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The supply and movement of Denarii in Roman Britain

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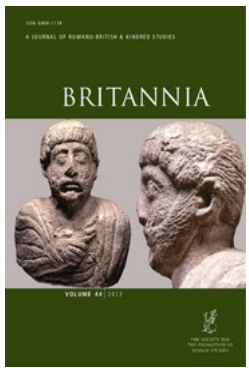

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The Supply and Movement of Denarii in Roman Britain

By JOHN CREIGHTON

ABSTRACT

Hoards of denarii are common in Britain and the number which have been recorded in detail means that it is now possible to suggest reasonably accurately what a 'normal' hoard of a particular date should look like. That being the case, we can then look for variation around that norm and both investigate and speculate what that variation means. A methodology is developed which suggests periods of faster and less rapid coin circulation which has implications for consideration of monetisation. The model also enables us to view where denarii entered circulation; unsurprisingly the army looms large in this picture. The methodology is directly transferable to other provinces and other periods where there are long-lived, relatively stable monetary systems.

Keywords: denarius; hoard; circulation; money-supply; Roman; Britannia

INTRODUCTION

The Late Republic and Early Roman Empire have often been perceived as a period of sustained economic growth.[1] The total stock of denarii in circulation was thought to be steadily increasing as monetisation took hold in the provinces and markets developed. This positive vision could even sustain the gradual debasement of the denarius and its descent into the billon radiates of the third century, followed by the plentiful bronzes of the fourth century, which was spun positively as evidence that this now abundant small change could facilitate market exchange in a way that high-value silver coins originally could not. From the perspective of the ongoing financial crisis since 2008, continued and sustained growth and monetisation is a comforting idea, but rarely a reality, bubbles burst. So how continuous was 'growth' and monetisation in Roman Britain through the two centuries after the Claudian conquest?

The long-term stability of the monetary system in operation during the first and second centuries makes it tricky to use the coinage to answer any of these questions. Such was the stability that a find from a site of a denarius of Mark Antony could have been lost at almost any time from Britain's first contact with the Roman world through to the early third century

[1] The classic paper placing discussion in such terms is Hopkins 1980.

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when the radiate took its place.[2] A histogram of site-finds of this period based on the date of coin production, therefore, only has limited value in informing us of the date of use, loss or deliberate deposition of coin, since its period of circulation could have spanned anything from a day to several centuries before being 'lost'. Instead economic discussion about the province has tended to focus upon other tangible evidence: the size of the garrisoned army; the rise and fall of the importation of fine wares and amphorae; the organisation of the major ceramic industries and the supply of the army;[3] and increasingly the direct ecofactual evidence for feeding the army rather than using the proxy of ceramics.[4] However, money lies behind the changes in taxation and trade. The army had to be paid for, supplied in kind or from the market; money lay behind the development of the urban markets; and money was an important medium through which to spread the image of the emperor and political messages. Finding a way to observe patterning and nuance in this long-lived stable currency system would be a significant step forward in creating narratives of the period.

The objective of this paper is to develop a methodology to try and unlock the potential of information from hoards in this period of apparent stability, to show how coin (in this case denarii) moved around the province, and to do this quantitative analysis in an accessible visually intuitive way. This entails creating a dynamic model from static data. Did new coin come from the mints to pay the soldiers? Is this where it entered circulation? Was the provincial capital (or later capitals) a place where new coin was issued and spent? Did money circulate faster and faster as monetisation took hold and people started using it more? These are the kinds of question which if answerable can challenge a presumption of sustained growth, and start moving towards a more nuanced and undoubtedly bouncier economic history of the province.

