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# New Developments in the Archaeobotany of South-east Nigeria

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*ABSTRACT*

Archaeobotany in south-east Nigeria is still a growing field of study. While the northern and south-western parts of Nigeria have a longer history of archaeobotanical research, the south-eastern region has only seen relatively recent studies, with much still unknown about its archaeobotanical history. This paper highlights the progress made so far in the development of archaeobotanical research in southeast Nigeria, a region with a rich history, cultural diversity, and geographic significance in West Africa. The article begins by reviewing the state of archaeological and archaeobotanical investigations in the region with the aim of identifying what has been done so far and what remains to be done. The paper then discusses the achievements, challenges, and prospects associated with the growth of archaeobotany, emphasising the need for local capacity building to advance the field. Recent archaeobotanical research in Igbo-Ukwu is used as a case study, demonstrating the ongoing work in the region and the potential it holds for understanding the paleoenvironment and early agricultural practices. Palynological and botanical macro-analysis of samples from recent excavations at Igbo-Ukwu reveals the presence of wood charcoal, food residue, seeds/fruits such as *Elaeis guineensis*, *Vitex* sp., *Pennisetum glaucum* syn. *Cenchrus americanus* and *Canarium* sp., as well as fungal and pteridophyte spores, all associated with the 10th–13th century CE cultural deposits. The paper concludes that south-east Nigeria offers great potential for unlocking Africa's rich agricultural history and hence the need to develop archaeobotanical research in the region.

## 1. Introduction

Archaeobotany, also known as paleoethnobotany, is a branch of archaeological sciences that deals with the study of plant remains (micro and macro) preserved in archaeological sites, in order to answer questions regarding people-plant interactions. Plant materials studied by archaeobotanists include *inter alia* seeds, pollen, spores, parenchyma fragments, fruits, flowers, leaves, stems, roots, wood, bark, epidermis, fibres, stomata, starch grains, phytoliths, resins, tannins, lignin, and lipids (Reitz *et al.,* 2008). These plant remains are excellent proxies that provide insights into past human behaviours, diets, agricultural practices, and environmental conditions. Africa is endowed with a rich ecological diversity that stretches from the north to the south of the continent. Yet, about half of the over 50 countries that constitute this region lack documentation of their past human plant use and archaeobotanical research (Fuller *et al.*, 2014). Nigeria's cultural and natural landscapes are richly endowed with diverse archaeological sites and ecological zones that span the country, making its terrain highly suitable for environmental archaeological research. Specifically, south-east Nigeria is well-resourced with a vast array of archaeological sites including rock shelters, caves, abandoned settlements, burials, forts, industrial sites (metal/lithic/glass working), sacred groves, war trenches and more, that hold much rich information about human cultural development from the Stone Age to the modern historic period. Unfortunately, many of the archaeologically- investigated sites have little or no associated archaeobotanical research. This paper examines the current state of archaeobotanical research in south-east Nigeria. It begins by looking more broadly at the historical development of archaeological research in the region while highlighting the gap in the paucity of documenting ancient human plant use and archaeobotanical research. The article

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further examines the challenges hindering the growth of the discipline, highlights the progress achieved in developing the subfield within the region, and explores the potential opportunities associated with its advancement. The site of Igbo-Ukwu is used as a case study to demonstrate the potential of archaeobotanical research in the south-east region. The paper concludes by projecting some of the future expectations of the discipline and suggesting ways for a smooth pathway to its development.

## 2. Geography and environment

South-east Nigeria with a total population of 16,388,378 according to the 2006 National Population Census data (NPC, 2006), is one of the six regions which doubles as a geographic and administrative/political zone in Nigeria. The region (7°4' 27.98"N 6°32'43.09"E; 4°51'15.35"N, 8°33'35.87"E) is located between the River Niger to the west and the Cross River State to the east, and the flat North Central and River Benue in the north down to the Niger Delta (Akwa Ibom and Rivers States) in the south (Figure 1). This paper focuses on the five Igbo-majority states of Abia, Anambra, Ebonyi, Enugu, and Imo that make up this region. Predominantly inhabited by the Igbo people, the region has a rich cultural heritage and history within Nigeria.

The climate of South-east Nigeria is humid tropical, with distinct rainy and dry seasons having an annual rainfall varying between 986 to 2380 mm with up to four dry months between November to February (Okonkwo and Mbajiorgu, 2010; Umeji *et al.*, 2012). The region is primarily covered by tropical lowland rainforest in the south and derived savanna vegetation in the north. The tropical rainforest is dominated by tree species such as *Khaya* sp. (mahogany), *Treculia africana* (African breadfruit), *Milicia excelsa* (iroko), *Dacryodes edulis* (African pear) and various species of palms (*Elaeis guineensis, Cocos nucifera* and *Raphia* sp.), as well as shrubs, herbs, and grasses in degraded areas. The oil-palm (*Elaeis guineensis*) is one of the most abundant species and of great importance to the people – for both its economic and cultural value in the region.

As noted by Ibeje and Ekeleme (2020), the area is well-drained, featuring prominent water bodies among others such as the Niger, Imo, Anambra, and Idemili Rivers, as well as the Njaba, Nkisi, Ezu, Ekulu and Oji Rivers. Notable lakes include Oguta Lake and Nike Lake. The south-east region of Nigeria is characterised by sedimentary rocks

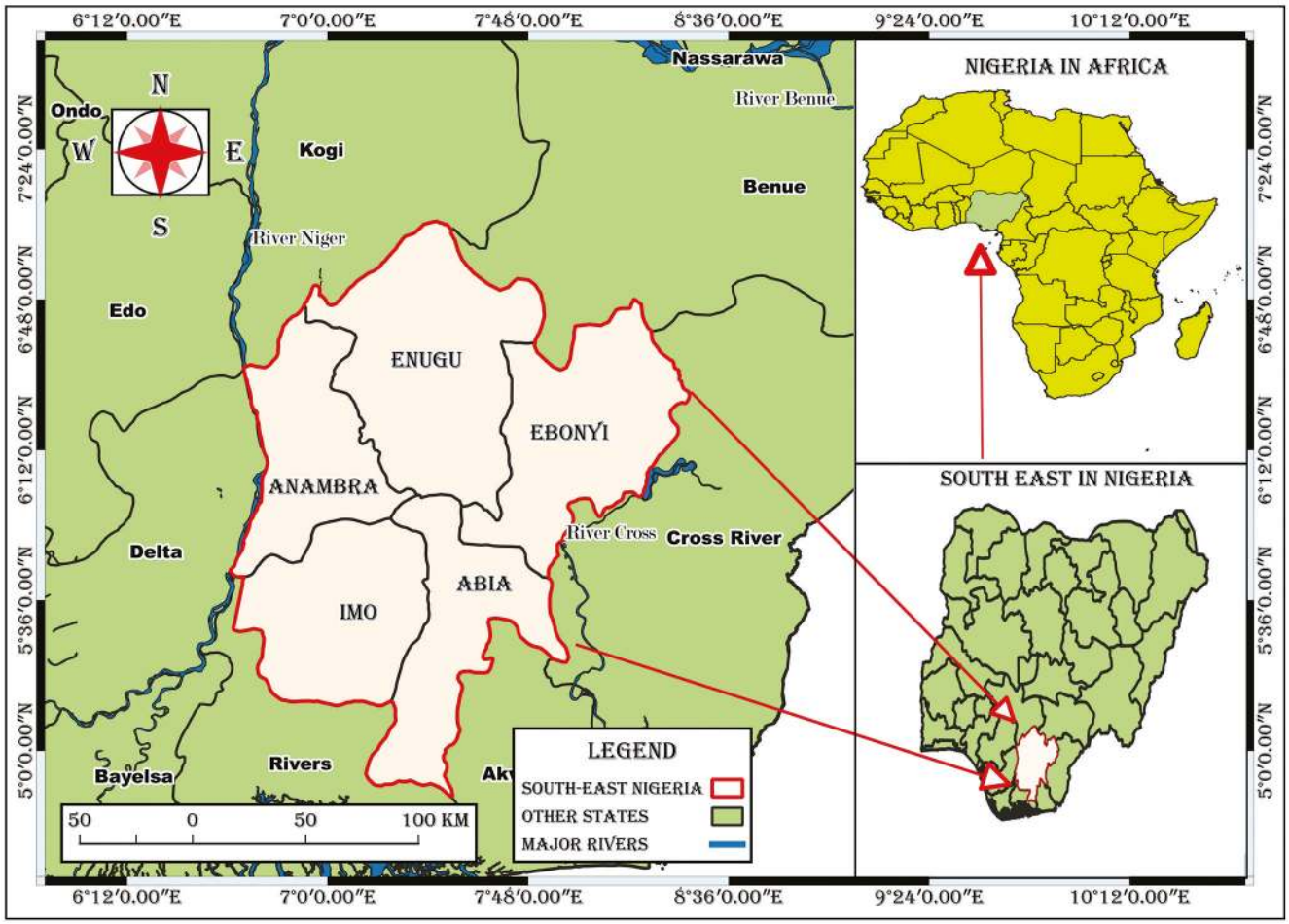



**Figure 1**. South-east Nigeria, West Africa.

of the southern Benue Trough which are younger than the ancient Precambrian basement rocks of the Oban Hills and Obudu Plateau (Umeji *et al.*, 2012). These sedimentary rocks extend into the Mamfe Embayment and the Calabar Flank, reflecting a complex geological history shaped by both ancient and more recent geological processes.

