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CHARACTERISTICS OF *LILIUM MARTAGON* L. POPULATION IN ŁASIN KOSZALIŃSKI (WESTERN POMERANIA)

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ABSTRACT. The paper presents the results of studies on the most numerous population of *Lilium martagon* L. in Łasin Koszaliński in Western Pomerania. Investigations were conducted in the years 2007-2009. Edaphic and phytocenotic conditions were described, 20 relevés were prepared with *L. martagon*, of which 12 were listed in a phytosociological table. Moreover, the analysis of variation was conducted for selected morphological characteristics of martagon lily.

KEY WORDS: *Lilium martagon*, manor park, Kasin Koszaliński, Western Pomerania

INTRODUCTION

Lilium martagon L. is a Euro-Western Siberian species of an extensive range, which is found in Europe (except for Great Britain, Scandinavia, Holland and northern Russia), and which in Asia reaches Lake Baikal (Meusel et al. 1965).

In Poland *L. 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 found rarely (Atlas... 2001). In Western Pomerania *L. martagon* belongs to species threatened with extinction (Żukowski and Jackowiak 1995).

The characterised population of *L. martagon* is located in the former manor estate and manor park in Łasin Koszaliński. Łasin Koszaliński is a small village in the Zachodniopomorskie (Western Pomerania) province with a geographical coordinates of 54°13'13"N and 15°49'28"E (Fig. 1). It is located on the left bank of the Czerwona River valley near its mouth to the Baltic Sea. In terms of the physical and geographical characteristics it is situated in the Wybrzeże Słowińskie coastal region (Kondracki 2004), in the administrative division it is located in the Koszalin county and the Będzino commune. Due to its location it is a holiday village, in which 16 families out of the 20 families being permanent residents of the village are involved in running agritourism farms. Since 1998 the park has been a private property. The former manor house and manor park today are not used and thus they are neglected. The only tending interventions performed in the former park include mowing performed twice within the vegetation season. Despite it being so neglected, the park is an object of particular interest. In the park abundant localities of *L. martagon* L., obviously of anthropogenic origin can be found.

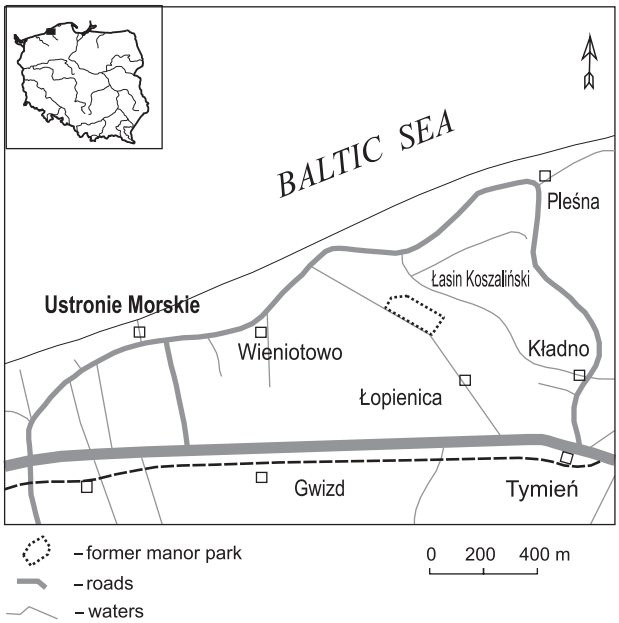

Fig. 1. Locality of a former manor park in Łasin Koszaliński

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

MATERIAL AND METHODS

Observations on the *Lilium martagon* L. population (Phot. 1-2) in the manor park (Fig. 2) in Łasin Koszaliński were conducted in the years 2007-2009. Soil analysis

PHOT. 1. General view of the manor park with *Lilium martagon* L. in Łasin Koszaliński (photo by M. Truchan)

PHOT. 2. *Lilium martagon* in a manor park in Łasin Koszaliński (photo by M. Truchan)

was performed twice, in 2008 as a preliminary survey and in 2009 from the established experimental plots 1, 2, 3 of 25 m^2 each (Fig. 2). Soil was collected with the rhizodermal layer in the immediate vicinity of the root system of the analysed 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), total phosphorus – using the molibdate method (NOWOSIELSKI 1974). Moreover, the content of organic matter in the analysed subsoil was determined.

Soil analysis was performed at a soil analysis laboratory of the Western Pomeranian University of Technology in Szczecin. Based on the decision of the Minister of the Environment DKFOPogiz-4211/I-22/560/08/ep of 24 June 2008 a total of 10 bulbs were collected, which were next placed in the garden of the Department of

