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Journal of Anthropological Archaeology

journal homepage: www.elsevier.com/locate/jaa

Profiling the people behind clay figurines: Technological trace and fingerprint analysis applied to ancient Egypt (Lahun village, MBA II, c. 1800–1700 BC)

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ARTICLE INFO

Keywords:

Figurines
Chaîne opératoire
Technological traces
Fingerprints
Bronze Age
Middle Kingdom
Lahun
Egypt
Children

ABSTRACT

Clay figurines represent one of the ideal object categories for tracing the profile of their makers since they preserve traces of the maker's gestures. The scope of the article is to reconstruct the different manufacturing steps of clay figurines, assess the complexity of the shaping sequences and study fingerprints to trace the profile of people who produced such artefacts in the ancient village of Lahun (Egypt, MBA II, c. 1800–1700 BC). The high number of production chains revealed that, despite an apparent roughness, clay figurine production was characterised by high stylistic and technological variability, indicating several levels of skill possessed by their producers. On this basis, Lahun clay figurines were not an extemporaneous or standardised product. A neat division can be established between anthropomorphic figurines and those representing animals, which show a lower degree of complexity and an attempt not to define clear shapes. Most of the figurines were revealed to be mainly shaped by adults, while children contributed in a marginal way to their production. However, the presence of sub-adult fingerprints on some of the clay figurines indicates that children were active agents producing material culture and integrating part of the adult production process through cooperation and/or playing.

1. Introduction: The difficulty of creating a social history for ancient Egypt

The archaeology of ancient Egypt has a strong 'top down' approach: its dynamics and development have led to a focus on monumental architecture (temples, palaces and rock-cut tombs) (Carruthers, 2016) and prestigious artefacts (statues, stelae, coffins, jewels), while the domestic areas have remained largely ignored or unexplored (cf. Moeller, 2016). This approach has caused the underprivileged population to appear like an undifferentiated mass of people in the historical record, lacking any distinct identity (Miniaci, 2022). The town of Lahun, one of the few excavated settlements in Egypt, however, provides abundant traces of its inhabitants, which belonged to a broad social spectrum ranging from the wealthier to the poorer layers of society (Petrie, 1890, 21–32; Petrie, 1891, 5–15; Quirke, 2005). In this respect, Lahun is rather different from other settlements, such as the more renowned village of Deir el-Medina (Davies, 2018), an artificially arranged community consisting of a privileged class of workmen and their families (those building the tombs

in the Valley of the Kings at Thebes; Andreu, 2002) or the settlement of Heit el-Ghurab at Giza, built to house the workers of the pyramids of Khufu and Khafra (Lehner and Hawass, 2017, 355–401). Although the foundation of the town of Lahun may have been originally constructed with the intent to house the workers for the pyramid of Senwosret II, in its last phase of use, it did not host only highly specialised (elite) workmen or indigent, unskilled manual labourers: the archaeological evidence suggests a productive and complex society, with families organised around smaller, mid-size and large houses (Quirke, 2005, 74–96; cf. Doyen, 1996; Kóthay, 2002; Mazzone, 2017), gathering a broader spectrum of people from Egyptian society (Szpakowska, 2008). The inhabitants of Lahun belonged both to the higher classes (Quirke identified the presence of leading officials' offices in the town, probably including the bureau of the vizier itself) as well as to the mid-lower levels of society (Quirke, 2005, 69–73). Suddenly abandoned, for unknown reasons and after a relatively short period of ca. 100 years, the archaeological site of Lahun preserved many household artefacts, tools of trade, personal possessions, administrative records, copies of business

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<https://doi.org/10.1016/j.jaa.2023.101543>

Received 12 April 2023; Received in revised form 28 August 2023;

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letters, transactions, and other written dossiers (Collier and Quirke, 2002, 2004, 2006).

1.1. Figurines as “gatekeepers” of the makers’ identity

Among the artefacts coming from Lahun, clay figurines constitute one of the best-suited object categories for profiling ancient Egyptian individuals from the middle/lower sectors of the population. Clay figurines played a key role in the cultural and social dynamics of past societies, being one of the most responsive vehicles for expressing and encapsulating concepts, ideas, feelings, emotions, and visions (Miniaci, 2023b; on the role of figurines as vehicles of social relations and human ideas see Bailey, 2005; Insoll, 2017; Lesure, 2011; Marcus, 2019; Meskell, 2017). The process of reducing scale namely creates portability and easy mobility. In turn, portability and mobility engender intimacy, which makes figurines extremely permeable elements that are closely involved in human interactions and are part of social movements (Foxhall, 2015, 4). Portability enhances the interaction and agency of the artefacts, which then have more opportunity to affect the behaviour of people, reducing the distance between the object and the human body. Moreover, the materiality of clay figurines reflects also the more technical gestures of their producers (Papadopoulos et al., 2019), and their accessibility allows them to be more easily imbued with individual stories.

The application of the concept of the ‘operational sequence’ (*chaîne opératoire*), a methodological tool borrowed from anthropological research (Lemonnier, 1993; Leroi-Gourhan, 1964; see recent critique in Coupaye, 2009; Martínón-Torres, 2002) to Egyptian clay figurines can lead to discovering the traces left behind by human actions and gestures during the production process. This may also permit profiling those individuals who are usually obscured in the written and archaeological sources (cf. Dobres, 1999). Technological trace analysis is the key to reconstructing the *chaîne opératoire* of clay figurines: by analysing the objects’ surfaces and detecting possible traces of the manufacturing

process (Kreiter et al., 2021; Sofaer, 2015) one can observe the gestures and shaping techniques used by the maker, reflecting their technical knowledge. This approach has been tested in recent years to study craftspeople such as potters (Roux, 2019 and references therein) with limited systematic application to other clay objects such as figurines (e.g. Sofaer, 2015; Pizzeghello et al., 2015; Kreiter et al., 2021). Trace analysis and the investigation of fingerprints are two approaches applied in this study in order to profile the clay figurines’ production and makers’ identity in Middle Bronze Age Egypt using Lahun as a case study from an area connected with the centres of production.

1.2. Core questions

Due to their rough manufacture and the ubiquity of the raw material, clay figurines have been considered to be the result of an impromptu action, the extemporary outcome of a moment of inspiration, at the impulse of an unskilled maker (see Murphy, 2020). The apparent roughness of the clay production, the approximation characterising the shape of several figurines, especially the zoomorphic artefacts, and the lack of selection of the raw material have addressed scholars to mostly connect these objects with the lower layers of society. This has also often led to associating the manufacture of clay figurines with basic creative and intellectual processes, being commonly considered poor and casual productions. Scholars have also often supposed that these figurines were toys made for – and even made by – children (cf. Tooley, 1991; Tyllesley, 2007, 26–8; see *contra* comments in Quirke, 1998), relegating them to an even more marginal domain of the literature (cf. see for instance the importance of stone or wood figurines, e.g. Breasted, 1948; Winlock, 1955). Also, the studies on clay figurines in ancient Egypt remain very limited or confined to determined areas, types, or time periods (especially earlier or later periods of the pharaonic history) (e.g. Ucko, 1968; Boutantin, 1999; Waraksa, 2008; Teeter, 2010; Braekmans et al., 2019; Ballet, 2020; Whitford et al., 2020).

Table 1
List of clay figurines from Lahun housed at the Petrie Museum of London and Manchester Museum.

Inv. Number	Museum	group	Inv. Number	Museum	group	Inv. Number	Museum	group	Inv. Number	Museum	group
UC 7154	Petrie	Undetermined	UC 7185	Petrie	Humans	UC 7215	Petrie	Animals	UC 7238	Petrie	Humans
UC 7155	Petrie	Humans	UC 7186	Petrie	Animals	UC 7216	Petrie	Animals	UC 7305	Petrie	Animals
UC 7156	Petrie	Humans	UC 7187	Petrie	Animals	UC 7217	Petrie	Animals	UC 7356	Petrie	Undetermined
UC 7157	Petrie	Humans	UC 7188	Petrie	Animals	UC 7218	Petrie	Animals	UC 7357	Petrie	Animals
UC 7158	Petrie	Humans	UC 7189	Petrie	Animals	UC 7219	Petrie	Animals	UC 16753	Petrie	Animals
UC 7159	Petrie	Humans	UC 7190	Petrie	Animals	UC 7220	Petrie	Vessels	126	Manchester	Humans
UC 7160	Petrie	Humans	UC 7191	Petrie	Animals	UC 7221	Petrie	Boat	127	Manchester	Animals
UC 7161	Petrie	Humans	UC 7192	Petrie	Animals	UC 7222	Petrie	Head	128	Manchester	Animals
UC 7162	Petrie	Humans	UC 7193	Petrie	Animals	UC 7223	Petrie	Head	129	Manchester	Animals
UC 7163	Petrie	Humans	UC 7194	Petrie	Animals	UC 7224	Petrie	Head	130	Manchester	Animals
UC 7164	Petrie	Humans	UC 7195	Petrie	Animals	UC 7225	Petrie	Head	131	Manchester	Boat
UC 7165	Petrie	Humans	UC 7196	Petrie	Animals	UC 7226	Petrie	Head	9839	Manchester	Animals
UC 7166	Petrie	Undetermined	UC 7197	Petrie	Animals	UC 7227	Petrie	Head			
UC 7167	Petrie	Humans	UC 7198	Petrie	Animals	UC 7228	Petrie	Head			
UC 7169	Petrie	Humans	UC 7199	Petrie	Animals	UC 7229	Petrie	Head			
UC 7170	Petrie	Humans	UC 7200	Petrie	Animals	UC 7230	Petrie	Head			
UC 7171	Petrie	Humans	UC 7201	Petrie	Animals	UC 7231	Petrie	Head			
UC 7172	Petrie	Humans	UC 7202	Petrie	Animals	UC 7232	Petrie	Head			
UC 7173	Petrie	Humans	UC 7203	Petrie	Animals	UC 7233	Petrie	Head			
UC 7174i	Petrie	Animal	UC 7204	Petrie	Animals	UC 7234	Petrie	Head			
UC 7174ii	Petrie	Humans	UC 7205	Petrie	Animals	UC 7235	Petrie	Head			
UC 7176	Petrie	Animal	UC 7206	Petrie	Animals	UC 7236 i	Petrie	Undetermined			
UC 7177	Petrie	Humans	UC 7207	Petrie	Animals	UC 7236ii	Petrie	Undetermined			
UC 7178	Petrie	Vessel	UC 7208	Petrie	Animals	UC 7236iii	Petrie	boat			
UC 7179	Petrie	Vessel	UC 7209	Petrie	Animals	UC 7236iii	Petrie	boat			
UC 7180	Petrie	Undetermined	UC 7210	Petrie	Animals	UC 7236 iv	Petrie	Undetermined			
UC 7181	Petrie	Undetermined	UC 7211	Petrie	Animals	UC 7236 v	Petrie	Undetermined			
UC 7182	Petrie	Humans	UC 7212	Petrie	Animals	UC 7236 vi	Petrie	Undetermined			
UC 7183	Petrie	Undetermined	UC 7213	Petrie	Animals	UC 7236 vii	Petrie	Undetermined			
UC 7184	Petrie	Humans	UC 7214	Petrie	Animals	UC 7237ii	Petrie	Undetermined			

