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# Native versus alien status of a rare plant species outside the limits of its main geographic range: distribution of *Virga pilosa* (L.) Hill in Wielkopolska, Poland and CE Europe

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**Abstract:** *Virga pilosa* (L.) Hill (= *Dipsacus pilosus* L.) is an example of a phytogeographically controversial species. Being nationally rare (in Poland), it sometimes becomes locally frequent and maybe even expansive. Its native vs alien status remains disputable, at least in a regional scale. This article provides a new, cartographical and phytocoenological documentation of the species occurrence within a forest complex situated in the middle part of the Wielkopolska region, Poland. It also contains new, updated distribution maps of *Virga pilosa* in Poland and Central Europe. The authors discuss the species' phytocoenological scale, particularly, in order to find potential explanations of its abundant presence within a single, in a supra-regional scale, and spatially separated locality. They conclude in relation to the species alien status in the region of Wielkopolska, where *Virga pilosa* has been recently established in one locality, that it is locally naturalised and spreading.

**Key words:** native and alien species, distribution range, separate localities, expansiveness, *Virga pilosa*, Central Europe, Poland

## 1. Introduction

The problem of species uncertain, i.e. native or alien status, is sometimes indicated in national taxonomic checklists (in case of Poland cf. Mirek *et al.* 2002) or in other country-focused elaborations, such as large-scale chorological atlases (e.g. Zając & Zając 2001). In sub-regional floras such issues are also sometimes discussed, though, usually only generally and briefly. However, particularly in local floristic syntheses, they seem to be hardly ever considered more deeply. Consequently, the so-called 'problematic species' are often more or less arbitrarily regarded as either native or alien, depending solely on the authors' subjective point of view. Perhaps even more often this designation is simply being made in accordance with one of the mentioned, though not necessarily (sub)-regionally confident labelling according to nationally-focused literature sources.

Nevertheless, the problem in its scientific essence remains completely unsolved and, furthermore, it is also rarely discussed in international scientific journals (e.g. Webb 1985). There seem to have been written much more than one could quote in a single article on such important issues as, for instance, transatlantic plant invasions and their influence on European biodiversity but, on the other hand: what makes other species native or alien in different areas within the same continent? In many cases, when we do not have sufficient historical evidences, the problem often refers to our interpretation of general biogeographical data in the light of contemporary observations, e.g. ecological conditions in which certain species have been recorded. Some arguments from the literature (e.g. Webb 1985; Latowski & Zieliński 2001) may indicate that among botanists there seems to be a general tendency to treat more species of indeed uncertain origin as 'probably native' rather than 'possibly alien' in certain areas. In many cases, this may be a consequence of possible misinterpretations of some alien species occurring with relatively high frequencies as a result of their advanced naturalization rather than

of primeval causes. Such species may simply appear to be 'native like' components of vegetation (Faliński 1969; 1972; Webb 1985).

Considering the dynamic and often complicated structure of many European plant species distribution ranges (cf. Hultén & Fries 1986; Meusel & Jäger 1992), it seems probable that, especially in case of widely-distributed species, some parts of their ranges may be substantially modified by man. The problem becomes more visible, when newly observed localities of a certain species are situated outside their known, more or less uniform distribution limits, especially, in areas which, for many years, have been relatively well explored by botanists.

In this article we would like to discuss these issues on the example of *Virga pilosa* (L.) Hill (=*Dipsacus pilosus* L.), a new species to the region of Wielkopolska (cf. Szulczewski 1951; Zając & Zając 2001), which is the second largest province of Poland. Additionally, the taxon's native/alien status remains also controversial as far as the whole country is considered (cf. annotations to the distribution map in Zając & Zając 2001) and this is mainly because it reaches its northern geographical limit in Poland (Meusel & Jäger 1992).

In this paper we present results of our local geobotanical investigations carried out within a new locality of *Virga pilosa* situated outside the species compact range in Europe, and so far the only one known site from the middle part of the Wielkopolska region (the middle part of Western Poland). Then we summarize and discuss available data on the species distribution and its (updated) geographical limits and ecological scale in Central Europe. Although our conclusions are not definitive, we hope they may contribute to and, perhaps, also stimulate a more general discussion.

## 2. Area of research, material and methods

In summer 2007, we carried out extensive field investigations within the large "Konstantynowo" Forestry Division (comprising ca. 128 km$^2$ of forests within an area of over 1000 km$^2$) situated in the SW vicinity of

