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Pikunda-Munda

Disappearance of Pottery Production in the Western Congo Basin at the end of the Early Iron Age

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Abstract The history of pottery-producing communities in Central Africa has long been seen as a study of its spread. This process started about two-and-a-half millennia ago and is often linked with the so-called 'Bantu Expansion'. Linguistic studies claimed substantial migratory events through the so-called 'Sangha River Interval', which mostly coincides with the Sangha river valley and the western part of the Congo Basin. This region is viewed as a 'gateway' communities followed to cross the equatorial rainforest during their spread south.

This paper presents novel data on the oldest pottery from that region, the Pikunda-Munda style. Its emergence in the last century BCE is equally shrouded in secret as its disappearance in the 5th to 6th century CE. The latter coincides with a distinct period of low human activity (600-1000 CE) observed throughout Central Africa.

New research into the technological decisions or *chaîne opératoire* of the potters' communities that produced the Pikunda-Munda pottery revealed that they followed a distinct path, different from that in adjacent regions such as the Inner Congo Basin. Only regarding clay procurement and processing similar preferences for riverine clay sources rich in sponge spicules can be seen. Drawing of a ring is the primary shaping or roughing-out technique. Differences in how the bottoms were attached or closed indicate differences in trans-generational training networks among the potters' communities of practice.

The disappearances of the Pikunda-Munda pottery marks an apparent abandonment of pottery production along the middle and lower Sangha river, with knowledge networks established earlier falling apart. There is no evidence for the persistence of the specific knowledge of Pikunda-Munda potters' communities. All groups encountered after the 'hiatus' show evidence of them originating from groups found in the Inner Congo Basin. Potters' communities

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responsible for the Pikunda-Munda pottery are among those whose knowledge transfer was interrupted by the widespread setback in human activity observed throughout the wider region.

Keywords Congo Basin · Ceramics · Knowledge transfer · *Chaîne opératoire* · Middle Iron Age Hiatus

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1 Introduction

The spread of communities producing pottery throughout Central Africa is regularly linked with the so-called 'Bantu Expansion' (Bostoen 2018, 2020). The diversity of Bantu-languages spoken today is regularly attributed to demic diffusion (Pakendorf et al. 2011; Bostoen and Gunnink 2022) and linguistic reconstructions of putative pathways favor rapid migrations through the equatorial rainforests of Central Africa (Grollemund et al. 2015; Bostoen et al. 2015; Koile et al. 2022). To cope with the lack of historicity in modern language data archaeological results are used to 'date' these migratory events. The results of finely selected archaeological investigations are used without any attempt to verify the connection these data have with the modern Bantu speakers living in the same region. Thus the resulting synopses are instead 'self-fulfilling prophecies' usually based on a premise that equates the emergence of pottery in a given region with the arrival of Bantu-speakers (Bostoen et al. 2015, 355,362,364).

These overreaching linguistic models influence archaeological research and raise the issue of continuity within the archaeological record. The primary source of information on the material culture of communities living in Central Africa for the past 2500 years is ceramic finds. Comprehensive sequences of pottery production are mainly known from the Congo Basin (Wotzka 1995; Seidensticker 2021) and Gabon (Clist 2004). Research in other regions, such as Cameroon (Gouem Gouem 2010; Nlend Nlend 2013), needs more data, e.g. the younger parts of the sequence. Amidst various research focuses and lack of data since vast regions have not been studied at all, a general trend

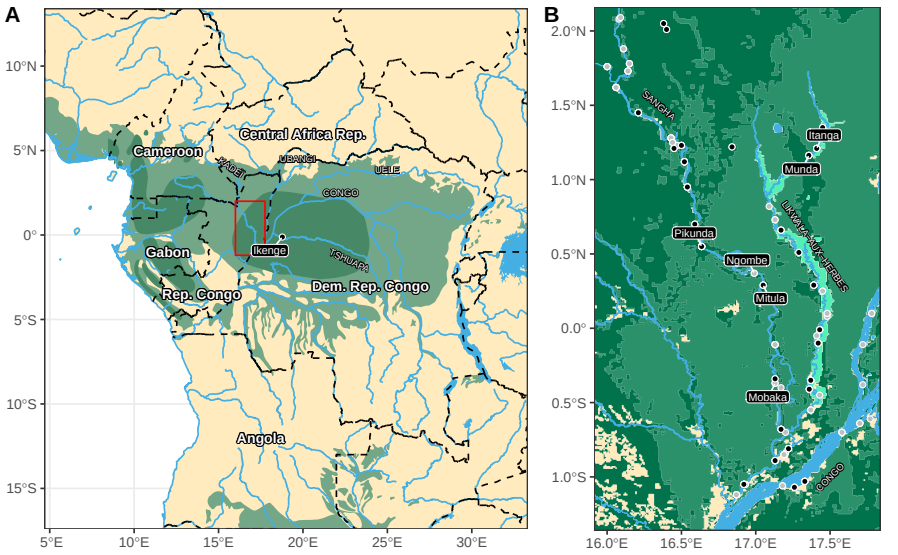

Fig. 1: Map of Central Africa (A) with the distribution of equatorial rainforest (White 1983) (light green) and its putative distribution during the 1st millennium BCE (Bremond et al. 2017; Maley et al. 2017) (dark green). The map of the study area along the rivers Sangha and Likwala-aux-Herbes (B) shows the distribution of landcover types based on satellite data (Mayaux et al. 2003): closed evergreen rainforest vegetation (dark green), swamp forest (medium green), and swamp bush- and grassland (light green). Black dots show sites with Pikunda-Munda style pottery, while grey dots represent sites with other pottery finds (Seidensticker 2021, 11 Fig. 1, 119 Fig. 49).

with consecutive boom-and-bust phases within the record of human activity in Central Africa can be reconstructed (Oslisly 1998; Oslisly et al. 2013b,a; de Saulieu et al. 2017, 2021; Seidensticker et al. 2021). A setback in human activity dates between the 7th to 10th century CE and divides the Early and Late Iron Ages. This widespread 'hiatus' questions the underlying assumption of historical linguists (Grollemund et al. 2015; Bostoen et al. 2015; Koile et al. 2022) of a direct connection between early ceramic finds in a given region and modern Bantu-speakers and, with it, the proposed reconstruction of the 'Bantu-Expansion' as a single migratory event.

