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Palynological Investigation of a Kettle near Ulmiz (Kanton Fribourg), Switzerland

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During the last glaciation the western part of the Swiss plain was covered by the Rhône glacier. In its maximum stage (ca. 18.000 B.P.) it reached Wangen a. Aare. The retreat (in time) of the Rhône glacier, however, is not very well known since endmoraines – delineating retreat-stages – hardly occur in the western Swiss Plain. It is known that part of the Lake Geneva basin became ice-free around 16.000 B.P. (Hantke, 1970). The Older Dryas has been recognized several times around Lake Geneva (a.o. Gaillard, 1977). One of the possibilities of dating the ice retreat is by pollen analysis of some of the many peats between these two dated glacier positions. When studying the soils of the Murten area, one of the authors obtained a 4.7 m long core from a kettle near Ulmiz which was analyzed and subsequently published (Van der Meer, 1976). One of the conclusions was that ice retreat in this area occured around 15.000 B.P. The interpretation of the pollen diagram however was not very satisfactory, among others because a pronounced Younger Dryas was suggested, which is not often the case in the alpine foreland (Watts, 1980). So it was decided to get a new core and have it ^{14}C dated. This new core was taken in 1977, the result of the pollen and mollusc analyses, together with ^{14}C dates are presented in this paper.

Location

The core was obtained from a small kettle near the village of Ulmiz (1:25.000 map no. 1165, Murten; co-ord. 581.2/196.7) some 12 km's north of Fribourg. The exact location is indicated in fig. 1.

Geology

The basin from which the core was obtained is interpreted as a kettle and is surrounded by fluvioglacial sands. These fluvioglacial sands are not of great extent because 400 m E of the sampling site a small gravel pit shows till on top of waxing stage sandur·

deposits ("Vorstossschotter"). Because a different lithology was found in the first core studied and the core dealt with in this paper, it was decided to study the filling of this basin more in detail.
One of the differences between the two cores was the occurrence of a calcareous mud (or lake marl) layer in the second core. The basin is at least 4.75 m deep. As it was known already that the lower part of the filling consisted of sterile clay on a sandy substratum, no systematic augering was done to study the bottom topography of the basin. Due to the cereals grown in the northern part of the basin no augering could be undertaken there.

The filling of the basin consists of four different units. From the bottom up, the filling consists for the greater part of clay, which contains some plant remains in its upper part. In several augerings reddish wood remains were found, about 6 to 7 mm thick and always in a more or less vertical position (^{14}C age: 3800 ± 160 B.P.; GrN-9814). Analysis of the wood in the Laboratory for Quaternary Wood of Dr. F.H. Schweingruber (Birmensdorf, Switzerland) gave as a result *Alnus sp.* (possibly root). This clay shows a gradual transition to a peaty clay layer, which varies in thickness from 15 to 70 cm. In this peaty clay wood is found regularly.

The upper part of this peaty clay is in two places replaced by calcareous mud (lake marl) containing wood and abundant molluscs. Dr. D. van Harten of the Geological Institute (University of Amsterdam) looked at the octracods in this material. He found that the fauna consisted almost exclusively of larvae of *Cypridopsis vidus* (O.F. Müller) and some fragments of *Candona sp.* He observed that decalcification had occurred, but since the deposit is very rich in carbonates (Many molluscs and *Characeae*) he did not think that this decalcification was due to an acute shortage of carbonates as Oertli does (in Schlüchter, 1976, p. 50). We suggest that this is the result of percolating humic acids from the overlying peat. Fig. 1 shows that this calcareous mud is not found in the whole basin, but in two clearly defined "sub"basins. The gradual transition from peaty clay to peat in the areas where no calcareous mud was found indicates that no deposition of this mud occured there. Besides it shows that no erosion occured either.

