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CONSERVATION PROGRAMME OF VASCULAR PLANT DIVERSITY IN THE POLISH TATRA MOUNTAINS

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INTRODUCTION

The endangerment of the flora of Poland, though still not so strong as in Western European countries, has increased markedly during the last 30 years. The process of extinction and declining of plant species from all systematic groups takes place also in our mountain areas, Sudetes (Fabiszewski, Kwiatkowski 1997, 2002) and Carpathians, including the Tatra Mountains (Mirek, Piękoś-Mirkowa 1992b; Piękoś-Mirek, Mirek 1993).

The Tatras, being the highest massif in the Carpathians, and protected since 1954 as a transboundary national park and since 1992 as a biosphere nature reserve, preserve the highest biodiversity of mountain flora not only in Poland, but in the whole Carpathian chain (Pawłowski 1972; Mirek, Piękoś-Mirkowa 1992a, c). Moreover, they appear to be the main centre of endemism in Poland as well as within the whole Western Carpathians (Pawłowski 1970; Piękoś-Mirkowa et al. 1996; Piękoś-Mirkowa, Mirek 2002). However, as many studies have revealed, neither legal regulations concerning species protection, nor the status of national park and biosphere reserve effectively secure the existence of species biodiversity. Particularly rare taxa represented by small populations, are threatened due to both natural processes and anthropogenic factors (Piękoś-Mirkowa 1982). Of nearly 1000 vascular plant species occurring in the Tatra National Park 69 ones are included in the "red list" (Zarzycki, Szeląg 1992) and "red book" (Kaźmierczakowa, Zarzycki 2001) of the threatened plants in Poland (Piękoś-Mirkowa 2001).

An analysis of the status and endangerment of the vascular plant flora of the Tatra National Park (TNP), was made in the 1990s when the first version of management plan of the Park was preparing. During this process a group of "species of special care", comprising rare, declining, endemic and relic taxa has been selected (altogether 154 species). Maintenance of their populations and their biotopes was included among the priority actions realized within the frame of the management plan of the TNP (Piękoś-Mirkowa, Mirek 1997). Of the 154 such taxa, for 7 species (*Dryopteris villarii, Senecio umbrosus, Astragalus penduliflorus, Cochlearia tatrae, Juncus triglumis, Pulsatilla slavica and Woodsia alpina*) extremely rare and endangered, individual action plans have been proposed because an existing forms of protection are or seem to be insufficient to ensure their existence in the area of the TNP. These action plans are described in the paper.

The programme has been realized by a team consisting of the staff of the Tatra Field Station and Mountain Botanical Garden of the Institute of Nature Conservation of the Polish Academy of Sciences (Halina Piękoś-Mirkowa, Anna Delimat, Maria Pacyna and Edward Walusiak) and Zbigniew Mirek from the Institute of Botany of PAS, in collaboration with two research workers of the Botanical Garden of PAS in Powsin (Roman Muranyi and Wiesław Gawryś) who participated in the restitution programme of *Dryopteris villarii* and active protection of *Astragalus penduliflorus* and *Pulsatilla slavica*.

SCOPE AND METHODS

Conservation programme of seven above mentioned species in the Tatra National Park comprises the following tasks:

– research on distribution, habitats, biology and population dynamics
– assessment of threats (type, degree)
– invention of effective protection measures
– monitoring of population condition, threats and effectiveness of the protection measures undertaken

– *ex situ* cultivation in the Mountain Botanical Garden in Zakopane
– storage of diaspores in the seed bank of the Botanical Garden of PAS in Powsin.

In the case of two extinct species, *Dryopteris villarii* and *Senecio umbrosus*, the programme includes their restitution. The basis for restitution of *D. villarii* have been young sporophytes obtained in the laboratory of the Botanical Garden of the PAS in Powsin from spores collected from the only individual of this species preserving in the Mountain Botanical Garden of the PAS in Zakopane. Plants of *Senecio umbrosus*, planned for its restitution have been multiplied from seeds in the Mountain Botanical Garden. In order to augment the only in the TNP population of *Astragalus penduliflorus*, ca 120 individuals of the species have been produced from seeds in the Botanical Garden in Powsin and then introduced in the natural locality in the Tatra Mtns.

