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Phytogeographical and syntaxonomical dependence of species reaching their western and northwestern limits of distribution in Poland

MARIA ZAJĄC AND ADAM ZAJĄC

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ABSTRACT: Eighteen species reaching their western and northwestern limits of distribution in Poland were selected from the ATPOL floristic data bank. Their distribution in Poland, phytogeographical elements and syntaxonomical affiliations were described. Cartograms were used to show their concentrations in Poland.

KEY WORDS: vascular plants, distribution limits, Poland

M. Zając and A. Zając, Department of Taxonomy of Plants and Phytogeography, Institute of Botany, Jagiellonian University, Lubicz 46, PL–31–512 Kraków, Poland; e-mail: zajacm@ib.uj.edu.pl; zajac@ib.uj.edu.pl

OBJECTIVE OF THE STUDY

One promising direction of research on the Holocene history of the flora of Central Europe is to study the distribution ranges of plant species in Poland with reference to their general distribution ranges and their possible syntaxonomic correlations.

Species reaching their western and northwestern limits of distribution in Poland were selected from the ATPOL floristic data bank. This study presents their concentrations and considers their general ranges as well as their affiliations to certain types of communities. Using data from the same source, similar studies were completed for species reaching their southwestern limits of distribution in Poland (Zając & Zając 2001). These were taxa of general Boreal distribution ranges, occurring in concentrations within the Northern Division and associated with the northeastern part of the distribution range of spruce in Poland.

SELECTION OF SPECIES FOR ANALYSIS

Selected for the study were species whose western or northwestern limits of distribution run almost completely across Poland from north to south or southwest. Several taxa reaching their western limits

nearly along the western national boundary of Poland were also included. Table 1 lists the species investigated. Figs 1, 2 and 3 present cartograms with the distribution ranges of the aforementioned species. The group selected is relatively small. It would have been much larger had the study included taxa having their limits of distribution in the eastern part of Germany (Benkert *et al.* 1998).

Table 1. Species of vascular plants reaching their western and northwestern limits of distribution in Poland. (E) – range extends east.

Species	Type of range	Syntaxonomical unit
Adenophora liliifolia (L.) Besser	Euro-Siberian (disjunctive)	*Querco-Fagetea*
Androsace septentrionalis L. subsp. *septentrionalis*	Euro-Siberian	*Sedo-Scleranthetea*
Asperula rivalis Sibith. & Sm.	Euro-Siberian	*Querco-Fagetea*
Carex pilosa Scop.	Central European (E)	*Querco-Fagetea*
Chamaecytisus ratisbonensis (Schaeff.) Rothm.	Central European (E)	*Vaccinio-Piceetea*
Chamaecytisus ruthenicus (Fisch. *ex* Woł.) Klásk.	Euro-Siberian (Western)	*Querco-Fagetea*
Cimicifuga europaea Schipcz.	Euro-Siberian (disjunctive)	*Querco-Fagetea*
Eryngium planum L.	Central European (E)	*Sedo-Scleranthetea*
Euonymus verrucosus Scop.	Euro-Siberian (Western)	*Querco-Fagetea*
Galium schultesii Vest	Central European (E)	*Querco-Fagetea*
Isopyrum thalictroides L.	Central European	*Querco-Fagetea*
Koeleria grandis Besser *ex* Gorski	Euro-Siberian	*Sedo-Scleranthetea*
Ononis arvensis L.	Euro-Siberian (Western)	*Festuco-Brometea*
Pulsatilla patens (L.) Mill.	Central European (E)	*Vaccinio-Piceetea*
Ranuncuslus cassubicus L. *s.l.*	Euro-Siberian (Western)	*Querco-Fagetea*
Succisella inflexa (Kluk) Beck	Central European	*Molinio-Arrhenatheretea*
Trifolium lupinaster L.	Euro-Siberian	*Vaccinio-Piceetea*
Valeriana simplicifolia (Rchb.) Kabath	Central European	*Scheuchzerio-Caricetea fuscae*

