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from centres of population to be an acceptable location for such a vile-smelling activity, too.

This is the first time that such direct evidence for an area devoted to tanning has been detected in York. Five sites have yielded medieval or post-medieval assemblages of sheep limb bones which have been interpreted as waste from hide preparation: 118–126 Walmgate (AY 15/1), 148 Lawrence Street (Carrott et al. 1994a), North Street (Dobney and Jaques 1993), St Andrewgate (Carrott et al. 1993) and Bedern (AY 10/5, 617). Confirmation would represent a significant contribution to our understanding of zonation in medieval York. As an aside, it is worth mentioning that although other sites, particularly that at 6–8 Pavement (AY 8/3; AY 14/4), have provided ample evidence of leatherworking, leather production sites have not yet been located.

We would strongly warn against using abundance of either *Trox scaber* or bark alone as indicators of tanning. Bark may have accumulated from decay of timber used for any number of other purposes. *T. scaber* is occasionally abundant in general occupation deposits, for example, in a late 14th-century 'organic dump' from High Street, Hull (Carrott et al. 1994b), though no association with tanning is suspected. Some other cases are less clear: *T. scaber* was abundant in a dump of material containing much leather in a late or post-medieval deposit at Palmer Lane, York (Carrott et al. 1993), and another dump of similar date at the nearby Adams Hydraulics II site at Peasholme Green also produced unusually large numbers of *T. scaber* (Allison et al. 1991). In this latter case, too, there was much leather and it was uncertain whether the beetle may have lived in it or have been in some way associated with its production (or of course neither!). There is also a record of several tens of individuals from a sample of unknown size from the Chaucer House site, Southwark, London (Kenward 1990).

Fragments of small strips of tightly rolled birch bark (*Betula* sp.) were found in levels from Period 4A onwards at 16–22 Coppergate, although not in any concentrations. These are discussed by Morris in AY 17/13 (pp.2348–9) and material of this kind may have been used in the tanning of hides.

The osteological evidence

Skin and bones: correlating the osteological and artefactual evidence

By T.P. O'Connor

The aim of this text is to review the osteological evidence from Anglo-Scandinavian and medieval York for the retrieval and working of skins and hides, and to cross-correlate that evidence with the data obtained from studies of leather artefacts. Although much of the animal bone debris from excavations in York appears to have derived from the butchering of animals for meat, and from their domestic consumption, some evidence of the retrieval of useful body parts, such as hides and horns, might be apparent. The text begins by discussing the nature of such evidence, and then reviews the available data.

What are we looking for?

The first, obvious, piece of information for which to search is to see whether the pattern of relative abundance of species observed in leather artefacts matches that observed in the animal bone debris, site by site or period by period. In fact, this is not as simple as it may seem. Both bones and leather will be subject to patterns of differential preservation, and the biases that distort the animal bone data will probably be quite different from those that affect the artefact data. Not least, the hides and skins of different species might have been treated in quite different ways, rendering them more or less likely to survive prolonged burial. Another complication is that of equating numbers of bones with numbers of potentially available hides. The relative (de)merits of different bone quantification methods have been worked over at length elsewhere (e.g. see AY 15/1, 6–7; O'Connor 2000, 54–67), and will not be reiterated. Suffice to say that the predominance of one species in terms of identifiable bone fragments need not indicate predominance in terms of numbers of individuals, and that the predominance of one species in terms of meat-weight contribution need not be the same as predominance in terms of available hide, one being a volume measure, the other an area measure. Thus if one ox equals eight sheep in terms of meat, it might only represent four sheep in terms of hide, and even that simple calculation makes no allowance for the value placed upon their respective hides. We need to compare measures of bone and

leather predominance with some care, therefore, and be prepared to use a broad brush.

A second line of enquiry is to look for bone assemblages diagnostic of the recovery of hide from animal carcasses. Because their skin is relatively thick and hairy, bovids such as cattle and sheep are generally skinned in the course of butchering them for meat. This process can be observed in cultures as different as post-medieval England (Sabine 1933) and North American Plains Indians (White 1953), and can probably be assumed for most bovids at most times and places. It follows, therefore, that recovering the hides of cattle and sheep for working into leather need not be a deliberate activity: the hides are made available by routine butchering of the animals. The same cannot be assumed for pigs, which, at least in northern Europe, have traditionally been butchered without skinning (An Roinn Talmhaidheachta 1941). The recovery of pig skin might, therefore, be a more deliberate process.