ACTION PLAN FOR SELECTED SPECIES

Information on researches, main threats and protection measures undertaken and proposed in the framework of conservation programme of seven selected species is given below. Threat categories follow Polish Red Data Book of Plant (Kaźmierczakowa, Zarzycki 2001).

Dryopteris villarii (Bellardi) Woyn. ex Schinz & Thell. – EW

It is a Central European high-mountain species occurring in the Alps, Jura, Appenines and in the mountains of the Balkan Penninsula. The only locality in the whole Carpathians discovered in 1986 was situated in the Świstówka Wielka (Fig. 1) in the Western Tatras at an altitude of 1360 m a.s.l. (Piękoś-Mirkowa, Mirek 1988). The extremely small population consisting of three plants, disappeared in 1997 after catastrophic storm which caused stone avalanche which covered with stone layer existing locality (Piękoś-Mirkowa 1998). About 100 young sporophytes derived from spores obtained from the only living individual transferred earlier to the Mountain Botanical Garden in Zakopane and germinated in the laboratory of the Botanical Garden of Polish Academy of Sciences in Powsin, are prepared to be used for restitution in the original locality. Since three years these plants are acclimatized in the Mountain Botanical Garden in Zakopane (Fig. 1).

Senecio umbrosus Waldst. & Kit. s.s. – EW

The only specimen found in 1988 in Poland at the northernmost station of the species general range, was growing in the Szeroki Żleb gully at an altitude of 1130 m a.s.l. (Mirek 1991). After 3 year observations, this individual plant extremely threatened due to dense cover of young spruces *Picea abies* growing nearby (natural succession on previously more open area), was transferred to the Mountain Botanical Garden in Zakopane and propagated both vegetatively and by seeds. What is important, during earlier 3 years of observation in the field no one viable seed was produced by this only individual. First ripe and able to germinate seeds have been obtained in 1997 after 6 years of plant growing in the experimental garden in Zakopane. Next year, 30 seedlings were obtained from seeds sown in Petri dishes and moved to the experimental plots in the Garden. Under the garden conditions, two individuals bloomed for the first time in 2002 and two next plants in 2003. A several dozen of young rosettes (Fig. 2) are now prepared to be transferred to the new site with suitable ecological conditions close the original stand.

Astragalus penduliflorus Lam. – CR

This high-mountain species is distributed in Europe in the Alps, Pyrenees, Carpathians and in Scandinavia. The only relict population in Poland comprising ca 40 plants, occurs in the Smytnia valley at an altitude of 1450–1470 m a.s.l. in the *Pinus mugo* belt. Detailed studies on habitats, phytocoenoses, phenology, production of flowers, fruits and seeds were carried out in 1979–1985 (Piękoś-Mirkowa, Kaczmarczyk 1990a). The population of *A. penduliflorus* is threatened due to avalanches and to some extent due to the regular gnawing by deer. In order to increase population size, 120 seedlings propagated from seeds in the Botanical Garden in Powsin and acclimatized in the Mountain Botanical Garden in Zakopane were added to the existing population in 1998. Moreover, this measure has been combined