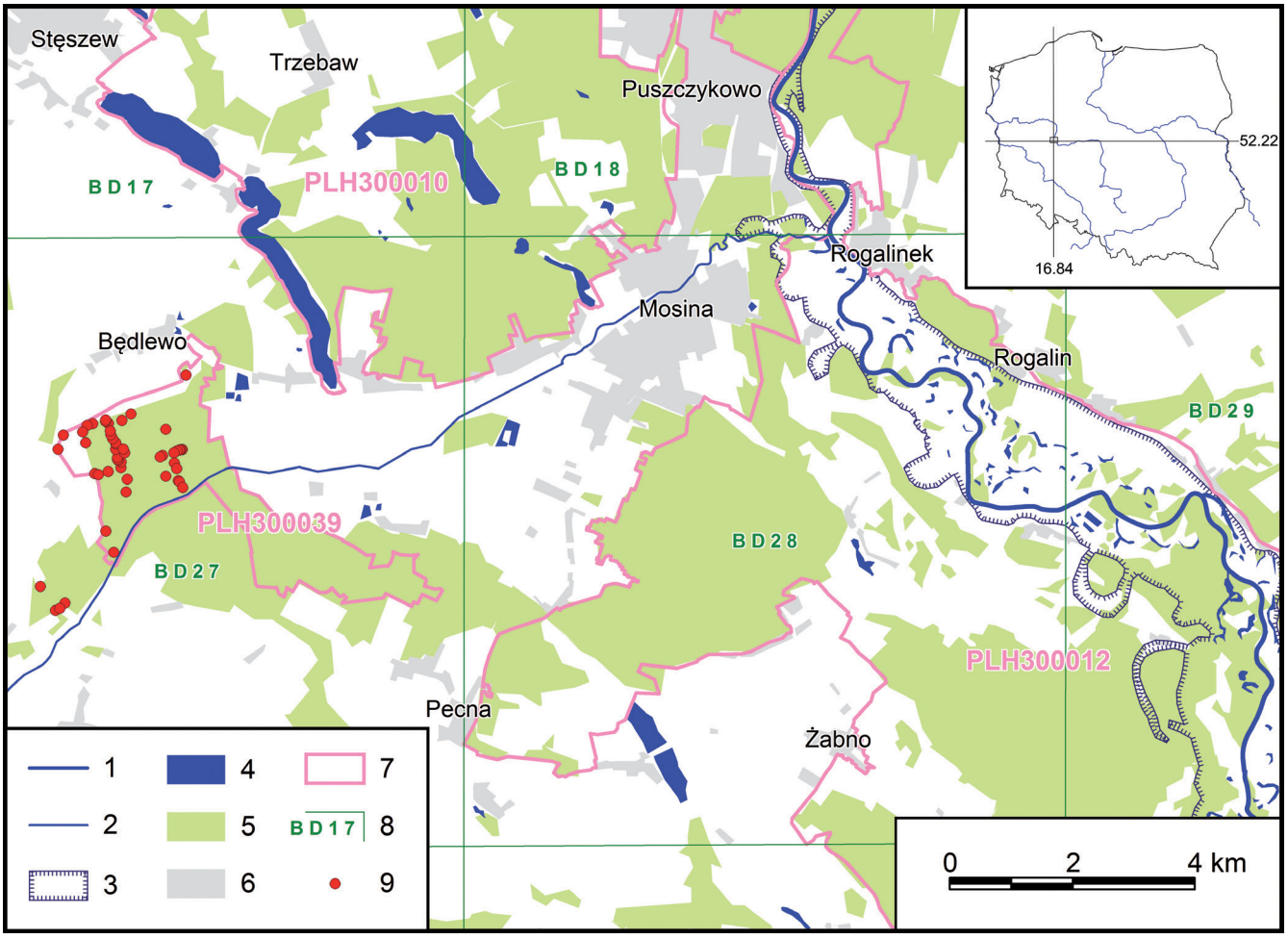


**Fig. 1.** Local distribution of *Virga pilosa* in the Będlewo Forestry and its situation against a background of the range of the Warta river valley

Explanations: 1 – The River Warta, 2 – Mosiński Canal (a tributary of Warta), 3 – floodplain of the Warta river, 4 – larger lakes, oxbows and ponds, 5 – forests, 6 – built-up areas, 7 – boundaries of the Natura 2000 SACs (PLH300010 – Ostoja Wielkopolska, PLH300012 – Rogalińska Dolina Warty, PLH300039 – Będlewo-Bieczyny), 8 – national cartographic square grid (ATPOL) with codes of basic fields, 9 – sites where *Virga pilosa* was observed in 2007

Poznań (Western Poland). The research was focused on a geobotanical inventory of habitats and plant species of European importance, i.e. listed in the Annex 1 and 2 of the EU's Habitat Directive (92/43/EEC). It resulted in our proposal of a new Natura 2000 Spatial Area of Conservation (SAC) called Będlewo-Bieczyny (PLH300039; Fig. 1). In physical-geographic division of Poland (Kondracki 2002) the area belongs to the Mesoregion of Dolina Środkowej Obry (the Valley of the Middle Obra River), whereas in the botanical regionalisation (Matuszkiewicz 1993), it is situated in Kraina Środkowo-Wielkopolska (the Middle-Wielkopolska Region) within the Brandenburg-Wielkopolska Division.

During our field investigations within the Będlewo Forestry (Fig. 1), we found a locally well-established population of *Virga pilosa* (=*Dipsacus pilosus*), which is a new species to the flora of the middle part of the Wielkopolska region (cf. Szulczewski 1951; Zając & Zając 2001). After our interviews among other botanists working in the region, it turned out that the mentioned locality has been undoubtedly known (to few of them) since 1992, when first, so far unpublished phytosociological relevés were made there by Prof. Andrzej Brzeg, who kindly agreed to provide us with these data (rel. 6-7 and 9-11 in Table 1). Consequently, in this article we considered all available observations on *Virga pilosa* made in the Będlewo Forestry, independently in 1992 (by Brzeg, so far unpublished) and in 2007 (by us).

The sites occupied by the species in 2007 were marked with an average accuracy of ca. 10 m using the GPS positioning. In some of these sites six standard phytosociological relevés were made according to the Braun-Blanquet's method. Table 1 includes also the mentioned documentation collected by Brzeg in 1992 (5 relevés). The discussed locality of *Virga pilosa* was also documented in a form of specimens deposited in the herbarium of the Department of Plant Taxonomy, Adam Mickiewicz University in Poznań.

Scientific names of vascular plants are used in this article according to Mirek *et al*. (2002), whereas names of bryophytes according to Ochyra *et al*. (2003).

In cartographic analysis, geographical coordinates of sites investigated by us in 2007 were subsequently used to obtain an updated cartogram of the species within the ATPOL grid system, which is widely used to present distribution of vascular plants in Poland (Zając & Zając 2001). We also considered available international literature, particularly, the latest published distribution maps of *Virga pilosa* in Germany: separately for its former eastern (Benkert *et al*. 1996) and western parts (Haeupler *et al*. 1989), and a generalised European range of the species (Meusel & Jäger 1992).

The information on ecology of *Virga pilosa* was taken from various references cited below, although the basis for our conclusion on the phytocoenological scale of the species in Wielkopolska were the results of our own investigations accompanied by some data on the soil analysis made previously in the same area (Kosakowski 1994).

## 3. Results and discussion

### 3.1. Local distribution of *Virga pilosa*

Local distribution of *Virga pilosa* is limited to the area of the Będlewo Forestry (Fig. 1), where the species is quite frequent in the following forestry sections: 230, 231, 234, 236, 237 and 241. Majority of these observations refer to the proposed Natura 2000 SAC Będlewo-Bieczyny (PLH300039; Fig. 1). During our investigations in 2007, we recorded 46 separate sites (positioned using the GPS unit with an accuracy of ca. 5-10 m), in which the species was found growing spontaneously as a wild plant. None of them were situated in the direct vicinity of human settlements, such as the forester's cottage or local villages, although a few sites were recorded outside the forest complexes (Fig. 1), usually, along ditches between meadows and pastures. Most of the discussed sites were linked to the presence of riparian forests and their substitute phytocoenoses, such as thickets or herbal forest edge communities. All these communities may be treated as natural, though sometimes auksochoric syntaxa (cf. Brzeg & Wojterska 2001; according to the syngenesis concept by Faliński 1969). On the other hand, some oral information obtained in 2008 from local foresters may suggest that the presence of *Virga pilosa* in the Będlewo Forestry complex could have been preceded by an introduction of the species into the neighbouring agricultural area. So far, however, there seems to be no clear evidence supporting this hypothesis. Moreover, the results of our investigation show that, currently, *Virga pilosa* is much more frequent and abundant inside the forests complex than along ditches situated within neighbouring meadows and pastures (Fig. 1). On the other hand, this may also be explained by an assumption that the mentioned forest communities turned to be more suitable habitats for the species which could either have been introduced there, perhaps unintentionally, or indirectly – could have spread from the neighbouring villages into forests – along ditches and roads.

