AGE, TAPHONOMIC HISTORY AND MODE OF DEPOSITION OF HUMAN SKULLS IN THE RIVER THAMES

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SUMMARY

A collection of human skulls from the river Thames has been examined in order to establish age, taphonomic history and mode of deposition. In particular the idea of ritual deposition of skulls in rivers and other wet places during the Bronze Age and Iron Age in Britain is considered. Assessment of cranial surface condition and relative intactness revealed a range of damage from minimal to severe. 50% of skulls were in relatively good condition, implying rapid submersion of fleshed heads or defleshed skulls in river silts in slow moving water or adjacent marsh/bog. The remainder showed varying loss of fragile and robust components, compatible with collisions during fluvial transport. The occurrence of occasional skulls with mandibles and isolated mandibles indicates that at least 10% entered the water as complete bodies or heads and were most likely the result of accident, murder, suicide or riverside burial. The paucity of mandibles and absence of postcranial bones is an argument for selective placement of isolated skulls; however, modern forensic studies have shown that heads and skulls are often rapidly separated from the remainder of the torso in fluvial conditions. Thus there is no definitive taphonomic evidence to distinguish selective deposition from cases in which whole skeletons or corpses entered the water.

Estimation of cranial indices for skulls from the Thames, and its tributary the Walbrook, showed that both groups exhibited a mix of phenotypes but the make-up of each group differed. The Thames skulls tended to show head shapes associated with Bronze Age and later medieval populations, while the Walbrook skulls inclined more to shapes that have been associated with Iron Age and Romano-British populations. Radiocarbon dating of six Thames skulls revealed specimens dating across a 3,500 year span, from Neolithic to medieval, and brought the total number of dated Thames skulls to thirteen. More than half of these are from the Bronze Age and most were recovered within a very short river distance, between Kew and Mortlake. This could reflect settlement patterns, but other factors, including sampling by dredging, local topography, dynamics of river flow and burial patterns, are likely to have affected the distribution. It is of interest that recent excavations have revealed that erosion of riverside burials dating from the Bronze Age to the Romano-British period may be a significant source of river skulls.

INTRODUCTION

Human skulls from riverine deposits in Britain pose archaeological puzzles about cultural significance and processes of deposition. Various authors have proposed that a significant proportion of river skulls originate from ritual, funerary activities (Bradley & Gordon 1988; Marsh & West 1981), while others favour more pragmatic explanations encompassing, for example, murder, suicide and accidental drowning (Knüsel & Carr 1995; Turner *et al* 2002). The former hypothesis is supported by the evidence for ritual deposition of metalwork and human remains in watery places, a practice that endured from the Bronze Age to the Late Iron Age in Britain (Bell *et al* 2000; Bradley & Gordon 1988; Brett 1996; O'Sullivan 1997; Wells *et al* 2001; Holder 2002), whereas the latter is reinforced by data from forensic taphonomy on the post-mortem fate of human remains in rivers and wetlands (Haglund & Sorg 1997; Boaz & Behrensmeyer 1976; Brooks & Brooks 1997).

Two studies that looked at skulls from the Thames and its Walbrook tributary have made significant contributions to these ideas. Bradley and Gordon (1988) considered *c*.300 skulls from the Thames which had been collected during 19th-century river dredging and were stored in museums. In this study, craniometric data led to the conclusion that half of the skulls shared characteristics with Bronze Age and Iron Age populations. This was supported by radiocarbon dating which showed that four of six skulls that were dated derived from the Bronze Age. In view of the large quantities of Bronze Age metalwork recovered from similar locations along the river, the authors proposed that skulls of this period were deposited as part of a 'rite of passage' for the dead.

Marsh and West's study (1981) focused on 48 skulls from the Walbrook, again recovered by workmen during the 19th and early 20th centuries, during excavations for buildings or sewers. In this instance craniometric data indicated a Romano-British and Iron Age origin. This provenance was supported by radiocarbon dates for three skulls (Bradley & Gordon 1988) and for preserved timber found in close proximity to other skulls (Marsh & West 1981) and the authors concluded that the Walbrook skulls may have been selectively deposited.

This present study includes 18 Thames skulls and 33 Walbrook skulls from the Museum of London (MOL) collection and aims to examine more closely ideas about where and how skulls entered the river. The revisiting of this topic seems timely in view of new evidence emerging from riverside excavations which is fuelling the debate about ritual deposition during the Bronze Age and up to the Romano-British period.

MATERIALS AND METHODS

Each skull was inspected for completeness, pathology, antemortem injuries and epigenetic/morphometric variations. Taphonomic changes, surface polishing and abrasion, colour, weathering, bone loss and other post-mortem damage were recorded. Estimates of age were based on tooth wear (Brothwell 1981).

Determination of sex was based on examination of features which show sexually dimorphic characteristics, *eg* supra-orbital ridge; mastoid process; nuchal crest; upper orbit margin (Buikstra & Ubelaker 1994; Meindl *et al* 1985; Molleson & Cox 1993; Murail 1999). Combined scoring for each feature led to categorization of each specimen as female, possible female, male or possible male. The category of 'indeterminate' was applied in those cases with less than two preserved sex-matched landmarks. In the text which follows male and possible male are combined and similarly female and possible female.

Standardised measurements were made to define the cranial morphology (Buikstra & Ubelaker 1994; Bass 2005) and following the Museum of London (MOL) Oracle database guidelines. The completeness of the record depended on how well landmarks had survived (Brothwell 1981; Brothwell & Krzanowski 1974).

All data were added to the MOL Oracle database and are available at http://www.museumoflondon.org.uk/English/Collections/OnlineResources/CHB/Resources/, under the data entry prefix GEN 01. Only those data relevant to the topic of this paper are considered here.

