THREATENED VASCULAR PLANTS OF THE SUDETEN MOUNTAINS

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(Received: June 25, 2002. Accepted: September 30, 2002)

ABSTRACT

The authors present a list of extinct, dying out and threatened species of vascular plants of the Sudeten Mts. (south-western Poland), based on their own field studies carried out since 1972, historical literature data, and herbarial collections. The list comprises 584 taxa, i.e. almost 33% of the Sudeten vascular flora. Sixty species were recognized as extinct and disappeared, 93 – as critically endangered, 161 – as endangered, 224 – vulnerable, and 12 – near threatened species. No definite kind of threat was ascribed to 34 taxa. Thus they were included in the group of „data deficient" species. The paper presents also a quantitative analysis of all the species from the particular threat categories at the background of basic phytosociological groups. Besides, exemplary maps of the distribution of some of the Sudeten plants are given.

KEY WORDS: Sudeten Mts., red list, vascular flora, categories of threatened species.

INTRODUCTION

The recently escalating phenomenon of dying out of plants as a result of the progressing degradation of the natural environment is one of the most apparent manifestations of the „civilization" influence of man. At the same time, the process of dying out is among the most often undertaken topics of scientific investigations. They concern the dying out of particular species, specific ecological or phytocoenotic groups, or the whole vascular flora – from regional to global. The problem of the decreasing species diversity of analysed areas is evidenced in so-called „red lists" (Lucas and Walters 1976; Council of Europe 1983; Niklefield 1986; Weeda et al. 1990; Ingelög et al. 1993; Maglocký and Feráková 1993; Oltean et al. 1994; Korneck et al. 1996; Schnittler and Gűnther 1999; Holub and Procházka 2000, among others). However, apart from pure statistical listing, it is also important to indicate the most anthropopression-susceptible group of plants, which in further prospect should make a basis for studies of their behaviour in natural conditions – active preservation (reintroduction, metaplantation etc). Among others, for these reasons it is particularly significant to make an evaluation of the real threat of species in their habitats. Regional „red lists" were elaborated most of all in European countries and in the United States of America (e.g. Zimmermann and Kniely 1990; Welsh and Chatterley 1985; Murray and Lipkin 1987; Feráková 1988; Benkert and Klemm 1990; Fukarek 1992; Sivinski and Lightfoot 1992; Tibor 2001).

In Poland, apart from countrywide elaborations (Jasiewicz 1981; Zarzycki and Szeląg 1992; Zarzycki et al. 2000) important regional lists of threatened taxa were published (Bróż 1990; Mirek and Piękoś-Mirkowa 1992; Kucharczyk and Wójciak 1995; Żukowski and Jackowiak 1995; Rutkowski 1997). In the case of the Sudeten Mts., so far only an initial list of extinct and dying out species has appeared (Fabiszewski and Kwiatkowski 1997). The intensive field investigations, carried out recently, have answered a number of questions concerning the distribution of many vascular plants. New sites of species recognized as dying out, or even extinct were found, showing differences in comparison with the former elaboration (Fabiszewski and Kwiatkowski 1997). The authors hope, that this imperfect list will make a starting point for more intense floristic and chorological studies in that part of Poland, and exertions concerning the active protection of dying out populations.

INVESTIGATED AREA AND METHODS

The present elaboration concerns the Sudeten Mts. in a broad meaning, i.e. higher mountain ranges forming the Polish part of the Sudeten Mts., together with Sudeten Pla-

teau and the Sudeten Foreland. Its western boundary is set by the valley of the Lusatian Neisse (Nysa Łużycka), adjacent to the German territory (from Sieniawka in the south to the town Pieńsk in the north). The northern and eastern border of this area runs NW-SE, connecting the towns: Pieńsk – Bolesławiec – Złotoryja – Jawor – Strzegom – Sobótka – Strzelin – Głuchołazy, separating the Sudeten Plateau and the Sudeten Foreland from the neighbouring Silesian Lowland. Finally, the southern border of the territory is the national border of the Czech Republic. The region delimited in this way covers an area of 9335 km^2 (Fig. 1). The highest mountain range is the Karkonosze Mts. (Giant Mountains) (1602 m above sea level), where the climatic-floristic zones are best developed (most of all the subalpine and alpine zones). They are characterized by a high contribution of alpine plants, and particularly by the occurrence of endemic taxa (e.g. *Hieracium corconticum*, *Saxifraga moschata* subsp. *basaltica*). On the other hand, the area of the Izerskie Mts. is distinguished by the highest concentration of mountain-peat bogs. Finally, the Kaczawskie Mts. and the Śnieżnik Massif with numerous limestone outcrops, as well as the Kaczawskie Plateau, Strzegomskie and Niemczańsko-Strzelińskie Hills, with preserved outcrops particularly of volcanic rocks, make habitats for the development of floristically diversified, xerothermic grasslands. In the Ślęża Massif the peculiar flora, with the contribution of fissure ferns of the genus *Asplenium*, finds suitable habitats on the serpentine rocks unique in Poland.

Studies of the distribution of threatened species in the Sudeten Mts. were carried out by means of the topographic method in the years 1972-2002. In order to classify correctly to the particular threat categories, the results of our own field investigations were compared with data included in herbarial collections (KRA, KRAM, KTU, POZ, WRAB, WRSL – compare: Mirek et al., 1997) and in botanical literature. In particular the monographies of German florists from the 19th and 20th centuries were referred to (e.g. Wimmer 1857; Fiek 1881; Winkler 1881; Schube 1903; Pax 1928; Limpricht 1942, 1944a, 1944b), as well as floristic notes published in „Jahresberichte der Schlesischen Gesellschaft für vaterländische Cultur", edited by Schube and Schalow until 1945, or the data from the 60-ties, published in the „Atlas rozmieszczenia roślin naczyniowych na Śląsku" edited by J. Mądalski. Among contemporary works the series of elaborations of rare components of the dendroflora of the Sudeten, edited by A. Boratyński, and the monographies of vascular flora of some mountain ranges (e.g. Šourek 1969; Szeląg 2000), are especially worth to notice. Moreover, all the publications concerning both taxonomy and distribution of vascular plant species (among others: Hrouda and Marhold 1993; Chrtek 1997; Kwiatkowski 1999, 2000), as well as data included in phytosociological elaborations (e.g. Pender 1990; Pender and Macicka-Pawlik 1996) were used. The distribution of selected taxa is presented in point maps (Fig. 2). The nomenclature of species was accepted according to the elaboration of Mirek et al. (1995).

