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# Who Made the White Gold? Exploring the Demographics of Iron Age Salt Production in England through Fingerprint Analysis

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*Ancient fingerprints preserved in clay artefacts can provide demographic information about the people who handled and manufactured them, leaving their marks as an accidental record of a moment's interaction with material culture. The information extracted from these ancient impressions can shed light on the composition of communities of practice engaged in pottery manufacture. A key component of the process is a comparator dataset of fingerprints reflecting as closely as possible the population being studied. This paper describes the creation of a bespoke reference collection of modern data, the establishment of an interpretive framework for prehistoric fingerprints, and its application to assemblages of Iron Age briquetage from coastal salterns in eastern England. The results demonstrate that briquetage manufacture was constrained by age and sex.*

**Keywords:** fingerprints, Iron Age, pottery, salt, briquetage, communities of practice

Fingerprints are sometimes preserved in the surface of clay and their potential to provide information about the people involved in making the artefacts has been recognised for some time (Primas 1975; Kamp *et al.* 1999; Králík & Novotný 2003; Hruby 2011; Sanders 2015; Zadeh 2017; Blaževičius 2019; Fowler *et al.* 2019; 2020). However, to date little work has been carried out applying techniques of fingerprint analysis to British prehistoric material. This article reports on the development of a technique tailored to later prehistoric material and its application to assemblages of ceramic material associated with salt extraction activities during the Iron Age. The scale and widespread nature of salt production attests to its value to later prehistoric societies across Europe and further afield. The utilitarian nature of ceramics employed in the processes of boiling brine to extract salt crystals lends itself to the accidental preservation of fingerprints (and sometimes impressions of whole fingertips), which presents an opportunity to explore who was involved in production of this valuable resource. The methods described herein are applicable beyond the case study assemblages to a wide range of ceramic artefacts and, with adaptations, to fingerprints preserved in other materials.

Analysing fingerprints allows insights into the demographic constitution of communities of practice, namely groups of people united by an interest or a craft and who share and deepen their knowledge of it by continual interaction, developing over time a body of common knowledge, practices, and approaches (Lave & Wenger 1991; Wenger *et al.* 2002). In the context of this research, communities of practice are those social networks in which the salt makers shared a technological tradition involving the manufacture of briquetage and the extraction of salt from sea water. This article explores the question of who made up communities of salt makers, focusing on evidence from Iron Age coastal salt working sites in eastern England.

## FINGERPRINTS

The visible lines on the skin of the fingertips are known as epidermal ridges. Each person's ridge pattern (comprising a central arch, whorl or loop, and surrounding

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lines with macro-features and ridge minutiae) is unique and develops in utero, being complete before birth (Gowland & Thompson 2013). Once formed, fingerprint patterns do not change. Ridge number and pattern are independent of age and ridges increase in size rather than number as the fingers grow. Once an individual reaches maturity, epidermal ridge characteristics are not affected by increasing age or by environmental factors (Mundorff *et al.* 2014).

Within geographically defined populations there is sexual dimorphism within the epidermal breadths of adult males and females, as well as differences in the mean ridge breadths between discrete populations (Acree 1999; Gungadin 2007; Gutiérrez-Redomero *et al.* 2008; 2011; 2013; 2014; Nayak 2010a; 2010b; Nithin 2011; Agnihotri 2012; Eshak *et al.* 2013; Krishan *et al.* 2013; Mundorff *et al.* 2014).

TABLE 1. AGE AND SEX OF PARTICIPANTS IN FINGERPRINT REFERENCE COLLECTION

| *Age (yrs)* | *No. females* | *No. males* | *Total* |
|---|---|---|---|
| 4 | 10 | 8 | 18 |
| 5 | 7 | 3 | 10 |
| 6 | 12 | 8 | 20 |
| 7 | 10 | 5 | 15 |
| 8 | 6 | 6 | 12 |
| 9 | 6 | 8 | 14 |
| 10 | 7 | 9 | 16 |
| 11 | 8 | 6 | 14 |
| 12 | 9 | 4 | 13 |
| 13 | 6 | 5 | 11 |
| 14 | 2 | 5 | 7 |
| 15 | 6 | 6 | 12 |
| 16 | 7 | 6 | 13 |
| 17 | 3 | 9 | 12 |
| 18 | 5 | 4 | 9 |
| Over 18 | 32 | 27 | 59 |
| Total | 136 | 120 | 256 |

## METHODOLOGY

Given the known geographic differences in epidermal ridge measurements, it was considered important to use a reference dataset matching as closely as possible the archaeological population under study. The shortage of published studies of British or northern European populations and the lack of data for subadults meant that, to study fingerprints found on British prehistoric artefacts, it was necessary to create a modern reference dataset of fingerprints from the same broad area as that under study. This approach was also adopted by Zadeh (2017) who examined Bronze Age Austrian fingerprints using modern Austrian fingerprints as a comparator. It is acknowledged that population movements during and since the prehistoric period mean there is no certain correlation between modern and prehistoric prints but a broadly geographically matched modern data set provides the best source of reference material.

Approval was obtained from the Ethics Committee at the University of Leicester for the collection of inked fingerprints from participants and parental or guardian consent was obtained in relation to each participant under the age of 18. Inked fingerprints from all ten digits were collected from 256 participants aged 4 years to adult (Table 1). Ethnographic research has shown that children start to become involved in pottery production from age 5 (Crown 2014), therefore 4 and 5 year olds were considered to be the youngest age group required for the study. Collection was restricted to Caucasian Europeans but not just British individuals, given that isotopic analysis has shown that many later prehistoric inhabitants of the British Isles had origins in continental Europe (Sheridan 2008; Olalde *et al.* 2018; Patterson *et al.* 2021) and populations are not static.

Inked fingerprints were scanned at 1200 dpi and the measurement tool in Adobe Photoshop CC was used to measure the epidermal ridges, calibrated by reference to 1 mm square graph paper fixed to each inked fingerprint recording form. Following Kamp *et al.* (1999), Mundorff *et al.* (2014), and Zadeh (2017), measurements were taken by drawing a line perpendicularly over a group of epidermal ridges starting at the beginning of an inked line representing a ridge and terminating with the edge of a furrow, thus giving measurements over a series of ridge and furrow sets. For each fingerprint, two lines were drawn at the distal end, perpendicularly across at least ten epidermal ridges, starting three or four ridges out from the centre, at approximately '10 to 2' positions, providing measurements from both the radial and ulnar sides of the digit (Fig. 1). The distal region was used to avoid distortion from the central whorl or arch features of the prints and because informal observation of pottery making indicates people use the tips of their fingers more than the proximal area when shaping pottery.

The edges of each print were avoided as the lines become less distinct due to the curvature of the fingertip away from the paper. Mean Ridge Breadth (MRB) was calculated by dividing the length of the line drawn over the ridges by their number. The two calculations

Fig. 1.
Inked fingerprint measurement technique

were averaged to give an MRB for each digit. The digits were averaged to give an overall MRB for each individual. It is accepted that using the overall MRB for each participant masks the variation in MRB of individual digits. However, given that it will not be clear from a print left on pottery which digit made it, the overall MRB is considered a useful (if, by its nature, average) guide to the size of epidermal ridges of individuals. Month and year of birth, sex, and height were also recorded for each participant.

