Journal of Archaeological Science (2000) **27,** 163–182
doi:10.1006/jasc.1999.0455, available online at http://www.idealibrary.com on IDEAL®

Ceramic Tradition in the African Forest: Characterisation Analysis of Ancient and Modern Pottery from Ituri, D.R. Congo

Julio Mercader*

Department of Anthropology, George Washington University, 2110 G. St. NW, Washington DC, 20052, U.S.A.

Manuel Garcia-Heras

Smithsonian Center for Materials Research and Education, 4210 Silver Hill Rd, Suitland, MD 20746–2863, U.S.A.

Ignacio Gonzalez-Alvarez

Departamento de Geologia, Area de Estratigrafia, Universidad de Oviedo, 33005, Asturias, Spain

(*Received 5 February 1999, revised manuscript accepted 7 April 1999*)

This paper aims to explain the major characteristics of pottery making in the Ituri rainforest during the last millennium AD by identifying and comparing technological aspects of archaeological and ethnographic assemblages with the primary goal of relating some present features of ceramic production to those of the past. Such comparison has been undertaken by archaeometric characterisation: mineralogical phase analysis, structure identification, and processing behavior.

This study points out that interaction between farmers and hunter–gatherers homogenised the technological repertoires throughout the diverse cultural settings of the N.E. Congo Basin. Recent ceramic assemblages share with ancient ones a consistent distribution and manufacture of pottery across a multiethnic setting in which pottery is used by ethnically diverse slash and burn farmers and bow/net hunter–gatherers. The degree of technological continuity inherent to these assemblages is measurable by empirical means, the results suggesting that ancient and modern traditions have shared, now as then, the five components that make the Ituri pottery tradition insofar as raw material extraction, preparation of clays, modelling, drying, and firing are concerned.

Keywords: D.R. CONGO, ITURI RAINFOREST, POTTERY, THIN SECTION, X.R.D., HUNTER–GATHERER/FARMER INTERACTION.

Introduction

This paper aims to explain the major characteristics of pottery making in the Ituri rainforest during the last millennium AD by identifying and comparing technological aspects of archaeological and ethnographic assemblages with the primary goal of relating some present features of ceramic production to those of the past. Such comparison has been undertaken by archaeometric characterisation of modern (Arnold *et al.*, 1991; Gosselain, 1991, 1992, 1994) and ancient pottery from the Ituri forest of D.R. Congo (formerly Zaire) in order to assess technological variability over time. This includes mineralogical phase analysis, structure identification, and processing behaviour (Bronitsky, 1986).

The late onset of ceramic technologies in the Ituri lowland tropical forests, c. 1080 ± 41 BP, indicates that farming colonisation of this region could be a late event. Furthermore, late chronologies for farming inception in the Ituri forest could denote the relevance that foraging strategies still have in local ways of life, the hypothesis that tropical forests of the Congo's watershed may have experienced differential colonisation processes over space and time, and the idea that, until recently, there have been large hunter–gatherer domains within a wider context of mixed hunting–gathering/farming economies first established 2500–2000 years ago.

The beginnings of farming and ceramic technology in this part of the Central African forests could be

*For correspondence: E-mail: MercaderJ@ancon.si.edu

0305–4403/00/020163+20 $35.00/0

related to the migration from the savanna and ecotone environmental zones of the Western Rift into the lowland evergreen forests of the Ituri region 1500 years after Iron Age farmers had already settled into other regions of the central and western Guineo-Congolian forest. In addition, it is possible that some of the so-called "traditional" aspects of modern farming and hunting–gathering societies may not have an "ancestral" time depth, but result instead from a combination of Late Holocene events, such as the several waves of farming migration into the forest during approximately 1000 years, colonial developments, and contemporary upheavals (see Rösler, 1997). When ancient farming communities of the Late Holocene came into the forest they interacted extensively with local hunting–gathering communities and possibly triggered several changes in hunter–gatherer societies, some of them being of technological nature. We are concerned with some of these technological changes in hunter–gatherer societies; namely regional ceramic homogenisation across diverse socio-economic and cultural settings (cf. Reid, 1990), and persistence of homogeneous ceramic features over time.

Although it is assumed that overall pottery inception is a direct consequence of farming migration into the Ituri forest, recent discoveries on ancient ceramic technology suggest that hunter–gatherers also fabricated, used, and discarded ceramics. This is not to say that an undetermined number of clay pots were not obtained through farmer to hunter exchange. Accordingly, archaeometric characterisation of archaeological pottery from hunter–gatherer rock shelter camps and modern pottery produced, used, and discarded by farming Lese (Malembi, Nduye) and Budu (Epulu) communities at their villages has been undertaken.

Overall, this study points out that ceramic diffusion from farmer to hunter–gatherer sites by means of interaction homogenised the technological repertoires of the complex and varied cultural and socio-economic settings of the N.E. Congo Basin. Unity and persistence over the last millennium are extensive, as suggested by the high degree of continuity observed in recent ceramic production processes.

The study area

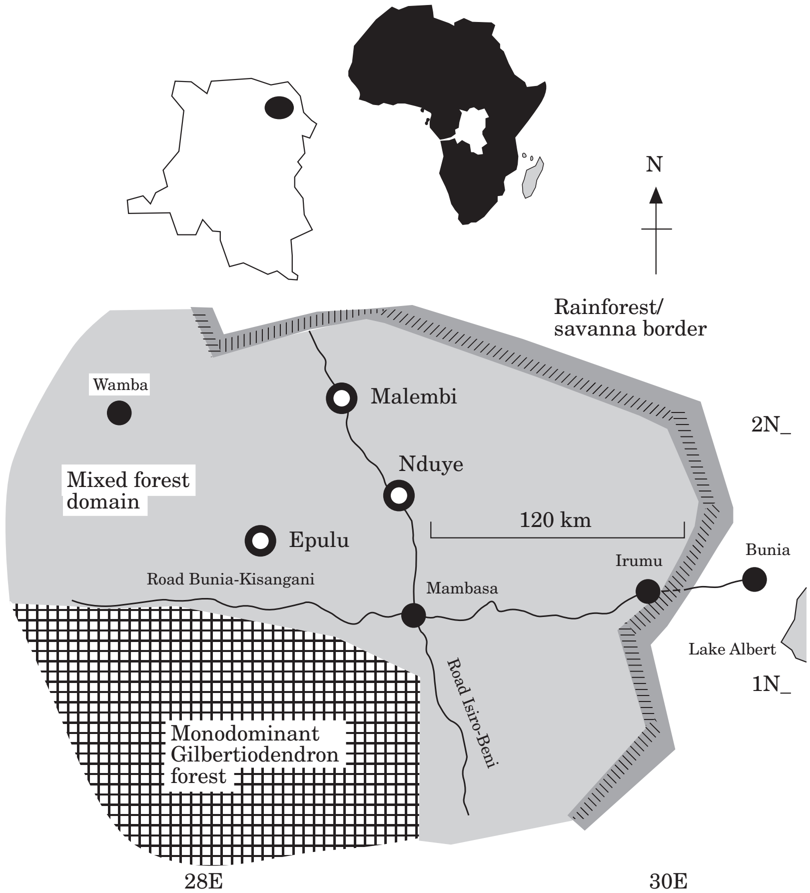
Located in the north-east corner of the central African forest belt (White, 1983) (Figure 1), the Ituri rainforest has a strategic geographical position: the study area lies in the N.E. Congo Basin (0–3° Lat. N./27–30° Long. E), a natural and cultural frontier between the African Rift and the interior *Cuvette*. Altitudes range from 1000 m in the eastern sectors to 600 m in the west. Almost evenly distributed throughout the year, an annual rainfall of 1600–1900 mm (Bultot, 1971) allows most of the Ituri district to support evergreen/semi-evergreen forests of Guineo-Congolian type. North and east of the forest zone, through the inter-lacustrine rim of the Ituri district, a smaller and heterogeneous annual rainfall sustain a transitional belt where mosaics and savannas are common. The phytogeographical setting surrounding the archaeological sites studied in this paper comprises both monodominant and mixed stocks (Hart, 1985; Hart & Hart, 1986; Hart *et al*., 1989).

The northeastern corner of the Congo Basin is also well known for its cultural complexity (Vansina, 1990), as four linguistic groups overlap: Ubanguian, Central-Sudanic, Bantu, and Nilotic. Central-Sudanic and Bantu speaking populations have settled in the Ituri forest, while no Nilotic presence is found, and a very slim Ubanguian stock is currently distributed through the Western Ituri. Present population density in the inner forest is very low (-1–4 people per km^2) (Doumenge, 1990; Bailey, 1991; Peterson, 1991) while dense settlement happens in the north-east ecotones (over 100 people per km^2). Forest peoples are classified in hunting–gathering (Efe, Sua, Asua) and farming groups (Lese, Bira, Baali, Mbo, Mdaaka, Budu, Nande). Defined as essentially interactive, current management and subsistence practices (Hart & Hart, 1986; Wilkie, 1987; Bailey & Peacock, 1988; Bailey, 1991; Grinker, 1994; Rosler, 1995) provide extensive patron–client relationships.

Central African lowland forests develop on two distinct substrates; in the central Basin (*Cuvette Centrale*), and on the surrounding igneous massifs. Extending 1,200,000 km^2, the intra-cratonic depression of the Congo River (Cahen, 1962; Goodwin, 1991) inter-digitates in granitic and karstic domains around its periphery (Figure 2) (Cahen, 1962; Cahen & Snelling, 1966; Cahen *et al*. 1984). The High Congo-Zaire Granitoid Massif, a north-eastern example of the latter (Lavreau, 1982), is partly covered by the Ituri rain-forest. This plutonic domain is surrounded (Goodwin, 1991) by the Nile formation to the north, the Lindian limestone belt to the south-west, the Bomu complex to the west, and the Cenozoic Rift, 100 km to the east of the forest–savanna border. The Ituri forest spreads over a landscape profoundly shaped by neotectonics (caused by the neighboring Rift) and granitic geomorphology. Consequently, *Grabens* and *Inselbergs* are common in that section of the forest nearest to the Rift (the north-east), and so are *tors* and rock shelters. Such cavities, in turn, have attracted human occupation up to the present.

Background

Recently, multidisciplinary research undertaken by one of us (JM) in the Ituri rainforest has retrieved a first series of sites that shed new light on forest settlement, environmental context, subsistence modes, and technological development from the Late Pleistocene up to the present. Granite outcrops in the vicinities of Malembi, Nduye and Epulu, located in the Okapi Wildlife Reserve, were surveyed: ten rock shelter sites were test excavated to various degrees (up to 2 m^2)



List of sites near:

Malembi:	Nduyu:	Epulu:
Wataka Gitatu E (WGE)	Koma Tufe SW (KTSW)	Lengbe (L)
Baiku W (BW)	Makubasi SE (MSE)	
Isak Baite SW (IBSW)	Makubasi SW (MSW)	
Matangai Turu NW (MTNW)	Makubasi NE o.(MNWO)	
	Makubasi NW i.(MNWI)	

Figure 1. The Ituri region, forest domains, locales covered by survey, and list of excavated sites.

for a total of 12 months between 1993 and 1995 (Mercader, 1997).

Despite the geological homogeneity of the region, the Ituri shelters observe a diverse petrology: granodiorite, granitoid rich in quartz, sienogranite, monzogranite, gneiss, quartzite, diabase and tonalite. Rock shelters developed either near *inselberg* peaks or on hill slopes. These were formed when boulders flaked off and experienced differential weathering (even dissolution) at their bases, or, alternatively, when two or more *tors* leaned against each other. Ten to fifteen metres in height, these boulders have their mouths randomly oriented, showing variable light conditions, and enclosed inhabitable spaces (51·9 m^2), including dry and wet areas. The average distance to the closest current water source is 184 m. Given space limitations, a selected sample of cave sections, floor plans, and stratigraphies are shown in Figures 3 and 4.