### 3.2. Ecological preferences and local phytocoenotic scale of *Virga pilosa*

*Virga pilosa* is considered by various authors as a riparian species linked to the alluvial, rich-in-nutrients, usually moist soils, with slightly acid to neutral or even a little alkaline reaction; sometimes also containing calcium (Ellenberg 1992; Zarzycki *et al*. 2002). In the

**Table 1.** Local phytocoenotic scale of *Virga pilosa* in the Będlewo Forestry

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of relevé | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Author(s) of relevés | | W&W | W&W | W&W | W&W | W&W | AB | AB | W&W | AB | AB | AB |
| Plant association | | EC | FA | FA | Cp | Cp | Cp | Cp | Cp | Cp | Cp | AA |
| | day | 15 | 15 | 24 | 24 | 15 | 11 | 11 | 15 | 11 | 11 | 11 |
| Date | month | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| | year | 2007 | 2007 | 2007 | 2007 | 2007 | 1992 | 1992 | 2007 | 1992 | 1992 | 1992 |
| Density of tree layer | a [%] | - | 65 | 70 | - | - | - | - | - | - | - | - |
| Density of shrub layer | b [%] | 75 | 20 | 15 | - | 20 | - | - | min | - | - | - |
| Cover of herb layer | c [%] | 100 | 80 | 70 | 80 | 60 | 95 | 100 | 100 | 95 | 100 | 100 |
| Cover of moss layer | d [%] | min | 15 | 6 | 15 | - | 5 | 10 | - | min | 10 | min |
| Area of relevé | [m$^2$] | 20 | 500 | 300 | 15 | 6 | 20 | 15 | 5 | 15 | 12 | 10 |
| Number of species | | 19 | 36 | 29 | 25 | 19 | 31 | 33 | 15 | 28 | 24 | 29 |
| **I. *Ch. (opt.) *Euonymo-Cornetum sanguinei* Pass. *in* Pass. *et* Hofmann 1968 and Ch. *Rhamno-Prunetea* Rivas-Goday *et* Borja Carbonell 1961 *ex* R.Tx. 1962** | | | | | | | | | | | | |
| **Cornus sanguinea* | b | 4.3 | 2b.2 | . | | | . | . | | . | . | . |
| **Cornus sanguinea* | c | . | 2a.1 | . | r | . | 2.1 | 1.2 | + | + | + | 1.2 |
| *Sambucus nigra* | b | . | 2a.1 | 2b.1 | . | 2b.2 | . | . | . | . | . | . |
| *Sambucus nigra* | c | . | . | + | + | + | . | . | . | . | . | + |
| *Euonymus europaea* | c | . | + | . | . | r | . | . | . | + | . | . |
| *Corylus avellana* | b/c | . | 2a.1/+ | . | . | ./1.1 | . | . | . | . | . | . |
| **II. *D. *Fraxino-Alnetum* W.Mat. 1952, Ch. *Alnion incanae* Pawł. *in* Pawł., M.Sokołowski *et* Wallisch 1928, ^Ch. *Fagetalia sylvaticae* Pawł. *in* Pawł., M.Sokołowski *et* Wallisch 1928 and 'Ch. *Querco-Fagetea* Br.-Bl. *et* Vlieger 1937** | | | | | | | | | | | | |
| *Festuca gigantea* | | . | + | + | + | . | . | +.2 | . | . | 2.2 | + |
| ^*Galeobdolon luteum* | | . | 1.2 | 3.3 | 2b.1 | . | + | . | . | . | +.2 | . |
| *Elymus caninus* | | . | 2a.2 | . | . | . | 1.2 | . | . | 1.2 | . | 2.2 |
| 'Brachypodium sylvaticum* | | . | + | . | . | +.2 | 3.4 | . | . | 1.2 | 2.2 | . |
| 'Viola reichenbachiana* | | . | . | . | . | + | + | + | . | + | + | 1.1 |
| **Alnus glutinosa* | a | . | 2a.1 | 4.3 | . | . | . | . | . | . | . | . |
| *^*Fraxinus excelsior* | a | . | 4.3 | 2b.1 | . | . | . | . | . | . | . | . |
| *^*Fraxinus excelsior* | b/c | . | ./1.1 | +/+ | . | . | ./1.1 | . | . | . | ./1.1 | ./1.1 |
| *Stachys sylvatica* | | . | + | . | + | + | . | + | . | . | . | . |
| 'Scrophularia nodosa* | | . | + | r | r | . | . | . | . | . | . | . |
| *Padus avium* | a2 | . | . | 2a.2 | . | . | . | . | . | . | . | . |
| *Padus avium* | b | . | 2a.1 | 2a.2 | . | . | . | . | . | . | . | . |
| *Padus avium* | c | . | r | + | . | + | . | . | . | . | . | . |
| **Cirsium oleraceum* | | . | r | 2a.1 | + | . | . | . | . | . | . | . |
| 'Acer pseudoplatanus* | a/c | . | 1.1/+ | . | . | . | . | . | . | . | . | . |
| *Chrysosplenium alternifolium* | | . | . | 1.2 | 2a.2 | . | . | . | . | . | . | . |
| **Lycopus europaeus* | | . | . | r | r | . | . | . | . | . | . | . |
| *Viburnum opulus* | b/c | . | . | 1.1/+ | . | . | . | . | . | . | . | ./+ |
| ^*Campanula trachelium* | | . | . | . | . | . | + | . | . | . | . | 1.1 |
| 'Atrichum undulatum* | d | . | . | . | . | . | + | 1.2 | . | . | . | . |
| ^*Ficaria verna* | | . | . | (x) | . | . | . | x | . | x | x | . |
| **III. *Ch. (opt.), ^D. *Cephalarietum pilosae* and Ch. *Galio-Alliarion* (Oberd. 1962) Lohmeyer *et* Oberd. *in* Oberd. *et al.* 1967** | | | | | | | | | | | | |
| **Virga pilosa* | | 2b.2 | 2a.2 | 4.4 | 4.3 | 3.3 | 2.1 | 3.2 | 3.2 | 3.1 | 3.1 | 2.1 |
| *Geum urbanum* | | + | 1.1 | 1.1 | + | 2a.1 | 1.1 | 2.1 | . | + | 1.1 | + |
| *Impatiens parviflora* | | . | + | . | . | + | . | 2.1 | + | 1.1 | 2.1 | . |
| *Lapsana commnis* | | . | + | . | . | + | 1.1 | 1.2 | . | 1.1 | + | . |
| *Torilis japonica* | | . | 2a.1 | . | . | . | + | + | . | . | . | . |
| *Chaerophyllum temulum* | | . | 1.1 | . | . | . | . | + | . | . | . | . |
| ^*Cerinthe minor* | | . | . | . | . | . | . | + | . | . | + | . |
| **IV. *Ch. (opt.) *Agropyro repentis-Aegopodietum podagrariae* R.Tx 1967 *em.* Neuhäuslová-Novotná *et al.* 1969 and Ch. *Petasition officinalis* Sillinger 1933 (=*Aegopodion podagrariae* R.Tx. 1967)** | | | | | | | | | | | | |
| **Aegopodium podagraria* | | 1.1 | + | 1.1 | + | . | . | . | . | 1.1 | 2.2 | 3.4 |
| *Anthriscus sylvestris* | | . | 2a.1 | + | 1.1 | . | . | . | . | . | 1.2 | 1.1 |
| *Chaerophyllum aromaticum* | | . | . | . | . | 2b.2 | . | + | . | . | . | . |