Structure of distribution ranges within Poland

The species having their western and northwestern limits of distribution in Poland fall mainly into two groups. The first type, an example of which could be *Asperula rivalis*, have distribution limits cutting across Poland from northeast to southwest. This type could include *Carex pilosa*, *Chamaecytisus ratisbonensis*, *Galium schultesii*, *Isopyrum thalictroides* and *Ranunculus cassubicus*. A common feature of their distribution in Poland is that they do not occur in western Pomerania and in the greater part of the Wielkopolska region (only sometimes they penetrate into its southern fringes). The second type of distribution is represented by species whose distribution limits in Poland run from north to south at various longitudes. *Euonymus verrucosus* is a typical example. *Adenophora liliifolia*, *Cimicifuga europaea*, *Chamaecytisus ruthenicus*, *Koeleria grandis*, *Succisella inflexa* and *Trifolium lupinaster* have similar ranges. What their ranges have in common is that they usually do not occur in Lower Silesia, or else have only a few stations there outside of their continuous ranges. The remaining five species require separate comments. Two of them, namely *Androsace septentrionalis* subsp. *septentrionalis* and *Pulsatilla patens*, reach almost to the western border of Poland (they have only single

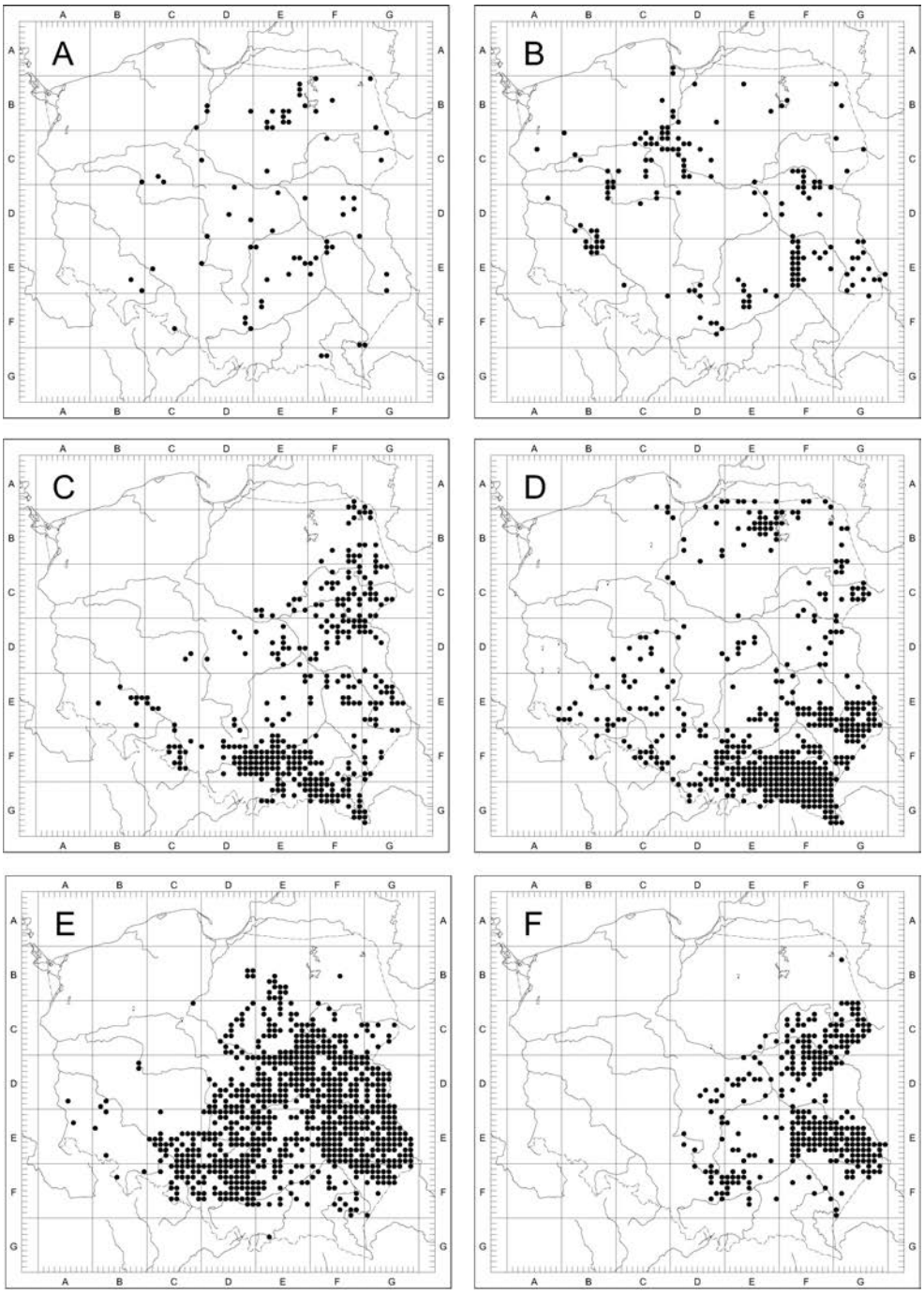

Fig. 1. Distribution of: A – *Adenofora liliifolia* (L.) Besser; B – *Androsace septentrionalis* L. subsp. *septentrionalis*; C – *Asperula rivalis* Sibith. & Sm.; D – *Carex pilosa* Scop.; E – *Chamaecytisus ratisbonensis* (Schaeff.) Rothm.; F – *Chamaecytisus ruthenicus* (Fisch. *ex* Woł.) Klásk. in Poland. ● – natural station; ? – uncertain station; ❍ – synanthropic station; Δ – station with uncertain status.

