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Weichselian chironomid and cladoceran assemblages from maar lakes

Wolfgang Hofmann
Max-Planck-Institut für Limnologie, Postfacth 165, D-2320 Plön, Germany

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Abstract

Sediments from maar lakes in the periglacial area were analysed to obtain information about the limnetic fauna of Pleniglacial lakes. On the basis of abundance and species composition of the subfossil chironomid and cladoceran assemblages, three major zones were biostratigraphically separated: the Upper Pleniglacial, the Middle Pleniglacial, and the Eem Interglacial.

Introduction

Biostratigraphical studies on Cladocera and Chironomidae almost exclusively deal with Late-Glacial/Holocene sediments (Hofmann, 1987, 1988; Walker, 1987). Sediments from periglacial maar lakes provide information about the fully glacial period. The aim of this study is to assess whether these animal groups can be used for a biostratigraphy of the Pleniglacial.

Material and methods

Sediment samples from three eutrophic Eifel maars; Meerfelder Maar, Holzmaar, Schalkenmehrener Maar (Lorenz & Büchel, 1980; Irion & Negendank, 1984) and from Lac du Bouchet, in the Massif Central, France (Bonifay, 1987) were kindly provided by Prof. Negendank (Trier). Figure 1 shows core lengths, the position of the volcanic tuff layer of the Laach eruption (11200 BP (Zolitschka, 1989)), and datings referring to Negendank (1989; in press) indicating that the sediments reach far into Weichselian period.

For preparation of the sediment samples and identification of the remains see Hofmann (in press). The sample fraction >200 µm was used for chironomid analysis and >100 µm for Cladocera.

Results and discussion

The Upper Pleniglacial sediments of the Holzmaar were characterized by extremely low abundances of cladoceran remains (Fig. 2). More than 10000 specimens per g DW occurred in the Holocene layers and more than 1000 in the Late-Glacial. Below the tuff layer concentrations rapidly decreased. In many samples no remains were found at all although the subsample size was mostly >1 g wet sediment. In the section from 12.22 m to 31.80 m sediment depth only 6 specimens were found in a total subsample volume of 27.5 g WW (one sample with higher abundance not included). Mean abundance was 0.2 remains per g WW (Table 1). Likewise, in the corresponding layers from Schalkenmehrener Maar and Lac du Bouchet mean abundance was <1 specimen per g WW. The value obtained in

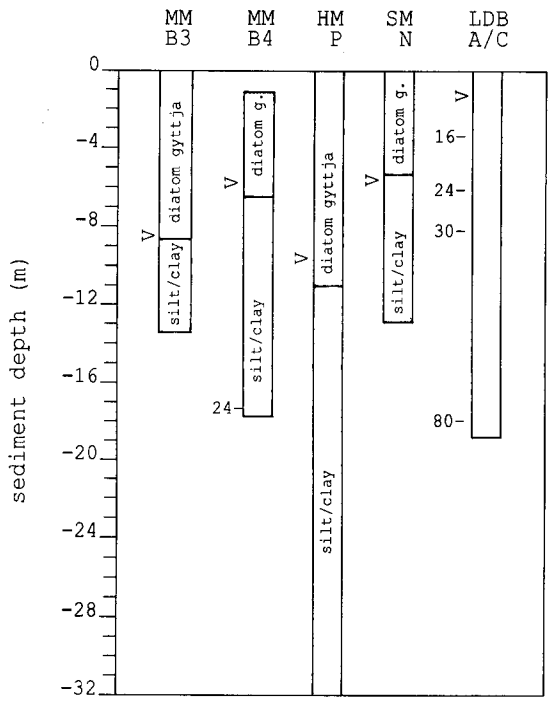

Fig. 1. Meerfelder Maar (MM), profiles B3, B4; Holzmaar (HM), profile P; Schalkenmehrener Maar (SM), profile N; Lac du Bouchet (LDB), profiles A/C: length of the profiles, position of the Laach volcanic tuff layer (11 200 BP) (arrows) and datings (10^3 years BP; classification of maar sediments and datings after Negendank (1989; in press).

