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Western element in the vascular flora of Poland

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Abstract: The western element in the Polish flora was determined by using published cartograms of distribution of vascular plants in Poland. The species that reach their eastern, southeastern or northeastern limits in Poland were taken into account, except mountain taxa and the species whose limits roughly coincide with Polish borders or partly reach outside the Polish territory. Three distribution range groups of native plants and one of anthropophytes were identified. Possible correlations between general ranges and affiliations to one of the studied elements were tested. Affiliations of the classified elements to large syntaxonomic units were also studied.

Key words: vascular plants, western element, geographic element, syntaxonomic classification, Poland

1. Introduction

Identifying the geographic elements in a given area helps to locate the provenance of its flora. In Polish botanical literature the best definition of the geographic element has been provided by Pawłowska (1977). The first ever statistical comparison for the geographic element in Poland was based principally on data concerning distribution limits reached by particular species included in *Rośliny polskie* by Szafer et. al. (1953). Results of that comparison were presented by Kornaś & Medwecka-Kornaś (1986, 2002) in both editions of *Geografia roślin*. The subject of geographic elements has been addressed by several papers published in Poland. In her account of mountain plant species found in the Polish lowlands (Zając 1996) selected a group of ca. 100 species, mostly those having their northern limit of distribution in Poland and therefore included in the southern element. In two other reports (Zając & Zając 2000, 2001) discussed the issues concerning the species that reach in Poland their southwestern and western distribution limits, i.e. species of northeastern and eastern elements. An analysis of geographic elements has also been more recently applied by Kucharczyk (2003) in the phytogeographic monograph on the Middle Vistula River valley.

2. Material and methods

According to our calculations based on the ATPOL database of the *Distribution Atlas of Vascular Plants in Poland* (Zając & Zając 2001), the species with their eastern distribution limits in Poland account for 6.2% of the flora, whereas those reaching their southeastern limit, for only 1.3%, with the overall number of 2467 species present in the Polish flora.

For the purpose of this study, only some species were selected from the western element. They included the species that have their distinct eastern distribution limit in Poland, but those reaching it along the eastern borders of Poland or partly outside the Polish territory, were excluded. The species reaching their northeastern limit include also the mountain taxa occurring in the Sudety Mts., as well as those occurring in the Sudety Mts. and Northern Carpathians, but the mountain species were also left out of consideration.

Many of the species reaching their southeastern limits in Poland, are associated with the Baltic coast, as they grow on dunes or saline soils. This kind of reduction in the scope of species was necessary, because the objective of this study was to consider the factors that cause some species of completely different geographic elements and occupying sometimes extremely different habitats to have a similar distribution within Poland.

Cartograms, which show the collective distribution of species of the western, northwestern and southwestern elements, were drawn by using RAR software. The function of drawing collective maps was used where the diameter of the circle is the square root of the number of species occurring in a given cartogram unit, and the transition between particular values is smooth (hence,

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the explanations to figures do not include diameters of circles representing a specific number of species). In identifying geographic elements, our decisions were based on a paper on the geographic elements of the native vascular flora in Poland, currently being prepared for publication (Zając & Zając mscr.), while the establishment of syntaxonomic affiliation was based on a number of sources, not referenced here in detail, because it was established at a very high level (i.e. classes), where there is a certain tradition in placing taxa in particular categories.

3. Results and discussion

3.1. List of species

The analysis of maps of the *Distribution Atlas of Vascular Plants in Poland* (Zając & Zając 2001) allowed us to distinguish the species that reach in Poland the limits concerned. In all, we took into consideration 72 species (43 with an eastern limit, 15 with a north-eastern limit and 14 with a southeastern limit). The list included some species that had a few stations in the west of Poland, but whose affiliation to the western element was not in doubt.

Below, the species are listed in alphabetical order. The name of each species (acc. to Mirek *et al*. 2002) is followed by an abbreviated form of information on its affiliation to a geographic element and its syntaxonomic classification. For species with a broad ecological spectrum, the likely ecological optimum was chosen. The explanation of the abbreviations is given below the list:

