

DISTRIBUTION PATTERNS AND HABITATS OF ENDEMIC VASCULAR PLANTS IN THE POLISH CARPATHIANS

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ABSTRACT

The paper deals with the richness and diversity of endemic and subendemic taxa in the Polish Carpathians. Based on critical studies in the literature and the authors' unpublished materials collected in the field, the distribution patterns of endemic species are analysed and discussed. The participation of endemics in the flora of single Carpathian ranges is assessed and analysed. The importance of the Tatra Mts as a centre of endemism is stressed. The frequency and altitudinal ranges of endemic taxa are characterized and their syntaxonomical spectrum is presented.

KEY WORDS: vascular plants, endemic and subendemic taxa, distribution patterns, habitats, Polish Carpathians.

INTRODUCTION

Due to their limited distribution, endemic species are an especially important floristic element, contributing to the identity of a given flora. For this reason they play an important role in biodiversity conservation. Their number, age and distribution are crucial to understanding the history of the flora of a given area. In general, mountains are especially rich in endemics. This is true also for Central Europe, including Poland, where most of the endemic taxa are concentrated in the Carpathians (Fig. 1).

From the Polish Carpathians, covering only ca 6% of the whole country, 111 endemic and subendemic vascular plant taxa (species and subspecies) have been reported (Piękoś-Mirkowa and Mirek 2003). Some of them are believed to be paleoendemics originating from the late Tertiary. The lack of endemic species in the prevailing part of the Polish lowlands is attributable to the Pleistocene glaciations, which destroyed the old flora occurring earlier in this part of Europe.

Here we present the results of studies on richness and distribution patterns of endemic taxa in the Polish Carpathians, and characterize their altitudinal distribution and habitats.

MATERIAL AND METHODS

All 111 taxa regarded as Carpathian endemic or subendemic ones occurring in the Polish Carpathians are characterized and analysed. A previous paper includes a list of them (Piękoś-Mirkowa and Mirek 2003); however additional studies and new findings have required updating of the list. A few controversial or doubtful taxa regarded as endemic up to now, such as *Alchemilla pungentiflora* (Plocek 1992), *Hylotelephium argutum* and *Linum extraaxillare* (Kliment 1999), were removed from the list. *Alchemilla tatricola* Pawł. was taken off the list as it appears to be conspecific with *A. subcrenata* (Kurtto et al. 2007). Two taxa which apparently are endemic to the area have been added to the list of Carpathian endemics: *Delphinium elatum* subsp. *nacladense* (Mitka and Nowosad 2002; Mitka et al. 2008) and *Euphrasia exaristata* (Staszkiwicz 2008). Three species (*Alchemilla ladislai*, *A. versipiloides* and *A. zmu-dae*) of which the endemic status was doubtful were confirmed (Plocek 1992; Kurtto et al. 2007).

Maps and diagrams showing the occurrence of endemic and subendemic taxa in the Polish Carpathians were drawn based on data from local "Florae" of single Carpathian ranges (e.g., Białęcka 1982; Grodzińska 1968, 1976; Grodziń-