In order to qualify a species to a particular group of threat, the following criteria were considered: ecological criteria (degree of preservation of habitats and plant communities, biotope threats), chorological criteria (area of occurrence, number of localities and degree of their diffusion,

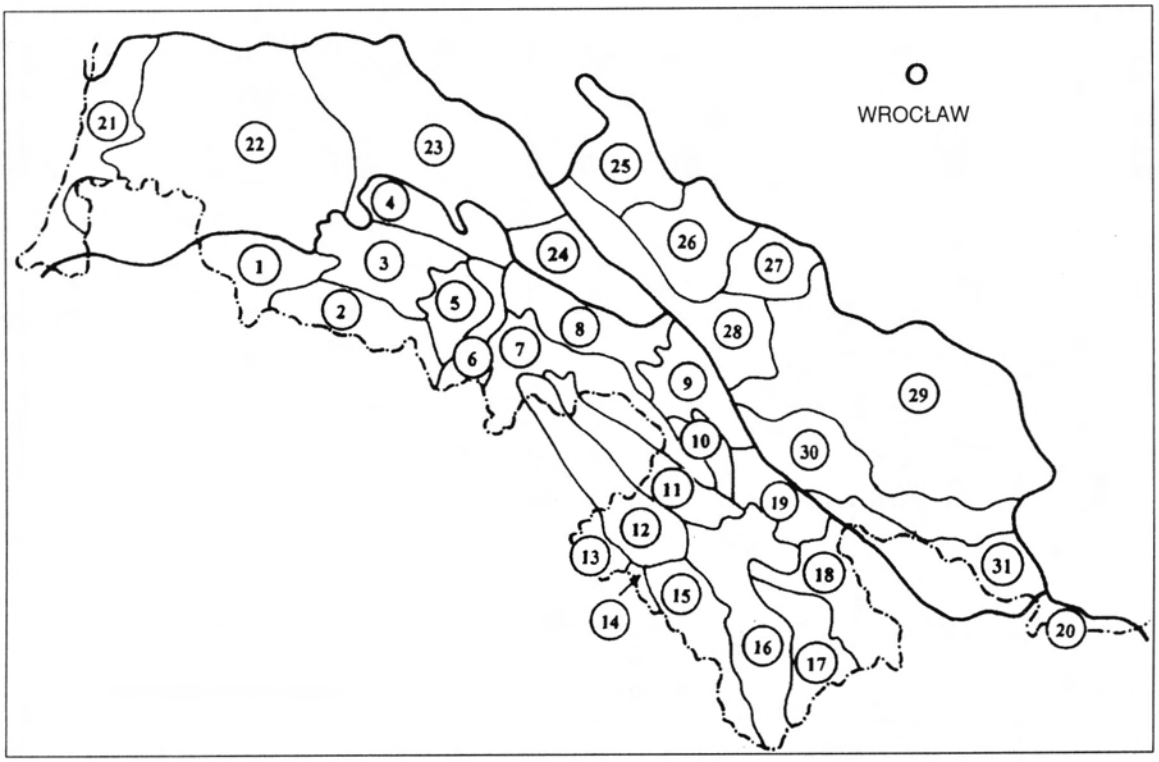

Fig. 1. The investigated area: Sudeten Mountains: 1 – Izerskie Mts., 2 – Karkonosze Mts., 3 – Jelenia Góra Depression, 4 – Kaczawskie Mts., 5 – Rudawy Janowickie Mts., 6 – Lubawka Gate, 7 – Kamienne Mts., 8 – Wałbrzyskie Mts., 9 – Sowie Mts., 10 – Nowa Ruda Depression, 11 – Ścinawka Depression, 12 – Stołowe Mts., 13 – Orlickie Plateau, 14 – Orlickie Mts., 15 – Bystrzyckie Mts., 16 – Kłodzko Depression, 17 – Śnieżnik Massif, 18 – Złote and Bialskie Mts., 19 – Bardzkie Mts., 20 – Opawskie Mts.; Sudeten Plateau: 21 – Żytawa-Zgorzelec Depression, 22 – Izerskie Plateau, 23 – Kaczawskie Plateau, 24 – Bolkowsko-Wałbrzyskie Plateau; Sudeten Foreland: 25 – Strzegomskie Hills, 26 – Świdnica Plain, 27 – Ślęża Massif, 28 – Podsudeckie Depression, 29 – Niemczańsko-Strzelińskie Hills, 30 – Otmuchów Depression, 31 – Paczków Foreland.