## 3. Archaeology and its history in south-east Nigeria

The overall picture of the archaeology in south-east Nigeria was virtually unknown until the archaeological excavation by Professor Charles Thurstan Shaw of Cambridge University in 1959/60 and 1964 at Igbo-Ukwu. Thurstan's work at Igbo-Ukwu marked the first professional archaeological research to be conducted in south-east Nigeria. Despite accidental discoveries made there since 1922, the site was not professionally investigated till 1959, thirty-seven years later. Shaw archaeologically investigated Igbo-Ukwu up until 1964 when he completed his research and published his findings in two remarkable comprehensive volumes (Shaw, 1970). Meanwhile, elsewhere in south-west Nigeria (Ife) the first scientific excavation in Nigeria is recorded in 1943 directed by John Goodwin of the University of Cape Town alongside Bernard Fagg and Kenneth C. Murray of the Department of Antiquities (Folorunso, 2011). Whilst the first university in the south-east, the University of Nigeria Nsukka, was founded in 1960, Nigeria's premier university, University of Ibadan, was set up in the south-west in 1948 hence the variance in the levels of development of archaeological practice in these different areas. There is no denying that the development of archaeology in south-east Nigeria, or by extension Nigeria as a whole, is connected to the establishment of institutions (*e.g.* universities and museums) – places where archaeology is taught as a subject and/or researched/practised as a discipline. Presently, the University of Nigeria Nsukka is the only university in the south-east that runs an active department of archaeology.

Shortly after the setting up of the University of Nigeria Nsukka in 1960, Donald Dean Hartle of Arizona, USA, joined the Department of History and Archaeology as an archaeologist. He sprung to action almost immediately in October 1963 by leading an archaeological survey of the eastern region under the umbrella of the University of Nigeria Nsukka with further support from the National Science Foundation, USA (Hartle, 1967). Apart from the work of Shaw at Igbo-Ukwu, no professional archaeological investigation had been conducted in south-east Nigeria prior to 1963. The paucity of archaeological research in Nigeria at the time as explained by Hartle and reported by Anozie (1985) was due to the lack of qualified Nigerians and the unwillingness of many foreign professional archaeologists to work in Africa. The reason for this may be associated with a poor conception of Africa: as a place lacking data to discuss early human cultural and technological development. This ideology changed with time especially with the reports of outstanding discoveries from different parts of the country. Within four years of Hartle's appointment, about 400 sites had been located but only fourteen of them were excavated (Hartle, 1967). The appointments of Fred Anozie and Emenike Chikwendu in 1975 and 1976, respectively, saw to the gradual development of archaeological research and teaching in the region – beginning with the setting up of the new Department of Archaeology in 1981 by the duo with some help from C. C. Ifemesia, who was the Head, Department of History/Archaeology, and D. D. Hartle who retired and left the university in 1980.

Many of the sites investigated by Hartle prior to 1967 when the Nigerian Civil War began were not published, as much of the data was lost during the war (Anozie, 2002). For the few sites that were published, some of the reports were sketchy archaeological accounts without radiocarbon dates, leaving no foundation for robust chronological and archaeological interpretation of those sites. Moreover, poor storage of materials from early excavations at the archaeology department in Nsukka hindered opportunities for revisiting the materials for further analysis. The emergence of indigenous Igbo archaeologists in the late 20$^{th}$ century (*e.g.* Anozie, 1975; Chikwendu, 1977; Okpoko,1984; Okafor, 1992; Ezike, 1998; Ibeanu, 2000) led to the beginning of an extensive archaeological survey of the region and the gradual but slow expansion of our knowledge of the region's archaeology and chronology (Table 1).

The prehistoric lithic site of Ugwuele-Uturu in Imo State represents one of the earliest archaeological sites in south-east Nigeria. The lithic industry at the site has been described by Anozie *et al.* (1978) as Acheulian, belonging to the Early Stone Age. However, this interpretation has been contested by Allsworth-Jones (2015), who argues that the lithic industry likely represents an axe factory of Holocene date. Until further research, including radiocarbon dating, resolves this debate, the true nature of the site remains uncertain. Currently, radiocarbon dates from approximately 20 archaeological sites in south-east Nigeria provide a chronological framework spanning from the fourth millennium BCE to the present day (Table 1). Among these, the oldest is the Ezi-Ukwu Ukpa rock shelter in Abia State, which dates between the fourth millennium BCE and the first millennium BCE. Although earlier dates (8000 BCE and 15,000 BCE) were obtained from Igbo-Ukwu, the dated contexts were not directly associated with material culture but instead represent old land surfaces, likely linked to bush clearing by Stone Age peoples (Shaw, 1970). The cultural assemblage at Ezi-Ukwu Ukpa includes stone tools and ceramics, but these were found mixed throughout the stratigraphic levels, creating challenges in distinguishing between the ceramic and aceramic (lithic) phases. Similar lithic tools have been identified at the Isi Ugwu Obukpa rock shelter in Enugu State, though the absence of radiocarbon dates for this site limits its comparative value with Ezi-Ukwu Ukpa. In contrast, investigations at the Ugwuagu rock shelter in Abia State (Chikwendu, 1977) revealed a well-stratified sequence with distinct lithic and ceramic phases. The aceramic horizon, representing the final phase of the Late

**Table 1.** Chronology of archaeological excavations in southeast Nigeria. C14 dates were recalibrated using https://c14.arch.ox.ac.uk/oxcal/OxCal.html#).

| Site/Location | Type | Sample | Depth (cm)/context | Uncal. years BP | 2 sigma cal. CE/BCE | Material assemblage | Investigator |
|---|---|---|---|---|---|---|---|
| Nwankwo site, Etiti Ulu, near Bende, ABIA STATE | Three excavated areas: 1. Ceremonial 2. Drinking area and 3. Garbage dump used until fairly recently with suspected periodic pit turning perhaps responsible for reversed stratigraphy. $C^{14}$ dates were obtained from the garbage dump. | GX-0587 | 46–61 | 1145±95 | 664–1116 CE | Pottery, stone work, iron, glass, beads, shells. | Hartle (1967; 1980) |
| | | GX-0588 | 168–183 | –145 | Possibly post- 1950 | | |
| Igbo-Ukwu, ANAMBRA STATE | Igbo Richard (burial) | I-2008 | Wood from stool | 1100±120 | 670–1167 CE | Ivory, beads, bronze, copper, pottery, bone. | Shaw (1966; 1975) |
| | Igbo Jonah (Disposal pit) | Hv-1514 | 335–427 (Pit VI) | 1075±130 | 664–1224 CE | | |
| | | Hv-1515 | 137–168 (Pit IV) | 1110±110 | 665–1165 CE | | |
| | | Hv-1516 | 152–168 (Pit IV) | 505±70 | 1303–1490 CE | | |
| | | I-1784 | 160–290 (Pit IV) | 1110±145 | 659–1210 CE | | |
| | Igbo Isaiah | Beta-541404 (textile) | 40–60 | 940±30 BP | 1028–1172 CE | Textile in association with bronze, copper, ceramic, and glass artefacts. | McIntosh and Cartwright (2022) |
| | Igbo IDU II | Beta-587119 | 120 (IU-2.1) | 1080±30 | 891–1024 CE | Pottery, iron object, iron slag, chalk, bone, palm kernel, *Canarium* sp. | Daraojimba *et al.* (2022) |
| | Richard Anozie Farmland | Beta-587120 | 44 (IU-1.1) | 1020±30 | 991–1116 CE | | |
| | | Beta-587121 | 145 (IU-1.2) | 800±30 | 1213–1277 CE | | |
| Umukete, Aguleri, ANAMBRA STATE | Abandoned habitation mound a.k.a 'deserted Igalla settlement' | N-3134 | Level 7 | 710±75 | 1213–1403 CE | Pottery, unworked stones, bones, glass; baked earth (possible furnace walls?); palm kernel. | Anozie (1977); Okpoko (1984) |
| | | N-3135 | Level 8 | 480±80 | 1304–1632 CE | | |
| | | N-3136 | Level 14 | 395±85 | 1400–1661 CE | | |
| | | N-3137 | Level 7 | 325±80 | 1431–1938 CE | | |
| | | N-3138 | Level 9 | 475±65 | 1309–1631 CE | | |
| Ifeka Garden Site, Ezira, ANAMBRA STATE | Burial site | GX 0942 | 46–61 | 455±95 | 1303–1646 CE | Bronze: anklets, bracelets, rings, various sizes of bells and unidentified ceremonial objects. | Hartle (1980) |