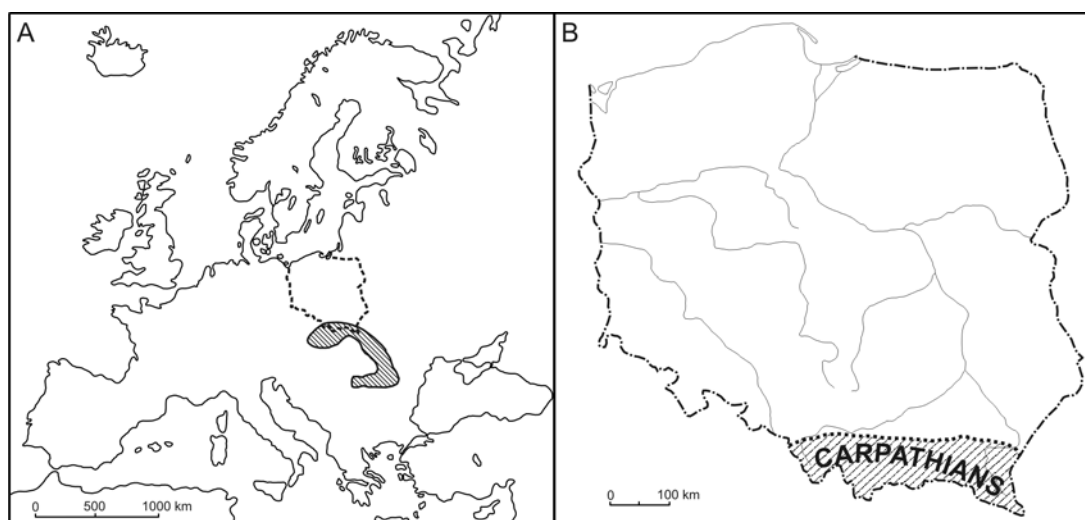


Fig. 1. Location of the Carpathians in Europe (A). Polish Carpathians – area studied (B).

ska and Pancer-Kotejowa 1960; Guzikowa 1977; Jasiewicz 1965; Kornaś 1957; Kotońska 1991; Kotula 1889-1890; Mirek 1993; Oklejewicz 1993; Pacyna 2004; Pawłowski 1925, 1956; Pelc 1967; Stuchlikowa and Stuchlik 1962; Towpasz 1975, 1987; Zajac 1989; Zapałowicz 1880; Zarzycki 1981; Zemanek 1981, 1989; Zemanek and Winnicki 1999). Besides the “Florae”, a great number of floristic papers and authors’ unpublished materials have been incorporated. The definition of endemic species follows an earlier paper (Piękoś-Mirkowa and Mirek 2003). With a few exceptions, the nomenclature of taxa follows Mirek et al. (2002).

MAIN CHARACTERISTICS OF THE STUDY AREA

The Polish Carpathians (Fig. 1) form the northernmost part of the whole range, spanning ca 330 km in length and up to 90 km in width. They cover 19 600 km², with 87% belonging to the Western Carpathians and only 13% to the Eastern Carpathians (Warszyńska 1995). In terms of geology, relief, landscape and plant cover, three geobotanical districts have been distinguished within the Western Carpathians (Pawłowski 1972): the Tatra Mts, Pieniny Mts and Beskidy Mts (with the adjacent Carpathian foothills). The Eastern Carpathians are represented in Poland only by the Bieszczady Mts and Przemyśl foothills.

The Tatras, covering only 220 km², built of crystalline and sedimentary rocks, are the highest mountain massif in the whole Carpathian range, with typical alpine landscape and rich glacial relief. The highest summit of the Polish Tatra Mts, Mt Rysy, reaches 2499 m a.s.l. The Pieniny Mts form a very small rocky massif built of Mesozoic limestone, with the highest point at 1052 m a.s.l. The Beskidy Mts are medium-altitude mountains with elevation up to 1725 m a.s.l. (Mt Babia Góra) in the Western Beskidy Mts and to 1346 m a.s.l. in Bieszczady Mts (the Eastern Beskidy Mts). They include several mountain ranges built mainly of flysch (Tertiary sedimentary bedrock consisting of alternate layers of sandstone and claystone). Their monotonous relief and landscape result in monotonous flora as well. The Carpathian foothills, where the submontane belt prevails, cover the lowest elevations between 250 and 550 (650)

m a.s.l. The natural environment of this belt has been significantly transformed and degraded by various forms of anthropoppression.

Substantial differentiation of climatic conditions along the altitudinal gradient creates well-defined vegetation belts. Six vegetation belts can be distinguished in the Carpathians (Pawłowski 1972): submontane, lower montane, upper montane, subalpine (dwarf pine), alpine and subnival. In the Carpathians the subnival belt is found only in the Tatras.

Despite its small area, the flora of the Polish Carpathians is relatively rich, comprising ca 2200 vascular plant species, including both native taxa and established aliens (Mirek and Piękoś-Mirkowa 2008). It includes ca 74% of the total flora of the country, and more than 450 species are represented by the mountain element.

RESULTS AND DISCUSSION

Progress in taxonomic and chorological studies has brought changes in the number of endemic and subendemic taxa, their listing, and their affiliation as Pan-Carpathian, West or East Carpathian endemics. Presently it is known that 111 endemic vascular plant taxa occur in the Polish Carpathians. They include Pan-Carpathian, West, East or East and South Carpathian endemic and subendemic taxa, as well as taxa endemic to single mountain ranges: the Tatras, Pieniny Mts and Babia Góra massif. The full list includes 49 well-defined species, 27 microspecies of the genus *Alchemilla*, and 35 distinct subspecies.