The temporal variability in the activity of ancient pottery-producing communities over the past 3000 years can be derived from the available record of radiocarbon dates (Seidensticker and Hubau 2021). The empirical summed probability distribution (SPD) derived from these dates, following a rigorous assessment of their 'chronometric hygiene' (Napolitano et al. 2019), already shows a distinct bi-modal pattern (Fig. 2.A: black line). To constrain the timing of these periods, the observed SPD is compared with four different models of hypothetical population growth using the rcarbon software (Bevan and

Crema 2022). This analysis resulted in four successive periods during which the observed SPD either exceeds or falls short of the population growth trends predicted by the models (Fig. 2.A: blue and red shading, respectively). The logistic growth model (Fig. 2.A: grey envelope) is probably most pertinent in the context of the Bantu Expansion, which is often presented as a large-scale and exceptionally rapid process followed by a continuous presence of Bantu-speaking people after the initial expansion (Pakendorf et al. 2011; Grollemund et al. 2015; Bostoen et al. 2015; Bostoen and Gunnink 2022; Koile et al. 2022).

Additional corroboration came from examining the meta-data about the known pottery groups or styles in Central Africa. The frequency of contemporaneous sites modeled for each known pottery style using a Gaussian normal distribution Roberts et al. (2012) shows a similar trend (Fig. 2.B): a surge in the number of sites in the second half of the 1st millennium BCE, that led into a stagnation phase, which is followed by a decline. The number of sites only increases after 1000 CE again. The same pattern can be observed when viewing the number of pottery styles through time (Fig. 2.C). This 'evolution' of pottery producing communities in Central Africa (Fig. 2C–E) confirms the temporal fluctuations reflected in the cross-regional SPD of archaeological 14C dates (Fig. 2A) and unveils a two-phase pattern during both the Early and Late Iron Age periods. Each starts with a phase of expansion during which stylistically homogeneous pottery groups became widely distributed and ends with a phase of high activity characterized by increasing abundance of local pottery styles reflecting a process of regionalization (Seidensticker et al. 2021).

The settlement history of the western Congo Basin, according to linguistic research (Grollemund et al. 2015; Bostoen et al. 2015; Koile et al. 2022) follows this general picture (Seidensticker 2016, 2021, Submitted). The disappearance of pottery in the region after the 5th to 6th century CE underlines the inaccuracies in simple historical projections of modern language data. It further raises the question of what happened to communities living in the western Congo Basin at the end of the Early Iron Age.

The Pikunda-Munda style, first described by Manfred Eggert (1992, 1993) following fieldwork of the *River Reconnaissance Project* in 1987, the oldest pottery found throughout the western Congo Basin, except for isolated finds of pottery of the Imbonga style in Mobaka and Mitula (Fig. 1B; 3). Its area of distribution is about 300 to 150 km large. The main characteristic of the Pikunda-Munda pottery is its wide, open-mouthed bowls with approximately parallel sides, flared rims and rounded bases (Fig. 4). The general ornament scheme is based on linear elements produced through incision and grooving. Rocker-stamp decoration is occasionally present. Stylistically, it shows some similarities to contemporaneous groups of the Inner Congo Basin, such as the styles Lokondola, Lusako, Lingonda, and Bokuma (Wotzka 1995, 107). The available data point towards an interpretation in which the Pikunda-Munda style is a rather distant sub-stream of the Equator-Co style tradition and no fully independent entity (Seidensticker 2021, 192). Based on the current knowledge of the region's archaeology, the style has no known predecessor. It is furthermore remarkable that its characteristics vanish from the region

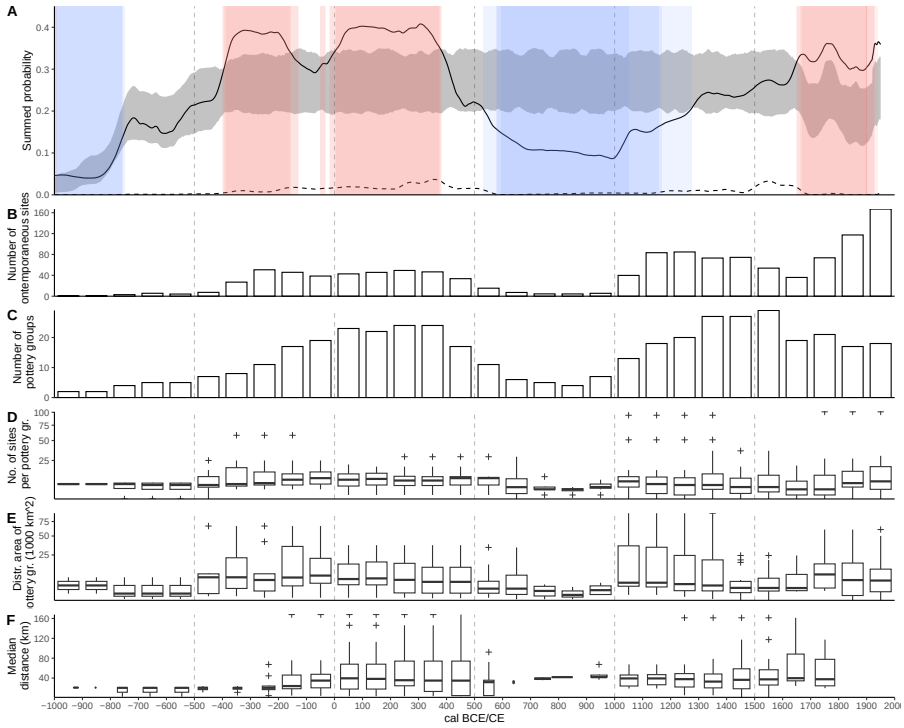

Fig. 2: **A)** Temporal variation in the activity of ancient pottery-producing communities in the Congo rainforest over the past 3000 years (regions A–H in Seidensticker et al. 2021, Fig. 2). Activity is discussed based on the SPD (full black lines) of all class Ia–c and IIa archaeological 14C dates (n = 1042) (Seidensticker and Hubau 2021), smoothed using a 60-year moving average. The dashed line represents the SPD for sites in the Sangha/Likwala-aux-Herbes region. Grey background shading represents the 95 % uncertainty envelope of summed probability in a logistic model of hypothetical population growth drawn from the same 14C datasets (Bevan and Crema 2022). Color shading demarcates periods of more or less intense human activity, defined as time windows during which the observed SPD surpasses (red; 'heating up') or falls below (red, 'cooling down') one (light shading) or multiple (dark shading) growth models (based on 1000 MC runs). **B)** Summed frequency of contemporaneous sites. The number of known sites for each pottery style was allocated for each century bin using a hypothesized function, in this case, Gaussian normal distribution, representing changes in saturation during the lifespan of a particular style (Roberts et al. 2012). **C–F)** Evolution of the numerical abundance and geographical distribution of pottery styles in the Congo rainforest (Seidensticker et al. 2021, Fig. 3). Abundance **(C)** is quantified as the number of pottery groups recorded within each century bin; spatial distribution is quantified as the number of sites where each pottery group is found **(D)** and by its total area of distribution **(E)**. **F)** The median distances of sites pertaining to the same pottery group per century bin. Distances were calculated by constructing a network for each pottery group with more than five sites. For each group, sites were connected with their four nearest neighbors (Bivand et al. 2023).

in the 5th to 6th century CE. All subsequent pottery styles found within the distribution area of the Pikunda-Munda style have their origin either in the Equator-Co tradition of the Inner Congo Basin (Wotzka 1995, 222-224 Fig. 4,273) or the Ngoko style tradition originating in south-east Cameroon (Seidensticker 2021, 189–192) (Fig. 3).