**Table 1.** Chronology of archaeological excavations in southeast Nigeria. C14 dates were recalibrated using https://c14.arch.ox.ac.uk/oxcal/OxCal.html#). (*Continuation*)

| Site/Location | Type | Sample | Depth (cm)/context | Uncal. years BP | 2 sigma cal. CE/BCE | Material assemblage | Investigator |
|---|---|---|---|---|---|---|---|
| Ezi-Ukwu Ukpa, near Afikpo, EBONYI STATE | Rock shelter | GX 0932 | 46–61 | 2045±95 | 360BCE–212CE | Stone tools (celts, hoes, cores, flakes, grinders, hammerstones, discs, querns, stone balls) and pottery. | Hartle (1967; 1980) |
| | | GX 0933 | 107–122 | 2055±85 | 356BCE–155CE | | |
| | | GX 0939 | 152–168 | 1935±80 | 102 BCE–311 CE | | |
| | | GX 0934 | 168–183 | 2620±380 | 1738 BCE– 128 CE | | |
| | | GX 0935 | 198–213 | 2860±65 | 1223–838 BCE | | |
| | | GX 0940 | 213–229 | 2935±85 | 1407–906 BCE | | |
| | | GX 0941 | 244–259 | 3125±95 | 1610–1125 BCE | | |
| | | GX 0936 | 259–274 | 3930±80 | 2625–2151 BCE | | |
| | | GX 0937 | 274–290 | 3350±95 | 1889–1430 BCE | | |
| | | GX 0938 | 305–320 | 4885± 140 | 3975–3368 BCE | | |
| Ugwuagu, Ugwuagu valley, Afikpo, EBONYI STATE | Rock shelterTrench B: Layer 2 | N-2544 | 15–30 | 2220±80 | 408–49 BCE | Polished stone axes, dimpled stone, grinding stone and microliths; better fired pottery from upper part of layer; snail shells. | Chikwendu (1977; 1998) |
| | | N-2545 | 30–46 | 2580±80 | 900–422 BCE | | |
| | Trench B: Layer 3 | N-2546 | 46–61 | 3232±90 | 1738–1297 BCE | Poorly fired pottery, and stone artefacts. | |
| | Trench B: Layer 4 | N-2547 | 61–76 | 2920±125 | 1440–812 BCE | No pottery. Snail shells, charcoal, dimpled stone, points, many cores and flakes, grinding stones and axes. | |
| | | N-2548 | 76–91 | 2970±90 | 1427–924 BCE | | |
| Ugwuagu, 750 m NE of Ugwuagu Rock shelter, Afikpo, EBONYI STATE | Abandoned settlement Layer 2 | N-2553 | 30–46 (Level 3) | 470±75 | 1317–1632 CE | Pottery, animal bones (cow, sheep, goat? and dog?), fish bone, grinding stone, stone rubber, red ochre, burnt earth and human burials. | Chikwendu (1977; 1998) |
| | | N-2551 | 30–46 (Level 2) | 505±75 | 1300–1615 CE | | |
| | Layer 3 | N-2550 | 46–61 | 695 ±85 | 1181–1416 CE | | |
| | | N-2552 | 58–76 | 395±120 | 1305–post 1950 CE | | |
| | Layer 4 | N-2549 | 76–91 | 1260±105 | 599–995 CE | | |

**Table 1.** Chronology of archaeological excavations in southeast Nigeria. C14 dates were recalibrated using https://c14.arch.ox.ac.uk/oxcal/OxCal.html#). (*Continuation*)

| Site/Location | Type | Sample | Depth (cm)/context | Uncal. years BP | 2 sigma cal. CE/BCE | Material assemblage | Investigator |
|---|---|---|---|---|---|---|---|
| Ozizza, EBONYI STATE | Rock shelter | Beta-543523 | 60–80 | 680±30 | 1276–1390 CE | Pottery, quartzite, palm kernel, seed husk, snail shells and metal objects. | Ikegwu (2014); Daniel *et al.* (2022) |
| | | Beta-543522 | 80–100 | 760±30 | 1222–1285 CE | | |
| University Farm site, Nsukka, ENUGU STATE | Abandoned settlement: irregular undulating pits perhaps responsible for reversed stratigraphy | GX-0592 | 76–91 | 4505±130 | 3625–2888 BCE | Pottery and few grinding tools. | Hartle (1967; 1980) |
| | | GX-0591 | 91–107 | 3410±115 | 2025–1443 BCE | | |
| Isi Ugwu Obukpa, Nsukka, ENUGU STATE | Rock shelter | No information | | Possibly Late Stone Age? | | Pottery and fourteen samples of crudely worked stones. | Hartle (1967; 1980) |
| Onualor-Ogadike, ENUGU STATE | Guano cave deposit | Beta-543521 | 20–40 | 220±30 | 1639–Post 1950 CE | Pottery, charcoal, polished stone, broken wooden stool, slag, palm wine gourd, tripod mud. | Daniel *et al.* (2022); Daniel and Ibeanu (2020) |
| | | Beta-543520 | 40–60 | 112.69±0.42 pMC | 1957–1995 CE | | |
| | | Beta-543519 | 60–80 | 4650±30 | 3517–3363 BCE | | |
| Amaovoko, Lejja, Nsukka, ENUGU STATE | Metal working (Iron) | Ua–34415 | | 4005±40 | 2624–2461 BCE | Tuyere, Pit furnace, iron slag, pottery. | Eze–Uzomaka (2009; 2010) |
| | | Ua–34417 | | 2370±40 | 719–388 BCE | | |
| | | Ua–34416 | | 1715±35 | 245–417 CE | | |
| | | Ua–37422 | | 3445±40 | 1885–1625 BCE | | |
| | | Ua–37421 | | 2050±30 | 155–24 BCE | | |
| | Metal working (Iron) | Beta-544341 | First phase (unit 1 – context 5) | 1600±30 | 412–552 CE | Unrefined pottery with single decoration, slag, tuyere fragments and plenty of charcoal. | Ngonadi (2023a; 2023b; 2023c) |
| | | Beta-606167 | Second phase (unit 1 – context 3) | 1540±30 | 432–599 CE | Increase in pottery with diverse decorations and decreased iron working remains. | |
| | | Beta-544342 | Unit 2 –Context 2 | 2110± 30 | 342–45 BCE | High frequency of pottery, iron working residue and plant remains. | |

**Table 1.** Chronology of archaeological excavations in southeast Nigeria. C14 dates were recalibrated using https://c14.arch.ox.ac.uk/oxcal/OxCal.html#). (*Continuation*)

| Site/Location | Type | Sample | Depth (cm)/context | Uncal. years BP | 2 sigma cal. CE/BCE | Material assemblage | Investigator |
|---|---|---|---|---|---|---|---|
| Amaebo-Attamah, Lejja, Nsukka, ENUGU STATE | Domestic site | Beta-601697 | Horizon I (context 7) | 1520± 30 | 440–604 CE | Pottery with few decoration types including mineralised seeds of Cannabaceae and charred parenchyma fragments. | Ngonadi (2023a; 2023b; 2023c) |
| | | | Horizon II | No date | No date | Charred seeds of palm and Rubiaceae. | |
| | | Beta-601698 | Horizon III (context 3) | 840±30 | 1161–1268 CE | Pottery with diverse decoration types including diverse plant remains such as seeds of Asparagaceae, Brassicaceae, Polygonaceae and parenchyma cells of possibly tuber yam crop. | |
| Umundu, Nsukka, ENUGU STATE | Metal working (Iron) | UNN 0029 | | 100±75 | 1650–post 1950 CE | Furnace remains, iron slag, mounds, tuyeres and pottery. | Anozie (1981) |
| | | UNN 0030 | | 185±75 | 1519–post 1950 CE | | |
| | | UNN 0031 | | 245±75 | 1460–post 1950 CE | | |
| | | OXA-2688 | | 200±80 | 1492–1950 CE | Slags, furnace walls, charcoal, roots and rootlets. | Okafor (1992) |
| | | OXA-2689 | | 205±80 | 1486–1950 CE | | |
| | | OXA-2690 | | 130±80 | 1639–1950 CE | | |
| Opi, Nsukka, ENUGU STATE | Metal working (Iron) | OXA-3201 | | 2305±90 | 749–164 BCE | | |
| | | OXA-2691 | | 2170±80 | 398 BCE–8 CE | | |
| | | OXA-3200 | | 2080±90 | 378BCE–126 CE | | |
| Owerre-Elu, Nsukka, ENUGU STATE | Metal working (Iron) | OXA-2738 | | 1060±60 | 777–1152 CE | | |
| | | OXA-2739 | | 570±60 | 1287–1444 CE | | |
| Amaorba, Nsukka, ENUGU STATE | Metal working (Iron) | OXA-2693 | | 300±90 | 1433–1950 CE | | |
| | | OXA-2694 | | 215±100 | 1454–1950 CE | | |
| | | OXA-2695 | | 295±85 | 1439–1950 CE | | |
| Eziamugwu, ENUGU STATE | Metal working (iron smelting site) | Beta-543524 | 80–100 | 360±30 | 1453–1637 CE | Slag, baked clay, tuyere, pottery, polished stone, palm kernels, cinder, lithics (non- tools). | Daniel and Ibeanu (2021); Daniel *et al.* (2022). |