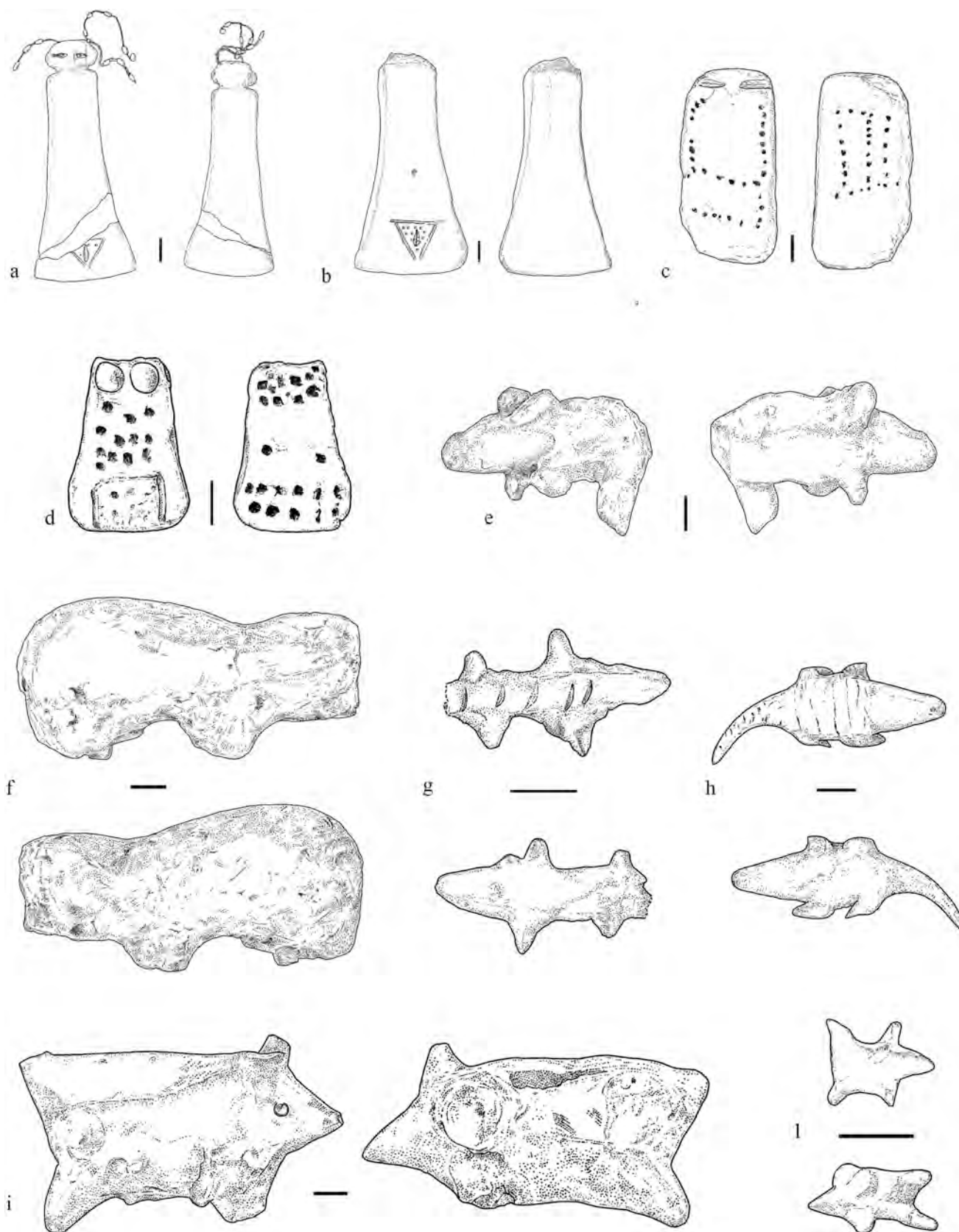


Fig. 1. Clay figurines from the Egyptian town of Lahun. a-d: anthropomorphic figurines (inventory numbers: a.UC 7156, b.UC 7157, c.UC 7159, d.UC 7169), e-l: zoomorphic figurines. (inventory numbers: e.UC 7187, f.UC 7188, g.UC 7192, h. UC 7196, i.UC 7206, l.UC 7204) (Illustrations made by Merel Eyckerman). Black bar corresponds to 1 cm.

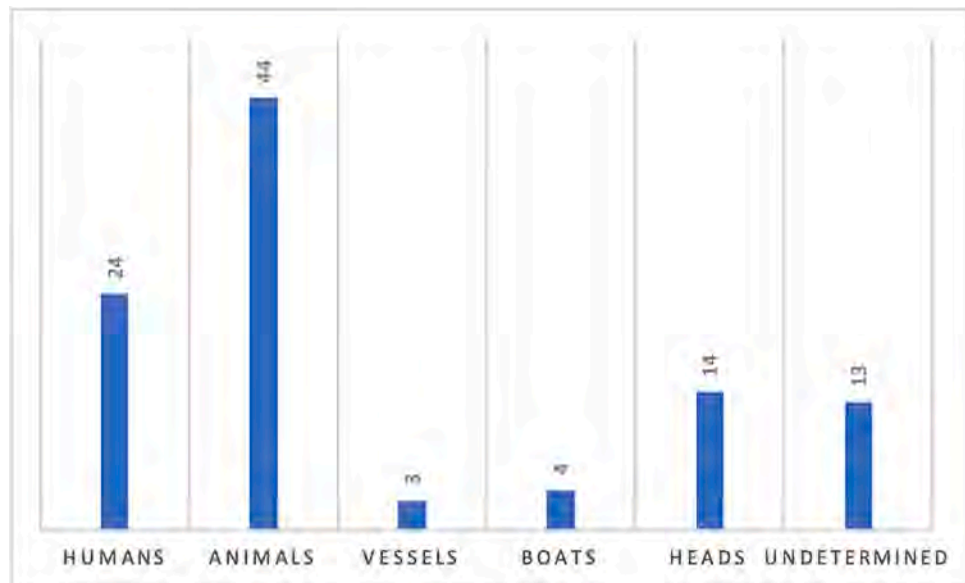


Fig. 2. Quantification of the diverse kind of clay figurines found at Lahun.

2. Materials and methods

2.1. The clay figurines of Lahun: corpus, provenance, dating and raw materials

2.1.1. The corpus

The clay figurines from Lahun were never fully published by Petrie. He briefly mentioned them in his published excavation report and illustrated some in a plate (Petrie, 1890, 31, pl. 8) and simply stated that there was “an abundance” of them (Petrie, 1890, 30) without giving a precise quantity or description (Miniaci et al., 2022). The vast majority of them, 95 out of 102 figurines, entered the private collection of Petrie, later forming the core of the collection of the Petrie Museum of Egyptian Archaeology in London (inventory numbers: UC 7154–7167, UC 7169–7174i, UC7174ii–UC7235, UC 7236i–UC-7236iii, UC7236iii–UC7236vii, UC7237ii, UC 7238, UC 7305, UC 7356–7357, UC 16735). The other 7 figurines were shipped to Manchester (inv. N. 126–131, 9839) (Griffith, 1910, 20–1; Quirke, 1998, 142) for a total of 102 clay figurines (Table 1).

The figurines mainly represent zoomorphic and anthropomorphic shapes, with the number of animal figurines slightly predominating over the whole assembled corpus (Figs. 1, 2; Table 1). The zoological identification of most animal figurines can be assessed with a reasonable degree of certainty. However, there are some shapes that are not securely identified and others that have remained entirely undetermined. Among the 25 human-shaped figurines, 12 can be identified as female representations. The rest of the corpus consists of undetermined shapes. The overall dimensions of the figurines fall in a range between 2 cm and 12 cm, with an average of 5–6 cm.

Most of the anthropomorphic figures are extremely simple in form and can be divided into two main groups: 1. Realistic human figurines, provided with of the necessary anatomical detail, such as facial features, breasts or nipples, legs, arms, and a head (Fig. 1); 2. Stylised and abridged human figurines, with elongated bodies featuring only the main anatomical features such as the body structure (sometimes with head) and pubic areas, which are often emphasised with a triangular incision and rows of dots, while the legs and arms are usually the parts that are cropped out (Fig. 1 a–d). The application of organic materials to emphasize details, such as seeds for eyes (Fig. 1a, c), long twisted linen fibers for hair on the head (Fig. 1a) or seeds within the pubic area, underline the intended female sex of the figurine (Fig. 1a).

Zoomorphic figurines show a higher stylistic variability. The most

represented animal species are crocodiles (perhaps also lizards), hippopotami (and/or pigs), horned animals (cattle, probably including cows and/or bulls), birds, and hedgehogs (Fig. 1 e–l). Even the animal figures, however, vary according to the accuracy of their body details (e. g. skin details) or the level of their manufacture, in many demonstrated by the approximation in the application and shaping of limbs. Other figurine types of the Petrie collection represent inanimate objects – not analysed in this article and lacking fingerprints – such as vessels, boats, or undetermined artefacts as flat circular shapes known as “heads” not considered in this study.

2.1.2. Provenance and archaeological context

The figurines come from the site of Lahun, a town located at the entrance of the Fayum region in Middle Egypt dominated by the large pyramid complex of Senwosret II (1895–1878 BC) and surrounded by the burials of his contemporaries (Fig. 3). One kilometre east of the pyramid lay the ruins of the attached valley temple. Immediately beside it, Flinders Petrie discovered a town in 1889–90, which he mistakenly called ‘Kahun’, misunderstanding the spelling of the name el-Lahun, the name of the modern market town close to the archaeological site.

The rapid clearance of the Lahun town site, excavated in only ten weeks, and the absence of a vertical stratigraphy, did not allow the time or possibility to record the precise find-spots of the majority of artefacts (Quirke, 2005, 40–1). In addition, Petrie did not even provide any notes regarding the contexts of the figurines. He does, however, mention the clay figurines together with other material retrieved from the town, “having examined hundreds of the rooms, and having discovered all the ordinary objects of daily life just as they were last handled by their owners” (Petrie, 1890, 21). Therefore, the probability they came from a domestic context is high. For the sake of comparison, in “rank A”, Petrie recorded in a composite wooden figurine of a lion-maned/-eared female human being (later to be identified with Beset) that was found buried in a hole in the floor of one of the middle group of southern chambers together with a pair of ivory clappers (Petrie, 1891, 30, pl. 8.13, 13A, 14). Such a context suggests that miniatures – in general – would have played an important role in daily life activities, so to be found in the chambers. Other well documented Middle Kingdom clay figurines are also mainly attested in settlements and domestic contexts (Stevens, 2006, 79–120; Stevens, 2006; Pierrat et al., 1995, 411–13, Fig. 4) including those found in the fortresses (Dunham, 1967, 37–63; Emery et al., 1979). Nonetheless, other types of contexts cannot be completely ruled out for the clay figurines from Lahun. As Petrie mentioned in a brief note in his report,

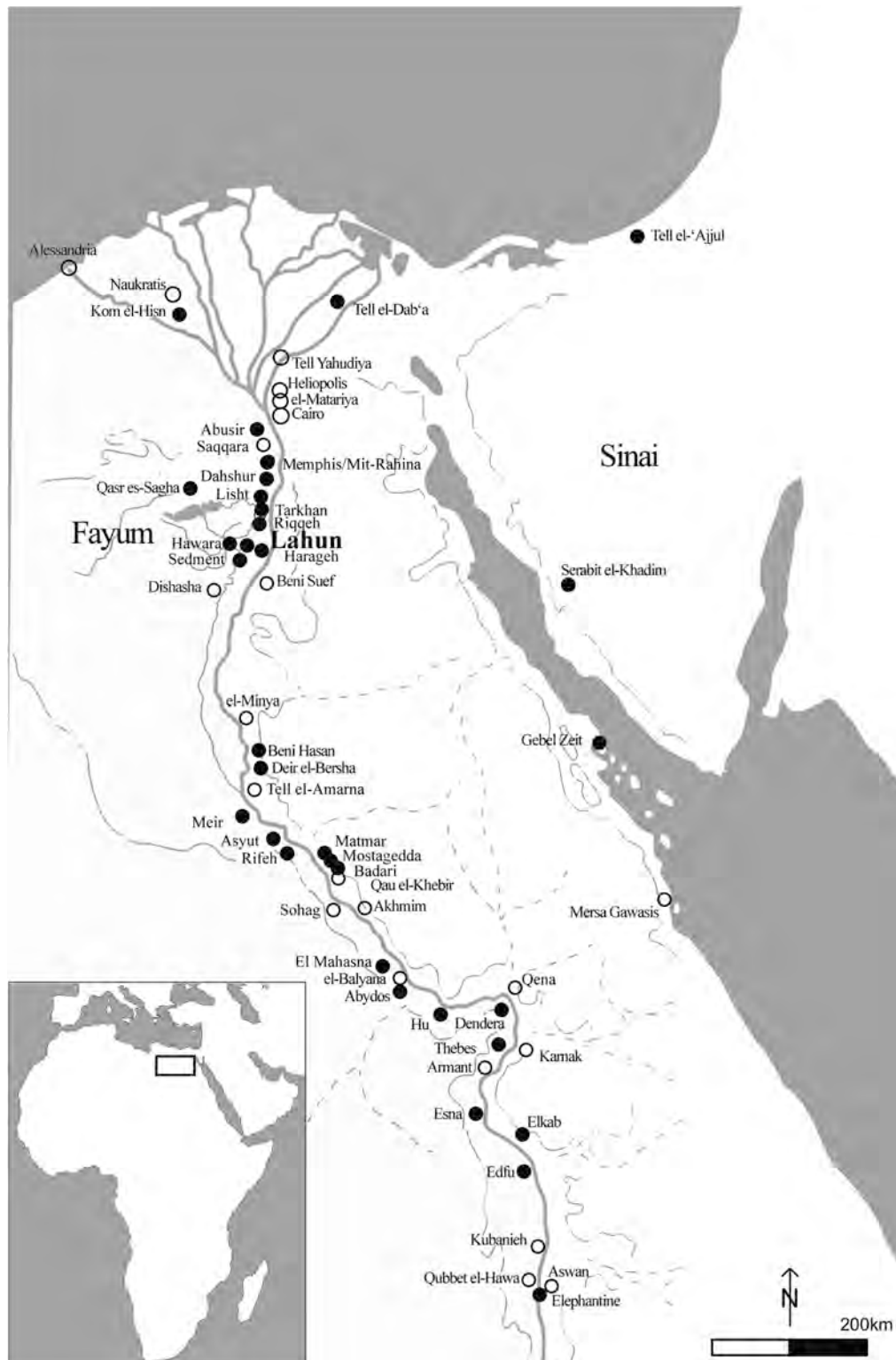


Fig. 3. Localisation of the town of Lahun.