If the collection of cattle and sheep skins is bound up with the butchering process, it is likely that the archaeological evidence for the two activities will also be closely associated. O'Connor (1993) discusses a theoretical sequence of butchering events through which a large bovid carcass might pass if the aim were to optimise the use of all parts of the carcass, including the skin. The initial stage of primary butchering has the live animal as input, a 'dressed' carcass as the intended product, and a mixture of skin, entrails, tail, head and foot bones as waste. The immediate resorting of the 'waste' component then allows the useful hide, horns and perhaps some larger bones to be retrieved for use. If the carcass is being used parsimoniously, relatively little material might remain to be deposited as the assemblage characteristic of the skinning and primary butchering: perhaps only some skull bones (but probably not the horn cores) and the tail vertebrae. More diagnostic evidence might result if the hide is removed from the butchering area with some bones still attached, so that those bones become the diagnostic assemblage at the place where hides are accumulated, trimmed and prepared. The most obvious bones to be deposited in this way are those of the feet, as there is little meat value distal to the carpus and tarsus, and retention of the feet on the hide might be useful in subsequent handling of the hide, or as a form of tally. Something of this nature clearly underlies the enor-

mous quantity of sheep foot bones recovered from post-medieval deposits at 118–26 Walmgate (AY 15/1, 30–54), and perhaps the smaller deposits noted at Bedern Foundry (AY 15/5, 367–8). Deposits with a high proportion of foot bones (i.e. metacarpals, metatarsals, phalanges) might therefore indicate the processing of hides, whereas deposits with a high proportion of foot and skull bones are more likely to derive from primary butchering, a process that might have included the recovery of hides. Our problem is likely to be one of visibility. If hides were recovered systematically, on a large scale, it is likely that they, and any diagnostic attached bones, were removed to locations at some distance from domestic occupation: tanning is notoriously malodorous. The most characteristic deposits, therefore, are likely to be at peripheral locations. On the other hand, if hides were recovered piecemeal, as a part of the butchering process, distinctive assemblages might not be deposited, or might become re-associated with other bones during refuse deposition, so losing their identity.

The available evidence

The great majority of the leather artefacts identified in this survey are of cattle or calf leather, and this is certainly consistent with the overwhelming predominance of cattle bones in Anglo-Scandinavian and medieval bone assemblages from York (AY 15/3, 149–51; AY 15/5, 378–83). Keeping in mind the points made above, we should not expect to see a match in terms of the degree of predominance, but the direction of it is certainly consistent. In the medieval leathers from Coppergate, there is a higher proportion of sheep/goat identifications in the late 11th- to early 13th-century material (mostly shoes) than in earlier periods, but a predominance of bovine leathers is apparent in later medieval groups. To some extent, this is matched in the animal bone debris. The relative abundance of sheep bones is higher in 11th- to 13th-century groups than in Anglo-Scandinavian material (AY 15/5, tables 90–1). However, this higher relative abundance persists or increases in later medieval bone samples at some sites (16–22 Coppergate; 58–9 Skeldergate), or is not really apparent in the earlier material at others (1–2 Tower Street; 9 Blake Street). What we can infer from the data is some increase in the amount of sheep bone deposited in the 11th to 13th century at sites where the excavated contexts seem to be directly associated with occupation (58–9 Skeldergate; 46–54 Fishergate; Bedern), rather than at sites where the deposited material might in-

clude a higher proportion of non-domestic debris (1–2 Tower Street; 9 Blake Street, see below).

The general dearth of objects made in pigskin is consistent with the point made above about the more deliberate procurement of pigskin. One deposit from Coppergate could be interpreted as including a dump of bones from the primary butchering (and so possibly the skinning) of pigs: context 30352, a Period 4A layer towards the front of the site, gave an assemblage with an unusually high proportion of pig skulls and foot bones. Some concentration of pig metapodials has also been noted in Period 5B deposits in Tenement B at Coppergate, probably indicating that pigs were slaughtered and butchered here during that particular period of occupation (AY 15/3, 179–80). However, for the reasons already given, even fairly large-scale primary butchering of pigs need not indicate the accumulation of pigskin. The shortage of pigskin artefacts might be a consequence of differential survival, but could equally indicate that cattle and sheep skins were available anyway, and thus were the hides most commonly used.

Apart from the post-medieval material from Walmgate, only a few deposits have given bone assemblages with a sufficiently high proportion of foot bones to indicate the accumulation of skins. Some late medieval assemblages from Period 3 and 4 contexts at the Bedern Foundry site included large numbers of sheep metapodials, though very few phalanges (AY 15/5, 367–8), and similar assemblages have been noted from post-medieval deposits at Bedern. Given the paucity of any bones other than metapodials in these assemblages, they have the appearance of deliberate collections of a particular bone element, rather than debris from primary butchering or skinning. However, even if the bones were actually collected as raw material for bone working, the fact that such quantities could be assembled indicates systematic carcass processing on a scale commensurate with the collection of skins.

