Assessment of endangered synanthropic plants of Hungary with special attention to arable weeds

G. Pinke\textsuperscript{a}; G. Király\textsuperscript{b}; Z. Barina\textsuperscript{c}; A. Mesterházy\textsuperscript{b}; L. Balogh\textsuperscript{d}; J. Csiky\textsuperscript{e}; A. Schmotzer\textsuperscript{f}; A. V. Molnár\textsuperscript{g}; R. W. Pál\textsuperscript{e}

\textsuperscript{a} Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary
\textsuperscript{b} Faculty of Forestry, University of West Hungary, Sopron, Hungary
\textsuperscript{c} Hungarian Natural History Museum, Budapest, Hungary
\textsuperscript{d} Natural History Collection, Savaria Museum, Szombathely, Hungary
\textsuperscript{e} Faculty of Sciences, University of Pécs, Pécs, Hungary
\textsuperscript{f} Bükk National Park Directorate, Eger, Hungary
\textsuperscript{g} Faculty of Sciences, University of Debrecen, Debrecen, Hungary

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Assessment of endangered synanthropic plants of Hungary with special attention to arable weeds


1Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaro´vár, Hungary, 2Faculty of Forestry, University of West Hungary, Sopron, Hungary, 3Hungarian Natural History Museum, Budapest, Hungary, 4Natural History Collection, Savaria Museum, Szombathely, Hungary, 5Faculty of Sciences, University of Pécs, Pécs, Hungary, 6Bükk National Park Directorate, Eger, Hungary, and 7Faculty of Sciences, University of Debrecen, Debrecen, Hungary

Abstract
In the present study, species were selected from the new Red List of the vascular flora of Hungary which can be regarded as a weed. For each species, current conservation status and the most important traits were assessed. Altogether 149 weed species were found to be at risk according to the International Union for Conservation of Nature (IUCN) categories: 11 species are extinct, 11 are critically endangered, 27 are endangered, 26 are vulnerable, 62 are near threatened and 12 are data deficient. These species belong to 37 plant families, from which the most important are Caryophyllaceae, Brassicaceae, Asteraceae, Scrophulariaceae, Chenopodiaceae, Poaceae and Fabaceae. The most significant chorological elements are Mediterranean (28%) and Eurasian (27%); endemic (Pannonian) taxa constitute only 5.4%. Over 90% of these species are of native or archaeophyte origin, according to their residence time. Considering the main habitat types, 46% of the species are originated from dry habitats, 23% from arable lands, 17.5% from wet habitats and 13.5% from ruderal habitats. In the life form spectra, a pronounced dominance of therophytes (81%) is represented. The factor that currently offers the greatest conflict to the conservation of endangered weed species in Hungary are side effects of strong eradication campaigns against the invasive Ambrosia artemisiifolia.

Keywords: Arable plants, biodiversity, conservation, rare weeds, Red List, weed flora

Introduction
Most modern definitions of weeds convey an opinion that the plants are considered undesirable in some way. This emphasizes that there is nothing special about the biology of weed plants but they merely have to interfere with the activity of humans (Naylor & Lutman 2002). Man-made habitats in central Europe can be broadly divided into arable land with arable weed vegetation, and settlements and their surroundings, harbouring ruderal vegetation. Although both of these types of synanthropic vegetation are strongly influenced by human activities, they differ in species composition and species attributes due to the different regimes and intensity of disturbances in fields and ruderal sites. The former is a predictable environment with frequent, regular and large-scale disturbances, while the latter is an unpredictable environment with irregular disturbances (Lososová et al. 2006; Lososová & Simonová 2008).

