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POPULATION STRUCTURE OF *LILIUM MARTAGON* L. IN CIEMINO (CENTRAL POMERANIA, POLAND)

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ABSTRACT. The paper presents results of studies on the population of *Lilium martagon* L. in Ciemino in Central Pomerania, Poland. Edaphic and phytocenotic conditions were determined in that population. Plants were characterised in terms of individual and group characters. *Lilium martagon* is found on mineral soil, with adequate resources of nitrogen and phosphorus, acid pH, and in terms of the population size it is one of the more numerous in the Pomerania region. The population is characterised by the cluster spatial distribution, low density and a high proportion of flowering plants in the population (44.77%).

KEY WORDS: *Lilium martagon*, manor park, Ciemino, Central Pomerania

INTRODUCTION

In Poland *Lilium martagon* was recorded in the past in large numbers in the Carpathian Mountains, in the foothills and in the Małopolska region (Raciborski 1919). At present it is relatively common, except for the Ziemia Lubuska region and Pomerania, where its localities are rarely found (Atlas... 2001). In Western Pomerania *L. martagon* belongs to species threatened with extinction (Żukowski and Jackowiak 1995).

In Central Pomerania, which boundaries are marked arbitrarily by the Łeba River in the east and the Parsęta River in the west (according to Kondracki (2004) it is the eastern part of Western Pomerania), *L. martagon* is found in former manor park planting arrangements and in Protestant cemeteries (Sobisz and Truchan 2006).

The investigated population of *L. martagon* is found in the former manor estate and manor park in Ciemino. Ciemino is a village located in the Główczyce commune at the Główczyce–Izbica road (Fig. 1).

The study presents edaphic, phytosociological and morphological characteristics of the *L. martagon* population.

MATERIAL AND METHODS

Investigations were conducted in 2009. The subject of the study was a population of *L. martagon* L. growing in the former manor estate and park in Ciemino. Martagon lily covers 284 m^2 forming two areas, A – 108 m^2 and B – 176 m^2, separated by a park path (Fig. 2). The entire area on which martagon lily was found was divided into squares of 1 m^2. For each area plant arrangement on the map was marked, according to their arrangement on site, at the same time denoting with symbols respective development phases. Based on the cartographic documentation group characteristics of the population in the analysed plots were determined, i.e. the number of plants, stocking density expressed as the number of plants per 1 m^2, mean crowding defined by the value of the Lloyd ratio (Collier et al. 1978), as well as the type of spatial structure – by calculating the dispersion index according to Trojan (1975). The age structure of the population was determined assuming after Łukaszewicz (1962), Jańczyk-Węglarska and Węglarski (1992), Kolon and Krawczyk (1996) four development phases of *L. martagon*: 1 – juvenile, i.e. one-year old, one-two leaves; 2 – immature (growing), i.e. two-three-year old, up to 12 leaves; 3 – virginal (vegetatively developed, non-flowering); and 4 – generative (flowering), i.e. four-year-old and older, more than 12 leaves.

Biometric measurements were taken on all flowering plants (201 specimens), which were characterised in terms of eight individual characteristics: 1 – height of shoots (cm), 2 – length of inflorescence measured from the bract (cm), 3 – number of flowers in the inflorescence, 4 – number of leaves on the shoot, 5 – length of the biggest leaf (cm), 6 – width of the widest leaf (cm), 7 – length of bract, and 8 – width of bract.

For each trait their mean values (X), standard deviations (SD) and coefficients of variation (V%) were calculated and their minimum and maximum values were established.

The statistical distribution of heights of flowering plants is presented in the form of a frequency diagram. The statistical distribution in terms of its consistence with normal distribution was verified using the chi-square test (Stanisz 2005).

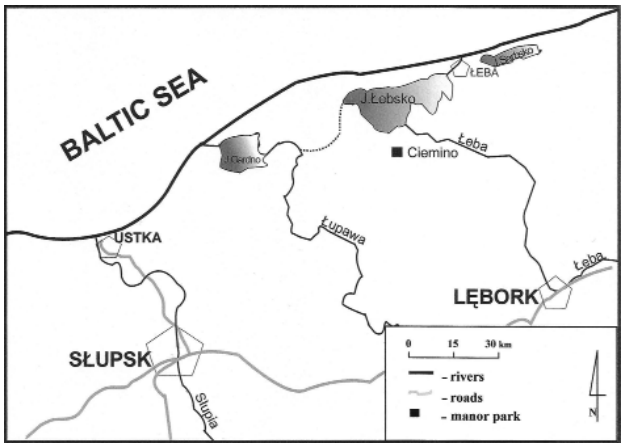

Fig. 1. Locality of a former manor park in Ciemino

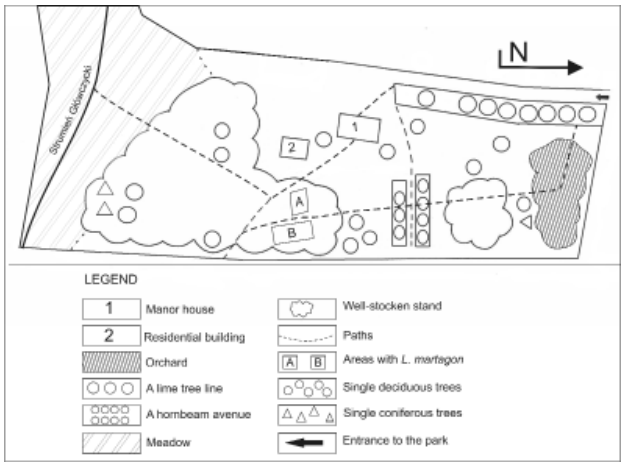

Fig. 2. Plan of a former manor park in Ciemino

In order to determine the chemical composition of soil two samples were collected for analysis, with one for each area from the rhizodermis layer, in the immediate vicinity of the root system of the examined plants. The following soil properties were determined: pH – by potentiometry in H_2O and 1 n HCl, total nitrogen – according to Kjeldahl, organic carbon – according to Tiurin (Bednarek et al. 2005) and total phosphorus – using the molybdate method (Nowosielski 1974). Moreover, the content of organic matter in the analysed subsoil was determined.

