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## Contemporary threat to the vascular flora of the Polish Carpathians (S. Poland)

Zbigniew MIREK and Halina PIĘKOŚ-MIRKOWA

### 1. INTRODUCTION

The Carpathian Mountains cover not more than 7% of the territory of Poland (Fig. 1). In this limited area, however, there is a relatively rich flora comprising more than 1700 vascular plant species (native and established aliens), which is 74% of the total flora of the country (2300 species). The relatively high degree of anthropogenic transformations in the environment of the Polish Carpathians has become a serious threat to many biotopes and species during the last decades. This threat, increasing from year to year, was the reason for preparing the regional list of extinct, threatened and rare vascular plants in the Polish Carpathians. In preparing the "List", special attention has been devoted to the native mountain, endemic, and relict species, as well as to those attaining regional or general limits of their distribution in the area under consideration. Old segetal and ruderal species (archeophytes) have also been taken into account. The critical taxa of *Alchemilla*, *Taraxacum* and *Hieracium* genera, except for principle species, could not be taken into consideration because of insufficient knowledge on their distribution. The threat to the particular species has been estimated according to internationally accepted IUCN categories of the "Red Book" (LUCAS and SYNGE 1978, HOW TO USE .. 1980).

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## 2. LIST OF EXTINCT, THREATENED AND RARE TAXA

All taxa of vascular plants in the Polish Carpathians have been classified according to their threat into five groups listed below.

### Ex - extinct and probably extinct taxa

- |   |  |
|---|--|
| <i>Anacamptis pyramidalis</i> (L.)<br>L.C.M.Richard   | <i>Linaria arvensis</i> (L.) Desf.                                 |
| <i>Asplenium adiantum-nigrum</i> L.                   | <i>Lolium remotum</i> Schrk.                                       |
| <i>Betula humilis</i> Schrank                         | <i>Lygia passerina</i> (L.) Fasano                                 |
| <i>Betula nana</i> L.                                 | <i>Montia fontana</i> L. ssp. <i>fontana</i>                       |
| <i>Botrychium lanceolatum</i> (S.G.Gmelin)<br>Angstr. | <i>Nymphaea candida</i> J. et C.Presl                              |
| <i>Bupleurum rotundifolium</i> L.                     | <i>Oenanthe fistulosa</i> L.                                       |
| <i>Camelina alyssum</i> (Mill.) Thell.                | <i>Orchis tridentata</i> Scop.                                     |
| <i>Caucalis platycarpus</i> L.                        | <i>Orobanche picridis</i> F.W.Schultz                              |
| <i>Chamaecytisus supinus</i> (L.) Link.               | <i>Pedicularis sceptrum-carolinum</i> L.                           |
| <i>Conringia orientalis</i> (L.) Dum.                 | <i>Polemonium caeruleum</i> L.                                     |
| <i>Cuscuta epilinum</i> Weihe ex Boenn.               | <i>Primula halleri</i> J.F.Gmelin                                  |
| <i>Dianthus nitidus</i> Waldst. et Kit.               | <i>Prunus fruticosa</i> Pallas                                     |
| <i>Dictamnus albus</i> L.                             | <i>Salvinia natans</i> (L.) All.                                   |
| <i>Gagea arvensis</i> (Pers.) Dum.                    | <i>Saxifraga hirculus</i> L.                                       |
| <i>Galium tricornerutum</i> Dandy                     | <i>Scandix pecten-veneris</i> L.                                   |
| <i>Gladiolus felicitis</i> Mirek                      | <i>Spergula arvensis</i> L. ssp. <i>linicola</i> (Bor.)<br>Janchen |
| <i>Iris graminea</i> L.                               | <i>Spergula morisonii</i> Bor.                                     |
| <i>Iris sibirica</i> L.                               | <i>Taraxacum pieninicum</i> Pawl.                                  |
| <i>Lathyrus nissolia</i> L.                           | <i>Trapa natans</i> L.   |
| <i>Ligularia sibirica</i> (L.) Cass.                  | <i>Vaccaria hispanica</i> (Mill.) Rauschert                        |