Lithostratigraphic and soil studies show that archaeological deposits from the Ituri rock shelters are composed of sandy clay loam matrices (70% clay, 24% quartz, 4% plagioclase, 1% biotite, and 1% opaque minerals) which have originated through alteration of erosion products from the surrounding granitoids. These deposits have then experienced soil development and diverse cultural formation processes. Rock shelters are filled to variable depths (down to 2·15 m). These deposits lack layering, but exhibit variation through the section in cultural, textural, edaphic, geochemical, and color parameters. Depositional environments at these cavities were very low energy, as indicated by the absence of significant hydraulic contribution or colluvial influx. At the onset of this project very little edaphological information for the Ituri region existed (Hart, 1985; Hart *et al.*, 1989). Soil studies (Table 1) suggest that edaphic development in Ituri varies from

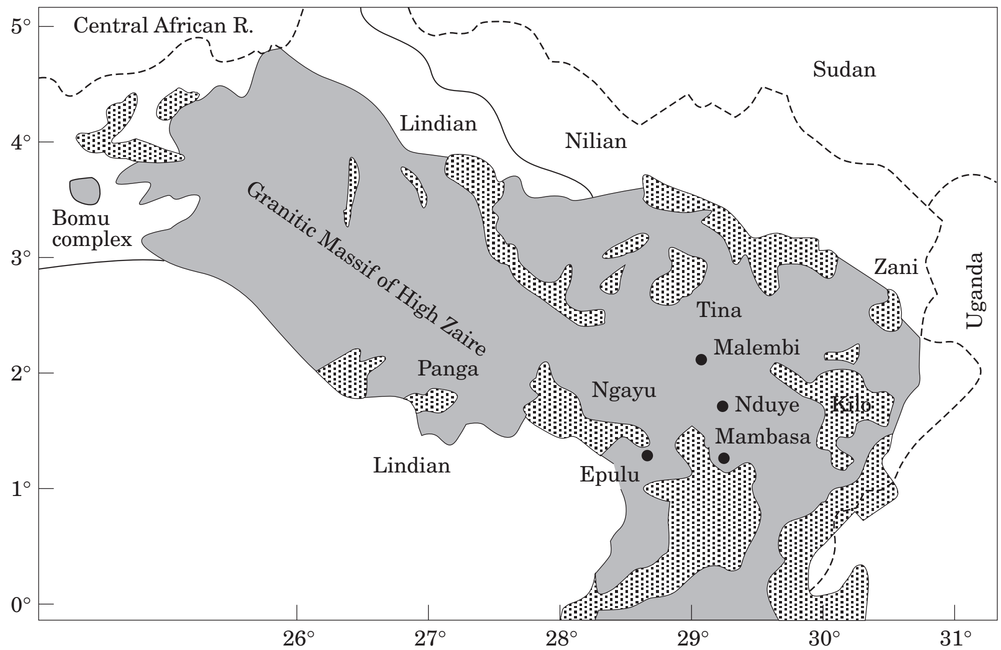


Figure 2. Geological sketch of North-East D.R. Congo showing both granitoids, metasediments, and volcanic rocks. Black dots show locales where samples were taken. ▦, Metasediments and volcanic complex; □, Granitic Massif. Based on Lepersonne (1974).

one site to another: soils comprise variable geochemical and textural environments, belonging to three soil orders—Inceptisol, Ultisol, Leptosol—and to at least six soil types. They also show a mostly neutral pH (around 6), a good drainage, and a limited water content (3·2% to 9·7%).

Radiometric dating suggests that forest occupation in this sector of the Congo Basin took place before 10,530 ± 50 BP (UtC Nr 5075: charcoal sample from Matangai Turu N.W. recovered 0·45 m above the first occupation remains), in the Late Pleistocene, continuing on through the Holocene, to the present. Evidence of hunter–gatherer occupation in the basal deposits just above bedrock (Matangai Turu N.W., depth 2·15 m) consists of environmental (phytoliths) and cultural remains (lithic assemblages with industries typical of Late Pleistocene times). Since no actual dating of Matangai Turu N.W.'s basal layers was possible, these early periods can be tentatively framed in a late phase of the Leopoldvillian (18,000–12,000 BP?). This basal occupation could be consigned to the peak of the hypothermal (LGM) and/or the beginnings of the re-establishment of dense forests in central Africa, around 12,000–10,000 BP (see neighbouring Western rift sequence in Sowunmi, 1991). Then, middle units (depth 1·70–0·45 m) represent hunter–gatherer occupations of the Early and Middle Holocene, while upper deposits (depth 0·45 m–surface) correlate the Late Holocene: 1080 ± 41 BP (UtC Nr 5076: charcoal sample from Makubasi N.W. associated with earliest pottery) to 813 ± 35 BP (UtC Nr 5074: human bone from earliest iron bearing layer at Matangai Turu N.W.). This sequence points to a lengthy hunter–gatherer settlement of the forest prior to farming.

Tropical rainforest cultures of the past and present are conventionally referred to a unified area, as if they comprise a single interaction and settlement zone. In the African case, this zone is dominated today by speakers of Bantu languages practicing either subsistence horticulture based on root crops and bananas or hunting–gathering closely tied to horticulturalists. On linguistic and ethnographic grounds the Congo Basin is widely presumed to have been settled from the West, through the so-called "Bantu expansion". In the past, however, the peripheric uplands of the northeast Congo Basin appear to have been a major crossroads in the settlement of Equatorial Africa. From the Late Pleistocene to modern times this region connects the different border-zones of the Great African Rift: the forested lowlands of the Congo watershed, the forest–savanna ecotones, the highlands of the Rift, the great lakes, and the savanna woodlands of the Rift itself and its periphery. In the light of the archaeological evidence so far uncovered, Ituri forest human populations seem not to have been oriented to the *Cuvette* or to more western locations of the central African forest, as previously presumed. Ituri's orientation towards the Rift is best represented by the similarity between technological resources used by local lowland forest dwellers and those found across the Northwestern Rift. These similarities comprise lithic, ceramic, and iron technology over time. On this paper, we focus on pottery alone (Figures 5–7).

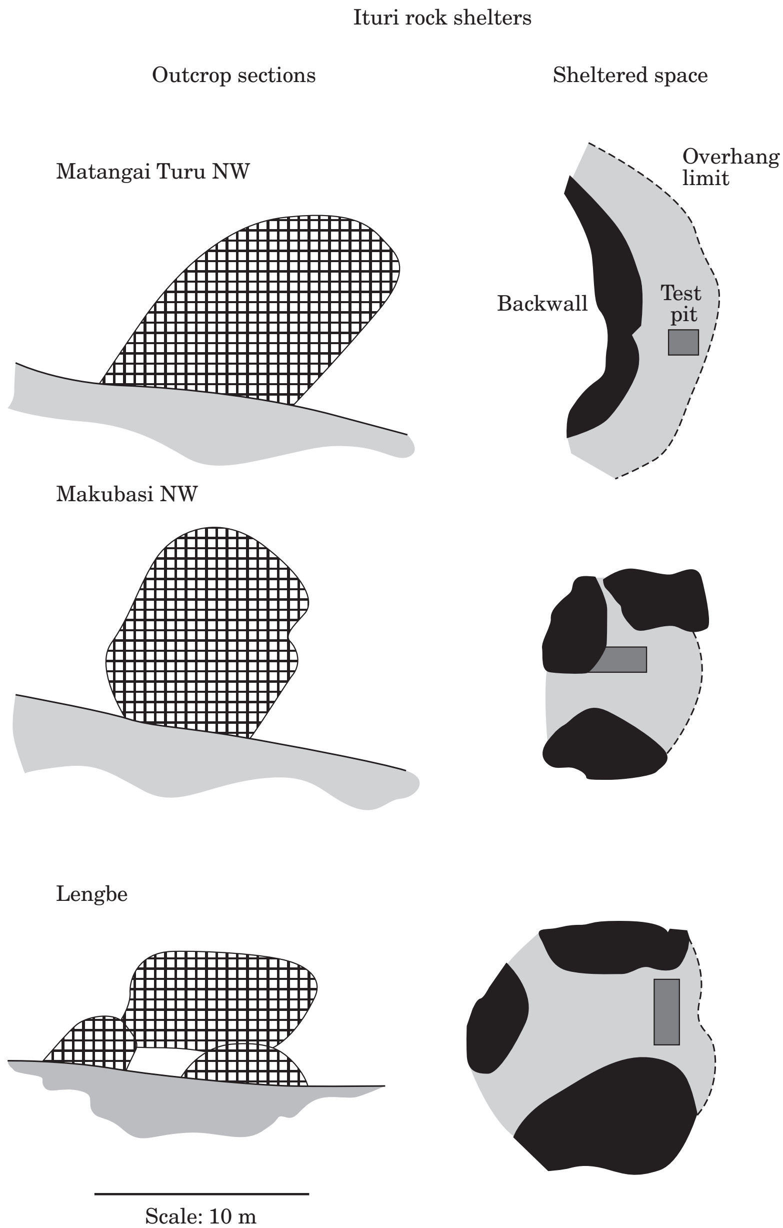


Figure 3. Ituri rock shelters: cross-sections, available space for inhabitation, and test pit location within the caves.

The farming settlement of the Ituri forest took place in several migration waves. Probably, the ancestors of the current Lese people, presumably the oldest farming settlers of the region (Wilkie, 1989; Bailey, 1991), could have fabricated and discarded the oldest ceramics found in the archaeological record of Ituri, 1000 years ago. Later in time Mbo, Mdaaka, and Bira arrived in the region (Bailey, 1991; Rosler, 1995) and must have interacted with both Lese agriculturalists and Efe, Sua, and Asua hunter–gatherers. Then, within the last 150 years, Budu farmers from the north-west, Baali people from the south-west, and Nande groups from the south-east (Peterson, 1991) joined the already complex ethnic mosaic of the Ituri forest to form the current ethnic setting.

Probably ceramic inception in the Ituri forest could be a late event. While sites in most central and western locations of the Congo Basin and throughout the Western Rift show an early onset of pottery making around *c.* 2500–2000 BP, the Ituri sites known to date present no evidence of pottery during this time period (e.g. between 2970 ± 70 BP and 850 ± 70 BP at the site of Lengbe, Central Ituri). Ceramic inception in the N.E. Congo Basin, unlike that of surrounding regions, could take place during the Late Iron Age, around 1000 BP, as indicated by the techno-typological features of the earliest ceramic occurrences from Ituri, by three radiocarbon dates from the earliest pottery bearing layers at sites within the evergreen forests of Ituri (1080 ± 41 BP, UtC Nr 5076; 971 ± 33 BP, UtC Nr

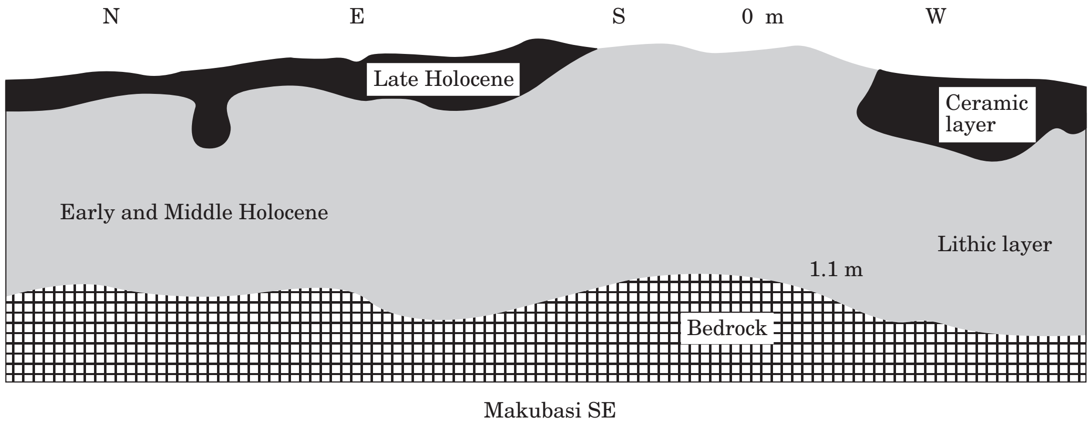


Figure 4. Stratigraphic section at Makubasi SE.

