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From pottery use-alteration to food habits: Perspectives from a 20th century Diola Kassa midden (Lower Casamance, Senegal)

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ABSTRACT

During the last decade, use-wear analysis on pottery has seen significant advances, both in the refining of reference collections and the application of this methodology to the archaeological material. Despite these contributions, the field has not yet paralleled the widespread dissemination achieved by lithic or bone materials. This paper aims to contribute to the methodology of the functional study of ceramic vessels and the interpretation of use-alterations. The method used is based on the determination of the main morpho-stylistic groups of a ceramic assemblage and their correlated use-alterations. It has been implemented on 365 pots and 3037 sherds from a well-preserved 20th century midden in Lower Casamance (Senegal), allowing for a statistically significant multivariate analysis.

By delivering information on pottery way of use, content and the types of contact, this analysis has yielded significant results regarding the correlations between pottery use-alterations and morpho-types, revealing specialized functions. The study of way of use evidenced eight main functional categories (cooking, transporting, storing etc.), while content was evidenced by specific alterations (carbonate dissolution, spalls) and the intersection with organic residues analysis and phytolith analysis. Finally, the types of contact on some of the groups could be evidenced. In particular, distinction between abrasion types has provided insights on material hardness, while pattern distribution evidenced the use of different pottery closing systems, utensils and associated motions. The investigation of pottery function significantly contributes to the reconstruction of past culinary and craft practices.

1. Introduction

The use-wear analysis of archaeological artefacts was developed in the 1960s (Semenov, 1964). These studies were mainly applied on lithic and bone tools. In parallel, a number of early works in the following two decades applied functional studies to ceramic materials (Matson, 1965; Griffiths, 1978; Bray, 1982; Hally, 1983; Braun, 1983). However, in the following years, ceramics did not experience the same exponential development as lithic and bone artefacts, despite the work of major contributors (Skibo, 1992, 1994; Henrickson, 1990; Kobayashi, 1994;

Lugli and Vidale, 1996). In recent years there has been a revival of the study of use-wear on ceramic vessels (Fanti et al., 2018; Forte, 2022; Vieugué, 2014a; van Gijn and Verbaas, 2020; Verbaas and van Gijn, 2020; Vieugué, 2014b among other scholars).

Research has firstly focused on American contexts, before opening to European, Middle Eastern and particularly Asian contexts (Skibo, 1992), and has covered a wide chronology from the first prehistoric vessels to the 18th century. Unlike lithic and bone tools, which have relied on optical instruments from the start, high and low magnification approaches have only recently been incorporated into the methodology

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(Taranto, 2022; van Gijn et al., 2020; Vieugué, 2010, 2014a, 2014b; Vieugué et al., 2010). This can be explained as a majority of pottery use-alterations interpretations can be done by relying on macroscopic observations and their distribution. Apart for some focus on ceramic tools, such as pottery smoothers (Lopez Varela et al., 2002; Vieugué, 2014b; Zebrowska, 2020), use-wear studies applied to ceramic containers primarily aims to understand food practices. Since the Neolithic period, ceramic vessels have indeed been closely associated with food processing and other domestic or craft activities, mainly due to the exceptional performance characteristics of this material, for example in its ability to withstand fire and retain liquids. The intersection of use-wear analysis with organic residue and microbotanical analysis has demonstrated the power of integrated approaches to understanding past practices (Bajeot et al., 2020; Debels, Drieu et al., 2024; Fanti et al., 2018; Skibo, 2012).

The main objective of this paper is to contribute to the methodological development of use-wear studies on ceramic vessels in West Africa, a particularly under-represented region in this regard. This research is part of an interdisciplinary project (SNF Sinergia “Foodways in West Africa”: an integrated approach on pots, animals and plants”), developing analyzes on pottery by combining morphometric, use-wear, organic residue and microbotanical analysis, in order to understand pottery function and more generally reconstruct the evolution of foodways through time. This investigation focuses on a 20th century midden in the Diola Kassa village of Edioungou (“La Poubelle des Mamans”, Lower-Casamance, Senegal). The exceptional preservation of the artefacts uncovered in this disposal area allowed the implementation of a quantitative approach on ceramic use-alteration, which has scarcely been conducted before. Therefore, functional groups are established based on a multivariate approach that both highlights the correlation between some specific use-alterations and pottery morphotypes, and the most significant deviations from the mean of use-alteration representation frequencies. The range of use-alterations and their interpretation allowed for the distinction between pottery way of use (cooking, storing, transporting, serving, grinding etc.), contents (food types, liquid or dry, acid or not, fermented or not) and the types of contact (closing systems, associated utensils etc.).

2. Context

The village of Edioungou (Department of Oussouye), is located in Lower-Casamance, in the South-West of Senegal. It is settled on the shore of a bolong (brackish water channel) and is surrounded by rice fields and mangroves. It is inhabited by an estimate of 1158 persons (PEPAM 2010) belonging to the Diola Kassa ethnic group, living in bordering family compounds distributed in different quarters. Each compound is composed of a building featuring a living area, bedrooms and granaries, as well as a specific building or light structure devoted to the kitchen, often located in the courtyard. Disposal areas are formed in between compounds and are used by the neighboring households.

Despite recent Christianization, people are still keeping ancestral beliefs and practicing important rituals for funerals and initiations (Gueye and Sall 2009; Peacock et al., 2007).

2.1. Diola Kassa food habits and craft activities

Diola Kassa people predominantly cultivate wet rice in alluvial valleys and reclaimed mangrove swamps (Linares de Sapir, 1971; Ollier et al., 2023; Pelissier, 1966). Their diet relies heavily on rice as well as fish and oyster (Cormier Salem 1989) while cattle is only consumed on special collective occasions. Traditional dishes often rely on the combination of white rice, topped with a meaty sauce, usually composed of marine resources (mainly fish and oyster, but also shrimp and crab) cooked in lemon juice, and sometimes in palm fruit or peanut sauce (personal observation and oral communication). This base can be enriched with occasional additions of vegetables (African eggplant, gombo...), leaves (hibiscus) or pulses (cowpea). On special occasions,

the marine meat can be swapped with pork, cattle or chicken. Although most recipes rely on boiled marine meat, crabs and oysters can sometimes be grilled over flames or cooked directly on embers. Diola people traditionally collect palm sap and honey (Stride and Ifeka 1971) as well as mango and cashew fruits, with which they produce fermented beverages that are usually consumed collectively.

Staples, mainly rice, are stored in the granaries. Culinary activities are performed in the courtyard or in the kitchen, where a light mobile hearth is located. All meals are mainly consumed in the courtyard during the dry season. Leftovers and kitchen waste are discarded in the disposal areas unless they are given to animals to feed or used as fertilizers in the rice fields. Culinary activities typically produce more waste than any other domestic activity and as such, disposal areas offer a valuable reflection of food habits.

The village of Edioungou has been reknown regionally for a long time for its pottery production, still vivid today (Sall, 2000). Women potters collect the clayey material with a pirogue in a specific place along the bolong, in the mangrove. They leave it for a few months under the rain to lower the salt content before use. The temper is made of shells (mainly *tympanosonus* and sometimes a few other species), left under the rain and then burnt, before being pounded and seaved. Potters fashion their pots on a ceramic rotative support and use the coiling technique. Various types of pots are still produced and used in the village, while touristic production is increasing. The production of tobacco, mainly to chew or snuff, was also observed in the village (personal observations). It is produced by roasting tobacco leaves in a specific pot and then grinding the leaves in a small ceramic shaped mortar, using a wooden pestle.

2.2. The excavation of “La Poubelle des Mamans”

The archaeological site of “La Poubelle des Mamans” is located in the heart of the village (Fig. 1). It consists of an elongated pile of garbage that has accumulated between compounds at least since the 20th century. In agreement with the village chief and the inhabitants of the neighbourhood, a 6 m² test pit was carried out in the easternmost part of the midden. According to the villagers, the dumping was stopped in the 1990 s (Debels, Drieu et al., 2024). The site displayed a great number of well-preserved pottery sherds on the surface, ensuring that the site received the broken pots of the households. The study of the stratigraphic section revealed the presence of an initial heap that gradually built up around the large roots of a kapok tree, and then more recent additions partially leaning on the initial heap. While the initial layers yielded glass and ceramic sherds, metal elements as well as fauna and malacofauna and various botanical remains, the latest addition mostly consists of discarded clothing and plastics.

The site of “La Poubelle des Mamans” yielded more than 3000 sherds of over 5 cm, all tempered with shell fragments, thereafter designated as “carbonate temper”. The pottery assemblage was particularly suited for a functional analysis, combining typometry and use-wear analysis as the pots present a low degree of fragmentation (365 archaeologically complete vessels were uncovered) and the pottery sherds show a great preservation of their surfaces. No sherds are eroded or display concretion. Given this high informative potential, we undertook the functional analysis of the pottery assemblage coming from this disposal area in order to better understand Diola Kassa food practices during the 20th century.

3. Material and method

The methodology used in this functional study combines multiple proxies, namely typometry and use-wear analyzes. By evidencing the way of use (cooking, storing, serving etc.) and the content of a pot (liquid, dry, food type etc.), the function of pots can be uncovered.

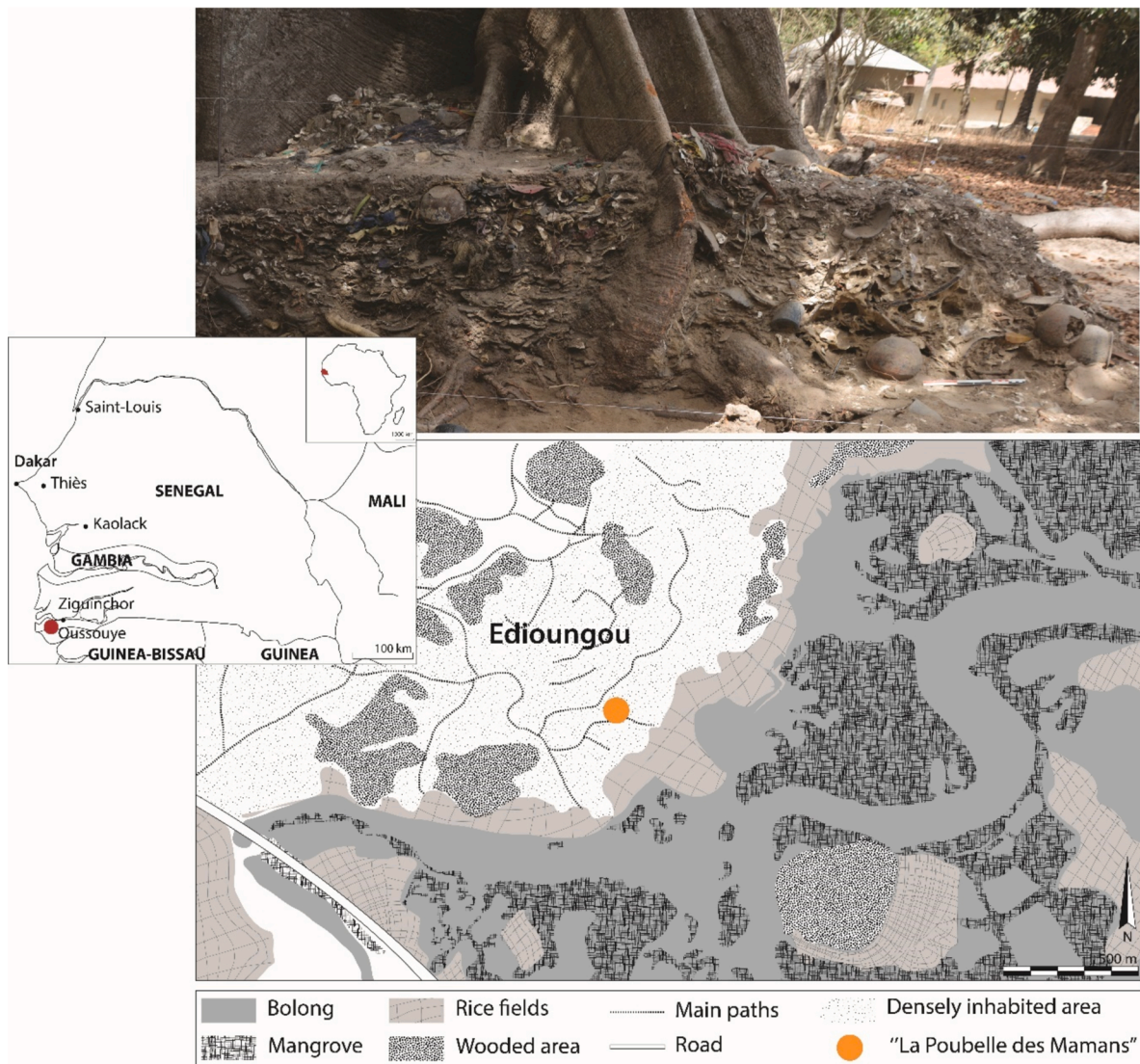


Fig. 1. Location of the site of “La Poubelle des Mamans”, inside the village of Ediungou (Oussouye, Lower-Casamance, Senegal) and photography of the main section of the excavation.