**Table 1.** Chronology of archaeological excavations in southeast Nigeria. C14 dates were recalibrated using https://c14.arch.ox.ac.uk/oxcal/OxCal.html#). (*Continuation*)

| Site/Location | Type | Sample | Depth (cm)/context | Uncal. years BP | 2 sigma cal. CE/BCE | Material assemblage | Investigator |
|---|---|---|---|---|---|---|---|
| Nsukka Okpe Igara, Odenigwe road, University campus, Nsukka, ENUGU STATE | Fort: hill-top enclosure and shrine | charcoal | | Probably 17th or 18th C. | | No finds from enclosure. Finds from shrine include inverted miniature pottery vessels containing offering. | Hartle (1967; 1980) |
| Ugwuele Uturu, Okigwe, IMO STATE | Stone Age site | | | No dates | Early–Late Stone Age? | Variety of Stone Tools (e.g., Hand axes, Cleavers, scrapers, Flakes and Picks). | Anozie *et al.* (1978) |
| Uhuchukwu, Okigwe, IMO STATE | Cave | | 14 | Post 1950 | Post 1950 | microlith, quartz flakes, and sandstones together with a concentration of pottery. | Ibeanu (2000) |
| | | | 70 | 4691±78 | 3640–3343 BCE | | |

NB: Sites presented here are only those with published relative or chronometric dates. Several hundreds of undated sites exist in the region.

Stone Age, was overlain by a layer of crudely made ceramics, followed by a more refined ceramic layer in the upper levels (Neolithic). This sequence has been dated to between the second millennium BCE and the first millennium BCE. Other sites, including Onualor Cave, Uhuchukwu Cave, and the University Farm site, exhibit similar chronologies to Ugwuagu and Ezi-Ukwu Ukpa, dating to the fourth millennium BCE. However, lithic artifacts at these sites are sparse. For example, the University Farm site yielded only a few grinding stones alongside the pottery (Hartle, 1980), while Uhuchukwu Cave produced a small assemblage, including one microlith, quartz flakes, sandstone fragments, and a concentration of potsherds (Ibeanu, 2000). These findings underscore the rich prehistoric heritage of south-east Nigeria but also highlight the need for further research, particularly in refining stratigraphic distinctions and expanding radiocarbon dating to better understand the region's lithic and ceramic traditions.

The Metal Age in south-east Nigeria marks a significant chapter in the region's history, characterised by the introduction and use of metals such as iron, copper, tin, and lead. The region boasts of a long and continuous sequence of metal working, spanning from the third millennium BCE to the second millennium CE (Anozie, 1981; Okafor, 1992; Eze-Uzomaka, 2009; 2010; Daniel and Ibeanu, 2021; Ngonadi, 2023a; 2023b; 2023c). Bronze artefacts, primarily composed of copper and tin alloys, have also been identified in the archaeological record. Igbo-Ukwu represents the oldest bronze-working site in West Africa, with remarkable bronze objects such as openwork ornaments, crotals, scabbard support rods, elephant head ornaments, the famous "Igbo vase", and other items, dated to the 9th–10th century CE (Shaw, 1970). Similarly, excavations at the Ifeka Garden site in Ezira suggest that bronze use, evidenced by artefacts such as anklets, bracelets, earrings, bells, and ceremonial staff-like objects, continued until the 17th century CE, showcasing similar designs with those from Igbo-Ukwu (Hartle, 1980). The south-east region's rich tradition of early bronze work is further supported by numerous oral accounts of bronze artefact discoveries by local communities in recent times. This cultural continuity highlights a clear progression from the Late Stone Age to the Neolithic through the Metal Age and into more recent historic periods. However, there remains a substantial gap in our understanding of plant domestication and the beginnings of agriculture in the region. Understanding how agricultural activities supported early societies' development is crucial, yet archaeobotanical studies in south-east Nigeria remain sparse. This gives extra weight to the pressing need to develop and expand this subfield to enhance our knowledge of the region's early societies and their interaction with the environment.

## 4. Archaeobotanical research in south-east Nigeria

The comprehensive application of botanical knowledge to explore past human plant utilisation within an archaeological framework in south-east Nigeria is a relatively recent advancement. Archaeobotanical studies in south-east Nigeria (Chikwendu 1998; Umeji *et al.* 2012; Daniel *et al.* 2022; Daraojimba *et al.* 2022; Ngonadi 2023b; 2023c) are still sparse with only few archaeological sites with archaeobotanical studies (Figure 2; Table 2). Though, an earlier attempt has been made (for example, Chikwendu,

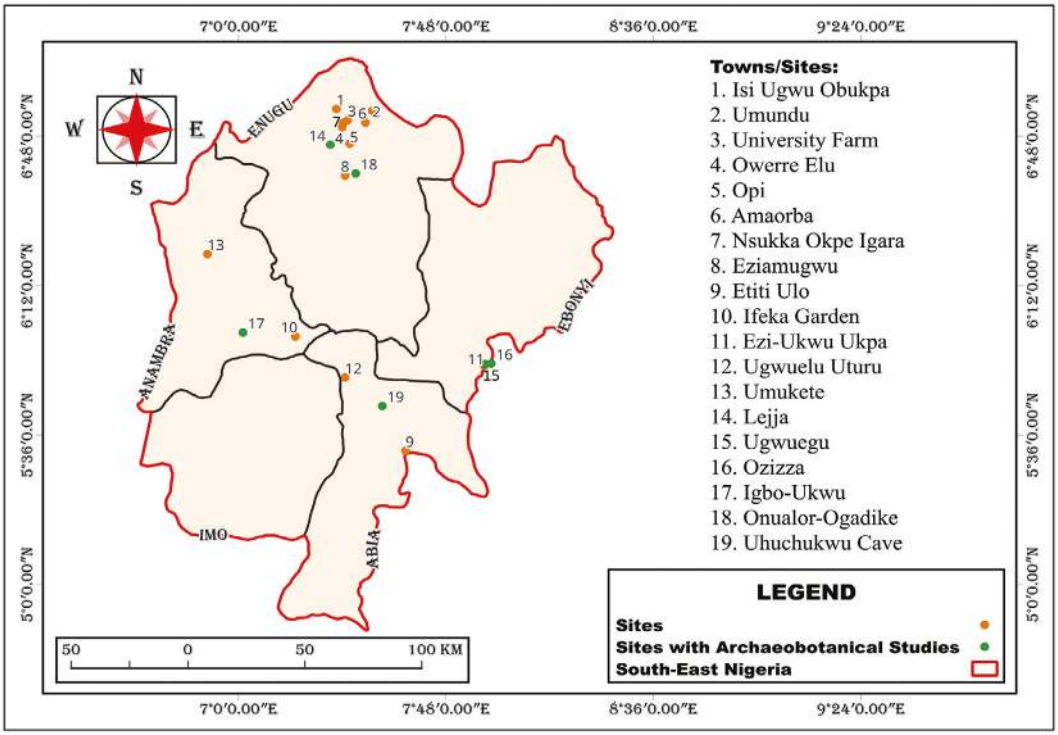



**Figure 2.** Sites in south-east Nigeria.

**Table 2**. Sites with archaeobotanical study in south-east Nigeria.

| Site | Type | Age of floated contexts | Investigator (s) | Method |
|---|---|---|---|---|
| Igbo-Ukwu, Anambra State | Domestic | First millennium to second millennium CE | Daraojimba *et al*. (2022); Daraojimba (this paper) | Flotation; Pollen analysis |
| Ugwuagu, Ebonyi State | Abandoned settlement | Second millennium CE to second millennium CE | Chikwendu (1977; 1998) | Botanical samples from excavation/dry sieving |
| Ozizza, Ebonyi State | Rock shelter | Second millennium CE | Ikegwu (2014); Daniel *et al.* (2022) | Pollen analysis |
| Amaebo-Attamah and Amaovoko (Lejja), Enugu State | Iron smelting | First millennium CE to second millennium CE | Ngonadi (2023b; 2023c) | Flotation |
| Onualor-Ogadike, Enugu State | Cave | Fourth millennium BCE to second millennium CE | Daniel *et al.* (2022) | Pollen analysis |
| Uhuchukwu, Okigwe, Imo State | Cave | Fourth millennium BCE to second millennium CE | Umeji *et al*. (2012) | Pollen analysis |

