

The ladybells *Adenophora liliifolia* (L.) Besser in forests near Kisielany (Siedlce Upland, E Poland)

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Abstract: The ladybells *Adenophora liliifolia* in Poland was found in only 8 sites after 1980, so it is now classified as critically endangered (E). Since 2001 the species has been strictly protected and enlisted in the Habitat Directive of the EU. In 1995 in Kisielany, northwest of Siedlce, a rich population of *Adenophora liliifolia* was found. This study was undertaken to characterize phytosociologically the patches with ladybells and to analyse the structure of this population. One hundred specimens were randomly selected for population analysis carried out in 2005. Measurements were done on live plants. Seven individual traits were measured or calculated, including plant height, number of flowers, leaf dimensions, etc. The analysed patches represent thermophilous oak forest *Potentillo albae-Qurcetum*. This is the largest Polish population of this species known so far, as it consists of several hundred flowering specimens. *Adenophora liliifolia* achieves greatest dimensions there and its mean height exceeds the data known from the literature. Quantitative contribution of ladybells to particular patches varies from „+” to „2” according to the Braun-Blanquet scale. The plant is accompanied by some protected species, like: *Laserpitium latifolium*, *Cimicifuga europaea*, *Aquilegia vulgaris* and *Lilium martagon*. A proposal has been submitted to protect the site as a nature reserve and the population will be studied further.

Key words: *Adenophora liliifolia*, protected species, endangered species, nature reserve, Siedlce Upland

1. Introduction

The ladybells *Adenophora liliifolia* (Campanulaceae) belongs to the Euro-Siberian element of disjunctive range (Euro-Siberian, East and West Siberian). In Poland the plant reaches its northeastern border and was once noted in 36 sites. After the year 1980 it was found in only 8 sites (unpublished data of ATPOL). There are few data on ladybells in Polish botanical literature. New sites of this species have been found recently in the Kozienice Forest in central Poland (Jakubowska-Gabara & Pisarek 1997), in the Iłża Upland (Nobis & Piwowarczyk 2002), and on the Bełżec Plain (Buczak 2004).

Since 2001 the species is under strict legal protection. Durczak (1976) and Głazek (1976) suggested the protection of the species already in the 1970s. The species is listed in the Habitat Directive of the EU (Makomaska-Juchiewicz *et al.* 2001). In the *Red Book of Endangered Plant Species* (Zarzycki & Szelağ 1992) it is recorded as a vulnerable species (VU) but in the year 2002 it was granted the status of a critically endangered (E) species (Zarzycki *et al.* 2002).

In Poland the ladybells grow mainly in thermophilous oak forests *Potentillo albae-Qurcetum* and in oak-pine forests *Quercus robor-Pinetum*. It can also be found in oak-hornbeam forest *Tilio-Carpinetum typicum*, in shrub communities of the order *Prunetalia* and on xerothermic swards of the class *Festuco-Brometea*.

Only one non-existing site from mid-eastern Poland was known until 1995 (Głowacki 1985). A new rich site of *Adenophora liliifolia* was found in 1995 in Kisielany, north-west of Siedlce (Ciosek 1998) (Fig. 1). Parameters of the specimens markedly differed from those given in the literature. Szafer *et al.* (1986) estimated plant height at 0.3-1 m, and Piękoś-Mirkowa & Mirek (2003) at 50 cm (seldom more). The same authors noticed that populations of the species usually consist of several individuals. Specimens found in Kisielany were much higher and their population comprised ca. 1000 specimens.

This study was undertaken to phytosociologically identify the patches with ladybells and to perform preliminary ecological investigations on this population.

2. Material and methods

The nomenclature of taxa followed Mirek *et al.* (2002), whereas the nomenclature of phytosociological units and syntaxonomic division followed Matuszkiewicz (2001). Phytosociological relevés in patches with ladybells were made with the commonly used Braun-Blanquet method. Randomly selected 100 specimens were taken for population analysis and measurements were made on live plants. The number of individuals in a tuft, plant height, number of branches in an inflorescence, number of flowers and leaves on a plant, and leaf length and width (means for 5 middle leaves) were measured or counted in the summer of 2005.

