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1 **Title:** The Use of Animals at Roman Roadside Settlements in Britain: contextualising some new
2 results from Ware, Hertfordshire

3 **Short running title:** Animals at British Roman Roadside Settlements

4 Elizabeth Wright^{a, b}

5 Sofia Tecce^a

6 Umberto Albarella^a

7 ^aDepartment of Archaeology, University of Sheffield, UK

8 ^bNorthern Archaeological Associates Ltd, Barnard Castle, UK

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13 comparative sites and providing data.

14 **Abstract**

15 Recent analysis of a large faunal assemblage from a Roman roadside settlement at Ware,
16 Hertfordshire has indicated potentially strong links between the nature of animal exploitation on site
17 and its location on Ermine Street. Animal husbandry was focused on the production of cattle and
18 sheep, both of which experienced stock ‘improvement’ by the late Roman period. Relatively high
19 proportions of horse, and the presence of young horses, suggest the importance of this animal and the
20 potential for its local breeding; the site could have acted as a station for changing or selling horses.
21 The presence of marine fish and black rat also indicate clear links to the wider trade network. This
22 was not an isolated settlement, outside the sphere of Roman influence, as rural Roman sites are often
23 considered to be, but well-connected to wider economic networks. This paper places these new results
24 in context, by providing a review of faunal assemblages from Roman roadside settlements across
25 Britain. The review indicates that most of the characteristics of animal exploitation at Ware are shared
26 with other roadside settlement sites, though interesting differences also emerge.

27 1. INTRODUCTION

28
29 Rural sites in Roman Britain are considered to have been more slowly affected than urban sites by the
30 political, social and economic changes brought about by the Roman occupation (Mattingly 2006;
31 Millett 1990). The impact of the occupation, and the nature of these changes, often described as
32 ‘Romanisation’, is complex and has been a subject of debate for many years (e.g. Freeman 1993; Hill
33 2001; Hingley 1996, 1997; James 2001, 2003; Mattingly 2006; Millett 1990; Woolf 1997; 1998).

34
35 Zooarchaeology – the study of animal remains from archaeological sites - has provided important
36 evidence contributing to this debate. Research has shown a change in the relative proportions of
37 domestic species compared to the preceding Iron Age, with cattle numbers increasing substantially at

38 the expense of sheep (e.g. Albarella 2007; Dobney 2001; Grant 1989, 2002; King 1999, 2001; Maltby
39 1981). Broad-scale studies have also identified differences between site types, with urban sites being
40 largely cattle-based and rural sites having higher sheep frequencies (King 1978; 1984; 1999).

41 In addition to the increase in cattle frequency, there is also an increase in the size of livestock, and in
42 the use of cattle for traction (Albarella 2007; Albarella et al 2008; Grant 1989; Maltby 1981). This is
43 thought to be the result of shifts in agricultural practices related to emerging long-distance economic
44 networks and an urgent need to feed the ever-growing urban population (Albarella 2007; Grant 1989).
45 Isotopic work has also confirmed this widening of the market (Minniti et al. 2014). These patterns
46 form the basis of our debates around Roman animal husbandry, and provide a useful framework for
47 the interpretation of our results. However, they are not universal and when did they occur, it was not
48 at the same rate at all sites (e.g. Albarella 2007; Gidney 1999; Grant 1989, 2002; Hamshaw-Thomas
49 2000). It has now become clear that, despite the benefits of these broad-scale approaches, we should
50 not neglect variation within site types.

51
52 Urban sites, with their dominance of large cattle, are often considered to be more ‘Romanised’ than
53 rural sites. These latter tend to be interpreted as continuing the tradition of Iron Age subsistence
54 strategies, and therefore to be regarded as more ‘native’. However, many of these assumptions rely
55 heavily on species representation, and livestock from rural sites have more rarely been investigated
56 biometrically, which means that our understanding of the impact of Roman-driven husbandry changes
57 in rural locations is highly incomplete.

58 Roadside settlements have traditionally been classified as ‘rural’, as they tend to be located in open
59 countryside. However, these sites straddle the boundaries between urban and rural, and it is often
60 difficult to distinguish a ‘roadside settlement’ from a ‘small town’ or a ‘village’. Roadside settlements
61 make up a substantial part of the dataset that has been used to define ‘rural’ sites as sheep-focused
62 (e.g. King 1999; 2001). Therefore, it is possible that this pattern may be determined by activities
63 taking place at settlements near to a road, rather than only their rural location. Sheep are not
64 unjustifiably considered as synonymous with a ‘native’ or less ‘Roman’ way of life, though this is
65 likely to be an oversimplification.

66 The literature discussing the nature of roadside settlements is relatively slim. A gazetteer produced 30
67 years ago (Smith 1987) listed 158 such sites across Britain, and made a number of general
68 observations about these site types. More recently, the Roman Rural Landscape Project has
69 highlighted the variability of roadside settlement sites (Allen and Smith 2016; Allen et al. 2017). The
70 basis on which sites were classified as ‘roadside settlements’ in these studies does differ slightly; for
71 example, small towns and villages are dealt with differently in the two studies, but in both cases the
72 location of sites either on, or very near, to a road was the most important feature needed for inclusion.
73 According to these studies, roadside settlements occur relatively regularly across Roman Britain and a
74 significant proportion of them are thought to have first century origins (Smith 1987). Many of these
75 sites occur on the intersection between two or more roads, and a considerable number are located at
76 river crossings (Allen and Smith 2016), as is the case at Ware. However, in general, excavations have
77 not yielded large numbers of finds, including animal bones, and little work has been done to bring

78 faunal data together (although see Allen 2017 for the largest synthesis to date, undertaken as part of
79 the Roman Rural Landscape Project).

