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Forests and rivers: The archaeology of the north eastern Congo

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ABSTRACT

The Central African Rainforest was long thought to be a green desert. Intensive archaeological research during the last decades has shown the contrary. The rainforest of the Congo bassin has a long and rich history, but its heavy vegetation cover made it difficult to find evidence of human settlements. Indeed, an overview of archaeological collections held at the RMCA (Royal Museum for Central Africa), shows that, before the 1980's, very few sites were reported for the Rainforest area of DRC (Democratic Republic of Congo). Since then a series of river-born reconnaissance have shown that there were sites aplenty in the Inner Congo Basin. Latter surveys along the Congo River and its tributaries further East, between Bumba and Kisangani (DRC), indicate that this is also true in the North-Eastern part of the Congo River. Our results show that the region's archaeological record consists primarily of pottery finds associated with old soil horizons or pottery arranged in pit-structures, with lithic assemblages being relatively rare. This work offers a first assessment of the past 2000 years of human occupation in a region that was an archaeological *terra incognita*. In the process, we also confirm a powerful research strategy, combining forestry inventories with systematic archaeological sampling. Recent work in forestry showed that there was not a single primeval rainforest, but rather a patchwork of forests. This approach allowed us to access inter-fluvial portions of a dense rainforest environment and provided essential data for the regional chrono-stratigraphy.

1. Introduction

Despite its central position within the African continent, the peopling and history of the central African rainforest, of which almost half lies in the Democratic Republic of Congo (DRC), remained virtually unknown until the end of the 1970's. Indeed, a review of the literature and an ongoing review of the archaeological collections and archives of the Royal Museum for Central Africa (RMCA, Belgium) show that those few excavated sites in the DRC before 1960 were situated outside or at the edge of the rain forest. Most of the surface finds in the north-eastern part of the rainforest consist of stone artefacts. Surveys of the Inner Congo Basin and the northern tributaries of the Congo River produced no stone artefacts and very few pottery finds. Thus this area of Central Africa was virtually an archaeological *terra incognita*, lending support to the assumption that the rainforest was 'hostile' to human occupation (the debate concerning living conditions in the rainforest is discussed in detail by Eggert, 2014).

These assumptions were seriously challenged through a series of surveys undertaken during the *River Reconnaissance Project* (RRP) between 1977 and 1987 conducted in the Inner Congo Basin, under the general direction of Manfred Eggert. This research revealed that people have lived in the forest of central Africa for at least the last

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2500 years, demonstrating that the lack of archaeological data was essentially reflecting the lack of archaeological survey. The research strategy was to navigate as far as possible upstream on various rivers, conducting short surveys and enquiries in villages. Test pits were excavated at the most promising locations during the downstream return (Eggert, 1980, 1984, 1987, 1992, 2014; Wotzka, 1993, 1995). Eggert, however, stressed right from the beginning that using rivers to survey the rainforest introduces a bias in archaeological site patterning, as it only takes into account occupations on or near riverbanks, leaving the interfluves unexplored. The vast interfluves, with their dense forest cover, offered none of the cuts and erosion surfaces needed for archaeological surveys making it difficult to identify ancient sites using conventional archaeological methods.

One way to move beyond this limitation is to use patterns of vegetation composition as a guideline to identify forest stands that are recovering from past trauma. The central African rainforest is a dynamic environment, where anthropogenic and climatic factors play a role in modifying forest composition and extent (Brncic et al., 2009, 2007; White, 2001; White and Oates, 1999). The successional status of forest stands is reflected in species composition and forest dynamics. Small patches of regenerating forest, resulting from natural events such as windstorms or lightning strikes, are normal in tropical ecosystems. However, large stands of regenerating forest species can very often be related to human disturbance such as slash-and burn practices (e.g. Bourland et al., 2015; Muller-Landau, 2009). A good example is the presence of large, sometimes monodominant, stands of *Aucoumea klaineana* that were used to locate human occupation sites in the Chaillu massif in Gabon (Oslisly and White, 2003:82; White et al., 2000). These large stands of regenerating forest species may indicate formerly forested areas that have been cleared, burned, used for agriculture, abandoned and finally recolonized by fast-growing pioneer trees. At a later stage, these short-lived fast colonizers are replaced by long-lived light-demanding pioneers (e.g. Bourland et al., 2015). Apart from using forest composition as an indicator for archaeological surveys, understanding forest history is also crucial to develop policies for sustainable forest management. In order to reconstruct past rainforest dynamics and confirm the role of humans in the process, various configurations of archaeological and anthracological surveys were tested in the central African rainforest (Dechamps et al., 1988; Hart et al., 1996; Hubau et al., 2015; Morin-Rivat et al., 2016). Furthermore, systematic forest inventories indicate the location of large stands of long-lived pioneers. As such, combining forest inventories with archaeological surveying and anthracological analysis, will significantly improve our understanding of past human rainforest occupation. Today, forest inventories are becoming standard practice in tropical forest research (e.g. Lewis et al., 2009) and management (e.g. Gourlet-Fleury et al., 2013), and they constitute a crucial tool for the selection of areas of archaeological interest in tropical forests.

In this paper, we present the first archaeological framework for the north-eastern Congo bend using data collected during three separate expeditions. First, in 2010 during the Boyekoli Ebale Congo River expedition, an archaeological survey was made on a series of tributaries of the Congo River, the lower Lomami, Itimbiri and Aruwimi rivers (Livingstone Smith et al., 2011). Second, during a follow-up field-work in 2013, an archaeological survey was made on the Lindi-river north of Kisangani (Cornelissen et al., 2013). Finally, we also use the data collected during an anthracological and archaeological sampling on a forest inventory transect in the Yangambi National Reserve inland from the Congo River (Isangi Territory, Tshopo District, Oriental Province of D.R.C.). As no archaeological research had ever been done in this area of Central Africa, we offer a first chrono-cultural sequence based on three pottery phases (Early, Middle and Recent), each composed of several styles. The presence/absence of archaeological material, pottery assemblages and, if present, stone artefacts, are briefly described for each site and then discussed in more detail. In doing so, we fill another gap in past human occupation of the central African rainforest. We also confirm the usefulness of a combined botanical and archaeological approach to tropical forest vegetation history.

2. Materials and methods

2.1. Sampling method 1: archaeological excavations during riverine surveys (2010, 2013)

The international project of *Boyekoli Ebale Congo (2010)* involved an interdisciplinary team of 67 zoologists, botanists, hydrologists, geologists, cartographers and also two archaeologists and two linguists. The river expedition aimed at documenting biodiversity and human impact along a stretch of the Congo River between Kisangani in the East and Engengele in the West. For the riverine archaeological exploration, villages were points of departure. Surveys started from basecamps that were successively put up at Yaekela on the Congo River, facing the Lomami, at Koni on the Itimbiri, at Bomane Yangwa on the Aruwimi and at Lieki on the Lomami river (Fig. 2) (Livingstone Smith et al., 2011). From there, the surroundings were explored by pirogue. A smaller survey took place in 2013 from a basecamp at Badilé exploring the riverbanks of the Lindi by motorcycle (Cornelissen et al., 2013).

During the riverine survey, whenever higher riverbanks were spotted from the water, enquiries on the local history for identifying old and abandoned areas were conducted in the village. Eroded surfaces or freshly dug pits were surveyed. After auger-drillings, test pits of 1 m^2 proceeding in shovel-large spits of 25 cm were dug, and artefacts were hand-picked. In the event of interesting archaeological finds, an additional test pit of 1 m^2 was excavated in 10 cm-spits. All the excavated material was wet sieved down to 2 mm. Charcoal was retrieved for environmental reconstruction and dating. In the Yaekela pit-structures land snails and freshwater shells were found, but as expected in the acid soils under forest cover, no bone material was retrieved on any of the sites.

2.2. Sampling method 2: forest survey (2015)

In 2015 as part of a forest survey transect in the *Xyladate* project, pottery was collected in two pits dug for environmental reconstructions. The test-pits were 2 m × 1 m and excavated by 10 cm spits. Charcoal and artefact samples were hand-picked following the same procedures as Hubau et al. (2013, 2012).

2.3. Pottery analysis

As pottery has never been described in the area, we use the pottery sequence established by Hans-Peter Wotzka (1995) for the neighbouring Inner Congo Basin as background reference. Style attributions are made on the basis of the shapes (base, body shoulder and neck), the decoration (ornamental tools and techniques) and the fabric (macroscopic characteristics of the matrix and non-plastic inclusions) of vessels found in distinct contexts. We also refer briefly to pottery building techniques, as observed by *macrotraces* - but this part of the study is at a preliminary stage (for a general description of the method, see for instance: Livingstone Smith, 1999, 2001, 2010; Livingstone Smith and Vysserias, 2010). The stratigraphic distribution allows us to sort these styles into three successive chronological stages, the Early, Middle and Late

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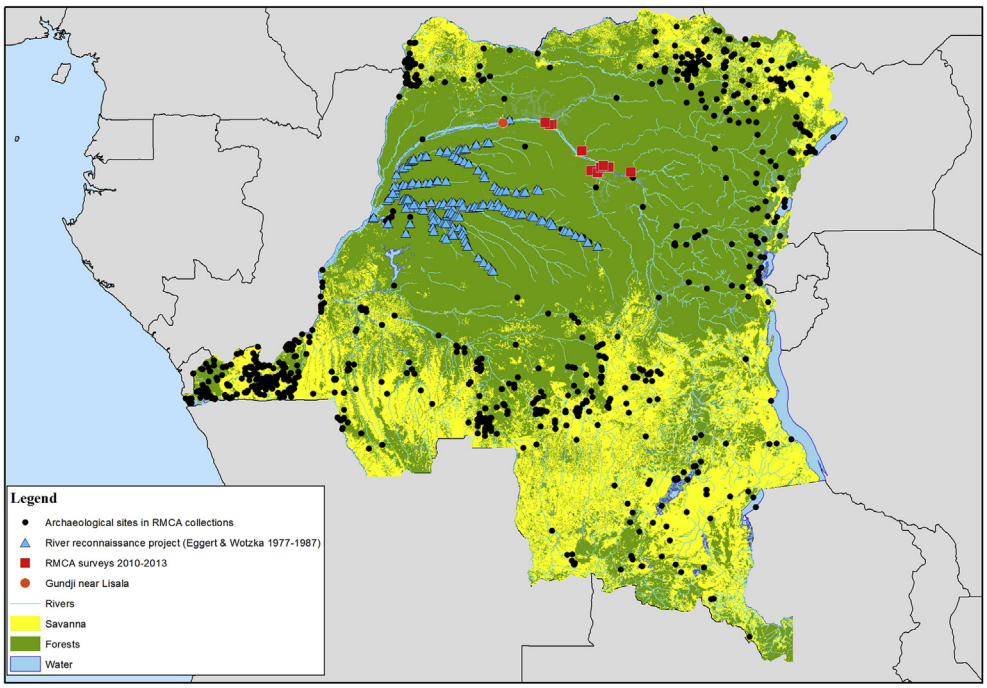

Fig. 1. Map of archaeological sites in the Democratic Republic of Congo (RMCA, Royal Museum for Central Africa, Belgium) © RMCA.

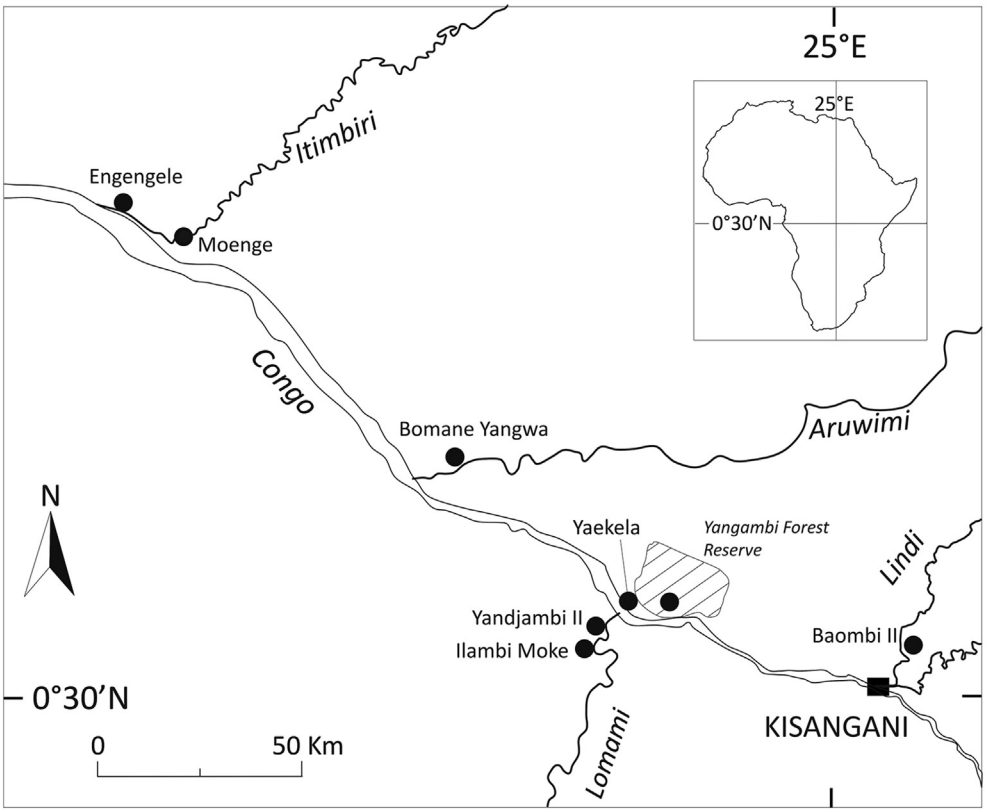

Fig. 2. Map of sites mentioned in the text © RMCA.

Phase. The various styles present in Early and Middle Phase assemblages have not been defined yet, but the Late Phase includes three identified styles: Ilambi, Nkomba and Yaekela. Finally, all the fabrics of all diagnostic sherds (i.e. with a recognisable shape or decoration) were examined with a binocular microscope. Though these analyses are not completed, raw materials and preparation techniques support the stratigraphic and stylistic division outlined here.

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2.4. Radiocarbon dating

In order to establish a chronological framework, a total of 10 charcoal fragments were selected for AMS radiocarbon dating. Calibration was performed with the OxCal v4.1.5 software (r:5) using the SHCal04 southern hemisphere 14C calibration curve (Bronk Ramsey, 2009; McCormac et al., 2004).

2.5. Pedological sampling

Undisturbed oriented samples for pedological analysis were collected at Bomane Yangwa (YNG), Ilambi Moke (MOK) and Yandjambi II (MBI), using Kubiena boxes (6 × 9 cm). The samples were impregnated using a cold-setting polyester resin, followed by production of thin sections using standard methods (Department of Geology, Ghent University; Benyarku and Stoops, 2005). The sections were analysed using a Leica DM RXP polarization microscope, and described using the concepts and terminology of Stoops (2003).

3. Results

Table 1 presents an overview of all 14 sites presented in this paper. For each site the excavation structure, presence of artefacts, pottery phase(s), stone artefacts, charcoal presence and radiocarbon dates are listed. Sites are categorized into (1) pit-structures (ancient pits filled during single or multiple events), (2) stratified sites with one or distinct occupation layer(s), (3) surface and exposure collections, and (4) forest survey pits.

3.1. Pit-structures

Pit-structures were identified at two places in the village of Bomane Yangwa on the right bank of the Aruwimi River (Fig. 2), YNG/10/I and YNG/10/II, and a pit structure, BAO/10/II, in the talus of a path leading from the village of Baombi II towards the Lindi River. At Yaekela a small pit structure, YAE/10/01, and a very large YAE/10/20, were tested.

3.1.1. Bomane Yangwa: YNG/10/II

YNG/10/II (23,734940 °E, -1,273030 °S) is a well-preserved pit structure that was eroding out next to a cliff overhanging the river (Fig. 3). The archaeological material uncovered consists of a significant quantity of pottery; some fragmentary, but also whole vessels, some stacked into one another.