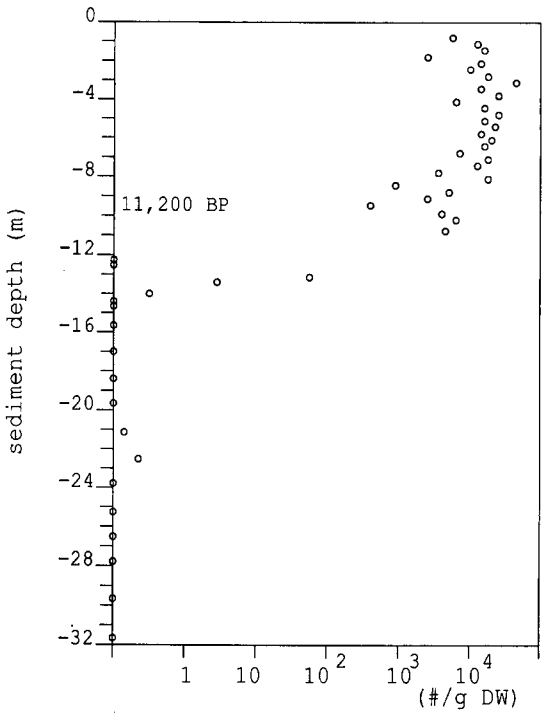

Fig. 2. Holzmaar P, Cladocera: abundance (numbers/g dry sediment).

Meerfelder Maar was slightly higher but is related to sediment dry weight.

These specimens are insufficient for any characterization of the cladoceran assemblages with respect to species composition. Hence, this zone can only be separated from the Late-Glacial by its extremely low concentrations of cladoceran remains. Similarly, chironomid remains were extremely rare during this period (Table 2). In all the maars studied abundance was less than 1 specimen per g WW/DW. The material was particularly scarce in the lower section of Holzmaar and Schalkenmehrener Maar.

However, in contrast to the Cladocera the chironomid assemblage of this zone exhibited a particular species composition and was thus well separated from the Late-Glacial. The most abundant taxa were *Diamesa*, *Protanypus*, *Paracladopelma*, and *Micropsectra* (Table 3). Species of Diamesinae were found in all the maars and were predominating in some cases. Species of the genus *Diamesa* are cold-stenothermous inhabiting flowing water, in particular running waters of mountain regions and less frequently shallow still waters (Oliver, 1983). In the lakes under discussion *Diamesa* was confined to this zone. The other three taxa are typical elements of the profundal zone of oligotrophic lakes under temperate conditions. In arctic/subarctic regions, they preferably occur in the littoral zone (Brundin, 1949).

Below this horizon, the data from Lac du Bouchet indicated a significant change in the cladoceran and chironomid assemblages with respect to both abundance and species composition (Fig. 3). Below 7 m concentrations of cladoceran remains increased again with maximum values of >100 specimens/g. But abundances varied by an order of magnitude over small depths. The development of the chydorid assemblage of this period was characterized by repeated alternations between two predominating species, *Alona quadrangularis* and *Chydorus sphaericus* (Hofmann, in press) (Table 4).

Table 1. Abundance of cladoceran remains in the sediment section below the Late-Glacial in three Eifel maars and the Lac du Bouchet.

	sediment depth (cm)	g sediment analysed	Nos.	Nos./g sediment
Meerfelder Maar B3	1010–1299	8.2 DW	37	4.5
Holzmaar P	1222–3180	27.5 WW	6	0.2
Schalkenm. Maar N	693–1315	26.9 WW	21	0.8
Lac du Bouchet A/C	125–530	87.4 WW	56	0.6

Table 2. Abundance of chironomid remains in the sediment section below the Late-Glacial in three Eifel maars and the Lac du Bouchet.

	sediment depth (cm)	g sediment analysed	Nos.	Nos./g sediment
Meerfelder Maar B3	1010–1299	59.8 DW	44	0.74
Meerfelder Maar B4	630–1800	170.5 DW	55	0.32
Holzmaar	1222–1703	107.4 WW	51	0.47
P	1736–3205	295.6 WW	3	0.01
Schalkenm.	693–1062	60.3 WW	30	0.50
Maar N	1095–1315	50.5 WW	0	0.00
Lac du Bouchet A/C	125–660	967.9 WW	21	0.02

Table 3. Occurrence of four chironomid taxa in the sediment section below the Late-Glacial in three Eifel maars (MM: Meerfelder Maar, HM: Holzmaar, SM: Schalkenmehrener Maar) and Lac du Bouchet (LDB) (** – predominance).