**V. Ch. *Convolvuletalia sepium* R.Tx. 1950 *em.* Oberd. *in* Oberd. *et al.* 1967 and *Ch. *Artemisietea vulgaris* Lohmeyer, Preising *et* R.Tx. *in* R.Tx. 1950**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Urtica dioica* | | 1.2 | 1.1 | 3.1 | 2b.2 | 2a.1 | 2.2 | 3.1 | 2a.1 | 3.1 | 2.1 | 1.2 |
| *Galium aparine* | | + | + | 1.1 | 1.1 | +.2 | 1.1 | 1.1 | + | 3.4 | 3.2 | 2.1 |
| *Rubus caesius* | | 2b.1 | 4.3 | 2a.2 | . | 2b.3 | . | . | 2b.2 | + | . | 2.1 |
| **Artemisia vulgaris* | | + | . | . | . | . | +.2 | + | . | + | . | . |
| *Humulus lupulus* | | + | . | 1.1 | r | . | . | . | 2a.1 | . | . | . |
| *Calystegia sepium* | | + | . | . | . | . | . | . | 2a.1 | . | . | . |
| *Carduus crispus* | | . | + | r | . | . | . | . | + | . | . | . |
| *Eupatorium cannabinum* | | . | . | + | + | . | . | . | 2a.1 | . | . | . |
| **Galeopsis pubescens* | | . | . | 1.1 | + | + | . | . | . | . | . | . |
| **Rumex obtusifolius* | | . | . | . | r | . | + | . | . | + | . | . |
| *Glechoma hederacea* | | . | . | . | . | . | 2.3 | 1.1 | . | 2.1 | 2.1 | + |
| **Arctium tomentosum* | | . | . | . | . | . | + | . | . | + | 1.2 | 1.1 |
| **Elymus repens* | | . | . | . | . | . | + | 1.1 | 1.1 | . | . | . |
| **VI. Others** | | | | | | | | | | | | |
| *Brachythecium rutabulum* | d | r | 2b.2 | 2a.2 | 2b.2 | . | . | + | . | . | 1.2 | + |
| *Poa trivialis* | | . | . | 2a.2 | 2a.2 | . | 2.2 | . | . | 2.4 | 1.2 | 3.4 |
| *Ranunculus repens* | | + | . | 1.1 | . | . | + | . | . | 2.1 | . | 1.1 |
| *Deschampsia caespitosa* | | . | . | 1.1 | + | . | + | . | + | . | . | . |
| *Carex acutiformis* | | . | . | + | 1.2 | . | . | . | . | . | . | . |
| *Lysimachia nummularia* | | r | . | . | . | . | + | . | . | . | . | + |
| *Mentha* x *verticillata* | | 2a.1 | . | . | . | . | . | . | 3.2 | . | . | . |
| *Scrophularia umbrosa* | | 2a.2 | . | . | . | . | . | . | + | . | . | . |
| *Salix fragilis* | a | . | 3.1 | . | . | . | . | . | . | . | . | . |
| *Oxyrrhynchium hians* | d | . | . | . | . | . | 1.2 | +.2 | . | + | 1.2 | + |
| *Veronica chamaedrys* | | . | . | . | . | . | + | 1.1 | . | . | . | . |
| *Scirpus sylvaticus* | | . | . | . | . | . | . | . | 2b.2 | . | . | . |
| *Fallopia convolvulus* | | . | . | . | . | . | . | . | . | . | + | 1.1 |

**Sporadic species: I.** *Crataegus monogyna* c 2 (r), *Rhamnus cathartica* c 2 (r); **II.** *Acer campestre* c 2 (r), ^*Asarum europaeum* 5 (+.2), *Circaea lutetiana* 6 (+), '*Epipactis helleborine* 2 (r), *Eurrhynchium angustirete* 10 (1.2), ^*Hepatica nobilis* 11 (+), ^*Pulmonaria obscura* 5 (r), *Stellaria nemorum* 7 (+), *Ulmus laevis* c 7 (+), 10 (+); **III.** *Alliaria petiolata* 7 (+), *Arctium nemorosum* 3 (r), 4 (r), *Chelidonium majus* 1 (r), *Geranium robertianum* 6 (+), 9 (+), *Impatiens noli-tangere* 6 (+), 9 (+), *Mycelis muralis* 7 (+), 11 (+), *Rumex sanguineus* 1 (r), 9 (+); **V.** **Arctium lappa* 2 (+), **Cirsium arvense* 9 (+), **C. vulgare* 9 (+), *Cucubalus baccifer* 2 (r), *Fallopia dumetorum* 5 (+), **Melandrium album* 9 (+), 11 (+), *Symphytum officinale* 4 (+), **Tanacetum vulgare* 7 (+); **VI.** *Agrimonia eupatoria* 11 (+), *Agrostis gigantea* 1 (1.1), *Clinopodium vulgare* 7 (+), 11 (+), *Galium album* 11 (+), *Linum usitatissimum* 9 (+), *Moehringia trinervia* 2 (+), 6 (+), *Myosotis palustris* 3 (r), *Oxalis acetosella* 6 (+), *Plagiomnium affine* d 6 (+), *P. elatum* d 7 (1.2), *Polygonum minus* 4 (+), *Primula veris* 7 (+), *Rubus idaeus* 7 (+), *Stachys palustris* 1 (+), *Taraxacum officinale* agg. 7 (+), *Trifolium medium* 7 (+)

**Explanations:** AB – Andrzej Brzeg, W&W – Wojciech Rakowski & Wojciech Stachnowicz; EC – *Euonymo-Cornetum sanguinei*, FA – *Fraxino-Alnetum*, Cp – *Cephalarietum pilosae*, AA – *Agropyro repentis-Aegopodietum podagrariae*

investigated area, it was growing on mineral-humified soils and humified black turf soils. The soil reaction varied from slightly alkaline to alkaline (pH in KCl 7.30-8.40, in $H_2O$ 7.70-8.55); a moderately acid to neutral reaction was observed only in the lowest horizons of the soil profile (Kosakowski 1994). These soils were poor in calcium carbonate $CaCO_3$, the content of which varied from 0.25 to 0.34%.

