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# PRODUCTIVITY INVESTIGATION OF TWO TYPES OF MEADOWS IN THE VISTULA VALLEY

## II. SOIL CONDITIONS

(Ekol. Pol. 19:107–119). The paper gives the characteristics of two investigated meadow areas, Strzeleckie and Kazuńskie. Both areas are located in the valley of the Vistula on alluvial river terraces. The Strzeleckie Meadow soil is formed from loose and slightly loam river sand, under conditions due to the effects of periods of heavy moisture and of meadow-bog plants. On the surface of the Strzeleckie Meadows are found mainly muck-like black soil, in which are accumulated humus and organic substances. Humus and organic substances decide the physical and chemical properties of the surface layers of this soil. The Kazuńskie Meadow soil is very fertile and rich in mineral components. It belongs to the group of brown gleyed and gley alluvial soils.

### INTRODUCTION

Complex studies performed on the productivity of meadow ecosystems by the Institute of Ecology Polish Academy of Sciences and the Institute of Soil Science, Warsaw Agriculture University, were based on two objectives, Strzeleckie Meadow soil and Kazuńskie Meadow soils which differed in basic ecological habitats. The general soil characteristics, hydrogeology, and certain physical and chemical properties of these objectives are mentioned below.

## METHODS OF INVESTIGATION

The hydrogeologic conditions and morphologic characteristics of the soils were formed on the basis of field studies. In the Strzeleckie Meadows, several soil profiles were dug, but only one was analyzed (profile 1); however, the Kazuńskie Meadows were divided into two sections (Kazuń I – profiles 2 and 3 and Kazuń II – profile 4).

The methods of analysis were as follows; the mechanical composition of the soil by Casagrande's areometric method using Prószyński's modification, the specific gravity by the picnometric method, bulk density and capillary water porosity by Kopecke's method, total nitrogen content by Kiejdahl's method, pH by electrical method, exchangeable cation contents extracted in a 1 N $NH_4Cl$ solution, and hydrolytic acidity by Kappen's method.

## RESULTS

### Strzeleckie Meadow soils

The Strzeleckie Meadows are located in the northern area of the Primeval Kampinos Forest on the old accumulated terrace of the Vistula. A large part of the meadows' is taken up by alluvial sediment containing mechanical compositions of loose and slightly loamy sand (Tab. I). In lower ground areas, the alluvial surface layer is composed of light loam.