2 Materials and Methods

2.1 Pikunda-Munda style pottery

The Pikunda-Munda pottery style, the oldest being present along the rivers Sangha and Likwala-aux-Herbes, was first described by Eggert (1992). Pottery of this style has been excavated at the two eponymous sites: Pikunda along the middle Sangha river and Munda on the upper Likwala-aux-Herbes river (Fig. 1B). In total, 37 complete vessels, or sufficiently preserved pieces allowing reconstruction of the entire profile, of to the Pikunda-Munda style have been uncovered (Seidensticker 2021, 114–115). Pikunda-Munda pottery is known from seven sites in the western Congo Basin (Seidensticker 2021, 119–120 Fig. 49). With some reservations, sherds from another 24 sites, including one in the Inner Congo basin, can be assigned to the Pikunda-Munda style (Fig. 1B; 3). The defining inventories are three pits excavated in 1987: pit PIK 87/1 at Pikunda (Seidensticker 2021, 288–300) and the two pottery deposits in pits from Munda labeled MUN 87/2-1-1 and MUN 87/2-1-3 (Seidensticker 2021, 321–335). A common delineator for the style are wide, open-mouthed bowls with flared rimes, cylindrical walls and rounded bases (Eggert 1993, 311-314). These bowls can be further divided into two sub-groups: one has a rounded transition from the wall to the base (Fig. 4.2–3), while the second group shows a distinct carination in the profile (Fig. 4.4–6,8). Bowls of the former type were exclusively found within the older infill of feature MUN 87/2-1-1 as well as the inventory from the neighboring pit MUN 87/2-1-3. Bowls with the characteristic carination were found in the upper infill of MUN 87/2-1-1 and pit PIK 87/1 at Pikunda (Seidensticker 2021, 115–117). Lesser represented among the complete vessels, but present in equal numbers in the overall inventory, are slightly globular vessels with everted rims (Fig. 4.7,9–13). Decorations consist of linear elements produced utilizing incision or grooving and rocker-stamping with a comb (Seidensticker 2021, 362 App. 4.12). Nine conventional radiocarbon dates (Seidensticker 2021, 117 Fig. 48, 355–356 App. 2) and one newer AMS date (Seidensticker Submitted, Tab. 2: RICH-30864) date the Pikunda-Munda style between the 2nd to 1st century BCE and 5th century CE.

This study focused on 65 vessel units of the Pikunda-Munda style. Nearly half (n=32) originate from the pit at Pikunda (PIK 87/1), while the inventories of the two pits at Munda are represented by 15 (MUN 87/2-1-1) and 17 (MUN 878/2-1-3) vessel units respectively. A single sherd originating from the modern pit PIK 87/2 at Pikunda was also included. The main goal

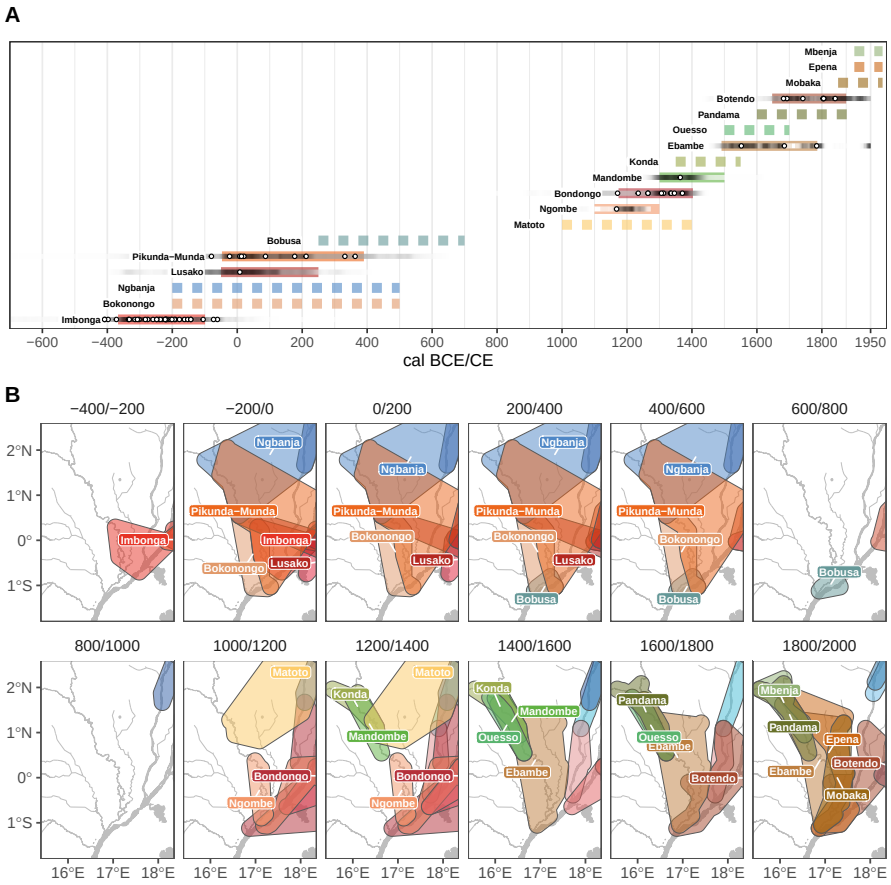

Fig. 3: **A)** Temporal distribution of known pottery styles in the Western Congo Basin over the past 2600 years. Circles represent the highest probability of calibrated calendar age of each pottery-linked 14C date. The intensity of grey-shading is proportional to the summed probability of the calendar-age windows of all pottery occurrences by type. Colored bars represent the phase duration of radiocarbon dates pottery styles. For groups with more than two associated radiocarbon dates, the phases' median start and end dates were calculated using a Bayesian model (Crema and Di Napoli 2021; Crema and Shoda 2021; Seidensticker Submitted, Fig. 2,Tab. 2). Dashed colored bars indicate estimated bins derived from stylistic resemblance (Seidensticker et al. 2021, Data S2). **B)** Time-sliced maps of occurrences of pottery styles in the Western Congo Basin. Negative numbers indicate calibrated ages BCE, while positive numbers represent calibrated ages CE. Extend per type was calculated as concave hull (Gombin et al. 2017) with a buffer of 20 km. The colors correspond to **(A)**.