5077: both dates on charcoal from MNW; 850 ± 70 BP, Beta 127078, charcoal from Lengbe), and by parallel chronologies from stylistically similar Late Iron Age assemblages in the forest–savanna border (Van Noten, 1977) and the Interlacustrine area (Connah, 1997).

The archaeological evidence for an early farming settlement of the Western Rift, unlike that of Ituri, indicates that farming groups had already settled the Interlacustrine area 2500 years ago (Soper, 1971; Phillipson, 1977; Van Grunderbeek *et al*., 1982; Clist, 1987) and that this area supported a complex ethnic mosaic (currently of Ubanguian, Central-Sudanic, and Bantu origin) since early times (Vansina, 1990). Since the farming colonisation of the adjacent lowland tropical rainforest of Ituri could take place around 1080 ± 41 BP, it can be hypothesised that farming migration from the Western Rift into the neighboring tropical forests of Ituri took place recently; namely 1500 years after Iron Age farmers had settled in other regions of the central and western Guineo-Congolian forest (e.g. Eggert, 1987; de Maret, 1986; de Maret *et al*., 1987; Denbow, 1990). This time gap between the dates for the earliest settlement of western versus eastern sectors of the forest zone invites us to consider whether there have been differential colonisation patterns of the central African forests during the Iron Age, and whether part of the north-east quadrant of the Congo Basin (the granitic uplands) was, as somehow still is, a hunter–gatherer domain. Other regions of the Congo's watershed, significantly the western outlier and the Central Basin, undertook an early farming occupation due either to their proximity to the Bantu homeland in south-west Cameroon or to the existence of riverine environments around the Central Basin.

Ceramics are variably abundant in all Holocene layers. Archaeological ceramics are typically associated with a high input of organic matter (up to 6·6%) perhaps derived from higher occupation rates during ceramic phases. Ceramics also come with abundant charcoal, some faunal remains, stone debitage, macrobotanical evidence concerning the exploitation of tropical oils (*Canarium schweinfurthii, Elaeis guineensis*), and iron slag. The presence of slag indicates that rock shelter inhabitants were smelting and forging iron, even though there seems to be a time gap between pottery inception and iron onset, shown by a consistent stratigraphic pattern where iron metallurgy is always preceded by stone and pottery. However, none of the pots found was related to iron-smelting.

Pottery is believed to appear at these hunting–gathering camps as a result of both exchange through interaction with local farming groups and from manufacture by hunters and gatherers. That former inhabitants at the cave site of Makubasi S.E. were potters is suggested by a high frequency and diversity in ceramic assemblages that seems to go beyond eventual acquisition of clay pots by hunter–gatherer groups from neighboring farmers. First, there is direct evidence for pottery manufacture in hunter–gatherer sites such as four discoidal smoothers from MSE and MTNW. Also, there is indirect evidence such as the wide frequency of finds (total ceramic assemblage at MSE/MTNW: 1932/260 specimens, respectively, average surface density: 26·4 pottery fragments per m^2), the high formal range of vessels, the unusual decoration ratios, and the highly diversified decorative patterns. Although our direct evidence for pottery production within hunting–gathering groups is limited, we consider that additional indirect evidence, especially abundance and decoration diversity, seriously questions the possibility that exchange or introduction of pottery as collected items alone could account for the numbers found. The high amount of pottery retrieved from Ituri's Late Stone Age rock shelter assemblages stands in stark contrast to what is known about occasional exchange of ceramics from farmers to hunter–gatherers during the Iron Age elsewhere (Yellen & Brooks, 1990; Sadr, 1997), which seems to produce a very slim ceramic record amounting to less than 5% versus average values ranging from 15% at MTNW to 75% at MSE of the total artifact inventory for late Holocene layers.

Ituri's ceramic assemblage can be characterised as follows (Figures 5–7): out of 123 rims, 46·5% of the

Table 1. Textural and geochemical analysis of soils at the sites of MTNW (Malembi), MSE (Nduye) and Lengbe (Epulu)

	MTNW III	MTNW II	MTNW I	
Sand (%)	64·03	55·65	45·00	
Silt (%)	9·44	9·07	11·82	
Clay (%)	21·15	35·27	39·17	
Silt/clay	0·44	0·26	0·30	
pH	6·31	5·94	5·92	
E.C. (mS cm^{-1})	0·91	0·20	0·22	
Organic matter (%)	4·00	0·38	0·44	
$CaCO_3$ (%)	6·62	6·43	6·43	
MgO (%)	0·2	0·2	0·1	
K_2O (%)	21·9	21·6	18·1	
Na_2O (%)	1·6	1·6	1·3	
CaO (%)	0·05	0·01	0·01	
ZnO (%)	0·008	0·005	0·004	
CuO (%)	0·001	0·001	0·001	
SiO_2 (%)	65·7	62·6	60·9	
Fe_2O_3 total (%)	1·2	1·8	2·1	
Fe_2O_3 (%)	0·8	1·2	1·5	
Fe free/total (100)	66·66	66·66	71·43	
Al_2O_3 total (%)	9·4	12·3	17·5	
Al_2O_3 free	0·08	0·11	0·16	
Al free/total	0·85	0·89	0·91	
	MSE IV	**MSE III**	**MSE II**	**MSE I**
Sand (%)	71·07	45·44	47·94	62·80
Silt (%)	9·77	8·52	9·49	11·70
Clay (%)	19·16	46·04	42·57	25·50
Silt/clay	0·51	0·18	0·22	0·46
pH	5·91	5·69	5·68	5·85
E.C. (mS cm^{-1})	0·05	0·04	0·03	0·03
Organic matter (%)	6·6	1·84	1·15	0·96
$CaCO_3$ (%)	6·95	7·14	7·01	6·58
MgO (%)	0·3	0·1	0·3	0·3
K_2O (%)	21·7	22·9	31·2	25·5
Na_2O (%)	3·1	2·5	3·4	4·4
CaO (%)	0·08	0·01	0·02	0·00
ZnO (%)	0·006	0·006	0·005	0·026
CuO (%)	0·005	0·001	0·000	0·000
SiO_2 (%)	56·9	54·1	57·3	57·0
Fe_2O_3 total (%)	2·8	2·1	2·3	2·2
Fe_2O_3 (%)	0·6	0·7	0·8	0·5
Fe free/total (100)	21·43	33·33	34·78	22·73
Al_2O_3 total (%)	11·0	10·0	14·1	16·9
Al_2O_3 free	0·06	0·04	0·06	0·15
Al free/total	0·54	0·40	0·42	0·88
	LENGBE III	**LENGBE II**	**LENGBE I**	
Sand (%)	49·97	43·90	40·79	
Silt (%)	9·28	6·26	6·50	
Clay (%)	40·75	49·84	52·71	
Silt/clay	0·22	0·12	0·12	
pH	4·46	4·57	4·89	
E.C. (mS cm^{-1})	0·72	0·29	0·19	
Organic matter (%)	2·74	1·69	0·93	
$CaCO_3$ (%)	5·93	5·86	5·79	
MgO (%)	0·1	0·1	0·1	
K_2O (%)	20·2	22·8	20·3	
Na_2O (%)	1·2	1·1	1·3	
CaO (%)	0·01	0·01	0·02	
ZnO (%)	0·005	0·006	0·006	
CuO (%)	0	0	0	
SiO_2 (%)	60·2	42·0	63·6	
Fe_2O_3 total (%)	3·9	5·7	3·8	
Fe_2O_3 (%)	2·0	2·3	2·1	
Fe free/total (100)	51·28	40·35	55·26	
Al_2O_3 total (%)	14·4	28·3	10·9	
Al_2O_3 free	0·69	0·83	0·78	
Al free/total	4·79	2·93	7·15	

Soil samples "I" represent basal units, while "III" or "IV" represent top ones. Soil classification for Matangai Turu NW: humic nitisol; Makubasi SE: humic acrisol; Lengbe: ferric acrisol. Tables and soil classification: Dr A. Sanchez and Dr P. Garcia.

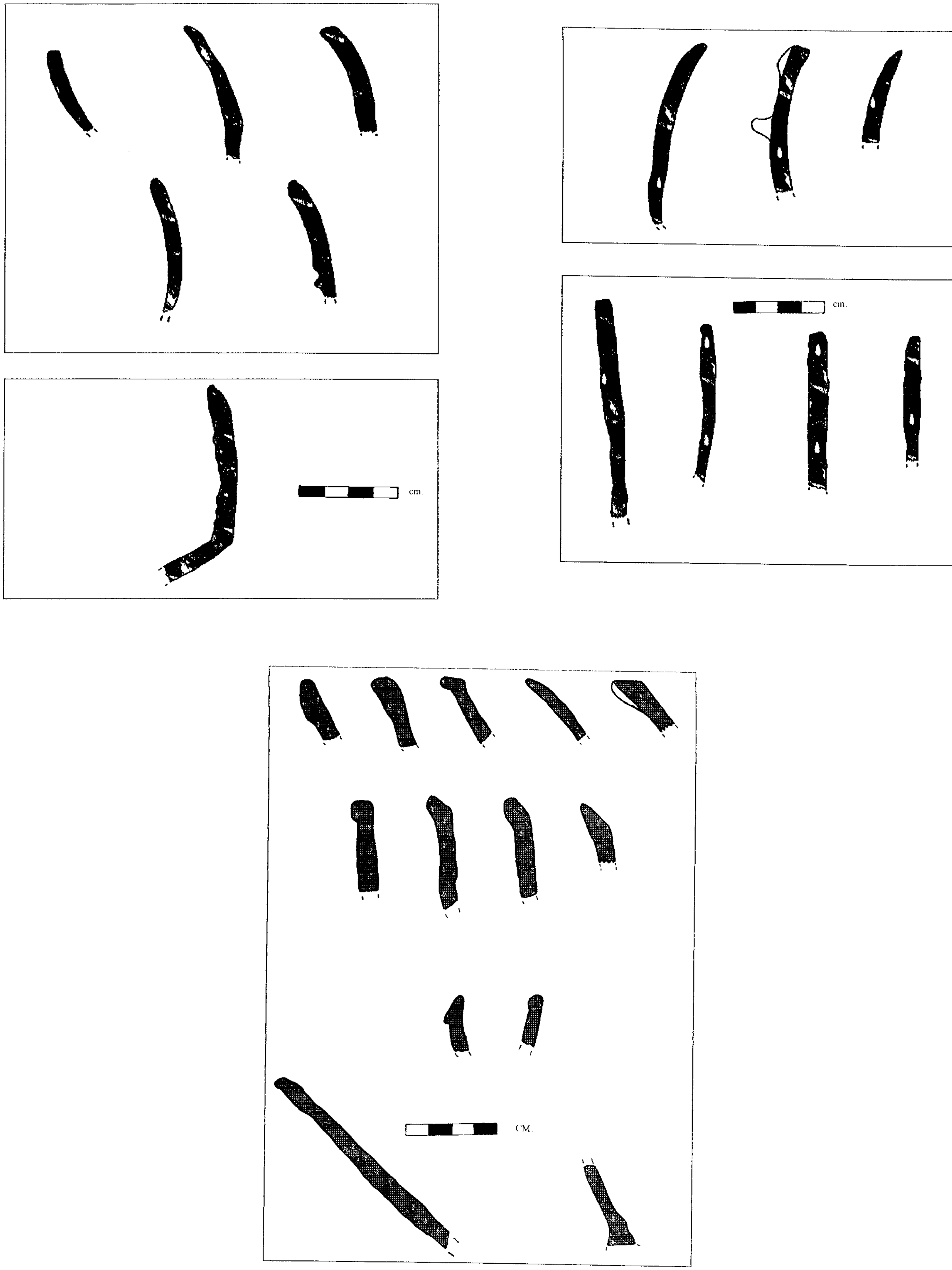


Figure 5. Ceramic forms from Makubasi SE.

