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Toolkits for ceramic production: informal tools and the importance of high power use-wear analysis

Abstract

The functional and technological analysis of tools made of different materials used by potters can provide us with insight into the technological system of past societies. Experiments conducted with tools of flint, pebbles, shells, coral and pottery sherds have shown that each of these materials may be used in different stages of the pottery production process and that they all have their own specific functionality. The research presented demonstrates that tools for pottery production in various archaeological contexts were used in a relatively ad hoc way, using readily available sherds and unmodified pieces of other materials, such as shell, coral and bone, lying around the potters' working area. This paper argues that these results imply that in the future specific attention should be paid to matters of sampling, since it is clear that we can no longer concentrate on formal tools only but must include the study of pieces formerly associated with food remains or general waste.

Keywords

Pottery production tools, functional analysis, technological systems.

Résumé

L'analyse technologique et fonctionnelle des «trousses à outils» de potier peut nous fournir des indications sur la structure des sociétés du passé. Les expérimentations menées avec des outils en silex, des galets, des coquillages, des coraux et des tessons ont montré que chacune de ces catégories d'objets pouvait être utilisée à différentes étapes de la chaîne opératoire de fabrication des vases, selon un mode de fonctionnement propre. La présente étude démontre que les outils de potier, issus de contextes archéologiques variés, étaient employés de la même manière. Ces outils constituaient un outillage peu investi. Les potiers réutilisaient en effet des tessons ou des fragments bruts d'autres matériaux tels que les coquillages, les coraux ou les os, qui étaient directement disponibles autour de l'aire de production. Ces résultats nous incitent à la prudence lors de l'échantillonnage d'un corpus, car il est clair que nous ne pouvons plus seulement nous concentrer sur les objets finis. Il faut aussi observer les pièces qui seraient, à première vue, assimilées à des restes alimentaires ou des déchets.

Mots-clés

Outils de potier, analyses fonctionnelles, systèmes techniques.

INTRODUCTION

Pottery production is usually addressed from a technological analysis of the pottery itself. However, another approach is to look at the tools involved in the production process, in order to examine cross-culturally which implements were selected for the various stages of manufacturing (Lemonnier, 1986; Van der Leeuw, 1993). In this way insight may be obtained into the overall technological system, and the technological and functional interrelationship between tools made of different raw materials. To this end a series of experiments was set up to investigate which tools could have been involved in the production process. These experiments focused on the Caribbean setting, where a great number of worn sherds were found that were demonstrated to have been involved in pottery production (Van Gijn and Hofman, 2008), as well as shell tools and polishing stones (Lammers-Keijsers, 2007). The experiments were inspired by ethnographical and ethnohistorical work in South America (Boomert, 2000; Vredendrecht, 2002). Subsequently the experimental tools were subjected to a functional analysis, using both low and high magnifications.

Several archaeological assemblages were studied with the issue of ceramic production specifically in mind. In other assemblages incidental pottery manufacturing tools were encountered. The archaeological case studies referred to in this paper concern the Late Classic Maya site of K'axob in Belize (López Varela *et al.*, 2002; López Varela *et al.*, 2005) and two settlement sites on the Caribbean island of Guadeloupe, Anse à la Gourde and Morel, dating roughly between 400 BC and AD 1400 (Lammers, 2007; Van Gijn and Hofman, 2008). Last, in the discussion the rare occurrence of tools involved in pottery production in the Neolithic of Northwest Europe will be addressed, using the data from a recently excavated Middle Neolithic site in the Netherlands (Van Gijn, 2006).

EXPERIMENTS

It should be stressed that many of the tools used for pottery production may be difficult to recognize in an archaeological context. Examples include wooden rolling sticks and spatulas, calabash moulds and scrapers and scrapers of other perishable materials. As a consequence it will be unusual to find complete tool-kits for pottery production, our finds being for the most part confined to less perishable materials like flint, stone pebbles and, albeit to a lesser extent, implements of bone, shell, coral and secondarily used pottery sherds. Our experiments have taken this into account and have focused only on those material categories regularly found in archaeological contexts.