The upper layer of the basin filling consists of peat, sometimes still clayey at its base. Where it is overlying the calcareous mud it sometimes contains some molluscs as well in its basal part. The maximum peat thickness that we observed was about 1 meter. According to the farmer who owns the parcel, the peat has been exploited during the last century, and that is probably the reason why the diagram does not extend beyond the Boreal.

Sampling and Processing

The core was obtained by a peat corer with a diameter of six cm. The lithostratigraphy is as follow:

0- 40	disturbed peat
40- 65	peat, black, many roots of *Carex*
65- 80	peaty calcareous clay, brown with roots of *Carex*, with oögones of *Chara* from 75 cm
80- 89	peaty calcareous clay, brown with roots of *Carex* and oögones of *Chara*

89-128	lake marl, yellowish with oögones of *Chara*
128-198	calcareous clay, grey

All samples were boiled with KOH for 10 minutes, sieved (screen opening 0.28 mm) and subjected at 98^0 C to acetolysis during 10 minutes. Pollen and other organic constituents were separated from mineral fragments by using a bromoform/alcohol mixture with specific gravity 2. The pollen was embedded in gelatine/glycerine without staining.

Description and interpretation of the diagram

The pollen diagram has been divided in the pollen zones Ia,Ib, Ic, IIa, IIb, III, IV and V of Firbas (1949), thus the Older Dryas, Bølling, Earlier Dryas, Allerød, Late Dryas, Preboreal and Boreal.

Zone Ia, Older Dryas, 198-128 cm: in the lowermost section 198-195 cm the pollen is indicative of a vegetation rich in steppe elements, *Artemisia, Chenopodiaceae, Gramineae.* Trees must have been totally lacking. It should represent the very end of the ultimate glaciation. During the period between 195–128 cm the species of *Betula* start rising gradually but they did not form dense stands, as can be deduced from pollen of many *heliophytes* occuring in high percentages. The large amounts species of *Betula* start rising gradually but they did not form dense stands, as can be deduced from pollen of many *heliopytes* occuring in high percentages. The large amounts of pollen from these plants growing on open and dry habitats as compared to the amount of marsh and waterplants may be ascribed to the width of the former lake which was between 200-150 m. Reconstructing the local vegetation during the Older Dryas it can be said that the dryer and higher sand bodies in the vicinity of the former lake delivered the open habitats for *Juniperus, Ephedra, Helianthemum, Plantago, Artemisia, Chenopodiaceae* and *heliophilous* species, being able to stand long and cold winters. Especially the abundance of *Artemisia,* together with the occurence of *Ephedra,* points to a climate with dry summers and cold winters (difference between mean January and mean July temperatures come to more than 20^0, Ellenberg, 1963). Along the borders reed swamps occurred and a zone of *Myriophyllum spicatum.* The presence of *Batrachium, Myriophyllum, Nuphar* and *Nymphea* suggests that the mean July temperature has been above 10^0C (Ellenberg, 1963; Kolstrup, 1980). The abundance of *Botryococcus, Pediastrum* and the presence of *Selaginella* indicates that the local environment had the character of an open shallow lake with eutrophic water.

Zone Ib, Bølling, 128-99 cm

The change in lithology from calcareous clay to lake marl coincides with the drastic alteration in the vegetation. The increase of *Betula* and the decrease of most herbs can only be interpretated as a sudden change of the vegetational environment from a rather open to a more closed woodland in which the heliophilous herbs are suppressed. On the surrounding sand bodies *Betula* drives out the heliophilous herbs. In the lake *Myriophyllum spicatum* and *Pediastrum* demand an open habitat where the light is bright

(Fitter, 1972) and the closed woodland around the lake causes full shade. *Myriophyllum* disappears, *Pediastrum* drops from 100% to less than 2.5%. In the lake marl oögones of *Chara* were frequently found, a genus that may occur in lakes with depth between 0.05 and 20 m (optimum between 2.5 and 2 m). In general this genus forms vast submerged prairies, excluding most of the other vegetations. The occurrence of *Chara* may indicate a rising water level in the lake possibly in response of a shift towards a warmer climate. *Chara* is responsible for the precipitation of lake marl.