Species with an eastern limit: *Aira carophyllea* (SA-CEw-M, Sed-Scler); *A. praecox* (SA, Sed-Scler); *Apium repens* (SA, Bid); *Batrachium fluitans* (CEw, Pot); *Bromus ramosus* (CEw, Epil); *Callitriche stagnalis* (SA-CE-M, Nan); *Cardamine parviflora* (CB(d), Nan?); *Carex arenaria* (SA-CE, Sed-Scler); *C. bohemica* (ES, Nan); *C. pulicaris* (SA-CE, Scheu-Car); *Chrysosplenium oppositifolium* (SA, Mont-Card); *Corriogiola litoralis* (SA-M, Nan); *Elatine hexandra* (SA-CE, Nan); *E. triandra* (CB(d), Nan); *Eleocharis multicaulis* (SA-Mw, Litor); *Erica tetralix* (SA, Oxyc-Sphag); *Galium pumilum* (CEw, Nard-Call); *G. sylvaticum* (CEw, Quer-Fag); *Gladiolus paluster* (CE-B, Mol-Arrh); *Hieracium prussicum* (CE, Sedo-Scler); *Juncus acutiflorus* (SA-CE-B, Mol-Arrh); *Lonicera peryclimenum* (SA, Quer rob-pet); *Luronium natans* (SA, Litor); *Minuartia viscosa* (CE-B, Sedo-Scler); *Montia fontana* s.l. (K?, Nan), *Oenanthe fistulosa* (SA-M, Phrag); *Ononis repens* (SA-Mw, Fest-Brom); *Ornithopus perpusillus* (SA-Mw, Sedo-Scler); *Pilularia globulifera* (SA, Litor); *Rosa zalana* (CE, Rham-Prun); *Rubus chaerophylloides* (CE, Rham-Prun); *R. gothicus* (CE, Rham-Prun); *R. lamprocaulos* (CE, Rham-Prun); *R. opacus* (CE, Rham-Prun); *R. pyramidalis* (CE, Rham-Prun); *R sprengelii* (CE, Rham-Prun); *Sagina ciliata* (K(s), Nan); *Scabiosa canescens* (CEw, Fest-Brom); *Sedum reflexum* (CEw-M, Sedo-Scler); *Silaum silaus* (SA, Mol-Arrh); *Sorbus torminalis* (SA-CE-M-IRw, Quer-Fag); *Stellaria pallida* (SA-CE-M-IRw, Nan); *Valeriana dioica* (CE, Mol-Arrh).

Species with a northeastern limit: *Apium nodiflorum* (A, Phrag); *Carex pseudobrizoides* (SA, Vacc-Pic); *Chamaecytisus supinus* (CEs-B, Vacc-Pic); *Dianthus caesius* (CE, Sedo-Scler); *Dichostylis micheliana* (K(s), Nan); *Potentilla sterilis* (SA, Quer-Fag); *Rubus angustipaniculatus* (CE, Rham-Prun); *R. capitulatus* (CE, Rham-Prun); *R. divaricatus* (CE, Rham-Prun); *R. guentheri* (CE, Rham-Prun); *R. hevellicus* (CE, Rham-Prun); *R. schleicheri* (CE, Rham-Prun); *Spergula pentandra* (SA-CE-B-M); *Trifolium striatum* (SA-CE-M, Sedo Scler); *Vulpia myuros* (SA-CE-M-IRw, Sedo-Scler).

Species with a southeastern limit: *Anthericum liliago* (CEw-M, Fest-Brom); *Apium inundatum* (SA-M, Litor); *Arum maculatum* SA-CE–M, Quer-Fag); *Carex ligerica* (CE-PONT, Sedo-Scler); *Corydalis pumila* (CE-B, Quer-Fag); *Dorycnium herbaceum* (SM, Fest-Brom); *Glaux maritima* (CE, Junc marit); *Isolepis supina* (K(s), Nan); *Juncus gerardi* (CB-IR, Junc marit); *J. subnodulosus* (SA-CE-B, Scheu-Car); *Leontodon taraxacoides* (SA-Mw, Mol-Arrh); *Oenanthe lachenali* (A-M, Phrag); *Rubus opacus* (CE, Rham-Prun); *Stipa borysthenica* (ESs, Fest-Brom).