In the investigated area, the species was observed in 2007 in at least 11 types of plant communities; most frequently in the following ones: *Carduo crispi-Rubetum caesii*, *Cephalarietum pilosae, Agropyro-Aegopodietum podagrariae*, *Eupatorietum cannabini*, *Euonymo-Cornetum sanguinei*, *Fraxino-Alnetum* (Table 1) and *Querco-Ulmetum minoris*. Its local phytocoenological scale may be considered as quite well recognised, because we penetrated most of the forestry sections.

In the Będlewo Forestry, *Virga pilosa* grew mainly on moist habitats of riparian forests. Many patches of these forests had a peculiar tree stand structure, full of gaps caused by dying of mature ash trees *Fraxinus excelsior*. Most of the above-mentioned habitats were therefore disturbed by forest service 'rebuilding' a tree stand by removing dying and dead specimens of ash *Fraxinus excelsior* and planting alder trees *Alnus glutinosa*. Hence, the vegetation of the Będlewo Forestry actually consisted of a mosaic of disturbed forest communities, secondary (substitute) thickets and herbal plant communities. As a light demanding species (cf. Ellenberg 1992; Zarzycki *et al*. 2002) *Virga pilosa* found

its optimum growth conditions in such habitats. Thus, the mentioned anthropogenic disturbance could have contributed to the species local expansion (including the effect of epizoochory etc.). Its occurrence in forest communities was documented by 2 phytosociological relevés (rel. 2-3, Table 1) representing the riparian alder--ash forest *Fraxino-Alnetum*, one patch of which (rel. 2) is floristically related to *Querco-Ulmetum minoris*. In many forest stands, *Virga pilosa* was very abundant under the tree canopy (rel. 3). Moreover, in some of such places it was even more abundant than in its own community of *Cephalarietum pilosae* (rel. 4-10, Table 1). Additionally, the occurrence of *Virga pilosa* in natural thickets of *Euonymo-Cornetum* was also documented (rel. 1, Table 1). One of the investigated phytocoenoses of *Cephalarietum pilosae* (rel. 8) was floristically related to tall herb and climbing communities of the *Calystegion sepium* alliance. On the other hand, the last relevé in Table 1 (made by Brzeg in 1992) was finally interpreted as representing a separate forest edge community of *Agropyro-Aegopodietum podagrariae* (already partially overgrown by *Virga pilosa*). These examples, in our opinion, may illustrate both the relatively broader (than usually considered for a 'good' characteristic species of the *Galio-Alliarion* alliance) scale of *Virga pilosa*, as well as the probably on-going local ecological expansion of the species.

Some non-forest patches, usually dominated by *Virga pilosa,* could not be unambiguously classified to any of the vegetation types known from the area, e.g. the above-mentioned *Eupatorietum cannabini, Agropyro-Aegopodietum* or *Euonymo-Cornetum.* They were classified as a separate community described as *Cephalarietum pilosae* Jouanne 1927 and documented by relevés 4-10 in Table 1. In the investigated patches we also recorded a significant presence of species representing the *Alnion incanae* alliance. Among them, the most frequent were: *Festuca gigantea*, *Ficaria verna* and *Stachys sylvatica*. The second species was not recorded in the relevés made in 2007, because the investigations were carried out in late summer.

Some patches of *Cephalarietum pilosae* from the Będlewo Forestry (e.g. rel. 10, Tab. 1) were closely linked to herb communities of the *Aegopodion podagrariae* alliance, such as the mentioned *Agropyro-Aegopodietum podagrariae* (rel. 11). They may be considered as representing the sub-association *C. p. aegopodietosum podagrariae* described by Müller (1993) from the Southern Germany. This syntaxon is distinguished by the following diagnostic species: *Aegopodium podagraria*, *Anthriscus sylvestris*, *Lamium maculatum* and others. Phytocoenoses of such a type could have developed in the consequence of overgrowing such communities as *Chaerophylletum aromatici* or *Agropyro-Aegopodietum* (rel. 11) by expansive populations of *Virga pilosa*.

According to our investigations in the studied area, *Virga pilosa* has quite a broad phytocoenotic scale limited not only to herbal forest edge communities. The species is linked with habitats of riparian forests and it is also able to form a separate herbal community of *Cephalarietum pilosae*, which develops in forest gaps and at its edges along roads.

## 4. General discussion

### 4.1. Regional status of *Virga pilosa* in the light of its distribution in Central Europe

Considered in a broad, (supra-)regional scale, the above discussed local distribution pattern may be treated as a single locality (Figs. 1-2) comprising a stable population of *Virga pilosa* remaining, so far, almost completely within a compact forest complex. From the regional point of view, the discussed locality is evidently a new one to the large Wielkopolska Province (as it has not been listed by neither e.g. Szulczewski 1951, nor Żukowski & Jackowiak 1995 or Jackowiak *et al*. 2007), whereas from the national perspective (cf. Zając & Zając 2001), it is an isolated locality of this rare species in Poland. The slightly updated distribution map (Fig. 2) shows that *Virga pilosa* appears to be significantly more frequent in the south of Poland.

As far as the general species range is considered, the discussed locality is most probably situated outside a compact part of the *Virga pilosa* geographic range (cf. a map by Meusel & Jäger 1992 and its new version updated by us for Central Europe – Fig. 3). *Virga pilosa* (= *Dipsacus pilosus*) is a widely distributed European species (Rothmaler *et al*. 1994). Since the first half of 20th century (Hegi 1906-1936), it has been known from the following countries: England, France, Spain, Belgium, Netherlands, Denmark, Germany, Switzerland, Austria, Hungary, N Italy, N parts of the Balkan Peninsula, S Russia, Caucasus and in some parts of Turkey. Although among the above-listed (by Hegi) countries there were no references to Poland, it should be now generally accepted that a considerable section of its N distribution limit stretches across Central Europe, precisely, it goes through Poland and Germany (Hultén & Fries 1986; Meusel & Jäger 1992). Considering recently published chorological data obtained from Germany (Haeupler *et al*. 1989; Benkert *et al*. 1996) and Poland (Zając & Zając 2001), we found the necessity for updating this part of the species range and took opportunity to publish it in this article (Figs. 3-4). In this light it can be more precisely said that the investigated locality in Wielkopolska seems to be indeed situated outside a compact geographical range of the species (Fig. 3), which appears to comprise only S parts of Poland (Figs. 2, 4).

