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Lateglacial and Early Holocene vegetation history near Hennigsdorf (C Brandenburg, NE Germany): a new interpretation of palynological data of Klaus Kloss

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Keywords:
Brandenburg, Holocene, NE Germany, pollen analysis, Weichselian Lateglacial

Abstract

This study presents a revision and re-interpretation of a pollen diagram of K. Kloss from a site near Hennigsdorf (C Brandenburg, NE Germany). The diagram shows a pollen sequence of the Lateglacial Betula/Pinus forest phase ("Allerød"), Open vegetation phase III ("Younger Dryas") and the early Holocene, and allows the interpretation of both the upland vegetation history and the local wetland vegetation succession. The revised interpretation of the data deviate from the previously published interpretation in that prominent pollen zones are now correlated with other time periods, and that an assumed Palaeolithic/Mesolithic anthropogenic pollen signal is questioned.

Schlüsselwörter:
Brandenburg, Holozän, NO-Deutschland, Pollenanalyse, Weichselpätglazial

Zusammenfassung: Spätglaziale und frühholozäne Vegetationsgeschichte nahe Hennigsdorf (Zentral-Brandenburg, NO-Deutschland): Eine neue Interpretation pollenanalytischer Daten von Klaus Kloss

Diese Veröffentlichung präsentiert die Revision und Neuinterpretation eines Pollendiagrammes von K. Kloss. Das Diagramm stammt von einer Lokalität nahe Hennigsdorf (Zentral-Brandenburg, NO-Deutschland) und zeigt Pollensequenzen der spätglazialen Betula/Pinus Waldphase ("Allerød"), der Offene Vegetationsphase III ("Jüngere Dryas") und des Frühholozäns. Es ermöglicht zudem die Rekonstruktion der „Upland" sowie der „Wetland"-Vegetationsgeschichte. Die revidierte Interpretation unterscheidet sich von der schon veröffentlichten Version dadurch, dass markante Pollenzonen jetzt mit anderen Zeitabschnitten korreliert werden. Außerdem wird ein abgeleitetes anthropogenes (paläolithisches/mesolithisches) Pollensignal in Frage gestellt.

1 Introduction

At present, many palynologically studied sites from central Brandenburg and Berlin (NE Germany) provide information on the vegetation history of the Weichselian Lateglacial and Early Holocene (cf. Fig. 1 and Table 1). Pollen analytical research within predominantly archaeological contexts was performed by the late Klaus Kloss who worked at the

“Brandenburgisches Landesmuseum für Ur- und Frühgeschichte”. Recently, it was decided to digitalise and revise part of his extensive material and to make it available to the scientific audience (DE KLERK 2004a/b, 2005, 2006).

One of the investigated sites of which the pollen counts were digitalised is “Schönwalde P Schö 2” near Hennigsdorf (Figs. 1, 2). The pollen diagram of this core has already been published by KLOSS & WECHLER (1987). They did, however, not display all pollen types, and provided - compared to the present-day knowledge on the vegetation history of the Weichselian Lateglacial and Early Holocene in NE Germany – an unfortunate erroneous interpretation of the pollen diagram. A new publication of the pollen diagram with a revised interpretation is therefore required to give it its appropriate place among the pollen diagrams of NE Germany.

2 Description of the study area

The studied locality (52°38´ N, 13°11´ E) is positioned between Schönwalde and Hennigsdorf, according to the field notes of Kloss in the vicinity of the forestry house Blockbrück (cf. Fig. 2A). This area is part of a north-south orientated Weichselian (probably meltwater) valley (cf. STACKEBRANDT et al. 1997).

The palynological study was triggered by the discovery of Palaeolithic artefacts on the northwestern slope of a dune along the terrestrialised valley of the Muhrgraben brook (KLOSS & WECHLER 1987).

Surveying corings revealed the presence of a ca. 50 m wide and 5 m deep kettle-hole at the foot of the dune (KLOSS & WECHLER 1987). This close distance to the archaeological find spot made this site ideal for the search for palaeolithical anthropological signals in the pollen diagram, which was one of the major research questions of KLOSS & WECHLER (1987).

Though both the field notes of Kloss and the publication of KLOSS & WECHLER (1987) state that the kettle-hole was terrestrialised, these sources describe only aquatic sediments for the complete core (cf. Fig. 3): the terrestrialisation, therefore, is unclear.

The palynologically studied sequence consists of (bottom to top) fine sand with gyttja, silty gyttja, undifferentiated gyttja with – according to the field notes - an only low lime content, calcareous gyttja, undifferentiated gyttja, peat gyttja, clayey gyttja, silty gyttja, and finally silty calcareous gyttja (cf. Fig. 3). The Laacher See tephra (LST), a tephra layer that occurs in many basins of NE Germany and that originates from a volcanic eruption in the Eifel around 12900 calendar years B.P. (cf. VAN DEN BOGAARD & SCHMINCKE 1985; THEUERKAUF 2003; DE KLERK et al. submitted) was found between 381 and 384 cm depth.