THE CONCEPT

There are many assumptions made about the circulation of coinage in the Roman world. Some are so 'obvious' and 'common sense' that they are rarely questioned. We have no accounts for the Roman state, but no ancient historian would question that the Roman army was the largest item of expenditure during the Principate. This has been the foundation for many models of the Roman economy.[5] We imagine that new coin largely entered circulation where the army was, and it might also have happened where provincial governors were based. Sometimes detailed analysis can show this: Fleur Kemmers examined the supply of coinage to the Lower Rhine revealing that often there appeared to be peaks in the presence of coins of the same date that each fort was founded, implying new coins dominated supply during campaigns.[6] However, at times countermarked coins of an earlier emperor might be used if supply was limited or demand for coins elsewhere was high. An example of this was the presence of TICLAVIM Claudian countermarks on Caligulan coin along the Rhine at the time when campaigns in Britain were taking place and new coin was demanded there.[7]

[2] There was a marked decrease in the proportion of Republican coins in circulation in the Neronian and Trajanic periods, but a few remained in circulation, particularly the debased legionary denarii of Mark Antony. The most extreme example in Britain is the denarius of 49 B.C. (*RRC* 442) found in the Patching (W Sussex) hoard which was deposited in the late A.D. 460s along with imitative material of the Visigothic kingdom of Toulouse. See Orna-Ornstein 2009.

[3] A classic example of this is Fulford's (1989) survey of the economy of Roman Britain.

[4] e.g. Stallibrass and Thomas 2008.

[5] e.g. Hopkins 1980.

[6] Kemmers 2004, 34.

[7] Kemmers 2004, 49; 2006.

However, despite the wealth of quantitative data from site finds and coin hoards, we still lack a large-scale dynamic model of the flow of money around the Roman world during the Early Empire. In other periods mintmarks have been used to track the movement of coin, but unlike the East, there were few mints in the West to aid us.[8] By contrast, in the later Roman world mintmarks offer the chance to model the flow of coinage from one area to another,[9] and in more recent times more advanced statistical techniques have been developed to study the spread of the Euro coins since its inception in January 2002 which could potentially be applied to the Later Roman Empire.[10] But in the Early Empire this tracking of coin has only been possible on a few, rare occasions. To develop a wider narrative we need more than the tracking of individual coin types from province to province, and we need more than large-scale observations that the coinage of one province was not identical to that of another. To look at the Roman economy and discover how integrated it was we need, as Chris Howgego has stated, 'to ask how much mixing of coin took place, how long it took, and in what context it happened'.[11]

In developing a new method we need to conceptualise the coin circulation pool. As each new moneyer or emperor issued denarii, the absolute number of these would gradually rise as the coins entered circulation; then decline and fall as coins disappeared through accidental loss, permanent votive deposition, or the non-recovery of stores of wealth or hoards (FIG. 1a). The tail-off might be gradual or subject to a sudden decline as an earlier issue was recalled or melted down because it had an excess of silver in it relative to contemporary issues (Gresham's Law). Some issues would be larger than others, but cumulatively all the series stacked together make up the entire coin circulation pool of denarii (FIG. 1b). Can we know the shape of this curve? Alas, we have no secure way of reconstructing the total number of coins in circulation in Britain; die studies might reconstruct for us notional issue sizes for the Empire as a whole,[12] but we cannot easily know the proportion of coin that came here rather than to another province. However, if we consider that coin hoards reflect coinage in circulation then we could at least attempt to reconstruct a proportionate image of the denarii in circulation (FIG. 1c), but would this be a legitimate assumption?

Many numismatists have expressed the view that if hoards are providing a consistent picture, then they would feel comfortable with correlating the pattern of coins of one denomination in hoards with the contents of the coin circulation pool. For example, Marion Archibald considered that: 'the proportions of coins of different reigns and types present in particular hoards are of course expressible as precise figures. These figures provide a very important guide to the relative commonness of these groups, but they must not be taken as evidence of