1977; 1998), the sample recovery was not done through proper sampling procedures (Champion and Fuller, 2019). The botanical specimens were primarily gathered by sieving excavated sediments through a mesh sieve with an approximate size of 6 mm. This suggests that smaller seeds and plant remains were likely lost compared to what could have been saved if the standardized 250–300 µm mesh sieve, with a mesh size over twenty times smaller, had been used for floated samples. Plant macroremains was featured as a specialist report in the published excavations at Afikpo (Chikwendu, 1998). Prepared by O. C. Nwankiti from the Botany department, the report represented a crucial step in exploring the role of plants in subsistence practices within the region's archaeological history. The report attributed cracks observed on oil palm shell remains to human activity, a conclusion supported by the presence of "dimpled stones" at the same stratigraphic level, which were believed to have been tools for cracking the shells.

Recent archaeobotanical studies in the region provide further evidence, revealing that human metal smelting significantly contributed to the transformation of natural vegetation on the south-eastern Nigerian plateau from rainforest to "oil-palm bush" over the last 5,000 years, despite increased rainfall (Umeji *et al.*, 2012). In addition, archaeobotanical analysis of samples from recent excavations at Igbo-Ukwu has identified wood charcoal and, for the first time, fruits of *Vitex* species and the oil palm tree. These finds, associated with the 10$^{th}$–13$^{th}$ century CE Igbo-Ukwu cultural deposits, suggest that these fruits likely played a role in the subsistence economy of the area during this period (Daraojimba *et al.*, 2022). Also, Daniel *et al.* (2022) revealed that pollen data from Onualor Cave in south-east Nigeria reflect alternating environmental conditions during the Late Holocene, transitioning between wet-forested and dry-savanna phases. The presence of pollen from edible and economically significant plants during the wet phase further points to human presence and activity in the area during this period. Additionally, archaeobotanical evidence from an iron smelting and domestic site in Lejja, south-east Nigeria, provides information about a plant food economy and the utilisation of plant resources that must have supported industrial-scale iron-working within the last 2000 years. The primary findings include the identification of key domestic food crops such as oil palm (*Elaeis guineensis*) and parenchyma, which likely indicates the presence of cooked tubers or yams (Ngonadi, 2023a; 2023b). These studies provide only a fragmented understanding of the region's archaeobotany, leaving a significant amount of data unexplored. This stands in contrast to northern and south-western Nigeria, where archaeobotanical research began much earlier and has produced more comprehensive insights into the archaeobotany of those regions (Sowunmi and Awosina, 1991; Oyelaran, 1993; Ballouche and Neumann, 1995; Neumann *et al.*, 1996; Klee *et al.*, 2000).

## 5. Approaches to archaeobotanical research in south-east Nigeria: Igbo-Ukwu example

Igbo-Ukwu (Figure 2) is famous for its royal burials, stores of intricate pottery, copper, fabric, elaborate bronze art, thousands of glass, carnelian and stone beads, and copper and iron regalia dated to over 1000 years ago (Shaw, 1970). These exquisite archaeological findings brought to our consciousness that Igbo-Ukwu represented a prosperous society that had established a complex social structure by the 9$^{th}$ century CE and had significantly interacted with the wider world through interregional and intercontinental exchange and trade. Despite the extraordinary insights that Shaw's work at Igbo-Ukwu shed on an ancient "civilisation" in south-east Nigeria and its significance in African and global archaeology, we still do not know the nature of the environment that supported this settlement growth, especially regarding early food production. Bearing in mind the cultural and economic significance of yam and oil palm to the Igbo people, it has been proposed that the ancient practice and efficiency of yam cultivation and oil palm exploitation contributed significantly to the high

population density in south-east Nigeria (Shaw, 1972). Thus, it is imperative to understand early subsistence strategies in this region by investigating more archaeological sites with evidence of farming.

Beyond excavation, archaeology is a multifaceted discipline that engages other fields in answering questions relating to human history. Since the commencement of the Igbo-Ukwu project in 2019, the project has attracted collaborations with specialists in beads, ceramics, geoarchaeology, proteomics and more generally in the archaeological sciences. Due to the preservation issues experienced on the site for plant microremains (especially pollen), it was necessary to expand the archaeobotanical data beyond pollen and spores to include botanical macroremains. Collaboration with Louis Champion, a tropical archaeobotanist and archaeologist at the Institute of Research for Development, Montpellier, France, was necessary to the actualisation of this objective. So far, botanical macro-data have begun to emerge from our excavations (see details in Daraojimba *et al.*, 2022).

## 6. Materials and methods

New archaeological investigations at Igbo-Ukwu have been conducted in five study areas (areas 1–5) distributed across 3.3 km area with intense archaeological excavations focused in areas 1 and 2 (Figure 3). Plant macro- and microremains have been recovered from excavations at units IU-1.1 (Figure 4) and IU-1.2 (Figure 5) at Igbo Richard Farmland (area 1) and IU-2.1 at Igbo IDU II (area 2). Archaeological plant macroremains were collected through the process of manual bucket flotation (Fuller, 2008; Champion and Fuller, 2019). The process involves mixing the excavated sediment in a bucket with water to allow the light fraction to float (Figure 6). The supernatant is then sieved using a 300-µm mesh size sieve to collect the light fraction, while the sand and heavy fraction remains in the bucket. This process was repeated for about three times with fresh clean water added to ensure all the plant organic materials embedded within the sediment matrix are recovered. A minimum of 10 l of soil was floated per context (level) of the excavated unit.