3.1. The identification of morphostylistic groups

After a refitting phase, a total of 365 pots showed the best morphometric preservation (interpretable rim diameter, maximum diameter AND height).

The 365 most complete pots were used to define morpho-stylistic groups by intersecting 1) aperture ratio ($\text{rim } \emptyset \times 100 / \text{maximum } \emptyset$; if $\text{rim } \emptyset > \text{max } \emptyset$, then the following equation is used: $\text{rim } \emptyset \times 100 / \emptyset$ at half height), which delivers information on the degree of openness of the pot; 2) height and 3) decoration technique. This led to the identification of morpho-stylistic groups based on objective and replicable criteria. Then, by identifying exclusive diagnostic criteria in each of these groups (morphometrics, decoration technique, rim shape, base shape, type of prehensile element, etc.), it was possible to assign a group to an additional 677 sherds, leaving 2360 sherds that can be either confused with two or more morpho-stylistic groups, or completely undetermined. While the processing of the morphometric data is mainly based on the 365 complete pots, the interpretations are put into perspective with the remaining 312 determinable sherds of the sample, in order to moderate fragmentation bias. The large size of the sample of morphometrically complete pots (365) and the sample of determinable sherds (312) allowed for the implementation of statistical analysis,

which remains scarce in ceramic functional studies.

3.2. The implementation of a systematic use-alteration investigation

3.2.1. Distinguishing pottery use-alteration from post-depositional alteration

Post-depositional processes are integral parts of pottery use-wear studies. Post-depositional mechanisms may lessen, cover or fully erase use-alterations, thus only offering a partial understanding of the pot's use-biography. Post-depositional alterations come in a variety of form, including abrasion during archaeological deposition (wind-blown particles, water flowing, cryoturbation, animal deterioration), biological deterioration of organic residues (fungi, bacteria, animals), discoloration due to the deterioration of ferrous oxides under acidic conditions, dissolution of carbonate temper due to an acidic environment or lime build up in calcareous environments (see [Odegaard and Watkinson 2023](#) for a detailed analysis of post-depositional processes). Many post-depositional alterations result in similar alterations than those created during the use of pots, which may lead to confusion. For example, soot deposits may appear when a pottery is used over fire or during an accidental fire long after the deposition; Carbonate dissolution may occur when a pot was used to contain acidic liquids or when immersed

or buried in an acidic environment; Abrasions may appear during manipulation throughout the life of a pot or result from complex post-depositional erosion or fragmentation processes; Spalls may appear during specific uses or because of cryoturbation and weathering, etc.

In order to distinguish post-depositional alterations from use-alterations, several criteria were used in this study, based on previous experimental and ethnographic studies:

- The distribution of alterations is considered a reliable criterion to distinguish post-depositional alterations from use-alterations (Vieugué, 2014a). When assessing content-related alterations, the absence of exterior alterations and edge alteration prevails, as post-depositional alteration are usually extended and covers edges and surfaces indiscriminately (Skibo and Schiffer, 1987p. 133–136). For example: lime deposits (Hendy et al., 2018), and carbonate dissolution (Debels et al., 2023).
- The materialization of a filling limit is an indicator of liquid contents, which can help differentiate post-depositional spalls or carbonate dissolution from those formed during use. Dissolution occurs when carbonates such as limestone, calcite, shells or bones are used as temper and come into contact with an acid, either in the contents or in the surrounding soil. In this study the distinction between use-related carbonate dissolution and post-depositional wear was based on three criteria: 1) preservation of the exterior surface and temper, 2) materialization of a filling limit, 3) homogeneity of wear pattern on all refitted sherds (Debels et al., 2023).
- The sharpness of edges is particularly useful when sherds display ambiguous abrasions. A sherd displaying both surface abrasion and edge abrasions should be excluded from the study sample for precaution measures (Beck et al., 2002).
- The homogeneity of alterations between all sherds refitted from the same vessel, allows to avoid and exclude post-breakage alterations.

It is worth noting that a very limited number post-depositional alterations were observed during this study, probably due to the recent nature of the archaeological site. The only case being a dozen sherds from a localized area of the surface of the site that presented covering soot deposits on the interior, exterior and the broken edges of sherds as well as heterogeneously distributed soot between refitting sherds. All have been excluded from the study. Following a thorough observation, each sherd was gently washed using a soft toothbrush.

The meticulous observation of the ceramic vessels from “La Poubelle des Mamans” has allowed us to identify two main categories of use-alteration 1) addition of matter (soot, carbonized organic residues, lime deposits); 2) subtraction of the ceramic matrix or the temper, (spalls, abrasion, dissolution of carbonates). As the pots are fired in an open kiln, leaving numerous oxydo-reduction traces, and their fragmentary state prevented the observation of cracks, these types of alterations were not included in this investigation. In this paper, we choose to call “trace” any addition of matter and “wear” any subtractive alterations. The term “alteration” is used when both are designated and the general approach is commonly called “use-wear analysis”.

As it is a crucial element in the interpretation, the distribution pattern of each alteration, either addition trace or subtractive wear, was recorded in details (internal: rim/neck, upper belly, middle belly, lower belly and base; external: top of rim, upper belly, middle belly, lower belly and base; prehensile elements).

The 365 most complete pots were examined macroscopically, using the naked eye and a stereo-microscope (Olympus SZX10 and Olympus SC50 camera) with 10 x eyepiece and magnifications from 0.8 x to 1 x , within the framework of the use-wear analysis. In order to better account for fragmentation bias, the entire sherd assemblage was examined using the same use-wear protocol.

3.2.2. Identifying use-alterations

3.2.2.1. Soot deposits. Soot can be deposited in thin or thick layers of dull black matter (Fig. 2). Thick layers tend to molder away and leave behind a more resistant thin black layer. This trace was recorded according to its presence or absence on the pots and its position.

3.2.2.2. Carbonized residues. Carbonized residues can be observed in the form of dark areas, inside or outside of the pots (Fig. 2). For the latter, they usually form drips which can start anywhere from the rim to the lower belly and stop at the lower belly or the base. This trace was recorded according to its presence or absence on the pots and its position.

3.2.2.3. Lime deposits. Lime deposits can be observed in the form of white deposits of different thickness and different resistance, from hard to crumbling (Fig. 2). They were recorded according to their presence or absence on the pot and their position.

3.2.2.4. Abrasions. Abrasion is the result of friction between two or more bodies. The abrader and the abraded are determined by which is the hardest body. Because ceramic vessels are made of a heterogeneous material, abrasion can affect the ceramic matrix, the temper, or both. When the abrader is softer than the mineral inclusions found in the ceramic matrix (such as temper), the ceramic surface is the first to be worn away, leaving the temper pedestalling (Skibo, 2012). Following intense pedestalling, the abrasions may dislodge the temper, resulting in grain extractions (Adams et al., 2009). If the body in contact is hard enough, mineral temper will be worn next, levelling both the grains and the ceramic surface, or causing fractures or polish on the mineral grains (Adams et al., 2009) (Fig. 2) In the event of grain extractions, the dislodged temper may act as a third body, causing further damage and accelerating wear. The microrelief is abraded firstly, while pottery wall can be visibly thinned down if the abrasion is intense enough. Additionally, abrasion on a fragilized surface may result in the detachment of ceramic matter, resulting in spalls. Abrasions may feature striations and scratches (Hamon, 2022; Forte et al., 2018; Procopiou, 2013) In this paper, abrasion wear is recorded based on frequency (isolated, closed, connected), incidence (shallow, deep), orientation (vertical, horizontal, oblique, circular or curvilinear), regularity (regular or irregular) and sharpness of edges (rounded or sharp) (Forte et al., 2018 p. 126).

3.2.2.5. Spalls. The term “spall” or “spalling” is herein used to qualify non-thermal and non-abrasive surface disintegration (Vukovic 2009). Spalls can have different depths (shallow, medium, deep), different morphologies (regular or irregular outline or section) and also different distributions (separated, closed, connected), density (covered, loose and concentrated). and position on the pottery (internal, external, rim, base, belly). Sometimes only the ceramic surface is affected and flakes off, sometimes a large chunk of tempered ceramic is detached (Fig. 2). They were recorded in this study based on presence, absence, position, distribution and density.

3.2.2.6. Carbonate dissolution. When carbonate dissolution occurs on carbonate tempered pots, they result in the formation of vacuoles (Fig. 2). Careful observation is required to differentiate empty vacuoles from burnt away organic tempered. As the acid does not affect the ceramic matrix, empty pits with sharp edges can be observed where the temper used to be. If the process is just beginning, the temper may be partially dissolved but still wedged in the ceramic matrix. Carbonate dissolution has been recorded according to its presence and absence on pots, its position and its intensity (completely dissolved or slightly dissolved).

3.2.2.7. Thermal spalls. Thermal spalls are usually circular, regular in

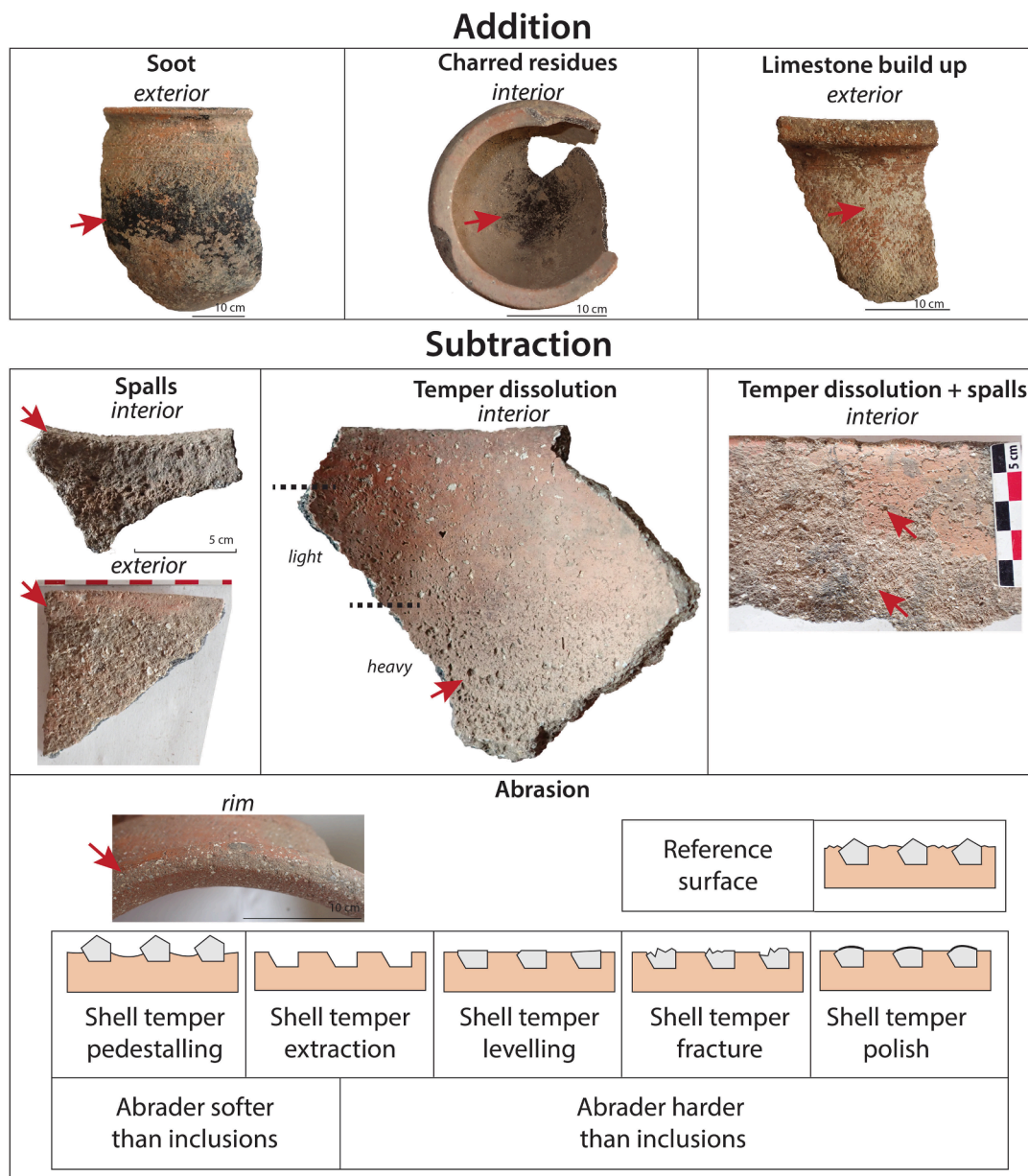


Fig. 2. Use-alterations observed during the study of pottery from “La Poubelle des Mamans”. The section on abrasive wear and the resulting surface damage according to the hardness of the abrader is based on Adams et al., 2009; Skibo, 2012 and Forte et al., 2018).

section and outline and can be relatively deep. They are only found on the exterior of pots.