[Explanations: **Geographic elements:** A = Atlantic; A-M = Atlantic-Mediterranean; CB (d) = Circumboreal (disjunctive); CB-IR = Circumboreal-Irano-Turanian; CE = Central-European; CE-B = Central-European-Balkan; CE-PONT = Central-European-Pontic; CEs-B = southern Central-European-Balkan; CEw = western Central-European; CEw-M = western Central-European-Mediterranean; ES = Euro-Siberian; ESs = southern Euro-Siberian; K = cosmopolitan; K(s) = cosmopolitan in the Old World; SA = Sub-Atlantic; SA-CE = Sub-Atlantic-Central-European; SA-CE-B = Sub-Atlantic-Central-European-Balkan; SA-CE-B-M = Sub-Atlantic-Central-European-Balkan-Mediterranean; SA-CE-M = Sub-Atlantic-Central-European-Mediterranean; SA-CE-M-IRw = Sub-Atlantic-Central-European-Mediterranean-western-Irano-Turanian; SA-CEw-M = Sub-Atlantic-western-Central-European-Mediterranean; SA-M = Sub-Atlantic-Mediterranean; SA-Mw = Sub-Atlantic-western-Mediterranean; SM = Sub-Mediterranean. Syntaxonomic affiliation (classes): Bid = *Bidentetea*; Epil = *Epilobietea angustifolii*; Fest-Brom = *Festuco-Brometea*; Junc marit = *Juncetea maritimi*; Litor = *Litorelletea*; Mol-Arrh = *Molinio-Arrhenatheretea*; Mont-Card = *Montio-Cardaminetea*; Nan = *Isoëto-Nanojuncetea*; Nard-Call = *Nardo-Callunetea*; Oxyc-Sphag = *Oxycocco-Sphagnetea*; Phrag = *Phragmitetea*; Pot = *Potametea*; Quer-Fag = *Querco-Fagetea*; Quer rob-pet = *Quercetea robori-petraeae*; Rham-Prun = *Rhamno-Prunetea*;

Scheu-Car = *Scheuchzerio-Caricetea fuscae*; Sed-Scler = *Sedo-Scleranthetea*; Vacc-Pic = *Vaccinio-Piceetea*.]

3.2. Distribution of species of the western element in Poland

The most numerous group among the studied species are those that reach in Poland their eastern limit of distribution. Their collective distribution in Poland is shown in Fig. 1. The eastern limit is clearly marked. Only few species with small numbers of stations cross the line of the Middle Vistula, whereas the places with obvious concentrated numbers of taxa appear up to the north-to-south line drawn along the valley of the lower section of the Vistula River. In this stretch, spanning from the western borders of Poland to the Lower Vistula valley, there are individual areas of exceptional density of taxa in the cartogram units. Lower Silesia with the Oder River valley, the environs of Poznań, Toruń and also Szczecin and Gdańsk could be distinguished within this stretch. In another stretch, with much more diluted records of taxa, to the east of the lower Vistula River line and further east, only a few species reach still further in the lowlands of Southern Poland than in the Masurian Lake District.

It is interesting to answer the question, what was the cause (or causes) behind the existence of such a limit for just this group of species? As shown by comparisons between the affinities of the species in this group to geographic elements, these causes were diverse (the issue is discussed later in this section). Again, as regards their habitats they are not a cohesive group either, and they occur in communities of extremely various phyto-sociological classes (high-level syntaxonomic units). In the monograph devoted to the phytogeography of northern Europe, Dahl (1998) published maps for Europe, where various synthetic data on climate are shown by isolines. These data were calculated also for the grid of the *Distribution Atlas of Vascular Plants in Poland* (Zając & Zając 2001). In principle, most of the isolines follow a latitudinal course, e.g. in case of precipitation, temperature in summer months, or length of the growing season. The only isolines running longitudinally across Central Europe and Poland in particular, are those representing the minimum