[8] Some work has been done showing the flow of denarii minted or issued in the East coming west, though it is not uncontentious. Duncan-Jones 1994, 175 observed the different proportion of denarii of the empress Sabina amongst Hadrian's types between Britain (5–8 per cent) and the Black Sea (11–18 per cent), suggesting differences in the distribution of coin never totally evened themselves out. He also made comparable observations on the distribution of Divus Marcus types under Commodus, and denarii of Marciana and Matilda under Trajan (Duncan-Jones 1990, 39–42). His position was firmly that coin did not move around much once it entered circulation. A debate ensued between Duncan-Jones and Howgego focusing on Severan coinage. The percentage of Severus' old-style eastern denarii can be seen to rise in British hoards over time, but Duncan-Jones concluded this was not because of the gradual flow of coin into the province over time, but owing to the selective withdrawal of later new-style heavier Severan coins, a consequence of the debasement that took place. An exchange of articles illustrated the complexities of Severan coinage with Howgego maintaining the evidence still supported the movement of denarii into Britain over time. See Duncan Jones 1994, 172–9; 2001; 2002; and Howgego 2002.

[9] e.g. Fulford 1978.

[10] Stoyan *et al.* (2002; 2004) reported on the *Euromobil* German-based project using techniques derived from epidemiology to model the movement; one clear observation was that the higher denominations were more mobile than small-change. A second project, *Eurodiffusie* based in the Netherlands, was similar (van Blockland 2002).

[11] Howgego 2002, 341.

[12] Though see the critique by Buttrey which suggests that even this might be a fool's errand: Buttrey 1993; 1994; and the more quantified critique by Lockyear 1999.