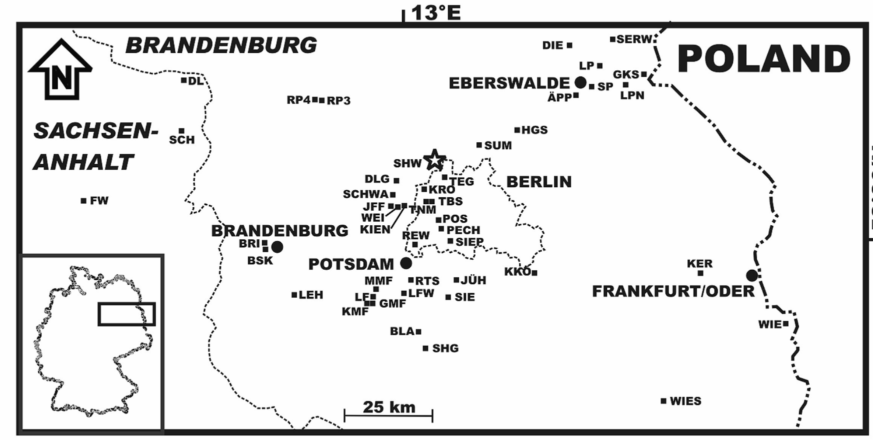

Fig. 1 Location of the study area (SHW) within the context of other palynologically studied sites in central Brandenburg and Berlin covering the Weichselian Lateglacial (cf. Table 1).

Abb. 1 Lage des Untersuchungsgebietes (SHW) in Beziehung zur anderen pollenanalytisch untersuchten Lokalitäten in Zentral-Brandenburg und Berlin, welche das Weichsel-spätglazial umfassen (vgl. Tabelle 1).

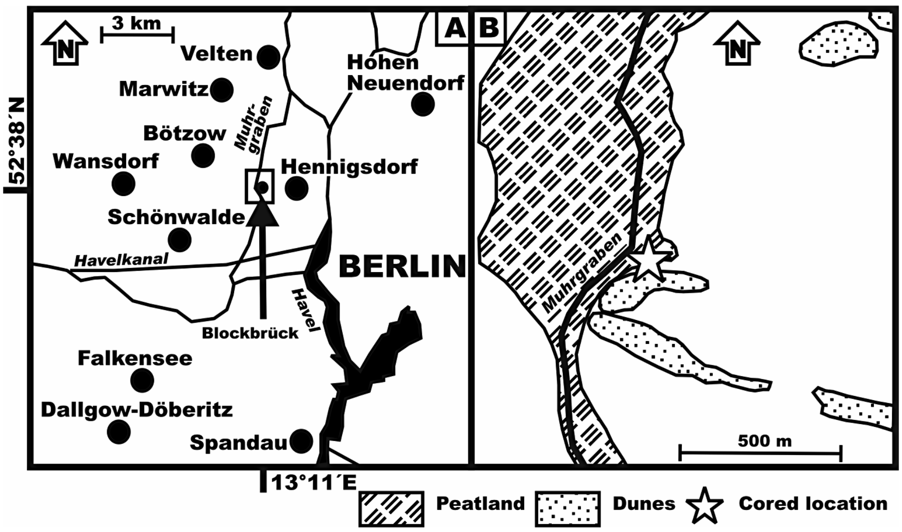

Fig. 2 A: Location of the study area NW of Berlin; B: Location of the cored site near the Muhrgraben at the foot of a dune (modified after KLOSS & WECHLER 1987), landscape-elements (dunes, peatland) are interpreted after the original figure that was presented without legend.

Abb. 2 A: Lage des Untersuchungsgebietes nordwestlich von Berlin; B: Lage der Entnahme-stelle des Bohrkerns nahe des Muhrgrabens am Fuß einer Düne (geändert nach KLOSS & WECHLER 1987), Landschaftseinheiten (Dünen, Moor) sind interpretiert nach der Originalabbildung, welche ohne Legende publiziert wurde.

3 Methods

The section “Schönwalde P Schö 2” was cored in 1979 probably with a chamber corer. Preparation of palynological samples included treatment with KOH, gravity separation with $ZnCl_2$, and acetolysis (S. Jahns pers. comm. July 2004). KLOSS (1989) provides information on his palynological methods.

For revision of the data, the original pollen counting lists of Kloss were used. Samples were named after their actual field depth (cm below surface). In the original counting lists incidentally a + was noted for pollen types observed after the count was finished. For graphical reasons this use was omitted in the present study. Pollen types that were only observed after finishing counting were incorporated with value 1 in the revised dataset, whereas a + was ignored for pollen types of which also counted data was available.