Before the industrial revolution, man’s activity promoted floristic diversity which reached a maximum during the eighteenth century in a landscape with some kind of balance between historical natural community types and new secondary ones (Kornsá 1983). Agricultural intensification that has been occurring throughout Europe since the 1950s has largely impoverished the weed flora of arable habitats. The following factors are primarily responsible for the decline: modern seed cleaning methods, the development of harvesting and threshing technologies, intensive soil cultivation, early stubble ploughing, enlargement of arable fields, the abandonment of extreme arable habitats and the application of fertilizers and herbicides (Hilbig & Bachthaler
Due to these factors, arable weed species had the highest extinction rate in the twentieth century in many rural landscapes (Van Calster et al. 2008). Agricultural intensification has been associated with changes in rural lifestyle and in socioeconomic structure of villages as well, which is related, for example, to the decline in keeping small animals, cleaning and paving the streets and village squares and consequently the loss of habitats enriched by ammoniacal nitrogen (Lososová & Simonová 2008). These changes have also resulted in the impoverishment of the weed flora (Lososová & Simonová 2008). Pioneer species, which occasionally can also behave as a weed, that occur in open habitats with very low or high pH and soil moisture, suffered large extinctions as well, mainly because of habitat loss and eutrophication (Walker & Preston 2006; Stehlik et al. 2007).

Weed species can have important ecological function in terms of supporting biodiversity of invertebrates and birds (Marshall et al. 2003; Andreasen & Stryhn 2008; Barberi et al. 2010). Related to this, a concept of a “good weed” has arisen recently, which refers to weed species combining a relatively low competitive ability with a high importance for invertebrates and birds (Storkey 2006; Storkey & Westbury 2007).

However, from a conservation perspective, it is also very important to determine which weed species are the most susceptible to changes of modern times, and these species can be used also as biodiversity indicators to evaluate the effectiveness of agro-environmental schemes (Albrecht 2003; Billetter et al. 2008; Hyvönen & Huusela-Veistola 2008; Moonen & Barberi 2008; Aavik & Liira 2009).

From the 2183 indigenous and established plant species in the Hungarian flora (Simon 2000), 805 species can be regarded as a weed (Ujvárosi 1973). The first attempt to list threatened Hungarian weed species was done by Pinke (1995), which was followed by listing endangered vineyard weeds by Pál (2006). As a result of intensive field-based botanical surveys in the past 15 years, a new Red List of the vascular flora of Hungary was published listing 943 plant species, which suggests that 43.2% of the Hungarian flora is threatened (Király 2007). The growing number of the endangered taxa in the past 20 years is also very significant. It has increased by 30%, but if we take into account only species belonging to the categories extinct and critically endangered, the growth rate is 110%. This phenomenon can be clearly explained by accelerated degradation and habitat loss (Király 2007). The situation of endangered weed species nowadays should merit special attention in Hungary, because the strong eradication campaigns against the invasive Ambrosia artemisiifolia L. seriously threaten the last remnant populations of rare weed species (Pinke & Pál 2009; Pinke et al. 2009).

Materials and methods

In the new Red List of the vascular flora of Hungary (Király 2007), the conservation status of species which can be regarded as a weed were assessed over the last 15 years according to the field observations and data collection of the present authors and covered almost the total area of Hungary. In the present study, threatened synanthropic species were selected from the 943 species in the new Red List, followed the International Union for Conservation of Nature (IUCN) categories. In some cases, the conservation status of some species from the data deficient category were also changed. For the main habitat types, four categories have been distinguished according to the field observations of the present authors and the literature (Soó 1964–1980; Ujvárosi 1973): (A) Arable lands; these species are strictly connected to arable fields. (R) Ruderal habitats; these species are strictly connected to ruderal habitats (e.g. settlements and their surroundings, dung heaps, poultry yards, degraded pastures, refuse dumps, soil deposits, pavements, road margins, railways). (D) Dry habitats; plant species of natural or semi-natural dry habitats which occasionally appear on arable lands (e.g. nutrient poor dry arable fields, young fallows) and ruderal habitats. (W) Wet habitats; pioneer species of natural or semi-natural wet habitats which occasionally appear on arable lands (e.g. inland waters, rice fields), ruderal habitats and irrigation channels. With respect to the residence time, that is, the native status or the time since the arrival of an introduced species in the territory, three categories were distinguished: natives, archaephytes (introduced before 1500 AD) and neophytes (introduced after that date). Native species occurred in the territory before the Neolithic agricultural colonization, approximately 6–5000 BC (cf. Pyšek et al. 2002). The status was marked as doubtful when the species’ native/archaephyte or archaephyte/neophyte status remained undecided owing to insufficient information (cf. Celestí-Grapow et al. 2009, 2010). These data are based on the following references: archaephytes (Terpö et al. 1999; Balogh 2010), neophytes (Balogh et al. 2004) and natives (Soó 1964–1980).

