

## UNFAVOURABLE CHANGES OF MEADOW COMMUNITIES IN THE AREA NEIGHBOURING 'KONIN' ALUMINIUM SMELTER

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**Abstract.** In years 1969 and 1980-91 geobotanical research was carried out on the area of 200 ha of permanent grasslands situated in the Gopło-Warta Canal depression in the zone of the strongest contamination with industrial gases from the neighbouring aluminium works.

The total of 150 phytosociological records were taken with the use of the Braun-Blanquet method. Furthermore, chemical soil and plant analyses as well as the examination of the site were conducted. Meadow plants showed varying concentrations of fluorine ranging from 0.65 to 85.2 mg %, and 95 % of the plant samples were toxic to farm animals.

The examined meadows are situated primarily on semihydrogenic and podzolic gley soils. However, there are also places where bog and black soils occur. Soils were mainly acid and slightly acid. Chemical analysis showed that the soils are poor in potassium and phosphorus.

During the period of studies unfavourable changes occurred in the physico-chemical properties of the site: both soil moisture content and density increased while its oxygenation and porosity declined. Soil reaction was also found to have increased.

Economically useful plant communities which used to occupy 37.5 % of the area were reduced considerably and now occupy only 12 % (*Arrhenatheretum elatioris* and *Lolio-Cynosuretum*). They were replaced by low value plant communities (*Deschampsia caespitosa*, *Carex fusca*, *Carex gracilis*, *Molinia coerulea*) which currently occupy 88 % of the area. Furthermore, considerable amounts of meadow weeds and plant semiparasites were also found in the examined meadow swards. The quantities of fluorine in plants showed a declining tendency which may have been due to a decrease in the discharge of fluorine into the atmosphere observed recently. Thus, it can be said that fluorine causes injury to plants and leads to the replacement of more valuable species by species economically less valuable. Moreover, these unfavourable changes

are further reinforced by negative site changes caused by incorrect management practices quite common on these contaminated areas.

**Key words:** meadow communities, aluminium smelter

### INTRODUCTION

Harmful effects of the 'Konin' aluminium works on natural and agricultural environment have been observed for several years [2-5]. Results of studies conducted in the past showed the presence of harmful concentrations of fluorine compounds both in agricultural crops and in meadow sward [3].

At the moment, there are possibilities of establishing a biologically active area which could protect man against harmful effects of emissions from the aluminium smelter [1,6].

The aim of this study was to determine the influence and range of fluorine emissions as well as the degree of plant contamination by its compounds. Moreover, in recent years the Department of Grassland Management has carried out comparative studies with the aim of determining the degree of negative changes in meadow communities.

### MATERIALS AND METHODS

Geobotanical investigations were carried out, with some intermissions, from 1969 until 1991.

The investigated areas were grasslands situated in the depression of the Warta-Gopło Canal, known as Morzysławicki Canal, where the influence of the smelter is the greatest. The entire area under investigation covered about 200 ha. Geobotanical investigations were carried out according to Braun-Blanquet method.

Moreover, external injuries of plants (necrosis) as well as chemical composition of plants (particularly fluorine content) were also studied.

Site investigations comprised: level of ground water, oxygenation; soil type, its porosity, chemical composition, reaction and fluorine content.

## RESULTS

Geobotanical studies carried out in 1991 confirmed the occurrence of communities from three classes: proper meadows - *Molinio-Arrhenatheretea* (they include groups from *Stellario-Deschampsietum caespitosae*, *Holcetum lanati*, *Molinietum coeruleae*, *Arrhenatheretum elatioris*, *Lolio-Cynosuretum*), meadow bogs - *Phragmitetea* (they include groups from *Scirpo-phragmitetum* and *Caricetum gracilis*) and *Scheuchzerio-Caricetea fuscae* (groups from *Carex fusca*).

In comparison with previous years [3], the increase of plants of low economical value is quite conspicuous. At present, economically valuable communities, that is *Arrhenatheretum elatioris* and *Lolio-Cynosuretum*, occupy only 12 % of the area. On the other hand, plant communities of low value such as *Scirpo-Phragmitetum*, *Caricetum gracilis*, *Caricetum paniculatae*, community with *Carex fusca*,

*Holcetum lanati* and *Molinietum coeruleae* occupy about 88 % of the area.

