

## Archaeobotanical Research of the SFB 268 in West Africa

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**Summary:** An overview over 20 years of archaeobotanical studies in West Africa is given. The Holocene vegetation history of the West African savannahs and the development of plant cultivation were major research topics. The existence of climatically induced savannahs throughout the Holocene could be confirmed. Archaeobotanical data indicate the late emergence of agriculture around 2000 BC and the development of a cultural landscape in the course of the last 2000 years.

Key words: Archaeobotany, palynology, plant cultivation, vegetation history, Holocene

### RECHERCHES ARCHÉOBOTANIQUES DU SFB 268 EN AFRIQUE DE L'OUEST

**Résumé:** Cet article donne une vue d'ensemble de 20 ans de recherches en Afrique de l'Ouest. L'histoire de la végétation de l'holocène des savanes ouest-africaines et le développement de la cultivation de plantes étaient des sujets de recherche principaux. L'existence de savanes climatiques dans tout l'Holocène pouvait être confirmée. Des données archéobotaniques indiquent l'apparition tardive de l'agriculture autour de l'an 2000 av.J.C et le développement d'un paysage de culture au cours des 2000 ans passés.

Mots clés: archéobotanique, palynologie, agriculture, histoire de végétation, Holocene

### ARCHÄOBOTANISCHE FORSCHUNG DES SFB 268 IN WEST AFRICA

**Zusammenfassung:** Der Beitrag gibt einen Überblick über 20 Jahre archäobotanische Studien in West-Afrika. Hauptforschungspunkte waren die holozäne Vegetationsgeschichte der westafrikanischen Savanne und die Entwicklung des Ackerbaus. Für das gesamte Holozän konnte die Existenz klimatisch bedingter Savannen bestätigt werden. Archäobotanische Daten bezeugen das Auftreten von Ackerbau für ungefähr 2000 v. Chr. und die damit verbundene Entwicklung einer Kulturlandschaft.

Schlagworte: Archäobotanik, Pollenanalyse, Ackerbau, Vegetationsgeschichte, Holozän

## 1 INTRODUCTION

The main focus of the archaeobotanical project was the Holocene vegetation history of the West African savannahs and the interdependency of human plant use and cultural development with environmental change. When the project started, it seemed to be self evident for many scientists that the West African savannah was mainly an anthropogenic landscape. Others, on the contrary, argued for a natural origin of the savannah. The archeobotanical project wanted to answer the question if natural savannahs existed in West Africa during the Holocene, or if they resulted from a long lasting human impact and the degradation of a formerly forested landscape. Furthermore, we were focusing on the emergence and development of agriculture in West Africa. Research areas were northern, southwestern and southeastern Burkina Faso, northern Nigeria, and Benin.

## 2 RESULTS

### 2.1. Vegetation history

In the frame of the SFB, the existence of savannahs throughout the Early and Middle Holocene could be confirmed for Burkina Faso and Nigeria. Palynological studies in the Manga Grasslands and on the Biu Plateau in northern Nigeria showed that even in more humid periods, savannahs existed several thousands of years before agriculture and pastoralism emerged in West Africa. Obviously in Sudanian and Sahelian West Africa, savannahs represent a natural, cli-

matically induced vegetation type (SALZMANN 2000b, SALZMANN & WALLER 1998, SALZMANN et al. 2002). For their maintenance even in periods of higher rainfall, fire plays an important role. However, a comparison of the recent vegetation in protected and unprotected areas shows that savannahs were not as poor in trees and shrubs as today. Particularly in the South Sudanian area, dry forests surely had a larger extension than today. A study on the modern dry forests of Southwest Burkina Faso revealed that forests today only can persist on sites not well suitable for agriculture (NEUMANN & MÜLLER-HAUDE 1999), whereas on deep, fertile soils, anthropogenic savannahs dominate, resulting from shifting cultivation. In the Sahelian zone, a combination of climatic deterioration and increasing human impact is responsible for the disappearance of many woody species in the course of the last 500 years (HÖHN 2007).