3. Results

Species composition of the herb layer allows for qualifying the patches as thermophilous oak forest *Potentillo albae-Quercetum* (Table 2). The tree stand is composed of naturally regenerating *Quercus robur*, accompanied (mainly in the tree layer) by *Betula pendula*. The shrub layer is dominated by *Frangula alnus*. *Brachypodium sylvaticum*, *Melica nutans* and *Galium schultesii* dominate in the herb layer (mean cover 95%). There are also many species diagnostic of the order *Quercetalia pubescentis* (e.g. *Betonica officinalis*, *Serratula tinctoria*, *Lathyrus niger*) and in some patches, of the association *Potentillo albae-Quercetum* (*Laserpitium latifolium*). In the group of accompanying species, *Pteridium aquilinum* and *Convallaria majalis* are the most abundant. Quantitative contribution of the ladybells varies from „+” to „2”. It is interesting that apart from specimens with pale blue flowers, there were some with white flowers. In addition to the already mentioned *Adenophora liliifolia* and *Laserpitium latifolium*, there are also many other rare or protected species in the studied oak forest, e.g. *Melitis melissophyllum*, *Lilium martagon*, *Aquilegia vulgaris*, *Cimicifuga europaea*, *Hepatica nobilis*, *Digitalis grandiflora*, *Hierochloë australis*, *Primula veris*, *Peucedanum cervaria*, *Carex montana*, *Galium verum*, *Potentilla alba*,

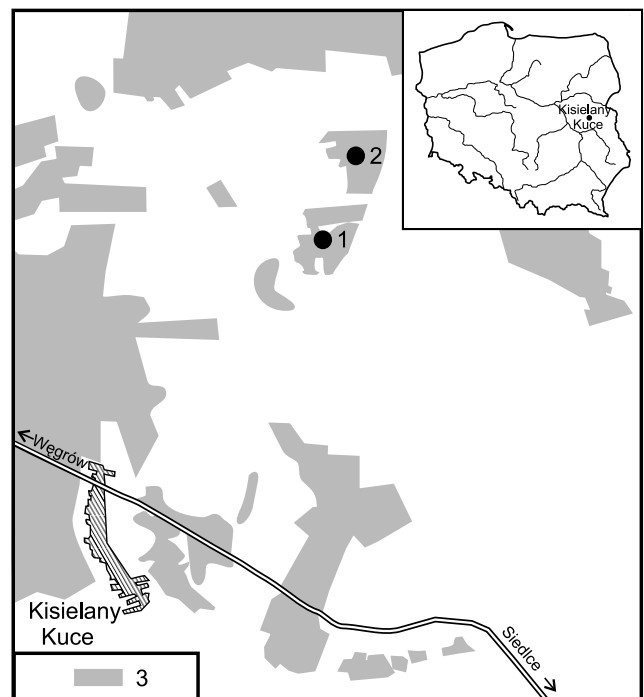


Fig. 1. Distribution of *Adenophora liliifolia* (L.) Besser in Kieselany near Siedlce

Explanations: 1, 2 – sites of *A. liliifolia*; 3 – forests

Pulmonaria angustifolia, *Hypericum maculatum*, *Thalictrum aquilegifolium* and *T. flavum*. On average, 48 plant species (range 41-56) were found per relevé.

The measured individual traits of *Adenophora liliifolia* are listed in Table 1 and shown in Fig. 2. The species in oak forests near Kieselany is present both as single plants and in tufts. Most specimens were found in small tufts of 2-5 individuals. The largest studied tufts contained 11 individuals (Fig. 2a). Mean number of individuals per tuft was 3. The height of most individuals ranged between 150 and 169 cm (Fig. 2b), the extreme ranges being 90-99 cm (1 individual) and 200-209 cm (1 individual), and the mean was 148 cm. The mean value of 11-12 branches in the inflorescence was found in 21 specimens. The maximum value for this trait is 40, represented only by 1 specimen (Fig. 2c). The number of flowers varied from 8 to 141 with a mean of 54 flowers. Only 1 specimen had 393 flowers

Table 1. Statistics of studied traits of *Adenophora liliifolia*

Morphological characters	Values			Class with most numerous individuals	Number of individuals in this class
	mean	minimum	maximum		
Number of individuals in tuft	3.6	1	11	2	23
Plant height (cm)	148.7	99.0	205.0	160.0-169.0	19
Number of branches in inflorescence	12.0	2	40	11-12	21
Number of flowers	54.0	8	141	30-39	20
Number of leaves	48.0	16	75	50-59	40
Leaf length (cm)	12.0	5.9	15.8	10.0-10.9	20
Leaf width (cm)	3.1	2.2	4.5	3.0-3.4	30