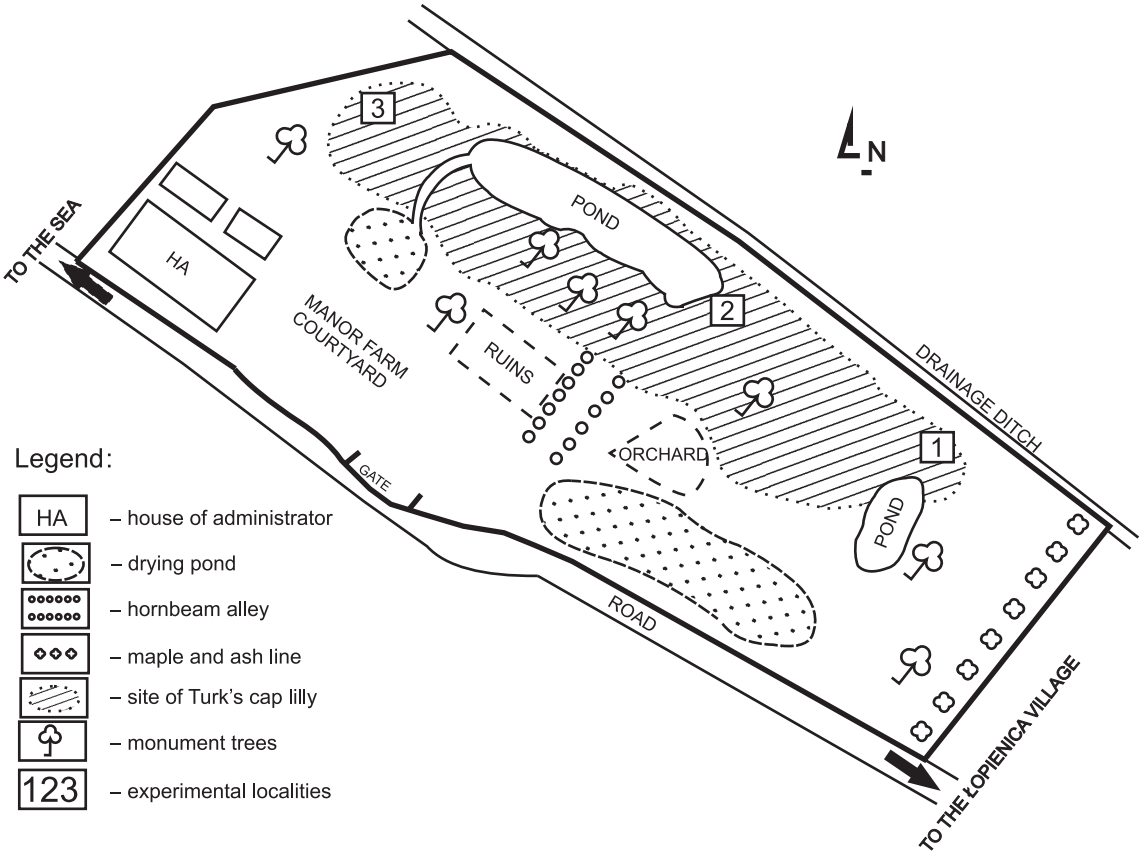

FIG. 2. Plan of a former manor park in Łasin Koszaliński

Botany, the Poznań University of Life Sciences. Jointly in the years 2007-2008 a total of 20 relevés were prepared, of which 12 were listed in a phytosociological table (Table 1).

In the years 2007-2009 the population size was established. In 2008 fifty specimens at anthesis were selected at random and their biometric measurements were taken. In turn, in 2009 in the established experimental plots (Fig. 2) biometric analyses were conducted

Table 1. Phytosociological structure of community with *Lilium martagon* L.

Successive number		1	2	3	4	5	6	7	8	9	10	11	12	S	D
Number of phytosociological relevé		405	520	461	546	523	574	572	570	437	592	580	584		
Date (day, month, year)		23.05.	18.04.	23.05.	03.05	18.04	11.07.	11.07.	11.07	15.07	11.07.	16.07	16.07.		
		2007	2008	2007	2008	2008	2007	2007	2007	2997	2008	2007	2007		
Mechanical composition of a horizon of soil (0-20 cm)		pgm	org	pgm	pgm	org	pgm	pgm	org	pgm	pgm	org	pgm		
Crown density (%)	a	50	25	50	40	30	40	40	30	25	50	45	20		
	b	30	35	20	40	30	35	10	25	30	35	25	30		
Cover of plant layers (%)	c	50	65	40	70	55	80	85	80	75	55	70	90		
	d	20	10	15	15	zn	20	20	5	10	10	5	5		
Area of relevé (m^2)		50	60	40	50	50	30	40	60	50	40	30	60		
Number of species in phytosociological relevé		35	39	39	38	40	27	30	33	28	32	26	28		
I. ChCl. *Querco-Fagetea*, ChO. *Fagetalia sylvaticae, ChAll. *Alno-Ulmion***, ChAll. *Carpinion betuli******															
**Lilium martagon*		1.2	+	2.2	1.1	+	4.4	5.5	4.4	4.4	3.3	4.4	5.5	V	4 100
Anemone nemorosa		2.2	1.2	1.1	2.2	2.2	+	.	.	.	+	.	.	III	537
**Anemone ranunculoides*		1.1	+.2	.	1.2	1.1	.	.	.	.	.	.	.	II	133
***Adoxa moschatelina*		1.2	1.2	.	+	+.2	.	.	.	.	.	.	.	II	100
**Ficaria verna*		.	1.1	+.2	+.2	+	.	.	.	.	.	.	.	II	66
***Gagea lutea*		.	1.2	.	+	+	.	.	+		.	.	.	II	66
**Pulmonaria obscura*		.	+.2	+	.	+	.	.	.	.	.	.	.	II	25
Lathraea squamaria		.	.	+	+	+.2	.	.	.	.	.	.	.	II	25
Fraxinus excelsior	a	3.3	2.2	3.3	3.3	2.2	3.3	3.3	2.2	2.2	3.3	3.3	2.2	V	2 916
	b	.	.	.	1.1	.	1.2	+	+	1.2	.	.	.	III	142
	c	.	+	+	.	.	+	+	.	+	+	+	.	III	58
****Carpinus betulus*	b	+.2	2.2	.	1.2	1.2	.	+	1.1	1.2	1.2	1.2	+.2	V	421
Poa nemoralis		+.2	1.2	+.2	1.1	+.2	.	+	+.2	.	+.2	1.2	+.2	V	183
Aegopodium podagraria		+	+.2	+	1.2	.	2.2	2.2	.	2.2	1.1	.	1.1	IV	587
Acer platanoides	a	1.1	.	1.2	1.2	1.2	.	+	1.1	1.2	1.2	1.2	.	IV	342
	b	.	.	+	1.2	.	+	.	+	+	+	.	.	III	83
**Viola reichenbachiana*		+	1.1	1.2	+	+	1.2	.	.	1.2	1.2	1.2	.	IV	275
Corylus avellana	b	1.1	+	.	.	1.1	.	1.1	1.2		+	.	+	III	233
**Polygonatum multiflorum*		.	+	.	+	.	.	1.1	1.1	1.1	.	.	.	III	142
**Milium effusum*		.	+.2	.	1.2	1.2	.	+	.	.	.	+	.	III	108
**Galeobdolon luteum*		.	1.2	1.1	+	.	.	+	.	.	.	.	+	III	108
Acer pseudoplatanus	b	1.1	.	.	.	+	.	.	+	.	.	1.1	.	III	100
**Scrophularia nodosa*		.	+	.	+	1.1	.	.	.	.	+.2	+	.	III	75
**Atrichum undulatum*	d	2.2	.	2.2	.	.	.	.	.	1.2	1.1	.	.	II	375
***Plagiomnium undulatum*	d	.	+.2	.	.	+.2	.	.	+.2	.	.	.	.	II	25
**Stachys sylvatica*		.	.	.	+	.	.	+	.	.	.	.	+	II	25
II. ChCl.ChO. *Epilobietea angustifolii, Atropetalia*, ChAll. *Sambuco-Salicion**															
**Sambucus nigra*	b	1.2	1.1	.	1.1	.	.	+	+	.	+	1.1	.	IV	275
	c	+	.	+	.	.	+.2	.	.	.	.	.	.	II	33
**Populus tremula* DAll.	b	+	+	.	1.1	1.2	.	+.2	.	+	.	+	+	IV	133
Fragaria vesca		1.2	.	+	.	+	.	.	+	.	.	+	+	III	83
**Salix caprea*	b	.	+	+	1.1	.	.	.	+	+	+	.	.	III	75