Lake	MM	MM	HM	SM	LDB
core	B3	B4	P	N	A/C
sediment depth	1010	734	1222	693	125
(cm)	– 1299	– 1800	– 3205	– 1062	– 660
Diamesa	**	**	*	*	**
Protanypus			*	*	*
Paracladopelma	*	**	*	*	
Micropsectra		*	**	**	*

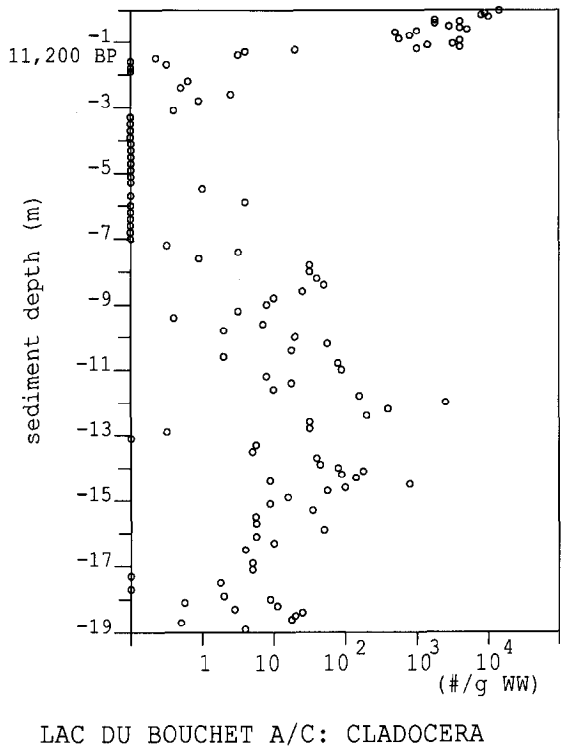

Fig. 3. Lac du Bouchet, profiles A/C, Cladocera: abundance (numbers/g wet sediment); (from: Hofmann, in press).

Similarly, there were very distinct alternations in the chironomids, between the groups *Microp-sectra/Tanytarus* and *Paracladius/Paratanytarsus* (Hofmann, in press).

In the lowermost section of the Lac du Bouchet core, a third stratigraphic unit was discernible by an increase in the number of chydorid species and appearance of taxa which prefer temperate climatic conditions: *Alona costata*, *Disparalona rostrata*, *Monospilus dispar* (Table 4). The restricted chironomid material from this zone also gave the impression of a species succession (Hofmann, in press).

In view of the dating of the Lac du Bouchet profile (3.20 m: 16000 yrs.; 6.10 m: 24000 yrs; 8.10 m: 30000 yrs; 18.10 m: 80000 yrs. Negendank, in press) and the chronostratigraphy of the last glaciation (Nilsson, 1982), the section of the profile under discussion represents the period from the Upper Pleniglacial to the Eem Interglacial.

Furthermore, the three biostratigraphic units presented correspond with the (1) Eem Interglacial, (2) the Middle/Lower Pleniglacial and Early Glacial, and (3) the Upper Pleniglacial.

The extremely low concentration of animal remains and the particular composition of the chironomid assemblage in the Upper Pleniglacial is obviously related to the temperature minimum and the glacial expansion occurring during this period (Nilsson, 1982).

In the Middle Pleniglacial abundance of remains was higher and the species composition

Table 4. Lac du Bouchet, profiles A/C, sediment depth: 550–1877, Chydoridae: mean percentage of predominant species in seven sections; N – numbers counted (from: Hofmann, in press).