3.3. Correlations between use-alterations and morpho-stylistic groups and interpretation of pottery function

The correlation between the morphometric and the use-alteration approach is assessed through both a matigraph (Desachy, 2016), highlighting deviations from the means through colored squares, and a Correspondence Analysis regrouped through a hierarchical clustering dendrogram. The latter exclude any groups with less than 5 individuals. Most importantly, this study uses statistical representativity to strengthen functional determinations. The repetition of alterations or a specific combination of alterations on a morphometric group prevents giving too much importance on anecdotal uses (or reuses) as well as taphonomic alterations and also showcases the specialization of activities.

Functional analysis of pottery, combining morpho-stylistic and use-

wear approaches has been carried out following a two-step protocol: 1) The identification of morpho-stylistic groups based on the most complete pots and the identification of discriminative morpho-stylistic criteria in each group to include fragmentary sherds. 2) The implementation of a systematic use-alteration investigation to identify the types of alterations correlated with morpho-stylistic groups.

The preservation of the assemblage is a crucial aspect of functional investigations as the first step of the protocol relies on low degrees of fragmentation to define morpho-stylistic groups, and the second step of the protocol relies on great surface preservation to implement the use-wear approach. In the case of La Poubelle des Mamans, the pottery assemblage has both a low degree of fragmentation and great general preservation of the surfaces. The interpretation of the pottery use-alterations was made by comparison with the different experimental and ethnographic references (Skibo, 1992; Reid and Young, 2000; Arthur, 2002, 2003). These comparisons allowed the interpretation of the use-alterations found on the pots in terms of way of use (cooking, storing, serving, transporting etc.), content (liquid, dry, sometimes

specific types of ingredients) and the types of contact (closing systems, carrying systems, utensils used etc.).

3.3.1. Interpreting the way of use of pottery

3.3.1.1. Cooking pots (soot deposits, charred residues, thermal spalls).

Traces and wear left by heating, such as soot deposits, charred residues and thermal spalls, are perhaps one of the most explored types of use-alterations. They are usually used as diagnostic criteria of cooking pots in the archaeological record (Fanti, 2015; Forte, 2022; Pétrequin, 1989). Cooking traces are particularly investigated through experimental archaeology (Dimoula et al., 2019; Forte et al., 2018; Martineau and Pétrequin, 2000; Taranto, 2022) and ethnographic surveys (Skibo, 1992, 2012; Kobayashi, 1994).

Soot deposits result from the combustion of organic matter, such as wood, and is usually associated with the use of a pot over a fire. The pattern of soot deposition brings information on the position of the pot over a fire and the distance from the flames (Hally, 1986; Pétrequin, 1989; Skibo, 1992, 2013; Forte et al. 2018, 2022).

Organic vessel content exposed to high temperatures (around 100 °C) will eventually carbonize if all the water and/or constitutional moisture is evaporated (Skibo, 1992, 2012). Residue deposition patterns are correlated with cooking modes. Wet cooking, especially when fatty contents are involved, tend to form rings of charred organic residues at the location of the filling limit, while dry cooking tends to develop under the filling limit, at the interior bottom of the pot (Debels, 2021; Forte et al., 2018; Kobayashi, 1994; Skibo, 1992, 2012).

High temperatures cause thermal stress on the pottery which can be more severe depending on the composition of the paste. Those spalls are caused by trapped water exerting great pressure on the outer surface layer. This water can be constituent of the pot or come from the content (Hally, 1983; Skibo, 1992). They must not be confused with “spalls” and “spallings”, which do not refer to thermal mechanisms in this paper.

3.3.1.2. Other categories (storage, transport, service...). Storage pots are usually identified based on morphometric criteria as they are usually large vessels, sometimes stabilized with stones, holes or pedestals, and possess an opening at least large enough to fit a fist, although it is not mandatory (Henrickson and McDonald, 1983; Rice, 1987). Storage pots are usually immobile to some extent which may be assessed through the presence or absence of abrasion on the base, and may feature a closing system (see below: types of contact).

Transport pots are also usually identified via morphometric criteria, such as narrow opening; specific features, such as prehensile elements (Henrickson and McDonald, 1983; Rice, 1987) which can be tied with a carrying system and shut with a closing system (see below: types of contact). Their transportability may be assessed through the presence and absence of abrasions on the base.

Service pots are also frequently identified based on morphometric criteria such as an open, sometimes shallow shape. As they may be used with cutlery or utensils and frequently manipulated, abrasion marks may also be a determinant criterion (see below).

These categories are far from exhaustive, nor are they impervious as some functional categories may overlap and use the same pots indistinctively or similarly shaped pots.

3.3.2. Interpreting pottery content

3.3.2.1. Acidic content (carbonate dissolution and sometimes spalls) and calcareous liquids.

Research on temper dissolution is scarce and this is probably in part because this wear can only be observed on carbonate tempered ceramics (Groat, 2020; Pétrequin and Pétrequin, 1989; Rey, 2013; van Gijn and Verbaas, 2020; Verbaas and van Gijn, 2020), and because the wear can easily be confused with natural post-depositional processes found in acidic environments such as karstic areas and

sometimes overlap the use-wear (Debels et al., 2023). Carbonate dissolution is formed when a liquid saturated with calcium bicarbonate and carbon dioxide is released, causing the precipitation of calcium carbonate crystals (Hendy et al. 2018). Water from limestone environments may naturally be saturated with calcium bicarbonate or an acidic liquid in contact with limestone.

Except for our personal observations in Edioungou (study in progress), no ethnographic studies report the presence of carbonate dissolution. Reference collections have relied on experimental works (van Gijn et al., 2020, p. 75-77; Debels, 2021) in order to interpret archaeological wear and distinguish use-wear from post-depositional wear (Debels et al., 2023). Experiments have demonstrated a correlation between carbonate dissolution and fermented beverages, such as wine, mead and beer after only a few uses (Debels et al., 2023; Groat, 2020; van Gijn et al., 2020, p. 75-77), although any liquid with high pH left long enough will produce the same effect and some scholars have interpreted the presence of acidic vegetal gruels (Rey, 2012; Pétrequin, 1989).

Spalls may occur directly due to the dissolution of the carbonate temper due to the fragilization of the pottery wall. The weakness of the pottery wall is positively correlated with the abundance and large size of temper particles. The construction of a typology of spalls remains necessary to differentiate causes.

3.3.2.2. Fermented contents (spalls and carbonate dissolutions).

Internal spalls have been linked to fermented contents through ethnographic observations. The wear usually distributes in a horizontal manner near the filling limit, in closed or connected frequency and on the rim when a narrow bottle neck pot is used. In some specific cases, may cover the entire interior surface (Arthur, 2002, 2003, 2012; 2021; Debels et al. 2024; Wayessa et al., 2015).

3.3.2.3. Salty content (spalls).

The morphology and distribution of spalls is influenced by ceramic technology and the cause of wear. The correlation between salt and spalls has been established on experimental ceramic tiles (O'Brien, 1990) and experiments on pots has demonstrated that the pattern distribution is a crucial aspect to interpret the presence of saline contents as this wear usually form on the exterior of pots, on the rim and belly and in lesser extent directly under the interior rim (Debels, 2021).

3.3.3. Interpreting the types of contact

The frequent or intense manipulation of pots may result in different types of abrasions, on various parts of the pot. Ethnoarchaeological works have demonstrated the link between wear and hard cleaning practices (Skibo, 1992, 2012) or processing activities (Reid and Young, 2000), while experimental work has strengthened the reference collection of utensil-related wear, including the type and motion (Forte et al., 2018; Lopez Varela et al., 2002; Van Gijn et al., 2020, pp. 80-85; Forte and Lemorini, 2017). Abrasion wear has been one of the focuses of attention since the beginning of use-wear studies (Griffiths, 1978) and has continued to be in the following decade, partly due to the diversity of its morphology. Research has shown that morphology depends on the composition, shape and firing of the vessel, as well as the position and cause of wear. Experimental archaeology has demonstrated the differences in wear formation according to temper and firing temperature (Schiffer and Skibo, 1989 pp. 105–108; Skibo et al., 1989; Beck et al., 2002) and finishing techniques (Skibo et al., 1997).

In addition to the reference collections, archaeological studies have relied on the study of the technology of the vessel as well as the distribution pattern of the wear to interpret the cause. They have evidenced tool marks such as cutlery (Banducci, 2014; Griffiths, 1978;), pestles (Reid and Young, 2000; Vieugué, 2014a) or lids (Vieugué, 2014a), and carrying systems such as cord marks around the knobs (Vieugué, 2014a). The storage position and degree of mobility of a vessel can also be

determined, whether they were resting on the rim for vertical display (Griffiths, 1978), stored and used upright (Fanti, 2015; Vieugué, 2014a), or stacked (Griffiths, 1978 pp. 77–78).

The use of ceramic sherds as tools and utensils can also be determined by the position of wear that suggest their use as ladles (Fanti, 2015; Vieugué, 2014a, p. 35; Lopez Varela et al., 2002), pottery tools such as scrapers and smoothers (Vieugué, 2014a pp. 63–128; Vieugué et al., 2010) and textile tools (Zebrowska, 2020).

3.4. Organic residue analysis and phytolith investigations

This use-wear analysis conducted on the 20th century pottery assemblage of La Poubelle des Mamans is part of a broader integrated functional analysis encompassing phytoliths and organic residue analysis (ORA), which method and results are published elsewhere (Debels, Drieu et al., 2024). A total of 12 pots, belonging to group 1, 2, 4, 5 and 6 were investigated using both approaches. An additional 4 pots coming from group 1 were sampled for further ORA and 3 others from group 1 for phytoliths analysis. Each pot was sampled after a preliminary morphometric and use-alteration study, in order to sample the most representative and well-preserved pots of each group. The objective on this interdisciplinary approach is to refine the interpretations of pot contents and way of use.

4. Results: Identifying pottery function

The intersection between the percentage of aperture (rim \varnothing x 100 / maximum \varnothing) and height, combined with the decorative techniques of the 365 most complete pots has defined 8 groups (Fig. 3). The matri-graph (Fig. 4) highlights the under and over-representation of some alterations according to pottery groups, based on deviations to the mean, disclosing the number of occurrences of each type of alteration. The factorial correspondence analysis of the archaeological morpho-stylistic groups and the use-wear data has highlighted strong correlation with

specific wear (Fig. 5), evidencing a few differences between the sample of the most complete pots (Fig. 5a) and the additional sherds that could be attributed to the morphostylistic groups (Fig. 5b). The repetition of specific types of use-alterations allows for general interpretations of the function of each group and their degree of specialization.

4.1. Group 1 (220 pots)

220 morphometrically complete pots could be identified (MNI). Although the decoration technique can be found on other pots, the combination of the flared rim shape, twisted cord roulette impression decoration technique and either rim diameter or aperture ratio or height is unique to this group. Using these criteria, 146 additional sherds could be determined. As they constitute more than half of the pots from group 1, the sample of the most complete ceramics can be considered representative.