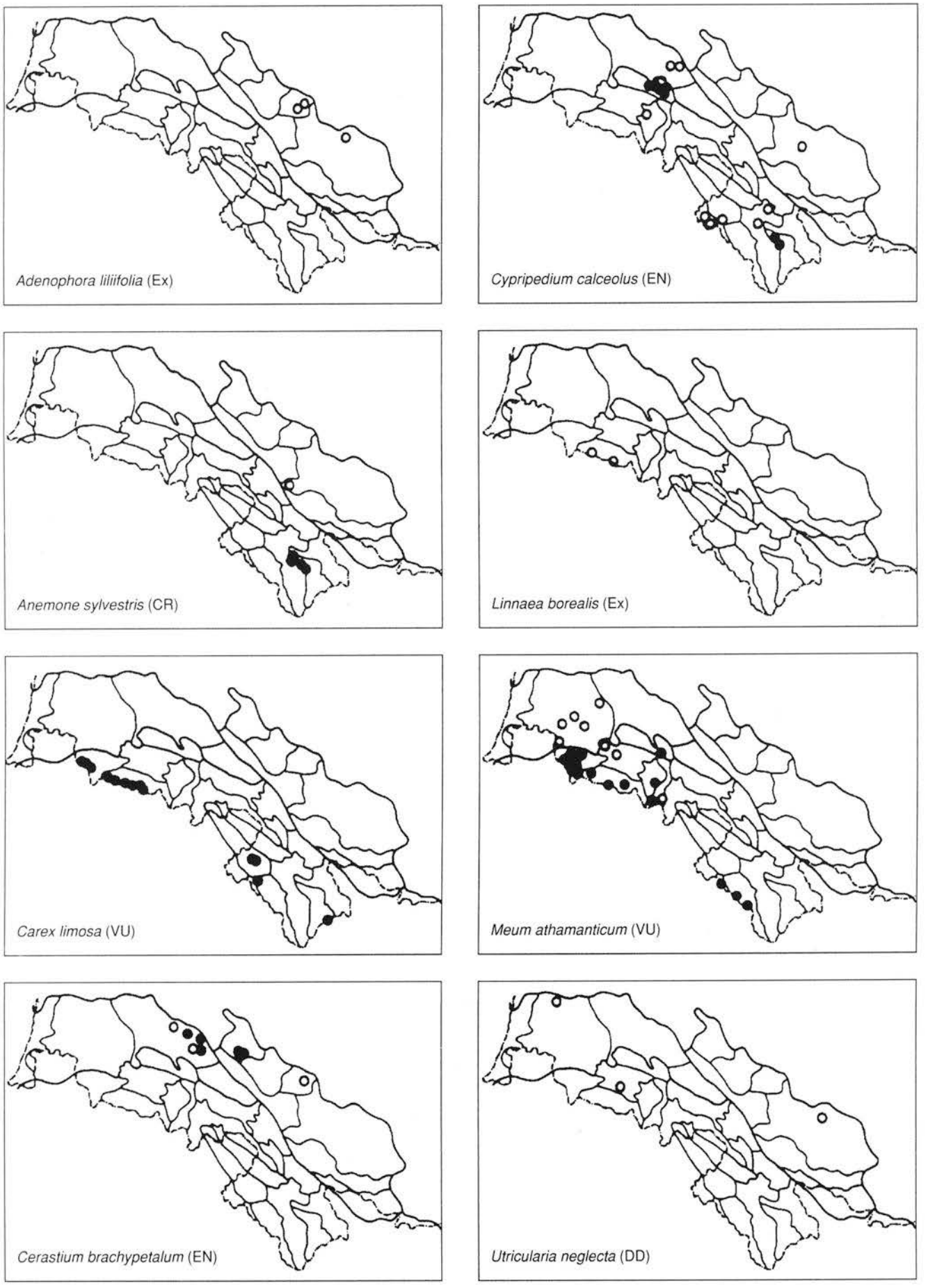

Fig. 2. The distribution of selected species in the Sudeten Mountains. Both localities recently confirmed by the authors (solid dots) and old, unconfirmed localities (empty dots) are shown.

contribution of endemic and relic taxa), population criteria (size and dynamics of population, number of mature individuals), and the present and anticipated influence of man.

In the present work six threat categories were accepted, according to the latest recommendations of IUCN (2001) and elaborations of Palmer et al. (1997) and Colyvan et al. (1999). The category EXTINCT (EX) includes taxa that are completely extinct. The last specimens of these species were observed, in most cases, over 50 years ago, and some of them even in the 19th century. Most of the species occurred on single localities – e.g. *Allium strictum* on the Kaczawskie Plateau, *Carex michelii* on the Niemczańskie Hills, *Gymnadenia odoratissima* in the Karkonosze Mts., *Hammarbya paludosa* in the Kamienne Mts., *Potentilla sterilis* on the Izerskie Plateau. Despite numerous trials, we failed in confirming their occurrence during the last 30 years. Into this group also species of the category ?Ex –missing were included, which are probably extinct. Taxa of this group are marked in our list with an asterisk. This applies among others to the representatives of the genus *Orobanche*. In this case there still exists a certain possibility of their localities confirmation.

The category of CRITICALLY ENDANGERED (CR) taxa includes plants which meet, among others, one of the following criteria: The area of their initial occurrence diminished recently, or shall diminish in the nearest future by at least 80% (e.g. *Botrychium matricariifolium*, *Carex pulicaris*, *Gentianella campestris*). They are frequently limited to only a single, isolated place of occurrence (*Carex vaginata*, *Orchis ustulata*, *Saxifraga nivalis*), or their very small localities are considerably distracted (*Anemone sylvestris*, *Medicago minima*, *Stachys germanica*). Finally, also plants, the number of mature specimens of which does not exceed 250 (*Alchemilla corcontica*, *Leucorchis albida*, *Trifolium striatum* etc) belong here. In the nearest future these taxa will probably become completely extinct.

ENDANGERED (EN) taxa, of high extinction probability in the near future. To this group species which area of occurrence will get reduced (or has already been reduced) at least by a half belong (e.g. *Arnica montana*, *Cypripedium calceolus*, *Listera cordata*). These are taxa with very dispersed and not abundant sites (*Anthericum ramosum*, *Crepis praemorsa*, *Potentilla rupestris*), or those known from not more than five localities (*Cardaminopsis arenosa* subsp. *borbasii*, *Delphinium elatum*, *Gentianella germanica*). A species belongs to the category also if the number of mature specimens does not exceed 2500 – *Carex magellanica*, *Cephalanthera damasonium*, *Oxycoccus microcarpus*. For species of this category a reduction in number by at least 20% is foreseen in the next five years, or during two generations.

VULNERABLE (VU) taxa are relatively least threatened from so far mentioned categories, though the risk of their extinction is very high. This is true especially in the case when the impact of anthropogenic factors will persist. This category includes, among other, species known exclusively from less than ten sites (*Diphasiastrum alpinum*, *Helleborus viridis*, *Omphalodes scorpioides*), or from a greater number of dispersed localities (*Eriophorum latifolium*, *Gymnadenia conopsea* subsp. *conopsea*, *Melittis melissophyllum*), including altogether less than 10.000 mature individuals (*Allium sibiricum*, *Cephalanthera longifolia*, *Sorbus torminalis*), and finally if their area of occurrence may get reduced in the future at least by 20% (*Galanthus nivalis*, *Phyteuma orbiculare*, *Salvia verticillata*).

In the present elaboration only some of the evaluated species were classified into the category of NEAR THREATENED (NT) taxa. This group includes only such taxa, which in our country have either their centre of occurrence only in the Sudeten (e.g. *Chrysosplenium oppositifolium*, *Leucojum vernum* subsp. *vernum*, *Poa supina*) and are at present not directly threatened by extinction, or species commonly regarded as rare plants or legally protected in Poland, but occurring commonly in the Sudeten Mts. – *Carex bigelowii* subsp. *rigida*, *Epipactis helleborine* group.

The last category includes DATA DEFICIENT (DD) taxa, for which the data are not sufficient for a direct or indirect determination of extinction risk. This group, rather numerous in the Sudeten Mts., includes plants with sites mentioned in the literature, several dozen of years old, or included in herbarial collections (e.g. *Chenopodium vulvaria*, *Rosa jundzilli*, *Utricularia intermedia*). It is difficult to determine unambiguously whether the given species is extinct or whether it is still represented by some small populations. Those are frequently species occurring ephemerally – particularly in slime-soil communities of the class *Isoëto-Nanojuncetea* (among others *Cyperus flavescens*, genus *Elatine*, *Lindernia procumbens*), or weed associations in cereal crops of the class *Secalietea* – *Anagallis foemina*, *Galium tricornutum*, *Kickxia spuria*. Thus, there is frequently the possibility of finding them again. This remark concerns many other species belonging to this category of threat.

THE LIST OF THREATENED VASCULAR PLANTS OF THE SUDETEN MTS

Extinct (Ex) and missing (probably extinct* – ?Ex) taxa

Adenophora liliifolia (L.) Besser
Allium strictum Schrad.
Anacamptis pyramidalis (L.) Rich.
Arctostaphylos uva-ursi (L.) Spreng.
Botrychium multifidum (S.G. Gmel.) Rupr.
Bupleurum falcatum L.
Bupleurum rotundifolium L.
Camelina alyssum Thell.
Carex buekii Wimm.*
Carex chordorhiza L.
Carex dioica L.
Carex michelii Host
Carex pediformis C.A. Mey.
Carex strigosa Huds.
Caucalis platycarpos L.
Chamaecytisus ratisbonensis (Schaeff.) Rothm.*
Chimaphila umbellata (L.) W.P.C. Barton
Cladium mariscus (L.) Pohl
Cnidium dubium (Schkuhr) Thell.
Conioselinum tataricum Hoffm.
Conringia orientalis (L.) Dumort.
Cuscuta epilinum (L.) L. s.s.
Cystopteris sudetica A. Braun & Milde
Dianthus speciosus Rchb.
Diphasiastrum tristachyum (Pursh) Holub
Eriophorum gracile W.D.J. Koch
Euphorbia villosa Waldst. & Kit. *ex* Willd.