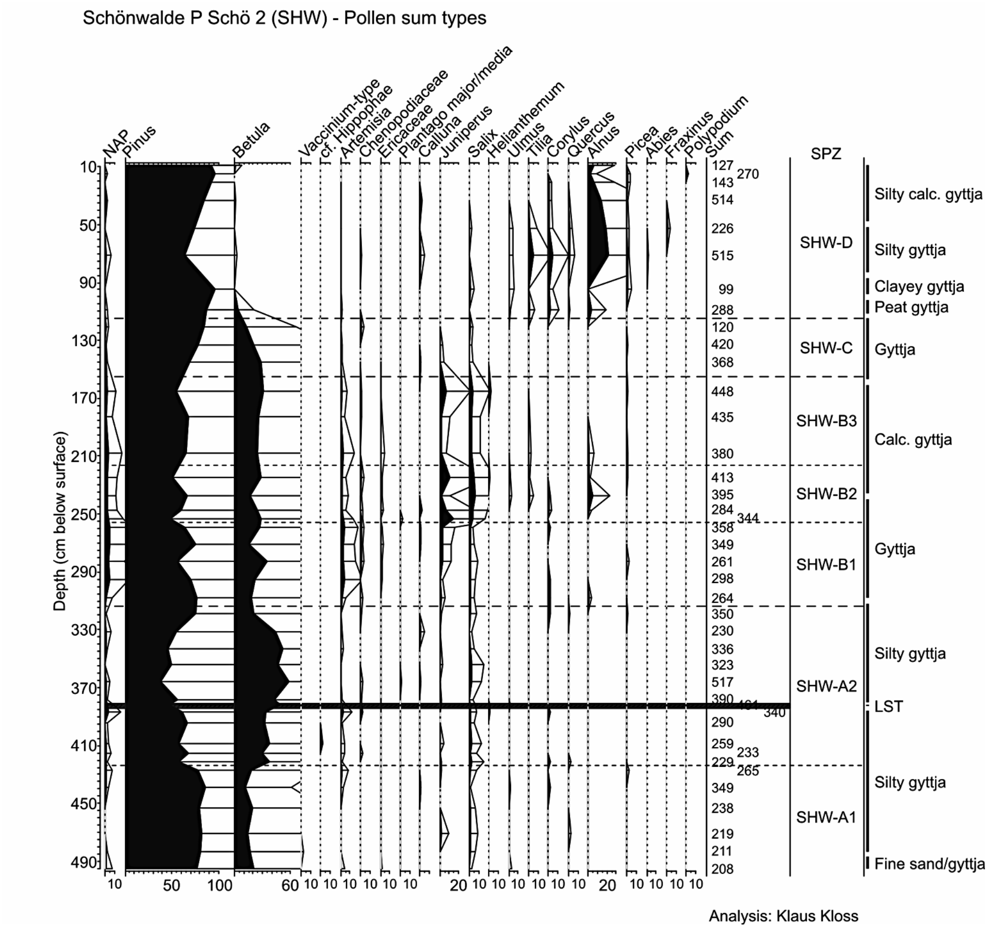

Fig. 3(a/b) Pollen diagram “Schönwalde P Schö 2” (SHW), calculated relative to an upland pollen sum. Pollen types are displayed with actual values (closed curves) and a 5-times exaggeration (open curves with depth bars).

In order to differentiate clearly between pollen types and plant taxa, the former are displayed in the text in SMALL CAPITALS (cf. JOOSTEN & DE KLERK 2002). In the pollen diagram (Fig. 3) and the text of this paper, pollen type nomenclature is not according to the rather outdated pollen type names of the original counting lists (using names like CYPERALES and AMMIACEAE), but the nomenclature as generally followed by Kloss in his publications was adopted (e.g. KLOSS 1991, 1993, 1994). As the publications do not present a consistent pollen type nomenclature (e.g. using different kinds of abbreviations), the pollen type names in this paper should be considered as a practical attempt to present pollen data, not as morphologically unambiguously defined morphotypes. For some of the German pollen type names a more appropriate English equivalent was used (i.e. TYP = TYPE, GETREIDE-TYP = CEREALIA-TYPE, GETREIDEART = CEREALIA-LIKE, WASSERPFLANZEN = AQUATICS UNDIFF., KRAUTIGE = UNDIFF.). In the publication of KLOSS & WECHLER (1987) the pollen type "GETREIDEART.-TYP" (probably encompassing both the GETREIDE-TYP and GETREIDEART.) was additionally named "BROMUS-AGROPYRON-POLLENTYP". MYRIOPHYLLUM was marked in the counting lists without any suffix but also with suffices s, v and a, that were written in full as SPICATUM, VERTICILLATUM and ALTERNIFLORUM in Fig. 3.