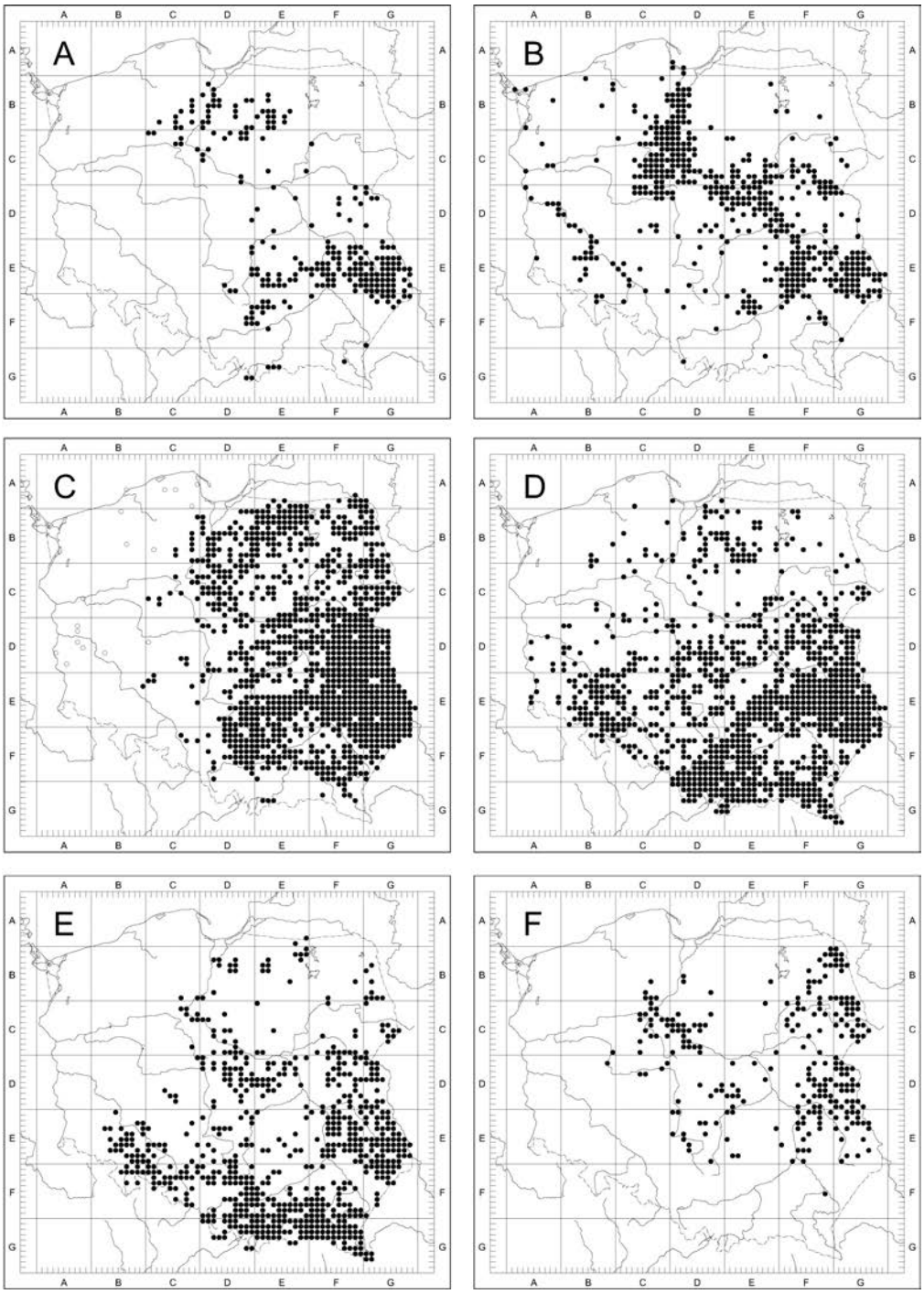

Fig. 2. Distribution of: A – *Cimicifuga europaea* Schipcz.; B – *Eryngium planum* L. C – *Euonymus verrucosus* Scop.; D – *Galium schultesii* Vest; E – *Isopyrum thalictroides* L.; F – *Koeleria grandis* Besser *ex* Gorski in Poland. Explanation of the symbols as in Fig. 1.