4.1.1. Way of use

Group 1 is composed of small and medium pots with a slightly restricted to restricted opening (rim \varnothing between 45 % to 95 % of the maximum \varnothing), a rim between 6 and 28 cm, and a height between 9 and 31 cm (Fig. 3). The rim is always flared and they display an impression of twisted cord roulette (TCR) with horizontal incisions in the upper part of the pot. Group 1 often display soot deposits (151 out of 220 pots = 63 % and 85 out of 146 additional sherds = 58 %) which generally cover the entire outer surface of ceramic vessels, but more rarely the base. Such distribution indicates that these pots were used directly over a fire, probably for cooking (Skibo, 2012). Surprisingly, charred residues have rarely been identified on the inner surface of ceramic vessels (20 out of 220 pots = 10 % and 23 out of 146 additional sherds = 15 %), located on the bottom. This may be related to careful cooking practices or careful cleaning of the vessel's inner surface after use.

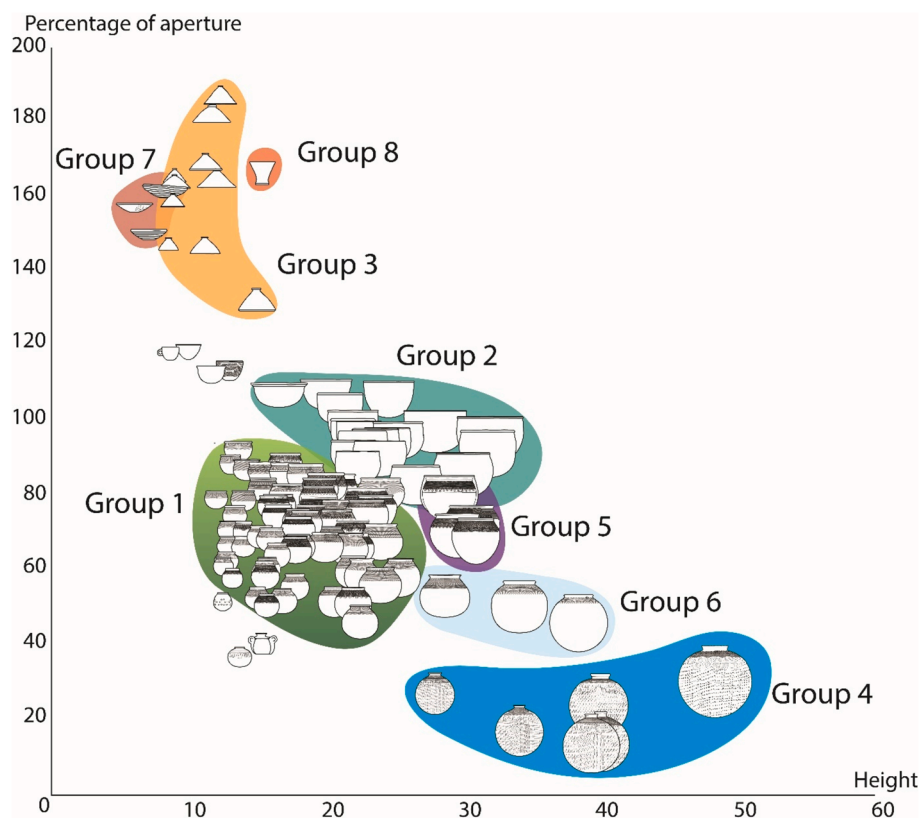


Fig. 3. Determination of morpho-stylistic group through the combination of aperture ratio and height.

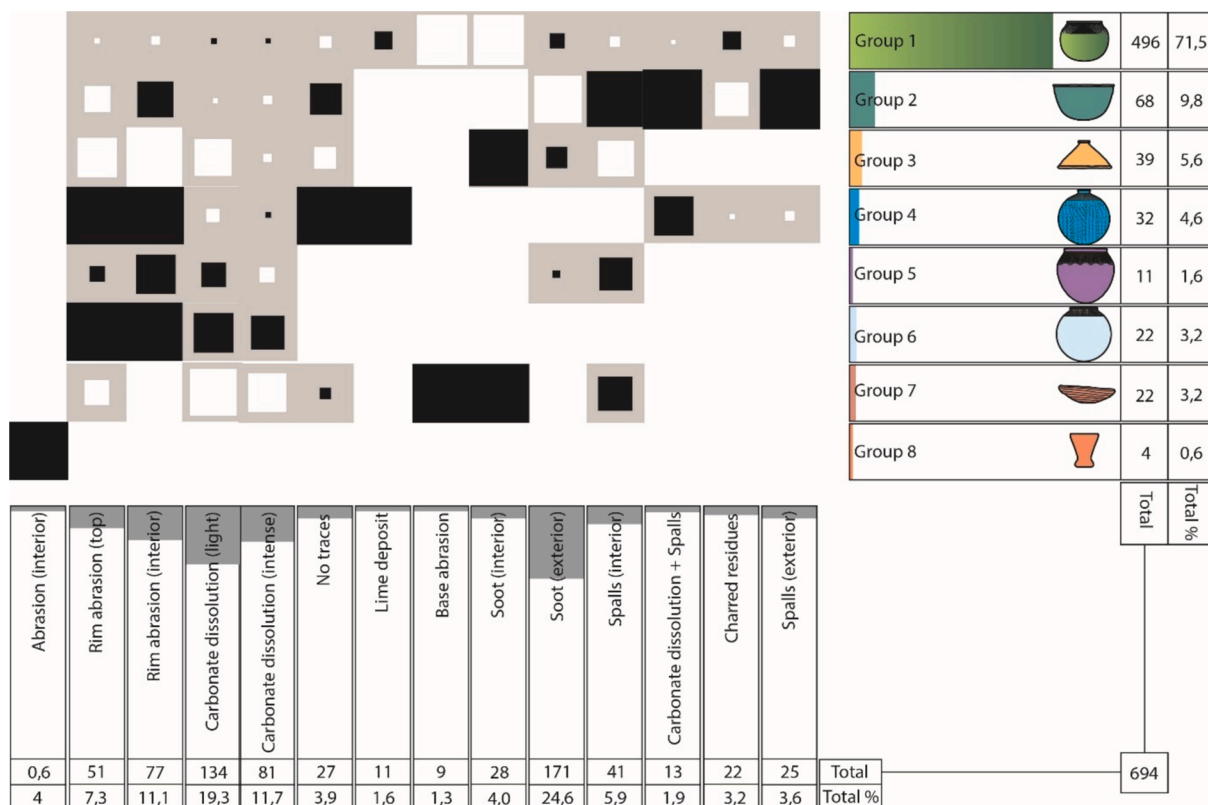


Fig. 4. Matrigraph of the link between occurrences of use-wear on pots and morpho-stylistic groups. Squares account for deviations from the average: over-represented (Black), under-represented or absent (white) and average (grey).

4.1.2. Content

Most of the pots from group 1 display either light or intense temper dissolution on the inner surface (respectively 102 and 60 out of 220 pots = 73 % and 29 and 24 out of 146 remaining sherds = 36 %). Such alteration is caused by acidic liquid contents, as demonstrated by the frequent materialization of a filling limit a few centimeters below the rim (Fig. 7). Specific inner spalls associated with carbonate dissolution have sometimes been identified (9 out of 220 pots = 11 % and 6 out of 146 additional sherds = 4 %). This subtractive alteration may be explained by the fragilization of the pottery wall following intense dissolution of carbonate temper. Some pots from group 1 displaying internal carbonate dissolution also display lime deposits on the exterior upper part of the pots (10 out of 220 pots = 4,5% and only 1 out of 146 additional sherds). Both alterations can be linked as dissolved carbonate temper creates bicarbonate acids (Van Gijn et al., 2020, p. 76-77) that precipitates in the form calcium carbonate crystals when the carbonate dioxide is released when exuded through capillary rise on the upper part of the pots. A few pots display exterior spalls on the upper part (15 out of 220 pots = 7 % and 4 out of 146 additional sherds = 3 %). Some pots from Group 1 do not present inner carbonate dissolution (58 out of 220 pots = 26 % and 121 out of 146 remaining sherds = 83 %), and several of those pots display spalls on the inner (16 out of 220 pots = 7 % and 15 out of 146 additional sherds = 10 %) and outer surface (15 out of 220 pots = 7 % and 4 out of 146 additional sherds = 3 %). Those located in the upper part of the ceramic vessels, between the mid belly and the rim, may be explained by the presence of a significant amount of salt in the pottery contents, as shown by previous experiments (Fig. 7) (Debels, 2021).

The result of organic residues analysis and phytolith investigation approaches has concluded that pots coming from group 1 show traces of animal (fat) and plant (waxes) products, as well as low fat contents and cereal phytoliths. This is consistent with the interpretation of cooking various foods of vegetal and animal origins. Isotopic analysis has

revealed that the animal fats derive mainly from ruminant carcasses with a possible contribution of freshwater product in at least one pot from group 1 (Debels, Drieu et al., 2024).

4.1.3. Types of contact

Intense abrasions were observed on the exterior side of the rim of some cooking pots from group 1 (34 out of 220 pots = 15 % and 8 out of 146 additional sherds = 5 %). This subtractive wear forms a connected homogeneous ring, affecting both the ceramic matrix and the temper that seems completely levelled, indicating a material harder or equal to ceramic and shell. Such side rim abrasions can be caused either by a non-flat hard material lid, such as the conical ones from Group 3, or by an upside-down very open pot, like the ones from group 7 (Fig. 9). Similar results have been obtained during the experimental recreation of ceramic lids (Van Gijn et al., 2020, p. 78) except the distribution of the wear in the case of group 1 pot is on the outside of the rim instead of the inside, indicating a concave conical shape instead of a convex one. Soot is absent on the rim of the cooking pots beyond the abrasion, which could indicate either the use of a lid during cooking, which prevented deposition of soot, or the use of a lid after cooking, which abraded the soot.

Internal abrasions were marginally observed on pots from Group 1. In this group, they are usually faint and connected, covering the entire vessel, leaving the temper slightly pedestalling (Fig. 2), indicating the use of relatively soft material. Internal abrasions are probably more common than could be identified. Since Group 1 pots were identified as cooking pots, the wear may have been caused by frequent contact with organic utensils (wood or calabash) or cleaning materials. Pedestalling has been successfully recreated experimentally during various cleaning material such as heather brush, pig's bristle brush or cloth and sand (Van Gijn et al. 2020, p. 86-89).

Although they display almost all use-alterations observed in the assemblage (Fig. 4), the study of the 365 most complete pots show that