### 2.2. Archaeobotany

In comparison with other continents, agriculture is a late phenomenon in Africa. Only around 2000 BC, pearl millet (*Pennisetum glaucum*) appears as the first African domesticate in the southwestern Sahara and the northern Sahel. There is evidence for small-scale agriculture with pearl millet as the major crop during the second millennium BC in numerous West African countries, including Burkina Faso and Nigeria where the archaeobotanical project was working. During the first millennium BC, the early agricultural com-

munities disappeared all over West Africa, due to a distinct climatic change which brought increasing aridity. With the beginning of the Iron Age, large settlements with numerous cultural innovations emerged in Nigeria, whereas fully sedentary farming communities established in Burkina Faso around 0 BC/AD. During the Iron Age, park savannahs with *Vitellaria paradoxa*, *Faidherbia albida* and other useful trees developed all over West Africa, eventually resulting in the cultural landscape we can observe today.

### 3 THESES AND PUBLICATIONS

In the first and second phase of the SFB (1988-1992) archaeo-botanical research focussed on the excavations in rockshelter sites of the *Chaine de Gobnangou* in Burkina Faso (NEUMANN & BALLOUCHE 1992, BALLOUCHE et al. 1995, FRANK et al. 2001), and on dune sites in the Sahel of Burkina Faso. A pollen diagram from the Mare d'Oursi in northern Burkina Faso showed a distinct change of the vegetation around 1000 BC, which was interpreted to be due to human impact and the beginning of agriculture in this region (BALLOUCHE & NEUMANN 1995a). In the course of the third phase (1994-1996), extended archaeobotanical studies were conducted in the Sahel of Burkina Faso, based mainly on the interpretation of plant macroremains, such as charred wood, fruits and seeds. In the frame of this phase three theses were prepared by KAHLHEBER (1995), UEBEL (1996), and HÖHN (1997). A forth thesis was dealing with the diatoms of the Mare d'Oursi (MORCZINEK 1995). Two PhD theses were started in the third phase, which gave detailed information about the development of agriculture and plant use from 2000 BP up to modern times. A palynological dissertation was conducted in Nigeria by SALZMANN (1998), resulting in several publications (e.g. SALZMANN 2000a, b, SALZMANN & WALLER 1998, SALZMANN et al. 2002, WALLER & SALZMANN 1999). In the fourth phase (1997-1999) the research area was amplified again, now also including Benin where a project on the history of the Dahomey Gap (with partners from Nigeria, Benin, France and Germany) was funded by the Volkswagen Foundation between 1999 and 2002. Results from the work in Benin were published by BALLOUCHE et al. (2000), PETIT et al. (2000), and SALZMANN & HOELZMANN (2005).

In the fifth and last phase of the SFB our work concentrated on the publication of the data. Detailed archaeobotanical studies on several archaeological sites in Burkina Faso and Nigeria were published, for example by NEUMANN et al. (1998), KAHLHEBER (1999), KLEE et al. (2000, 2004), HÖHN (2002), and ZACH & KLEE (2003). Overviews on the history of plant cultivation in the Sahel of Burkina Faso were published by NEUMANN (1999), KAHLHEBER & NEUMANN (2001, 2007) and HÖHN et al. (2004). A general overview on the settlement history of Nigeria and Burkina Faso, including archaeology and archaeobotany, was given by BREUNIG & NEUMANN (1999, 2002a, 2002b). The main results from the interdisciplinary work in the SFB are presented in a final volume (ALBERT et al. 2004), including prehistory and environmental change (BREUNIG & NEUMANN 2004), the history of the West African savannahs (NEUMANN et al. 2004), and the prehistory of northern Burkina Faso in an interdisciplinary perspective (HÖHN et al. 2004). All in all 4 diploma and

3 PhD-theses were written; 1 monograph, 3 edited volumes, and 62 articles were published.

Today the Frankfurt archaeobotany is still present in West Africa, mainly focussing on the emergency of cultural complexity, the development of agroforestry and plant resource management in the later prehistory from the first millennium BC onwards. New interdisciplinary projects were started and conducted in the Nok area of central Nigeria, the Chad Basin of northern Nigeria and in the southern Cameroonian rainforest.

