyrus neurolobus</i>	<i>Petasites paradoxus</i>
<i>Lathyrus palustris nudicaulis</i>	<i>Peucedanum aegopodioides</i>
<i>Leontodon berinii</i>	<i>Peucedanum gallicum</i>
<i>Leontodon pyrenaicus</i>	<i>Peucedanum lancifolium</i>
<i>Leucojum vernum</i>	<i>Phoenix theophrasti</i>
<i>Limosella tenella</i>	<i>Pilularia globulifera</i>
<i>Lonicera nigra</i>	<i>Pilularia minuta</i>
<i>Luzula sylvatica henriquesii</i>	<i>Pinguicula grandiflora</i>
<i>Lysimachia ephemerum</i>	<i>Pinguicula leptoceras</i>
<i>Malcolmia graeca</i>	<i>Pinguicula nevadensis</i>
<i>Malus praecox</i>	<i>Plagiopus flosculosus</i>
<i>Marsilea azorica</i>	<i>Poa cenisia cenisia</i>
<i>Melanoselinum decipiens</i>	<i>Poa cenisia sardoa</i>
<i>Mentha longifolia cypria</i>	<i>Polygala amara</i>
<i>Meum athamanticum</i>	<i>Polygala amarella</i>
<i>Myosotis gallica</i>	<i>Primula clusiana</i>
<i>Myosotis lamottiana</i>	<i>Primula deorum</i>
<i>Myosotis rehsteineri</i>	<i>Primula farinosa exigua</i>
<i>Najas microcarpa</i>	<i>Pseudorchis albida albida</i>
<i>Narcissus cyclamineus</i>	<i>Ranunculus aconitifolius</i>
<i>Narcissus jonquilla</i>	<i>Ranunculus barceloi</i>
<i>Narcissus longispathus</i>	<i>Ranunculus cordiger</i>
<i>Narthecium ossifragum</i>	<i>Ranunculus flammula minimus</i>
<i>Narthecium reverchonii</i>	<i>Ranunculus flammula scoticus</i>
<i>Odontites kaliformis</i>	<i>Ranunculus fluitans</i>
<i>Oenanthe conioides</i>	<i>Ranunculus hederaceus</i>
<i>Oenanthe divaricata</i>	<i>Ranunculus kykkoensis</i>
<i>Oenanthe fluviatilis</i>	<i>Ranunculus longipes</i>
<i>Oenanthe lisae</i>	<i>Ranunculus montanus</i>
<i>Oenanthe tenuifolia</i>	<i>Ranunculus ololeucos</i>
<i>Oenothera ammophila</i>	<i>Ranunculus platanifolius</i>
<i>Origanum cordifolium</i>	<i>Ranunculus revelieri</i>
<i>Oxytropis triflora</i>	<i>Ranunculus wilanderi</i>
<i>Papaver laestadianum</i>	<i>Rheum rhaponticum</i>
<i>Papaver sendtneri</i> agg.	<i>Rhododendron ponticum baeticum</i>

Romulea revelierei
Rosa chionistrae
Rumex balcanicus
Sagina pilifera
Sagina saginoides nevadensis
Salix apennina
Salix bicolor
Salix cantabrica
Salix daphnoides
Salix glabra
Salix mielichhoferi
Salix repens
Salix salviifolia
Salix silesiaca
Sanguisorba dodecandra
Sanguisorba laterifolia
Saponaria cypria
Saponaria ocymoides
Saussurea alpina esthonica
Saussurea alpina macrophylla
Saussurea porcii
Saxifraga aquatica
Saxifraga clusii
Saxifraga hostii
Saxifraga hypnoides
Saxifraga mutata
Saxifraga oppositifolia amphibia
Saxifraga spathularis
Saxifraga umbrosa
Scorzonera fistulosa
Scrophularia alpestris
Scrophularia hirta
Scrophularia racemosa
Scrophularia trifoliata
Scutellaria minor
Securinega tinctoria
Sedum aetnense
Senecio doria legionensis
Senecio subalpinus
Sibthorpia peregrina
Silene asterias
Silene laconica
Silene pusilla
Silene saxifraga
Sisymbrella aspera aspera
Sisymbrella aspera praeterita
Sisymbrium supinum
Solanum patens
Soldanella pindicola
Symphytum officinale uliginosum
Syringa josikaea
Taraxacum fontanum group
Taraxacum schroeteranum
Thalictrum morisonii
Thalictrum speciosissimum
Thlaspi cepaeifolium cepaeifolium
Thlaspi cyprium
Thorella verticillato-inundata
Tofieldia calyculata
Tolpis azorica
Tragopogon brevirostris bjelorusicus
Tragopogon brevirostris longifolius
Tragopogon floccosus
Trichomanes speciosum
Trifolium saxatile
Trisetum fuscum
Vaccinium padifolium
Verbascum banaticum
Veronica dabneyi
Veronica repens
Viola cretica

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