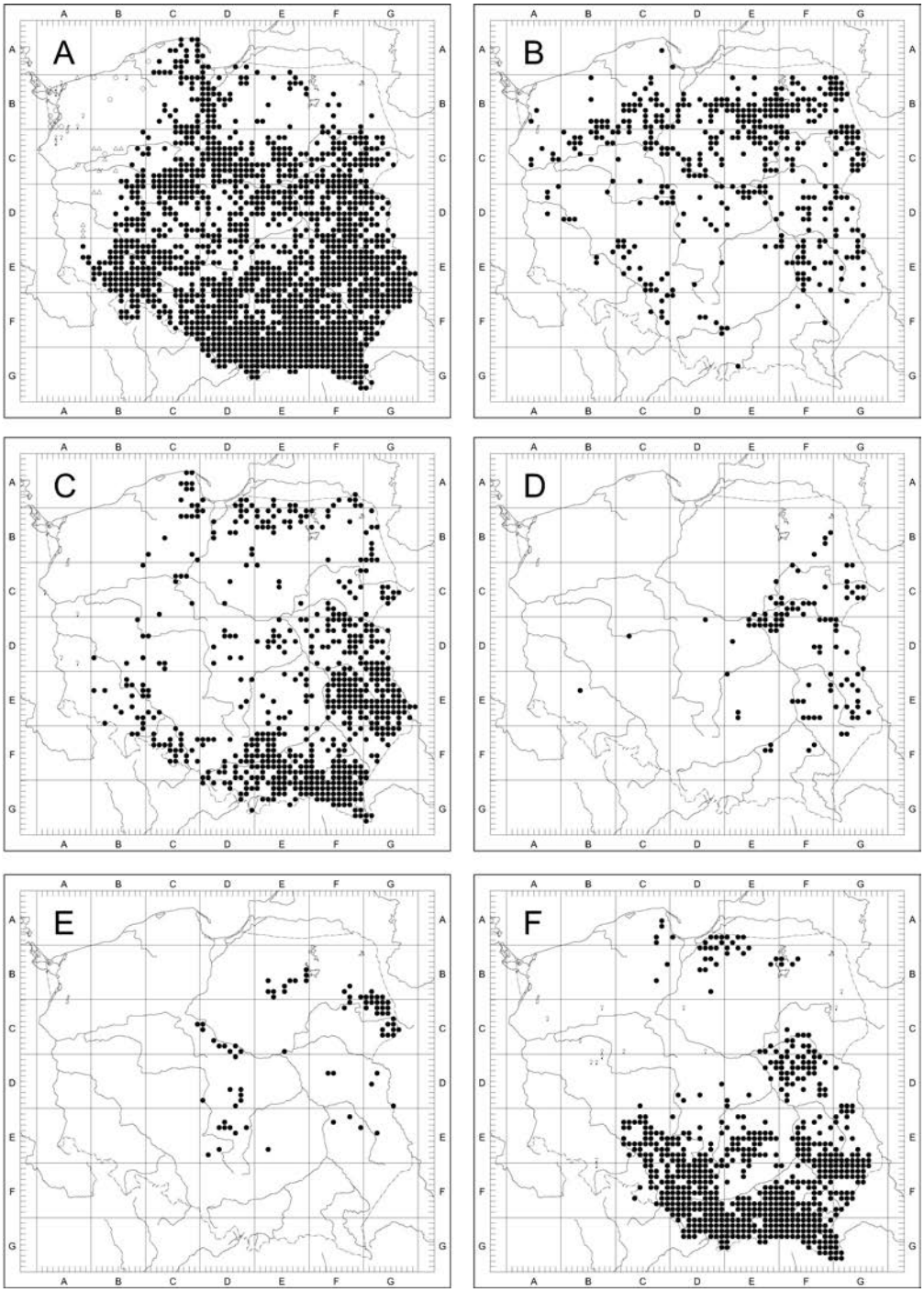

Fig. 3. Distribution: A – *Ononis arvensis* L.; B – *Pulastilla patens* (L.) Mill.; C – *Ranunculus cassubicus* L. s. l.; D – *Succusella inflexa* (Kluk) Beck; E – *Trifolium lupinaster* L.; F – *Valeriana simplicifolia* (Rchb.) Kabath in Poland. Explanation of the symbols as in Fig. 1.

historical stations west of the Odra River – Benkert *et al.* 1998). *Eryngium planum* has an extremely interesting distribution range. It includes the Vistula River valley and adjacent areas together with the eastern tributaries, and the middle Odra River valley, where this species has become rare. West of Poland the species has only single stations, perhaps synanthropic. No information is available on whether it retains this range characteristic further east, accompanying wide valleys of lowland rivers, or whether this is true of the range only near its western limit. Also interesting is the range of *Ononis arvenis*, a common species in southern and central Poland. In the northwest and west its dispersed stations require revision. Some of them are definitely ruderal sites, and some are misidentifications of plant material. The species penetrates north with a larger number of sites only through the Vistula River valley. In the eastern part of Germany it is only a very rare anthropophyte. *Valeriana simplicifolia* has a completely different type of distribution. It has a disjunctive range. The southern part corresponds with the first group of species described above, with limits of distribution running from northeast to southwest. The northern part, separated widely from the other one, covers the Pojezierze Mazurskie and Pojezierze Gdańskie lake districts. Perhaps such a type of range is associated with Holocene climatic changes and the division of the area into two parts.

