COMPARISON BETWEEN BURIED UNCULTIVATED AND CULTIVATED IRON AGE SOILS ON THE WEST COAST OF JUTLAND, DENMARK

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Abstract

Wind blown sands have buried and preserved the soil profiles of some Iron Age soils near an Iron Age settlement in the present day Parish of Lodbjerg on the west coast of Jutland, Denmark. Some of these buried soils show signs of Iron Age agriculture, while others were not disturbed. The present study attempts to clarify this difference and to see how Iron Age cultivation affected soil-forming processes. We have found that the cultivated soils contain an abundance of fine charcoal and silt, which is integrated with the top horizon of the soil. In fact, this can be used as a diagnostic criterion for the cultivated soils. Our physical and chemical data show that the ancient cultivation affected particle size distribution, distribution of organic matter, C/N ratio, and organic phosphorous content, as well as some other parameters.

Introduction

Evidence of cultivation is generally given by palynological analysis which shows phases of clearance followed by the development of cultivated species. The soils where such evidence is found have also been studied from a pedological point of view in order to characterize the influence of ancient cultivation on the soil profile development and to determine the human impact on recent Quaternary landscape history. A number of analytical methods have been used in the attempt to gain information on the soils. Among these is determination of total phosphate content which is a frequent method used in archaeological relations e.g. (Eidt, 1977; Bakkevig, 1980). High phosphate rates, when detected around archaeological sites, are generally considered to be the result of an intense human activity. Ancient soils are frequently polluted by the present-day intensive agriculture and the interpretation of analytical data may then be critical. However, with this analytical method it seems very difficult to reach more detailed information that would reveal the origin of the high phosphate ratio.

Micromorphology has been used a few times in order to study buried soils in relation to archaeological sites (Dalrymple, 1958), and have benefit from a development of recent years (Fisher and Macphail, in press; Nisbet and Macphail, 1983). The approach of this method is to identify in thin sections any feature related to a phase of soil development or to human activity. All the features observed are then ordered hierarchically and a history of soils, based on a relative chronology, can be reconstructed with the help of archaeological data. The microfeatures (features observed in thin sections with the optical microscope) related to ancient cultivation are not, at the present time, very well known because only few undoubtly ancient cultivated soils have been investigated by this method and little experimental work has been made on cultivation with primitive tools. Both can bring basic information to the knowledge of ancient cultivation and for the characterization of microfeatures related to agricultural practices.

This paper illustrates the application of the first way of investigation to ancient cultivated soils. Buried soils well dated by archaeological data and with clear evidence of ancient cultivation are compared with the same types of buried soils, but non cultivated, in order to identify any features related to cultivation. The second purpose of this study is to bring more information on the type of cultivation that has been practised: Has some material been added to the soil as fertilizer? Have the fields been cultivated for a long period?

The study area

The area studied is located on the West coast of Jutland, Denmark, close to the present-day Parish of Lodbjerg. Along this coast, wind blown sands have been deposited at least since the 3rd millenium B.C., burying moraine materials. The recent coast line erosion has exposed an up to more than twenty meters thick section with in most places till materials at the bottom and on top of that windblown sand. In the sand three superimposed podzolized soils have developed. At the level of the lower soils remnants of an Iron Age occupation have been discovered. The excavation carried out by David Liversage, The Danish National Museum, has shown the presence of an Iron Age house surrounded by cultivated fields. Very clear furrow marks have been exposed on extensive surfaces associated with material from the Iron Age period such as small potsherds, and some flints.

Materials and methods

Two profiles were selected for detailed study:
— a podzolized profile which was not affected by cultivation,
— a comparative profile at the same level in the cultivated area.

They were described according to the Soil Taxonomy, U.S. Soil Survey Staff (1975). In each horizon, both undisturbed and bulk samples were collected respectively for thin section preparation and physico-chemical analysis.

Complementary samples to characterize lateral variations were taken in the plough layer along a profile in a cultivated field, slightly sloping from the remnants of a house in south about 100 m to a dike in north. Samples were also taken around the floor of this Iron Age house which was covered by a plough layer, and in a Bronze Age site, 3 km further North along the same beach, where human occupation layers rich in ashes were well preserved, buried under sand dunes.

