The Beginning of the Iron Age South of the Congo Rainforest: The First Archaeological Investigations around Idiofa (DRC), 146 BC – AD 1648

Peter R. Coutros,[a]* Igor Matonda,[b] Jessamy H. Doman,[a] Sara Pacchiarotti,[a] Isis Mesfin, [c,d] and Koen Bostoen[a]

[a] *UGent Centre for Bantu Studies, Department of Languages and Cultures, Ghent University, Ghent, Belgium;*

[b]*Département des Sciences Historiques, University of Kinshasa, Kinshasa, Democratic Republic of the Congo*

[c]*Fyssen Foundation – Museu Nacional de Arqueologia de Benguela, Angola*

[d]*Muséum national d'Histoire naturelle, UMR 7194 HNHP – MNHN, CNRS, UPVD – Alliance Sorbonne Université. Paris, France. Institut de Paléontologie Humaine, 1 rue René Panhard, 75013 Paris, France.*

*Peter R. Coutros

Department of Languages and Cultures
Ghent University
Peter.Coutros@UGent.be

The Beginning of the Iron Age South of the Congo Rainforest: The First Archaeological Investigations of Idiofa (DRC), 146 BC – AD 1648

Archaeological investigations of the Idiofa region in the Kwilu Province of the Democratic Republic of Congo have yielded the earliest evidence for iron production, combined with ceramics and lithics, south of the Congo rainforest during the 2nd century BC. Palaeoecological data show that the producers of this industry did not settle in open grasslands but nonetheless in a habitat whose forests had started to undergo climate-induced degradation before their arrival. The EIA at Idiofa continues until the 3rd century AD and is followed by a long hiatus that is not driven by climate change and lasts until the 15th century AD. The LIA pottery (1487-1648 AD) is markedly distinct from the EIA pottery (146 BC-226 AD) in vessel forms, size, recipe, and decoration. EIA pottery from Idiofa resembles most closely slightly younger Kay Ladio pottery (30-475 AD) from the Lower Congo region further west, also associated with the first metallurgy there. Idiofa's LIA pottery is indicative of a 15th-17th centuries exchange network between the Kamtsha-Kasai Rivers. These shifting dynamics in pottery production are reflected in the region's linguistic stratigraphy, which may contribute to the interdisciplinary reconstruction of the history of ancestral Bantu speakers south of the rainforest.

Keywords: Iron Age, Democratic Republic of the Congo, iron production, ceramic analysis, lithics, palaeoecology

Résumé

Les recherches archéologiques dans la région d'Idiofa, dans la province du Kwilu, en République Démocratique du Congo, ont mené à la découverte des premières traces de la production du fer au sud de la forêt du bassin du Congo. Elles remontent au cours du 2ème siècle avant J.-C et sont associées à de la céramique et des vestiges lithiques. Les données paléoécologiques montrent que les producteurs de cette industrie ne se sont pas installés dans les savanes ouvertes, mais dans un habitat dont les forêts avaient tout de même commencé à se dégrader avant leur arrivée, suite aux changements climatiques. L'Âge du Fer ancien à Idiofa continue jusqu'au 3ème siècle de notre ère. Après cela un long hiatus non lié au climat perdure jusqu'au 15ème siècle. La poterie de l'Âge du Fer récent (1487-1648 AD) se distingue nettement de celle de l'Âge du Fer ancien (146 BC-226 AD) par la

forme, la taille, la composition et la décoration. La poterie de l'Âge du Fer ancien d'Idiofa ressemble davantage à la poterie Kay Ladio (30-475 AD) de la région du Bas-Congo, située plus à l'ouest et de date un peu plus récente. Elle est également associée à la métallurgie la plus ancienne de cette région. La poterie d'Idiofa de l'Âge du Fer récent est révélatrice d'un réseau d'échange qui s'étendaient entre les rivières Kamtsha et Kasai du 15ème au 17ème siècle de notre ère. Ces dynamiques en mutation dans la production de la poterie se reflètent dans la stratigraphie linguistique de la région, ce qui est pertinent pour la reconstruction interdisciplinaire de l'histoire des communautés bantouphones ancestrales au sud de la forêt tropicale.

Introduction

The initial dispersal of Bantu languages and the communities speaking them across Africa had a major impact on the continent's linguistic, cultural, and demographic history and present-day outlook and is therefore a subject of ongoing debate in different research fields (e.g. de Maret 2013; Russell *et al.* 2014; Bostoen *et al.* 2015a; Grollemund *et al.* 2015; Patin *et al.* 2017; Bostoen 2018; Crowther *et al.* 2018; Bostoen 2020; Wang *et al.* 2020; de Saulieu *et al.* 2021; Seidensticker *et al.* 2021; Koile *et al.* 2022). Insights from linguistics and genetics concur in showing that migration of West-Africans was the principal population dynamic behind the spread of this subbranch of the Niger-Congo language phylum originating in West Africa (Tishkoff *et al.* 2009; de Filippo *et al.* 2012; Pickrell *et al.* 2012; Schlebusch *et al.* 2012; Li *et al.* 2014; Dimmendaal and Storch 2016; Schlebusch and Jakobsson 2018; Good 2020; Bostoen *et al.* forthcoming-a).

In archaeology, many (Oslisly 1993; de Maret 1994; Wotzka 2001; Clist 2006a; Bostoen, 2018) have argued that the initial stages of this major Late Holocene population event, commonly known as the Bantu Expansion, are associated with the spread of new, more sedentary lifeways across the Congo rainforest during the first millennium BC. Those settlements yield material cultures that are significantly different from those of earlier forest dwellers and are

characterized by variable combinations of archaeological features new to the region, such as refuse pits (Wotzka 2001), pottery (de Maret 1986; Wotzka 1995), large stone tools (Clist 2006b), evidence for plant cultivation and/or animal husbandry (Neumann *et al.* 2022), and later sometimes metallurgy. Nonetheless, in the absence of written records and ancient DNA, identifying traces of the Bantu Expansion in Central Africa's archaeological record is a challenging enterprise (Eggert 2005, 2016). Debates therefore persist on the most basic questions concerning the Bantu Expansion in Central Africa, such as its precise pathways and chronology (Russell *et al.* 2014; Grollemund *et al.* 2015; Koile *et al.* 2022), whether it was driven by agriculture or palaeoclimatic change (Schwartz 1992; Bayon *et al.* 2012; Neumann *et al.* 2012b; Bostoen *et al.* 2015a; Clist *et al.* 2018a; Garcin *et al.* 2018a; Bayon *et al.* 2019), and whether their settlement was continuous since the initial migration or interrupted by a hiatus between the Early Iron Age (EIA) and Late Iron Age (LIA) (Oslisly 2001; de Maret 2003; Wotzka 2006; Oslisly *et al.* 2013; Clist *et al.* 2021; de Saulieu *et al.* 2021; Seidensticker *et al.* 2021; Bostoen *et al.* forthcoming-b). Significant voids in the archaeological documentation of the Congo rainforest and its margins hamper serious progress in these matters. One of those archaeologically unknown key zones is the area immediately south of the Congo rainforest where several studies have situated a major secondary hub of Bantu Expansion (Heine *et al.* 1977; Vansina 1995; Grollemund *et al.* 2015; Pacchiarotti *et al.* 2019; Koile *et al.* 2022), especially the zone east of the Congo River and south of the Kasai-Kwa Rivers. For this reason, the area has been the centrepiece of archaeological field research within the interdisciplinary BantuFirst project (2018-2023, ERC Consolidator's Grant n° 724275, https://www.bantufirst.ugent.be) since 2018 (Seidensticker *et al.* 2018; Matonda Sakala *et al.* 2019; Matonda Sakala *et al.* 2021; Coutros *et al.* 2022, 2023).

This article focuses on the archaeological surveys and excavations which the BantuFirst team carried out in the eastern end of that area, i.e. within the vicinity of Idiofa, between August 18 and September 3, 2019. The results of this research include several significant findings that help fill important gaps in our understanding of the history of the southwestern rim of the Congo Basin. While the archaeology of the wider region has seen an uptick in recent years, the majority of this work has been focused on the Kongo-Central Province of the Democratic Republic of the Congo (DRC) bordering the Atlantic Coast (Clist *et al.* 2019a, b). More inland regions generally, to include all of Kwilu and Kwango provinces, as well as the majority of the neighbouring Kasai and Mai-Ndombe provinces, remain largely unexplored archaeologically. Prior to the present work, the closest archaeological excavations were located ~100 km to the southwest of Idiofa at the 16th century AD site of Mashita Mbanza – itself somewhat of an archaeological island (de Maret and Clist 1985; Pierot 1987). Earlier archaeological collections were carried out by Bequaert near Tshikapa (1947) and the Kwango region (Bequaert 1956b) and by van Moorsel (1970) along the lower reaches of the Kasai and Lukenie rivers. Bequaert (1956a) also conducted a series of excavations across the former Belgian-Congo, including at Dinga and Mukila – both in the *Territoire de Kenge*. More recently, as part of the BantuFirst research project, Seidensticker *et al.* (2018) revisited Mukila to further explore the Late Pleistocene and Holocene sequences Bequaert had uncovered. Still, due to the inconsistent and diffuse nature of archaeological research across the southwestern edge of the Congo Basin, very little is currently known about the pre-modern history of the region and how it fits into the broader narratives of Central African history regarding – among other major questions – the spread of food, iron and pottery production and the expansion(s) of Bantu-speaking peoples.

Linguistic research within this region, however, is somewhat more advanced. Based on the most comprehensive lexicon-based phylogeny of the West-Coastal Bantu languages to date, Pacchiarotti *et al.* (2019) have placed the homeland of this major branch of the Bantu family between the Kamtsha and Kasai Rivers, approximately 350 km further east than previously thought based on less exhaustive phylogenies (de Schryver *et al.* 2015). This is the area where the greatest present-day linguistic diversity within West-Coastal Bantu can be observed. According to Pacchiarotti *et al.* (2019), after Proto-West-Coastal Bantu speakers emerged south of the rainforest, there would have been two distinct westward movements from the homeland in the interior toward the Atlantic coast coinciding with the two main sub-branches emerging from the phylogeny, namely Kwilu-Ngounie and the Kikongo Language Cluster (KLC) Extended. The latter sub-branch consists of the KLC, which stretches out from the Kwilu River all the way through the Lower Congo region to the Atlantic Coast, and its closest relatives currently spoken around Idiofa and Kikwit. One of them is Mbuun, the main local language spoken around Idiofa, and the easternmost of the KLC Extended languages. Hence, from an historical linguistic point of view, the Mbuun-speaking area round Idiofa is situated at the extreme eastern end of an ancient east-to-west language expansion of Bantu languages, and possibly also of the people speaking them. However, due to the dearth of archaeological research from within this region, no data on occupation chronologies, pottery traditions, or technological change exist against which this hypothesis may be tested.

Idiofa

The city of Idiofa lies 485 km east of Kinshasa in Kwilu Province, to the south of the Kasai River between the valleys of the Kamtsha and Loange Rivers. The city occupies the summit of one in a series of massifs established by the erosion of Upper Cretaceous-Cenozoic

Kalahari duricrust and the underlying red sandstone of the Kwango Group (Schwartz 1990; Linol *et al.* 2015). This succession reaches approximately 700m above Mean Sea Level and is capped by sandy ferralic arenosols (Nicolaï 1963; Datok *et al.* 2021). Today, though receiving an average of 900-1000mm of annual rainfall, the region is defined as a forest-savannah mosaic while vegetation zones generally follow topographic gradients; with the massif summits being dominated by herbaceous and semi-wooded savannah and the lower valleys with dense patches of Guinean forest species (Nicolaï 1963; Mushi *et al.* 2019).

The main objective of the 2019 BantuFirst field season was to identify and map all archaeological phenomena from within the study region, with a particular focus on Early Iron Age (EIA) deposits (ca. 300 BC – AD 1000). Through a combination of informal reconnaissance, pedestrian survey, and targeted excavation, the BantuFirst archaeology team identified 41 sites ranging from the EIA to the Late Iron Age (LIA) (Figure 1). In Mbuun, abandoned villages are called "eyum." Excavations were conducted at several "eyum" near the modern villages of Ingung Kapia and Musanga, to the north and south of Idiofa respectively. Here, 4 units were excavated at Ingung Kapia (4°86'S 19°57'E), and 47 units were excavated near Musanga at Nkar (4°98'S 19°59'E), Okwon (4°99'S 19°6'E), Isem (4°99'S 19°59'E), and Esal (4°59'S 19°35'E) – the latter three of these sites take their names from Mbuun clan names (De Decker, 1950).