Fourteen experiments were done with flint implements, including tasks like scraping soft and leather-hard clay, drilling perforations in leather-hard clay and in baked pots, and engraving (decorating) leather-hard clay. The polish on the flint scrapers is very bright but

highly abraded, the depth and width of the ubiquitous striations being dependent on the nature of the tempering material (fig. 1a). The flint scrapers must however have a relatively obtuse but unretouched angle to be effective for the task of scraping either wet or leather-hard clay. Retouched pieces only made a lot of scratches and are therefore useless. The flint drills were highly effective in making perforations in leather-hard clay. This was different for baked clay which caused extensive microfracturing of the tip. If sturdy enough, however, the tip would eventually stabilize and display a rounded aspect which could still produce a perforation in fired ceramics, albeit much more slowly.

Hard stone tools included seven extremely rounded water-worn pebbles, which were used to burnish an already fired pot. Such tools are known from ethnographic contexts and are still used by potters today. The wear traces are highly distinctive, involving a bright, smooth gloss covering the entire surface of the pebble which can be distinguished with the naked eye (fig. 1b).

Shells turned out to be perfect pottery working implements, at least in the later stages of production, especially bivalves with their naturally curved convex edges. A total of nine experiments were conducted, five with *Codakia orbicularis*, one with *Chama sarda* (both Caribbean species of shell), two with *Cardium edule* and one with *Pecten jacobaeus*. Some were used for scraping soft, wet clay but because of the irregular edge of most of these shells, as well as their relatively sharp edge, they turned out to be less suitable for this purpose. Six were used on leather-hard material, which proved to be highly effective. The resulting use-wear polish displayed a rough, dull texture with a cratered and corrugated topography (fig. 1c). The edges wore significantly during the duration of the experiment.

Tools made of coral also turned out to be effective for scraping pottery (Kelly, 2003; Kelly and Van Gijn, 2008). In total three such tools were experimentally used, two scrapers made on *Porites porites* and one *Acropora cervicornis* (Kelly and Van Gijn, 2008, fig. 9.2). One of the scrapers and the *Acropora* were used on dry clay, the other scraper on leather-hard clay. The wear traces were characterized by the development of rounded (rather than bevelled) corallite ridges in combination with a bright polish with flat topography, and numerous randomly oriented striations in the polished area (fig. 1d). All tools were highly effective. Only one experimental bone tool was involved in scraping clay. The tool, a jaw fragment of a cow, had a regular and convex edge, which was effective in scraping leather-hard clay.

The majority of the tools involved in pottery manufacturing were ceramic sherds (N=23). Activities include scraping, polishing, smoothing, incising or graving and boring. In addition to experiments with recently baked sherds, we also used sherds originating from Caribbean midden deposits. This material was chosen because it had the same fabric characteristics as the probable tools from the Caribbean sites and, therefore, comparable abrasive properties. Normally this is not a preferable situation because it is

theoretically possible that the sherd had already been used in the past. However, by selecting and breaking the sherds very carefully, we feel confident that this problem was avoided. Also, all experimental tools were examined by microscope prior to use.

The experimental tools involving the ceramic tools included smearing, scraping, pressing and smoothing the clay in several dry stages of the paste. Most were

used for only one task (*e.g.* scraping leather-hard clay in one direction, polishing the surface), while two were used for the entire process of smearing, scraping, pressing and smoothing. Two were used for engraving in leather-hard clay, two for boring leather-hard clay, and three for polishing the surface. All tools were effective, although it is clear that the soft “Caribbean” tools are less suitable for polishing the surface than the recently