Table 1 – cont.

Successive number		1	2	3	4	5	6	7	8	9	10	11	12	S	D
III. ChCl. *Rhamno-Prunetea, Prunetalia spinosae,* ChAll. *Pruno-Rubion fruticosi**															
Prunus spinosa	b	+	1.2	+	+	.	1.2	+	.	+.2	.	+.2	+	IV	142
**Rubus plicatus*		.	+.2	+	.	1.2	.	+	1.1	.	+.2	.	+.2	III	125
Crataegus monogyna	b	+	.	1.1	.	1.1	.	+	+	.	+	.	.	III	117
	c	.	.	+	+.2	.	.	.	.	.	.	+.2	.	II	25
Crataegus laevigata	b	.	.	.	.	.	1.1	.	.	1.1	.	.	.	II	92
Rosa canina	b	.	.	+	.	.	+.2	.	.	1.1	.	.	.	II	58
IV. ChCl. *Molinio-Arrhenatheretea,* ChO. *Arrhenatheretalia, ChO. *Trifolio fragiferae-Agrostietalia stoloniferae*****															
**Achillea millefolium*		1.1	1.2	+	1.1	.	1.1	1.1	1.1	+	1.2	+.2	1.1	V	358
**Taraxacum officinale*		+	+.2	+	1.1	.	+	.	+	.	+	.	1.1	IV	133
***Ranunculus repens*		1.1	+	.	.	1.2	.	.	.	+	+	.	+	III	117
Cerastium holosteoides		.	1.2	+	1.1	.	.	+.2	.	+	.	.	.	III	108
**Dactylis glomerata*		.	.	1.2	.	+.2	+.2	.	+	.	1.2	.	.	III	108
Poa trivialis		.	.	+	.	+.2	.	.	.	.	.	.	+.2	II	25
V. ChCl. *Artemisietea*															
Anthriscus sylvestris		+.2	.	+.2	.	1.2	1.1	+.2	.	1.1	.	+.2	+	IV	166
Glechoma hederacea		1.2	.	+	.	+	.	.	+	.	.	+	.	IV	75
Geum urbanum		.	.	.	+	+.2	.	.	.	.	1.1	.	+	IV	66
Artemisia vulgaris		+	+	.	.	.	+	.	1.2	.	.	.	+	III	66
Urtica dioica		.	.	+	.	+	.	+	+	.	+	.	.	III	42
Chelidonium majus		.	.	+	.	+	+	.	.	+	.	.	+	III	42
VI. Accompaning species															
Quercus robur	b	1.1	.	+	.	1.1	+.2	+	1.1	.	2.2	1.1	2.2	IV	317
Hedera helix		1.1	1.2	.	.	1.2	1.1	.	+.2	+	+	.	+	IV	200
Aesculus hippocastanum	b	+	.	.	1.1	.	1.1	+	1.1	+..2	+	.	+	IV	175
	c		.	+	+	1.1	.	.	.	.	.	.	.	II	58
Brachythecium rutabulum	d	1.2	.	.	2.2	.	2.2	.	1.2	.	.	1.2	.	III	417
Salix fragilis	a	1.1	.	1.2	.	.	.	+	1.1	.	1.1	.	.	III	217
	b	.	.	+	1.2	.	+	.	.	.	.	.	1.1	II	58
	c	+	.	.	+	.	.	.	.	.	.	.	+	II	25
Oxalis acetosella		.	1.2	1.2	.	1.2	.	.	.	1.2	1.1	.	.	III	208
Pohlia nutans	d	.	.	+.2	.	.	+.2	.	.	1.1	1.1	.	1.2	III	175
Galanthus nivalis		+.2	1.2	1.1	1.2	+	.	.	.	.	.	.	.	III	142
Maianthemum bifolium		+.2	1.2	.	1.2	+.2	.	.	.	.	.	+	.	III	108
Convallaria majalis		.	+.2	.	1.1	+.2	.	.	.	.	.	.	.	II	58
Lapsana communis		+	+	.	.	.	.	.	1.2	.	.	.	.	II	50
Amblystegium serpens	d	.	+.2	.	.	.	.	1.2	.	.	+.2	.	+.2	II	66
Veronica chamaedrys		.	.	+	.	+	.	.	+	.	.	+.2	.	II	33
Galeopsis tetrahit		.	.	.	.	+	.	+	+	.	.	.	.	II	25