Similar evidence of systematic butchering, this time of cattle, comes from medieval material from 9 Blake Street (AY 15/5, 376–7). The high proportion of cattle bones, mentioned above, can in most Blake Street medieval contexts be attributed to poor preservation of the assemblages, with robust cattle teeth and jaw fragments predominating amongst the surviving fragments. However, in context 4373, the fill

of scoop 4395, the bone assemblage consisted largely of cattle skulls, metapodials and phalanges: a good candidate for primary butchering debris. Again, this is not *prima facie* evidence for the collection of cattle hide, but it is certainly debris from systematic butchering during which hides would almost inevitably have become available.

Goats present an interesting problem, with only a few examples of goatskin positively identified amongst the artefacts. A number of medieval sites in York, along the south-west bank of the Ouse and on Aldwark, have given evidence that goat horns were being collected on quite a large scale (AY 15/1, 28–9; AY 15/5, 371). Elsewhere in Europe, it has been argued that the collection of goat horn and of goatskins went on together (Schmid 1973; Prummel 1982). In her delightful *exegesis* on goats, Noddle (1994) draws attention to several 13th- and 14th-century sites in Germany at which goat bones were particularly abundant, sometimes matched by abundant finds of goatskin artefacts. Apart from the horncore accumulations, goat bones are scarce in Anglo-Scandinavian and medieval samples from York, and the scarcity of goatskin objects would seem to match this general lack of goat bones. On a parsimonious interpretation, that would suggest that the goat horncore accumulations represent the collection of horn, not horns and hides. Perhaps the lack of goatskins is unsurprising. As Noddle points out, goats were of greatest importance to the rural economy in those regions where rough hill grazing abounded — Wales, Northumberland and the Scottish Highlands — rather than the comparatively lush Vale of York. However, if craftsmen in York provided a steady market for the raw material, horn could be easily transported over considerable distances, still attached to part-skulls and chopped-off horncores, and would degrade far less during a week's overland travel than would the corresponding number of goats-worth of skins.

Smaller animals may have provided skins that have not been identified amongst the artefacts. Anglo-Scandinavian Coppergate yielded some cat skulls from Period 4 and 5 deposits with knife-cuts consistent with the cats having been skinned, and some groups of cat metapodials and phalanges (AY 15/3, 186). However, these are only a few specimens from a site that yielded quite a lot of cat bones, particularly from Tenements A and B. The use of cat skins in medieval York was probably small-scale and op-

opportunistic. McCormick (1988; 1997) interprets cat mortality data from Dublin and Waterford to indicate the deliberate culling of town cats for their skins, and the mortality profiles for cats from Anglo-Scandinavian and medieval York are not markedly different to those tabulated by McCormick. However, there is copious documentary evidence from Ireland of the collection and export of cat skins to support the tenuous osteological data, and the same support does not exist for York. The mortality profiles are equally consistent with adolescent cats dying through misadventure during their first few months of independence, rather than young cats being culled for their skins (O'Connor in AY 8/4 in prep.). The difference between the deliberate culling of young cats and the opportunistic use of animals that died without human intervention is quite a subtle one, and is unlikely to be easily resolved from the osteological evidence alone.

There is less ambiguous evidence for the use of red squirrel skins. Several contexts from Coppergate yielded specimens of squirrel, all of them metapodials or phalanges (AY 15/3, 191; AY 15/5, 362), and a 14th-century pit-fill from Bedern (context 1505) yielded 267 identified fragments of squirrel, the great majority of which were metapodials and phalanges (*ibid.*, 365–6). This material is interpreted as being the debris from the working of squirrel pelts that came into York with the feet still appended. Just one of the bones from the Bedern assemblage, a cuboid, bore a faint transverse knife-cut, consistent with cutting around the hind foot. Bones of rabbit are found only infrequently in medieval deposits in York, and none has yet given any evidence that rabbit skins were systematically collected or used.

Brown bear was represented in Period 4B deposits at Coppergate by several specimens of third phalanges (AY 15/3, 187, 190, pl.XIa), which were probably derived from bear skins to which the claws were still attached. Given the uncertain status of bears in medieval Britain (Yalden 1999), the skins might have been locally obtained or imported, with importation seeming the more likely. Several other wild mammals that might have been valued for their fur have been recorded from sites in York in small numbers. Period 3 deposits at Coppergate gave a single specimen of otter, a humerus bearing no marks of butchering or skinning (AY 15/3, 187, pl.XIb).