### REFERENCES

#### Diploma theses

HÖHN, A. (1997): Vergleichende Untersuchungen der Holzstruktur ausgewählter Mimosoideae und Caesalpinioideae (Leguminosae) Westafrikas. Diplomarbeit am Fachbereich Biologie der J.W. Goethe-Universität Frankfurt am Main.

KAHLHEBER, S. (1995): Vergleichende anatomische und morphologische Untersuchung ausgewählter Paniceenfrüchte. Diplomarbeit am Fachbereich Biologie der J.W. Goethe-Universität Frankfurt am Main.

MORCZINEK, I. (1995): Diatomeen aus dem Mare d'Oursi – Ein Beitrag zur holozänen Paläoökologie des westafrikanischen Sahel. Diplomarbeit am Fachbereich Biologie der J.W. Goethe-Universität Frankfurt am Main.

UEBEL, D. (1996): Die Holzkohlen von Saouga (Burkina Faso) – Ein Beitrag zur Vegetationsgeschichte Westafrikas. Diplomarbeit am Fachbereich Biologie der J.W. Goethe-Universität Frankfurt am Main.

#### Dissertations

HÖHN, A. (2005): Zur eisenzeitlichen Entwicklung der Kulturlandschaft im Sahel von Burkina Faso. Untersuchungen von archäologischen Holzkohlen.– 159 S. + 79 S. [Dissertation im Fachber. Biologie und Informatik der J.W. Goethe-Universität Frankfurt] <http://publikationen.ub.uni-frankfurt.de/volltexte/2005/2253/>

KAHLHEBER, S. (2004): Perlhirse und Baobab - Archäobotanische Untersuchungen im Norden Burkina Fasos.– 290 S. + 296 S. [Dissertation im Fachber. Biologie und Informatik der J.W. Goethe-Universität Frankfurt] <http://publikationen.ub.uni-frankfurt.de/volltexte/2005/561/>

SALZMANN, U. (1998): Zur holozänen Vegetations- und Klimaentwicklung der westafrikanischen Savannen. Paläoökologische Untersuchungen in der Sahel- und Sudanzone NO-Nigerias.- Dissertation, Julius-Maximilians-Universität Würzburg. Ber. Sonderforschungsbereich 268, 13. Frankfurt a. Main, 144 S.

#### Publications

ALBERT K-D & KAHLHEBER S. (2001): Review of and outlook on an interdisciplinary research project. – Ber. SFB 268 17: 121-128.

ALBERT K-D, HALLIER M, KAHLHEBER S & PELZER C (2000): Montée et abandon des collines d'occupation de l'âge de fer au Nord du Burkina Faso. – Ber. SFB 268 14: 335-351.

ALBERT K-D, LÖHR D & NEUMANN K (Eds.)(2004): Mensch und Natur in Westafrika. Abschlussbuch des SFB 268. Weinheim, Wiley-VCH.