### E - taxa endangered

- |   |  |
|---|--|
| <i>Aconitum tauricum</i> Wulfen ssp. <i>nanum</i><br>(Baumg.)Gay. | <i>Carex strigosa</i> Huds.                |
| <i>Adonis aestivalis</i> L.                                       | <i>Chenopodium murale</i> L.               |
| <i>Aphanes microcarpa</i> (Boiss. et Reuter)<br>Rothm.            | <i>Cyperus fuscus</i> L.                   |
| <i>Astragalus penduliflorus</i> Lam.                              | <i>Dianthus superbus</i> L.                |
| <i>Avena strigosa</i> Schreber                                    | <i>Dorycnium herbaceum</i> Vill.           |
| <i>Betula x oycoviensis</i> Besser                                | <i>Drosera anglica</i> Huds.               |
| <i>Botrychium matricariifolium</i> A. Braun                       | <i>Dryopteris cristata</i> (L.) A. Gray    |
| <i>Botrychium multifidum</i> (S.G.Gmelin)<br>Rupr.                | <i>Elatine hydropiper</i> L. em.Oeder      |
| <i>Bromus arvensis</i> L.   | <i>Eleocharis uniglumis</i> (Link) Schult. |
| <i>B. racemosus</i> L.  | <i>Empetrum nigrum</i> L.                  |
| <i>Butomus umbellatus</i> L.                                      | <i>Eriophorum gracile</i> Koch ex Roth     |
| <i>Camelina sativa</i> (L.) Cr.                                   | <i>Euphorbia palustris</i> L.              |
| <i>Carex acutiformis</i> Ehrh.                                    | <i>Fumaria rostellata</i> Knaf             |
| <i>Carex buxbaumii</i> Wahlenb.                                   | <i>Fumaria schleicheri</i> Soy.-Will.      |
| <i>Carex limosa</i> L.  | <i>Gagea minima</i> Kern.-Gav.             |
| <i>Carex pseudocyperus</i> L.                                     | <i>Gentiana pneumonanthe</i> L.            |
| <i>Carex pulicaris</i> L.   | <i>Gratiola officinalis</i> L.             |
|   | <i>Hesperis matronalis</i> L.              |
|   | <i>Hottonia palustris</i> L.               |
|   | <i>Hydrocharis morsus-ranae</i> L.         |

*Hydrocotyle vulgaris* L.  
*Juncus alpino-articulatus* Chaix  
*Juncus bulbosus* L.  
*Kickxia elatine* (L.) Dum.  
*Linnaea borealis* L.  
*Lotus tenuis* Waldst. et Kit.  
*Lycopodiella inundata* (L.) Holub  
*Lythrum hyssopifolia* L.  
*Molinia caerulea* (L.) Moench  
*Myosurus minimus* L.  
*Myriophyllum verticillatum* L.  
*Nigella arvensis* L.  
*Nonnea pulla* (L.) DC.  
*Nuphar lutea* (L.) Sm.  
*Nymphoides peltata* (S.G.Gmelin)  
O.Kuntze  
*Oenanthe aquatica* (L.) Poir.  
*Oxycoccus microcarpus* Turcz. ex Rupr.  
*Peucedanum palustre* (L.) Moench  
*Pinus mugo* Turra ssp. *rotundata* (Link)  
Janchen et Neumayer  
*Potamogeton alpinus* Balbis  
*Potamogeton compressus* L.  
*Potamogeton obtusifolius* Mert. et Koch  
*Potamogeton polygonifolius* Pourr.  
*Primula farinosa* L.  
*Primula vulgaris* Huds.  
*Prunella grandiflora* (L.) Scholler

#### V - vulnerable taxa

*Abies alba* Mill.  
*Agrostemma githago* L.  
*Anchusa arvensis* (L.) M.Bieb.  
*Andromeda polifolia* L.  
*Avenula pubescens* (Huds.) Dum.  
*Betula pubescens* Ehrh.  
*Calla palustris* L.  
*Callitriche hamulata* Kütz. ex Koch  
*Carex appropinquata* Schum.  
*Carex davalliana* Sm.  
*Carex dioica* L.  
*Carex elata* All. ssp. *elata*  
*Carex filiformis* L.  
*Carex montana* L.  
*Carex pauciflora* Lightf.  
*Carex vulpina* L.  
*Centaurium pulchellum* (Sw.) Druce  
*Cephalanthera damasonium* (Mill.)  
Druce  
*Cephalanthera rubra* (L.) L.C.M.Richard  
*Chenopodium hybridum* L.  
*Cicuta virosa* L.

*Pulicaria vulgaris* Gaertn.  
*Ranunculus lingua* L.  
*Ranunculus peltatus* Schrank  
*Rhinanthus alectorolophus* (Scop.) Poll.  
ssp. *buccalis* (Wallr.) Schinz et Thell.  
*Rhinanthus serotinus* (Schönheit) Oborny  
ssp. *apterus* Fries  
*Rumex hydrolapathum* Huds.  
*Sagittaria sagittifolia* L.  
*Salix rosmarinifolia* L.  
*Scheuchzeria palustris* L.  
*Schoenoplectus tabernaemontani*  
(C.C.Gmelin) Palla  
*Scirpus lacustris* L.  
*Senecio umbrosus* Waldst. et Kit.  
*Serratula tinctoria* L.  
*Silaum silaus* (L.) Schinz et Thell.  
*Silene gallica* L.  
*Stachys annua* (L.) L.  
*Thelypteris thelypteroides* (Michx.) Holub  
*Trollius europaeus* L. ssp. *europaeus*  
*Utricularia australis* R.Br.  
*Utricularia minor* L.  
*Valeriana dioica* L.  
*Valerianella locusta* (L.) Laterrade  
em. Betcke  
*Veronica longifolia* L.  
*Viola alba* Bess.