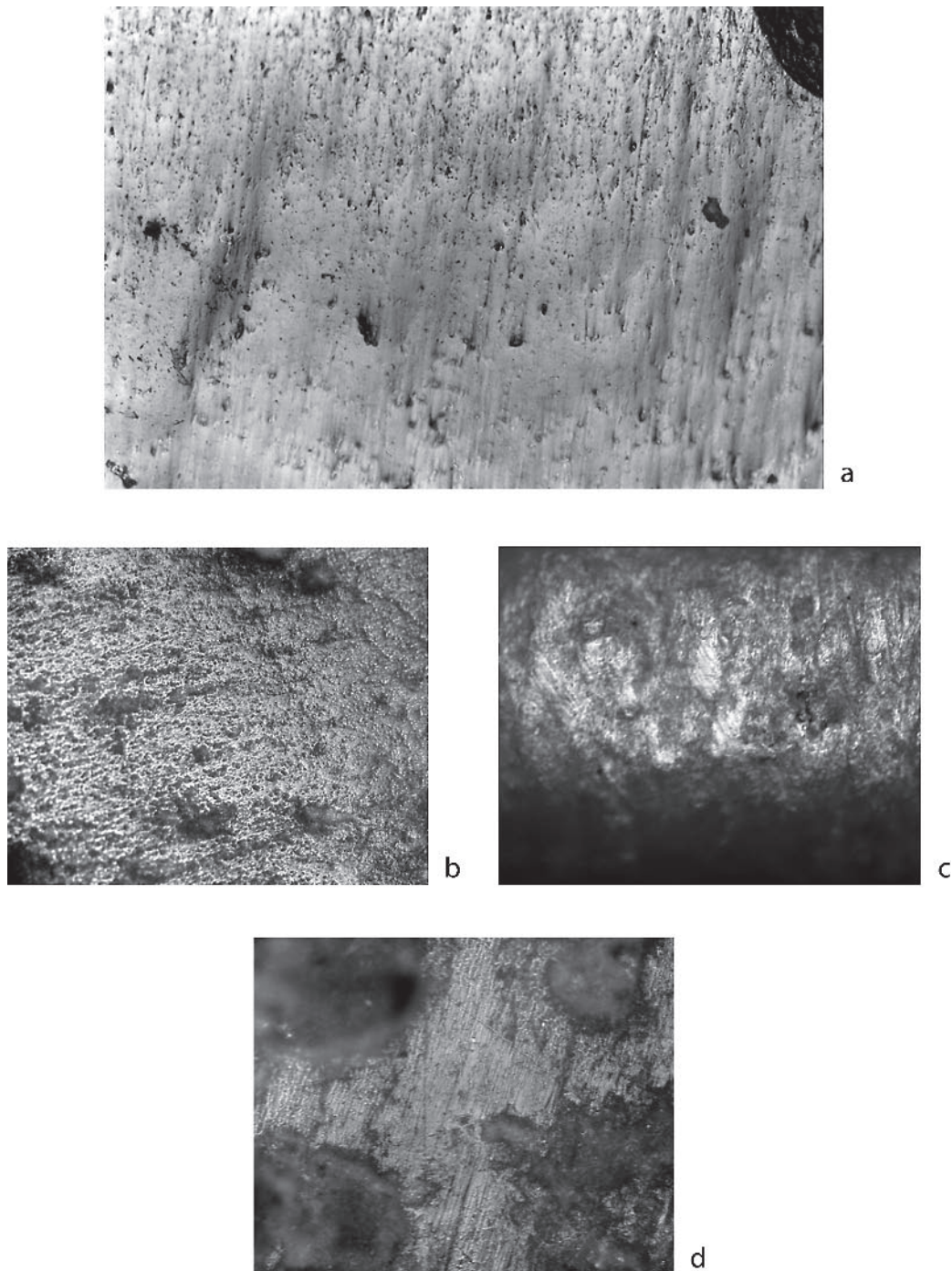


Fig. 1 – Photographs of the use-wear traces seen on experimentally used potter’s tools: a) flint scraper (exp. 199, 200x orig. magnif.); b) stone burnisher (exp. 995, 100x orig. magnif.); c) shell scraper of *Codakia* sp. (exp. 627, 200x orig. magnif.); d) coral scraper (exp. 730, 200x orig. magnif.).

Fig. 1 – Traces d’usure observées sur des outils de potier utilisés expérimentalement : a) *racloir en silex* (exp. n° 199, grossissement x 100); b) *brunissoir en pierre* (exp. n° 995, grossissement x 100); c) *racloir sur coquillage Codakia* sp. (exp. n° 627, grossissement x 200); d) *racloir en corail* (exp. n° 730, grossissement x 200).