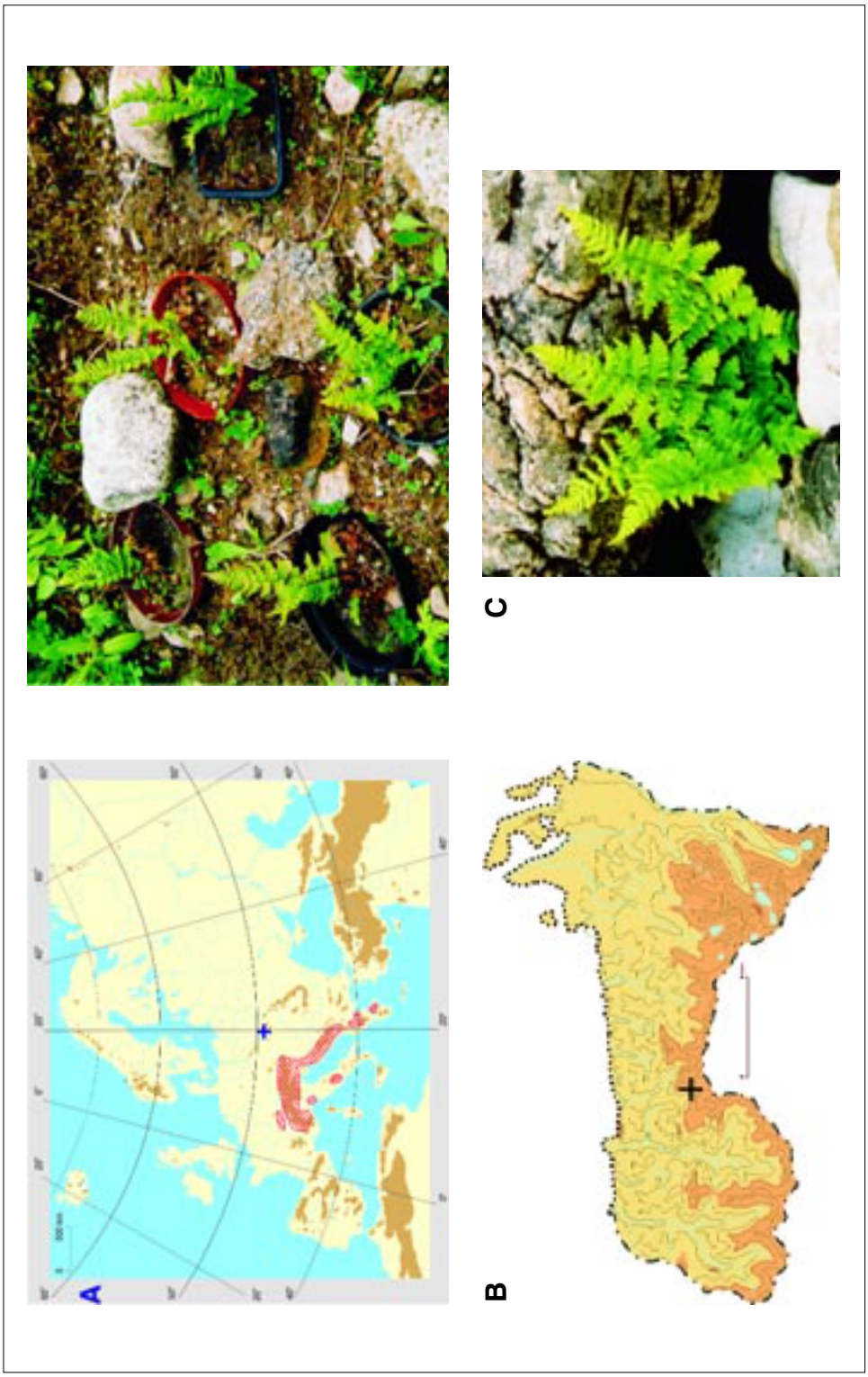

Fig. 1. *Dryopteris villarii* – a species extinct in the wild in Poland. A – area of occurrence; the historical locality in Poland marked with cross; B – the only stand in the Tatra National Park which disappeared in 1997; C – a part of population obtained from spores preserved in the Mountain Botanical Garden in Zakopane.