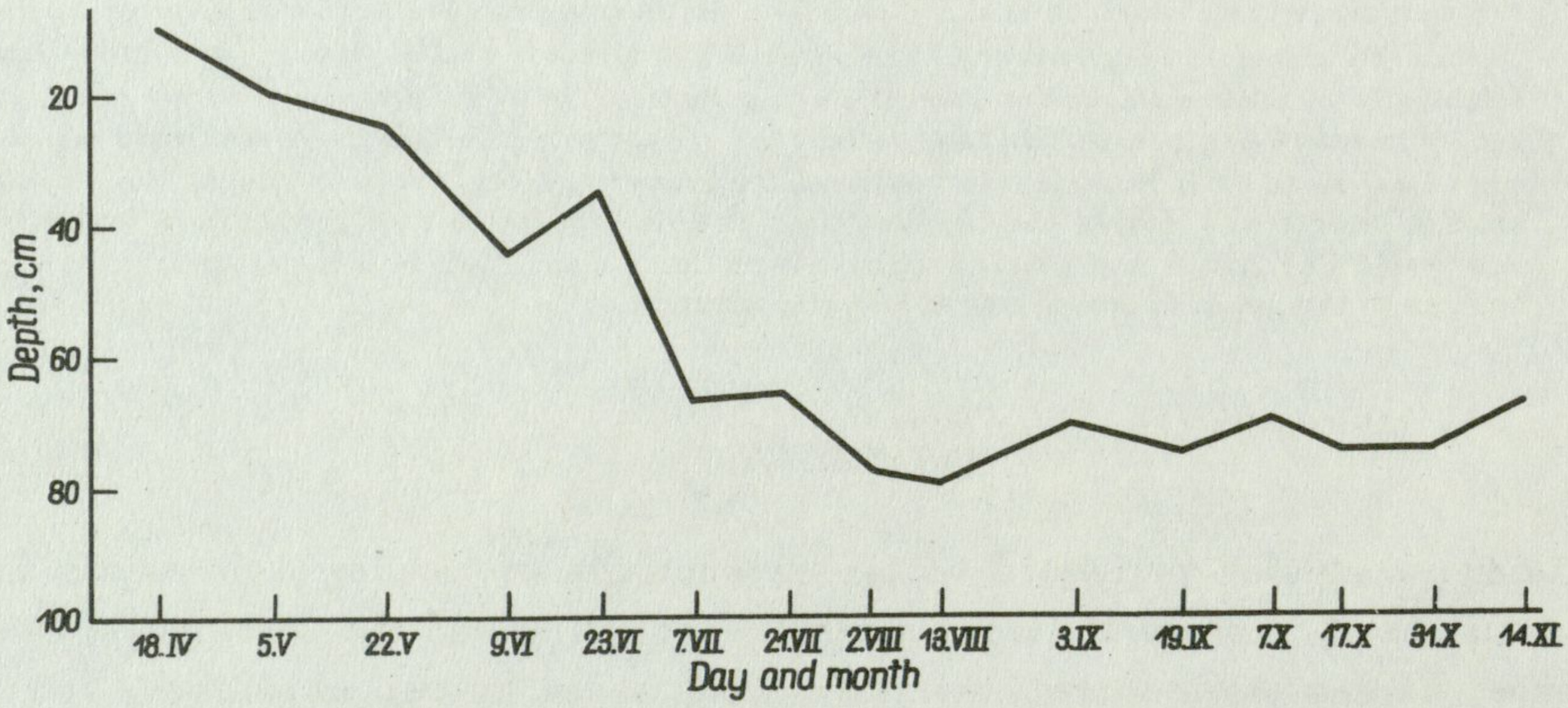


Fig. 1. Ground water table in 1969 of the Strzeleckie Meadows

The actual process of soil formation in the Strzeleckie Meadows depends a great deal upon hydrological conditions. The lower locations, in years of

heavy rain, are covered by water a great deal of the year. In higher areas, the level of ground water varies greatly during the year (Fig. 1), as well as from year to year. In early spring, water covers the surface. During the summer, the level of ground water systematically falls, being lowest during August and September. On higher ground the minimal level of ground water during specific years varies and is dependent on the amount of precipitation, ranging from 40 to 80 cm. As a consequence of the moisture, there is great variance in the surface soils. In areas of constant water stagnation are found hydromorphic soils; shallow strongly decomposed peat, muck, and gley soils. However, on flat very dry surfaces are found muck-like black earths and degradated black earths.

A complex of studies have been performed on the muck-like black earths of the Strzeleckie Meadow. Therefore, further detailed characteristics of this type of soil are covered.

Soil profile No. 1 of the muck-like black earth of the Strzeleckie Meadows

$A_o$ 0–8 cm, a layer composed of moss and dead nondecomposed plant residues;
$A_1^o/M$ 8–20 cm, accumulative, muck-like horizon, black in colour, friable, of an unstable crumbly structure and moist;
$A_1$ 20–31 cm, humus horizon, dark gray in colour, slightly compact, moist, of an unstable crumbly structure;
$A_1/C$ 31–36 cm, transitional horizon, yellow in colour with gray humus spots of a loose consistency, crumbly structure and moist;
C/G 36 cm and below, gleyed, nonstructural parent rock of a yellow-gray colour with red ferric spots of a loose consistency and wet.

Muck-like black earths are formed from loose sand (Tab. I) due to the plant assotiation *Stellario-Deschampsietum* (Traczyk 1966). This leads to phases of great moisture and a constant flow of organic substances in the surface soil layers, which accumulate a great amount of slightly decomposed organic material, forming an accumulate-muck horizon. A great amount of organic matter (7.2%) influences the physico-chemical properties of the $A_1/M$ horizon (Tab. II, III). In this horizon the total porosity (62.8%) and capillary water capacity (50%) are twice as large and the air porosity is twice to five times as large as the parent rock. The bulk density is 0,93 g/cm$^3$ in the $A_1/M$ horizon, increasing with profile depth, and reaches a value of 1.80 g/cm$^3$ in the parent rock.

River sand, which formed the black earths, contained a slight absorption capacity of 1.15–1.28 m.e./100 g of soil. The accumulation of humus compounds is one of the most important absorption complex components (Siuta 1960), increasing the absorption capacity of the $A_1/M$ and $A_1$ horizons (Tab. III).