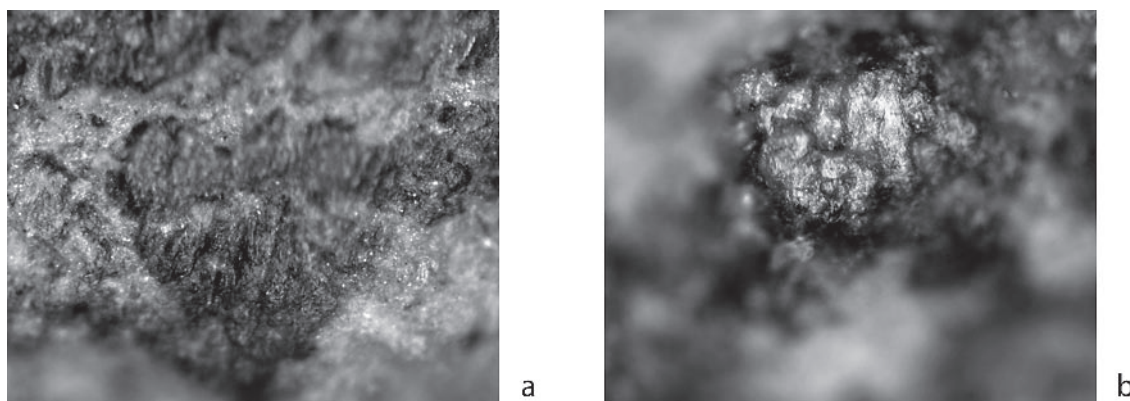


Fig. 2 – Wear traces on experimental clay scraping tools (orig. magnif. 200x): a) exp. 991; b) exp. 1353.

Fig. 2 – Traces d'usure observées sur des outils expérimentaux utilisés pour racler l'argile (grossissement x 200) : a) exp. n° 991 ; b) exp. n° 1353.

baked counterparts. Scraping the leather-hard surface seems to be their most useful application which results in abraded edges and a distinctive smooth and bright polish, distributed in patches and with a clear directionality (fig. 2). It is clear that the relative hardness of the sherds determines their suitability for different tasks. The experimental sherds that were fired at higher temperatures were harder and less easy to break during experimental use. These sherds turn out to be effective for boring clay in leather-hard condition and also for incising and engraving a dried pot (López Varela *et al.*, 2002).

USE-WEAR ANALYSIS: METHODOLOGY

The wear trace analysis of flint implements is now relatively well-established. We are reasonably well acquainted with the limits of inference, the range and extent of taphonomic agents (Levi Sala, 1986; Plisson and Mauger, 1988) and other methodological limitations of the method (see for an overview Odell, 2001). The number of instances in which a match occurs between experimental and archaeological traces is high and we can therefore assume that our experimental programmes are relevant. The old dichotomy between adherents of the low-power and high-power approaches has disappeared with the standard usage of both stereomicroscopes and metallographic microscopes in conjunction with each other.

Wear trace analysis of tools made of materials other than flint is however only starting to develop. Methodological procedures have not yet been extensively established: the range of traces that can be distinguished has not yet been fully explored and the extent to which taphonomic modifications hamper analysis has not been addressed sufficiently. However, it is very clear that wear traces can be distinguished on tools made of “other” materials such as bone (Maigrot, 1997; Maigrot, 2003; Van Gijn, 2006; Van Gijn, 2007), shell (Lammers-Keijsers, 2007; Van Gijn *et al.*, 2008), coral (Kelly, 2003; Kelly and Van Gijn,

2008), and ceramic sherds (López Varela *et al.*, 2002; Van Gijn and Hofman, 2008). Initially, much of this research was done by means of the low-power approach, based on the premise that for example pottery or coral is too coarse-grained to allow use-wear polish to develop. It is now becoming increasingly clear that polish is also visible on more coarse-grained raw materials like hard stone (Van Gijn and Houkes, 2006), coral and pottery sherds (Van Gijn and Hofman, 2008).