Gentianella uliginosa (Willd.) Börner
Geranium bohemicum L.*
Gymnadenia odoratissima (L.) Rich.
Hippuris vulgaris L.
Hammarbya paludosa (L.) Kuntze
Iris aphylla L.
Lindernia procumbens (Krock.) Borbás
Linnaea borealis L.
Lolium remotum Schrank
Luronium natans (L.) Raf.
Nymphoides peltata (S.G. Gmel.) Kuntze
Orchis coriophora L.
Orchis palustris Jacq.
Orobanche alsatica Kirschl.*
Orobanche arenaria Borkh.*
Orobanche flava Mart. *ex* F.W. Schultz
Orobanche picridis F.W. Schultz
Potentilla sterilis (L.) Garcke*
Prunella lacinata (L.) L.
Pulsatilla vernalis Mill.
Rhynchospora fusca (L.) W.T. Aiton
Salix myrsinifolia Salisb.
Salix myrtilloides L.*
Scorzonera purpurea L.
Spiranthes spiralis (L.) Chevall.*
Stellaria pallida (Dumort.) Piré*
Spergula pentandra L.
Tofieldia calyculata (L.) Wahlenb.
Vaccaria hispanica (Mill.) Rauschert*
Veronica bellidioides L.*
Viola pumila Chaix
Viola stagnina Kit.
Woodsia ilvensis (L.) R. Br.

Critically threatened (CR) taxa

Achillea stricta Schleich.
Adonis aestivalis L.
Aira praecox L.
Alchemilla corcontica Plocek
Alchemilla obtusa Buser
Alchemilla reniformis Buser
Allium victorialis L.
Androsace obtusifolia All.
Anemone sylvestris L.
Arabis alpina L. subsp. *alpina*
Armeria maritima (Mill.) Willd. subsp. *hallerii* (Wallr.) Á. Löve & D. Löve
Asperula cynanchica L.
Asplenium onopteris L.
Astragalus cicer L.
Avenula planiculmis (Schrad.) W. Sauer & Chmelitschek
Botrychium matricariifolium (Retz.) A. Braun *ex* W.D.J. Koch
Bupleurum longifolium L.
Cardamine resedifolia L.
Carex buxbaumii Wahlenb.
Carex capillaris L.
Carex humilis Leyss.
Carex pulicaris L.
Carex vaginata Tausch
Cephalanthera rubra (L.) Rich.
Cerastium fontanum Baumg.
Cirsium acaule Scop.
Coeloglossum viride (L.) Hartm.
Cyclamen purpurascens Mill.
Dactylorhiza incarnata (L.) Soó
Diphasiastrum complanatum (L.) Holub
Elatine hydropiper L. *em.* Oeder
Epipogium aphyllum Sw.
Erica tetralix L.
Euphorbia lucida Waldst. & Kit.
Euphrasia micrantha Rchb.
Euphrasia minima Jacq.
Euphrasia picta Wimm.
Euphrasia tatrae Wettst.
Festuca versicolor Tausch
Galium anisophyllum Vill.
Galium sudeticum Tausch
Gentiana pneumonanthe L.
Gentianella baltica (Murb.) Börner
Gentianella campestris (L.) Börner
Gladiolus paluster Gaudin
Goodyera repens (L.) R. Br.
Helianthemum nummularium (L.) Mill. subsp. *nummularium*
Hieracium schmidtii Tausch
Hierochloë australis (Schrad.) Roem. & Schult.
Hierochloë odorata (L.) P. Beauv.
Isoëtes lacustris L.
Lathyrus heterophyllus L.
Ledum palustre L.
Leucorchis albida (L.) E. Mey.
Linosyris vulgaris Cass.
Lythrum hyssopifolia L.
Malaxis monophyllos (L.) Sw.
Medicago minima (L.) L.
Moneses uniflora (L.) A. Gray
Muscari comosum (L.) Mill.
Ononis repens L.
Orchis militaris L.
Orchis morio L.
Orchis ustulata L.
Orobanche elatior Sutton
Orobanche purpurea Jacq.
Phyllitis scolopendrium (L.) Newman
Pimpinella rupestris Weide
Pinguicula vulgaris L. subsp. *vulgaris*
Poa bulbosa L.
Polygala amarella Crantz
Polystichum lonchitis (L.) Roth
Potamogeton trichoides Cham. & Schltdl.
Pulmonaria angustifolia L.
Pyrola media Sw.
Rosa gallica L.
Salix herbacea L.
Saxifraga bryoides L.
Saxifraga decipiens Ehrh.
Saxifraga moschata Wulfen subsp. *basaltica* Braun.-Blanq.
Saxifraga nivalis L.
Saxifraga oppositifolia L.
Scabiosa lucida Vill.
Sedum villosum L.
Selaginella selaginoides (L.) P. Beauv. *ex* Schrank & Mart.
Sesleria tatrae (Degen) Deyl
Sparganium minimum Wallr.
Stachys germanica L.

Thesium pyrenaicum Pourr.
Trifolium striatum L.
Veronica pumila All.
Viola collina Besser subsp. *porphyrea* R. Uechtr.
Woodsia alpina (Bolton) S.F. Gray