Of primary concern for the above discussion on the early expansion of ancestral West-Coastal Bantu speakers is the EIA occupation of the Idiofa region. Analysis of both phytoliths and soil geochemistry has shown that the region underwent climate-induced forest contraction well before the earliest evidence for occupation of Idiofa. In line with the assumption that the Bantu Expansion was facilitated by such a forest crisis (Schwartz, 1992, Bostoen et al., 2015,

Grollemund et al., 2015), climate change may have aided the settlement of new pottery and iron-producing people in the study area. Here, we have also identified the earliest evidence for iron production south of the Congo rainforest – dating to the first and second centuries BC. While no ground or polished stone tools were recovered, these iron-using populations may have maintained a technological continuity through the use of knapped stone tools. Such a technological continuity is widespread, if not common, throughout Central Africa during the EIA (see: Clist 2021: 72) and may represent the earliest stages of the adoption of this new technology. Nangara-Komba in the Central African Republic is perhaps the best example of this continuity (Lupo *et al.* 2021). In more recent periods, there appears to be a long-distance trade network throughout the Kamtsha-Kasai River network ranging from Mashita Mbanza in the south to Eolo in the north. This network, dated to the 15-17th centuries AD, is represented by pottery quite distinct from that of the coeval Kongo Kingdom, located immediately to the west. Below we provide a detailed description of these results and their contexts, building upon the preliminary report published by Matonda Sakala *et al.* (2019).

Survey

Figure 1. Idiofa Region Survey Results shown by survey collections (black circles) and excavation units (white squares)

The survey was conducted by foot and car and oriented on various axes along the summit of the large (~9 km wide) sandstone massif on which modern Idiofa sits (Figure 1). Work was largely focused on the periphery of Idiofa, particularly near the villages of Ingung Kapia, Ingung Ateng, Elom Idiofa, Bea Impanga, Impanga Mopila, Inswem Mbel, and Musanga. A total of 41 artefact-bearing localities were identified within the study region, including ceramic concentrations, slag, and lithic scatters. Diagnostic sherds and lithics were collected from each

site encountered, while the presence of slag on the surface was noted but not collected. If a locality yielded a promising amount of surface finds, a 5 cm auger was used to assess the presence, character, and depth of any sub-surface deposits down to 1 m. Over the course of the survey, it became apparent that the most promising locations for excavations were within the vicinity of Musanga to the immediate south of Idiofa.

Excavations

In total, 51 units were excavated within the study area. Units measured 1x1 m and were generally excavated in linear axes oriented to cardinal directions and spaced at intervals determined by the local conditions. As the natural horizons measured between 40-60 cm thick, more precise stratigraphic context was defined through the excavation of 20 cm artificial spits. All units were excavated to at least 1 m and continued 20 cm below the final artefact-bearing levels to ensure the presence of archaeologically sterile soil. All cultural material recovered during excavations was collected in labelled bags and transported to Kinshasa for further study. In addition, a series of soil samples for archaeobotanical, palaeoecological, and soil isotope analysis were taken from excavation units at Nkar (Tr. 41 and 47) as well as a sterile excavation profile of Okwon Tr. 7 in order to provide a background signal unaltered by cultural deposits.

As evidenced by the stratigraphy of the majority of excavation units, the cultural deposits within the Idiofa region followed a relatively similar pattern. The A horizon extended between 0-5 cm, and from 5-40 cm most units maintained dense cultural deposits within a dark sandy-loam horizon. Between 40-60 cm was an archaeologically sterile horizon of brown sandy-loam, followed by a second – less dense – cultural horizon from 60-120 cm within a yellowish loamy-sand. Below this deepest cultural horizon was an archaeologically sterile horizon of yellow sand. There were exceptions, however, whereby the upper horizon and cultural material extended

deeper (Okown Tr. 05, 10, 14, 16; Nkar Tr. 37; Isem Tr. 20, 21, 22; and Ingung Kapia Tr. 2), however this material never reached below 65 cm. Conversely, the lower horizon at Isem Tr. 29 was encountered after only 20 cm. These exceptions notwithstanding, the general pattern of the first (60-120 cm) and second (0-40 cm) occupations being separated by ~20 cm of archaeologically sterile soil was maintained across the vast majority of units.

Table 1. Radiometric dates on wood charcoal collected from Idiofa region by age. Depths are below surface.

Figure 2. Radiometric dates calibrated OxCal 4.4 with the SHCal20 calibration curve for the Southern Hemisphere within 2σ

The absolute occupation chronology of the region was defined by ten radiometric dates collected from nine excavation units (Table 1). All dates were analysed by the Radiocarbon Dating Lab at the Belgian Royal Institute for Cultural Heritage (KIK-IRPA) and Beta Analytic, and were calibrated using OxCal 4.4 with the SHCal20 calibration curve for the Southern Hemisphere within 2σ (Bronk Ramsey 2009; Hogg *et al.* 2020). The results show three general periods of occupation, largely corroborating the finds of the ceramic seriation (*cf. infra.*) and the stratigraphic analysis (Figure 2). The earliest cluster, taken from the orange loamy-sand horizon between 60-120 cm, consists of six overlapping dates that span cal. 146 BC – AD 226. A second cluster, including two dates between cal. AD 690 – 989, was taken from the archaeologically sterile horizon of Okwon Tr. 5 and Esal Tr. 30. Finally, there is one sample dated to cal. AD 1487 – 1648 (350 ± 30BP; Beta-630485) that was retrieved from the dark sandy-loam horizon between 20-40 cm. The 19th –20th century date (122 ± 0.46; Beta-630484) from Okwon Trench 1 was taken from within the A horizon near the surface of the unit and reflects the modern occupation of the area.

Concerns over the nature and integrity of archaeological deposits at open-air sites in Central Africa have been raised since the 1970s (Cahen and Mortlemans 1973). However, there are several reasons to believe that, at Idiofa, there has been neither inter- nor (significant) intra-horizon mixing. The consistent stratigraphy across all of the units within the entire Idiofa region is strong evidence for *in situ* deposition rather than any mass transport of the archaeological materials (i.e. colluvium). While not the 'pits' often targeted at Central African sites, the Idiofa archaeological deposits are interpreted as occupation debris generally found in discreet 10-20 cm lenses – captured particularly well in the 10 cm spits excavated at Okwon Tr. 11-18. The distribution of these thin Early Phase deposits likely represents shifting settlement patterns across the four centuries of occupation. This is most clearly shown in Iseme Tr. 29 (*cf. infra*), where there are two distinct Early Phase occupation deposits between 20-40 cm and again at 80-80 cm. Likewise, in Nkar Tr. 42-41 there is one occupation dated to the 1st century BC and a distinct second occupation in Tr. 47 dated to the 1st century AD – both of which contain similar Early Phase ceramic material.

The presence of the archaeologically sterile horizon is also significant, as it indicates there was no inter-horizon mixing or downward migration of archaeological materials from the Late Phase into the Early Phase deposits. This is particularly important at Nkar Tr. 40-47 and Okwon Tr. 10-15, where the earliest evidence for iron production and the co-occurrence of iron slag and lithics were found respectively. Likewise, the stratigraphic position of all of the dates collected suggests a limited vertical movement of materials. For example, at Nkar, where the three wood charcoal samples were taken from the 100-120 cm spit (Tr. 42), at 95 cm (Tr. 41), and the upper half of the 80-100 cm spit (Tr. 47), produced sequential dates in stratigraphic alignment. Further, below the A Horizon, the stratigraphy does not show any evidence for

bioturbation; no meaningful root systems and no evidence for termites or small animal burrows were encountered. Thus, although the archaeological deposits at Idiofa represent an open-air occupation, the apparent stratigraphic integrity affirms the association between the artifacts and radiometric dates as presented below.

Nkar

Figure 3. Photograph of backfilling Nkar Tr. 40-47 facing south. Hashing on the grid layout indicates non-excavated units.

Nkar is located to the northeast of Musanga, on the eastern slope of the massif. The vegetation lacks any fruit or palm trees, and is instead composed of savannah shrub species such as *ikɔs* (*Hymenocardia acida*) in Mbuun, short grasses, wild fruits (*ɪfʊŋ́, Anisophyllea quangensis*) and a scattering of cassava fields (Figure 3). Pedestrian survey located several small surface concentrations of pottery along the edge of a large depression leading to the valley below. Surface material was also found on the upland extensions of the massif which border the depression to the north, south, and west. Based on these finds, thirteen units were opened up across the Nkar area: eight around the eastern edge of the depression and another five on the northern and southern adjacent uplands.

Figure 4. Stratigraphy of Nkar Tr. 40-47 southern profiles and Tr. 43 northern profile Early Phase deposits (hashed polygons) and Late Phase deposits (grey polygons) and locations of soil samples (black squares), iron slag (x's) lithics (diamonds) and dated wood charcoal samples (red circles)

The two units were placed on the summit of the upland to the north (Tr. 38-39) and three to the south (Tr. 35-37) of the depression. These units, as well as further auger sounding across the upland areas, produced few archaeological materials in the upper 20 cm, suggesting an

ephemeral deposition during the later phase. On the edge of the depression, however, as auger testing yielded cultural material to a depth of ~92 cm, eight adjacent 1x2 m units (Tr. 40-47) were excavated to a depth of 140 cm. Here, in addition to a small amount of more recent material within the upper 25 cm, excavations recovered evidence for an early occupation between 80-120 cm (Figure 4). This includes an Early Phase deposit that stretched across Tr. 42 and Tr. 41 that yielded pottery, iron slag, and two dates: 146-18 cal. BC (2103 ± 25; RICH-27769) from 100-120 cm and 65 cal. BC – cal. AD 61 (RICH-27767) from 95 cm. In addition to cultural material, three soil samples were taken from these lower artefact-bearing levels, including one from Tr. 41 (90-100 cm), and two samples from the north wall of Tr. 47, one at 100-110 cm and the other at 110-120 cm.

Okwon

Figure 5. A-C: Schematic of Okwon excavation unit clusters; D: Photograph of Okwon Tr. 1-3 facing east

Okwon is located along the centre of the massif to the east of the modern village of Musanga and south of Nkar. The area is dominated by tall grass and agricultural fields with palm and mango trees interspersed. Pedestrian survey revealed numerous ceramic scatters over an area of ~200 m in diameter. To capture the spatial extent of the subsurface deposits, a series of 1x1 m units were excavated across the area on an east-west transect (Figure 5D). In three instances, these test units yielded substantial subsurface material below the 40-60 cm sterile horizon, for which additional conjoined units were then established (Figure 5A-C). Eighteen units were excavated at Okwon, all but one produced material.

Figure 6. Stratigraphy of Okwon Tr. 16-17 north-west profiles.

As with Nkar, the early horizons at Okwon produced early pottery, lithics and iron slag. In order to test any association between these artefacts, the artificial depth of the excavation spits was reduced to 10 cm for all units after Tr. 10 (i.e. Tr 11-18). This is significant, as it has also allowed for a more refined stratigraphic resolution for defining the relationship between the Early Phase deposits and the C^{14} dates. Interestingly, in addition to pottery, Okwon Tr. 11 (1977 ± 26 BP; RICH-27765) contained both lithic material and iron slag (Figure 6). The apparent stratigraphic integrity of the Idiofa sites implies that this represents a contemporaneous use of these technologies over the earliest periods of occupation. In addition to cultural material, soil samples were taken from the archaeologically sterile Tr. 7 in order to provide a background for archaeobotanical, palaeoecological and soil isotope analyses unaltered by anthropogenic deposits. The unit was excavated to 3 m and samples were taken from the western profile every 20 cm.

