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Autor: Korna, Jan / Dubiel, Eugeniusz

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Land use and vegetation changes in the hay meadows of the Ojcow National Park during the last thirty years

Jan KORNAŚ and Eugeniusz DUBIEL

1. INTRODUCTION

Secondary hay meadows of the *Arrhenatheretalia* order formed a very typical component of the agricultural landscape in Europe 30-40 years ago. Since then most of them have been destroyed or strongly modified due to the changes in management practices. Such processes have been reported e.g. from Great Britain (HOPKINS and WAINWRIGHT 1989, HUGHES and HUNTLEY 1988), Holland (BAKKER 1987, OOMES and MOOI 1981), Norway (LOSVIK 1988, NORDENHAUG 1988), Switzerland (ANON. 1987, SCHMID and THOMET 1986, ZOLLER et al. 1983), Germany (DIERSCHKE 1978, 1980, HUNDT 1964, MEISEL 1983, MEISEL and HÜBSCHMANN 1976, ROSENTHAL and MÜLLER 1988, WEGENER and REICHHOFF 1989, WOLF 1979), Czechoslovakia (NEUHÄUSL and NEUHÄUSLOVA 1985) and other countries. They are presently very intensive in Poland. Methods of vegetation mapping are particularly suitable in documenting them. We should like to illustrate this by the example of the Ojcow National Park.

Acknowledgements

The project was partly supported by the grant of the Polish Academy of Sciences CPBP 04.04.

2. STUDY AREA AND METHODS

The Ojcow National Park (1570 ha), established in 1956, is located 22 km NNW of Cracow, in the southern part of the Cracow-Czestochowa Upland (Fig. 1). It includes the Pradnik River valley, 300 m a.s.l., with some secondary valleys and the adjacent plateau areas, rising to an altitude of 478 m. On the slopes, still covered with forests, picturesque rocks of white Jurassic limestone project from under younger deposits of Pleistocene loams and loess. On valley bottoms warp soils of alluvial origin prevail.

In 1958-1961 the actual vegetation was surveyed in the Ojcow National Park; 22 plant community types have been distinguished and their distribution has been mapped in the scale of 1:10'000 (MEDWECKA-KORNAS 1962, MEDWECKA-KORNAS and KORNAS 1963a,b,c). At that time, only two years after the National Park was established, the valley bottoms were covered mainly with semi-natural grassland vegetation, formed through the long-lasting traditional methods of mowing and grazing. Colourful hay meadows of the *Arrhenatheretum medioeuropaeum* association dominated. A minor part was played by fertile pastures (*Lolio-Cynosuretum*), wet meadows (*Cirsietum rivularis*), small-sedge communities (*Scheuchzerio-Caricetea fuscae*) and tall-sedge reeds (*Magnocaricion*). There were also scattered areas of arable fields and fragments of riverside forests (*Alno-Padion*), as well as tall-forb communities (*Geranio-Petasitetum hybridi*) along the rivulets.

Around 1960 the *Arrhenatheretum* in the Ojcow National Park was very homogenous and species-rich. In a single relevé 41-58 species of vascular plants per 100 m² were noted (average: 50 species per 100 m²). The community occupied mostly the habitats of the potential natural oak-hornbeam forests (*Tilio-Carpinetum*). It was very stable under the existing conditions, being maintained by the firmly settled traditional forms of human interference: hand-mowing (usually twice a year), extensive grazing (after the haymaking, especially in autumn) and regular manuring with stable dung. This dynamic equilibrium has been correctly defined in the first papers on the vegetation of the Ojcow National Park by Anna MEDWECKA-KORNAS and coworkers (MEDWECKA-KORNAS 1962, 1977a,b, MEDWECKA-KORNAS and KORNAS 1963a,b,c), and confirmed experimentally. For this purpose a permanent plot consisting of one of the most typical *Arrhenatheretum* stands in the Ojcow area has been excluded from mowing and studied continuously since 1964 by Krystyna JANKOWSKA and her colleagues (JANKOWSKA 1967, 1971, 1975, JANKOWSKA and WITKOWSKI 1978, MEDWECKA-KORNAS 1977a,b, WITKOWSKI 1969). Al-

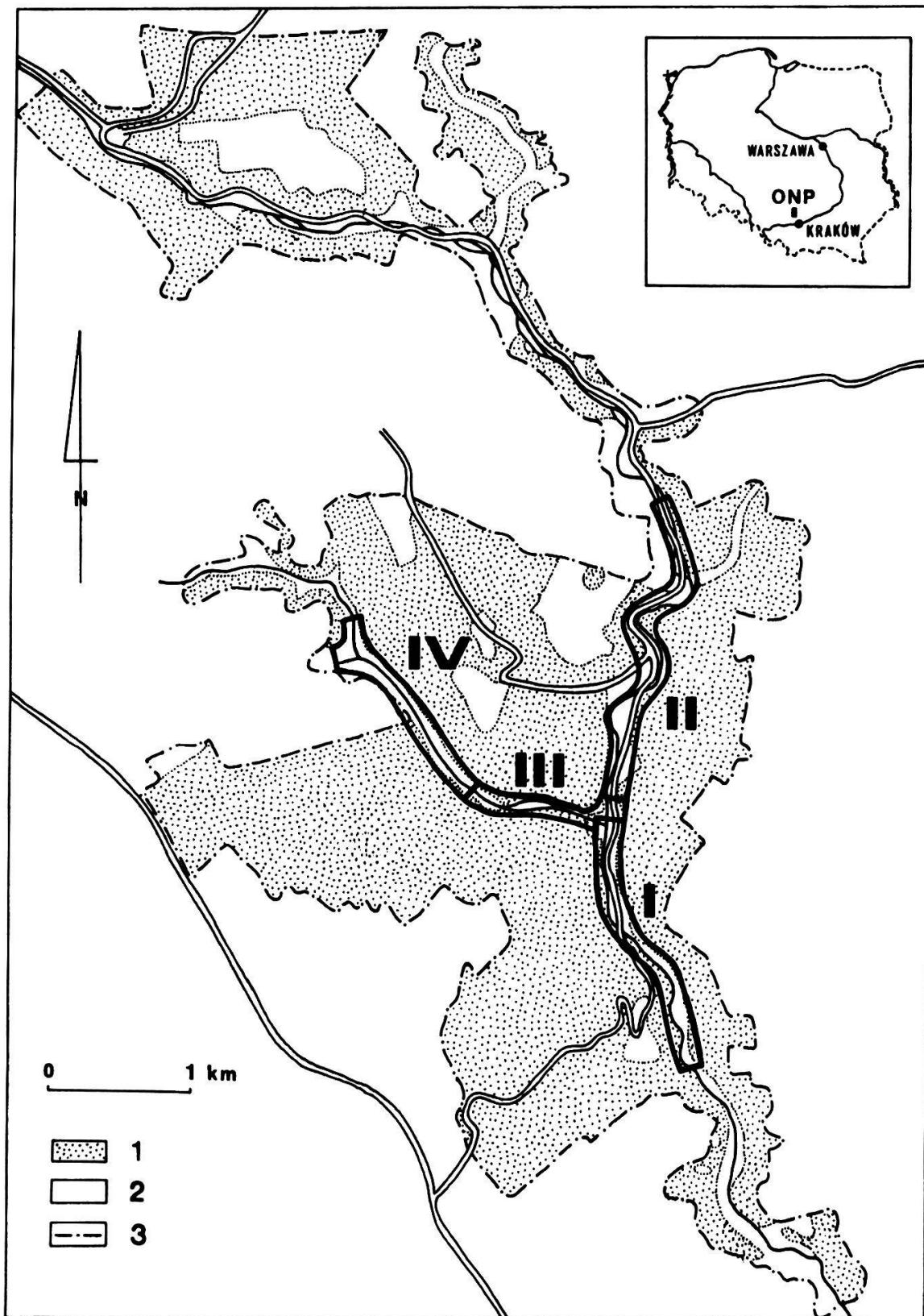


Fig. 1. Ojcow National Park

1 - forests, 2 - arable fields and hay meadows, 3 - Park boundaries.