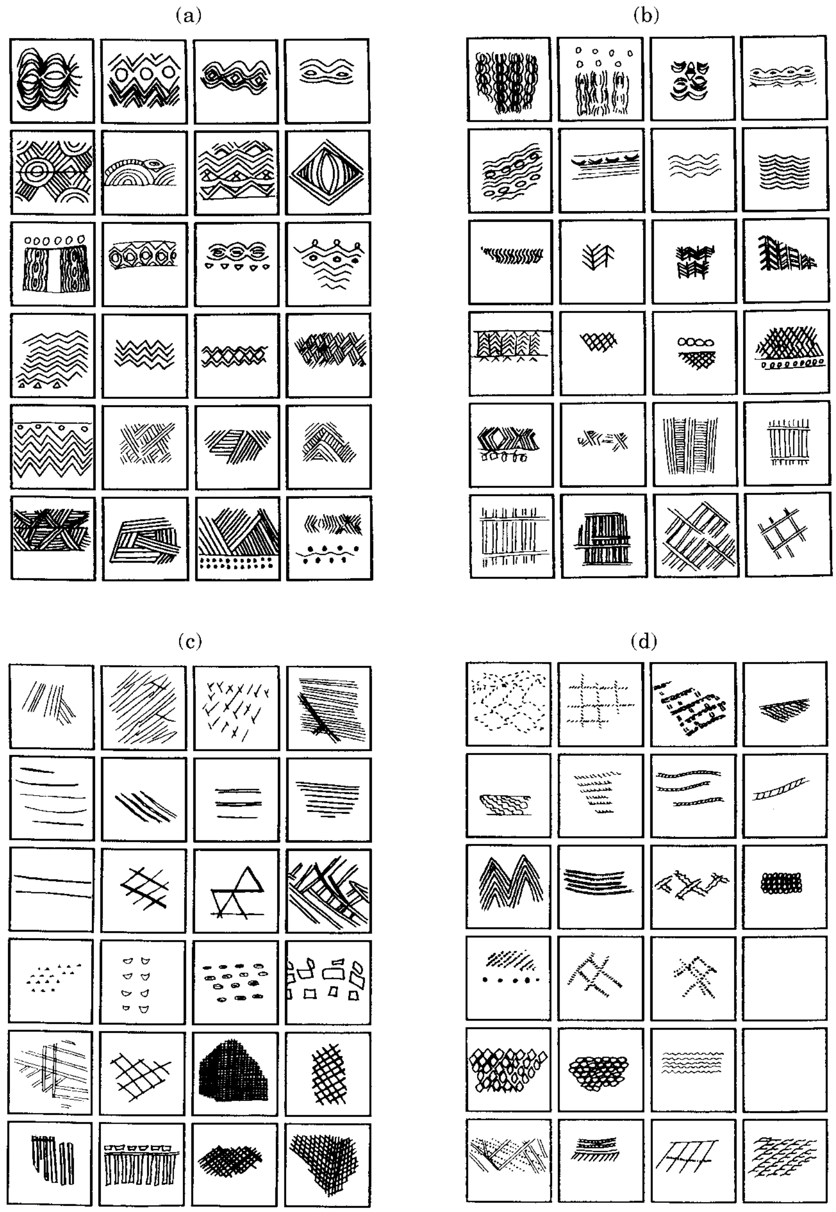


Figure 6. Roulette decoration patterns from Makubasi SE. a, b, carved wooden roulette; c, incision, impression, and comb-dragging; d, flexible roulettes.

wares belonged to straight vessels; 39·5% belonged to open bowls; and 14% belonged to hemispheric containers. Some bottles were also found. Decoration is always geometric and concentrates on the upper third of the vessel, mostly on the outer surface, but also in the inside. A high proportion (63·5%) of the wares show roulette patterns (wooden carved and flexible roulettes), while 36·5% belong to the non-roulette type (incision, impression, grooving, comb dragging and applied decoration). Fifty per cent of the roulette decoration was accomplished by rolling wooden carved cylinders over the fresh surfaces of the pots. The other half comprises, after Soper's terminology (1985): cord wrapped stick, knotted string roulette and knotted strip roulette. Rigid roulettes dominate the assemblage (78% of the roulette decorations), but they are not exclusive, since 22% of potsherds provide decorations from flexible roulettes.

Since the onset of pottery tradition, ceramics assemblages are made up of mostly straight wall and open vessels with both roulette (wooden carved and flexible) and non-roulette (incision, impression, grooving, comb dragging and applied decoration) decorations. Roulette decoration techniques have often been found outside the forest belt (Smith *et al.*, 1996), but also in the tropical forest. Ituri's finds complement the existing forest roulettes to include those from deep forest regions such as Ituri in which both types of roulette

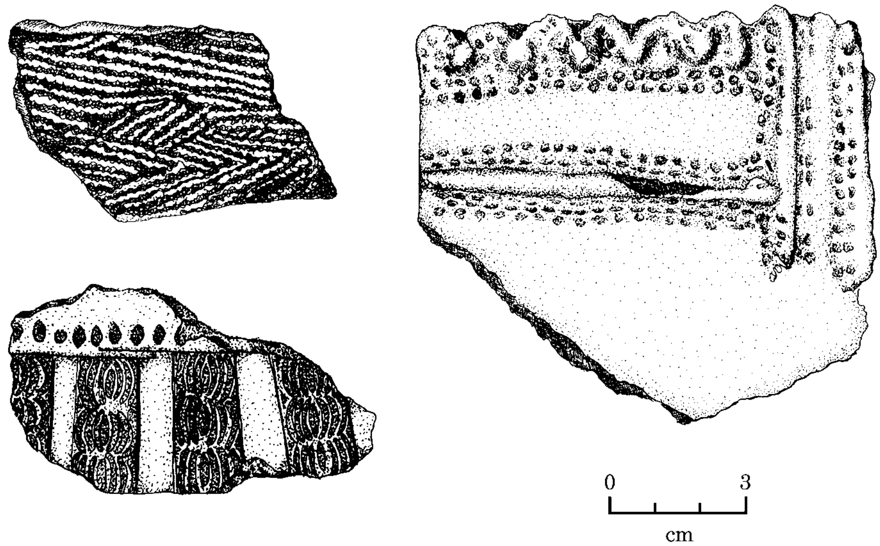


Figure 7. Flexible roulette, rigid roulette and non-roulette from Makubasi SE. The section of the rim presented on the right is given in Figure 5 (upper right box: middle fragment). Drawing: J. Clark.

(rigid and flexible) are found together. The 10th century AD ceramics from Ituri obviously diverge from other central African wares such as Imbonga/Batalimo in the central Cuvette (Eggert, 1987, 1992, 1993; Wotzka, 1993), Ngovo in "Bas-Zaire", D.R. Congo (de Maret, 1986), Tschissanga/Madingo in Congo Republic (Denbow, 1990), or Shum Laka in Cameroon (de Maret *et al.* 1987): Ituri's are much younger. Yet as suggested elsewhere for earlier lithic periods (Mercader & Brooks, 1998), the close resemblance between local ceramic materials and those from the inter-lacustrine area points out that this area of the Congo Basin may have had a closer affiliation with the inter-lacustrine sphere than with other central and west African areas. Similarities with non-forest domains of the inter-lacustrine region include: late chronologies, some of their roulette procedures, the designs, and the presence of "Chobi" ware. Stylistic parallels with a similar chronology are found in the upper layers of Matupi Cave (unpublished material deposited at the Musee Royal de l'Afrique Centrale, Tervuren, Belgium), in the Kibiro area (Connah, 1997), and in Chobi (Soper, 1971). It will be, thus, for future research to determine if these discoveries conform to a new "tradition" (Makubasi) or if they merely extend Western Rift materials into the Congo Basin or vice versa.

Materials and Methods

Field procedures

Archaeological samples were retrieved from the Late Holocene layers (Figure 4) of four hunter–gatherer rock shelter camps in the vicinity of Malembi (Matangai Turu N.W.), Nduye (Makubasi S.E. and Koma Tufe S.W.), and Epulu (Lengbe) (Figure 1). Significant contextual data such as sediment texture, geochemistry, soil classification, stratigraphy, and archaeological context and dating have been presented above.

Modern ceramic and clays were collected at different times between April and August 1995 from a total of nine households (three per area) in Malembi (among the Lese Dese people), Nduye (among Lese Caro), and Epulu (among Budu). Therefore, archaeological and ethnoarchaeological data for any of these main three locations overlap. Notice, however, that the study of these modern potters include two cases of groups with a long tradition in forest settlement (Lese Dese and Lese Caro) as well as one case (Budu) with a more recent history of arrival in this region (Peterson, 1991).

At these locations, field procedures included the collection of raw clay samples from clay pits following the potter's own selection criteria, description of current procedures of pottery making among one Lese and one Budu potter; and retrieval of pottery sherds previously produced, used, and abandoned at nine different farming villages throughout the region.

Lab techniques

Lab analyses were undertaken by two of the authors (MGH, an archaeologist trained in ceramic characterisation techniques, and IG, a geologist). These two authors undertook lab work without having access to contextual data known to a third of us only (JM) with the purpose of keeping preconceptions to a minimum. Goals and, importantly, logistical constraints have allowed two mineralogical techniques to be used for this work: petrographic characterization by thin section and X-ray diffraction (X.R.D.). Thin section analysis identifies mineralogical characteristics of non-plastic inclusions according to their optical properties as well as void shapes and locations, surface treatments, and particle orientations in ceramic body samples. It also provides textural or modal analysis by describing attributes such as size, shape, and inclusion percentages (Darvill & Timby, 1982; Middleton *et al.*, 1985). Thin sections, additionally, are very useful to determine some technological aspects, such as raw material treatments and paste preparations (Freestone, 1991). X.R.D. identifies mineral phases from their crystalline structure, some of which can be conceived as thermoparameters or mineral phase reactions related to firing temperature (Tite, 1995).

Two microscopes (Olympus, C011 and Nikon Labophot-pol) were used for petrographic observations. X.R.D. was performed by means of Siemens D-5000 equipment, using K α of Cu radiation (1,54060 A), under working conditions of 40 Kv and 40 mA. Diffractograms were obtained between 2 and 60° 2 θ. Colour estimations of both clay and pottery samples were undertaken by comparison with the Munsell soil color chart.

Modern raw clays

These consisted of eight samples amounting to 1500 g. From north to south, those from Malembi were named as locale C, those from Nduye as locale A, and those from Epulu as locale B. Samples from Nduye were taken at different steps during paste preparation (A-1 stored at the potter's village; A-2 after being kneaded for a few minutes; A-3 after kneading was completed; and A-4 directly from the clay pit) to evaluate the extent to which behavioral factors such as kneading can modify clay textural parameters. Texture was determined by mechanical analysis through the Robinson pipette, establishing their organic matter content, and their percentages of sand, silt and clay. Then, the rest of the sample was used for experimental firing briquettes, for which part of the sediment was kept at room temperature and the rest was fired in an electric kiln (Hobersal, HE-22) under oxidizing atmospheres at temperatures of 600, 700, and 800°C. The resulting replicas have been utilised for X.R.D. firing temperature estimation for modern and ancient pottery, whose actual firing temperature possibly fell within the experimental thermal range described above.

