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

Autor(en): **Mirek, Zbigniew / Piko-Mirkowa, Halina**

Objekttyp: **Article**

Zeitschrift: **Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübel, in Zürich**

Band (Jahr): **107 (1992)**

PDF erstellt am: **22.07.2024**

Persistenter Link: https://doi.org/10.5169/seals-308948

Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich, *107* (1992), 151-162

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).

Acknowledgements
The authors are very grateful to M.Sc. B. Bzowska and M.Sc. J. Sucharska for their technical assistance.

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

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

E - taxa endangered

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

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.
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 Mnch.
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
Bellardiochloa 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. Szipcz.
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 zawadzkii (Herb.)Tzvel.
Draba dubia Sut.
Draba nemorosa L.
Draba tomentosa Clairv.
Dryopteris villarii (Bellardi) Woynar 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 triphyllos 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 pieninicum* 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 platycarpos, Conringia orientalis, Gagea arvensis, Galium tricornutum, 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 pieninicum* (Ex), *Erysimum pieninicum* (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-Sphagnetea*, *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 (*Lemnetea, Litorelletea, Potametea, Utricularietea*)	3	13	9	1
Mires, calcareous fens, minerotrophic flushes and peat-bog vegetation (*Scheuchzerio-Caricetea fuscae, Oxycocco-Sphagnetea*)	4	13	17	3
Slime-covered shores of waters (*Isoeto-Nanojuncetea*)	-	5	3	1
Wet, humid, and fresh hay-meadows (*Molinio-Arrhenatheretea*)	3	12	10	2
Carrs, swamp shrub vegetation (*Populetalia albae, Alnetea glutinosae, Alno-Padion*)	2	5	7	-
Reed-grass and tall sedge vegetation (*Phragmitetea*)	1	10	7	-
Segetal weed communities (*Secalinion, Linion, Caucalidion*)	13	11	10	1
Ruderal weed vegetation (*Onopordetalia*)	-	3	7	1
Vegetation of rocks, walls and rock crevices (*Asplenietea rupestris*)	2	-	-	9
Scree, gravel and riverside gravel vegetation	-	-	3	6
High-mountain grasslands (*Elyno-Seslerietea, Caricetea curvulae*)	2	1	1	34
Sand communities (*Sedo-Scleranthetea*)	1	-	3	3
Species-poor acid grasslands and heaths (*Nardo-Callunetea*)	-	3	4	2
Xerothermic chalk and limestone steppe grasslands (*Festuco-Brometea*)	3	1	6	31
Thermophilous tall-herb and scrub vegetation of woodland edges (*Trifolio-Geranietea sanguinei, Rhamno-Prunetea*)	2	2	3	12
Xerothermic woodland and shrub communities (*Quercetalia pubescentis*)	-	-	5	7
Mixed woodlands on nutrient-rich soils (*Carpinion, Fagion, Alno-Padion*)	1	1	5	7
Fir, spruce and pine forests (*Vaccinio-Piceetea*)	-	1	2	6
Tall-herb and tall-grass communities (*Betulo-Adenostyletea*)	-	1	-	11
Others	3	5	3	15
Total	40	87	105	152

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-

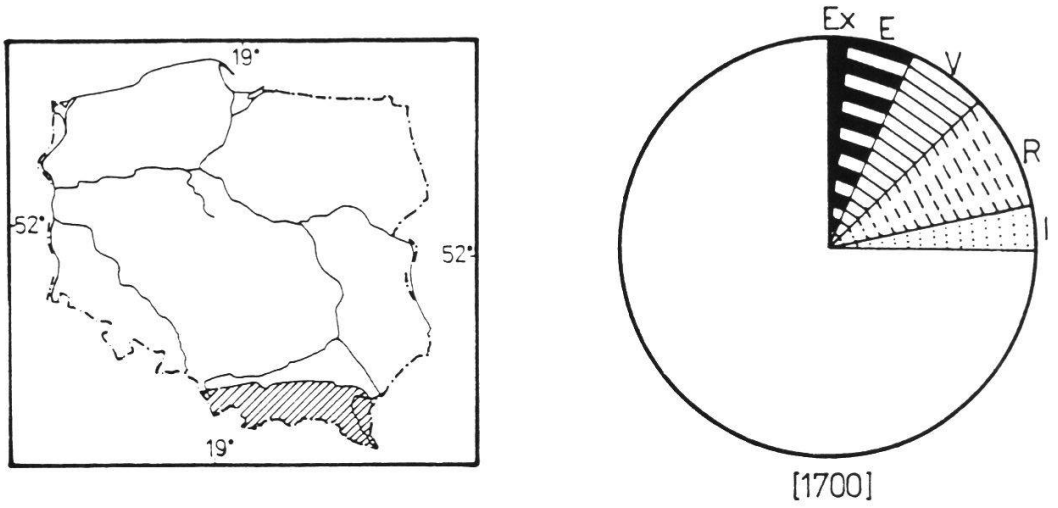

Fig. 1. Proportion of various groups of the extinct and threatened vascular plants in relation to the total flora of the Polish Carpathians.

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.

REFERENCES

ALEXANDROWICZ Z. (ed.), 1989: Nature and landscape protection of the Polish Carpathians. (In Polish). Stud.Nat., ser. B *33*, 1-241.

BLAB J., NOWAK E., TRAUTMAN W. and SUKOPP H., 1978: Rote Liste der gefährdeten Tiere und Pflanzen in der Bundesrepublik Deutschland. Naturschutz Aktuell *1*, 1-67.