It is possible to use density of ridges in a defined area to infer sex of adult print makers (Sanders 2015; Fowler *et al.* 2019; 2020, although Zadeh 2017 argues it is unreliable) but as the primary focus of this study was age, MRB was the preferred measurement (Kamp *et al.* 1999; Hruby 2011; Zadeh 2017; Blaževičius 2019).

Tests for inter- and intra-rater reliability were performed to check the robustness of the method when performed by different individuals and by the same individual on different days. Intra-class correlation coefficients were 0.849 for inter-rater and 0.992 for intra-rater tests, indicating the methods used to take measurements to create the reference collection were methodologically robust.

The relationship between age and overall MRB (Fig. 2) has a clear trend of increasing MRB with age until around 180–200 months. After this, the correlation is less evident and a broad pattern of sexual dimorphism emerges, with females generally (although not exclusively) having narrower MRBs than males. MRBs over 0.48 mm were exclusively from males over 16 years.

There is also clear correlation between an individual's height and their overall MRB (Fig. 3). The Pearson correlation coefficient for bivariate data (height and MRB) is 0.838, indicating strong correlation and thus the importance of considering height when interpreting MRB. Given the broad correlation between height and MRB, height should be translated into age using a knowledge of height variability in the population under study (Kamp *et al.* 1999). Therefore, it is important to consider stature in the period to which specific archaeological fingerprints date.

In the British Iron Age, stature, albeit from temporally and regionally limited inhumation burials, is reported as 168 cm for males and 162 cm for females (Roberts & Cox 2003), or 167 cm for males and 156 cm for females (Dent 2010). Combining these provides an average height of 167.5 cm for adult males and 159 cm for adult females. The average height for adult males (18 years and over) in the modern reference collection was 180 cm and for adult females was 167 cm, respectively 12.5 cm and 8 cm taller than the Iron Age averages. Both are slightly higher than averages in published studies on adult height in the UK (Moody 2013; NCD Risk Factor Collaboration 2016; Galofré-Vilà *et al.* 2017; National Institute for Health and Care Excellence 2017) but this may be a result of the relatively small sample size or the socio-economic status of the participants. Prehistoric subadult heights are harder to gauge as we do not know the relationship between growth rates and chronological age for later British prehistoric populations. Subadult heights in the