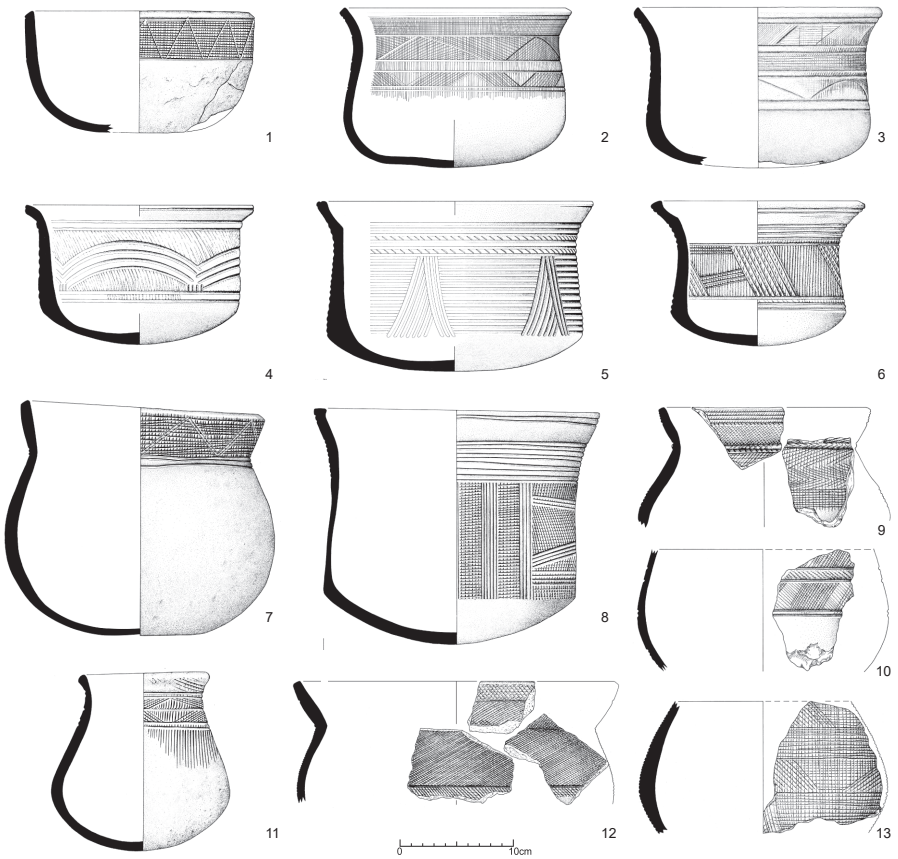

Fig. 4: Vessels of the Pikunda-Munda style group.

of the re-examination was to ameliorate a preliminary study concerning the *chaîne opératoire* of potters' communities, which only included six vessels of the Pikunda-Munda style (Seidensticker 2021, 45–73).

2.2 Pottery fabrics and thin-section petrography

Previous research established a reference system with nine primary macroscopic ceramic fabrics (Seidensticker 2021, 60–69). This system grouped sherds according to criteria observable without technical means other than a magnifier. Each major group was conceptualized as a putative 'recipe' prehistoric potters followed while sourcing and preparing used raw materials, most importantly clay and temper agents (Lange 2006, 49). The main characteristics to differentiate 'fabrics' (cf. Riemer 2011, 38–51) were the composition and texture of the clay matrix and non-plastic components as well as the firing color

(Nordström 1972, 34). Differences within the nine main fabrics resulted in a general reference system of 27 macroscopic ceramic fabrics for the western and northern Congo Basin (Seidensticker 2021, 62–65 Tab. 11). Some main macroscopic fabrics correlate with stylistic groups (Seidensticker 2021, 69 Tab. 12). For example, all investigated sherds that are either part of the "West tradition" of the "Equator-Co-style tradition" of the Inner Congo basin (Wotzka 1995, 221–222 Fig. 4) or stylistically closely related to those are part of the same macroscopic fabric group, labeled 'fabric 1'. This fabric is characterized by whitish firing colors and almost no visible non-plastic particles. Pottery from sites along the Likwala-aux-Herbes and lower Sangha river are almost exclusively part of this fabric (Seidensticker 2021, 67 Fig. 21). Thus, in this region, potters followed the same 'recipe' for sourcing and preparing clay since the onset of pottery production in that region in the last centuries BCE. The available qualitative descriptions of the technological aspects of the pottery styles in the Inner Congo Basin by Wotzka (1995, 59–210) indicate that all styles in the western parts of this region would be assigned to the same fabric group 1 as they display comparable characteristics. Only styles that date after the 15th century CE and are part of the Tshuapa, Maringa or northern style tradition in the eastern part of the Inner Congo Basin show higher concentrations of quartz inclusions and would thus be grouped in macroscopic fabric 4 (Seidensticker 2021, 62–65 Tab. 11).

To further elaborate on this preliminary and superficial analysis, a comprehensive study of the mineralogical compositions of pottery sherds from the Congo Basin was started. For this paper, four thin-sections from ceramics of the Pikunda-Munda style (Fig. 5A–F) as well as nine thin-sections from younger pottery from the two main sites Pikunda and Munda (Fig.5G–L) were studied. The petrographic analysis was conducted using an Olympus BX41 microscope, and the description and interpretation of observations were based on established reference works regarding ceramic petrography (MacKenzie et al. 2017; Quinn 2022).

2.3 Macro-traces and x-radiographs

The shaping technique is the second aspect of the *chaîne opératoire* of Pikunda-Munda potters under investigation in this paper. The shaping process can be sub-divided into two phases: the forming or roughing-out phase, henceforth referred to as the 'primary shaping technique', and the subsequent 'secondary' shaping technique (Shepard 1956 (reprint 1985; Rye 1981; Livingstone Smith 2007; Livingstone Smith and Visseyrais 2010). Distinct actions of the potter during the shaping process can be deduced through surface features such as fissures, cracks, or breaks and their pattern, defective joints, as well as variations in the texture of the surfaces. Systematically spatially co-occurring features, systematized as configurations following Livingstone Smith (2007); Livingstone Smith and Visseyrais (2010), are physical remnants of technical behaviors. These are compared and interpreted in reference to available ethno-

graphic descriptions of potting practices (Eggert and Kanimba-Misago 1980; Kanimba Misago and Mpunga 1991; Eggert in prep.).

A preliminary study on 28 vessels from the western and northern Congo Basin, including six vessels of the Pikunda-Munda style, could identify three main groups of vessels sharing observed macro-traces and surface features (Seidensticker 2021, 45–60,69–73). The present study included 32 vessel units of the Pikunda-Munda style alone.