80 One of the major obstacles to our understanding of faunal remains from roadside settlements has been
81 the lack of detailed work undertaken on assemblages excavated decades ago. The faunal assemblage
82 at Ware is one that falls into this category; a report was written when it was initially excavated in the
83 1970s (Ashdown Unpublished), but this was brief and did not provide useable or comparable data.
84 The reanalysis of this material has proven to be valuable not only for the interpretation of this site, but
85 also for our growing knowledge of rural life in Roman Britain. This paper presents these new data
86 alongside those from other British roadside settlements, in an attempt to identify common trends and
87 characterise these sites further. The overarching questions here addressed are whether roadside
88 settlements have unique characteristics that can be defined zooarchaeologically and, if so, how these
89 can help our understanding of Romano-British society.

90

91

2. MATERIAL AND METHODS

92

2.1 *Material*

94 The Roman settlement at Ware has been the subject of archaeological investigations since the early
95 19th century. Most of this work was undertaken during excavations which took place in the 1970s on
96 the site of the GlaxoSmithKline (then Allen & Hanbury) campus. These excavations took place
97 predominantly on the north bank of the River Lea, although some work was also undertaken on the
98 southern side. The work was led by East Hertfordshire Archaeological Society and the Hart
99 Archaeological Unit. Since then, investigations have continued as new parts of the site have been
100 exposed during redevelopment, and work is still ongoing. KDK Archaeology, who commissioned the
101 reanalysis of the faunal remains discussed here, are currently bringing together all of this work into a
102 monograph (Kaye and Kaye Forthcoming). The assemblage discussed in this paper was unearthed
103 during the 1970s excavations.

104

105 Recovered archaeological remains have been attributed to at least nine phases of occupation, from the
106 Mesolithic to the post-Roman period, but the majority of material (including animal bone) was from
107 the Roman phases (Phases four to eight). The Roman settlement is thought to have been established in
108 the first century AD with the building of Ermine Street, which crossed the River Lea at this location
109 (Kiln and Partridge 1995). Evidence strongly indicates that the development of the settlement was
110 closely linked to activity on the road and the associated river crossing (Kiln and Partridge 1995;
111 Shlasko Forthcoming) and it can logically be placed into the category of ‘roadside settlement’. Some
112 of the evidence is directly related to the use of animals; there are, for instance, large numbers of
113 hipposandals (a predecessor of the horseshoe, used to protect horse hoofs), in addition to horse bits
114 and harness fittings. These finds indicate that draught animals formed an important part of the traffic
115 on the road (Crummy Forthcoming). Additionally, there is evidence that the site was influenced by
116 long distance trade, through the presence of samian ware, and other imported fine wares and coarse
117 wares (Shlasko Forthcoming). There is, therefore, extensive evidence that this site was not isolated as

118 rural sites are often seen, but instead was very well connected to the network of Roman economic and
119 cultural influence.

120 The faunal assemblage from Ware is one of the largest from a roadside settlement in Britain, with
121 more than 6000 recorded mammal and bird specimens (Wright et al. Forthcoming). The large sample
122 allowed comprehensive ageing and biometrical studies, which constitute a useful comparative
123 resource for the Roman period, especially rural settlements.

124 A number of faunal assemblages from other ‘roadside settlements’ were chosen for comparison with
125 the assemblage from Ware (Table 1 and Figure 1). Our selection was based on a number of factors:

- 126 • Proximity to the road
- 127 • Size of settlement
- 128 • Excavators’ interpretations of the site as a ‘roadside settlement’¹
- 129 • Size of faunal assemblage
- 130 • Data availability in faunal reports.

131 Where possible, raw data were extracted from faunal reports to enable a direct comparison with Ware.
132 This was not always possible, as data were not always published, or were presented in a form that was
133 not comparable with our data. The faunal report for the large roadside settlement site at Bainesse, in
134 north Yorkshire, for example, divided only the biometrical data by phase; all other data, including
135 relative frequencies and ageing, were presented as one ‘Roman’ group (Meddens 1998). This site has
136 therefore only been included in the biometrical part of this study.

137

138 2.2 Methods

139 The animal bone assemblage from Ware was studied at the University of Sheffield, using the facilities
140 of the *Tony Legge Zooarchaeology Laboratory*. The material was recorded using a protocol involving
141 the selection of diagnostic zones (following a modified version of Davis 1992 and Albarella and
142 Davis 1994); for a full description of the recording and quantification methods see Appendix 1 and 2.
143 The full database is provided as Supporting Information.

144 There was no record regarding the mode of collection of the animal bones, and it is unknown whether
145 any sieving was carried out. However, as part of our study we carried out an assessment of recovery
146 bias. This suggested that differential recovery was impacting the assemblage, but the presence of
147 relatively large numbers of amphibian and small rodent bones in some contexts, and large numbers of
148 loose sheep teeth overall, indicated that sieving may have been taking place in some areas and/or that
149 hand-collection was fairly efficient in some areas of the excavation.