Bone samples from six skulls were submitted to the Oxford Radiocarbon Accelerator Unit, Oxford University, for accelerator mass spectrometry (AMS) radiocarbon dating (Masters 1987; Tuross *et al* 1988). Samples were prepared and measured using methods outlined in Bronk Ramsey *et al* (2004). Radiocarbon ages are quoted in accordance with the Trondheim Convention (Stuiver & Kra 1986; Stuiver & Polach 1977). Calibrations relating the radiocarbon measurements directly to the calendrical time scale were calculated using datasets published by Reimer *et al* (2004) and the OxCal (v3.10) program (Bronk Ramsey 1995; 1998; 2001). Ranges were calculated according to the maximum intercept method (Stuiver & Reimer 1986) and quoted at 95% confidence in the form recommended by Mook (1986), with the end points rounded outwards to 10 years.

RESULTS

Location of skulls

Eighteen Thames skulls were examined in detail. The collection was seen as likely to include skulls which entered the water by various routes and at intervals over many centuries. Sixteen skulls were retrieved from the bed of the Thames between Syon and Chelsea, a stretch of approximately 23km (Fig 1), with eight of these coming from Mortlake. Two skulls were retrieved during foreshore surveys at low tide. The first of these (MOL L344) was found by the authors (AW and YE) at Cheyne Walk Moorings (TQ 2725 7760), Chelsea (site code: FKN01) in 2001 and comprised only the frontal bone; this specimen was remarkable for a large trepanation on the left side. It lay partly embedded in a submerged Neolithic forest peat bed, in which oak leaves, acorns and animal faunal remains of a variety of species could be seen. A matching fragment of left temporal bone was retrieved from excavations of an area around the skull but there was no trace of a mandible or other elements. The other foreshore skull (MOL 2004.97) was found by an amateur enthusiast on the Surrey foreshore at Putney (TQ 2430 7562) in 2003. The attention of MOL was drawn to this find and the skull excavated. It was partly submerged in black-grey silty sand and comprised a skull vault, with frontal, parietal and occipital bones and a small fragment of left temporal bone (Cotton & Green 2004, 136). Apart from these two specimens the majority were collected by dredging and their apparent locations are given as the stretch of river being dredged, rather than a precise point. This included two skulls from further downstream in the Hay's Wharf area.

For comparative purposes 33 skulls from the course of the river Walbrook, were included in the present study; of these 24 were part of the Marsh and West (1981) study but it was decided to reassess the specimens since individual cranial measurements were not published. MOL records showed that the skulls were recovered from locations along the relic course of the Walbrook during various construction works, with more than half from two sites, Bank of England and the London Wall Estate Office at Finsbury Circus.

Condition of the skulls

Most of the Thames skulls were mid- to

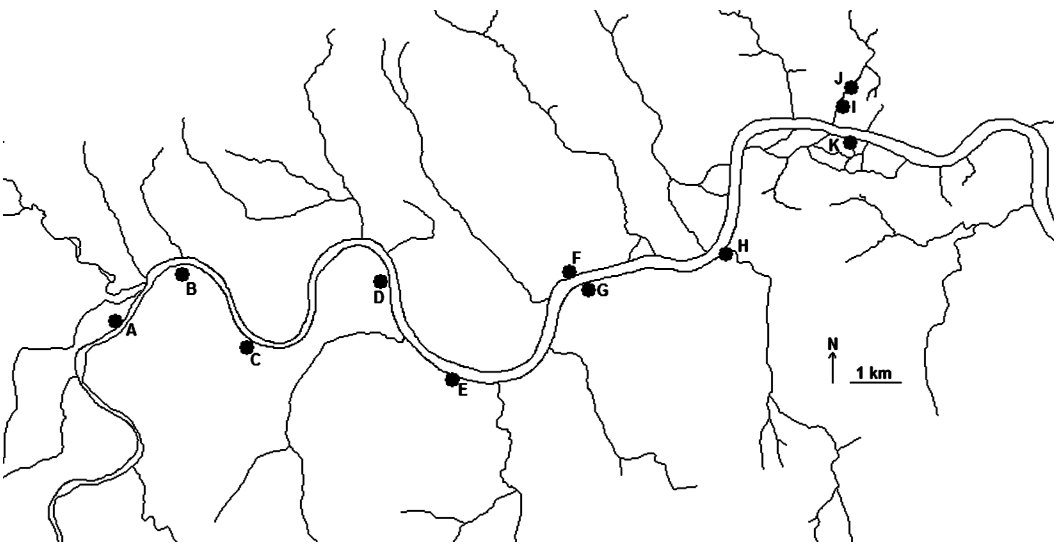

Fig 1. Map of locations along the Thames and Walbrook mentioned in the text.
A: Syon; B: Kew; C: Mortlake; D: Barn Elms; E: Putney; F: Chelsea; G: Battersea; H: Vauxhall; I: Bank of England: J: Finsbury Circus; K: Hays Wharf

Fig 2. Six skulls from the river Thames selected for radiocarbon dating and displaying variable levels of preservation. A. Frontal view; B. Basal view (Further information is given in Table 3 using the MOL GEN-01 numbering as follows: 1. GEN-01-43; 2. GEN-01-52; 3. GEN-01-29; 4. GEN-01-31; 5. GEN-01-51; 6. GEN-01-27)

dark brown in colour (78%) and in some cases the surface was polished and bony edges worn smooth. These features reflect their taphonomic history of exposure to moving water charged with fine silty deposits (Brooks & Brooks 1997). Seventeen skulls represented adults or young adults, while the other was that of a child about five years of age, recovered from Hays Wharf. This latter was accompanied by a mandible and some postcranial material. Eight (47%) of the adult skulls were reasonably complete but only one of them included a mandible and only five had both zygomatic arches intact. Loss of incisors and premolars amongst this sub-set was extensive. Seven of the adult skulls exhibited more severe damage with loss of fragile facial bone and maxillae and in the case of the two foreshore specimens one was reduced to frontal only, while the other comprised simply the skull vault and a temporal bone. Fig 2 shows some examples of Thames skulls in different states of preservation. The variable preservation of frontal and facial elements is displayed in Fig 2A, while the basal view, Fig 2B, demonstrates the variable preservation of maxilla, occipital region and other basilar structures.

