The occurrence of distinct prismatic and platy structures in organic soil profiles

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Summary

Distinct soil-structure development, *viz.* prisms and plates, was observed in organic soils of the north-eastern part of the Netherlands.
Field investigations revealed that these peds were correlated with a deep groundwater table. The latter appeared to be associated with:
1. a close vicinity of a brook, which drains the area;
2. a sufficient thickness of the organic layer to form an impermeable, reduced-peat horizon. The impermeable layer prevents seepage water from higher sandy soils to rise in the profile;
3. iron coatings on the peds, which favor a high permeability of the oxidized peat.

1. Introduction

During field investigations in the dry summer of 1959, distinct prismatic structures in organic soils were noticed for the first time in the Netherlands. Two layers of prisms were found on top of each other. In the upper layer, very distinct prisms of 5—10 cm width and about 15 cm length were noticed. In the lower layer prisms were also very distinct, but reached 20 cm in width and 30 cm in length. The prisms had a brilliant appearence, caused by the red- to orange-coloured iron coatings.
The structures were at that time supposed to occur only in very dry summers. The phenomenon, however, was apparent again during the wet summers of the following years. It was also noticed that great differences in distinctness of the prismata occurred over short distances. The occurrence of these prismata and the factors determining their development were studied and will be described hereafter.

2. Landscape

In the province of Drente (NE part of the Netherlands) valleys have been eroded in the sandy-soil areas during earlier eras. The valleys are usually 1 to 2 km wide and only a few meters deep.
Sedges, reeds, mosses and wood have formed peat, which have filled the valleys partially. Amidst the dry, sandy areas, nowadays meandering strips of organic soils which locally are called "madelanden" (made = meadow; these lands are in use as

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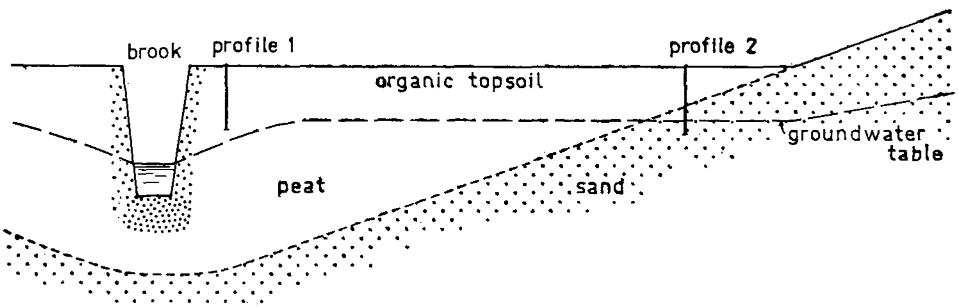
grassland) exist. In the lowest part of each valley a brook flows, ordinarilly shallow in summer, but locally flooding the whole valley in wintertime.
The FIGURE shows a cross section through a valley.

FIGURE. Cross section through a valley



3. Method of investigation

In a line rectangular to the brook, pits were dug; in these pits detailed profile descriptions were made. The descriptions included among others: horizon designations, type, size and grade of soil structure, depth of the groundwater table, the occurrence of seepage water from the higher sandy soils, the degree of oxidation or reduction of the soil material, soil colours (Munsell notation), thickness of the peat and distance from the brook.
The horizon designations were adopted from PONS (1961). In characterizing the soil structure the terminology as found in the Soil Survey Manual (1951) was used. The depth of the groundwater table was determined in the pit. After perforating the underlying peat down to the sandy subsoil by means of a plastic rod, seepage water came up. When the water table had established itself, its depth was measured. The degree of oxidation and reduction was determined by means of colouring ferrous- and ferric ions (JACKSON, 1958).

4. Field observations

Out of nine profile descriptions, two were chosen. These two showed extreme differences in development of platy and prismatic types of soil structure. The descriptions are as follows:

Profile 1. Distance from the brook 20 m; thickness of the peat 145 cm; groundwater table 95 cm below surface. After perforating the peat, the water table rose and in a rather short time it established itself at 67 cm below surface.