Nevertheless, it should be mentioned that the compilation of the new Hungarian Red List took only indigenous or archaephyte
species into consideration. Neophytes were normally excluded from the list, except for some long-ago established and definitely declining species (Király 2007). The nomenclature of plant species is based on Király (2007), the chorological areas, life cycles and life forms are based on Újvárosi (1973), Simon (2000) and Király (2009).

Results

Altogether 149 weed species were found to be at risk according to the IUCN categories (Table I). Eleven species are extinct, 11 are critically endangered, 27 are endangered, 26 are vulnerable, 62 are near threatened and 12 are data deficient (Figure 1). These species belong to 37 plant families. The most important families are Caryophyllaceae (14 species), Brassicaceae (13 species), Asteraceae (12 species), Scrophulariaceae (11 species), Chenopodiaceae (11 species), Poaceae (11 species), Fabaceae (9 species), Boraginaceae (7 species), Rubiaceae (5 species), Apiaceae (4 species) and Elatinaceae (4 species) (Figure 3). As shown in Figure 3, the most significant chorological elements were as follows: Mediterranean (28%), Eurasian (27%) and European (10%). In addition, there are also cosmopolitan (6.7%), Atlantic (5.7%), Pannonian (5.4%), Pontic (5.4%), adventive (3.4%), Asiatic (3%), Balkan (2.3%), Circumpolar (2.3%) and continental (0.7%) elements present in lower amounts. According to residence time, the proportion of native species was the largest (48%) followed by archaeophytes (42%) and neophytes (10%) (Figure 3). Considering the main habitat types, 46% of the species originated from dry habitats, 23% from arable lands, 17.5% from wet habitats and 13.5% from ruderal habitats (Figure 3). The analysis of the life cycle spectra shows that most of the species are winter annuals (42%) and summer annuals (39%) followed by perennials (12%) and biennials (7%) (Figure 3). The proportions of life forms are presented also in Figure 3. A pronounced dominance of therophytes is represented (81%). Hemitherophytes (7%), hemicryptophytes (6%), geophytes (5%) and hydro- to-helophytes (1%) show lower presence.

Discussion

Altogether 149 weed species were found to be at risk in Hungary. Regarding to some other countries, in Slovakia 150 (Eliaš et al. 2005), in Croatia 78 (Hulina 2005) weed species, while in Turkey 112 (Türe & Böcük 2008) arable weed species are included in the current Red Lists. In other Central-European countries, for example, in Germany (Korneck et al. 1996) and in Austria (Nikfeld & Schratt-Ehrendorfer 1999) also several weeds can be found among endangered plants. It is worth to mention, that in the present list, from the 11 extinct species Camelina abyssum (Mill.) Thell., Cuscuta epilinum Weihe and Lolium remotum Schrank are flax specialists, and they have disappeared also from the whole of Europe (Kornaś 1988). From cereal specialists, which are also threatened throughout Europe, Lolium temulentum L. (Eliaš et al. 2010) is also extinct, Bromus secalinus L. is endangered, while Agrostemma githago L. was put in the near threatened category. A. githago is the most well-known declining arable weed in Hungary, thus it may function as a “flagship species”, and deserves special attention. Due to the farmland intensification, A. githago has significantly retreated in Hungary after the 1950s. At the end of the 1980s, it was known only in 22 localities in our country. Between 1995 and 2005, A. githago was reported from 366 different Central European floristic mapping units in Hungary. This means, it occurred in 12.9% of the Hungarian floristic mapping units. It is not likely that the populations of this species have increased to such a great extent as a consequence of contemporary lower-intensity farming situations in post-communist times in the 1990s. It is more likely that the greater number of new localities is mainly the result of more thorough field botanical surveys in the last decade. Most of the occurrences were discovered in extensively cultivated small fields in the mountainous, hilly and sandy regions of Hungary (Pinke et al. 2006b).