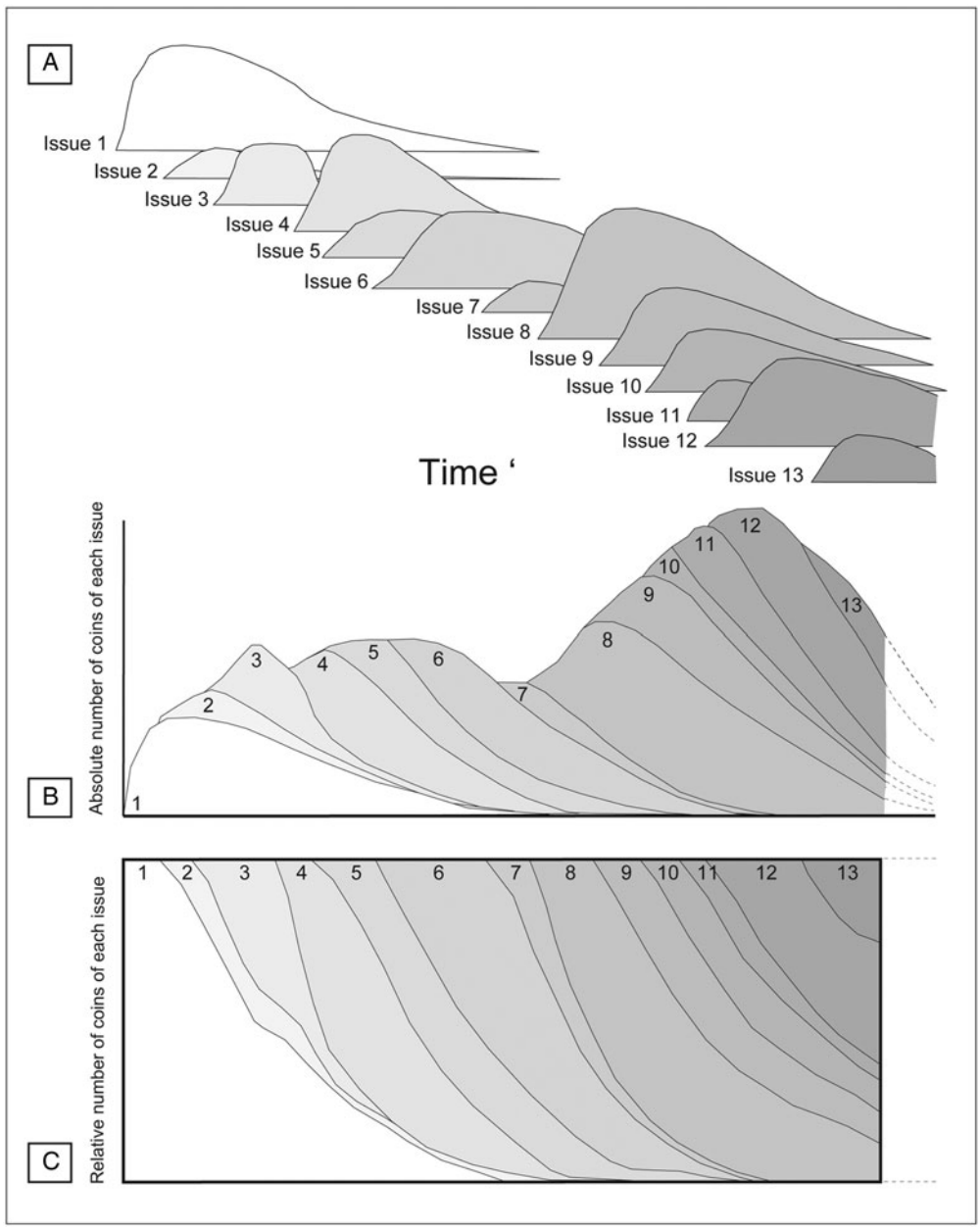

FIG. 1. The composition of the circulation pool: conceptual model.

the presence of precisely those proportions among the coins in circulation unless this is borne out by a considerable body of homogeneous hoard evidence.'[13] Similar sentiments have been expressed by Philip Grierson;[14] Michael Crawford agreed but qualified the equation of hoards with the circulation pool further by specifying that a large database was needed in order to remove various 'freaks and aberrations'.[15] Even by the 1950s Anne Robertson was concluding that 'an analysis of well listed Romano-British hoards does show that a group of hoards of the same period had, as a rule, the same general composition';[16] so much so that when an aberrant hoard was discovered, such as the Falkirk hoard in 1933 (discussed later), it clearly stood out as having far more older coins within it than other contemporary hoards.[17] Richard Reece most notably started to graph and tabulate how consistent the contents of Romano-British denarius hoards were from the 1970s onwards.[18] Since which, with the growth in metal detecting and the improved recording and publication of coin hoards, the data are now in place to attempt to put these hoards on a firm quantitative footing.

THE DATABASE

Britannia is a province rich in denarius hoards. 43,301 coins identified to individual emperors or their family can be associated with 287 hoards that contain five or more denarii. These are listed in Appendix 1 along with a reference to a corpus where the full bibliographic details of each individual hoard can be found. A corpus of coin hoards from Roman Britain was accumulated by Robertson (2000) — it missed a few antiquarian reports but was otherwise pretty comprehensive; since then new denarius hoards have mainly been published in the *Coin Hoards from Roman Britain* series, and the British Museum has also maintained an archive of Treasure reports. All hoards up until finds in mid-2009 are listed here. No datasets are without their challenges, so here are some with this one.

First, a threshold was needed as to how many coins a hoard required to be included in the analysis? The cut-off used is essentially arbitrary, but hoards of ten or more denarii were used to create the benchmark of what the 'normal' hoard structure should look like, whereas all hoards of five or more denarii have been tested against this benchmark and are listed in the appendix. The smaller the hoard the less likely the latest coin in the hoard is going to give an accurate date and the more random noise and variation will enter into the analysis.[19]

Secondly, while many recent finds have full and accurate records, this analysis includes finds reported as far back as the seventeenth century when there was only a list of emperors (and wives) available. It was important to be able to include these since they make up a significant number of hoards. While it would have been ideal to use Reece or Casey coin periods, the level of detail then required would have excluded the inclusion of a lot of earlier recorded hoards.[20] So instead a series of 17 broadly chronological groups A–Q has been established (Appendix 2). In the first two groups, the denarii of Mark Antony (Group B) have been separated out from other Republican