Description:

A_{11}	0—6 cm:	many weak, very fine subangular blocky elements and some weak, fine, crumbly elements. Colour: 5YR 2/1.5 (moist). Soil material oxidized. Some small iron spots on the peds.
A_{12}	6—10 cm:	compound, moderately strong, thick platy, composed of strong, fine, subangular to angular blocky elements. Colour: 5YR 2/2 (moist). Soil material oxidized. The platy elements are partially coated with fine dark organic

		matter and partially with iron (colour 5YR 4/6, moist). Around fossile root holes, iron coatings occur to a thickness of 1 mm.
C_{1g}	10—45 cm :	upper part of this horizon: compound, strong, very coarse prisms, composed of moderate, fine, subangular to angular blocky elements. Soil material mainly oxidized. Colour: 2.5YR 2/3 (moist). Iron occurring both in and on the peds. Lower part of this horizon: moderate, coarse prisms. Inside, the peds are reduced, outside, oxidized. Iron coatings occur on the peds. Colour of the reduced soil material: 7.5YR 2/0 (wet).
C_{2g}	45—100+ cm :	reduced peat. Original plant structure visible: sedges, reeds and twigs. Colour: 7.5YR 2/0 (wet). Below 145 cm, sandy subsoil.

P r o f i l e 2. Distance from the brook 200 m. Thickness of the peat 33 cm. Groundwater table at ± 40 cm below surface.

Description:

A_1	0—14 cm :	sod with a flat bottom. Only very few, weak, fine, subangular blocky elements. Colour: 5YR 2/1 (wet). Soil material mainly reduced. Very few iron coatings. Many roots.
C_{1g} –C_{2g}	14—33 cm :	reduced peat, at greater depth somewhat mixed with sand. In the upper part of this horizon, some fissures (oxidized), resulting in a small trend to platiness. Colour: 7.5YR 2/0 (wet). Larger plant remnants, such as sedges, reeds and twigs can be recognized. Mosses, however, cannot be recognized.
IIC_g	33+ cm :	fine-gravelly, loamy sand. Reduced.

We can conclude from the above descriptions that p r o f i l e 1 shows a distinct and p r o f i l e 2 a faint structural development.

The factors which will appear hereafter to determine the structural development, differ in these two profiles as follows:

	p r o f i l e 1	p r o f i l e 2
Depth of oxidation	45 cm	14 cm
Distance from the brook	20 m	200 m
Amount of iron present	large	small
Depth of groundwater table before perforation	95 cm	40 cm
The same, after perforation	67 cm	—

Other profiles in this sequence show the same relationship between structural development and the structure-forming factors.

5. Discussion

From the investigations it appears that a distinct structural development only occurs in profiles with a groundwater table below at least 50 cm. The depth of the groundwater table is a result of the supply and discharge of water.

The supply of water may consist of seepage water and rain water.

From the mere fact that the water table in p r o f i l e 1 rises after perforating the underlying reduced peat, follows that seepage water is potentially present, but that the reduced peat is impermeable and prevents the water to come up.

Profile development in p r o f i l e 2 shows that the groundwater table never falls below 50 cm. This is only possible if seepage water is present and if it is not prevented from rising by an impermeable peat layer.

Thus, the supply of water in p r o f i l e 1 is less than in p r o f i l e 2, due to an

insufficient thickness of the reduced peat in profile 2.
The amount of rainfall is equal for both profiles. From the above it is evident that discharge of water by vertical movement is impossible. Lateral movement requires both a sufficient lateral permeability and a sufficient slope of the groundwater table. The latter condition requires a short distance to the brook. The former condition is fulfilled by deep fissures in the peat.
Thus, distinct structural development and a deep groundwater table go together. Moreover, iron coatings on the peds favour horizontal permeability, since they weaken the reversibility of the peat.

Summarizing, distinct structural development is enhanced by a deep groundwater table. Factors determining a deep groundwater table are:

1. a close vicinity of a brook;
2. a sufficient thickness of reduced (impermeable) peat;
3. iron coatings on the peds.

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