*Cirsium eriophorum* (L.) Scop.  
*Colchicum autumnale* L.  
*Comarum palustre* L.  
*Cynoglossum officinale* L.  
*Cypripedium calceolus* L.  
*Dactylorhiza sambucina* (L.) Soó  
*Diphasiastrum issleri* (Rouy) Holub  
*Drosera rotundifolia* L.  
*Eleocharis acicularis* (L.) Roem. et Schult.  
*Eleocharis austriaca* Hayek  
*Eleocharis mamillata* H.Lindb. fil. in  
Dörfler  
*Eleocharis quinqueflora* (F.X.Hartmann)  
O.Schwarz  
*Epilobium dodonaei* Vill.  
*Epipactis palustris* (L.) Crantz  
*Equisetum ramosissimum* Desf.  
*Eriophorum vaginatum* L.  
*Euphorbia exigua* L.  
*Filago arvensis* L.  
*Filago minima* (Sm.) Pers.  
*Filago vulgaris* Lamk.

- Fumaria officinalis* L.  
*Fumaria vaillantii* Lois.  
*Galium boreale* L.  
*Galium spurium* L.  
*Gladiolus imbricatus* L.  
*Glyceria nemoralis* (Uechtr.) Uechtr. et Koern.  
*Hyoscyamus niger* L.  
*Inula hirta* L.  
*Juncus squarrosus* L.  
*Juncus triglumis* L.  
*Ledum palustre* L.  
*Leonurus cardiaca* L.  
*Leersia oryzoides* (L.) Sw.  
*Ligustrum vulgare* L.  
*Limosella aquatica* L.  
*Lithospermum officinale* L.  
*Lolium temulentum* L.  
*Matteucia struthiopteris* (L.) Tod.  
*Menyanthes trifoliata* L.  
*Myricaria germanica* (L.) Desv.  
*Myriophyllum spicatum* L.  
*Nepeta cataria* L.  
*Nepeta pannonica* L.  
*Odontites verna* (Bell.) Dum.  
*Onopordon acanthium* L.  
*Ophioglossum vulgatum* L.  
*Orchis coriophora* L.  
*Orchis morio* L.  
*Orchis pallens* L.  
*Orchis purpurea* Hudson  
*Orchis ustulata* L.  
*Oxycoccus palustris* Pers.  
*Pinguicula vulgaris* L.  
*Platanthera chlorantha* Custer ex Reichenb. in Mössler  
*Poa remota* Forselles  
*Polygala amarella* Cr.  
*Primula veris* L.  
*Pulmonaria mollis* Wulfen ex Hornem.  
*Pulsatilla slavica* Reuss  
*Ranunculus aquatilis* L.  
*Ranunculus arvensis* L.  
*Ranunculus circinatus* Sibth.  
*Ranunculus trichophyllus* Chaix.  
*Ribes nigrum* L.  
*Ribes spicatum* Robson  
*Rumex maritimus* L.  
*Salix daphnoides* Vill.  
*Scorzonera humilis* L.  
*Scrophularia umbrosa* Dum.  
*Scutellaria galericulata* L.  
*Succisa pratensis* Mch.  
*Swertia perennis* L. s.str.  
*Taxus baccata* L.  
*Taraxacum* Sect. *Palustria* Dahlst.  
*Taraxacum* Sect. *Erythrosperma* Dahlst. em Lindb. fil.  
*Telekia speciosa* (Schreb.) Baumg.  
*Utricularia vulgaris* L.  
*Vaccinium uliginosum* L. s.str.  
*Valerianella dentata* (L.) Poll.  
*Valerianella rimosa* Bastard  
*Verbena officinalis* L.  
*Vinca minor* L.  
*Zannichellia palustris* L.  
*Zannichellia pedicellata* (Whlb. et Rosen) Fries