¹ Some of the sites included in this paper were not necessarily described as a ‘roadside settlement’ by their excavators, but instead fell into the categories of ‘small town’ or ‘village’. There was no reason we could see why these smaller settlements should not be comparable to sites interpreted as roadside settlements so long as they were in close proximity to the road. In Table 1 the sites are categorised according to the site ‘type’ ascribed by the excavators

150 For this paper the following broad chronological phasing has been adopted:

151 Early Roman: first - second century AD

152 Middle Roman: second - third century AD

153 Late Roman: third - fourth century AD

154 There was some variation in the way faunal assemblages were presented with regards to phasing and
155 dating, with some sites only dated generically to the Roman period and others split into numerous
156 defined phases, often with very small samples sizes. The above phasing provided the ability to use
157 data that had been relatively broadly dated and also have large enough sample sizes for our analysis to
158 be reliable. This is also the phasing adopted by the recent regional review of Roman sites for Central
159 England (Albarella with al. Forthcoming) and so it allowed us to use some comparative datasets from
160 that project in order to provide a broader picture, including various different site types. This review
161 provided the largest collated zooarchaeology dataset in Britain, so is ideal for contextualising the
162 Ware dataset. Regional datasets for the southern and northern regions of England have not yet been
163 published.

164

165 3. KEY RESULTS IN CONTEXT

166 The results from our study of the faunal assemblage from Ware (Wright et al. Forthcoming) can be
167 summarised as follows:

- 168 1. Species representation indicates a major focus on cattle and sheep husbandry, with the two
169 species represented in relatively equal proportions.
- 170 2. The cattle population was relatively old, indicating the primary use of these animals for
171 traction.
- 172 3. Sheep were slaughtered at a relatively young age – indicating their primary use for meat
173 production.
- 174 4. Sheep postcranial bones are underrepresented – indicating either their deposition outside the
175 unexcavated area, or that heads had been removed from the body before the meat was then
176 sold and taken off site – perhaps by people using the road.
- 177 5. Cattle and sheep increased in size by the late Roman period.
- 178 6. Horses were important, and, to some extent, they must have been bred nearby.
- 179 7. There were good connections with the road network, as suggested by the presence of
180 potentially imported species, such as marine fish, and black rat.

181 The aim of this review is to compare these results with those from other similar sites, to ascertain
182 whether common zooarchaeological characteristics of roadside settlements can be identified.

183 3.1 *Species representation – cattle and sheep focus*

184 Figures 2-4 display proportions of cattle, sheep/goat and pig for the early, middle and late Roman
185 periods for a variety of site types, alongside the material from Ware (there is no middle Roman period
186 at Ware, but other sites with material from this period are displayed for comparison), and also the
187 other roadside settlements considered in this review. Sites used in this broader comparison were
188 selected from the regional review of Roman sites in Central England (Albarella with al. Forthcoming).
189 All the assemblages, except Springhead, were exclusively hand-collected and they are expected to be
190 affected by the same under-representation of smaller species as discussed for Ware. The degree of
191 bias is likely to be variable, so comparisons need to focus on substantial differences, as minor ones
192 may simply be the result of differential recovery bias. On all sites sheep and pig will be under-
193 represented in relation to cattle and horse.

194 The Ware assemblage has relatively high proportions of sheep remains in both its early and late
195 Roman phases, although they do reduce in importance by the late period. During the early phase
196 sheep make up 57% of the three main domesticates, with cattle at 33%. By the late phase sheep and
197 cattle show much more equal proportions with sheep accounting for 43% and cattle 45%. This broad
198 shift to an increase in cattle can also be seen across other site types, as has previously been noted
199 (Albarella 2007; Dobney 2001; Grant 1989, 2002; King 1999, 2001; Maltby 1981).

200 In both the early and late Roman periods the assemblage from Ware sits quite centrally within the plot
201 of roadside settlements and therefore reflects well the overall pattern seen at these sites. Roadside
202 settlements have some of the highest proportions of sheep during all phases. Even in the late Roman
203 period, when there is a countrywide increase in cattle frequencies, roadside settlements never have a
204 cattle representation of more than 60% (with the exception of Clausentum – which is one of the most
205 ‘urban’ of the sites included), even when some other ‘rural’ sites do. Roadside settlements tend to
206 have relatively equal proportions of cattle and sheep even by the late Roman period, and do not
207 display such a large shift towards cattle as other sites. In contrast, other rural sites show a large shift to
208 high proportions of cattle between the early and late Roman phases.

209

210 *3.2 Age at death – cattle and sheep*

211 *3.2.1 Cattle.* At Ware adult and elderly cattle dominate the assemblage (Figure 5), a pattern that is
212 reflected at other roadside settlements (Figure 6), and across the whole of Britain (Grant 1989:138;
213 Grant 2004; Albarella 2007:397; Albarella with al. Forthcoming). This pattern is typical of
214 populations that have been used primarily for traction, with the additional exploitation of younger
215 adults for their meat.

216 At Ware there is also evidence of neonatal cattle deaths, indicating that cattle breeding was taking
217 place on site. Remains of very young cattle have also been found at other roadside settlements,
218 including Tort Hill East, Silbury and Neatham.

219 The higher frequency of juveniles at Nettleton and Shiptonthorpe may indicate a higher degree of
220 infant mortality, and therefore a more challenging husbandry context. The exploitation of milk, which
221 could also explain that pattern, is less likely, as Roman agricultural writers (Cato, Varro, Columella)

222 do not mention cattle dairy use (White 1970). It must be emphasised, however, that they did not write
223 about Britain, where different customs may have existed.