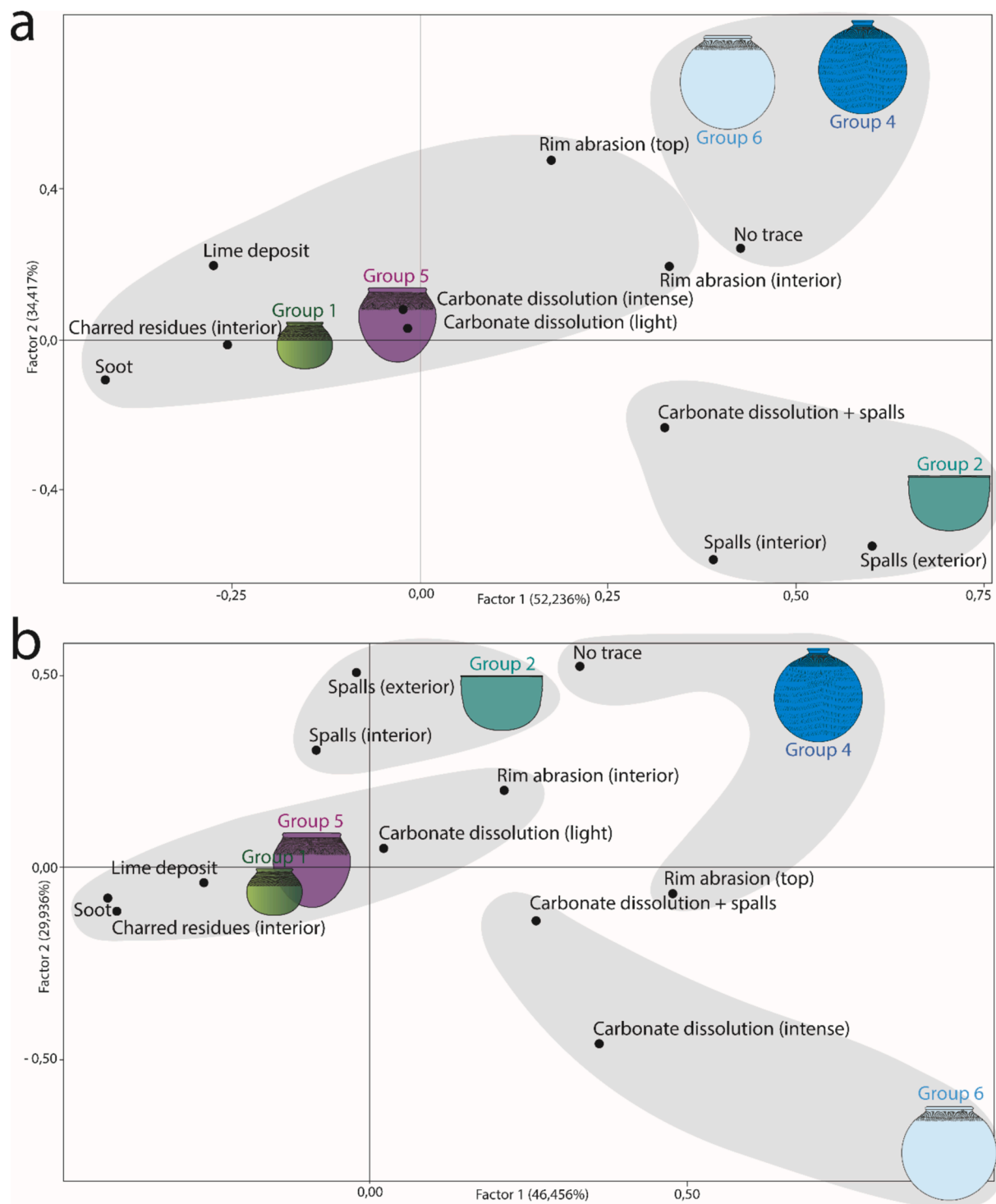


Fig. 5. Correspondence Analysis of the correlation between use-alteration types and morpho-stylistic groups. a) occurrences of use-alterations per morpho-stylistic groups on the 365 most complete pots, Chi Pearson 115.302. b) occurrences of use-alterations per morpho-stylistic groups on the 677 supplementary determinable sherds, Chi Pearson 206,7039. Grey areas were traced based on the results of the hierarchical clustering dendrogram.

some alterations are over-represented in this group. Only one pot from Group 1 displayed simultaneously soot deposits on the outside and no alteration on the interior and 17 pots displayed no alterations at all, suggesting that the use-activities of Group 1 pots are easily prone to alteration or that the lifespan of the pots from this group is sufficiently long to form alterations.

Group 1 pots from the site of La Poubelle des Mamans exhibit a wide morphometric range. Within a morphological group, size is generally

correlated with the amount of food rather than the type of content (DeBoer et Lathrap 1979, pp. 105–106; Gally 1986, pp. 130–131, 143; Gosselain et Van Berg 1992, p. 106; Skibo 1992, p. 60; Kobayashi, 1994, p. 136). However, more than size, this group also displays variety in the degree of aperture, which was further investigated to understand if this can be identified as a functional criterion. Results concluded that the degree of aperture of Group 1 pots is only slightly correlated with the type of alterations. Nevertheless, the most open pots are more correlated

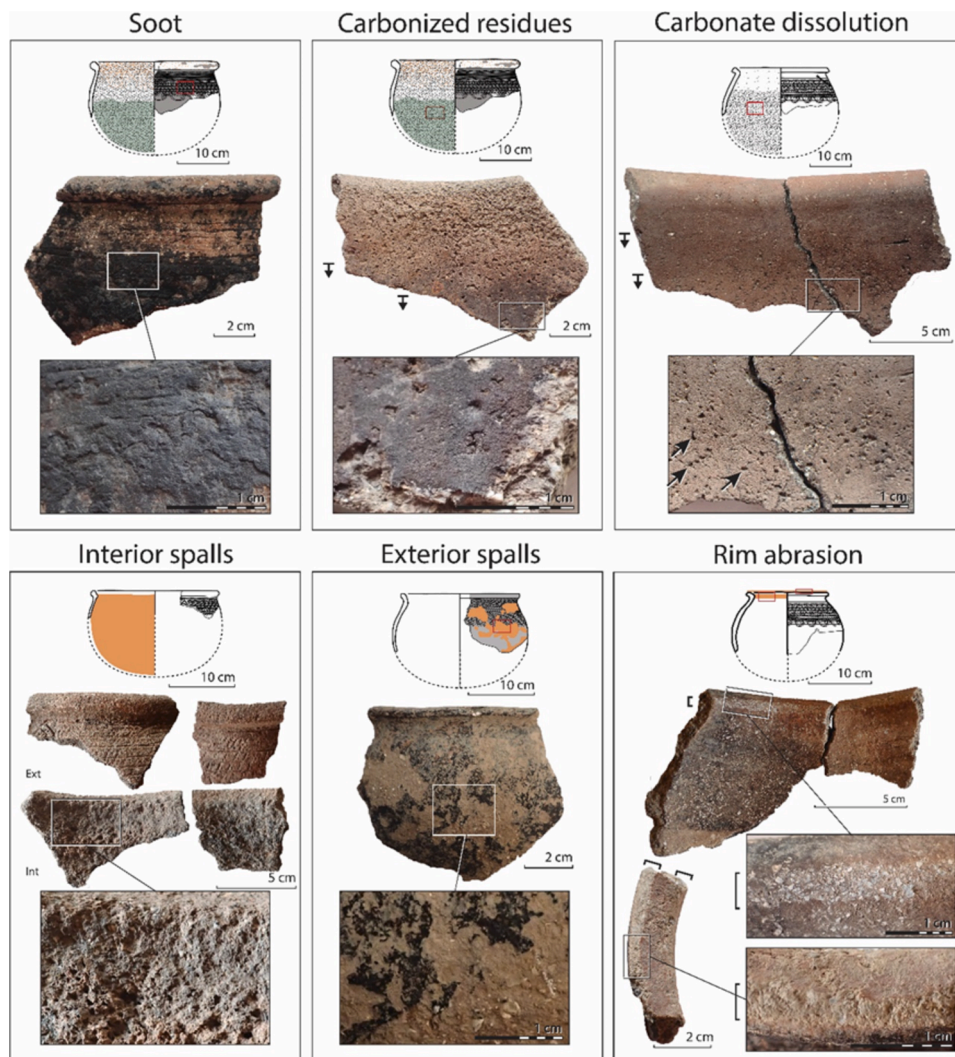


Fig. 6. Sample of use-alterations frequently observed on group 1.

with carbonate dissolution and lime deposits (acid liquids), soot and charred residues (use over fire and easily carbonized contents), internal spalls (salt?) and the absence of alterations, while more restricted pots are correlated with external spalls (salt?), top rim abrasion (covered content) and interior rim abrasion (stirred contents? Cleaning?) (Fig. 6).

4.2. Group 2 (44 pots)

A total of 44 individuals showed sufficient morphometric conservation to be categorized into group 2 (MNI). The straight, flattened or thickened shapes of the rim being unique to this group, 34 additional sherds could be determined. Two additional individuals were not sufficiently complete to be attributed to group 2 with certainty and could be confused with one other group (group 3). The most complete vessels are therefore relatively representative as they are more numerous than the sherd sample.

4.2.1. Way of use

Group 2 is composed of medium size pots with a slightly restricted, straight or slightly open mouth (rim \varnothing between 80 % and 110 % of the maximum \varnothing), rim diameter between 20 and 40 cm, and height between 12 and 40 cm (Fig. 3). They are mostly undecorated but a few individuals display a twisted cord impression at the top of the rim. The rim is either straight, flattened or thickened. Because of their open shape, the ceramic vessels from group 2 may have been used for a large range of

activities, including service (Rice, 1987). A small number of those pots display soot on the exterior surface (4 out of 44 pots and 10 out of 34 sherds), but considering that soot is exceptionally well preserved in the ceramic assemblage, the absence of this deposition on other pots from this group testify that heating was anecdotal.

4.2.2. Content

The dissolution of carbonate temper can be observed along the entire inner wall, stopping a few centimeters below the rim. Light and intense dissolution (respectively 13 and 7 out of 44 pots, and 6 and 3 out of 34 sherds) indicate frequent liquid and acidic contents.

Spalls are over-represented in group 2 as they display the most significant mean to the average compared to all other groups (Fig. 4). External spalls are located on the upper part of the pots and contribute to 9 out of 44 pots and can be found on 1 out of 34 sherds, suggesting that they might have contained significant amounts of salt. Spalling can also be found on the interior belly and bottom of the pots (12 out of 44 pots and 1 out of 34 sherds) (Fig. 8), sometimes in association with carbonate dissolution (3 out of 46 pots and 1 out of 34). This indicates that some pots from this group frequently contained acidic liquids.

ORA on pots from group 2 yielded lipids (animal fat profile) but were inconclusive regarding the phytolith investigation. It could suggest that some pots were used to serve meat (Debels, Drieu et al., 2024).

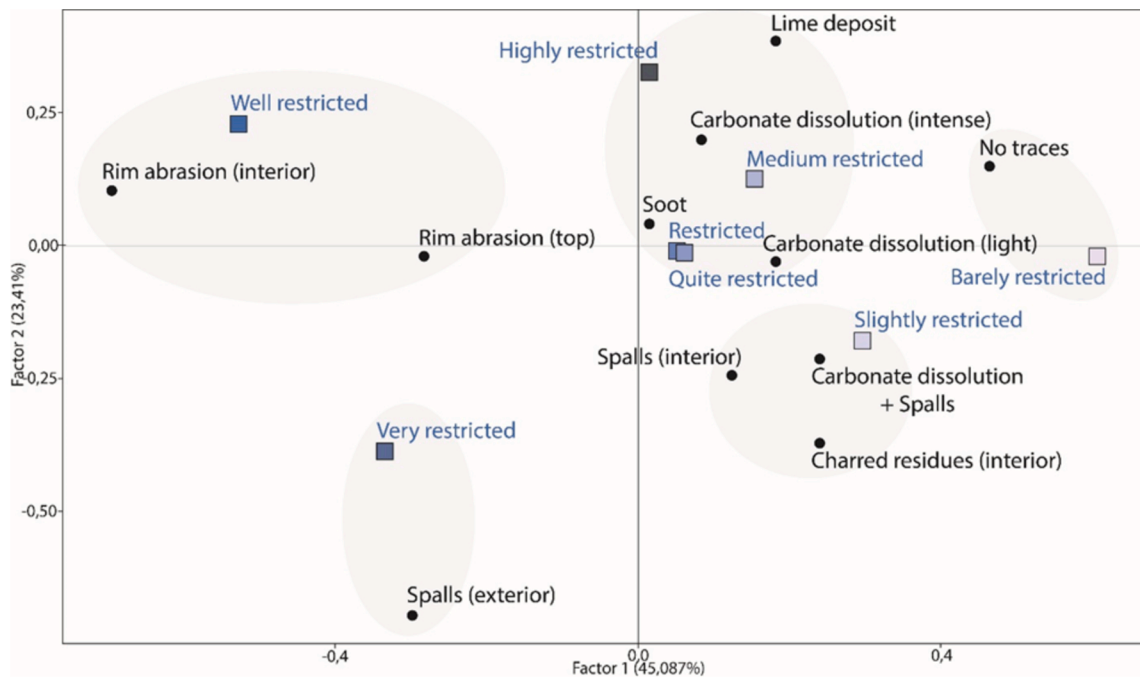


Fig. 7. CA of the correlation between use-alteration types and aperture of pots from group 1.

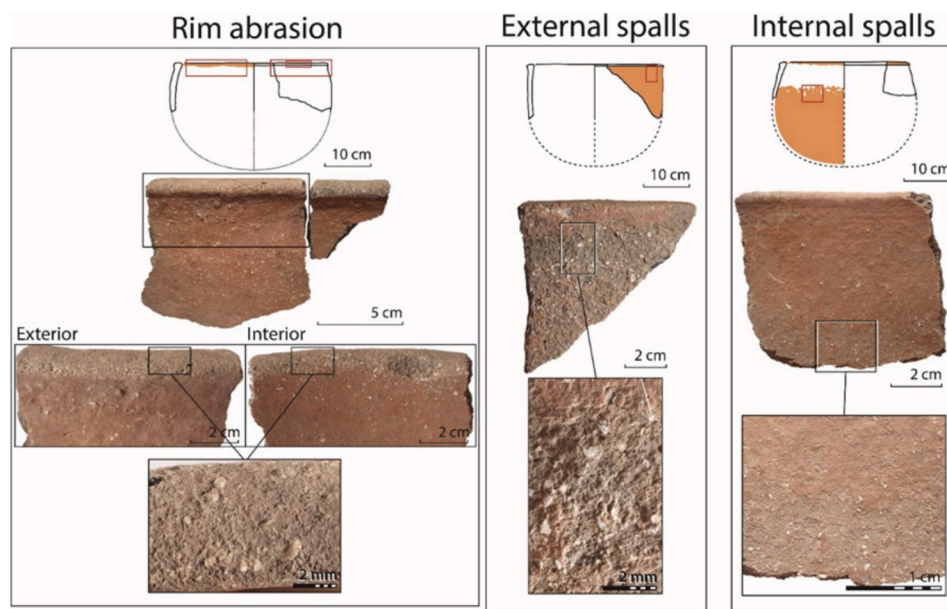


Fig. 8. Sample of use-alteration frequently observed on group 2.

