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The Ojców National Park (S. Poland)

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1. INTRODUCTION

The Ojcow National Park, (1570 ha) established in 1956, is located 22 km NNW from Cracow in the southern part of the Cracow-Czestochowa Upland. It forms an island of natural vegetation in a region nearly completely reclaimed by agriculture. It includes the valley of the river Pradnik, 300 m a.s.l., with some secondary valleys, as well as the adjacent parts of the plateau, rising to an altitude of 478 m. On the slopes many picturesque rocks of white Jurassic limestone project from under younger deposits of Pleistocene loam and loess (Figs. 1 and 4). The plateau is covered by a thick layer of loess. The main soil types are the alluvial soil (warp soil) on the valley floors, the rendzinas and brown forest soil on the slopes, and the leached soil (grey brown podzolic soil, lessive soil) on the plateau. The climatic data for the region are: mean annual temperature, c. 8°C, mean monthly temperature, c. 18°C in July and c. -3°C in January; annual rainfall, c. 740 mm. The local climate is extremely varied. The northern slopes are relatively cool and humid, the southern much warmer and drier, and on the valley floors especially low night temperatures occur, caused by the flow of cold air down the slopes. The Ojcow area has been subjected to human influence since very remote times: the first traces of man found here date from the early Paleolithic epoch, and agriculture has been practiced on the plateau as early as in the Neolithic epoch. The destructive effects of felling the forest stands in the 19th and early 20th centuries are still evident at many sites in the Park. In the last decades an ever increasing impact of industrial air pollution has been noticed, manifested in

mass-death of coniferous trees, especially firs (*Abies alba*) (MEDWECKA-KORNAS and GAWRONSKI 1991).

More than 950 species of vascular plants of very different ecological requirements occur in the Ojcow N.P. (MICHALIK 1978). There are more than 50 mountain species among them (e.g. *Aconitum moldavicum, Centaurea mollis, Dentaria glandulosa* [= *Cardamine glanduligera*], *Polystichum aculeatum, Valeriana tripteris*, etc.). There are also very many xerothermic elements of southern and southeastern origin (e.g. *Aster amellus, Campanula sibirica, Cirsium pannonicum, Elymus hispidus* [= *Agropyron intermedium*], *Festuca rupicola* [=*Festuca sulcata*], *Melica transsilvanica, Prunus fruticosa* [= *Cerasus fruticosa*], *Stipa joannis, Thymus glabrescens, Veronica austriaca*, etc.). Locus classicus of *Betula oycoviensis*, a controversial taxon formerly believed to be a local endemic, is situated in the lower part of the Pradnik Valley (STASZKIEWICZ and WOJCICKI 1992, this volume).

Fig. 1. Limestone rocks in the northern part of the Ojcow National Park. In the foreground a mown meadow of the *Arrhenatheretum elatioris* association.
Photo by A. Medwecka-Kornas, 1962.