3.1.1.1. Stratigraphy. The assumed undisturbed soil material is characterised by a relatively high clay content, poor sorting of the

Table 1
Overview of all sites, with for each site the excavation context, artefact types, the pottery phase, charcoal presence and radiocarbon dates © RMCA.

Site code	Village/River	Structure	Artefacts	Pottery phase	Charcoal	Radiocarbon date	
YNG/10/I	Bomane/Aruwimi (Yangwa)	Pit structure, initial U-shaped pit	Very few		Few		
		Pit structure, later V-shaped pit	Abundant Potsherds	Middle Phase	Abundant	Poz-39121	1880 ± 30 BP
YNG/10/II	Bomane/Aruwimi (Yangwa)	Pit structure, initial U-shaped pit	Very few		Few		
		Pit structure, later V-shaped pit	Abundant Potsherds + complete vessels	Early Phase	Abundant	Poz-39122	2110 ± 35 BP
MOK/10/I	Ilambi Moke/Lomami	Pit structure (truncated by erosion)	Abundant Potsherds, well preserved	Middle Phase	None		–
MOK/10/II	Ilambi Moke/Lomami	Occupation layer - top layer	Potsherds	Late Phase - Ilambi	Abundant		–
		Occupation layer - middle layers	Potsherds + lithics	Early/Middle Phase	Abundant	Poz-39116	1990 ± 30 BP
		Occupation layer - lower layer	Potsherds + complete vessels + lithics	Early Phase	Abundant	Poz-39117	2085 ± 35 BP
MBI/10/II	Yandjambi II/Lomami	Occupation layer - top layer	Potsherds + few lithics	Late Phase - Ilambi	Abundant		–
		Occupation layer - middle layers	Potsherds + abundant lithics	Early/Middle Phase	Abundant	Poz-39115	1685 ± 30 BP
		Occupation layer - lower layer	Potsherds	Early Phase	Abundant		–
YAE/10/01	Yaekela/Congo	Pit structure	Abundant Potsherds + shells	Late Phase - yaekela	Abundant		–
YAE/10/20	Yaekela/Congo	Pit structure	Abundant Potsherds + shells	Late Phase - yaekela	Abundant		–
BAO/13/I	Baombi II/Lindi	Pit structure	Abundant Potsherds + complete vessels	Early Phase	Abundant	Poz-57246	2085 ± 30 BP
						Poz-57248	2155 ± 30 BP
YAS/15/02	Yangambi	Forest survey, 50–60 cm spit	Very few Potsherds	Late Phase - Ilambi	Abundant	Poz-75462	1230 ± 30 BP
YAN/15/05	Yangambi	Forest survey, 40–50 cm spit	Few potsherds	Late Phase - Ilambi	Abundant	Poz-75451	370 ± 30 BP
		Forest survey, 60–70 cm spit	Few potsherds	Middle Phase	Abundant	Poz-75452	1670 ± 30 BP
ENG/10/01	Engengele/Itimbiri	Surface - near potter (†6yrs ago)	Potsherds + copal	Late Phase - Nkomba	Abundant		Recent
ENG/10/02	Engengele/Itimbiri	Surface - near potter (†50yrs ago)	Potsherds	Late Phase - Nkomba	Abundant		Recent
ENG/10/03	Engengele/Itimbiri	Surface - near potter (†65yrs ago)	Potsherds	Late Phase - Nkomba	Abundant		Recent
MOE/10/III	Moenge/Itimbiri	Pit structure, 0–35 cm	Potsherds	Late Phase -Yaekela	Abundant		–
		Pit structure, 35–50 cm	Potsherds	Late Phase -Nkomba	Abundant		–
		Pit structure, 50–70 cm	Potsherds	Late Phase -Ilambi	Abundant		–
		Pit structure, 120–160 cm	Potsherds	Middle Phase	Abundant		–

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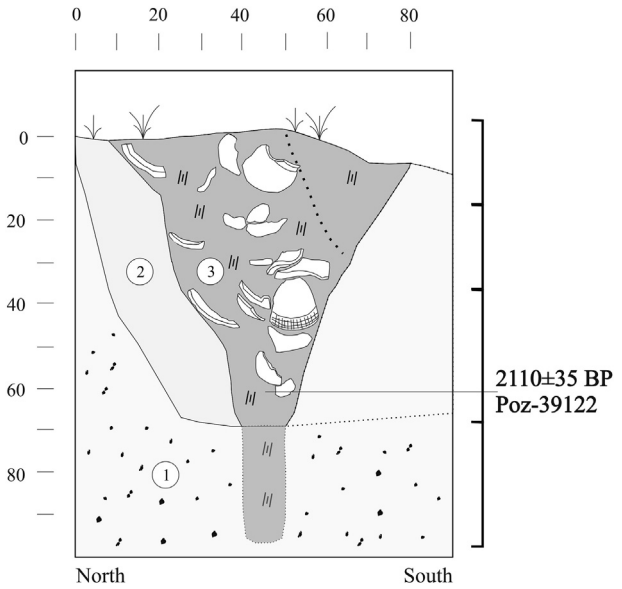

Fig. 3. Profile of YNG/10/II-AB showing: unit 1,2 and 3. Unit 1. Undisturbed soil. Unit 2: Filling of initial pit-structure1 and Unit 3: Filling of pit 2 which was cut into pit 1 © RMCA.

sand fraction, and the presence of anorthic lateritic fragments (Fig. 4. A). Fine clay coatings are common, partly as deformed coatings and fragments of coatings (Fig. 4. B). The fill of a later second pit dug into the initial pit has a higher sand content than the surrounding soil, and the grain size of the sand fraction is different, with a significant coarse sand admixture (Fig. 4. C). The micromass is browner than that of the reference soil material. Fine clay coatings are common. The fill of the second, later pit also contains some unidentified coarse fabric elements, composed of optically isotropic material with high refractive index (Fig. 4. D). The thin section analysis confirms the undisturbed nature of the soil. The parent material formed in low-energy conditions or proximal settings that were not conductive to clay-sand separation or to sand fraction sorting. The possible fill structure is different from the surrounding soil in terms of clay content and sand size distribution, demonstrating that it represents a different stage of accumulation, either natural or anthropogenic.

From the preceding observations the following sequence of events can be reconstructed: the opening of a first pit with a wide U shape directly in the undisturbed clayey soil (Fig. 3. Unit 1), rapid probable anthropogenic infilling of this pit (Fig. 3. Unit 2). Incomplete re-excavation then resulted in a second pit with V-shaped profile in which a large number of mostly complete pots were stacked which were rapidly covered with loose sediment not rich in charcoal succeeded by a loose filling of charcoal rich sediment (Fig. 3. Unit 3). Finally, recent erosion has exposed the top of these pit-structures.

3.1.1.2. Radiocarbon dating. A carbonised palm nut endocarp sampled within a stack of vessels at a depth of 50–70 cm below surface yielded a date for this event of 2110 ± 35 BP (Poz-39122).

3.1.1.3. Finds. Archaeological finds consist of a concentration of poorly preserved potsherds and complete vessels partly found in a careful arrangement, and carbonised vegetal remains. The pottery is typical for the Early Phase (see below 4.3.1.).

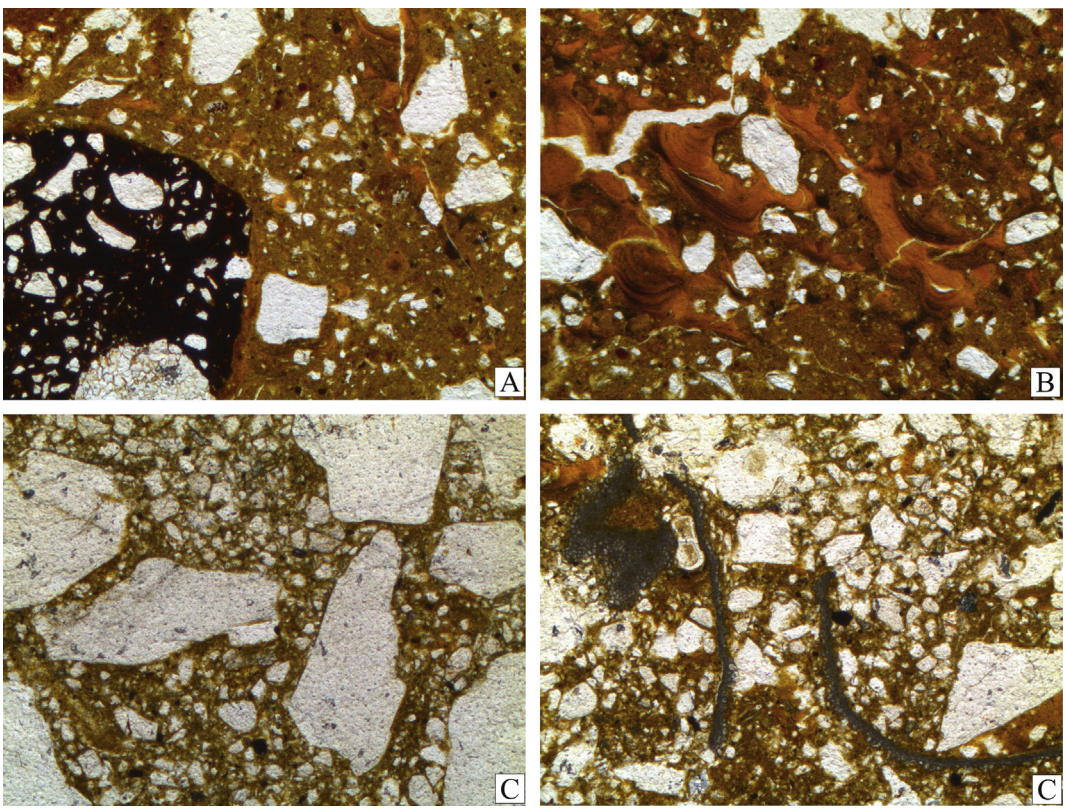

Fig. 4. Microscopic features of profile YNG/10/IIB. A. Assumed undisturbed soil, with poor sorting of the sand fraction and with large anorthic lateritic fragments. B. Assumed undisturbed soil,, with fine clay coatings, deformed by natural processes. C. Typical heterogeneous groundmass, with higher sand content than the undisturbed soil and with coarse sand admixture from the second pit. D. Unidentified fabric elements (dark grey, elongated) of probably anthropogenic origin. Frame width 2.6 mm© F. Mees, RMCA.

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3.1.2. Bomane Yangwa: YNG/10/I

YNG/10/I (23,733010 °E, -1,271090 °S) is a pit partially destroyed by a modern pit dug to repair the walls of a nearby house in the village of Bomane Yangwa (Fig. 5). As the pit was poorly preserved we rectified its profile and sampled the various units.

3.1.2.1. Stratigraphy. The pit-structures at YNG/10/I were formed after a sequence of events similar to those at YNG/10/II. A first pit was dug in the natural substrate (Fig. 5. Unit 1) before being rapidly filled in (Fig. 5 unit 2). This was then reopened and completely filled in (Fig. 5. Unit 3). The difference from YNG/10/II lies in the content of the second pit here, where there is no stacking of complete vessels at its base in contrast to YNG/10/II.

The undisturbed soil material is essentially similar to that of the other excavation at Bomane Yangwa (YNG/10/II), except for the lower clay content of the groundmass (Fig. 6. A) and the presence of a second generation of clay coatings, with coarser texture (Fig. 6. B). The occurrence of coarse illuvial clay reveals deposition of mechanically dispersed material either following flooding or through tillage.

The material lining the second pit structure (Fig. 6. C) has a higher sand content than the surrounding soil, and the fine material has a more brownish colour. The sample includes one subhorizontal band with much finer grain size of the coarse fraction, with sharp lower boundary and gradual upper boundary (Fig. 6. D). One burrow is lined by a fibrous iron oxide coating, with associated groundmass impregnation (Fig. 6. D), recording hydromorphic conditions. Fine clay coatings are present in the same manner as in the surrounding soil, but coarse illuvial clay is absent.

3.1.2.2. Radiocarbon dating. A mature wood charcoal found under a potsherd found between −50 and −55 cm below surface was dated to 1880 ± 30 BP (Poz-39121).

3.1.2.3. Finds. The archaeological material consists mainly of potsherds and carbonised vegetal remains. The poorly preserved pottery is assigned to the Middle Phase (see below 4.3.2.). All fragments display very eroded surfaces.

3.1.3. Ilambi Moke: MOK/10/I

A probable pit structure was eroding out of the left bank of the Lomami river at Ilambi Moke (Fig. 7). The structure was cut in two, forming MOK/10/IA and B (24,184201 °E, -0,638864 °S). Another test-pit, discussed in 3.2.1, was made 5 m behind the river bank, MOK/10/IIA&B.

3.1.3.1. Stratigraphy. This structure is a pit excavated in the sandy substrate.

3.1.3.2. Finds. The archaeological material consists mainly of abundant and diverse well-preserved pottery - several vessels appear to have been broken *in situ*, but despite wet sieving, not a single fragment of carbonised organic material was found and direct dating was not possible. The pottery is typical for the Middle Phase (see below 4.3.2.).

3.1.4. Yaekela: YAE/10/01 and YAE/10/20

Close to the base camp at the village of Yaekela at a place said to have been the compound of a female potter, two test pits, YAE10 (24,281810 °E, -0,810030 °S) and YAE12 (24,283950 °E, -0,806010 °S) were dug in 25 cm shovel-spits and pottery was hand-picked (Fig. 8). Auger probing was used to determine the extent of a larger structure that for logistic reasons could only be rapidly shovel tested.

3.1.4.1. Stratigraphy. Both pits were dug into the yellow clayey sediments close to the riverbank and have clear boundaries (Fig. 9). The outline of the pit YAE01 becomes very distinct at some 20 cm below the surface and has a diameter of 46 cm. The base is irregular at a depth of 71 cm. The structure YAE20 is much larger and though its exact contours could not be established, the part that was test excavated reached a depth of 1–1.2 m for a width of 3 m. Between

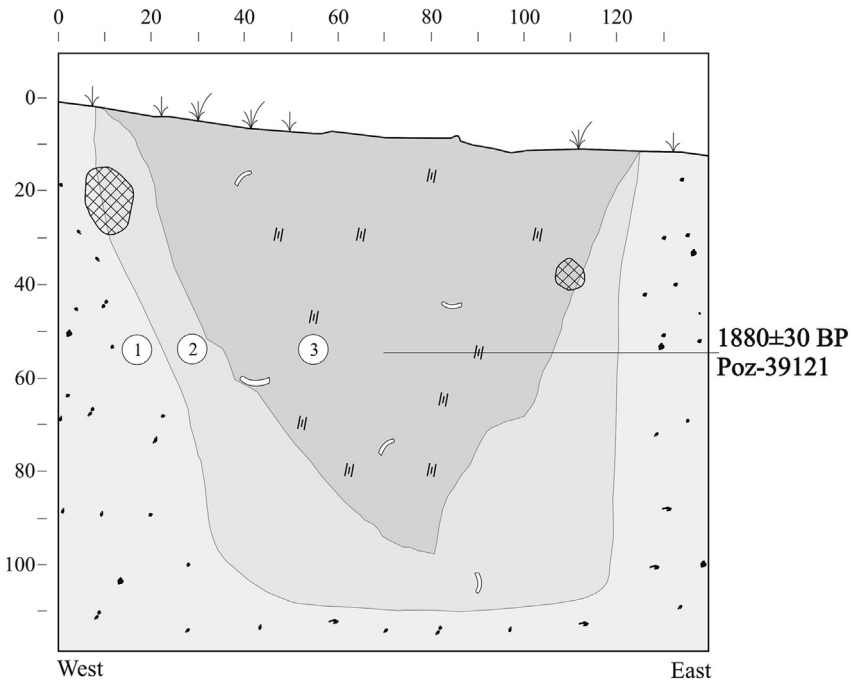

Fig. 5. Profile at YNG/10/I showing: unit 1, 2 and 3. Unit1. Undisturbed soil "yellow clayey sediment with abundant red laterite nodules"; Unit 2. Filling of Pit 1 "yellow orange clayey sediment with occasional potsherds and charcoal". Unit 3. Filling of pit 2 with abundant carbonised vegetal remains and poorly preserved potsherds © RMCA.