Zone 1c, Earlier Dryas, 99–95 cm.

In this zone there is a slight decrease in *Betula.* This caused more open *Betula* woods by which *Juniperus* could expand again.

Zone IIa, b; Alllerød, 95–81 cm.

During the first part of the Allerød (IIa) the immigration of *Pinus* is very vigorous. *Betula* drops. In the second part (IIb) *Pinus* dominates *Betula.* The herb percentages are low. The landscape must have been covered with a dense *Pinus-Betula* wood. The lake marl changes into peaty calcareous clay. The lake is silting up. A ^{14}C date was obtained from the organic material between 81–83 cm: 11.300 ± 90 B.P. (GrN-9345). This date suggests a late Allerød age. The Allerød lasts from 11.000 - 11.800 B.P.

Zone III, Late Dryas, 81–78 cm.

Betula increases. *Pinus* drops. There is a small expansion of the herbs. *Juniperus* returns, indicating some open spots in the *Betula-Pinus* woods. *Chara* disappears.

Zone IV, Preboreal, 78–65 cm.

Pinus expands again. Very dense *Pinus-Betula* woods covered the landscape through which the herbs are suppressed.

Zone V, Boreal, 65–55 cm.

The transition from zone IV into zone V is charcterised by the immigration of *Corylus, Alnus, Quercus, Ulmus* and *Tilia,* due to the final amelioration of the climate. *Pinus* and *Betula* decrease. The clay sedimentation ceased, which points to an amelioration of the climate too.

The surroundings of the lake, which was being filled with peat now, were covered with dense forest.

It is supposed that *Corylus* mainly occured in the wetter sites along the margin of the lake. Another species along the margin of the lake was *Ulmus*, which is abundant in the Alno-Ulmion.

A ^{14}C date from material between 56–60 cm confirms the Boreal time of the deposit: 8.135 ± 50 B.P. (GrN-9345).

Mollusc analysis

From one of the augerings a 30 cm's long core was taken from the calcareous mud (fig. 1) for mollusc analysis. This analysis was kindly performed by Dr. G. Spaink of the State Geological Survey of the Netherlands. His main findings are presented in table 1 (taken from Spaink, 1980). Based on differences in colour and plant remains he divided this small core in five parts. For each part the number of species and the number of individuals or fragments are indicated in this table.

The fauna throughout the sample is fairly uniform and points to stagnating or standing, shallow sweet water, with probably a rich flora. Especially the gastropods live in this environment, while the bivalves in general prefer a somewhat broader environment. No species, typifying running water, were found.

As for the temperature the fauna is clearly cooler than the present-day fauna and it fits well with the dating of this calcareous mud of Bølling and Allerød age.

The fauna at Ulmiz is in good agreement with that found by Arn (1978) in the neighbourhood of Lausanne, also dating from the Bølling and Allerød periods. The faunas presented by F. & M. Burri (1977) from Lausanne and by Burri (1979) from Yverdon, also dating from the Bølling and in the latter case from the Allerød and Younger Dryas as well, show resemblances, although especially the latter contains many more species.

Conclusion

The pollen diagram from the Late-Glacial shows trends in the pollen curves pointing to changes in the regional vegetations as well as to changes in the lake ecosystem. As mentioned above it deepens, by which the *Potamion* changes into a *Charion*.