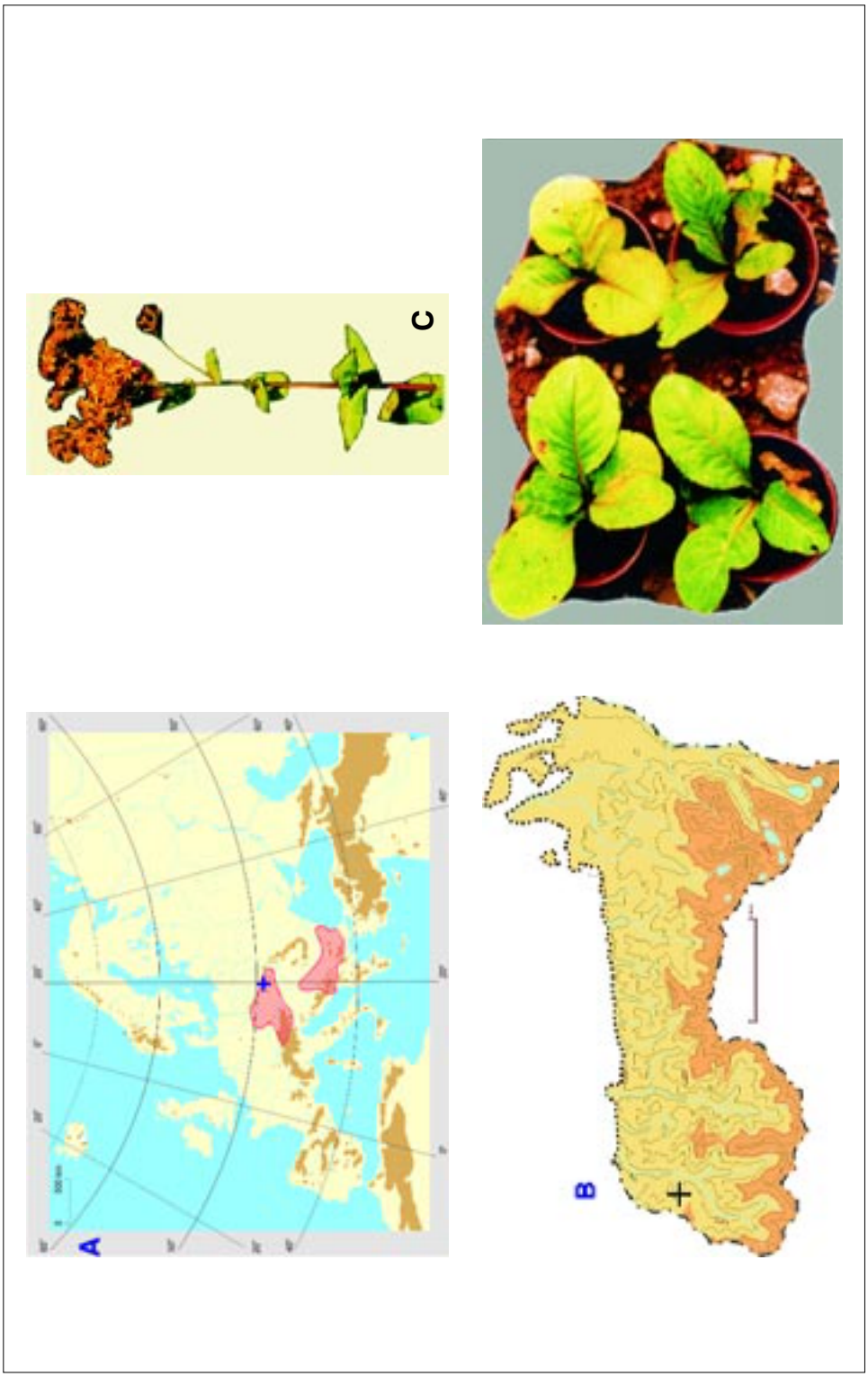

Fig. 2. *Senecio umbrosus* – a species extinct in the wild in Poland. A – area of occurrence; the historical locality in Poland marked with cross; B – stand in the Tatra National Park; C – adult flowering plant and young rosettes derived from seeds (a part of collection preserved in the Mountain Botanical Garden).

with sowing ca 200 seeds of *A. penduliflorus* in the place of its occurrence. Since 1999, the population has been monitored. Of 120 plants introduced in 1998, 41 survived in 1999, 14 till 2001 and 13 till 2004. One individual produced ripe seeds for the first time in 2004. Moreover the species is cultivated *ex situ* in the Mountain Botanical Garden in Zakopane and in the Botanical Garden in Powsin. Seeds are stored in seed bank in Powsin (Muranyi 2003).