4.2.3. Types of contact

Some pots from group 2 display rim abrasions located on the top (15 out of 44 pots and 7 out of 34 sherds), that are connected and homogenous throughout the rim (Fig. 8). The ceramic matrix was not levelled down and the wear seems to slightly fit the curvature of the rim, indicating friction with a material softer than ceramic. Such wear may suggest that a soft material was used to cover the pot or that the pot was rested on a soft floor. However, the shell temper is sometimes fractured, which is consistent with hard material. This ambivalence could possibly indicate that the wear was caused by a heterogenous material, both soft and hard or one after the other. Anyhow, some pots from this group were frequently covered or stored upside down.

Only 8 pots from group 2 display no alterations at all.

4.3. Group 3 (17 lids)

Group 3 includes 17 morphometrically complete vessels (MNI). 19 other individuals have been added to this functional class of pots, due to their conical shape and their prehensile elements which are highly distinctive features. As the most complete pots from group 3 constitute almost as much as the sherd sample of the pots from group 3, they are therefore quite representative.

4.3.1. Way of use and types of contact

Group 3 is composed of open, conical pots with a central prehensile element at the bottom (aperture ratio between 125 and 184 %; rim Ø between 12 and 26 cm, height between 9 and 14 cm). Given their shape,

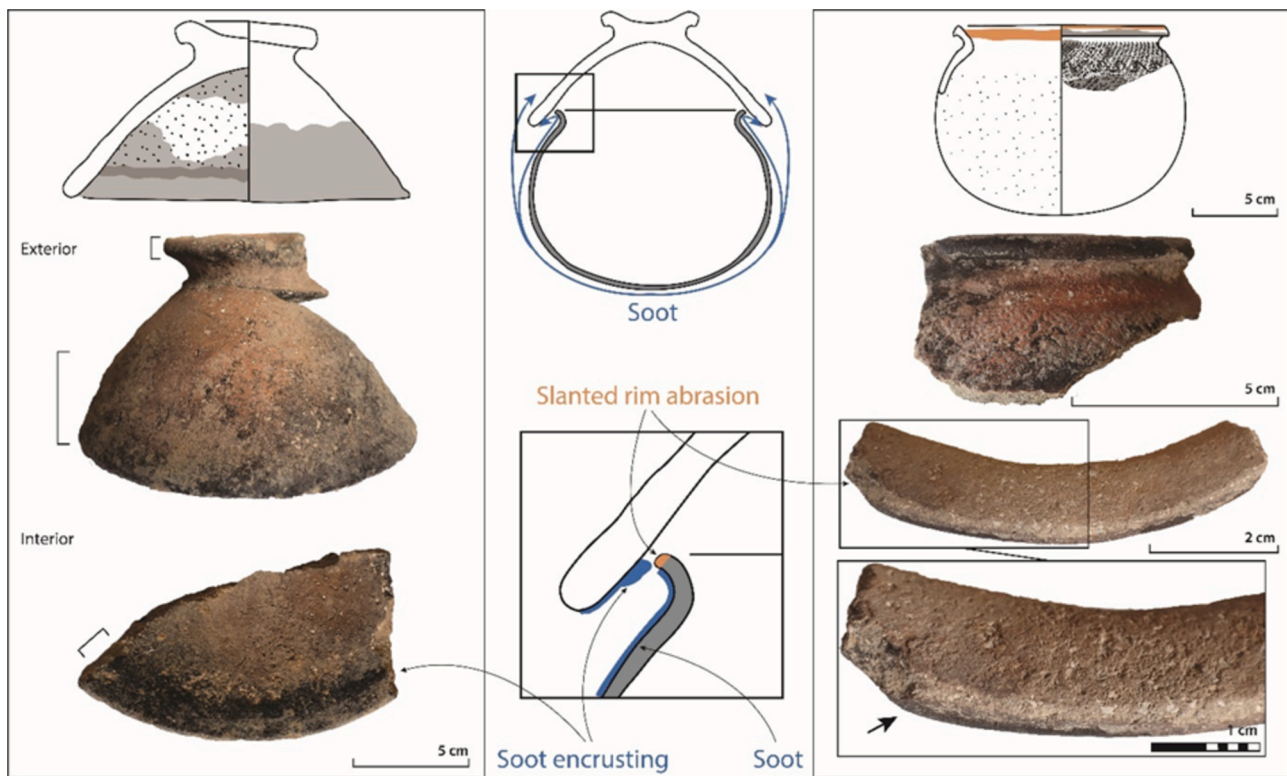


Fig. 9. Use-alteration showing the functional association of conical lids (group 3) and cooking pots (group 1), through soot deposition and slanted abrasion on the rim.

they can be interpreted as lids. Lids display frequently sooting on the exterior (13 out of 17 pots and 19 out of 19 additional sherds) and interior (16 out of 17 pots and 16 out of 19 additional sherds) (Fig. 4, Fig. 5), which is unique to this group. This evidences their use in combination with the cooking pots from group 1. In addition, patterns of soot deposition show that soot builds up to form a crust a few centimeters below the rim of the lids, indicating an overhanging of the lids over the cooking pot (Fig. 9). Some lids (7 out of 17 pots and 14 out of 19 additional sherds) display light or intense carbonate dissolution which could be interpreted as the evaporation of acidic liquids contained in cooking pots.

Two lids do not display any soot deposition and may have been used to cover pots that were not heated over a fire.

4.4. Group 4 (21 pots)

Group 4 includes 21 individuals with sufficient morphometrical preservation to interpret their profile (MNI). The very small diameter of the rim and the unique decoration (band of short horizontal incisions and the rolled shell impressions) are the distinctive features that allowed the identification of 25 additional sherds. As they are almost as numerous as the sherd sample from group 4, the mostly complete pots are quite representative.

4.4.1. Way of use

Group 4 is composed of medium to large globular vessels with very restricted openings (rim \emptyset between 10 and 25 % of the maximum \emptyset ; between 5 and 15 cm), they have the smallest rim to body ratio of the assemblage and the narrowest openings of the entire assemblage. They are big pots which height varies between 15 and 47 cm (Fig. 3). They systematically have a flared rim and are decorated with a combination of TCR, horizontal incisions, a band of short vertical incisions on the upper part of the pot, and a distinctive rolled shell impression covering the belly and sometimes the base of the pot. Such distinctive rim to body

ratio is usually associated with storing and transporting (Henrickson and McDonald, 1983; Rice, 1987).

4.4.2. Content

Such closed shapes are usually linked to the storage and transport of liquids (such as water), although we cannot exclude dry goods (Henrickson and McDonald, 1983; Rice, 1987). Carbonate dissolutions have been observed along the entire inner wall of the vessels (10 out of 21 pots and 11 out of 25 additional sherds), stopping a few centimeters below the rim, near the shoulder area. One pot from this group presents both carbonate dissolution and internal spalls, located at the bottom of the ceramic vessel (Fig. 4) and one pots presents both internal carbonate dissolution and exterior lime deposits in the upper part. All these cases demonstrate the presence of acidic liquids. External spalls are anecdotal too and can be found on one pot from group 4. The wear is located on the upper part of the pot, between the shoulder or body curve and the top of the rim and may be related to salt contents (Debels, 2021). However, the very low frequency requires caution. Organic residue analysis concluded that pots from group 4 show evidence of low lipid products on some individuals (Debels, Drieu et al., 2024). The phytolith investigation was inconclusive. It is consistent with the storage or transport of liquids, such as water and sometimes alternative liquids.

4.4.3. Types of contact

Pots in this group show an over-representation of abrasions in the rim area (top and interior). Top rim abrasion in this group (7 out of 21 pots and 6 out of 25 additional sherds) is characterized by extensive connected wear, levelling and flattening down the rim over several millimeters. This could be caused by a flat lid made of a hard material (see Van Gijn et al., 2020p.78–79). Alternatively, this wear may be caused by frequently turning the pot upside down on a hard floor so that it rests on its rim. Abrasions at the narrowest internal point of the neck (7 out of 21 pots and 5 out of 25 additional sherds), can be interpreted as frequent contact with utensils or contact with a plug (Fig. 11), as some

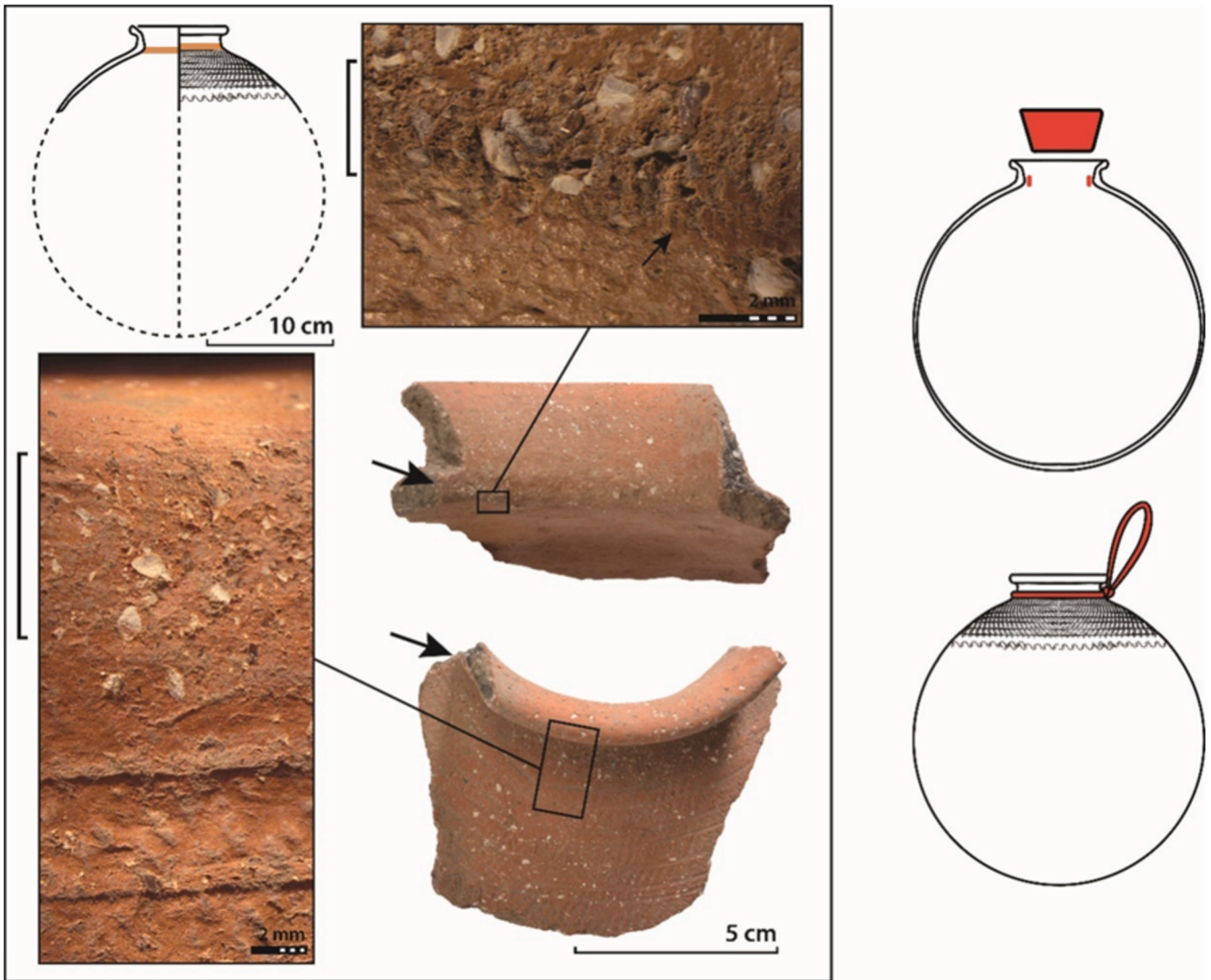


Fig. 10. Interior and exterior abrasion on the neck of a pot from group 4, assessing the contact of a closing (plug) and a carrying (ligature) system.

individuals show vertical linear striations and scratches cutting deep into the ceramic matrix and abrading the carbonate temper, suggesting the use of a hard material moving vertically up or down the neck. As the rim diameters of group 4 are usually too narrow to fit a hand, let alone a hand holding a small drawing vessel, the plugging system hypothesis would be more plausible (Fig. 11). Abrasion of the top of the rim and inner neck can be found in association (3 occurrences).