Modern pottery

This consisted of 15 pottery sherds from vessels currently made and used by Lese (Malembi, Nduye) and Budu (Epulu) potters. These ceramics were analysed by thin section and X.R.D. Textural analysis by point counting procedures ($N=150$) was then carried out on six of these samples; two per area (A,B,C).

Archaeological pottery

After the entire archaeological assemblage from the Ituri sites was studied by low-powered microscope (Nikon, 80 X), 50 pottery sherds were chosen. Thirty were from Makubasi S.E. (the most significant site for pottery development in the Ituri forest): 15 supported rigid roulette decorations (carved wooden roulette) and 15 supported flexible roulette and non-roulette decorations. Then, eight fragments from Lengbe, ten from Matangai Turu N.W. and two from Koma Tufe S.W. were chosen. All the above samples were studied by thin section and X.R.D. The latter was applied to 42 out of 50 samples. Textural analysis was undertaken in nine cases (four from Makubasi S.E., two from Lengbe, two from Matangai Turu N.W. and one from Koma Tufe S.W.).

Results

Textural and mineralogical characterisation of modern clay sediments: detecting variation within homogeneity

Ituri clays have primarily originated from the decomposition of the local plutonic basement (Lavreau, 1982; Goodwin, 1991) (Figure 2). In lithological terms, this substrate is made of granodiorite, granitoids rich in quartz, sienogranites and monzogranites, although outcrops of amphibolite, diabase, eclogite and tonalite are also distributed through the region. From a textural point of view, the Ituri clays are "sandy loam" or "sandy clay loam" (Figure 8, Table 2). Mineralogical phases in these clays are: illite, kaolinite, montmorillonite, quartz, albite, microcline, biotite, muscovite, and small amounts of epidote and amphibolite (Figure 9).

Behavioural factors do not seem to introduce relevant compositional changes in clay matrices, whether in textural or in mineralogical terms. Local clays have contained enough non-plastic natural inclusions to allow potters not to add sandy temper. Similar granulometries (Figures 10 and 11) and mineralogies have been observed in clays taken before and after being ground and kneaded. Nevertheless, organic matter seems to increase in those clays that have been extracted and stored (Table 3).

Although the Ituri clays are homogeneous, two minor mineralogical variations have been detected: the relative abundance of quartz and albite (plagioclase) versus that of microcline (potassic feldspar). Thus, quartz and microcline seem to abound basically in clays of the north-east sector (that of Malembi), resulting from the alteration of acidic rocks (high silica content), while albite predominantly occurs in those matrices of the eastern and central domains (those of Nduye and Epulu) resulting from the alteration of less acidic rocks (low silica content).

In sum, clay sediments of the Ituri rain forest are largely homogeneous, although they derive from the alteration of a relatively varied plutonic basement. Despite clay homogeneity, some mineralogical variations exist throughout the region.

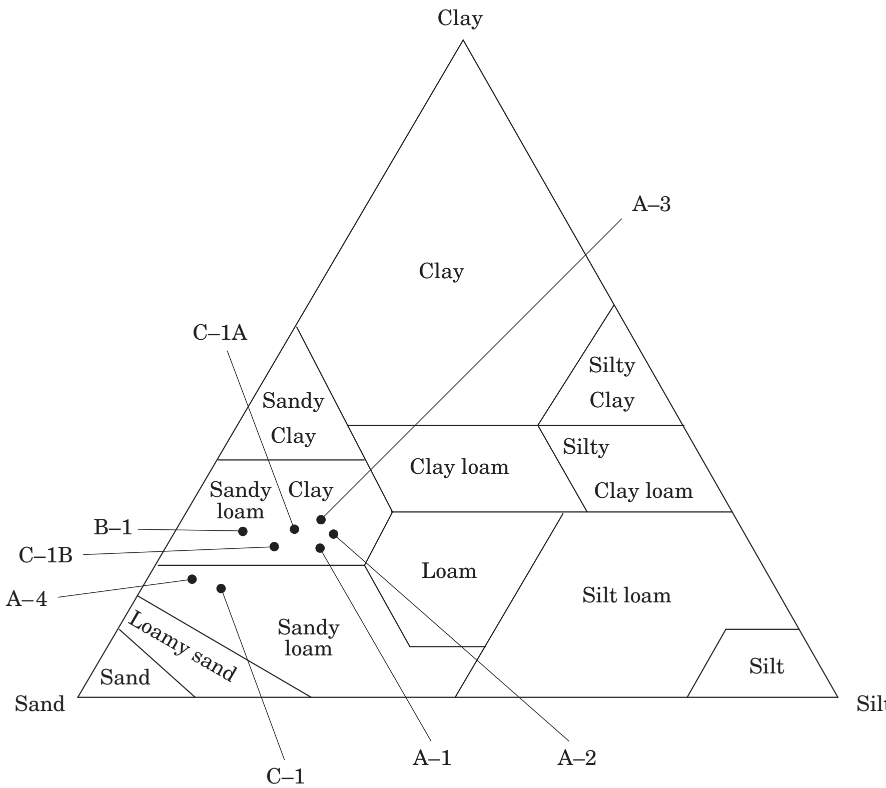


Figure 8. Textural classification of clay samples.

Ceramic characterisation

The identification of closely similar mineralogical assemblages from clay samples, modern ceramics, and archaeological sherds have allowed us to present ceramic characterisation from ancient and recent times together (Figures 12 and 13). The Ituri pottery tradition shares over time the following technological features:

- Ituri ceramics have been made of clays derived from the local plutonic basement. These clays contain abundant granitic inclusions (Figure 13(a)). This is illustrated by the existence of closely similar mineralogical assemblages in clay samples, ancient pottery and modern ceramics. Nonetheless, a distinct mineralogy (micaceous fabric, Figure 13(f)) and granulometry in archaeological specimens from Koma Tufe S.W. could indicate ancient extra-regional mobility.
- Preparation of clays has been kept to a minimum. Similar granulometric profiles in both clays and pottery seems to suggest that behaviour has modified the textural features of natural clays very little. Probably, during ancient times, grog (Figure 13(e)) and organic matter (Figure 13(d)) were used as temper. But neither in ancient times nor during modern periods was sand added to the paste, given that clays with abundant aplastic inclusions of quartz occurring naturally were selected.
- Modelling has been based on coiling. Decoration is mostly on the roulette. Coiling has been the major shaping resource, as shown by the marks left by coiling in the orientation of macropores, and in that of inclusions in the clay matrix, already present in the earliest pottery and, then, through modern specimens (Figures 13(b) and (c)). It is to be noted that different decoration techniques and patterns share, however, the same technological processes. This is suggested by the fact that sherds with rigid roulette, or flexible roulette, or non-roulette decoration on them (Figure 7) are technologically identical. Therefore, archaeometric characterisation of these ceramics does not support the idea that technological distinctions could be made on the basis of decorative strategies alone.

Table 2. Percentages of sand, silt, and clay fractions in modern clay samples

Sample	Locale	Sand	Silt	Clay
A-1	Nduye	42·56	20·36	37·07
A-2	Nduye	41·48	20·90	37·62
A-3	Nduye	41·30	19·39	39·31
A-4	Nduye	70·99	6·86	22·15
B-1	Epulu	58·35	7·71	33·93
C-1	Malembi	66·84	9·18	23·98
C-1A	Malembi	47·62	15·19	37·19
C-1B	Malembi	51·38	14·64	33·98

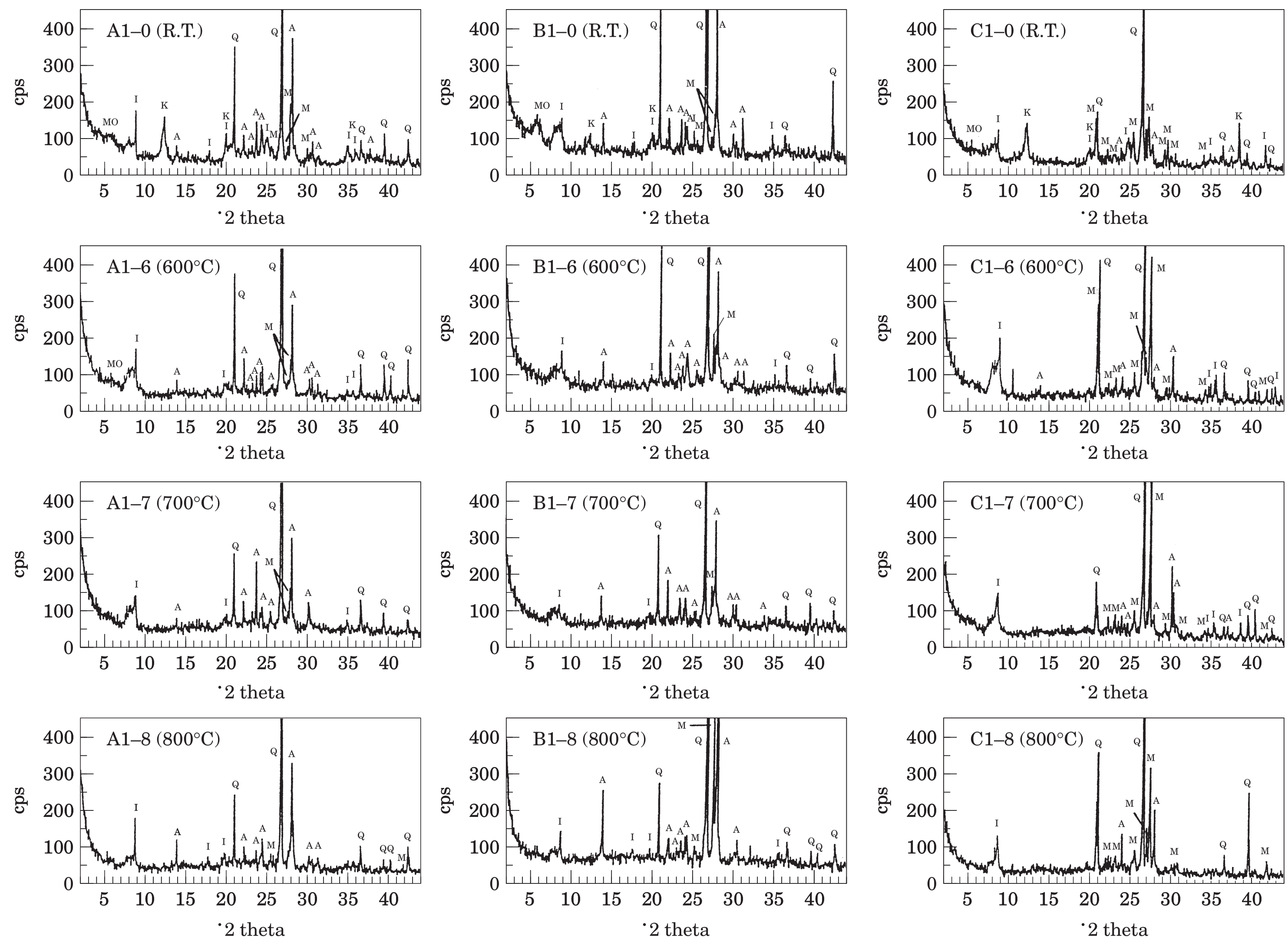


Figure 9. Diffractograms of selected clay samples from locales (A) Nduye, (B) Epulu, and (C) Malembi. Samples on which these diffractograms are based were calcined in an electric kiln under oxidising atmospheres at 600, 700 to 800°C. R.T., room temperature; A, albite (Na plagioclase); I, illite and phyllosilicates; K, kaolinite; M, microcline (K feldspar); MO, montmorillonite; Q, quartz.