[13] Archibald 1974, 236.
[14] Grierson 1966, viii.
[15] Crawford 1983, 201. Lockyear 2007, 28, examining Crawford's Republican coin hoards, felt that 'within periods of stability … it appears that coin selection within a single denomination is random which allows us to examine the distribution of denarii during the later Republic with some confidence'.
[16] Robertson 1956, 270; a similar view was expressed by Reece 1974, 81.
[17] MacDonald 1934.
[18] Reece 1987, 46–70, particularly figs 4.3 and 4.4.
[19] The impact of hoard size was explored in the original thesis this paper is based on. It graphically shows that the variation in hoards of *c.* 10–40 denarii was all fairly similar, and that a noticeable reduction in variation only takes place in hoards of 50 or more: Creighton 1992, 105–7.
[20] For a comparison of the two, see Brickstock 2004, 14, table 3.

coins (Group A), partly because more antiquarians recorded them separately meaning this could be done, and also because they behave differently; Republican coins dropped off in circulation after Nero's reforms and are few after Trajan, but coins of Mark Antony persisted longer into the third century, so it was felt appropriate to separate them. Another chronological overlap comes where some early records are not specific about whether an individual was Caesar or Augustus on their coins (i.e. whether the coins were issued under their father or in their own reign), or when imperial wives outlasted their husbands. For example, antiquarian records often refer to a 'coin of Faustina' which could be Faustina the first or second, and if the second then was it minted under Antoninus Pius or Marcus Aurelius? So the pragmatic decision has been taken to lump all the Faustinas together in Group J along with Antoninus Pius.[21] Appendix 2 makes the details of the groups clear.

Thirdly, occasionally a hoard will contain an irregular coin. Much as today, irregular issues circulated amongst genuine ones. If there were any, it was often only one or two in a hoard of a hundred or so; in this case they have not been treated differently. However, very occasionally hoards entirely comprised irregular issues or else a significant package of copies in with regular ones. In these cases the irregular portion has been treated separately, and they have been considered as hoards in their own right. The patterning they reveal is discussed below.

Fourthly, particularly with antiquarian finds, only a sample of coins was recovered from the hoard. Often an idea of the actual size of the hoard was available and so the proportion identified could be judged. Sometimes there was no way of telling if there had been any selection of the sample. Nonetheless, many of these groups had the 'look and feel' of a 'normal' hoard, not suggesting that just the choicest specimens had been selected by the antiquarian. These have been included as hoards in their own right, but have been noted in the tables and analysis.[22]

Fifthly, establishing the *terminus post quem* (*TPQ*) of a hoard is usually by reference to its latest coin. Sometimes this can be very specific and dated to a single year, sometimes only to an emperor's reign. However, in the case of the earliest Roman coin hoards in Britain it can be a very moot point. For example, the Raydon hoard from Suffolk (1995) ended with a coin of 7 to 6 B.C. Because there were relatively few early Julio-Claudian denarii in circulation, it is possible this was actually a hoard deposited much later, and the practice used to be to assume that all such hoards dated to the Claudian conquest of A.D. 43 or later. Increasingly, I think that some of these may have been pre-conquest deposits, but for the purpose of this analysis any hoard with a closing coin earlier than the invasion has been given a *TPQ* of A.D. 43,[23] and interpretation of the conquest period should bear this in mind. Should this study ever be extended to examine hoards on the other side of the Channel in the Caesarean to Claudian era then it may be possible to re-examine this.

[21] There are more groups here than in the classic Reece coin periods. The earlier periods are divided more as are a few later ones, and also an explicit decision was made as to how to allocate all partial data, as in the case of 'a coin of Faustina', which in the PAS interpretation of the Reece periods would be in either Period 8 or 9. Hence, there is not an absolute match between the two.

[22] In the analysis that follows in this article, and the data shown in Appendix 1, it can be seen that of the 19 hoards where only a known proportion of the hoard was retrieved and identified, half have slightly more 'modern' coins in them than the average pattern established, and half less. This suggests there are no consistent distorting patterns of selection (such as picking out only the higher silver coins), but that these hoards do indeed represent useable data. The report from the primary record usually makes clear why only a selection was recovered.