General ranges

The geographical elements corresponding to the species reaching their western or northwestern limits of distribution in Poland are compiled in Table 1. They were classified according to the definitions given by Pawłowska (1977), on the basis of the distribution maps contained in the following works: Trumel (1948), Meusel *et al.* (1965), Zieliński (1974), Meusel *et al.* (1978), Hultén and Fries (1986) and Meusel and Jäger (1992). More detailed references to particular maps are given in Zając 1992. As might be inferred from their distribution limits in Poland, principally they represent two subelements: Euro-Siberian (10 species) and Central European (8 species). Two species, *Adenophora liliifolia* and *Cimicifuga europaea* have Euro-Siberian ranges with wide disjunctions between the European parts and the Far Eastern parts of the range in Asia. Four species of the Euro-Siberian subelement (*Chamaecytisus ruthenicus, Euonymus verrucosus, Ononis arvensis, Ranunculus cassubicus*) have their ranges limited to the western part of Siberia. Five species of the Central European subelement (*Carex pilosa, Chamaecytisus ratisbonensis, Eryngium planum, Galium schultesii, Pulsatilla patens*) have ranges clearly extending east, into the East European Lowland. The remaining species classified in this subelement, namely *Isopyrum thalictroides, Succisella inflexa* and *Valeriana simplicifolia*, have relatively narrow ranges. Their eastern limit runs close to the eastern border of Poland. It is a very interesting group whose Quaternary history calls for dedicated research; the major part of their range is within the maximum extent of the Pleistocene glaciation.