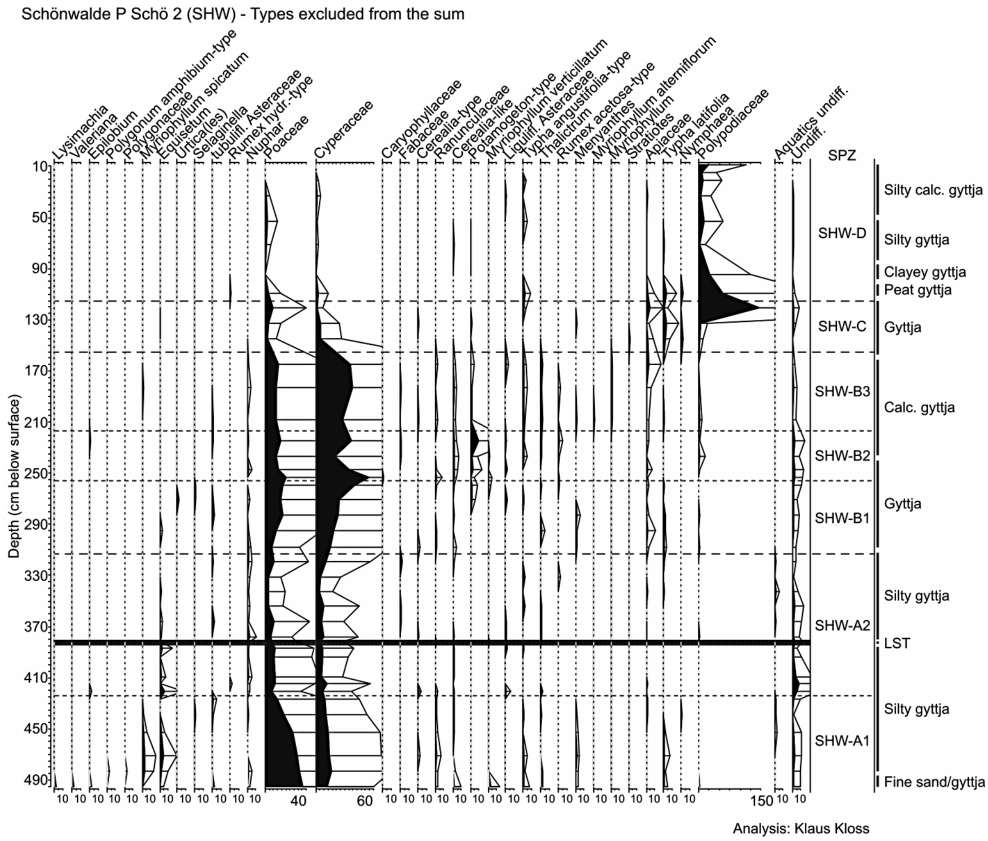

Abb. 3(a/b) Pollendiagramm "Schönwalde P Schö 2" (SHW) berechnet auf eine „upland" Pollensumme. Alle Pollentypen sind mit reellen Werten (geschlossene Kurven) und einer 5-fachen Überhöhung (offene Kurven mit Tiefenlinien) dargestellt.

The data were calculated and presented with the computer programs TILIA 1.12, TILIA GRAPH 1.18, and TGView 1.6.2 (GRIMM 1992, 2004). Pollen frequencies were calculated relative to a pollen sum including pollen types attributable to trees and shrubs (AP) and upland herbs (NAP). The NAP values are an indication for the relative openness of the upland vegetation. Pollen types that might originate from both upland and wetland herbs (e.g. POACEAE and CYPERACEAE) were excluded from the sum since (extra)local effects (sensu JANSSEN 1973) might erroneously indicate an opening of the upland vegetation when in reality a change in the wetland vegetation occurs (cf. DE KLERK 2004c). CEREALIA-TYPE and CEREALIA-LIKE were excluded from the pollen sum since it can be expected that these types do not include pollen of cultivated cereals, but grains of wild grasses.

Pollen percentages in the pollen diagram (Fig. 3) are presented with actual values (closed curves) and a 5-time exaggeration (open curves with depth bars). Pollen types are ordered stratigraphically in order to facilitate a successional interpretation. The diagram is divided into several Site Pollen Zones (SPZ's) (DE KLERK 2002) that are a combination of informal acme zones and informal interval zones sensu HEDBERG (1976) and SALVADOR (1994).

In order to avoid the current widespread confusion on the stratigraphic and geochronologic terminology of the Weichselian Lateglacial (cf. ERIKSEN 2002; DE KLERK 2004c; TERBERGER et al. 2004), the pollen diagram is interpreted in terms of "Vegetation phases of Vorpommern" (DE KLERK 2002) that allow the interpretation of pollen diagrams independent of the existing terminology, and that appear to be valid also for the regions directly south of Vorpommern (cf. DE KLERK submitted). A correlation of these vegetation phases with various "traditional" stratigraphic and geochronologic divisions is presented by DE KLERK (2002, p. 297; 2004d, p. 32) and TERBERGER et al. (2004, p. 140). For readers not familiar with the vegetation phases of Vorpommern, in the text additionally the more traditional terminology is mentioned.

The sediment description of the pollen diagram (Fig. 3) follows the original unpublished field descriptions of Kloss. This is slightly less diverse than the sediment descriptions in the publication of KLOSS & WECHLER (1987), but seemed to be more objective since the basis for the published description was not preserved among the material available to the present author.

4 Discussion: interpretation of the pollen diagram

4.1 Lateglacial Betula/Pinus forest phase (Allerød; Bølling-Allerød complex) - SPZ SHW-A1/A2

The basal pollen zone of the Schönwalde diagram (SPZ SHW-A) is characterised by relatively low NAP values (compared to the overlying zone SHW-B), high values of PINUS pollen and substantial values of BETULA pollen. This zone is therefore correlated with the Lateglacial Betula/Pinus forest phase (Allerød, or Bølling-Allerød complex sensu USINGER (1985)). The beginning of this vegetation phase is characterised in the regions of southern Mecklenburg-Vorpommern, northern/central Brandenburg and Berlin by a peak of BETULA pollen followed by prolonged high values of PINUS pollen (cf. DE KLERK submitted; DE KLERK & STOLZE 2002; cf. the studies mentioned in Table 1). Since this peak of BETULA pollen does not occur in the Schönwalde diagram, it can be concluded that the early part of the Lateglacial Betula/Pinus forest phase is not recorded in the Schönwalde core.