sub-adults buried in boxes were, indeed, frequently found beneath the floors of the chambers in the town (Petrie, 1890, 12, 24): the clay figurines of Lahun could have also come from these infant burials. Other examples from Egypt, contemporary with Lahun, attest that clay figurines may also belong to a funerary context. At Beni Hassan, for instance, John Garstang documented a few clay figurines deposited in the tombs of the lower cemetery (e.g. tomb 487, Garstang, 1907, 113–14). Excavators at Buhen refer to some clay figurines found ‘in C-group

cemeteries’, but unfortunately, they do not provide any further information about their find context (Emery et al., 1979, 146). A few clay figurines might come from the cemetery of Lisht but since although most of the tombs were ravaged by ancient plundering and above them there were the remains of an ancient village, figurines could have also fallen down into the shafts from the domestic rooms (Miniaci, 2023a).

Finally, it is also possible that the clay figurines from Lahun came from a cultic context, such as domestic chapels. However, the number of

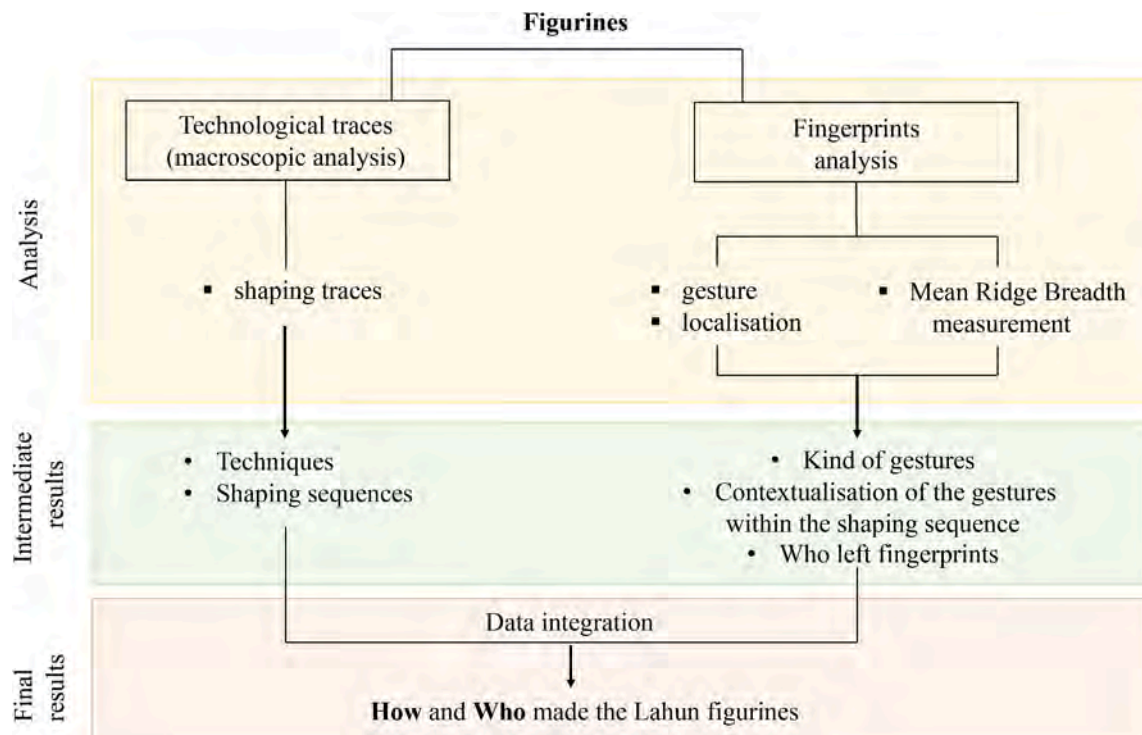


Fig. 4. Methodological approach adopted to analyse the clay figurines of Lahun.

clay figurines documented in temples/shrines in Middle Kingdom Egypt is extremely low (see for instance, Emery et al., 1979, 98; for other periods clay figurines in cult and temple contexts are much more abundant, see Waraksa, 2008, Teeter, 2010).

In conclusion, although the find-spot is not secure, it is very likely that the clay figurines from Lahun – like other clay figurines documented in Middle Kingdom Egypt – are related to the settlement/domestic context.

2.1.3. Dating

The material recovered from Lahun mainly testifies to later phases of activity at the site, corresponding to the late Middle Kingdom, *i.e.*, the late Twelfth and Thirteenth Dynasties (c. 1800–1700 BC; Lilyquist, 1979, 123–30), although the city was also sporadically reused during the New Kingdom (c. 1550–1069 BC) and the first millennium BC. Stephen Quirke attempted to date the figurines of Lahun based on the data provided by excavations in the Nubian fortresses of Buhen and Uronarti, which were both in use mainly during the late Middle Bronze Age (c. 1800–1700 BC) (Quirke 1998). While the clay figurines found at Buhen cannot be pinned down to a precise chronological range because the archaeological context of the site shows a mixed period of occupation in the Middle and New Kingdoms (spanning c. from 1900 to 1300 BC) (Emery et al., 1979, 5–14), the clay figurines from Uronarti are rather uniformly dated to the late Middle Kingdom, as they were often found together with hieratic papyri and seals of the time (Quirke, 1998, 147–9 based on Dunham, 1967). The analogy of shapes and forms between Uronarti and Lahun figurines may speak in favour of a late Middle Kingdom date for the Lahun figurines. However, as shown by Anna Stevens for the Nubian sites at Amara West, clay figurines are both very resilient, adapting across borders and cultures, and conservative, as their typology is not continuously under transformation (Stevens, 2017). Therefore, it is not easy to distinguish different chronological transformation phases in the production of clay figurines along the Nile Valley between the late Middle and New Kingdom (Stevens, 2006, 90; often regional differences may be confused with chronological transformations).

2.1.4. Raw material

The figurines from Lahun are commonly known as artefacts made of ‘mud’. Mud is a term commonly used to name the unidentified, plastic, and unfired sediment used to shape objects (Bourriau et al., 2000). In this article, we chose to use clay as a general and more correct term to define plastic and unfired natural sediments used to shape objects. Clay objects show a better cohesion due to the composition, and hence the capacity, of specific soils to keep the new shape even after the drying stage and after the exposure of the artefact to fire. The contact with the fire is the process that transforms the unfired clay into ceramic (Rice, 2015; Cuomo di Caprio 2007).

According to a macroscopic analysis, it was observed that the Lahun figurines were shaped using diverse recipes which are likely variations of clay fabrics used in the production of ancient Egyptian fired ceramics. These fabrics are usually split into two main groups deriving from ‘Nile silt’ and Egyptian ‘Marl clay’, which are uniformly distributed along the Nile valley (Maritan et al., 2021; Braekmans et al., 2019; Zakrzewski et al., 2016; Michelaki and Hancock, 2013; Bourriau et al., 2000; Arnold et al., 1993). The Nile clays are alluvial deposits found in the present and historic Nile floodplain, deposited between the Upper Pleistocene period until today. The deposits are generally high in silica and iron which distinguishes them from the calcareous ‘Marl clays’ found along the Nile between Esna and Cairo that are derived from the weathering of shale and limestone and are rich in mineral salts (Bourriau et al., 2000:121–122).

In Egyptian archaeological ceramics, while the calcareous nature of the marl clay matrix is the main distinguishing feature between the two fabrics, they can be further separated into subgroups based upon the size and predominance of the main inclusions: mainly quartz, organic plant fibers and limestone particles. Additionally, Nile silt that has been mixed with marl clay or limestone is also common (Braekmans et al., 2019). Geochemical analysis has indicated that in general the Nile clays contain c. 2.5–4 wt% of CaO compared to c. >10 wt% in Marl clays (Bourriau et al., 2000; Braekmans et al., 2019; Zakrzewski et al., 2016; Bourriau and Nicholson, 1992).

The site of Lahun is situated near sources of Nile silt as well as

Table 2
Analysis applied to the clay figurines of Lahun.

Sampling and analyses applied								
Anthropomorphic			Zoomorphic					
ID	Technological traces	Fingerprint measurement	ID	Technological traces	Fingerprint measurement	ID	Technological traces	Fingerprint measurement
UC 7155	X	X				UC7184		X
UC 7156	X	X	UC7186	X	X	UC7204		X
UC 7185	X	X	UC7187	X		UC7219		X
UC 7157	X		UC7188	X	X	UC 7217	X	X
UC 7158	X		UC7189	X		UC 7218	X	X
UC 7159	X		UC7190	X		UC 7357	X	X
UC 7160	X		UC7191	X	X	UC	X	X
						16753		
UC 7161	X		UC7192	X	X	126		X
UC 7162	X		UC7193	X		127		X
UC 7163	X		UC7194	X	X	129		X
UC 7165	X	X	UC7195	X	X	130		X
UC 7167	X		UC7196	X	X	9839		X
UC 7169	X		UC7197	X	X			
UC 7170	X		UC7198	X	X			
UC 7171	X		UC7199	X				
UC 7177	X		UC7200	X	X			
UC 7182	X	X	UC7201	X				
UC	X		UC7202	X	X			
17239								
UC	X		UC7203	X	X			
7174ii								
UC 7173	X		UC7205	X				
UC 7207	X		UC7206	X	X			
UC 7208	X		UC7210	X				
UC 7209	X		UC7211	X				
UC 7176	X	X	UC7213	X				

limestone and marl from middle Eocene deposits and the Mokattam group, Wadi Rayan formation (Klitzsch et al., 1987). Preliminary as yet unpublished geochemical analysis suggests that the Lahun figures are relatively homogeneous in composition, suggesting a common or related raw material source. However, while the majority of the figurines macroscopically display a Nile silt fabric, over three quarters of figurines examined (16 out of 75) had a clay paste enriched in CaO (>6 wt%). This preliminarily suggests that Nile clay was being mixed with marl clay or a calcium carbonate component. Unfortunately, due to no access to local raw material samples from the region around Lahun, it was not been possible to ascribe a likely provenance for the clay used in the figurines (Page, pers comms.).

The amount of vegetal/plant remains in the pastes of Lahun figurines is not enough to be interpreted as intentionally added as temper but likely due to low processing and cleaning of the raw material before its use.

The macroscopic observation also allowed us to ascertain that the clay figurines could have been exposed to fire, as shown by 24 of them. At the current state, it is impossible to know if the exposure to heat sources is intentional or unintentional. Nevertheless, some figurines are characterised by features of firing, reaching temperatures high enough to transform the clay paste into ceramic, as suggested by the reddish colour. Other cases show an exposure to heat sources as suggested by the grey-reddish colour associated, in at least one case (UC 7173), with traces of spalls likely due to thermal shocks (Gibson and Woods, 1997; Garcia Rosselló and Calvo Trias, 2006:11, Fig. 6; Conati Barbaro et al., 2021, Fig. 4).

2.2. Sampling, technological traces and fingerprint analysis

The analysis was structured in two parts: a) technological trace analysis; and b) fingerprint examination (Fig. 4).