Undisturbed samples were impregnated with synthetical resin; 6 × 12 cm thin sections were then prepared according to the method of Guilloré (1980) and studied under the optical microscope according to Bullock et al. (1985); the organic matter was described using the terminology of De Coninck (1980). On the bulk samples all laboratory analysis except for bulk density were carried out on material < 2 mm. Data are based on 110°C dried samples. Texture analysis were carried out on 50 g samples treated with 6 % hydrogen peroxide to remove organic matter. The samples were separated by wet sieving into two fraction at 63 µm. Particles coarser than 63 µm were dry sieved for

20 min. using ASTM standard sieves. The particles smaller than 63 μm was sedimented in Andreasen pipettes. Samples for bulk density was taken by means of steel tubes of known volume. pH was measured in a 1:1 soil/water mixture. Organic carbon was determined by dry combustion and weighing of the carbon dioxide generated. Nitrogen was determined by the macro Kjeldahl method of Bremmer in Black et al. (1965). Fe and Al complexed by organic matter was determined by extraction with 0.1 M sodium pyrophosphate after Soil Survey Staff (1975). Phosphorous was determined by extraction with 0.2 N sulphuric acid. Organic phosphorous is the difference between the content in an ignited and a nonignited sample. The ratio between the organic P in ppm and the loss on ignition in ‰ in used as an expression for the phosphorous content in the organic matter.

Profile descriptions

Description of the buried uncultivated soil (Fig. 1).

I 15—5 cm. alternation of brownish grey loose sand (7.5YR5/2) and black brown to black (7.5YR3/2 to 2/0) heatherpeat layer, few mm thick, massive, friable, abrupt wavy boundary.

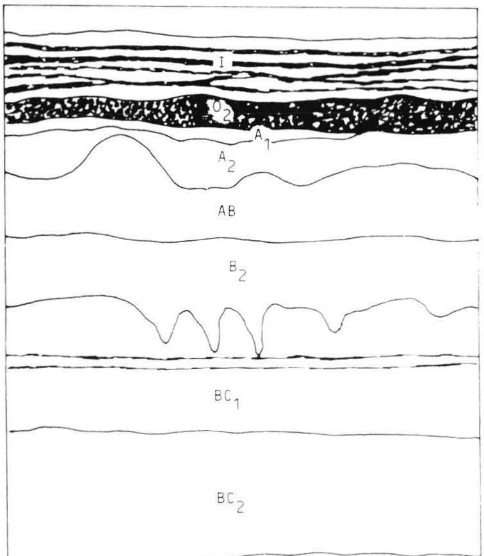

Fig. 1. Section of the buried uncultivated soil.

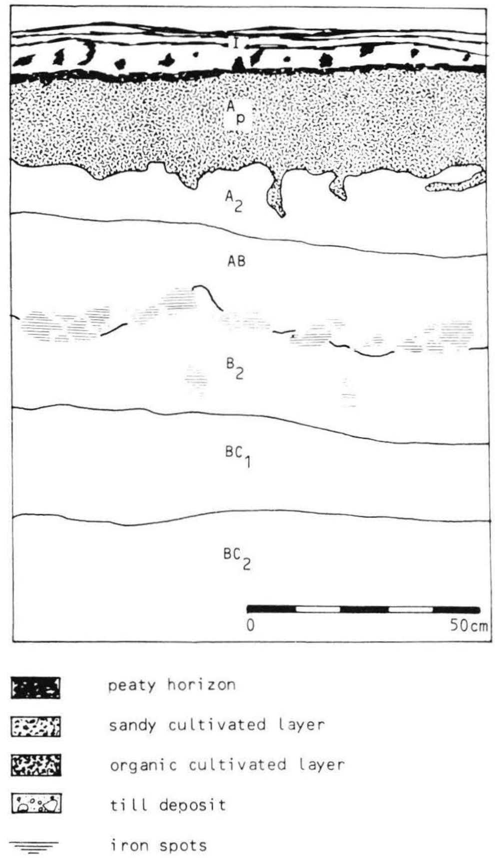

Fig. 2. Section of the buried cultivated soil.

O_2 5—0 cm. black brown (7.5YR3/2) to black (7.5YR2/0) sandy heather-peat, massive friable, with a dark brown (7.5YR4/4), thin moderately cemented mineral pan, abrupt wavy boundary.

A_1 0—3 cm. Brownish grey (7.5YR4/2), structureless, friable sand, abrupt wavy boundary.

A_2 3—10 cm. Brownish grey (7.5YR5/2) with few grey white (7.5YR8/0) pockets, structureless, friable sand, gradual wavy boundary.

AB 10—22 cm. Brownish grey (7.5YR4/0) with black brown to black spots (7.5YR3/2 to 2/0) sand, structureless, friable, abrupt wavy boundary.

B_2 22—43 cm. Black (7.5YR2/0) at the upper part, then gradually lighter dark brown (7.5YR3/4) to the bottom with many black subvertical spots, sand, structureless, friable, gradual wavy boundary.

BC_1 43—73 cm. Yellowish brown (10YR5/4) with black (7.5YR3/2) spots, sand, structureless friable, diffuse wavy boundary.

BC_2 73—106 cm. Grey yellowish brown (10YR6/4) sand, structureless friable, abrupt wavy boundary.

C 106—186. cm. Yellow (10YR7/4), sand, structureless friable, clear smooth boundary.