I, II, III, IV - segments of valley bottoms mapped in 1959-1961 and 1988 (see Figs. 2-4)

ready in the first year of observations, the amount of the dead organic matter increased considerably, tall hygrophilous grasses (such as *Dactylis glomerata* and *Deschampsia caespitosa*) became dominant, and several dicotyledonous plants decreased in number quite drastically. After 3-4 years of continual retrogression the plot no longer represented a stand of *Arrhenatheretum*, and after ten years shrubs and young trees became abundant, showing the incipience of forest encroachment.

To avoid this type of successional change in the meadows of the Ojcow National Park, recommendations for optimal management of the valley bottoms have been formulated, with strong emphasis on the active preservation of the existing greenland communities through traditional management practices (MEDWECKA-KORNAS 1977a,b). Unfortunately, very few of these demands have been realized. On the majority of meadows in the Park land use methods have been radically modified, and this resulted in a sweeping change in the plant cover. To document this change a second survey of vegetation of the valley bottoms was carried out by Eugeniusz DUBIEL and Jan KORNAS 30 years after the first one (KORNAS and DUBIEL in print). The phytosociological relevés from the years 1958-1959 were repeated in 1986-1987 (Tables 1, 2, 3), and the actual vegetation was remapped in 1988 (Figs. 2, 3, 4).

3. RESULTS

The results obtained may be summarized as follows: Mown grassland is still the dominant form of land use on the valley bottoms in the Ojcow National Park. Its total area even increased by 1 1/2 during the last 30 years. Plant community types distinguished in 1958-1959 still occur there, although the majority of stands appear to be profoundly modified. The most essential changes are those concerning the dominant community of *Arrhenatheretum medioeuropaeum*; they perfectly agree with the results of the successional

Figs. 2-4 (p. 212-214). Plant communities on valley bottoms of the Ojcow National Park in 1959-1961 and 1988.

1 - *Arrhenatheretum*, 2 - *Arrhenatheretum*, *Cirsium oleraceum* variant, 3 - *Arrhenatheretum*, fragmentary stands, 4 - *Lolio-Cynosuretum*, 5 - *Lolio-Cynosuretum*, fragmentary stands, 6 - *Calthion*, 7 - transitional stands between *Calthion* and *Arrhenatheretum*, 8 - *Urtica dioica*-*Cirsium oleraceum* community, 9 - *Geranio-Petasitetum*, 10 - ponds, 11 - *Alno-Padion*, 12 - *Alno-Padion*, fragmentary stands, 13 - *Alno-Padion* and *Arrhenatheretum* complex, 14 - *Tilio-Carpinetum*, 15 - *Origano-Brachypodietum*, fragmentary stands, 16 - *Ruderali-Secalieta*.

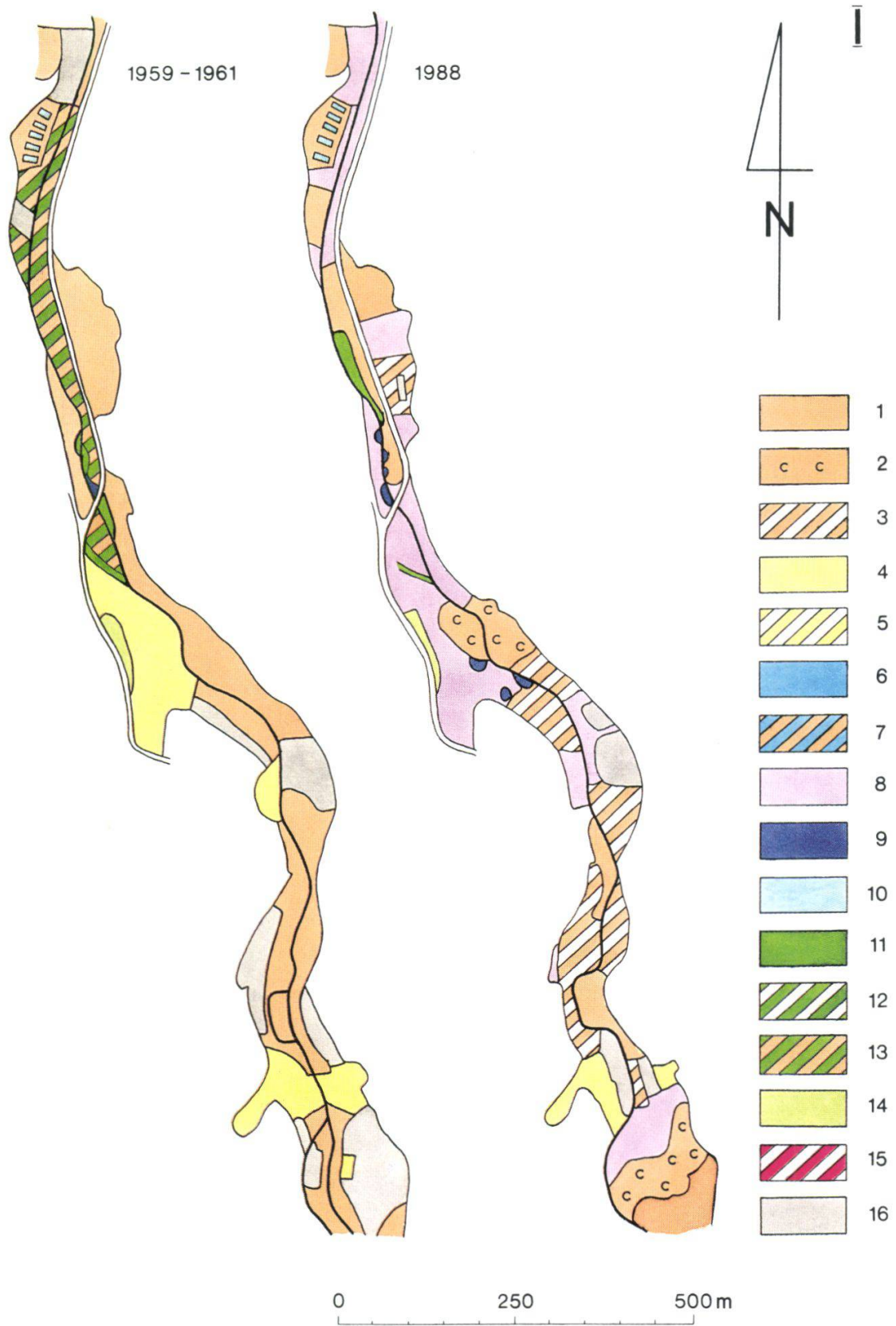


Fig. 2. Plant communities on valley bottoms of the Ojcow National Park in 1959-1961 and 1988. (For further details see p. 211).