Plant species occuring only in I degree of phytosociological stability:
I. **Oxyrrhynchium hians* d 2 (1.2);
II. *Digitalis purpurea* 6 (+);
IV. *Heracleum sibiricum* 6 (+); **Leucanthemum vulgare* 7 (+.2); *Plantago lanceolata* 9 (+); *Rumex acetosa* 11(+); *Holcus lanatus* 11 (+.2)
V. *Cirsium arvense* 7 (+.2); *Melandrium album* 8 (+); *Geranium robertianum* 9 (+); *Alliaria petiolata* 10(+); *Rumex obtusifolius* 11(+)
VI. *Deschampsia flexuosa* 4 (+); *Plagiomnium affine* d 2 (1.2), 7 (2.3); *Symphytum officinale* 2 (+.2), 8 (+); *Solidago virgaurea* 11 (+); *Sarothamnus scoparius* 12 (+.2)
Ch.Cl. Festuco-Brometea: *Centaurea scabiosa* 9 (r)
Ch.Cl. Alnetea glutinosae: *Alnus glutinosa* a 2 (1.1), 5 (1.2);
Ch.Cl. Vaccinio-Piceetea: *Picea abies* 6 (+), *Vaccinium myrtillus* 10 (1.1)

Explanation: org – organic soil, pgm – heavy loamy sand, S – phytosociological stability, D – cover coefficient.

on all specimens growing there. Plants were characterised in terms of six individual characters. Measurements were taken for the following characteristics: 1 – height (cm), 2 – number of leaves on a shoot, 3 – length and 4 – width of the widest leaf (cm), 5 – the length of the inflorescence measured from the base (cm), and 6 – number of flowers in the inflorescence. For each trait their mean values (X), mode (M), standard deviations (SD) and coefficients of variation (V%) were calculated and their minimum and maximum values were established.

For the investigations on the population of martagon lily in 2009 the distribution of the first trait was presented in the form of a histogram (Fig. 3), while its consistence with normal distribution was verified using the chi-square test (Stanisz 2005). Population density expressed in the number of plants per 1 m^2 and mean stocking density defined by the value of Lloyd's index were determined (Collier et al. 1978). Numerical characteristics for *L. martagon* from 2008 and 2009 are presented in Table 3.

The type of spatial structure was determined based on cartographic documentation (Figs 4-6) and the calculated coefficient of dispersion according to Trojan (1975).

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 prepared using the Braun-Blanquet method (Pawłowski 1972) the type

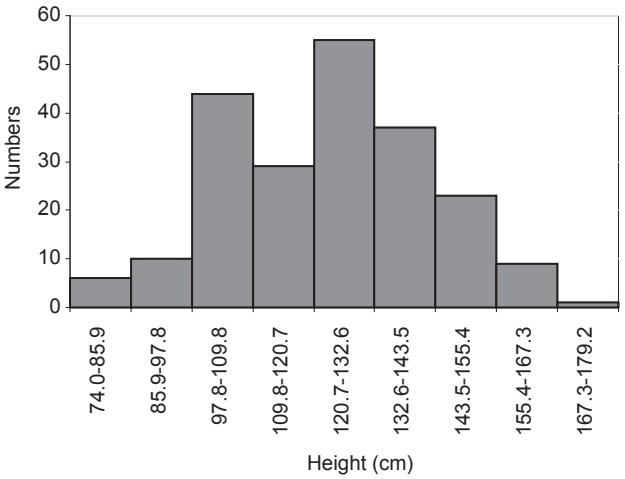

Fig. 3. Distribution of height of blooming plants in the studied population

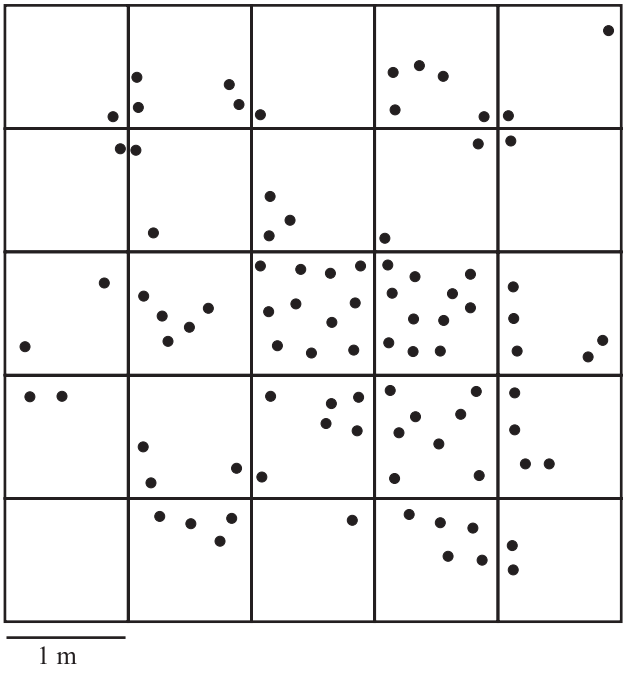

Fig. 4. Spatial structure of specimens in generative phase at the experimental locality 1

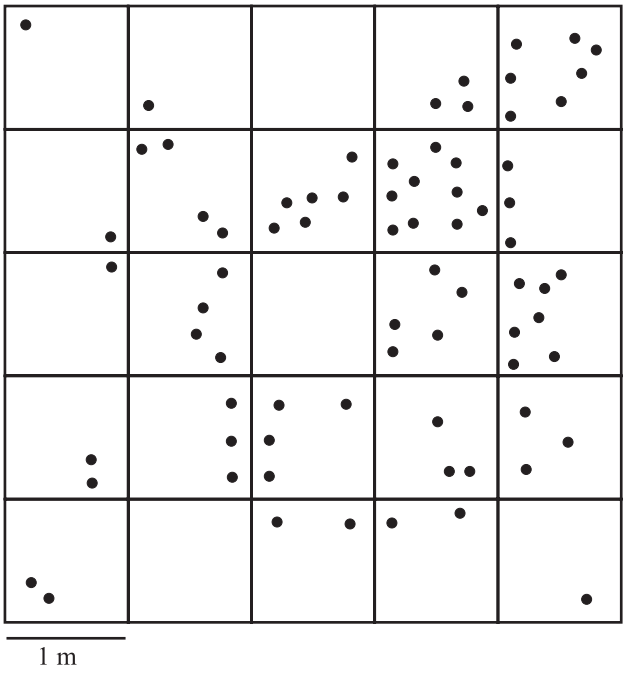

Fig. 5. Spatial structure of specimens in generative phase at the experimental locality 2