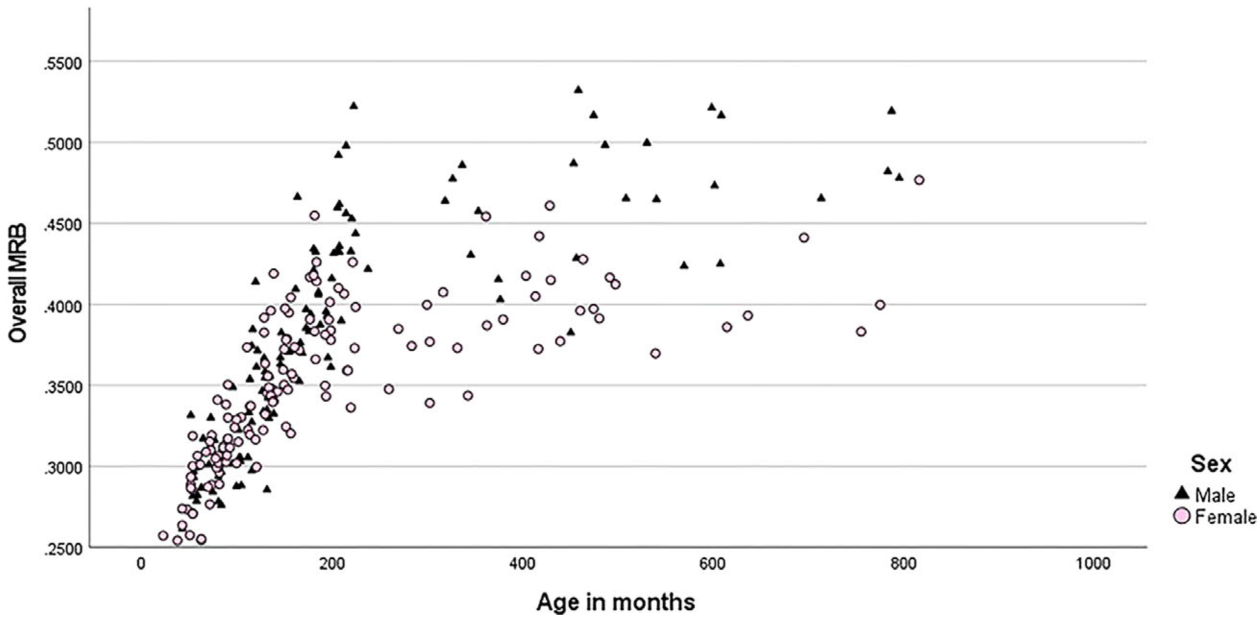


Fig. 2.
Average MRB by age in months

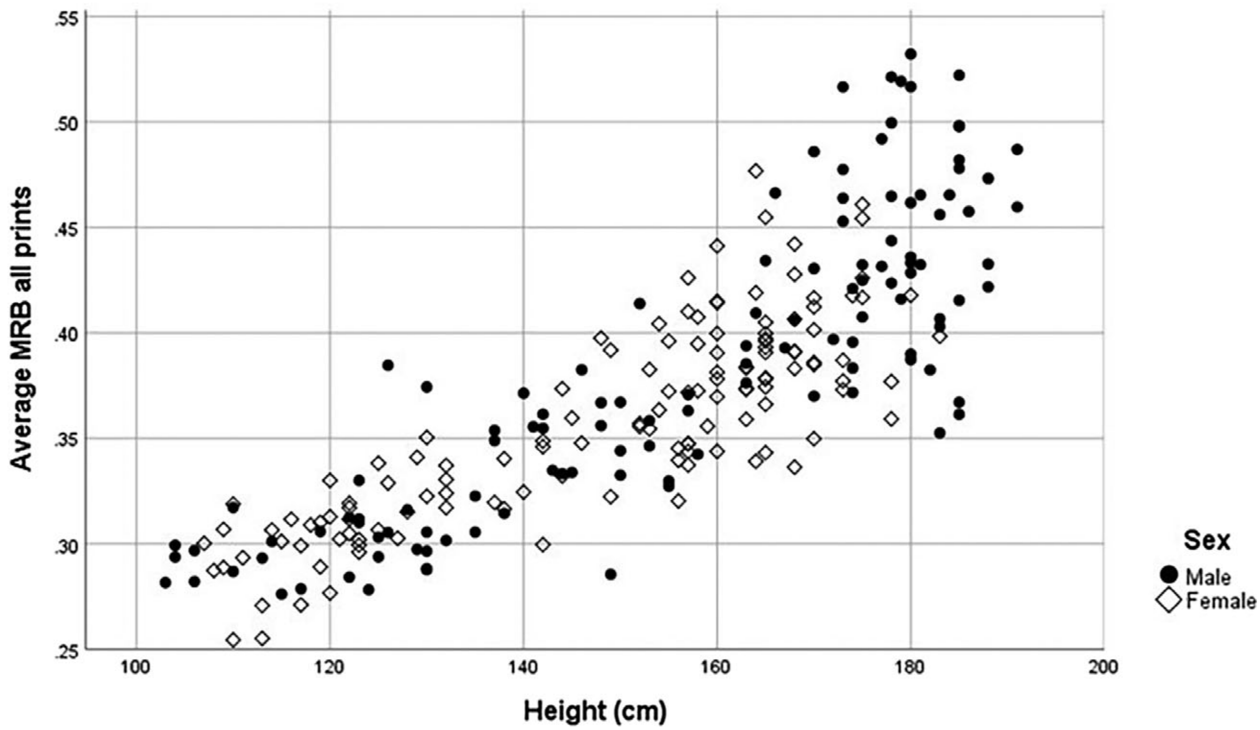


Fig. 3.
Average MRB and height



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TABLE 2. MRB AND INTERPRETATION FOR IRON AGE FINGERPRINTS

| *Mean ridge breadth (mm)* | *Iron Age interpretation* |
|---|---|
| ≤0.275 | child ≤ 7 yrs |
| 0.275–0.299 | child ≤9 yrs |
| 0.3–0.324 | child ≤10 yrs |
| 0.325–0.399 | females ≥ 8 yrs; males 7–16 yrs |
| 0.4–0.449 | females ≥14 yrs, males ≥ 13 yrs |
| ≥0.45 | males ≥ 16 yrs |
| ≥0.5 | adult males |

reference collection fall within the parameters of 'UK90' (a chart containing growth data for 25,000 white British children) which is considered reliable by a working party of the Royal College of Paediatrics and Child Health (Wright *et al.* 2002; Cameron & Hawley 2010).

The reference collection data and knowledge of average heights during the British Iron Age enable a series of parameters to be developed for interpretation of archaeological fingerprints. MRB is used to determine the height of the printmaker and then their age is determined based on a rescaling of height data to reflect changes in average height between the Iron Age and now.

As one cannot initially tell whether a male or female made a fingerprint, a uniform approach to rescaling to account for height difference was employed. The mean of the adult height differences (94.1%) was used to adjust the height profiles for all ages to be of potential applicability to Iron Age populations. This assumes that although average heights have changed since the Iron Age, the relationship between height and MRB has not changed significantly.

Based on the detailed data, and given the overlapping MRBs and age categories, a simplified set of broad demographic categories for interpreting fingerprints was devised (Table 2). Previous studies (eg, Kamp *et al.* 1999; Kralik & Novotny 2003) have employed regression equations to provide an age from MRB but the data in the reference collection in this study does not demonstrate a clear enough link between MRB and age for the calculation of a regression equation (*contra* Kamp *et al.* 1999, and Kralik & Novotny 2003). Instead, the data enable a series of parameters to be developed to enable interpretation of the archaeological fingerprints into broad demographic groups (Zadeh 2017). This method can indicate with some confidence whether a print was made by a younger child or by males in their late teens or adulthood. The overlaps between adult female print dimensions and those of adolescents render confident interpretation of the middle range of MRBs difficult. Data from this study indicate MRBs under 0.324 mm are from children under 10 years and those over 0.5 mm are from adult males. This largely concurs with the conclusions of Králik and Novotný (2003) and Fowler *et al.* (2020) who argue MRBs under 0.37 mm represent pre-pubescent children and those over 0.52 mm correlate to adult males, with a broad adolescent/adult group represented by MRBs between those figures.

In developing a framework for interpreting archaeological fingerprints, the recommendation of Appleby *et al.* (2015) was adopted, namely the use of an adapted version of the *Istanbul Protocol Manual on the Effective Investigation and Documentation of Torture and other Cruel, Inhuman or Degrading Treatment or Punishment* (UNHMO 2004). The adapted version of Appleby's recommendations applied herein is:

- MRB consistent with coming from an individual of [a specified] height/age bracket, meaning the print could have been made by a person within that classification but could also come from an individual outside it;
- MRB highly consistent with coming from an individual of [a specified] height/age bracket, meaning the print could have been made by a person within that classification and it is unlikely to have been made by someone else;
- MRB typical of an individual of [a specified] height/age bracket, meaning the print dimensions are usually found within a certain height/age group although it is possible it was made by someone outside that group;
- MRB diagnostic of [a specified] height/age bracket meaning the print could only have some from someone within the specified group.

## RECORDING ARCHAEOLOGICAL FINGERPRINTS

Clear, undistorted prints were photographed using a digital SLR camera with macro-lens, with the fingerprint positioned parallel to the camera lens. An oblique light source at *c.* 45° provided raking light

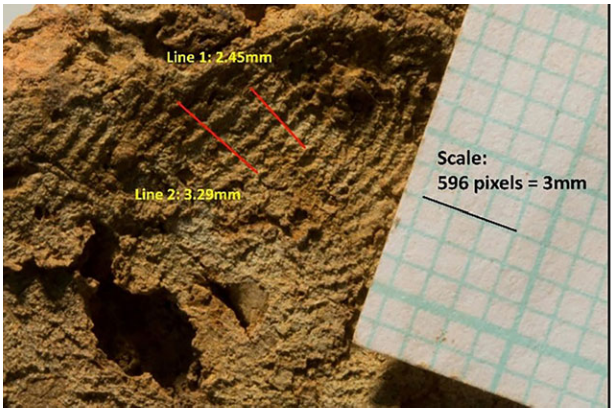


Fig. 4.
Fingerprint measurement technique

across the surface and highlighted the ridges and furrows. To provide an accurate scale, a small piece of 1 mm graph paper was positioned on or adjacent to the fingerprint surface.

Using the same approach as used to measure the inked fingerprints, photographs were processed in Adobe Photoshop CC, in which the measurement tool was set by reference to the 1 mm graph paper. Measurements were taken perpendicularly across several ridges, with the line length divided by the number of ridges to determine MRB (Fig. 4). Two or three lines per print were measured and an average calculated. Given the partial nature of most of the fingerprints, this approach is considered the most feasible to use with archaeological specimens (Kamp *et al.* 1999; Králík & Novotný 2003; Mundorff *et al.* 2014; Zadeh 2017), and replicates that used for the inked prints.

## CLAY SHRINKAGE

It is important to account for clay shrinkage when analysing the measurements of epidermal ridges recorded on pottery so that measurements can be rescaled to living dimensions. It is generally accepted that clay shrinks by between 2% and 9%, depending on its water content, mineral composition, and the firing environment. A working average of 7.5% used by fingerprint researchers (Kamp *et al.* 1999; Králík & Novotný 2003; Sanders 2015; Zadeh 2017) was adopted for this research. Further study of the local clays used in individual saltern sites would allow refinement of the figure although it would be unlikely to affect the overall results.