[23] Debate about the early arrival of denarii into Britain is on-going. Some would date hoards late, for example hoards with no Claudian or Neronian coins in them have been dated to as late as A.D. 60 and the Boudican revolt by Orna-Ornstein 1997. This is of course technically possible. On the other hand others are more ready to accept that denarii started coming into Britain before the Claudian conquest and that there is no problem dating finds to before A.D. 43. There are good discussions relating to possible pre-conquest finds at Hayling Island temple (Haselgrove 2005, 386) and Hallaton (Leins 2007, 32; Score 2011, 42–3, 39–60); the issue is more broadly discussed in Walton 2012, 57–78.

THE 'NORMAL' HOARD

The data from the *c.* 230 hoards with ten or more denarii were used to create a concept of what an average or 'normal' hoard in Britain should look like at different dates (FIGS 2–3). In the graphs in FIG. 2, each individual hoard is represented as a point. The top left graph, therefore, shows the percentage of Republican denarii in hoards (Group A) declining over time.[24] Similarly the graph on the bottom right shows the presence of coins up to and including Group N (Caracalla) in hoards. Naturally these make up 100 per cent of all coins until after his death in A.D. 217, at which point the proportion in the hoards starts to fall. Graphs like this were created for each group from A–Q. A curve was fitted to each line, and FIG. 3 shows all the curves added together onto the same plot. This effectively represents our third-tier illustration in FIG. 1.

The curves provide, ultimately, only a rough approximation to the average composition of the denarius circulation pool at any date in Britain. The curves were arrived at in two ways. First by plotting directly the data points of the cumulative composition of the hoards (as seen in FIG. 2) and attempting to fit a curve to the line; and secondly by plotting the proportion of each coin group separately (as seen without all the individual data points in FIG. 4), then adding them together to ensure they totalled 100 per cent. No mathematical curves were fitted to the data. There is absolutely no reason why any of the graphs illustrated should conform to a simple mathematical function. Occasions such as the sudden input or withdrawal of a coin series in circulation would cause a step in the line which a fitted curve would in all probability smooth out. Instead, various interpolation techniques were used to suggest segments of curves, though in the end a judgement by eye was used to link them up. Ultimately this is simply a heuristic device, a crude measuring instrument by which to judge normality. The analysis later demonstrated that about half the hoards were judged by this benchmark to be 'archaic' and half 'modern' in comparison (i.e. half are above and half below the line in FIG. 6), which suggests that as 'an average' the curve has some broad validity or at least utility. The data for the final benchmark are given in Appendix 3. Doubtless the picture might be slightly different in another part of the Empire. The data exclude hoards which predominantly contained irregular denarii.

FIG. 4 shows all the individual series separated out. For coins which were already in circulation before Claudius, you can see their proportion in circulation roughly decline over time. For emperors later than the Claudian invasion, you can see their coin rise in proportion as their numbers entered circulation, and then generally decline as a percentage as they disappeared and new coins entered as well. For the final issues towards the end of the denarius' life, you can see how virtually all the denarii of Septimius Severus and earlier were withdrawn from circulation, just leaving the baser later issues in play. The vertical shaded areas on these graphs are added to assist visual perception of the effect of the end of production of the denarius and the institution of the radiate (also often called the antoninianus). The shaded area represents the time when the denarius was in its primacy. The first line at A.D. 215 represents Caracalla's introduction of the new coin, while the second and third represent the suspension from production of radiates during A.D. 219–38 and their subsequent reintroduction. However, it is stressed that all the information on the graph comes from only denarii.[25]

We now have a heuristic device representing 'normal hoard composition'. The spread of the individual hoards on either side of these lines in FIG. 2 should warn us that there is still much variation in the data, and the benchmark only represents a guide to the average composition; but it is in measuring that variation and analysing its temporal and geographical aspects that we may learn new information about the past.

[24] This graph of the declining proportion of Republican denarii in hoards is essentially the same as Reece's 1987, fig. 4.4, but with the data from 287 hoards instead of *c.* 99.

[25] For the introduction of the radiate, see Bland 1996.