Table 1. Mollusc fauna

	0,70 – 0,74 m	0,74 – 0,84 m	0,84 – 0,90 m	0,90 – 0,96 m	0,96 – 1,00 m
Armiger crista			3-	7aa	1/
Bathycomphalus contortus		2-			
Bithynia leachii	1op-				
Bithynia tentacula	2op-	3op aa	3op aa		
Gyraulis laevis	6-	12aa	3-	19aa	12aa
Hippeutis complanatus	1		1-;2-	1-	1=

Lymnaea stagnalis	3̲-				
Pisidium casertanum	2/d		3-;1/-	2;7/aa	
Pisidium hibernicum	3;8/aa		1-;1/-	2;2̲	1;1/
Pisidium lilljeborgi		2/	2;1/		
Pisidium milium	3aa		1/	2;1/	4;3/aa
Pisidium nitidum	5;22/aa	3;1/;1̲8̲aa	1;1/;1̲	4-;1/-	4;3/aa
Pisidium obtusale	2/d		1̲	1-;1/-	
Radix auricularia		5̲	2̲-		
Radix peregra		7̲-	1-;1̲1̲-	8aa;2̲4̲-	
Sphaerium corneum	1̲0̲	5̲	6̲4̲aa	1/=;73aa	35aa
Valvata cristata			2-		1=
Valvata piscinalis alpestris	47aa;1̲	126aa	105aa	72aa	23aa
Valvata pulchella	8-	17-	7-	16-	7aa
number of species	13	10	16	12	10

aa = all ages; == very juvenile;/ = loose valves; op = operculum or opercula
- = juvenile; _ = fragmentary; d = defect

The filling by plant growth begins at a depth of 89 cm. In the calcareous oligotrophic water the succession in plant communities in the riparian zone is weakly expressed. Only the submerged *Characeae* are luxuriantly developed. It is striking that from the Bølling this part of the "Mittelland" was a wooded area. The changes in the AP/NAP ratio in the Older Dryas and Younger Dryas stadials are only weakly expressed. This is in agreement with the results of Wegmüller (1966) and Matthey (1971).

As for the dating of deglaciation of this area the profile does not help much. Hantke (1970) indicates that the most eastern lobe of the Rhône glacier had withdrawn to Fétigny (SW of Payerne) by 16.000 B.P. This makes the area of Ulmiz icefree somewhere before this date.