Isem

Figure 7. Stratigraphy of Isem Tr. 28, 29, and 21 eastern profiles

Isem is located in a vast, flat area on the same massif as Okwon, but at a slightly lower elevation. As with Okwon, the landscape was dominated by grass, but contained few trees (*olún*, *Milicia excelsa*) or bushes. The area is still periodically used to grow groundnuts and/or beans. Given the extent of the landscape, eleven individual excavation units (Tr. 19-29) were established along four 100 m-long axes oriented by the cardinal directions – two north-south and two east-west. These axes were laid out in a ‘step’ alignment, with the northern extent of the first (n-s) axis being the western extent of the second (e-w) axis, then the eastern extent of the second axis was the southern extent of the third (n-s) axis and the northern extent of the third axis was

the western extent of the fourth (e-w) axis. This alignment was designed to capture two cross-sections of the massif's natural stratigraphy while intersecting several visible surface pottery concentrations. The stratigraphy in all the trenches (Figure 7) is composed of a humus layer followed by a light grey or brown soil layer and finally a yellow sandy-clay layer. No trash-pits or other features were encountered during excavations. All trenches were excavated to 120 cm, and while the majority of material was concentrated between the surface and 40 cm, several units (Tr. 21, 22, 26, 28, 29) yielded pottery and lithics between 60-100 cm. Overall, though, Isem produced little material when compared to either Okwon or Nkar.

Ingung Kapia and Esal

Both Ingung Kapia and Esal were smaller-scale excavations than Okwon or Nkar, and each only produced the more recent material found in the upper horizons. The site of Esal was located immediately to the south of Musanga village. Here, five (1x1 m) units were excavated to 100 cm in depth. While the cultural material was concentrated in the upper 30 cm of each of these units, the dark sandy-loam horizon continued for the entirety of the section. As such, no earlier material was recovered from any of the excavation units here. In addition, Esal was the only example of more recent material being recovered in association with iron slag.

On the north-western edge of Idiofa, the site of Ingung Kapia is located along a vast massif extension near the modern village of the same name. Through a combination of pedestrian survey and auger testing, two locations with significant concentrations of surface ceramics were selected for the installation of four units (1x2 m). Units 1 and 2 were excavated to a depth of 1 m, and only produced a small amount of recent material between 0-60 cm. The conjoined units 3 and 4, however, yielded several objects, including human remains, fragments

of raffia fabric, circular glass beads of several colours, iron and copper objects (bracelet and chains), as well as several clay pipe bowls. As human remains were recovered, excavations were called off by local leaders and the team was only permitted to retain the pottery. Despite this, the excavations at Ingung Kapia and Esal reveal the vast spatial extent of the latter occupation of the Idiofa region. From Okwon, Esal is approximately 2 km west and Ingung Kapia more than 15 km to the north.

Ceramic Chronology

Post-fieldwork analysis of the cultural material was conducted in Kinshasa between March and April 2022. No complete vessels were recovered, and thus all of the ceramic results are based on fragmented pottery sherds. As this was the first modern archaeological project in the region, the main objectives included establishing an anchoring sequence of pottery form and style. Thus, the ceramic material was divided into 'mutually exclusive attribute groups,' including rim, decorated, special (e.g. lids), and non-diagnostic sherds (McIntosh and Guèye 2016: 123). All non-diagnostic sherds were counted, weighed, and set aside. For all rim, decorated, and special sherds, thickness, type and position of decoration, surface Munsell colour, and paste coarseness were recorded. The latter was recorded using the Udden-Wentworth granulometric scale (Druc 2015), whereby three main categories were defined: Fine (few to no inclusions), Medium (grain sizes between 0.5-2 mm), and coarse (grain sizes between 1.5-4 mm). An additional diameter measurement was also taken for all rim sherds. However, while all sherds were counted, measurements and décors from any series of sherds that were successfully refit were only counted once so as to avoid 'insofar as possible' the overrepresentation in any given measurement (McIntosh and Guèye 2016: 123)

From the analysis of 3289 excavated sherds, three distinct pottery traditions were identified. However, while both Early and Late Phase material was recovered in substantial quantities, the 'Middle Phase' is represented by a meagre three sherds from Esal Tr. 30 and Okwon Tr. 5 – with only one sherd being diagnostic (Figure 8i). Thus, a full and statistically meaningful analysis was impossible and the 'Middle Phase' remains more theoretical than concrete. Still, the material is decidedly distinct from either the preceding or following phases and comes from a horizon dated from two separate sites to between cal. AD 690-989. However, as a consequence of the limited 'Middle Phase' sample size, the results below will focus on the Early and Late Phases of the Idiofa pottery assemblage.

Early Phase Assemblage (146 cal. BC – cal. AD 226)

The Early Phase pottery assemblage at Idiofa was recovered exclusively from the yellowish loamy-sand and upper portions of the yellow sand horizons found generally below 60 cm. While this early material is a comparatively small portion (n=264) of the total assemblage, with 56 sherds per m^3, elements were recovered from a high proportion of units at Okwon, Nkar, and Isem. However, no early material was collected from units in either Ingung Kapia or Esal. While the pottery is distinct, it somewhat superficially resembles the slightly later Kay Ladio material (Figure 8j) found within the Kongo-Central province of the DRC and across the Congo River in the Republic of Congo (Clist *et al.* 2019a).

Surface colours largely range between light red (10R 7/8) to yellowish red (5YR 5/8), however several incidences of reddish brown (5YR 5/4) and grey (7.5YR 5/1) were also encountered. The paste is quite coarse and porous, with a low density of large (~5 mm) inclusions and voids (~3 mm) throughout the matrix. While the latter likely a result of organic temper, the inclusions appear to be a combination of undifferentiated stone and grog.

Surprisingly, then, the pottery is quite thin, with a mean wall thickness of 6.9 mm (SD = 1.60). The fabric of the pottery is uniformly consistent with the outer surfaces (i.e., Type 1 in Clist (2005)).

Figure 8. Representative Idiofa Early and Middle pottery assemblage and potential analogues: a-h examples of Early Phase Idiofa pottery; i Idiofa Middle Phase; j Kay Ladio Group pottery from Sakuzi; k potential cord-wrapped Idiofa Early Phase pottery.

Decorative treatments are few – present on only ~11% of the total assemblage, thus possibly reflecting a preference for décor on the upper body of the vessels, including the shoulder, neck, and rim. What décors there were, were dominated by thick (~2 mm) dragged-comb incisions with a 'U' shaped profile (Figure 8a-g). These incisions are relatively shallow and almost exclusively arranged in parallel and linear patterns of more than 8 rows – although no complete vessels were recovered to establish a maximum count. While it is possible that these are the result of a wide-toothed comb, several examples displayed an irregularity consistent with a single instrument being repeatedly dragged across the surface, and thus it is likely there was a combination of methods. In most instances, these groups of rows intersected with other groups at approximate 90° angles, producing a criss-crossed motif. Outside of this incision motif, only one example of a different décor was recovered from Okwon (Tr. 13). This sherd displays what appears to be a series of roulette impressions, which produced linear bands of depressions reminiscent of cord-wrapped roulette impressions (Figure 8k).

As with décor, vessel forms were also relatively homogeneous – exclusively restricted with either a 'simple' closed or slightly everted rim. Vessels were also quite small, with diameters ranging between 6-10.5 cm (mean of 8.38 cm), placing them in the 'pot' category of Clist *et al.*(2019b). In addition, these vessels were flat-bottomed, as evidenced by three base

sherds recovered from both Okwon (Tr 5 and 11) and Nkar (Tr 41). This is in line with Wotzka's (1995) initial observation that, contrary to later periods, flat-based vessels are 'omnipresent' throughout the Inner Congo Basin throughout the EIA.

Late Phase Assemblage (cal. AD 1487-1648)

Late Phase Idiofa material was recovered from within the dark sandy loam horizon generally positioned in the upper 40 or 60 cm of most excavation units. It has been identified from nearly all units at Okwon, Nkar, Isem, Esal, and Ingung Kapia (exceptions include: Okwon Tr3 and 6; Nkar Tr 41, 42, and 45). In addition to this near-ubiquity, Late Phase material was found in large quantities (n=3025), with ~201 sherds per m^3, making up nearly 90% of the total pottery recovered during excavations. The breadth and quantity of the late phase cultural deposits suggests a significantly larger occupation when compared to the previous phase (i.e. 201 vs. 56 sherds per m^3).

Surface colours were generally dark grey (5YR 4/1) with a sizable minority of light red (2.5YR 6/8) and yellow (10YR 7/6). The thickness of Late Phase material ranged between 2.7-10 mm; however, the average was only slightly thinner than the previous phase at 5.4 mm (SD = 1.94). The paste was generally classified as fine, with few to no inclusions. Likely highly fired, many of the sherds produce the 'high-pitched clinking' when tapped together (MacDonald, 2011: 64). The majority of Late Phase sherds contained a darker core (Clist (2005): Types 2 and 3).

Figure 9. Representative Idiofa Late Assemblage Pottery: a geometric pin incision; b paintbrush on interior of lip; c geometric pin incision with poinçonnage; d appliqué ledge with poinçonnage; e paintbrush; f cordons with poinçonnage on bottle; g lid; h geometric pin incision with poinçonnage.

Nearly all vessels from which a form was successfully reconstructed were carinated with everted rims (Figure 9). Two round bases were recovered from Ingung Kapia (Tr. 3 and 4) and remain the only evidence we have for the base shape of late phase vessels. However, if taken as representative, these bases (as with the flat-bases of the previous phase) fit well within the general transition from flat to round seen across the Congo Basin (Wotzka 1995). The average diameter of 12.1 cm – still falls within the 'pot' category as defined by Clist *et al.* (2019b). Although few (4%), a second class of everted-rim vessel were defined as bottles based on elongated restricted necks (Figure 9f). The pervasiveness of everted rims may also account for the high number of lid fragments recovered. These lids, ~16 cm in diameter, were concave disks with a central handle of two types; either a single protrusion or a protrusion pinched to create two finger holes on either side (Figure 9g).

While decorated sherds only make up 9% of the assemblage, the diversity of décors is substantially greater than in the previous phase. Three major categories of plastic décor, including poinçonnage (Figure 9h), 'pin' incision (linear and geometric) (Figure 9a,c,d,h), and what we termed 'paintbrush' (Figure 9b,e) were common in the Late Phase assemblage. However, their use was found in various combinations and positions. Pin incisions appeared on ~40% of the decorated sherds, making it the most common décor. These are defined as thin and deep incisions, in rows of 3-11, with an irregularity consistent with a single "pin or thorn sized tool" being used for each incision (McIntosh and Guèye 2016: 166). They appear in various positions and patterns, including linear bands on the neck, shoulder and/or lip, triangular geometric patterns on the shoulders, crosshatching on the concave side of lids, and less commonly on the interior of an everted rim.

The décor next in popularity (31% of all decorated sherds) was ‘paintbrush’ – likely the most distinctive identified. This décor was defined as the shallow imprint of a bundle of fibres - perhaps similar to a stiff-bristle paintbrush – which is dragged across the surface of the vessel in triangular and linear patterns, as well as wavy lines and zig-zags. It can be found on any part of the vessel anatomy except for the base and lip – particularly the interior of the everted rims (Figure 9b). The poinçonnage (12% of all decorated sherds) was really formed by two distinct tools; one thicker and rounded and one thinner and sharp. The thicker examples are arranged in linear bands across the carination, through the top of the appliqué ledge (Figure 9d), or around the lip on the concave side of lids. The thinner ‘tics’ were created with the point of a sharp tool and are often found in geometric groups in combination with pin incisions or along the top of the lip. In smaller quantities there were also cordons (applied in bands around the neck of the vessel), appliqué ledges (applied to the carination), fingernail impressions (found below the ledge or carination), and perpendicular impressions with a straight edged instrument along the carination. Despite the variety of decorative treatments, the Late Phase assemblage was relatively homogenous and cohered to a generally uniform style.