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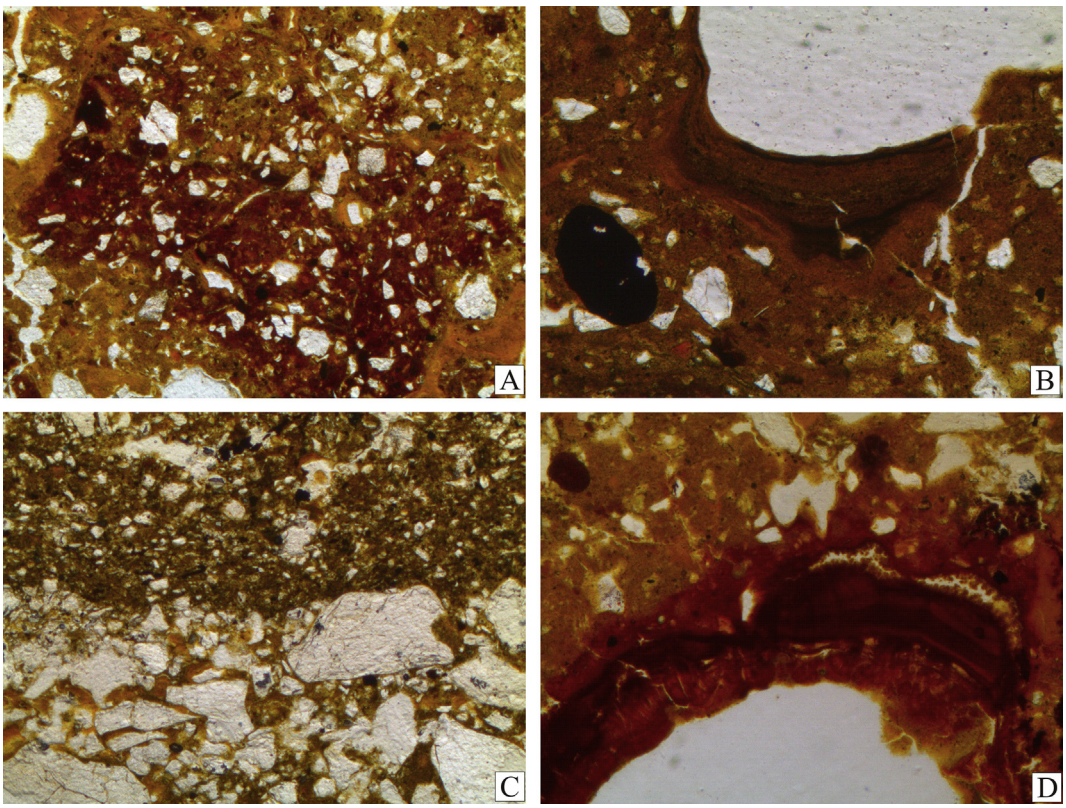

Fig. 6. Microscopic features of profile YNG/10/I. A. Undisturbed soil: typical groundmass also showing an orthic iron oxide nodule and fine clay coatings. B. Illuvial coarse clay coating, covering fine illuvial clay. C. Infilling of second pit structure, basal part of fine-grained intercalation, with sharp lower boundary. D. Iron oxide coating, with associated hypocoating. (Frame width 1 and 3: 2.6 mm, 2 and 4: 1.3 mm) © F. Mees, RMCA.

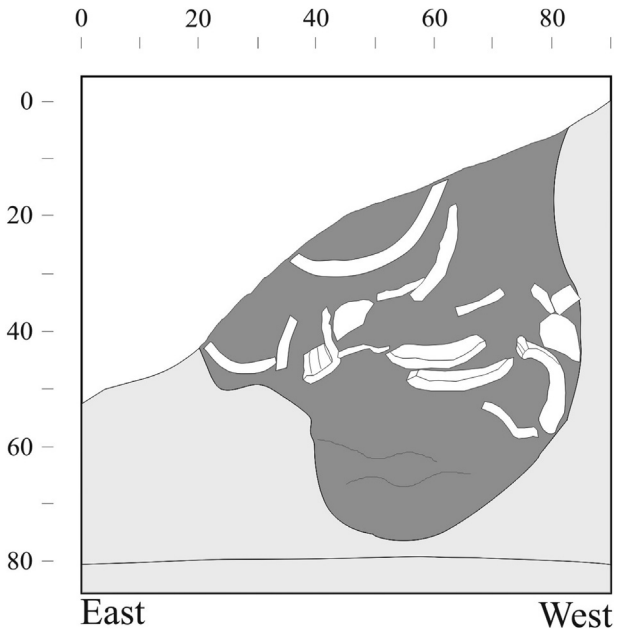

Fig. 7. Profile of MOK/10/I A/B showing the truncation of the pit structure due to the erosion of the river bank © RMCA.

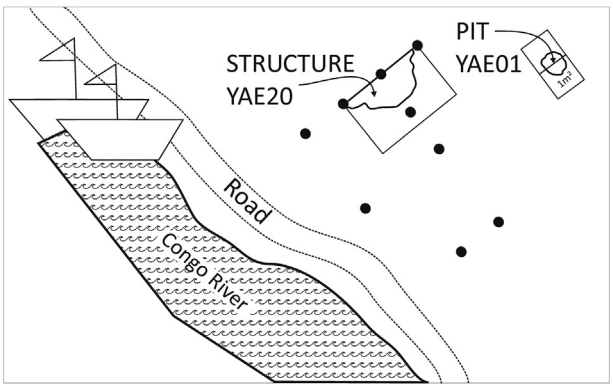

Fig. 8. Yaekela. Sketch of location of two test pits YAE/10/01 and YAE/10/20, boats indicate base camp along the Congo River © RMCA.

0,8 and 1 m depth the soil is very loose, an indication that the infilling is not yet compacted.

3.1.4.2. Finds. The finds consist mainly of potsherds. They can be attributed to the Late or recent pottery phase and more specifically to the *Yaekela style* (see below). Both pit structures and especially the large YAE20 contained layers and dense concentrations of charcoal as well as of shell, preliminary identified as the land snails and some bivalves. Today this type of freshwater shells are used as a spoon, as a tool in pottery making, and also grinded as an ingredient for medicinal applications. Tough complete shells are well preserved, no bone material was found in any of the two structures.

3.1.5. Baombi II: BAO/13

3.1.5.1. Stratigraphy. The edge of what turned out to be a pit filled with a stack of pots (Fig. 10) was found eroding out of the steep talus of an intensively used path connecting the village of Baombi II

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Fig. 9. View of YAE/10/20 during the excavations. The Congo river is visible in the background (© Cornelissen, RMCA).

to the left bank of the Lindi river. Two of the walls of the cutting were drawn when the stack of pots was lifted out. During excavation a difference in soil composition was observed between the sandy yellow soil in place and the apparently rapid infilling of the pit, which consisted of looser, mottled earth, and black soil. This could parallel the observations on the primary and secondary pits at MOK/10/I & II.

3.1.5.2. Radiocarbon dating. Two radiocarbon dates were made on two charred fragments of *Elaïs guineensis* found in between the shards of the stack of pottery: Poz-57246 2085 ± 30 BP and Poz-57248 2155 ± 30 BP.

3.1.5.3. Finds. The material uncovered consists of a large concentration of whole vessels and pottery fragments in a vague pit structure. Excavation had to proceed very quickly due to time and local permission constraints. The pottery found is typical of the Early Phase (see below 4.3.1.). A few quartz fragments were found interspersed between the pottery shards. One is a small split cobble with four radial scars and would not be aberrant in a Late Stone Age context. Its presence alongside another ten small quartz flakes with water-worn cortex, plus a few water-saturated very breakable sandstone fragments in the stack of pots is peculiar. Either they are contemporary with the pottery or they were part of the sediment in which the pots were buried or placed.

3.2. Ancient occupation layers

3.2.1. Ilambi Moke – MOK/10/IIA-B

After auger drilling over a distance of 40 m parallel to the river bank of the Lomami in the village of Ilambi Moke, a shovel test-pit was excavated (60 × 100 cm by spits of 25 cm): MOK/10/II A

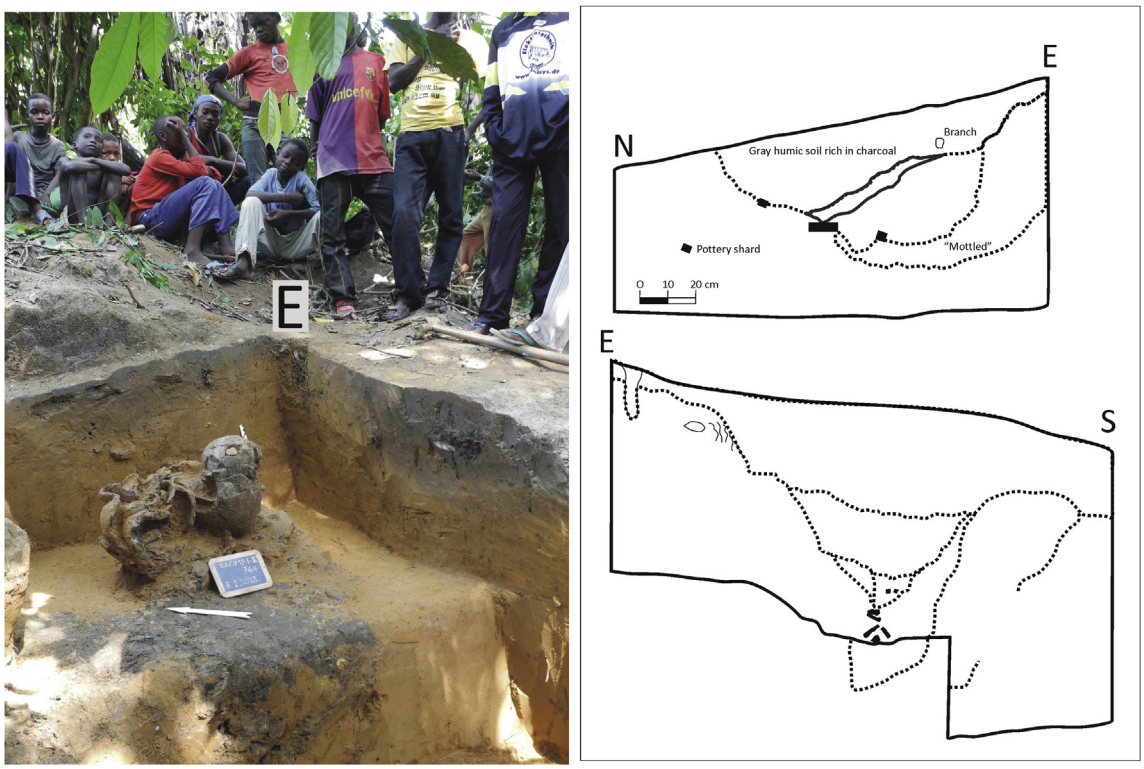

Fig. 10. Baombi II (BAO/13/I), excavation of a stack of pots eroding out of the talud of a path (left) and sketch of the East to North and East to South wall after excavation (© Cornelissen, RMCA).

(24,184201 °E, -0,638864 °S). As it revealed an interesting stratigraphy, a proper test-pit (1 m^2 - spits of 10 cm, wet sieving down to 2 mm) was excavated next to it: MOK/10/II B. Despite its location, near the bank of the Lomami and in a relatively densely inhabited area – hence likely exposed to both fluvial erosion and human disturbance – MOK/10/II displayed a clear stratigraphy of superimposed layers with distinct colours (shades of grey to dark brown).

3.2.1.1. Stratigraphy. The test pits revealed a series of sand layers that contain varying quantities of archaeological material. Three main layers (Fig. 11 units 2, 3 and 4) are identified above the substrate (Fig. 11 unit 1). In the centre of square B a group of carefully stacked complete vessels were found in what appeared to be a shallow pit starting at the base of unit 3. A later structure cuts through the south-western part of the profile (Fig. 11. Unit 6) near the stack of pots.

The lower and middle layers (Fig. 11. Samples 1 and 2) contain only minor amounts of fine material characterised by a dark brown colour (Fig. 12. A). The upper layer (Fig. 11. Box sample 3) contains a larger proportion of fine material, but it is otherwise similar to the other layers (Fig. 12. A). The coarse fraction is well rounded and moderately sorted throughout the profile. The middle layer contains large charcoal fragments (Fig. 12. B), as well as aggregates with a different composition than the enclosing groundmass (Fig. 12. C). Both types of features are absent in the lower and upper units. For the lower unit, only aggregates with the same composition as the groundmass, with a higher clay/sand ratio, are seen. Burrows, which are present in all samples, are partly lined by termite plaster deposits, followed by infillings composed of groundmass material (Fig. 12. D) and reveal a certain degree of bioturbation.

As a result of the high sand content, the potential of recognizing horizon development by pedogenic processes is low. The dark colour and type of aggregation of the fine material indicate high organic matter content as in surface horizons and anthropogenic layers.

3.2.1.2. Radiocarbon dating. A mature wood fragment found at a depth between 40 and 50 cm below surface was dated to 1990 ± 30 BP (Pz-39116). Two fragments of palm nut endocarp found inside a whole vessel found at a depth between 60 and 80 cm below surface were dated to 2085 ± 35 BP (Pz-39117).

3.2.1.3. Finds. The finds at MOK/10/II A&B consisted mainly of potsherds, several complete vessels, stone artefacts and carbonised vegetal remains. Most of the pottery may be attributed to the Early and Middle Phase, overlain with the Late Phase (Fig. 13). This excavation also revealed stone artefacts that are extremely rare for the Inner Congo Basin (see Section 4.3.4.). The total of 436 lithic artefacts are predominantly flaked in chert-silicified mudstone (62%), sandstone (26%) and quartz (12%) (Fig. 14). Artefacts are generally in very mint condition with sharp edges and ridges. Cortex on quartz pieces is waterworn indicating that small river cobbles were collected. The hard, bright and sometimes black cortex on chert and silicified mudstone artefacts is reminiscent of a desert varnish; the source of this raw material is, however, more difficult to establish.

None of the raw materials exploited seem to have been available in large size blanks or nodules (maximum size class for quartz, silicified mudstone and sandstone artefacts is respectively 4, 7 and 8 cm). The large amount of cortex on both small (<2 cm) and large (>= 2 cm) artefacts lends support to this. For silicified mudstone, cortex is present on 24% of the small and on 86% of the large pieces, for quartz this is 35% and 78% and for sandstone artefacts 7% and 24%, respectively.

The peak in the vertical distribution of lithic artefacts is between 30 and 50 cm below surface. Between 30 and 40 cm Middle and Early Pottery sherds were collected whereas all underlying stone artefacts are associated with Early Pottery (compare Figs 13 and 14). Whether associated with Middle or Early phase pottery, stone artefacts are essentially flaking debris; there are only two cores and four more formal tools, all found at depths of more than 30 cm below surface. The tools made of silicified mudstone are an unfinished bifacially flaked, non-polished triangular axe-like tool (Fig. 15) and two small composite flake-tools (max. 2,7 cm) with a scraping edge as well as an edge shaped into a perforator (Fig. 16). A small quartz cobble also has a perforator-like edge.