The status of *Virga pilosa* in the whole Poland seems to remain still disputable: there is no clear answer,

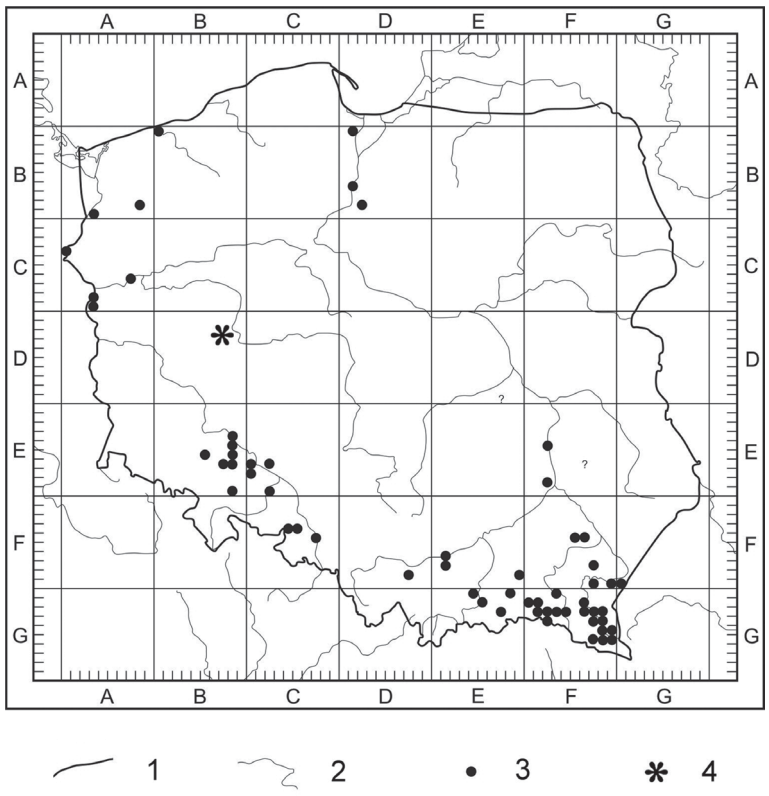


**Fig. 2.** An updated distribution of *Virga pilosa* in Poland

Explanations: 1 – border of Poland, 2 – main rivers, 3 – localities of *Virga pilosa* published in the national atlas (Zając & Zając 2001), 4 – new locality of *V. pilosa* in the middle part of Wielkopolska


**Fig. 3.** Distribution of *Virga pilosa* in Europe (acc. to Meusel & Jäger 1992; updated and modified)

Explanations: 1 – phytogeographical range, 2 – uncertain parts of phytogeographical range, 3 – new, separated locality of the species in Wielkopolska (Poland)

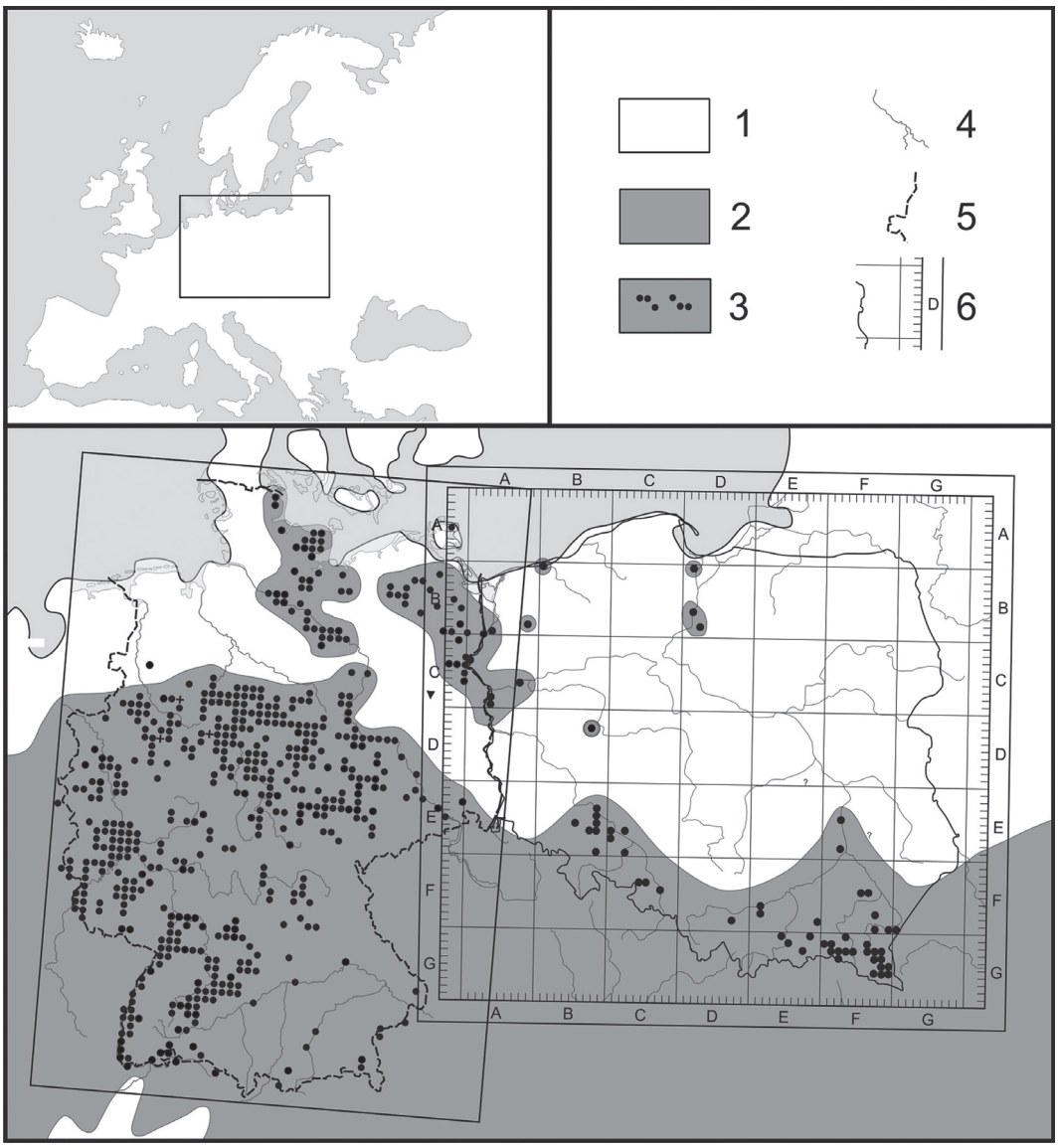


**Fig. 4.** Central European part of the geographical range of *Virga pilosa*, where the species reaches its northern distribution limits
Explanations: 1 – range of the main map, 2 – the European range of *Virga pilosa* (Meusel & Jäger 1992; updated and modified), 3 – cartogram data (according to: Haeupler *et al*. 1989; Benkert *et al*. 1996; Zając & Zając 2001; updated), 4 – main rivers, 5 – borders of Germany, 6 – borders of Poland and the national square grid (ATPOL)