- ANDRES W, BALLOUCHE A & MÜLLER-HAUDE P (1996): Contribution des sédiments de la Mare d'Oursi à la connaissance de l'évolution paléocéologique du Sahel du Burkina Faso. – Ber. SFB 268 7: 5-15.
- BALLOUCHE A (1998): Dynamique des paysages végétaux sahélo-soudaniens et pratiques agro-pastorales à l'Holocène. – Bull. Ass. Géogr. France 75(2): 191-200.
- BALLOUCHE A (2001): Un diagramme pollinique de la Mare de Kissi (Oudalan, Burkina Faso). Nouveaux éléments pour l'histoire anthropique de la végétation sahélienne. – Ber. SFB 268 17: 129-135.
- BALLOUCHE A & NEUMANN K (1994): Contribution à la connaissance du peuplement et du paléoenvironnement holocène du Sud-Est du Burkina Faso. – Association Ouest Africaine d'Archéologie, Actes du 5ème Colloque, Porto-Novo, Benin, pp. 3-21.
- BALLOUCHE A & NEUMANN K (1995a): A new contribution to the Holocene vegetation history of the West African Sahel: pollen from Oursi, Burkina Faso and charcoal from three sites in northeast Nigeria. – Veg. Hist. Archaeobot. 4: 31-39.
- BALLOUCHE A & NEUMANN K (1995b): La végétation du Sahel burkinabé à l'Holocène: la Mare d'Oursi.– 2nd Symposium on African Palynology, Tervuren (Belgium). Occasional Publication CIFE 31 Orléans, pp. 19-25
- BALLOUCHE A, KÜPPERS K, NEUMANN K & WOTZKA H-P (1993): Aspects de l'occupation humaine et de l'histoire de la végétation au cours de l'Holocène dans la région de la Chaîne de Gobnangou, S.E. Burkina Faso. – Ber. SFB 268 1: 13-31.
- BALLOUCHE A, AKOÉGNINOU A, NEUMANN K, SALZMANN U & SOWUNMI MA (2000): Le projet „Dahomey Gap“: une contribution à l'histoire de la végétation au Sud-Bénin et Sud-Ouest du Nigeria. – Ber. SFB 268 14: 237-251.
- BREUNIG P & NEUMANN K (1996): Archaeological and Archaeobotanical Research of the Frankfurt University in a West African Context. – Ber. SFB 268 8: 181-191.
- BREUNIG P & NEUMANN K (1999): Archäologische und archäobotanische Forschungen in Westafrika. – Archäol. Nachrichtenblatt 4: 336-357.
- BREUNIG P & NEUMANN K (2002a): From hunters and gatherers to food producers: new archaeological and archaeobotanical evidence from the West African Sahel.– In Hassan F (ed.): Ecological Change and Food security in Africa's Later Prehistory. New York et al., Kluwer Academic/Plenum Publishers, pp. 123-155.
- BREUNIG P & NEUMANN K (2002b): Continuity or discontinuity? The 1st millennium BC–crisis in West African prehistory. – In LENSSEN-ERZ T et al. (eds.): Tides of the Desert. Contributions to the Archaeology and Environmental History of Africa in Honour of Rudolph Kuper. Africa Praehistorica 14: 499-505.
- BREUNIG P & NEUMANN K (2004): Zwischen Wüste und Regenwald. Besiedlungsgeschichte der westafrikanischen Savanne im Holozän. – In ALBERT K-D, LÖHR D & NEUMANN K (eds.): Mensch und Natur in Westafrika. Ergebnisse aus dem Sonderforschungsbereich 268 "Kulturentwicklung und Sprachgeschichte im Naturraum Westafrikanische Savanne". Weinheim, Wiley-VHC, pp. , 93-138.
- BREUNIG P, BALLOUCHE A, NEUMANN K, RÖSING F, THIE-MEYER H, WENDT KP & VAN NEER W (1993): Gajiganna - New Data on Early Settlement and Environment in the Chad Basin. – Ber. SFB 268 2: 51-74.