3.2.2. Yandjambi II: MBI/10/IIA

At Yandjambi II (24,218956 °E, -0,723020 °S) on the left bank of the Lomami River (Fig. 2), the erosion of a small cliff revealed the existence of stratified deposits. The sandy cliff was cut roughly South-North, and cleaned to confirm these preliminary observations. A large test pit MBI/10/I A of 2 by 1 m was excavated by 25 cm spits, just behind the cliff, to verify the extension of the stratigraphy

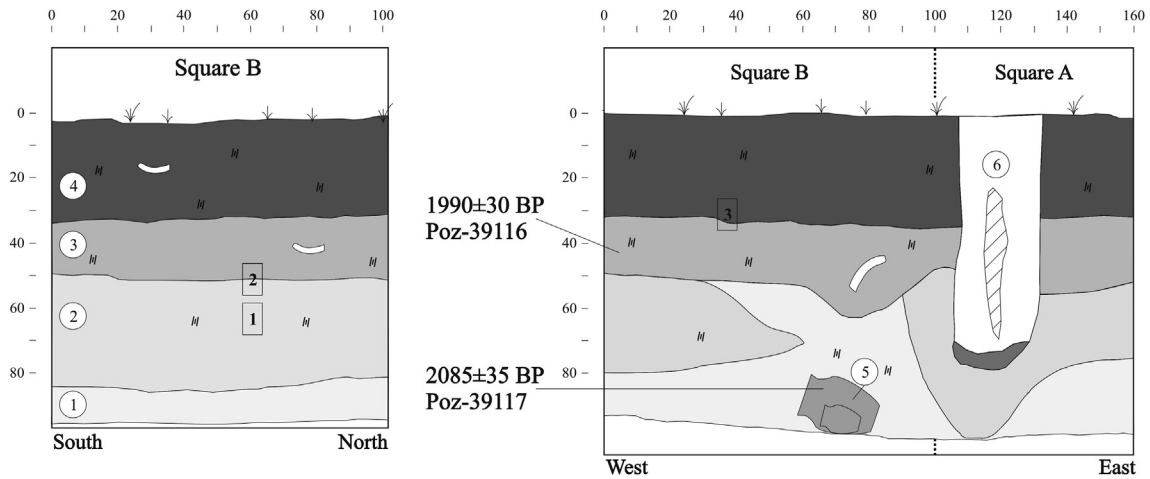

Fig. 11. MOK/10/II A B, North profile. MOK/10/II-B, West profile showing: unit 1, 2, 3, 4, 5, 6. Unit 1. Light beige sand (substrate); Unit 2. Grey sand, with pottery, lithic, charcoal. Unit 3. Dark brown sand with pottery, charcoal and occasional lithic. Unit 4. Black sand rich in organic material, pottery, charcoal. Unit 5. Complete pottery vessels stacked on top of one another in the middle of square B. Probably a pit structure disrupting the West profile. Unit 6. Posthole. Numbered boxes 1-3 are location of soil samples mentioned in the text © RMCA.

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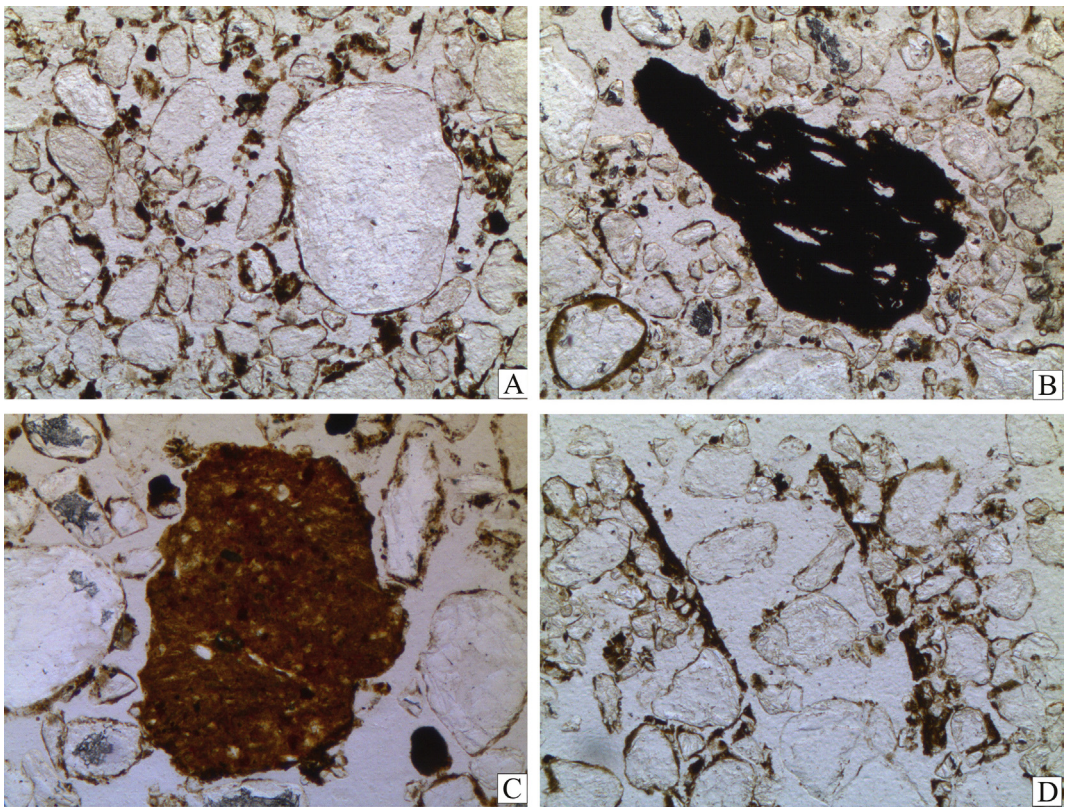

Fig. 12. Microscopic features of profile MOK/10/IIB. A. Typical groundmass of the upper unit, with somewhat larger relative amount of dark brown fine material than the lower and middle units (MOK Sample 3, Fig. 11. Unit 4). B. Charcoal fragment (MOK Sample 1, Fig. 11. Unit 2). C. Sediment aggregate with different composition than the groundmass (Mok/ Sample 1, Fig. 11. Unit 2). D. Burrow lined by termite plaster and filled with groundmass-derived material (MOK sample 2, Fig. 11. Unit 2). Frame width 1, 2 and 4: 2.6 mm, 3: 1.3 mm) © F. Mees, RMCA. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

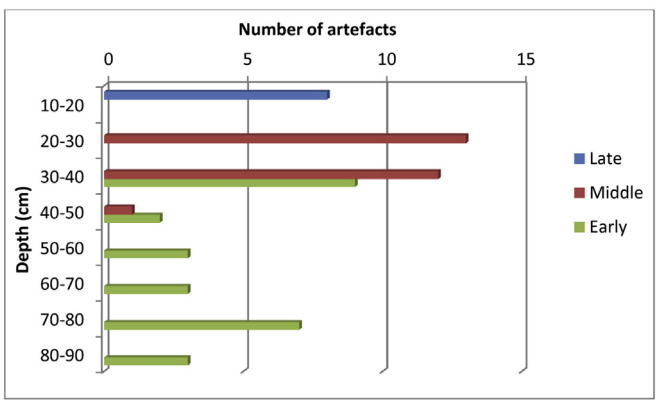

Fig. 13. Vertical distribution of pottery shards at MOK/10/IIA-B. Number of shards (x-axis) per 10 cm excavation spit (y-axis), classified into Early (green), Middle (red) and Late (blue) Phase pottery © RMCA. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

towards the west. The W-E profile revealed an interesting stratigraphy (Figs. 17 and 18) and a standard test pit MOK/10/I B (1 m^2, spits of 10 cm and wet sieving down to 2 mm) was made in the adjacent square or NW of MOK/10/IA.

3.2.2.1. Stratigraphy. As was the case at Ilambi Moke, the location of the site on a sandy beach in a village on the bank of the Lomami River has not affected the general stratigraphic features. The excavation revealed a series of layers of sand varying in colour (shades of grey to dark brown) and in abundance of archaeological material. Three main layers (Fig. 20 units 2, 3 and 4) are observed above the *in situ* sediment (Fig. 20. Unit 1). In contrast to MOK/10/II there is no structure disturbing the stratigraphy. A later pedological feature developed throughout layer 2 (Fig. 20. Unit 6).

The nature of the sediment is similar in all layers, but with lower relative amounts of fine material in the lower layer than in the middle and highest layer. In all contexts, the sand fraction is overall well-sorted, but with scattered coarse grains. The micromass is dark brown, with a darker aspect in the upper interval (Fig. 20. Unit 2). Around the contact between units 2 and 3, the deposits include an intercalation containing a larger relative amount of fine material, which is further characterised by a sharp upper boundary, a gradual lower boundary, and local cross-bedding (Fig. 21. A). The low clay content and overall good sorting are indicative of an eolian origin for the deposits, but this is not compatible with the occurrence of a major cross-bedded intercalation that consists of larger relative amounts of fine material.

Large charcoal fragments occur in all soil-samples. Illuvial clay, with relatively coarse grain size, is most abundant in the lower part of unit 3 (Fig. 21. B). Special features are the occurrence of phytoliths in unit 2 (Fig. 21. C) yielding potential for additional palaeoenvironmental reconstruction to charcoal analysis, and of a silicified sandstone fragment in unit 3 (Fig. 21. D). This latter fragment is most likely derived from 'polymorphic sandstones', although this formation is only exposed in the distant southern parts of the Congo Basin. Bioturbation is evidenced in burrows and termite plasters as in the MOK/10/IIA&B profile.

3.2.2.2. Radiocarbon dating. Two fragments of charcoal (from

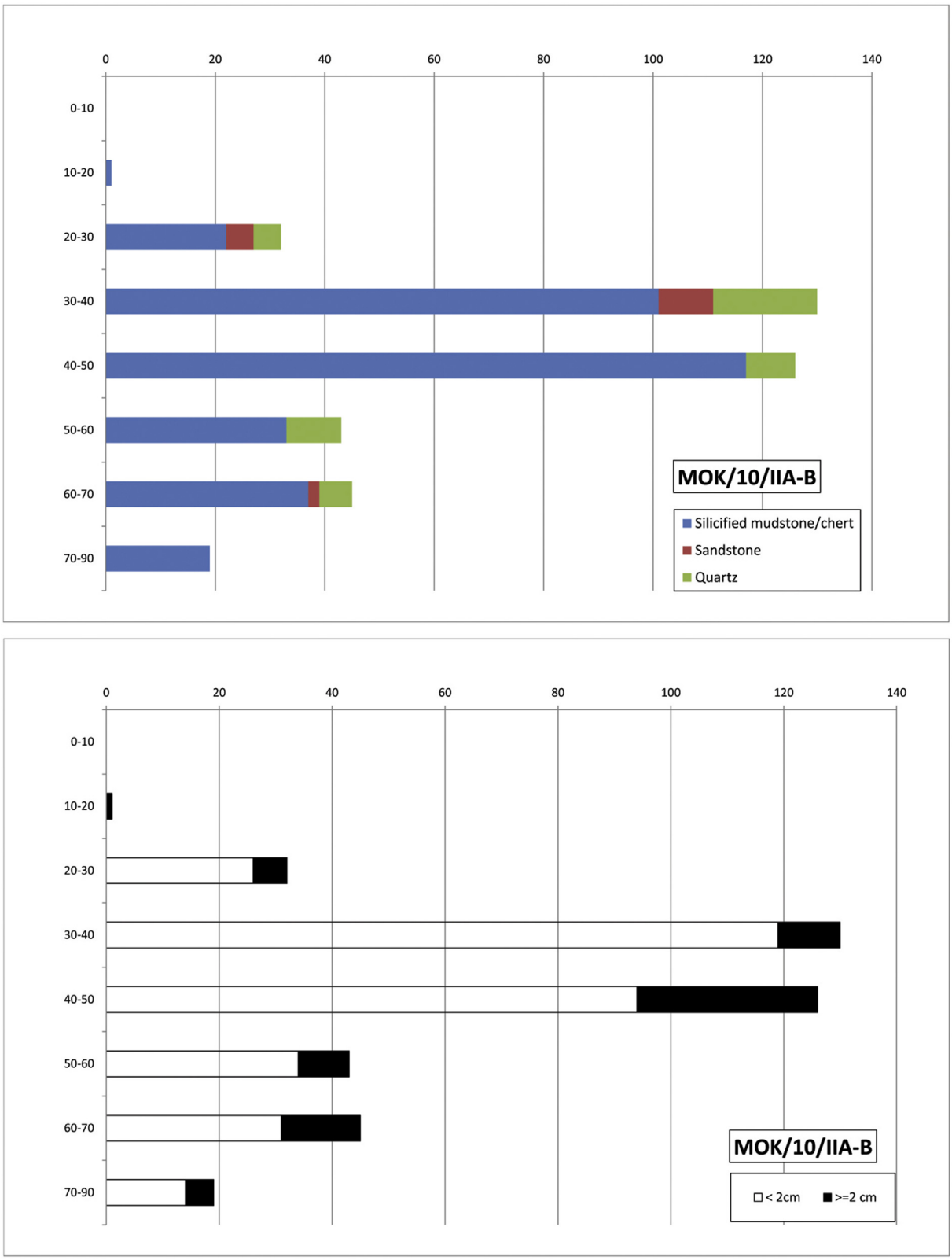

Fig. 14. Vertical distribution of lithic artefacts at MOK/10/IIA-B. Number of stone artefacts (x-axis) per 10 cm excavation spit (y-axis), classified into three categories of raw materials (above) and according to size into small (<2 cm) and large (>= 2 cm) artefacts (below), all raw materials taken together © RMCA.

mature wood) found at a depth of 50–60 cm below surface in MBI/10/IIA were dated to 1685 ± 30 (Poz-39115).

3.2.2.3. Finds. The finds consist mainly of potsherds, lithic artefacts and carbonised vegetal remains. Pottery can be attributed to the Early, Middle and Late Phase (Fig. 18). Early Phase pottery is found

Fig. 15. Flaked axe/adze-like tool in silicified mudstone, Ilambi Moke MOK/10/IIB-40-50, scale in cm © E. Cornelissen, RMCA.

Fig. 16. Composite (perforator and scraping edge) small tool in silicified mudstone/chert with black shiny hard cortex (scale in cm, 2.4 × 1.9 × 0.9 cm), Ilambe Moke MOK/10/IIA-B © E. Cornelissen, RMCA.

artificial spits of 10 cm (Fig. 10), a total of 257 artefacts were collected during hand-picking and sieving. Of these, 72% come from between −30 and −50 cm below surface (Fig. 19) and are essentially associated with Early Phase pottery.

Of a total of 286 stone artefacts collected in the two test pits at Yandjambi, 232 are made on silicified mudstone, 46 in sandstone and only 5 on quartz (Fig. 19) and 56% of all artefacts retain cortex. Maximum sizes for the three groups of raw materials are 6.2, 6.4 and 1.5 cm. As on the site of Ilambe Moke, stone artefacts are mostly flaking debris and there are very few cores (2) or tools (1) or specimen that underwent modification or shaping (2) of any kind.

A piece of 5.3 × 5.3 × 2.7 cm is a rare example of an almost complete cobble (Fig. 22). This would point to retrieving the raw material from riverbeds or possibly riverbanks and beaches at low water levels, though they may equally come from a layer cut through by the current river and only exposed in the riverbanks during receding waters. Six flake removals result in a sharp edge on

Fig. 17. MBI/10/IIA W-E profile showing the different layers © RMCA.

between 30 and 60 cm below surface with a majority of sherds between 30 and 50 cm, while Late Phase material is found exclusively in the upper 20 cm. Pottery from the Middle Phase is very rare and appears to be mixed into the top of the layers containing Early phase material. A hiatus in the vertical distribution of pottery occurs between 20 and 30 cm below surface.

In the test pit MBI/10/IIB, where excavation proceeded in the boulder with a marked notch, whereas the opposite, battered edge may point to its use as a hammerstone.