224 3.2.2 *Sheep*. At Ware the sheep/goat mortality peak is consistently around the second or third year –
225 Payne’s age stages D and E - with some animals surviving into later adulthood (Figure 7). This is
226 consistent with the pattern seen at other roadside settlements for which we have raw data (Figure 8).
227 This high frequency of sub-adults and young adults is typical of a flock which would have been
228 exploited predominantly for its meat, but additionally for wool.

229 This pattern is in contrast to that of the settlement at Grandford. We do not have raw data to display,
230 but the publication presents a sheep/goat mortality peak at an older age, which has been interpreted as
231 indicating a particular focus on wool (Stallibrass 1982). This pattern is certainly an exception,
232 however, and the situation at Ware is in line with the evidence observed at most roadside settlement
233 types in Roman Britain.

234 3.3 *Sheep body part representation*

235 At Ware both the cattle and, particularly, sheep assemblage were dominated by teeth (Figures 9 and
236 10). Teeth are made of a very hard tissue and tend to preserve better than bones; therefore, to some
237 extent, this may be due to differential preservation. However, the pattern is too extreme, particularly
238 for sheep, for this to constitute the only explanation.

239 It seems that postcranial remains were not being deposited on site, or at least in the excavated part of
240 the site, at the same rate as cranial remains. It is possible that some postcranial remains may have
241 been deposited in parts of the settlement outside of the excavation area, or that heads could have been
242 brought to the site without their bodies. A more likely explanation, however, is that mutton, and
243 perhaps some beef too, was being sold on the bone after the head had been removed from the body,
244 which resulted in the postcrania being taken offsite. The position of the settlement on the side of a
245 major roadway would have provided a good opportunity for this kind of activity.

246 It has been difficult to undertake a direct comparison of body part patterns across the different
247 settlements included in this study, due to the variety of different methods used to calculate body part
248 representation, in addition to the generally small sample sizes recovered from these sites. However, a
249 general picture can be gathered from comments made in the text of a number of reports. Springhead
250 stands out as having a similar sheep teeth:postcrania ratio as Ware (Worley 2011). At this site there is
251 a considerable predominance of mandibles, which has been interpreted as either a situation where
252 heads were being brought to the site, or where postcrania were taken away; a similar scenario to
253 Ware.

254 Considering the dearth of sieving at most sites, small elements, such as loose teeth, may be
255 underrepresented. Considering that sieving was practiced at Springhead and, possibly, in some Ware
256 contexts, this may explain why more teeth were found at these sites than others. However, recovery
257 bias still cannot explain the imbalance between teeth and postcranial bones, which, therefore, is likely
258 to be attributed to human activity.

259 3.4 Cattle and sheep 'improvement'

260 The relatively large samples at Ware allowed for a biometrical study of both cattle and sheep remains,
261 and our review of other roadside settlements has indicated that this is now the most thorough
262 biometrical study from this site type in Roman Britain. Most of the settlements included in this study
263 had sample sizes that were too small to conduct a detailed study, and even fewer had published raw
264 data available for a direct comparison. Only Tort Hill, Stonea and Bainesse had raw biometrical data
265 which could be compared to the dataset from Ware. Data from the farm site at Heybridge, where there
266 are large samples, and there is clear evidence for size increase of the animals, have been used for
267 comparative purposes (Albarella et al. 2008; Johnstone and Albarella 2015).

268 3.4.1 Cattle. At Ware the cattle population showed no change in size between the early and late
269 Roman phases, according to both postcranial and tooth measurements (Figures 11 and 12).
270 Comparison of the pattern from Ware with that seen at Heybridge, however, indicates that the cattle at
271 Ware are larger than the Iron Age animals at Heybridge, and had therefore already undergone a
272 process of stock improvement by the early Roman period.

273 Middle Roman cattle from both Tort Hill and Stonea seem to have been of a similar size to the early
274 Roman animals at Ware (Figure 13). The population at Bainesse, where we have data from both the
275 Early and Middle Roman period, shows a clear shift over time; from smaller sized animals during the
276 early Roman period (albeit with a small sample) to a mixture of small and larger animals during the
277 Middle Roman period. The majority of the Middle Roman sample at Bainesse is still made up of
278 smaller cattle, however, suggesting that the process of stock improvement was still taking place. At
279 Tort Hill and Stonea there is no sign of the small cattle seen at Bainesse during the Middle Roman
280 period, suggesting that in southern areas the process was at a more advanced stage.

281 During the late Roman period (Figure 14), the cattle population at Bainesse also contains the smallest
282 cattle, but does have some overlap with the southern sites, and a number of particularly large outliers.
283 Again this suggests that the process of stock improvement at this northern site was lagging behind the
284 southern sites, with perhaps the addition of a few large imports.

285 3.4.2 Sheep. Sheep at Ware underwent a slight increase in size between the early and late Roman
286 phases, which can be seen in both postcrania and teeth (Figures 15 and 16). This indicates that our
287 dataset covers at least part of a period of sheep improvement at the site. Interestingly, sheep from the
288 early Roman phase at Ware are larger than those at the equivalent phase at Heybridge, whereas by the
289 late Roman phase they are a similar size at both sites. This may indicate that the process of stock
290 improvement began earlier at Ware than at Heybridge, which is noteworthy considering that
291 Heybridge is thought to be the more urban of the two sites.