Table 2. *Adenophora liliifolia* in oak forest in Kisielany near Siedlce

Successive number of releve		1	2	3	4	5	6	7
Cover of layer	a/a ₁ /a ₂	60/30/30	60/50/20	50/30/20	50/50/20	60/30/40	60/50/40	50/40/30
	b	40	30	20	40	50	40	30
	c	100	100	100	100	100	70	100
	d	-	-	-	10	30	10	-
Number of species in releve		41	53	45	49	50	56	44
<i>Adenophora liliifolia</i>		1	+	1	2	+	+	1
Trees and shrubs								
<i>Betula pendula</i>	a ₁ /a ₂ /b/c	1/./1/1	2/./1/+	1/././.	2/1/./.	2/././.	1/1/./.	2/1/./.
<i>Frangula alnus</i>	bc	1+	1+	2.	2+	31	3.	2+
<i>Quercus robur</i>	a/a ₁ /b/c	2/1/1/+	3/2/1/+	3/2/./+	3/1/1/+	3/3/1/.	3/2/1/+	2/2+/+
<i>Pyrus communis</i>	b/c	1/+	./.	./+	./+	./.	./+	+/+
<i>Viburnum opulus</i>	c	+	.	+	+	+	..	+
<i>Crataegus monogyna</i>	b/c	+./.	./+	./.	./+	./.	./+	./.
<i>Sorbus aucuparia</i>	b/c	./.	./.	1/+	./.	./+	./+	+/.
<i>Padus avium</i>	b/c	1/.	./.	./.	./+	+./.	./.	./.
<i>Prunus spinosa</i>	b/c	+/+	./.	./.	./.	./.	./+	./+
<i>Ribes spicatum</i>	b/c	1/.	./.	./.	./.	./.	+/+	./+
<i>Juniperus communis</i>	b/c	./.	+./.	+./.	2/+	./.	./.	./.
<i>Populus tremula</i>	a/b/c	./.	./.	2/+1	./.	.//1	.//1	./.
<i>Rhamnus catharticus</i>	b/c	1/.	./.	./.	1/+	./.	./.	./.
<i>Tilia cordata</i>	a/b/c	./.	./.	./.	./.	./.	2./+	1/1/.
Ch. <i>Querceto-Fagetea</i>								
<i>Brachypodium sylvaticum</i>		5	1	3	3	2	1	4
<i>Melica nutans</i>		2	2	2	2	3	2	2
<i>Anemone nemorosa</i>		1	.	1	1	+	+	+
<i>Eurynchium zeterstedtii</i>	d	.	.	.	1	2	1	.
<i>Ranunculus auricomus</i>		.	+	.	.	+	+	1
<i>Aegopodium podagraria</i>		.	.	.	+	r	.	.
<i>Carex digitata</i>		.	.	.	.	+	+	.
Ch. D. <i>Quercetalia pubescentis</i>								
<i>Betonica officinalis</i>		1	2	1	2	2	2	2
<i>Lathyrus niger</i>		1	+	1	1	1	1	1
<i>Melittis melissophyllum</i>		+	+	+	2	1	+	1
<i>Peucedanum cervaria</i>		+	+	+	1	2	1	+
<i>Serratula tinctoria</i>		2	2	2	2	2	1	2
<i>Clinopodium vulgare</i>		1	+	+	1	+	+	1