Mechanical composition

Tab. I

| Profile No. | Horizon | Depth cm | > 1 mm % | < 1 mm % | Per cent of fractions in diameter | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1–0.5 | 0.5–0.25 | 0.25–0.1 | 0.1–0.05 | 0.05––0.02 | 0.02––0.006 | 0.006––0.002 | < 0.002 |
| | Strzeleckie Meadows muck-like black earth | | | | | | | | | | | |
| 1 | $A_1$/M | 8–20 | 0.1 | 99.9 | 5.0 | 24.2 | 50.8 | 4 | 5 | 4 | 3 | 4 |
| | $A_1$ | 20–30 | 0.2 | 99.8 | 5.2 | 24.5 | 51.3 | 4 | 3 | 6 | 2 | 4 |
| | C/G | 38–50 | 0.3 | 99.7 | 6.0 | 20.5 | 63.5 | 2 | 1 | 3 | 1 | 3 |
| | C/G | 70–85 | 0.8 | 99.2 | 17.2 | 46.2 | 26.6 | 6 | 1 | 0 | 2 | 1 |
| | Kazuńskie Meadows Kazuń I alluvial brown gleyed soil | | | | | | | | | | | |
| 2 | $A_1$ | 0–10 | 0.0 | 100.0 | 0.3 | 0.6 | 10.1 | 7 | 35 | 20 | 12 | 15 |
| | $A_1$ | 10–20 | 0.0 | 100.0 | 0.0 | 0.3 | 7.7 | 7 | 28 | 20 | 14 | 22 |
| | $A_1$ | 20–30 | 0.0 | 100.0 | 0.3 | 0.5 | 7.2 | 7 | 26 | 23 | 14 | 22 |
| | $A_1$(B) | 30–40 | 0.0 | 100.0 | 0.0 | 0.3 | 5.7 | 7 | 33 | 24 | 11 | 19 |
| | (B) | 40–50 | 0.0 | 100.0 | 0.0 | 1.2 | 6.8 | 6 | 20 | 26 | 11 | 28 |
| | (B)Gor | 50–60 | 0.0 | 100.0 | 0.3 | 4.5 | 17.2 | 7 | 17 | 20 | 11 | 23 |
| | (B)Gor | 60–70 | 0.0 | 100.0 | 1.5 | 9.0 | 24.5 | 10 | 16 | 14 | 8 | 17 |
| | Gor | 70–80 | 0.0 | 100.0 | 2.0 | 6.7 | 0.3 | 31 | 26 | 11 | 5 | 18 |
| | Gr | 80–100 | 0.0 | 100.0 | 2.0 | 10.7 | 29.3 | 15 | 17 | 11 | 1 | 14 |
| | D/Gr | 115–120 | 0.0 | 100.0 | 0.7 | 46.0 | 34.3 | 5 | 4 | 3 | 1 | 6 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | alluvial brown strongly gleyed soil | | | | | | | | | | |
| 3 | $A_1$ | 0–10 | 0.0 | 100.0 | 0.3 | 0.5 | 6.2 | 8 | 27 | 20 | 24 | 14 |
| | $A_1$ | 10–20 | 0.0 | 100.0 | 0.0 | 0.3 | 6.7 | 7 | 25 | 22 | 15 | 24 |
| | $A_1$ | 20–30 | 0.0 | 100.0 | 0.0 | 0.3 | 5.7 | 6 | 25 | 22 | 14 | 27 |
| | (B)Gor | 30–40 | 0.0 | 100.0 | 0.0 | 0.0 | 9.0 | 4 | 22 | 27 | 15 | 23 |
| | Gor | 40–50 | 0.0 | 100.0 | 0.0 | 0.0 | 8.0 | 8 | 27 | 22 | 15 | 20 |
| | Gor | 50–60 | 0.0 | 100.0 | 0.0 | 0.0 | 9.0 | 7 | 27 | 23 | 16 | 18 |
| | Gr | 70–100 | 0.0 | 100.0 | 0.0 | 0.8 | 19.2 | 7 | 12 | 18 | 16 | 27 |
| | Gr | 100–120 | 0.0 | 100.0 | 0.5 | 4.0 | 30.1 | 11 | 18 | 12 | 10 | 18 |
| | | Kazuń II<br>alluvial gley soil | | | | | | | | | | |
| 4 | $A_1$ | 0–23 | 0.0 | 100.0 | 0.2 | 0.5 | 11.3 | 6 | 28 | 19 | 12 | 23 |
| | Gor | 38–50 | 0.0 | 100.0 | 0.4 | 0.4 | 9.2 | 8 | 24 | 22 | 13 | 23 |
| | Gor | 60–80 | 0.0 | 100.0 | 0.6 | 1.2 | 17.2 | 10 | 14 | 16 | 11 | 30 |
| | Gor | 90–100 | 0.0 | 100.0 | 0.2 | 0.6 | 22.2 | 16 | 23 | 15 | 4 | 19 |
| | Gr | 110–120 | 0.0 | 100.0 | 0.0 | 0.4 | 39.6 | 27 | 18 | 4 | 2 | 9 |