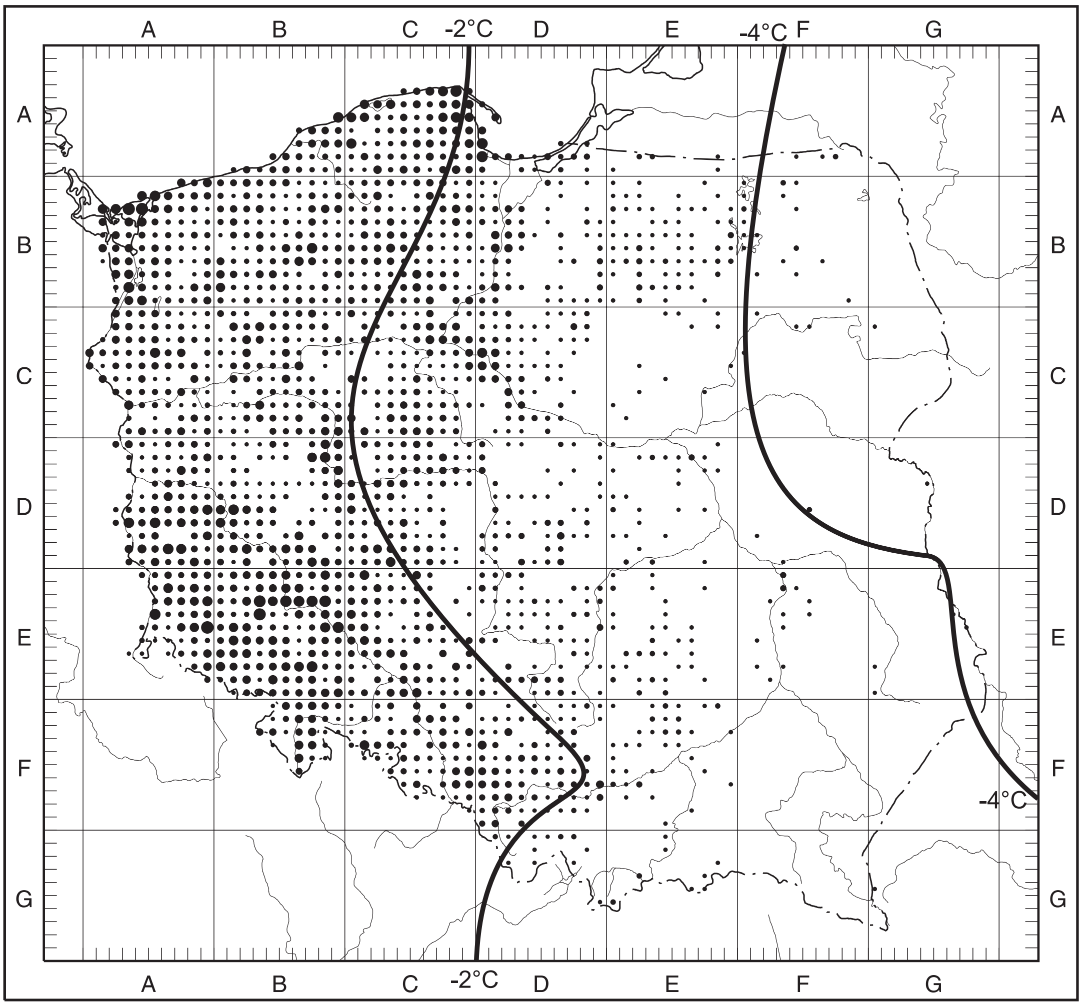

Fig. 1. Collective distribution of native taxa with eastern limits in Poland. The marked isolines represent the minimum temperatures for the coolest month of the year, calculated in relation to sea level (after Dahl 1998)

temperatures for the coolest month of the year (i.e. January), calculated in relation to sea level. Also, the climatic data compiled for Poland on transparent overlays in the *Distribution Atlas of Vascular Plants in Poland,* showing the average temperatures in January, display this kind of longitudinal arrangement. Again, the isolines of temperature fluctuations over the whole year are oriented nearly longitudinally. It seems that the extreme winter temperatures decreasing from west to east and the temperature differences increasing eastwards, are the most likely to be the reason for such a course of distribution limits.

The collective distribution of species with the northeastern limit is shown in Fig. 2. In the south, these species end their distribution range upon reaching the Middle Oder River valley. The distribution of these species in the area that they occupy is not uniform. They are concentrated in the valleys of the Oder, Lower Vistula and the Middle Warta River, while not occurring at all in many areas of Northern Pomerania. When trying to identify a relationship between the general range of this group and the climatic parameters, one can see that the limit lines correspond with the isoline of -2°C, calculated for the coolest month of the year in relation to the highest elevation above sea level in Europe (Dahl 1998). Therefore, it seems that in both cases discussed above, it is winter temperatures that limit the eastern spread of the species classified into these groups.

For the third group of species, which reach their southeastern limits in Poland, their general range is shown in Fig. 3. The figure shows evident concentrations of ranges of the species within the Lower Silesia region, including the Sudety Mts. As the mountain species were left out of consideration, these shown will be only plants colonizing the lower zones in mountains. Some of their scattered ranges obviously do reach further north with single stations (with a small 'island' in the Gdańsk Pomerania region) but the outline of the borders of the solid part of the range is unambiguous. On the climatic maps for Europe published by Dahl (1998), such a general range would correspond with two parameters. From the north it would be limited by the isoline of 400 mm