ACO	*Alona costata*	MDI	*Monospilus dispar*
ARU	*Alona rustica*	DRO	*Disparalona rostrata*
AQU	*Alona quadrangularis*	ANA	*Alonella nana*
AAF	*Alona affinis*	CPI	*Chydorus piger*
GTE	*Graptoleberis testudinaria*	CSP	*Chydorus sphaericus*

sediment depth (cm)	N	ACO	ARU	AQU	AAF	GTE	MDI	DRO	ANA	CPI	CSP
550–800	139										100
820–860	220			100							
880–1020	287			9.8							89.5
1040–1369	3607			<0.1							>99.9
1389–1529	2415		1.8	1.0							97.0
1549–1749	168			94.6							3.0
1789–1877	113	7.1		15.0	7.1	5.3	28.3	13.3	8.0	15.0	0.9

of the cladoceran and chironomid fauna was different indicating that the climatic conditions were not so extreme as in the following period. However, low species diversity reflected the influence of the cold climate.

Increasing species diversity and occurrence of faunal elements of the temperate zone in the lowermost sediments indicates a warmer climate. These sediments therefore apparently originated from the Eem Interglacial (or Early-Glacial).

The results obtained from the Lac du Bouchet profile suggest that climatic changes during the Pleniglacial period significantly affected the abundance and species composition of the limnetic fauna of periglacial lakes. Hence, the remains of these organisms can be used for the purpose of a biostratigraphy.

The outline of the stratigraphy presented has to be considered as a first attempt. The general validity of the distribution pattern found in Lac du Bouchet will have to be checked by additional case studies. Furthermore, the conclusions deduced from these data will have to be discussed in connection with the results of geological and climatological studies.

The application of the stratigraphy proposed for the Lac du Bouchet profile to the cores from the Eifel maars leads to the conclusion that these profiles represent the Upper Pleniglacial only, because the section characterized by particular species composition and species alternations was missing. Thus, it would be desirable to see if, in older sediments from Eifel maars, assemblages occur which resemble the Middle Pleniglacial fauna of Lac du Bouchet. This would also answer the question whether the Pleniglacial biostratigraphy of Lac du Bouchet represents a general pattern of succession in lakes in periglacial regions.

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References

Bonifay, E. (ed.), 1987: Travaux francais en Paleolimnologie. Doc. C.E.R.L.A.T. 1: 1–275.

Brundin, L., 1949. Chironomiden und andere Bodentiere der südschwedischen Urgebirgsseen. Rep. Inst. Freshw. Res. Drottningholm 30: 1–914.

Hofmann, W., 1987. Cladocera in space and time: Analysis of lake sediments. Hydrobiologia 145: 315–321.

Hofmann, W., 1988. The significance of chironomid analysis (Insecta: Diptera) for paleolimnological research. Palaeogeogr., Palaeoclimatol., Palaeoecol. 62: 501–509.

Hofmann, W., in press: Stratigraphy of Chironomidae (Insecta: Diptera) and Cladocera (Crustacea) in Holocene and Wurm sediments from Lac du Bouchet (Haute Loire, France). Doc. C.E.R.L.A.T.

Irion, G. & J. F. W. Negendank (eds.), 1984. Das Meerfelder Maar – Untersuchungen zur Entwicklungsgeschichte eines Eifelmaares. Cour. Forsch.-Inst. Senckenberg 65: 1–101.

Lorenz, V. & G. Büchel, 1980. Zur Vulkanologie der Maare und Schlackenkegel der Westeifel. Mitt. Pollichia 68: 29–100.

Negendank, J. F. W., 1989. Pleistozäne und holozäne Maarsedimente der Eifel. Z. dt. geol. Ges. 140: 13–24.

Negendank, J. F. W., in press. Doc. C.E.R.L.A.T.

Nilsson, T., 1982. The Pleistocene. Reidel: Dordrecht, Boston, London.

Oliver, D. R., 1983. The larvae of Diamesinae (Diptera: Chironomidae) of the Holarctic region – Keys and diagnoses. Ent. scand. Suppl. 19: 115–138.

Walker, I. R., 1987. Chironomidae (Diptera) in paleoecology. Quat. Sci. Rev. 6: 29–40.

Zolitschka, B., 1989. Jahreszeitlich geschichtete Seesedimente aus dem Holzmaar und dem Meerfelder Maar. Z. dt. geol. Ges. 140: 25–33.