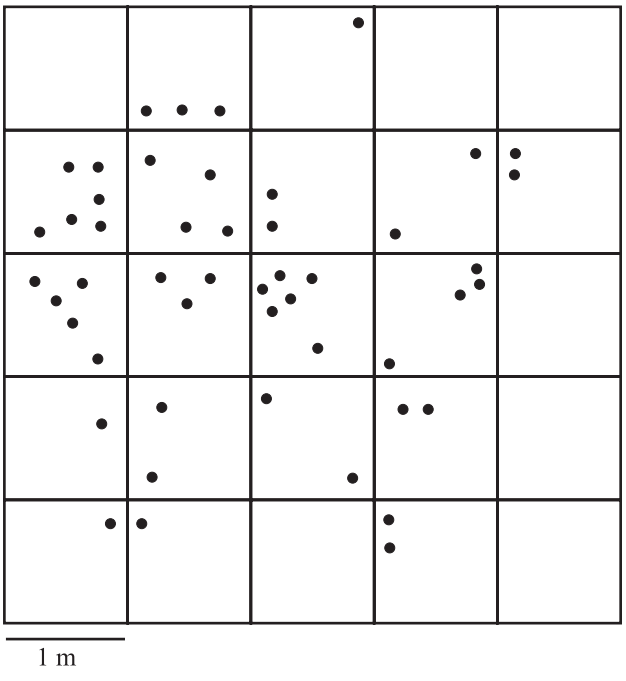

Fig. 6. Spatial structure of specimens in generative phase at the experimental locality 3

of community with *L. martagon* was identified (Matuszkiewicz 2001).

In the characteristics of the park, after the name of the village, the reference number and the date of entry in the register of historic monuments were given according to the data of the Provincial Office for Conservation of Historic Monuments in Szczecin, Branch Office in Koszalin.

RESULTS

The former manor estate and park in Łasin Koszaliński (A-13, 16 XI 1953) is located in the north-western part of the village, through which runs a highly devastated macadam road linking in the south with the Koszalin-Kołobrzeg road, while in the north with a minor road leading from Ustronie Morskie to an agricultural settlement of Pleśna. Remnants of the former manor estate cover the area of 6.8 ha. It comprises the former courtyard and park, in which water bodies account for approx. 1.12 ha (including four ponds, of which two are drying out) and drainage ditches (the Provincial Office for the Conservation of Historic Monuments in Szczecin, Branch Office in Koszalin – personal information). The courtyard covers the central-western part of the estate and is located immediately at the village road. Exact limits of the courtyard are difficult to identify, since former buildings were pulled down and the area was overgrown by dense clusters of shrubs and self-sown trees.

The park with an outline resembling a rectangle occupies the area around the courtyard. It is surrounded with a wire mesh. The park is spatially oriented in the north-eastern and south-eastern directions. With its longer side it is adjacent to the road running through the village. Along the northern and north-eastern boundary of the park there is a drainage ditch. The network of communication routes is not clear. An avenue composed of *Carpinus betulus* L. consists of 34 trees (19 on one and 15 on the other side of the avenue). From the north east the park borders with a complex of meadows furrowed with a network of drainage ditches.

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

Lilium martagon grows on an area of approx. 2.1 ha. Boundaries of the covered area are delineated by the open stand in the north-eastern corner of the park, from the west by manor house ruins, from the east by the biggest pond with the adjacent drainage ditch and from the south east by a smaller pond (Fig. 2). Soil analyses performed twice, in 2008 and in 2009, showed that soil has an acid reaction (from pH = 3.85 to pH = 4.74), it is relatively well-supplied with nitrogen and slight amounts of organic matter show that it is mineral soil. A narrow range of the C/N ratio (approx. 13-14) indicates good soil tilth and good habitat quality, while the soil is sufficiently abundant in phosphorus (Table 2).

The population of *L. martagon* in Łasin Koszaliński is highly numerous and spatially constitutes a comprehensive entity. In 2007 a total of 3042 specimens were found, all being in the flowering phase. At that time the youngest specimens in the juvenile phase may have been overlooked, due to the dense vegetation cover of the park floor at that time of the year and it being overgrown. Most specimens were then from 110 to 130 cm and had approx. 15-20 flowers on a shoot. We need to mention here particularly one specimen of 181 cm in height and with 61 flowers, recorded in 2007. In 2008 it was found that the number of specimens dramatically dropped to 1827 specimens. In the spring when the undergrowth was not abundant yet, in places specimens in the juvenile stage were found (had one leaf each). In the summer of 2008 lilies were markedly lower and had fewer flowers in relation to those in 2007. The tallest specimen was 171 cm in height and had 31 flowers on a shoot. Such showy plants had exceptionally large bulbs (Phot. 3). Plants were mostly 100-120 cm in height and had 10-15 flowers in an inflorescence. In the summer of 2009 a total of 1251 specimens were recorded. Plants were lower and ranged from 90 to 110 cm in height and had 7-10 flowers on a shoot. There were also specimens with more than 30 flowers on a shoot. The biggest specimens were over 170 cm in height (Phot. 4).