The condition of the Walbrook skulls was very similar to the Thames group, with only three specimens showing significant weathering or scratch marks. Three included a mandible and twelve retained both zygomatic arches but about 60% of them lacked the facial region and maxillae. These data align with the descriptions provided by Marsh and West (1981) and West (1996) for their Walbrook material. None of the skulls showed signs of premortem injuries which could have been fatal and/or accounted for their being in the river, although several showed evidence of healed trauma.

The loss of facial and lateral structures and of single rooted teeth seen amongst these specimens is likely to be the result of rolling and erosion in river-bed deposits (Nawrocki *et al* 1997), but very few showed evidence of the severe pitting and cracking associated with continuous bumping along in a fast flowing river. Only two of the Thames skulls and three from the Walbrook had pitted, scratched or eroded surfaces. One skull from Mortlake showed a pattern of weathering indicative of period(s) of exposure on dry land. The relatively good condition of almost half of the Thames and Walbrook skulls, with retention of facial bones, maxilla and palate, would be consistent with rapid submersion in organic deposits/silts in a slow moving area of the river or adjacent fen bog.

Knüsel and Carr (1995), who reassessed more than half of the specimens previously examined by Bradley and Gordon, reported that 'many of the crania' had lost their facial region and showed evidence of erosion. As part of the present study the six skulls selected by Bradley and Gordon for radiocarbon dating and stored at the Natural History Museum were re-examined; all lacked a mandible but three retained facial structures and were in good condition. Several specimens showed post-mortem loss of teeth, two had minor surface pitting, and one showed post-mortem cracks in the area behind the mastoid.

Sex distribution

Amongst the Thames group eight males (including possible males) and four females (including possible females) were identified while sex was not assigned to skulls from two adults, three young adults and a child.

The Walbrook skulls included ten males (including possible males), twelve females (including possible females), and one juvenile, together with three young adults and seven adults where the average score did not firmly distinguish one sex from the other. This estimation of sex distribution (46% males) is not the same as that from the Marsh and West (1981) study which indicated a striking preponderance of males (80%). However, our study included skulls not examined by Marsh and West while theirs included skulls from the Pitt Rivers Museum (Oxford) and Natural History Museum collections, not examined by us. In addition Marsh and West (1981) followed a scoring system widely used in the 1970s and 1980s in which all adult (including most young adult) specimens were assigned a sex. Skull fragments with only a single feature were also assigned a sex. In contrast we followed the MOL database guidelines, where averaging scores for several features could result in an indeterminate score (see Materials and Methods), and specimens with only a single scorable feature were also classed as indeterminate.

Morphometric analysis

A wide range of cranial and facial measurements was recorded for the Thames and Walbrook skulls. However the relatively small sample sizes, together with the loss of landmark features, prevented the use of multivariate analysis to compare these two populations with each other and published data. Instead we used the maximum cranial length and breadth measurements obtained to estimate cranial indices (CI) and, in a smaller number of cases, upper facial height and bizygomatic breadth to estimate facial indices (Bass 2005). The use of cranial/facial indices as indicators of population affinity has been thoroughly investigated and discussed by Brodie (1994). In a study where this approach was compared with more complex multivariate analyses, Brodie concluded that cranial indices embody a large amount of information and are useful in the discrimination of ancient populations.

The data indicate that each set of skulls comprises a different mixture of skull shapes with some overlap (Bass 2005). Despite the overlap, there is a clear difference, with the Thames group (n=16) having high numbers with average head shape (mesocrany) but tending to round head shape (brachycrany) (mean CI 79.5 +/- 3.8; range 74.6–85.6mm), while amongst the Walbrook specimens (n=28) higher numbers trend towards a long head shape (dolichocrany) with some mesocrany (mean CI 75.6 +/-3.4; range 69.5–84.4mm) (Table 1; Fig 3). The differences between the means was assessed using a *t* test (tails 2) and the associated probability was p = <0.002, indicating that the samples are not likely to have derived from the same population. Upper facial indices were also determined for a smaller number of specimens (Thames n=5; Walbrook n=12) and this also shows a significant (p = 0.004) difference between the two groups, with the Thames group tending towards medium face shape (meseny, *ie* between broad and narrow; Bass 2005) and the Walbrook group to narrow faces (Fig 4).

The mean cranial indices were compared with those estimated for prehistoric and

Table 1. Cranial indices of human skulls from the Thames and Walbrook compared with published data (British Neolithic skulls are dolichocephalic ('long'), Bronze Age skulls are variable but tend to brachycephaly ('round'), skulls from Iron Age, Romano-British and Saxon sites are of intermediates phenotype, while in the later medieval period there is trend towards brachycephaly)

Location	Period		All skulls mean cranial index (n)	Reference
London Thames	unknown		79.5 +/- 3.8 (16)	present study
London Walbrook	unknown		75.6 +/- 3.4 (28)	present study
Location	**Period**	**mean cranial index (n)** **Females**	**Males**	**Reference**
Britain	Neolithic	71.3 +/- 3.7 (28)	70.1 +/- 3.2 (53)	Brodie 1994
North France	4950BC-3400BC	-	73.4 +/- 3.8	Riquet 1973
Orkney	Late Neolithic	-	73.4 (11)	Hedges 1983
Britain	Bronze Age	78.8 +/- 4.2 (48)	78.1 +/- 5.3 (109)	Brodie 1994
Britain	Bronze Age	-	78.1 (1)	Wells *et al* 2001
North France	3400BC-1750BC	-	77.8 +/- 5.2	Riquet 1973
Denmark	2600BC-1800BC	-	77.2 +/- 3.8	Jorgensen 1973
Britain	Iron Age	-	73.5 +/- 3.8	Brodie 1994*
Britain	Romano-British	-	73.6 +/- 8.4	Brodie 1994*
Britain	Saxon	-	74.5 +/- 3.2	Brodie 1994*
Britain	950-1600AD	-	77.1 +/- 4.3	Brodie 1994*
London	1600-1700AD	-	74.3 +/- 3.3	Brodie 1994*

* Data from various authors summarised in Brodie 1994.