The methods used for the analysis conform to the standard practice at the Laboratory for Artefact Studies (Van Gijn, 1990). Stereomicroscopes fitted with both oblique and incident light and with magnifications of 10x to 160x allow the examination of the rounding, abrasion and larger striations (low-power method). Traces of residue are also best localized by means of a stereomicroscope. To examine polish and smaller striations, all tools, except the sherds from the site of K'axob, were also studied with a metallographic microscope, at magnifications up to 560x (high-power method). Cleaning of the experimental implements was done in an ultrasonic tank in distilled water and was kept to a minimum, except for the flint tools which were subjected to the standard cleaning procedure of immersion in 10% HCl and KOH, followed by extensive rinsing in distilled water.

Last, it cannot be stressed enough that methods of use-wear analysis, both the low and the high power approach, rely on experimentation to obtain a reference collection of experimental wear traces. The characteristics of these experimental wear traces can subsequently be compared to the traces seen on archaeological implements. When these traces show sufficient similarities in terms of polish characteristics, abrasive features and edge removals, we can infer that the function of the archaeological tool was the same as the experimental one. However, it can never be fully excluded that the same combination of wear traces was caused by an activity not yet addressed experimentally. This means that the use of archaeological implements can only be interpreted, not determined.

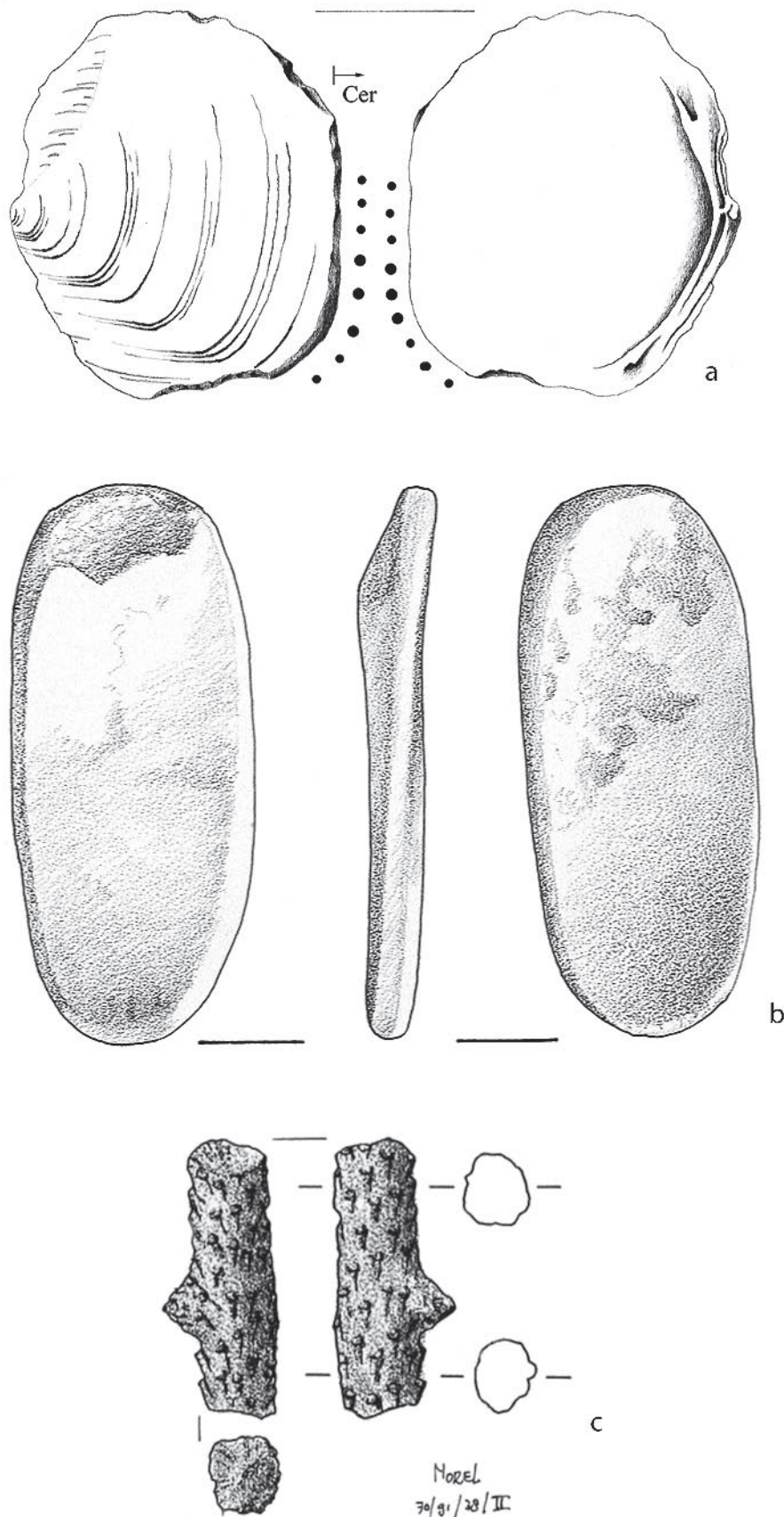


Fig. 3 – Composition of the toolkit used for ceramic production from the Caribbean sites of Anse à la Gourde and Morel (scale 1:1): a) *Codakia* shell from the site of Anse à la Gourde (Ce = ceramics); b) ceramic sherd from Morel; c) piece of coral used to scrape clay from Morel.

Fig. 3 – Outils utilisés dans la production céramique des sites caraïbes de l'anse à la Gourde et de Morel (échelle 1:1) : a) coquillage *Codakia* de l'anse à la Gourde (Ce = céramique); b) tesson céramique de Morel; c) fragment de corail de Morel utilisé pour racler l'argile.