Frequency

Most of the endemics and subendemics occurring in the Polish Carpathians are rare or very rare taxa; some of them are known from single stations only. Examples are *Delphinium elatum* subsp. *nacladense*, *Euphrasia exaristata*, and *Taraxacum pieninicum*, each noted from single stations, *Pulsatilla slavica* (two stations) and *Pyrola carpatica* (three stations). Others, such as *Poa babiogorensis* and *Erysimum pieninicum* (Fig. 2) and a dozen species of the genus *Alchemilla*, have no more than ten stations concentrated in a small area. Among the Carpathian endemics is one

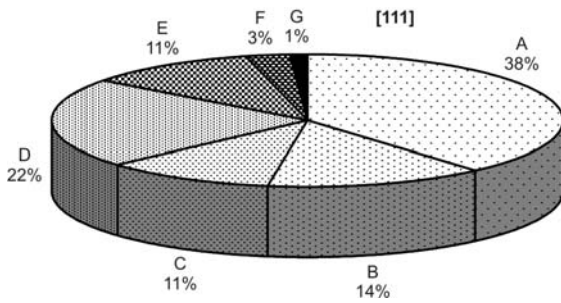


Fig. 2. Frequency of endemic and subendemic taxa in the Polish Carpathians. A – very rare; B – rare; C – fairly rare; D – fairly frequent; E – frequent; F – common; G – extinct.

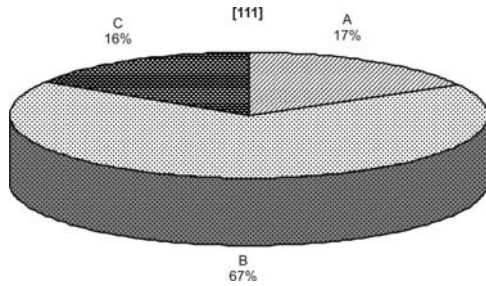


Fig. 3. Proportion of mountain multizonal (A), high mountain (B), and montane taxa (C) in the group of endemics and subendemics occurring in the Polish Carpathians.

extinct paleoendemic species, *Dianthus nitidus*. It was reported in the 19th century from the Pieniny Mts (Zarzycki 1981). Rare endemic taxa are usually limited to only one mountain range, as exemplified by the taxa mentioned above. Some endemic species, though limited to only one range in the Polish Carpathians, are frequent or very frequent. Examples include *Festuca tatrae*, *Leontodon pseudotaxaci*, *Leucanthemopsis tatrae* and *Ranunculus pseudomontanus*, which occur at numerous localities in the Tatras. Only a few endemic and subendemic taxa are widely distributed in the entire Polish Carpathians (e.g. *Dentaria glandulosa*, *Symphytum cordatum*, *Leucanthemum waldsteinii*). Others are common in several ranges, such as *Campanula polymorpha* and *Crocus scepusiensis*. The latter, occurring in seminatural pastured grasslands and mown meadows, has been spread by human activities.

Altitudinal ranges and distribution

As concerns vertical distribution, most of endemics and subendemics in the Polish Carpathians represent the high-mountain element (Fig. 3). This group comprises 74 taxa (67%) of all 111 endemic taxa known from the Polish Carpathians. The multizonal and montane groups are evidently less numerous, with 18 (16%) and 19 (17%) taxa, respectively. The proportions of endemic and subendemic taxa representing these three groups change along the altitudinal gradient (Fig. 4). Most of endemic and subendemic taxa in the Polish Carpathians occur between 1400 and 2000 m a.s.l. (Fig. 5). Their participation in the total flora of particular vegetational belts increases with altitude, reaching about 12% in the highest (subnival) belt (Piękoś-Mirkowa et al. 1996).