Based on fluctuations in the curves of PINUS, BETULA, and SALIX pollen two subzones can be distinguished.

Tab. 1 Palynologically studied sites in central Brandenburg and Berlin covering the Weichselian Lateglacial (cf. Fig. 1).

Tab. 1 Pollenanalytisch untersuchte Lokalitäten in Zentral-Brandenburg und Berlin, welche das Weichselspätglazial umfassen (vgl. Abb. 1).

CODE	**DIAGRAM NAME**	**SOURCE**
ÄPP	Äppelbruch	MÜLLER (1961)
BLA	Blankensee	KLEINMANN et al. (2002)
BRI	Breitlingsee Br I/91	KLOSS (unpubl.)
BSK	Kesselmoor am Breitlingsee	KLOSS (unpubl.)
DIE	Diebelsee	SCHLAAK & SCHOKNECHT (2002)
DL	Düstere Lake	LANGE & SUCCOW (1985)
DLG	Dallgow Dall 94/1	KLOSS (unpubl.)
FW	Fenn in Wittenmoor	LANGE (1986)
GKS	Große Krebssee	JAHNS (2000)
GMF	Großes Moor bei Ferch	BÖSE et al. (1993); BÖSE & BRANDE (2002)
HGS	Hegesee HGS II	NITZ et al. (1995)
JFF	Jungfernfenn	WOLTERS (2002)
JÜH	Jühnsdorf 93/1	KLOSS (unpublished)
KER	Kersdorf-Briesen 2	SCHULZ & STRAHL (2001)
KIEN	Kienfenn	WOLTERS (2002)
KKÖ	Klein Köris Pkkö 82/10	KLOSS (unpubl.)
KMF	Kleines Moor bei Ferch	BÖSE & BRANDE (2002)
KRO	Kleiner Rohrpfuhl	BRANDE (1980a)
LEH	Lehnin Nord	MÜLLER (1970)
LF	Langes Fenn	WOLTERS (1999)
LFW	Langes Fenn bei Wilhelmshorst	MÜLLER (1970, 1971)
LP	Leckerpfuhl	ENDTMANN (1998); cf. MÜLLER (1966)
LPN	Lieper Posse LPN	MICHAELIS & SKRIEWE (2004)
MMF	Moor bei Mittelbusch/Ferch	BÖSE & BRANDE (2002)
PECH	Pechsee	BRANDE (1980b)
POS	Postfenn	BÖCKER et al. (1986)
REW	Rehwiese	BRANDE (unpublished)
RP3	Rhinluch Pollendiagramm 3	KLOSS (1987)
RP4	Rhinluch Pollendiagramm 4	KLOSS (1987)
RTS	Ravensberge – Teufelssee Ra 93/1	DE KLERK (2006)
SCH	Schollene	MATHEWS (2000)
SCHWA	Schwanengrabenrinne	WOLTERS (2002)
SERW	Serwest	MÜLLER (1967)
SHG	Schönhagen	KLOSS (unpubl.)
SHW	Schönwalde Pschö 2	This study
SIE	Siethener See	KLEINMANN et al. (2002)
SIEP	Siepegrabenmoor	BRANDE et al. (1990)
SP	Schlangenpfuhl	KLOSS (1994)
SUM	Summt	MÜLLER (1970)
TBS	Teufelsbruch in Berlin-Spandau	MÜLLER (1965)
TEG	Tegeler See	BRANDE (1980b)
TNM	Teufelsbruch-Nebenmoor	BRANDE (1995a)
WEI	Weidenkuhle	WOLTERS (2002)
WIE	Wiesenau 1/86	KLOSS (unpubl.)
WIES	Wiese	ILLIG & LANGE (1992)

4.1.1 Middle part of the Lateglacial Betula/Pinus forest phase ("Allerød") - SPZ SHW-A1

Subzone SHW-A1 contains high values of PINUS pollen, substantial values of BETULA and SALIX pollen, whereas all other types included in the pollen sum are absent or occur only incidentally. This indicates that on the upland pine forests prevailed. These forests might also have included birch and willow, though these might also have occurred in the wetland vegetation along the basin shores.

The types excluded from the sum show peaks of MYRIOPHYLLUM SPICATUM, EQUISETUM and POACEAE pollen and spores, whereas also CYPERACEAE pollen has substantial values. TYPHA ANGUSTIFOLIA-TYPE, MENYANTHES and TYPHA LATIFOLIA pollen also have somewhat higher values than in the overlying zones. This demonstrates that the open water in the kettle-hole was inhabited by *Myriophyllum spicatum,* whereas the wetland vegetation along the basin shores probably consisted of *Equisetum,* sedges, grasses, and possibly also *Typha latifolia*, *Typha angustifolia* and/or *Sparganium* (both latter taxa producing a similar pollen type, cf. MOORE et al. 1991), and *Menyanthes*.