One individual displays both an abrasion with a hard material on the inner neck and another type of abrasion on the lower part of the exterior neck. The latter wore out a thin layer of surface ceramic that exposed some carbonate inclusions (pedestalling), without altering them, indicating the use of a material softer than ceramic. A possible interpretation for the location and nature of this abrasion can be the friction of a cord around the neck, supposedly to carry the vessel or to attach the plug (Fig. 11). Ethnographic investigations in the Nepalese Terai (Lugli and Vidale 1996) have documented the use of ropes tightened around narrow pottery necks in order to carry transport vessels although abrasion was not observed probably due to the addition of an organic coating and content-related organic deposits, that might have prevented wear formation or covered it. The authors have however linked the chipping of the flared rim to the pressure exerted by the rope. Such wear was not clearly identified on the pots from group 4.

4.5. Group 5 (6 pots)

Group 5 includes 6 individuals with an interpretable profile (MNI). They mostly show similar shape and decoration to group 1, but the large size of these pots is what distinguishes them from group 1. No other individual were identified using this criteria (total of the group = 6 sherds), however, 238 additional sherds could be attributed to either group 1 or 5 or one other group. The sample of almost complete vessels is representative despite its very low number.

4.5.1. Way of use

Group 5 is composed of medium size pots with slightly restricted openings (rim \varnothing between 60 % and 80 % of the maximum \varnothing , rim diameter between 21 and 28 cm) and a great height between 23 and 31 cm (Fig. 3). Similar to group 1, they are decorated using TCR and horizontal incisions in the upper part of the body and display a flared rim. Several pots of group 5 show external soot deposits (3 out of 6), but no inner charred residues or thermal spalls (Fig. 5). According to their capacity and their use-alterations, these ceramic vessels seem to have been involved in heating (cooking?) activities to produce large quantities.

4.5.2. Content

Group 5 pots show interior carbonate dissolution (6 out of 6) and interior spalls (1 out of 6).

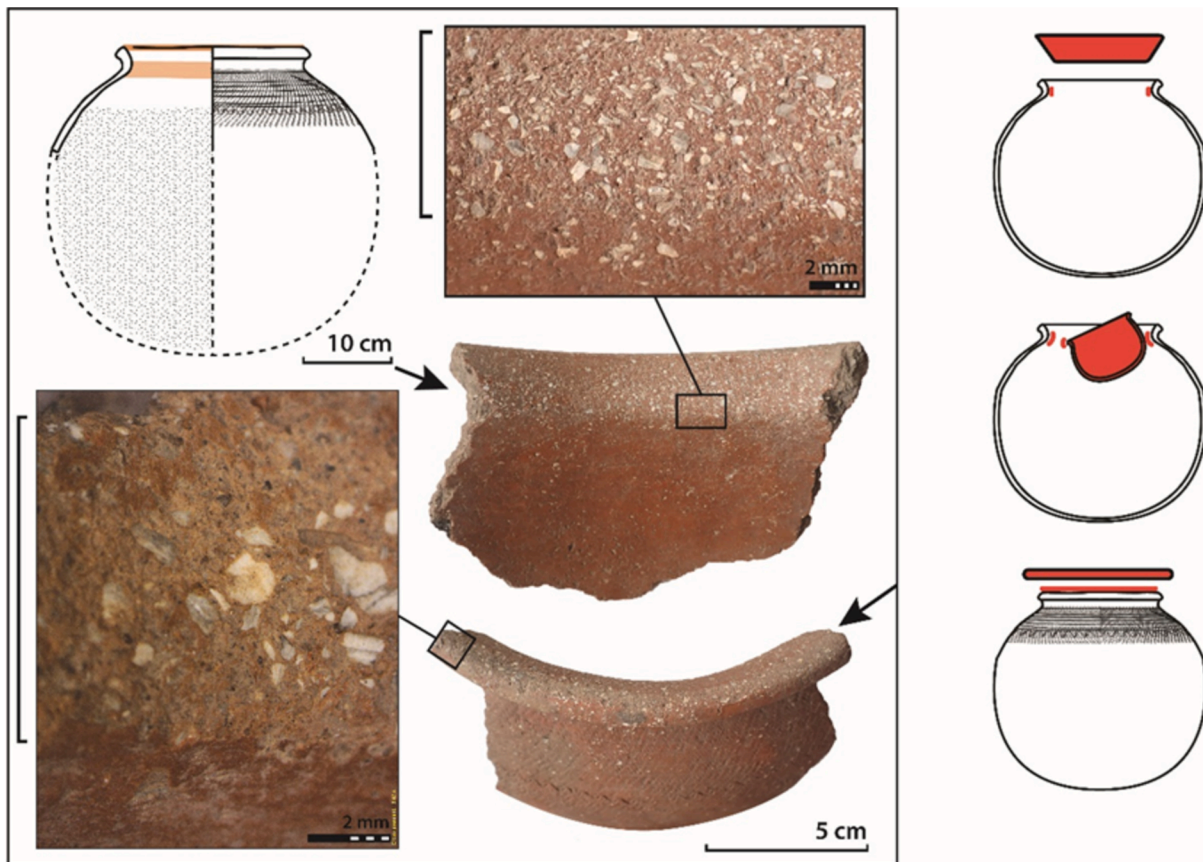


Fig. 11. Interior rim abrasion and flat top rim abrasion on a pot from group 6, assessing the contact of a closing system (plug) and/or a drawing utensil, and a hard flat surface, such as the floor or a flat lid.

The result of the organic residue analysis and the phytolith investigation has concluded that pots coming from group 5 show traces of animal (fat) and plant (waxes) products, as well as low fat contents and cereal phytoliths. This is consistent with the interpretation of cooking various foods of vegetal and animal origins.

4.5.3. Types of contact

Pots from group 5 display abrasion on the exterior top of the rim (1 out of 6) and the inner rim (2 out of 6), showcasing the use of conical lids.

The small size sample (6) implies that those are preliminary conclusions.

4.6. Group 6 (12 pots)

Group 6 is composed of 12 pots with sufficient morphometrics preservation (MNI). The most distinctive feature is the relatively small diameter of the rim. This led to the identification of 29 additional sherds.

4.6.1. Way of use

Group 6 is composed of pots with a restricted mouth opening (rim \emptyset between 45 % and 50 % of the maximum \emptyset). They show similar morphology and wear to group 4, except that the rim diameter is larger (between 14,5 cm and 18 cm; mean at 16,7 cm) and their great height is between 30 and 40 cm (Fig. 3). They are decorated using TCR and horizontal lines in the upper part of the body. The mouth to body ratio in the pottery vessels from this group, although less restricted than group 4, is traditionally interpreted to be storing vessels (Henrickson and McDonald 1983, Rice, 1987).

4.6.2. Content

This group frequently displays a light or intense carbonate temper dissolution (respectively 7 and 4 out of 12 pots and 1 and 19 out of 29 additional sherds). Their inner bottom sometimes shows a combination of temper dissolution and spalls (3 out of 29 sherds), indicating in both cases the presence of acidic liquids, possibly combined with mechanical actions that came in contact with the fragilized pottery wall and led to the formation of those spalls.

The CA based on the 365 most complete pots show they are more strongly correlated with rim abrasion on the top or the interior and lack of use-alterations (Fig. 5a), while the CA based on 677 supplementary determinable sherds show correlation with intense carbonate dissolution and carbonated dissolution associated to spalls (Fig. 5b). This difference can be explained as group 6 are large pots, making them harder to refit body and base sherds with rim sherds. Therefore, the sample of the most complete pots shows an underrepresentation of body and base sherds, where the carbonate dissolutions and spalls can most frequently be observed.

Pots from group 6 show evidence of low lipid products on some individuals and were inconclusive regarding the phytolith investigation (Debels, Drieu et al., 2024). It is consistent with the storage or transport of liquids.

4.6.3. Types of contact

Extensive abrasion, levelling down the rim indicates the use of a flat lid or storage upside down on the rim (7 out of 12 pots). Similar to group 4, the levelling down of the rim, which affects both the ceramic and the temper, indicates contact with a material harder than ceramic (Van Gijn et al. 2020, p. 78-79). Abrasions on the inner part of the neck (4 out of 12 pots) affect a large area, exceeding the narrowest point, which would be inconsistent with a plug. Some individuals show wear of both the

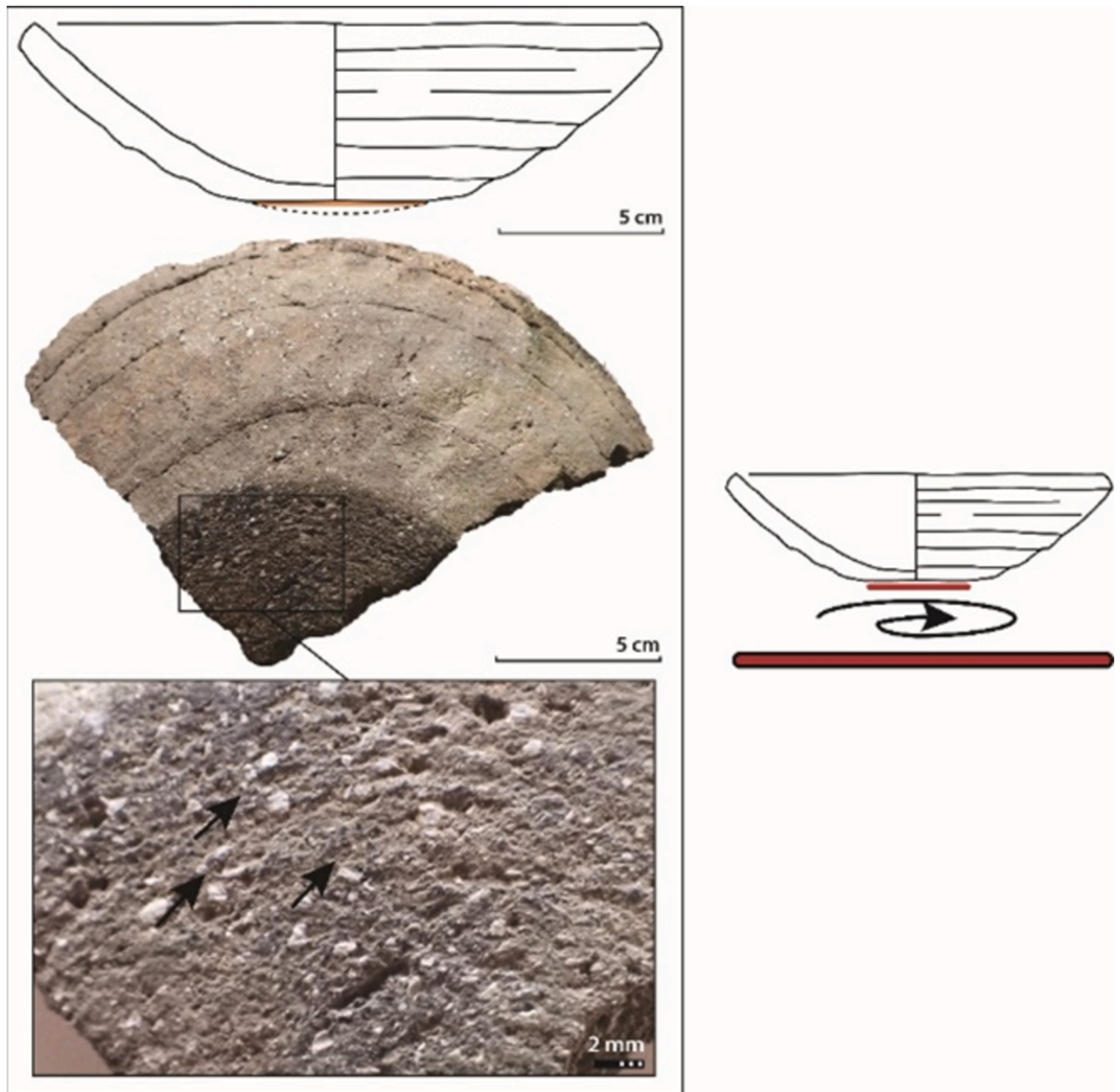


Fig. 12. Exterior bottom abrasion on a pot from group 3, assessing rotation on a flat and hard surface, such as the floor.

ceramic and the carbonate temper, while others (Fig. 12) show only a thinning out of the ceramic surface, leaving the temper pedestalling, indicating the use of a material softer than ceramic. It is plausible that various factors caused this wear, such as plugs made of both hard and soft materials, or contact with a scooping vessel made of ceramic or organic material.