Physical properties

Tab. II

| Profile No. | Horizon | Depth cm | Specific gravity | Bulk density | Total porosity % vol. | Capillary porosity % vol. | Air porosity non capillary % vol. |
|---|---|---|---|---|---|---|---|
| | | | g/cm³ | | | | |
| | Strzeleckie Meadows muck-like black earth | | | | | | |
| 1 | $A_1/M$ | 8–14 | 2.50 | 0.93 | 62.8 | 50.0 | 12.8 |
| | $A_1$ | 20–26 | 2.59 | 1.34 | 48.3 | 40.0 | 8.3 |
| | $A_1/C$ | 30–36 | 2.66 | 1.69 | 36.5 | 25.6 | 10.9 |
| | C/G | 40–46 | 2.63 | 1.74 | 33.8 | 27.6 | 6.2 |
| | C/G | 50–56 | 2.63 | 1.70 | 35.4 | 29.1 | 6.3 |
| | C/G | 64–70 | 2.65 | 1.80 | 32.1 | 29.5 | 2.6 |
| | C/G | 74–80 | 2.62 | 1.78 | 32.1 | 27.9 | 4.2 |
| | Kazuńskie Meadows Kazuń I alluvial brown gleyed soil | | | | | | |
| 2 | $A_1$ | 0–10 | 2.62 | 1.35 | 48.5 | 42.5 | 6.0 |
| | $A_1$ | 10–20 | 2.62 | 1.32 | 49.6 | 42.7 | 6.9 |
| | $A_1$ | 20–30 | 2.62 | 1.35 | 48.5 | 44.0 | 4.5 |
| | $A_1$(B) | 30–40 | 2.64 | 1.36 | 48.5 | 43.5 | 5.0 |
| | (B) | 40–50 | 2.66 | 1.27 | 52.2 | 46.0 | 6.2 |
| | (B)/Gor | 60–70 | 2.66 | 1.41 | 47.0 | 45.5 | 1.5 |
| | Gr | 80–90 | 2.67 | 1.66 | 37.8 | 37.6 | 0.2 |
| | D/Gr | 110–120 | 2.61 | 1.78 | 31.8 | 32.0 | 0.0 |
| | alluvial brown strongly gleyed soil | | | | | | |
| 3 | $A_1$ | 0–10 | 2.57 | 1.22 | 52.5 | 49.3 | 3.2 |
| | $A_1$ | 10–20 | 2.60 | 1.26 | 51.5 | 47.5 | 4.0 |
| | $A_1$ | 20–30 | 2.61 | 1.21 | 53.6 | 47.2 | 6.4 |
| | (B)/Gor | 30–40 | 2.64 | 1.22 | 53.8 | 47.2 | 6.6 |
| | Gor | 40–50 | 2.66 | 1.28 | 51.9 | 46.1 | 5.8 |
| | Gor | 50–60 | 2.67 | 1.39 | 47.9 | 40.6 | 7.3 |
| | Gor | 60–70 | 2.67 | 1.31 | 50.9 | 43.9 | 7.0 |
| | Gor | 70–80 | 2.67 | 1.06 | 60.3 | 58.0 | 2.3 |
| | Gor | 80–90 | 2.67 | 1.45 | 45.7 | 41.4 | 4.3 |
| | Kazuń II alluvial gley soil | | | | | | |
| 4 | $A_1$ | 5–11 | 2.58 | 1.15 | 55.4 | 47.9 | 7.5 |
| | $A_1$ | 20–26 | 2.64 | 1.26 | 52.4 | 45.2 | 7.1 |
| | Gor | 30–36 | 2.67 | 1.27 | 52.1 | 43.0 | 9.1 |
| | Gor | 50–56 | 2.66 | 1.32 | 50.4 | 41.4 | 9.0 |
| | Gor | 70–76 | 2.57 | 1.02 | 60.3 | 56.7 | 3.6 |

With the increase in absorption capacity there occurs a biological accumulation of basic ions on the surface layers of soil (Tab. III). The amount of calcium exchanged in the $A_1$/M horizon is about twice, potassium ten times, and sodium five times as large as the parent rock. Magnesium exchanged in the parent rock is found in trace amounts in the $A_1$/M horizon (0.23 m.e./100 g of soil). The absorption complex is saturated with basic ions (77.3–86.9%).

## Kazuńskie Meadow soil

The Kazuńskie Meadows are situated on the present terrace of the accumulation of the Vistula. They are not covered during flood times, because they are isolated from the corridor of the river by an antiflood dam.

The Kazuńskie Meadow soils are formed from fertile alluvial sediment. containing mechanical compositions of silty clay and silt (Tab. I). The thickness of the deposit is a meter or more (profile 2). In the horizon are green-blue slightly loamy sands, containing cemented ferrous compounds. The level of ground water depends upon the microrelief which occur in the spring at depths of 20–50 cm. The alluvial gleyed brown soil (profile 2), alluvial strong gleyed brown soil (profile 3), and alluvial gley soils (profile 4) of the Kazuńskie Meadows are a result of the various levels of ground water (Fig. 2).