## SALT MAKING AND SALTERNS

Salt was a valuable commodity in later prehistoric times for preservation of foodstuffs and processing of animal hides (Morris 2007; Harding 2014; 2021). Evidence has emerged for salt extraction from sea water and saline springs during the Neolithic at sites in the Balkans, western France, Germany, and North Yorkshire (Weller & Dumitroaia 2005; Weller 2015; Harding 2021; Sherlock 2021). Early Bronze Age salterns are known from the Iberian peninsula (Guerra-Doce *et al.* 2011), sites dating between the 16th and 9th centuries BC are known from Romania and Ukraine (Harding 2013; 2021), and Middle Bronze Age (*c.* 1500–1150 BC) sites are known from Somerset (Bell 1990) and Lincolnshire (Dymond *et al.* 2000).

During the Iron Age, inland salt working at saline springs took place at sites across the Seille Valley (France), Baden-Württemberg and Hesse (Germany; Olivier & Kovacik 2006; Harding 2013), and on the Atlantic and Channel coasts (Harding 2021). In Britain, while inland brine spring sites are known from Droitwich, Worcestershire (Hurst 1998) and Middlewich, Cheshire (Nevell 2005), coastal sites predominate with over 300 Iron Age and Roman salterns known from the Lincolnshire Fenland (Morris 2007) and a similar number from the coastal areas of Essex (Fawn *et al.* 1990; Wilkinson & Murphy 1995). The Essex 'Red Hills' are low mounds of reddish material comprising briquetage fragments, ash, and charcoal, located within salt marshes, with dates spanning the Late Iron Age and 1st century of the Roman period (Sealey 1995; Harding 2021). In Lincolnshire, known sites cluster around the Linsey Marshland (broadly from Skegness to the Humber estuary) and further south in the Fenland bordering Cambridgeshire. The Fenland sites are located on land which was tidal saltmarsh during later prehistory but is now inland due to coastline changes. Salt was also being extracted from sea water at locations in Kent, Dorset, and Sussex, although fewer sites are currently known.

Excavations at salterns across eastern England have uncovered features which allow putative reconstructions of the process. Clay-lined settling tanks stored sea water whilst some impurities settled out. The brine was transferred to shallow evaporation troughs supported on either pedestals or fire-bars, positioned within a hearth structure cut into the ground surface.

Salt crystals were probably removed as they formed to avoid contamination. Others have suggested salt may have been obtained by burning halophytic marsh plants whose ash was mixed with sea water and filtered to create brine which was boiled to extract the salt (Kinory 2012; Biddulph *et al.* 2012; Biddulph 2016). Most sites are identified by the presence of briquetage, settling tanks, hearths, and, occasionally, flues. It is likely that the supports for the troughs and all other briquetage, with the possible exception of the evaporation pans, were manufactured on site from local clay (Rodwell 1979).

The term 'briquetage' encompasses a range of fired clay artefacts fashioned to facilitate production of salt, including brine evaporation troughs, their supports, and hearth structures (Fawn *et al.* 1990; Lane & Morris 2001; Kinory 2012). Briquetage is a crude ceramic, lacking the finished appearance of other pottery, manufactured only to the standard necessary to fulfil a specific purpose. This particularly applies to pedestals, supports, and stabilisers, which were roughly fashioned and probably wedged into place under troughs or between troughs and the hearth wall, and fired *in situ*. As each one has a unique shape, they may not have been re-useable, being discarded to form part of the saltern mound. Analysis of the mound material at Stanford Wharf Nature Reserve, Essex (Biddulph *et al.* 2012) showed that it comprised discarded briquetage, fuel waste and burnt salt marsh sediment.

Assemblages from Middle and Late Iron Age sites in Essex and Lincolnshire formed the basis of this study, from which examples of the various forms are shown in Figure 5. Uncalibrated radiocarbon dates in reports were calibrated using OxCal 4.3 (Bronk Ramsay 2009) to improve the accuracy of dating. Calibrated dates were checked using the same program to ensure consistency in dating as far as possible.

## RESULTS

Earlier briquetage from the East Anglian fen edge was made from the same fossil shell-bearing clays as contemporary domestic pottery (Morris 2007). Early Iron Age briquetage from the fenland sites at Thorney (Daniel 2009), Billingborough (Chowne *et al.* 2001), Hogsthorpe (Kirkham 1981), and Tetney (Palmer Brown 1994), was examined but fingerprints were not preserved, possibly due to intentional smoothing of the surfaces by the makers. Only one fingerprint from an earlier assemblage was found. Welland Bank Quarry was a domestic site on the fen edge in Lincolnshire (Dymond *et al.* 2000). While the majority of the site's briquetage is dated to the Late Bronze or Early Iron Age, around 10% came from securely dated Middle Bronze Age contexts. One trough fragment preserved two measurable prints (one shown in Fig. 7) but it is unclear to which phase of the site it belongs. Unusually in the context of this study, this print is consistent with having been made by a subadult under 16 years (0.364 mm MRB).

Fingerprints were more numerous on Middle and Late Iron Age briquetage and were found in assemblages within the Lindsey Marshland of Lincolnshire, the Fenlands, one coastal site in Norfolk, and from the Red Hills of Essex (Fig. 6, Table 3). Overall, 78 fingerprints were found and measured (Table 4). Selected examples are shown in Figure 7. Several supports, principally pedestals, packing pieces, and stabilisers preserved fingerprints, as they were hand squeezed into shape as required and their surfaces not smoothed, unlike the containers (pans and troughs) used to hold brine or salt.

At the two Middle Iron Age Fenland sites, Helpringham (from which a radiocarbon determination of 380–110 cal BC (HAR-2280; 2180±80 BP) was recorded for timber from one of the hearths (Bell *et al.* 1999) and Langtoft (Lane 2001), 14 of the 15 (93%) fingerprints were typical of adult males (n = 9, MRBs over 0.51 mm) or males over 16 years (n = 5, MRBs 0.457 mm and above), and one (at 0.458 mm) was highly consistent with an individual over 13 years (the adolescent/adult group).

During the 2nd century BC there is evidence for an intensification of salt production. Sites were located where local clay was silty and organic temper began to be used to improve thermal shock resistance, principally chaff from wheat, barley, and oats (de Brisay 1978), presumably transported from further inland.

Three Late Iron Age Fenland sites (dated based on briquetage typology and associated pottery) produced 11 fingerprints: Spalding to Eye Road Improvement Scheme (Peachey *et al.* 2011); Spalding Clay Lake site (Casswell 2011); and Willow Tree Fen (Cope-Faulkner 2013). Two fingerprints at 0.473 mm and 0.499 mm MRB were highly consistent with males over 16 years and the other nine all exceeded 0.52 mm, so were typical of adult males.