The study of macro-traces was supplemented through x-radiographs that offered insight into the internal micro-structure of the vessels (Stevenson 1953; Rye 1977; Vandiver 1987). Within the context of Central African archaeology, Livingstone Smith and Visseyrais (2010) used radiographs for reconstructing the primary shaping techniques of pottery vessels from the Katanga province of the DRC dating into the 13th to 18th c. CE. Radiographs of 26 vessels pertaining to the Pikunda-Munda group were produced at the Royal Museum for Central Africa (RMCA). The bulk of these vessels originated from the two neighboring pit features MUN 87/2-1-1 (n=8) and MUN 87/2-1-3 (n=16) at Munda on the Likwala-aux-Herbes river. Only two vessel units from the pit PIK 87/1 were sufficiently big enough to the radiographed.

3 Results

3.1 Macroscopic and Petrographic Fabrics

Previous studies Seidensticker (2021, 60–69) established that the Pikunda-Munda ceramics are unanimously part of the same macroscopic fabric: a fine clay paste usually dark or whitish in colour with no or very few macroscopic inclusions. The petrographic analysis corroborated this. Four sherds of vessels of the Pikunda-Munda style group showed strong similarities (Fig. 5A–F). The petro-fabric is based on fine clays showing no or very little birefringence (Fig. 5C,5F). Its main feature is large quantities of sponge spicules. Sponge spicules appear as elongated isotropic rods in plane-polarized light (PPL; Fig. 5A,E,H) and are the remains of the micro-sized, siliceous skeletons of freshwater sponges. Sponges, known as Cauixi, were often added as temper agents to pre-Columbian pottery in Amazonia (Linné 1932, 1957; da Costa et al. 2004; Rodrigues et al. 2017; Villagran et al. 2022), as well as along the Orinoco river (Lozada Mendieta 2019) and in the Paraná valley (Ottalagano 2016). They are known to improve the mechanical properties of the vessels after firing by increasing mechanical rigidity (Natalio et al. 2015). In Africa, as in other parts of the world (Cordell 1993; Bloch et al. 2019), they indicate the use of lacustrine or riverine clay sources. Sponge spicules rich pottery is a rare phenomenon in sub-Saharan Africa though. Some examples are known from Mali (Brissaud and Houdayer 1986; Mcintosh and MacDonald 1989; Nixon and MacDonald 2017), Sudan (Adamson et al. 1987) and the great lakes region of East Africa (Ashley 2005, 185). Their presence in ceramics from the Congo Basin is a complete novelty. The lack of observed

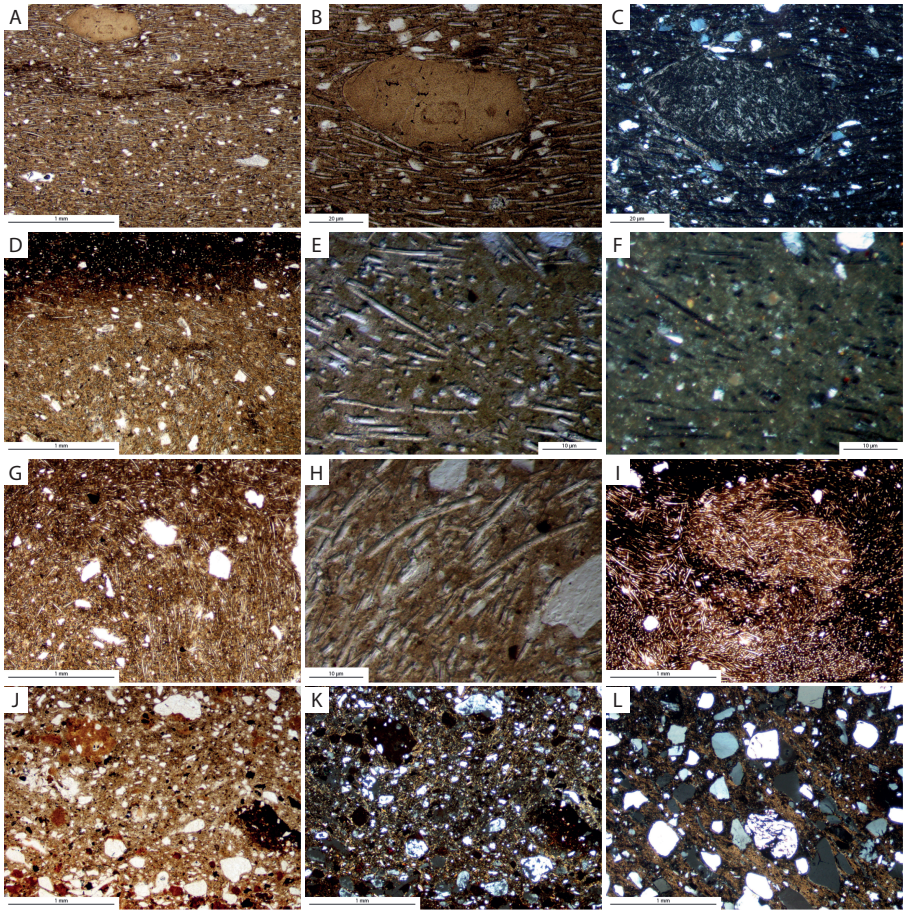

Fig. 5: Photomicrographs of ceramics from Pikunda (A–C, J–L), Munda (D–H) and Itanga (I) (*cf.* Fig. 1B) dating into the Early (A–F) and Late Iron Age (G–L) illustrating the main petro-fabrics encountered (A–B,D–E,G–J in plain-polarized light [PPL]; C,F,K–L in cross-polarized light [XPL]). Pikunda-Munda pottery (A–F) is unanimously produced using riverine clays rich in sponge spicules (A–H). Samples from Pikunda dating into the Late Iron Age were systemically produced using terrestrial clays void of sponge spicules (J–L). Additional features include clay pellets (B–C) and clay mixing (I).

gemmules in the thin sections hampers species identification. A synthesis of spongillofauna in Africa by Manconi and Pronzato (2009) offers some potential candidates: *Metania pottsi* is widely distributed in the region, but spicules often show conules on the surface, and the species is best identified based on their gemmuloscleres (Manconi and Pronzato 2009, 38–47); which are lacking the archaeological samples. Other species are either not documented in the western Congo Basin, such as *Eunapius nitens* (Manconi and Pronzato 2009,

149–151), which shows very similar spicules, or are poorly documented, such as *Trochospongilla philottiana* (Manconi and Pronzato 2009, 198-199).

The quartz fraction observed within this fabric consists of sub-angular monocrystalline grains interpreted as natural components of the source clays (Fig. 5C,F). Occasionally clay pellets (Fig. 5C) and evidence for clay mixing (Fig. 5A,I) were observed. Clay mixing results in varying 'optical activity' under cross-polarized light (XPL) (Whitbread 1986). In general, only very limited or no birefringence was observed. One sherds from Munda on the upper Likwala-aux-Herbes river (Fig. 5D) showed a zonation separating a clay matrix without birefringence from one with reddish interference colours and slight birefringence. The petro-fabric corresponds to the described fine macroscopic fabric 1 (Seidensticker 2021, 60–69).