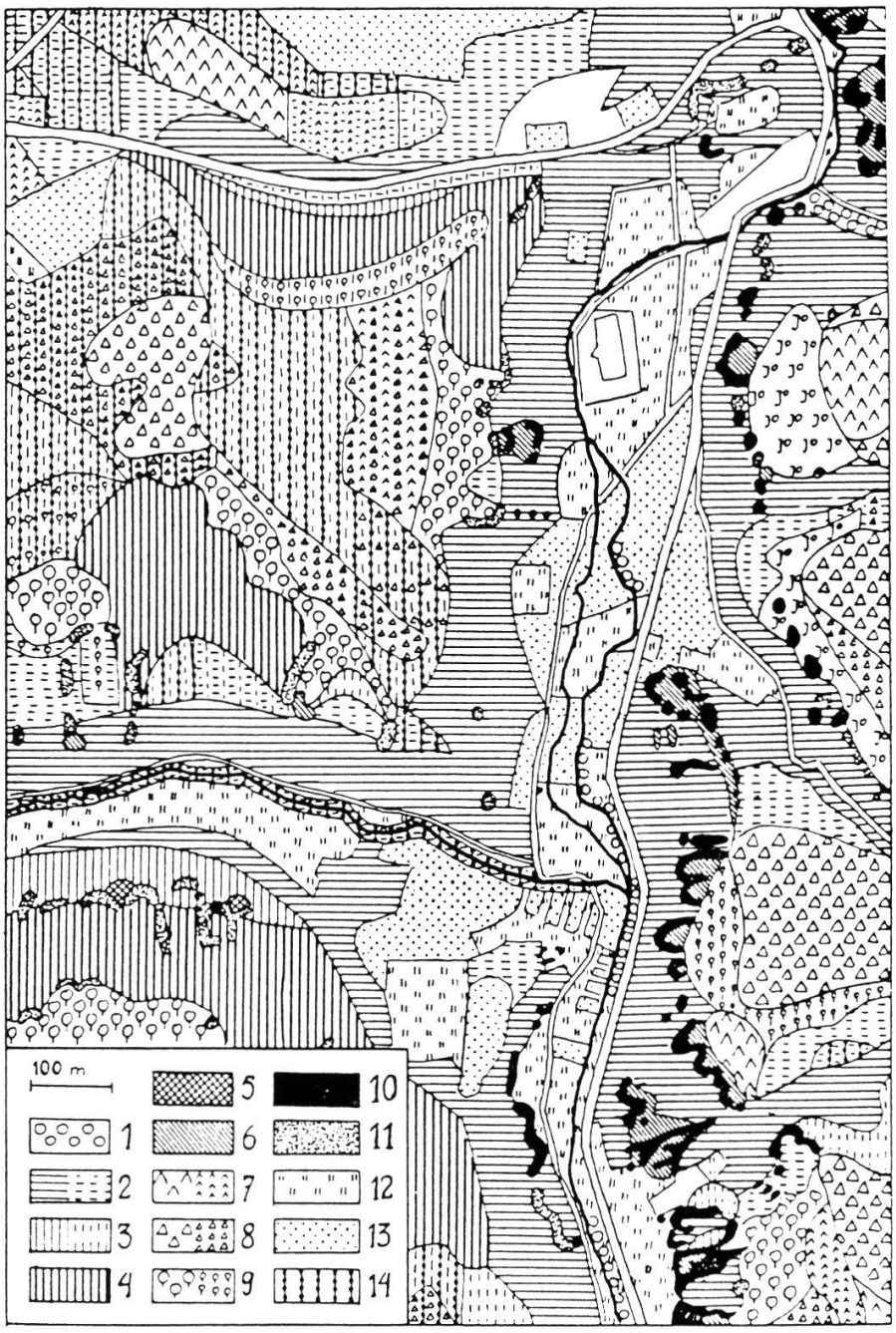

Fig. 2. Distribution of plant communities in the central part of the Ojcow National Park in 1959-1961 (MEDWECKA-KORNAS and KORNAS 1963).
1 - *Alno-Padion*, 2 - *Tilio-Carpinetum*, 3 - *Dentario-Fagetum, Dentaria glandulosa* variant, 4 - *Dentario-Fagetum, Galium odoratum-Majanthemum bifolium* variant, 5 - *Phyllitido-Aceretum*, 6 - *Peucedano cervariae-Coryletum*, 7 - *Pino-Quercetum, Pinus sylvestris* variant, 8 - *Pino-Quercetum, Abies alba* variant, 9 - *Pino-Quercetum, Fagus sylvatica* variant, 10 - *Festucetum pallentis*, 11 - *Ctenidietalia*, 12 - *Lolio-Cynosuretum* and *Arrhenatheretum elatioris*, 13 - *Secali-Violetalia arvensis*, 14 - *Atropetalia*, young stands of *Abies alba*, blank areas - buildings with their surroundings.
Dashed or diminished signatures indicate fragmentary stands.