THE ARCHAEOLOGICAL CASE STUDIES

K'axob

The use of pottery tools for the manufacture of ceramic vessels has come to light through the study of López Varela, Van Gijn, and Jacobs on Late Classic K'axob Maya pottery from Belize (López Varela *et al.*, 2002). Here the tools were clearly intentionally shaped and revealed a remarkable resemblance to the toolkit of a modern potter (López Varela *et al.*, 2002, fig. 6). Low-power analysis of the wear traces of 70 archaeological tools confirmed this interpretation. High-power analysis of these tools was not, however, done. In total 31 implements displayed traces of wear, whereas 25 were too eroded to allow analysis; 14 sherds did not show any traces. The 31 used implements displayed traces from smoothing, scraping, incising, polishing and boring pottery. Interestingly enough, the K'axob tools were associated with pottery kilns, further supporting the inference as potter's tools.

Anse à la Gourde and Morel

Both Anse à la Gourde and Morel have produced several artefacts which could be related to a potter's toolkit, including sherds, shells and coral (fig. 3; Van Gijn *et al.*, 2008). The "sherds as tools" are the most common, displaying convex, highly abraded edges (for Gourde N=22, for Morel N=16; Van Gijn and Hofman, 2008). This abrasion cannot be attributed to a taphonomic origin because it is very localized and limited to one or two edges. The use-wear polish is mainly seen on the edge, not on the outer and inner surface of the sherds as these are usually too severely affected by trampling or contact with the surrounding matrix to allow a functional interpretation. The polish is smooth and bright, and distributed in patches all along the rounded edges displaying a distinct directionality (fig. 4). The polish follows every indentation

of the edge, indicative of contact with a pliable contact material. The severe rounding of the edge and the well-developed polish suggests a very abrasive contact material was worked, most likely clay. The faceted edges of the Morel sherds suggest that a leather-hard clay was worked, something not observed on the Anse à la Gourde sherds (Van Gijn and Hofman, 2008).