COUNCIL OF EUROPE, 1983: List of rare, threatened and endemic plants in Europe. Nature and Environment Series, Council of Europe, Strasbourg. No. 27, 357 p.

HOW TO USE the IUCN Red Data Book Categories., 1980: Threatened Plants Committee Secretariat, IUCN, Kew, Royal Bot. Gardens.

KORNAS J., 1970: Contemporary changes of the flora of Poland. (In Polish). Wszechswiat *9*, 229-234.

KORNAS J., 1987: Changes of segetal vegetation in the Gorce Mts. (Polish Western Carpathians) during the last 35 years. (In Polish with English summary). Zesz.Nauk. Uniw.Jagiellon. 834, Prace bot. *15*, 7-26.

LANDOLT E., FUCHS H.P., HEITZ Ch. and SUTTER R., 1982: Bericht über die gefährdeten und seltenen Gefässpflanzenarten der Schweiz. ("Rote Liste"). Ber.Geobot.Inst.ETH, Stiftung Rübel,Zürich, *49*, 195-218.

LUCAS G. and SYNGE H., 1978: The IUCN plant red data book. IUCN, Morges. 540 p.

MIREK Z., 1976: The extinction of flax weed *Camelina alyssum* (Mill.) Thell. in Poland. (In Polish with English summary). Phytocoenosis *5(3/4)*, 227-236.

MIREK Z. and PIEKOS-MIRKOWA H., 1990: *Juncus triglumis* L. - ecology, threat, and conservation. In: PIEKOS-MIRKOWA H. (ed), Ecology, threat and conservation of rare mountain plant species. (In Polish with English summary). Stud.Nat., ser. A *33*, 107-132.

PIEKOS-MIRKOWA H., 1982: Rare taxa of vascular plants of the territory of the Tatra National Park - their endangerment by tourism and problems of their conservation. (In Polish with English summary). Stud.Nat., ser A, *22*, 79-132.

PIEKOS-MIRKOWA H., 1986: Actual problems of gene resources conservation of vascular plants in the Tatra National Park. (In Polish with English summary). Acta Univ.Lodz., Folia sozol. *3*, 143-159.

PIEKOS-MIRKOWA H., 1990a: The functioning of the plant species protection in Poland. (In Polish with English summary). In: KLIMEK K. (ed.), Protected areas and species conservation in southern Poland - functioning, evaluation, perspectives. Stud.Nat., suppl., (1990) 141-167.

PIEKOS-MIRKOWA H., 1990b: Threat of rare mountain plant species and their conservation. (In Polish with English summary). In: PIEKOS-MIRKOWA H. (ed.), Ecology, threat and conservation of rare mountain plant species. Stud.Nat., ser. A, *33*, 7-15.

PIEKOS-MIRKOWA H. and LOBARZEWSKA A., 1990a: *Cortusa matthioli* L. - ecology, threat, and conservation. (In Polish with English summary). In: PIEKOS-MIRKOWA H. (ed.), Ecology, threat and conservation of rare mountain plant species. Stud.Nat., ser. A *33*, 16-68.

PIEKOS-MIRKOWA H. and LOBARZEWSKA A., 1990b: *Pedicularis hacquetii* Graf. - ecology, threat, and conservation. (In Polish with English summary). In: PIEKOS-MIRKOWA H. (ed.), Ecology, threat and conservation of rare mountain plant species. Stud.Nat., ser. A, *33*, 69-107.

PIEKOS-MIRKOWA H. and KACZMARCZYK D., 1990a: *Pulsatilla slavica* Reuss - ecology, threat, and conservation. In: PIEKOS-MIRKOWA H. (ed.), Ecology, threat and conservation of rare mountain plant species. Stud.Nat., ser. A *33*, 133-166.

PIEKOS-MIRKOWA H. and KACZMARCZYK D., 1990b: *Astragalus penduliflorus* Lam. - ecology, threat, and conservation. (In Polish with English summary). In: PIEKOS-MIRKOWA H. (ed.), Ecology, threat and conservation of rare mountain plant species. Stud.Nat. ser. A, *33*, 167- 199.

PIEKOS-MIRKOWA H. and MIREK Z., 1988: *Dryopteris villarii* (*Dryopteridaceae*: Pteridophyta) a new high-mountain species in the Carpathians. Fern Gaz. *13(4)*, 245-246.

PIEKOS-MIRKOWA H. and MIREK Z., 1989: *Dryopteris villarii* (Bellardi) Woynar ex Schinz et Thell. - a new high-mountain species in the flora of Poland. (In Polish with English summary). Fragm.Flor.Geobot. *34(3/4)*, 277-282.

RAUSCHERT S., 1980: Liste der in den thüringischen Bezirken Erfurt, Gera und Suhl erloschenen und gefährdeten Farn- und Blütenpflanzen. Landschaftspfl.Natursch. Thüringen *17(1)*, 1-32.

ZARZYCKI K., 1976: Small populations of relict and endemic plant species of the Pieniny Range (West Carpathians Mts.), their endangerment and conservation. (In Polish with English summary). Ochr.przyr. *41*, 7-75.

ZARZYCKI K., 1986: List of threatened vascular plants in Poland. (In Polish with English summary). In: ZARZYCKI K. and WOJEWODA W. (eds.), List of threatened plants in Poland. PWN, Warszawa. 11-27.

Address of the authors:

Dr. Zbigniew MIREK
W. Szafer Institute of Botany
Polish Academy of Sciences
Lubicz 46
31-512 Krakow, Poland

Dr. Halina PIEKOS-MIRKOWA
Nature Protection Research Centre
Polish Academy of Sciences
Lubicz 46
31-512 Krakow, Poland