Generally, weed species at risk in Hungary mostly belong to Caryophyllaceae, Brassicaceae, Asteraceae, Scrophulariaceae, Chenopodiaceae, Poaceae and Fabaceae. These families are also included in the top 10 families of the Hungarian weed species (Hunyadi et al. 2000). The most significant chorological elements were Mediterranean and Eurasian, they together make up 55% of the species spectra. According to Holzner (1978), several Mediterranean–Eurasian weed species are at the northern or western limit of their range in central and in western Europe, and because of this fact, they are more sensitive and less vigorous under intensified agriculture. The proportion of Pannonian elements are only 5.4%, they are endemic taxa of Hungary. Respectively, endemic species constitute 67.8% among the threatened weed species in Turkey (Türe & Böcük 2008). As the flora in the Carpathian-Basin is largely affected also by Eurasian, Submediterranean and Subatlantic influences, in some cases, it is hard to make any separations between the native and archaeophyte status of species. Nevertheless, according to the residence time, most of the threatened species are of native or archaeophyte origin, their common proportion is 90%. Lososová and Simonová (2008) and Brun (2009) also indicated that the abundance of native and archaeophyte weed species
<table>
<thead>
<tr>
<th>Taxa</th>
<th>Family</th>
<th>Chorological area</th>
<th>Residence time</th>
<th>Conservation status</th>
<th>Main habitat</th>
<th>Life cycle</th>
<th>Life form</th>
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<td>Pan-Dal</td>
<td>Ntv/Ar?</td>
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(continued)
has decreased, while the abundance of neophytes has increased in the last century.

In life form spectra, a pronounced dominance of therophytes (81%) was documented, which means that these species are adapted to stands with frequent disturbances. If the disturbances cease, these species will quickly disappear from this habitat, therefore weedy plants cannot be protected by the usual conservation methods. Altogether 63.5% of the species originated from dry and wet habitats, and these plants can contribute to a larger and more valuable biodiversity of weed communities. In certain cases, the nutrient-poor dry arable fields (Pinke et al. 2006a), other extreme arable habitats with inland waters (Király et al. 2008) and degraded

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**Table I. (Continued).**

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<th>Taxa</th>
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<th>Residence time</th>
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<td>Euras-Med</td>
<td>Ntv/Ar?</td>
<td>NT</td>
<td>D</td>
<td>Wa</td>
<td>Th</td>
</tr>
<tr>
<td>Verbascum densiflorum Bert.</td>
<td>Scrophulariaceae</td>
<td>Eu-Med</td>
<td>Ntv</td>
<td>NT</td>
<td>R</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Verbascum pulverulentum Vill.</td>
<td>Scrophulariaceae</td>
<td>Atl-Med</td>
<td>Ntv</td>
<td>NT</td>
<td>R</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Verbascum speciosum Schrad.</td>
<td>Scrophulariaceae</td>
<td>Eu</td>
<td>Ntv/Ar?</td>
<td>NT</td>
<td>R</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Verbena serpentina</td>
<td>Verbenaceae</td>
<td>Pont-Med</td>
<td>Ntv</td>
<td>W</td>
<td>Wa</td>
<td>Th</td>
<td></td>
</tr>
<tr>
<td>Veronica acicinfolia L.</td>
<td>Scrophulariaceae</td>
<td>Euros</td>
<td>Ntv</td>
<td>EN</td>
<td>A</td>
<td>Wa</td>
<td>Th</td>
</tr>
<tr>
<td>Veronica agrestis L.</td>
<td>Scrophulariaceae</td>
<td>Eu-Med</td>
<td>Ar</td>
<td>CR</td>
<td>A</td>
<td>Wa</td>
<td>Th</td>
</tr>
<tr>
<td>Veronica opaca Fr.</td>
<td>Scrophulariaceae</td>
<td>Eu</td>
<td>Ar</td>
<td>CR</td>
<td>A</td>
<td>Wa</td>
<td>Th</td>
</tr>
<tr>
<td>Vicia lutea L.</td>
<td>Fabaceae</td>
<td>Atl-Med</td>
<td>Ar/Neo</td>
<td>EN</td>
<td>D</td>
<td>Wa</td>
<td>Th</td>
</tr>
<tr>
<td>Vicia narbonensis L. subsp.</td>
<td>Fabaceae</td>
<td>Med</td>
<td>Ntv/Ar?</td>
<td>VU</td>
<td>D</td>
<td>Wa</td>
<td>Th</td>
</tr>
</tbody>
</table>