Macroscopic trace analysis focused on traces and surface characteristics associated with the modelling sequence. Analysis of technological traces allowed us to differentiate between the different parts of objects,

distinguish the production sequences and reconstruct the gestures and steps necessary to achieve a specific result. This detailed analysis made it possible to identify the number of steps necessary to produce a specific figurine, determine how these steps were connected during the creative process and infer the timing necessary to conclude a shaping sequence. Moreover, trace analysis allowed us also to identify the most common modeling techniques at Lahun. The analysis focused on the recurrence, localization, and morphology of junction points on preformed lumps of clay and on traces left by possible tools. To enhance our interpretation of the technological traces, a comparative collection of clay figurines was created, replicating the most common artefacts found at Lahun. The experimental figurines allowed us to test the efficacy of the main shaping techniques and obtain technological trace replicas to support the interpretation of the archaeological items. The interpretation of traces was also supported by formerly published studies regarding technological traces on clay and ceramic figurines (Kreiter et al., 2021, Ignat et al., 2018, Pizzeghello et al., 2015, Sofaer, 2015). Fingerprint analysis was applied to the Lahun figurine collection with the purpose of tracing the producers' profiles and replying to a series of open questions concerning, most of all, the age of the makers and the role of these figurines as toys or ritual and religious objects.

2.2.1. Sampling

Considering the fragmentation of several figurines (Forte, 2022) and the alteration of the surfaces due to post-depositional processes, a sample of 59 figurines, suitable for studying production processes and for collecting data on the producers' profiles, were selected. The group consists of 21 anthropomorphic and 38 zoomorphic figurines, which were analysed by combining the observation and interpretation of surface topography features and fingerprint measurements (Table 2).

2.2.2. Criteria for shaping traces analysis (surface topography, tools and traces of gestures)

Technological trace analysis is the study and characterization of the features and anomalies of artefacts that were left by the maker during



Fig. 5. Technological traces found on the archaeological figurines (a-b, d, f, h, i) and technological traces of the experimental reference collection (c, e, g, l). Black bar corresponds to 1 cm.

the production process. The study of this evidence allows us to reconstruct techniques and gestures underpinning the actual manufacturing sequence. The Lahun figurines were investigated through a macroscopic analysis of surface topography, focusing on anomalies which interrupt the homogeneity of a figurine's topography (e.g. junction points among preformed lumps and crevices due to the hygrometry of the paste) and traces of tools (e.g. gouges left by wooden sticks) described according to their shape and distribution (Sofaer, 2015; Pizzeghello et al., 2015; Forte, 2019, 2020; Kreiter et al., 2021).

2.2.3. Criteria for fingerprint analysis

Fingerprints consist of negative dermatoglyphic impressions, namely dermal features recurring along human hands and feet. They are characterised by ridge and furrow pairs that remain unchanged over the lifetime of an individual, except for their measurements, which change according to age; they can vary also in connection to sex (Dyowe Roig et al., 2023; Fowler et al., 2019, 2020; Kantner et al., 2019; Kralik et al., 2022; Králík and Nejman, 2007; Kralik and Novotny, 2003; Sanders, 2015). Fingerprints identified on the surfaces of the clay figurines of Lahun were investigated by recording their position, shape, and

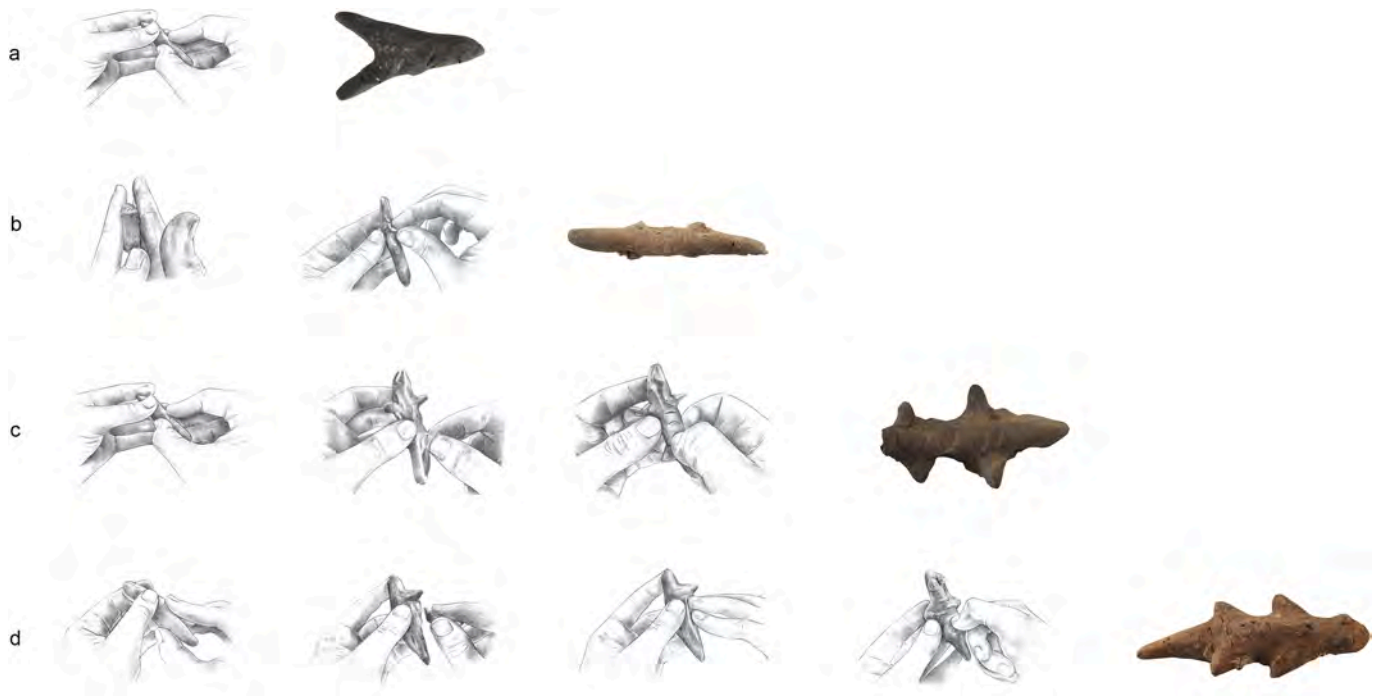


Fig. 6. Shaping techniques reconstructed on the basis of archaeological manufacturing traces. a-c: shaping by pinching, d: shaping by coiling (Illustrations made by Merel Eyckerman).

recurrence, specifying whether fingerprints are single (isolated) or overlapping (Fowler et al., 2019), and longitudinal or transversal in relation to the figurine. Based on this characterisation, the fingerprint is associated with specific gestures: pressuring/pinching or sliding/smoothing.

To establish the age range of the makers, the distinction is based on the Mean Ridge Breadth (henceforth MRB), calculated according to ridge and furrow pairs of the fingerprints (see Kralik and Novotny, 2003; Fowler et al., 2019, 2020). Dermatoglyphic impressions were identified at a macroscopic observation and measured using high-resolution pictures imported into Image J software. For each identified fingerprint, three ridge and furrow pairs were measured. The MRB measures were then processed by adding the percentage of the clay shrinkage. Considering that the majority of the Lahun figurines with fingerprints were exposed to fire and taking into account the lack of access to the original raw material to measure the actual shrinkage, the value of shrink percentage of 6% as proposed by Fowler et al. (2019) was considered a reliable value applicable to the Lahun clay figurines. The results of the mean MRB measurements were compared with the age categories assessed by former studies, using, in particular, the distinction among children, adolescents/adults, and adults (Kralik and Novotny, 2003; Fowler et al., 2020).

3. Results

3.1. Techniques and manufacturing sequences

The analysis of technological traces revealed differences in the used techniques, adopted gestures and manufacturing sequences of the Lahun figurines. A high variation in the shaping techniques, number of steps and the order of those steps in the manufacturing sequence was identified.

3.1.1. Body and anatomical details

Most of the anomalies identified along the surfaces consist of junction points corresponding to the connection of preformed lumps of clay (cf. Starnini, 2018, 92; Greenan et al., 2016, 18, Fig. 5; Sofaer, 2015, p.

30, fig 1.4). Also frequent are irregular or circular depressions due to pinching or pressing gestures, gouges due to engravings by sticks (cf. Sofaer, 2015, 30, fig 1.4 g; Fig. 5i) or impressions left by nails or organic items (e.g., seeds, beads, etc.). According to the analysis of the surface topography and the morphology of the traces' edges, most of these gestures were made at a regular or at a low hygrometric stage of clay paste, as respectively suggested by the lack or recurrence of superficial crevices. Usually, crevices develop following low plasticity, namely low hygrometry of the clay, which reacts in this way (Fig. 5 d-e). Hygrometry could be affected by the weather or even the unintentional long exposure of clay to the direct sun during or after the shaping. The analysis of the above-mentioned features leads to identify two main techniques used for shaping the Lahun figurines: (1) shaping by pinching and (2) shaping by coiling (Fig. 6):

1. Shaping by pinching consists in working a lump of clay under the pressure of the hands through repeated gestures of pinching or pressing using mainly fingertips (Sofaer, 2015, 25-39; Fig. 6a, c-d). This technique is suggested by frequent isolated or overlapping circular fingerprints and elongated depressions in correspondence with junction points along legs or other anatomical parts (Fig. 5f-g; Fig. 6a, c-d). These technological traces can be found on the same figurine but with a diverse distribution. Shaping by pinching is used for producing small and "simple" figurines, modelled from a single lump of clay or by assembling several preformed parts (Fig. 5c, 6c-d) (Sofaer, 2015, 25-39). On small-sized figurines, the lack of anomalies and depressions in correspondence with protruding parts can be considered as an indicator of pinching (Fig. 5f-g). Lack of preferential orientation of the pores along the fractures (Roux, 2019) could indicate that no separated lumps have been assembled in correspondence of these parts. Moreover, the homogeneity of the figurines' surfaces and the lack of anomalies in fracture represents an additional indicator of shaping by pinching a single lump of clay. Some figurines are completed by adding other details such as hair, skin features or even perishable items to the object (e.g., impression of a rope in two cases of animal figurines or the application of seeds along the pubic area of human figurines) (Fig. 1 a-b, i).

Table 3
Technological traces analysis of anthropomorphic figurines.

ID	Measures (length)	Exposure to fire	Fractures/ Crevices	Hygrometry	Fingerprints		Surface Topography	Shaping	Anatomical details								Steps	Shaping Sequence
					Shape	Localisation			Eyes	Nose	Mouth	Hear	ears	Arms	Legs	Other details		
UC 7144 ii	4 cm ca			right	printed	multiple along the body	sinuous	pinching	impressed + blue beads applications	impression (seed)							2	13
UC 7185	12 cm ca			right	elongated and printed	multiple along the body	sinuous	pinching	impressed	applied						beard applied	2	13
UC 7170	6 cm ca		fracture upper part	right			flat	pinching								impressions lower body	3	4
UC 7171	5 cm ca			right			uneven	pinching	impressed				impressed			pubis engraved	3	4
UC 7155	10 cm ca	X	fracture upper part	right	elongated	shoulder	flat	pinching	impressed							pubis engraved	3	4
UC 7158	8,5 cm ca		fracture lower part	right	elongated	along one side	flat	pinching		applied						pubis engraved and impressed	3	5
UC 7159	6,5 cm ca	X		right	elongated	body	sinuous	pinching	impressed	impressed							3	5
U 7173	6,5 cm ca	X	fracture of the body (termal shock)	stage			flat	pinching								wooden stick print (within the body)	3	5
UC 7160	6 cm ca		fractures back of the head	right			flat	pinching	pinched	pinched						belly button impressed	3	6
UC 7167	8 cm ca		fractures head, arms and lower part	right			flat	pinching								pubis engraved	3	7
UC 7161	4 cm ca	not clear	crevices	low			sinuous	pinching	engraved	pinched	impressed					beads application close to the eyes	3	8
UC 7165	5–6 cm ca		fractures head, arms and lower part	right	elongated	along the body	flat	pinching						applied		wooden sticks within the body	3	9
UC 7182	8 cm ca			right	printed	isolated on the head	sinuous	pinching					applied and impressed				3	10
UC 7169	4,5 cm ca		fracture lower part	right			flat	pinching	impressed (seeds)							belly button impressed	3	12
UC 7177	6,5 cm ca	X		right			uneven	pinching						applied	applied		3	11
UC 7156	11,5 cm ca		fracture lower part	right			flat	pinching	impressed	pinched		applied	pinched			belly button impressed, pubis engraved + seed application	4	1
UC 7157	11,5 cm ca		Fractures head and upper part	right			flat	pinching								belly button imoressed, pubis engraved	4	1

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Table 3 (continued)

ID	Measures (length)	Exposure to fire	Fractures/Crevices	Hygrometry	Fingerprints		Surface Topography		Shaping	Anatomical details							Steps	Shaping Sequence		
					Shape	Localisation	Shape	Topography		Eyes	Nose	Mouth	Hear	ears	Arms	Legs			Other details	
UC 7162	6 cm ca	X	fractures head and arms	right			flat	pinching										+ seed application back support applied	4	2
UC 7163	7 cm ca	X	fractures head and hand	right			flat	pinching							applied	applied			4	3
UC 17,239	8 cm ca	X	fractures arm and legs	right	elongated	on the head	flat	Pinching			pinched				applied	applied	necklace impressed		4	3

2. Shaping by coiling, observed only in 2 examples, consists in modeling the figurine by rolling a small lump of clay to obtain a coil, then pinching it to make limbs or applying preformed clay parts (Fig. 6b). This technique, suggested by the elongated and rounded shape of the body figurine, the morphology of protruding parts and lack of junction points (Fig. 6b), finds comparison with the experimental replicas (Fig. 5l).