Description of the buried cultivated soil (Fig. 2).

I 12—0 cm. alternation of brownish grey (7.5YR5/2) and brown (7.5YR5/6) sandy layers with yellowish brown (5YR5/6) spots at the lower part, structureless, friable. The limit between I and the cultivated layer is marked by a black brown (7.5YR3/2), few mm thick, moderately cemented pan, abrupt boundary.

A_p (plough layer). 0—18 cm. Dark grey (10YR4/1) sand, with few yellowish brown (7.5YR4/6) spots, few gravels and very small charcoal particles, structureless friable clear wavy boundary.

A_2 18—29 cm. Grey (10YR6/2) sand with few yellowish brown (7.5YR4/6) spots, structureless, single grain, loose, gradual wavy boundary.

AB 29—41 cm. Degraded B horizon with bleached sand grains, in lighter parts brown to dark brown (7.5YR5/2—4/2) in darker parts, very dark grey to dark brown (7.5YR3/0—3/2) the darker parts get more common at the bottom of the horizon with black (7.5YR2/0) spots and few rusty streaks strong brown (7.5YR4/6), structureless single graing, loose, clear wavy boundary.

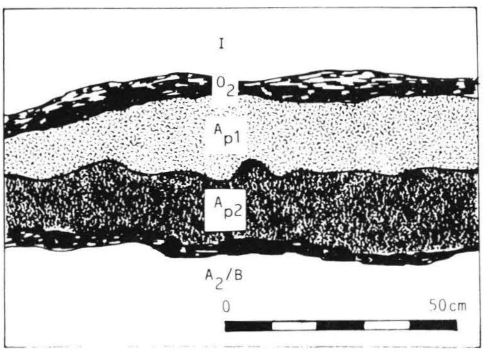

Fig. 3.

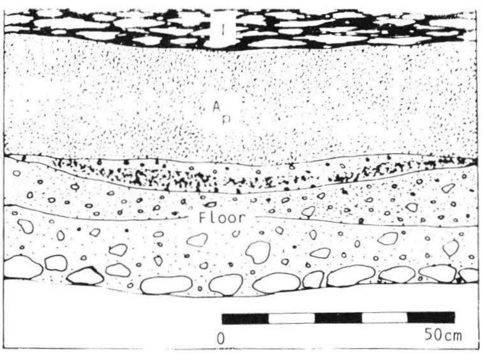

Fig. 4.

Fig. 3. Section of the cultivated layer where two different surfaces with furrow marks have been identified.

Fig. 4. Section of the Iron Age, house showing the till floor and the overlying cultivated layer.

B_2 41—66 cm. Black brown (7.5YR3/2) at the upper part with many black spots to dark brown (7.5YR4/4) at the lower part, sand, structureless, friable, gradual wavy boundary.

BC_1 66—86 cm. Yellow brownish grey (10YR5/3) with black brown (7.5YR3/2) spots, sand, structureless, single grain, loose, gradual wavy boundary.

BC_2 86—136 cm. Yellow brownish grey (10YR6/3) with few dark brown (7.5YR4/4) spots, sand, structureless, single grain, loose, abrupt wavy boundary. The BC_2 is overlying a till.

In the buried cultivated soil described above clear furrow marks are visible at the bottom of the plough layer (A_p). Locally the plough layer was thicker (Fig. 3) and furrow marks have been observed during the excavation between A_{p1} and A_{p2} and between A_{p2} and AB horizons. These layers have been sampled.

The Iron Age house (Fig. 4) was characterized by a floor made of till materials, very coarse at the lower part, then finer consisting of clayey sand. A thin charcoal layer was observed and interpreted as occupation dirt on the floor. This floor was truncated by the cultivation, an A_p horizon, with the same morphological properties as the one described above overlied the floor.

The section in the Late Bronze Age site exhibited grey black (10YR3/1) and reddish brown (5YR4/6) sandy layers rich in organic matter, charcoal and archaeological material, alternating with brownish grey (7.5YR5/2) loose sand. The transition between the occupation layers and the dune sand was gradual and appeared as an alternation of grey sand and very thin dark layers.