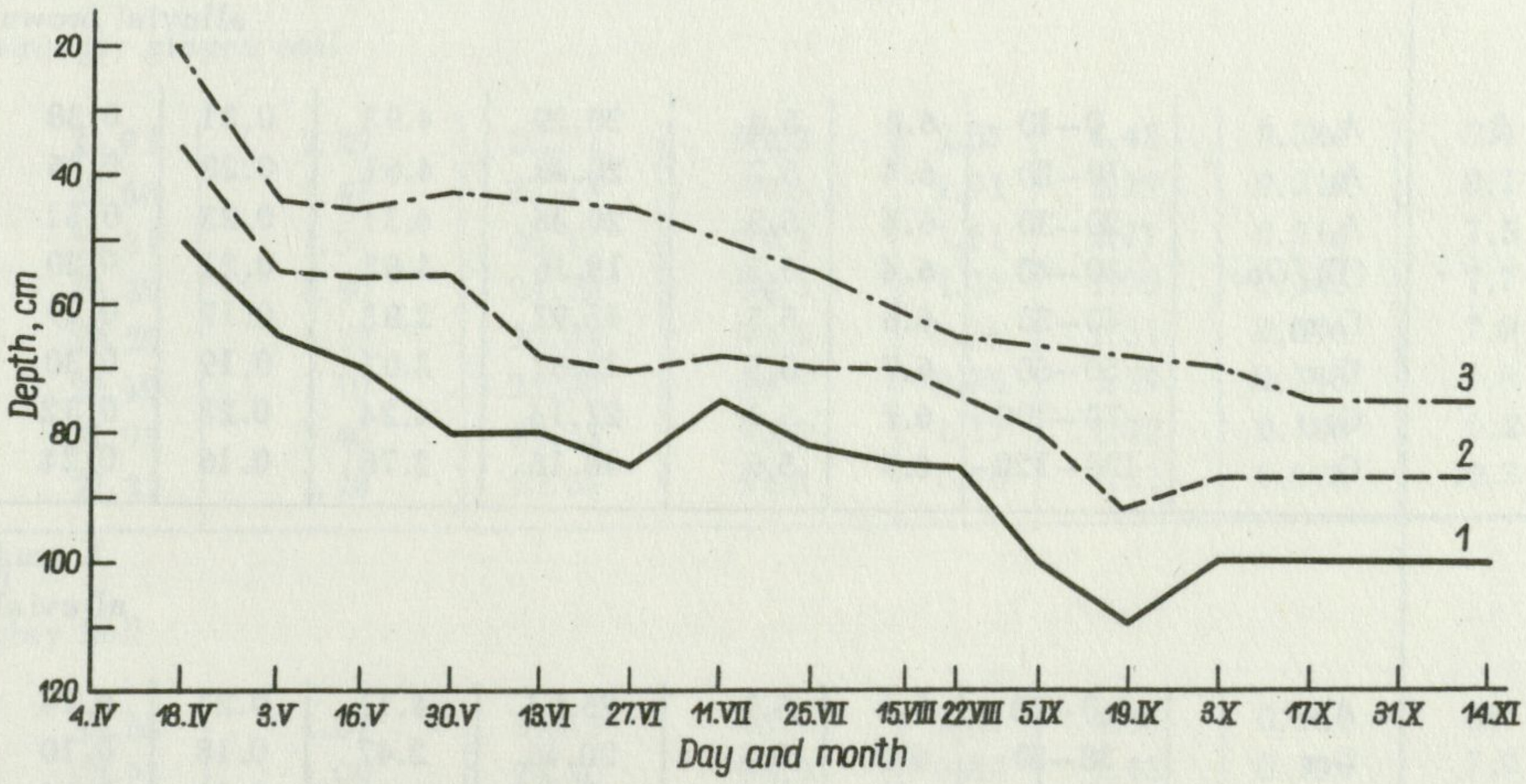


Fig. 2. Ground water table in 1969 of the Kazuńskie Meadows

*1* – Kazuń I profile No. 2, *2* – Kazuń I profile No. 3, *3* – Kazuń II profile No. 4