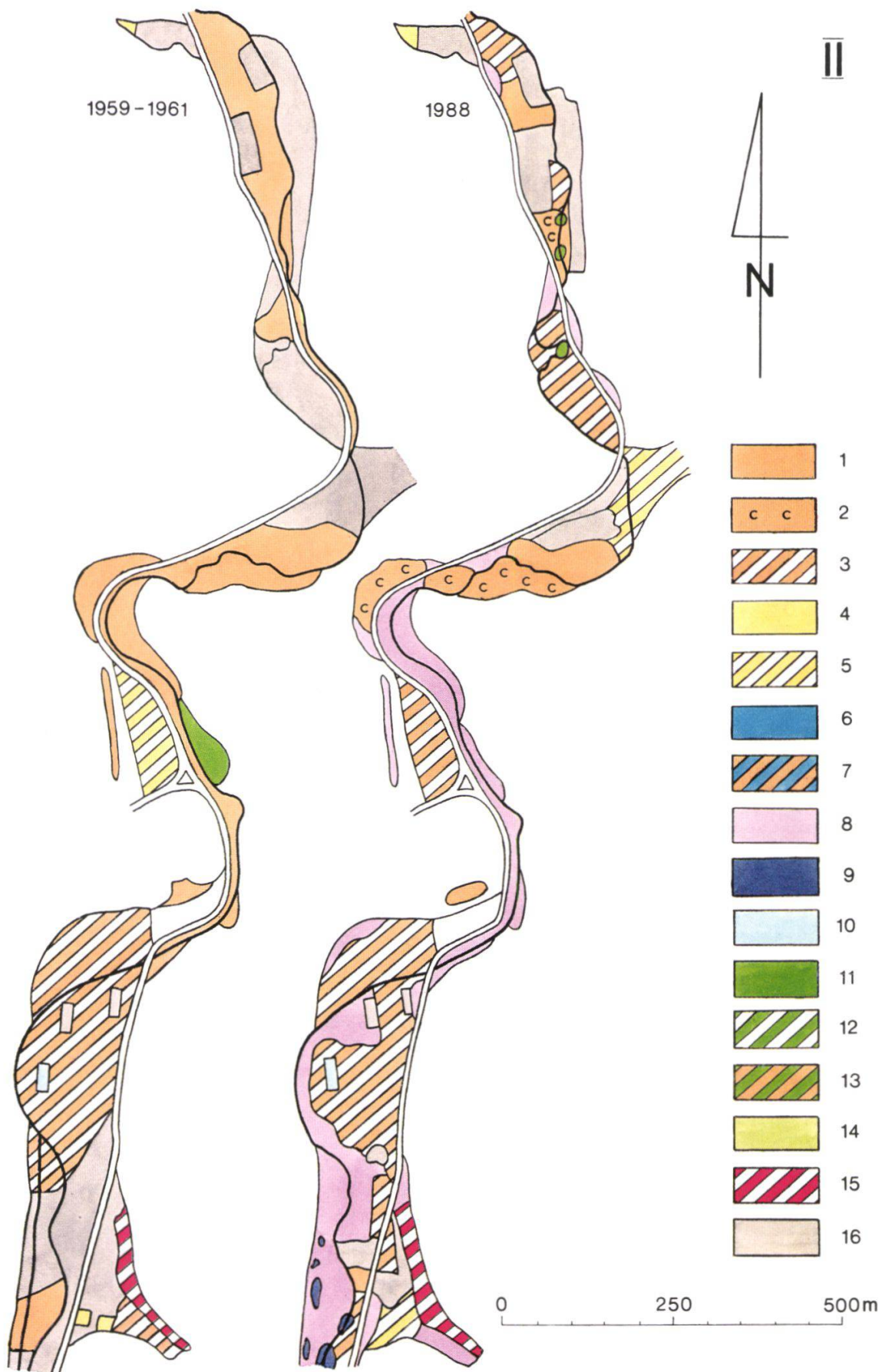


Fig. 3. Plant communities on valley bottoms of the Ojcow National Park in 1959-1961 and 1988. (For further details see p. 211).

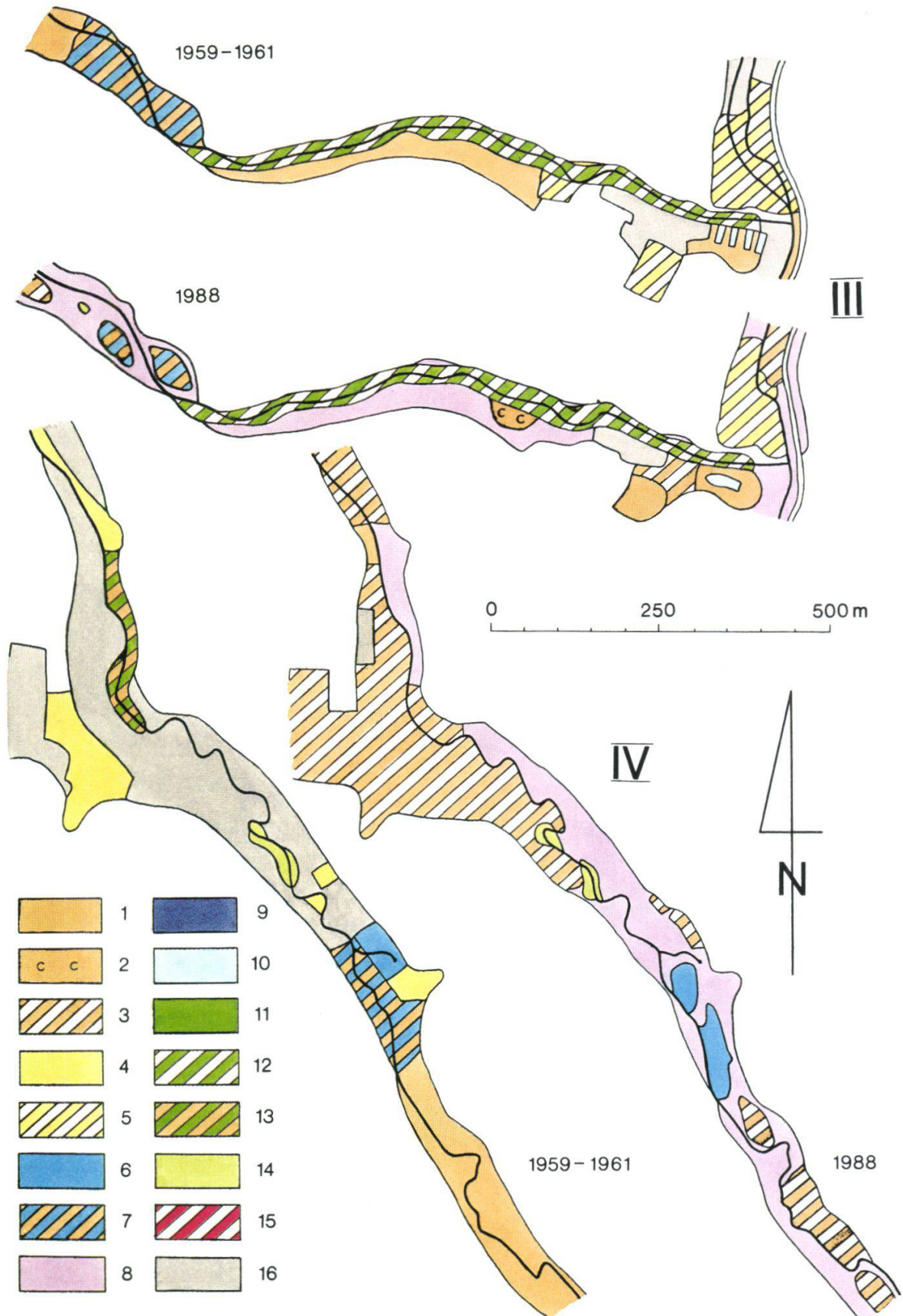


Fig. 4. Plant communities on valley bottoms of the Ojcow National Park in 1959-1961 and 1988. (For further details see p. 211).

experiment of Krystyna JANKOWSKA and her colleagues (JANKOWSKA 1967, 1971, 1975, JANKOWSKA and WITKOWSKI 1978, MEDWECKA-KORNAS 1977a,b, WITKOWSKI 1969).