Iron Metallurgy

Although excavations did not yield any iron artefacts, as previously mentioned small amounts of iron slag were recovered from a number of contexts at Idiofa (Table 2). Interestingly, the Late Phase contexts yielded extremely little evidence of iron production or use. Instead, the Early Phase horizons from multiple units at both Nkar and Okwon provided nearly all of the ferrous material and one tuyère fragment (Okwon Tr. 18 70-80 cm). The earliest context containing slag, located at Nkar Tr. 42 (100-120 cm), is dated between 146-18 cal. BC (2103 ± 25; RICH-27769). This now represents the earliest evidence of iron production south of

the Congo rainforest; nearly 200 years prior to the Kay Ladio tradition sites (ca. 30-475 AD) of Bu, Kindu and Mantsetsi, etc. found further to the west (Clist *et al.* 2019a).

Table 2. Iron slag recovered by unit. Depths are below surface.

It is important to note that no slag was recovered from the sediments above the Early Phase horizons – including the archaeologically sterile (40-60 cm) or Late Phase (0-40 cm) horizons – at either Nkar or Okwon. Furthermore, the oldest dated context at Nkar Tr. 42 (2103 ± 35 BP; RICH-27769) lacks any Late or Middle Phase material in the upper layers, significantly minimizing the likelihood of mixed contexts or the downward migration of slag from later periods. A second date (2052 ± 26 BP; RICH-27767) from the upper portion of this context is in broad agreement with this early date, providing a high-level of confidence that the late 2nd and early 1st century BC context from which the dates and slag were recovered were secure. As iron use is obviously known to have existed in the region during the 15th century AD, the general absence of slag in the more recent strata likely reflects a difference in site organization, whereby smelting occurred in different locations – possibly outside of the habitation zone. Only at the eastern site of Esal was slag recovered in association with Late Phase pottery, perhaps suggesting the centres of iron production during this period were located to the southwest of the areas investigated during this project.

Lithics

Few stone tools were also recovered from the earlier horizons, and thus only from Okwon, Nkar and Isem. Table 3 presents the technological inventory of these artefacts. The methodology for recording the techno-typological patterns of the artefacts (e.g. dorsal surface removals patterns, butt typology and measurements) followed Inizan *et al.* (1995). All the sites,

despite the small size of the assemblage, maintain a homogeneous technology based on the exploitation of small blocks of local polymorphous sandstone (Petit 1990), a dominant rock in the regional Stone Age record. Except for a few pieces which could not be interpreted, all the artefacts echo one single reduction strategy indicating this homogeneity between the sites and the techno-cultural integrity of the deposits. In addition to the technological homogeneity, the artefacts present fresh ridges and edges and metrical profiles are quite similar among the three assemblages with small-size flakes – but not qualifying as microlithic (Table 4; Figure 10). The production does not present clear typical characteristics of the Later Stone Age technology (e.g. bipolar microlithic flaking, small-shaped tools, polished tools). Indeed, it is rather a 'side production' characterized by small size assemblages marked by a middle-size flake production turned toward obtention of parallel-sided short to elongated flakes thanks to uni- or bidirectional short reduction sequences and the use of bipolar technique (Figure 10). No retouched pieces nor macro-use wears could be observed except for one small flake fragment from Isem, and two pieces from Okwon (Figure 10-A,D,G). These three pieces present a similar type of macro-usewear located on a thin and rectilinear cutting edge of rectangular-shape flakes. Further investigation could help to reveal whether these artefacts could have been used for similar types of activities. Besides the small size of the assemblage, the absence of debris and all *chaîne opératoire* elements seem to suggest off-site production.

Table 3: Techno-typological inventory of the lithic artefacts from Isem, Nkar and Okwon

Table 4: Minimum, mean and maximal values of length, width, thickness of flakes from Isem, Nkar and Okwon, based on technological orientation, in millimetres.

Excavations at Okwon produced 19 lithic remains. Only one core has been recovered from within the 60-80 cm spit. The blank is a small block of polymorphous sandstone. This core displays the pattern of three blade-like removals (L = 2x width). These removals have been produced by unidirectional flaking on an elongated and convex flaking surface thanks to a flat striking platform. This striking surface has been obtained as a result of one extended removal. However, no equivalent blade-like flakes are present in the overall assemblages despite the similar raw material. Rather, flakes from Okwon display attributes of unidirectional flaking from short flaking surfaces and five flakes from the 80-100 cm spit present scars of bipolar flaking with opposite bulbs and an impact point along the flaking axis on the ventral surface (Soriano *et al.* 2010). One atypical *pièce esquillée* (Brun-Ricalens 2006: 97) made of chert with crush wears on both the distal and proximal parts was also identified in Okwon Tr. 16 80-100 cm. In the 80-100 cm spit of Okwon Tr.16, one core-fragment also in polymorphous sandstone has been recovered along with a thick flake showing peripheral unidirectional short removals ("square-shape" flakes) obtained by using the ventral surface of the flake blank as a striking platform.

Figure 10: Artefacts Isem Tr. 21 80-100 cm (A,B,C), from Okwon Tr. 16 80-100 cm (D, E, G) and Nkar Tr. 43 80-100 cm (F). A, D and G are small flakes displaying distal or proximal bifacial macro-usewear. B and C are blade- and bladelet-like flakes. F and E are flakes associated with bipolar knapping.

At Isem, only six polymorphous sandstone flakes were recovered from the 80-100 cm in Tr. 21. These artefacts display consistent technical features including unidirectional elongated removals on their dorsal surface (except for one unreadable flake fragment). These dorsal patterns are associated with plain butts (n=2) or linear butt (n=2) and some butts are absent (n=2). One flake fragment presents a distal bifacially crushed cutting edge suggesting a potential

use. Finally, at Nkar, only two artefacts of polymorphous sandstone have been recorded in the Tr.43 80-100 cm spit. Both feature similar technological patterns as Isem flakes and have been obtained via a bipolar technique.

Palaeoecology

With a view to provide palaeoenvironmental context to the prelude to and duration of human occupation in the Idiofa region, soil samples taken from Okwon and Nkar were processed for $\delta^{13}C$ of soil organic carbon (SOC) and phytolith analysis (Table 5). The ratios of woody (C_3) and grassy (C_4) vegetation from soil organic matter, in combination with the proportions of grass, tree and palm phytoliths, provide complimentary methods of evaluating changing hyperlocal environmental conditions. Only a very limited amount of fragmentary charred macrobotanical evidence has thus far been recovered from Idiofa (a nut or fruit endocarp fragment from Nkar, and a few as-yet unidentified grass rachilla from Okwon). Therefore, the combination of isotopic and phytolith evidence provides a crucial dataset that may shed light on changing past environmental conditions in the study area.

Table 5: Soil samples from Okwon and Nkar analysed for phytoliths and $\delta^{13}C$ of SOC

Carbon Isotopes

Between 1 and 5g of dried soil samples from Nkar (n=3) and Okwon (n=15) were analysed for $\delta^{13}C$ of SOC. The isotope analyses were performed using the elemental analyser EA-IsoLink coupled to a DELTA Q IRMS (Isotope Ratio Mass Spectrometer) via a ConFLo IV interface at the Isotope Bioscience Laboratory (ISOFYS; Ghent University). Reference materials of millet flour (USGS-90) and rice flour (USGS-91) (-13.75 ± 0.06 ‰ and -28.28 ± 0.08 ‰ v.s.

V-PDB, respectively) were used to normalise to the V-PDB scale. A quality assurance soil sample (-22.69 ± 0.04 ‰ v.s. V-PDB) was introduced every 10 samples; deviation from accepted values were always smaller than 0.3 ‰. Reproducibility was 0.4 ‰ and combined uncertainty on the V-PDB scale was 0.5 ‰.

The relative proportion of soil organic carbon derived from grasses versus trees, or the grass fraction (fg), was computed, where $fg = (\delta^{13}C_S - \delta^{13}C_f)/ (\delta^{13}C_g - \delta^{13}C_f)$ (Table 5). The endmembers for continuous woody and grass cover, C_f and C_g respectively, were taken from published topsoil values from modern savanna grassland and forest clumps on the Bateke Plateau (Ifo, 2017).

Figure 11: Variation in SOC $\delta^{13}C$ isotopic composition with soil depth at Okwon (blue circles) and Nkar (orange diamonds). The Early and Late phases of human occupation at Okwon are indicated by the dashed boxes.

The $\delta^{13}C$ data clearly show a general trend of decreased forest vegetation over time at Okwon, with notable contributions of C_4 vegetation not visible in the isotopic record until above 200 cm (Figure 11). All $\delta^{13}C$ values below 200 cm remain in the range of -24.1‰ to -23‰, suggestive of consistent dense forest before this time. Following the vegetation categories of White (1983), where trees make up >80% in forests, 40-80% in woodlands, and 10-40% in wooded grasslands, we find that the computed forest fractions indicate a transition of forest to woodland from 200 to 100 cm depth. By the time of Early Phase occupation at Okwon, the isotopic signature hints at a greater grass component in the area, although significant C_3 vegetation remained (37.2-48.1.8% forest fraction). Okwon and Nkar (44.2-56.6% forest fraction) show similar woodland vegetation contributions during the Early Phase. The greatest degree of $\delta^{13}C$ enrichment is seen at 20-40 cm, during the Late Phase occupation at Okwon

(73.6% grass fraction, reminiscent of a wooded grassland). The apparent deviation towards more negative $\delta^{13}C$ values in the top-most layer is likely an artefact related to isotopic fractionation that enriches the SOC with $\delta^{13}C$ with soil depth (Balesdent and Mariotti 1996).

Phytoliths

Phytoliths were analysed from two samples at Nkar and eight samples from Okwon, including a continuous profile between 20 and 140 cm. The recovery protocol incorporated that of Piperno (2006). Organic material was removed from 15 g of dried sediment using H_20_2, followed by removal of carbonates using 10% HCl, then deflocculation with sodium diphosphate. Phytoliths were extracted via heavy liquid separation using sodium polytungstate. The resulting phytolith material was mounted on slides in Entellan New. At least 200 phytoliths were counted, where possible, and classified following (Neumann *et al.* 2019). For the purposes of this study, phytoliths were classified into the broad groups of trees (woody dicots, mainly represented by spheroid ornate morphotypes), grasses (*Poaceae*, represented by grass silica short cell morphotypes), palms (*Arecaceae*, represented by spheroid echinate morphotypes), and 'other'. Although not identified in detail at this time, the latter category included various morphotypes diagnostic of river weeds (*Podostemaceae*), sedges (*Cyperaceae*), squashes/gourds (*Cucurbitaceae*), the parenchyma of roots or tubers, an assorted 'herbaceous' component including representatives of the arrowroot family (*Marantaceae*), and non-diagnostic forms.

Figure 12: Ternary plot showing the relative proportions of palm, tree and grass phytoliths from Okwon (OK) and Nkar (NK) soil samples. The modern biome spaces were produced from published modern surface phytolith counts (Yost, 2021: SOM Table S2). Figure created with TernaryPlot.com

The relative abundances of palm, tree, and grass phytoliths were calculated following Yost *et al.* (2021), as a means to evaluate the ecological space each site and level occupied (Figure 12), and temporal trends in relative phytolith proportions at Okwon are presented in Figure 13. The phytolith data broadly echoes the forest signatures indicated by carbon isotopes at Nkar and Okwon but allow a more detailed look at the environmental composition. Tree phytoliths are continuously significant contributors to the assemblages, ranging in abundance between 35 and 75% of the total. Only in the lowest level at Okwon are tree phytoliths outnumbered by Marantaceae (arrow-root) phytoliths. Members of the Marantaceae are a common herbaceous understory component of closed-canopy forests in DRC today (Mercader *et al*., 2000). During Early Phase occupation, tree phytoliths make similar contributions at both sites, but palm trees are the more significant contributor of non-tree vegetation at Nkar, whereas grasses and herbaceous taxa make up a lot of that remaining proportion at Okwon. Palm phytoliths are represented by around 12-22% of the total phytolith counts at Nkar, compared to 0-5% at Okwon. This plots Okwon in a forest setting with drier and more open woodland conditions at 80-100 cm, and Nkar in a more semi-evergreen type forest with palm stands, such as might be seen in a riverine setting. The number of palm tree phytoliths at Okwon only show a significant increase above 40 cm, during Late Phase occupation, rising to ~35% of the total vegetation profile. It is unsurprising that throughout the soil column, palm, grass and sedge phytoliths are a rare component in the vegetative profiles, as all are shade intolerant and are usually absent from African forest understories (Pan *et al.* 2006; Bremond *et al.* 2017; Lombard 2022).