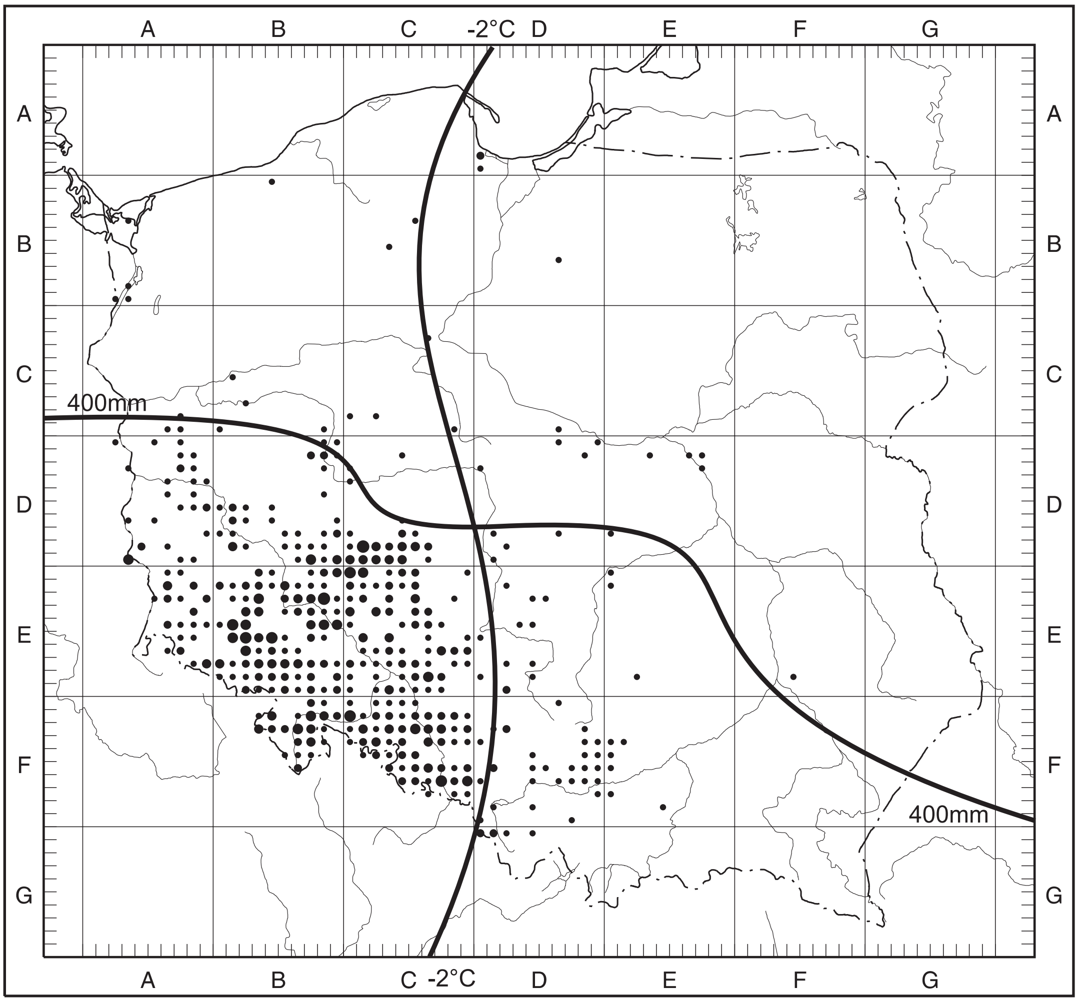

Fig. 2. Collective distribution of native taxa with northeastern limits in Poland. The vertical line is the isoline for –2°C, calculated for the coolest month of the year in relation to sea level, while the nearly horizontal line is the isoline of 400 mm average precipitation during the growing season (after Dahl 1998)

average precipitation during the growing season, whereas from the south – by the isoline of the average temperature of the coolest month of the year calculated in relation to sea level (-2°C).

This climate-based explanation of the limits reached by distribution ranges is probable. As the affiliation to a geographic element was given for all species, they are worthy of a closer look, even though there are no simple and evident correlations, as was mentioned at the beginning.