3.1.2. Surfaces

Most of the analysed figurines were not refined through proper surface treatments. This is evidenced by the high number of artefacts showing an uneven and sinuous surface (Table 3, Table 4) (Fig. 5a-b, d, f, -i). The lack of a thorough surface treatment using tools favoured the preservation of technological traces left after shaping, which mainly include traces of dermatoglyphics of the makers. The most common traces consist of: (1) linear fingerprints formed after the sliding of the producer's fingertips with the purpose of homogenizing or smoothing a rough or an uneven surface, or (2) single and overlapping prints, which are a result of regularization of the surface by pressing it with fingertips (Fowler, 2019, 1486, Fig. 4). Traces of refined surface treatment are scant even on well preserved figurines where they commonly develop through smoothing at a wet stage (cf. Roux 2019, p.197, Fig. 3,52; Forte 2020, p.51, Fig. 23).

3.1.3. Tools

The use of sticks, along with fingers, characterise the main toolkit of the makers of the Lahun figurines. Fingers were used not only for shaping the body but also for homogenising the anatomical details, pinching them, or even for smoothing clay surfaces (see 3.1.2). Engravings and circular impressions featured on some of the figurines, however, are compatible with wooden sticks. These non-specialised, and likely casual, tools were also often found pierced entirely through the figurines, likely to give them internal support or attach separate components (e.g., sticks inserted within the neck of a human figure in order to attach the head). Possibly they could have even been used for letting the figurines stand upright on a base. Some technological traces, however, remain unclear (e.g., UC 7156; UC 7157, Fig. 1a-b). According to the highly homogeneous surface, they could be associated with the use of soft tools (e.g., a wooden spatula). No clear traces of pebbles were identified on the figurines; Nonetheless, in examples for which the topography is carefully refined, it is not possible to completely exclude the use of small pebbles to homogenise clay in a wet state, also using water that, according to experimental trials, leaves a flat surface lacking irregularities (Forte, 2019, p 8-10).

3.1.4. Shaping steps

In line with the trace analysis, the studied clay figurines can be divided into different groups according to the number of steps involved in their shaping.

The anthropomorphic figurines can be divided into three groups: figurines made in two steps, three steps and four steps (Fig. 7, Table 5). The zoomorphic figurines count four groups: figurines made in one, two, three or four steps of modeling respectively (Fig. 8, Table 5).

3.1.5. Shaping sequences

The shaping steps described in the paragraph above were identified in 13 shaping sequences underpinning the production of both the anthropomorphic and zoomorphic figurines. Their variation depends on the number of each specific technical step and their position along the figurines shaping chain. The group of anthropomorphic figurines analysed is characterised by 3 sequences made of 4 steps (22,7%), 9 sequences made of 3 steps (63%) and 1 sequence made of 2 steps (13,6%), listed below in detail (Figs. 9-12, Table 6). The group of zoomorphic figurines is characterised by 3 sequences made of 4 steps (9,6%), 11 sequences made of 3 steps (35,4%), 16 sequences made of 2 steps (51,6%) and one sequence made of a single step (3.2%) (Figs. 9-12, Table 6).

Table 4
Technological traces analysis of zoomorphic figurines (*und* refers to species of animals impossible to identify).

ID	Animal	Measures (length)	Exposure to fire	Fractures/ Crevices	Hygrometry	Fingerprints		Surface Topography	Shaping	Anatomical details						Steps	Shaping Sequences
						Shape	Localisation			Eyes	Nose	Mouth	Ears	Legs	Other details		
UC7176	dog	3 cm	X	horizontal crevices	low			uneven	pinching						1	13	
UC7186	pig	6 cm ca		fracture of the legs, crevices along the preserved leg	Right (body), legs (barely low)			uneven			engraved	applied	applied	tail applied	2	10	
UC7187	pig	6 cm ca.			right			uneven	pinching			applied	applied		2	10	
UC 7188	hippo	11 cm ca		fractures along the neck and hind legs	right	prints	isolated (neck and legs junction)	ueven	pinching				applied		2	10	
UC 7194	crocodile	6 cm ca	X		right			flat	coiling	applied	pinched	pinched		applied	2	10	
UC 7195	crocodile	5 cm ca	not clear		right	prints	multiple along the head	sinuous	pinching					applied	2	10	
UC 7197	crocodile	6,5 cm ca	not clear	small parallel crevices	low		along the legs	smooth	coiling					pinched	2	10	
UC 7198	crocodile	5 cm ca	X		right	prints	lower body, legs	sinuous	pinching					applied	2	10	
UC 7199	crocodile	4 cm ca.	X	multiple crevices	low			ueven	pinching				pinching	not clear	2	10	
UC 7200	crocodile	4 cm ca	X	multiple crevices	low			uneven	pinching			engraved		applied	2	10	
UC 7201	crocodile	5 cm ca	not clear		low			flat (upper part)/uneven (lower part)	pinching			impressed		applied	2	10	
UC 7205	pig	3 cm ca	X		right			flat	pinching	impressed			applied	applied	tail applied	2	10
UC 7209	und	8 cm	X		right			ueven						applied	2	10	
UC 7211	und	7 cm ca.		fracture of legs	right			ueven						applied	2	10	
UC 7218	turtle	4 cm ca	X		right	prints	multiple on body and legs	flat	pinching						2	10	
UC 7202	crocodile	4,5 cm ca	X		right	prints	multiple along body and legs	sinuous	pinching					pinched	2	11	
UC 7357	bird	3 cm	x		right	prints	wings	sinuous						wings application	2	12	
UC 7189	bird	4 cm ca			right			sinuous	pinching					body perforation	3	4	
UC7190	bird	5 cm ca		crevice along the hole edges	low			sinuous	pinching					body perforation	3	4	
UC 7207	und	5 cm ca.	X		right			sinuous	pinching			applied	applied		3	5	
UC 7192	crocodile	4 cm ca	X	fracture along the neck	right	prints	isolated impressed (legs /lower body)	sinuous	pinching				applied	applied	skin impressed by nails	3	5
UC 7203	crocodile	2 cm ca	X		right	prints	multiple along the body and legs	sinuous	pinching					applied	3	6	
UC 16,753	und	5 cm	not clear	fracture head and legs	right	prints	multiple on body and legs	sinuous	pinching					applied	3	6	
UC 7193	crocodile	6,5 cm ca			right	elongated	isolated (laterally along the body)	ueven	pinching	applied		impressed		applied	3	7	

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Table 4 (continued)

ID	Animal	Measures (length)	Exposure to fire	Fractures/Crevices	Hygrometry	Fingerprints		Surface Topography	Shaping Anatomical details					Steps	Shaping Sequences
						Shape	Localisation		Eyes	Nose	Mouth	Ears	Legs		
UC 7208	und	5 cm ca.			right		sinuous	pinching	impressed	incised or impressed		applied		3	8
UC 7210	und	7 cm ca.			right		ueven	impressed	impressed			applied		3	8
UC 7213	pig	3.5 cm ca.		fracture of legs	right		sinuous	impressed	impressed	impressed		applied		3	8
UC 7217	pig	5 cm ca.	X	crevices and legs fractures	right		sinuous	pinching			applied	applied		3	9
UC 7191	lizard	11 cm ca	X		right		flat	pinching	applied	engraved or impressed		applied	skin impressed by nails	4	1
UC 7196	crocodile	5 cm ca	X		right		flat	pinching	impressed	engraved or impressed		applied	skin engraved and impressed	4	2
UC 7206	pig	7 cm ca.	X	fracture of legs	right		sinuous	pinching	impressed		applied	applied	rope impression	4	3

3.2. The makers' fingerprints

The fingerprint analysis of the Lahun figurines has focused on age identification.

According to the shape and distribution of the dermatoglyphic impressions, the most common shaping gestures consisted in pinching the lump of clay, while rolling was rare. The size and shape of the fingerprints, usually circular or sub-circular, isolated or even overlapping, indicate that essentially the whole process consisted of using fingertips for pressing the raw material lump and giving it a human or animal-like shape. These traces can also be associated with peripheral areas around junction points, suggesting gestures of pressure applied to connect parts, such as limbs, to the main body. Other fingerprints consist of elongated traces, with the shape of small parallel gouges corresponding to the negative of the crests of prints and left by sliding gestures. The latter recur along the figurine's body and are associated with smoothing treatments. In some cases, fingerprints are also observed along junction points and are associated with a reinforcement and a homogenisation of the application. One hundred preserved fingerprints were identified and measured on a total of 31 figurines (Table 2), suggesting that on a single figurine, more than one print can be isolated and, in some cases, these appear to overlap (Fig. 13).

Based on studies carried out by Kralik and Novotny (2003) and Fowler and colleagues (2019), the values of fingerprints need to be contextualized. Three main groups can be more securely distinguished: the fingerprint values of the first group correspond to pre-pubescent children (values <0.37 mm), followed by a second, larger group characterised by measures falling between 0.37 and 0.52 mm, corresponding to adolescents of both sexes and adult women, while the third group (>0.52 mm) comprises fingerprint values corresponding to adults of the male sex (Fowler, 2019, 2020). According to Fowler (2019, Table 3), a further distinction could be proposed for the second group, with the lower values (0.37–0.40) corresponding with early adolescents (10–12 years) and the higher values corresponding to late adolescents of both sexes and/adult women. Based on this distinction and the age range established by Buikstra and Ubelaker (1994), the results of Lahun fingerprints suggest that the majority of the MRB measurements, (20 figurines, 73% of the study), fall within the category of early/late adolescents of both sexes (10/12–20 years) and adult women (20–80 years). The second most represented group, characterized by measures <0.37 (Fowler et al., 2019, 2020) and made up of 8 figurines, correspond to children (birth to 10–12 years approximately). Finally, the less represented group is composed of 3 figurines (130, 9839, UC7196) featuring fingerprints with values corresponding to 0.56–0.57 that fall within the group of adult males (20–80 years) (see Kralik and Novotny, 2003; Fowler et al., 2019, 2020). It may be noted here that the distribution of age range in the corpus of figurines is strongly biased since the human figurines are substantially connected with profiles corresponding to adolescents/adults, while the animal figurines, exception made for one case, show an association even with children (Fig. 13).

4. Discussion and conclusion

Combining the results of the fingerprint analysis and the study of technological traces, it is possible to profile the techniques and the makers' identity of the Lahun figurines production.

4.1. Identifying the techniques and production sequences of clay figurines

Both groups of anthropomorphic and zoomorphic figurines reflect 13 different production chains and are composed of several steps varying from 2 to 4 for the human-like artefacts and from 1 to 4 for the animal-like group.