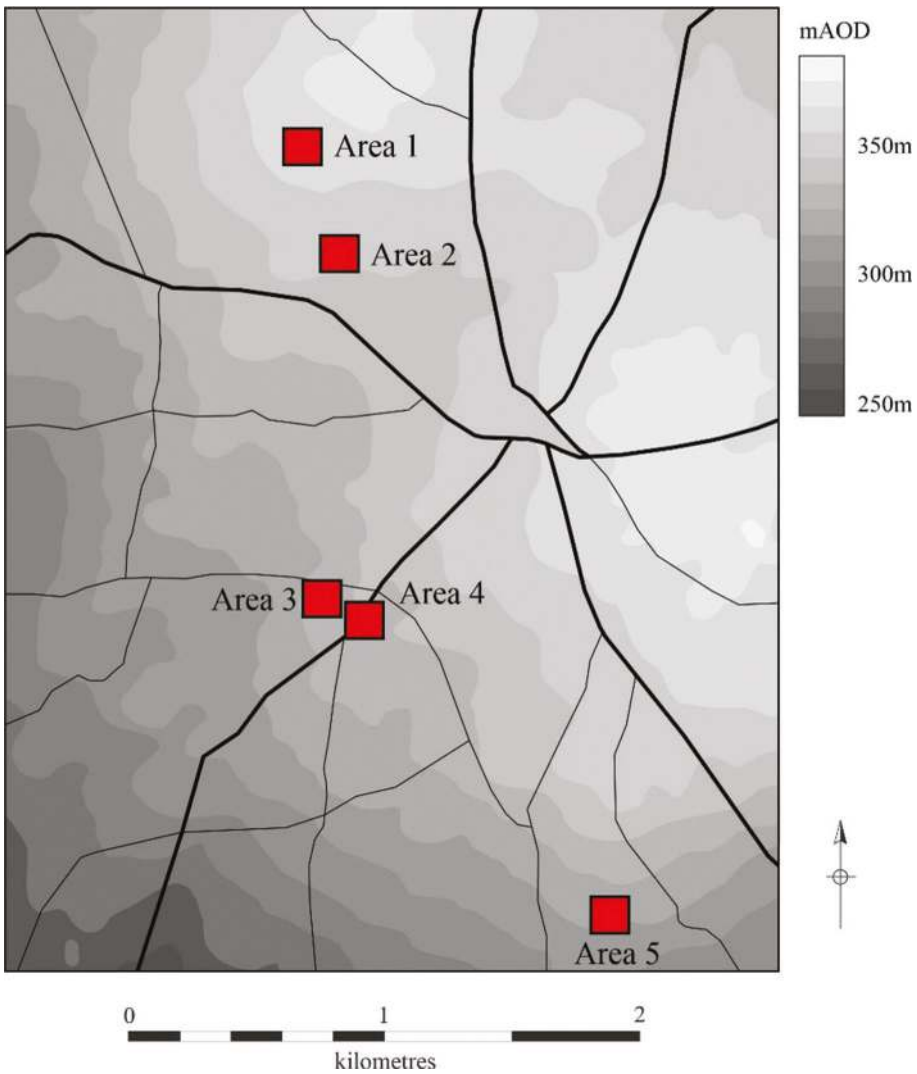



**Figure 3.** Archaeologically investigated areas at Igbo-Ukwu.




**Figure 4.** Sampling unit (IU-1.1) for archaeobotanical remains.

Plant microremains were recovered by subjecting twenty grams of sediment from the stratified layer of the excavated unit to standard treatment (Faegri and Iversen, 1989) (60% HF, 36% HCl, $ZnCl_2$/HCl [specific gravity: 2.0], 0.5% HCl), and without acetolysis, for pollen and spore recovery. Pollen slides were studied under ×20 and ×40 objectives of a GXM-L 3230 microscope with an attached camera at the Pitt-Rivers Laboratory, McDonald Institute for Archaeological Research, University of Cambridge and partly with a GXM UltraBio-3 biological microscope at the Environmental Archaeology Laboratory, Department of Archaeology and Heritage Studies, University of Nigeria, Nsukka. Archaeobotanical data presented here is with the intention of demonstrating the potential of the site for archaeobotanical studies.

## 7. Results and discussion

The data presented here are the results of archaeobotanical analysis from samples collected at IU-1.1 and IU-1.2 at Igbo Richard Farmland (Tables 3 and 4). The analysis of plant macro- and microremains from the Igbo IDU II site is still ongoing. Once completed, a comprehensive archaeobotanical dataset will be used to address questions related to agricultural practices and human-environment interactions in a forthcoming publication. In the meantime, botanical macroremains from four floated samples comprising a fragment of a carbonised food residue (potential residue of porridge), as well as some remains of *Vitex* sp., of African crops such as pearl millet (*Pennisetum glaucum*, syn. *Cenchrus americanus*), oil palm




**Figure 5.** Sampling unit (IU-1.2) for archaeobotanical remains.

**Figure 6**. Hand stirring sediment in water.



**Table 3.** Raw quantitative botanical macroremains data.

| Finds/Depth (cm) | IU-1.1 (20–30) | IU-1.1 (30–50) | IU-1.2 (60–90) | IU-1.2 (127) | IU-1.2 (150–160) |
|---|---|---|---|---|---|
| *Vitex* sp. | 4 (20) | 1 (5) | | | |
| *Elaeis guineensis* | 6 (30) | 2 (10) | | | |
| Indet. Endocarp | 1 (10) | 1 (5) | 1 (3) | | |
| cf. *Cenchrus americanus* | | | | | |
| *Canarium* sp. | | | | 1 | |
| Food Residue | | 1 | | | |
| Wood Charcoal | + + + | + + + | + + | | + |
| Intrusive Rootlets | + + + | + + + | – – | | P |

– – < 10 items, + 10–50 items, + + 50–100 items, + + + > 100 items, P = present.
Modified after Daraojimba *et al*. (2022) with inclusion of *Canarium* from excavation and depth of recovery.

**Table 4.** Raw quantitative palynomorph data from IU-1.2.

| Palynomorph/Depth (cm) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 90 | 100 | 120 | 130 | 140 | 150 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Elaeis guineensis* | 1 | | 2 | 1 | 4 | | 1 | | | | | 2 | |
| Poaceae | 1 | 1 | | | | | | | | | | | |
| Asteraceae | | | | | 1 | | | | | | | | |
| Amaranth/Chenopod | 1 | | | | | | | | | | | | |
| Unidentified pollen | 1 | | 1 | | 2 | | | | | | | | |
| *Pseudoschizea* | | | 2 | | | | | | | | | | |
| *Meliola* | 4 | | | | 1 | | | | | | | | |
| *Delitschia* | 31 | 73 | 15 | 3 | 1 | 4 | 3 | | | | | | |
| *Lasidoplodia* sp. | 40 | 12 | | | | | | | | | | | |
| *Canalisporium* | 8 | 2 | | | | | | | | | | | |
| *Cookeina* | 1 | | | | | | | | | | | | |
| *Puccinia* | 3 | 1 | | | | | | | | | | | |
| *Podospora* | | | | | | | | 3 | | | | | |
| *Polypodium* sp. | 1 | | 1 | | | | | | | | | | |
| Other Fern spore | | | 4 | | | | | | 1 | | | | |
| Other Fungal spore | 185 | 70 | 79 | 178 | 106 | 9 | 2 | | 7 | 3 | 2 | 9 | 6 |

(*Elaeis guineensis*) and a single *Canarium* sp. seed recovered from IU-1.2 at 127 cm depth during the excavation. The identification of the fossilised remains of these African food crops within archaeological contexts dating between the 10th and 13th century CE suggests the possible knowledge of these crops by the people within that period. Be that as it may, these crops have been exploited much earlier in other parts of West Africa. Research indicates that pearl millet was domesticated in West Africa earlier than the 2nd millennium BCE, with evidence from Mali suggesting domestication occurred well before previously established dates (Manning and Fuller, 2014; Champion and Fuller, 2019). Furthermore, early evidence for the exploitation of oleaginous forest species, *Canarium schweinfurthii* and *Elaeis guineensis*, has been recorded at Bosumpra, Ghana, dating to the mid-6th millennium BCE and mid-8th millennium BCE, respectively (Oas *et al.*, 2015). However, new research from Iho Eleru, Nigeria, indicates that the exploitation of these tree fruits occurred earlier, dating to the 12th millennium BCE and 10th millennium BCE, respectively (Cerasoni *et al.*, 2023). Microscopic examination of the sediments from Igbo-Ukwu reveals that the samples were dominated by fungal spores with few pollen grains and fern spores (monolete and trilete), which may have been caused by the moderately acidic pH of 6.6 and oxidising conditions of the samples. The occurrence of *Pseudoschizaea* suggests a relatively warm climate with local seasonal drying (Carrión and Navarro, 2002). Parasitic fungi represented by *Lasiodiplodia, Meliola, Puccinia* and *Cookeina* also occurred in the palynomorph assemblage indicating the presence of a wide range of host plants in the area. Coprophilous fungal spores (*Delitschia* and *Podospora*) occurred at the topmost layers of the sediment profile suggesting herbivore activity within the landscape.

## 8. Challenges, achievements and prospects of archaeobotany in southeast Nigeria

Archaeobotanical research in south-east Nigeria faces several challenges that hinder its growth and development. Key issues among others include the poor preservation of organic materials, a shortage of skilled personnel, shortage of electricity supply, inadequate facilities, insufficient funding and insecurity.

Archaeobotanical research fundamentally relies on the presence of archaeobotanical data, making the preservation, availability, and accessibility of such data essential for advancing the field. However, the predominantly acidic soils in the region (Kayode *et al.*, 2019) exacerbate the poor preservation of both organic and inorganic materials. Despite this, pollen and spores are known to thrive in acidic conditions. To mitigate this challenge, adopting a mixed-method approach that integrates both plant macro- and microremains would be ideal for overcoming the limitations caused by taphonomy issues.

Since 2017, I have been the only trained academic staff in archaeobotany (archaeopalynology) at the University of Nigeria, Nsukka, up until recently when a colleague completed her PhD in archaeobotany in Cambridge with a focus on plant macroremains. Since the department's inception over four decades ago, there has been no dedicated laboratory for environmental archaeology, aside from the space used for typological pottery analysis. More needs to be done to mentor students and provide them with practical experience to make archaeobotany an attractive and viable career path. Currently, the sessional archaeology field school does not offer training in the methods of archaeobotanical sample recovery and analysis.

There is also an irregular electric power supply which is a major frustration for archaeobotanical research in the region. This makes it difficult to process samples and organise practical teaching for students. Additionally, the reference collection is insufficient, especially when compared to the vast plant diversity in the region. For instance, the University of Ibadan has around 3,600 pollen reference slides, while Nsukka has less than 3% of that collection. Also, due to the lack of a flotation machine which is expensive to procure, fieldwork has relied on bucket flotation techniques, which is cheaper and also effective in recovering plant macroremains. With the growing number of staff with a research interest in archaeobotany, there is hope for improvement in the discipline's future. The rising insecurity in the region is a serious matter of concern because of the risk of possible kidnapping and violence that archaeologists might be exposed to.