Nomenclature of vascular plants is consistent with the list given by Mirek et al. (2002), while that of mosses – with the list by Ochyra et al. (2003). Nomenclature of trees and shrubs was adopted after Seneta and Dolatowski (2003). Based on relevés tables prepared according to the Braun-Blanquet method (Pawłowski 1972) the type of community with *L. martagon* was defined (Matuszkiewicz 2001).

Characteristics of localities, edaphic and phytocenotic conditions and morphological features of the Lilium martagon population

The park in Ciemino, of 3.8 ha, is found in the western part of the village. From the north-west it borders with farm buildings of the former manor farm, from the north-east – with a complex of meadows, crossed by the Główczycki stream, while from the east it borders with arable fields. The population of martagon lily is located in the eastern part of the park. The population is found on two plots of 108 m^2 and 176 m^2 separated by a park path leading to a hornbeam avenue (Fig. 2).

Analyses showed that soil on which the lily population is growing has a strongly acid reaction (pH = 3.28 and pH = 3.33). The slight content of organic matter indicates a mineral soil. It has relatively good resources of nitrogen, as it is evidenced by the carbon to nitrogen ratio, amounting in plot A to 14.06 and in plot B to 14.03, respectively (Table 1).

The internal structure of phytocenoses with *L. martagon* is presented in Table 2. In natural localities martagon lily is found in meso- and eutrophic broad-leaved forests of order *Fagetalia sylvaticae* Pawł. in Pawł., Sokoł. et Wall. 1928 (matuszkiewicz 2001). It also enters shrub communities with different syntaxonomic affiliations. It grows in semi-shaded positions, on sandy loams and new loams, rich in minerals and humus (Zarzycki 1984) of varied grain size composition – from loose sands, heavy loamy sands to heavy loam (Piękoś-Mirkowa and Mirek 2003). The locality of *L. martagon* at Ciemino is undoubtedly anthropogenic in character, but the nature and characteristics of the habitat to a certain degree are consistent with the conditions of its natural distribution range.

Jointly 80 taxa were recorded in the community. At individual phytocenoses there were from 22 to 34 species (mean 29). In the stand of analysed phytocenoses the following species predominate: *Acer platanoides* L., *Fraxinus excelsior* L. and *Robinia pseudoacacia* L. The shrub layer was well-developed. The following species are found in this layer: *Corylus avellana* L., *Rubus idaeus* L., *R. caesius* L., *Euonymus europaea* L., *Symphoricarpos albus* (L.) S.F. Blake and *Philadelphus coronarius* L. Moreover, the undergrowth of *Acer platanoides* L., *A. pseudoplatanus* L., *Carpinus betulus* L., *Populus tremula* L. and *Quercus robur* L. was found in layer b in most phytocenoses. We need to stress here the presence of *Sambucus nigra* L. (consistency class IV) – a characteristic taxon of the *Sambuco-Salicion* R. Tx. et Neum. 1950 alliance. Black alder is a phytoindicator of anthropogenic habitats of high soil eutrophication degree (Haeupler and Muer 2007). In the vegetation cover taxa of two syngenetic groups predominate, i.e.

Table 1. Chemical parameters of soil

No of trail	pH		Humus	C (%)	N (%)	P (%)	C/N	C/P	N/P
	H_2O	KCl							
A	4.22	3.33	7.76	4.50	0.32	0.0218	14.06	206.42	14.68
B	4.18	3.28	7.58	4.35	0.31	0.0203	14.03	214.28	15.27