Chemical

| Profile No. | Horizon | Depth cm | pH | | Exchangeable cations – m.e./100 g | | | |
|---|---|---|---|---|---|---|---|---|
| | | | $H_2O$ | KCl ln | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ |
| | | | | | | | | Strzeleckie muck-like |
| 1 | $A_1$/M | 8–20 | 5.5 | 4.3 | 11.68 | 0.23 | 0.10 | 0.22 |
| | $A_1$ | 20–30 | 5.7 | 5.1 | 6.89 | 0.07 | 0.03 | 0.11 |
| | C/G | 38–50 | 6.1 | 5.7 | 0.90 | 0.00 | 0.01 | 0.08 |
| | C/G | 70–85 | 6.2 | 5.7 | 0.95 | 0.00 | 0.01 | 0.04 |
| | | | | | | | | Kazuńskie Kazuń alluvial brown |
| 2 | $A_1$ | 0–10 | 6.2 | 5.6 | 16.67 | 3.09 | 0.23 | 0.38 |
| | $A_1$ | 10–20 | 6.2 | 5.5 | 16.27 | 2.99 | 0.22 | 0.35 |
| | $A_1$ | 20–30 | 6.5 | 5.7 | 16.67 | 3.78 | 0.21 | 0.38 |
| | $A_1$/(B) | 30–40 | 6.4 | 5.6 | 16.37 | 2.99 | 0.20 | 0.29 |
| | (B) | 40–50 | 6.3 | 5.3 | 19.96 | 3.24 | 0.20 | 0.29 |
| | (B)/Gor | 50–60 | 6.3 | 5.4 | 20.96 | 3.32 | 0.17 | 0.25 |
| | (B)/Gor | 60–70 | 6.4 | 5.4 | 17.46 | 2.37 | 0.13 | 0.21 |
| | Gor | 70–80 | 6.5 | 5.5 | 15.77 | 1.91 | 0.13 | 0.20 |
| | Gr | 80–100 | 6.7 | 5.7 | 10.38 | 0.83 | 0.13 | 0.14 |
| | D/Gr | 115–120 | 7.5 | 6.2 | 3.09 | 0.30 | 0.05 | 0.06 |
| | | | | | | | | alluvial brown |
| 3 | $A_1$ | 0–10 | 6.0 | 5.4 | 20.29 | 4.93 | 0.31 | 0.38 |
| | $A_1$ | 10–20 | 6.4 | 5.7 | 20.46 | 4.61 | 0.23 | 0.36 |
| | $A_1$ | 20–30 | 6.4 | 5.5 | 20.46 | 4.31 | 0.23 | 0.31 |
| | (B)/Gor | 30–40 | 6.4 | 5.5 | 19.16 | 3.82 | 0.21 | 0.20 |
| | Gor | 40–50 | 6.6 | 5.5 | 15.97 | 2.83 | 0.17 | 0.29 |
| | Gor | 50–60 | 6.7 | 5.5 | 16.67 | 3.03 | 0.19 | 0.30 |
| | Gr | 70–100 | 6.7 | 5.5 | 27.14 | 4.24 | 0.23 | 0.32 |
| | Gr | 100–120 | 6.9 | 5.6 | 18.16 | 2.76 | 0.16 | 0.24 |
| | | | | | | | | Kazuń alluvial |
| 4 | $A_1$ | 0–23 | 6.5 | 5.9 | 26.04 | 4.11 | 0.27 | 0.14 |
| | Gor | 38–50 | 6.3 | 5.5 | 20.46 | 2.47 | 0.18 | 0.10 |
| | Gor | 60–80 | 6.3 | 5.3 | 27.54 | 3.29 | 0.20 | 0.12 |
| | Gor | 90–100 | 6.2 | 5.4 | 13.57 | 0.94 | 0.13 | 0.08 |
| | Gr | 110–120 | 4.9 | 3.8 | 4.39 | 0.12 | 0.07 | 0.02 |