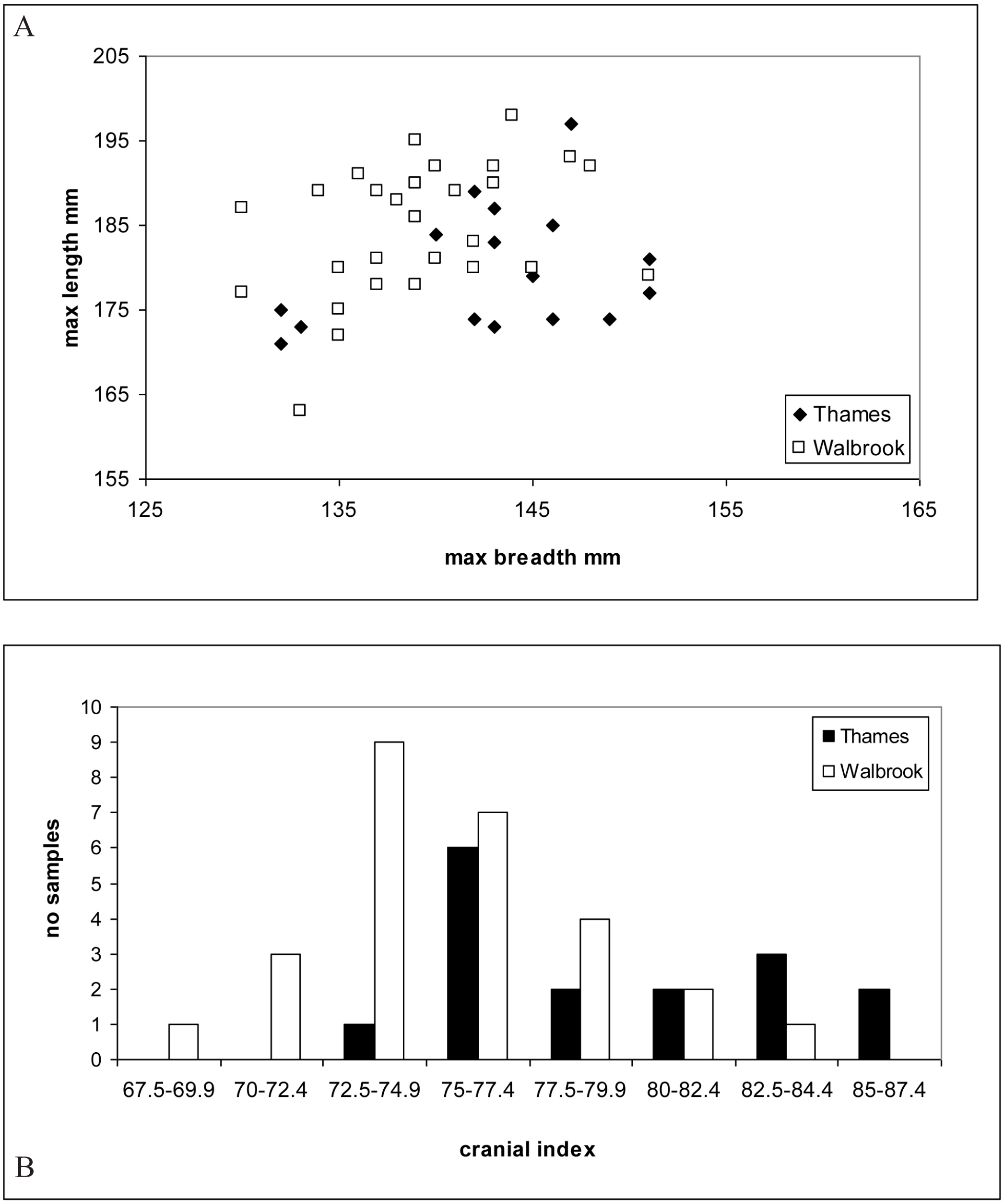

Fig 3. Craniometric data for skulls from the Thames and Walbrook. A. Bivariate plot of maximum length versus maximum breadth (mm); B. Distributions of estimates of cranial index (CI = maximum breadth x 100/ maximum length)

historic European populations, see Table 1. Overall the mensural data suggest that the Thames group could include a significant proportion of Bronze Age and/or late medieval specimens. It is relevant to note that estimations for cranial indices for the six Thames skulls from the study by Bradley and Gordon (1998) (Table 2) are similarly

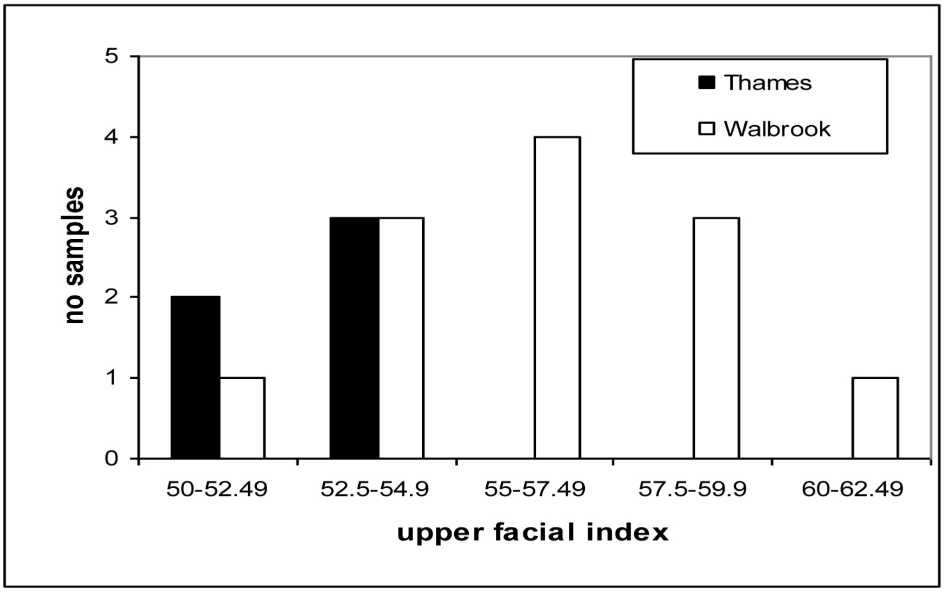

Fig 4. Facial metric data for skulls from the Thames and Walbrook examined in the present study (Upper facial index = nasion to alveolare x 100/ zygomatic to zygomatic (Bass 2005))