Results

Laboratory data

The results of the particle size analysis show that the material as expected is very well sorted with in most samples more than 90 % medium and fine sand. Generally the top horizons have a higher content of fine material than the lower ones, most clearly seen in the top A_p horizon in the cultivated profile. The silt and clay size material < 38 μm total as much as 6—6.3 % in the A_p horizon of the cultivated soils while the corresponding A_1 and A_2 horizons in the uncultivated profile contain 2.8 and 0.9 %. In the uncultivated profile accumulation of organic matter has taken place in the O_2 horizon, and there is indication on accumulation of organic matter in the B_{21} horizon in agreement with that we here found the highest content of pyrophosphate extractable Fe and A1. In the cultivated profile the content of organic matter is again higher in the top horizon (A_p), and there is a slight accumulation in the top B_2 horizon here also in agreement with pyrophosphate extractable Fe and A1. The C/N-ratio in the A_p horizon in the cultivated soil is low compared to the top horizons of the uncultivated one, though it is not as low as it probably would be in the same soil cultivated today. The pH is about one unit lower in the top horizons in the uncultivated soil than in the cultivated. This is a normal thing to see, in comparative present day profiles too. The organic phosphorous content can only be compared from profile to profile when expressed in relation to organic matter, here loss on ignition (I) and if org. P/I is compared in the cultivated and the uncultivated soil it can be seen that the ratios are considerably higher in the A_p and A_2 horizon of the cultivated soil than in the O_2, A_1 and A_2 horizons of the uncultivated.

Horizon	Depth cm	Texture % of <2 mm: 2-1 mm	1-0.5	0.5-0.25	0.25-0.125	0.125-0.063	0.063-0.038	0.038-0.016	0.016-0.008	0.008-0.004	0.004-0.002	< 0.002	< 38µm	Bulk density	%	Org. C %	%	C/N	pH H_2O 1:1
I	15-5	0.06	0.66	16.39	71.07	4.77	2.92	0.88	0.70	0.69	0.34	1.52	5.46	1.55		1.47		20	4.05
O2	5-0															8.33		49	3.42
A1	0-3	0.0	2.56	23.49	68.07	2.54	0.93	0.47	0.51	0.17	0.30	0.97	2.78			1.07		47	3.95
A2	3-10	0.0	0.14	7.73	89.32	1.73	0.15			0.93			0.93	1.64		0.32		29	4.28
AB	10-22	0.02	1.21	24.11	72.20	1.33	0.34	0.04	0.02	0.20	- 0.58 -		1.01	1.62		0.34		28	4.27
B21	22-	0.02	0.75	17.83	78.69	1.29	0.58	- 0.01 -		0.11	0.04	0.71	1.32	1.62		0.72		33	4.35
	-43	0.0	0.24	24.00	74.01	0.97	0.04	-	-	0.73			0.73	1.69		0.45		32	4.60
BC1	43-73	0.02	1.53	32.59	64.56	0.86	0.03	-	-	0.41			0.41			0.12			4.60
BC2	73-106	0.0	0.83	30.38	67.79	0.76	0.03	-	-	0.20			0.20			0.08			4.48
C	106-156	0.01	1.59	25.01	71.47	1.59	0.06	-	-	0.28			0.28			0.06			4.54

Prøve nr.	Prøve dybde cm	Horisont	Karbonat som $CaCO_3$ %	Udbyttelige kationer pH 7: Ca^{++} (mekv/100g)	Mg^{++}	K^+	Na^+	CEC NH_4OAc pH7	H^+ pH8	CEC sum	Basemætn. grad %	Fe_2O_3 % Pyro	DCB	Ox.	Al_2O_3 % Pyro	DCB	Ox.	Org. P ppm	Org.P/I
												0.037			0.084			89	35
												0.070			0.225			96	7
												0.027			0.040			18	11
												0.010			0.021			14	27
												0.015			0.050				
												0.045			0.018				
												0.034			0.014				
												0.017			0.055				
												0.012			0.052				
												0.016			0.039				

Table 1. Laboratory data for the buried uncultivated soil.

Horizon	Depth cm	Texture % of <2 mm: 2–1 mm	1–0.5	0.5–0.25	0.25–0.125	0.125–0.063	0.063–0.038	0.038–0.016	0.016–0.008	0.008–0.004	0.004–0.002	< 0.002	<38µm	Bulk density	%	Org. C %	%	C/N	pH H_2O 1:1
I	12-0	0.02	3.72	63.51	31.93	0.25	0.03	-	-	0.54			0.54			0.09			4.95
Ap	0-18	0.11	0.70	17.31	70.35	4.20	3.16	0.77	0.73	0.57	0.38	1.73	6.01	1.52		0.85		20	4.75
A2	18-29	0.0	0.21	10.06	86.84	1.57	0.07	0.18	0.14	0.12	0.21	0.61	1.12	1.53		0.20		40	4.83
AB	29-41	0.06	4.39	30.10	63.26	1.21	0.13			0.85			0.85	1.64		0.24		34	4.83
		0.0	0.70	25.39	72.79	0.65	0.03			0.44			0.44			0.31		34	4.92
B2	41-66	0.0	0.51	25.93	72.19	0.67	0.06			0.65			0.65	1.56		0.57		29	5.16
		0.02	2.08	38.12	58.88	0.43	0.02			0.44			0.44	1.61		0.22		28	5.06
BC1	66-86	0.01	1.92	26.43	68.66	2.57	0.11			0.30			0.30	1.58		0.11			5.00
BC2	86-136	0.02	2.07	40.45	56.20	0.94	0.02			0.30			0.30	1.73					5.16