- BREUNIG P, NEUMANN K & VAN NEER W (1996): New research on the Holocene settlement and environment of the Chad Basin in Nigeria. – Afr. Arch. Rev. 13(2): 111-145.
- FRANK T, BREUNIG P, MÜLLER-HAUDE P, VAN NEER W, VOGELSANG R, NEUMANN K & WOTZKA H-P (2001): The Chaîne de Gobnangou, SE Burkina Faso: archaeological, archaeobotanical, archaeozoological and geomorphological studies. – Beitr. Allgem. Vergleichende Archäol. 21: 127-190.
- GRONENBORN D, WIESMÜLLER B, SKORUPINSKI T & ZACH B (1996): Settlement history of the Kala-Balge region, Borno State, Nigeria. – Ber. SFB 268 8: 201-213.
- HÖHN A (1999): Wood anatomy of selected west African species of Caesalpinioideae and Mimosoideae (Leguminosae): a comparative study. – IAWA J. 20(2): 115-146.
- HÖHN A (2002): Vegetation changes in the Sahel of Burkina Faso (West Africa). – Analysis of charcoal from the Iron Age sites Oursi and Oursi-village. – In THIÉBAULT S (ed.): Charcoal Analysis. Methodological Approaches, Palaeoecological Results and Wood Uses.- British Archaeol. Report, Internat. Series 1063, pp. 133-139.
- HÖHN A (2007): Where did all the trees go? Changes of the woody vegetation in the Sahel of Burkina Faso during the last 2000 years. – In CAPPERS R (ed.): Fields of change. Progress in African archaeobotany. Groningen Archaeol. Studies 5: 35-41.
- HÖHN A, KAHLHEBER S & HALLIER-VON CZERNIEWICZ M (2004): Den frühen Bauern auf der Spur – Siedlungs- und Vegetationsgeschichte der Region Oursi (Burkina Faso).– In ALBERT K-D, LÖHR D & NEUMANN K (eds.): Mensch und Natur in Westafrika, 221-288. Abschlussbuch des SFB268. Weinheim, Wiley - VCH.
- HOELZMANN P, GASSE F, DUPONT LM & SALZMANN U (2004). Palaeoenvironmental changes in the arid and sub-arid belt (Sahara-Sahel-Arabian Peninsula) from 150 ka to present. – In BATTARBEE RW, GASSE F & STICKLEY CE (eds.): Past Climate Variability through Europe and Africa. Dordrecht, Kluwer, 219-256.
- KAHLHEBER S (1999): Indications for agroforestry: archaeobotanical remains of crops and woody plants in medieval Saouga, Burkina Faso. – In VAN DER VEEN M (ed.): The exploitation of plant resources in ancient Africa. New York, Plenum Publishers, 89-100.
- KAHLHEBER S & NEUMANN K (eds.)(2001): Man and Environment in the West African Sahel – An Interdisciplinary Approach. – Ber. SFB 268 14. Frankfurt a. Main, 555 p.
- KAHLHEBER S & NEUMANN K (2007): The development of plant cultivation in semi-arid west Africa. – In DENHAM TP, IRIARTE J & VRYDAGHS L (eds.): Rethinking agriculture: archaeological and ethnoarchaeological perspectives. One World Archaeology 51. London, University College Press, 320-346.
- KAHLHEBER S, ALBERT K-D & HÖHN A (2001): A contribution to the palaeoenvironment of the archaeological site Oursi in north Burkina Faso. – Ber. SFB 268 17: 145-159.
- KLEE M & ZACH B (1999): Crops and wild cereals of three settlement mounds in NE-Nigeria - charred plant remains and impressions in ceramics from the last 4000 years. – In VAN DER VEEN M (ed.): The exploitation of plant resources in ancient Africa. New York, Plenum Publishers, 81-88.
- KLEE M, ZACH B & NEUMANN K (2000): Four thousand years of plant exploitation in the Chad Basin of NE Nigeria,