Pulsatilla slavica G. Reuss. – VU

It is a West-Carpathian endemic species included in Bern Convention and in the world list of threatened plant species (IUCN 1997). In Poland it occurs in two nearby situated stands in the Koryciska ravine at an altitude of 1000–1170 m a.s.l. growing on dolomitic rocky ledges. Studies on edaphic factors, phytocoenoses, phenology, flower and seed production as well as seed germination capacity both *in situ* and *ex situ* in the Mountain Botanical Garden in Zakopane were performed in 1979–1985 (Piękoś-Mirkowa, Kaczmarczyk 1990b). This attractive plant is threatened by man direct destruction. In the Mountain Botanical Garden in Zakopane a collection comprising ca 70 plants propagated from seeds has been preserved with a view to augment the population existing *in situ* when necessary. Moreover, seeds are stored in the seed bank in Powsin (Muranyi 2003).

Cochlearia tatrae Borbas – VU

It is a high-mountain Tatra endemic species included in the world list of threatened plants (IUCN 1997). The species has been recorded in the TNP from 10 localities in the High Tatras having a centre of occurrence in the alpine and subnival belt. It grows on siliceus screes and fine gravels. The population size of *C. tatrae* varies in different localities from a few individuals to hundreds of plants. Generally, its sites are not threatened being difficult to tourists to access. The studies on ecological requirements of species were carried out by Piękoś-Mirkowa et al. (1996). Current research on life history and genetical variability are conducted by Korzeniak and Szeląg (Institute of Botany, Polish Academy of Sciences). Two populations have been under monitoring since 2000. The share of generative individuals exceeds 50% in the monitored populations. *C. tatrae* is preserved in the Mountain Botanical Garden in Zakopane. The seeds are stored in seed bank of the Botanical Garden in Powsin (Muranyi 2003).

Juncus triglumis L. – EN

This high-mountain circumpolar species occurs in the arctic areas and in the mountains. In Poland it is restricted to the Tatra Mtns where was reported from six stands distributed between 1020 and 1700 m a.s.l. Studies on biology and ecology of *J. triglumis* were conducted in 1980-1985 (Mirek, Piękoś-Mirkowa 1990). The species is a component of spring and flush vegetation as well as poor alpine fens. Three populations are heavily threatened; two of them have been included in the monitoring since 1980. The locality on Czarny Staw lake is nearly completely devastated by the thousands of tourists visiting this place and all individuals of *J. triglumis* are sterile there. A small clump representing the mentioned population is preserved *ex situ* in the Mountain Botanical Garden in Zakopane. The monitoring of *J. triglumis* in Mała Łąka valley revealed a continuing regression of its population. In the last 4 years only single shoots have been observed. In order to rescue the vanishing population, transfer of population sample to new site is considered.

Woodsia alpina (Bolton) S. F. Gray – CR

It is a circumpolar species spread in the arctic areas and the high mountains. In Poland it occurs in one locality in the Karkonosze Mtns (Fabiszewski, Piękoś-Mirkowa 2001) and in the Tatra Mtns where it is known from three stands (Szafer, Sokołowski 1927; Piękoś-Mirkowa 1982; Piękoś-Mirkowa, Delimat 2002). Two of three Tatra localities have been not confirmed in the recent years. The third one was found in 1999 in the Koński Żleb gully. The subpopulations of *W. alpina* occupy there three separate dolomite rocks occurring in rock crevices. The mentioned subpopulations are very small consisting of a few clumps comprising juvenile plants and individuals with spores. The species is potentially threatened due to its small number of individuals and isolated occurrence. The locality in Koński Żleb gully has been included in monitoring since 2000. A cultivation *ex situ* in the garden appeared to be not

successful. Propagation *in vitro* as an active protection measure is taking into account.

CONCLUSIONS

The status of the national park does not guarantee an effective protection of all rare and endangered species occurring in its area. Some of them, especially those represented by extremely small populations, may become extinct due to genetic erosion, natural catastrophes or human impact. Presented case studies show the role of botanical gardens in conservation of threatened plant species. An effective conservation of threatened species requires adoption of an appropriate integrated strategy and special action plans combining both *in situ* and *ex situ* measures. This strategy should be based on permanent field research improving our knowledge on distribution, biology and ecology of threatened species. It also needs permanent monitoring of threat assessment as well as efficiency of applied actions.

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