Table 2. Social structure of phytocenoses with *Lilium martagon*

Successive number		1	2	3	4	5	6	7	8	9	10	11	12	S	D
Number of phytosociological relevé		628	638	626	629	643	662	646	649	645	657	664	660		
Date (day, month, year)		26.04. 2009	12.05. 2009	26.04. 2009	26.04. 2009	12.05. 2009	2.08. 2009	12.07. 2009	21.07. 2009	12.07. 2009	21.07. 2009	2.08. 2009	2.08. 2009		
Mechanical composition of a H horizon of soil (0-20 cm)		pgm	żg	pgm	pgm	pgm	pgm	żg	pgm	pgm	pgm	żg	pgm		
Crown density (%)	a	15	zn	5	10	zn	zn	10	zn	15	5	10	25		
	b	25	30	15	20	20	15	30	30	25	25	30	20		
Cover of plant layers (%)	c	35	50	60	50	55	45	55	50	75	50	30	35		
	d	–	5	zn	–	10	–	zn	–	5	5	zn	zn		
Area of relevé (m^2)		30	25	25	20	30	40	25	30	40	25	25	25		
Number of species in phytosociological relevé		23	33	34	34	33	26	24	23	34	30	21	32		
I. ChCl. *Querco-Fagetea*, ChO. *Fagetalia sylvaticae, ChAll. *Alno-Ulmion***, ChAll. *Carpinion betuli******															
**Lilium martagon*		+	1.1	1.2	+	1.2	2.2	3.3	3.3	3.3	2.2	2.2	2.2	V	1 662
Anemone nemorosa		1.2	1.2	2.2	1.2	1.2	.	.	.	.	.	.	.	III	312
***Adoxa moschatellina*		1.2	+.2	.	+	1.2	.	.	.	.	.	.	.	II	100
**Ficaria verna*		.	1.1	+.2	+.2	+	.	.	.	.	.	.	.	II	67
***Gagea lutea*		.	.	1.1	+	+.2	.	.	.	.	.	.	.	II	58
Acer platanoides	a	1.1	+.2	.	1.1	+	+.2	1.1	+	.	1.1	+	1.2	V	250
	b	1.1	.	1.2	.	1.1	+	2.2	2.2	1.2	1.1	1.2	.	IV	541
****Carpinus betulus*	b	+.2	2.2	.	1.2	.	+	1.2	1.2	1.2	.	1.2	+.2	IV	379
Aegopodium podagraria		+	+.2	+	1.2	+	2.2	.	.	1.1	+	.	1.1	IV	312
Poa nemoralis		1.1	.	+.2	.	1.1	.	.	1.2	1.1	1.2	.	.	III	217
Corylus avellana	b	1.1	+	.	.	.	1.1	.		+	.	.	+	III	108
**Polygonatum multiflorum*		.	+	.	+	.	1.1	.	1.1	.	.	.	+.2	III	108
Acer pseudoplatanus	b	+.2	.	+	.	.	.	+.2	.	.	+.2	1.1	.	III	75
**Atrichum undulatum*	d	.	.	+.2	.	.	.	+.2	.	.	1.2	.	+.2	III	67
**Scrophularia nodosa*		.	+	.	+	.	.	+	.	+.2	.	+	.	III	42
Fraxinus excelsior	a	.	.	1.1	+	.	.	.	.	.	.	1.2	1.1	II	133
	c	.	.	.	+	+	.	.	.	+	.	+	.	II	33
****Tilia cordata*	b	.	.	.	+	.	+		.	+		.	.	II	25
II. ChCl., ChO. *Epilobietea angustifolii, Atropetalia*, ChAll. *Sambuco-Salicion**															
**Sambucus nigra*	b	1.2	1.1	2.2	1.1	.	+	1.1	1.1	+.2	.	1.1	2.2	V	558
**Populus tremula*	b	+	+	.	1.1	.	+.2	+	+	.	.	+	+	IV	100
Rubus idaeus		1.2	.	+	.	+.2	.	+	.	.	+	+	+	III	92
Calamagrostis epigeios		.	+	+	.	.	.	.	+.2	+	+	.	.	III	42
III. ChCl. *Rhamno-Prunetea, Prunetalia spinosae*, ChAll. *Pruno-Rubion fruticosi**															
Crataegus monogyna	b	+	.	1.1	.	1.1	+	.	.	+	1.1	1.1	1.1	IV	233
	c	+	.	+	+.2	.	.	+.2	.	.	+	+.2	.	III	50
Rubus caesius		.	+	.	+.2	+	1.1	.	.	+	.	.	+	III	83
Euonymus europaeus	b	.	1.2	.	1.1	1.1	.	.	1.1	.	.	.	.	II	167
Rosa canina	b	.	.	+	.	+.2	.	.	+.2	.	+	.	.	II	33
IV. ChCl. *Molinio-Arrhenatheretea*, ChO. *Arrhenatheretalia, ChO. *Trifolio fragiferae-Agrostietalia stoloniferae*****															
**Dactylis glomerata*		1.1	1.2	+	1.1	1.1	1.1	2.2	+	1.2	+	+.2	1.1	V	471
**Taraxacum officinale*		+	+.2	+	1.1	+	.	.	.	+	+	.	1.1	IV	133
***Ranunculus repens*		1.1	+	.	.	.	.	+.2	+	+	.	1.1	+	III	125

Table 2 – cont.

Successive number		1	2	3	4	5	6	7	8	9	10	11	12	S	D
Cerastium holosteoides		.	1.2	+	1.1	.	+.2	.	+	.	1.1	.	.	III	125
**Achillea millefolium*		.	.	1.2	.	+.2	.	.	.	1.2	+.2	.	.	II	100
Poa pratensis		.	.	+	.	.	.	.	.	.	+	.	+.2	II	25
V. ChCl. *Artemisietea vulgaris*															
Glechoma hederacea		+.2	1.2	+.2	.	1.1	+.2	+.2	1.1	.	+.2	+.2	+	V	183
Anthriscus sylvestris		.	+.2	+	1.1	.	.	+	1.2	1.2	+	+	.	IV	167
Geum urbanum		.	+	.	+	.	+.2	.	.	1.1	1.1	.	+	III	117
Chelidonium majus		.	.	+	.	+	.	1.1	+	.	.	1.1	+	III	117
Artemisia vulgaris		.	+	.	.	+	.	.	.	.	.	.	+	II	25
Urtica dioica		.	.	+	.	.	+	.	.	.	+	.	.	II	25
VI. Accompanying species															
Robinia pseudoacacia	a	1.1	.	+	.	+.2	+	1.1	.	2.2	+	1.1	2.2	IV	450
	b	.	+	+	.	.	+	.	.	.	+	.	.	II	33
Quercus robur	b	+	.	.	+	1.1	+	.	+..2	1.1	1.1	.	+	IV	167
	c	.	.	+	+	.	.	.	.	.	+	.	.	II	25
Poa annua		.	.	+.2	.	+.2	.	.	1.1	1.1	2.2	.	1.2	III	287
Convallaria majalis		1.1	1.2	+.2	1.1	2.2	.	.	.	+.2	.	.	.	III	279
Ornithogalum boucheanum		+.2	1.2	.	1.2	1.2	.	+	.	.	.	.	.	III	142
Leucoium vernum		.	1.1	1.1	1.1	+.2	.	.	.	+	.	.	.	III	142
Galanthus nivalis		.	+.2	1.2	1.1	1.1	r	.	+	.	.	.	.	III	142
Symphoricarpos albus	b	1.2	.	.	.	+.2	.	1.2	.	.	.	1.2	.	III	133
Hedera helix		.	1.2	1.2	.	.	.	.	.	+	1.2	.	.	III	133
Philadelphus coronarius	b	.	.	.	.	.	1.2	.	.	+	1.1	.	r	III	92
Sorbus aucuparia	b	.	.	+	+	.	.	+.2	.	.	+	+.2	.	III	42
Aesculus hippocastanum	c	.	+.2	.	.	.	1.2	.	.	+.2	.	.	+.2	II	67
Taxus baccata	c	.	.	+	+	.	.	.	.	.	+	+.2	.	II	33
Mycelis muralis		+	+	.	.	.	.	.	+	.	.	.	.	II	25
Betula pendula	c	.	.	.	.	+	+	.	.	.	.	.	+	II	25