Endangered (EN) taxa

Agrostemma githago L.
Alchemilla connivens Buser
Alchemilla cymatophylla Juz.
Allium angulosum L.
Allium scorodoprasum L.
Anemone narcissiflora L.
Anthericum ramosum L.
Aphanes microcarpa (Boiss. & Reut.) Rothm.
Arabis planisiliqua (Rchb.) Pers.
Arnica montana L.
Arnoseris minima (L.) Schweigg. & Körte
Arum alpinum Scott & Kotschy
Asperula tinctoria L.
Asplenium adiantum-nigrum L.
Asplenium adulterinum Milde
Asplenium cuneifolium Viv.
Asplenium viride Huds.
Baeothryon alpinum (L.) T.V. Egorova
Bartsia alpina L.
Betula nana L.
Bromus arvensis L. subsp. *arvensis*
Bromus racemosus L.
Calla palustris L.
Campanula barbata L.
Campanula cervicaria L.
Campanula bohemica Hruby in Polivka, Domin & Podp.
Cardamine trifolia L.
Cardaminopsis arenosa (L.) Hayek subsp. *borbasii* Zapał.
Carex atrata L. *agg.*
Carex davalliana Sm.
Carex magellanica Lam.
Cephalanthera damasonium (Mill.) Druce
Cerastium brachypetalum Pers.
Cerinthe minor L.
Chrysanthemum segetum L.
Corallorhiza trifida Châtel.
Cotoneaster niger Fries
Crataegus rhipidophylla Gand. var. *lindmanii* (Hrabětová) K.I. Chr.
Crepis conyzifolia (Gouan) Dalla Torre
Crepis praemorsa (L.) Tausch
Crocus cfr. *albiflorus* Kit. & Schult.
Cypripedium calceolus L.
Dactylorhiza psychrophila (Schlechter) Holub *ex* Soó
Dactylorhiza sambucina (L.) Soó
Delphinium elatum L.
Dianthus armeria L.
Dianthus superbus L. s.s.
Diphasiastrum issleri (Rouy) Holub
Drosera anglica Huds.
Drosera intermedia Hayne
Eleocharis ovata (Roth) Roem. & Schult.
Empetrum hermaphroditum Hagerup
Empetrum nigrum L. s.s.
Epilobium alsinifolium Vill.
Epilobium anagallidifolium Lam.
Epilobium nutans F.W. Schmidt
Epipactis albensis Nováková & Rydlo
Epipactis palustris (L.) Crantz
Epipactis purpurata Sm.
Equisetum variegatum Schleich.
Euphorbia amygdaloides L.
Euphrasia coerulea Hoppe & Fürnr.
Ficaria nudicaulis A. Kern.
Fumaria vaillantii Loisel.
Galium valdepilosum Heinr. Braun
Gentianella amarella (L.) Börner *agg.*
Gentianella bohemica Skalický
Gentianella germanica (Willd.) Börner
Gentianella lutescens (Velen) Holub subsp. *lutescens*
Geum montanum L.
Gladiolus imbricatus L.
Gnaphalium luteo-album L.
Gratiola officinalis L.
Gymnadenia conopsea (L.) R. Br. subsp. *densiflora* (Wahlenb.) K. Richt.
Hieracium apatelium Nägeli & A. Peter
Hieracium atratum Fr.
Hieracium bifidum Kit. *ex* Hornem.
Hieracium corconticum (K. Knaf) Čelak.
Hieracium echioides Lumn.
Hieracium fritzei F.W. Schultz
Hieracium glaucinum Jord.
Hieracium inuloides Tausch
Hieracium iseranum R. Uechtr.
Hieracium onosmoides Fr.
Hieracium racemosum (Waldst. & Kit.) Willd.
Hieracium stoloniflorum Waldst. & Kit.
Hypericum montanum L.
Hypochoeris glabra L.
Hypochoeris maculata L.
Hypochoeris uniflora Vill.
Inula hirta L.
Iris sibirica L.
Juncus alpino-articulatus Chaix
Juncus capitatus Weigel
Koeleria pyramidata (Lam.) Domin
Laserpitium prutenicum L.
Lathyrus montanus Bernh.
Lilium bulbiferum L.
Linaria arvensis (L.) Desf.
Listera cordata (L.) R. Br.
Luzula spicata (L.) DC.
Lycopodiella inundata (L.) Holub
Matteucia struthiopteris (L.) Tod.
Melampyrum cristatum L.
Melampyrum herbichii Woł.
Melica ciliata L. *agg.*
Menyanthes trifoliata L.
Misopates orontium (L.) Raf.
Monotropa hypophegea Wallr.
Montia fontana L. subsp. *chondrosperma* (Fenzl) Walters
Myosotis decumbens Host subsp. *variabilis* (Angelis) Grau
Oenanthe fistulosa L.
Ophioglossum vulgatum L.
Ornithogalum collinum Guss.
Orobanche caryophyllacea Sm.
Orobanche lutea Baumg.
Orobanche pallidiflora Wimm. & Grab.

Oxycoccus microcarpus Turcz. *ex* Rupr.
Parnassia palustris L.
Pedicularis palustris L.
Pedicularis sudetica Willd.
Platanthera chlorantha (Custer) Rchb.
Pleurospermum austriacum (L.) Hoffm.
Polystichum braunii (Spenn.) Fée
Potentilla collina Wibel s.s.
Potentilla rupestris L.
Prunella grandiflora (L.) Scholler
Pyrola chlorantha Sw.
Rhodiola rosea L.
Rosa micrantha Borrer *ex* Sm.
Rubus chamaemorus L.
Sagina ciliata Fr.
Sagina saginoides (L.) H. Karts.
Salvia glutinosa L.
Scabiosa columbaria L. s.s.
Scorzonera humilis L.
Scrophularia scopolii Hoppe
Sedum alpestre Vill.
Seseli annuum L.
Silene gallica L.
Stachys alpina L.
Stachys annua (L.) L.
Stachys arvensis (L.) L.
Stachys recta L.
Staphyllea pinnata L.
Swertia perennis L. subsp. *alpestris* (Baumg. *ex* Fuss) Simonk.
Tanacetum corymbosum (L.) Sch. Bip. subsp. *corymbosum*
Taraxacum nigricans (Kit.) Rchb. (sect. *Alpestria* Soest.)
Thalictrum flavum L.
Thalictrum minus L.
Thlaspi perfoliatum L.
Thymus alpestris Tausch *ex* A.Kern
Traunsteinera globosa (L.) Rchb.
Trifolium ochroleucon Huds.
Verbascum blattaria L.
Verbascum phoeniceum L.
Veronica prostrata L.
Vicia cassubica L.
Viola collina L.
Viola biflora L.
Vulpia myuros (L.) C.C. Gmel.