The comparison of geographic elements to which particular species are affiliated is shown in Fig. 4. The graph shows the evident predominance of species associated with the Atlantic province. The most numerous are Sub-Atlantic species or those of more extended ranges, e.g. Atlantic-Central-European. Also many are Central-European species of narrower ranges, not penetrating the Atlantic province. When viewing the list of taxa presented in Chapter 3.1, one can see that *Rubus* spp. predominate in the group with Central-European ranges. It seems that many of them do not penetrate into the Atlantic province, although this

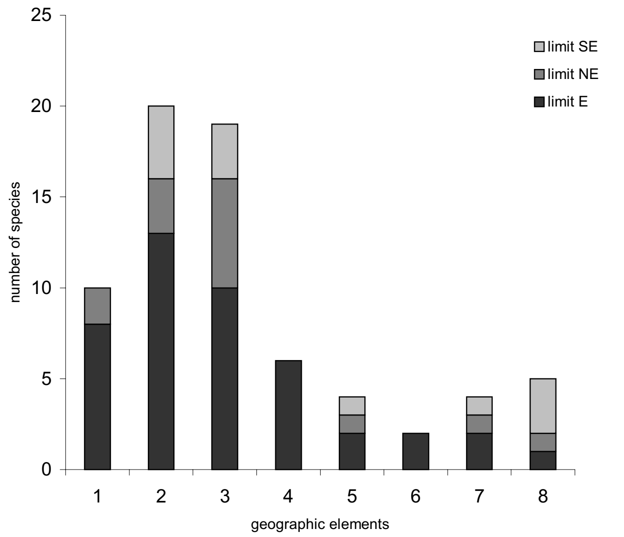

Fig. 4. Geographic elements among taxa with eastern, northeastern and southeastern limits in Poland: 1 – Sub-Atlantic taxa; 2 – taxa connected with the Atlantic region, with their ranges extending in various directions; 3 – Central-European taxa; 4 – western-Central-European taxa; 5 – Central-European-Balkan taxa; 6 – Circumboreal (disjunctive) taxa; 7 – cosmopolitan species; 8 – other types of distributional ranges