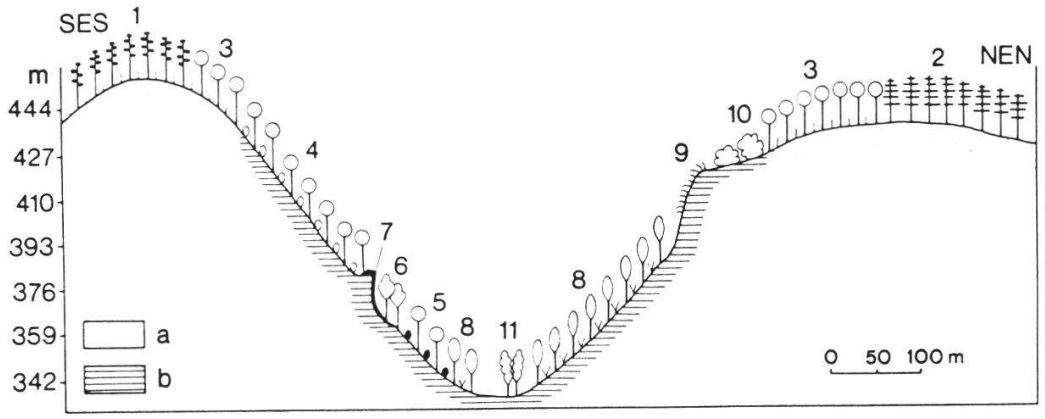

Fig. 3. Transect through the side valley Dolina Saspowska in the Ojcow National Park (MEDWECKA-KORNASS and KORNAS 1963).
1 - *Pino-Quercetum, Pinus sylvestris* variant, 2 - *Pino-Quercetum, Abies alba* variant, 3 - *Pino-Quercetum, Fagus sylvatica* variant, 4 - *Dentario-Fagetum, Galium odoratum-Majanthemum bifolium* variant, 5 - *Dentario-Fagetum, Dentaria glandulosa* variant, 6 - *Phyllitido-Aceretum*, 7 - *Ctenidietalia*, 8 - *Tilio-Carpinetum*, 9 - *Festucetum pallentis*, 10 - *Peucedano cervariae-Coryletum*, 11 - *Alno-Padion* (fragments).
a - acid podzolic soil, b - neutral soil (brown forest soil, rendzina soil, etc.).

Fig. 4. The Pradnik river valley in the Ojcow National Park. Rocks with *Festucetum pallentis* and the xerothermic brushwood *Peucedano cervariae-Coryletum*; unmown meadows with *Cirsium oleraceum* in the foreground. Photo by A. Medwecka-Kornas, 1988.

More than 30 different plant communities have been found in the Ojcow N.P. (Figs. 2 and 3). They were studied and mapped on a scale of 1:10'000 in 1959-1961 (MEDWECKA-KORNAS and KORNAS 1963). Since then far reaching changes have occurred in some of them. These processes are being followed in both the hay-meadow communities on valley floors (KORNAS and DUBIEL 1991) and the forest communities (MEDWECKA-KORNAS and GAWRONSKI 1991).

2. NATURAL PLANT COMMUNITIES

2.1. FOREST AND SHRUB COMMUNITIES

1) Fragments of riverside forests (*Alno-Padion*) with *Alnus glutinosa, Fraxinus excelsior, Padus avium* (= *Prunus padus*), *Salix fragilis*, etc., in very poorly preserved valley floors, on humid warp soil or brown forest soil.
2) Mixed deciduous forest (*Tilio-Carpinetum*), widely distributed on valley slopes with brown forest soil. The stands are composed of *Carpinus betulus, Acer platanoides, A. pseudoplatanus, Abies alba* (in danger of disappearing), rarely also of *Tilia platyphyllos* and *Quercus petraea*. The herb layer is very rich in species, its most characteristic components being *Stellaria holostea, Carex pilosa, Ranunculus cassubicus, Aconitum moldavicum*, etc. In some places the rare *Arum maculatum* s.l. and *Omphalodes scorpioides* occur.
3) Beech forest (*Dentario glandulosae-Fagetum* = *Fagetum carpaticum*), restricted mostly to the northern slopes, with rendzina or brown forest soil. The tree layer is dominated by *Fagus sylvatica* with some *Abies alba* (in danger of disappearing), while other trees (*Ulmus glabra, Acer pseudoplatanus*) are very scarce. The herbs appear most abundantly in spring. On rich soil with high humus contents the *Dentaria glandulosa* variant occurs with *Corydalis bulbosa, Mercurialis perennis, Polystichum aculeatum*, etc. The *Galium odoratum* (= *Asperula odorata*)-*Maianthemum bifolium* variant is connected with slightly poorer soil. *Dentario glandulosae-Fagetum*, the zonal community of the lower montane zone of the Polish Carpathian Mts. occurs extrazonally in the Ojcow N.P. strictly limited to the locally coolest and most humid sites on valley slopes.
4) Sycamore maple forest (*Phyllitido-Aceretum*) constitutes another mountain forest community, found only in very few places in the Ojcow N.P. on