Threatened (VU) taxa

Abies alba Mill.
Achillea collina Becker *ex* Rchb.
Aconitum variegatum L.
Aira caryophyllea L.
Alchemilla crinita Buser
Alchemilla fissa Günther & Schummel
Alchemilla glaucescens Wallr.
Alchemilla plicata Buser
Alchemilla propinqua H. Lindb.
Alchemilla subcrenata Buser
Alchemilla walasii Pawł.
Allium montanum F.W. Schmidt
Allium sibiricum L.
Angelica archangelica L. subsp. *archangelica*
Anthyllis vulneraria L. subsp. *polyphylla* (Ser.) Nyman
Aquilegia vulgaris L.
Artemisia campestris L. subsp. *campestris*
Aruncus sylvestris Kostel.
Atropa belladonna L.
Avenula pratensis (L.) Dumort.
Baeothryon caespitosum A. Dietr.
Batrachium fluitans (Lam.) Wimm.
Batrachium penicillatum Dumort.
Betula x *oycoviensis* Besser
Blechnum spicant (L.) Roth
Botrychium lunaria (L.) Sw.
Bromus commutatus Schrad.
Bromus ramosus Huds.
Bromus secalinus L.
Calamagrostis stricta (Timm) Koeler
Callitriche hamulata Kütz. *ex* W.D.J. Koch
Camelina microcarpa Andrz. subsp. *sylvestris* (Wallr.) Hiitonen
Campanula glomerata L.
Campanula latifolia L.
Cardamine amara L. subsp. *opizii* (J. Presl & C. Presl) Čelak.
Cardamine flexuosa With.
Carduus nutans L.
Carex bohemica Schreb.
Carex hostiana DC.
Carex lepidocarpa Tausch
Carex limosa L.
Carex montana L.
Carex pallescens L. var. *corcontica* Jenik
Carex pauciflora Lightf.
Carex pendula Huds.
Carex tomentosa L.
Carex umbrosa Host
Carlina acaulis L. subsp. *simplex* (Waldst. & Kit.) Nyman
Carlina intermedia Schur
Carlina longifolia Rchb.
Catabrosa aquatica (L.) P. Beauv.
Centaurea oxylepis (Wimm. & Grab.) Hayek
Centaurea phrygia L.
Centaurea pseudophrygia C.A. Mey.
Centaurium pulchellum (Sw.) Druce
Cephalanthera longifolia (L.) Fritsch
Cerastium macrocarpum Schur. *em.* Gartner
Cerastium pumilum Curtis *agg.*
Chamaecytisus supinus (L.) Link
Cirsium helenioides (L.) Hill
Comarum palustre L.
Corydalis intermedia (L.) Mérat
Cotoneaster integerrimus Medik.
Crepis succisifolia (All.) Tausch
Cryptogramma crispa (L.) R. Br.
Cuscuta epithymum (L.) s.s.
Cuscuta lupuliformis Krock.
Cyperus fuscus L.
Dactylorhiza fuchsii (Druce) Soó
Dactylorhiza maculata (L.) Soó
Dactylorhiza majalis (Rchb.) P.F. Hunt & Summerh.
Daphne mezereum L.
Dentaria enneaphyllos L.
Diphasiastrum alpinum (Rouy) Holub
Doronicum austriacum Jacq.
Drosera rotundifolia L.
Dryopteris cristata (L.) A. Gray

Eleocharis acicularis (L.) Roem. & Schult.
Eleocharis quinqueflora (Hartman) O.Schwarz
Epilobium alpestre (Jacq.) Krock.
Epilobium collinum C.C. Gmel.
Epipactis atrorubens (Hoffm.) Besser
Equisetum hyemale L.
Equisetum telmateia Ehrh.
Eriophorum latifolium Hoppe
Euphorbia exigua L.
Euphrasia nemorosa (Pers.) Wallr.
Falcaria vulgaris Bernh.
Festuca heterophylla Lam.
Gagea arvensis (Pers.) Dumort.
Galanthus nivalis L.
Gentiana cruciata L.
Geranium sanguineum L.
Glyceria nemoralis (R. Uechtr.) R. Uechtr. & Körn.
Gnaphalium supinum L.
Gymnadenia conopsea (L.) R. Br. subsp. *conopsea*
Gymnocarpium robertianum (Hoffm.) Newman
Helleborus viridis L.
Hieracium alpinum L.
Hieracium arvicola Nägeli & A. Peter
Hieracium chlorocephalum R. Uechtr.
Hieracium diaphanoides Lindeb.
Hieracium flagellare Willd.
Hieracium floribundum Wimm. & Grab.
Hieracium lactucella Wallr.
Hieracium nigrescens Willd.
Hieracium prenanthoides Vill.
Huperzia selago (L.) Bernh. *ex* Schrank & Mart.
Isolepis setacea (L.) R. Br.
Isopyrum thalictroides L.
Jovibarba sobolifera (Sims) Opiz
Juncus acutiflorus Ehrh. *ex* Hoffm.
Juncus bulbosus L.
Juncus tenageia Ehrh.
Juniperus communis L. subsp. *alpina* (Suter) Čelak.
Juniperus communis L. subsp. *communis*
Koeleria glauca (Spreng.) DC.
Koeleria macrantha (Ledeb.) Schult.
Lappula squarrosa (Retz.) Dumort.
Laserpitium latifolium L.
Lavathera thuringiaca L.
Lembotropis nigricans (L.) Griseb.
Libanotis pyrenaica (L.) Bourg.
Lonicera periclymenum L.
Luzula sudetica (Willd.) DC.
Lycopodium annotinum L.
Lycopodium clavatum L.
Melampyrum arvense L.
Melittis melissophyllum L.
Meum athamanticum Jacq.
Monotropa hypopitys L. s.s.
Montia fontana L. subsp. *amporitana* Sennen
Mutellina purpurea (Poir.) Thell.
Nasturtium officinale R. Br.
Neottia nidus-avis (L.) Rich.
Neslia paniculata (L.) Desv.
Nigella arvensis L.
Omphalodes scorpioides (Haenke) Schrank
Onobrychis viciifolia Scop.
Ononis spinosa L.
Orchis mascula (L.) L. subsp. *signifera* (Vest) Soó
Ornithogalum umbellatum L.
Orthilia secunda (L.) House
Padus petraea Tausch
Pedicularis sylvatica L.
Petasites kablikianus Tausch *ex* Bercht.
Petrorhagia prolifera (L.) P.W. Ball & Heywood
Peucedanum cervaria (L.) Lapeyr.
Phleum phleoides (L.) H. Karst.
Phyteuma orbiculare L.
Pinus x *rhaetica* Brügger
Platanthera bifolia (L.) Rich.
Poa chaixii Vill.
Poa laxa Haenke
Potentilla aurea L.
Potentilla heptaphylla L.
Potentilla inclinata Vill.
Primula minima L.
Pulsatilla alba Rchb.
Pyrola minor L.
Pyrola rotundifolia L.
Ranunculus arvensis L.
Ranunculus cassubicus L. s.l.
Ranunculus serpens Schrank subsp. *nemorosus* (DC.) G. López
Rhinanthus alpinus Baumg.
Rhynchospora alba (L.) Vahl
Ribes petraeum Wulfen
Rosa agrestis Savi
Rosa inodora Fr.
Rosa scherardii Davies
Rubus chaerophylloides Spreng.
Rubus chaerophyllus Sagorski & W. Schultze
Rubus constrictus P.J. Müll. & Lefčvre
Rubus fasciculatus P.J. Müll
Rubus franconicus H.E. Weber
Rubus glivicensis
Rubus gothicus Frid. & Gelert *ex* E.H.L. Krause
Rubus graecensis Maurer
Rubus henrici-egonis Holub
Rubus macrophyllus Weihe & Nees
Rubus nemoralis P.J. Müll
Rubus nemorosus Hayne & Willd.
Rubus radula Weihe
Rubus saxatilis L.
Rubus scaber Weihe
Rubus senticosus Köhler ex Weihe
Rubus wahlbergii Arrh.
Salix lapponum L.
Salix repens L. subsp. *repens*
Salix rosmarinifolia L.
Salvia verticillata L.
Saxifraga tridactylites L.
Scheuchzeria palustris L.
Scirpus radicans Schkuhr
Scleranthus polycarpos L.
Sedum reflexum L.
Senecio rivularis (Walldst. & Kit.) DC.
Silene nutans L. subsp. *glabra* (DC.) Rothm.
Sorbus torminalis (L.) Crantz
Stellaria longifolia Muhl. *ex* Willd.
Stellaria neglecta Weihe
Teucrium botrys L.

