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Iron Age plant subsistence in the Inner Congo Basin (DR Congo)
Vegetation History and Archaeobotany

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Online Resource 4

Differential diagnosis of archaeological pearl millet finds with modern related Poaceae

We compared shape and size of the archaeobotanical finds with available information on seven related *Cenchrus* species and hybrids, and sugarcane (*Saccharum officinarum*) which is currently cultivated in the ICB. In contrast to the characteristic club-shape of pearl millet, all other species have caryopses with either elliptic, lanceolate or ovate shapes.

In addition, we conducted morphometric measurements (L=Length, B=Breadth, T=Thickness, and their corresponding ratios) for 40 charred archaeobotanical caryopses (classified as domesticated *Cenchrus americanus* or cf. *C. americanus* according to their size and state of preservation) (Online Resource 3) in comparison with modern grasses. Most Poaceae species were excluded from the measurements because their caryopses are *per se* too small to match the archaeobotanical individuals, or because the general shape of their caryopses deviates distinctly from the charred caryopses. The morphometric measurements concentrated on modern domesticated pearl millet, wild and domesticated sorghum and *C. purpureus* (syn. *Pennisetum purpureum*), a wild close pearl millet relative which Kahlheber et al. (2014) did not comprehensively consider in the differential diagnosis of the pearl millet finds of Boso-Njafo (Online Resource 5). In total, 109 individual caryopses from 13 modern samples were measured in three dimensions (length, breadth, thickness, and the respective ratios; 36x *C. americanus*, 6x *C. purpureus*; 37x wild sorghum (*Sorghum bicolor* ssp. *verticilliflorum*), and 30x domesticated sorghum (*S. bicolor* ssp. *bicolor*).

In some cases, bloating or corrosion during carbonisation and/or post-deposition restricted feasible documentation to minimum values or estimates. The bases of the archaeobotanical caryopses were often missing, and the ratio L/B, often applied in the study of ancient cereal caryopses, turned out to be problematic. In contrast, the ratio B/T, reflecting whether caryopses are dorsoventrally flattened or more or less terete, turned out to be especially useful. The caryopses of the modern domesticate are highly variable in size, but in contrast to the wild progenitor and hybrids of both species, their shape is obovate (= club-shaped), and terete, i.e. almost circular in transverse section. The B/T ratio, consistently around 1, reflects the terete shape. This is the most robust criterion for

differentiating them from closely related *Cenchrus* species, sugar cane and potentially from extraordinarily small sorghum caryopses. The 40 measured archaeological pearl millet specimens also have B/T values around 1, confirming the identification.

For some species of the genus *Cenchrus* (syn. *Pennisetum*) occurring in the DR Congo, we go further into detail here (Table 1). Domesticated pearl millet does currently no longer occur near the investigated sites. However, domesticated pearl millet *C. americanus* (syn. *P. glaucum*) and the closely related perennial wild species *C. purpureus* (syn. *P. purpureum*, napier grass), which is widely distributed in the Inner Congo Basin, hybridise easily. The resulting caryopses are more similar to domesticated pearl millet caryopses in shape than to napier grass caryopses (Dowling 2011). This fact is relevant when considering the Late Iron Age archaeobotanical finds. Theoretically, once present in the area, domesticated pearl millet might have hybridised with napier grass, and therefore finds of caryopses reminiscent of pearl millet might represent naturalised hybrids. The triploid F₁ hybrid plants resulting from pearl millet and napier grass crossing are, however, sterile (Brunken 1977; Dowling 2011:22; Nunes et al. 2013) precluding a persistence or an uncontrolled reproduction and establishment of pearl millet x napier grass hybrids in the wild. Therefore, the persistence of hybrids would constantly require the presence of domesticated pearl millet plants in the vicinity. The strongly dorsoventrally flattened, elliptic to oblong caryopses of the wild species *C. purpureus* itself cannot be confused with domesticated pearl millet caryopses.