Ormesby St Margaret was the only site studied from Norfolk and is currently the only known Iron Age



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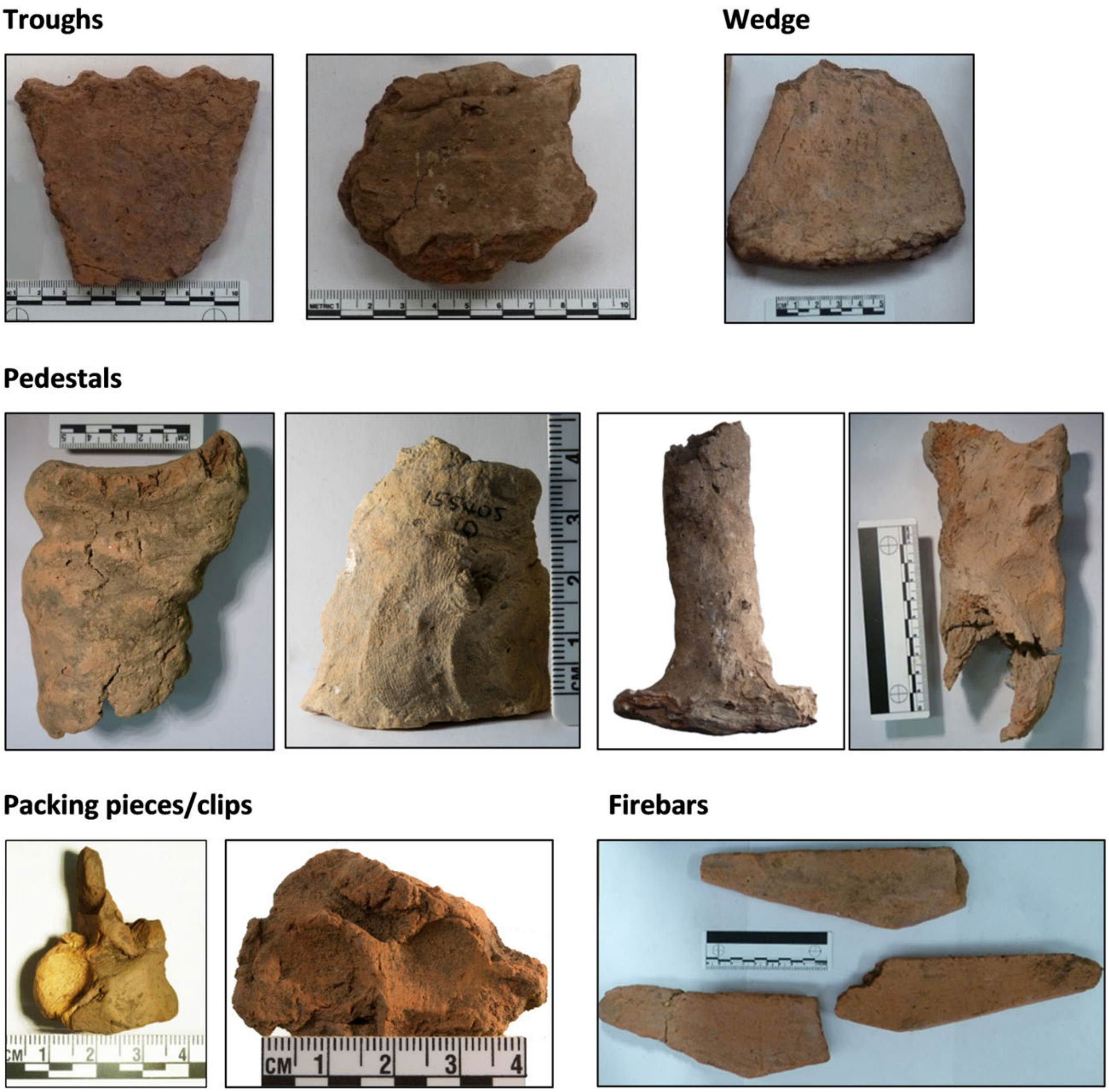


Fig. 5.
Examples of different forms of briquetage

saltern around the Great Estuary (Porter & Anderson 2017). Radiocarbon dates of 170–1 cal BC (SUERC 76905; 2064±24 BP) and 350–40 cal BC (SUERC 75961; 2121±35 BP; dates rounded out to 10 years) place its operation within the Middle–Late Iron Age. Five fingerprints were typical of adult males (n = 3, all exceeding 0.5 mm) or males over 16 years (n = 2, both over 0.48 mm), and one (0.445 mm) highly consistent with having been made by a person over 13 years, of either sex.

Four Late Iron Age saltern sites from the Lindsey Marshland were examined: three from the



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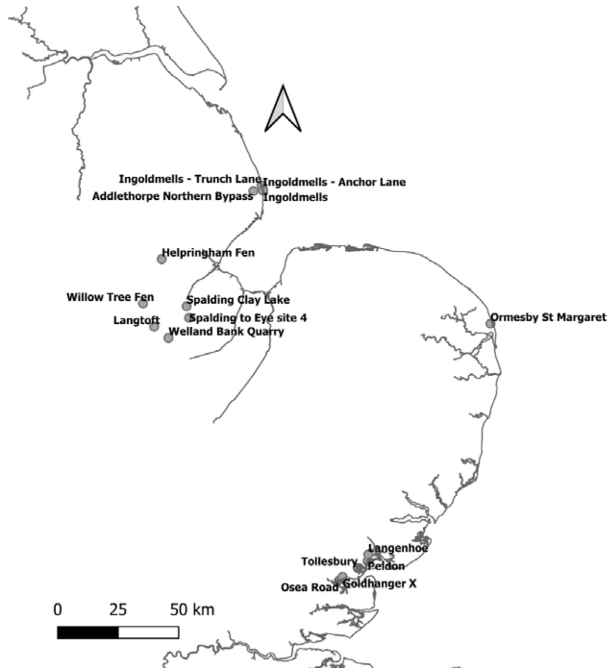


Fig. 6.
Location of briquetage assemblages

Ingoldmells area (unpublished) and one at Addlethorpe Northern Bypass (Cope-Faulkner 2006), which collectively produced 33 fingerprints. Two were highly consistent with having come from individuals over 13 years (0.439 mm and 0.407 mm), two with males over 16 years (0.493 mm and 0.456 mm) and the remaining 29 were typical of adult males (MRBs over 0.51 mm).

Most pedestals bear curved impressions of trough edges as well as impressions of the manufacturer's fingers and thumbs left as they were squeezed into shape. The widths of fingertip impressions can also be measured to assign an age to the person whose fingertips the impressions record (Sharpe & Van Gelder 2006a; 2006b; Laing in press). Figure 8 shows an example of an impression on a pedestal from Trunch Lane, Ingoldmells, whose width indicates it was made by an adult male thumb (Laing 2021), which correlates with the epidermal ridge measurements within the print.