The number of endemic and subendemic taxa in various Carpathian ranges varies significantly. Most of them concentrate in the Tatra Mts (Figs 6 and 7). There occur 90 taxa (81.8% of the total number of endemics and subendemics

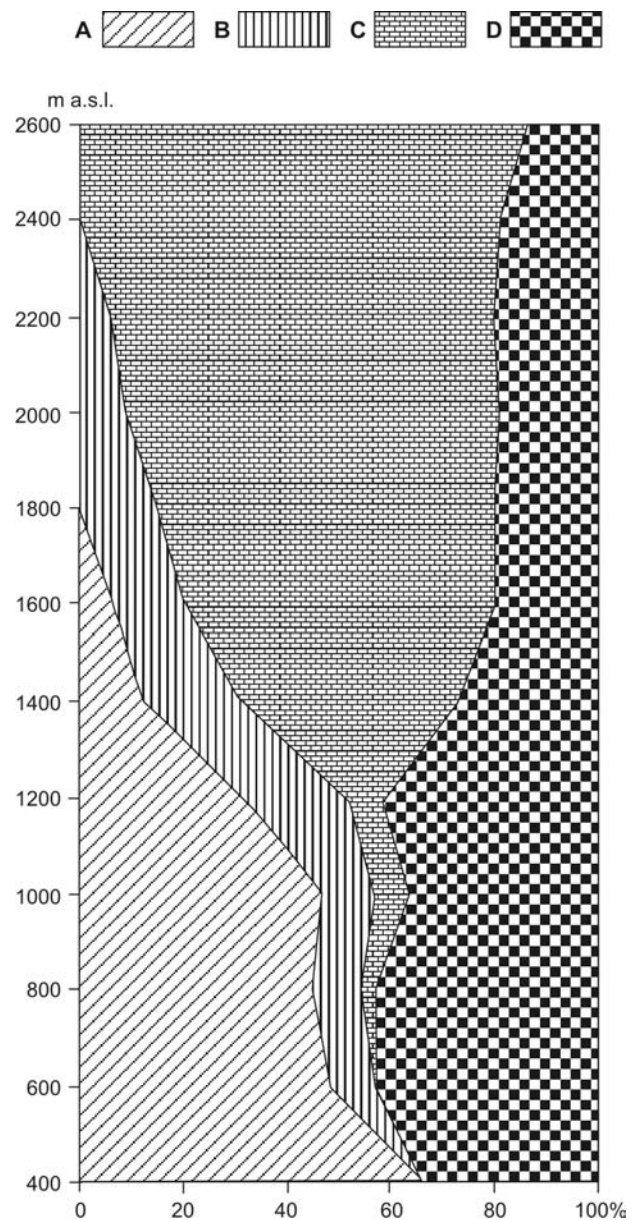


Fig. 4. Proportion of A – montane; B – subalpine; C – alpine; D – mountain multizonal endemic taxa at various altitudes in the Polish Carpathians.

known from the Polish Carpathians); 62 of them are known in Poland only from this area (e.g. *Cochlearia tatrae* – Fig. 8A). This shows the significance of the Tatra Mts as a centre of endemism. Diversity of endemic species is associated with the area's geological, relief, soil, climate and habitat diversity, as well as history of the area (Mirek and Piękoś-Mirkowa 1992a, b). Though small in area and low in elevation, the Pieniny Mts are a second important centre of endemism within the Polish Western Carpathians, harbouring 19 endemic and subendemic taxa. Two of them, *Taraxacum pieninicum* and *Erysimum pieninicum* (Fig. 8B), are known only from this range. The Beskidy Mts are much poorer in endemics, with no more than 15 taxa. Mt Babia Góra, the highest massif within the Western Beskidy Mts, is the only exception. It supports 18 taxa, of which *Poa babiogorensis* is regarded as endemic to this massif (Fig. 8C). Two others, *Alchemilla babiogorensis* and *A. bogumilii*, previously regarded as endemic to Mt Babia Góra, appear to have a wider distribution in the Carpathians (Plocek 1992; Volgin

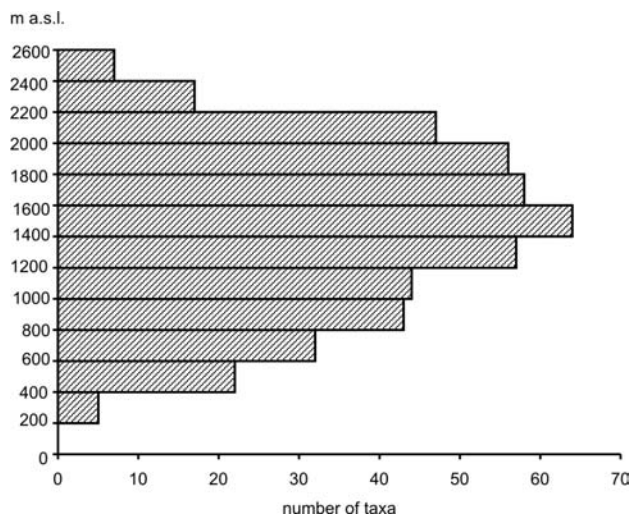


Fig. 5. Total number of endemics and subendemics in various altitudinal belts in the Polish Carpathians.