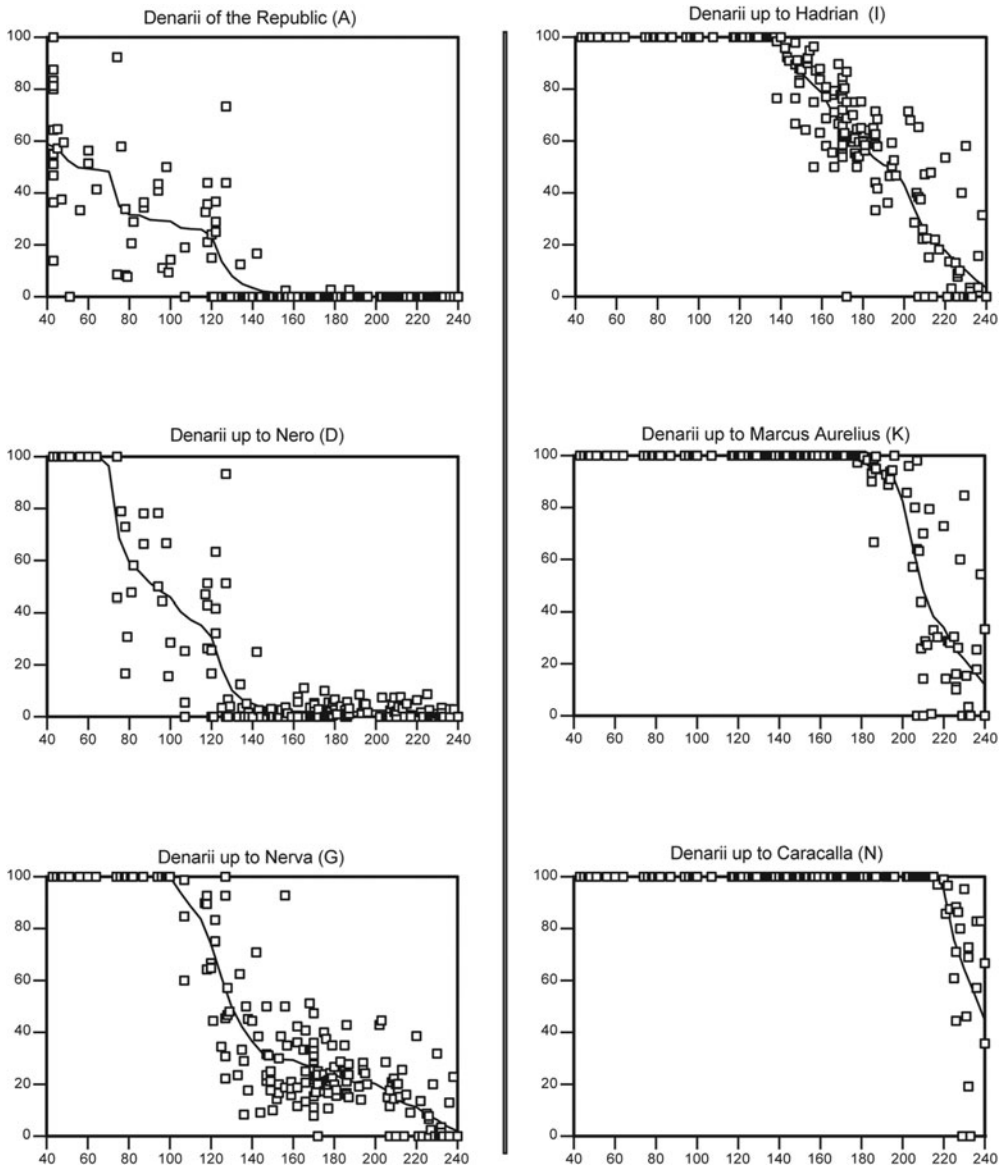

FIG. 2. The benchmark: the 'normal' composition of denarii hoards in Britain.

MEASURING VARIATION FROM THE BENCHMARK

Having established a benchmark, we now need a way of measuring difference from it. One way of visually expressing hoard structure is by drawing a cumulative frequency graph.[26] FIG. 5 shows

[26] This kind of graph was used extensively by Lockyear 2007 to visualise Republican denarius hoard structures.