properties

Tab. III

| $S_1$ = $Ca^{\cdot\cdot}$ + $Mg^{\cdot\cdot}$ + $K^{\cdot}$ + $Na^{\cdot}$ | Hydrolitic acidity $H_h$ | T = $S_1 + H_h$ | V = $\frac{S_1}{T} \cdot 100\%$ | C % | Organic matter % | N % | C : N |
|---|---|---|---|---|---|---|---|
| m.e./100 g soil | | | | | | | |
| **Meadows black earth** | | | | | | | |
| 12.23 | 3.16 | 15.39 | 79.5 | 4.07 | 7.20 | 0.217 | 18.7 |
| 7.10 | 1.40 | 8.50 | 83.5 | 1.73 | 2.98 | 0.077 | 22.4 |
| 0.99 | 0.29 | 0.28 | 77.3 | 0.05 | 0.08 | 0.009 | 5.5 |
| 1.00 | 0.15 | 1.15 | 86.9 | 0.03 | 0.05 | 0.007 | 4.3 |
| **Meadows I gleyed soil** | | | | | | | |
| 20.37 | 1.62 | 21.99 | 92.6 | 2.04 | 3.52 | 0.273 | 7.5 |
| 19.83 | 1.32 | 21.15 | 93.7 | 1.55 | 2.67 | 0.191 | 8.1 |
| 21.04 | 1.03 | 22.07 | 95.3 | 1.46 | 2.52 | 0.165 | 8.8 |
| 19.85 | 1.10 | 20.95 | 94.7 | 0.84 | 1.45 | 0.120 | 7.0 |
| 23.69 | 1.47 | 25.16 | 94.1 | 1.23 | 2.12 | 0.132 | 9.3 |
| 24.70 | 1.47 | 26.17 | 94.4 | 0.86 | 1.48 | 0.156 | 5.5 |
| 20.17 | 1.40 | 21.57 | 93.5 | 0.70 | 1.20 | 0.096 | 7.3 |
| 18.01 | 1.18 | 19.19 | 93.8 | 0.52 | 0.90 | 0.076 | 6.8 |
| 11.54 | 0.81 | 12.35 | 93.4 | 0.19 | 0.33 | 0.037 | 5.1 |
| 3.50 | 0.07 | 3.57 | 98.0 | 0.07 | 0.12 | 0.012 | 5.8 |
| **strongly gleyed soil** | | | | | | | |
| 25.91 | 2.20 | 28.11 | 92.2 | 2.57 | 4.43 | 0.281 | 9.1 |
| 25.66 | 1.47 | 27.13 | 94.6 | 1.91 | 3.29 | 0.219 | 8.7 |
| 25.31 | 1.54 | 26.85 | 94.3 | 1.61 | 2.77 | 0.214 | 7.5 |
| 23.39 | 1.40 | 24.79 | 94.3 | 1.10 | 1.90 | 0.143 | 7.7 |
| 19.26 | 1.18 | 20.44 | 94.2 | 0.76 | 1.31 | 0.096 | 7.9 |
| 20.19 | 1.10 | 21.29 | 94.8 | 0.75 | 1.29 | 0.110 | 6.8 |
| 31.93 | 1.40 | 33.33 | 95.8 | 1.17 | 2.02 | 0.188 | 6.2 |
| 21.32 | 1.18 | 22.50 | 94.8 | 0.70 | 1.21 | 0.056 | 12.5 |
| **II gley soil** | | | | | | | |
| 30.56 | 1.07 | 31.63 | 96.6 | 2.61 | 4.50 | 0.301 | 8.7 |
| 23.21 | 1.09 | 24.30 | 95.5 | 0.83 | 1.43 | 0.105 | 7.9 |
| 31.15 | 1.56 | 32.71 | 95.2 | 1.20 | 2.07 | 0.114 | 10.5 |
| 14.73 | 1.09 | 15.82 | 93.1 | 0.35 | 0.60 | 0.038 | 9.2 |
| 4.60 | 1.45 | 6.05 | 76.0 | 0.13 | 0.22 | 0.015 | 8.7 |

Soil profile No. 2 Kazuńskie Meadows "Kazuń I" alluvial brown gleyed soil.

| | | |
|---|---|---|
| $A_1$ | 0– 35 cm, | humus horizon, gray-brown in colour with granular structure of a hard consistency and fresh; |
| (B) | 35– 50 cm, | brown horizon with prismatic structure of a hard consistency and moist; |
| (B)/Gor | 50– 70 cm, | gleyed brown horizon, brown in colour with gray-green spots and black-brown ferro-manganous precipitation, plastic consistency and wet: |
| Gor | 70– 80 cm, | gley horizon (oxidation and reduction) with green and rusty spots, of a plastic consistency and wet; |
| Gr | 80–110 cm, | gley horizon green-blue in colour with black-brown ferro-manganous precipitation, of a plastic consistency and wet; |
| D/Gr | * 110 cm and below; | underlying rock-river sand, blue in colour, sand grains cemented by divalent iron compounds, compact and wet |

Profile No. 3. Kazuń I alluvial brown strongly gleyed soil.

| | | |
|---|---|---|
| $A_1$ | 0– 30 cm, | humus horizon, gray-brown in colour, granular structure, of a hard consistency and fresh; |
| (B)/Gor | 30– 40 cm, | brown horizon with gleyed spots, black-brown ferro--manganous precipitation, of a prismatic structure and moist; |
| Gor | 40– 70 cm, | gley horizon, gray-green in colour with iron brown spots, of a plastic consistency and wet; |
| Gr | 70 cm and below, | gley horizon, green-blue in colour, of a plastic consistency, and wet. |

Profile No. 4. Kazuń II. Alluvial gley soil.

| | | |
|---|---|---|
| $A_1$ | 0– 30 cm, | humus horizon, gray-black in colour, of a granular structure, hard consistency, and fresh; |
| Gor | 30–102 cm, | gley horizon (oxidation and reduction), gray-green in colour with ferro-manganous spots, of a plastic consistency, and wet; |
| Gr | 102 cm and below; | gley horizon blue-green in colour, compact, and wet. |

The physial properties of Kazuńskie Meadow soil depend mainly upon the mechanical and mineral composition of specific layers. There exists a great deal of correlation between the amount of particles < 0.02 mm (Tab. I) and total porosity, capillary water capacity, and bulk density (Tab. II). The total porosity of layers of mechanical composition of silt and silty clay is large and ranges from 47.0–60.3%. At greater depths are found less total porosity (31.8–45.7%), due to the increase in sand fractions. Water capillary capacity is 32–58% and air porosity is 0.0–9.1%. Generally, the surface layers have greater air porosity, which helps in water penetration and air circulation in the soil.