The Late Iron Age Red Hills in Essex did not produce as many fingerprints as the Lincolnshire sites: ten from five sites: Osea Road (de Brisay 1972; 1975); Peldon (de Brisay 1978); Goldhanger X (Reader 1908); Langenhoe III (Rodwell 1979); and Tollesbury (de Brisay 1979). Nonetheless, the picture is similar with seven fingerprints typical of adult males (all over 0.543 mm), one (0.47 mm MRB) highly consistent with a male over 16 years, and two (at 0.43 mm and 0.44 mm MRBs) in the adolescent/adult category.

## DISCUSSION

The similarity of Late Bronze and Early Iron Age briquetage to domestic pottery has been used to suggest earlier briquetage was made by women (Morris 2007), based on Peacock's (1981) 'modes of production' in which he used certain ethnographic examples to show that hand-made open fired pottery for everyday use was made by women, whereas men controlled production when it reached an industrial level. Lane (2017) argues the early salt makers were integrated into a community which included potters as their briquetage was nicely made and well-finished. In contrast, the Late Iron Age saw intensified production with sites located away from settlements and the standard of manufacture declining. Following Peacock (1981), Morris (2007) suggests that men controlled its production. However, Peacock's ideas may be criticised for viewing men as industrial workers and women as unskilled domestic producers. More recent ethnographic studies have shown greater variety among salt producers: at Kibiro in Uganda salt production is an hereditary, female occupation (Connah *et al.* 1990), all community members are involved at Teguidda-n'Tessum in Niger, whereas men are the salt makers in New Guinea (Gouletquer & Weller 2015).

In this study, fingerprints were primarily preserved on pedestals and on pieces of clay used to support the troughs which contained the brine. Trough fragments in the assemblages studied did not generally preserve prints (although there were a few exceptions, namely the Middle Iron Age salterns at Helpringham Fen and Langtoft and the Late Iron sites at Tollesbury and Langenhoe). This could mean troughs were made by potters skilled in surface finishing, either on site or made elsewhere and brought to the salterns for use by the salt workers. Supports were made *in situ* as required by the saltern operators from local clays (Rodwell 1979) and it is these which preserve predominantly late teenage and adult male prints.

Fingerprint evidence cannot tell us about all aspects of the process and it may be that other parts were



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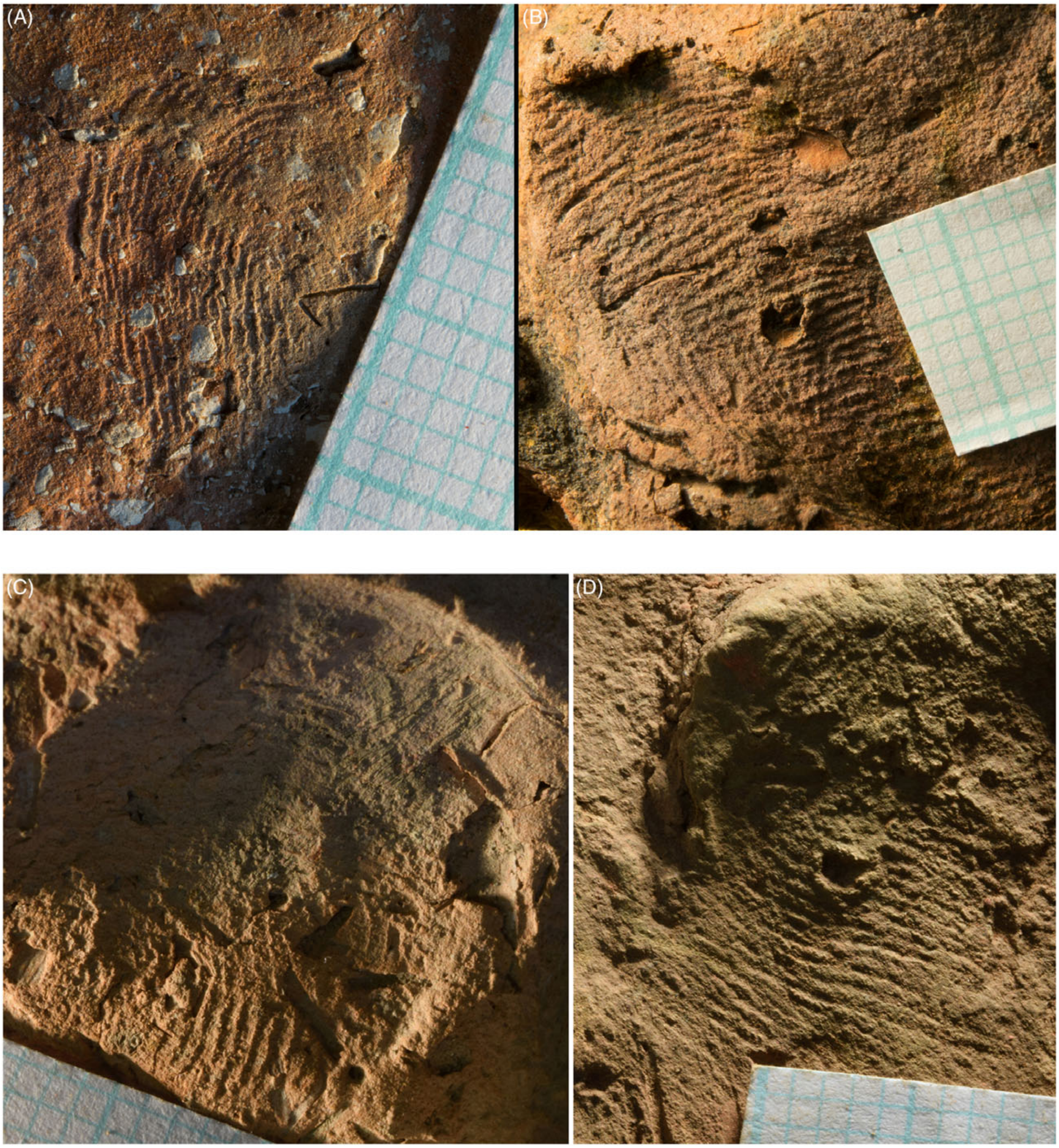


Fig. 7.
Examples of fingerprints on briquetage: A. Spalding to Eye Road Improvement Scheme; B. Trunch Lane, Ingoldmells; C. Welland Bank Quarry; D. Tollesbury Red Hill