Prøve nr.	Prøve dybde cm	Horisont	Karbonat som $CaCO_3$ %	Udbyttelige kationer pH 7: Ca^{++}	Mg^{++}	K^{+}	Na^{+} (mekv/100g)	CEC NH_4OAc pH7	H^{+} pH8	CEC sum	Basemætn. grad %	Fe_2O_3 % Pyro	DCB	Ox.	Al_2O_3 % Pyro	DCB	Ox.	Org. P ppm	Org.P/I
												0.035			0.032			5	26
												0.029			0.091			84	53
												0.009			0.017			13	43
												0.011			0.039			11	34
												0.015			0.098			5	9
												0.020			0.226				
												0.013			0.114				
												0.018			0.076				
												0.017			0.046				

Table 2. Laboratory data for the buried cultivated soil.

Micromorphological properties

The upper layers consist in the two profiles of alternating beds of clean quartz sand grains, with an average size of 200 μm and thin black layers of polymorphic organic matter.

The O horizon of the buried uncultivated soil is characterized by the same coarse fraction as the upper layer and by an abundant, regularly distributed, black, dense, polymorphic organic matter, partly microaggregated and partly coating the sand grains (Pl. 1). A little fine silt (15—20 μm) and small fragments of charcoal are closely mixed to the polymorphic organic matter.

The A_1 horizon consists of well sorted, loosely packed sand grains mainly quartz, hornblende and few opaques, slightly coated by dark polymorphic organic matter (Pl. 9).

In the A_2 horizon the sand grains are clean and loosely packed. The AB horizon is characterized by the juxtaposition of patches where sand grains are clean as in the A_2 horizon and patches where sand grains are slightly coated with dark brown polymorphic organic matter. With depth the polymorphic organic matter merges gradually into monomorphic organic matter. The BC horizon is characterized by brownish yellow coatings of monomorphic organic matter, few μm thick.

The A_p horizon of the cultivated soil consists of the same coarse fraction as the A_1 of the uncultivated soil but polymorphic organic matter is very rare. The fine fraction consist of dusty yellowish brown silty clay forming small aggregates between and around sand grains, with a size of 100 to 500 μm. This material is also present as rare subrounded patches, few mm in extent (Pl. 2). At high magnification (P1.3) this fine fraction appears to consist of some silt and very fine sand grains (150 to 50 μm), abundant, poorly sorted fine fraction (50 to few μm), many fragments of phytoliths and small organic residues all mixed with a very dusty, yellowish brown, non birefringent fine mass. At some places small domains characterized by a yellow, slightly birefringent fine fraction mixed with silt and fine sand have been observed; they are more abundant and regularly distributed in the A horizon just above the floor of the Iron Age house. Very rounded fragments of potsherds have also been observed in the A_p.

The microfabric of the cultivated layer can vary locally. In the lower part of the A_p horizon at a place where two layers of furrow marks have been observed (Fig. 3) the

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LIST OF PLATES

1. Polymorphic organic matter and quartz sand grains of the O horizon of the buried virgin podzol. Plain light, ×50.

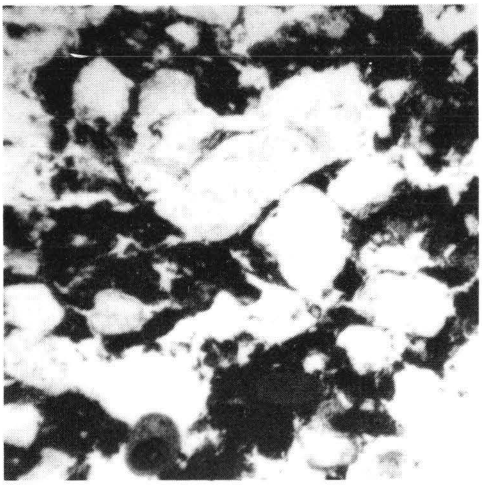
2. Typical microfabric of the cultivated layer: mixture of fine charcoal, silts and fine sands with a dusty yellowish brown fine fraction. Plain light, ×50.

3. Detail of plate 2 showing the abundance of fine charcoal and the presence of phytoliths (one is indicated by the arrow) Plain light, ×130.

4. One piece of ceramic in the cultivated layer. Plain light, ×50.

5. Microfabric of the Ap_2 layer (Fig. 3) intermediate between the microfabric of the peaty horizon and the typical microfabric of the cultivated layer. Plain light, ×50.