Pinching is the most utilised technique for shaping a figurine's body. The human figurines of Lahun are generally reduced to a stylised shape that suggests the idea of a human body on which a few emphasised

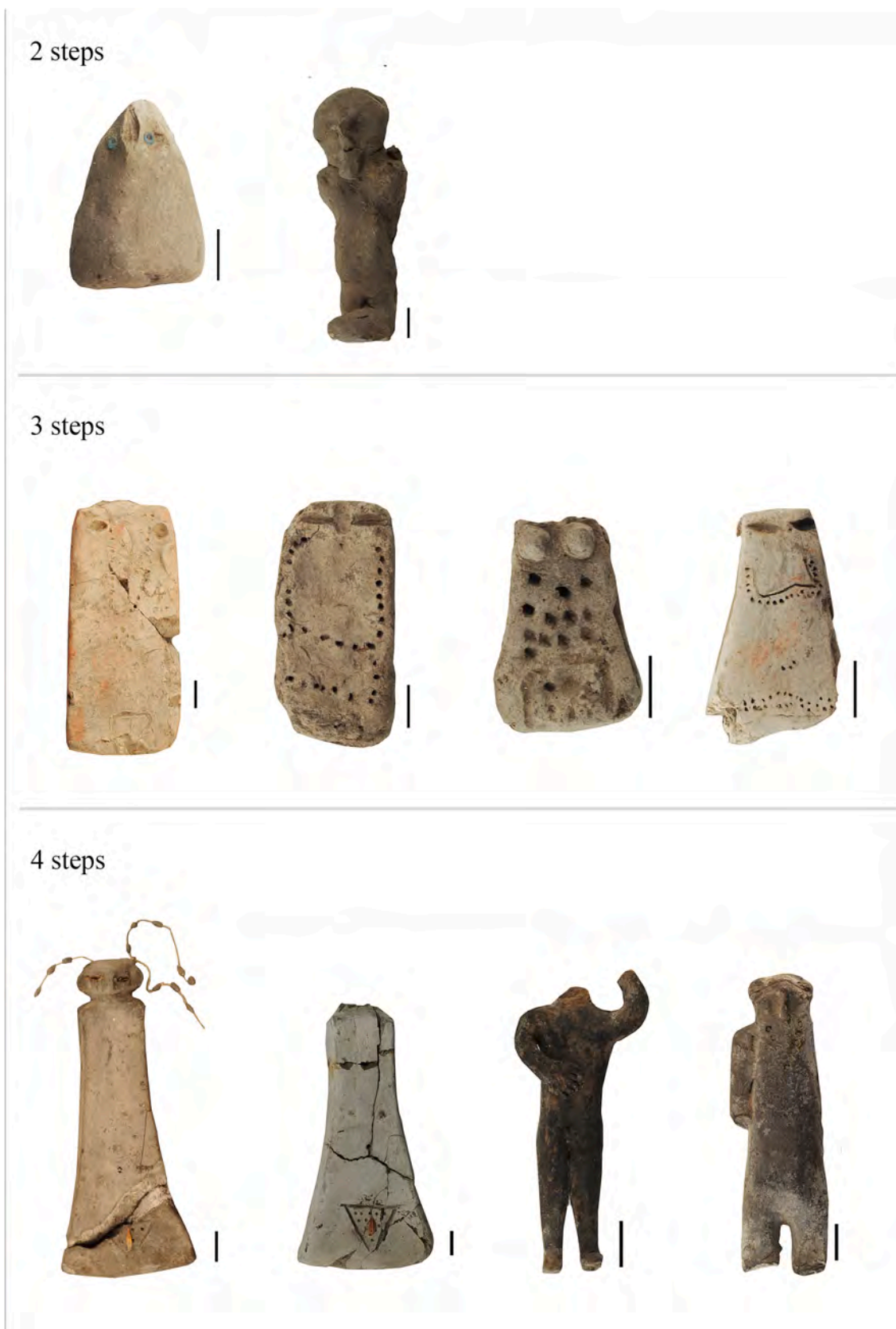


Fig. 7. Grouping of the anthropomorphic figurines based on the number of steps involved in their shaping. Black bar corresponds to 1 cm.

Table 5
Grouping of the anthropomorphic and zoomorphic figurines based on the number of steps involved in their shaping.

Grouping of anthropomorphic figurines			
Groups	Number of Shaping Steps	Number of Figurines	Description
GROUP 1	1	0	
GROUP 2	2	3	All the objects share the first and basic step made of a rough shaping of the body by pinching, followed by the application of anatomical details.
GROUP 3	3	14	Shaped by pinching, followed by two further steps. Body shape varies from anthropomorphic, with arms and head, to geometrically shaped bodies, lacking arms or any other distinct anatomical details. Some figurines of this group were smoothed and then completed with the last step consisting of the application of anatomical details through a large variety of techniques, including engraving, impressing, pinching or applying small items like beads as eyes. In other cases, after the shaping of the body, the application of anatomical details by engraving, impressing or pinching was followed by a third step of homogenisation via smoothing or pinching.
GROUP 4	4	4	The group comprises only a few items produced through a first step of body shaping by pinching, followed by a step of smoothing or a step of application of distinct anatomical details (head/arms), depending on the shape of the figurines, and completed with two additional steps consisting in detail modeling as engraving/impression of anatomical details (e.g. pubis/eyes) using organic <i>appliques</i> as seeds. Some figurines were completed via smoothing used as a final refining treatment.
Grouping of zoomorphic figurines			
GROUP 1	1	1	The group of figurines made through one step is composed of one small figurine made exclusively by pinching.
GROUP 2	2	16	The group of figurines made through two steps is composed of artefacts produced by shaping the main body by pinching and applying the main anatomical details as limbs or ears. In one case, a figurine is made by rolling a small lump of clay under the hands to make the body and then completing it by applying the arms. The surfaces of the figurines in this group were not smoothed or refined; indeed, depressions along the main junction points are visible.
GROUP 3	3	11	Animal figurines made through three steps were modeled shaping the body via pinching, then followed by a smoothing of the surfaces and the application of anatomical details through impression or the impression of further details (e.g., around the neck and along the body). Other figurines, after the shaping of the body by pinching, were completed through an intermediate step of anatomical details application and a final step of smoothing.
GROUP 4	4	3	Animal figurines made of four steps are the most complete and show a major accuracy in details applications and surface refinement. This group is homogeneous and made of a step of body shaping by pinching, application of anatomical details (legs), smoothing of surfaces and application of other anatomical details as eyes or skin features. This group includes figurines with anatomical details such as limbs, eyes and ears as well as skin details, emphasised by nail impressions as in the case of crocodile skin features. Moreover, in two cases of pig-shaped figurines the impression of a rope is clearly visible. In one case in particular, it appears around the neck, the tail and along the body. In the other case, the rope impression recurs around the tail (Fig. 1i). Moreover, the impression in one case is superficial; in the other case, it appears to be deeper on the surface. However, it is not possible to say if a small rope was actually part of the figurine, as suggested by the frequent fiber <i>appliques</i> characterising the human figurines (e.g., Fig. 1a), or if a small rope was only used to make the impression.

anatomical details (e.g. head, ears and engraved pubic area completed with seed applications) express their sexual characters (Fig. 1a-b). Only in one case, the arms and fingers were shaped in detail. Nonetheless, the most complete figurines fall within the group of artefacts made in at least 4 steps, including, in diverse order, shaping of the body, application, engraving or impressing of anatomical details and surface finishing. The latter step in particular, has an effect on the accuracy of the final product and appears on 22,7 % of the human figurines (Figs. 9-12).

Most of the anthropomorphic figurines (63%) were produced in three steps of shaping. Nine different sequences have been distinguished within this group where the application of organic items, such as seeds or hair, is not recorded, and the most practiced consisted in sequences 5 and 4 (Figs. 9-12). The two sequences correspond to shaping the body by pinching, smoothing the surface and completing the figurine through a final step of engraving or impression of anatomical details (cf. three steps Fig. 10). Only in one case, the use of small beads inserted as eyes was identified. 13,6% of the human figurines were made in two steps of shaping, and only one sequence was identified and characterised by a shaping by pinching followed by the application of anatomical details (Figs. 10-11).

Also, within the group of zoomorphic figurines it is possible to identify high variability in the order of the shaping steps. Compared to the human figurines, only 9,6% is made in 4 steps and appears to be the most complete of the shaping sequences. Most of the animal figurines, corresponding to 51,6 %, are made in two steps, in particular using sequence 10 (shaping the body by pinching and application of anatomical details) (Fig. 10), while 35,4% are made in three steps. As for the human figurines, these artefacts are shaped by pinching and completed through the application of pre-formed small clay lumps

shaped as limbs or pinched along the body. In one case, a small figurine is made just by pinching the lump of clay to shape the head of a dog looking like a jackal (Fig. 6a, 10-12).

4.2. Identifying timing, tools and skills

The step that is usually missing in the production process is related to the refining of the figurine itself, which would usually complete the shaping cycle of an object. The lack of this last step could be interpreted as: 1. Unintentional and a consequence of the low level of skill of the maker who could be identified as a sub-adult or an unskilled adult; 2. Intentional, when the roughness of the figurines is a result of a disinterest in making them into a refined product. In this case, the rapidness of the production process can affect the final product even if the maker possesses the correct skills. In the Lahun figurine collection, the approximation is particularly evident in the group of figurines made in 2 or in single steps as well as in some objects made in 3 steps. The most complete figurines, on the other hand, are the ones made in 3 and 4 steps, which are generally the most complete with regards to the production chain. The difference in accuracy consists not only of the lack of symmetry and the approximate shaping (as, for example, the lack of homogenization after the application of anatomical details or the irregularity of the line made by circular impressions and the irregular engravings), but also of a low ability to reproduce realistic figures. In this case, a combination of shaping the clay in the right proportions, application of anatomical details in the right spots and following proportions suggest that the capacity of the producer in making the most of the lump of raw material is high (or higher) as the time dedicated to the whole process and, specifically, the application of details. It may not be

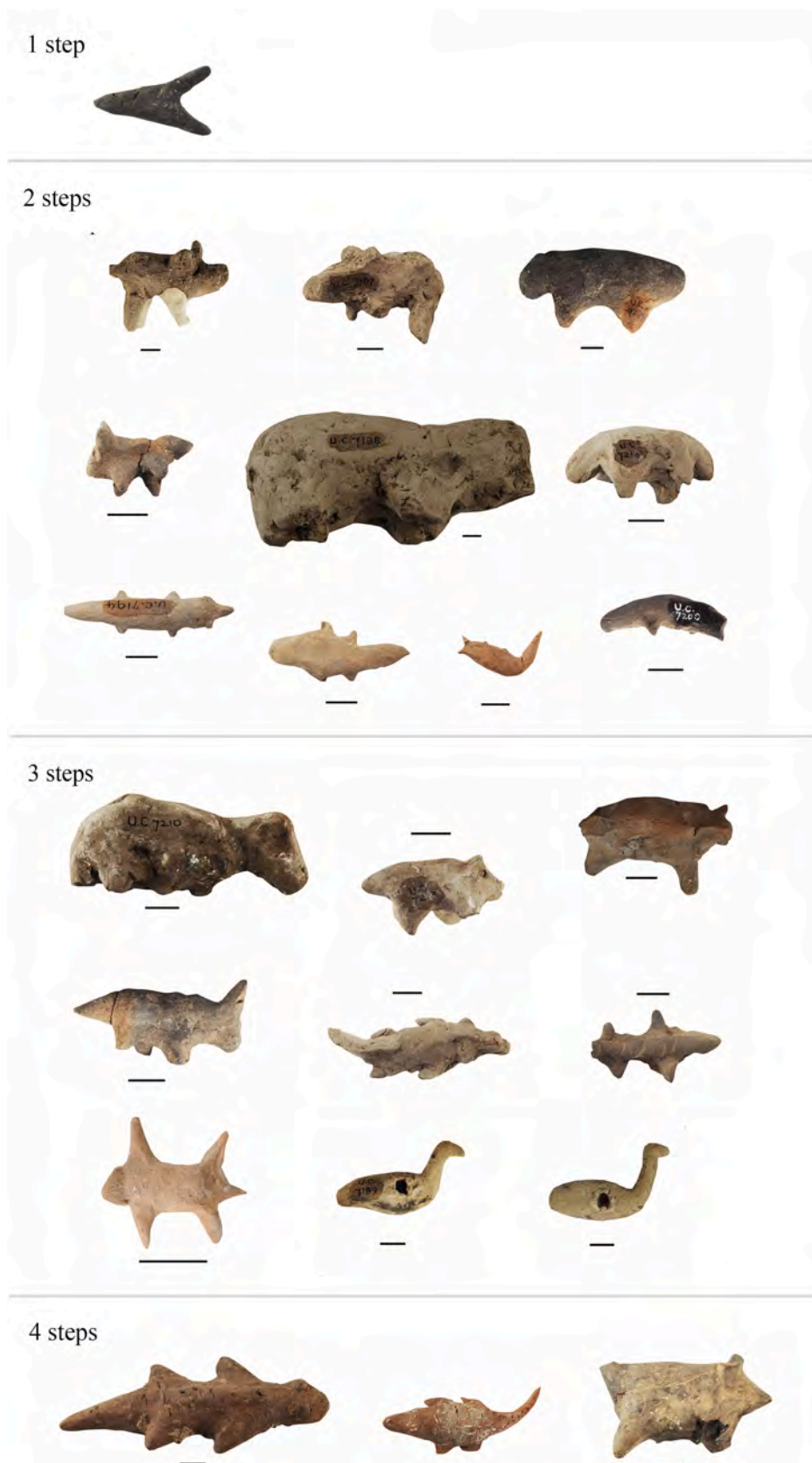


Fig. 8. Grouping of the zoomorphic figurines based on the number of steps involved in their shaping. Black bar corresponds to 1 cm.