292 The sheep at early Roman Bainesse were of a much smaller size to those at Ware (Figure 17),
293 indicating that the sheep at Ware had already undergone some improvement by the early Roman
294 period, and that the sheep at Bainesse were of an unimproved type.

295 An increase in body size can be seen at Stonea between the middle and later Roman periods,
296 indicating that some sheep improvement was taking place here during this time (Figure 18). The

297 sheep at Bainesse, however, do not show any clear size increase, although the Late Roman population
298 does not contain as many small specimens as the Middle Roman population. At Tort Hill the pattern is
299 unclear, due in part to small sample sizes; in the mid Roman period sheep seem to be a similar size to
300 the improved animals at Ware, but during the late Roman period some particularly small individuals
301 are present.

302 The size-increase in livestock such as that seen at Ware and some other roadside settlement sites can
303 be seen across Britain at many Roman sites. It is thought to reflect a process of stock improvement,
304 related to the intensification of agriculture and a need to increase meat production, as networks
305 widened after the Roman invasion (Albarella et al. 2008).

306 *3.5 The significance of horses*

307 At Ware horse is better represented than one would usually expect during the Romano-British period.
308 It makes up approximately 11% of the domestic assemblage in the early Roman period and around
309 9% in the late Roman period (Figure 19). Additionally, horse epiphyseal fusion and tooth data from
310 Ware indicate that some young animals were present on site (Figure 20 and Table 2). In the late
311 Roman phase this included an unfused humerus from a very young, perhaps neonatal animal, in
312 addition to a number of deciduous teeth (Wright et al. Forthcoming).

313 The proportion of horses at Ware is higher than the average across all site types in both the early and
314 late Roman phases, which show average proportions of under six percent (Figure 19 – comparative
315 data from Albarella with al. Forthcoming), and a number of the other roadside settlement assemblages
316 also have relatively large proportions of horse. The majority of these sites also have some young horse
317 specimens. This is especially noteworthy in view of the small size of many of these assemblages,
318 compared to those from larger urban sites. To provide some context, no immature horse remains were
319 found in any of the very large Roman assemblages from Exeter (Maltby 1979) and Wroxeter
320 (Hammon 2005) and none are mentioned at Colchester (Luff 1993).

321 *3.6 Imported species*

322 One of the most significant findings in the assemblage from Ware was the presence of a small number
323 of specimens from species which must have been imported to the site, either deliberately or
324 accidentally.

325 *3.6.1 Marine Fish.* At Ware we have identified two specimens of plaice (*Plueuronectes platessa*)
326 from a late Roman context. Plaice are restricted to marine and estuarine environments, neither of
327 which exist near to Ware. Comparing the situation at Ware to other roadside settlements is difficult, as
328 when fish are present at most of our comparative sites, they do not tend to have been identified to
329 species. One exception is at nearby Puckeridge-Braughing, the closest of our comparative small
330 settlement sites, where flat fish has been identified (Fifield 1988). Flatfish are predominantly marine,
331 but in this case these remains are thought to be from flounder (*Platichthys flesus*), which can enter
332 fresh water and is found along rivers. Nevertheless, there is a possibility that these remains would
333 have been imported. Both the settlements at Ware and Puckeridge are situated on the major roadway
334 of Ermine Street, so it seems particularly interesting that both of these sites have potential evidence of

335 marine fish, whilst at the same time being very well connected to each other. The excavators
336 confirmed that some marine shell, including oyster, were recovered at Ware, which provides further
337 evidence of coastal imports, though these remains were not made available to us for this study.

338 3.6.2 *Black rat*. At Ware we have also identified two specimens of black rat (*Rattus rattus*) in the late
339 Roman period. The black rat is thought to have been introduced to Britain in Roman times (Rackham
340 1979; Armitage et al. 1984; Armitage 1994), but the identification of this species is still a relatively
341 rare occurrence at British Roman sites. Black rat was also found at Springhead, in an early Roman
342 context (Worley 2011). The possibility that these specimens are intrusions cannot be completely
343 disregarded, but it seems unlikely, as the black rat is not a burrowing animal (unlike the brown rat,
344 *Rattus norvegicus*, which was introduced into Europe much later). Although there have been other
345 black rat specimens identified on British Roman sites, including those that are not on roadways, it is
346 worth thinking about the processes by which this species may have spread across Britain, after it
347 arrived probably accidentally by boat. One potential scenario is that it could have spread inland in
348 vehicles that travelled around the road network, such as in carts filled with hay. The proximity of both
349 Ware and Springhead to roads therefore may not be accidental.

350 4. SUMMARY AND DISCUSSION

351 The faunal assemblage from the roadside settlement at Ware has provided an important contribution
352 to our knowledge of these Romano-British settlement sites. The patterns from Ware also seem to
353 reflect those seen at other roadside settlements. Sheep was particularly common and proportions of
354 cattle do not increase as rapidly over time as at other site types, including other types of rural sites.

355 The tendency of rural sites to have higher sheep frequencies compared to other site types has
356 previously been identified by King (1978; 1984; 1999), who suggested that this pattern indicates some
357 form of continuity with an 'Iron Age' type of husbandry. King's work, however, was looking for
358 broad patterns, and his general hypotheses may not be appropriate for the interpretation of every site;
359 after all, the term 'rural' can be applied to sites with a variety of different functions. Bearing this in
360 mind, a continuation of an 'Iron Age' way of life might make sense at more remote sites, but would
361 seem more surprising at sites that would have been exposed to the passing influence of travellers on
362 the road.