The most important cause of the vegetation changes are changes in plant cover management practices. Three divergent trends have been discovered on meadows treated in three different ways:

Trend I (Table 1). On the meadows owned by individual farmers the hay is still being collected. The meadows are being fertilized with large quantities of mineral compounds (especially nitrogen) and mown regularly twice a year (usually by machinery). The former extensive grazing has been abandoned. Fodder-grass seeds are often sown, with or without ploughing of the sward. As a consequence of this type of management, the hay yields increased considerably, but at the same time the plant community became destabilized. The formerly homogeneous stands became much poorer and heterogenous with regard to their floristic composition, abundance-dominance values and vegetation structure. The average species number per 100 m² decreased from 50 to 33. As much as 32% of formerly recorded plant species disappeared, and only 19.4% of newcomers appeared in their stead. Thus, the total species list became poorer by 12.6%. Presence degrees and abundance-dominance values of the majority of the old components of the community markedly diminished. Many species formerly common in the *Arrhenatheretum* stands became very scanty and sporadic. The meadow turf is now usually composed mainly of one or a few fodder-grasses favoured by the farmers (e.g. *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca pratensis*, *Alopecurus pratensis*, *Poa pratensis*) and a few tall-forbs (e.g. *Geranium pratense*, *Heracleum sphondylium*, *Rumex acetosa*). The legumes (*Papilionaceae*, e.g. *Trifolium medium*, *T. pratense*, *Vicia cracca*) disappeared nearly completely, as also did the majority of species of the ground layer, more or less depending on sporadic grazing (e.g. *Prunella vulgaris*, *Leontodon hispidus*, *Plantago media*, etc.). Among the species which appeared as newcomers or expanded visibly, the most outstanding are the tall nitrophytes (e.g. *Rumex obtusifolius*, *Urtica dioica*, *Chaerophyllum aromaticum*). Changes in soil conditions, parallel to those in the plant cover, are testified by an increase in the average Ellenberg ecological indices with regard to assimilable nitrogen and - to some extent - to the soil reaction (pH).

Table 1. Trend I: Extensification
a) *Arrhenatherum* (traditional use) → b) impoverished *Arrhenatherum* (intensive use)

	1	2	3	4	5	6	7	1'	2'	3'	4'	5'	6'	7'	
Table No. of record	124	143	150	140	148	144	172	124'	143'	150'	140'	148'	144'	172'	
Field No. of record	59.	59.	59.	59.	59.	59.	60.	87.	86.	86.	87.	87.	87.	87.	
Date	06.	06.	06.	06.	06.	06.	06.	06.	06.	06.	06.	06.	06.	06.	
Maximum height of plants (cm)	15.	15.	17.	16.	15.	15.	15.	20.	19.	17.	25.	25.	25.	25.	
Average height of plants (cm)	80	90	90	80	80	50	120	100	80	130	80	80	80	130	
Cover of herbaceous plants (%)	20	30	30	20	30	20	30	40	30	50	35	40	60	60	
Area of sample plot (m ²)	95	100	100	100	100	98	100	100	100	100	100	100	100	100	Presence degree
Number of species	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
	49	51	58	46	54	49	43	50	37	33	37	29	19	28	a b
	←----- a -----→														
	←----- b -----→														
Ch. Arrhenatherion															
<i>Geranium pratense</i>	3.2	2.2	2.1	2.2	3.2	2.2	+	3.2	1.2	+	+2	2.2	+2	.	V
<i>Knautia arvensis</i>	2.1	+	+	1.1	+	1.1	1.1	+2	.	+2	+	.	.	+	V
<i>Crepis biennis</i>	+	2.1	+	2.1	1.1	2.2	.	.	1.1	+	+	.	.	.	V
<i>Arrhenatherum elatius</i>	2.2	+	.	+2	+2	1.1	.	2.2	2.3	3.3	.	.	.	.	IV
<i>Galium mollugo</i>	2.1	+	+2	.	+2	+2	.	+	2.2	1.2	.	.	.	.	IV
<i>Campanula patula</i>	.	+	+	+	+	+	.	.	.	.	+	+	.	.	IV
<i>Alchemilla gracilis</i>	.	+	+	+	+	.	.	.	.	.	.	.	.	.	IV
<i>Alchemilla monticola</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
<i>Alchemilla</i> cfr. <i>walasii</i>	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
<i>Pastinaca sativa</i>	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ch. Cynosurion															
<i>Bellis perennis</i>	+	2.2	2.2	1.1	+	+	+	.	1.1	+	+	+	.	.	V
<i>Phleum pratense</i>	.	+	+2	+	+2	+2	+2	.	+	.	+	+	2.2	+	V
<i>Trifolium repens</i>	2.1	1.2	2.2	2.3	1.1	1.1	2.2	.	.	.	1.2	2.2	1.2	2.2	V
<i>Cynosurus cristatus</i>	.	.	+	.	+2	.	.	.	.	.	+2	.	.	.	II
<i>Lolium perenne</i>	.	+	+	.	.	.	.	.	.	.	+	.	.	.	II

Table 1 (continued)