The phytosociological structure of the *L. martagon* population is presented in Table 1. Despite the obviously anthropogenic origin of the localities of martagon lily in Łasin Koszaliński, the character and characteristics of the habitat correspond to the conditions of their natural occurrence. Martagon lily in natural habitats is found in fertile broad-leaved forests belonging to the *Fagetalia sylvaticae* class (Matuszkiewicz 2001). It also enters shrub communities with different syntaxonomic affiliation. It inhabits semi-shaded locations on sandy loam and fresh loamy soils, abundant in mineral and humus substances (Zarzycki 1984). Similar habitat conditions

Table 2. Chemical characteristics of soil

Year of study/ No. of sample	pH		Humus (%)	C (%)	N (%)	P (%)	C/N	C/P	N/P
	H_2O	KCl							
2008	5.67	4.57	5.95	3.45	0.26	0.0244	13.27	141.4	10.66
2009/1	5.43	4.74	7.26	2.95	0.22	0.0215	13.41	137.2	10.23
2009/2	5.05	3.85	7.06	2.80	0.21	0.0193	13.33	145.1	10.88
2009/3	5.21	4.05	5.15	2.70	0.19	0.0188	14.21	143.6	10.11

Phot. 3. Shapely bulb of *Lilium martagon* (photo by M. Truchan)

Phot. 4. Measured individual of *Lilium martagon* (photo by M. Truchan)

were found for the area where *L. martagon* was growing in the analysed park.

Among plants found together with martagon lily we need to mention taxa of the following syngenetic groups: *Fagetalia sylvaticae* Pawł. in Pawł., Sokoł. et Wall. 1928 and *Querco-Fagetea* Br.-Bl. et Vlieg. 1937. They comprise the most numerous group of plants recorded together with *L. martagon*. Among 20 taxa from these syntaxonomic groups high constancy was observed for *Poa nemoralis* L. (V), *Aegopodium podagraria* L. (V), *Viola reichenbachiana* Jord. ex Boreau (IV), *Galeobdolon luteum* Huds. (III), *Milium effusum* L. (III), *Polygonatum multiflorum* (L.) All. (III), *Scrophularia nodosa* L. (III) and *Stachys sylvatica* L. (III). In the moss layer the presence of *Atrichum undulatum* (Hedw.) P. Beauv. needs to be stressed, the species being found in the 2nd degree of constancy and with a relatively high coverage degree (D = 365). The proportions of other mosses characteristic of both syntaxa *Plagiomnium undulatum* (Hedw.) T.J. Kop. and *Oxyrrhynchium hians* (Hedw.) Loeske are slight. Among plants of the spring aspect (Table 1, relevés 1-5), geophytes are most frequent, i.e. *Anemone nemorosa* L., *A. ranunculoides* L., *Adoxa moschatellina* L., *Ficaria verna* L. and *Gagea lutea* (L.) Ker. Gawl. They are accompanied by *Lathraea squamaria* L. and protected species *Galanthus nivalis* L. and *Convallaria majalis* L. In phytocenoses of the summer aspect martagon lily was found facially (Table 1, relevés 6-12). Jointly 81 taxa were found in the community. In individual phytocenoses from 27 to 40 species were found (on average 33). The stand of the analysed phytocenoeses is formed by eight species, among which the dominant role is played by *Fraxinus excelsior* L., *Acer platanoides* L. and *Aesculus hippocastanum* L. The shrub layer is rich in species, but it is relatively loose. It is represented by *Sambucus nigra* L., *Rubus plicatus* Weihe & Ness as well as hawthorns *Crataegus monogyna* Jacq. and *C. laevigata* (Poir.) DC. In most phytocenoses the underwood of *Fraxinus excelsior, Acer platanoides* and *A. pseudoplatanus* was observed. Species of class *Rhamno-Prunetea* Rivas Goday et Garb. 1961, i.e. plants of thermophilous shrub communities are represented in the phytocenoses by seven species, of which the highest constancy (IV) was found for *Prunus spinosa* L. Synanthropization of the analysed phytocenoses of communities with *Lilium martagon* is shown by the presence of *Artemisia vulgaris* L., *Stellaria media* (L.) Vill., *Taraxacum officinale* F.H. Wigg. and *Urtica dioica* L. A numerous group comprises 14 accompanying species, of which we need to mention particularly *Hedera helix* in the 4th and *Oxalis acetosella* in the 2nd constancy class. The moss layer is formed by four taxa, among which *Brachythecium rutabulum* (Hedw.) Schimp. was recorded more frequently (3rd constancy class).

Biometric analysis conducted on 50 specimens of *L. martagon* in 2008 (Table 3) showed that shoots of lilies were from 100 to 163 cm (mean 129.68 cm) in height. Variation in the height of the analysed plants was relatively small (V = 9.97%), which may indicate low variation of the microhabitat in terms of edaphic conditions. The number of leaves ranged from 37 to 67 (mean 50.70). Mean length and width of the biggest leaf were 14.02 cm and 3.85 cm and apart from the height of plants these traits were least variable among the six analysed

characters. Coefficients of variation for these traits were V = 10.39% and V = 12.24%, respectively.

Length of the inflorescence from the base ranged from 25 cm to 43 cm (mean 32.80). The number of flowers was the most variable characteristic (V = 23.04%). Values of this trait ranged from eight to 21 (mean 13.13). Among the analysed specimens the inflorescences with 14 flowers were most numerous.

In 2009 in the course of observations of the three established experimental plots marked differences were found between them. They concerned both values of the investigated traits and the number of plants (Table 3, Table 4). The biggest number of specimens was found for locality 1 (91), while the fewest for locality 3 (49). For most of the analysed traits, apart from the width of the biggest leaf, specimens from plot 3 reached the highest values (Table 3). In the total sample n = 214 specimens (Table 5) it was found that shoots of lilies were from 80 to 175 cm (mean 123.13 cm in height). The modal value (Table 5) of plant height was higher than the arithmetic mean, thus in the population plants with a height bigger than the mean predominated. The distribution of the height of shoots in the three analysed plots was normal (Fig. 3). The coefficient of variation for height of analysed plants (V = 16.21) shows that, next to the length of the biggest leaf (V = 13.20%) and the width of the biggest leaf (V = 16.34%), it is one of the least variable traits. The number of leaves ranged from 21 to 89 (mean 48.55). It is one of the most variable traits among those analysed (V = 34.11%). The modal for the number of leaves is much smaller than the arithmetic mean, thus plants with a lower number of leaves than the average predominated in the population. The length of the biggest leaf reached values from 11 to 19.6 cm (mean 14.58). The modal value for this trait indicates that plants with the length of the biggest leaf slightly bigger than the average predominate in this population. Width of the biggest leaf assumed values from 2.30 to 5.10 cm (mean 3.46). The modal value for this trait indicates that in the population specimens with a slightly smaller width of the biggest leaf than the arithmetic mean predominate. Length of the inflorescence from the base ranged from 15 to 56 cm (mean 33.62 cm). Plants with a slightly smaller value of this trait predominated in this population, as it is shown by the modal value. The coefficient of variation for this trait was relatively high (V = 26.31%).