The group of species under study has the center of its range on the East European platform. The evolutionary connections of these plants with close Asiatic species require separate studies.

Syntaxonomic characteristics

The general phytosociological characteristics of the species are provided in Table 1. It shows that the highest number of species (9) have their habitats in deciduous forests of the *Querco-Fagetea* class. However, when lower syntaxonomic units are considered it turns out that this group is not homogenous. *Adenophora liliifolia* and *Cimicifuga europaea* are associated with secondary communities of the order *Quercetalia pubescentis*, and – in the past – with other types of temperate oak woods. The remaining species are associated with fertile forest of the order *Fagetalia silvaticae* (*Asperula rivalis*, *Carex pilosa*, *Chamaecytisus ruthenicus*, *Euonymus verrucosus*, *Galium schultesii*, *Isopyrum thalictroides*, *Ranunculus cassubicus*). Three of the species studied (*Chamaecytisus ratisbonensis*, *Pulsatilla patens*, *Trifolium lupinaster*) are associated with various coniferous forest communities of the *Vaccinio-Piceetea* class. They occur in thin and fairly dry pine forests. The species connected with these include plants recently occurring in grasslands on sands (*Sedo-Scleranthetea* class), and primarily in thin and dry pine forests in gaps between trees (*Androsace septentrionalis* subsp. *septentrionalis*, *Eryngium planum*, *Koeleria grandis*). Several species of western provenance occur in Poland in grassland communities on sand. It seems that the eastern element entered them as secondary, being primarily associated with communities with manifestly different characteristics. Three species (*Ononis arvenis*, *Succisella inflexa*, *Valeriana simplicifolia*) represent types of habitats other than these described above. These are principally secondary habitats, and at present their original syntaxonomic affiliations cannot be given. *Ononis arvenis* occurs in xerothermic grasslands. Nevertheless, most of the stations in Poland occur in other communities. These are roadsides, forest fringes and sometimes ruderal habitats. Thus the distribution shown in the cartogram is definitely a secondary range of this taxon, and it is impossible to even guess the shape of its native distribution range. *Succisella inflexa* occurs on wet meadows. At present these are secondary communities, and there is no clue as to the primary habitat of this species. *Valeriana simplicifolia* occurs on bogs and peatland meadows in communities of the *Scheuzerio-Caricetea fuscae* class, and that seems to be its primary syntaxonomical characteristic.

Concentrations in Poland

In the software serving the ATPOL data base one of the options produces synthetic maps for any combination of species and represents them graphically as circles whose diameter reflects the number of species in a given cartogram unit. The best pictures, with the intensity of shading corresponding proportionally to the number of species, can be obtained when the second root of the diameter is taken as the measure of the number of species. The cartograms in Figures 4 and 5 were obtained by this method. The first one shows a synthetic picture of the distribution for all 18 species under study. The second cartogram shows only the species that occur in deciduous forests of the *Querco-Fagetea* class. All synanthropic stations, uncertain stations and those of uncertain status were deleted from the cartograms of individual species.

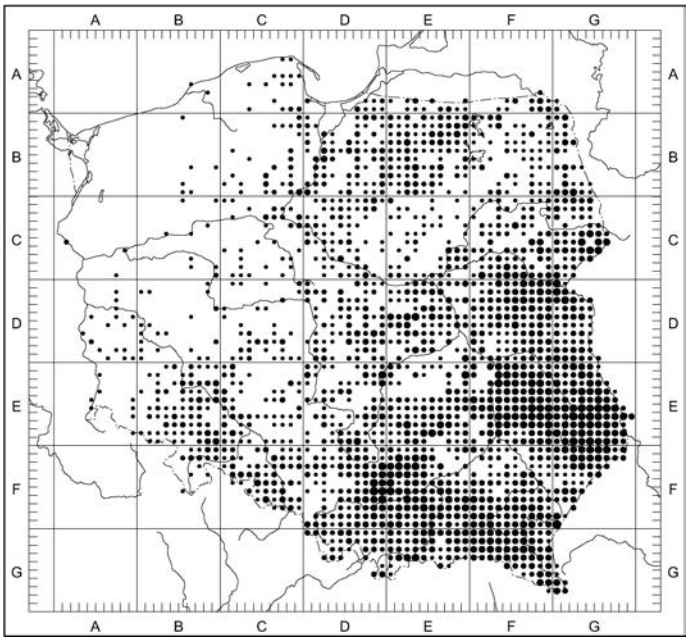

Fig. 4. Concentration of species with western and northwestern limit in Poland. For explanation see text.