- part I: The archaeobotany of Kursakata. – Veg. Hist. Archaeobot. 9: 223-237.
- KLEE M, ZACH B & STIKA H-P (2004): Four thousand years of plant exploitation in the Chad Basin of NE Nigeria, part III: Plant impressions in potsherds from the Final Stone Age Gajiganna Culture. – Veg. Hist. Archaeobot. 13: 131-142.
- MAGNAVITA S, HALLIER M, PELZER C, KAHLHEBER S & LINSEELE V (2002): Nobles, guerriers, paysans. Une nécropole de l'Age de Fer et son emplacement dans l'Oudalan pré- et protohistorique. – Ber. Allgem. Vergleichende Archäol. 22: 21-64.
- MÜLLER-HAUDE P & NEUMANN K (1995): Böden und Vegetation in Trockenwäldern Südwest-Burkina Fasos.– Ber. SFB 268 5: 177-188.
- NEUMANN K (1999a): Charcoal from West African savanna sites - questions of identification and interpretation. – In VAN DER VEEN M (ed.): The exploitation of plant resources in ancient Africa. New York, Plenum Publishers, 205-220.
- NEUMANN K (1999b): Early plant food production in the West African Sahel - new evidence from the Frankfurt project. – In VAN DER VEEN M (ed.): The exploitation of plant resources in ancient Africa. New York, Plenum Publishers, 73-80.
- NEUMANN K (2001): Masakwa farming in the Chad Basin of Northeast Nigeria – Introduction. – Ber. SFB 268 17: 9-13.
- NEUMANN K (2002): Die westafrikanische Savanne – eine Kulturlandschaft. – In REIKAT A (ed.): Leben in Westafrika. – SFB 268 „Kulturentwicklung und Sprachgeschichte im Naturraum Westafrikanische Savanne). Frankfurt am Main, Plexus-Verlag, Johann Wolfgang Goethe-Universität, 70-83.
- NEUMANN K (2003): The late emergence of agriculture in Sub-Saharan Africa: Archaeobotanical evidence and ecological considerations. – In NEUMANN K, BUTLER EA & KAHLHEBER S (eds.): Food, fuel and fields. Progress in African archaeobotany. Africa Praehistorica 15: 71-92.
- NEUMANN K (2005): The romance of farming – plant cultivation and domestication in Africa. – In STAHL AB (ed.): African Archaeology. A Critical Introduction. Malden, Blackwell, 249-275.
- NEUMANN K & BALLOUCHE A (1992): Die Chaîne de Gobnangou in SE Burkina Faso - Ein Beitrag zur Vegetationsgeschichte der Sudanzone WAfrikas.– Geobot. Kolloq. 8: 53-68.
- NEUMANN K & BALLOUCHE A (1995): Anthropogenic Change in the Vegetation History of the Sahel - Only a Question of Viewpoint? – 2nd Symp. Afr. Palyn., Tervuren (Belgium) 1995. – Publ. Occas. CIFE 31: 27-33.
- NEUMANN K & MÜLLER-HAUDE P (1999): Forêts seches au Sud-Ouest du Burkina Faso: végétations - sols - action de l'homme. – Phytocoenol. 29(1): 53-85.
- NEUMANN K & SALZMANN U (2001): Feuerökologie der westafrikanischen Savannenlandschaft. Würde die Savanne ohne Brand existieren? – In BUSCH B, GOLDAMMER JG & DENK A (eds.): Feuer. Schriftenr. Forum 10, Köln, Wienand, 280-289.
- NEUMANN K & VOGELSANG R (1996): Paléoenvironnement et préhistoire au Sahel du Burkina Faso. – Ber. SFB 268 7: 177-186.
- NEUMANN K, BALLOUCHE A & KLEE M (1996): The emergence of plant food production in the West African Sahel: new evidence from northeast Nigeria and northern Burkina Faso. – In PWITI G & SOPER R (eds.): Aspects of African Archaeology. Papers from the 10th Congress of the PanAfrican Association for Prehistory and Related Studies. Harare, University of Harare Publications, 441-448.