Table No. of record	1	2	3	4	5	6	7	1'	2'	3'	4'	5'	6'	7'	a	b
	←	←	←	←	←	←	←	←	←	←	←	←	←	←	←	←
Ch. Arrhenatheretalia																
<i>Dactylis glomerata</i>	+	3.2	1.1	1.1	2.2	2.2	2.1	1.1	3.3	1.2	+2	+2	3.3	3.3	V	V
<i>Heracleum sphondylium</i>	+	2.1	1.1	2.2	1.1	1.1	2.2	+	2.2	1.1	+	1.1	1.1	1.1	V	V
<i>Taraxacum officinale</i>	+	1.2	1.1	1.1	1.1	+	2.1	1.2	+	+3	+2	1.1	1.2	1.1	V	V
<i>Leucanthemum vulgare</i>	3.2	+2	2.2	1.1	2.2	+2	+	2.2	2.2	2.2	1.1	1.1	1.1	1.1	III	III
<i>Trisetum flavescens</i>	·	2.2	+2	2.2	1.1	+	2.2	·	·	·	·	·	·	·	·	·
<i>Trifolium dubium</i>	·	+	·	·	+	+	·	·	·	·	·	·	·	·	III	·
<i>Tragopogon orientalis</i>	·	·	·	·	·	·	·	·	·	·	·	·	·	·	III	·
<i>Pimpinella major</i>	·	·	·	+	·	·	·	·	+	·	·	·	·	+	I	II
Ch. Molinietalia																
<i>Deschampsia caespitosa</i>	·	1.2	+2	+2	+2	+2	2.2	·	+2	·	3.2	3.2	·	·	V	III
<i>Lychnis flos-cuculi</i>	·	·	+	·	+	·	1.1	·	·	+	·	+	·	1.1	III	III
<i>Cirsium rivulare</i>	·	·	+	·	·	·	+2	·	·	·	·	·	·	+2	I	I
<i>Equisetum palustre</i>	·	·	·	·	+2	·	+	·	·	·	·	·	·	·	II	·
<i>Cirsium oleraceum</i>	·	·	·	·	·	·	1.2	·	·	1.2	·	·	·	+2	II	II
Ch. Molinio-Arrhenatheretea																
<i>Festuca pratensis</i>	+	2.2	2.2	+2	·	3.2	3.2	+2	2.2	·	2.2	2.2	2.2	2.2	V	V
<i>Ranunculus acris</i>	+	1.1	2.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	+	+	·	1.1	V	V
<i>Rumex acetosa</i>	1.1	2.2	2.1	1.2	2.1	2.1	1.1	1.1	·	+	3.2	2.1	1.1	2.1	V	V
<i>Veronica chamaedrys</i>	1.1	1.2	1.1	+	1.2	1.1	+2	2.1	2.2	2.2	+	1.1	1.1	1.1	V	V
<i>Alopecurus pratensis</i>	·	2.2	2.2	2.3	2.2	2.2	2.1	·	·	+	1.1	1.1	+	3.3	IV	IV
<i>Cerastium vulgatum</i>	·	2.1	2.1	1.1	1.1	2.1	1.1	1.1	1.1	·	2.2	2.2	+	1.1	V	IV
<i>Achillea millefolium</i>	+	1.1	1.1	+	+	1.1	+	+	1.2	+	·	1.2	·	·	V	III
<i>Festuca rubra</i>	1.1	1.2	2.2	2.2	2.2	1.2	3.2	+	·	·	2.2	2.1	·	+	V	III
<i>Lathyrus pratensis</i>	1.1	1.1	+	+	+	+	1.1	2.2	1.1	·	·	·	+	+	V	III
<i>Plantago lanceolata</i>	1.1	+	2.1	1.1	1.1	2.1	2.1	·	·	·	1.1	+	·	1.1	V	III
<i>Poa trivialis</i>	·	2.1	+	1.1	2.1	1.2	1.1	+	+	1.2	·	·	·	3.3	V	III

Table 1 (continued)

Table No. of record	1	2	3	4	5	6	7	1'	2'	3'	4'	5'	6'	7'	a	b
	←			a			→			b			→			
<i>Carex muricata</i>	+	.	+2	.	.	.	.	+2	.	.	.	.	.	.	II	I
<i>Equisetum arvense</i>	.	.	.	+	.	+	+	.	.	II	I
<i>Carex hirta</i>	.	.	+2	.	.	.	+	.	.	.	.	.	.	.	II	-
<i>Eurynchium hians</i> (d)	.	1.1	.	+	.	.	.	.	.	.	.	.	.	.	II	-
<i>Potentilla reptans</i>	+	.	+	II	-
<i>Sinapis arvensis</i>	.	+	II	-
<i>Rumex obtusifolius</i>	.	.	+2	.	.	.	+	.	.	.	.	2.3	1.2	1.2	II	III
<i>Vicia sepium</i>	+	+2	1.1	1.1	.	.	.	.	I	III
<i>Anthriscus sylvestris</i>	+	+	.	+2	1.1	.	-	III
<i>Urtica dioica</i>	+2	+2	.	+2	1.2	.	-	III
<i>Agropyron repens</i>	+	.	3.3	.	-	II
<i>Chaerophyllum aromaticum</i>	+	+	-	II
<i>Galium aparine</i>	+	.	+	-	II
<i>Geranium phaeum</i>	2.1	.	1.2	.	.	.	.	-	II
Sporadic species																
<i>Ch. Cynosurion</i> : <i>Leontodon autumnalis</i> 6, 4'.																
<i>Ch. Arrhenatheretalia</i> : <i>Carum carvi</i> 4, <i>Lotus corniculatus</i> 6.																
<i>Ch. Molinietalia</i> : <i>Filipendula ulmaria</i> 7, <i>Geranium palustre</i> 1 (1.1), 3' (3.2), <i>Mentha longifolia</i> 3', <i>Scirpus sylvaticus</i> 7.																
<i>Ch. Molinio-Arrhenatheretea</i> : <i>Agrostis stolonifera</i> 7, 5' (1.2).																
Other species: <i>Acer pseudoplatanus</i> 3, 1', <i>Ajuga reptans</i> 1, 1', <i>Alchemilla subcrenata</i> 5, <i>Anthemis arvensis</i> 3, <i>Arabis hirsuta</i> 1', <i>Arenaria serpyllifolia</i> 1, <i>Asarum europaeum</i> 1' (1.1), <i>Brachypodium pinnatum</i> 1' (1.2), <i>Calligonella cuspidata</i> (d) 6, 5', <i>Carpinus betulus</i> 1', <i>Cerastium arvense</i> 1', <i>Clinopodium vulgare</i> 1, 1', <i>Coronilla varia</i> 1, 1' (1.2), <i>Fragaria viridis</i> 1 (3.2), 1', <i>Galium verum</i> 1 (1.1), 1', <i>Hypericum maculatum</i> 4, <i>H. perforatum</i> 1, <i>Lamium maculatum</i> 1', <i>Lophocolea</i> sp. (d) 2, <i>Mentha arvensis</i> 5, <i>Moehringia trinervia</i> 1', <i>Myosotis sylvatica</i> 1', <i>Phalaris arundinacea</i> 7, <i>Pimpinella saxifraga</i> 1 (1.1), 2', <i>Plantago major</i> 4', <i>Poa annua</i> 5, <i>Potentilla anserina</i> 6', <i>Primula elatior</i> 3, 3' (1.1), <i>Salix caprea</i> 1', <i>Salvia pratensis</i> 1, <i>Sedum sexangulare</i> 1, <i>Stellaria holostea</i> 1' (+2), <i>Thymus pulegioides</i> 1 (1.2), <i>Viola collina</i> 1.																

Table 2. Trend II: Extensification

a) *Arrhenatheretum* (traditional use) → c) truncated *Arrhenatheretalia* community (mowing without hay removal).