**R - rare taxa, having usually not more than ten localities in the Polish Carpathians**

- Achillea stricta* Schleich.  
*Achillea setacea* Waldst. et Kit.  
*Aconitum lasiocarpum* Rchb.  
*Ajuga chamaepitys* (L.) Schreb.  
*Allium carinatum* L.  
*Allium schoenoprasum* L.  
*Allium scorodoprasum* L.  
*Alyssum saxatile* L. ssp. *saxatile*  
*Anemone sylvestris* L.  
*Anthericum ramosum* L.  
*Arctostaphylos uva-ursi* (L.) Spreng.  
*Arnica montana* L.  
*Artemisia absinthium* L. var. *calcigenum* Rehm.  
*Artemisia campestris* L.  
*Artemisia petrosa* (Baumg.) Fritsch ssp. *petrosa*  
*Aster linosyris* (L.) Bernh.  
*Astragalus australis* (L.) Lam.  
*Astragalus cicer* L.  
*Astragalus frigidus* (L.) A.Gray  
*Asperula cynanchica* L.  
*Asperula tinctoria* L.  
*Avenula planiculmis* (Schrader) W. Sauer et Chmelitschek  
*Bellardiachloa violacea* (Bellardi) Chiov.  
*Betula pendula* Roth. var. *carelica* (Merklin) Hejtmanek  
*Betula szaferi* Jentys-Szaferowa ex Stasz.  
*Bothriochloa ischaemum* (L.) Keng

- Bupleurum longifolium* L.  
*Calamagrostis stricta* (Timm) Koeler  
*Campanula bononiensis* L.  
*Campanula cervicaria* L.  
*Campanula latifolia* L.  
*Campanula rotundifolia* L. ssp. *kladniana* (Schur) T.Tacik  
*Campanula scheuchzeri* Vill.  
*Campanula sibirica* L.  
*Carduus collinus* Waldst. et Kit.  
*Carduus lobulatus* Borb.  
*Carex bigelowii* Torrey ex Schweinitz  
ssp. *rigida* Schultze-Motel  
*Carex hostiana* DC.  
*Carex lachenalii* Schkuhr  
*Carex michelii* Host  
*Carex nigra* (L.) Reichard ssp. *dacica* (Heuffel) Soó  
*Carex parviflora* Host  
*Carex praecox* Schreber  
*Carex rupestris* All.  
*Carlina intermedia* Schur  
*Centaurea triumfetti* All. var. *pieninica* Pawl.  
*Cerastium alpinum* L.  
*Cerastium latifolium* L.  
*Chaerophyllum bulbosum* L.  
*Chamorchis alpina* (L.) L.C.M.Richard  
*Cimicifuga europaea* N. Szipc.  
*Cirsium decussatum* Janka  
*Cochlearia tatrae* Borb.  
*Conioselinum tataricum* Hoffm.  
*Corydalis capnoides* (L.) Pers. em. Koch  
*Corydalis intermedia* (L.) Mer.  
*Cotoneaster tomentosus* (Ait.) Lindl.  
*Crataegus macrocarpa* Hegetschw.  
*Crataegus palmstruchii* Lindm.  
*Crepis praemorsa* (L.) Tsch.  
*Cuscuta campestris* Yunck.  
*Cuscuta lupuliformis* Krocker  
*Cyperus flavescens* L.  
*Dendranthema zawadzki* (Herb.) Tzvel.  
*Draba dubia* Sut.  
*Draba nemorosa* L.  
*Draba tomentosa* Clairv.  
*Dryopteris villarii* (Bellardi) Woyнар ex Schinz et Thell.  
*Epilobium nutans* Schmidt  
*Epipactis microphylla* (Ehrh.) Swartz  
*Epipogium aphyllum* Swartz  
*Erigeron alpinus* L. ssp. *intermedius* (Schleich.) Pawl.  
*Erigeron macrophyllus* Herb.  
*Erigeron nanus* Schur  
*Erigeron uniflorus* L.  
*Erysimum pieninicum* (Zap.) Pawl.  
*Erysimum hieracifolium* L.  
*Erysimum wittmannii* Zawadzki  
*Festuca pseudovina* Hackel ex Wiesh.  
*Festuca rupicola* Heuffel  
*Fragaria moschata* Duch.  
*Gentianella tenella* (Rottb.) Börner  
*Geranium sanguineum* L.  
*Helianthemum oelandicum* (L.) DC.in Lam.et DC. ssp. *rupifragum* (A.Kerner) Breistr.  
*Helichrysum arenarium* (L.) Moench  
*Helleborus purpurascens* Waldst. et Kit.  
*Hesperis nivea* Baumg.  
*Hieracium piliferum* Hoppe  
*Hieracium sparsum* Friv. ssp. *silesiacum* Krause  
*Hypochoeris maculata* L.  
*Inula ensifolia* L.  
*Jasione montana* L.  
*Juniperus sabina* L.  
*Laserpitium archangelica* Wulf.  
*Laserpitium prutenicum* L.  
*Linum flavum* L.  
*Melampyrum saxosum* Baumg.  
*Microstylis monophyllos* (L.) Lindley  
*Minuartia setacea* (Thuill.) Hayek var. *pieninica* (Zap.) Pawl.  
*Onobrychis montana* Lam. et DC.  
*Ophioglossum azoricum* C.B.Presl  
*Ophrys insectifera* L.  
*Orobanche alba* Steph.ex Willd.  
*Orobanche caryophyllacea* Smith  
*Orobanche lutea* Baumg.  
*Orobanche ramosa* L.  
*Orobanche teucrii* Holandre  
*Oxytropis campestris* (L.) DC.  
*Oxytropis halleri* Bunge ex Koch  
*Pedicularis hacquetii* Graf.  
*Peucedanum cervaria* (L.) Lap.  
*Plantago atrata* Hoppe var. *carpatica* Pilger  
*Pleurospermum austriacum* (L.) Hoffm.  
*Poa glauca* Vahl.  
*Potentilla alba* L.  
*Potentilla arenaria* Borkh.  
*Potentilla inclinata* Vill.  
*Potentilla tabernaemontani* Aschers.