Hairgrass meadows (*Deschampsietum caespitosae*) turned out to be most common on the examined area occupying 33 % of the area. The economic value of these meadows is very low; they are treated as idle land. Away from the aluminium works these meadows are grazed, and certain parts characterized by a better floristic composition, are cut.

Valuable communities of *Arrhenatheretum elatioris* occur in this region in a non-typical, poor form. Such valuable grasses as *Arrhenatherum elatius* and *Dactylis glomerata* persist quite well. Moreover, such legumes as *Trifolium repens*, *Lotus corniculatus*, *Lathyrus pratensis*, *Trifolium pratense* also occur in these communities. Herbs are represented by *Plantago lanceolata*, *Achillea millefolium*, *Pastinaca sativa*, *Taraxacum officinale* and as for weeds - the following can be found: *Equisetum arvense*, *Potentilla reptans*, *Rumex acetosa*, *Centaurea jacea*, *Prunella vulgaris* (Table 1).

Such a considerable presence of plants from the group of herbs and weeds indicate that these meadows were badly neglected and this, in turn, is closely connected with the current state of agriculture in the examined region. Also the next community - *Lolio-Cynosuretum*, usually of higher economic value, shows considerable negative changes as evidenced by the share of plants in individual botanical groups (Table 1).

It is interesting to observe that even bog communities display considerable changes showing that they are undergoing transformations.

**Table 1.** Percentage share of plant groups in meadow communities

Meadow communities	Grasses	Sedges	Legumes	Herbs and weeds
<i>Scirpo-Phragmitetum</i>	27	10	5	58
<i>Caricetum paniculatae</i>	13	20	-	67
Com. with <i>Carex Fusca</i>	27	4	9	61
<i>Caricetum gracilis</i>	17	4	13	66
<i>Stellario-Deschampsietum</i>	29	6	9	56
<i>Holcetum lanati</i>	33	2	11	54
<i>Molinietum coeruleae</i>	19	16	8	57
<i>Arrhenatheretum elatioris</i>	28	-	13	59
<i>Lolio-Cynosuretum</i>	31	3	12	54

A high share of *Calamagrostis lanceolata* in the *Scirpo-Phragmitetum* group can serve as an example (Table 1).

Similarly, in *Caricetum gracilis*, which constitutes 15 % on the examined area, a high share of species from the class *Molinio-Arrhenatheretea* was noticeable indicating that these areas are slowly drying out with a conspicuous succession towards proper meadows. A considerable proportion of herbs and weeds is also worth noticing (Table 1). Currently formation of the *Caricetum paniculatae* community was observed: it occupies 6 % of the area. Because of the unfavourable composition, tufty structure and marshy site conditions, it is economically useless.

It is further worth noticing that a significant area (16 %) is occupied by the economically worthless community with *Carex fusca* in which, apart from *Carex fusca*, a considerable share of species from class *Molinio-Arrhenatheretea* occurs (Table 1).

As regards the site, the determined communities (Table 2) developed primarily on mucks, peats and mucks on peats of low fertility.

Contamination with fluorides of the plant material from the examined region ranged from

0.65 to 85.2 mg % calculated per D.M.; 95 % of the examined plant samples showed fluoride concentrations toxic for farm animals. Considerably high fluoride concentrations were found on meadows situated towards S, SSE and EES approximately 4 km from the emission source. In these areas, high fluoride concentrations affected species compositions of plants on meadows and pastures. Additionally, frequent leaf injuries as well as necroses on dicotyledons were observed. However, it was considered that the influence of industrial contaminations (fluorine) on the examined meadow flora correlated with the poor trophic characteristics of sites.

#### DISCUSSION

The studies carried out confirm the negative changes of the meadow flora in the area affected by emissions from the 'Konin' aluminium smelter as previously indicated by Dziubek and Grynia [3].