TABLE 3. SALTERN SITES STUDIED

| *Site name* | *Date range* | *Description of site* |
|---|---|---|
| *Lincolnshire* | | |
| Helpringham Fen | MIA 370–110 cal BC | Series of hearths on low mounds, with chaff tempered briquetage |
| Spalding to Eye pipeline | LIA | 2 phases of occupation. Briquetage dump & later settling tanks cut though flood deposit |
| Addlethorpe Northern Bypass | LIA | Dumped briquetage deposit |
| Ingoldmells: Anchor Lane | LIA | Not available |
| Ingoldmells: Trunch Lane | LIA | Not available |
| Ingoldmells: Maudson Grant collection | LIA | Not available |
| Langtoft | MIA | Gullies, settling tanks & briquetage |
| Spalding Clay Lake | LIA: *c.* 1st BC–*c.* 1st AD | Ditches & briquetage |
| Welland Bank Quarry | MBA or LBA–EIA | Settlement, enclosures, field system & briquetage |
| Willow Tree Fen | LIA or v. early Roman | Settling tanks, gullies, briquetage |
| *Norfolk* | | |
| Ormesby St Margaret | M-LIA 170–1 cal BC & 200–90 cal BC | Hearth and dumped briquetage |
| *Essex* | | |
| Peldon | LIA: *c.* 1st BC–*c.* 1st AD | Red Hill with evidence of settling tanks, hearth & briquetage |
| Osea Road | M-LIA 200–70 cal BC | Red Hill with evidence of settling tanks, working floors & briquetage |
| Goldhanger X | LIA: *c.* 1st BC–*c.* 1st AD | Red Hill with hearth, flues & briquetage |
| Langenhoe | LIA: *c.* 1st BC–*c.* 1st AD | Red Hill with briquetage |
| Tollesbury | LIA: *c.* 1st BC | Red Hill with hearths & briquetage |

carried out by women and children as well as men. This might include gathering fuel, clay, or sea water – all archaeologically invisible activities. However, the preponderance of male prints on the briquetage pedestals and supports indicates that the on-site ceramic manufacture, boiling, and salt extraction parts of the process were the preserve of men.

Accepting that pedestals and supports for the troughs were made *in situ* at the salterns by those working on the sites (Thomas & Fletcher 2001), it is reasonable to hypothesise that operation of the salt making process (boiling the brine and extracting salt crystals) during the Middle and Late Iron Age was performed by a selective male-dominated community of practice to which membership was limited by age and sex. Younger children were not involved in making equipment for salt extraction and induction into a community of salt makers may have been a rite of passage for young men in the Iron Age. This makes an interesting contrast to the Hallstatt salt mines in which men, women, and children were all involved in salt mining (Pany & Teschler-Nicola 2007; Pany-Kucera *et al.* 2010). It supports the idea that industrial scale salt making, as practised in the Late Iron Age, was the preserve of adult men (Morris 2007) but also indicates that men were the salt makers in the Middle Iron Age too.

Epidermal ridges reach adult dimensions around 15–16 years. If the results consistent with the maker of the print being males of 16 years and above are added to those of adult males then, excluding the earlier print from Welland Bank Quarry as a chronological outlier, the pattern is clear: during the Middle and Late Iron Age the fingerprints found on briquetage are almost exclusively from adult males. Given that there was just one print from the earlier Welland site it is impossible to draw conclusions about the changing make-up of the earlier briquetage producing communities of practice but further examination of assemblages of this date may reveal evidence of other younger hands at work, allowing discussion of the changing composition of salt making communities over time.

In Essex and Lincolnshire the lack of evidence for domestic occupation at saltern sites combined with a consideration of the British climate has led to

TABLE 4. FINGERPRINT MEASUREMENT BY SALTERN

| *Site name* | *Chronological period* | *Artefact* | *Mean MRB for print (rescaled) (mm)* | *Demographic indicators* |
|---|---|---|---|---|
| *Lincolnshire* | | | | |
| Welland Bank Quarry | MBA/LBA–EIA | trough print 1 | 0.364 | individual ≥9 yrs |
| | | trough print 2 | 0.419 | female ≥14 yrs, or male ≥12 yrs |
| Helpringham Fen | MIA | clip/packing | 0.643 | adult male |
| | | seat/support print 1 | 0.459 | male ≥16 yrs |
| | | seat/support print 2 | 0.549 | adult male |
| | | trough rim print 1 | 0.479 | male ≥16 yrs |
| | | trough rim print 2 | 0.652 | adult male |
| | | trough rim print 3 | 0.549 | adult male |
| | | pedestal | 0.495 | male ≥16 yrs |
| | | pedestal | 0.608 | adult male |
| | | pedestal | 0.441 | adult female or male ≥13 yrs |
| | | trough rim | 0.65 | adult male |
| | | trough sherd print 1 | 0.511 | adult male |
| | | trough sherd print 2 | 0.457 | male ≥ 16yrs |
| | | trough rim | 0.514 | adult male |
| Langtoft | MIA | trough rim print 1 | 0.575 | adult male |
| | | trough rim print 2 | 0.462 | male ≥ 16 yrs |
| Spalding Clay Lake | LIA | trough rim | 0.534 | adult male |
| Spalding to Eye site 4 | LIA | pedestal | 0.599 | adult male |
| | | pedestal | 0.499 | male ≥16 yrs |
| | | pedestal | 0.534 | adult male |
| | | pedestal | 0.568 | adult male |
| | | pedestal print 1 | 0.523 | adult male |
| | | pedestal print 2 | 0.554 | adult male |
| | | pedestal print 3 | 0.473 | male ≥16 yrs |
| Willow Tree Fen | LIA-RB | support print 1 | 0.522 | adult male |
| | | support print 2 | 0.54 | adult male |
| | | support print 3 | 0.558 | adult male |
| Ingoldmells: Anchor Lane | LIA | pedestal | 0.611 | adult male |
| | | pedestal | 0.643 | adult male |
| Ingoldmells: Trunch Lane | LIA | pedestal | 0.634 | adult male |
| | | clip | 0.407 | male ≥12yrs, or female ≥14 yrs |
| | | clip | 0.545 | adult male |
| | | pedestal | 0.743 | adult male |
| | | pedestal print 1 | 0.738 | adult male |
| | | pedestal print 2 | 0.708 | adult male |
| | | pedestal print 3 | 0.456 | male >16 yrs |
| | | pedestal print 1 | 0.643 | adult male |
| | | pedestal print 2 | 0.581 | adult male |
| | | pedestal print 1 | 0.623 | adult male |
| | | pedestal print 2 | 0.557 | adult male |
| | | pedestal | 0.673 | adult male |
| | | trough | 0.646 | adult male |

(Continued)