Table 2. Cranial and upper facial indices for six Thames skulls from the Natural History Museum (Radiocarbon dates are from Bradley & Gordon (1988) with recalibration (see caption Table 4))

OxA no	BMNH no	Location	sex	age	cranial index	upper facial index	14C age (BP)	Calibrated date (95% C)
1191	62.2.21.8	Battersea	probable M	adult	73.8	46.7	1320± 60	cal AD 610-860
1195	4.7172	Mortlake	probable M	35+yrs	76.2	~	2740 ± 60	1020-790 cal BC
1196	1957.1.8.3	Mortlake	probable F	adult	73.5	~	2750 ± 80	1120-790 cal BC
1199	4.7191	Battersea	probable F	25+yrs	71.2	~	4880 ± 80	3910-3510 cal BC
1198	4.7196	Battersea to Vauxhall	M	adult	69.5	56.1	2950 ± 60	1390-990 cal BC
1197	1893.4.19.9	Kew	probable M	17-25yr	76.9	46.7	2910 ± 60	1310-920 cal BC

mixed, such that the Bronze Age specimens comprised two 'average' head shapes and two 'long-headed', while the Neolithic and Anglo-Saxon skulls had low cranial indices commensurate with 'long heads'.

The mensural data for the Walbrook skulls are in line with previous studies which proposed that a significant proportion probably derive from a Romano-British/ Iron Age population (Marsh & West 1981; Bradley & Gordon 1988). This view fits well with finds made during excavation which show that from the 1st century AD onwards the marshland of the Walbrook Valley was transformed into a Romano-British industrial settlement. During this period of occupation, many artefacts and skulls found their way into the river (Maloney & de Moulins 1990; Merrifield 1995; Seeley & Drummond-Murray 2006; Powers *et al* in prep).

Age of the Thames skulls

Six Thames skulls were selected for radiocarbon dating (see Table 3; Fig 2). The selection provided examples of skulls showing

Table 3. Mensural data and other details for six Thames skulls selected for radiocarbon dating; data for the Chelsea foreshore specimen L344 are also given (ind = indeterminate; M = male; F = female)

Catalogue no.	MOL GEN01-	Location	Sex	Age	Cranial index	Upper facial index
A20001	43	Barn Elms	ind	18-25 yrs	85.6	50.1
A13603	52	Syon Reach	probable M	adult	83.9	~
A13601	31	Kew	ind	18-25 yrs	75.1	61.7
A2004.97	51	Putney foreshore	M	adult	74.7	~
A13495	27	Mortlake	probable M	adult	85.3	~
A13496	29	Mortlake	F	18-25 yrs	75.4	53.6
L344	59	Chelsea foreshore	M	adult	~	~

Notes

GEN01-43	purchase pre-1918 with label 'Bronze Age'; found with mandible
GEN01-52	purchase pre-1918 with label 'associated with pile dwelling': healed trauma to parietals
GEN01-31	healed fracture and cuts to left parietal
GEN01-51	healed circular trauma to frontal
GEN01-27	purchase pre-1914 with label 'prehistoric'
GEN01-29	purchase pre-1914 with label 'prehistoric'
GEN01-59	partly healed possible trepanation hole in left frontal

a variety of preservation and morphological characteristics. Two comprised only calottes (joined frontal, parietals and occipitals). The other four were relatively complete and of these one was found with its mandible. Radiocarbon determinations are summarised in Table 4. One of the calottes (GEN-01-52) dated to the Late Neolithic, two skulls (GEN-01-27 and -29) to the Bronze Age, and another (GEN-01-51) to the Late Iron Age. Two skulls (GEN-01-31 and -43), of which one was found with its mandible, dated to the medieval period. δ^{13}C and δ^{15}N values were also determined (Fig 5) and are of interest since they indicate that the marine component in the diet of these specimens was very small across the entire date range (Schoeninger *et al* 1983).

Two dates, both placing the skull recovered from the Chelsea foreshore (MOL L344) in the Bronze Age (1750–1520 cal BC and 1880–1610 cal BC) were obtained in 2001 (Haughey & Hamilton 2003). The submerged forest peat bed which lay immediately below the

Table 4. Radiocarbon dates and C:N isotope ratios for six skulls from the river Thames. Two dates obtained for the Chelsea foreshore specimen L344 are also given
(Calibration has been undertaken using the calibration curve of Reimer et al 2004 and the computer program OxCal v.3.10 (Bronk Ramsey 1995; 2001). Calibrated date ranges have been calculated using the maximum intercept method (Stuiver & Reimer 1986) and are quoted in the form recommended by Mook (1986))

OxA no.	MOL db GEN01-	Location	C:N Ratio	δ 13C (‰)	δ 15N (‰)	14C age (BP)	Calibrated date (95% C)
14727	43	Barn Elms	3.2	-18.9	12.3	768 ± 27	cal AD 1210-1290
14728	52	Syon Reach	3.3	-21.2	10.8	3819 ± 33	2440-2140 cal BC
14729	31	Kew	3.3	-19	10.9	1070 ± 29	cal AD 890-1030
14730	51	Putney foreshore	3.3	-20.5	11.9	2232 ± 29	390-200 cal BC
14731	27	Mortlake	3.3	-21	10.8	3485 ± 33	1900-1690 cal BC
14765	29	Mortlake	3.2	-20.6	10.5	2904 ± 33	1260-990 cal BC
3373	59	Chelsea foreshore	~	-20.4	11.3	~	1750-1520 cal BC
3412	59	Chelsea foreshore	~	-20.3	11.5	~	1880-1610 cal BC