and Sychak 1989a, b; Stoyko and Tassenkevich 1993). Also Bieszczady Mts, the only higher range in the Eastern Carpathian Beskidy Mts are relatively rich, with 22 East- and

PanCarpathian endemic taxa found (e.g. *Melampyrum saxosum* – Fig. 8D); but with no local endemics.

At least eight Carpathian taxa are so far recognized as local stenochoric endemics of the Polish flora, not present elsewhere: *Taraxacum pieninicum*, *T. pawłowskii*, *Erysimum pieninicum*, *Alchemilla calviflora*, *A. jasiewiczii*, *A. tacikii*, *A. versipiloides* and *A. zmduae*. However small changes in this group are not excluded and further investigations can reveal wider distribution of some taxa. It already happened in respect to *Alchemilla babiogorensis* and *A. bogumilii*, previously regarded as endemic to Babia Góra massif. They appeared to have a wider distribution in the Carpathians (Plocek 1992; Volgin and Sychak 1989a, b; Stoyko and Tassenkevich 1993). All the other West-, East-, and PanCarpathian endemic species occurring in Poland (e.g. *Soldanella carpatica* and *Campanula serrata* – Figs 8E and F) have broader distribution in the Carpathians, and exceed country border. They represent mesochoric or eurychoric endemics (Mirek and Piękoś-Mirkowa 2009 (in press)).

Habitats

The endemic and subendemic taxa occurring in the Polish Carpathians represent a broad spectrum of habitats

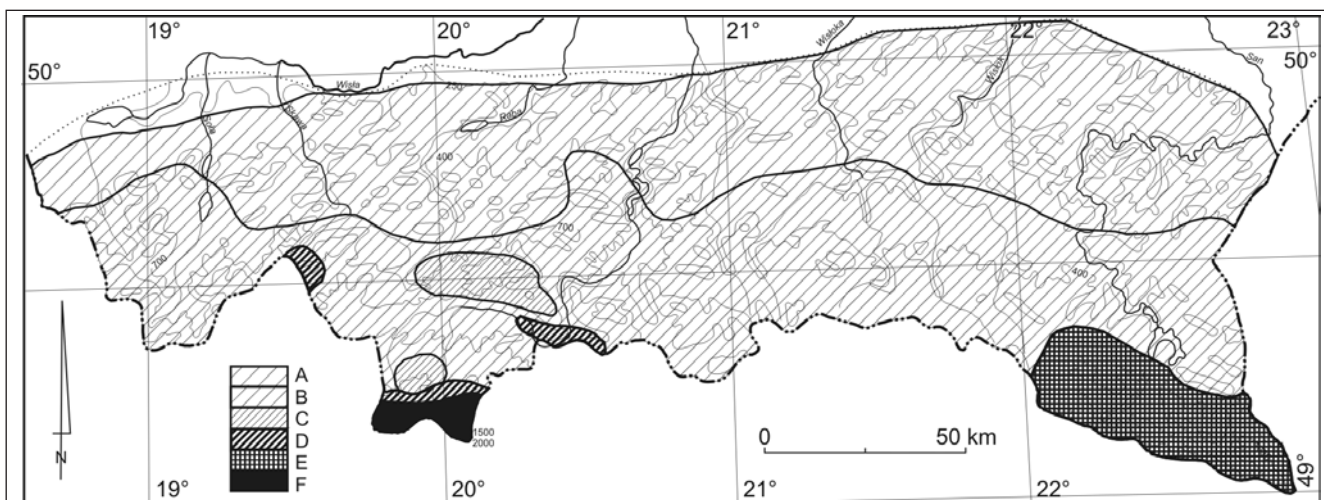


Fig. 6. Richness of endemic and subendemic taxa in the territory of the Polish Carpathians (simplified and generalized). A – 1-5 species; B – 6-10 species; C – 11-15 species; D – 16-20 species; E – 21-25; F – >25 species.