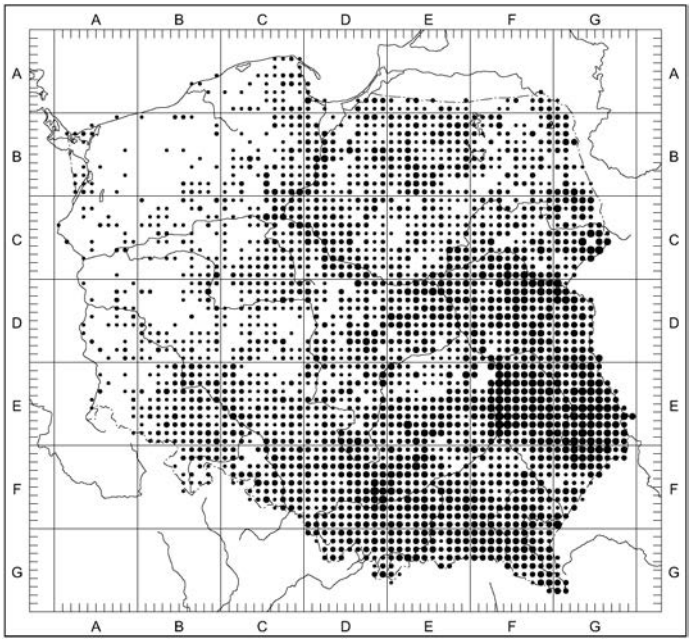

Fig. 5. Concentration of species of the *Querco-Fagetea* class with western and northwestern limit in Poland. For explanation see text.

The synthetic map for all species (Fig. 4) illustrates a gradual decrease in the number of species per cartogram unit going from east to west. Evidently more species reaching their western and northwestern limits in Poland are concentrated on the Wyżyna Lubelska upland and in the valleys of the Vistula and Bug Rivers. The synthetic map for taxa associated with deciduous forests (Fig. 5) gives a slightly different picture. The eastern half of Poland and the ranges in Lower Silesia are distinct. A local concentration also occurs in the western and central parts of the Pojezierze Mazurskie lake district. The synthetic cartograms (Figs 4 & 5) illustrate well the range characteristics of the species described.

Conclusions

The species reaching their western and northwestern limits in Poland are not a very large group in the flora of Poland. This results from their geographical characteristics, as most of them represent the Euro-Siberian and Central European subelements (the latter with an eastern extension). In the European Lowland, the stations of species of this type gradually diminish from east to west. The species that reach their distribution limits in Poland are perhaps more continental in their climatic requirements, or their westward expansion was slower than other species of similar geographic origin. The fact that the most numerous of them are the taxa associated with deciduous forests on the one hand and with thin coniferous forests on the other indicates that some of the species of the herbaceous layer of these forests migrated in the Holocene not from the south but from the east. On the isopollen maps for trees in Poland (Ralska-Jasiewiczowa 1983), *Quercus* approximately 8000 years ago shows a range similar to the species of deciduous forests occupying southeastern Poland. The density of the isopollen lines in this area is similar for *Carpinus* approximately 4000 years ago. Perhaps at least some of the species of deciduous forest shown in the cartograms arrived from the east also. A pine of the *Diploxylon* group, i.e. *Pinus sylvestris* (Huntley & Birks 1983), also arrived to Poland from this direction. The studied species associated with coniferous forests may have migrated from the east together with *Pinus sylvestris*.

Phytogeographical studies that search for certain common features of range and habitat for particular groups of species distinguished for their similarity of ranges within a particular area may allow us to put forward interesting hypotheses, which nevertheless have to be verified by other research methods.

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