Chorological area: Euras, Eurasian; Med, Mediterranean; Eu, European; Circ, Circumpolar; Cosm, cosmopolitan; Pan, Pannonian; Pont, Pontic; Atl, Atlantic; Adv, adventive; Bal, Balkan; As, Asiatic; Cont, continental. Residence time: Ar, archaeophyte; Neo, neophyte; Ntv, native; ?, species with doubtful status. Conservation status (IUCN categories): EX, extinct; CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; DD, data deficient. Main habitat: A, arable lands; R, ruderal habitats; D, dry habitats; W, wet habitats. Life cycle: Wa, winter annuals; Sa, summer annuals; B, biennials; P, perennials. Life form: He, hemicycrophytes; Ge, geophytes; HH, hydatherrhophytes; HT, hemitherophytes; Th, therophytes (See Materials and methods for details).
pastures (Molnár 1997) can function as refugia for these species, but in general, their existence and endangerment are not strictly connected to agricultural production. The survival of these species would demand active management to prevent secondary succession of natural and semi-natural open habitats (Van Calster et al. 2008). For the survival of the obligate arable (23%) and ruderal (13.5%) weed species, special conservation measures are essential in the more anthropogenic environments. Although there are projects supporting farmland birds through managing arable fields without pesticides in a few regions of Hungary (Faragó 1997), there is still lack of any conservation program aiming primarily the preservation of weed species in Hungary. Previous surveys in Hungary indicated that the weed vegetation on extensively managed fields supported many Red List weed species (Pinke & Pál 2008), and extensively managed fields also have greater conservation value compared with intensively managed fields (Pinke et al. 2009). Therefore, from a conservation perspective, maintaining low-input cropping within these habitats would offer the best solution for the preservation of threatened weed species. Kleijn et al. (2009) also suggested that conservation initiatives are most effective if they are preferentially implemented in extensively farmed areas that still support high levels of biodiversity.

Figure 2. Number of threatened weed species in Hungary, by family.
Arable farming is a major system in the European Union (EU), but low-intensity arable farming systems of a high ecological quality are rare and confined to southern and eastern Europe (Stoate et al. 2009). Unfortunately, also in Hungary, only a few traditionally managed small fields remain and they are continuously being abandoned, afforested, built up or intensified. It would be regrettable to let the most valuable extensively managed farming habitats in the new EU states decline as predicted by Donald et al. (2001). An exemplary way would be offered for saving these habitats by creating new programs similar to the German project ‘100 Fields for Diversity’, in which a sustainable network of sanctuaries for permanent conservation of endangered arable weed species is established (Meyer et al. 2008). Many papers indicated that in the intensively managed fields, rare and threatened weed species (if they still exist) are usually restricted only to the outermost few metres of the crop, and there is greater species richness and weed cover at the edge of the fields than in the centre (Elsen & Scheller 1995; Wilson & Aebischer 1995; Fried et al. 2009; Kovács-Hostyánszki et al. 2011). Because of this phenomenon, an alternative conservation practice could be the option of agri-environment schemes in field margins, which has proved to be effective in Western Europe, in conserving arable plants, including rare species (Marshall et al. 2006; Walker et al. 2007).

For threatened species that are harboured by stubble fields, the postponing of stubble ploughing until late autumn would offer the best conservation method (Pinke & Pál 2009). References about the possibilities and projects for the preservation of ruderal weed vegetation are scarce in Europe, as their conservation seems to be more difficult, because the maintenance of essential human disturbances in such habitats can be rather complex (Wittig 2002).

The factor that currently offers the greatest conflict to the conservation of endangered weed species in Hungary is the increasing spread of *A. artemisiifolia*, not only because it is invading more and more habitats of rare weed species but also because its allergenic effects have resulted in strong eradication campaigns which promote total weed control (Kömives et al. 2006; Kazinczi et al. 2008; Novák et al. 2009). Authorities inspecting the infestation of *A. artemisiifolia* and meeting punishments for farmers and landowners should also consider the conservation value of other weed species. Arable and ruderal habitats supporting higher biodiversity should deserve special consideration by conservationists.

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References