Plant species occurring only in I degree of phytosociological stability:
I. *Corydalis intermedia* 2 (+.2); ****Plagiomnium undulatum* d (1.1), 5 (+); *Acer pseudoplatanus* a 4 (1.1), 6 (+);***Ribes spicatum* b (+.2).
ChAll. *Fagion sylvaticae*: *Fagus sylvatica* b 9 (1.2), 12 (+.2).
II. *Verbascum nigrum* 8 (+); *Digitalis purpurea* 10 (+).
III. *Viburnum opulus* b 9 (+); *Rosa canina* c 9, 12 (+).
IV. *Ranunculua acris* 4,5 (+); *Bromus hordeaceus* 6,11 (+.2); *Vicia cracca* 7 (+.2); *Plantago lanceolata* 7,9 (+); *Cirsium arvense* 10, 12 (+); *Festuca rubra* 12 (+).
V. *Viola odorata* 5, 10 (+.2); *Melandrium album* 6,9 (+); *Geranium robertianum* 7, 8 (+); *Alliaria petiolata* 9 (+); *Impatiens glandulifera* 12(+).
VI. *Erophila verna* 2,4 (+); *Luzula pilosa* 3 (+.2); *Quercus petraea* b 4,7 (+.2); *Brachythecium rutabulum* d 5 (1.1), 9 (1.2); *Oxalis acetosella* 5,6 (+.2).
Pohlia nutans d 7, 11 (+); *Larix decidua* b 8 (+.2); *Syringa vulgaris* b 10 (+); *Stellaria graminea* 11 (+); *Frangula alnus* b 12 (+.2).

Explanation: pgm – heavy loamy sand, żg – clay gravel, zn – minimal, S – phytosociological stability, D – cover coefficient.

Fagetalia sylvaticae Pawł. in Pawł., Sokoł. et Wall 1928 and *Querco-Fagetea* Br.-Bl. et Vlieg. 1937. They constitute the most numerous group of plants recorded together with *Lilium martagon*. The moss layer is poorly developed. We need to mention here only *Atrichum undulatum* (Hedw.) P. Beauv., which was found in consistency class III with a relatively high coverage degree (D = 108). The proportion of *Plagiomnium undulatum* (Hedw.) T. J. Kop – a moss characteristic of both syntaxa – is slight.

A significant characteristic of phytocenoses is a marked early spring aspect (Table 2, relevés 1-5), which falls at the turn of April and May. Physiognomy of early spring phytocenoses is formed by geophytes: *Anemone nemorosa* L., *Adoxa moschatelina* L., *Ficaria verna* L. and *Gagea lutea* (L.) Ker. Gawl. They are accompanied by the protected: *Convallaria majalis* L., *Galanthus nivalis* L., *Leucoium vernum* L. and *Ornithogalum* – a rare antropophyte acclimated in our flora. Early spring plants are

rapidly replaced by species of the summer aspect (Table 2, relevés 6-12), among which high consistency was found for: *Aegopodium podagraria* L. (IV), *Poa nemoralis* L. (III) i *Scrophularia nodosa* L. (III). In phytocenoses of this aspect martagon lily is found only facially (Table 2, relevés 7-9). Species of class *Rhamno-Prunetea* Rivas Goday et Garb. 1961 – plants of thermophilic shrub communities – are represented in phytocenoses by five taxa, of which the highest consistency (IV) was found for *Crataegus monogyna* Jacq. Apart from the above mentioned *Sambucus nigra*, synanthropication of analysed phytocenoses of the community with *Lilium martagon* is evidenced by the presence of: *Artemisia vulgaris* L., *Chelidonium majus* L., *Geum urbanum* L. and *Urtica dioica* L. A numerous group (25 species) is composed of accompanying species, of which we need to mention particularly legally protected: *Frangula alnus* Mill., *Hedera helix* L. and *Taxus baccata* L.

Individual characteristics

Mean values of individual characteristics of flowering plants from two experimental plots A and B, as well as the entire are covered by lilies at Ciemino together with their characteristics are given in Table 3. Plants reached height of 72 to 125 cm. Mean values of this character indicate that in plot A lilies were slightly taller (97.84 cm) than in plot B (95.45 cm). For the entire area the mean value of this trait was 96.29 cm. Modal values for plant height indicate that in plot A slightly lower plants predominated than in plot B. In relation to the entire area on which lilies were found, slightly taller plants than the arithmetic mean predominated. The distribution of height for flowering plants in the population was normal (Fig. 3), which means that the most numerous group was composed of plants with average height. Variation in height among analysed plants in plot A was 10.51%, while in plot B it was 12.57%, whereas in relation to the entire area on which lilies were found it

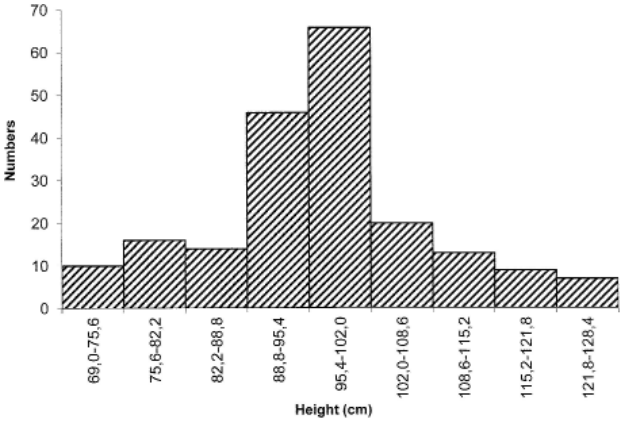

Fig. 3. A frequency diagram for height of flowering plants in the population of *Lilium martagon* in Ciemino

was 11.89%. Height of plants, apart from the length of the biggest leaf had the lowest coefficients of variation among all the analysed traits.

Length of inflorescence measured from the bract assumed the values from 14.6 cm to 41 cm. Mean values of this trait indicate that plants with shorter inflorescences were found less frequently in plot B (26.53 cm) than in plot A (28.03 cm). The mean value of the length of inflorescence calculated for the entire population (27.00 cm) is consistent with the modal value (27.03 cm). Plants with the length of inflorescence of 27.00 cm predominated in the population.