The deposition of (predominantly) silty gyttja during this vegetation phase shows that soil erosion lead to the washing-in of clastic particles.

Originally, KLOSS & WECHLER (1987) concluded that the lower samples (up to sample 471) represented the cool "Older Dryas" (in original: "Ältere Tundrenzeit"). This conclusion was probably based on the high values of POACEAE pollen that were interpreted to represent an upland grass tundra vegetation (cf. KLOSS & WECHLER 1987). It is unclear why they placed the palynostratigraphic boundary at 471 cm depth, since no important palynologic changes occur at this level. It is hazardous to interpret peaks of pollen possibly produced by wetland taxa as originating from an upland vegetation (cf. DE KLERK 2002, 2004c). Two phenomena of the Schönwalde diagram should have warned KLOSS & WECHLER (1987) that their interpretation was wrong. The first is the striking absence of ARTEMISIA pollen that normally has relatively high values in pollen diagram sections corresponding with time periods prior to the Lateglacial Betula/Pinus forest phase (cf. DE KLERK submitted and the studies of Table 1). The second is the occurrence of TYPHA LATIFOLIA pollen that is indicative for relatively high summer temperatures (KOLSTRUP 1979, 1980).

4.1.2 Later part of the Lateglacial Betula/Pinus forest phase ("Allerød") - SPZ SHW-A2

Subzone SHW-A2 is distinguished from the previous subzone by higher values of BETULA and SALIX pollen. Rises in BETULA pollen towards the top of pollen zones correlated with the Lateglacial Betula/Pinus forest phase occur regularly in pollen diagrams from NE Germany (e.g. diagrams FW, JFF, KER, MMF, REW, SCHWA, SIE; cf. Fig. 1 and Table 1). If such rises are compared with the position of the isochronous LST these rises all date differently and, thus, do not represent an (over)regional phenomenon. It has been suggested that these rises reflect the expansion of birch carrs along the margins of the investigated basins (WOLTERS 2002; THEUERKAUF 2003). The distinction of the subzone SHW-A2, therefore, has no overregional significance. Since SALIX pollen values rise simultaneously with BETULA pollen values, willow probably also inhabited the carr vegetation.

A prominent feature of the Schönwalde pollen diagram is a minor peak of ARTEMISIA pollen immediately below the LST. This is in great contrast with many other pollen diagrams from NE Germany that display a peak of NAP pollen types immediately above the LST (cf. THEUERKAUF 2003; De Klerk et al. submitted).

The types excluded from the pollen sum that showed prominent values in the underlying subzone have lower values in this subzone, indicating that the associated vegetation types lost importance. A small rise in the values of NUPHAR pollen in the lower part of subzone SHW-A2 indicates expansion of *Nuphar* in the open water.

4.2 Open vegetation phase III ("Younger Dryas"/"Late Dryas") – SPZ SHW-B1/B2/B3

Zone SHW-B is distinguished from both adjacent zones by relatively high NAP values that can be mainly attributed to ARTEMISIA, CHENOPODIACEAE, and ERICACEAE pollen. This zone is therefore correlated with Open vegetation phase III, the last cold phase of the Lateglacial classically known as Younger Dryas (cf. ISARIN 1997). Zone SHW-B can be subdivided into three subzones: SHW-B1 is characterised by high values of ARTEMISIA pollen, SHW-B2 is distinguished from both adjacent subzones by lower values of ARTEMSIA pollen and higher values of JUNIPERUS and SALIX pollen, and SHW-B3 is characterised by an increase (followed by a decrease) of ARTEMSIA pollen values and a decrease (followed by an increase) of JUNIPERUS and SALIX pollen. A tripartition of Open vegetation phase III, but based on other pollen types, was also described for a locality in northern Vorpommern (DE KLERK et al. 2001). These subphases, therefore, can probably not be correlated with those inferred in the present paper.

KLOSS & WECHLER (1987) interpreted only a part of the depth trajectory of the present SPZ SHW-B to represent the Younger Dryas: samples 319-253 (i.e. approximately the present subzone SHW-B1 that encompasses the trajectory between 313.5 and 256 cm depth). Subsequently they noticed that there was no clear visible transition to the Preboreal. They interpreted the trajectory between samples 247 and 225 as the beginning of the Holocene, basing this conclusion on the presence of QUERCUS, ULMUS and TILIA pollen and on an inferred expansion of juniper (with reference to conclusions of USINGER (1981)). This interpretation neglects the facts that these types might also have been redeposited due to soil erosion in Lateglacial open vegetation phases (cf. IVERSEN 1936; JOOSTEN & DE KLERK 2002), and that QUERCUS pollen does not even occur in the mentioned depth trajectory (probably they intended to refer to CORYLUS and/or ALNUS pollen). Sample 165 then was originally interpreted to represent the mid-Preboreal temperature decline. Comparison of the Schönwalde diagram with other Lateglacial pollen diagrams from central Brandenburg and Berlin (cf. Fig. 1 and Table 1) must, however, lead to the revised interpretation that the complete depth trajectory of SPZ SHW-B represents the Open vegetation phase III (Younger Dryas).