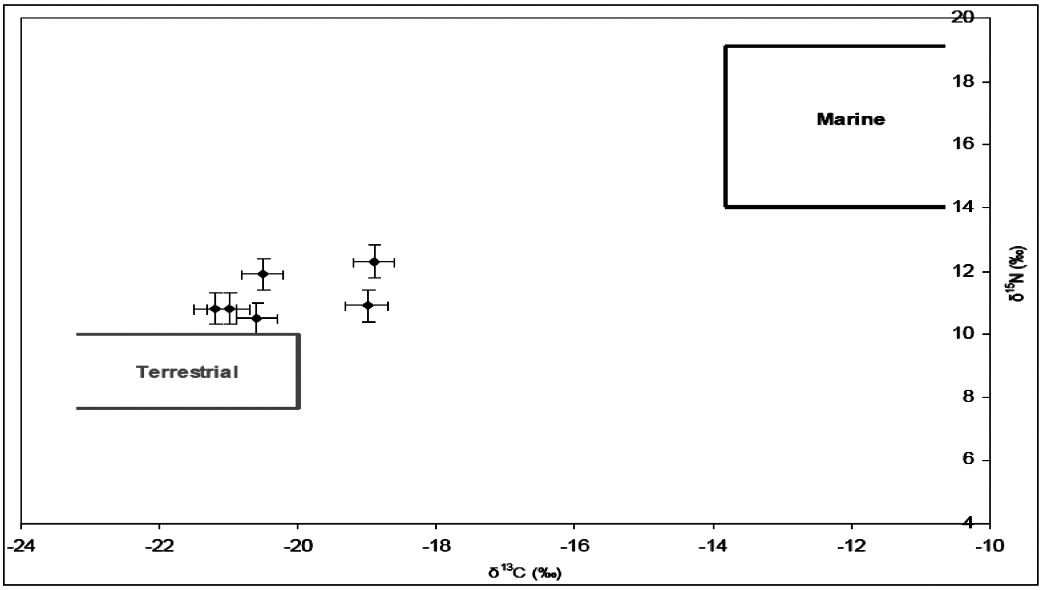

Fig 5. Estimated protein foods contribution to stable isotope values in bone. Isotope values in these human bone samples suggest that diet contained predominantly terrestrial sources of protein. Boxes are based on known ranges for protein sources (Mays 1998)

skull was subsequently dated to the Neolithic (3940–3370 cal BC; Cohen 2006). This would be consistent with the erosion of younger organic deposits originally lying above the present layer of peat with concurrent sinking of the skull.

As noted in the previous section the only other dates available for Thames skulls are those obtained by Bradley and Gordon (1988; Table 2) for six skulls that formed part of the BMNH collection. Four of these date to the Middle and Late Bronze Age, of which two were recovered from Mortlake, one from Kew, and the fourth from further downstream between Vauxhall and Battersea Bridge. Two other skulls, dating to the Neolithic and Anglo-Saxon periods respectively, were from Battersea.

If all the dating evidence for Thames skulls is considered together, then of the thirteen now dated, two date to the Neolithic, seven to the Bronze Age, one to the Iron Age, one to the Anglo-Saxon period, and two are later medieval. It is worth noting that a cluster of Bronze Age skulls has been recovered from the Mortlake to Kew stretch of the river, although this may simply reflect the relative intensity of dredging operations.

DISCUSSION

There are two contentious areas concerning skulls found in rivers — how the skulls came to be in the water and whether their deposition was associated with ritual activity.

Traumatic death

It seems likely that accidents, suicides and murders could account for a significant number of river skulls, particularly given the time span over which such material was deposited. However, disparities in the recovery of body parts, resulting in large numbers of skulls and only a few postcranial bones, has confused the interpretation and led to the idea that skulls are most often selectively deposited (Marsh & West 1981; Bradley & Gordon 1988; Bell & Neumann 1997; Turner *et al* 2002). Nevertheless, the discrepancy in body part recovery has been partly explained by forensic taphonomy studies using experimental models and animal remains (for summary, see Nawrocki *et al* 1997). These show that when whole corpses are placed in moving water, the heads readily separate. Heads complete with tissues are heavy and likely to sink into river-bed deposits or get rolled along the bottom. However the morphology of defleshed crania also predisposes them to float and make rapid progress through the water. In either case forensic studies indicate separation from postcranial bones and mandible (Nawrocki *et al* 1997; Haglund 1993).

Nawrocki *et al* (1997) described four modern cases judged to be accident/suicide or murder where isolated skulls were found in riverine contexts, three on river sand-bars and one in a drainage pond, and no other bones were found. However, these observations do not reflect the whole picture since instances of accident/suicide or murder in fluvial contexts have been reported where crania are found quite close to the other body parts (Boaz & Behrensmeyer 1976; Brooks & Brooks 1997; Haglund & Sorg 1997; Nawrocki *et al* 1997).

Apart from bodies entering the water, it is important to include the possibility that skulls in rivers may also derive from burials. Skeletons eroded from river banks are susceptible to fluvial sorting and are rapidly dispersed, dependent on the weight and shape of various elements. Crania tend to sink and may be rapidly buried, although some crania which remain intact may contain gas bubbles and float or roll along the river bottom (Boaz & Behrensmeyer 1976).

Another factor that might explain the preponderance of skull discoveries in rivers is that most are easily recognised whereas mandibles, torso and long bones are much less obvious and less recognisable as human (Bradley & Gordon 1988; Knüsel & Carr 1995). This is another very plausible argument but does it explain certain river sites where excavation rather than dredging has recovered a preponderance of skulls? One such example is the cluster of 23 isolated human skulls recovered, along with many red deer skulls, aurochsen and equid crania, from the river Ribble during the construction of Preston Docks in the 1880s (Turner *et al* 2002). The variation in damage and spread of radiocarbon dates (4,500 years) amongst the human crania indicate that they entered the water at different places and times, and probably for a variety of reasons. Original lists of items recovered include a single human mandible and a few ungulate postcranial bones but no mention of human postcrania (Turner *et al* 2002). The recovery of only non-human postcranial bones could argue against bias on the part of the collectors. However, the relative size and gracility of human postcranial bones compared with those from large ungulates may, nonetheless, have resulted in biased recovery.