Examined plants had from one to nine flowers on the shoot. Lower mean values of this trait were observed in plot B (5.11) than in plot A (6.16). Calculated modal values for the number of flowers indicate that both for plot A and B, as well as the entire population, the biggest number of specimens were those with inflorescences having six flowers. The number of flowers is the most variable characteristic of all the analysed traits. This is evidenced by the calculated coefficients of variation:

Table 3. Individual characteristics of flowering plants of *Lilium martagon*

Character	Area A (79 individuals)						Area B (122 individuals)						Total area (201 individuals)					
	min.	max.	X	M	SD	V(%)	min.	max.	X	M	SD	V(%)	min.	max.	X	M	SD	V(%)
Height of shoots (cm)	72.00	122.0	97.84	89.77	10.28	10.51	73.00	125.0	95.45	97.99	12.00	12.57	72.00	125.0	96.29	97.39	11.45	11.89
Length of inflorescence from bract (cm)	15.00	41.00	28.03	25.99	5.79	20.66	14.60	39.00	26.53	28.80	5.28	19.90	14.60	41.00	27.00	27.03	5.50	20.37
Number of flowers	2.00	9.00	6.16	6.37	1.64	26.62	1.00	9.00	5.11	5.70	1.71	33.46	1.00	9.0	5.49	5.63	1.77	32.24
Number of leaves	21.0	36.0	28.08	28.99	3.55	12.64	18.0	34.0	26.52	29.12	4.41	16.62	18.00	36.0	27.11	28.39	4.20	15.49
Length of the biggest leaf (cm)	10.40	15.80	12.97	12.48	1.30	10.02	10.30	15.6	12.54	12.41	1.35	10.77	10.30	15.80	12.70	12.51	1.34	10.55
Width of the widest leaf (cm)	2.80	4.80	3.61	3.38	0.49	13.57	2.4	5.2	3.57	3.42	0.63	17.64	2.40	5.20	3.59	3.42	0.58	16.16
Length of bract (cm)	2.30	6.10	4.36	4.62	0.76	17.43	2.3	8.4	4.58	4.06	1.06	23.14	2.30	8.40	4.49	4.43	0.97	21.60
Width of bract (cm)	0.50	1.60	0.98	1.04	0.19	19.39	0.50	1.80	0.94	1.03	0.25	26.60	0.50	1.80	0.96	0.99	0.23	23.96

26.62% for plot A, 33.46% for plot B and 32.24% for the entire area.

From 18 to 26 leaves were found on shoots. In plot A plants had a mean of 28.8 leaves, in plot B it was 26.52 leaves, while in the entire area it was 27.11, respectively. Modal means for this characteristic are slightly higher than arithmetic means both for plot A and B, as well as the entire area covered by lilies. The coefficient of variation for this trait calculated for all flowering specimens (201 specimens) was 15.49%.

Length of the biggest leaf takes values from 10.30 to 15.80 cm. The mean value of this characteristic for the entire population was 12.70 cm. The modal value for the length of the biggest leaf calculated for all plants in the generative phase (28.39) indicates that the biggest number of specimens in the population had slightly longer leaves than the arithmetic mean. Length of the biggest leaf is the least variable trait of all analysed characteristics. Coefficients of variation for this trait are as follows: for plot A (V = 10.02%), for B (V = 10.77%), and the entire area (V = 10.55%).

Width of the biggest leaf takes values from 2.40 to 5.20 cm (mean 3.59). The modal for this trait indicates that the population is dominated by specimens with a slightly smaller width of the biggest leaf than that of the arithmetic mean. Coefficient of variation for this trait was V = 16.16%.

Length of the bract ranged from 2.30 to 8.40 cm (mean 4.49). Calculated modal values indicate that specimens with slightly longer bracti than the arithmetic mean predominated in plot A, while in the entire area dominant specimens had slightly shorter bracti that the value of the arithmetic mean. Width of the bract ranged from 0.50 to 1.80 cm. The mean value of this trait for the population was 0.96 cm. The modal value of the width of the bract was bigger than the arithmetic mean, thus plants with a bigger value of this trait predominate in the population. Calculated coefficients of variation for this trait indicate that next to the number of flowers it is the most variable of the analysed traits.

Group characteristics

Analysis of group characteristics (Table 4) showed that density of specimens in plot A was 1.86, while in plot B it was 1.41. Stocking density of specimens in relation to the entire area covered by *L. martagon* was 1.58. Mean crowding expressed by the Lloyd coefficient in analysed plots A and B was 2.60 and 2.46, respectively, for the entire area overgrown by lilies it was 2.52 and it was higher than mean density.

Based on the prepared cartographic documentation (Figs 4, 5) and calculated values of dispersion coefficient (Table 4) it was found that in the analysed plots the cluster type of specimen distribution is observed (dispersion coefficient > 1).

The age structure is presented in Table 5 and in Figure 6, in the form of age spectra illustrating the proportions of individual development phases in examined plots. In plots A and B the lowest proportion of juvenile specimens was found, amounting to 7.46% and 4.44%,

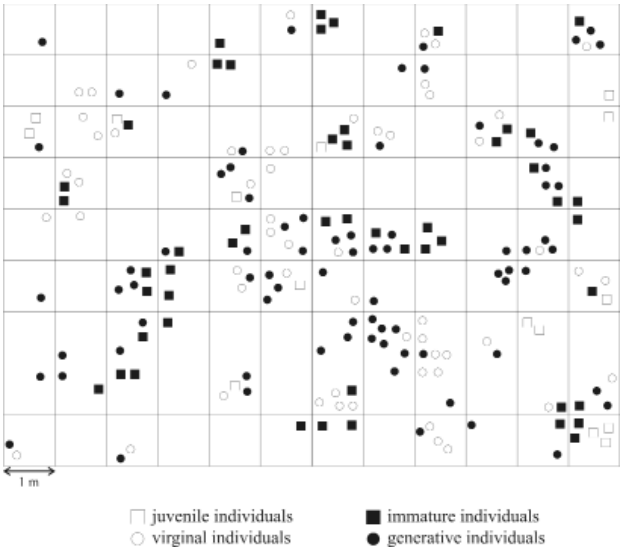

Fig. 4. Spatial and age structure of *Lilium martagon* specimens in plot A

Table 4. Values of phenotypic traits of *Lilium martagon* on experimental plots A and B