northern slopes shaded by rocks and covered with limestone boulders and a very thin layer of soil. *Acer pseudoplatanus* is the dominant tree. Among the herbs, the most interesting are *Lunaria rediviva* and *Phyllitis scolopendrium.*

5) Xerothermic brushwood (*Peucedano cervariae-Coryletum*) limited to the warmest and driest sites of the upper parts of slopes facing S or SW, on rocky cliffs or just above them. Stunted trees (*Quercus petraea. Q. robur, Pinus sylvestris*) form an open canopy: the undergrowth is composed of various shrubs, and the ground vegetation includes many colourful herbs, such as *Campanula persicifolia, Geranium sanguineum, Laserpitium latifolium, Melittis melissophyllum, Tanacetum corymbosum, Trifolium alpestre, T. rubens*, etc.
6) Mixed acidophilous forest (*Pino-Quercetum*), occurring on the plateau, on grey-brown podzolic soil, formed on loess. The stands were formerly composed of conifers or conifers and deciduous trees: the ground layer was dominated by acidophilous species, mostly *Vaccinium myrtillus.* Three lower syntaxonomic units were distinguished. The *Fagus sylvatica* variant with *Luzula luzuloides* still occurs in relatively good condition high on the slopes along the edges of the plateau. The other two variants occupied the plateau sites on gray-brown podzolic soil (leached soil, lessive soil). The *Abies alba* variant with *Trientalis europaea* and *Lycopodium annotinum* appeared on somewhat moister soil, while the *Pinus sylvestris* variant with *Hieracium laevigatum* and *Melampyrum pratense* ssp. *vulgatum* was distributed on relatively dry sites. Recently most stands of acidophilous forests in the Ojcow N.P. have been badly damaged by air pollution. Many conifers have died and in some places the acidophilous herb layer has been replaced by a luxurious growth of nitrophilous vegetation, typical of felled forest areas. More details about these phenomena are given below.

2.2. PETRICOLOUS VEGETATION OF CRYPTOGAMIC COMMUNITIES AND XEROTHERMIC GRASSLANDS

7) Bryophytic communities on shaded rocks (*Ctenidietalia*) composed of large mosses (*Neckera complanata, Anomodon viticulosus, Homalothecium philippeanum*, etc.) and liverworts (e.g. *Plagiochila asplenioides*), but only very few vascular plants. They are especially abundant on limestone outcrops in dense deciduous forests, the most common community

being that of *Neckera complanata* and *Anomodon viticulosus*.

8) Epilithic tuft grass community (*Festucetum pallentis*), a pioneer community on steep inaccessible rocks. It occurs on black humus soil accumulated in small crevices and on narrow ledges of limestone outcrops and does not tolerate the deep shade of the forest. *Festuca pallens* dominates; other important species are *Allium senescens* (= *Allium montanum*), *Hieracium bifidum, Sempervivum* (*Jovibarba*) *soboliferum, Seseli libanotis* (= *Libanotis montana*), etc. On southern rocks the subassociation *Festucetum pallentis sempervivetosum* occurs, with many xerothermic species. The subassociation *Festucetum pallentis neckeretosum*, rich in mesophytic mosses and mountain elements (e.g. *Valeriana tripteris*), is found on slightly shaded northern rocks.
9) Xerothermic forbs community (*Origano-Brachypodietum*), especially rich in species with showy flowers. It occurs either as a primary community colonizing rocky sites with shallow soil, or as a secondary grassland in places formerly covered with xerothermic brushwood. It is restricted to dry and sunny slopes with rendzina soil. Some of its most abundant species are: *Brachypodium pinnatum, Coronilla varia, Hypericum perforatum, Origanum vulgare, Poa* (*pratensis* ssp.) *angustifolia, Verbascum chaixii* ssp. *austriacum*, etc.