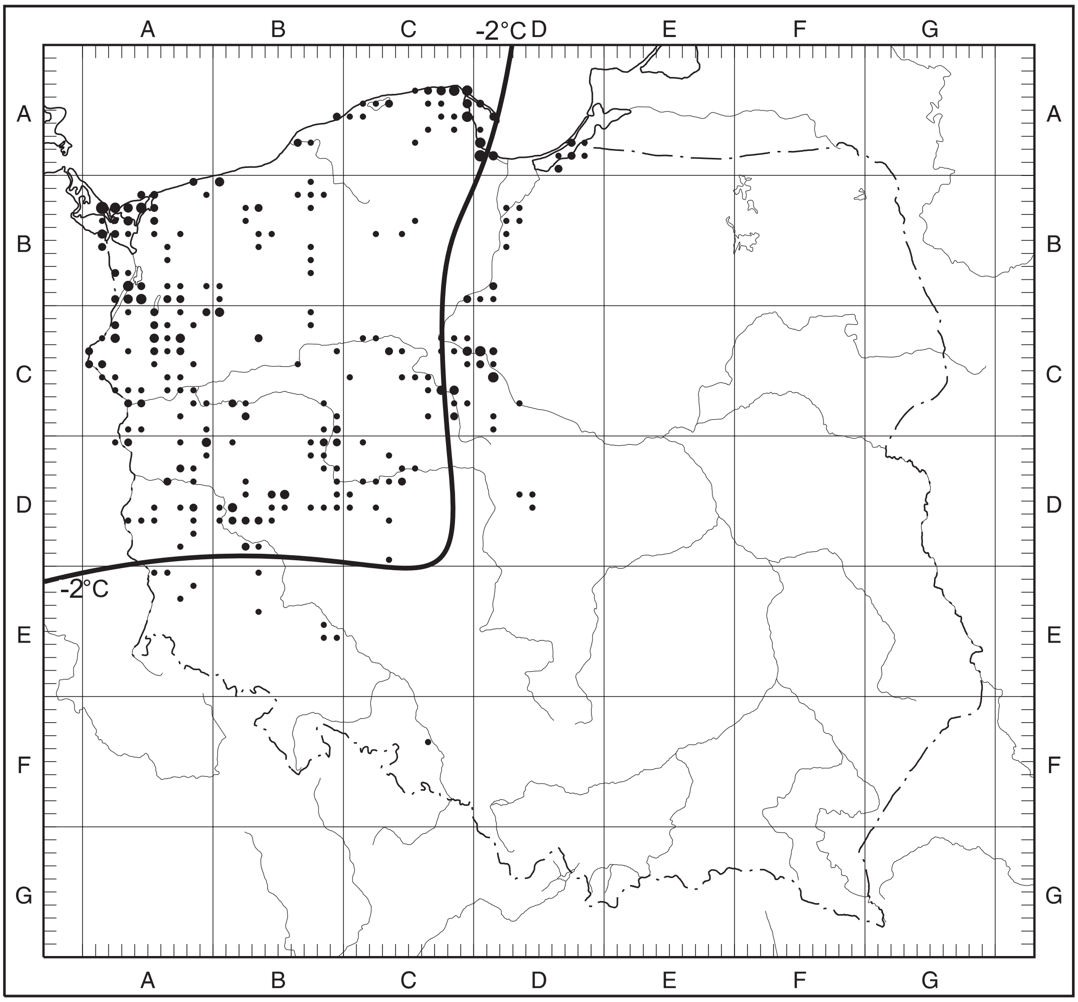

Fig. 3. Collective distribution of native taxa with southeastern limits in Poland. The marked line is the isoline of -2°C for the coolest month of the year in relation to the highest elevation in Europe (after Dahl 1998)

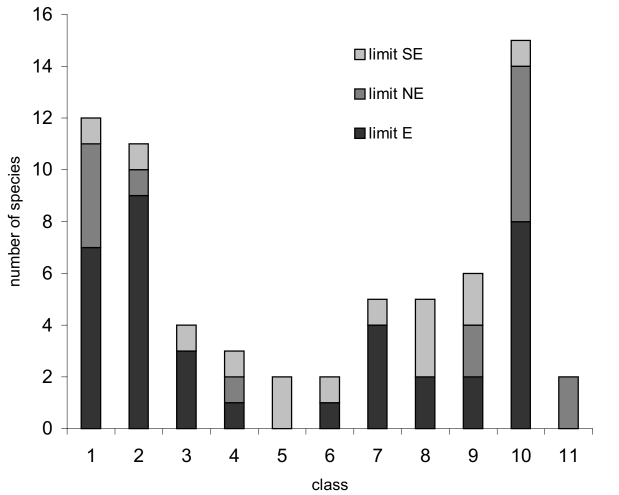

Fig. 5. Syntaxonomic affiliation of taxa with eastern, northeastern and southeastern limits in Poland: 1 – *Sedo-Scleranthetea*; 2 – *Isoëto-Nanojuncetea*; 3 – *Litorelletea*; 4 – *Phragmitetea*; 5 – *Juncetea maritimi*; 6 – *Scheuchzerio-Caricetea fuscae*; 7 – *Molinio-Arrhenatheretea*; 8 – *Festuco-Brometea*; 9 – *Querco-Fagetea*; 10 – *Rhamno-Prunetea*; 11 – *Vaccinio-Piceetea*

conclusion might be premature and could simply reflect the insufficient level of knowledge about species of that genus in France. Less numerous are the typically western European species and taxa of wider distribution. One may say that for the selected species that reach in Poland their eastern, southeastern or northwestern limits, the general ranges are somewhat correlated. There are almost no taxa of broad ranges, and reaching the above limits is 'reserved' for species that respond adversely to certain features of the continental climate.

The question of syntaxonomic affiliation of the studied species is addressed in Fig. 5. The first 2 bars of the diagram show the numbers of species evidently associated with a milder climate, which clearly disappear in Poland towards the east; namely the class *Sedo-Scleranthetea*, various types of grasslands on sands, and the communities of small therophytes on periodically flooded places from the class *Isoëto-Nanojuncetea*. There is an evidently high number of species of the class *Rhamno-Prunetea*, but this results from an excessive proportion of *Rubus* spp. among the species analysed. Other classes of plant communities are represented in moderate proportions. It can be concluded that the species with western ranges in Poland, manifest a certain geographic habitat preference towards