whether it is a native or alien species in the country (cf. Zając & Zając 2001; Mirek *et al*. 2002). It is undoubtedly a rare species in Poland, because it occurs in less than 100 localities and a decrease in this number or in the number of individuals was observed within the last decade (Zarzycki *et al*. 2002). In neighbouring countries, the species is also not frequent: in the red list of the Czech Republic it is regarded as vulnerable (Procházka 2001), while in Germany it is considered as threatened only regionally (Korneck *et al*. 1996).

Consequently, there may be even more doubts as far as the origin of the species in the Wielkopolska region is considered. There are two possible answers: (1) it may be considered as a regionally extremely rare, though native taxon, which is, however, locally frequent or (2) as a newly established and potentially expansive alien. None of these claims, however, seem to be undisputable.

If the first answer is correct, it must be assumed that the species has arrived to the investigated locality due to some unknown, though natural reasons. Considering linear parts of the species chorology (particularly in Germany), Burkart (2001) regarded *Virga pilosa* as one of the so-called river corridor plants in Central Europe. Although this statement may be discussed, especially in the light of the species distribution pattern in Poland – namely, a concentration of its localities in the southern part of the country (Fig. 2), it still seems reasonable that plants which prefer riparian habitats may enlarge their ranges using large rivers as potential corridors of expansion. In this context we considered the investigated locality in relation to its distance to the Warta river valley (i.e. its contemporary floodplain terrace), which is at least 10 km in a straight line (Fig. 1). Moreover, despite comprehensive geobotanical in-

vestigations carried out by one of the authors since 2007 onwards, not only in the adjacent part, but also in other sections of the valley of the Warta river (Stachnowicz, unpubl. data; cf. also Borysiak 1994; Ratyńska 2001), no other locality of *Virga pilosa* has ever been found in Wielkopolska. Additionally, in the discussed case it seems hardly possible for the species' propagules to be transported from the river valley to the Będlewo Forest, which is quite a large distance, only by means of hydrochory. Precisely, that would require a migration of more than 10 km against the current of the main water course – the Mosiński Canal (Fig. 1) which flows through the Będlewo Forestry to the River Warta.

Another possible natural distribution way seems to be zoochory. There is no data available on the species potential endozoochoric dispersion, although it seems rather less probable considering the plant's habit and especially the presence of numerous bristles on its leaves and inflorescences. As far as epizoochory is considered, there are two possible units which may be occasionally transported by wild animals on their hair: (a) larger parts of plants such as, e.g., whole clusters of fruits (heads) with covering leaves which contain many hairs or (b) fruits or seeds alone. The second possibility was a subject of experimental studies by Römermann *et al*. (2005), who investigated the potential attachment of various seeds to sheep and cattle coat. According to these authors, there were no correlations between the seed shape and their attachment potential. They concluded that regardless of seed morphology, seeds do not keep attached to cattle hair, if they exceed a certain mass, which is ca. 10 mg. In this light the seeds of *Virga pilosa* may be considered as moderately attachable because their mass was 5.30 mg and they were classified as possessing no appendages and the measured and predicted attachment potentials of sheep wool were 22.67% and 34.03% respectively, whereas in case of the cattle hair, it was only 0.67% and 2.21% respectively (Römermann *et al*. 2005). However, in the case of *Virga pilosa*, it seems that a real diaspore is not the seed alone but the whole fruit (nut) with an appendage (Klotz *et al*. 2002) and it is not clear whether the former authors meant the same using the term seed in a more popular sense.

Moreover, it should be mentioned that classical epizoochory may not necessarily be the only potential way of the species dispersion. The species could have been transported anthropogenically, though unintentionally. One could easily imagine, for instance, that numerous propagules of these highly productive plants could have been attached to dirty tyres of tractors and other vehicles coming from farmlands to the forest roads. The investigated forest complex is surrounded from the North and West by extensive agricultural farms, often pastured. Although the species was not frequently observed there and it rather seemed that current local distribution centre was probably situated inside the forest complex (Fig. 1), it could also be explained as an effect of its further, ecological expansion within more suitable intra-forest habitats, whereas, possibly, the initial, agricultural localities, may have been less stable in time.

Aside from the mentioned potential epizoochoric capacity and the presence of arable fields, pastures etc. in the direct neighbourhood of the discussed forest complex, what else would support a second hypothesis, i.e. of anthropogenic origin of the investigated locality? In our opinion, a considerable suggestion may be derived from what we already know for sure about the presence of *Virga pilosa* in Wielkopolska. This is simply a case of one locality on which the species has probably been present for ca. 20 years or longer. Despite a relatively good recognition of regional flora (cf. e.g. Szulczewski 1951; Żukowski & Jackowiak 1995 and extensive herbarium collections deposited at the Adam Mickiewicz University), and particularly the flora of vascular plants of the adjacent Wielkopolski National Park (Żukowski *et al*. 1995) or the Natura 2000 SAC Rogalińska Dolina Warty (PLH300012 in Fig. 1; Stachnowicz, unpublished), it seems to have been, so far, virtually no evidence of any other locality of *Virga pilosa* within a large, middle part of Wielkopolska. If we now consider the above-documented good condition and quite broad local syn-ecological scale of the species within the investigated forest complex, its locally high frequency and a viable population, it seems obvious that a lack of any other sites occupied by *Virga pilosa* within similar forest types (even on the opposite side of the Mosiński Canal; Fig. 1), which are not rare in the region, makes its earlier presence in Wielkopolska highly improbable. Consequently, it turns us to the conclusion, that the presence of the discussed species in Wielkopolska may be an effect of recent, probably accidental introduction by man. This claim may be even more justified, while taking into account a few biological features of *Virga pilosa* – as a potentially expansive alien – which will be discussed later.