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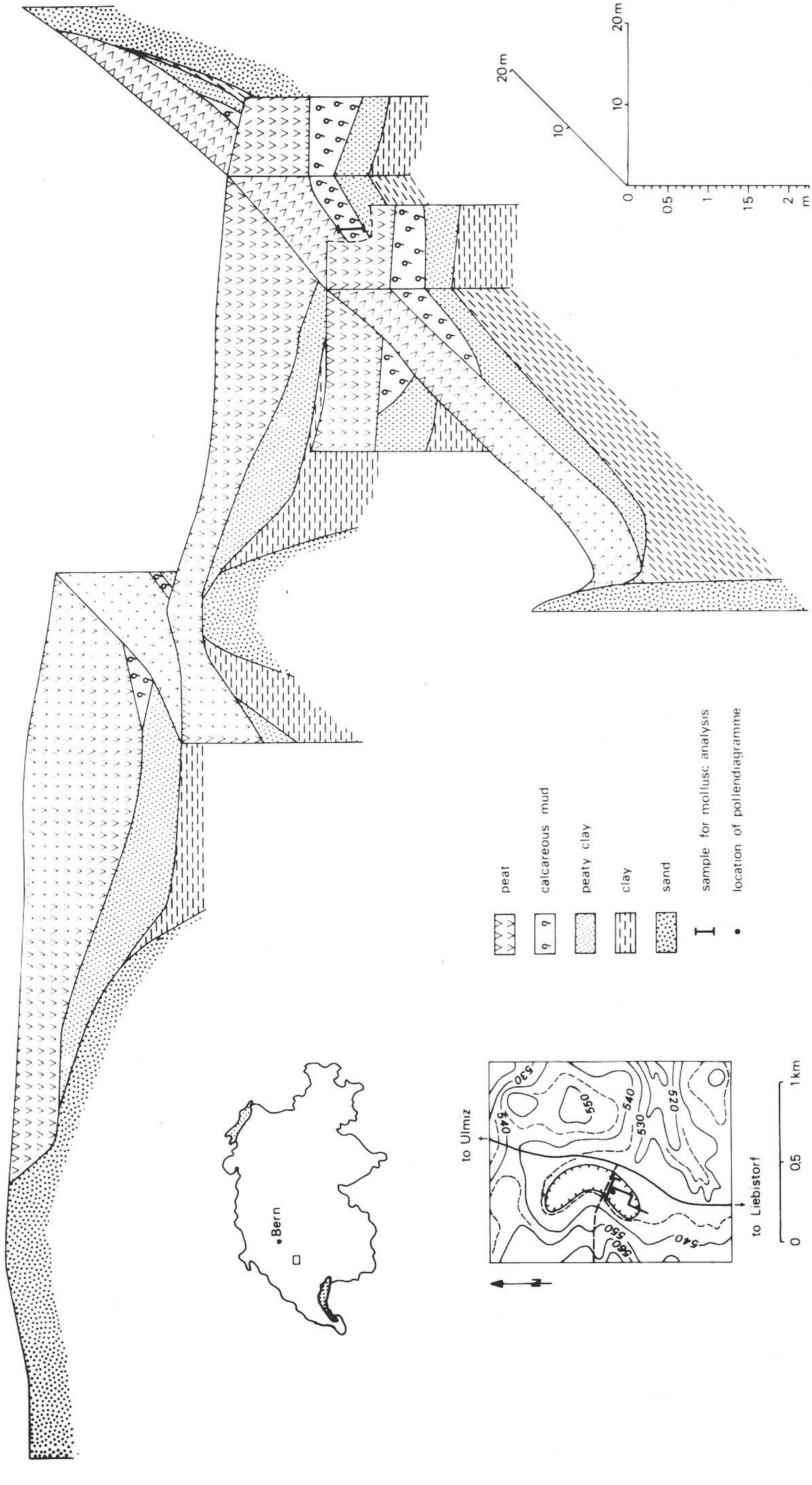
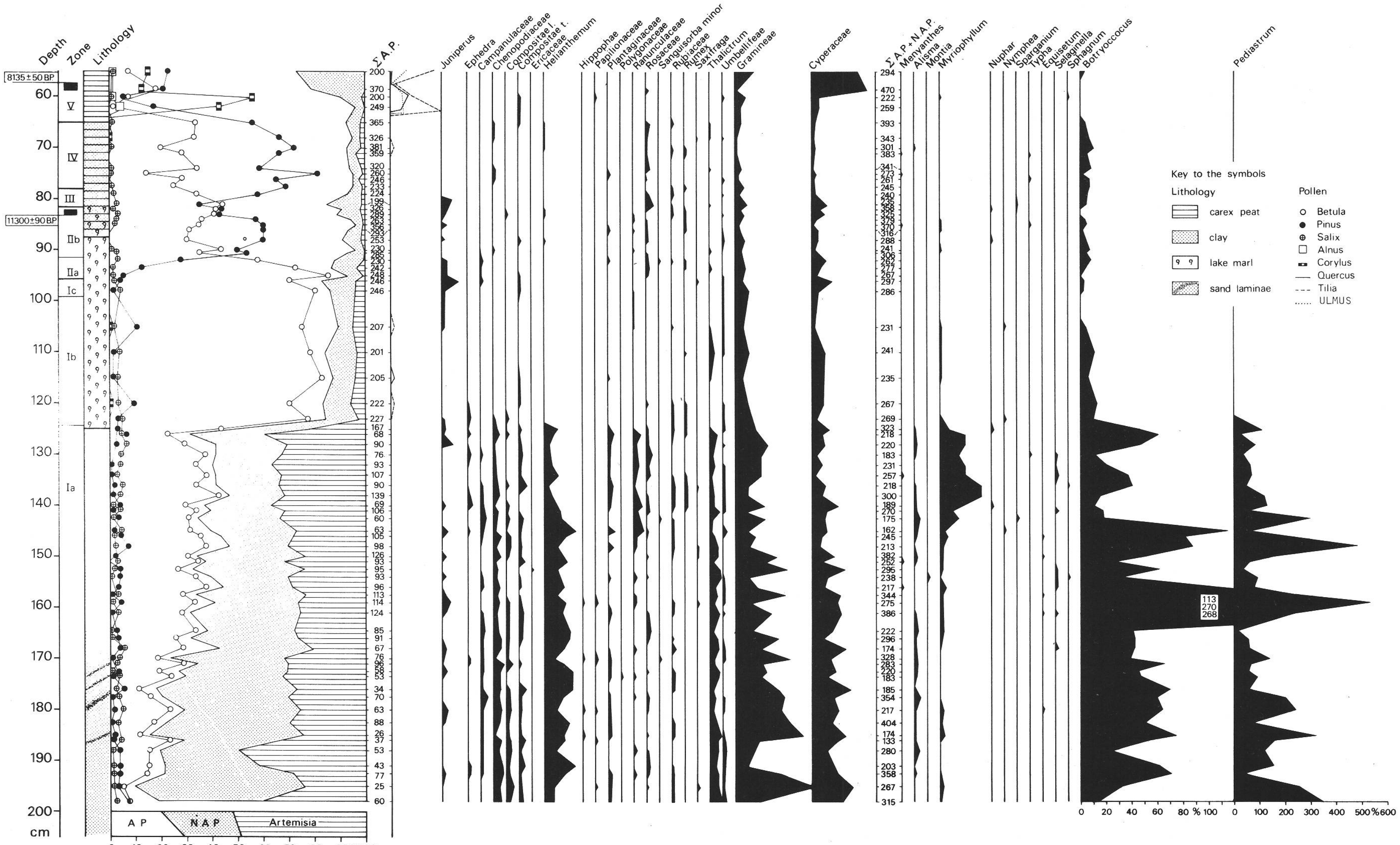