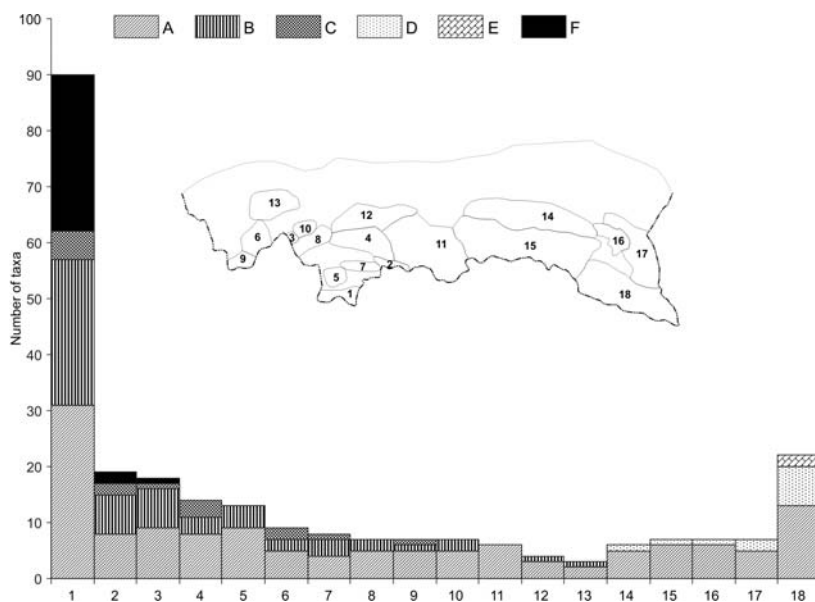


Fig. 7. Numbers of endemic and subendemic taxa occurring in particular ranges of the Polish Carpathians (in respect to main geobotanical units). A – Pan-Carpathian; B – West Carpathian; C – West and East Carpathian; D – East Carpathian; E – East and South Carpathian; F – taxa endemic to single ranges. Mountain ranges and their locations on the map: 1 – Tatras; 2 – Pieniny Mts; 3 – Mt Babia Góra; 4 – Gorcke Mts; 5 – Wzniesienie Gubałowskie; 6 – Mt Pilsko; 7 – Pas Skalicowy; 8 – Działy Orawskie; 9 – Wielka Raczka range; 10 – Mt Polica; 11 – Beskid Sądecki range; 12 – Beskid Wyspowy range; 13- Beskid Mały range; 14 – Doły Jasielsko-Sanockie; 15 – Beskid Niski range; 16 – Góry Słonne Mts; 17 – Bieszczady Niskie and Otryt ranges; 18 – Bieszczady Mts.