Table No. of record	1	2	3	4	5	1'	2'	3'	4'	5'		
Field No. of record	145	9	157	158	8	145'	9'	157'	158'	8'		
Date	59.	58.	59.	59.	58.	87.	86.	86.	87.	86.		
	06.	07.	06.	06.	07.	06.	06.	06.	06.	06.		
	15.	08.	17.	17.	08.	25.	17.	17.	19.	17.		
Maximum height of plants (cm)	80	80	100	80	80	160	90	140	140	130		
Average height of plants (cm)	30	25	30	15	40	70	20	50	30	70		
Cover of herbaceous plants (%)	100	100	98	100	98	100	95	100	100	100	Presence	
Area of sample plot (m ²)	100	250	100	100	100	100	250	100	100	100	degree	
Number of species	52	56	55	61	63	26	42	35	39	29	a	c
	← a →					← c →						
Ch. Arrhenatherion												
<i>Arrhenatherum elatius</i>	.	2.2	+2	+2	1.1	3.2	2.2	+	.	1.1	IV	IV
<i>Crepis biennis</i>	.	1.1	+	+	1.1	.	.	.	.	.	IV	-
<i>Alchemilla gracilis</i>	.	1.1	+	.	+	.	+	.	+	.	III	II
<i>Galium mollugo</i>	.	+	+2	.	1.1	.	2.2	.	.	2.2	III	II
<i>Knautia arvensis</i>	.	1.1	.	+	1.1	.	1.1	.	+2	.	III	II
<i>Alchemilla</i> cfr. <i>walasii</i>	.	+	.	+	.	.	+2	.	+	.	II	II
<i>Campanula patula</i>	.	.	.	+	+	.	.	.	+	.	II	I
<i>Geranium pratense</i>	.	.	+	2.2	.	1.2	.	.	.	.	II	I
<i>Alchemilla monticola</i>	.	+	.	.	.	.	.	.	.	.	I	-
Ch. Cynosurion												
<i>Phleum pratense</i>	1.2	1.1	+	+	+	+	.	.	.	.	V	I
<i>Trifolium repens</i>	+	3.3	2.3	3.3	1.1	.	.	.	.	.	V	-
<i>Bellis perennis</i>	2.1	+	2.2	.	+	.	.	.	.	.	IV	-
<i>Cynosurus cristatus</i>	.	1.1	1.2	+	1.1	.	.	.	.	.	IV	-
<i>Leontodon autumnalis</i>	.	1.1	.	+	1.1	.	.	.	.	.	III	-
<i>Lolium perenne</i>	.	.	1.1	+	.	.	.	.	.	.	II	-
Ch. Arrhenatheretalia												
<i>Leucanthemum vulgare</i>	+	2.2	2.2	2.2	+	.	+	+	+	+	V	IV
<i>Taraxacum officinale</i>	2.1	+	2.2	1.1	2.2	+	.	+	.	.	V	II
<i>Dactylis glomerata</i>	.	1.1	+	+2	2.2	2.2	2.2	+2	+2	2.2	IV	V
<i>Trisetum flavescens</i>	.	+	+2	2.2	2.2	.	+2	1.2	1.1	1.2	IV	IV
<i>Heracleum sphondylium</i>	+	1.2	.	1.1	+2	.	+	.	.	.	IV	I
<i>Trifolium dubium</i>	+	.	1.1	1.2	+2	.	.	.	.	.	IV	-
Ch. Molinietalia												
<i>Deschampsia caespitosa</i>	2.2	2.3	2.2	1.2	4.3	+2	1.2	1.2	3.2	3.3	V	V
<i>Lychnis flos-cuculi</i>	+	.	2.1	+	+	1.1	+	+	+	+	IV	V
<i>Geranium palustre</i>	.	+	.	+	1.1	.	2.2	1.2	2.2	2.2	III	IV
<i>Cirsium oleraceum</i>	1.2	+2	.	.	.	1.2	1.2	2.3	+	3.3	II	V
<i>Equisetum palustre</i>	.	.	2.1	+	.	.	.	1.1	+	1.1	II	III
Ch. Molinio-Arrhenatheretea												
<i>Rumex acetosa</i>	2.1	1.1	2.1	2.2	2.2	+	2.2	2.2	2.1	1.1	V	V
<i>Lathyrus pratensis</i>	1.1	1.2	+	1.1	+	.	2.2	1.2	1.1	2.2	V	IV
<i>Veronica chamaedrys</i>	+	+	2.2	1.1	+	1.1	.	2.2	1.1	2.2	V	IV
<i>Cerastium vulgatum</i>	1.1	1.1	2.1	2.2	+	1.1	.	+	1.1	.	V	III
<i>Festuca rubra</i>	3.2	+	3.2	2.2	1.2	.	.	+2	+2	.	V	II

Table 2 (continued)

Table No. of record	1	2	3	4	5	1'	2'	3'	4'	5'		
	← a →					← c →					a	c
<i>Plantago lanceolata</i>	1.1	1.1	2.2	2.2	1.1	.	+	.	.	.	V	I
<i>Prunella vulgaris</i>	+	+	1.1	+	+	.	.	+	.	.	V	I
<i>Alchemilla crinita</i>	.	2.2	+	1.2	2.2	.	2.2	2.2	1.1	2.2	IV	IV
<i>Alchemilla glabra</i>	.	2.2	+	+	2.2	.	1.2	+	1.1	2.2	IV	IV
<i>Ranunculus acris</i>	2.2	1.1	2.1	.	1.1	1.1	2.2	1.1	+	.	IV	IV
<i>Anthoxanthum odoratum</i>	.	+	2.1	2.1	+	.	1.1	+	+	.	IV	III
<i>Festuca pratensis</i>	3.2	.	1.1	1.2	+	3.3	.	3.3	+	.	IV	III
<i>Achillea millefolium</i>	.	+	+	+	+	+	.	.	+	.	IV	II
<i>Agrostis capillaris</i>	.	+	1.2	1.2	+	.	1.2	.	.	.	IV	I
<i>Leontodon hispidus</i>	.	1.1	+	+	1.1	.	+	.	.	.	IV	I
<i>Leontodon hispidus glabr.</i>	+	.	+	1.1	+	.	.	.	.	.	IV	-
<i>Trifolium pratense</i>	1.2	2.2	+2	.	+	.	.	.	.	.	IV	-
<i>Alopecurus pratensis</i>	2.2	.	3.2	1.2	.	+2	.	3.3	4.3	.	III	III
<i>Avenula pubescens</i>	.	3.2	.	1.1	1.1	.	1.2	.	2.2	.	III	II
<i>Vicia cracca</i>	+	+	+	.	.	.	1.1	.	1.1	.	III	II
<i>Briza media</i>	.	1.1	.	2.1	+	.	+	.	.	.	III	I
<i>Bromus hordaceus</i>	+	.	+	+	.	.	.	.	.	.	III	-
<i>Luzula campestris</i>	.	+	.	1.1	+2	.	.	.	.	.	III	-
<i>Poa trivialis</i>	+	.	2.2	.	.	2.2	3.3	4.3	3.3	3.3	II	V
<i>Poa pratensis</i>	.	.	+	2.1	.	.	+	.	+	1.2	II	III
<i>Stellaria graminea</i>	.	.	.	+	+	.	2.2	1.1	+	.	II	III
Other species												
<i>Ranunculus repens</i>	2.2	+	2.2	+	3.2	3.3	.	1.2	1.1	.	V	III
<i>Plantago media</i>	+	2.2	+	3.3	2.2	.	+	.	.	.	V	I
<i>Carex hirta</i>	1.1	+	+2	+	+2	.	.	.	.	.	V	-
<i>Primula elatior</i>	.	+	+	+	2.1	.	1.1	2.1	+	+	IV	IV
<i>Equisetum arvense</i>	+	+	.	+	+2	+	+	.	.	.	IV	II
<i>Lysimachia nummularia</i>	+	.	+	+	+	.	2.2	1.2	.	.	IV	II
<i>Rhynchospora</i>												
<i>squarrosus</i> (d)	.	2.2	+	1.1	+	.	.	.	+	.	IV	I
<i>Carex muricata</i>	+2	+	+	.	+2	.	.	.	.	.	IV	-
<i>Plagiomnium elatum</i> (d)	1.1	.	1.1	2.2	3.3	.	.	.	.	.	IV	-
<i>Galium vernum</i>	.	1.1	.	+2	1.1	.	2.2	.	+	.	III	II
<i>Brachythecium</i>												
<i>rutabulum</i> (d)	+	.	1.1	.	.	.	.	1.2	.	.	II	I
<i>Glechoma hederacea</i>	+	.	.	.	+	.	.	.	.	1.2	II	I
<i>Alchemilla glaucescens</i>	.	.	+	+	.	.	.	.	.	.	II	-
<i>Brachythecium</i>												
<i>mildeanum</i> (d)	.	+	.	1.1	.	.	.	.	.	.	II	-
<i>Euphrasia rostkoviana</i>	.	+	.	+	.	.	.	.	.	.	II	-
<i>Hieracium pilosella</i>	.	.	+	+	.	.	.	.	.	.	II	-
<i>Medicago lupulina</i>	+	+	.	.	.	.	.	.	.	.	II	-
<i>Plagiomnium</i>												
<i>cuspidatum</i> (d)	.	2.2	.	.	+	.	.	.	.	.	II	-
<i>Pimpinella saxifraga</i>	.	.	.	+	+	.	.	.	.	.	II	-
<i>Hypericum maculatum</i>	.	.	.	+2	+	.	+2	.	+2	1.2	II	III