Taxus baccata L.
Thalictrum lucidum L.
Thesium alpinum L.
Thesium linophyllon L.
Thlaspi caerulescens J. Presl & C. Presl
Trifolium rubens L.
Trifolium spadiceum L.
Trollius europaeus L. s.s.
Ulmus minor Mill. var. *suberosa* (Moench) Soó
Valeriana angustifolia Tausch
Valeriana dioica L.
Verbascum lychnitis L.
Veronica spicata L.
Veronica teucrium L.
Vicia lathyroides L.
Vicia pisiformis L.
Viola lutea Huds. subsp. *sudetica* (Willd.) W. Becker
Viola montana L.
Viola rupestris F.W. Schmidt
Viola saxatilis F.W. Schmidt
Viscum album L. subsp. *abietis* (Wiesb.) Abrom.
Vulpia bromoides (L.) S.F. Gray

Near threatened (NT) taxa

Andromeda polifolia L.
Callitriche stagnalis Scop.
Carex bigelowii Torr. *ex* Schwein. subsp. *rigida* W. Schultze-Motel
Chrysosplenium oppositifolium L.
Epipactis helleborine (L.) Crantz
Galium pumilum Murray
Gentianella ciliata (L.) Borkh.
Lathyrus tuberosus L.
Leucojum vernum L.
Listera ovata (L.) R. Br.
Oxycoccus palustris Pers.
Poa supina Schrad.

Rare taxa in data-deficient category (DD)

Achillea salicifolia Besser
Allium carinatum L.
Anagallis foemina Mill.
Astragalus arenarius L.
Bidens radiata Thuill.
Cardamine parviflora L.
Chenopodium vulvaria L.
Chondrilla juncea L.
Corrigiola litoralis L.
Cyperus flavescens L.
Elatine alsinastrum L.
Elatine hexandra (Lepierre) DC.
Elatine triandra Schkuhr
Eleocharis uniglumis (Link) Schult.
Erigeron droebachiensis O.F. Müll
Euphorbia serrulata Thuill.
Fumaria capreolata L.
Galium tricornutum Dandy
Geranium divaricatum Ehrh.
Hypericum pulchrum L.
Kickxia elatine (L.) Dumort.
Kickxia spuria (L.) Dumort.
Lathyrus palustris L.
Lindernia procumbens (Krock.) Borbás
Lithospermum officinale L.
Polygala amara L. subsp. *brachyptera* (Chodat) Hayek
Rosa jundzilli Besser
Rosa majalis Herrm.
Scabiosa canescens Waldst. & Kit.
Scandix pecten-veneris L.
Thalictrum simplex L.
Trapa natans L. s.s.
Utricularia australis R. Br.
Utricularia intermedia Hayne

THREAT ASSESSMENT OF VASCULAR PLANTS IN THE SUDETEN MOUNTAINS

The vascular flora of the Polish Sudeten Mts. comprises slightly more than 1800 taxa of vascular plants, disregarding the small, apomictic taxa of the genera *Epipactis* or *Taraxacum*, and hybrids. The present „red list" of threatened plants includes 584 species, i.e., almost 33% of the Sudeten vascular flora. The degree of threat of the local flora is definitely the highest in Poland. For example, the index of threat for the Polish Carpathian Mts. is 26% (Mirek and Piękoś-Mirkowa 1992), and for the Świętokrzyski Region 15% (Bróż 1990). On the other hand, there are regions in Europe, where almost a half of the vascular flora is threatened – e.g. the area of Brandenburg (Benkert and Klemm 1990).

During the field studies and analysis of the available materials 60 taxa were recognized as totally extinct or missing (Ex, ?Ex). This is a relatively high number in comparison with other Polish regions for which local „red lists" were elaborated. From this group *Allium strictum* and *Veronica bellidioides* are worth to be mentioned. They had the only localities in our country in the Sudeten Mts. Most of the species recognized as extinct had single localities, and the reason of disappearance of their populations were most of all the habitat changes, like: drainage of meadows and bogs (e.g. *Eriophorum gracile*, *Tofieldia calyculata*, *Viola stagnina*), overgrowth of xerothermic grasslands (*Carex michelii*, *Iris aphylla*, *Scorzonera purpurea*), disappearance of appropriate water sites (*Hippuris vulgaris*, *Lindernia procumbens*, *Nymphoides peltata*), or the intensification of agriculture (*Camelina alyssum*, *Caucalis platycarpos*, *Cuscuta epilunum*), and forest cultivation (*Arctostaphylos uva-ursi*, *Diphasiastrum tristachyum*).

As much as 93 taxa of vascular plants were included into the group of critically endangered (CR), which members will soon die out, if no limitation of anthropopressure will take place. Unfavourable is the fact of the presence in the CR group of species, currently known in Poland only on several mountain ranges in the Sudeten Mts. This concerns among others *Alchemilla corcontica*, *Asplenium onopteris*, *Cardamine resedifolia*, *Cyclamen purpurascens*, *Galium sudeticum*, *Pimpinella rupestris*, *Saxifraga nivalis*, *Trifolium striatum*, *and Viola collina* subsp. *porphyrea*. Their possible extinction would be a loss for the whole vascular flora of Poland. Of importance is also the fact that 1/3 of all the Orchidaceae species growing in the Sudeten Mts. belong to the CR group, and the very high number of grassland, meadow, and bog species in this group.

As endangered (EN) taxa 161 species were recognized, a dozen or so of which are limited in their occurrence exc-

lusively to the Sudeten, e.g. *Asplenium adulterimum*, *A. cuneifolium*, *Campanula barbata*, *C. bohemica*, *Carex magellanica*, *Hieracium schmidtii*, *Melica ciliata*, *Pedicularis sudetica*. They are in majority connected with the specific rocky habitats, especially with the serpentine or basaltic bedrocks, unique in our country, and high mountain ecosystems.

The group of vulnerable (VU) taxa, the most numerous among all of the analysed groups from the „red list", consists of 224 species. Beside taxa known only from the Sudeten Mts., like *Alchemilla fissa*, *Batrachium penicillatum*, *Carex pallescens* var. *corcontica*, *Cryptogamma crispa*, *Helleborus viridis*, *Meum athamanticum*, the group also includes plants having their centre of distribution in our country, e.g. *Cephalanthera longifolia*, *Cirsium helenioides*, *Padus petraea*, *Salix lapponum*, *Thlaspi caerulescens*.