3.3. Forest surveys

As has been convincingly shown in the lowland forests of the western Congo Basin (Hubau et al., 2015; Morin-Rivat et al., 2014),

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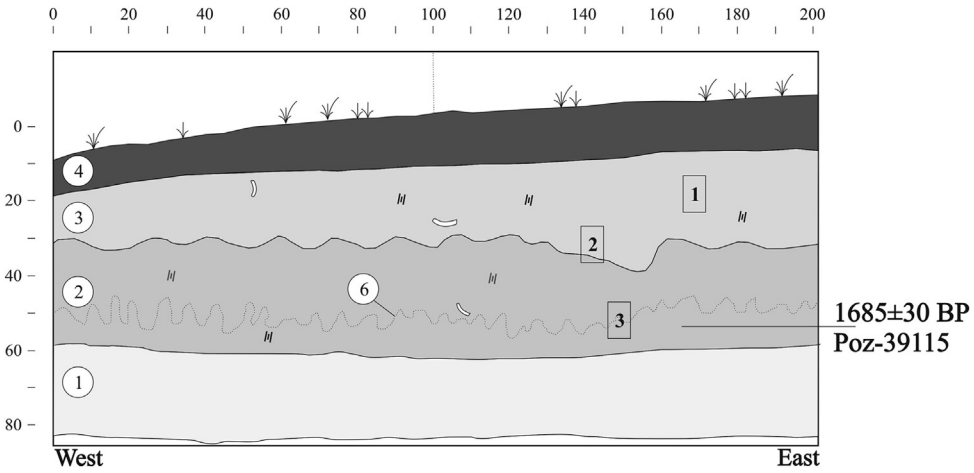

Fig. 18. Schematic drawing of MBI/10/IIA W-E profile showing the different layers. Numbered boxes are the location of the various soil samples mentioned in the text © RMCA.

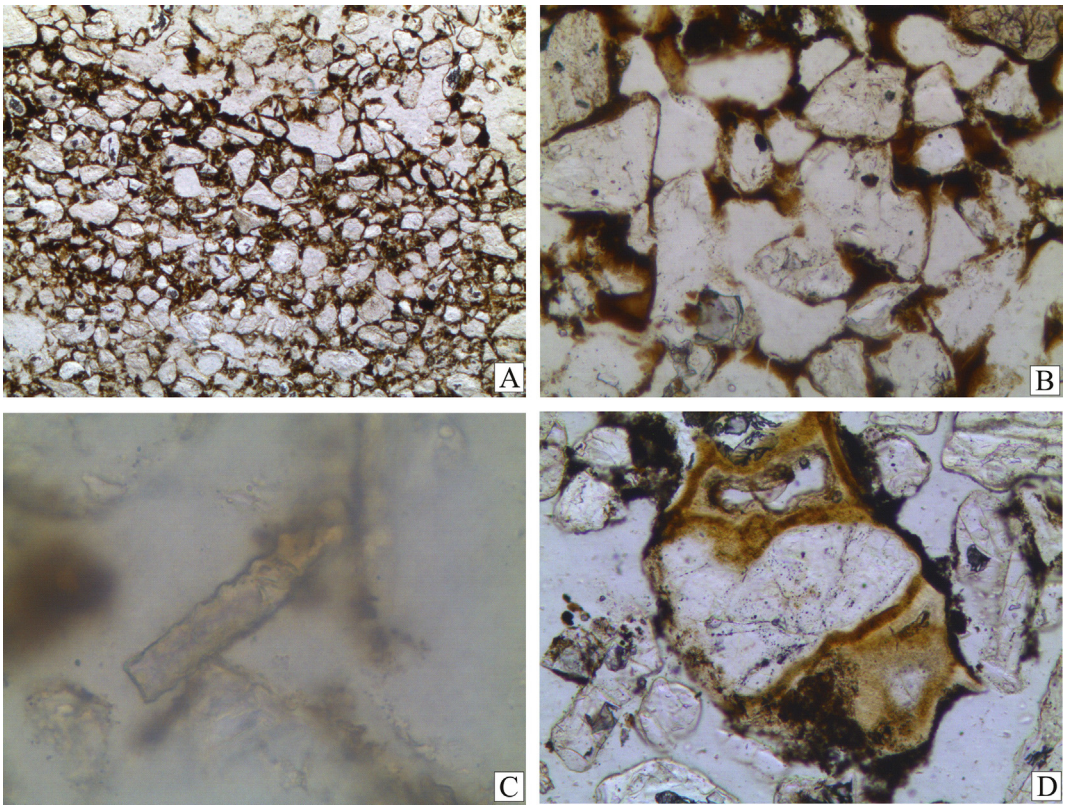

Fig. 19. Microscopic features of profile MBI/10/II. A. Top of intercalation with higher relative amount of fine material (MBI sample 2, boundary between 16, units 2 & 3). B. Dark coarse illuvial clay (MBI sample 1). C. Phytolith (MBI sample 3). D. Silicified sandstone fragment (MBI sample 1). Framewidth 1: 2.6 mm, 2 and 4650 μm and 3163 μm. Location of soil samples, see Fig. 16 © F. Mees, RMCA.

coring in order to document forest history also allowed the mapping of human presence in previously undocumented areas. The identification of patches of light-demanding species in the rain forest was proved to be associated to anthropic disturbance (Bourland et al., 2015). This was applied for the first time away from the riverbank on the Congo river through forest inventories at the Yangambi Man and Biosphere Forest Reserve. Two of these pits, YAS/2015/2 (24,506864°E, -0,797940°S) and YAN/2015/5 (24,512666°E, -0,821751°S) from which charcoal was collected also contained fragments of pottery. Although in poor condition and small quantity, these pits turned out to be of crucial importance in the reconstruction of the occupation of the forest. The test pits were located in areas displaying high proportions of light-demanding trees indicative of forest clearance roughly estimated between 100 and 300 years ago.

3.3.1. Yangambi: YAS/15/02

All the test pits in the Yangambi forest were standard 2 m^2 excavated by 10 cm spits with hand-picking down to 2 mm.

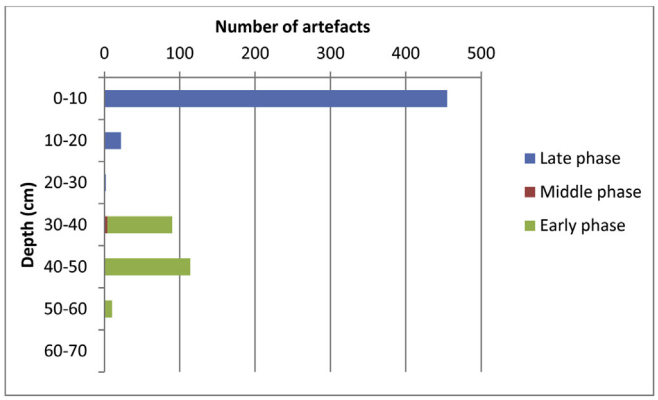

Fig. 20. Vertical distribution of pottery fragments at MBI/10/II B. Number of pottery shards (x-axis) per 10 cm excavation spit (y-axis). There seems to be a hiatus between 20 and 30 cm. Most of the Late Phase material is found above 20 cm, while most of the Early phase material is found between 30 and 50 cm below surface © RMCA.

3.3.1.1. Stratigraphy. The stratigraphy of YAS/15/02 consists of one large unit of yellow clayey soil and shows no specific soil development, layers or other pedological features. Pottery was collected at a depth of 50–60 cm below surface.

3.3.1.2. Radiocarbon dating. One radiocarbon date of 1230 ± 30 (Poz-75462), calibrated to 1183–985 AD, was obtained from unidentified charcoal collected between 50 and 60 cm below surface.

3.3.1.3. Finds. Most of the finds consist of charcoal and some poorly preserved pottery which is attributed to the Late Ilambi style.

3.3.2. Yangambi: YAN/2015/05

3.3.2.1. Stratigraphy. During the sampling of YAN5 of 2 m^2 no specific soil development or layers or other pedological features were observed in the yellow loamy soil. Pottery was collected from four 10 cm excavation spits comprised between 30 and 70 cm below surface.

3.3.2.2. Radiocarbon dating. Two dates were obtained on charcoal; 370 ± 30 (Poz-75451) from a fragment collected at a depth of between 40 and 50 cm and 1670 ± 30 (Poz-75452) from an unidentified fragment found at a depth between 60 and 70 cm. From both of these spits pottery was also collected.

3.3.2.3. Finds. The finds consist of charcoal and some poorly-preserved pottery. Shards found between 30 and 50 cm below the surface belong to the Ilambi style of the Late Pottery Phase and those found in the underlying spits between 50 and 70 cm belong to the Middle Phase. At Ilambi Moke, Ilambi style shards of the Late Phase pottery were only found in the topsoil or first 10 cm mixed with occasional contemporary pottery. This made an assessment of its age based on the stratigraphic position difficult. At YAN/2015/05 shards of the Ilambi style are overlain with 30 cm of sterile sediment with no admixture of recent pottery thus lending support to the assumption that the Ilambi style is at least older than the contemporary pottery tradition.

3.4. Non-excavated sites

3.4.1. Engengele; ENG/10/01-03

At Engengele, pottery was collected from just below the surface at several places, but there was no time to conduct test excavations. One such collection was made near the house of a potter who died in 2006 (ENG/10/01, 22,663710°E, -2,09983°S). The finds consist mainly of potsherds, charcoal and fragments of copal. All the pottery can be attributed to one of the Late phase styles, the Nkomba style.

A second collection was made in an old compound near the river, of a potter who was said to have died at least 50 years ago. Here the pottery includes fragments of the red painted pottery or Nkomba style, and four comb impressed potsherds (ENG/10/02, 22,663710°E, -2,09983°S).

The third surface collection was made next to an abandoned house, again where a potter had been practicing 65 years ago, according to informants (ENG/10/03, 22,666520°E, -2,097020°S).

3.4.2. Moenge: MOE/10/III

At the village of Moenge permission was granted for survey, but not for digging test pits. We took advantage of a freshly dug latrine pit (MOE/10/III, 22,860410°E, -2,047210°S) for collecting pottery fragments from the pit walls. This allowed us to extend the distribution area of vessel types from the Middle and Late Pottery Phases. Further archaeological investigations are needed to clarify the stratigraphic position and context of the pottery.

4. Discussion

4.1. Survey methods

Rivers have proven once again to be a powerful means of exploring little-researched areas in the Central African forest. Surveying either by auger drillings or test pits, on cleared and accessible surfaces in villages along the rivers, has been highly effective on the lower stretch of the tributaries of the Congo River between Kisangani and Engengele. The collaboration with forest management programs also clearly has significant potential in the area for documenting human occupation away from rivers. Forest management companies must provide forest inventories in order to be able to obtain a certification for sustainable forest management (such as FSC). Forest stands dominated by light-demanding species are suspected to be in an early forest succession stage. This means that these forests are recovering from past disturbances. One hypothesis is that large stands of these forest types could be a legacy of past large-scale slash-and-burn practices, as natural disturbances in the rainforest often have smaller areal impact. Following forest inventories, one can look for areas displaying vast stands of trees dominated by light-demanding species and set-up test pitting transepts through these areas (e.g. Bourland et al., 2015). Here, as elsewhere in Central Africa, our test pits inside patches of regenerating forest have yielded clear traces of human activity. As with the *River Reconnaissance Project* in the Inner Congo Basin, the blanks on the archaeological map of the rain forest are best explained by absence of research rather than by absence of human settlement, at least over the last 2500 years as documented in the sequence of Early, Middle and Late Pottery phases.

4.2. Site types

Find contexts have been classified here into (1) pit structures, (2) superimposed layers of old land surfaces, (3) forest surveying pits and (4) non-excavated sites where additional data were collected for areal distribution patterns of pottery (see Table 1). Pits cover the entire time span of the pottery phases. Early Phase pottery was found accumulated in pit structures at Bomane, Ilambi Moke and Baombi II whereas Middle and Late phase pottery was also found in pits, both fragmentary and as complete vessels, though not in careful arrangements. Except for the twelve small quartz fragments interspersed between the pots in the stack of

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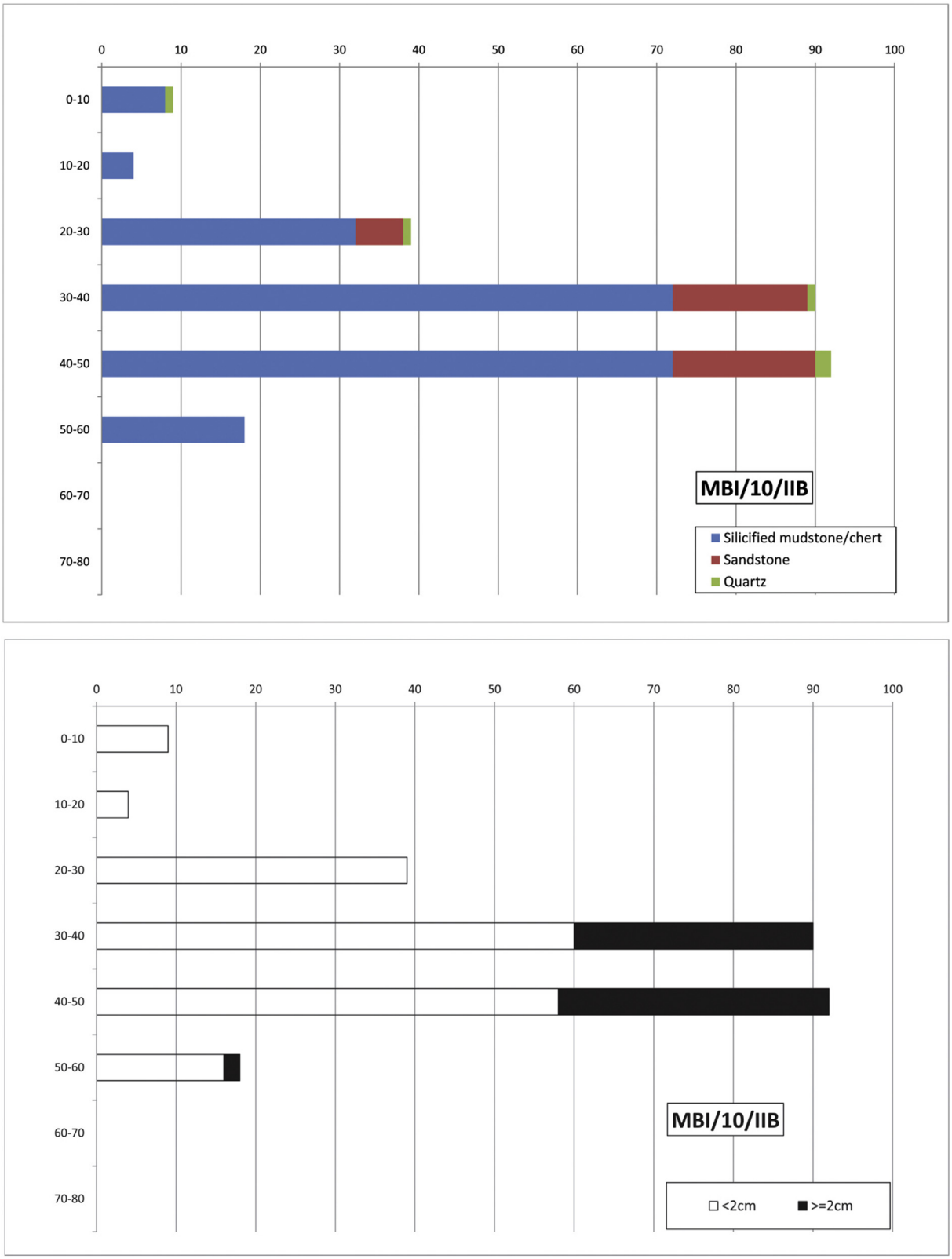

Fig. 21. Vertical distribution of lithic artefacts at MBI/10/IIB. Number of artefacts (x-axis) per 10 cm excavation spit (y-axis), classified into (above) three categories of raw material, and into small (<2 cm) and large (>=2 cm) pieces, all raw materials taken together (below) © RMCA.

pottery at Baombi II, pit structures do not contain lithic artefacts. This is also the case in the Inner Congo Basin where no lithic artefacts at all were found in association with pottery (Wotzka, 1995).