Despite these challenges, there have been significant successes in the development of archaeobotany in south-east Nigeria. The updated curriculum for the new archaeology programme at the University of Nigeria, Nsukka, is gradually taking shape. This includes courses in bioarchaeology, science in archaeology, and metal analysis, which will significantly enhance students' learning experiences. The bioarchaeology and science in archaeology courses will introduce students to aspects of archaeobotany. However, there is still a gap in the availability of external courses in the Plant Science (formerly botany) and Geography departments, which are crucial for understanding plant-human interactions. Currently, the only external courses available that provide a scientific foundation are *Geochronology and Precambrian Geology of Africa* from the Geology Department and *Digital Humanities* from the Computer Science Department. These fall short of what is needed to properly understand the technicalities of archaeobotany, particularly since most students come from an arts background.

For about seven years now, advancing archaeobotany has been a top priority for me. My training at the University of Ibadan, where this field is relatively well-established, has inspired my efforts. In 2017, the Head of Department at the time, Anselm M. Ibeanu, encouraged me to draft a proposal for the establishment of an environmental archaeology unit. Funding remained a major challenge, a common issue for archaeological research in sub-Saharan Africa. However, in late 2020, I received a Cambridge-Africa Alborada joint research grant as the African PI (Principal




**Figure 7.** Palynomorphs from Igbo-Ukwu archaeological sediments (×400 magnification): a. Fungal spore; b. *Elaeis guineensis*; c. Poaceae; d. Fungal spore; e. *Canalisporium*; f. Unknown; g. *Pseudoschizea*; h. Fern spore.

Investigator) with Abidemi Babalola at the Centre of African Studies, University of Cambridge, United Kingdom. This grant allowed for the establishment of an archaeobotany laboratory, which was completed in 2021/22. A. M. Ibeanu generously offered space in the newly refurbished museum building for the lab. Although the lab's reference collection is still developing, it currently houses 100 reference pollen slides and several essential pieces of equipment, such as microscopes (both electric powered and rechargeable), a desktop computer, refrigerator, fume cupboard, centrifuge, and sample preparation tools (Figure 7). In 2024, Diane Lister, Research Manager in the Conservation Research Institute, University of Cambridge donated duplicates of 30 modern African reference materials for seeds and fruits to support archaeobotanical studies in Nigeria. These developments are promising, setting the stage for the discipline to thrive.

There are several prospects for archaeobotanical research in south-east Nigeria. The recent completion of a research PhD in the archaeobotany of Lejja, one of the oldest iron smelting sites in Africa, is a testament to the growing interest in integrating archaeobotanical approaches to archaeological studies in the region. The research would deepen our understanding of how long-established agricultural practices in the region supported the development of advanced, industrial-scale ironworking technology from the first millennium BCE to the second millennium CE (Ngonadi, 2023c).

Similarly, new collaborations between indigenous researchers and scholars from the Global North are now fostering local capacity building. This is exemplified in the Igbo-Ukwu archaeology project where the skills of foreign collaborators are being harnessed alongside indigenous scholars to provide a comprehensive interpretation of the archaeological site. With the region's rich history and biodiversity, the future of archaeobotanical research in south-east Nigeria offers exciting opportunities to explore human-plant relationships and contribute to a global understanding of ancient practices.

## 9. Conclusion

There are still numerous research questions in south-east Nigeria that have been poorly addressed such as the origins of agriculture and ancient agricultural practices, the exploration of indigenous plant use, and the dynamics of trade, migration, and cultural exchange networks in pre-colonial times. Additionally, the region offers opportunities to investigate climate and environmental changes, as well as human-environment interactions. Collaborating with local communities could enable community-based research projects that integrate indigenous knowledge with scientific analyses, enriching both archaeobotanical studies and cultural heritage networks. This approach would significantly advance an African perspective on these critical research questions. Igbo-Ukwu serves as a shining example of how diverse archaeobotanical methods can complement each other to provide a more comprehensive understanding of the past.

Studies have shown that the African continent was not simply a passive recipient of agricultural innovations from elsewhere (Harlan, 1982). Instead, Africa was a centre of independent plant domestication, characterised by diverse agricultural systems and complex interactions with its varied environments (Neumann, 2018). More archaeobotanical investigations in south-east Nigeria would contribute to a better understanding of the role of Africa in the development of early agricultural practices, plant domestication, and human-environment interactions. Such studies could provide insights into regional adaptations, innovations, and the



**Figure 8.** Environmental archaeology laboratory in Nsukka.

complex cultural and ecological dynamics that shaped the continent's agricultural heritage. Collaborations between indigenous and western scholars should be primarily targeted at local capacity building rather than being solely co-authors in publications. Likewise, it is imperative for indigenous scholars to learn the skills rather than having a constant dependence on western scholars for their data interpretation: hence the need for a decolonisation of the discipline. As methods continue to improve and more archaeobotanical investigations are executed in south-east Nigeria and West Africa in general, there exists great potential in the region to further unlock Africa's rich agricultural history over the last several millennia.

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## References

ALLSWORTH-JONES, P., 2015. Ugwuele-Uturu: A Lithic Exploitation Site in South-East Nigeria. *Journal of African Archaeology*, 13(2), 215–232.

ANOZIE, F.N., 1975. *Contribution à l'étude de la Préhistoire de l'Afrique occidentale.* Unpublished thesis (PhD), University of Bordeaux.

ANOZIE, F.N., 1977. Excavation in Aguleri- a preliminary report. *Odinani Journal,* 2, 91–94.

ANOZIE, F.N., CHIKWENDU, V.E., and UMEJI, A.C., 1978. Discovery of a Major Prehistoric Site at Ugwuele-Uturu, Okigwe. *West African Journal of Archaeology*, 8, 171–176.

ANOZIE, F.N., 1981. *Early Iron Technology in Igboland (Lejja and Umundu).* Nsukka: Institute of African Studies Gallery, University of Nigeria.

ANOZIE, F.N., 1985. *Archaeology of Igboland*. Nimo: Asele Institute Monography.

ANOZIE, F.N., 2002. Archaeology of Igboland: The Early Prehistory. In: G.E.K. Ofomata, ed. *A Survey of the Igbo Nation.* Nigeria: Africana First Publishers, pp. 13–23.

BALLOUCHE, A., and NEUMANN, K., 1995. A new contribution to the Holocene vegetation history of the West African Sahel: pollen from Oursi, Burkina Faso and charcoal from three sites in northeast Nigeria. *Vegetation History and Archaebotany*, 4, 31–39.

CERASONI, J.N., HALLETT, E.Y., ORIJEMIE, E.A., ASHASTINA, K., LUCAS, M., FARR, L., HÖHN, A., KIAHTIPES, C.A., BLINKHORN, J., ROBERTS, P., MANICA, A., and SCERRI, E.M.L., 2023. Human interactions with tropical environments over the last 14,000 years at Iho Eleru, Nigeria. *iScience*, 26(3), 106153. https://doi.org/10.1016/j.isci.2023.106153

CARRION, J.S. AND NAVARRO, C., 2002. Cryptogam spores and other non-pollen microfossils as sources of palaeoecological information: case-studies from Spain. *Annales Botanici Fennici,* 39, 1–14.

CHAMPION, L., and FULLER, D.Q., 2019. Archaeobotany: Methods and Themes. In: P. Mitchell, ed. *The Oxford Encyclopedia of African Histories: Methods, Sources and Historiographies*. Oxford: Oxford University Press. https://doi.org/10.1093/acrefore/9780190277734.013.204

CHIKWENDU, V.E., 1977. *Afikpo Excavations May–June 1975: The Ugwuagu Rockshelter (Site 1) and the abandoned Habitation site (Site 2).* Unpublished thesis (PhD), University of Birmingham.

CHIKWENDU, V.E., 1998. *Cultural succession and community in S.E. Nigeria: Excavations at Afikpo.* England: Archaeopress.

DANIEL, K.C., 2019. *Archaeological investigation of Ojebe-Ogene clan, Enugu state, Nigeria.* Unpublished thesis (PhD), University of Nigeria.

DANIEL, K.C., and IBEANU, A.M., 2020. Archaeological Investigation of Onualor Cave in Ojebe-Ogene Area of South-eastern Nigeria. *Nigerian Journal of Archaeology,* 3(1), 1–14.

DANIEL, K.C., and IBEANU, A.M., 2021. Archaeological investigation of iron smelting in Ukehe, Nsukka Southeast, Nigeria. *West African Journal of Archaeology,* 51, 49–62.

DANIEL, K.C., IBEANU, A.M., IKEGWU, J.U., and ORIJEMIE, E.A., 2022. New radiocarbon dates from archaeological sites in parts of Igboland, southeastern Nigeria. *Radiocarbon,* 64(1), 35–50.