peat
calcareous mud
peaty clay
clay
sand
sample for mollusc analysis
location of pollendiagramme
Bern
to Ulmiz
to Liebistorf
530
540
550
520
560
0
0.5
1 km
0
0.5
1
1.5
2
m
10
20 m
10
20 m



Analyse: R.T. Slotboom
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Zusammenfassung

Pollenanalytische Untersuchungen in einem Toteisloch bei Ulmiz (Kt. Freiburg)

Diese Arbeit stellt eine Revision eines vor einigen Jahren vom zweiten Autoren publizierten Pollendiagramms dar. Im heutigen Diagramm konnten die Zonen Ia, Älteste Dryaszeit, Ib, Bølling, Ic, Ältere Dryaszeit, II (a + b), Allerød, III, Jüngere Dryaszeit, IV, Präboreal und V, Boreal, festgestellt werden. Dies wird durch zwei ^{14}C-Datierungen belegt. Dazu wurde für die Zonen Ib - IIb eine Molluskenanalyse gemacht.

Résumé

Ce travail est une révision d'un diagramme pollinique qui était publié par le deuxième auteur il-y-a quelques ans. Dans le présent diagramme on a distingué les zones suivants: Ia, Dryas ancien inférieur, Ib, Bølling, Ic, Dryas ancien supérieur, II (a + b) Allerød, III, Dryas récent, IV, Préboréal et V, Boréal. C'est confirmé par deux datations à ^{14}C. De plus on a laissé faire une analyse malacologique des zones Ib–IIb.

Abstract

This article is a revision of a pollen diagramme published a few years ago by the second author. In the present diagramme the following zones have been established: Ia, Older Dryas, Ib, Bølling, Ic, Earlier Dryas, II (a + b) Allerød, III, Younger Dryas, IV, Preboreal and V, Boreal. This is confirmed by two ^{14}C dates. For zones Ib–IIb a mollusc analysis has also been performed.

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