4.2.1 First part of Open vegetation phase III – SPZ SHW-B1

The increase in NAP values (especially of ARTEMISIA, CHENOPODIACEAE and ERICACEAE pollen) and the increase in JUNIPERUS pollen indicate the expansion of open vegetation types mainly consisting of *Artemisia*, Chenopodiaceae, heather and Juniper. The high values of PINUS pollen indicate that pine remained important in the landscape and might have formed open park-like stands, contrary to regions in the north of NE Germany where the vegetation was inferred to have been much opener (BRANDE 1995b; DE KLERK & STOLZE 2002; TERBERGER et al. 2004; De Klerk submitted).

The pollen types excluded from the sum show a gradual increase of CYPERACEAE values within this subzone. It cannot be ruled out that this pollen stems from upland Cyperaceae species, but a comparison with much lower CYPERACEAE pollen values in other pollen diagrams covering the same time period (cf. Fig. 1 and Table 1) allow the conclusion that the values of the Schönwalde diagram are (extra)local (sensu JANSSEN 1973): Cyperaceae populations, thus, must have grown within the investigated basin. A sedge vegetation probably gradually expanded along the basin shores. Continuous presence of NUPHAR pollen and incidental occurrences of MENYANTHES and TYPHA LATIFOLIA pollen indicate an open water vegetation of *Nuphar* and the presence of *Menyanthes* and *Typha latifolia* in the marginal wetland vegetation. The latter species is remarkable for a phase with a cold climate because of its demand for relatively high summer temperatures (cf. KOLSTRUP 1979, 1980). It is however possible that the Schönwalde site was during this vegetation phase positioned at the northern boundary of the area of climatic requirements of that species (cf. ISARIN 1997; ISARIN & BOHNCKE 1999).

4.2.2 Second part of Open vegetation phase III – SPZ SHW-B2

This subzone corresponds with two peaks of JUNIPERUS pollen separated by a sample with decreased values. A peak of JUNIPERUS pollen in the middle part of Open vegetation phase III (the Younger Dryas) is more often found in pollen diagrams of central Brandenburg and Berlin (e.g. pollen diagrams BSK, GMF, KER, KRO, LF, LP, PECH, SHG, SP, TEG; cf. Fig. 1 and Table 1), even with values that are conspicuously higher than those in the Schönwalde diagram. As no spatial pattern for this phenomenon can be discerned (cf. DE KLERK 2004e, submitted) a palaeoecological or palaeoclimatical explanation can not yet be given. The presence of a vegetation zone with prominent juniper vegetation situated between the open northern areas and the predominantly park-like vegetations in the south as posed by BRANDE (1995b) seems unlikely, since no clear S-N pattern of JUNIPERUS peak occurrences is observed.

The types excluded from the sum show relatively high values and/or peaks of CYPERACEAE, RANUNCULACEAE, CEREALIA-LIKE, POTAMOGETON-TYPE, MYRIOPHYLLUM VERTICILLATUM, TYPHA ANGUSTIFOLIA-TYPE and RUMEX ACETOSA-TYPE pollen, whereas NUPHAR pollen is almost continuously present. This leads to the conclusions that an open water vegetation of *Potamogeton, Myriophyllum verticillatum* and *Nuphar* inhabited the studied basin and that sedge vegetation types continued their presence along the basin shores. TYPHA ANGUSTIFOLIA-TYPE pollen probably mainly originates from *Sparganium* species (producing a similar pollen type as *Typha angustifolia*, cf. MOORE et al. 1991) within the marginal sedge vegetation, since *Typha angustifolia* needs even higher summer temperatures than *Typha latifolia* (cf. KOLSTRUP 1979, 1980). RANUNCULACEAE and RUMEX ACETOSA-TYPE pollen are recorded with too low values to definitely conclude whether their producing plants grew in the studied basin or on the upland. It is not clear what the CEREALIA-LIKE pollen represents (cf. sections 3 and 5). Probably the type encompasses relatively large POACEAE grains produced by a wide variety of wild grasses (cf. ANDERSEN 1979). The presence of cultivated cereal species can be ruled out for the Lateglacial period.

During the time-frame covered by this subzone, sedimentation within the basin changed to calcareous gyttja, indicating a shift from $CaCO_3$-poor to $CaCO_3$-rich water feeding into basin.

4.2.3 Third part of Open vegetation phase III – SPZ SHW-B3

Decreasing amounts of JUNIPERUS pollen indicate that juniper lost again importance in the last part of Open vegetation phase III. NAP values, however, do not reach the values of the beginning of Open vegetation phase III, indicating that maximum openness was at the beginning of Open vegetation phase III. This is in contrast with the data from northern Vorpommern where maximum of openness is inferred for the end of Open vegetation phase III (cf. DE KLERK et al. 2001a; DE KLERK 2002).

The lower values of POTAMOGETON pollen indicate a reduction of *Potamogeton* populations. The continued occurrence of NUPHAR, CEREALIA-LIKE, TYPHA ANGUSTIFOLIA-TYPE, the presence of MYRIOPHYLLUM (undifferentiated) pollen, and the high values of CYPERACEAE pollen indicate the continuation of the open water and basin shore vegetation types inferred for the previous subphase.