The large air pores are formed of a whole network of longitudinal earthworm channals of a diameter of 8 mm. The earthworm channals reach to a depth of 90 cm and in part are filled with plant roots. In the second profile, an the 80–120 cm level are found almost entirely capillary pores. Most of the pores due to the process of reduction, are filled with ferrous compounds. The bulk

density of specific layers varies a great deal, from 1.06 to 1.78 g/cm³. The small specific gravity certain layers shows the presence of a great amount of montmorillonite minerals. Following analysis showed that the amounts of this mineral in the Kazuńskie Meadow soils range up to 20%. The montmorillonite mineral group have the ability to absorb great amounts of water, swelling and increasing its volume. The specific gravity of particular layers is similar and in accumulated horizons is less.

Alluvial deposits already at the moment of sedimentation contain humus compounds. This is why a great amount of humus is found in the deeper layers of this soil. At present, due to influence of meadow plants there occurs humus accumulation in the surface layers, specifically in the 0–10 cm layer. Organic substances in the Kazuńskie Meadow soils undergo rapid decomposition, which can be seen by the narrow ratio of C : N.

The Kazuńskie Meadow soils have a great absorption complex capacity, saturated mainly with calcium and magnesium and in lesser amounts by sodium and potassium. These four basic ions compose 76.0 to 98.0% of the entire absorption complex capacity.

## DISCUSSION AND CONCLUSIONS

The investigated soils vary in typology, hydrological conditions, and physial and chemical values and can be divided into two groups.

The Strzeleckie Meadow soil (muck-like black earth)(Musierowicz 1958) formed from oligotrophic river sand was poor in mineral elements essential for plant growth. The main minerals derived from sand are quartz and minute amounts of mica and feldspar, which are potential sources of small amounts of calcium, magnesium, potassium, and other elements. Basic ions, which are released by the weathering process from elementary minerals, are held in the soil, as long as mineral and organic absorbants are present. In the deeper layers of Strzeleckie Meadow soil, there is a lack of organic absorbants; and mineral absorbants are found in minute amounts (1–3% colloidal clay fraction). This is why the deeper layers contain a small absorption complex capacity, and this minimal amount is easily assimilated by plants.

Brown gleyed alluvial soil, brown strongly gleyed alluvial soil, and alluvial gley soil (Tomaszewski 1968) are formed on the Kazuńskie Meadows from rich alluvial deposits, containing humus sedimentary compounds and large amounts of colloidal mineral components. Into the colloidal composition enters among other clay minerals, the montmorillonite groups, which increase the absorption complex capacity and decide the physical properties of this

Calculation of the value of exchangeable Ca, Mg and K in g/m³ of soil

Tab. IV

| | Ca | Mg | K |
|---|---|---|---|
| Strzeleckie Meadow soil (profile No. 1) | 668.8 | 3.21 | 10.96 |
| Kazuńskie Meadow soil (profile No. 2) | 5489.3 | 611.53 | 96.49 |

soil. The absorption complex of the Kazuńskie Meadow soil contains large cation amounts, calcium, magnesium, and potassium, as seen by Table IV.

The Kazuńskie Meadow soil, in comparison to Strzeleckie Meadow soil, is more fertile meadow habitat.

## REFERENCES

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## BADANIA PRODUKTYWNOŚCI DWÓCH TYPÓW ŁĄK W DOLINIE WISŁY

### II. WARUNKI GLEBOWE

Streszczenie

W pracy podana jest charakterystyka gleb dwóch zbadanych obiektów łąkowych – Łąk Strzeleckich i Łąk Kazuńskich. Oba obiekty położone są w dolinie Wisły na aluwiach rzecznych. Gleby Łąk Strzeleckich wytworzyły się z luźnych i słabo gliniastych piasków rzecznych, w warunkach okresowo nadmiernego uwilgotnienia pod wpływem roślinności łąkowo-bagiennej. Na znacznej powierzchni Łąk Strzeleckich występują głownie czarne ziemie murszaste, w których występuje akumulacja próchnicy i substancji organicznej. Próchnica i substancja organiczna decydują o właściwościach fizycznych i chemicznych wierzchnich warstw tych gleb.

Gleby Łąk Kazuńskich to bardzo żyzne, zasobne w składniki mineralne mady brunatne oglejone i mady glejowe o składzie mechanicznym pyłów ilastych i iłów pylastych. Aktualnie w wierzchnich warstwach gleb Łąk Kazuńskich zachodzą łącznie z akumulacją próchnicy procesy brunatnienia, a w strefie zalegania poziomu wód gruntowych procesy redukcyjne.

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