Along the Lomami river on the other hand, in two of the assemblages found associated with probable old land surfaces, a non-standardized flaked industry was found. Within the same area

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Fig. 22. MBI/10/IIB-30-40 cm (Layer 2), flaked fragment, silicified mudstone with hard, black, shiny cortex, scale in cm © E. Cornelissen, RMCA.

there are pit-structures with no stone equipment contemporary with ancient occupation surfaces on which stone artefacts were collected. This may lend support to the assumption that the absence of stone equipment in the early phases of pottery producing communities is not necessarily an indication of absence of stone use to the benefit of iron-use with or without iron-production and of which the material traces are sparse. This observation on site context adds a new perspective to the discussion on the technological realm of the oldest pottery producing communities in the Central African forests. Situated at the end of the Late Stone Age and before the Early Iron Age they are considered to have worked and polished stone for hoes and axes used in the onset of slash-and-burn agriculture (Oslisly et al., 2013:1379). Another perception is that in the absence of clear material traces of stone and iron production, these communities may have used but not produced iron tools in the 'From Stone to Metal Age' (de Maret, 2013). This concept of a transitional phase has been questioned since the end of the Stone Age and the beginning of the Iron Age are equally undefined (Eggert, 2014:187). For the Inner Congo Basin the oldest pottery style, *Imbonga*, is not found with any trace of flaked or polished stone considered as Early Iron Age, dating to the second half of the 1st millennium BC or between 400 and 200 BCE (Kahlheber et al., 2014; Wotzka, 1995).

The absence of stone might also be a by-product of find circumstances and site function where the oldest pottery is found in stacks or pit structures. This will need further investigation.

Pedoanthracological pits in the Yangambi reserve occasionally contain pottery sherds, allowing an assessment of the inland extension of occupation of the riverbanks, at least during the Middle and Late pottery phases. Surface collections in the villages at places that the informants indicated as old potter's compounds complete the picture of pottery as a craft that must have been much more wide-spread than today, though we were informed in the villages that there are important pottery production centres today at Banalia on the Aruwimi river and at Yafunga on the Congo River.

4.3. Chrono-cultural sequence

Pottery is the omnipresent archaeological indicator of human presence in this region over the last 2500 years and has been classified into Early, Middle and Late Phases with each of their own specific technological traits, fabric and decoration. A survey of the current dating evidence is presented in (Fig. 23).

4.3.1. Early phase pottery

Pots of the Early Phase (Fig. 24) have ovoid shapes with convex necks, accentuated shoulders and a flat base. Occasional disc footed bowls are present in the assemblages of Bomane Yangwa and Baombi II. The decoration consists mainly of horizontal bands of chevrons and crosshatching on the shoulder, traced with a stylus, though sometimes comb impressed wavy lines occur on the shoulder. Fabrics are of brown to orange colour and characterised by the use of fine clay often tempered with grog. Some of the vessels bare macrotraces indicating that they were made with the *drawing of a ring* technique (Gosselain, 2002; Livingstone Smith, 1999).

This pottery was dated on two sites, Baombi II (BAO) the most eastern occurrence on the Lindi river and at Bomane Yangwa (YNG) the most western occurrence on the Aruwimi river, with almost overlapping timespans somewhere during the last four centuries BC. Other finds show that similar occupations occurred at Ilambi Moke and Yandjambi II on the Lomami River.

While detailed stylistic attributions are still in progress, these Early Phase assemblages display obvious resemblances with pottery traditions identified downstream in the Inner Congo Basin - along the Ruki river and its tributaries (Wotzka, 1995). Although distinct, mainly with regard to ornamental structures and motifs, the closest parallels with Early Phase pottery lie with the *Imbonga style*. This *Imbonga style* is the earliest pottery in the Inner Congo Basin, and is also found in pit structures where whole vessels are stacked together and is also dated to the last 500 years BC. The chrono-cultural sequence outlined by Wotzka shows a slow progress of pottery producing communities moving onto the tributaries of the Congo River from the West or North West towards the South-East (Wotzka, 1995, 2006). The data presented in this paper show that the progression of pottery bearing cultures is faster on the Congo River going upstream towards the East.

4.3.2. Middle Phase Pottery

The vessels of the Middle Phase Pottery (Fig. 25) are characterised by light orange to buff coloured sub-spherical to ovoid flat-based shaped pots and jars. The most striking feature is the presence of a carinated neck and thinned lips. Decorations were made with pivoting/rocking blade, stylus impressions, or square toothed comb simple impressions, and are generally located on the neck and the shoulder. A few vessels bear comb-impressed wavy lines on the shoulder. Fabrics are often characterised by the use of fine clay with abundant, coarse temper of well-rounded quartz and sometimes grog. Vessels belonging to this stylistic group are found as far as Gundji further downstream on the Congo river (Fig. 1).

Dating evidence for this phase comes from a pit structure at Bomane Yangwa (YNG/10/I) and a layer of pottery and charcoal in the forest at Yangambi (YAN/15/5). These two dates set the time frame for Middle phase styles in the area. Middle Phase pottery is rare at Yandjambi II (MBI/10/II), where a similar date was obtained on a palm nut endocarp found in association with Early Phase material. Either the Early Phase overlaps with the Middle Phase or the charcoal selected for radiocarbon dating is intrusive in the Early

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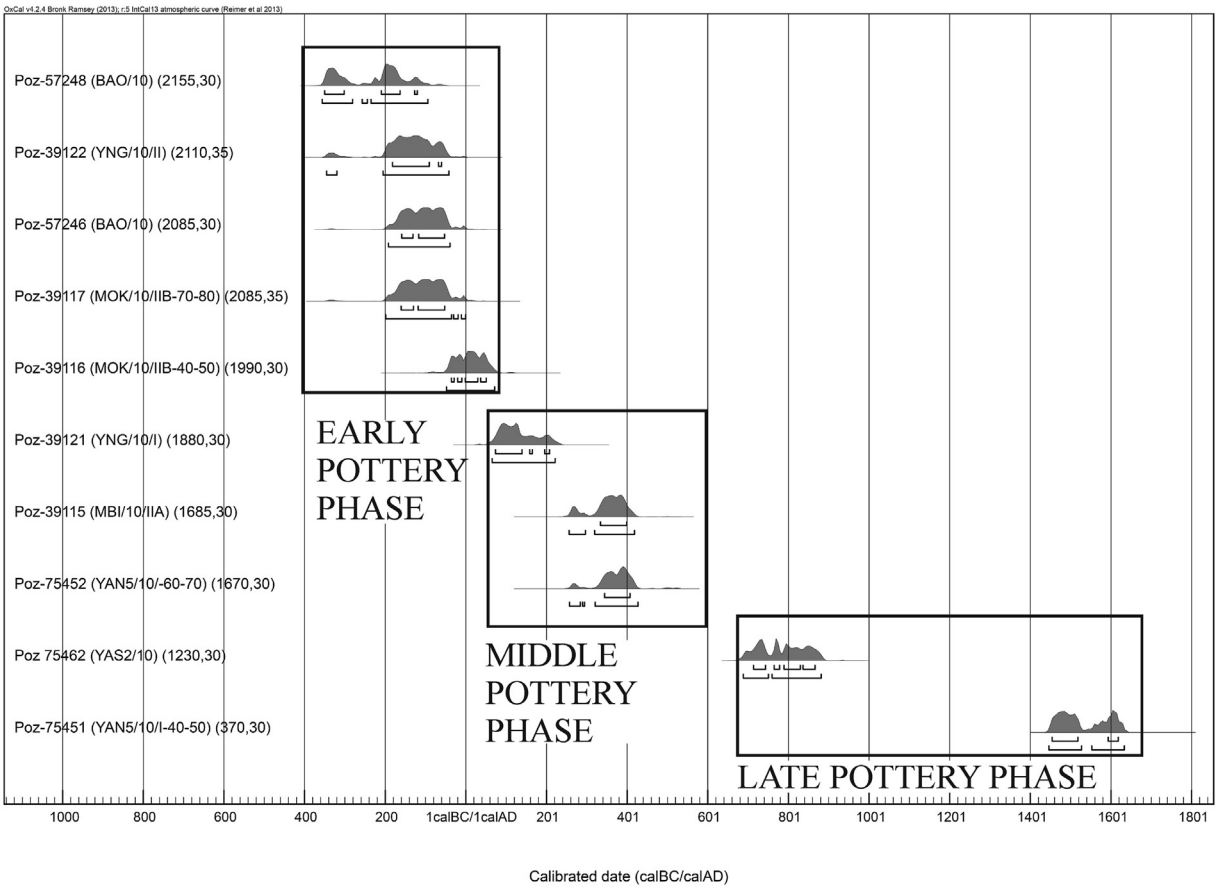

Fig. 23. Dating evidence from various sites (Baombi II BAO, Bomane Yangwa YNG and Yandjambi MBI) and from forestry survey (Yangambi, YAN and YAS) and pottery phases. Calibrated under Oxcal v4.4.2, Bronk Ramsey (2009); r:5 IntCal13 atmospheric curve (Reimer et al., 2013) Bronk Ramsey (2009). Bayesian analysis of radiocarbon dates. Radiocarbon, 51(1), 337-360 © RMCA.

Phase layer.

4.3.3. Late phase pottery

The pottery typical of the Late Phase encompasses several identified styles, the *Ilambi*, *Yaekela* and *Nkomba* styles. Generally, vessels attributed to this phase are from buff to brown in colour, thin walled spherical or hemispherical and have round-based shapes. Specific shapes and decorations allow for the distinction of three styles. A very striking feature of the Late Phase pottery is the almost-systematic presence of pestle-depressions on the internal surface, typical of the use of the pounding on a concave mold pottery building method (Livingstone Smith, 2001), and the frequent use of rouletting tools for decoration. This is the southernmost occurrence of roulettes in this part of Africa. This is intriguing as pounding on a concave mould and rouletted decoration are essentially Sahelian techniques (Huysecom, 1992). It has even been suggested that there could be environmental constraints to the use of pounding on a concave mold - that is, that the technique was suited for a very dry climate (Sterner and David, 2003). Their appearance in the rainforest implies a major cultural shift that still needs to be explained.

The first, the *Ilambi style* (Fig. 26) is characterised by buff to light brown thin-walled vessels with a ridged shoulder, short sinuous neck, and thin lips. There are two main categories in the decoration. The first is situated on the upper part of the vessel and made by tracing and comb impression. The second type includes vessels displaying undecorated shoulders and neck, but the lower parts are decorated with what appears to be cord-wrapped roulette on multiple independent wood cores (Haour et al., 2011, Fig. 1.29) or matt impressions resulting from pounding on a concave depression.

At Yandjambi II (MBI) and Ilambi Moke (MOK), along the Lomami river, Ilambi style shards essentially come from the topsoil or the upper 20 cm, where they represent the bulk of the fragmented/trampled material mixed to contemporary pottery. But in the Yangambi forest the *Ilambi style* is found below 30 cm. At YAS/15/02, Ilambi shards are associated to charcoal dated to 1230 ± 30 (Poz 75462), calibrated to the 8th-9th c. AD. Potsherds and charcoal come from a unique event in this test-pit. At YAN/15/05, the Ilambi style pottery is found between 40 and 60 cm and associated to charcoal dated to 370 ± 30 (Poz-75451), calibrated to mid-15th to late 16th century AD. In this case, pottery shard and charcoal are associated to a multiple event sequence and it is possible that the date was obtained on an intrusive charcoal.

The second, the *Yaekela style* (Fig. 27), is mainly found at Yaekela, where it is dominant, but it is also present on the surface of YNG, MOE and BAO along the northern tributaries of Aruwimi, Itimbiri and Lindi. This style is characterised by thin walled vessels with short everted necks with squared lips and open-mouthed vessels with slightly everted walls and, again, squared lips. The distinctive decorations include carved wooden roulette impressions, sometimes bordered with small square toothed comb impressions, which are also regularly observed on the lips.

The third, *Nkomba style* (Fig. 28) – as labelled by Wotzka (1995: p. 434, 536, Tafel 102) - is characterised by thin walled grey pottery with - almost horizontal - closed necks. The internal surface of most

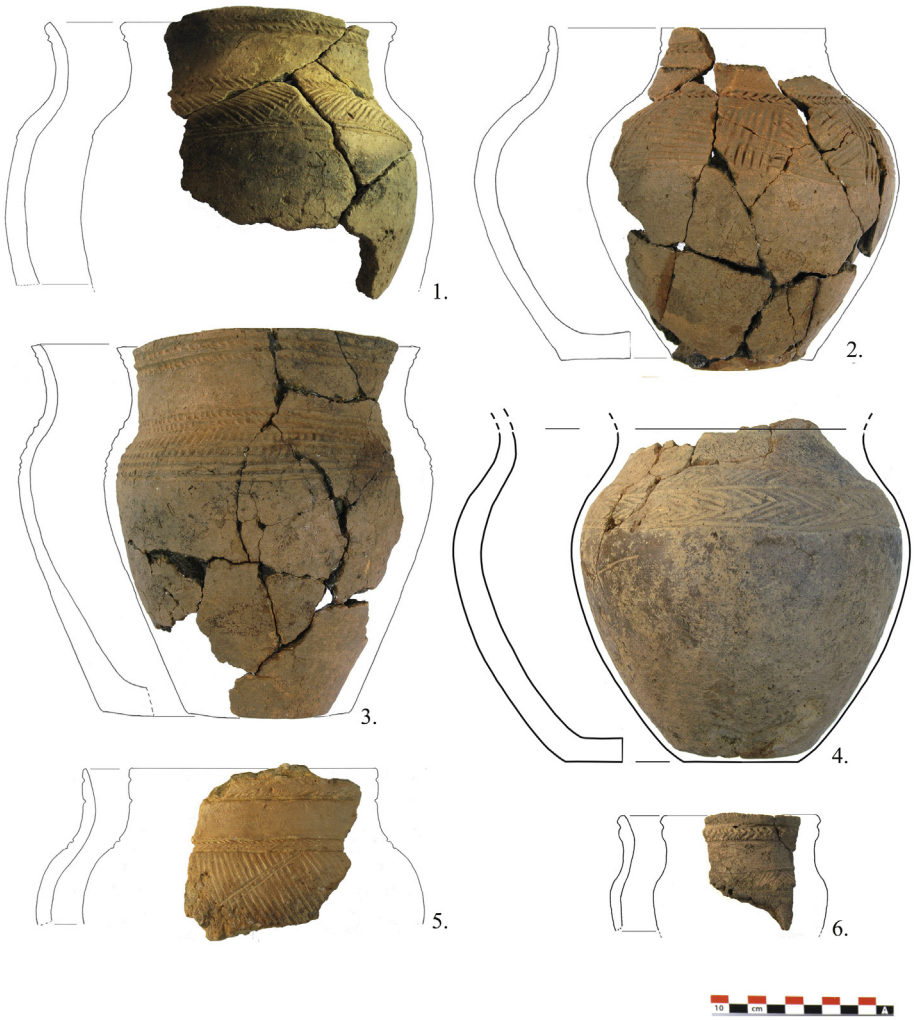

Fig. 24. Early phase pottery: Ilambi Moke (Lomami river) 1. MOK/10/IIB-40-50, 2. MOK/10/IIB-60-80, 3. MOK/10/IIB-70-80; Bomane Yangwa (Aruwimi river), 4. YNG/10/IIB-20-30; Baombi II (Lindi river); 5. BAO/13/I; Yandjambi (Lomami river) 6. MBI/10/IIB-40-50 © A. Livingstone Smith, C. de Franquen, RMCA.

potsherds bare abundant tamper marks. The decoration is characterised by tracing with a thin blade, grooving, frequently overlain with red painting. Coart and de Haulleville report it is painted with *Ngula* red pigment (Coart and de Haulleville, 1907:158), who also report on the use of copal for post-firing treatment. Copal was found associated with the pottery fragments at ENG.