6. Microfabric of the hearth in the Iron age house: abundant fragmented charcoal closely mixed with the clayey sands. Plain light, ×50.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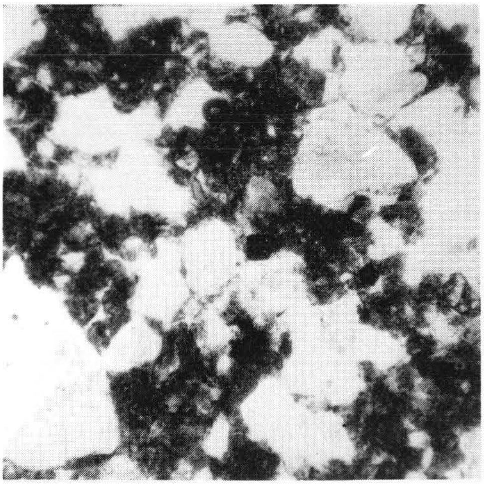
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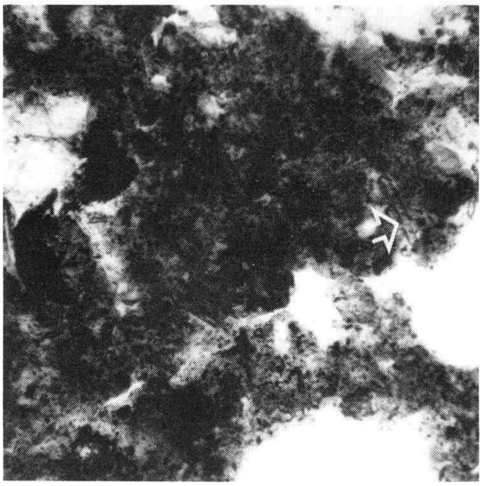
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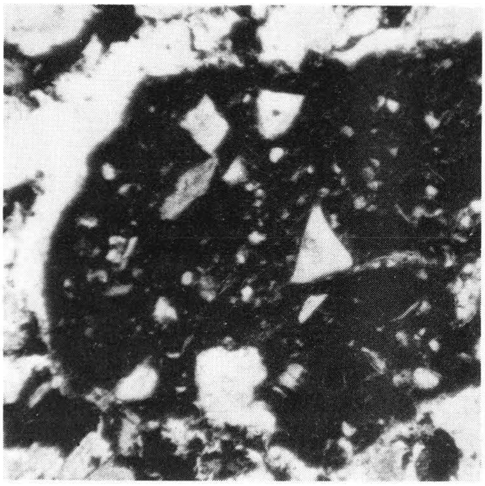
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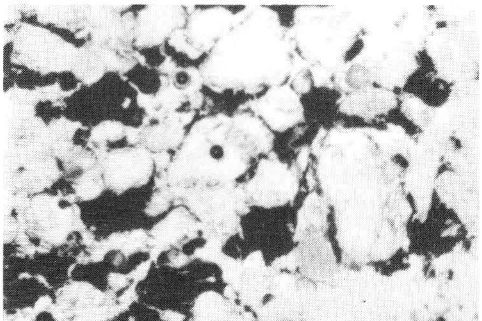
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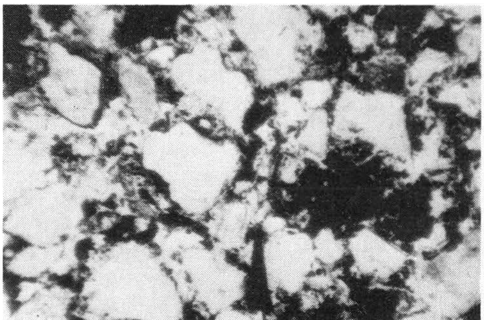
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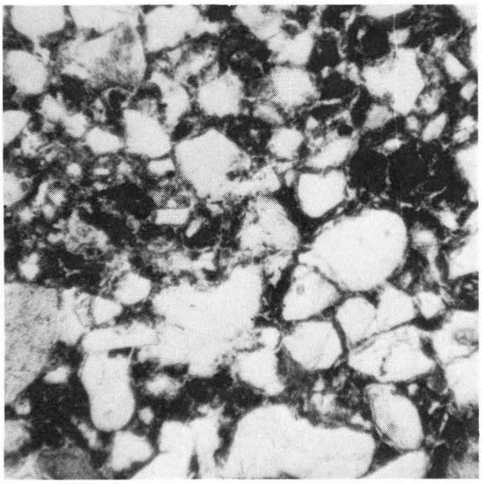