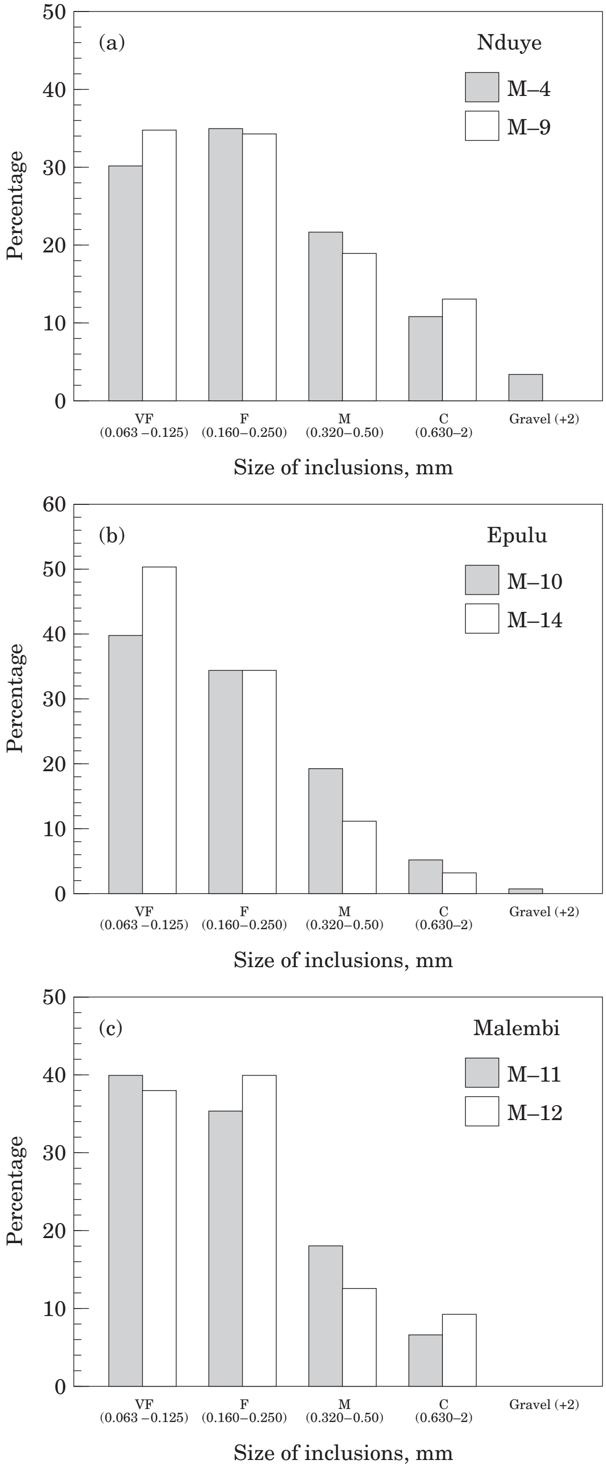


Figure 10. Textural analysis of modern pottery samples. VF, very fine sand; F, fine sand; M, medium sand; C, coarse sand.

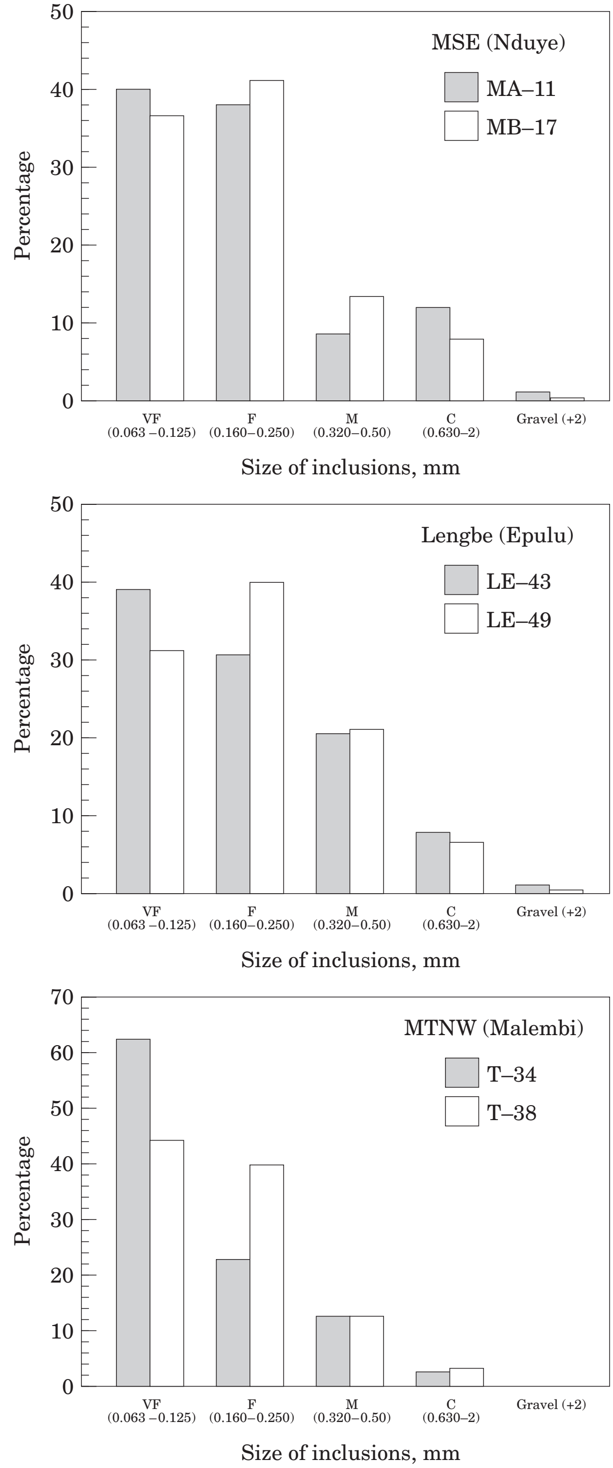


Figure 11. Textural analysis of archaeological pottery samples. VF, very fine sand; F, fine sand; M, medium sand; C, coarse sand.

- Drying periods cannot be inferred from our data. Hypothetically, making an assumption of continuity, drying periods could have been variable, as they are today, probably spanning several days.
- The comparison of firing estimates results from clay samples with those from modern and archaeological pottery samples (Figure 9) indicates that the bottom firing range for Ituri pottery (ancient and modern) could be 600°C. Firing has taken place in bonfires, where shifting oxidising and reducing conditions have provided irregularly fired products, as suggested by the changes in matrix colour in one

Table 3. Organic matter content in recent clays

Sample	Locale	Weight (g)	Percentage
A-1	Nduye	0·89	4·44
A-2	Nduye	0·57	2·89
A-3	Nduye	0·77	3·88
A-4	Nduye	0·38	1·96
B-1	Epulu	1·08	5·26
C-1	Malembi	0·57	2·85
C-1A	Malembi	1·40	6·83
C-1B	Malembi	1·40	6·82

pot. Since direct estimation of firing temperatures is not possible[1], an alternative procedure has been used: the controlled firing of experimental briquettes (Rye, 1988; Tite, 1995). For this study, clay minerals are assumed to be the only reliable thermoparameters (Figure 9), since other phases do not experience structural changes within the low temperature range discussed here. Kaolinite never appears in those briquettes fired at temperatures above 600°C; montmorillonite is rarely present in samples fired above 700°C. Notably, illite and the rest of the phyllosilicates are present in those briquettes fired at

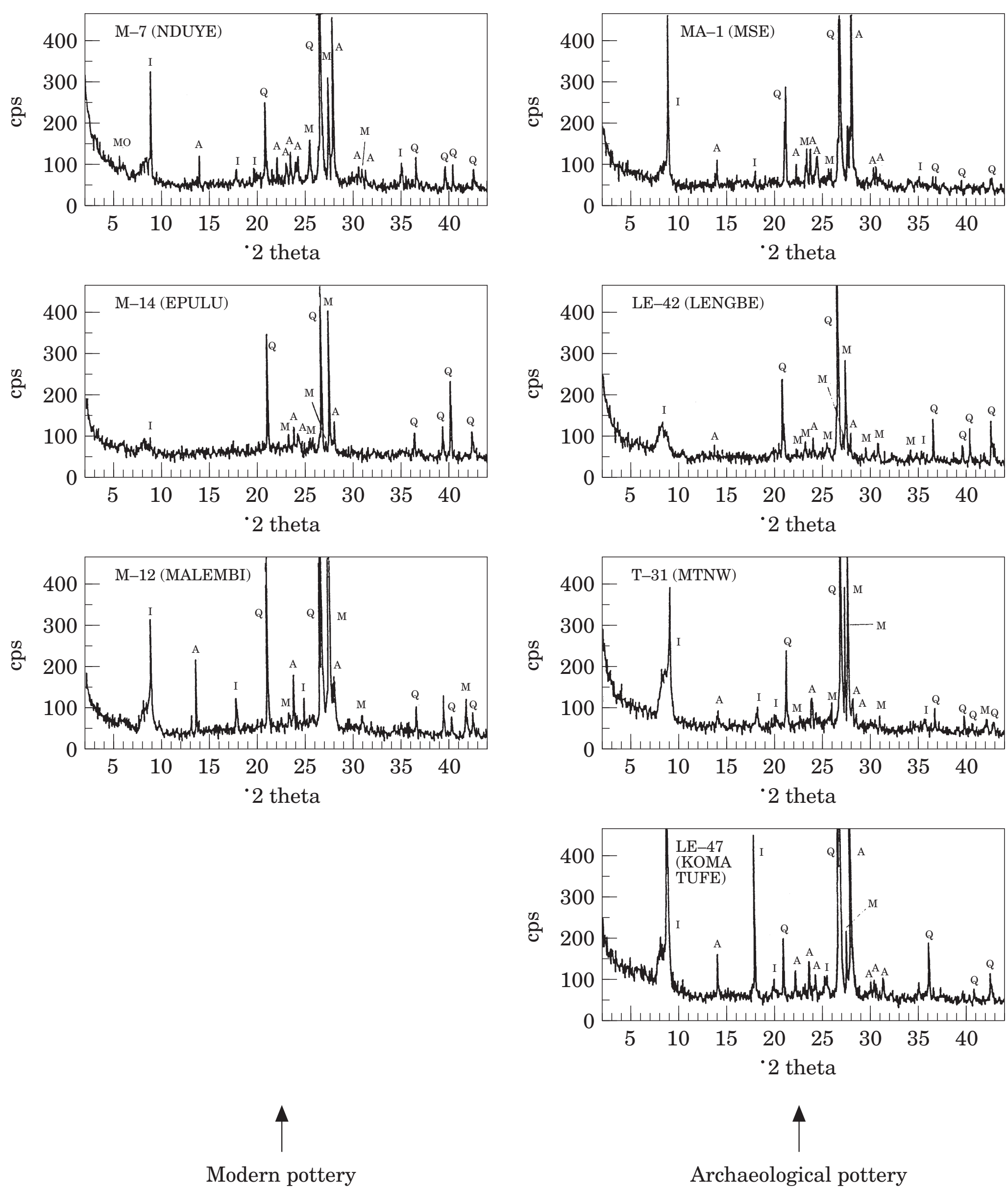


Figure 12. Diffractograms of selected modern and archaeological pottery samples. A, albite (Na plagioclase); I, illite and phyllosilicates; M, microcline (K feldspar); MO, montmorillonite; Q, quartz.