The Nkomba style (Fig. 26) is found at Engengele, almost exclusively, but a few fragments were found at the village of Moenge upstream from Engengele on the Itimbiri. Coart and de Hauleville report that this type of vessel was produced in the Bangala region by populations living along the Congo river and its tributaries (the ethno-linguistic attribution of the producers is not clear in their records). This places it in the Mongala district around Lisala and Bumba, 200 km west on the Congo River, where H.-P. Wotzka (1995) also reports this pottery to be present.

4.3.4. Association of stone technology and pottery

The lithic assemblages from the Lomami river are particularly interesting since so far there has been only one single instance of stone industry reported from this area. That material was collected during construction works in 1914 at Lileke (Menghin, 1926) further downstream from Ilambi Moke and Yangambi and is part of the old collections stored at the Royal Museum for Central Africa. There is a striking resemblance in raw materials. Since the Lileke material has been hand-picked there are little to no small artefacts, and this may possibly also explain the absence of quartz artefacts. As for maximum size distribution, none of the excavated artefacts at the Lomami sites measure over 8 cm, whereas there is one piece of 9 cm and one of 13 cm in the museum collection, demonstrating the relatively small size in which the raw material must have been available. Most are cortical flakes in silicified mudstone and a fine-grained sandstone, with the characteristic dark to yellow glossy cortex. Typological analysis shows no polished implements. Out of the 55 museum artefacts, there is a series of 7 unfinished or finished bifacially and unifacially flaked implements that are very similar to the one found *in situ* at Ilambi Moke associated with pottery, a small pick, and an angular flake- and a core scraper.

The main difference between the excavated assemblages and the museum collection from the banks of the Lomami river is not in raw materials nor in typological composition, but in the absence of an association with pottery. Granted, for the latter, the collectors mention the presence of a fragment of "crude and badly fired ware" (Menghin, 1926, p. 840). During colonial times, pottery was admittedly very rarely collected. So this lack of a pottery association for the artefacts found at Lileke may be circumstantial.

Lithic assemblages from the Congo River Basin, and by extension from the rainforest in north-eastern DRC, are rare (Cornelissen, 2016), and lithic assemblages in stratigraphic context in

Fig. 25. Middle phase pottery: Ilambi Moke (Lomami river) 1. & 2. MOK/10/IIB-30-40, Yangambi Forest Reserve 3. YAN5/15/50-70, Moenge (Itimbiri river), 4. MOE/10/III-120-160, and Ilambi Moke (Lomami river), 5. MOK/10/IIB-20-30, 6. MOK/10/IIB-30-40, 7. MOK/10/IIB-40-50, 8. MOK/10/IA&B © A. Livingstone Smith, C. de Franquen, RMCA.

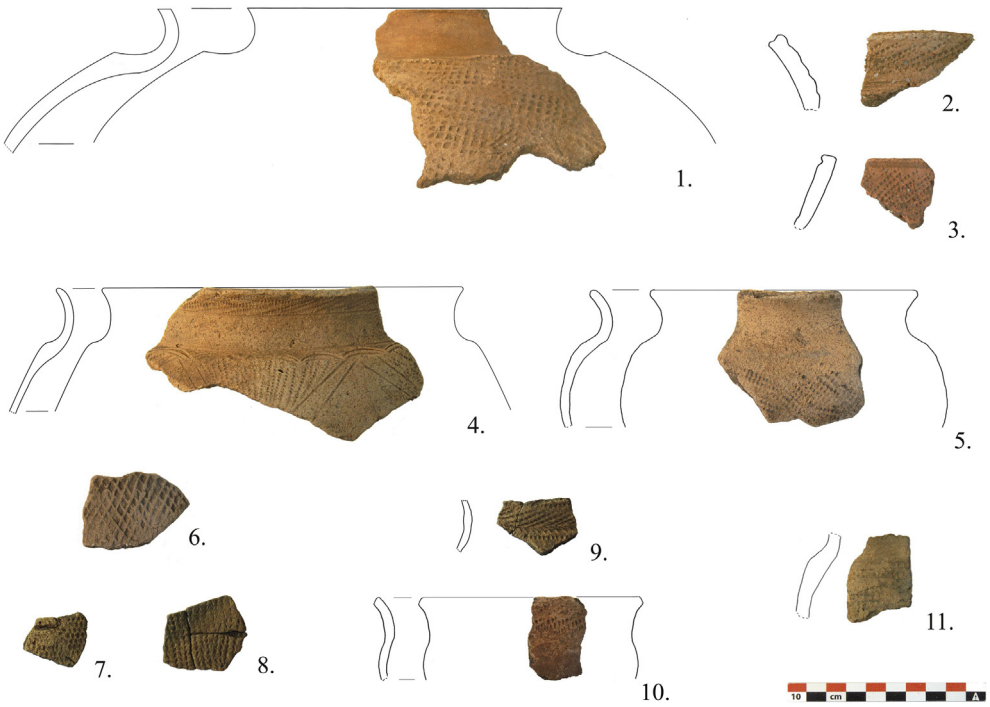

Fig. 26. Late phase pottery, Ilambi style: Yandjambi (Lomami river) 1. & 4. MBI/10/IA-0-25, 5. MBI/10/IA-25-50, 6. MBI/10/IIA-25-50, 7-10. MBI/10/IIB-10-20; Moenge (Itimbiri river) 2. MOE/10/50-70; Ilambi Moke (Lomami river) 3. MOK/10/IIA-15-30; Yangambi Forest reserve 11. YAN/15/5-30-40 © A. Livingstone-Smith, C. de Franquen, RMCA.

association with pottery even more so. In fact, the best-documented lithic assemblages from the Inner Congo Basin are those collected from the surface and exposures during surveys in 1981 and 1983 (Fiedler and Preuss, 1985; Preuss, 1990a, b; Preuss and Fiedler, 1984). In the description of the raw materials a distinction is made, as for the Lomami-assemblages, between two

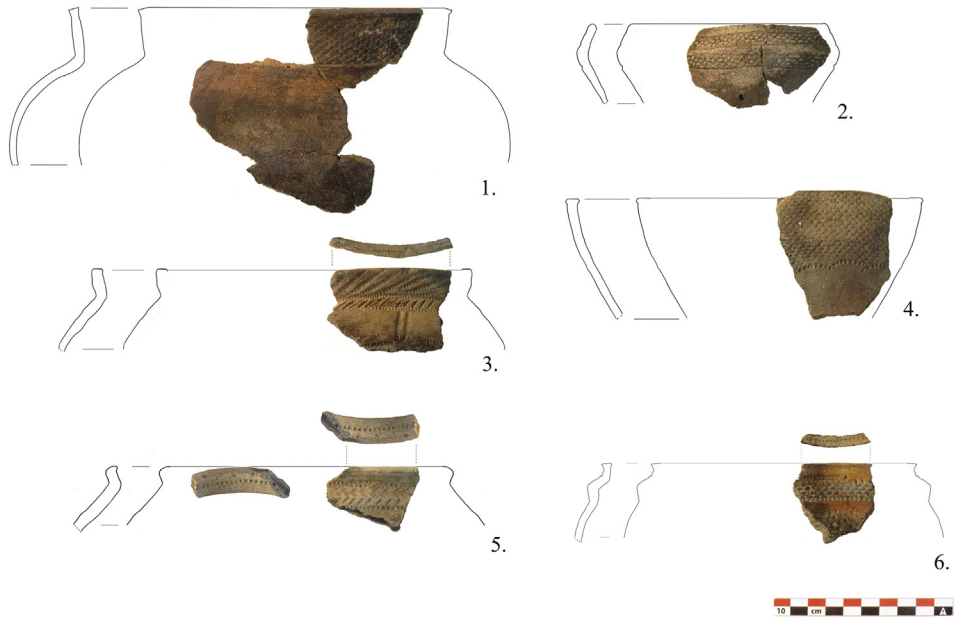

Fig. 27. Late phase pottery, Yaekela style: Yaekela (Congo river) 1. YAE/10/Surf, 3. YAE/10/50-75, 4. YAE/10/-40, 5. YAE/10/-40, 6. YAE/10/-40; Moenge (Itimbiri river) 2.MOE/10/III-0-35 © A. Livingstone Smith, C. de Franquen, RMCA.

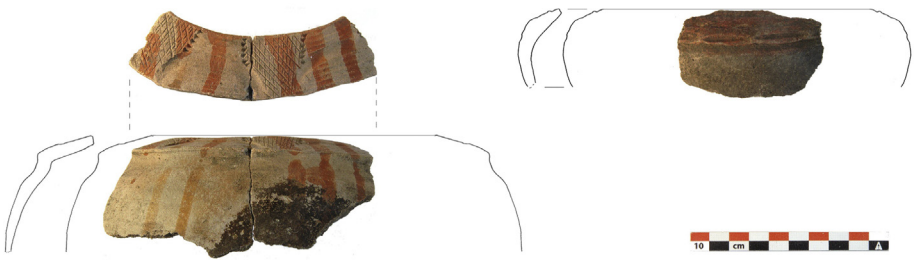

Fig. 28. Late phase pottery, Nkomba Style, Engengele (Itimbiri river) 1. ENG/10/Surf.; Moenge (Itimbiri river) 2. MOE/10/III-35-50 © A. Livingstone Smith, C. de Franquen, RMCA.

large groups of rocks.

One is referred to as “grès polymorphe” (as such in French between quotation marks), including for the eastern sites along the Busira and Tshuapa a partially silicified sandstone (Preuss, 1990b). It is only this type of rock for which an outcrop was seen at Ingende (Preuss, 1990b:433). The second group is composed of milky vein quartz (Preuss and Fiedler, 1984:232). Quartz pebbles of more than 1 cm were only found to the East, for instance East of Wete on the Tshuapa River (Preuss, 1990b:433). The characteristic and omnipresent black desert varnish cortex of the Lomami sites is absent on the specimens from the Inner Congo Basin, except for two pieces; a core (Preuss and Fiedler, 1984, Fig.8.7) from Ikua on the Ruki River, and a flake with a cortical flaking platform found at Besongo KM259 on the Busira River. These occurrences are located some 520 and 400 km in a direct line from the Lomami sites.

The Inner Congo Basin assemblages were described as ‘microlithic’ (Preuss and Fiedler, 1984:236 between quotes in the original publication) for which the paucity of raw material and the large distances over which it needed to be transported lead to exploitation down to the smallest possible size. The typo-technological composition of Inner Congo Basin surface assemblages points to relatively unstandardized assemblages (Preuss and Fiedler, 1984:239). The exception is a series of bifacially and unifacially trimmed arrowheads (Preuss and Fiedler, 1984:242–243) collected at various sites on the eastern shore of Lake Tumba and at two sites some 50 km East of Mbandaka. The most eastern occurrence is a leaf shaped arrowhead found at “km 259” on the Busira River. At the eastern shore of Lake Tumba one single small polished adze was found at Ibonzi and a core-axe-like tool was found at Mpotia 2 (Preuss and Fiedler, 1984:242). The latter tool is considered by Preuss and Fiedler to be close in shape to the Lupemban core-axes or to a broken piece of a Sangoan artefact.

The category of well-represented bifacial arrowheads and the one instance of a polished implement in the Inner Congo Basin are absent from the Lomami assemblages. There is a resemblance between the bifacially trimmed core-axe like tool found near Lake Tumba and the bifacially flaked axe-like tools from the sites along the Lomami river, found in a stratigraphic context associated with pottery and for which we can assure that a Lupemban affinity is no longer warranted. Their stratigraphic position also casts doubt on the Lupemban or Tshitolian affinity of the Inner Congo Basin sites, suggested in Preuss and Fiedler (Preuss, 1990b; Preuss and Fiedler, 1984:432). None of the stone artefacts in the Inner Congo Basin were found in any association with the abundant pottery occurrences.

To the East of the Lomami sites the rain forest stretches into the Ituri forest where field work was conducted by J. Mercader (a comprehensive overview is offered in Mercader, 2003 and references therein). Based on the radiocarbon dates, phytolithic analysis and flaked quartz assemblages the presence of hunter-gatherers is

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established from the end of the Pleistocene to the Early and Middle Holocene. These flaked quartz assemblages, however, do not come from excavated open-air sites, but from 10 rock shelters. In almost all of these rock shelters the upper "cap" also contains Late Iron Age pottery, with *knotted strip roulette* decoration, and in 4 instances associated with iron production debris (Mercader et al., 2000a, 2000b). Thus these finds offer a very different view, in terms of both lithic and pottery style or technology. This is not entirely surprising as these sites also differ as regards site type, and chronology. Indeed, all the Ituri sites are rockshelters. There is also a gap between 1000 BCE and 1000 CE in their chronology, precisely where the Lomami dates are to be inserted. In fact the only chronological overlap between Ituri and Lomami is between the Late Iron Age in the Ituri and the Late Pottery Phase along the Lomami, but the later has not been found in association with stone artefacts, nor for that matter with traces of iron use/production.

In the Ituri forest Mercader argues there is evidence of ancient presence of hunter-gatherers at the end of the Pleistocene and perhaps also in the Late Holocene, but the stone artefacts stratigraphically associated with the Ancient and Middle Pottery Phase from this ongoing research do not allow for any such conclusions on the Lomami.

5. Conclusion

The riverine and forest surveys reported here have allowed a first chrono-cultural sequence to be developed for the north-eastern bend of the Congo River and the lower stretch of its tributaries between the Lindi river in the east and the Aruwimi river in the west. The uncovered sequence of occupation stretches, with many gaps, from the 4th century BC till the late 20th century AD. The Early phase pottery found outside of pit structures is associated with an unstandardized flaked stone industry that had been previously documented, though undated, in the area.

The data presented here expands the debate on stone-versus metal-using early pottery communities in Central Africa. The near contemporaneity of the Early Phase pottery of the Lomami and Aruwimi with the Imbonga style of the Inner Congo Basin indicates a rather fast expansion of pottery technology in the rain forest. This settlement process was originally thought to be a slow progression on the basis of the spread and dating of pottery phases and styles in the Inner Congo Basin. The precise nature of the relationship between the Early Phase pottery of the North East Congo bend and Imbonga style pottery from the Inner Congo Basin needs further exploration. Stylistic differences are clear, but there are also obvious parallels – for instance in vessel shape and ornamental techniques. Ongoing studies on the *chaînes opératoire* of these early traditions will provide some clarification. Finally, Late Pottery Phases document the appearance of typically Sahelian potting techniques in the rainforest.

This urges new perspectives on population dynamics in the northern part of the Central African rainforest. Indeed, we have indications that some of the vessels attributed to the early phase are made using the *drawing of a ring* technique. The radiography of *Imbonga* vessels (i.e. early phase style of the Inner Congo Bassin, sensu Wotzka, 1995) in the collections of the RMCA also shows indication of the use of the *drawing of the ring* technique. In fact, a variant of this technique is still in use in the Inner Congo Bassin (Eggert and Kanimba, 1980). Thus it seems that, while the first wave of villagers who settled this part of Central Africa shared a common heritage, an important cultural shift related to the influence of Sahelian pottery traditions occurred in the North-Eastern part of Congo River basin towards the turn of the first millennium AD. This shift is attested by the appearance of the *pounding on a concave mould* or *martelage* with various kinds of roulette decoration. This situation fits with the spread of roulette decoration in Central Africa, in general, during the last millenium (see Livingstone Smith, 2007).

The next step will be to compare the environmental data from the various settlement types and phases along the Aruwimi and Lomami rivers and inland to establish to which extent the type of forest had an impact on the occupation of the river-banks and interfluves throughout the last 2500 years. For this purpose, the archaeological sequence established here will serve as a reference framework.