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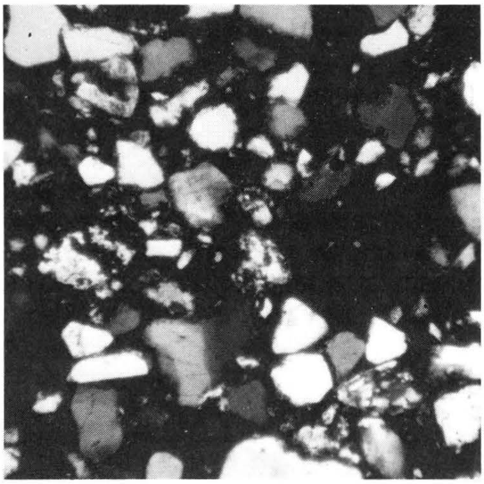

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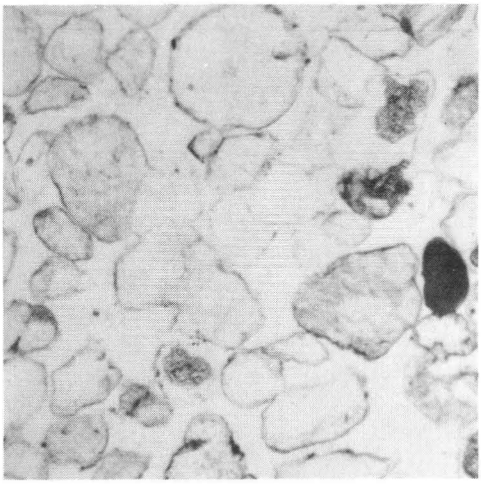

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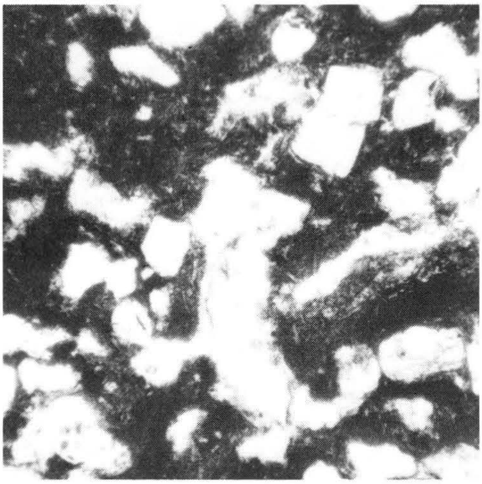

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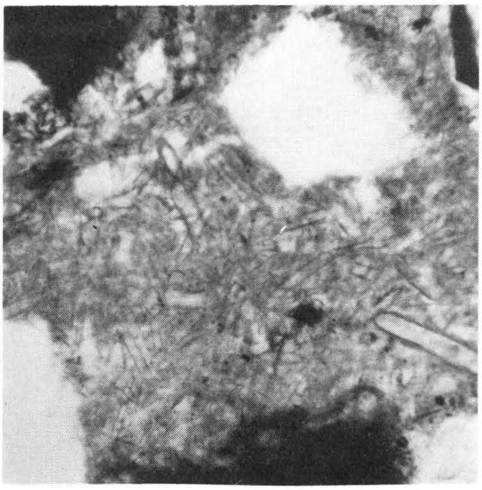

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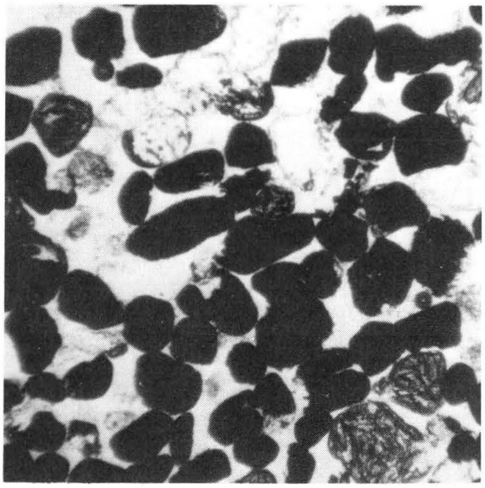

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fine fraction is present as very dark brown aggregated rich in fine charcoal, polymorphic organic matter and a little silt, between and around the sand grains (Pl.5); the features, here are intermediate between those described above in the A_p and in the O horizons.

The microfeatures of the horizons below the cultivated layer are very close to those described in the equivalent horizons of the buried uncultivated soil.

The till material used as floor in the Iron Age house consists of well rounded quartz sand grains, subangular fine sand and silt and a yellowish, slightly birefringent silty clay fine fraction (Pl. 7&8); these features are very close to those observed in the yellow domains of the Ap horizon. In the thin dirt layer on the floor (Fig. 3) this material is mixed with abundant fragmented charcoal (Pl. 6).

In order to compare with the Lodbjerg Iron Age site, a few features have been selected in the Late Bronze Age site observed further North. The occupation layers are characterized by a very dense fabric composed of the same coarse fraction as those described previously in the buried soils. The fine fraction is yellowish brown, isotropic with few slightly birefringent domains with abundant silt and fragmented charcoal (Pl. 10) which appear at a higher magnification to be very rich in diatoms (Pl. 11), and in which local concentrations of phytoliths have also been observed.