Table 2 (continued)

Table No. of record	1	2	3	4	5	1'	2'	3'	4'	5'		
	← a →					← c →					a	c
<i>Rumex obtusifolius</i>	+	.	.	.	.	3.4	.	.	.	+2	I	II
<i>Galium aparine</i>	.	.	.	.	.	+2	.	1.1	+	1.1	-	IV
<i>Urtica dioica</i>	.	.	.	.	.	+2	1.2	+2	+2	3.4	-	V
Sporadic species												
<i>Ch. Arrhenatheretalia</i> : <i>Carum carvi</i> 1, <i>Pimpinella major</i> 2. <i>Ch. Molinietalia</i> : <i>Cirsium rivulare</i> 1, <i>Climacium dendroides</i> (d) 2, <i>Lotus uliginosus</i> 4', <i>Mentha longifolia</i> 1, 3' (1.1), <i>Myosotis scorpioides</i> 1', <i>Scirpus sylvaticus</i> 1, <i>Trollius europaeus</i> 3'. <i>Ch. Molinio-Arrhenatheretea</i> : <i>Agrostis stolonifera</i> 3', <i>Cardamine pratensis</i> 3', <i>Centaurea jacea</i> 2 (1.2), 2', <i>Holcus lanatus</i> 1, 2' (1.2), <i>Luzula multiflora</i> 3 (1.1), <i>Rhinanthus angustifolius</i> 1.												
Other species: <i>Acer pseudoplatanus</i> 2', <i>Aegopodium podagraria</i> 5, 5', <i>Agropyron repens</i> 4 (+2), 4', <i>Alchemilla acutiloba</i> 4', <i>Alnus glutinosa</i> 5, <i>Anthriscus sylvestris</i> 1' (1.1), <i>Calliergonella cuspidata</i> (d) 1 (1.1), <i>Carex acuta</i> 1 (2.2), <i>C. nigra</i> 1, <i>C. ovalis</i> 3, <i>C. pallescens</i> 2, <i>C. sylvatica</i> 2', <i>Chaerophyllum aromaticum</i> 5, 1', <i>Cirriphyllum piliferum</i> (d) 5, 3', <i>Cirsium arvense</i> 1, 2', <i>Galium verum</i> 2' (2.3), <i>Eleocharis palustris</i> 1, <i>Geranium phaeum</i> 5 (+2), 5' (2.1), <i>Lolium multiflorum</i> 1' (1.1), <i>Myosotis sylvatica</i> 1, <i>Parnassia palustris</i> 2, <i>Phalaris arundinacea</i> 1, <i>Polygala comosa</i> 4, <i>Potentilla reptans</i> 1, 5', <i>Rosa</i> cfr. <i>canina</i> 2', <i>Rorippa sylvestris</i> 1, <i>Rumex crispus</i> 1, <i>Sagina procumbens</i> 3, <i>Salix caprea</i> 5, <i>Senecio jacobaea</i> 5, <i>Sinapis arvensis</i> 3, <i>Stellaria nemorum</i> 5' (1.2), <i>Thuidium philiberti</i> (d) 5, <i>Tripleurospermum inodorum</i> 1', <i>Vicia sepium</i> 5'.												

Trend II (Table 2). Meadows belonging to the National Park administration, especially those situated in more remote valley areas, are being mown irregularly, once a year or even less often, the hay being left on the spot. Such a procedure, aimed to prevent the meadows becoming overgrown by shrubs and trees, is equivalent to a very intensive organic fertilization (composting) of the soil. The organic matter deposited on the meadow (estimated as 5-8 t/ha/year) by far exceeds all the fertilizer doses used by the farmers. Accordingly, the general trend in vegetation change here is similar to that of the meadows intensively fertilized with mineral compounds, but goes still much further. This is especially evident in the impoverishment of the floristic composition (decrease in average species number from 57 to 34; loss of 43.5% of formerly recorded species, increase by 15.8% of new species, net result 27.7% of species impoverishment). The sharp decrease in the share of characteristic species of association, alliance and order has to be especially emphasized, and the total elimination from the ground layer of the pasture elements (of the *Cynosurion* alliance). On the other hand, the share of hygrophilous

grasses markedly increased (especially with regard to *Poa trivialis*, which became dominant in numerous stands). Very abundant became also the ubiquitous dicotyledonous nitrophytes: *Urtica dioica*, *Galium aparine* and *Rumex obtusifolius*. Mean Ellenberg ecological indices confirm a marked increase in assimilable nitrogen and soil humidity, as well as slight increase in soil pH. In spite of such profound modifications the stands under discussion still retain the general features of fresh hay-meadows and may be classified as extremely impoverished ("truncated") communities ("Rumpfgesellschaften") of the *Arrhenatheretalia* order.

Trend III (Table 3). Quite a few less accessible meadows on forest edges and rivulet banks have come into complete disuse. This has caused the most radical vegetation changes. However, the expected encroachment by the potential natural forest vegetation is not yet clearly visible. Instead of this, a fairly stable community of tall-forbs developed, dominated by *Urtica dioica* and *Cirsium oleraceum*, and strikingly poor in species (10-25 species per 100 m², average: 17 species instead of the initial number of 56 species). As much as 62.5% of species of the former *Arrhenatheretum* have been lost, only 21.9% of new species emerged, and the net floristic impoverishment culminated at 40.6%. The Ellenberg ecological indices prove a very high increase in assimilable nitrogen, a marked increase in humidity and a high increase in soil pH. Nitrophilous tall-forb communities, similar to that of *Urtica dioica* and *Cirsium oleraceum* in the Ojcow area, have already been described from the forest edges by many authors ("nitrophile Saumgesellschaften" DIERSCHKE 1974, HILBIG et al. 1972, KOPECKY and HEJNY 1971, OBERDORFER 1983, WILMANN 1984). They have been called *Urtico-Aegopodietum podagrariae* (Tx. 1963) Oberd. 1964, and included in the higher syntaxa of *Aegopodion podagrariae* Tx. 1967, *Galio-Alliarietalia* (Tx. 1950) Oberd. 1967 or *Glechometalia* Tx. in Tx. et Brun Hol 1972, and *Galio-Urticetea* Passarge 1967 em. Kopecky 1969. Changes of the same type as those discussed for the *Arrhenatheretum medioeuropaeum* have also been noticed in fertile pastures (*Lolio-Cynosuretum*) in the Ojcow area. Lack of grazing resulted also in this case in the development of the nitrophilous *Urtica dioica-Cirsium oleraceum* community. On the contrary, the humid meadows (*Cirsietum rivularis*) remained nearly unchanged until recently.