Plot	Area (m^2)	Density of plants per 1 m^2			Dispersion coefficient	Mean crowding	Numbers
		min.	max.	mean			
A	108	1	7	1.86	1.78	2.60	201
B	176	1	9	1.41	2.06	2.46	249
Total	284	1	9	1.58	2.05	2.52	450

Table 5. Age structure of the *Lilium martagon* population

Experimental plot	Age spectra							
	juvenile		immature		virginal		generative	
	number	%	number	%	number	%	number	%
A	15	7.46	50	24.88	57	28.36	79	39.90
B	11	4.44	71	28.63	44	17.74	122	49.19
Total	26	5.79	121	26.95	101	22.49	201	44.77

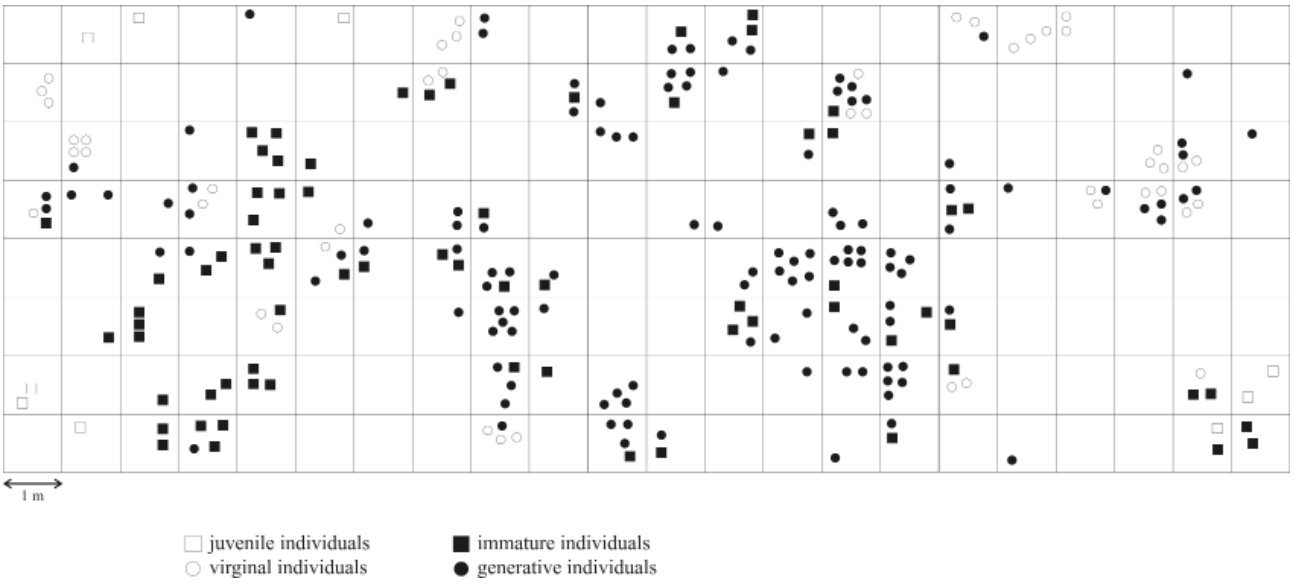

Fig. 5. Spatial and age structure of *Lilium martagon* specimens in plot B

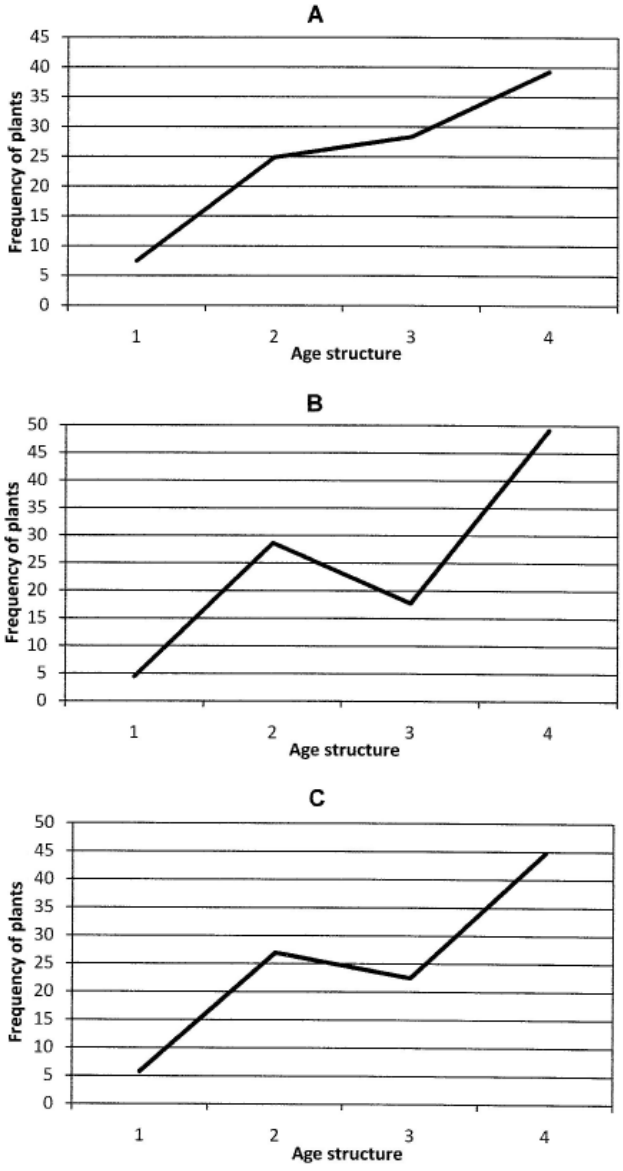

Fig. 6. Age spectra for plots A and B and for the entire population – C; 1 – juvenile phase, 2 – immature phase, 3 – virginal phase, 4 – generative phase

respectively. In the entire population (449 specimens) the juvenile phase accounts for 5.79%. The highest proportion in the population is recorded for generative specimens, constituting 39.8% in plot A and in plot B – 49.19%. The proportion of generative specimens in the entire population was 44.77%.