While the selection of riverine clays, rich in sponge spicules and an absence of any additional tempering, can be considered a distinct characteristic among Pikunda-Munda potters, substantial changes can be observed in later times among potters' communities along the middle to upper Sangha river versus those on the lower reaches of the Sangha and along the Likwala-aux-Herbes river. At Pikunda on the Sangha river, potters' approached vastly different clay sources and tempered their clays (Seidensticker 2016, 2020). There are no indications that riverine clays rich in sponge spicules were used further. The late Iron Age sherds from Pikunda show distinct birefringence (b-fabric; Fig. 5K–L) (Stoops 2021, 131-141). The mineral component is considerably different, quartz grains are bigger, more angular and occasionally, multi-crystalline. Rock fragments can be observed (Fig. 5K). Runiquartz (Marcelino et al. 2018, 673 Fig. 6) are regularly present as well (Fig. 5L). They indicate weathering of the quartz and, thus, a highly altered environment. The sherds also contain opaque components (Fig. 5J–K), reminiscent of iron-rich minerals potentially related to lateritic soil formation processes (Scheffer and Schachtschabel 2010, 351–352). Occasionally, organic inclusions are visible. These observations indicate that potters of the late Iron Age preferred terrestrial clay sources that show some relation to soil formation processes and tempered those clays with mineral components and organics.

On the lower Sangha and the Likwala-aux-Herbes river, on the other hand, Late Iron Age potters still use similar or the same riverine clay sources prevalent in the Early Iron Age pottery. The pottery of the younger styles Ngombe, Ebambe, Epena and Mobaka (Fig. 3) all show the same macroscopic fabric 1 (Seidensticker 2021, 69 Tab. 12), which corresponds with the petro-fabric rich in sponge spicules, indicating the use of riverine clays. The concentric orientation of sponge spicules in a sherd from Munda (Fig. 5G) indicates either clay mixing or shaping by coiling.

3.2 Shaping techniques

The shaping technique used by Pikunda-Munda potters has been deduced based on features observed as macro-traces and within radiographs. The most

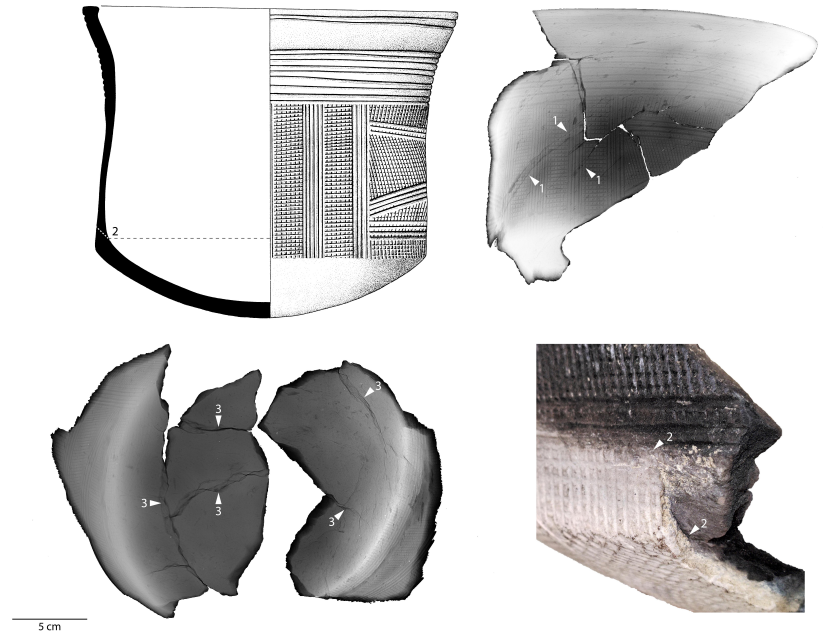

Fig. 6: Technical observations on PIK 87/1-8:1: (1) helical fissures and breaks; (2) joint between the wall and base; (3) radial and concentric fissures and breaks in the base; not depicted: horizontal polishing facets on the inside, wall-parallel lamination in the breaks and paddle marks on the exterior of the base.

Fig. 7: Technical observations on MUN 87/2-1-1-4:7: (1) helical fissures and breaks; (2) horizontal joint connecting the wall and the base.

common feature observed among vessels of the Pikunda-Munda style, which are often characteristic wide-mouthed bowls with parallel sides, flared rims and round bases, are helical fissures, cracks or breaks (Fig. 7–8, 10, 6). This feature, which usually occurs during the drying stage, indicates an upward, rotating movement the potter applies during the primary shaping stage. Such a drawing movement was documented by Kanimba Misago and Mpunga (1991) at the potters' village of Ikenge on the Ruki river (Fig. 1; Eggert and Kanimba-

Fig. 8: Technical observations on MUN 87/2-1-1-5:2: (1) horizontal polishing facets; (2) helical fissures and breaks; (3) vertical lamination of the wall; (4) concentric break; (5) radial fissures and cracks; (6) thickening of the base.

Misago 1980). Another common feature is wall-parallel 'lamination', usually visible on the breaks (Fig. 8). The same internal structure can be visible as flaking of the surface. These two features indicate a drawing technique to be applied by Pikunda-Munda potters to shape the upper parts of the vessels.

Nearly all vessels studied showed some signs that the upper part of the vessel and its base were shaped separately. While all features of the upper parts of the vessels are strikingly similar, indicating that the potters performed similar actions and motions to shape these parts, there are two modes of constructing the bases. The most widespread configuration of features is radial as well as concentric fissures, cracks or breaks in the base (Fig. 8–10). These are regularly coupled with patchy differences in the densities of the base, as

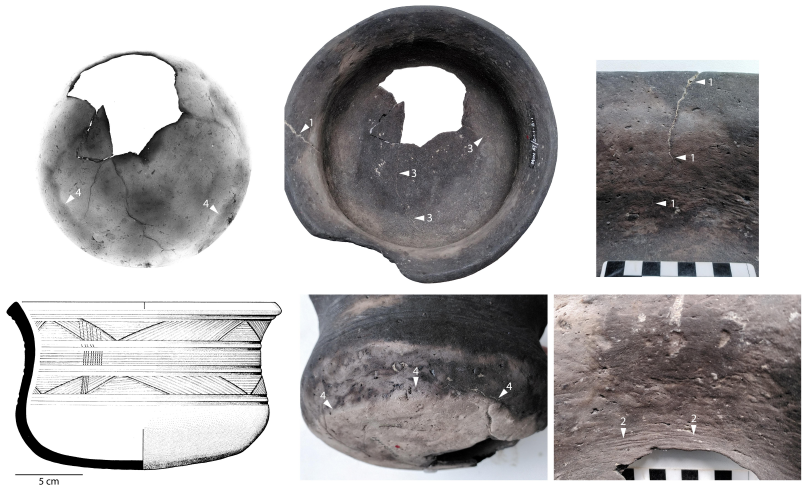

Fig. 9: Technical observations on MUN 87/2-1-1-8:1: (1) single vertical fissure and crack in the wall; (2) horizontal compression folds near the base; (3) radial fissures in the base; (4) thickening on the outside at the base.