Regarding the issue on the contact between migrating pottery producing groups with already established hunter-gatherers in this area of the lowland forest, we have no archaeological evidence to offer. The issue remains to what extent the three stone assemblages most likely associated with only the Early Pottery phase are a true association in material culture or are a systematic settlement by these groups on litters of stone debris left at an earlier stage or by contemporary stone using/producing groups. So far, we have no chronological or other grounds to dismiss these as litter on the ground or accept these as part of the material culture of the producers of the Early Pottery.

The data presented in this paper does, however, allow for new insights on the Bantu languages expansion phenomenon. In this regard, we need to focus our attention on a careful integration of ethnographic, linguistic and archaeological data. Ongoing research in this matter will integrate detailed technical data on contemporary and ancient pottery traditions, with historical and linguistic data. In this way we hope to avoid the usual pitfalls of simplistic archaeological and linguistic comparisons (for a review of the shortcomings of this approach, see de Luna, In press/2016; Eggert, 2005).

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References

Benyarku, C.A., Stoops, G., 2005. Guidelines for Preparation of Rock and Soil Thin Sections and Polished Sections. Universitat de Lleida, Spain.

Bourland, N., Cerisier, F., Daïnou, K., Livingstone Smith, A., Hubau, W., Beeckman, H., Brostaux, Y., Fayolle, A., Biwolé, A.B., Fétéké, F., Gillet, J.-F., Morin-Rivat, J., Lejeune, P., Tiba, E.N., Van Acker, J., Doucet, J.-L., 2015. How tightly linked are pericopsis elata (fabaceae) patches to anthropogenic disturbances in south-eastern Cameroon? Forests 6, 293–310.

Brncic, T.M., Willis, K.J., Harris, D.J., Telfer, M.W., Washington, R., 2009. Fire and climate change impacts on lowland forest composition in northern Congo

during the last 2580 years from palaeoecological analyses of a seasonally flooded swamp. Holocene 19, 79–89.
Brncic, T.M., Willis, K.J., Harris, D.J., Washington, R., 2007. Culture or climate? The relative influences of past processes on the composition of the lowland Congo rainforest. Philos. Trans. R. Soc. 362, 229–242.
Bronk Ramsey, C., 2009. Bayesian analysis of radiocarbon dates. Radiocarbon 51, 337–360.
Coart, E., de Haulleville, A., 1907. Notes analytiques sur les collections ethnographique du Congo belge, t. Ii. Les industries indigènes, fasc. 1. La céramique. Royal Museum for Central Africa (MRAC-KMMA), Tervuren (Belgium).
Cornelissen, E., 2016. The later Pleistocene in the northeastern central african rain forest. In: Jones, S.C., Stewart, B.A. (Eds.), Africa from MIS 6-2: Population Dynamics and Paleoenvironments. Springer, Dordrecht, pp. 301–322.
Cornelissen, E., Lihanzu Ebosso, O., Mambu Nsangathi, C., 2013. Prospections sur la Lindi (Province Orientale, République démocratique du Congo). Nyame Akuma 79, 74–82.
de Luna, K., 2016. Conceptualizing vegetation in the Bantu expansion: reflections on linguistics in central african history. Quat. Int. Vol. (In press).
de Maret, P., 2013. Chapter 43: archaeologies of the Bantu expansion. In: Lane, P., Mitchell, P. (Eds.), The Oxford Handbook of African Archaeology. Oxford University Press, Oxford, pp. 627–643.
Dechamps, R., Lanfranchi, R., Le Cocq, A., Schwartz, D., 1988. Reconstruction d'environnements quaternaires par l'étude de macrorestes vegetaux (Pays Bateke, R.P. du Congo). Palaeogeogr. Palaeoclimatol. Palaeoecol. 66, 33–44.
Eggert, M.K.H., 1980. Der Keramikfund von Bondongo-Losombo (Région de l'Equateur, Zaïre) und die Archäologie des Aquatorialen Regenwaldes. Beitr. Allg. Vgl. Archäol. 2, 381–427.
Eggert, M.K.H., 1984. Imbonga und Lingonda: Zur frühesten Besiedlung des äquatorialen Regenwaldes. Beitr. Allg. Vgl. Archäol. 6, 247–288.
Eggert, M.K.H., 1987. Imbonga and Batalimo: ceramic evidence for early settlement of the equatorial rain forest. Afr. Archaeol. Rev. 5, 129–145.
Eggert, M.K.H., 1992. The Central African rainforest: historical speculation and archaeological facts. World Archaeol. 24, 1–24.
Eggert, M.K.H., 2005. Chapter 12: the Bantu problem and african archaeology. In: Stahl, A.B. (Ed.), African Archaeology: a Critical Introduction. Blackwell Publications, Maiden, MA, pp. 301–326.
Eggert, M.K.H., 2014. The archaeology of the central african rainforest: its current state. In: Renfrew, C., Bahn, P. (Eds.), The Cambridge World Prehistory. Cambridge University Press, Cambridge, pp. 183–203.
Eggert, M.K.H., Kanimba, M., 1980. Aspects d'un métier traditionnel: l'industrie de la poterie à Ikenge. Baessler-Archiv 28, 387–430.
Fiedler, L., Preuss, J., 1985. Stone tools from the Inner Zaire Basin (Région de l'Equateur, Zaïre). Afr. Archaeol. Rev. 3, 179–187.
Gosselain, O.P., 2002. Poteries du Cameroun Méridional. Styles techniques et rapports à l'identité. CNRS Editions, Paris.
Gourlet-Fleury, S., Mortier, F., Fayolle, A., Baya, F., Ouédraogo, D., Bénédet, F., Picard, N., 2013. Tropical forest recovery from logging: a 24 year silvicultural experiment from Central Africa. Philos. Trans. R. Soc. Biol. 368, 20120302.
Haour, A., Guené, B., Gosselain, O.P., Livingstone Smith, A., N'Dah, D., 2011. 2011. Survey along the Niger river valley at the Bénin-Niger border, Winter. Nyame Akuma 76, 23–32.
Hart, T.B., Hart, J.A., Dechamps, R., Fournier, M., Ataholo, M., 1996. Changes in forest composition over the last 4000 years in the Ituri basin, Zaire. In: Van der Maesen, L.J.G., Van der Burgt, X.M. (Eds.), The Biodiversity of African Plants. Kluwer, Dordrecht, pp. 545–563.
Hubau, W., Van den Bulcke, J., Kitin, P., Mees, F., Baert, G., Verschuren, D., Nsenga, L., Van Acker, J., Beeckman, H., 2013. Ancient charcoal as a natural archive for paleofire regime and vegetation change in the Mayumbe, Democratic Republic of the Congo. Quat. Res. 80, 326–340.
Hubau, W., Van den Bulcke, J., Kitin, P., Mees, F., Van Acker, J., Beeckman, H., 2012. Charcoal identification in species-rich biomes: a protocol for Central Africa optimised for the Mayumbe forest. Rev. Palaeobot. Palynol. 171, 164–178.
Hubau, W., Van den Bulcke, J., Van Acker, J., Beeckman, H., 2015. Charcoal-inferred Holocene fire and vegetation history linked to drought periods in the Democratic Republic of Congo. Glob. Change Biol. 21, 2296–2308.
Huysecom, E., 1992. Les percuteurs d'argile: des outils de potières africaines utilisés de la préhistoire à nos jours. Bull. Du. Cent. Genev. d'Anthropol. 3, 71–98.
Kahlheber, S., Eggert, M.K.H., Seidensticker, D., Wotzka, H.-P., 2014. Pearl millet and other plant remains from the early iron age site of Boso-Njafo (inner Congo basin, Democratic Republic of the Congo). Afr. Archaeol. Rev. 31, 479–512.
Lewis, S.L., Lopez-Gonzalez, G., Sonké, B., Affum-Baffoe, K., Baker, T.R., Ojo, L.O., Phillips, O.L., Reitsma, J.M., White, L., Comiskey, J.A., Djuikouo, K.M.N., Ewango, C.E.N., Feldpausch, T.R., Hamilton, A.C., Gloor, M., Hart, T., Hladik, A., Lloyd, J., Lovett, J.C., Makana, J.R., Malhi, Y., Mbago, F.M., Ndangalasi, H.J., Peacock, J., Peh, K.S.H., Sheil, D., Sunderland, T., Swaine, M.D., Taplin, J., Taylor, D., Thomas, S.C., Votere, R., Wöll, H., 2009. Increasing carbon storage in intact African tropical forests. Nature 457, 1003–1007.
Livingstone Smith, A., 1999. Poteries "ethnographique" et archéologiques: analyse de la chaîne opératoire. In: Léotard, J.-M. (Ed.), Actes de la journée d'archéologie en Province de Liège. Méthodes d'analyse de la terre cuite. Ocquier 28-11-98. Ministère de la Région Wallonne, Liège, pp. 59–68.
Livingstone Smith, A., 2001. Chaîne opératoire de la poterie: Références ethnographiques, analyses et reconstitution. Faculté de Philosophie et Lettres. Université Libre de Bruxelles, Bruxelles.
Livingstone Smith, A., 2007. Histoire du décor à la roulette en Afrique subsaharienne. J. Afr. Archaeol. 5, 189–216.
Livingstone Smith, A., 2010. Reconstitution de la chaîne opératoire de la poterie: bilan et perspective en Afrique sub-saharienne. Nouv. l'Archéol. Approch. chaîne opératoire céramique 119, 9–12.
Livingstone Smith, A., Cornelissen, E., Hubau, W., Ebosso, V., 2011. Prospections et Fouilles Archéologiques de la Mission « Boyekoli Ebale Congo 2010 » (RDC). Nyame Akuma 75, 11–16.
Livingstone Smith, A., Vysserias, A., 2010. Shaping Kabambian pottery: identification and definition of technical features. Open Anthropol. J. 3, 124–141.
McCormac, F.G., Hogg, A.G., Blackwell, P.G., Buck, C.E., Higham, T.F.G., Reimer, P.J., 2004. SHCal04 Southern Hemisphere calibration, 0-11.0 cal kyr BP. Radiocarbon 46, 1087–1092.
Menghin, O., 1926. Neue Steinzeitfunde aus dem Kongostaate und ihre Beziehungen zum europäischen Campignien. Anthropos. XXI 833–850.
Mercader, J., 2003. Foragers of the Congo. The early settlement of the Ituri forest. In: Mercader, J. (Ed.), Under the Canopy. Rutgers University Press, New Brunswick, pp. 93–116.
Mercader, J., Garcia-Heras, M., Gonzalez-Alvarez, I., 2000a. Ceramic tradition in the African forest: characterisation analysis of ancient and modern pottery from Ituri, D. R. Congo. J. Archaeol. Sci. 27, 163–182.
Mercader, J., Rovira, S., Gómez, P., 2000b. Shared Technologies: forager-farmer interaction and ancient iron metallurgy in the Ituri rain forest, Democratic Republic of Congo. Azania 35, 107–122.
Morin-Rivat, J., Biwolé, A.B., Gorel, A.P., Vleminckx, J., Gillet, J.F., Bourland, N., Hardy, O.J., Livingstone Smith, A., Daïnou, K., Dedry, L., Beeckman, H., Doucet, J.-L., 2016. High spatial resolution of late-Holocene human activities in the moist forests of central Africa using soil charcoal and charred botanical remains. The Holocene.
Morin-Rivat, J., Fayolle, A., Gillet, J.-F., Bourland, N., Gourlet-Fleury, S., Oslisly, R., Bremond, L., Bentaleb, I., Beeckman, H., Doucet, J.-L., 2014. New evidence of human activities during the Holocene in the lowland forests of the northern Congo Basin. Radiocarbon 56 (1), 209–220.
Muller-Landau, H., 2009. Sink in the african jungle. Nature 457, 969–970.
Oslisly, R., White, L., 2003. Etudes des traces de l'impact de l'homme sur l'environnement au cours de l'Holocène dans deux régions d'Afrique centrale forestière : la réserve de la Lopé (Gabon central) et le sanctuaire du Banyang Mbo (ouest-Cameroun). In: Froment, A., Guffroy, J. (Eds.), Peuplements anciens et actuels de des forêts tropicales (actes du séminaire-atelier, Orléans 15-16 octobre 1998). IRD édition, Paris, pp. 77–87.
Oslisly, R., White, L., Bentaleb, I., Favier, C., Fontugne, M., Gillet, J.-F., Sebag, D., 2013. Climatic and cultural changes in the west Congo Basin forests over the past 5000 years. Philos. Trans. R. Soc. Biol. Sci. 368, 20120304.
Preuss, J., 1990a. L'évolution des paysages du bassin intérieur du Zaïre pendant les quarante derniers millénaires. In: Lanfranchi, R., Schwartz, D. (Eds.), Paysages quaternaires de l'Afrique centrale atlantique. Editions de l'Orstom, Paris, pp. 260–270.
Preuss, J., 1990b. Premières séries d'artefacts lithiques originaires du bassin intérieur du Zaïre. In: Lanfranchi, R., Schwartz, D. (Eds.), Paysages quaternaires de l'Afrique centrale atlantique. Editions de l'Orstom, Paris, pp. 431–435.
Preuss, J., Fiedler, H., 1984. Steingeräte aus dem inneren Kongobecken und ihre geomorphologische Einbindung. Beitr. Allg. Vgl. archaologie 6, 227–246.
Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T.J., Hoffmann, D.L., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., Manning, S.W., Niu, M., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Staff, R.A., Turney, C.S.M., van der Plicht, J., 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55 (4), 1869–1887.
Sterner, J., David, N., 2003. Action on matter: the history of the uniquely African tamper and concave anvil pot-forming technique. J. Afr. Archaeol. 1, 3–38.
Stoops, G., 2003. Guidelines for Analysis and Description of Soil and Regolith Thin Sections. Soil Science Society of America, Madison, Wisconsin.
White, L., Abernethy, K., Oslisly, R., Maley, J., 2000. L'Okoumé (Aucoumea klaineana): expansion et déclin d'un arbre pionnier en Afrique centrale atlantique (Gabon) au cours de l'Holocène. In: Servant, M., Servant-Vildary, S. (Eds.), Dynamique à Long Terme des Ecosystèmes Forestiers Intertropicaux: Symposium International, Paris (FRA), 1996/03/20-22. IRD. UNESCO, Paris, pp. 399–411.
White, L.J.T., 2001. Past and present trends in the African rain forest: overview. In: Weber, B., White, L., Vedder, A., Naugthon-Treves, L. (Eds.), African Rain Forest Ecology and Conservation. Yale University Press, New Haven, CT, pp. 47–49.
White, L.J.T., Oates, J.F., 1999. New data on the history of the plateau forest of Okomu, southern Nigeria: an insight into how human disturbance has shaped the African rain forest. Glob. Ecol. Biogeogr. 8, 355–361.
Wotzka, H.-P., 1993. Zur Tradition der Keramikdeponierung im äquatorialen Regenwald Zaïres: ein Benenntnis allgemeinvergleichenden Analogie (On the tradition of depositing ceramics in the equatorial rainforest of Zaïre : a plea for the use of comparative analogies in archaeology). Ethnogr. Z. 34, 251–283.
Wotzka, H.-P., 1995. Studien zur Besiedlungsgeschichte des äquatorialen Regenwaldes Zaïres: Die archäologische Keramik des inneren Zaïre-Beckens und ihre Stellung im kontext der Bantu-Expansion. Heinrich Barth Institut, Köln.
Wotzka, H.-P., 2006. Records of activity: radiocarbon and the structure of iron age settlement in central Africa. In: Wotzka, H.-P. (Ed.), Grundlegungen. Beiträge zur europäischen und afrikanischen Archäologie für Manfred K.H. Eggert. Francke Attempto Verlag GmbH and Co. KG, Tübingen, pp. 271–289.

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