Figure 13: Phytolith spectrum diagram showing relative abundance of vegetation types throughout the soil column at Okwon, expressed as a percentage of all diagnostic phytoliths. Figure created using Tilia 3.0.1.

Scalloped spheres diagnostic of *Cucurbitaceae* and blocky and multiple-lobed parenchyma types originating from a root/tuber are found in the lowest samples analysed for phytoliths at Okwon. Sedges (*Cyperaceae*, represented by polyhedral phytoliths) have a small but consistent presence throughout the soil column, as do aquatic river weeds (*Podostemaceae*, represented by perforate or short irregular protrusion morphotypes), although these show an increase in abundance within the strata of the occupation hiatus between 40 and 60 cm. Finally, the herbaceous component consists of a variety of phytolith types including platelet, druse and seed-body types of flowering monocots, including those in the particularly well represented arrowroot (*Marantaceae*) family.

Discussion

The results of the BantuFirst archaeological and palaeoenvironmental analysis have significant implications for the history of both the Idiofa region specifically and Central Africa more broadly. For instance, the extent of past tree cover in the Congo Basin is of significant import to the discussion surrounding how and when early Bantu speakers passed through the equatorial forest block. In particular, evaluating the timing of shifts in the vegetative composition of the region may help shed light on whether the Bantu Expansion was facilitated by climate-induced vegetation change (Schwartz 1992; Bostoen *et al.* 2015), or forest reduction was a response to human occupation and cultivation practices (Bayon *et al.* 2012; Garcin *et al.* 2018b). Both environmental proxies from Idiofa indicate a continued degree of tree cover throughout the soil column, but a gradual $\delta^{13}C$ shift towards more open conditions that begins prior to human occupation. This decrease in tree cover is in line with previous studies that indicate an aridification trend that saw the replacement of humid forest species with pioneer and savanna

species in the late Holocene (Vincens *et al.* 1999; de Menocal *et al.* 2000; Neumann *et al.* 2012a). General and widespread forest destruction in Central Africa ~3000-2000 years ago has previously been suggested based on pollen records (Maley 2002), but more localized records such as the Idiofa dataset are of great importance if we are to extrapolate such changing conditions to human activities. Based on the current dataset, it is a likely scenario that the first pottery and iron-producing communities in the Okwon and Nkar forests took advantage of a somewhat decreased density of trees, but did not require open grassland environments to settle in these areas. The variation in forest-types represented at Nkar and Okwon over time may instead allude to the development of more mosaic environments of mature and pioneer forests in response to increasing seasonality (Neumann *et al.* 2012a; Hubau *et al.* 2015; Bremond *et al.* 2017) – future classification of the tree phytoliths from these sites may aid in clarification. Likewise, our data do not support the absence of forest in this region nor an intense erosional period, or 'Stone-Line event,' prior to 2000 BP (Runge 2001; Thiéblemont *et al.* 2013).

Thus, the environmental context of both the Early and Late Phase occupations at Idiofa was one of progressive forest contraction – beginning prior to the first settlers' arrival by the 1st century BC. Notwithstanding the ephemeral Middle Phase material collected from Okwon and Esal, both the stratigraphic interruption in cultural deposition and the acute differences between the pottery traditions suggest a hiatus in any substantial occupation of the region between the 3rd and 15th centuries AD. At Idiofa, at least, it appears that this hiatus was not climate induced. This pattern potentially fits with a trend seen across the Congo rainforest (Oslisly *et al.* 2013; de Saulieu *et al.* 2021; Seidensticker *et al.* 2021), whereby a population 'collapse' or restructuring may have led to fewer people or possibly the movement of people into new localities. In addition, based on the marked differences in vessel forms, size, recipe, and decorative

treatments, the two occupation phases at Idiofa clearly represent distinct populations rather than any continuation.

Early Phase

Perhaps the most striking aspect of the Early Phase occupation is the presence of iron technology from within the earliest dated levels (146–18 cal. BC). At present, this represents the earliest evidence for iron production south of the rainforest – nearly 200 years before the communities producing the Kay Ladio tradition pottery (ca. 30–475 AD) further to the west (Clist *et al.* 2019a). This is in stark contrast to the broadly contemporary non-iron using communities associated with the Imbonga (ca. 400–100 BC), Inganda (ca. 200 BC – AD 100), and Monkoto (100 BC – 200 AD) pottery traditions to the north (Wotzka 1995; Seidensticker *et al.* 2021). Indeed, the earliest evidence for iron production from within the Inner Congo Basin comes during the Bondongo Phase (1000–1400 AD) (Wotzka 1995: 288). The presence of iron production at Idiofa in the 2nd century BC is doubly interesting, as it is associated with both lithic and pottery technologies. While much of the lithic material was recovered from immediately below the Early Phase ceramics (i.e. Okwon Tr. 16), both lithics and ceramics were found in association at Nkar Tr. 43 and Okwon Tr. 11, with iron slag also found at the latter site. The homogeneity of the lithic assemblage suggests the continued use of this technology across the earliest periods of occupation. This, then, may represent the gradual adoption of – or increase in – iron smelting at the expense of lithic technology in the region towards the end of the 1st century BC.

Figure 14 Regional map including locations of KLC (de Schryver et al. 2015) and Mbuun (Vansina 1966: 131) languages and Kay Ladio (Clist *et al.* 2019a) and Idiofa sites.

Interestingly, for Idiofa, the closest iron producing communities in time are also producing the closest analogues to the Early Phase pottery – the so-called Kay Ladio pottery tradition (Figure 14). While Kay Ladio is found more than 600 km to the west of Idiofa in the present-day Kongo-Central Province of the DRC and the adjacent region of the Congo Republic, several elements – both decorative and morphological – link these two traditions (Clist 1982; Clist *et al.* 2019a). Both traditions are defined by a limited set of closed (everted) vessels made of coarse paste with high numbers of large, irregular inclusions and voids. Decorative treatments for both Kay Ladio and Early Phase Idiofa are also dominated by thick horizontal, vertical, and oblique dragged-comb incisions. For Kay Ladio, Clist (1982: 89) describes "*unités triangulaires dont le remplissage comprenait des traits obliques. Le sens du remplissage de ces unités s'oppose de l'une a l'autre et d'un bandeau à l'autre*" ("triangular units with oblique lines in the filling. The direction of the filling of these units is opposite from one to the other and from one band to the other"). Such decorative treatments are likewise found on numerous examples at Idiofa (Figure 8a,b,d,e).

These findings, along with additional forthcoming results from the BantuFirst research project, hint at the presence of a larger iron-using population to the east than is currently appreciated – and perhaps along the southern savannah region – during the 1st millennium BC. It is likewise tempting to hypothesize, based on possible connection with the later Kay Ladio material, an east-west movement of iron technology or iron-using peoples from the Lower Kasai region into the Lower Congo region around the turn of our era. However, any assumption of migration would require substantially more evidence beyond superficial similarities in pottery décor. Still, the presence of earlier iron production associated with pottery that shares some attributes with Kay Ladio does raise the possibility. Indeed, this scenario fits with the hypothesis

of a 'northeast to southwest movement of peoples' previously proposed by Clist *et al.* (2019a: 19) based on the current inability to link Kay Ladio with earlier northern or northwestern traditions. Only further research, however, within the Kwilu and Kwango provinces and the regions between the more heavily researched Kongo-Central province will shed the much-needed light on these processes.

Late Phase

Today, the region of Idiofa still maintains a substantial pottery production industry. At the village of Ingung Ateng, local informants explained that pottery produced locally is traded as far south as Gungu and as far north as Mangai, on the Kasai River. Interestingly, the 2021 BantuFirst survey along the Kasai and Kamtsha Rivers (Coutros *et al.* 2022) recovered Late Phase Idiofa material in varying quantities from sites including Intshwem Mukongo, Ivang, Ikulu, and Eolo – locations more than 100 km away (Figure 15). Several examples appear to be more accurately defined as Idiofa-inspired, as they maintain Idiofa motifs – particularly the wavy 'paintbrush' incisions on the interior of the lip – but are executed on vessels made with radically different recipes than those found anywhere at Idiofa. Further, there are some examples where the wavy 'paintbrush' designs were made by a very different utensil (Figure 15a-d). Likewise, to the south near Gungu, the BantuFirst team recovered additional evidence for connections with Idiofa during recently revived excavations at the 15th – 17th century site of Mashita Mbanza (Coutros *et al.* 2023). While the full analysis of this material is ongoing, several sherds with Late Idiofa-type decorative motifs have been recovered – particularly the distinctive triangular 'pin' incisions combined with poinçonnage (Figure 15e).

Figure 15. Regional distribution of Late Phase Idiofa Material. a) Eolo, b) Ivang, c) Ikulu, d) Intshwem Mukongo, and e) Mashita Mbanza.

While the location of Idiofa near the headwaters of the Kamtsha River makes it a natural trade route with the communities residing along its banks, it is interesting that no later 'Idiofa ware' has been recovered from closer – and contemporary – sites along the Kwilu River (e.g. near Kikwit). While the Late Phase Idiofa material does share some vague similarities with material collected from the contemporary sites within the Kikundi region (e.g. triangular incisions and everted vessels with poinçonnage or incised carination), the latter possesses a decidedly distinctive style and lacks the 'paintbrush' décor and any décor on the interior of the lip. Along the Kasai, Idiofa material was only recovered from sites at the Kamtsha-Kasai confluence and upriver and only along the left bank. The wide distribution of the distinctive Late Idiofa attributes throughout the 15th – 17th centuries AD suggest that the time depth of these connections is considerable. Of course, one must also contend with the possibility that Idiofa is not the centre of this trade network, but rather the most well studied site within it. Additional research within the region is essential to better define the modes of production and distribution. However, its position at the geographic centre of the distribution zone – between Mashita Mbanza and the Kasai River, as defined by the BantuFirst surveys (Coutros *et al.* 2002, 2023) – and the ethnographic accounts of pottery production and exportation within the same space, provide evidence for the Idiofa region acting as a potential exporter of pottery – and possibly ideas or other goods – from at least the end of the 15th century AD.

Conclusion

Our archaeological investigations of the previously unexplored Idiofa region in the Kwilu

Province of the DRC has provided evidence for the oldest iron production so far known south of the Congo rainforest (146-18 cal. BC). It is associated with both lithics and ceramics and about two centuries older than the earliest documented iron production from the Lower Congo region some 600 km to the west, itself linked with Kay Ladio pottery (30 and 475 AD). Palaeoenvironmental data from the Okwon and Nkar sites near Idiofa show that climate induced forest contraction started well before those pottery- and iron-producing people colonized the region, even if it did not result in the total disappearance of forest. The newcomers certainly did not settle in open grassland environments but probably benefited from diminished forest density to immigrate. After their arrival, forest recession went on until modern times.

The ceramic production of the EIA around Idiofa is characterized by a small assortment of closed-rim vessels made with a coarse paste and decorated with thick horizontal, vertical, and oblique dragged-comb incisions. Stylistically, the Early Phase pottery from around Idiofa (146 BC – 226 AD) is, at present, most closely related to Kay Ladio pottery (30 and 475 AD) from the Lower Congo region, also associated with the earliest iron production there. This correspondence in pottery and iron production and the two-century time difference is by no means compelling evidence for an east-to-west migration of pottery and iron-producing communities, but it is certainly a historical scenario that merits further archaeological investigation, particularly by multiplying excavations in intermediate regions. This is even more so, because historical-linguistics evidence situates Idiofa at the extreme eastern end of an ancient east-to-west expansion of Bantu languages, i.e., the major branch of West-Coastal Bantu that gave rise to the Lower Congo region's Kikongo Language Cluster (Figure 14). New research should test whether the EIA record of the Idiofa and Lower Congo regions might indeed reflect the archaeological backdrop of an

early expansion of West-Coastal Bantu speakers from their homeland region in the interior between the Kasai and Kamtsha Rivers towards the Atlantic coast.