*Prunus padus* L. ssp. *borealis* (Schüb.)  
Cajander  
*Pulsatilla vernalis* (L.) Mill.  
*Pyrola media* Sw.  
*Rosa gallica* L.  
*Rosa jundzillii* Besser  
*Salix bicolor* Ehrh. ex Willd.  
*Salix hastata* L.  
*Salix helvetica* Vill.  
*Saussurea pygmaea* (Jacq.) Spreng.  
*Saxifraga cernua* L.  
*Saxifraga retusa* Gouan ssp. *retusa*  
*Sedum acre* L. var. *calcigenum* Wol.  
*Senecio aurantiacus* (Hoppe ex Willd.)  
Less.  
*Sesleria coerulans* Friv.  
*Sibbaldia procumbens* L.  
*Sorbus chamaemespilus* (L.) Cr.

*Sorbus graeca* (Spach) Kotschy  
*Sorbus torminalis* (L.) Cr.  
*Sparganium angustifolium* Michx.  
*Spiraea media* F.Schmidt s.str.  
*Spiranthes spiralis* (L.) Cheval.  
*Stachys recta* L.  
*Staphyllea pinnata* L.  
*Teucrium botrys* L.  
*Tozzia alpina* L.  
*Trichophorum alpinum* (L.) Pers.  
*Trifolium alpestre* L.  
*Trifolium ochroleucum* L.  
*Verbascum lychnitis* L.  
*Verbascum phoeniceum* L.  
*Veronica spicata* L. ssp. *spicata*  
*Veronica teucrium* L.  
*Woodsia alpina* (Bolt.) S.F.Gray  
*Woodsia ilvensis* (L.) R.Br.

### I - indeterminate taxa

*Adenophora liliifolia* (L.) Bess.  
*Asplenium septentrionale* (L.) Hoffm.  
*Carex divulsa* Stokes in With.  
*Carlina biebersteinii* Bernh. ex Hornem.  
*Chimaphila umbellata* (L.) Barton  
*Conium maculatum* L.  
*Epipactis purpurata* Sm.  
*Equisetum hyemale* L.  
*Euphorbia villosa* Waldst. et Kit.  
*Euphrasia micrantha* Rchb.  
*Festuca tenuifolia* Sibth.  
*Gentianella amarella* (L.) Börner  
*Hypericum montanum* L.  
*Inula salicina* L.  
*Lappula squarrosa* (Retz.) Dum.  
*Lathyrus laevigatus* (Waldst. et Kit.)  
Gren.  
*Lathyrus niger* (L.) Bernh.  
*Lemna gibba* L.  
*Libanotis pyrenaica* (L.) Bourgeau  
*Libanotis sibirica* (L.) Koch  
*Lilium bulbiferum* L.  
*Melittis melisophyllum* L.  
*Molinia arundinacea* Schrank  
*Myosotis caespitosa* C.F. Schultz  
*Myosotis discolor* Pers.  
*Myosotis palustris* (L.) Nath.s.str.  
*Myosotis ramosissima* Roch. ex Schult.  
*Myosotis sparsiflora* Mikan  
*Omphalodes scorpioides* (Haenke)  
Schrank