DISCUSSION

In the Pomerania region we may find *L. martagon* particularly in the former manor parks and in cemeteries. However, usually these localities comprise from several, around a dozen to several dozen specimens. The population size very rarely amounts to approx. 1000 specimens, as it was the case in the former park in Motłowo (Sobisz and Truchan 2006). A peculiar incidence was the size of the population of this species discovered in 2007 in Łasin Koszaliński (Truchan and Sobisz 2009), where in the years 2007-2009 there were 3042, 1827 and 1251 generative specimens.

Martagon lily is considered to be a species characteristic of meso- and eutrophic broad-leaved forests of order *Fagetalia sylvaticae* (Medwecka-Kornaś et al. 1977, Matuszkiewicz 2001). The structure of phytocenoses with *L. martagon* in Ciemino is not typical of the above mentioned community. This is confirmed by a lack of many species characteristic of the natural incidence of martagon lily and a relatively high proportion of synanthropic taxa, which was obviously caused by the anthropogenic character of this locality.

Soil analyses for Ciemino showed that it had a strongly acid reaction. According to Kuczyńska et al. (1985) and Bednorz (1999) such soil pH has a negative effect on growth, foliage and flowering of *L. martagon*, or even - as it was reported by Pindel (2002) – it may cause a complete destruction of populations of martagon lily. Investigations conducted by Jańczyk-Węglarska and Węglarski (1992) in the Wielkopolski National Park, Kolon and Krawczyk (1996) in Grudno near Bolków in Lower Silesia, Truchan and Sobisz (2009) in Western

Pomerania practically contradict a dependence between acid pH of soil and its negative effect on the development of *L. martagon*. In the Wielkopolski National Park martagon lily showed optimum occurrence on very strongly and strongly acid soils, while biometrically analysed specimens from Grudno had the highest values of individual traits in case of a habitat, which soil reaction was strongly acid. In Łasin Koszaliński at acid soil pH the population of martagon lily was of impressive size and dimensions.

Shoots of lilies at the Ciemino locality were considerably much taller than those reported by Medwecka-Kornaś (1949). The tallest of the measured specimens (Table 3) exceeded heights given by Raciborski (1919), while they were lower than those recorded by Matthews (1980), Szafer et al. (1988), Piękoś-Mirkowa and Mirek (2003) and Rutkowski (2004).

Mean values for all analysed traits of *L. martagon* from Ciemino are higher than those given by Kolon and Krawczyk (1996) from Lower Silesia. Mean height of flowering plants in Ciemino is higher than lilies described by Kuczyńska et al. (1985) from Lower Silesia, Bednorz (1999) from the Bieniszew Forest District, Pindel (2002) from the Central Beskid Mts, Miciniak and Ząтek (1999) from the Wielkopolski National Park. The mean number of leaves on shoots of lilies in Ciemino is higher than the value of this trait given by Kuczyńska et al. (1985), Pindel (2002) or Bednorz (1999). The mean value for the length of the biggest leaf and the width of the biggest leaf in the investigated population was bigger than the value of this trait for most populations in Lower Silesia (Kuczyńska et al. (1985), as well as those reported from Bieniszewo by Bednorz (1999). The mean number of flowers on shoots in Ciemino is bigger than in most populations described by Kuczyńska et al. (1985) as well as Pindel (2002), Miciniak and Ząтek (1999) and Bednorz (1999).

The population of *L. martagon* in Ciemino comprises a total of 451 specimens, and as such it is a locality of a high population size. Starting from 2005 (Sobisz and Truchan 2006) the number of specimens in the Ciemino population was reduced by over 40%. It is difficult to determine precisely the causes of such a situation. Optimal conditions for the development of *L. martagon* are found in lighted positions (Kuczyńska et al. 1985, Pindel 2002), while in Ciemino it grows in considerable shade and it is overgrown by an abundantly developing undergrowth of Norway maple, which is becoming bigger and bigger with every passing year. The park itself is open and accessible for visitors, thus lily bulbs could have been dug out and used for plantings for ornamental purposes. However, this species was not observed in home gardens of Ciemino residents, although this may not be stated beyond any doubt. Traces of feeding by scarlet lily beetle (*Lilioceris lilii*) were observed on lily leaves; however, they were scarce and they may hardly be considered a direct cause for such a dramatic reduction of the number of specimens within the last four years. The age structure could have potentially contributed to the drop in the population size of *L. martagon* in Ciemino. Although in 2005 only the size of the population was determined, and not its age structure, but studies conducted in 2009 might to a certain degree explain the probable cause for the reduction of the population size.

The population of *L. martagon* in Ciemino is formed by specimens in four development phases: juvenile, immature, virginal and generative. The low frequency of juvenile plants needs to be mentioned here, as it accounts for only 5.79% population, at the particularly high frequency of flowering plants. Such proportions of the age structure may lead to a reduction of the population size and its decrease might result from this factor. This condition of the population may be temporary and age relations may be fluctuations related with the changes in weather conditions in previous years. As it was shown by observations from Łasin Koszaliński in the years 2007-2009 reported by Truchan and Sobisz (2009), temperature and precipitation in the period of intensive growth (from April to June) had a considerable effect on the size of that population of *L. martagon* in the successive years of observations.

CONCLUSION

1. Martagon lily in Ciemino is found on mineral soil, with good resources of nitrogen and phosphorus and with acid reaction (from pH = 3.85 to pH = 4.74). It seems that the acid pH of the substrate does not have an effect on growth, foliage and flowering of *L. martagon*, as it has been suggested in their studies by some authors.

2. The anthropogenic locality of *L. martagon* in Ciemino in terms of the number of specimens is one of the biggest in the Pomerania region, it is characterised by the cluster spatial distribution, low density and a high proportion of flowering plants in the population (44.77%).

3. Specimens of *L. martagon* in the generative phase are characterised by a considerably bigger height, number of leaves and flowers on shoots than the values of these traits from natural habitats, reported by many authors.

4. Despite the observed big reduction in the number of specimens (over 40%) in 2009 in relation to 2005 the population does not seem to be threatened in the nearest future.