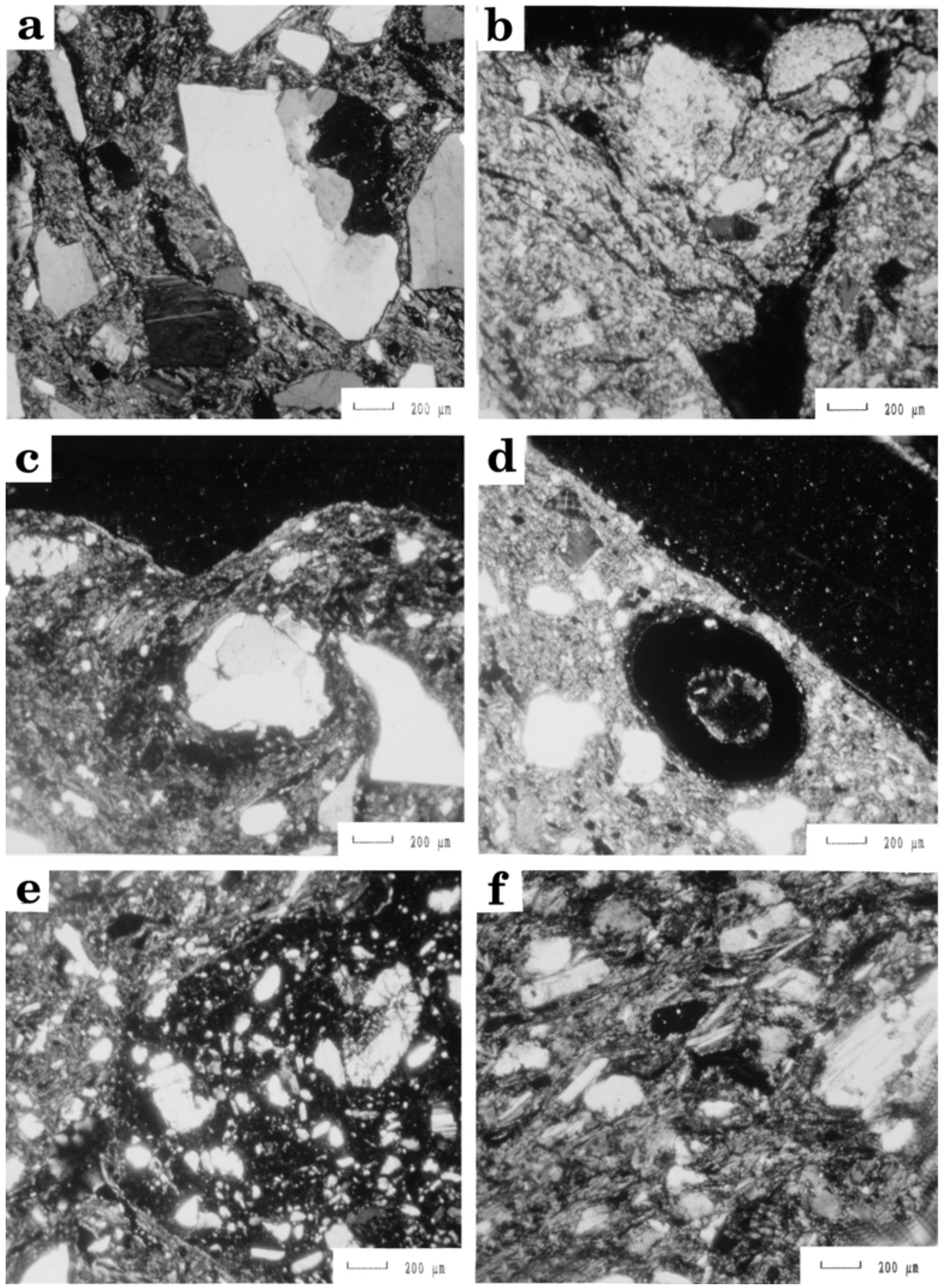


Figure 13. Thin-section microphotographs from selected modern and archaeological pottery samples. Crossed nicols: (a) matrix: modern pottery sample M-3 (A. Nduye); (b) close-up: coils and outer surface smoothing. Modern pottery sample M-7 (A. Nduye); (c) close-up: inclusions, void orientation, and decoration on the outer surface. Archaeological pottery sample MB-22. MSE (A. Nduye); (d) close-up: organic inclusion. Archaeological pottery sample MA-11. MSE (A. Nduye); (e) matrix with grog (black inclusion). Archaeological pottery sample MB-25. MSE (A. Nduye); (f) micaceous fabric. Archaeological pottery sample LE-46. Koma Tufe SW (A. Nduye).

800°C. It is also significant that the crystalline structure of kaolinite collapses at 550°C (Maggetti, 1982; Rice, 1987), and that montmorillonite begins to break down at 678°C (Rye, 1988). Full structural transformation of illite's crystalline structure occurs at 850°C (Maggetti, 1982; Rice, 1987). It is to be noted that illite-phase peaks are still present at 800°C (Figures 9 and 12). Support for these estimates comes from the close match between them and *de facto* firing temperatures (Kanimba & Bellomo, 1990). Additional evidence is provided by colour analysis of briquettes and by petrographic analysis,

Figure 14. Modern Lese/Budu pottery production: (a) pit for clay extraction; (b) paste preparation; (c) coiling and shaping; (d) surface smoothing; (e) drying vessels; (f) firing.

during which no evidence of vitrification was found. Thus, 600–700°C can be considered as an equivalent firing temperature.

Modern pottery production

Having presented the above characterisation of clays and pottery and, especially, having shown the strong technological continuity between modern and ancient ceramic products of the Ituri forest, it is now possible to make a meaningful presentation of current behavioural features observed during ethnoarchaeological research.

The present pottery tradition observed in Ituri is similar to that of neighbouring regions such as Kivu, eastern D.R. Congo (Kanimba & Bellomo, 1990). Generally speaking, this tradition consists of brown/reddish ware for basically utilitarian purposes: primarily cooking, but also storage of water and other products. Most vessels are medium sized and comprise few forms, the globular body with outward rim being the most common shape. Decoration techniques are roulette (rigid and flexible) and non-roulette (e.g. incision, grooving).

Pottery makers are usually female. They travel 1–5 km for clay extraction (Figure 14(a)) sometimes accompanied by other women to aid in the extraction process, for which machetes and shovels are used. Clays are obtained at a considerable depth (1 m or deeper), over extensions of 6 m^2 in circular pits. Extraction may take several hours; and, on average, each potter retrieves enough clay to make up to 10 medium size vessels. Clay is stored at the potter's village for one or several days before starting the shaping process.

The next step is the preparation of the paste, during which water is added to the clay and then kneaded with a pestle on a stone slab or wooden plank

(Figure 14(b)). Temper is not added nor are different clays mixed. This step takes, approximately, 10 min. The amount of clay needed by Lese and Budu potters to make a medium size cooking vessel is around 500 g.

When the clay reaches a proper texture, the potter proceeds to make balls, and then shape them in coils 35–50 cm long, and 2 cm in diameter. These ropes are left aside on a palm leaf as they are ready, until enough coils to make the desired pot (e.g. a medium size cooking pot requires nine coils) are prepared.

The next step is outlining a shape for the future pot, which first takes place by forming a spiral with the coil (either on her knee/foot) as a base, and, then, by adding coils in this fashion until a conic shape is formed (Figure 14(c)). Once this form has grown large enough, it is placed either on a pillow or over the base of an old pot, now reused as a pedestal.

Surface smoothing (Figure 14(d)) is accomplished by using circular calabash smoothers for the inner surfaces and long rectangular planks for the outer ones. As this part of the process goes on, walls become thinner and the overall size of the pot grows. Afterwards, the neck and the rim are made by adding several coils and by shaping them outwards.

The decoration of the pot comes next, focusing on the upper third of the vessel; mostly on the outer surfaces, but sometimes also on the inner surfaces. Preferably, decorations are executed by rolling both flexible and rigid roulettes over the fresh clay, although non-roulette decoration also appears, whether combined with rouletting or not. Sometimes, surfaces are polished with rounded pebbles.

The drying process takes between 2 and 7 days, in the interior of rooms, but also outside (Figure 14(e)). Usually, direct sunshine is avoided; however, if needed, potters place drying vessels in the sun, near fireplaces or even prefire them to speed up the drying period.

When time for firing approaches, the potter collects firewood, then builds a conical pile, places up to six medium size vessels in the center of the pile, covers them up with more firewood, and lights it (Figure 14(f)). This fire can be located either near her house, or in temporary locations (e.g. farming fields), where potters attend to several domestic obligations. The firing stage goes on for over half-an-hour. Bonfires of this type are characterised for their irregular temperatures (Kanimba & Bellomo, 1990) and atmospheres. After firing has been completed, pots are removed by the same person who started the process using a long pole. Immediately after, these vessels are put aside a few metres, and, then, a previously prepared organic coating solution made of either bark or leaves is applied to both surfaces of the pot by splashing it over its entire surface with the help of a long palm brush (cf. Hexter & Hopwood, 1992; Diallot *et al.*, 1995). Then, pots are allowed to cool.

Potters through the north-eastern Ituri (e.g. those of Malembi and Nduye) rarely market their productions on a regional scale. Most of the time their products are distributed throughout local households, although in some cases most vessels stay within the domestic unit where the potter lives. This explains why pottery vessels are more abundant in pottery-making villages, while surrounding households comprise less ceramic vessels and a higher amount of containers made of recent substitute raw materials: glass, plastic, and tin.

Now as Then? Concluding Remarks

Despite today's wide ethnic diversity, the Ituri region comprises one ceramic tradition alone. This tradition may have resulted from homogenisation of several traditions initially occurred outside the forest, in the Western Rift. Current farming groups of the Ituri forest interacted with other farming groups living along the ecotones north-east of the Ituri forest before they settled in the forested lowlands. This is indicated by the fact that Ituri's oldest ceramic repertoires, those originally brought to Ituri, perhaps by the ancestors of current Lese farmers over one millennium ago, display Late Iron Age features like those from sites outside the lowland forest (Soper, 1971; Van Noten, 1977; Connah, 1997). The homogenisation of pottery-making techniques in the North-East quarter of the Democratic Republic of Congo is also a consequence of close interaction between farmers and hunter–gatherers. This interaction has created a continuous flow of material culture across ethnic and socio-economic boundaries that have brought about almost identical technological repertories in both farming and foraging contexts.

Results point to the conjunction of archaeology and archaeometry as a fruitful avenue to empirically identify and compare technological aspects of archaeological assemblages to those of the ethnographic record. Such comparison sheds light on how one differs from another. Perhaps the most notable aspect of this Ituri tradition is that pottery production processes have apparently persisted without major visible changes from pottery inception, around the tenth century AD, up to the present. Recent ceramic assemblages share with those of ancient pottery a consistent distribution and manufacture of pottery across a multiethnic setting in which pottery is used by ethnically diverse slash and burn farmers and bow/net hunter–gatherers. The degree of continuity inherent to these assemblages is measurable by empirical means, the results suggesting that ancient and modern traditions have shared, now as then, the five components that make the Ituri pottery tradition insofar as raw material extraction, preparation of clays, modelling, drying, and firing are concerned.

In the Ituri region, therefore, there have been long-term processes through which Late Pleistocene and Early Holocene hunter–gatherer societies established regional features which served as a foundation for modern dynamics. But there were other processes such as the appearance of farming communities and that of their ceramic and metal technologies which came about during late periods and had no precedent in early times. Some of these changes were: technological diversification through the introduction of pottery and metals, regional tool kit homogenisation by means of extensive interaction among all local populations, and persistence of these homogenised technological inventories across socio-economic and cultural backgrounds, whether farmer or hunter–gatherer.