DARAOJIMBA, K.C., BABALOLA, A.B., BRITTAIN, M., ADEYEMO, E., CHAMPION, L., SMITH SHAW, P.J., and SULAS, F., 2022. Expanding Space and Time at Igbo-Ukwu: Insights from Recent Fieldwork. *African Archaeological Review*, 39, 437–459. https://doi.org/10.1007/s10437-022-09499-1

EZE-UZOMAKA, P.I., 2009. Iron Age Archaeology in Lejja, Nigeria. In: G. Pwiti, C. Radimilahy, and S. Macamo, eds. *Dimensions of African Archaeology: Studies in the African Past 7.* Dar es Salaam: E & D Vision Publishers Ltd., pp. 41–51.

EZE-UZOMAKA, P.I., 2010. Excavation of Amaovoko: A Further Study of the Lejja Iron Smelting Culture. In: F.A. Chami, and C. Radimilahy, eds. *Studies in the African Past. The Journal of African Archaeology Network 8*. Dar es Salaam. E & D Vision Publishers Ltd. 8, pp. 178–191.

EZIKE, J. 1998. *Ethnoarchaeological Investigations into the Beginning of Agriculture and Metal working in the Old Nsukka Division*. Unpublished thesis (PhD), University of Nigeria.

FAEGRI, K., and IVERSEN, J., 1989. *Textbook of pollen analysis*. 4th ed. Caldwell: The Blackburn Press.

FOLORUNSO, C.A., 2011. The Practice of Archaeology in Nigeria. In: L.R. Lozny, eds. *Comparative Archaeologies*. New York (NY): Springer, pp. 807–826. https://doi.org/10.1007/978-1-4419-8225-4_25

FULLER, D.Q., 2008. Archaeological Science in Field Training. In: P.J. Ucko, L. Qing, and J. Hubert, eds. *From Concepts of the Past to Practical Strategies: The Teaching of Archaeological Field Techniques*. London: Saffron Press, pp. 183–205.

FULLER, D.Q., NIXON, S., STEVENS, C.J., and MURRAY, A.M., 2014. African Archaeobotany Expanding: An Editorial. In: C.J. Stevens., S. Nixon., M.A. Murray, and D.Q. Fuller, eds. *Archaeology of African plant use*. New York (NY): Routledge, pp. 17–24.

HARLAN, J.R., 1982. The Origins of Indigenous African Agriculture. In: J.D. Clark, ed. *The Cambridge History of Africa.* Cambridge: Cambridge University Press, pp. 624–657.

HARTLE, D.D., 1967. Archaeology in Eastern Nigeria. *Nigeria Magazine*, 93, 134–143.

HARTLE, D.D., 1980. Archaeology east of the Niger: A review of cultural-historical developments. In: B.K. Swartz, and R.E. Durnett, eds. *West African culture dynamics: Archaeological and historical perspectives.* Mouton: De Gruyter, pp. 195–203.

IBEANU, A.M., 2000. *A Contribution to the Archaeology of Okigwe and its Environs*. Unpublished thesis (PhD), University of Nigeria.

IBEJE A.O., and EKELEME, A., 2020. Statistical Analysis of Climate Data of Southeast Nigeria. *Umudike Journal of Engineering and Technology,* 6(2), 82–87.

IKEGWU, J., 2014. *Archaeological study of Ozizza in Afikpo north local government area, Ebonyi State, Nigeria*. Unpublished thesis (PhD), University of Nigeria.

KAYODE, O.T., AIZEBEOKHAI, A.P., and ODUKOYA, A.M., 2019. Soil characterisation for precision agriculture using remotely sensed imagery in southeastern Nigeria. *Journal of Physics: Conference Series*, 1299, 012070. https://doi.org/10.1088/1742-6596/1299/1/012070

KLEE, M., ZACH, B., and NEUMANN, K., 2000. Four thousand years of plant exploitation in the Chad Basin of northeast Nigeria I: The archaeobotany of Kursakata. *Vegetation History and Archaeobotany,* 9, 223–237.

MANNING, K., and FULLER, D.Q., 2014. Early Millet Farmers in the Lower Tilemsi Valley, Northeastern Mali. In: C.J. Stevens., S. Nixon., M.A. Murray., and D.Q. Fuller., eds. *Archaeology of African plant use.* New York (NY): Routledge, pp. 73–81.

MCINTOSH, S.K., and CARTWRIGHT, C.R., 2022. Igbo-Ukwu Textiles: AMS Dating and Fiber Analysis. *African Archaeological Review,* 39, 405–418.

NATIONAL POPULATION COMMISSION (NPC), 2006. The 2006 *Nigeria Demographic and Health Survey: Findings and Implications for Action, South East Zone.* Abuja: Government Printer.

NEUMANN, K., BALLOUCHE, A., and KLEE, M., 1996. The Emergence of Plant Food Production in the West African Sahel: New Evidence from Northeast Nigeria and Northern Burkina Faso. In: G. Pwiti, and R. Soper, eds. *Aspects of African Archaeology: Papers from the 10th Congress of the Pan African Association for Prehistory and Related Studies*. Harare: University of Zimbabwe Publications, pp. 441–448.

NEUMANN, K., 2018. Development of Plant Food Production in the West African Savannas: Archaeobotanical Perspectives. In: T. Spear, ed. *Oxford Research Encyclopaedia of African History.* Oxford: Oxford University Press, online. https://doi.org/10.1093/acrefore/9780190277734.013.138

NGONADI, C.V., 2023a. The Archaeology of Igboland, South-eastern Nigeria. In: *Oxford Research Encyclopedia of Anthropology.* https://doi.org/10.1093/acrefore/9780190854584.013.556

NGONADI, C.V., 2023b. Archaeobotanical investigation at Lejja iron smelting site, southeastern Nigeria. *Nyame Akuma,* 100, 34–39.

NGONADI, C.V., 2023c. *Early Agricultural Communities in Lejja Southeastern Nigeria: An Archaeobotanical Investigation*. Unpublished thesis (PhD), University of Cambridge. https://doi.org/10.17863/CAM.105544

OAS, S.E., D'ANDREA, A.C., and WATSON, D.J., 2015. 10,000-year history of plant use at Bosumpra Cave, Ghana. *Vegetation History and Archaeobotany,* 24, 635–653. https://doi.org/10.1007/s00334-015-0514-2

OKPOKO, A.I., 1984. Archaeology and ethnoarchaeology in the Anambra valley. In: A.R. Hands, and D.R. Walker, eds. *History and Ethnoarchaeology in Eastern Nigeria: A Study of Igbo-Igala relations with special reference to the Anambra Valley.* Cambridge Monographs in African Archaeology 7, BAR International Series 195, Oxford: BAR Publishing, pp. 1–125. https://doi.org/10.30861/9780860542490

OKAFOR, E.E., 1992. *Early Iron Smelting in Nsukka Nigeria: Information from slags and residues.* Unpublished thesis (PhD), University of Sheffield.

OKONKWO, G.I., and MBAJIORGU, C.C., 2010. Rainfall Intensity-Duration-Frequency Analyses for Southeastern Nigeria. *Agricultural Engineering International: the CIGR Ejournal,* 12(1), 22–30.

OYELARAN, P., 1993. A preliminary report on palaeoenvironmental investigations in Iffe-Ijumu, southwestern Nigeria. *Papers from the Institute of Archaeology*, 4, 1–8.

PEARSALL, D.M., 2015. *Paleoethnobotany: A Handbook of Procedures.* 3rd ed. New York: Routledge.

REITZ, E.J., NEWSOM, L.A., SCUDDER, S.J., and SCARRY, C.M., 2008. Introduction to Environmental Archaeology. In: E.J. Reitz, S.J. Scudder, C.M. Scarry, eds. *Case Studies in Environmental Archaeology. Interdisciplinary Contributions to Archaeology.* New York (NY): Springer. https://doi.org/10.1007/978-0-387-71303-8_1

SHAW, T., 1966. Stop press: radiocarbon dates for Igbo-Ukwu. *West African Archaeological, Newsletter,* 4, 41.

SHAW, T., 1968. Radiocarbon Dating in Nigeria. *Journal of the Historical Society of Nigeria,* 4(3), 435–465.

SHAW, C.T., 1970. *Igbo-Ukwu: An account of archaeological discoveries*

*in Eastern Nigeria (1–2)*. London: Faber and Faber Limited.
SHAW, T., 1972. Early Agriculture in Africa. *Journal of the Historical Society of Nigeria*, 6(2), 143–191.
SHAW, T., 1975. Those Igbo-Ukwu Radiocarbon Dates: Facts, Fictions and Probabilities *Journal of African History,* 16(4), 503–517.
SOWUNMI, M. A., and AWOSINA, E.O., 1991. Pollen analyses of Kariya Wuro Rock Shelter, Bauchi State. *Nigerian Field,* 56, 163–170.
UMEJI, O.P., IBEANU, A.M. and AGWU, C.O.C., 2012. Holocene human occupation of the eastern Nigerian scarp lands: An impact assessment study. *Quaternary International,* 262, 2–13.