3. SECONDARY (ANTHROPOGENOUS) PLANT COMMUNITIES AND THEIR CHANGES

3.1. HAY MEADOWS AND PASTURES

Secondary hay-meadows dominated thirty years ago on valley floors in the Ojcow N.P. Relatively small areas of moist sites were occupied by communities of the *Calthion* alliance. A few permanently grazed plots were covered by pasture vegetation (*Lolio-Cynosuretum*). By far, the most common were stands of fresh hay-meadows (*Arrhenatheretum elatioris alchemilletosum*) developed on sites of the potential natural vegetation of oak-hornbeam forests (*Tilio-Carpinetum*). These meadows, floristically very homogeneous and rich (with an average of 50 vascular plant species per 100 m^2, Fig. 1) were maintained by traditional methods of management. They were mown twice a year, extensively grazed after the hay-harvest and regularly fertilized with cow manure. Changes in land-use practices which have occurred since then, have

resulted in far-reaching modifications of the former *Arrhenatheretum*. In places where hay is still being harvested and meadows intensively fertilized (mostly with mineral compounds) impoverished stands of *Arrhenatheretum* (with an average of 33 vascular plants species per 100 m^2) still persist. In places where meadows are being mown to prevent the succession of shrubs and trees, and the hay left on the spot, strongly modified (truncated) communities of the *Arrhenatheretalia* order have developed (with an average of 34 vascular plants species per 100 m^2 including many ubiquitous nitrophytes). In meadows which have been completely abandoned and not mown for several years, nitrophilous and hygrophilous tall-forb communities, dominated by *Urtica dioica* and *Cirsium oleraceum,* developed (with an average of 17 vascular plants species per 100 m^2). Consequently, many of the meadow plants formerly common in the Ojcow N.P. retreated dramatically (e.g. *Crepis biennis, Knautia arvensis, Galium mollugo, Trifolium dubium, Trifolium pratense, Trifolium repens, Vicia cracca, Bellis perennis, Prunella vulgaris, Leontodon hispidus*, as well as several *Alchemilla* spp., e.g. *Alchemilla crinita, Alchemilla glabra, Alchemilla walasii*, etc.). The same is even more true of some rare elements of the meadow flora (e.g. *Alchemilla obtusa, Crepis mollis* and *Phyteuma orbiculare*, which apparently became extinct in the Ojcow area). On the other hand, tall ubiquitous nitrophytes have become particularly abundant and noticeable (e.g. *Galium aparine, Aegopodium podagraria, Chaerophyllum aromaticum, Rumex obtusifolius, Elymus* (*Agropyron*) *repens*, and especially *Urtica dioica* and *Cirsium oleraceum*).

Repeated mapping of plant communities on valley floors in 1988 revealed that in the last 30 years the share of *Arrhenatheretum* decreased from 21% to 7% of the area, while the share of *Urtica dioica* stands increased from nil to 21% of the area.

In 1985 beavers (*Castor fiber*) were successfully reintroduced to the Park. Through the construction of dams on the Pradnik and Saspowka streams they raised the local water level and turned the adjacent stands of fresh meadows into wet ones.

The maintenance of meadows in Ojcow N.P. - highly desirable because of their floristic and faunistic diversity - requires active conservation, either through traditional management practices or through ecologically equivalent treatments (e.g. mowing with partial removal of dead plant material). These practices are to be carefully checked and constantly monitored for eventual corrections.