Apart from the use of broken sherds as potter's tools coral and, only rarely so, shells were also employed. Both can be considered *ad hoc* or opportunistically used implements: one *Codakia orbicularis* was used as scraper for clay (fig. 3a). At Anse à la Gourde fifteen pieces of coral were involved in pottery production, involving both the angle-abraded tools made on *Porites* *sp.* as well as the rod-shaped tools made on fragments of *Acropora cervicornis* (fig. 3b and 3c; Kelly, 2003; Kelly and Van Gijn, 2008). The angle-abraded tools were used for scraping clay, whereas the rods of *Acropora cervicornis* showed red residue that was identified as clay (Kelly, 2003). Obviously other materials, like wooden rollers and scrapers made of calabash sherds, must have been involved as well, but clearly these will rarely be found. It is clear, however, that the potter's toolkit at Anse à la Gourde and Morel consisted of a collection of opportunistically collected materials that were not or only marginally modified into formal tools.

DISCUSSION

The conclusion can only be that the potter's toolkit in Caribbean ceramic sites is characterized by informal tools that could easily be picked up in the domestic context (broken sherds), or on the adjacent beach (shell and coral). These pieces of material probably already had a general shape that made them suitable for scraping clay. They are only marginally modified, with the possible exception of the angle-abraded tools which may have acquired their cutting edge either by use or by intentional abrasion (Kelly, 2003). Some are not modified at all, like the coral rods and the shell. Formal

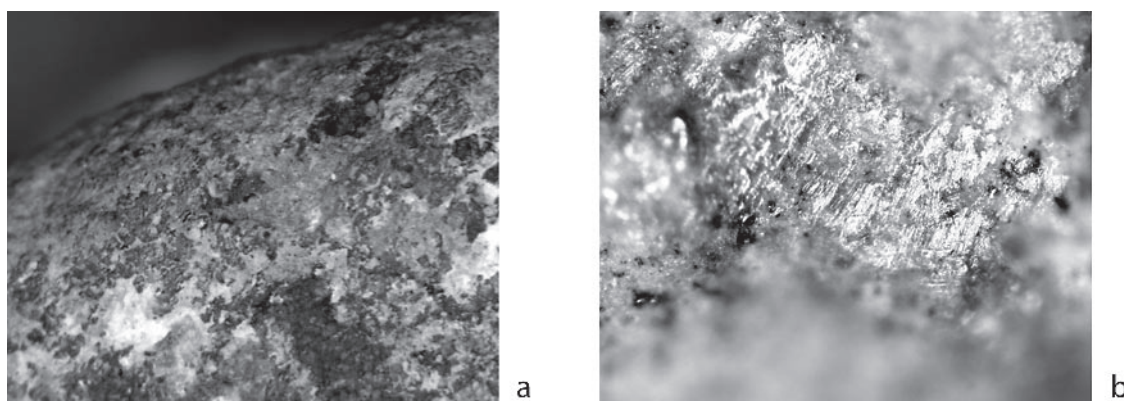


Fig. 4 – Traces on ceramic tools from Anse à la Gourde: a) rounded edge seen on tool 10 (stereomicroscope, 10x orig. magnif.); b) polish and striations on tool 3 (incident light microscope, 200x orig. magnif.).

Fig. 4 – Traces d'usure observées sur des outils en céramique de l'anse à la Gourde : a) émoussé du bord observé sur la pièce n° 10 (binoculaire, grossissement x 10); b) poli et stries sur la pièce n° 3 (microscope métallographique, grossissement : x 200).