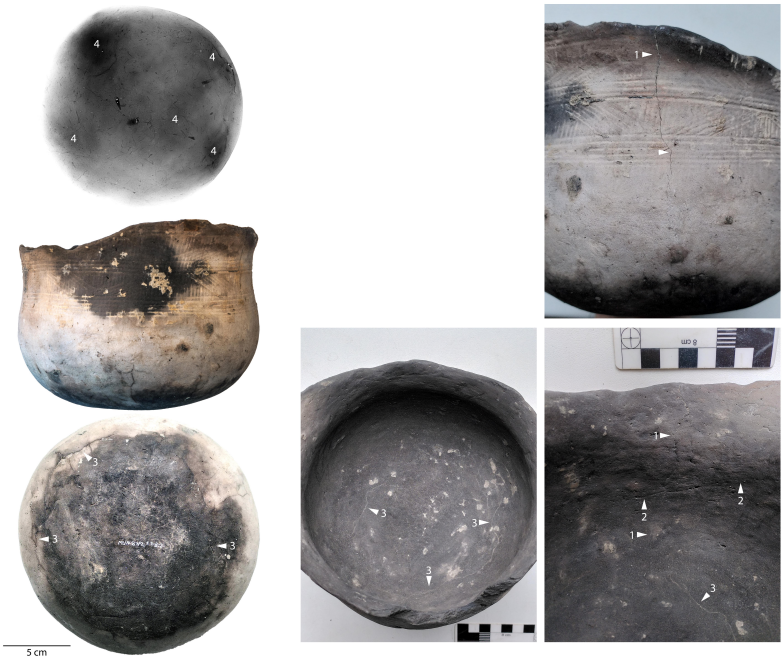

Fig. 10: Technical observations on MUN 87/2-1-1-8:2: (1) single vertical fissure and crack in the wall; (2) helical fissures; (3) concentric fissures; (4) thinning of the base and paddle marks.

observed in the radiographs. This set of co-occurring features is distinct from the features observed at the upper parts. The current working hypothesis is that these features are the remains of additional clay used to 'close' the rough-out. After adding clay, the base was shaped using pounding and paddling, similar to what Eggert and Kanimba-Misago (1980) and Kanimba Misago and Mpunga (1991) documented at Ikenge.

A second, slightly different mode is attested for in two vessels (Fig. 6–7) and characterized by a visible joint between the wall and the base, right at the carination. In one particular case (Fig. 6) the base overlaps the wall, including part of the decoration of the upper parts being covered. This indicates that the upper part must have been roughed-out, shaped and already decorated once the base, presumably pre-shaped separately, was attached. Thus, the second mode combines the drawing of a ring technique with a slab bottom.

That the initial rough-out was shaped by drawing of a ring (Livingstone Smith 2010, cf), which is a different technique from the pierced lumps observed at Ikenge (Eggert and Kanimba-Misago 1980; Kanimba Misago and Mpunga 1991), can be deduced from the singular vertical fissures and cracks in some vessels (Fig. 9–10). This feature is interpreted as a remnant of the construction of the initial ring.

The configuration of features constituting core stages of the *chaîne opératoire* of Pikunda-Munda potters consists of helical fissures, cracks of breaks in the upper part, lamination visible in the breaks and either the addition of clay to close the base, involving usage of pestles and paddles, or slab bottoms.

4 Discussion

A robust theoretical pillar to understanding material objects, on an individual and collective level, is the choices made during their production. The production process is best divided up into phases consisting of sequences of distinct actions and organized sets of operations to retrace the transformative trajectories that progressively alter the state of all used material resources; in the case of pottery, the raw clay and any additional temper materials (Gosselain 2018, 3–4). The integration of all those actions can be summed up using the concept of *chaîne opératoire*, which has already been the predominant analytical approach to behavioral analysis in lithic technology since the 1980s (Pelegrin et al. 1988). *Chaîne opératoire* approaches enable systematic and structured comparisons between sequences of actions on an intra- and inter-community level (Gosselain 1992; Livingstone Smith 2007; Ard 2014; Gomart 2014).

For decades, variations in pottery technology have been interpreted as a result of forced adaptations to constraints imposed by raw materials rather than a result of socio-historical choices (Gosselain 2018, 6). Pioneering studies on the socio-cultural nature and putative history of potters' behavior focused only on observations within ethnoarchaeological contexts (Lechtman 1977). In general, potting practices are learned behaviors, whose knowledge base is transferred within tight-knit social networks, mostly through kinship. The work of individ-

ual potters is interrelated through collective knowledge, tools, and materials, forming a "community of practice" (Wenger 1998; Roddick and Stahl 2016). Within such communities, knowledge is transmitted by a lived experience of participation within a social network, and actions are guided by dispositions and cultural competencies (Heitz and Stapfer 2017). Training and learning, on the other hand, happen in continuous loops of applying embodied and cognitive knowledge with the use of specific tools (Kuijpers 2018).

The results presented in this study allow reconstructing key phases within the *chaîne opératoire* of potters producing Pikunda-Munda style vessels. The initial stage concerns the procurement and preparation of the raw materials. All previously studied vessel units of the Pikunda-Munda style (Seidensticker 2021, 114–120) showed a strikingly similar macroscopic fabric (Seidensticker 2021, 62 Tab. 11,69 Tab. 12), indicating similar related clay sources. The petrographic analyses presented here are further corroborating the macroscopic fabrics as all studied samples of Pikunda-Munda pottery were made using clays extremely rich in sponge spicules (Fig. 5A–F), that must originate from the floodplains of the rivers and smaller streams traversing the study area.

Research by Gosselain and Livingstone Smith (1997, 148) showed that potters usually "satisfy themselves with a very wide spectrum of clays" and that "processing techniques are not justified by techno-functional requirements but governed by traditions and/or individual perceptions of a particular clay's appropriateness". Thus the observed preferences for specific clay sources and the 'recipe' in which the raw materials are handled are chosen behaviors linked to the social identity of the potters. The findings of this study corroborate earlier observations (Seidensticker 2016, 123–124). Despite slightly varying shaping techniques and stylistic characteristics, the sole preference for riverine clays indicates multiple potters communities of practice being responsible for inventory subsumed under the same name Pikunda-Munda sharing some social identity. Especially telling is the findings from Pikunda (Seidensticker 2020), where riverine clays were not used by potters of the younger Ngoko tradition (styles colored greenish in Fig. 3) but still used by potters producing other styles such as Ngombe, Ebambe, Epena, or Mobaka (Fig. 3). This indicates that the potters of the Ngoko tradition, whose vessels are also shaped by coiling (Seidensticker 2021, 53–54 Fig. 16B,72 Tab. 13), while potters along the lower Sangha, as well as the Likwala-aux-Herbes river, pertained the knowledge of riverine clays. These are also the prevalent clays used in the western parts of the Inner Congo Basin, and all pottery dating into the Late Iron Age along the lower Sangha and Likwala-aux-Herbes river are stylistically similar to styles of the West tradition of the Equator-Co style tradition (Wotzka 1995, 221–222 Fig. 4). Future research will test to what degree the preference for riverine clays is also a hallmark of the Equator-Co tradition.