4.7. Group 7 (11 pots)

Group 7 is composed of 11 pots (MNI). Their unique corrugated exterior surface led to the identification of 54 additional sherds. The sample of most complete vessels is possibly poorly representative of the group.

4.7.1. Way of use

Group 7 feature very open pots in the shape of sphere cap or cones (rim Ø between 15 and 36 cm, aperture ratio between 148 and 165 %) with a low height (between 5 and 9 cm). They have a very corrugated exterior surface composed of unsmoothed coils. This coarse vessel has a thick base with systematic and significant abrasion. This abrasion has resulted in a large reduction in thickness, potentially up to several centimeters, and has severely affected both the ceramic matrix and the shell temper, by levelling any microrelief and thinning down the pottery wall along a horizontal plane. This wear is connected, homogenous and deep. It features striations that are deep, isolated, with sharp edges and organized in a curvilinear fashion. This wear assesses contact with a flat surface that is harder than ceramic. Numerous striations can be observed, some associated with empty shell temper vacuoles, in the

shape of comets. Such striations may be caused by detached carbonate temper or hard elements stuck between the vessel and a flat hard surface. The organization of the striations have been caused by a rotative motion (Fig. 10). We have interpreted such shape as a rotational support for pottery making (base abrasions), as still in use today (personal observations). A total of 8 out of 54 sherds also show interior soot deposits

in addition to the base abrasions, which is similar to group 3 pots, and may suggest some were reused or used in parallel to pottery craft activities, as lids.

4.7.2. Content

Neither typometric nor use-wear analyses have not provided any

	ABRASION				HEATING TRACES	SPALLING	CARBONATE DISSOLUTION	FUNCTIONAL INTERPRETATION
	Base	Neck and int; rim	Interior	Rim				
Group 1				Hard body (Slant)	Charred residues Soot			COOKING
Group 2				Soft body?				PREPARATIONS WITHOUT FIRE
Group 3					Soot			LID
Group 4		Soft body		Hard body				LIQUID TRANSPORT
Group 5				Hard body (Slant)	Soot			COOKING
Group 6		Hard body		Hard body				LIQUID STORAGE
Group 7	Hard body							CRAFT POT
Group 8			Soft body					CRAFT POT
USE-ALTERATION INTERPRETATION								
WAY OF USE	ROTATION		GRINDING		USED OVER FIRE (frequent)	VARIABLE + SALT PRODUCTION (occasional)		
CONTENT			SOFT CONTENT (systematic)		ORGANIC LIQUID (frequent)	VARIABLE + SALT (occasional)	ACIDIC LIQUID (occasional)	
TYPES OF CONTACT	ROTATION ON HARD FLAT SURFACE (systematic)	PLUG OR CORD AROUND NECK (occasional)	SOFT PESTLE (systematic)	FLAT LID or stored on rim AND CONICAL LID (frequent)				

Fig. 13. Synthesis of use-alterations distribution pattern per morpho-stylistic groups and their interpretation.

information regarding the original content of the ceramic vessels.

4.7.3. Types of contact

The types of contact in use for the pots from Group 7 is inherent to its way of use: namely, the rotation on a hard flat surface.

4.8. Group 8 (1 mortar)

Group 8 counts one complete individual. The distinctive hourglass shape allowed the identification of 3 additional individuals (Total = 4 sherds and MNI = 4). As only a quarter of the pots are almost complete, this group is relatively poorly represented by the sample of complete pots.

4.8.1. Way of use

Group 8 pots are open shapes and display a thick footing. They are in the general shape of mortars. Only one individual was morphometrically complete (rim $\varnothing = 15$, aperture ratio = 170 %; height = 15) (Fig. 3). All of them are undecorated. They all show extensive abrasion on the interior body and bottom. The wear is connected and only affects the ceramic matrix, leaving the shell temper pedestalling, indicating an abrading material softer than the temper but harder than ceramic. In this case, the wear suggests a soft material pestle, such as a wooden one. Experiments on herb pounding with a wooden pestle for 60 min has resulted in relatively little wear formation (Van Gijn et al., 2020p. 72–73), perhaps suggesting longer use to develop intense wear.

4.8.2. Content

As the abrasion only affect the ceramic matrix, leaving the temper pedestalling, it is consistent that a soft material was grinded. Similar pots are still used today in Edioungou to grind tobacco leaves, and are fast disappearing (personal observations).

4.8.3. Types of contact

The types of contact in action for the pots for group 8 is inherent to its way of use, namely, a utensil (pestle) grinding and abrading the interior bottom and body.

4.9. Synthesis of pottery function

To conclude with, the integrated analysis of morphometric and use-wear of the pottery assemblage from “La Poubelle des Mamans” has delivered significant results regarding the function of the 8 main groups of pots. Interpretations could be drawn based on the frequency of certain types of use: (Fig. 13).

- Pots from group 1 were mainly used as cooking pots given that they often display outer soot deposits, sometimes associated with inner charred residues. They obviously contained acidic liquids given the presence of inner carbonate dissolutions, and possible salty contents may have caused exterior and interior spalls. These pots were frequently closed using conical lids made of hard material as evidenced by the slant rim abrasion.
- Pots from group 2 may have been used for different activities, as evidenced by the variety of use-alterations. The uses may include serving, based on their semi-sphere open shape and their scarce use-alterations. Some pots from group 2 have also contained acidic liquids given the presence of inner carbonate dissolutions. Others may have contained salty contents, that are responsible for the exterior and interior spalls. These pots from group 2, which may have been used in the salt production process, can be linked to the cooking pots from group 1, which may have processed the salt within meals.
- Pots from group 3 were identified as lids because of their very open conical shape and their prehensile element. Most of them were used in association with the cooking pots from Group 1 and 5 given that

they frequently display soot deposits on their outer surface and inner rim, and have fitting rim and openings.

- Pots from group 4 have been interpreted as liquid transport vessels because of their large-size globular shape and very restricted opening. They have likely contained acidic liquids due to the regular presence of inner carbonate dissolutions. Some of these transport vessels were closed using a plug made of soft material as evidenced by the abrasion of the inner rim. One individual was likely tied with a rope as shown by the soft abrasion visible on the exterior neck.
- Similar to pots from Group 1, Group 5 pots were used for cooking, as evidenced by the soot deposits on the exterior surface. They too contained acidic liquids, showcased by the dissolution of the carbonate temper.
- Pots from Group 6 have been identified as storage vessels due to their large-size globular shape and their restricted opening. They contained acidic liquids as evidenced by the numerous carbonate dissolutions visible on their inner surface. Such pots were closed using flat lids or plugs made of hard material given that the abrasion has levelled down the ceramic matrix and the temper.
- Pots from group 7 have been interpreted as rotational supports for pottery-making due to their very open semi-sphere shape and their heavily abraded base showing curved deep striations. The presence of clay as a content could not, however, be proven from the study of use-alterations.
- Pots from group 8 have been identified as mortars due to their open conical shape, their thick base and the covering, connected abrasion on the interior body and bottom. They were likely used to grind soft organic content using soft material pestles as the abrasions only affected the ceramic matrix and not the shell temper.

5. Discussion and conclusion

The use-wear investigation conducted on the ceramic vessels of a 20th century dump in Edioungou (Lower-Casamance) has allowed both the reconstruction of some past food practices and the better understanding of the formation of use-alterations through their morphology, position and combination. The results of this research confirm the positive correlation between specific use-alterations and activities and highlight the specialization of some pottery shapes and sizes.

This study is original both by the large size of the sample, allowing for the implementation of statistical analysis, and the systematic implementation of the use-alteration analysis on the entire assemblage. The methodology used ensured the distinction between post-depositional alterations and use-alterations by observing the homogeneity of the traces between refitted sherds, and absence of alteration on the edges of sherds. This stage of the analysis revealed the exceptional preservation of the ceramic assemblage, which is not surprising given the site's chronology (20th century). Furthermore, the functional interpretation is built on a statistically significant sample, relying on the overrepresentation (matrigaph) or strong correlation (CA) of certain types of wear on specific morphological pottery groups, thus, avoiding giving too much importance to anecdotic use-alterations.

The first stage of the study protocol was to define principal pottery groups based on morphometry and style. A sample of the 365 most complete pots (interpretable rim diameter, maximum diameter, height, shape and decoration technique) was used as a reference to identify diagnostic criteria from each group. This allowed the attribution of more fragmentary sherds to the groups, partly overcoming representativity issues. The extension of the use-wear analysis on both the sample of morphometrically complete pots and the sample of fragmentary sherds allowed the mitigation of biases commonly caused by the lack of refitted base in larger pots. Secondly, the use-wear analysis relies on the frequency of certain types of use-alterations per morpho-stylistic groups of pots.

The use-wear investigation has provided important information on past practices by revealing pottery way of use, contents and the types of

contact. Together, these different aspects reflect the function of ceramic vessels. Pots used for cooking were revealed through the presence of outer soot deposits and more marginally inner charred residues. One group of pots were used for grinding soft contents as evidenced by the pedestalling abrasion. Other ways of use were rather revealed through morphometrical aspects, such as big sizes and restricted opening suggesting storage, and similar shapes with very restricted opening suggesting transport etc. Contents were evidenced through specific use-alterations, such as carbonate dissolution materializing a filling limit, demonstrating the presence of acidic liquids, and specific spalls on the interior and exterior wall possibly caused by salty contents. Finally, the morphology, frequency and distribution of abrasions have brought significant information regarding pottery manipulation, closing systems, such as conical, flat lids and plugs, carrying systems and in some cases, the rotative motion associated to pottery craft.

The functional analysis evidenced that 20th century Diola Kassa enjoy the taste of acidic and salty meals heated in cooking pots over an open fire. The pots were frequently covered using conical lids, uncovered during the excavation, as evidenced by the systematic soot deposits. This means that those lids were exclusively used in association with cooking pots. The storing and transporting of liquids and acidic liquids were also commonly practiced and required covering using lids or plugs to protect the content. Neither the flat and hard lids nor the plugs were uncovered during the excavation. It is a possibility that instead of flat and hard lids, the abrasions on the rim were caused by turning the pot upside down when not in use. A variety of different activities, including food serving and non-heated food processing may have been carried out using large open bowls. Salt processing or storing may also have been evidenced inside the morphotype and then used to season the contents of the cooking pots. Finally, specific craft activities were also evidenced, such as pottery making using a rotative support made of ceramic and the grinding of soft contents inside ceramic mortars.

The construction of a large ethnoarchaeological reference database has now been achieved in the village of Edioungou, as well as in two other villages from Lower Casamance, with the objective of characterizing all the pottery functions and main current food recipes. The combination of morphometry, use-wear, ORA and phytoliths analysis will assess the signature of use-alterations related to these current functions. This solid reference collection will help refine the preliminary functional interpretations of the archaeological pottery assemblage from “La Poubelle des Mamans” and has the ambition to be useful in other archaeological contexts more distant in time and space. In conjunction with ORA, microbotany, experimental and ethnographic analogies, use-wear investigations are able to depict past culinary and craft practices using pottery vessels (Debels, Drieu et al., 2024; Drieu et al., 2024). While such investigations were often conducted individually in the past, the last decades have evidenced the power of such interdisciplinary approaches.

CRediT authorship contribution statement

Pauline Debels: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Julien Vieugué:** Validation, Supervision, Conceptualization, Writing – review & editing. **Léa Drieu:** Writing – review & editing, Validation, Investigation, Data curation, Formal analysis. **Aline Garnier:** Data curation, Formal analysis, Investigation, Validation. **Moustapha Sall:** Supervision, Project administration. **Anne Mayor:** Validation, Supervision, Project administration, Funding acquisition, Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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