If a significant proportion of the skulls found in rivers represents whole bodies or skeletons entering the water, then it might be expected that at least some mandibles and postcranial bones would be recovered and identified, even if dispersed to different points along the river. This study found that amongst the Thames and Walbrook skulls *c.*10% were accompanied by a mandible and it is perhaps significant that one of these was the most 'recent' of the Thames skulls, dating to the 13th century, and perhaps experienced the shortest exposure to the riverine environment. In addition, three isolated mandibles, two found near to Barn Elms and another downstream, are present amongst the MOL collection (GEN01-57, -55 and -60), four are listed in the BMNH Thames collection (Kruszynski BMNH pers comm), and 14 loose mandibles were reported by Bradley and Gordon (1988). Apart from the postcranial material associated with the Hays Wharf child skull, there are no other isolated postcranials recorded in either the MOL or BMNH collections. However, two left femurs have been found in the same general area as the Bronze Age skull MOL L344 described earlier in this report. One of these was recovered in the 1990s by Thames Archaeological Survey and the other during a survey by Museum of London Archaeology at Cheyne Walk Moorings, Chelsea in 2006. The femurs were found in different contexts and were judged not to be associated with the skull; radiocarbon dating has recently established that one femur is Neolithic in date while the other is Bronze Age (Nathalie Cohen pers comm). The recovery of even small numbers of mandibles and non-cranial elements from the river supports the view that a significant proportion of skulls may have entered the water as an intact or partially intact body.

While this may clarify the deposition of some skulls, it does not explain evidence emerging from excavation of river-side sites (rather than dredging) which has shown that skulls appear to have been deposited selectively; many of these sites date to the Bronze Age (Thomas *et al* 1986; Bell & Neumann 1997; Needham 1993; Wells *et al* 2001; Ritchie *et al* 2009).

Ritual deposition

Ritual deposition of human bones, particularly skulls, has been widely proposed for prehistoric Britain and much of the discussion centres on materials recovered from the Thames and its tributaries (Bradley 1990; Carr & Knüsel 1997; Cotton 1996). It has been conjectured that rivers and other 'watery places' represent a boundary with a spiritual world after death and are therefore fitting places to lay ancestral bones to rest. With rather more certainty, it can be said that the river Thames was an artery for communication from the prehistoric period onwards and is likely to have been a tribal/political boundary during the Bronze Age, Iron Age and Anglo-Saxon periods (Allen *et al* 1997; Sidell *et al* 2000; Merriman 2000). Hence, everyday interactions with the river provided opportunities for accidental traumatic death, while cultural perspectives might have enhanced the ritual significance of the river.

The idea of ritual deposition developed in response to observations that were otherwise difficult to explain. One of these, the abundance of skulls without postcranial bones, has been discussed in the previous section. Another factor is the high proportion of Bronze Age specimens and their association with contemporary metalwork (Bradley 1990; Needham & Burgess 1980; Ehrenberg 1980).

Dredging of the stretch of river between Richmond and Mortlake yielded large quantities of Bronze Age and Iron Age metalwork in addition to skulls. While this is a compelling observation, it is relevant to note that dates for the skulls span almost 1,000 years, with one in the early part of this period when metal deposition was not common (Tables 2 and 4). Furthermore, although at some river locations skulls and metalwork appear to have been collected during the same phases of dredging (Bradley & Gordon 1988), this does not imply simultaneous deposition, since it is equally possible that items, entering the water at different times during the Bronze Age, were effectively kept together, immobilised by their submersion in deep river-bed sediments. Moreover, all the skulls may not have entered the water at this location; the five Bronze Age skulls from this stretch of river vary in their degree of preservation, indicating different taphonomic histories which may include variation in: (i) time between death and entering the water; (ii) distances travelled along the river before submersion in river silts; (iii) re-exposure on land.

An over-preponderance of specimens from adult males also appears to support selected skull deposition, although the bias in favour of males is not dramatic. Amongst the *c.*300 Thames skulls examined by Bradley and Gordon (1988), females constituted 40%. Similarly amongst the skulls recovered from the river Ribble, *c.*41% were identified as female and the remainder as male (Turner *et al* 2002). The small group of Thames skulls examined here appeared to include more males than females, though the numbers are too small to be certain. At least half of the Walbrook skulls examined in this study were classified as females, although earlier work on a different assemblage indicated that females accounted for *c.*20% of the total (Marsh & West 1981). Various factors can explain a greater incidence of male skulls in rivers; for example, males may have had more exposure to risky river-based activities than females. Indeed, Knüsel and Carr (1995) examined the figures for 20th-century drowning in the Thames and showed that 79% of several hundred victims were males. They also reported that suicides were more common amongst men. It is also necessary to compare the sex ratio of river finds with the mortality profile of the contemporary living population; for example, in the Roman period many urban cemeteries in Britain show an excess of males of *c.*2:1 (Barber & Bowsher 2000; Taylor 2003). Finally, there may be an inherent bias during assignation of sex of crania in favour of males.

Reservations about the likelihood of selective deposition of skulls are balanced to some extent by findings from excavations at locations along the Thames and river Severn. For example, human skulls dating to the Bronze Age have been found on the Middle Thames at Wallingford (Thomas *et al* 1986) and Runnymede (Needham 1993), on the river Lea at Enfield (Ritchie *et al* 2009), and at Goldcliffe in the Severn estuary (Bell & Neumann 1997). All seem to have been deposited as single items and furthermore, physical clues which might suggest excarnation prior to deposition are also emerging (Carr & Knüsel 1997). For example, at the Enfield site, a four-post structure was interpreted as an excarnation platform (Ritchie *et al* 2009) and Mays (in Wells *et al* 2001) concluded that a Late Bronze Age male skull recovered from a relict mire at Poulton le Fylde had been excarnated by temporary burial or protected exposure. The bones found at the Late Bronze Age/Iron Age site at Eton showed cut marks suggesting that defleshing or dismemberment had occurred prior to burial (Allen & Cox 2000).