C. clandestinus (syn. *P. clandestinum*) occurs in the DR Congo but is restricted to highland sites (1950–2700 m a.s.l.). Its caryopses are within the size range of small domesticated pearl millet but are dorsoventrally flattened and lack the diagnostic club-shape of pearl millet. *C. unisetus* (syn. *P. unisetum*) displays ovate to elliptic caryopses with an acute apex that are much smaller than the caryopses from Boso-Njafo, identified as pearl millet (Kahlheber et al. 2014). The shapes of *C. macrourus* (syn. *P. macrourum*) and *C. ciliaris* (syn. *P. ciliare*) caryopses differ from pearl millet due to their truncate apexes. According to the literature survey, *P. macrourum* caryopses also differ by their dorso-ventrally compressed shape and their length/breadth ratio (Scher et al. 2015). Caryopses of *C. trachyphyllus* (syn. *P. trachyphyllum*) are 2.5 mm long and have an oblong, dorsoventrally flattened shape (Kew Science Plants of the World Online 2020b). Besides morphological differences, Kahlheber et al. (2014) excluded this species as a candidate for confusion with pearl millet as it grows in altitude ranges of 1,000–2,500 m a.s.l. (Clayton and Renvoize 1982), i.e. not in the Inner Congo Basin lowlands.

Sugar cane (*Saccharum officinarum*) is an introduced crop but is considered in our differential diagnosis because its caryopses might occur as possible intrusions and/or during recent periods, e.g. at Bolondo. According to Clayton et al. (2006 onwards) the caryopses of this species are distinctly oblong, isodiametric and 1.5 mm long. Sugar cane caryopses displayed in Cheavegatti-Gianotto et al. (2011) lack the characteristic club-shape of pearl millet.

Species	<i>Cenchrus ciliaris</i> (syn. <i>P. ciliare</i>)	<i>C. clandestinus</i> (syn. <i>P. clandestinum</i>)	<i>C. macrourus</i> (syn. <i>P. macrourum</i>)	<i>C. purpureus</i> (syn. <i>P. purpureum</i>)	<i>C. americanus</i> x <i>C. purpureus</i>	<i>C. trachyphyllus</i> (syn. <i>P. trachyphyllum</i>)	<i>C. unisetus</i> (syn. <i>P. unisetum</i>)	<i>Saccharum officinarum</i>
Caryopsis shape details	obovoid, dorsally compressed, brown, glabrous, apex truncate or obtuse	dorsoventrally flattened, truncate apex (illustration); truncate apex (Kahlheber et al. 2014)	truncate apex (Kahlheber et al. 2014)	elliptic to obovate, dorsally compressed, narrowly oblong in profile	club-shape	oblong, dorsally compressed	ovate to elliptic, acute apex	oblong, isodiametric according to reference
Caryopsis size details	1–2.5 mm long	2.6–3 mm long x 1.4–1.6 mm wide (measured in illustration)	2.4 mm long x 1 mm wide (measured in illustration)	1.8–2 mm long, 1 mm wide, 0.6 mm 'thick' (Brunken 1977); L: 1.55–2.07 mm, W: 0.65–0.93; 0.38–0.64 (own measurements, reference material)	very variable, four seed size classes	2.5 mm long	smaller than the charred caryopses from Boso-Njafo	1.5 mm long
Reference	Kew Science Plants of the World Online 2020a	Plants Database USDA 2020 (illustration); Kahlheber et al. 2014	Scher 2008 (illustration); Kahlheber et al. 2014	Brunken 1977; own measurements (reference material obtained from Kew)	Dowling 2011	Kew Science Plants of the World Online 2020b	Kahlheber et al. 2014	Clayton et al. 2006 onwards; Cheavegatti-Gianotto et al. 2011, illustration

Table 1 Description and metrical data of *Saccharum officinarum* and *Cenchrus* species related to *C. americanus*

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