Although earlier in date than the remit of this survey, note should be made of the 8th-century records of beaver and pine marten from 46–54 Fishergate (AY 15/4, 256, 259, pls.XIIa–b, XIIIa–b). Although there was no direct evidence that the beaver had been skinned, the pine marten bones included a calcaneum with transverse knife-cuts reminiscent of the squirrel cuboid from Bedern, and consisted entirely of foot bones.

Discussion

In so far as the different forms of data can be directly compared, the animal bone evidence and the leather artefact evidence are broadly consistent. Just one apparent disparity requires further discussion. Most of the Anglo-Scandinavian leather artefacts from Coppergate are identified as 'calf' rather than 'cattle', with 'cattle' identifications becoming more common in the medieval period. If we follow agricultural practice and limit the term 'calf' to animals of a year old or less, then that age category would be approximately equivalent to the 'juvenile' and 'immature' categories used in age at death analyses in AY 15. However, in Anglo-Scandinavian contexts, only 19 out of 293 mandibles fall into those two categories (6.5%), with the great majority classed as 'adult' (53.9%) or 'elderly' (14.7%). Even if we stretch the definition of 'calf' to include the dentally 'subadult' category (probably 2–2½ years), there is still quite a disparity between the leather artefacts and the dental data.

One possibility to consider is that the bone assemblages might be heavily biased against the younger animals through differential destruction of their less mineralised bones, so that the artefacts are giving a better reflection of the age at death distribution. However, it would take a quite remarkable degree of taphonomic bias to account for leather artefact identifications in which three-quarters of the specimens are of calf leather whilst less than one-tenth of the recovered mandibles are from calves, particularly for Coppergate where bone preservation was good and samples recovered by sieving were available to check the quality of recovery on site. Differential preservation of bones seems an unlikely explanation. It is more probable simply that there was a degree of selection going on, not taking any hide that butchering made available, but selecting the younger hides for their particular working properties. If that was the case, then perhaps supply exceeded demand, or at least

met demand sufficiently that it was not necessary to use more than a small proportion of the thicker hides obtained from adult animals. The later medieval artefact samples show a shift away from calf to cattle leather. This does not appear to be matched by anything in the bone data. If anything, the bone data would lead one to expect more calf leather to have been available, as there is some evidence for the emergence of specialist milking herds and thus the slaughter of veal calves (AY 15/5, 383–7). However, if the osteological evidence for an increased proportion of sheep in this later period actually reflects an increase in numbers of sheep at the expense of cattle, it is just possible that demand came to exceed supply, requiring increased use of thicker cattle leather where calf would be preferable were it available. Any further discussion of this point would require a more precise correlation of calf and cattle leathers with the age categories derived from dental data.

Of course, all of the above is predicated on the great majority of the leather artefacts having been made from locally derived material. If a high proportion were imported to York as finished artefacts, then the link between skins and bones is broken, and no correlation should be expected. One means of testing this would be to undertake detailed study of the leather offcuts, as these pieces surely represent the leathers that were worked in York, rather than leather artefacts that might or might not have been locally manufactured.

Though not particularly conclusive, this has been an interesting and useful comparison, putting together the data from a particular class of artefacts with other evidence for the animals from which their raw material was derived. What it has mostly brought to light is the degree of uncertainty over, for example, means of quantification or correlation of age categories. Some closely focused research on these issues is necessary if future analyses of skin and bones are to be made more meaty.

Limitations of the precision of the leather species identification in this study

Professor O'Connor's thought-provoking discussion above concerning the correlation of the bone evidence and the leather remains raises a number of interesting questions. The limitations of the leather species identifications made in this study, however,

must be stated here. These limitations apply not only to this study, but to all archaeological leather assemblages. The difficulties of distinguishing between the grain pattern of the skins of sheep and goat are well known to all those who attempt it. A general identification of sheep/goat has been made during this study, unless a positive identification of sheep or goat was possible. Similarly the criteria used to distinguish calfskin from cattle hide was rather more subjective than that used by Professor O'Connor and his colleagues engaged in the study of bone assemblages. The size of the hair follicles, the appearance in section and the thickness of the leather were all considered. The terms 'calf' and 'cattle' were used to convey a notion of the maturity of the animal but no idea of a specific age range was implied. Much archaeologically recovered leather, including these assemblages, has heavily worn surfaces and the structure may be degraded, so that the subtleties which would allow more precise identification of a hide or skin are often well beyond our reach. A consideration of the leather species identified during this study and the selective use of particular leathers through time are provided elsewhere in this section (pp.3265–7).