3.2. THE SEGETAL VEGETATION

In the last thirty years, the segetal vegetation of arable grounds (*Secali-Violetalia arvensis*) has lost a large part of its former area, because many fields have been transformed into grassland or young forest stands. On the valley floors, the share of cultivated fields has shrunk by more than half (from 38% in 1959-1961 to 16% in 1988). The segetal plant communities themselves are presently in the course of far-reaching changes due to the modernization of agricultural practices.

4. DECAY OF CONIFEROUS TREES AND CHANGES IN FOREST ASSOCIATIONS

From about 1960 an increasing decay of coniferous trees in the Ojcow National Park was observed. The pine, *Pinus sylvestris*, and the fir, *Abies alba*, were most strongly affected. The fir, which occurs in Poland nearly exclusively in the southern part of the country, used to be very abundant in the Ojcow region but has been severely decimated in the last years.

The decay of coniferous trees is evidently connected with air pollution imported by winds from urban and industrial areas and produced locally by the motor vehicle traffic (at present restricted in the major part of the Park). In winter, measurements of the SO_2 content in the park's air indicated concentrations up to 200% or even 300% of the maximum allowable concentration according to the Polish norm for protected areas (0.075 mg/m^3 in 24 h). Maximum short-term concentrations are even higher (up to 0.520-0.995 mg/m^3 in 2-8 hours). Excessive concentrations of heavy metals were found in mosses (GRODZINSKA 1980), in the wood of the beech, *Fagus sylvatica*, and in the upper soil layers. Measurements of the electrolytic conductivity and sulphate concentration in water extracts from the bark of the pine, *Pinus sylvestris*, (the "bark test" as recommended by Härtel and Grill) revealed values several times higher than those found in analogical samples from relatively clean areas of northeastern Poland (MEDWECKA-KORNAS et al. 1989). Data concerning the vitality of, and the degree of damage to fir trees in the Ojcow National Park in 1986 (collected from 25 trees at each of ten forest stands) also confirmed the very critical ecological situation of this species in the study area (MEDWECKA-KORNAS and GAWRONSKI 1990).

The decay of coniferous trees exerts a heavy impact on the forest associations

- chiefly the mixed forest *Pino-Quercetum* in the two variants occurring on the plateau-sites: that of *Pinus sylvestris* and that of *Abies alba*. The comparison of phytosociological relevés from 1956-1957 with those made in the same places in 1986 indicated manifold changes in the phytocoenoses. Some stands still preserve their former character, although their floristic composition has become very impoverished. In other places the ground layer vegetation has nearly disappeared. There are also forest stands in which the share of beech in the tree layer and of neutrophilous species of the *Fagetalia* order in the ground layer have markedly increased, as well as open canopy stands which have been invaded by species characteristic of forest clearings (*Atropetalia*).

In the shrub layer, *Sorbus aucuparia* is fairly resistant to the occurring changes, and *Sambucus nigra* as well as *S. racemosa* are strongly favoured by the present situation.

In the ground layer, acidophilous and oligotrophic species, characteristic of the *Vaccinio-Piceetea* class and its subordinate syntaxa, have suffered particularly serious losses. The retreat of the blueberry, *Vaccinium myrtillus*, and the carpet-forming large mosses (e.g. *Pleurozium schreberi* and *Polytrichum attenuatum*) is the most obvious. Some less common acidophilous species which occurred sporadically at earlier times in the mixed forest of Ojcow N.P. (e.g. *Lycopodium annotinum*) have not been found recently. The most profoundly affected stands of these forests are presently dominated by nitrophilous forbs, both native (e.g. *Senecio nemorensis* ssp. *nemorensis* and ssp. *fuchsii*) and introduced (*Impatiens parviflora*).

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For almost two centuries the Ojcow Valley has been a favourite object of botanical investigations, as testified by the long list of relevant papers. In the 1960's it was the site of an interdisciplinary project of the initial phase of the Polish IBP-Programme (MEDWECKA-KORNAS 1967). In the present list only a few of the most recent publications on the flora and vegetation of the Ojcow National Park are cited.

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