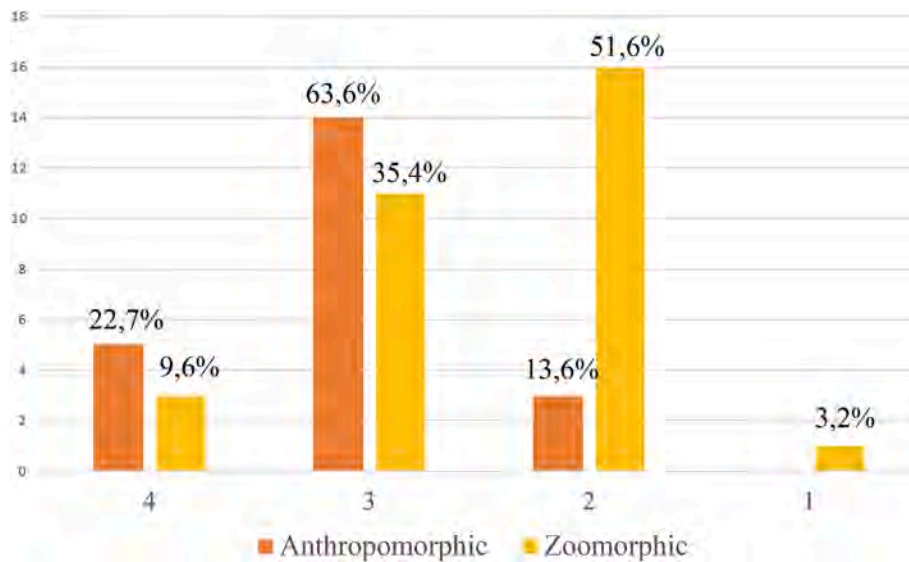


Fig. 9. Relationship among number of shaping steps and group of figurines.

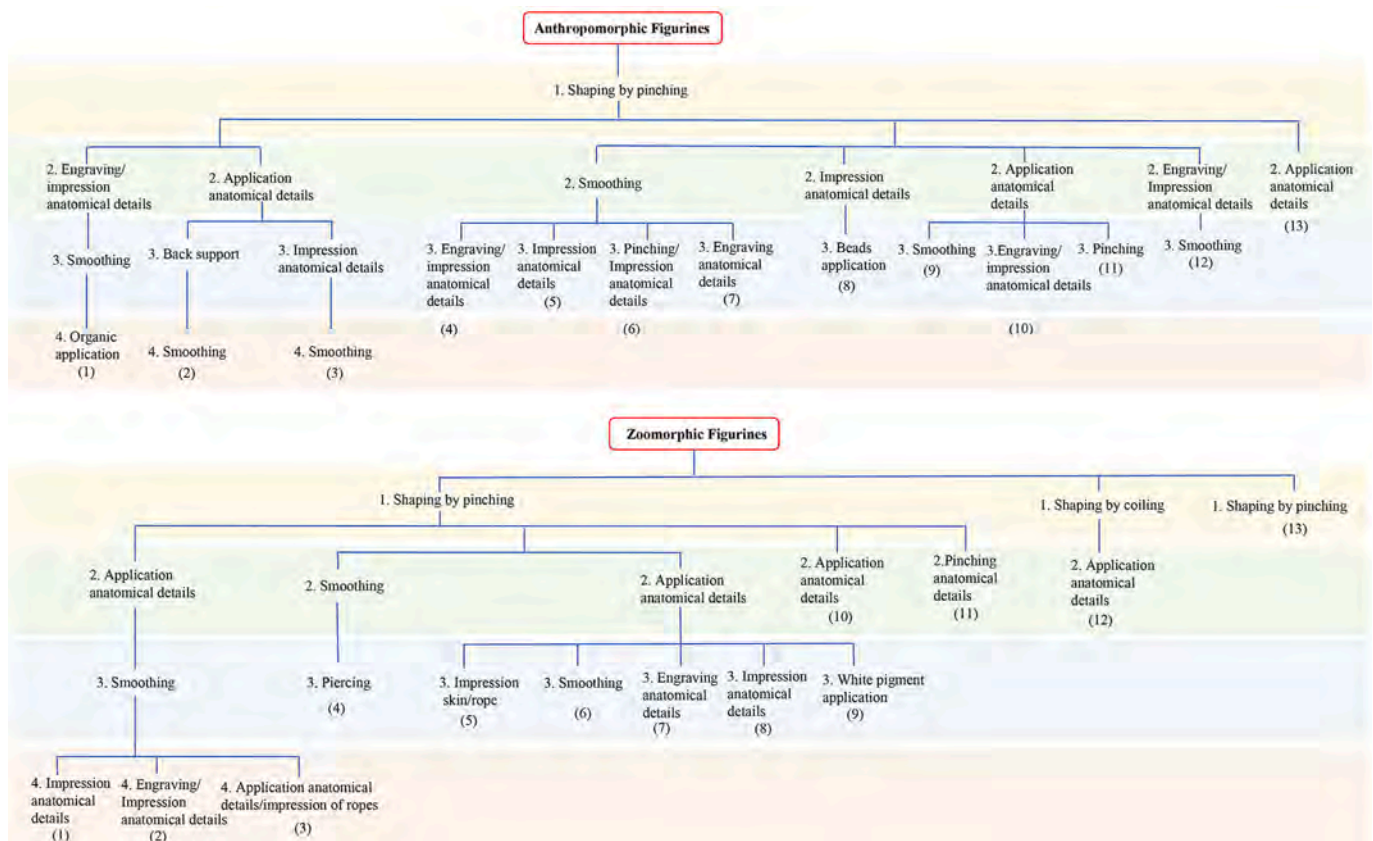


Fig. 10. Shaping sequences adopted to produce the Lahun figurines.

coincidental that this skill in shaping is associated mainly with anthropomorphic figurines, while only a few zoomorphic miniatures show such a level of work.

4.3. Identifying the makers of the figurines

Fingerprint studies suggest that it is possible to identify the age of the people who left their prints on surfaces of clay. A distinction can be made between the categories of children, adolescents, and adults (Kralik

and Novotny, 2003; Králík and Nejman, 2007; Sanders, 2015; Kantner et al., 2019; Fowler et al., 2019, 2020). Based on fingerprint study, the clay figurines of Lahun were the products of makers of different ages. The main hypothesis, first presented by Petrie, considers these objects as toys made by children. This interpretation appears to be based on subjective features such as the roughness of the production, considered to be typical of children, the poor quality of the raw material or the undecipherable shape. All these aspects do, in fact, coincide with the features of toys and playing conditions documented by ethnoarchaeological

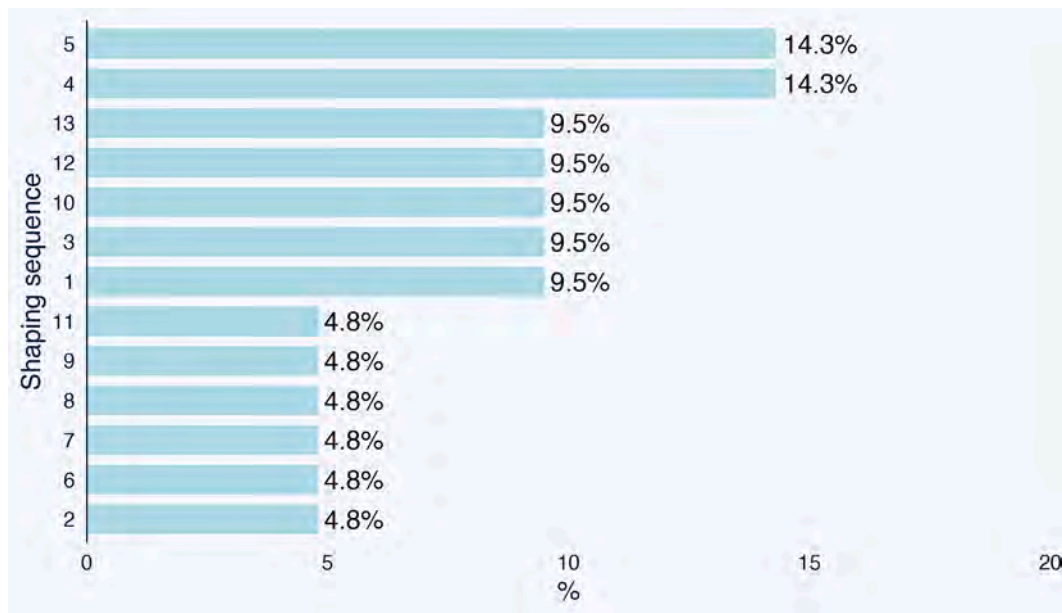


Fig. 11. Quantification of shaping sequences underpinning the production of the anthropomorphic figurines.

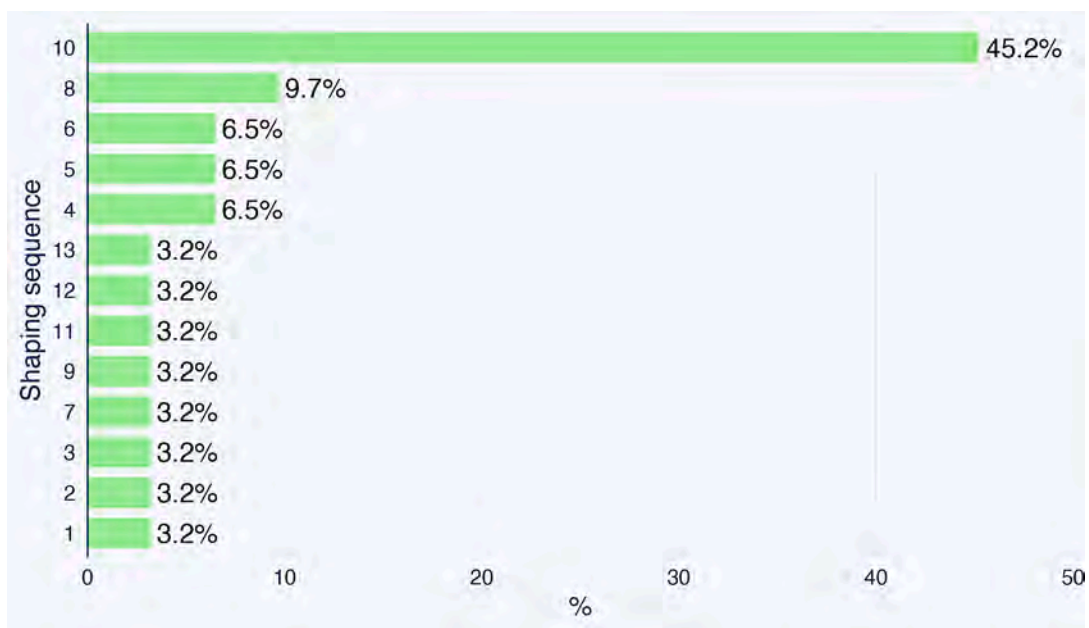


Fig. 12. Quantification of shaping sequences underpinning the production of the zoomorphic figurines.

studies such as, for example, African case studies (Bugarin, 2005, Rossie, 1995, Ember and Cunnar, 2015). Clay was the most common material used by children to shape toys and emulate, on a reduced scale, adults' activities, using household objects and animals characterising the environment where they grew up (cf. Kamp, 2001; Baxter, 2005; Uziel and Avissar, 2013; Langley and Litster, 2018; Fassoulas et al., 2020, Rossie, 1995). However, contrary to what was expected or suggested in previous literature, the fingerprints observed on the clay figurines from Lahun correspond mostly with the range of age of adolescents and adults (>10/12 years). These data cast a new light on the production of the clay figurines of Lahun, which was a matter mainly in the hands of adolescents and adult individuals. The results need to be contextualized for ancient Egypt, where the life duration, the age perception and the sociocultural role of the people who are biologically young differ when compared to the present. No cemetery sample has been fully and

accurately inspected in order to suggest some parameters for life expectancy and longevity for the population structure (Zakrzewski, 2015). Certainly, the ideal life expectancy (110 years; see Mofteh, 1983) or the long reigns of the pharaohs (Ramses II, dead at the age of c. 90) cannot be taken as general life expectancy for the population of ancient Egypt. Roman Egypt is the only period for which documented evidence of the age composition of the general population has survived: a demographic graph can be built on the census list enumerating 63 households registered on the verso of the papyrus P. Oxy. 984. Life expectancy seems to decrease for the male population after 25–29 years, while for the female population after 30–39 years, with documented peaks of individuals reaching over 65 years (Bagnall et al., 1994, 314–23, 348–50, 1997, 100; data commented in Scheidel, 2012). The observations for the Roman period can be compared with data from the cemetery excavated at Minshat Abu Omar (from 700 BC to 400 CE), where the average life-

Table 6
Shaping techniques reconstructed on the basis of the archaeological manufacturing traces.