363 Cattle mortality profiles at roadside settlements tend to reflect the pattern seen across the whole of
364 Roman Britain, regardless of site type, and reflect the specialisation of cattle as traction animals in
365 addition to meat production. There is no evidence to suggest that cattle were being managed
366 differently at these smaller settlement sites than they were elsewhere.

367 Most roadside settlements seem to have kept sheep for wool but, particularly, meat. There is evidence
368 that such products were important for the economy of the local area surrounding these sites. Some
369 settlements, such as Grandford, may have had specialised productions (e.g. wool), which must have
370 been produced in quantities beyond the use of local residents. Others, such as Ware and Springhead,
371 have interesting body part patterns which may be explained by the selling of certain portions of meat
372 on the road. These sites, then, were sometimes used as production centres, well connected to wider
373 economic networks.

374 Further indication that these sites were well connected and exposed to Roman influence comes from
375 the clear evidence of stock improvement occurring even earlier than the more urban site of Heybridge.
376 The production of larger cattle is thought to be partly down to the introduction of new, larger, breeds
377 from the continent (Albarella et al. 2008). The patterns seen at these roadside settlement sites may be
378 reflecting the geographical and temporal spread of larger breeds throughout the country. This process
379 seems to begin particularly early at Ware (the southernmost site in our biometrical study), where there
380 is evidence of both cattle and sheep improvement by the early Roman period. At Tort Hill and Stonea
381 (geographically located between Ware and Bainesse) there is some evidence that stock improvement
382 may have taken place by, or during the middle Roman period. At our most geographically northern
383 site, Bainesse, in contrast, the process of stock improvement seems to be lagging behind the southern
384 sites.

385 There does not seem to be much delay in stock improvement at sites a little further north than Ware
386 (i.e. Stonea and Tort Hill). However, the adoption of animal improvement was delayed the longest at
387 Bainesse, the most northern comparative site in this study, indicating a logical geographical pattern in
388 the spread of these new innovations.

389 Roadside settlements also seem to have a particular focus on horses and horse breeding. Since Roman
390 sites with high frequencies of horse tend to have specialised functions, such as the amphitheatre at
391 Silchester (Grant 1989) or the ‘ranching’ farms highlighted by King (1978), this pattern implies that
392 roadside settlements may have had some kind of specialised function involving horses, which
393 potentially also involved horse breeding. Albarella (1997) previously noticed this pattern at the Tort
394 Hill sites, and suggested that they may have been supplying horses to travellers on Ermine Street.
395 Certainly the settlement at Ware had strong links with the transport on the road, as is attested by the
396 large number of hipposandal fragments and other related items recovered here (Crummy
397 Forthcoming). The results presented here indicate that this was a more generalised pattern and that
398 horses were important at roadside settlements in general, probably a consequence of the connection
399 these sites had with broader trade and exchange networks. Developed and well-maintained roads,
400 draught animals, the driving of animals on the hoof, and the opportunity to transport goods, meant that
401 long-distance commercial systems were indeed possible (cf. Groot 2016, 17).

402 Finally, the presence of black rat, oyster and marine fish at multiple roadside settlements provides
403 further evidence of how connected many of these sites were.

404 5. CONCLUSION

405 There is much debate around how the Roman economy functioned, and whether the main driving
406 force was trade and exchange at local markets (e.g. Silver 2007; Temin 2001; 2017) or political
407 decisions made by the imperial estate (e.g. Bang 2008; Hopkins 1980; Wickham 2005). It is generally
408 agreed, however, that the two main sources of demand for agricultural production in Roman Britain,
409 and indeed other areas of North-western Europe were urban centres and the army (Allen and Lodwick
410 2016; Groot 2016; Thomas and Stallibrass 2008). We do not know exactly how the economic system,
411 by which products were supplied to these destinations, was organised. Some products may have been

412 traded through markets, but some may have formed part of the taxation system. Either way,
413 agricultural production responded to the demand from these two main stimuli.

414 Rural sites are generally considered to be producer sites and urban settlements consumer sites (Groot
415 2016), but this is of course an over-simplification, which does not take into account the complexity of
416 production, consumption, trade and exchange networks – ‘producer’ sites also need to feed
417 themselves. Roadside settlements may encapsulate this complexity by taking a role which cannot be
418 classified along the lines of consumption and production.

419 Our evidence suggests that these sites were well ‘plugged in’ to the wider economic system through
420 being centres for the movement of goods and innovations. In some cases, they were producing
421 surpluses of certain products themselves - such as at Grandford, with its focus on wool - and in
422 general they seemed to be a hub for horses, and perhaps even horse breeding. These products were
423 evidently traded or exchanged at these roadside locations and then moved around using the road
424 network. It is also clear that some roadside settlements were also quickly impacted by agricultural
425 innovations brought about by the Roman occupation, such as the introduction of new larger cattle and
426 sheep. These settlements may also have acted as stop-off points for traders moving their products
427 around the road network, although this is difficult to detect in the archaeological record of these sites,
428 as most would end up being deposited elsewhere.