<i>Campanula persicifolia</i>		.	+	+	+	+	r	.
<i>Digitalis grandiflora</i>		.	+	+	1	1	1	.
<i>Polygonatum odoratum</i>		.	+	+	.	+	+	+
<i>Carex montana</i>		.	1	.	+	+	+	.
<i>Origanum vulgare</i>		.	1	.	.	+	+	+
<i>Anthericum ramosum</i>		+	.	.	.	+	.	.
<i>Campanula glomerata</i>		.	+	.	+	.	.	.
<i>Galium verum</i>		.	.	.	.	1	+	.
Ch. D. <i>Potentillo albae-Quercetum</i>								
<i>Laserpitium latifolium</i>		+	+	1	1	r	3	1
<i>Vicia cassubica</i>		+	+	+	.	+	.	.
<i>Potentilla alba</i>		+	+	.	.	1	+	.
<i>Vincetoxicum hirsutinaria</i>		+	.	r	.	.	.	+
<i>Pulmonaria angustifolia</i>		.	1	.	.	.	+	.
<i>Ranunculus polyanthemus</i>		.	.	.	.	+	+	.
Ch. <i>Fagetalia silvaticae</i>								
<i>Viola reichenbachiana</i>		+	1	+	1	1	1	.
<i>Dryopteris filix-mas</i>		.	+	1	.	+	.	.
<i>Atrichum undulatum</i>	d	.	.	.	1	2	1	.
<i>Primula veris</i>		+	+	.	.	.	1	.
<i>Lilium martagon</i>		.	r	r	.	.	+	.
Ch. D. <i>Peucedano-Pinetum</i>								
<i>Convallaria majalis</i>		2	1	3	3	2	2	3
<i>Solidago virgaurea</i>		.	1	.	1	+	+	+
<i>Scorzonera humilis</i>		.	.	.	1	1	+	.
<i>Peucedanum oreoselinum</i>		.	.	.	+	.	.	r
Ch. <i>Carpinion betuli</i>								
<i>Galium schultesii</i>		4	2	4	4	.	1	3
<i>Dactylis polygama</i>		+	+	+	1	1	+	.
Accompanying species:								
<i>Pteridium aquilinum</i>		1	1	3	2	2	1	2
<i>Angelica sylvestris</i>		+	+	+	1	1	+	+
<i>Geum urbanum</i>		2	+	+	1	1	+	+
<i>Veronica chamaedrys</i>		1	2	r	1	1	1	+
<i>Calamagrostis arundinacea</i>		.	1	2	2	1	1	1
<i>Euphorbia angulata</i>		1	+	+	+	1	.	+
<i>Anthriscus sylvestris</i>		2	+	+	.	.	+	.
<i>Hieracium umbellatum</i>		.	2	+	+	.	.	+
<i>Knautia arvensis</i>		.	+	.	1	+	+	.
<i>Luzula pilosa</i>		.	.	+	+	+	+	.
<i>Urtica dioica</i>		+	.	2	.	.	.	+
<i>Galeopsis pubescens</i>		+	+	+	.	.	.	.
<i>Ajuga reptans</i>		.	1	.	2	3	.	.
<i>Maianthemum bifolium</i>		.	1	.	+	.	+	.
<i>Sedum maximum</i>		.	+	.	.	.	+	+
<i>Hypericum maculatum</i>		.	.	.	+	+	.	+