### 4.2. *Virga pilosa* as a structural component of vegetation: *Cephalarietum pilosae*

In Central Europe, according to Ellenberg (1992), Mucina (1993), Müller (1993), Pott (1995) and Rothmaler *et al.* (2002), *Virga pilosa* may be considered as a diagnostic species of the *Galio-Alliarion* alliance and the *Cephalarietum pilosae* association (see Chapter 3.2.). In Slovakia, the species was documented, with high abundance, in the patch of *Chrysosplenio-Petasitetum hybridi* Hadač et Soldán 1989 of the *Aegopodion podagrariae* (= *Petasition officinalis*) alliance (Bernátová *et al*. 2002). In another community of the same alliance, i.e. *Urtico-Parietarietum officinalis* Segal in Mennema

**Fig. 5.** A community dominated by *Virga pilosa* (*Cephalarietum pilosae*) – at the edge of a riparian forest (photograph by W. Stachnowicz)

**Fig. 6.** Young rosettes of *Virga pilosa* often observed in the vicinity of mature plants in the investigated site (photograph by W. Stachnowicz)

**Fig. 7.** Flowering inflorescences (heads) of *Virga pilosa* in the investigated locality (August 2007; the Będlewo Forestry, middle Wielkopolska; photograph by W. Stachnowicz)

*et* Segal ex Klotz 1985, *Virga pilosa* was reported from the Czech Republic (Kochjarová *et al*. 2005).

It was Brzeg (1989), who first suggested the probability of occurrence of the *Cephalarietum pilosae* association in Poland. As it was mentioned above, the first phytosociological records were made by this author in the Będlewo Forestry in 1992 (Table 1, rel. 6-7, 9-11). Thus, *Cephalarietum pilosae* was listed by Brzeg & Wojterska (2001) as a plant community undoubtedly occurring in Wielkopolska, however, there has been no published phytosociological documentation from the region up to date. The association was reported also from: Austria (Mucina 1993), Croatia (Markovič & Regula-Bavilaqua 1988), Czech Republic (Chytrý & Rafajová 2003) and Germany (Pott 1995). It is considered as a threatened plant community in Wielkopolska (Brzeg & Wojterska 2001) and in Germany (Rennwald 2000).

According to Müller (1993), *Cephalarietum pilosae* is linked to habitats of potentially riparian forests, however, it was observed also within more dry forests from the alliances: *Carpinion betuli*, *Fagion silvatici* and *Tilio-Acerion pseudoplatani*. Patches of this association occur on moderately sunny sites with moist and quite rich in nutrients soils (Mucina 1993, Müller 1993). It is distinguished by the dominance of *Virga pilosa* which is the only diagnostic species. However, as shows Table 1, *V. pilosa* is also able to grow very abundantly in other communities, even under forest canopy (rel. 3 in Table 1). Both in our and in other researchers' phytosociological documentation, a significant share of species diagnostic of the *Alnion incanae* alliance was observed, which suggests that *Cephalarietum pilosae* is frequently a substitute community of the potential riparian alder forests (*Fraxino-Alnetum*; Table 1).

### 4.3. *Virga pilosa* as a potentially expansive species

Regardless of the above-discussed native or alien species status in the flora of Poland and Wielkopolska, the results presented in this article seem to suggest that *Virga pilosa* may be considered as a locally (i.e. within the Będlewo Forestry) expansive taxon. In 2007, it was often found forming its own dense aggregations of many shoots reaching up to 2 m in height and documented (Table 1; Fig. 5) as a separate community, i.e. *Cephalarietum pilosae*. In such places, under the dense foliage of *Virga pilosa*, individuals of other plant species were usually significantly less abundant (Fig. 5). Moreover, on intra-forest ground roads and along them, young plant rosettes of *Virga pilosa* were often observed (Fig. 6) which may suggest that the species is capable of quickly taking over newly available and moderately disturbed space. Whether this is an early manifestation of the on-going invasion, may not be stated so far, but it seems quite probable that the species is at least potentially expansive. To seek an in-depth answer to this question one should take into consideration the species whole life history (acc. to Grime 2002) which includes also various measurable characteristics of its population structure and demographic features. Although detailed data were not available for *Virga pilosa* by the time of writing this article, it is generally considered as representing the Grime's type C (competitor) strategy (Klotz *et al.* 2002). In this context, below we would like to consider briefly some biological features of *Virga pilosa* which may be of importance.

As most of the *Dipsacaceae* family, *Virga pilosa* is a hemicryptophyte with a primary storage root and winter-green leaves in a rosette (Fig. 6). Sometimes, the species is considered to be biennial (Clapham *et al.* 1987), though its lifespan can also be pluriennial (Klotz *et al*. 2002). In summer, the plant produces a branched stem which reaches up to ca. 2 m in height and is ended by numerous heads (1-2 cm in diameter) containing several white or yellowish flowers (Fig. 7). These inflorescences appear to be easily accessible to bees and other pollinating insects. It seems, therefore, highly probable that it may be a combination of a very effective sexual reproduction and a relatively durable life form, which is responsible for the locally observed spread of the species.

## 5. Final conclusions: naturalization or local invasiveness?

Taking into account the above arguments, we cautiously conclude that, from a local and regional perspective (i.e. in the Province of Wielkopolska), *Virga pilosa* should be regarded as a recently established and probably alien species. Similarly the species is treated as a casual alien in Ireland (Reynolds 2002) and even in Great Britain, where some authors (Clapham *et al*. 1987) considered it to be "native in S Russia and Ukraine but introduced and naturalized elsewhere in Europe". Perhaps that last quotation is an example of more islander's than European point of view but it, consequently, may also provoke further questions, such as whether the species should be treated as naturalized and (potentially) invasive in some areas?

It seems acceptable that according to definitions proposed by Richardson *et al*. (2000), a species considered to be alien in a particular region may be regarded as naturalized there, if it reproduces freely and "sustains its populations (without or in spite of human interventions) over many life cycles". However, crossing over a reproductive barrier (i.e. a successful production of reproductive offspring) is not enough for an alien species to be regarded as invasive (Richardson *et al*. 2000). In this case, a production of reproductive offspring must take place "at a considerable distances from parent plants",

at least approximately of more than 100 m, within less than 50 years for taxa spreading by seeds (Richardson *et al*. 2000). In the light of our observations, this condition appears to be fully met in the investigated area (i.e. up to approx. 4 km within ca. 15-20 years; Fig. 1). Thus, in our opinion, *Virga pilosa* may be regarded in the region of Wielkopolska as probably alien, though still rare, recently established and locally well-naturalised, thus potentially expansive species. On the other hand, in the light of available (supra)national chorological data (Figs. 2-3), it seems that *V. pilosa* is probably native in the south of Poland.

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