429 Overall, roadside settlements had an important role as facilitators between net producer and consumer
430 sites. They are likely to have had a key role in the organisation of the Roman society and economy
431 and in facilitating the societal and agricultural changes that came about during the Roman occupation
432 of Britain. They cannot therefore be treated as remote sites devoid of Roman influence, as rural sites
433 often are. Despite their obvious importance, these sites have been slightly neglected, as emphasis
434 placed on the physical reconstruction of the Roman road network has somewhat sidelined research
435 focused on the activities of those who spent their lives alongside those roads. In this paper we have
436 illustrated aspects of the vitality of these settlements and provided an insight in the key role they
437 played in the Roman society.

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7. TABLES (SEE FOLLOWING PAGE)

Table 1. Comparative sites used in this review. Total NISP refers to the sum of cattle, sheep, pig, and horse NISP only.

SITE	CHRONOLOGY	NUMBER OF IDENTIFIED SPECIMENS (NISP)					REFERENCE
		Cattle	Sheep	Pig	Horse	Total ^a	
NORTHERN ENGLAND							
Roadside settlement							
Bainesse	Roman	3284	2224	926	764	7198	Meddens 1998
Nettleton and Rothwell	Late Iron - Early Roman (AD 20-120)	80	342	80	17	519	Rackham 2013
	Early Roman (AD 50 - 200/220)	53	188	49	4	294	
	Middle Roman (AD 150 - 300)	6	8	9	-	23	
	Mid - Late Roman (AD 200 - 330)	1	-	-	-	1	
	Late Roman (4th century AD)	6	26	5	-	37	
	Late - Post Roman	2	6	2	-	10	
Shiptonthorpe	Roman	114	72	14	12	212	Mainland 2006
	Phases 1 - 2 (AD 100 - 255)	11	40	12	-	63	
	Phases 3 - 4 (AD 225 - 325)	277	332	76	61	746	
	Phase 5 (AD 325 - 350)	369	409	92	34	904	
	Phase 6A - B (AD 340 - 410)	142	163	36	8	349	

CENTRAL ENGLAND							
Roadside settlement							
Racecourse 74	2nd century AD	162	162	22	24	370	Harman, Bramwell and Baker 1986
	3rd century AD	188	165	32	8	393	
Sidbury	Early Roman (1st - 2nd century AD)	431	451	71	231	1184	Scott 1992
	Late Roman (3rd - 4th century AD)	1690	874	237	61	2862	
Stonea	Middle Roman (2nd - 3rd century AD)	419	496	127	20	1062	Stallibrass 1996
	Late Roman (3rd - 4th century AD)	1294	1271	340	48	2953	
Tort Hill East	Phase 1 (late 1st - early 2nd century AD)	3	0	3	2	8	Albarella 1997
	Phase 2 (early - mid 2nd century AD)	47	37	6	19	109	
	Phase 3 (late 3rd - 4th century AD)	47	41	6	17	111	
	Phase 4 (post Roman)	2	1	-	-	3	
Tort Hill West	Phase 2 (pre Roman - Late Iron)	64	39	14	9	126	Albarella 1997
	Phase 3I (1st - 3rd century AD)	78	64	15	55	212	
	Phase 3II (late 2nd - 4th century AD)	4	14	-	1	19	
Village							
Grandford	Early Roman	218	461	91	9	779	Stallibrass 1982

	Middle Roman	224	462	53	2	741	
	Late Roman	636	1099	143	11	1889	
Small town							
	Phase 1 (up to AD 75)	1348	1546	1412	53	4359	
Puckeridge-Braughing	Phase 2 (late 1st - mid 2nd century AD)	366	701	215	19	1301	Fifield 1988
	Phase 3 (late 2nd - mid 3rd century AD)	105	107	75	20	307	
	Phase 4 (mid 3rd - late 4th century AD)	406	490	125	101	1122	
SOUTHERN ENGLAND							
Roadside settlement							
Shepton Mallet	Roman	394	283	61	36	774	Pinter-Bellows 2001
Silbury	Early Roman (2nd century AD)	27	22	4	2	55	Baker 2013
	Late Roman (3rd - 4th century AD)	52	58	27	6	143	
Springhead	Early Roman	724	1201	221	72	2218	Worley 2011; Hamilton-Dyer 2011
	Mid Roman	219	149	47	24	439	
	Late Roman	135	77	39	14	265	
Wilcote 1990-92	Phase 1 (AD 40-75)	146	633	153	13	945	Hamshaw-Thomas 1993
	Phase 2 (AD 70-120)	465	914	134	20	1533	

	Phase 3 (AD 120-200)	732	1190	157	31	2110	
Small town							
Alchester	Period 3 (mid - late 1st century AD)	3	2	1	4	10	
	Period 4 (late 1st - early/mid 2nd century AD)	1	10	-	-	11	
	Period 5 (early/mid - later 2nd century AD)	40	28	9	47	124	
	Period 6 (late 2nd - mid 3rd century AD)	129	100	29	34	292	Powell and Clark 2002
	Period 7 (mid 3rd - late 3rd/early 4th century AD)	269	238	41	155	703	
	Period 8 (early - mid 4th century AD)	474	451	99	29	1053	
	Period 9 (late 4th century AD)	383	321	100	45	849	
Clausentum	Early Roman (AD 70-180)	88	12	12	-	112	Bilton 1958
	Late Roman (AD 350 - 400)	223	48	99	6	376	Cornwall 1958
Neatham	Early Roman (AD 75 - 250)	120	174	21	2	317	Done 1986
	Late Roman (AD 250 - 400)	942	318	127	70	1457	

Table 2. Frequency of horse deciduous and permanent teeth at Ware, by phase. NISP=Number of Identified Specimens. Percentages have only been calculated for overall NISPs of at least 10.