In any event, the early occupation phase around Idiofa ends in the 3rd century AD and is followed by a long stratigraphic interruption in cultural deposition that lasts until the 15th century AD, despite some short-lived 'middle phase' evidence collected from Okwon and Esal. Our palaeoclimatic data suggest that this hiatus was not conditioned by climate change. The Late Phase pottery (1487-1648 AD) that emerges afterwards is markedly distinct from the EIA pottery in vessel forms, size, recipe, and decorative treatments. Thanks to other archaeological surveys of our team in the Kwilu Province, we know that the paintbrush design typical of those LIA Idiofa ceramics is spread throughout the wider region, i.e., from the Kasai River in the north to Mashita Mbanza in the south but often executed with different tools and on vessels made with different recipes. It is absent though further west along both the Kasai and Kwilu Rivers where our team has also conducted surveys. It is also very distinct from 15-17th centuries AD pottery that circulated in the Kongo Kingdom in the Lower Congo region (Clist *et al.* 2018b). Hence, this LIA pottery from Idiofa seems to be indicative of a long-distance network of trade and possibly other types of exchange throughout the Kamtsha-Kasai River network ranging from Mashita Mbanza in the south to Eolo in the north. Interestingly, the Mbuun language currently spoken around Idiofa shows the deepest genealogical connections with the Kikongo Language Cluster, just like EIA pottery from Idiofa is most similar to EIA Kay Ladio pottery from the Lower Congo region (*cf. supra*). At the same time, as the result of more recent language contact, Mbuun language shares several salient sound changes with languages from the Kwilu-Kamtsha-Kasai River network spoken in its immediate vicinity but belonging to different deep branches within West-Coastal Bantu (e.g. Koni Muluwa and Bostoen 2012; Bostoen and Koni Muluwa

2014; Pacchiarotti and Bostoen 2021). The contact-induced spread of those phonological oddities may be the linguistic reflection of the 15-17th centuries AD exchange network manifested in the archaeological record of Idiofa and the broader Kamtsha-Kasai River network. More research is needed to better understand the cultural, social, political and/or economic processes driving these regional communication chains.

Acknowledgements

The authors would like to thank Prof. Placide Mumbembele Sanger, the then General Director of the Institut des Musées nationaux du Congo (IMNC) and his successor Mr. Jean-Pierre Bokole Ompoka as well as the IMNC staff for all their support. We will also extend a special thank you to Isidore Nkanu, our *chef de fouilles*, and Prof. Léon Mundeke (UNIKIN), who participated in the 2019 BantuFirst fieldwork mission in Idiofa. Thank you also to Chad Yost and Samuel Bodé. The project would not be possible without the assistance of our full team and local collaborators. The 2019 mission was carried out under the Arrêté ministériel n°091/CAB/MIN/CA/PKB/2018. This work was supported by the European Research Council under Consolidator's Grant n° 724275.

Biographical Notes

Peter R. Coutros: (ORCID: 0000-0002-4861-6432) is a postdoctoral researcher at Ghent University with the BantuFirst project since early 2021. He received his PhD in anthropology from Yale University (2017) where he directed the DARE project, focused on the reconstruction of the Late Stone Age/Early Iron Age socio-ecological landscape of the Diallowali site system in northern Senegal. His research interests include ceramic seriation, social and technological change, and the social impacts of climate change. In addition to the DRC and Senegal, he has conducted archaeological and palaeoenvironmental research in Mali, Mauritania, Kenya, Madagascar, Peru, Guatemala, and Mongolia.

Igor Matonda Sakala: (ORCID: 0000-0002-9428-7705) holds a joint PhD in African Languages and Cultures from Ghent University (2017) and History, Art History and Archaeology from Brussels University (2017), which he obtained as part of the KongoKing project. His dissertation focused on the the Inkisi Valley in the Era of the Kongo Kingdom and relied on historical, archaeological and linguistic data. Since 2018, he has been an Associate Professor at the University of Kinshasa (UNIKIN) in the

Department of Historical Sciences. His teaching and research focus on African precolonial and colonial history, the early and more recent settlement and population history of the Congo, demographic history, historical archaeology, and ceramic traditions.

Jessamy H. Doman: (ORCID: 0000-0002-5040-3348) is a BantuFirst postdoctoral researcher focused on reconstructing palaeoenvironments. Her PhD from Yale University (2017) was the result of several expeditions as the lead director of the Baringo Palaeontological Research Project (BPRP) in Kenya, resulting in a new understanding of the environmental backdrop to Miocene-Pliocene faunal and human evolution in Africa and the development of novel methods in palaeoecological reconstruction. Other past research projects include extinction and replacement across the Cretaceous-Paleogene boundary; social and environmental transitions in Holocene West Africa; the use of natural history collections in the study of climate change patterns; and the application of isotope sampling as a means to identify and repatriate unaccounted-for US service members from the Korean War.

Sara Pacchiarotti: (ORCID: 0000-0003-1360-5060) is an FWO-funded post-doctoral researcher focused on morphosyntactic change in West-Coastal Bantu. She obtained her PhD in Linguistics from the University of Oregon (2017) where her dissertation focused on the different functions of Bantu applicative constructions involving *-ɪd, with special emphasis on "misbehaving" applicative forms in Tswana. Beyond Bantu, Sara has worked on Bribri (Chibchan, Costa Rica) and Mooré (Gur, Burkina Faso). She is currently also involved in a cooperation project between the Senegal-Oregon Center at the University of Oregon and the Centre de Linguistique Appliqué de Dakar (CLAD, Université Cheikh Anta Diop) to document some Jóola varieties. She is particularly interested in historical linguistics, (diachronic) syntax and language change.

Isis Mesfin: (ORCID: 0000-0003-1322-6925) is an archaeologist and postdoctoral researcger with the Fondation Fyssen at the Museu Nacional de Arqueologia de benguela in Angola. She completed her PhD (2021) at the Muséum national d'Histoire naturelle in Paris on the early hominins' dispersal along the Southern African Atlantic coast during the Early and Middle Pleistocene. Her research focuses on techno-cultural dynamics and evolution in central Africa and the origin and adaptation of early hominins in the coastal landscapes of Africa.

Koen Bostoen: (ORCID: 0000-0003-2284-6165) has been professor of African Linguistics and Swahili at Ghent University since 2011. His research focuses on the study of Bantu languages and interdisciplinary approaches to the African past. He obtained an ERC Starting Grant for the KongoKing project (2012-2016) and an ERC Consolidator's Grant for the BantuFirst project (2018-2023). He is author of, among others, *Des mots et des pots en bantou: une approche linguistique de l'histoire de la céramique en Afrique* (2005, Peter Lang) and co-editor of *The Kongo Kingdom: Origins, Dynamics and Cosmopolitan Culture of an African Polity* (2018, Cambridge University Press), *Une archéologie des provinces septentrionales du royaume Kongo* (2018, Archaeopress), *The Bantu Languages*, 2nd edition (2019, Taylor and Francis), and *On reconstructing Proto-Bantu grammar* (2022, Language Science Press).

Declaration of interest statement

The authors report there are no competing interests to declare.

References

Ard, V. and Darvill, T. 2015. "Revisiting of friends: the production, distribution and use of Peterborough Ware in Britain." *Oxford Journal of Archaeology* 34: 1-31.

Balesdent, J. and Mariotti, A. 1996. "Measurement of soil organic matter turnover using 13C natural abundance," in *Mass Spectromerty of soils,* edited by T.W. Boutton and S.I. Yamasaki: 83-111. New York: Marcel Dekker Inc.

Bayon, G., Dennielou, B., Etoubleau, J., Ponzevera, E., Toucanne, S. and Bermell, S. 2012. "Intensifying weathering and land use in Iron Age Central Africa." *Science* 335: 1219-1222.

Bayon, G., Schefuß, E., Dupont, L., Borges, A.V., Dennielou, B., Lambert, T., Mollenhauer, G., Monin, L., Ponzevera, E., Skonieczny, C. and André, L. 2019. "The roles of climate and human land-use in the Late Holocene rainforest crisis of Central Africa." *Earth and Planetary Science Letters* 505: 30-41.

Bequaert, M. 1947. "Traces de la culture Néolithique de l'Afrique Occidentale dans le sud de bassin du Kasai." *Bulletin de la Société Royale Belge D'Anthropologie et de Préhistoire* 58: 315-327.

Bequaert, M. 1956a. "Préhistoire au Congo belge: fouilles de 1950-1952." In *Actes du IVe congrès international des sciences anthropologiques et ethnologiques (Vienne, 1-8 septembre 1952),* edited by R. Ruggles Gates, 30-35. Vienna: Adolf Holzhausens.

Bequaert, M. 1956b. "Recherches archéologiques au Kwango en 1952." In *Actes du 4ème Congrès International des Sciences Préhistoriques, Madrid 1954, 29-45.* Madrid: Zaragoza.

Bostoen, K. 2018. "The Bantu Expansion." In *Oxford Research Encyclopaedia of African History,* edited by T. Spear. Oxford: Oxford University Press, Oxford Research Encyclopedia Online, doi:10.1093/acrefore/9780190277734.013.191.

Bostoen, K. 2020. "The Bantu Expansion: Some Facts and Fiction." In *Language Dispersal, Diversification, and Contact,* edited by M. Crevels and P. Muysken: 227-239. Oxford: Oxford University Press.

Bostoen, K. and Koni Muluwa, J. 2014. "Umlaut in the Bantu B70/80 languages of the Kwilu (DRC)." *Transactions of the Philological Society* 112: 209-230.

Bostoen, K., Clist, B., Doumenge, C., Grollemund, R., Hombert, J.-M., Koni Muluwa, J. and Maley, J. 2015. "Middle to Late Holocene Paleoclimatic Change and the Early Bantu Expansion in the Rain Forests of West Central-Africa." *Current Anthropology* 56: 354-384.

Bostoen, K., Coutros, P. and Schlebusch, C. forthcoming-a. "Niger-Congo including Bantu." In *Oxford Handbook of Archaeology and Language,* edited by M. Robbeets and M. Hudson. Oxford: Oxford University Press.

Bostoen, K., Pacchiarotti, S. and Hubau, W. forthcoming-b. "À la recherche des sentiers perdus du passé en forêt. Réflexions sur l'effondrement de la population en Afrique centrale il y a 1500 ans." *Proceedings of the Royal Academy for Overseas Sciences*.

Bremond, L., Bodin, S.C., Bentaleb, I., Favier, C. and Canal, S. 2017. "Past tree cover of the Congo Basin recovered by phytoliths and δ13C along soil profiles." *Quaternary International* 434: 91-101.

Bronk Ramsey, C. 2009. "Bayesian analysis of radiocarbon dates." *Radiocarbon* 51: 337-360.

Brun-Ricalens, F.L. 2006. "Les pièces esquillées: État des connaissances après un siècle de reconnaissance." *PALEO. Revue d'archéologie préhistorique* 18: 95-114.

Cahen, D. and Mortlemans, G. 1973. Un site Tshitolien sur le plateau des Bateke (République du Zaire) Tervuren: Musée Royal de L'Afrique Central.

Clist, B. 1982. "*Etude Archéologique du Matériel de la Mission Maurits Bequaert de 1950-1952 au Bas-Ziare.*" M.A. thesis, Université Libre de Bruxelles.

Clist, B. 2005. "*Des premiers villages aux premiers européens autour de l'estuaire du Gabon: quatre millénaires d'interactions entre l'homme et son milieu."* PhD diss., Université Libre de Bruxelles.

Clist, B. 2006a. "Coexistences matérielles entre 6000 et 20 cal BC en Afrique centrale : une mosaïque Culturelle." In *Normes techniques et pratiques sociales. De la simplicité des outillages pré- et protohistoriques,* edited by L. Astruc, F. Bon, V. Lea, P.Y. Milcent and S. Phillibert: 377-383. Antibes: Editions APDCA.

Clist, B. 2006b. "Mais où se sont taillées nos pierres en Afrique Centrale entre 7.000 et 2.000 bp?" In *Grundlegungen : Beiträge zur europäischen und afrikanischen Archäologie für Manfred K.H. Eggert,* edited by B.O. Clist and H.-P. Wotzka, 291-302. Tübingen: l'Allemagne Francke Attempto Verlag GmbH and Co. KG.