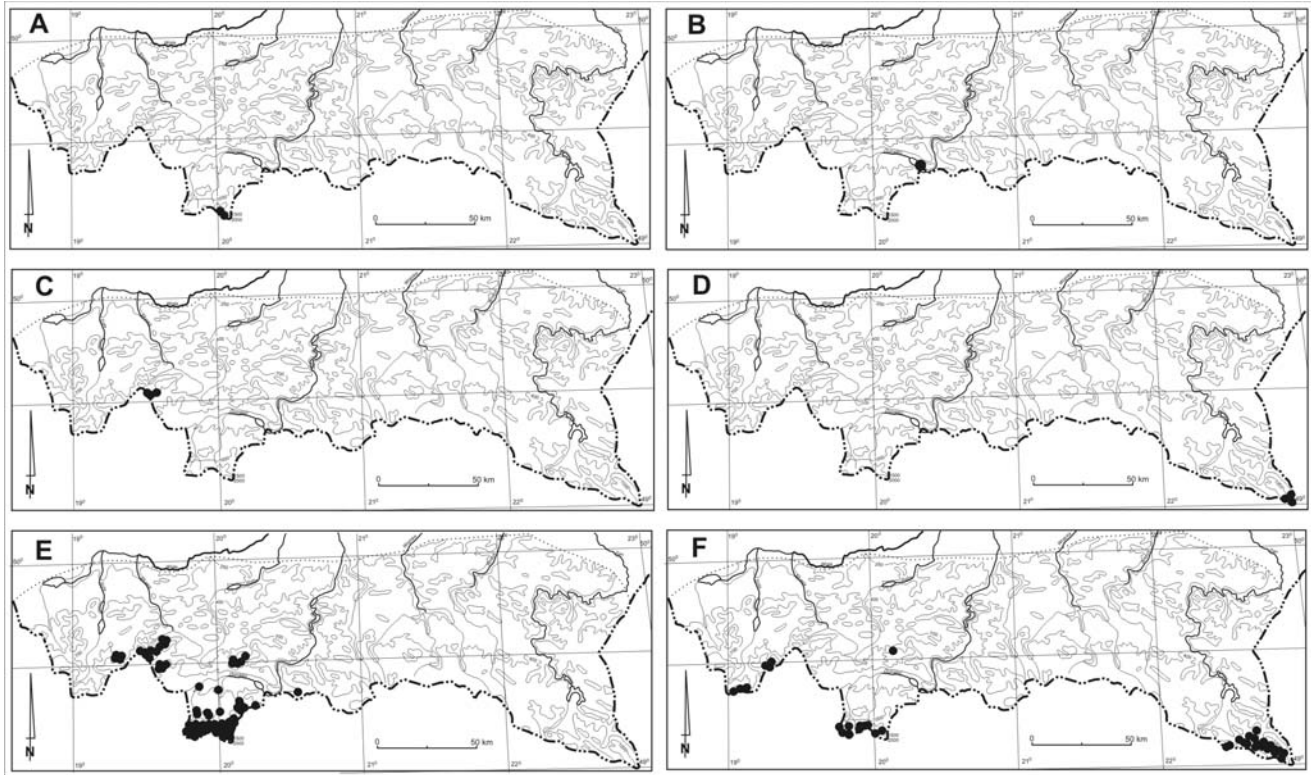


Fig. 8. Distribution of selected endemic taxa in the Polish Carpathians. A – *Cochlearia tatrae* Borbás – Tatra endemic; B – *Erysimum pieninicum* (Zapal.) Pawł. – endemic to Pieniny Mts; C – *Poa babiogorensis* Bernátová, Májovský et Obuch – endemic to Mt Babia Góra; D – *Melampyrum saxosum* Baumg. – East Carpathian endemic; E – *Soldanella carpatica* Vierh. – West Carpathian endemic; F – *Campanula serrata* (Kit.) Hendrych subsp. *serrata* – Pan-Carpathian endemic.

(Fig. 9). The largest group, comprising ca 27% of the taxa, is associated with high-mountain grasslands, especially those occurring on calcareous rock, and representing the class *Seslerietea varia*. A fair number of endemics and subendemics (26%) can be found as components of scree, gravel, rock crevice and snow patch vegetation both on calcareous and silicious substrata (classes *Thlaspietea rotundifolii*, *Salicetea herbaceae* and *Asplenieta rupestris*). Most of the taxa representing these groups are restricted to the Tatra Mts. There is also a significant number (ca 20%) of taxa occurring in tall-herb and tall-grass vegetation (representatives of the class *Betulo-Adenostyletea*). Only seven endemic and subendemic taxa (ca 6%) are associated with woodlands (classes *Quercu-Fagetea* and *Vaccinio-Piceetea*).

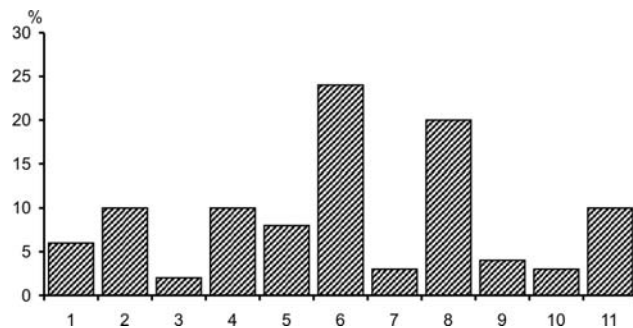


Fig. 9. Syntaxonomic spectrum of endemic and subendemic taxa occurring in the Polish Carpathians. Phytosociological units (classes): 1 – *Asplenieta rupestris*; 2 – *Thlaspietea rotundifolii*; 3 – *Montio-Cardaminetea*; 4 – *Salicetea herbaceae*; 5 – *Molinio-Arrhenatheretea*; 6 – *Seslerietea varia*; 7 – *Juncetea trifidi*; 8 – *Betulo-Adenostyletea*; 9 – *Quercu-Fagetea*; 10 – *Vaccinio-Piceetea*; 11 – others.

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