Sporadic species. Trees and shrubs: *Malus sylvestris* c: 3(+); *Cornus sanguinea* b: 4(1), c: 4(+); *Pinus sylvestris* a: 4(1); *Carpinus betulus* b: 5(+); *Ribes uva-crispa* b: 7(1); Ch. D. *Quercetalia pubescentis*: *Trifolium alpestre* 2(+); *Geranium sanguineum* 7(1); Ch. *Fagetalia silvaticae*: *Scrophularia nodosa* 6(r); Ch. *Carpinion betuli*: *Melampyrum nemorosum* 7(+); Accompanying species: *Veronica officinalis* 2(1), 3(+); *Chamaecytisus ratisbonensis* 2(+), 4(+); *Stellaria media* 6(+), 7(+)

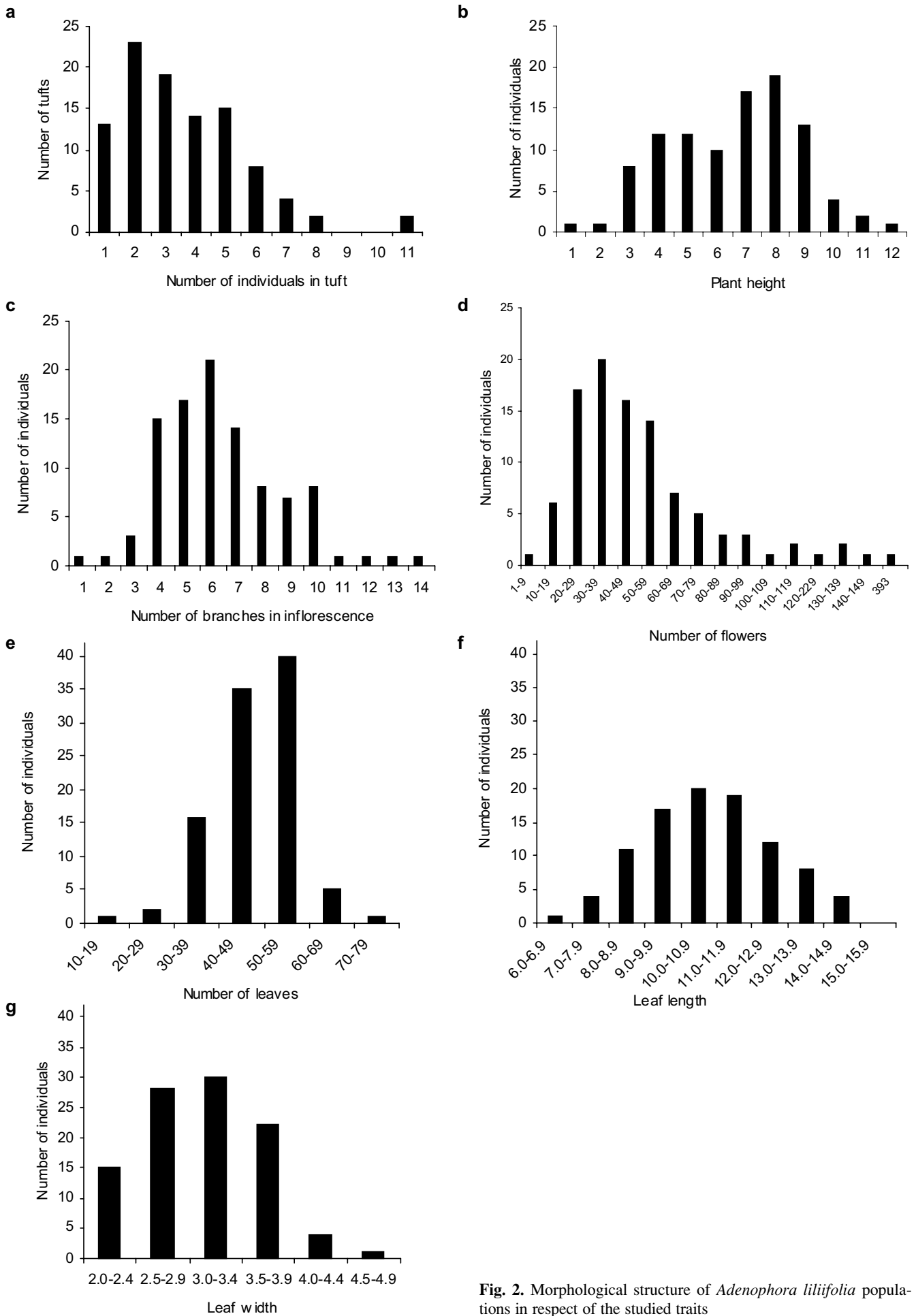


Fig. 2. Morphological structure of *Adenophora liliifolia* populations in respect of the studied traits

(Fig. 2d). The number of leaves, their length and width were normally distributed. The mean number of leaves was 48, their mean length was 12.0 cm and mean width was 3.1 cm (Figs. 2e-g). Maximum number of leaves was 75 and the extreme lengths and widths of leaves were 5.9-15.8 cm and 2.2-4.5 cm, respectively.

4. Conclusions

The presented paper is the first Polish report on the ecology of *Adenophora liliifolia*. The study demonstrated that it was the richest site in mid-eastern Poland, containing several hundred flowering individuals. *Adenophora liliifolia* achieved the largest dimensions

there and the measured mean height was markedly greater than that given by Piękoś-Mirkowa & Mirek (2003) and Szafer *et al.* (1986). For comparative purposes, similar studies should be performed on this species in other presently known sites in Poland.

The ladybells and other critically endangered species should be involved in the monitoring programme. Apart from phytosociological and biometric features, the studies should include habitat properties, like the soil, light and water regime.

The site was reported to the provincial nature conservation officer in order to be protected as a nature reserve.

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