The group of near threatened (NT) taxa, comprising merely 12 taxa, includes plants having numerous localities in the Sudeten Mts., but at the same time very rare in Poland or recorded only in some of its regions. These species are represented by populations of hundreds, or even thousands of individuals, which are stable or, in many cases, dynamic. This concerns for example *Leucojum vernum* subsp. *vernum*, which is in fact growing in every mountain range of the Sudeten, or *Carex bigelowii* subsp. *rigida*, showing recently an unusual expansion in the subalpine communities of the Karkonosze Mts. and the Śnieżnik Massif.

Finally, 34 taxa were classified to the data deficient (DD) category, i.e., plants without current data on their occurrence, or their definite extinction. As mentioned before, some of them make an ephemeral component of communities from the class *Isoëto-Nanojuncetea*, or *Secalietea*, or they inhabit aquatic ecosystems, e.g. *Bidens radiata*, *Eleocharis uniglumis*, *Trapa natans*, *Utricularia* sp. Intensive investigations should be devoted to this group in future.

Furthermore, the analysis of endangered taxa in the Sudeten Mts. allows us to draw several interesting conclusions. Above all, noteworthy is the high frequency of some of the systematic groups, i.e., the ferns (in particular *Asplenium*, Lycopodiaceae), monocotyledonous plants mainly from the family Orchidaceae (the list includes all of their representatives), Cyperaceae, Liliaceae, and the ecologically specialized genera and families, among others *Gentianella*, *Orobanche*, *Saxifraga*, Pyrolaceae. Next, the contribution of the particular syngenetic groups in all the threat categories is strongly differentiated (Table 1). It can be concluded from data included in this Table, that the most endangered are stenothermal plants belonging to grasslands and xerothermic scrub. Remarkably, these ecological groups are the most frequently represented in all the threat groups. Species of meadow ecosystems and those representing the alpine vegetation are endangered to a similar extent. Altogether, the xerothermic, meadow and alpine species make over 40% of the analysed flora. A high degree of threat is shown also by species of wet, marshy and bog habitats. Another important fact is the rather high contribution of the segetal flora, particularly the archaeophytes.

In general, it can be assumed, that every type of ecosystem in the Sudeten Mts. is more or less changed, or frequently badly deteriorated. This implies the high losses and the threat of species. The most quickly changing types of vegetation are undoubtedly the seminatural plant communities, particularly those of grasslands and meadows. For the latter, the decline of agricultural activities (pasturage, mowing, moderate fertilization, controlled burning out, etc.), which used to stimulate their persistence, becomes re-

TABLE 1. The biotopes spectrum of vascular plant species in particular categories of threat.

Biotopes	Ex	CR	EN	VU	NT	DD	Σ
Xerotermic grasslands and scrub (*Festuco-Brometea*, *Trifolio-Geranietea sanguinei*)	11	15	30	29	2	4	90
Sand communities (*Koelerio-Corynephoretea*)	3	4	5	15	0	1	28
Wet, humid and fresh hay-meadows (*Molinio-Arrhenatheretea*, *Calluno-Ulicetea*)	6	13	20	29	2	2	72
Aquatic vegetation (*Lemnetea*, *Litorelletea*, *Potamegetonetea*, *Utricularietea*)	3	3	1	4	1	3	15
Peat-bogs, fens, calcareous marshes (*Oxycocco-Sphagnetea*, *Scheuchzerio-Caricetea*, *Phragmitetea*)	11	5	16	18	2	2	54
Slime-covered shores of water (*Isoëto-Nanojuncetea*)	2	2	3	7	0	6	20
Decidous forests (*Quercetalia pubescentis*, *Carpinion betuli*, *Tilio-Acerion*, *Fagion sylvaticae*)	3	7	20	25	2	2	59
Coniferous and mixed forests (*Vaccinio-Piceetea*, *Quercetea robori-petraeae*)	5	8	4	15	0	2	34
Riparian forests (*Alno-Ulmion*, *Alnetea glutinosae*, *Salicetea purpureae*)	2	0	4	13	2	1	22
Scrub communities (*Rhamno-Prunetea*)	0	1	3	20	0	2	26
Segetal weed communities (*Secalietea*)	7	2	12	5	1	5	32
Vegetation of rocks and walls (*Asplenietea rupestria*, *Thlaspietea rotundifolii*)	1	9	6	5	0	0	21
Vegetation of subalpine and alpine belts (*Elyno-Seslerietea*, *Caricetea curvuleae*, *Betulo-Adenostyletea*, *Pinion mughi*)	5	19	25	27	1	0	77
Spring-head communities (*Montio-Cardaminetea*, *Salicetea herbaceae*)	0	4	10	5	0	0	19
Others (*Bidentetea tripartiti*, *Chenopodietea*, *Epilobietea angustifolii*, *Artemisietea vulgaris*, *Galio-Urticetea*, *Violetea calaminariae* etc.)	1	1	2	7	0	4	15
Total	60	93	161	224	12	34	584

cently characteristic. It has its implications in the presented list of threatened plants of the Sudeten Mts. The intention of creating such lists should above all be to make the basis for undertaking substantial actions in the aid of protection of the most precious components of the vascular flora in that area. Considering the status of threat, species growing in Poland exclusively in the Sudeten Mts., or those showing here a distinct concentration of localities, should be regarded as species of particular care in the Sudeten Mts. Their conservation should depend on preservation of habitats specific for them, and in the case of small, isolated and frequently endemic or relic populations a proper programme of active protection should be applied.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Prof. K. Zarzycki (Cracow) and Dr. F. Krachulec (Pruhonice near Prague) for their critical remarks concerning the list of taxa, to Prof. J. Zieliński (Kórnik) for the critical revision of the threatened taxa from genera *Crateagus*, *Rosa* and *Rubus*, and to Dr. K. Świerkosz (Wrocław) and Dr. Szczęśniak (Wrocław) for their valuable information on distribution of some of the species of the Sudeten flora.

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ZAGROŻONE GATUNKI ROŚLIN NACZYNIOWYCH W SUDETACH

STRESZCZENIE

W oparciu o własne badania terenowe prowadzone od 1972 roku z uwzględnieniem historycznych danych z literatury i zbiorów zielnikowych przedstawiono wykaz wymarłych, ginących i zagrożonych gatunków roślin naczyniowych Sudetów (południowo-zachodnia Polska). Lista nasza obejmuje 584 taksony, tj. blisko 33% flory naczyniowej tych gór. Za wymarłe i zaginione uznano 60 gatunki, krytycznie zagrożone – 93, zagrożone – 161, narażone – 224, o niskim ryzyku wyginięcia – 12. Dla 34 taksonów nie podano konkretnego rodzaju zagrożenia, stąd zaliczono je do grupy „brak danych". Przedstawiono również analizę ilościową wszystkich gatunków w poszczególnych kategoriach zagrożenia na tle podstawowych grup fitosocjologicznych oraz pokazano przykładowo obraz rozmieszczenia niektórych roślin w Sudetach.

SŁOWA KLUCZOWE: Sudety, czerwona lista, flora naczyniowa, kryteria gatunków zagrożonych.