Clist, B. 2021. "West-Central African Diversity from the Stone Age to the Iron Age, Continuities and Transitions during the Late Pleistocene and the Holocene." In *Africa, the Cradle of Human Diversity,* edited by C. Fortes-Lima, E. Mtetwa and C. Schlebusch: 63-110. Leiden: Brill.

Clist, B., Bostoen, K., De Maret, P., Eggert, M.K.H., Höhn, A., Mbida Mindzié, C., Neumann, K. and Seidensticker, D. 2018a. "Did human activity really trigger the late Holocene rainforest crisis in Central Africa?" *Proceedings of the National Academy of Sciences* 115: E4733-E4734.

Clist, B., Nikis, N. and De Maret, P. 2018b. "Séquence chrono-culturelle de la poterie kongo (13e-19e siècles)." In *Une archéologie des provinces septentrionales du royaume Kongo,* edited by B. Clist, P. De Maret and K. Bostoen: 243-295. Oxford: Archaeopress.

Clist, B., Hubau, W., Tshibamba, J.M., Beeckman, H. and Bostoen, K. 2019a. "The earliest iron-producing communities in the Lower Congo region of Central Africa: new insights from the Bu, Kindu and Mantsetsi sites." *Azania: Archaeological Research in Africa* 54: 221-244.

Clist, B., Kaumba, M., Matonda, I. and Bostoen, K. 2019b. "Kitala Ware: a new Early Iron Age pottery group from the Lower Congo region in Central Africa." *African Archaeological Review* 36: 455-477.

Clist, B., Denbow, J., Giresse, P., Da Piedade Jesus, M., Lanfranchi, R., Maley, J. and Mbida Mindzié, C. 2021. "Saving 1,000 years of African history: there is no evidence of a population collapse in Congo rainforest from 400 to 600 CE – 1. The radiocarbon dates." *Science Advances* 7: E-letter in response to DOI: 10.1126/sciadv.abd8352.

Coutros, P.R., Matonda Sakala, I., Mabuaka Duki, A., Nkanu Tsatsa, I. and Bostoen, K. 2022. "The BantuFirst project: 2021 fieldwork report on the Kwilu-Kasaï-Kamtsha-Loange river reconnaissance mission." *Nyame Akuma* 97: 14-21.

Coutros, P.R., Matonda Sakala, I., Mabuaka Duki, A., Nkanu Tsatsa, I. and Bostoen, K. 2023. "The BantuFirst Project: 2022 fieldwork report on the Kwilu-Kasai River reconnaissance and Mashita Mbanza excavations (Democratic Republic of the Congo)." *Nyame Akuma* 99: 29-34.

Crowther, A., Prendergast, M.E., Fuller, D.Q. and Boivin, N. 2018. "Subsistence mosaics, forager-farmer interactions, and the transition to food production in eastern Africa." *Quaternary International* 489: 101-120.

Datok, P., Sauvage, S., Fabre, C., Laraque, A., Ouillon, S., Moukandi N'kaya, G. and Sanchez-Perez, J.-M. 2021. "Sediment balance estimation of the 'Cuvette Centrale' of the Congo River Basin using the SWAT hydrological model." *Water* 13(10):1310.

De Decker, J. M. (1950). "*Les clans Ambuun (Bambunda) d'après leur littérature orale.*" (Mémoires in-8° - Tome XX - fasc.1). Institut Royal Colonial Belge, Bruxelles.

De Filippo, C., Bostoen, K., Stoneking, M. and Pakendorf, B. 2012. "Bringing together linguistic and genetic evidence to test the Bantu Expansion." *Proceedings of the Royal Society B (Biological Sciences)* 279: 3256-3263.

De Maret, P. 1986. "The Ngovo Group: an industry with polished stone tools and pottery in Lower-Zaire." *African Archaeological Review* 4: 103-133.

De Maret, P. 1994. "Pits, pots and the far-west streams." *Azania: Archaeological Research in Africa* 29-30: 316-323.

De Maret, P. 2003. "Synthèse des données archéologiques récentes sur l'Afrique centrale forestière : des mosaïques dans la quatrième dimension." In *Peuplements anciens et actuels de des forêts tropicales (Actes du séminaire-atelier Orléans 15-16 octobre 1998),* edited by A. Froment and J. Guffroy: 169-179. Paris: IRD Editions.

De Maret, P. 2013. "Archaeologies of the Bantu Expansion." In *Oxford Handbook of African Archaeology,* edited by P. Mitchell and P. Lane: 319-328. Oxford: Oxford University Press.

De Maret, P. and Clist, B. 1985. "Archaeological Research in Zaire." *Nyame Akuma* 26: 41-42.

De Menocal, P.B., Ortiz, J., Guilderson, T., Adkins, J., Sarnthein, M., Baker, L. and Yarusinsky, M. 2000. "Abrupt onset and termination of the African Humid Period: rapid climate response to gradual insolation forcing." *Quaternary Science Reviews* 19: 347-361.

De Saulieu, G., Garcin, Y., Sebag, D., Nlend, P.R.N., Zeitlyn, D., Deschamps, P., Ménot, G., Di Carlo, P. and Oslisly, R. 2021. "Archaeological evidence for population rise and collapse between~ 2500 and~ 500 cal. yr BP in western Central Africa." *Afrique: Archéologie and Arts* 17: 11-32.

De Schryver, G.-M., Grollemund, R., Branford, S. Bostoen, K. 2015. "Introducing a state-of-the-art phylogenetic classification of the Kikongo Language Cluster." *Africana Linguistica* 21: 87-162.

Dimmendaal, G.J. and Storch, A. 2016. "Niger-Congo: A brief state of the art." In *Oxford Handbooks Online: Linguistics.* Oxford: Oxford University Press, https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199935345.001.0001/oxfordhb-9780199935345-e-3.

Druc, I.C. 2015. *Portable Digital Micorscope. Atlas of Ceramic Pastes. Components, Texture and Technology (with technical collaboration of B. Velde and L. Chavez)*. WI: Deep University Press.

Eggert, M. 2005. "The Bantu problem and African archaeology." In *African Archaeology: A Critical Introduction,* edited by A.B. Stahl: 301-326. Malden: Blackwell.

Eggert, M. 2016. "Genetizing Bantu: historical insight or historical trilemma?" *Medieval Worlds* 4: 79-90.

Garcin, Y., Deschamps, P., Ménot, G., De Saulieu, G., Schefuß, E., Sebag, D., Dupont, L.M., Oslisly, R., Brademann, B., Mbusnum, K.G., Onana, J.-M., Ako, A.A., Epp, L.S.,

Tjallingii, R., Strecker, M.R., Brauer, A. and Sachse, D. 2018b. "Early anthropogenic impact on Western Central African rainforests 2,600 y ago." *Proceedings of the National Academy of Sciences* 115: 3261-3266.

Good, J. 2020. "Niger-Congo, with a special focus on Benue-Congo." In *Oxford Handbook of African Languages,* edited by R. Vossen and G.J. Dimmendaal: 139-160. Oxford: Oxford University Press.

Gosselain, O.P. 2000. "Materialising identities: an African perspective." *Journal of Archaeological Method and Theory* 7: 187-217.

Grollemund, R., Branford, S., Bostoen, K., Meade, A., Venditti, C. and Pagel, M. 2015. "Bantu Expansion shows that habitat alters the route and pace of human dispersals." *Proceedings of the National Academy of Sciences of the United States of America,* 112: 13296-13301.

Heine, B., Hoff, H. and Vossen, R. 1977. "Neuere ergebnisse zur territorialgeschichte der Bantu." In *Zur Sprachgeschichte und Ethnohistorie in Afrika,* edited by W. Möhlig, F. Rottland and B. Heine: 57-72. Berlin: Dietrich Reimer Verlag.

Herbert, J.M. 2009. *Woodland Potters and Archaeological Ceramics of the North Carolina Coast*. Alabama: The University of Alabama Press.

Hogg, A., Heaton, T., Hua, Q., Palmer, J., Turney, C., Southon, J., Bayliss, A., Blackwell, P., Boswijk, G., Bronk Ramsey, C., Petchey, F., Reimer, P., Reimer, R. and Wacker, L. 2020. "SHCal20 Southern Hemisphere calibration, 0-55,000 years cal BP." *Radiocarbon* 62(4): 759-778.

Hubau, W., Van Den Bulcke, J., Van Acker, J. and Beeckman, H. 2015. "Charcoal-inferred Holocene fire and vegetation history linked to drought periods in the Democratic Republic of Congo." *Global Change Biology* 21: 2296-2308.

Ifo, S. A. 2017. "Variation of δ13C and soil organic carbon dynamics in the savannah of Plateau Bateke, Congo Bassin." *International Journal of Scientific and Technology Research* 6(1): 181–185.

Inizan, M.-L., Reduron, M., Roche, H. and Tixier, J. 1995. *Technologie de la pierre taillée*. Meudon: CREP.

Koile, E., Greenhill, S.J., Blasi, D.E., Bouckaert, R. and Gray, R.D. 2022. "Phylogeographic analysis of the Bantu language expansion supports a rainforest route." *Proceedings of the National Academy of Sciences* 119: e2112853119.

Koni Muluwa, J. and Bostoen, K. 2012. "La diphtongaison dans les langues bantu B70-80 (Bandundu, RDC): typologie et classification historique." *Africana Linguistica* 18: 355-386.

Li, S., Schlebusch, C. and Jakobsson, M. 2014. "Genetic Variation Reveals Large-Scale Population Expansion and Migration During the Expansion of Bantu-Speaking Peoples." *Proceedings of the Royal Society B (Biological Sciences)* 281: 20141448.

Linol, B., De Wit, M.J., Guillocheau, F., De Wit, M.C.J., Anka, Z. and Colin, J. 2015. "Formation and collapse of the Kalahari Duricrust ['African Surface'] across the Congo Basin, with implications for changes in rates of Cenozoic off-shore sedimentation." In *Geology and Resource Potential of the Congo Basin. Regional Geology Reviews.,* edited by M. De Wit, F. Guillocheau and M. De Wit, 193-210. Berlin, Heidelberg: Springer.

Lupo, Karen D., Schmitt, Dave N., Ndanga, Jean-Paul, Nguerede, Lucien P., Amaye, Guy T., Livingstone Smith, Alexandre, Edwards, Nicolette M., Power, Robert C., Young D. Craig and Npo, Frank 2021. "Hunter-gatherers on the basin's edge: a preliminary look at