Of the thirteen Thames skulls dated thus far, six fall within a period of about 1,000 years, corresponding to the Late Neolithic/Bronze Age (Fig 6). Taken at face value, the numbers imply that more skulls entered the river during this millennium than at other times, but the situation is likely to be more complex with other mechanisms shaping these data. These include sampling bias, local topography, dynamics of river flow, and human settlement. To take one example, most of the Thames skulls, and Bronze Age metalwork, were collected by dredging and it may be that areas of the river that are prone to build up of silt and thus require frequent dredging are just those locations that were most attractive for Late Neolithic/Bronze Age settlement. Yates (1999) in his review of Bronze Age field systems describes how land within a meander loop was enclosed with a single linear bank and ditch across the narrow neck of land. This allowed controlled access to the settlement and fields, an important factor at a time of intensified livestock farming. Given the lowland valley nature of the stretch of river between Syon and Battersea where many of the skulls were found, a meandering course, such as exists today, is likely and may well have attracted settlement. Such factors may contribute to the clustering of skulls in the Mortlake region.

River action and erosion are very pertinent

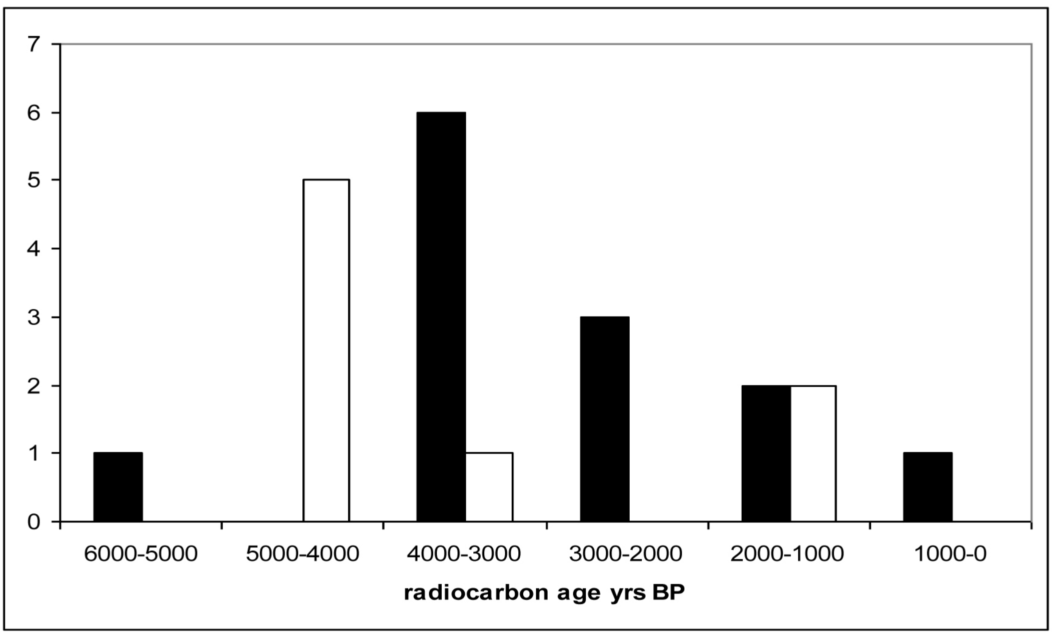

Fig 6. Radiocarbon age yrs BP (before present) for skulls from the rivers Thames and Ribble (Thames = black bars; Ribble = white bars). Thames data from present study and Bradley & Gordon 1987; Ribble data from Turner et al 2002

to this discussion. For the Thames, the tidal range and levels of erosion have varied over the millennia it has been carving its route through south-east Britain. By the Bronze Age the Thames was a single channel with strong tidal surges which reconfigured the floodplain, with presumably flooding and significant erosion in some locations. Sea level change and significant migration of the tidal head have occurred throughout the last 3,000 years, dramatically affecting patterns of erosion (Sidell *et al* 2000). These forces are active today with an ever-expanding tidal range and modern levels of erosion, revealing prehistoric land surfaces previously buried beneath later layers of deposits (Haughey 1999).

Thus, although traumatic death and possibly ritual deposition are likely to account for some of the skulls found in rivers, river activity, particularly erosion, is also likely to be an important contributor. Evidence for the erosion of burials placed close to the river or on small islands has emerged recently and points to another significant source of riverine skeletal material. For example, excavations at Eton in the Middle Thames uncovered indications of burials on sandbank islands in the middle of the river. Skulls and bones from *c.*15 individuals were found, dating *c.*1300–200 BC. The bones were from *in-situ* skeletons and it appears that whole or part bodies were weighted down to prevent complete disintegration in the case of flood (Allen & Cox 2000). Several Saxon foreshore burials have been discovered at Thames Court (City of London), Corney Reach, Chiswick, and from the mouth of the Fleet near Blackfriars Lane (Cohen 2003, 17–18). More recently, excavations on the north-eastern side of Finsbury Circus in the Upper Walbrook Valley have uncovered a Romano-British cemetery and shown that bodies have been eroded out into the river bed by seasonal increased river flow and flood. Thus burials close to rivers and subsequent erosion of human bones into the river may account for many of the skulls in the Thames and from the Walbrook river bed (Powers 2005; cityoflondon web site 2008).

Excavations of a relict channel of the river Trent uncovered at least a dozen Late Neolithic/Early Bronze Age human skulls, including several children and young teenagers. There were also human postcranial bones and animal bones. In this case the bones were clustered and to some extent protected, because they had been caught in a jam of cut timbers and wickerwork. The authors offered two explanations — catastrophic flood or ritual deposition (Bishop 1996), although their findings did not appear to exclude sudden erosion of a burial site.

Finally it is worth noting that, in contrast to the Thames skulls, the river Ribble skull group (Turner *et al* 2002) dated mainly to the Neolithic period (Fig 6). While this could reflect different cultural practices in different parts of Britain, it also perhaps emphasises the need for more complex investigations taking into account such factors as geographical location, patterns of sedimentation/alluviation in or near to rivers, and associated human settlement patterns. In addition, the notion of skull deposition rests heavily on the absence of extra-cranial elements and it may be worthwhile to confront this problem by a deliberate search. It is timely that the Thames Discovery Programme (www.thamesdiscovery.org) has been established to continue the foreshore work of the Thames Archaeological Survey.

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