REFERENCES

Atlas rozmieszczenia roślin naczyniowych w Polsce. (2001). Eds A. Zając, M. Zając. Pracownia Chorologii Komputerowej Instytutu Botaniki UJ, Kraków.

Bednarek R., Dziadowiec H., Pokojska U., Prusinkiewicz Z. (2005): Badania ekologiczno-gleboznawcze. PWN, Warszawa.

Bednorz L. (1999): Charakterystyka ekologiczna populacji lilii złotogłów (*Lilium martagon* L.) w Leśnictwie Bieniszew koło Konina. Rocz. AR Pozn. 316, Bot. 2: 19-27.

Collier B.D., Cox G.W., Johanson A.W., Miller P.C. (1978): Ekologia dynamiczna. PWRiL, Warszawa.

Haeupler H., Muer T. (2007): Bildatlas der Farn- und Blütenpflanzen Deustchlands. Ulmer KG, Stuttgart.

Jańczyk-Węglarska J., Węglarski K. (1992): Ekologiczna i morfologiczna charakterystyka *Lilium martagon* L. na obszarze Wielkopolskiego Parku Narodowego. Biul. Ogrod. Bot. 1: 31-45.

Kolon K., Krawczyk A. (1996): Ekologiczna organizacja populacji *Lilium martagon* L. z Grudna koło Bolkowa na Dolnym Śląsku. Acta Univ. Wratisl. 1835, Pr. Bot. 68: 91-104.

Kondracki J. (2004): Geografia regionalna Polski. PWN, Warszawa.

Kuczyńska I., Sarosiek J., Szymańska E. (1985): Populacje *Lilium martagon* L. Acta Univ. Wratisl. 637, Pr. Bot. 28: 155-178.

Łukaszewicz (1962): Morfologiczno-rozwojowe typy bylin. Pr. Kom. Biol. PTPN 27, 1.

Matthews V.A. (1980): *Lilium martagon*. In: Flora Europaea. Vol. 5. *Alismataceae* to *Orchidaceae* (*Monocotyledones*). Eds T.G. Tutin, V.H. Heywood, D.M. Moore, D.M. Valentine, S.M. Walters, D.A. Webb, A.D. Chater, T.B.K. Richardson. Cambridge University Press, Cambridge: 17-74.

Matuszkiewicz W. (2001): Przewodnik do oznaczania zbiorowisk roślinnych Polski. PWN, Warszawa.

Medewcka-Kornaś A. (1949): Złotogłów. Chrońmy Przyr. Ojcz. 7-8: 9-15.

Medwecka-Kornaś A., Kornaś J., Pawłowski B., Zarzycki K. (1977): Przegląd ważniejszych zespołów roślinnych Polski. In: Szata roślinna Polski. Vol. 1. Eds W. Szafer, K. Zarzycki. PWN, Warszawa: 279-481.

Meusel H., Jäger E., Weinert E. (1965): Vergleichende Chorologie der Zentraleuropäischen Flora. Vol. 1. Text 583 pp., Karten 258 pp. Fischer Verlag, Jena.

Miciniak E., Zątek W. (1999): Zmiany liczebności populacji lilii złotogłów (*Lilium martagon* L.) w Wielkopolskim Parku Narodowym. Rocz. AR Pozn. 361, Bot. 2: 87-96.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M. (2002): Flowering plants and pteridophytes of Poland. A checklist. Vol. 1. Biodiversity of Poland. – Krytyczna lista roślin naczyniowych Polski. T. 1. Różnorodność biologiczna Polski. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Nowosielski O. (1974): Metody oznaczania potrzeb nawożenia. PWRiL, Warszawa.

Ochyra R., Żarnowiec J., Bednarek-Ochyra H. (2003): Census catalogue of Polish mosses. Biodiversity of Poland. Vol. 3. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Pawłowski B. (1972): Skład i budowa zbiorowisk roślinnych oraz metody ich badania. W: Szata roślinna Polski. Vol. 1. Eds W. Szafer, K. Zarzycki. PWN, Warszawa: 237-269.

Piękoś-Mirkowa H., Mirek Z. (2003): Atlas roślin chronionych. Multico Oficyna Wydawnicza, Warszawa.

Pindel Z. (2002): Wpływ warunków środowiska na populację i wzrost lilii złotogłów (*Lilium martagon* L.). Zesz. Probl. Post. Nauk Roln. 483: 167-172.

Raciborski M. (1919): *Lilium martagon* L. In: Flora polska. Vol. 1. Rośliny naczyniowe Polski i Ziem Ościennych. Eds M. Raciborski, W. Szafer. PAU, Kraków: 106-129.

Rutkowski L. (2004): Klucz do oznaczania roślin naczyniowych Polski niżowej. PWN, Warszawa.

Seneta W., Dolatowski J. (2003): Dendrologia. PWN, Warszawa.

Sobisz Z., Truchan M. (2006): *Lilium martagon* L. in former manor parks and Protestant cemeteries in the central part of Polish Pomerania. Biodiv. Res. Conserv. 3-4: 308-310.

Stanisz A.(2005): Biosystematyka. Wyd. UJ, Kraków.

Szafer W., Kulczyński S., Pawłowski B. (1988): Rośliny polskie. PWN, Warszawa.

Trojan P. (1975): Ekologia ogólna. PWN, Warszawa.

Truchan M., Sobisz Z. (2009): Characteristics of *Lilium martagon* L. population in Łasin Koszaliński (Western Pomerania). Rocz. AR Pozn. 388, Bot.-Stec. 13: 85-95.

Zarzycki K. (1984): Ekologiczne liczby wskaźnikowe roślin naczyniowych Polski. Instytut Botaniki PAN, Kraków.

Żukowski W., Jackowiak B. (1995): Lista roślin naczyniowych ginących i zagrożonych na Pomorzu Zachodnim i w Wielkopolsce. In: Ginące i zagrożone rośliny naczyniowe Pomorza Zachodniego i Wielkopolski. Eds W. Żukowski, B. Jackowiak. Pr. Zakł. Takson. Rośl. UAM Pozn. 3. Bogucki Wyd. Nauk., Poznań.

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