The number of flowers in the total sample ranged from three to 33 (mean 13.73). The coefficient of variation for this trait was V = 55.53% and it was biggest among all the analysed traits. The modal number of flowers was much lower than the arithmetic mean. Plants with seven flowers predominated in the population.

Analysis of group characteristics (Table 5) showed that the density of specimens in the investigated plots was on average 2.85 plants/m^2. Mean stocking density expressed by Lloyd's index was 3.74 and it was higher than mean density. Based on the prepared cartographic documentation (Figs 4, 5, 6) and calculated coefficients of dispersion (Table 5) in all examined plots the cluster distribution type was found for the specimens (coefficient of dispersion > 1).

Table 3. Individual characters of blooming plants of *Lilium martagon* in the years 2008-2009

Character	2008 (n = 50)					2009														
						1 (n = 91)					2 (n = 74)					3 (n = 49)				
	min.	max.	X	SD	V (%)	min.	max.	X	SD	V (%)	min.	max.	X	SD	V (%)	min.	max.	X	SD	V (%)
Height of plants (cm)	100	163	129.68	12.93	9.97	80	151	114.9	17.49	15.22	93	159	119.7	17.28	14.43	123	175	143.54	12.94	9.01
Number of leaves	37	65	50.70	7.49	14.77	21	67	39.74	10.44	26.67	22	89	48.34	17.46	36.11	46	82	65.22	10.84	16.62
Length of the greatest leaf (cm)	11.2	16.5	14.02	1.46	10.36	11	18	13.47	1.52	11.27	11	18.3	15.27	1.89	12.40	13.30	19.60	15.58	1.60	10.30
Width of the greatest leaf (cm)	3.2	5.3	3.85	0.47	12.24	2.8	5.1	3.65	0.49	13.34	2.30	4.60	3.21	0.57	17.68	2.50	4.90	3.50	0.56	16.09
Length of the inflorescence measured from the base (cm)	25	43	32.8	4.77	14.55	15	19	29.7	6.95	23.39	22	45	31.43	5.46	17.36	31	56	44.16	7.69	17.41
Number of flowers	8	21	13.13	3.03	23.04	3	20	8.91	3.83	43.03	5	32	14.31	7.57	52.86	12	33	21.80	5.63	26.09

n – number of observation.

Table 4. Group features of *Lilium martagon* population

No. of plot	Area (m^2)	Denisty of plants per 1 m^2		Dispersion coefficient	Mean crowding	Numbers
		mean	max.			
1	25	3.64	11	2.40	4.90	91
2	25	2.96	10	2.01	3.78	74
3	25	1.96	6	1.74	2.53	49
Mean	25	2.85	9	2.05	3.74	71.3

Table 5. Individual characters of *Lilium martagon* in 2009 (general sample, n = 214)

Character	Min.	Max.	X	M	SD	V (%)
Height of plants (cm)	80	175	123.13	126.02	19.95	16.21
Number of leaves	21	89	48.55	38.35	16.56	34.11
Length of the greatest leaf (cm)	11	19.60	14.58	15.05	1.92	13.20
Width of the greatest leaf (cm)	2.30	5.10	3.46	3.36	0.57	16.34
Length of the inflorescence measured from the base (cm)	15	56	33.62	32.05	8.84	26.31
Number of flowers	3	33	13.73	7.29	7.62	55.53

DISCUSSION

In Pomerania *L. martagon* is found particularly in former manor parks and on cemeteries. However, its localities comprise from several, around a dozen to several tens of specimens. A population of several hundred specimens, as it is the case in the former park in Motłowo, is very rare (Sobisz and Truchan 2006).

Martagon lily is considered to be a species characteristic of meso- and eutrophic broad-leaved forests *Fagetalia sylvaticae* (Medwecka-Kornaś et al. 1977). The phytosociological structure of the community with *L. martagon* in the former manor park in Łasin Koszaliński is not typical of this forest community. This is confirmed by the relatively high proportion of synanthropic species, which was obviously caused by the anthropogenic character of this locality.

Analyses of soil from Łasin Koszaliński showed that it has an acid pH. Results of analyses of individual samples were: pH = 3.85, pH = 4.05, pH = 4.57 and pH = 4.74. Soil with such a pH value according to Kuczyńska et al. (1985) has a negative effect on growth, foliage and flowering of *L. martagon*. Also Bednorz (1999) in his ecological studies on this species agreed with an opinion by Kuczyńska et al. (1985) that an acid pH of the substrate has an adverse effect on growth and development of the *L. martagon* population in the Bieniszew Forest District near Konin. Pindel (2002) reported that a decrease of soil pH to 4.6 may result in a destruction of a martagon lily population, as it was the case in the area near Myślenice in the Beskid Średni region. Studies by Mynett (1976) conducted on *L. martagon* in cultivation showed that the optimal substrate for this species is soil with pH 6-7. Preliminary investigations conducted in Łasin Koszaliński did not confirm such dependencies. Despite the acid soil pH *L. martagon* reaches here impressive numbers and size. There is not sharp dependence between the negative effect of acid soil pH and the development of *L. martagon* seems to confirm the studies by Kolon and Krawczyk (1996) conducted in Grudno near Bolków in Lower Silesia and that of Jańczyk-Węglarska and Węglarski (1992) from the Wielkopolski National Park. In the Wielkopolski National Park martagon lily showed an optimum occurrence on very strongly and strongly acid soils and in the specimens from Grudno, subjected to biometric analyses, the highest values of the reported individual traits were found for those collected from the habitat where soil reaction was strongly acid. The one soil sample, collected for preliminary analysis from Łasin Koszaliński in 2008 and the three samples from 2009 collected from different parts of the park showed that soil in the park has an acid pH. Plants found in the localities in Łasin Koszaliński – based on the population size and the stage of development – have been growing in that locality for a very long time, although the determination of the duration of this population is rather impossible. According to Hellwig (1957) bulbous plants are long-living. In his opinion genus *Lilium* may grow well at one location even for 50-70 years. Thus it is likely that *L. martagon* in the park in Łasin Koszaliński is still a remnant of the last, former owners of this manor estate and park. In the period from 1955 to 1989 the park was never used. Starting from 1989, when it became private property, it has been mowed twice a year. Plants growing there have obviously found very good conditions for growth and development and they have remained there for many years.