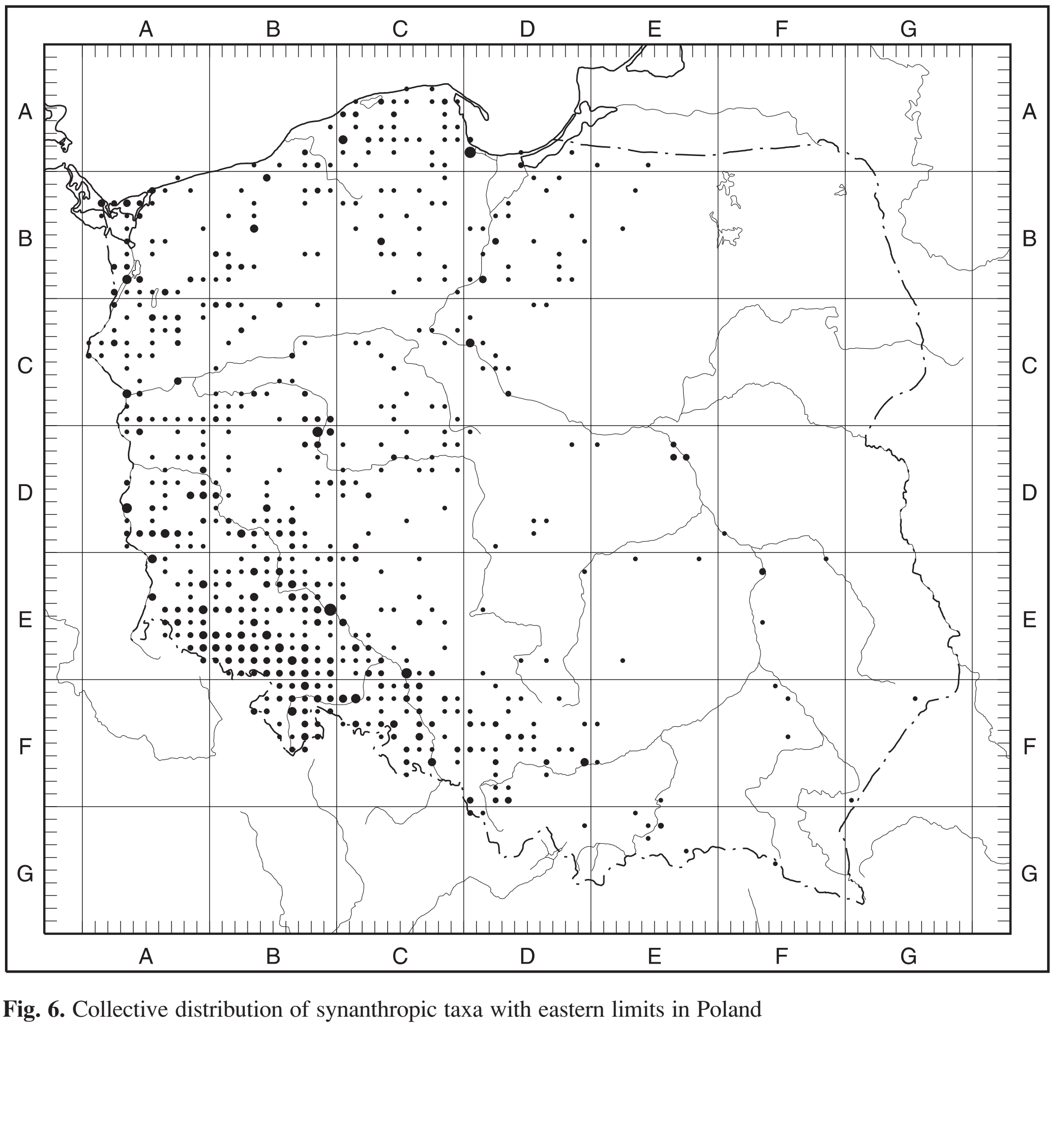

Fig. 6. Collective distribution of synanthropic taxa with eastern limits in Poland

these communities, which can be thus regarded as a western element in the vegetation of Poland.

3.3. Synanthropic species with eastern distribution limits in Poland

One may ask whether synanthropic species also have their eastern distribution limits in Poland. The answer is difficult. Only a dozen or so taxa with an evident eastern limit in Poland are included in Fig. 6. These include: *Anthriscus caucalis*, *A. cerefolium*, *Chenopodium opulifolium*, *Corydalis lutea*, *Cymbalaria muralis*, *Helianthus ×laetiflorus*, *Helleborus viridis*, *Lathyrus nissola*, *Mimulus guttatus*, *Myrrhis odorata*, *Ornithogallum boucheanum*, *Parietaria officinalis*, *Petrorhagia saxifraga*, *Picris echioides*, *Pulicaria desynterica*, *Rubus armeniacus*, *R. laciniatus*, *Stachys arvensis*, *Vicia pannonica*.

Some of them are established synanthropes, no longer expanding within Poland, namely archaeophytes. However, most of them are kenophytes, perhaps still in the process of colonising the area of Poland. Some of them originate from various regions of Western Europe and their further migration eastward is rather unlikely. These will be mostly garden escapes, such as *Corydalis lutea*, *Cymbalaria muralis* or *Helleborus viridis*. In our opinion, further studies on identifying the western element among anthropophytes will be possible after their actual climatic preferences are better understood.

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