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table 4. (Continued)

| *Site name* | *Chronological period* | *Artefact* | *Mean MRB for print (rescaled) (mm)* | *Demographic indicators* |
|---|---|---|---|---|
| Ingoldmells: Maudson Grant | LIA | pedestal | 0.613 | adult male |
| | | pedestal | 0.773 | adult male |
| | | pedestal print 1 | 0.571 | adult male |
| | | pedestal print 2 | 0.662 | adult male |
| Addlethorpe Northern Bypass | LIA | pedestal | 0.439 | adult female or male ≥13 yrs |
| | | pedestal | 0.586 | adult male |
| | | pedestal | 0.613 | adult male |
| | | pedestal print 1 | 0.512 | adult male |
| | | pedestal print 2 | 0.567 | adult male |
| | | pedestal | 0.575 | adult male |
| | | clip print 1 | 0.536 | adult male |
| | | clip print 2 | 0.577 | adult male |
| | | pedestal print 1 | 0.561 | adult male |
| | | pedestal print 2 | 0.512 | adult male |
| | | clip | 0.578 | adult male |
| | | pedestal | 0.592 | adult male |
| | | pedestal | 0.493 | male ≥16 yrs |
| | | pedestal | 0.554 | adult male |
| *Norfolk* | | | | |
| Ormesby St Margaret | MIA-LIA | pedestal 1 | 0.743 | adult male |
| | | pedestal 2 | 0.487 | male ≥16 yrs |
| | | pedestal 3 print 1 | 0.445 | adult female or male ≥13 yrs |
| | | pedestal 3 print 2 | 0.573 | adult male |
| | | pedestal 3 print 3 | 0.49 | male ≥16 yrs |
| | | pedestal 4 | 0.554 | adult male |
| *Essex* | | | | |
| Osea Road | MIA-LIA | hearth wall | 0.429 | adult female or male ≥13 yrs |
| Peldon | LIA | pedestal | 0.536 | adult male |
| | | pedestal | 0.443 | adult female or male ≥13 yrs |
| | | wedge | 0.47 | male ≥16 yrs |
| Goldhanger X | LIA | pedestal print 1 | 0.546 | adult male |
| | | pedestal print 2 | 0.568 | adult male |
| Tollesbury | LIA | trough fragment | 0.555 | adult male |
| Langenhoe III | LIA | trough fragment print 1 | 0.598 | adult male |
| | | trough fragment print 2 | 0.647 | adult male |
| | | trough fragment print 3 | 0.712 | adult male |



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Fig. 8.
Thumb impression on pedestal from Ingoldmells

suggestions that salt making was a seasonal activity, taking place in late summer after the harvest (de Brisay 1978; Morris 2007; Biddulph 2012). The addition of chaff, a by-product of cereal harvesting, as a tempering agent in later briquetage supports this (Percival 2011). The lack of occupation debris may be functional, reflecting the difficulty of year-round occupation of exposed sites in the saltmarsh away from fresh water supplies, or may reflect social controls on times and individuals permitted access to the sites. Given the assumed value of salt to Iron Age communities, and possible social controls over the operation of the extraction process, the apparent lack of any enclosing or defensive structures around salterns is interesting (Kinory 2012).

Communities of salt workers may have been viewed as especially skilled or socially distinct people, creating a valuable new material from water at liminal locations. If, as the results of this study suggest, salt working at coastal locations was carried out by groups of teenage and adult males, this raises further questions around the status of these relatively transient communities of practice.

## CONCLUSIONS

During the Middle and Late Iron Age in eastern England salt extraction was carried out at the end of the summer in coastal marshes lacking permanent habitation. A picture emerges of a gendered and age-specific activity in which the participants were temporarily separated from their communities, perhaps with younger adolescents being inducted into the practices of salt extraction once they had reached a culturally accepted level of maturity. The inclusion of adolescent males within the salt making communities of practice suggests biological adolescents may have been culturally viewed as adults at this period.

The technique of interpreting age and possibly sex of a maker of a fingerprint by measuring the breadth of the epidermal ridges has wider application within archaeology. Modern reference data reflecting as far as possible the geographical locale of those whose fingerprints are being studied is important, as is allowing for height differences between modern and ancient people, given the correlation between height and MRB. Provided the modern reference collection data is adjusted to reflect height differences in the period under study, there is great potential to shed light on demography among communities of practice engaged in ceramic manufacture.

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## RÉSUMÉ

*Qui a fabriqué l'or blanc ? Exploration de la démographie de la production de sel à l'âge du Fer en Angleterre par l'analyse des empreintes digitales*, par Meredith Laing

Les anciennes empreintes digitales conservées dans les objets en argile peuvent fournir des informations démographiques sur les personnes qui les ont manipulés et fabriqués, laissant leurs marques comme un enregistrement accidentel d'un moment d'interaction avec la culture matérielle. Les informations extraites de ces anciennes empreintes peuvent éclairer la composition des communautés de pratique engagées dans la fabrication de poteries. Un élément clé de ce processus est un ensemble de données de comparaison d'empreintes digitales reflétant aussi fidèlement que possible la population étudiée. Cet article décrit la création d'une collection de référence sur mesure de données modernes, l'établissement d'un cadre interprétatif pour les empreintes digitales préhistoriques, et son application à des assemblages de briquetage de l'âge du Fer provenant de salines littorales de l'Est de l'Angleterre. Les résultats démontrent que la fabrication de briquetages était contrainte par l'âge et le sexe.

## ZUSAMMENFASSUNG

*Wer machte das Weiße Gold? Untersuchungen zur Demographie der eisenzeitlichen Salzherstellung in England durch die Analyse von Fingerabdrücken*, von Meredith Laing

Antike Fingerabdrücke, die in Artefakten aus Ton erhalten sind, können demografische Informationen über die Menschen liefern, die diese Gegenstände bearbeitet und hergestellt haben und dabei ihre Abdrücke als zufällige Aufzeichnung eines Moments der Interaktion mit der materiellen Kultur hinterlassen haben. Die aus diesen alten Abdrücken gewonnenen Informationen können Aufschluss über die Zusammensetzung von Gemeinschaften geben, die mit der Herstellung von Töpferwaren beschäftigt waren. Eine Schlüsselkomponente des Prozesses ist ein Vergleichsdatensatz von Fingerabdrücken, der die untersuchte Population so genau wie möglich widerspiegelt. Dieser Beitrag beschreibt die Erstellung einer maßgeschneiderten Referenzsammlung moderner Daten, die Entwicklung eines Interpretationsrahmens für prähistorische Fingerabdrücke und deren Anwendung auf eisenzeitliche Briquetagen aus Küstensalinen in Ostengland. Die Ergebnisse zeigen, dass die Herstellung von Briquetagen abhängig war von Alter und Geschlecht.

## RESUMEN

*¿Quién elaboró el oro blanco? Explorando las demografías de la producción de la sal durante la Edad del Hierro en Inglaterra a través del análisis de huellas dactilares*, por Meredith Laing

Las huellas dactilares preservadas en los artefactos de arcilla pueden aportar información demográfica sobre la gente que las elaboró y llevó a cabo su manufactura, dejando sus marcas como un registro accidental de un momento concreto de interacción con la cultura material. La información extraída de estas impresiones antiguas puede aportar luz sobre la composición de estas comunidades y las prácticas involucradas en la manufactura cerámica. Un componente crucial del proceso de elaboración de una base de datos de huellas dactilares que reflejan de forma lo más cercana posible la población analizada. Este artículo describe la creación de una colección a medida de datos recientes, el establecimiento de un marco interpretativo de las huellas dactilares prehistóricas y su aplicación a los conjuntos de la Edad del Hierro de las salinas costeras del este de Inglaterra. Los resultados demuestran que la manufactura de estos productos cerámicos estaba constreñida por edad y sexo.



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