Holocene human occupation of Nangara-Komba shelter, Central African Republic." Azania: Archaeological Research in Africa, 56:1, 4-33.
Livingstone Smith, A. 2007. "Histoire du décor à la roulette en Afrique Subsaharienne." *Journal of African Archaeology* 5: 189-216.
Lombard, M. 2022. "Sedge foodplants growing in the Cradle of Humankind, South Africa, and Cyperus esculentus tubers (Patrysuintjies) as a C4 Superfood." *Open Quaternary* 8(1): 1-21.
Macdonald, K.C. 2011. "Betwixt Tichitt and the IND: the pottery of the Faïta Facies, Tichitt Tradition." *Azania: Archaeological Research in Africa* 46: 49-69.
Maley, J. 2002. "A catastrophic destruction of African forests about 2,500 years ago still exerts a major influence on present vegetation formations." *IDS Bulletin* 33: 13-30.
Matonda Sakala, I., Bigohe Mugisha, S. and Bostoen, K. 2019. "Le projet BantuFirst: rapport sur les recherches de terrain archéologiques 2019 dans les provinces du Kwilu et de Kinshasa, République démocratique du Congo." *Nyame Akuma* 92: 19-24.
Matonda Sakala, I., Bigohe Mugisha, S., Mambu, C. and Bostoen, K. 2021. "Le projet BantuFirst: rapport sur les recherches de terrain archéologiques le long du bas-Kasaï dans les provinces du Kwilu et du Mai-Ndombe (RDC)." *Nyame Akuma* 95: 25-30.
Mercader, J., Freya, R., Vrydaghs, L., Doutrelepont, H., Ewango, C.E.N., Juan-Tresseras, J. "Phytoliths from archaeological sites in the tropical forest of Ituri, Democratic Republic of Congo." *Quaternary Research* 54: 102-112.
Mcintosh, S.K. and Guèye, N.S. 2016. "The Cubalel and Siwré pottery assemblages." in *The Search for Takrur: Archaeological Excavations and Reconnaissance along the Middle Senegal Valley,* edited by R.J. Mcintosh, S.K. Mcintosh and H. Bocoum, 162-187. New Haven: Department of Anthropology and The Peabody Museum: Yale University Publications in Anthropology.
Mushi, C.A., Ndomba, P.M., Trigg, M.A., Tshimanga, R.M. and Mtalo, F. 2019. "Assessment of basin-scale soil erosion within the Congo River Basin: a review." *CATENA* 178: 64-76.
Neumann, K., Bostoen, K., Höhn, A., Kahlheber, S., Ngomanda, A. and Tchiengué, B. 2012a. "First farmers in the Central African rainforest: A view from southern Cameroon." *Quaternary International* 249: 53-62.
Neumann, K., Eggert, M.K.H., Oslisly, R., Clist, B., Denham, T., De Maret, P., Ozainne, S., Hildebrand, E., Bostoen, K., Salzmann, U., Schwartz, D., Eichhorn, B., Tchiengué, B. and Höhn, A. 2012b. "Comment on "Intensifying weathering and land use in Iron Age Central Africa"." *Science* 337: 1040.
Neumann, K., Eichhorn, B. and Wotzka, H.-P. 2022. "Iron Age plant subsistence in the Inner Congo Basin (DR Congo)." *Vegetation History and Archaeobotany* 31: 481-509.
Neumann, K., Strömberg, C.a.E., Ball, T., Albert, R.M., Vrydaghs, L. and Cummings, L.S. 2019. "International code for phytolith nomenclature (ICPN) 2.0." *Annals of Botany* 124: 189-199.
Nicolaï, H. 1963. *Le Kwilu: Etude géographique d'une region congolaise*. series LXIX). CEMUBAC.
Oslisly, R. 1993. "The Neolithic/Iron Age transition in the middle reaches of the Ogodue Valley in Gabon: chronology and cultural change." *Nyame Akuma* 40: 17-21.
Oslisly, R. 2001. "Chronologie des Âges du Fer dans la moyenne vallée de l'Ogooué au Gabon." In *The Origins of Iron Metallurgy. Proceedings of the First International Colloquium on the Archaeology of Africa and the Mediterranean Basin held at the Museum of Natural*

History in Geneva, 4–7 June, 1999, edited by J.-P. Descoeudres, E. Huysecom, V. Serneels and J.-L. Zimmermann: 263-268. Sydney: Meditarch.
Oslisly, R., White, L., Bentaleb, I., Favier, C., Fontugne, M., Gillet, J.-F. and Sebag, D. 2013. "Climatic and cultural changes in the west Congo Basin forests over the past 5000 years." *Phil. Trans. R. Soc. B* 368: 20120304.
Pacchiarotti, S. and Bostoen, K. 2021. "Final vowel loss in Lower Kasai Bantu (DRC) as a contact-induced change." *Journal of Language Contact* 14: 437-474.
Pacchiarotti, S., Chousou-Polydouri, N. and Bostoen, K. 2019. "Untangling the West-Coastal Bantu mess: identification, geography and phylogeny of the Bantu B50-80 languages." *Africana Linguistica* 25: 155-229.
Pan, A.D., Jacobs, B.F., Dransfield, J. and Baker, W.J. 2006. "The fossil history of palms (*Arecaceae*) in Africa and new records from the Late Oligocene (28–27 Mya) of north-western Ethiopia." *Botanical Journal of the Linnean Society* 151: 69-81.
Patin, E., Lopez, M., Grollemund, R., Verdu, P., Harmant, C., Quach, H., Laval, G., Perry, G.H., Barreiro, L.B., Froment, A., Heyer, E., Massougbodji, A., Fortes-Lima, C., Migot-Nabias, F., Bellis, G., Dugoujon, J.-M., Pereira, J.B., Fernandes, V., Pereira, L., Van Der Veen, L., Mouguiama-Daouda, P., Bustamante, C.D., Hombert, J.-M. and Quintana-Murci, L. 2017. "Dispersals and genetic adaptation of Bantu-speaking populations in Africa and North America." *Science* 356: 543-546.
Pearson, R. 2006. "Jomon hot spot: increasing sedentism in south-western Japan in the Incipient Jomon (14,00-9250 cal. BC) and Earliest Jomon (9250-5300 cal. BC) periods." *World Archaeology* 38: 239-258.
Petit, M. 1990. “Les grands traits morphologiques de l’Afrique centrale atlantique.” In *Paysages quaternaires de l’Afrique centrale Atlantique,* edited by R. Lanfranchi and D. Schwartz: 20-30. Paris: ORSTOM.
Pickrell, J.K., Patterson, N., Barbieri, C., Berthold, F., Gerlach, L., Güldemann, T., Kure, B., Mpoloka, S.W., Nakagawa, H., Naumann, C., Lipson, M., Loh, P.-R., Lachance, J., Mountain, J., Bustamante, C.D., Berger, B., Tishkoff, S.A., Henn, B.M., Stoneking, M., Reich, D. and Pakendorf, B. 2012. "The genetic prehistory of southern Africa." *Nature Communications* 3: 1143.
Pierot, F. 1987. “*Etude ethnoarchéologique du site de Mashita Mbanza (Zaïre).*” PhD diss., Université libre de Bruxelles.
Piperno, D.R. 2006. *Phytoliths: a comprehensive guide for archaeologists and paleoecologists*. Lanham: AltaMira Press.
Rünge, J. 2001. “On the age of stone-lines and hillwash sediments in the eastern Congo basin – palaeoenvironmental implications.” In *Quaternary Sedimentary Records in Central Africa and Their Palaeoenvironmental Interpretation, Proceedings of the XVth INQUA Conference, Durban, South Africa, 3-11 August 1999,* edited by J. Rünge, 19-36. Palaeoecology of Africa.
Russell, T., Silva, F. and Steele, J. 2014. "Modelling the spread of farming in the Bantu-speaking regions of Africa: an archaeology-based phylogeography." *PLoS ONE* 9: e87854.
Schlebusch, C.M. and Jakobsson, M. 2018. "Tales of human migration, admixture, and selection in Africa." *Annual Review of Genomics and Human Genetics* 19: 405-428.
Schlebusch, C.M., Skoglund, P., Sjödin, P., Gattepaille, L.M., Hernandez, D., Jay, F., Li, S., Jongh, M.D., Singleton, A., Blum, M.G.B., Soodyall, H. and Jakobsson, M. 2012.

"Genomic variation in seven Khoe-San groups reveals adaptation and complex African history." *Science* 338: 374-379.

Schwartz, D. 1990. “La couverture pédologique de l'Afrique Centrale Atlantique.” in *Paysages Quaternaires de L'Afrique Centrale Atlantique,* edited by R. Lanfranchi and D. Schwartz, 52-59. Paris: ORSTOM.

Schwartz, D. 1992. "Assèchement climatique vers 3000 B.P. et expansion bantu en Afrique Centrale Atlantique: quelques réflexions." *Bulletin de la Societé Géologique de France* 163: 353-361.

Seidensticker, D., Hubau, W., Verschuren, D., Fortes-Lima, C., De Maret, P., Schlebusch, C. and Bostoen, K. 2021. "Population collapse in Congo rainforest from 400 CE urges reassessment of the Bantu Expansion." *Science Advances* 7, eabd8352.

Seidensticker, D., Jungnickel, K., Mambu, C., Yogolelo, J., Kidebua, R. and Bostoen, K. 2018. "The BantuFirst Project: 2018 fieldwork report from the Kinshasa, Kwango, Kwilu and Mai-Ndombe Provinces of the Democratic Republic of the Congo." *Nyame Akuma* 90: 23-29.

Soriano, S., Robert, A. and Huysecom, E. 2010. “Percussion bipolaire sur enclume: choix ou contrainte? l’exemple du Paléolithique d’Ounjougou (Pays dogon, Mali).” In *Entre le marteau et l’enclume...” La percussion directe au percuteur dur et la diversité de ses modalités d'application. Actes de la table ronde de Toulouse, 15- 17 mars2004. Les Eyzies : SAMRA, (PALEO, 2009-2010, numéro spécial),* edited by V. Mourre and M. Jarry: 123-132.

Thiéblemont, D., Flehoc, C., Ebang-Obiang, M., Rigollet, C., Prian, J.-P. and Prognon, F. 2013. "Geochronological arguments for a close relationship between surficial formation profiles and environmental crisis (c. 3000-2000 BP) in Gabon (Central Africa)." *Comptes Rendus Geoscience* 345: 272-283.

Tishkoff, S.A., Reed, F.A., Friedlaender, F.R., Ehret, C., Ranciaro, A., Froment, A., Hirbo, J.B., Awomoyi, A.A., Bodo, J.-M., Doumbo, O., Ibrahim, M., Juma, A.T., Kotze, M.J., Lema, G., Moore, J.H., Mortensen, H., Nyambo, T.B., Omar, S.A., Powell, K., Pretorius, G.S., Smith, M.W., Thera, M.A., Wambebe, C., Weber, J.L. and Williams, S.M. 2009. "The Genetic Structure and History of Africans and African Americans." *Science (New York, N.Y.)* 324: 1035-1044.

Van Moorsel, H. 1970. "Recherches préhistoriques au pays de l’entre-fleuves Lukenie-Kasaï." *Études d’Histoire Africaine,* I: 7-36.

Vansina, J. 1966. *Kingdoms of the Savanna*. Madison: University of Wisconsin Press.

Vansina, J. 1995. "New Linguistic Evidence and the Bantu Expansion." *Journal of African History* 36: 173-195.

Vincens, A., Schwartz, D., Elenga, H., Reynaud-Farrera, I., Alexandre, A., Bertaux, J., Mariotti, A., Martin, L., Meunier, J.-D., Nguetsop, F., Servant, M., Servant-Vildary, S. and Wirrmann, D. 1999. "Forest response to climate changes in Atlantic Equatorial Africa during the last 4000 years BP and inheritance on the modern landscapes." *Journal of Biogeography* 26: 879-885.

Wang, K., Goldstein, S., Bleasdale, M., Clist, B., Bostoen, K., Bakwa-Lufu, P., Buck, L.T., Crowther, A., Dème, A., Mcintosh, R.J., Mercader, J., Ogola, C., Power, R.C., Sawchuk, E., Robertshaw, P., Wilmsen, E.N., Petraglia, M., Ndiema, E., Manthi, F.K., Krause, J., Roberts, P., Boivin, N. and Schiffels, S. 2020. "Ancient genomes reveal complex patterns

of population movement, interaction, and replacement in sub-Saharan Africa." *Science Advances* 6: eaaz0183.

White, F. 1983. *The vegetation of Africa: a descriptive memoir to accompany the Unesco/AETFAT/UNSO vegetation map of Africa.* Paris: UNESCO.

Wotzka, H.-P. 1995. *Studien zur Archäologie des zentralafrikanischen Regenwaldes. Die Keramik des inneren Zaïre-Beckens und ihre Stellung im Kontext der Bantu-Expansion*. Köln: Africa Praehistorica 6.

Wotzka, H.-P. 2001. "Central African Neolithic." In *Encyclopedia of Prehistory: Volume 1: Africa,* edited by P.N. Peregrine and M. Ember: 46-58. Boston, MA: Springer US.

Wotzka, H.-P. 2006. "Records of activity: radiocarbon and the structure of Iron Age settlement in Central Africa." In *Grundlegungen. Beiträge zur europäischen und afrikanischen Archäologie für Manfred K.H. Eggert,* edited by H.-P. Wotzka: 271-289. Tübingen: Francke Attempto Verlag.

Yost, C.L., Ivory, S.J., Deino, A.L., Rabideaux, N.M., Kingston, J.D. and Cohen, A.S. 2021. "Phytoliths, pollen, and microcharcoal from the Baringo Basin, Kenya reveal savanna dynamics during the Plio-Pleistocene transition." *Palaeogeography, Palaeoclimatology, Palaeoecology* 570: 109779.