Table 3 (continued)

Table No. of record	1	2	3	4	5	1'	2'	3'	4'	5'	6	7	8	9	10	a	d
<i>Carex muricata</i>	.	+2	.	+	.	.	.	.	.	.	.	.	.	.	.	II	-
<i>Euphrasia rostkoviana</i>	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	II	-
<i>Hypericum maculatum</i>	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	II	-
<i>Aegopodium podagraria</i>	+ ⁰	.	.	+ ⁰	.	+	+	.	+	+	.	.	1.2	.	.	II	IV
<i>Ranunculus repens</i>	+	.	.	+	.	2.2	1.2	2.2	2.2	+	.	.	.	.	.	II	III
<i>Galium aparine</i>	+	.	.	.	.	1.1	+	.	+	1.1	1.1	1.1	1.1	1.1	1.1	I	V
<i>Geranium phaeum</i>	+	.	.	.	.	.	+	.	1.1	1.1	1.1	+	.	+	+	I	IV
<i>Agropyron repens</i>	+	.	.	.	.	2.2	.	.	.	.	+	+	2.2	1.2	2.3	I	III
<i>Urtica dioica</i>	.	.	.	.	.	3.3	5.5	4.4	4.4	5.5	3.3	3.3	4.4	5.5	4.4	-	V
<i>Asperula rivalis</i>	.	.	.	.	.	2.2	.	.	.	.	3.3	.	2.2	2.2	+2	-	III
<i>Chaerophyllum aromaticum</i>	.	.	.	.	.	+	.	.	.	.	4.4	2.2	1.2	+2	1.2	-	III
<i>Rumex obtusifolius</i>	.	.	.	.	.	3.3	+2	+2	+2	.	.	1.1	2.3	.	.	-	III
<i>Stellaria nemorum</i>	.	.	.	.	.	.	1.1	.	.	1.1	.	+	.	+	+	-	III
<i>Carduus crispus</i>	.	.	.	.	.	+	.	.	.	.	.	+	+	.	+	-	II
<i>Lamium maculatum</i>	.	.	.	.	.	1.1	1.1.	.	.	.	.	1.1	.	.	1.1	-	II
<i>Phalaris arundinacea</i>	.	.	.	.	.	+3	.	.	.	.	.	.	.	+2	+2	-	II

Sporadic species
Ch. Moliniatalia: Filipendula ulmaria 2, 8 (1.2), *Petasites hybridus* 1, 1' (+.2).
Ch. Molinio-Arrhenatheretea: Agrostis stolonifera 1, *Centaurea jacea* 5, *Stellaria graminea* 5, 3' (+.2), 4' (1.2).
Other species: *Acer pseudoplatanus* 3, 3' (1.1), *Alchemilla subcrenata* 2, *A. xantochlora* 1, *Alnus glutinosa* 3', *Anthriscus sylvestris* 6, *Arctium tomentosum* 7 (+.2), *Brachythecium rutabulum* (d) 5 (1.1), 5' (3.3), *Bromus benekenii* 10, *Calligonella cuspidata* (d) 2, *Carex brizoides* 4, *Cerastium arvense* 3 (+.2), *Chaerophyllum hirsutum* 9, 10, *Cirriphyllum piliferum* (d) 2, *Cirsium arvense* 1, *Convolvulus arvensis* 2, *Fraxinus excelsior* 2', *Geum urbanum* 7, *Hieracium pilosella* 4, *Impatiens noli-tangere* 9, *Impatiens parviflora* 7, *Linum cathartica* 5, *Plagiomnium undulatum* (d) 5', *Potentilla reptans* 1, *Sinapis arvensis* 2, *Stachys sylvatica* 8, *Tanacetum vulgare* 8 (+.2), *Thuidium philiberti* (d) 4, *Tussilago farfara* 1, *Vicia sepium* 1.

4. CONCLUSIONS

Modifications of management practices in the valley bottoms of the Ojcow National Park caused notable shifts in the share and distribution patterns of various community types (Table 4). The area of riverine forest remnants (*Alno-Padion*) decreased nearly by half. The total areas of greenland increased by 1 1/2. However, a large majority of it is presently formed of highly disturbed and impoverished (truncated) stands. Normally developed *Arrhenatheretum* maintained only 1/3 of its former area, and the pastures of *Lolio-Cynosuretum* only 1/10. As a new element the tall forb community of *Urtica dioica-Cirsium oleraceum* emerged, not recorded 30 years ago. It now occupies 1/5 of the valley bottoms. The decrease by nearly 2/5 of the arable fields is also notable. They are being continuously transformed into grassland (as proved by the presence of new fallow land). The general balance of all these processes is an ever more pronounced impoverishment of the flora and fauna

Table 4. Changes in areas occupied by various types of plant communities on valley bottoms in the Ojcow National Park during the last 30 years.

Plant communities	1959-1961		1988	
	ha	%	ha	%
Natural vegetation	7.99	11.48	5.09	7.32
<i>Alno-Padion</i> fragm.	6.62	9.51	3.01	4.32
<i>Geranio-Petasitetum hybridi</i>	0.11	0.16	0.46	0.67
<i>Scirpo-Phragmitetum</i>	0.21	0.30	0.25	0.36
open waters - ponds	1.05	1.51	1.37	1.97
Semi-natural vegetation	35.12	50.51	52.91	76.08
<i>Calthion</i>	0.39	0.56	0.83	1.19
<i>Calthion/Arrhenatherion</i>	2.39	3.44	1.90	2.73
<i>Arrhenatheretum medioeuropaeum</i>	14.47	20.81	4.86	6.98
<i>Arrhenatheretum</i> with <i>Cirsium oleraceum</i>	-	-	4.01	5.76
<i>Arrhenatheretalia</i> fragm.	3.52	5.06	20.88	30.03
<i>Arrhenatheretum</i> / comm. of <i>Urtica dioica</i>	-	-	0.38	0.54
community of <i>Urtica dioica</i>	-	-	14.55	20.93
<i>Lolio-Cynosuretum</i>	10.05	14.46	1.14	1.65
<i>Lolio-Cynosuretum</i> fragm.	4.30	6.18	4.36	6.27
Synanthropic vegetation	26.44	38.01	11.55	16.60
arable fields and built over areas	26.44	38.01	11.14	16.02
fallow land	-	-	0.41	0.58
Total	69.55	100.00	69.55	100.00

(especially the entomofauna) of the Park, and an ever more pronounced decrease of the landscape value. Reversing these trends represents certainly the most important task of nature conservation in the Ojcow area (MICHALIK 1985).

SUMMARY

Secondary hay meadows (*Arrhenatheretum medioeuropaeum*), which dominated 30 years ago on valley bottoms in the Ojcow National Park, became highly modified during the last years due to far-going changes in the management practices. In places where hay is still being harvested and the meadows are being intensively fertilized, impoverished stands of *Arrhenatheretum* still exist. In places where the meadows are being mown to prevent the forest encroachment, but the hay is being left on the spot, "truncated" communities of the *Arrhenatheretalia* order developed. In meadows completely abandoned, nitrophilous tall forb community, dominated by *Urtica dioica* and *Cirsium oleraceum*, was formed. These changes result in a drastic reduction of the floristic and faunistic diversity of the Park.

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Address of the authors: Prof. Dr. Jan KORNAS
Dr. Eugeniusz DUBIEL
Institute of Botany
Jagiellonian University
Lubicz 46
31-512 Krakow, Poland