The perceived technological similarities between different socio-economic groups over time (hunter–gatherer rock shelter ceramic samples from the archaeological record and farmer ceramic samples from the ethnographic record) supports the authors' conclusion that, despite homogeneity in clay sources in this area, Ituri potters, no matter what their ethnic or socio-economic orientation was, have made ceramics according to a shared tradition. Given the pervasive technological homogeneity and constant flow of technological resources among local groups, we suggest that strong interaction among farmers themselves and between them and indigenous foragers is a feasible explanation for the patterning of technological homogenisation found across the forest for 1000 years. Perhaps the most important consequence of this interpretation is that there are not clear cut technological differences between hunting–gathering and farming technological repertories whenever interaction intertwines their ethnicities and socio-economic behaviours. Moreover, this study suggests that, like in many other tropical forest regions of the world, foraging and farming blended to create societies for which mixed economies and technologies have proven to be a successful long-term lifestyle, not a transitional stage towards full-scale agricultural societies.

Note

(1) Two important parameters (atmosphere and firing time) cannot be estimated from archaeological samples. Additionally, temperature variation in these open bonfires are so wide, even for the same pot (Gosselain, 1992), that precise determinations of temperatures for archaeological specimens remain barely reliable.

Acknowledgements

We would like to acknowledge the following people and institutions that made this work possible. The Spanish Ministry of Education and Culture provided funds for research, and the cultural and military authorities of D.R. Congo kindly issued authorisations. R. Bailey gave us logistical support, access to multiple resources, and the best guidance: to his remarkable help and wisdom we are grateful. B. Curran was most helpful in recovering clay and pottery samples. The Department of Anthropology at George Washington University, and especially Dr A. Brooks, provided logistical support and encouragement. J. Donaldson greatly improved the style of this article.

An earlier draft of this paper was read by Drs M. Stark, H. Neff, P. Crown, N. David, and N. Benco. We thank them for their very useful comments on it.

We also thank M.C. Lopez de Azcona at Instituto de Geologia Economica, CSIC, Madrid, for providing us with access to optical and photographic equipment.

Finally, this paper is indebted to Dr L.P. Fernandez, Department of Geology, University of Oviedo, for his advice and support.

References

Arnold, D. (1991). Ethnoarchaeology and investigations of ceramic production and exchange: can we go beyond cautionary tales? In (R. Bishop & F. Lange, Eds) *The Ceramic Legacy of Anne O. Shepard*. Niwot (Colorado): C. University Press, pp. 321–345.

Arnold, D., Neff, H. & Bishop, R. (1991). Compositional analysis and "sources" of pottery: an ethnoarchaeological approach. *American Anthropologist* **93,** 70–90.

Bailey, R. (1991). *The Behavioral Ecology of Efe Pygmy Men in the Ituri Forest, Zaire*. Anthropological Papers, 86. Ann Arbor: University of Michigan.

Bailey, R. & Peacock, N. (1988). Efe Pygmies of north-east Zaire: subsistence strategies in the Ituri forest. Copying with uncertainty in food supply. In (I. de Garine & G. Harrison, Eds), pp. 88–117.

Bronitsky, G. (1986). The use of materials science techniques in the study of pottery construction and use. *Advances in Archaeological Method and Theory* **9,** 209–276.

Bultot, F. (1971). *Atlas Climatique du Bassin Congolase*. Brussels: Ineac.

Cahen, L., Snelling, N., Delhal, J. & Vail, J. (1962). Grand traits de l'agencement des éléments du soubassement de l'Afrique Centrale, esquisse tectonique au 165·000·000. *Ann. Soc. Géologique de Belgique* **85**.

Cahen, L. (1984). *The Geochronology and Evolution of Africa*. Oxford: Clarendon.

Cahen, L. & Snelling, N. (1966). *The Geochronology of Equatorial Africa*. Amsterdam.

Clist, B. (1987). A critical reappraisal of the chronological framework of the early Urewe Iron Age industry. *Muntu* **6,** 35–62.

Connah, G. (1997). The cultural and chronological context of Kibiro, Uganda. *African Archaeological Review* **14,** 25–67.

Darvill, T. & Timby, J. (1982). Textural analysis: a review of potentials and limitations. In (I. Freestone, Ed.) *Current Researches in Ceramics: Thin-Section Studies*. British Museum Occasional Paper 32, pp. 73–87.

de Maret, P. (1986). The Ngovo group: an industry with polished stone tools and pottery in Lower Zaire. *African Archaeological Review* **4,** 103–133.

de Maret, P., Clist, B. & Van Neer, W. (1987). Résultats des premiéres fouilles dans les abris de Shum Laka et d'Abeke au Nord-Ouest du Cameroun. *L'anthropologie* **91,** 559–584.

Denbow, J. (1990). Congo to Kalahari: data and hypotheses about the political economy of the Western stream of the early Iron Age. *African Archaeological Review* **8,** 139–176.

Diallot, B. (1995). Plant constituents involved in coating practices among traditional African potters. *Experientia* **51,** 95–97.

Doumenge, C. (1990). *La Conservation des Ecosystemes Forestiers du Zaire*. UICN.

Eggert, M. (1987). Imbonga and Batalimo: ceramic evidence for early settlement of the equatorial rain forest. *African Archaeological Review* **5,** 129–145.

Eggert, M. (1992). The central African rain forest: historical speculation and archaeological facts. In (I. Glover, Ed.) *The Humid Tropics*. World Archaeology, 24.

Eggert, M. (1993). Central Africa and the archaeology of the Equatorial rain forest: reflections on some major topics. In (T. Shaw *et al*., Eds) *The Archaeology of Africa, Foods, Metals and Towns*. OWA, pp. 289–329.

Freestone, I. (1991). Extending ceramic petrology. In (A. Middleton & I. Freestone, Eds) *Recent Developments in Ceramic Petrology*. British Museum Occasional Paper 81, pp. 399–410.

Garcia-Heras, M., Fernandez, R. & Tornero, J. (1997). Analysis of archaeological ceramics by TXRF and contrasted with NAA. *Journal of Archaeological Science* **24,** 1003–1014.

Goodwin, A. (1991). *Precambrian Geology. The Dynamic Evolution of the Continental Crust*. London: Academic Press.

Gosselain, O. (1991). Technologie céramique et ethno-archéométrie. Résultats préliminaires de la mission 1990 au Cameroun. *Nsi* **8–9,** 6–15.

Gosselain, O. (1992). Bonfire of the enquiries. Pottery firing temperatures in archaeology: What for? *Journal of Archaeological Science* **19,** 243–259.

Gosselain, O. (1994). Skimming through potters' agendas: an ethnoarchaeological study of clay selection strategies in Cameroon. In (S. Childs, Ed.) *Society, Culture, and Technology in Africa*. Philadelphia: Research Papers in Science and Archaeology, Supplement to Vol. 11, pp. 99–107.

Grinker, R. (1994). *Houses in the Rainforest*. Berkeley: University of California Press.

Hart, T. (1985). *The Ecology of a Single-species Dominant Forest and a Mixed Forest in Zaire*. Africa: UMI, 215 pp.

Hart, T., Hart, J. & Murphy, P. (1989). Monodominant and species rich forests of the humid tropics: causes for their co-ocurrence. *The American Naturalist* **133,** 613–633.

Hart, T. & Hart, J. (1986). The ecological basis of hunter–gatherer subsistence in African rain forests: the Mbuti of Eastern Zaire. *Human Ecology* **14,** 29–55.

Hexter, M. & Hopwood, W. (1992). Investigation of decorative coating on Kongo ceramics using UV Light and FTIR analysis. In (P. B. Vandiver, Ed.) *Materials Issues in Art and Archaeology III*. San Francisco: Materials Research Society Symposium Proceedings Vol. 267, pp. 291–307.

Kanimba, M. & Bellomo, R. (1990). Methods of pottery construction and firing techniques observed in the village of Bukokoma III, Zaïre. In (T. Boaz, Ed.) *Evolution of Environments and Hominidae in the African Western Rift Valley*. Martinsville (Virginia): Virginia Museum of Natural History, pp. 339–356.

Lavreau, J. (1982). *Etude Geologique du Haut-Zaire. Genese et Evolution d'un Segment Lithospherique Archeen*. Tervuren: Sciences Geologiques, 88.

Lepersonne, J. (1974). *Notice et Carte Geologique au 2,000,000 e. du Zaire*. Dir. Mines et Geologie, Kinshasa.

Maggetti, M. (1982). Phase analysis and its significance for technology and origin. In (J. S. Olin & A. D. Franklin, Eds) *Archaeological Ceramics*. Washington DC: S.I. Press, pp. 121–133.

Mercader, J. (1997). Bajo el techo forestal. La evolucion del poblamiento en el bosque ecuatorial del Ituri, Zaire. Ph.D. dissertation. Universidad Complutense, Madrid.

Mercader, J. & Brooks, A. (1998). Long term settlement of lowland tropical rainforests: the evidence from Ituri, D.R. Congo. *Journal of Human Evolution* **34,** A14–A15.

Middleton, A., Freestone, J. & Leese, M. (1985). Textural analysis of ceramic thin section: evaluations of grain sampling procedures. *Archaeometry* **27,** 64–74.

Peterson, R. (1991). To search for life: a study of spontaneous immigration, settlement and land use on Zaire's Ituri forest frontier. Ph.D. dissertation. University of Wisconsin Madison.

Phillipson, D. W. (1977). *The Later Prehistory of Eastern and Southern Africa*. New York: Africana Publishing Company.

Reid, K. (1990). A materials science perspective on hunter–gatherer pottery. In (G. Bronitsky, Ed.) *Pottery Technology: Ideas and Approaches*. Boulder (Colorado): Westview Press, pp. 167–180.

Rice, P. (1987). *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.

Rösler, M. (1997). Shifting cultivation in the Ituri forest (Haut Zaire): colonial intervention, the present situation, and economic and ecological prospects. *Les Peuples de la Foret Equatoriale* (D. Joiris, D. Lavelege, Eds), pp. 44–61. Brussels: Guyot.

Rye, O. (1988). *Pottery Technology. Principles and Reconstruction*. Washington: Taraxacum Inc.

Sadr, K. (1997). Kalahari archaeology and the Bushman debate. *Current Anthropology* **38,** 104–112.

Smith, A. *et al*. (1996). Rolling across Africa: the past and present of roulette decorated pottery (paper given at the XIII SAFA meeting, Poznan).

Soper, R. (1971). Iron Age archaeological sites in the Chobi sector of Murchison Falls National Park, Uganda. *Azania* **VI,** 59–88.

Soper, R. (1985). Roulette decoration on African pottery: technical considerations, dating and distributions. *African Archaeological Review* **3,** 29–51.

Sowunmi, A. (1991). Late Quaternary environments in Equatorial Africa: palynological evidence. *Palaeoecology of Africa* **22,** 213–238.

Tite, M. (1995). Firing temperature determinations. How and why? In (A. Lindahl & O. Stilborg, Eds) *The Aims of Laboratory Analyses of Ceramics in Archaeology*. Stockholm: Historie och Antikvitets Akademien, pp. 37–42.

Van Grunderbeek, M. C., Roche, E. & Doutrelepont, H. (1982). L'Age du fer ancien au Rwanda et au Burundi. Archeologie et environment. *Journal des Africanistes* **52,** 5–58.

Van Noten, F. (1977). Excavations at Matupi Cave. *Antiquity* **LI**(201), 35–40.

Vansina, J. (1990). *Paths in the Rainforests. Toward a History of Political Tradition in Equatorial Africa*. London: James Curvey.

White, F. (Ed.) (1983). *The Vegetation of Africa*. Paris: Unesco. 336 pp.

Wilkie, D. (1987). Impact of swidden agriculture and subsistence hunting on diversity and abundance of exploited fauna in the Ituri forest of north-eastern Zaire. Ph.D. dissertation. University of Massachusetts.

Wotzka, H. (1993). *Studien sur Archälogie des zentralafrikanischen regenwaldes*. Kohln Heinrich-Barth Institut.

Yellen, J. & Brooks, A. (1990). The Late Stone Age archaeology in the/Xai/Xai region: a response to Wilmsen. *Botswana Notes and Records* **22,** 17–19.