Horse Teeth	Phase 4 (Early Roman)		Phase 5+6 (Early Roman)		Phase 7+8 (Late Roman)	
	NISP	%	NISP	%	NISP	%
Deciduous	6	40	1	1	11	10
Permanent	9	60	67	99	97	90
Total	15	100	68	100	108	100

8. CAPTIONS OF ILLUSTRATIONS

Figure 1. Map of Great Britain showing the sites mentioned in the text. References: 1. Baines; 2. Shiptonthorpe; 3. Nettleton and Rothwell; 4. Racecourse; 5. Tort Hill; 6. Grandford; 7. Stonea; 8. Sidbury; 9. Wilcote; 10. Alchester; 11. Puckeridge-Braughing; 12. Ware; 13. Silbury; 14. Springhead; 15. Shepton Mallet; 16. Neatham; 17. Clausentum.

Figure 2: Relative proportions (according to Numbers of Identified Specimens - NISP) of cattle, sheep/goat and pig at Early Roman sites, grouped by site type.

Figure 3: Relative proportions (according to % NISP) of cattle, sheep/goat and pig at Middle Roman sites, grouped by site type.

Figure 4: Relative proportions (according to % NISP) of cattle, sheep/goat and pig at Late Roman sites grouped by site type.

Figure 5: Cattle mortality at Ware according to tooth eruption and wear for the whole archaeological assemblage, and then the Early and Late Roman phases. Age categories assigned according to O'Connor 1988.

Figure 6: Cattle mortality at Nettleton and Shiptonthorpe according to tooth eruption and wear. Age categories assigned according to O'Connor 1988.

Figure 7: Sheep/goat mortality at Ware according to tooth eruption and wear for the whole archaeological assemblage (top diagram), and then the Early (middle) and Late (bottom) Roman phases. Age categories assigned according to Payne (1973).

Figure 8: Sheep/goat mortality from roadside settlement sites: Early Roman Nettleton (top diagram), Middle and Late Roman Shiptonthorpe (middle two diagrams) and Late Roman Sidbury (bottom diagram). Note the E-H combined category for Nettleton and Sidbury - this is due to restrictions on the way that the data was presented in the original publications.

Figure 9: Cattle body part representation at Ware according to Minimum Animal Units - MAU, *sensu* Binford 1984 (see Appendix 2) for all archaeological phases combined, and then for Early and Late Roman phases. Only elements with the highest MAU value for each body portion (cranium, upper limbs, lower limbs and extremities) have been included, and are specified in parentheses.

Figure 10: Sheep/goat body part representation at Ware for all archaeological phases combined and then for the Early and Late Roman phases. Only elements with the highest MAU value for each body portion (cranium, upper limbs, lower limbs and extremities) have been included, and are specified in parenthesis.

Figure 11: Log ratio plots combining all cattle postcranial width measurements, from Ware (top two diagrams) and Heybridge (bottom four diagrams). The standard is marked with a line. The mean is marked with a circle (means only calculated for samples of more than 5). Note that the two sites are shown on a different vertical scale.

Figure 12: Cattle 3rd molar width measurements from Ware (top two diagrams) and Heybridge (bottom four diagrams). Note that the two sites are presented on a different vertical scale.

Figure 13: Log ratio plots showing Early and Middle Roman cattle postcranial width measurements from a number of roadside settlement sites. The standard is marked with a line. The mean is marked with a circle (means only calculated for samples of more than 5).

Figure 14: Log ratio plots showing Late Roman cattle postcranial width measurements from a number of roadside settlement sites. The standard is marked with a line. The mean is marked with a circle (means only calculated for samples of more than 5).

Figure 15: Log ratio plots showing sheep/goat postcranial width measurements from Ware and Heybridge. The standard is marked with a line, the mean is marked with a circle (means only calculated for samples of more than 5).

Figure 16: *Sheep/goat* 3rd molar width measurements from Ware (top two diagrams) and Heybridge (bottom three diagrams). Note that the two sites are presented on a different vertical scale.

Figure 17: Log ratio plots of *sheep/goat* postcranial widths from Early Roman Ware and Bainesse. The standard is marked with a line. The mean is marked with a circle (means only calculated for samples of more than 5).

Figure 18: Log ratio plots of *sheep/goat* postcranial widths from a number of Middle and Late Roman roadside settlements. The standard is marked with a line. The mean is marked with a circle (means only calculated for samples of more than 5).

Figure 19: Proportions of equid remains (according to total NISP of horse, cattle, sheep/goat, and pig) at roadside settlement sites, compared to the average for the central region (comparative data taken from the regional review by Albarella et al. Forthcoming).

Figure 20: Fusion of horse bones at Ware, for all archaeological phases combined and then Early Roman and Late Roman phases. Unfused epiphyses have been excluded. Fusion stages follow Silver 1969.

9. LIST OF APPENDICES

1. Recording Protocol for mammal and bird bones
2. Quantification formulae

10 SUPPORTING INFORMATION

1. The Ware animal bone database