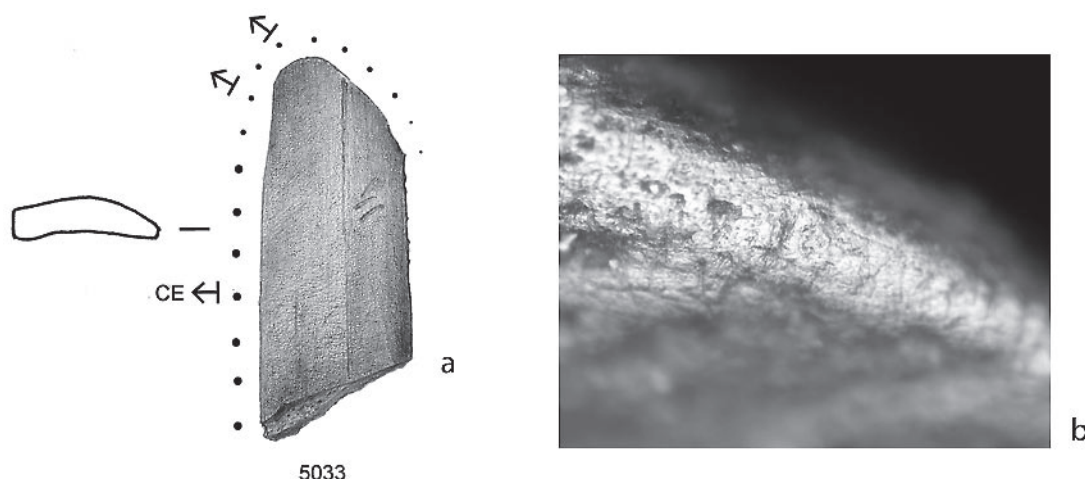


Fig. 5 – Using bone tool production waste as tools: a) bone “scraper” from the Middle Neolithic site of Schipluiden (find nr. 5033) used to scrape clay (CE = ceramics; scale 1:1); b) polish observed on the tool (200x orig. magnif.).

Fig. 5 – Déchets de fabrication d’outils en os eux-mêmes utilisés comme outils : a) « racloir » en os du site Néolithique moyen de Schipluiden (n° 5033) utilisé pour racler l’argile (CE = céramique; échelle 1 : 1); b) poli observé sur l’outil (grossissement x 200).

implements, specifically made for pottery production, have not been found, although obviously wooden spatulas and rollers may have been present but not preserved.

The notion that the potter’s toolkit may be a very informal one (something also seen in many present-day societies) is interesting if we look at Neolithic Europe. During this period, clearly, pottery production must have been an important craft activity and we also expect this to have taken place in a domestic context. However, despite the fact that many assemblages of flint and bone implements have been studied, the number of tools involved in pottery production is low. We would suggest that this may be because of the very informal character of the potter’s toolkit. This is supported by the analysis of the material from the Middle Neolithic site of Schipluiden (Louwe Kooijmans and Jongste, 2006). This site dates to around 3700-3400 cal BC and is attributed to the Hazendonk group. It is located on a dune in the coastal area near the present-day town of The Hague. The site has been excavated in its entirety. A relatively large sample of flint and hard stone artefacts from Schipluiden was subjected to microscopic analysis. However, no evidence was found for the presence of pottery production tools amongst the lithic assemblage (Van Gijn *et al.*, 2006; Van Gijn and Houkes, 2006). The number of modified bone tools was limited and all were subjected to use-wear study. However, in addition to the formal tools, a small number of potentially used bone artefacts were selected by archaeozoologist Jorn Zeiler for analysis as well. This yielded one small, unmodified bone fragment that was used as a scraper on clay (fig. 5). This finding indicates that we have to be much more aware of the possible presence of potter’s tools amongst the “waste” material: artefacts that do not show any traces of intentional modification. It is therefore very important to include unmodified artefacts in the sample studied and not

consider them as “waste”. This pertains both to lithic artefacts and to organic ones like bones or shells. Although lithic “waste” or debitage is nowadays considered to be worthy of study because of the possibility of reconstructing the *chaîne opératoire*, the awareness that much of this debitage may be potential tools is still lacking. As far as bone, coral and shell tools for ceramic production are concerned, it is likely that we overlook a large number of them if we only look at species and the contribution of different species to the subsistence base, the customary way of studying these materials. There is too little awareness that all these materials, traditionally associated with food, also constitute excellent raw materials for tools. Not only for the production of tools from bone or coral, tools that can easily be discerned in archaeological assemblages, but also in unmodified form. Unfortunately it is usually not clear to the naked eye whether a piece of bone or coral, or a shell, has been used. This can only be done by means of use-wear analysis, preferably at high magnification as distinctive traces cannot always be seen below 200x. This leads us to the issue of sampling: it is impossible to examine the thousands of bivalves present in many sites as food debris, nor can we study the thousands of pieces of butchering debris. Careful sampling programmes, linked to very specific research questions, are necessary, as well as building up experience in recognizing the way people selected potential informal tools in the past. ■

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