*Peucedanum oreoselinum* (L.) Moench  
*Pinguicula bicolor* Wol.  
*Poa x nobilis* Skalinska  
*Potentilla heptaphylla* L.  
*Potentilla recta* L.  
*Ranunculus friesianus* Jordan  
*Ranunculus strigulosus* (Schur) Hyl.  
*Rosa rubiginosa* L.  
*Rosa tomentosa* Sm.  
*Saxifraga granulata* L.  
*Scopolia carniolica* Jacq.  
*Senecio congestus* (R.Br.) DC.  
*Senecio integrifolius* (L.) Clairv.  
*Senecio sylvaticus* L.  
*Seseli annuum* L.  
*Sorbus carpatica* Borb.  
*Spirodela polyrrhiza* (L.) Schleiden  
*Teucrium chamaedrys* L.  
*Teucrium scordium* L.  
*Valeriana angustifolia* Tausch  
*Verbascum blattaria* L.  
*Verbascum densiflorum* Bertol.  
*Verbascum phlomoides* L.  
*Veronica triphyllus* L.  
*Veronica urticifolia* Jacq.  
*Veronica verna* L.  
*Vicia dumetorum* L.  
*Viola mirabilis* L.  
*Viscum abietis* Beck.  
*Viscum album* L.  
*Xanthium strumarium* L.

### 3. RESULTS AND CONCLUSIONS

Consequently, 444 species (26% of the total flora of the Polish Carpathians) are to be found in the "Red list". Their contribution to the categories distinguished is as follows: Ex - 40 species, E - 87 species, V - 105 species, R - 152 species, I - 60 species.

One hundred eleven taxa are common with the "Red list" of Poland (ZARZYCKI 1986). The red list of Carpathian flora comprises 40 species which have become extinct in the Polish Carpathians since the beginning of the century. Among this group one may distinguish endemic species (*Gladiolus felicis*, *Taraxacum pienanicum* and *Dianthus nitidus*) and relict ones (e.g. *Betula humilis*, *Saxifraga hirculus*). There is a group of eight species which were known only from the Pogorze Slaskie (westernmost part of the Carpathian Foothills): *Chamaecytisus supinus*, *Iris graminea*, *I. sibirica*, *Lathyrus nissolia*, *Montia fontana* ssp. *fontana*, *Oenanthe fistulosa*, *Orchis tridentata*, and *Spergula morisonii*.

Another group of extinct species consists of highly specialized speirochorous flax-weeds: *Camelina alyssum*, *Cuscuta epilinum*, *Lolium remotum*, and *Spergula arvensis* ssp. *linicola*.

Extinct are also following nine calciphilous and thermophilous weed species representing the alliance *Caucalidion*: *Bupleurum rotundifolium*, *Caucalis platycarpus*, *Conringia orientalis*, *Gagea arvensis*, *Galium tricornerutum*, *Linaria arvensis*, *Lygia passerina*, *Scandix pecten-veneris* and *Vaccaria hispanica*.

A special attention should be paid to the endemic taxa included into the list of extinct, threatened and rare plants. There are the following 19 taxa:

- Endemic of Poland: *Gladiolus felicis* (Ex)
- Pan-Carpathian endemic and subendemic taxa: *Erysimum wittmannii* (R), *Artemisia petrosa* ssp. *petrosa* (R), *Plantago atrata* var. *carpatica* (R), *Erigeron macrophyllus* (R)
- West-Carpathian endemic taxa: *Dianthus nitidus* (Ex), *Pulsatilla slavica* (V), *Carduus lobulatus* (R)
- East-Carpathian endemic taxa: *Aconitum lasiocarpum* (R), *Aconitum tauricum* ssp. *nanum* (E), *Melampyrum saxosum* (R)
- Endemic and subendemic taxa of the Tatra Mts.: *Poa x nobilis* (I), *Cochlearia tatrae* (R)
- Endemic taxa of the Pieniny Mts.: *Taraxacum pienanicum* (Ex), *Erysimum pienanicum* (R), *Artemisia absinthium* var. *calcigenum* (R), *Cen-*

*taurea triumfetti* var. *pieninica* (R), *Sedum acre* var. *calcigenum* (R), *Minuartia setacea* var. *pieninica* (R).

Moreover, there have been included into the list numerous very rare relic taxa which are potentially endangered because of their rarity. Their populations consist usually of very few individuals occurring in a limited area. Most spectacular examples of them are: *Dryopteris villarsii* and *Astragalus penduliflorus*. The population comprising three plants of *Dryopteris villarsii* has been recently discovered in the Tatra Mts. It is the only locality for the Carpathians as a whole (PIEKOS-MIRKOWA and MIREK 1988, 1989).

The list comprises 101 mountain taxa which makes 23% of all threatened plants in the Carpathian Mts. Among them there are 59 high-mountain (i.e. subalpine and alpine) ones. The majority of the mountain taxa have been classified as rare (74%).