The present state of these communities, from the economical standpoint, is highly unsatisfactory. They occupy 12 % of the area, i.e. 68 % less than in the previous 20 years period. The opinion of Bender and Szolonek [1], that

Table 2. Percentage share of individual communities on the examined area in years 1969 and 1991

Class and plant community	% share of community in the year of studies	
	1969	1991
C1. <i>Phragmitetea</i>		
<i>Scirpo-Phragmitetum</i>	2	3
<i>Caricetum gracilis</i>	8	15
<i>Caricetum paniculatae</i>	-	6
<i>Caricetum rostrato-versicariae</i>	1	-
<i>Glycerietum aquaticae</i>	2	-
<i>Phalaridetum arundinacea</i>	1	-
C1. <i>Molinio-Arrhenatheretea</i>		
<i>Molinietum coeruleae</i>	7	9
<i>Arrhenatheretum elatioris</i>	-	3
Com. with <i>Deschampsia caespitosa</i>	28	33
<i>Holcetum lanati</i>	-	6
<i>Lolio-Cynosuretum</i>	0.5	9
Com. with <i>Dactylis glomerata</i> - <i>Festuca pratensis</i>	37	-
C1.		
<i>Scheuchzerio-Caricetea fuscae</i>	8	16
Com. with <i>Carex fusca</i>		

the concentration of fluorine in grasses is the lowest and they can be safely fed to animals is questionable. There is ample evidence of the negative influence of fluorine emissions of meadow plants, including mechanical damage to plants in the form of necroses and, on grasses, drying of their tops. The most severe damage is found on dicotyledonous plants, herbs and meadow weeds as well as on trees growing in the neighbourhood of the aluminium works.

Concern must also be expressed at the growing number of meadow semiparasites such as *Alectorolophus glaber*, *Euphrasia Rostkoviana* which is the results of the contamination of the regions and, consequently, increasing negligence of proper management practices.

#### CONCLUSIONS

1. Negative changes were found to occur in the sward of meadows as expressed in the disappearance of economically valuable plants which are being replaced by worse types of grasses as well as herbs and weeds, including plant semiparasites.

2. Despite assurances of the management of the aluminium plant that fluorine emissions have been considerably reduced, studies conducted recently (1990-91) do not confirm such claims. Their results indicate considerable increase of areas with low value communities (40 % in comparison to previous years). They include the following communities: *Scirpo-Phragmitetum*, *Caricetum paniculate*, *Carex fusca*, *Holcetum lanati* and *Molinietum coeruleae*.

3. Poor management practices on meadows and pastures are the results of the negative influence of the neighbouring aluminium works. Farmers ignore proper fertilization recommendations, fail to cut the grass at optimum times and use free grazing system. These practices create conditions for further negative floristic changes and further decrease forage quantity and quality.

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#### NIEKORZYSTNE ZMIANY ZBIOROWISK ŁĄKOWYCH W REJONIE HUTY ALUMINIUM 'KONIN'

W latach 1969 i 1980-91 wykonano badania geobotaniczne na obszarze ok. 200 ha trwałych użytków zielonych położonych w obniżeniu Kanału Warta-Gopło zwanego Marzysławickim, w obrębie największego oddziaływania gazów przemysłowych Huty Aluminium.

Wykonano 150 zdjęć fitosocjologicznych stosując metodę Braun-Blanquet'a. Wykonano też badania siedliska oraz chemiczne gleby i roślinności. Roślinność wykazała zawartość fluoru od 0.65 do 85.2 mg %, a 95 % prób roślinnych było toksycznych dla zwierząt gospodarczych.

Łąki występują przeważnie na glebach semihydrogenicznych typu glejobielicowego, miejscami stwierdza się też czarne ziemie i bagienne. Odczyn gleb jest kwaśny i lekko kwaśny. Badania wykazały, iż gleby te są mało zasobne w potas i fosfor.

Na przestrzeni lat badań nastąpiły niekorzystne zmiany w siedlisku, dotyczące właściwości fizyko-chemicznych gleby; zwiększyło się uwilgotnienie gleby oraz jej gęstość, zmniejszyło natlenienie i porowatość a gleby uległy większemu zakwaszeniu.

Z obszaru 37.5 % wartościowych gospodarczo zbiorowisk, obecnie pozostało tylko 12 % (*Arrhenatheretum elatioris* i *Lolio-Cynosuretum*), a małowartościowe zajmują 88 % (zbiorowiska z *Deschampsia caespitosa*, *Carex fusca*, *Carex gracilis*, *Molinia coeruleae*). W runi łąk stwierdzono także znaczną ilość chwastów łąkowych i półpasożytów roślinnych. Pod względem zawartości fluoru ilość jego w roślinach się obniżyła. Ma to związek ze zmniejszeniem się w ostatnich latach emisji fluoru do atmosfery.

Sł o w a k l u c z o w e: zbiorowiska łąkowe, huta aluminium.