Shaping Sequences			
1	2	3	4
Anthropomorphic figurines			
1. Shaping by pinching	engraving/impression anatomical details	smoothing	organic application
3. Shaping by pinching	application anatomical details	impression anatomical details	smoothing
4. Shaping by pinching	smoothing	engraving/impression anatomical details.	
5. Shaping by pinching	smoothing	impression anatomical details	
6. Shaping by pinching	smoothing	pinching/impression anatomical details	
7. Shaping by pinching	smoothing	engraving anatomical details	
8. Shaping by pinching	impression anatomical details	beads application	
9. Shaping by pinching	application anatomical details	smoothing	
10. Shaping by pinching	application anatomical details	engraving/impression anatomical	
11. Shaping by pinching	application anatomical details	pinching	
12. Shaping by pinching	engraving anatomical details	smoothing	
13. Shaping by pinching	application anatomical details		
Zoomorphic figurines			
1. Shaping by pinching	application anatomical details	smoothing	impression anatomical details
2. Shaping by pinching	application anatomical details	smoothing	engraving/impression anatomical details
3. Shaping by pinching	application anatomical details	smoothing	application anatomical details/impression of ropes
4. Shaping by pinching	smoothing	piercing	
5. Shaping by pinching	application anatomical details	impression skin/rope	
6. Shaping by pinching	application anatomical details	smoothing	
7. Shaping by pinching	application anatomical details	engraving anatomical details	
8. Shaping by pinching	application anatomical details	impression anatomical details	
9. Shaping by pinching	application anatomical details	white pigment application	
10. Shaping by pinching	application anatomical details		
11. Shaping by pinching	pinching anatomical details		
12. Shaping by coiling	application anatomical details		
13. Shaping by pinching			

expectancy for the group between at age 20–29 amounted to 14.65 years (Parsche and Zimmermann, 1991). Although life expectancy is different from the age when a child transforms into an adult (see Janssen and Janssen, 2007; Frood, 2010), the age range gathered from the analysis of the fingerprints (>10/12) does seem to point more towards the adult age. In fact, what can be currently considered an adolescent would have been most probably considered to be an adult in ancient Egypt. The relationship of the majority of the fingerprints with the age range of late adolescents and young adults suggests that the majority of the figurines of Lahun were made by people perceived by society as adult individuals, with a range of biological age corresponding approximately to 18–20 years. Based on the fingerprints, the production of all the anthropomorphic figurines and most of the animal figurines at Lahun is associated with the group of adolescents/adults. (Fig. 9). Conversely, only eight figurines feature fingerprints of children (UC 7155, UC7176, UC7186, UC7191, UC7197, UC7219, UC 7200, UC7204) (Fig. 13).

However, the dermatoglyphic analysis also suggests that children were somehow involved in the production of figurines, although only a few attestations are preserved of, and they are almost exclusively related to the corpus of animals (see below). Such information provides further insights into the production chain: to a limited degree, children were taking part in the production activities of clay figurines. The limited participation of children can be interpreted as a form of play (products of playing), as an imitation of adult activities ('learning by playing'), or an actual participation in production activities. Playing is indeed a means for children to acquire mastery of adult activities and allows to prepare them for their future role in society (Boyette, 2016; Riede, et al., 2018). The ethnoarchaeological literature is rich of studies exploring how children take part in household activities, emulating the adults in their family, and this is how they grow up and learn to behave in conformity with social dynamics (Crown, 2002, 2001; Huffman, 2012; Wendrich, 2013; Fassoulas et al., 2020; Rossie, 2021). The production and use of objects of everyday life as miniaturist artefacts of animals and even human representations are powerful means to educate children and prepare them for their role as adults in society. For example, several studies on North African toys, particularly in the region of Tiznit,

Morocco, show how children carry out a whole production process of clay figurines and other objects. From the procurement of the clay to the firing, they reproduce artefacts inspired by the adult's life, such miniature objects employed in food preparation and consumption, or dolls, animals and houses (Fassoulas et al., 2020). Until 30 years ago, before the introduction of plastic products, clay was one of the most used materials involved in children's playing activities in North Africa (Rossie 1995). In other traditional contexts in Zimbabwe, clay was used not only by children but also by adults to shape a specific type of doll, named *Mwan*. These dolls, made for little girls and characterised by their accentuated sexual organs, have an initiatory role, leading girls to the wedding ceremony (Fassoulas et al., 2020, 17; Huffman, 2012; Hechter-Schulz, 1966).

With regards to the clay figurines of Lahun, the results of technological and fingerprint analysis have led to reflection on the commonly accepted assumption that associates well-refined products with adult makers and unrefined objects with children. The equation of rough products to toys, and of refined objects to ritual figurines is not always correct. Indeed, the group of adolescents/adults is associated with artefacts made by people with diverse expertise in shaping and accuracy devoted to making a figurine. There is not a clear correspondence between age and quality of the final artefact. Differently, the fingerprints children were identified mostly on zoomorphic figurines, mostly made in a few steps (Figs. 8, 13). The features of the clay figurines, and the prevalence of artefacts made in a few quick steps (sequences of two steps are predominant in zoomorphic figurines, see Fig. 9), support the assumption that the rough manufacture was due not only to a fast-shaping process but likely to a lower level of skill. This latter can be associated with a low experience in shaping a raw material as well as with the age of the maker, as the case of children (Crown, 2001, 2002). The low skill expected in younger people could consist of low accuracy and lack of intention in refining an artefact and completing the production process.

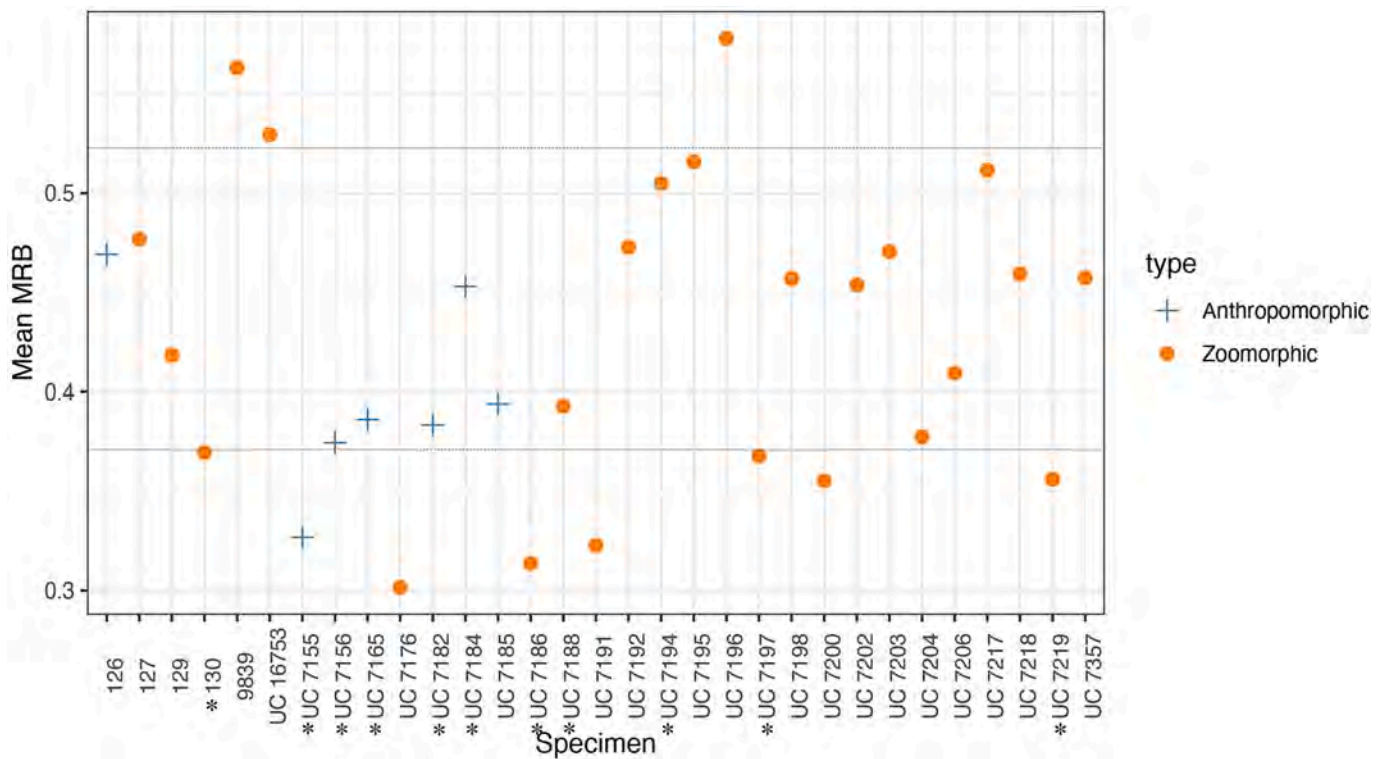


Fig. 13. Chart of MRB recorded on Lahun figurines, * indicates single prints.

5. Conclusions

The study of anthropomorphic and zoomorphic clay figurines from Lahun provides, for the first time, a social and technological profile of the artisans from the Nile Valley. This profile is based on the multiple – and often non-simultaneous – stories encapsulated within the artefact production, which reproduces segments of life of the non-wealthy and non-dominant people. The ubiquity of the raw material (clay), the apparent roughness of the figurine production and the approximation of their shapes have led scholars to consider them to be primarily the result of an *impromptu* action, the extemporary outcome of a moment, an inspiration, an impulse of an unskilled maker. This often leads to associating the manufacture of clay figurines with basic creative and intellectual processes and commonly considering them poor and casual productions. The study of the Lahun figurines revealed a high number of production chains that characterised high stylistic and technological variability and indicates multiple levels of skill. The paper demonstrates that there was a neat division between anthropomorphic and zoomorphic figurines and that clay figurines were not a poor reproduction of images in different materials. The complexity of manufacture and the exclusive presence of late adolescent/adult fingerprints on the anthropomorphic figurines, seem to indicate a privileged ritual aspect provided to this category of figurines. Animal figurines presented a tendency toward major abstraction and less complexity: in this type of figurine, also children's fingerprints have been identified, indicating that they contributed in a marginal way to zoomorphic figurine production. Most probably, the scope of zoomorphic figurines was rather different from those of a human shape and some of them could relate to playing or the rituality associated with these figurines did not require any definition of the shape. The presence of sub-adult fingerprints on some of the clay figurines indicates the impact of children in producing material culture, in the form of informal cooperation in the adult production process and/or during playing activities (learning and growing up by playing).

CRediT authorship contribution statement

Vanessa Forte: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Visualization. **Gianluca Miniaci:** Conceptualization, Resources, Visualization, Funding acquisition.

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.

Acknowledgements

We are grateful to Anna Garnett from the Petrie Museum of Egyptian Archaeology in London and Campbell Price from The Manchester Museum for their kind permission to study the figurine corpora in their collection. We are also grateful to Merel Eyckerman for the drawings, Camilla Saler for the research in the museum and leading the first phases of the project, Georgia Long for revising the English (any mistake remains ours) and Hannah Page for the fruitful discussion about the clay pastes of the figurines. We would also like to thank the anonymous reviewers for their constructive comments.

Funding

This research was carried out under the project PROCESS – *Pharaonic Rescission: Objects as Crucibles of ancient Egyptian Societies*, University of Pisa (PI: Prof. Gianluca Miniaci), funded by the Ministry of University and Research under the scheme PRIN 2017 (201758TWK5).

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