The arrangement of the extinct (Ex), endangered (E), vulnerable (V) and rare (R) taxa according to habitats they occupy (Table 1) allows to distinguish the main factors responsible for the phenomenon of extinction. An especially threatened group are species related to water and swampy habitats (lakes, rivers, peat-bogs, wet and humid meadows, carrs and the like), i.e., species representing the phytosociological classes: *Potametea*, *Litorelletea*, *Isoeto-Nanojuncetea*, *Phragmitetea*, *Utricularietea*, *Scheuchzerio-Caricetea fuscae*, *Oxycocco-Sphagnetetea*, *Alnetea glutinosae*, and *Molinio-Arrhenatheretea*. Drainage of peatlands, exploitation of peat bogs, great changes of water regime in river valleys, water pollution and intensification of meadow culture have been responsible for the threat to species of the habitats mentioned.

Extinction of segetal weeds, especially speirochorous archeophytes, representing the alliance *Secalinion* and *Linion*, has been observed throughout the Polish Carpathians (MIREK 1976, KORNAS 1987). Improved agricultural practices (intensive mineral fertilization, more efficient methods of cleaning the seed material of crop plants and chemical control of weeds with herbicides), are the main factors responsible for the changes observed.

In many other cases, especially when extinction of coniferous and mycorrhizal species are considered, a very important role seems to be played by air pollution (acid rains, heavy metal contamination) acting not only directly but also indirectly.

This short analysis clearly suggests that the phenomenon of extinction of vascular plant species in the Polish Carpathians is, in general, caused by the same factors as in other regions of Poland (KORNAS 1970, ZARZYCKI 1986, and lit.) and Central Europe (BLAB et al. 1978, LANDOLT et al. 1982, COUNCIL OF EU-

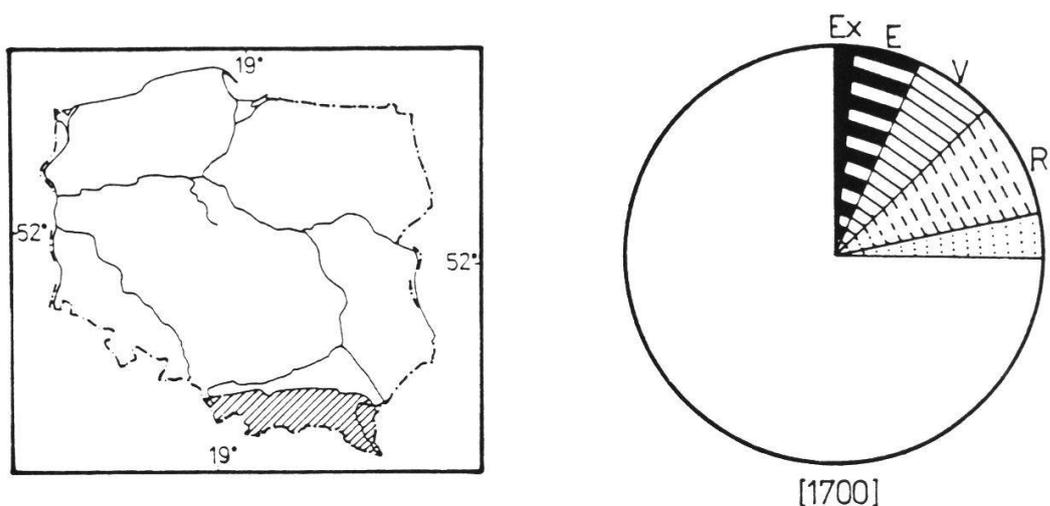
**Table 1.** Number of the extinct, endangered, vulnerable and rare taxa in the Polish Carpathians according to habitats they occupy.