Lily shoots at the locality in Łasin Koszaliński reach much bigger heights that it is reported by Medwecka-Kornaś (1949). The tallest of the measured plants (Table 3) exceed in height the values given for this species by Raciborski (1919), Szafer et al. (1988), Piękoś-Mirkowa and Mirek (2003) and Rutkowski (2004). The tallest recorded *L. martagon* plants in Łasin Koszaliński fell with the range of height reported by Matthews (1980). Marked differences observed between the three established experimental plots (1, 2, 3) concerning values of the analysed traits were most probably caused by different soil moisture contents. The lowest values of analysed traits were found for plants growing on a slight elevation, while the highest values of these traits were found for plants from plot 3 growing in a depression, in the vicinity of a drainage ditch. Specimens from plot 2 had intermediate values for most of the investigated traits. This experimental plot was established in the vicinity of a park pond, i.e. probably plants growing these had better water supplies than those growing on an elevation, but poorer than those growing in the depression and the vicinity of a drainage ditch. Such a situation is undoubtedly a reflection of dramatically low precipitation in spring 2009, when water requirement was high, particularly as the temperature was relatively low (Table 6).

The fact of a dramatic decrease in the number of specimens in each of the successive year of observations may be disturbing. The area is fenced, thus plants are not fed on by animals, although on lily leaves signs of feeding by scarlet lily beetle (*Lilioceris lilii*) were found, but they were scarce and obviously it was not the cause of such a dramatic reduction in the number of specimens. Differences in the number of *L. martagon* specimens in the three successive years of the study were probably caused by weather conditions. During the vegetation season these three years differed considerably in terms of the level of precipitation and mean temperatures in individual months (Table 6).

In 2007 in the period from May and June temperature was higher than in the analogous period of 2008. In 2009, apart from April, the temperature in May and June was lower than in 2007 and 2008. Total precipitation from May to July, i.e. in the period of intensive growth and development, was also markedly higher in 2007. Undoubtedly better conditions for growth and development were found in the vegetation season of 2007, when 3042 specimens of *L. martagon* in the former manor park in Łasin Koszaliński. In 2009 in April at the highest mean temperature of the three previous years, precipitation was very low and could have had a significant effect on the reduction of the population size of martagon lily.

Table 6. Climatic data from the Water an Weather Station in Koszalin

Year	Mean temperature (°C)							Total precipitation (Hg mm)						
	IV	V	VI	VII	VIII	IX	X	IV	V	VI	VII	VIII	IX	X
2007	8.7	14.00	17.5	17.2	17.7	12.9	8.00	30	70	132	188	78	98	50
2008	7.2	12.4	16.3	17.9	17.6	12.6	9.2	62.9	16	64.3	55.5	130.7	34.8	65.1
2009	10.1	11.9	14.1					15.1	65.6	96.9				

Source: Institute of Meteorology and Water Management in Poznań, Office in Słupsk.

Mean height of flowering plants, mean number of leaves and mean number of flowers in the inflorescence for *L. martagon* from Łasin Koszaliński are markedly higher than those reported by Kuczyńska et al. (1985), Kolon and Krawczyk (1996) from Lower Silesia, Bednorz (1999) from the area of the Bieniszew Forest Division and Pindel (2002) from the Beskid Średni region. Only the values concerning mean length of the biggest leaf and mean width of the biggest leaf are similar to those reported by Kuczyńska et al. (1985), Kolon and Krawczyk (1996) as well as Bednorz (1999). Investigations conducted over many years by Miciniak and Zątek (1999) in the period of 1991-1998 (with breaks in 1992 and 1996) in the Wielkopolski National Park indicate that in the examined populations there were very few flowering specimens and few flowers on shoots. Anthropogenic localities of *L. martagon* from Łasin Koszaliński in terms of the population size or abundance did not resemble in the least any of those described in literature.

CONCLUSIONS

Anthropogenic localities of *Lilium martagon* in Łasin Koszaliński most probably belong to the richest in terms of the number of specimens in the Pomerania region.

In the area occupied by *L. martagon* eight monument trees were found: *Aesculus hippocastanum* L. (340 cm), *Carpinus betulus* L. (240 cm), *Fraxinus excelsior* L. (360 cm, 320 cm), *Populus alba* L. (390 cm), *Tilia cordata* Mill. (540 cm, 390 cm), *Ulmus laevis* Pall (290 cm).

Despite the very big drop in the number of specimens recorded in 2009 in relation to 2007 and 2008 the population does not seem to be threatened in the nearest future.

Specimens of *L. martagon* observed in Łasin Koszaliński are found in the generative phase.

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

Martagon lily in Łasin Koszaliński is found in mineral soil, well-supplied in nitrogen and phosphorus, with acid reaction (from pH = 3.85 to pH = 4.74). It seems that the acid soil reaction of the substrate does not have an effect on growth, foliage and flowering pf *L. martagon*, as it was suggested by many authors in their studies.

Most probably climatic conditions have a significant effect on the development of martagon lily.

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