4.3 Early Holocene Betula/Pinus forest phase (“Preboreal”) – SPZ SHW-C

SPZ SHW-C contains prominently lower NAP values than SPZ SHW-B. This zone is therefore correlated with the early Holocene during which forests of birch and pine dominated the upland.

The pollen types excluded from the sum have such low values that they do not allow the reconstruction of plant taxa within the basin, with the exception of TYPHA LATIFOLIA, NYMPHAEA and POLYPODIACEAE pollen and spores, of which the latter has a peak in the top sample of this zone. This must reflect an open water vegetation of *Nymphaea* and a shore vegetation of *Typha latifolia* with later an expansion of ferns (possibly *Thelypteris palustris*).

4.4 Remaining part of the Holocene – SPZ SHW-D

The upper pollen zone SHW-D is difficult to interpret. The sudden increase in values of ULMUS, TILIA, CORYLUS, QUERCUS and ALNUS pollen at the base of this zone indicates a hiatus between zones SHW-C and SHW-D. The pollen curves do not show enough typical palynostratigraphic trends to allow a linkage to the general vegetation history of central Brandenburg and Berlin. The absence of pollen types typical for the late Holocene (e.g FAGUS, CARPINUS, CEREALIA, PLANTAGO LANCEOLATA) shows that the later phases of the Holocene are not recorded in the investigated basin.

The occurrence of a layer of peat gyttja indicates peat formation within the basin but not necessarily at the cored spot: the peaty gyttja might have been reworked. The hiatus between this and the preceding zone indicates a drying-out of the basin for a substantial period of time and a renewed sedimentation of aquatic sediments after water levels rose again at some time-point during the middle Holocene. The absence of a late Holocene record points to a renewed drying-out of the basin. This is in contradiction with the original interpretation of KLOSS & WECHLER (1987) who assumed an extremely low accumulation rate for the peat gyttja and a renewed accumulation in the late Holocene.

The types excluded from the sum do not provide any information on a local wetland vegetation within the basin, with the exception that the relatively high but decreasing values of POLYPODIACEAE spores indicate an (extra)local presence of ferns.

5 The question of a Palaeolithic/Mesolithic anthropogenic pollen signal

Little is known about the Palaeolithic and Mesolithic anthropogenic influence on the vegetation and landscape of the Lateglacial and Early Holocene, because such influence was of such limited scale that it is impossible to distinguish it from natural processes recorded in pollen diagrams. An exception is a site in the southern Netherlands that displays anthropogenic impact on the Allerød tree vegetation (BOS & JANSSEN 1996; BOS 1998; BOS et al. 2006). Pollen analysis at a few m distance to a Palaeolithic settlement site in northern Vorpommern from the Lateglacial Betula/Pinus forest phase (Allerød) revealed no inferable anthropogenic influence (cf. KAISER et al. 1999; DE KLERK 2002).

Probably in a phase of 'wishful thinking', KLOSS & WECHLER (1987) hypothesised on the possibility of an anthropogenic pollen signal in the Schönwalde diagram originating from a core close to a settlement site. They rightfully note that pollen types that are often indicative for human activities (cf. BEHRE 1981) - i.e. CHENOPODIACEAE, ARTEMISIA, BROMUS-AGROPYRON TYPE, and pollen types attributable to *Polygonum* and *Rumex* - also might occur under natural conditions in the Lateglacial. They, however, also state that when these types occur together with higher values than other herbaceous pollen types, these must represent human influence (KLOSS & WECHLER 1987, p. 61). This is for the "Allerød" thought to be the case with pollen of *Artemisia*, Chenopodiaceae, *Bromus-Agropyron*, and for the Younger Dryas also with *Rumex*. For pollen of the latter, it must be noted that RUMEX hardly occurs in the diagram section that KLOSS & WECHLER (1987) interpreted as Younger Dryas (approximately corresponding with the current SPZ SHW-B1), making their argumentation obscure. The pollen type BROMUS-AGROPYRON-TYPE (which encompasses both the CEREALIA-LIKE and CEREALIA-TYPE, see sections 3 and 4.2.2) probably equals the HORDEUM GROUP of ANDERSEN (1979) and MOORE et al. (1991) or the HORDEUM TYPE of FÆGRI & IVERSEN (1989), which might also include pollen of wild grasses (e.g. some *Glyceria* species). Therefore, it provides no hard evidence of anthropogenic activities. Values of Chenopodiaceae pollen in the Schönwalde diagram are too low to allow convincing conclusions, with the exception of the pollen zone correlated with the Younger Dryas during which Chenopodiaceae taxa might have occurred naturally in the open upland vegetation. Only the somewhat enlarged values of Artemisia pollen in the diagram sequence corresponding with the Allerød might represent anthropogenic activities, but the position of these higher values immediately below the LST fits chronologically with the cool Gerzensee oscillation (cf. Lotter et al. 1992) that might have triggered a minor opening of the upland vegetation.

Only one conclusion is possible: in contrast to the opinion of Kloss & Wechler (1987), the dataset of the Schönwalde pollen diagram does not support the inference of a anthropogenic pollen signal.

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