Furthermore, this study provides further insight into the primary and secondary shaping techniques of Pikunda-Munda style pottery. While earlier research (Seidensticker 2021, 47–51 Fig. 13,69–73) already suggested that Pikunda-Munda vessels were produced through drawing, this study could further specify the technique: Pikunda-Munda potters produced their vessels

through the drawing of a ring technique. Bases were either closed with additional clay or a separately shaped slab bottom.

Ethnographic research at Ikenge on the Ruki river (Fig. 1), the foremost potters villages in the Inner Congo Basin, describes a *chaîne opératoire* in which the primary shaping or roughing-out starts with hollowing out of a lump (Eggert and Kanimba-Misago 1980; Kanimba Misago and Mpunga 1991). The pierced lump, now practically converted into a ring of clay, is further shaped by drawing and additional clay is added to shape the base. This process involves pounding of the base on a flat surface and paddling of the outside (Kanimba Misago and Mpunga 1991). Among modern potters along the rivers Tshuapa, Busira Maringa, this general approach is altered as the pounding happens on a mat (Wotzka 1995, 188,196–197). Preliminary research on the shaping techniques of vessels dating into the Early Iron Age in the Inner Congo basin revealed features more related to a 'pure' drawing of a lump technique, as there are no signs of any addition of clay or separate forming techniques being used for the bases than the upper parts. Thus, the distinct drawing of a ring technique employed by Pikunda-Munda potters has no immediate connection to contemporaneous communities further east. A similar approach is only practices around the region of Kisangani. There, pottery of the early and middle phase has been shaped via drawing of a ring (Livingstone Smith et al. 2017, 110,115). This region saw a substantial change in shaping techniques as all pottery pertaining to the Late Iron Age is produced via pounding on a concave mold (Livingstone Smith et al. 2017, 111,115). In the northern Congo Basin, along the Ubangi river, the *chaîne opératoire* of only the youngest ceramics could be identified. Along the middle part of the river, coiling has been documented, while further north, already in the northern Savannas, pounding on a concave mold is practiced (Seidensticker 2021, 55–60 Fig. 19–20,73). This current patchwork of data on pottery technology in the Congo Basin and its evolvement through time prevents any integration of the *chaîne opératoire* of Pikunda-Munda potters into a wider framework.

While there are no indications for the origin of the Pikunda-Munda pottery and its distinct *chaîne opératoire*, the exact cause for its disappearance is equally unclear. The youngest feature yielding Pikunda-Munda style pottery is a pit connected to an open bowl furnace or smith's hearth at Munda dating into the 3rd to 6th century CE (Seidensticker 2021, 335–339 Fig. 170). The next youngest pottery style identified along the lower Sangha river is the Ngoko style (Fig. 3; Seidensticker 2021, 125–128), recently dated into the late 12th to mid 13th century CE (Seidensticker Submitted, Tab. 1). The vessels of the Ngoko style show solid stylistic similarities to the Longa and Mbandaka pottery of the Inner Congo Basin (Wotzka 1995, 121–128,139–143). They are made of riverine clays rich in sponge spicules (Seidensticker 2020), and shaped potentially via drawing of superimposed rings (Seidensticker 2021, 52–53 Fig. 15). Along the Likwala-aux-Herbes river, pottery production is only attested for from the 16th century CE onward again (Fig. 3), as represented by the Ebambe style (Seidensticker 2021, 131–136). Vessels of that style are very similar to the modern Epena style (Seidensticker 2021, 137–141) and both

styles are produced exclusively using riverine clays again (Seidensticker 2020). Regarding shaping techniques, preliminary research found that vessels of both styles share features indicative of the drawing of a ring or drawing of superimposed rings technique (Seidensticker 2021, 55–57 Fig. 17–18). Of particular interest in terms of the 'heritage' of the Pikunda-Munda pottery is the modern Mobaka style (Seidensticker 2021, 141–144). The defining feature of this style is carinated bowls of seemingly the same basic shape as in the Pikunda-Munda group (Seidensticker 2021, 142 Fig. 63.1,64).

Further upstream of Pikunda (Fig. 1), pottery production commences again from the 13th century onward (Fig. 3). The stylistic characteristics are substantially different, and ceramics are part of the Ngoko style tradition consisting of five successive style groups: Mandombe, Konda, Ouoesso, Pandama, and Mbenja (Seidensticker 2021, 145–162). Besides globular pots being the dominant vessel shape among these styles, they all have been produced using terrestrial clays void of sponge spicules (Seidensticker 2020). Preliminary research indicates on archaeological finds (Seidensticker 2021, 53–54 Fig. 16B) and ethnographic records indicate that coiling is the defining shaping technique within the Ngoko tradition. Thus, the styles of the Ngoko tradition are considered distinct, potentially originating further upstream along the Sangha and Ngoko/Dja river in south-east Cameroon.

5 Conclusions

This paper presents novel data on the pottery of the Pikunda-Munda style, the oldest ceramics found in the western Congo Basin, dating from the 2nd century BCE to the 5th/6th century CE. While it is not the first pottery in the Congo Basin, this is the Imbonga group found further east that is at least some 200 years older, Pikunda-Munda pottery shares certain characteristics with contemporaneous ceramics of the Inner Congo Basin. Besides stylistic similarities, such as the usage of similar tools for decorating and preferences of motives, including rocker-stamping with a comb, Pikunda-Munda potters also used riverine clays rich in sponge spicules without the addition of any temper agents. What sets Pikunda-Munda vessels apart are the shape of the vessels: its carinated bowls with round bases are unique within the Congo Basin, especially during the Early Iron Age. All its characteristics vanish after the 5th to 6th century CE, and they leave no trace in any other pottery nearby.

This research, while still in its infancy, shows that the focus on stylistic changes seen within the archaeological research of the region (Wotzka 1995; Seidensticker 2021) is only scratching the surface. Vessel morphology and decorations depict changes in fashion trends, while the detailed technical analyses shown here enable a reconstruction of decisions made by potters that tie together communities of practices.

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All data, images and computer code generated during this research is available here: `https://github.com/dirkseidensticker/PikundaMunda_DissapearingPotteryTraditions_AAR`.

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