Biotopes	Number of species			
	Ex	E	V	R
Freshwater aquatic vegetation ( <i>Lemnetea</i> , <i>Litorelletea</i> , <i>Potametea</i> , <i>Utricularietea</i> )	3	13	9	1
Mires, calcareous fens, minerotrophic flushes and peat-bog vegetation ( <i>Scheuchzerio-Caricetea fuscae</i> , <i>Oxycocco-Sphagnetea</i> )	4	13	17	3
Slime-covered shores of waters ( <i>Isoeto-Nanojuncetea</i> )	-	5	3	1
Wet, humid, and fresh hay-meadows ( <i>Molinio-Arrhenatheretea</i> )	3	12	10	2
Carrs, swamp shrub vegetation ( <i>Populetales albae</i> , <i>Alnetea glutinosae</i> , <i>Alno-Padion</i> )	2	5	7	-
Reed-grass and tall sedge vegetation ( <i>Phragmitetea</i> )	1	10	7	-
Segetal weed communities ( <i>Secalinion</i> , <i>Linion</i> , <i>Caucalidion</i> )	13	11	10	1
Ruderal weed vegetation ( <i>Onopordetalia</i> )	-	3	7	1
Vegetation of rocks, walls and rock crevices ( <i>Asplenietea rupestris</i> )	2	-	-	9
Scree, gravel and riverside gravel vegetation	-	-	3	6
High-mountain grasslands ( <i>Elyno-Seslerietea</i> , <i>Caricetea curvulae</i> )	2	1	1	34
Sand communities ( <i>Sedo-Scleranthetea</i> )	1	-	3	3
Species-poor acid grasslands and heaths ( <i>Nardo-Callunetea</i> )	-	3	4	2
Xerothermic chalk and limestone steppe grasslands ( <i>Festuco-Brometea</i> )	3	1	6	31
Thermophilous tall-herb and scrub vegetation of woodland edges ( <i>Trifolio-Geranieta sanguinei</i> , <i>Rhamno-Prunetea</i> )	2	2	3	12
Xerothermic woodland and shrub communities ( <i>Quercetalia pubescentis</i> )	-	-	5	7
Mixed woodlands on nutrient-rich soils ( <i>Carpinion</i> , <i>Fagion</i> , <i>Alno-Padion</i> )	1	1	5	7
Fir, spruce and pine forests ( <i>Vaccinio-Piceetea</i> )	-	1	2	6
Tall-herb and tall-grass communities ( <i>Betulo-Adenostyletea</i> )	-	1	-	11
Others	3	5	3	15
<b>Total</b>	<b>40</b>	<b>87</b>	<b>105</b>	<b>152</b>

ROPE 1983, LUCAS and SYNGE 1978, RAUSCHERT 1980); however, some regional peculiarities do exist.

The "List" allows to estimate the general extent of the extinction and threat to the vascular plants in the Polish Carpathians. Of threatened taxa 40 have been classified as extinct and probably extinct, 87 as endangered with extinction, 105 as vulnerable and 152 as potentially threatened on account of a very rare occurrence. It makes 2.4%, 5.1%, 6.2% and 8.9% respectively of the whole flora of the Carpathians (Fig. 1). It may be assumed that the threat to the Carpathian flora will increase in the near future. In this situation more effective forms of protection of threatened plant species must be undertaken. At present there are 72 threatened species (of 444 in the list) which are protected by law. Moreover, there are numerous taxa preserved in five national parks and 83 reserves established in the territory of the Polish Carpathians (ALEXANDROWICZ 1989). However, protection by law may only slacken the process of extinction of some species, but is unable to safeguard the existence of all threatened species (PIEKOS-MIRKOWA 1990a). Even national parks and reserves cannot ensure an automatic and effective conservation of all threatened and rare taxa (PIEKOS-MIRKOWA 1982). Nowadays successful conservation must apply various methods and means. It should base on sufficient knowledge on distribution, biology and ecology of the most threatened taxa and on real and potential threat to them (PIEKOS-MIRKOWA 1986).

This strategy was applied for preservation in situ small populations of some rare plants in the Pieniny Mts. (ZARZYCKI 1976) and in the Tatra Mts. (PIEKOS-MIRKOWA 1990a, PIEKOS-MIRKOWA and LOBARZEWSKA 1990a,b, PIEKOS-MIR-



**Fig. 1.** Proportion of various groups of the extinct and threatened vascular plants in relation to the total flora of the Polish Carpathians.

KOWA and KACZMARCZYK 1990a,b, MIREK and PIEKOS-MIRKOWA 1990). Moreover, there are over 90 rare and threatened taxa preserved ex situ and multiplied in the Mountain Botanic Garden in Zakopane.

## SUMMARY

On the basis of literature and other investigations carried out in the field a list of extinct, threatened and rare vascular plant species in the Polish Carpathians has been elaborated. The list comprises 444 taxa (native and established aliens), which is 74% of the total flora of the Polish Carpathians (Fig. 1). Of 444 taxa 40 (9%) were classified as extinct, 87 (19.6%) as endangered with extinction, 105 (25%) as vulnerable, 152 (34.2%) as rare and 60 (13.5%) as indeterminate ones.

There are 19 endemic and subendemic taxa included into the "List". They are endemic of Poland (1), of the Carpathian Mts. (4), of the West-Carpathians (3), of the East-Carpathians (3), of the Tatras (2) and the Pieniny Mts.(6).

The arrangement of the extinct, endangered, vulnerable and rare taxa according to the biotopes they occupy (Tab. 1) allows to analyse main factors responsible for contemporary threat to the vascular flora of the Polish Carpathians. The problems concerning conservation of threatened and rare plant species are discussed. A successful conservation needs adoption of an appropriate strategy based on information about distribution, biology and ecology of particular taxa and about threat to them.

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