- NEUMANN K, BREUNIG P & KAHLHEBER S (2000): Early food production in the Sahel of Burkina Faso. – Ber. SFB 268 14: 327-334.
- NEUMANN K, BUTLER EA & KAHLHEBER S. (eds.)(2003): Food, Fuel and Fields. Progress in African archaeobotany. – Africa Praehistorica 15: 1-304.
- NEUMANN K, HAHN-HADJALI K & SALZMANN U (2004): Die Savannen der Sudanzone in Westafrika - natürlich oder menschengemacht? – In ALBERT K-D, LÖHR D & NEUMANN K (eds.): Mensch und Natur in Westafrika. Abschlussbuch des Sonderforschungsbereichs 268. Weinheim, Wiley – VCH, 39-68.
- NEUMANN K, KAHLHEBER S & UEBEL D (1998): Remains of woody plants from Saouga, a medieval West African village. – Vegetation History Archaeobot. 7: 57-77.
- NEUMANN K, SCHOCH W, SCHWEINGRUBER FH & DÉTIENNE P (2001): Woods of the Sahara and the Sahel - an anatomical atlas. With a contribution by H.G. Richter. – Bern, Stuttgart, Paul Haupt.
- PETIT LP, BAGODO O, HÖHN A & WENDT KP (2000): Archaeological sites of the Gourma and Mékrou Plains. – Ber. SFB 268 14: 229-236.
- SALZMANN U (1996a): Holocene Vegetation History of the Sahelian Zone of NE Nigeria: Preliminary Results. – Palaeoecol. Africa 24: 103-114.
- SALZMANN U (1996b): Pollenanalytical Studies in NE-Nigeria: Preliminary Results from the Manga Grasslands and Lake Tilla, Biu Plateau. – Ber. SFB 268 8: 321-333.
- SALZMANN U (1997): Holozäne Vegetationsgeschichte NO-Nigerias: Pollenanalytische Untersuchungen in den Manga Grasslands. – Würzburger Geogr. Arb. 92: Geowissenschaftl. Untersuchungen Afrika 3: 51-69.
- SALZMANN U (2000a): Between desert and forest: The Holocene savannas of NE-Nigeria. – Ber. SFB 268: 14: 21-32.
- SALZMANN U (2000b): Are savannas degraded forests? - A Holocene pollen record from the Sudanian zone of NE-Nigeria. – Vegetation History Archaeobot. 9: 1-15.
- SALZMANN U & HOELZMANN P (2005): The Dahomey Gap: an abrupt climatically induced rain forest fragmentation in West Africa during the late Holocene. – The Holocene 15(2): 190-199.
- SALZMANN U & WALLER M (1998): The Holocene vegetational history of the Nigerian Sahel based on multiple pollen profiles. – Rev. Palaeobot. Palynol. 100(1/2): 39-72.
- SALZMANN U, HOELZMANN P & MORCZINAK I (2002): Later Quaternary climate and vegetation of the Sudanian zone of NE-Nigeria deduced from pollen, diatoms and sedimentary geochemistry. – Quaternary Res. 58: 73-83.
- VOGELSANG R & NEUMANN K (1996): Paléoenvironnement et préhistoire au Sahel du Burkina Faso.– Ber. SFB 268 7: 177-186.
- VOGELSANG R, ALBERT K-D & KAHLHEBER S (1999): Le sable savant: Les cordons dunaires sahéliens au Burkina Faso comme archives archéologiques et paléocéologiques pour l'Holocène. – Sahara 11: 51-68.

WALLER M & SALZMANN U (1999): Holocene vegetation changes in the Sahelian zone of NE-Nigeria: The detection of anthropogenic activity. – *Palaeoecol. Africa* 26: 85-102.

ZACH B & KLEE M (2003): Four thousand years of plant exploitation in the Chad Basin of NE Nigeria II: Discussion on the morphology of caryopses of domesticated *Pennisetum* and complete catalogue of the fruits and seeds of Kursakata. – *Veg. Hist. Archaeobot.* 12: 187-204.

ZACH B, KIRSCHT H, LÖHR D, NEUMANN K & PLATTE E (1996): Masakwa Dry Season Cropping in the Chad Basin. – *Ber. SFB 268* 8: 349-356.

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