At the boundary between the occupation layers and the dune sand the wind blown materials consist mainly of very well rounded black grains, organized as subhorizontal layers and mixed with few quartz sand grains (Pl. 12); these black grains are charcoal.

Discussion

The increase in fine fraction in top horizons of sandy soils was reported earlier (Nørnberg, 1977) and it has been shown that in this climatic region the main reason is in situ fragmentation (Nørnberg, 1980). It was also shown that the increase in silt and clay size material was more distinct in cultivated soils than in the corresponding uncultivated soils (Nørnberg, 1977) which is also obvious from the analysis in this study. This indicates that the soil has probably been cultivated for some time. The horizon developments and the distribution of organic carbon tells us that the uncultivated soil has never been cultivated. The rather thick O_2 horizon changes in direction away from the cultivated area into a peaty layer and we are probably at the border of a flat wet plane comparable to what is seen today in the dune sand areas. The transport of organic matter iron and aluminium down into the B horizon is an indication of the

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7. The till floor of the Iron age house composed of a yellowish silty clay mixed with well rounded sand grains. Plain light, ×50.

8. View in polarized light of plate 7 showing the slight birefringence of the yellowish fine fraction. ×50.

9. A_1 horizon of the buried virgin podzol showing sand grains slightly coated by dark polymorphic organic matter. Plain light, ×100.

10. Microfabric of the occupation layers of the Late Bronze age site characterized by a yellowish brown fine fraction mixed with the coarse sand fraction. Plain light, ×50.

11. Detail of plate 10 showing the local abundance of diatoms. Plain light, ×130.

12. Well rounded sand grains of charcoal at the bottom of the sand dune overlying the Late Bronze age site. Plain light, ×50.

chilate transport podzolization process. If the total content of organic C is calculated in the A_p horizon of the cultivated profile it is somewhat lower (23 t/ha) than the corresponding upper 18 cm (incl. O_2) of the uncultivated soil (33 t/ha). This indicates that if the O horizon was not burnt completely before cultivation the content or organic matter is lower in the cultivated than in the uncultivated soil which is in correspondance with what is seen in present day soils (Nørnberg 1977). The C/N ratio is lower in the A_p horizon than in the uncultivated top horizons and that again indicates that the decomposition rate of the organic matter is higher. The pH change from about 3.8 to 4.8 in the top soil is also an indication on the decomposition of organic matter during cultivation.

The micromorphological observations show that charcoal has been spread around over the Iron Age fields. The abundance of till just above the floor of the Iron Age house is probably a consequense of reworking of the floor by the plough, as it is not seen in the cultivated layer studied few hundred meters away from the house.

Different hypothesis can be proposed to explain the abundance of charcoal in the cultivated layer. Slash and burnt practices, in which the heathland or the weeds would be burnt before the ploughing, could be one of them. They could also have been added by wind, reworked from the Iron Age settlement. However, we would expect the wind transportation to give at least few well rounded charcoal pieces like those observed just above the occupation layers of the Late Bronze Age site, but perhaps the short way of transport did not create rounded particles or the charcoal came together with hearth sweepings spread on the fields. The A_p horizon is influenced by ashes, phosphate and close to the settlement mixed with till from the house floor. The till, has a certain chalk content as proved by the abundance of diatoms. The organic matter and ashes are good natural fertilizers and were probably added intentionally to improve the soils.

Conclusion

The micromorphological observations of the Iron Age fields has shown that the cultivated layers are characterized by an original fabric compared to the equivalent horizons of the buried uncultivated soil. This fabric is the consequence of a human influence. Human and animal organic waste was probably spread over the fields for the purpose of fertilizing. House sweepings, a mixture of till from the floor, ashes from the hearth, ceramics, bones and flints, was thrown out and mixed with the topsoil by ploughing. During the years this gave rise to the homogenous A_p horizon which was buried by the windblown sand.

It is to some extent a questionable matter to estimate for how long time the fields have been cultivated. The increase in silt and clay size materials which seems to be a general feature in cultivated soils compared to uncultivated. The decrease in total amount of organic matter, the lowering of the C/N-ratio, the increase in pH and the increase in phosphorous content in the organic matter indicates that the soil has been cultivated for a rather long period. The mechanical fragmentation has accelerated the decomposition of the top organic horizons which explains that only very rare fragments of polymorphic organic matter have been identified in the microfabric of the cultivated layer (A_p).

However, locally polymorphic organic matter are more abundant (Pl. 5) a fact which can be explained by variation in thickness of the original O horizon. All together it seems likely that the soil was cultivated for at least one hundred years, maybe a few hundred years.

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