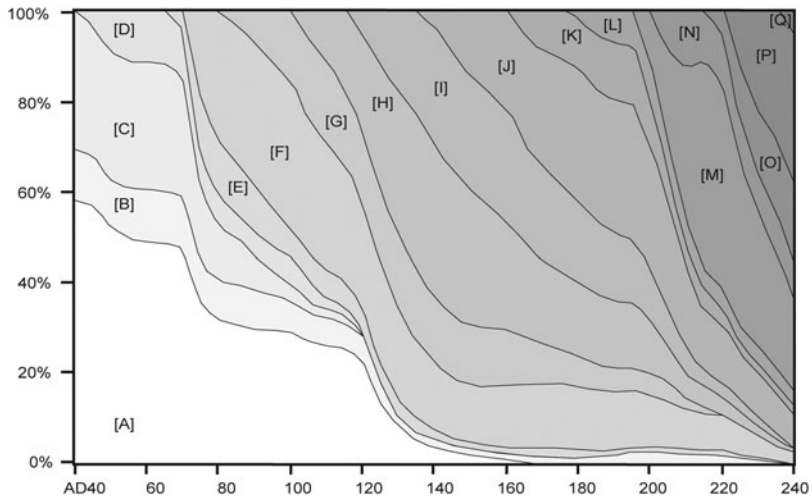

FIG. 3. Creating the benchmark: the cumulative proportion of different rulers on denarii within hoards over time. Each point represents an individual hoard containing more than five denarii. The Groups are: A. Republican; B. Mark Antony; C. Early Julio-Claudian; D. Later Julio-Claudian; E. Civil War; F. Early Flavian (Vespasian); G. Later Flavian (Domitian); H. Trajanic; I. Hadrianic; J. Antonine 1 (Antoninus Pius); K. Antonine 2 (Marcus Aurelius); L. Antonine 3 (Commodus–Didius Julianus); M. Early Severan 1 (Septimius Severus); N. Early Severan 2 (Caracalla); O. Later Severan 1 (Macrinus–Elagabalus); P. Later Severan 2 (Severus Alexander–Maximinus); Q. Later Severan 3 (Balbinus–Gallienus).

these curves for two early third-century hoards, one a fairly normal hoard from Wigan with a terminal date of *c.* A.D. 228, the other a large deposit from north of the Antonine Wall from Falkirk, with a terminal date of *c.* A.D. 230. Both of these are also compared against our benchmark curve for A.D. 230, representing what an average hoard of that date would look like.

The construction of the curves is straightforward: the percentage of each coin group represented in the hoard is calculated, then the cumulative percentage by adding one another (see Table 1). On the graph the proportion of coins in the Wigan hoard starts with 0.8 per cent of Julio-Claudian coins, rising to 1.5 per cent of issues up to the end of the Civil War, then 4.5 per cent dating to the end of Vespasian's reign etc., until 100 per cent is reached with the latest coin in the hoard, which in this case was *c.* A.D. 228 (Group P).

We now have a way of visually describing hoard structure. FIG. 5a compares three curves. It can be seen that the Falkirk hoard is largely above the benchmark line of A.D. 230, meaning it has an 'archaic' content, containing a larger component of earlier coins than might be expected. While the Wigan hoard is largely below the A.D. 230 line, meaning that it has a marginally higher proportion of newer coin in it than would be normal.

To create a measure of difference to the norm the difference in area between the two curves has been calculated. This is done by calculating the area under each curve individually[27] (FIG. 5b), and then subtracting the area of the actual hoard curve from the benchmark curve (e.g. the shaded areas in FIGS 5c and 5d). The larger the difference the more divergent the hoard; if the hoard is above the benchmark line, it is a negative divergence marking out a hoard with an 'archaic' composition, and if it is positive, it is a hoard with a more up-to-date content.

[27] This is calculated in the spreadsheet which created the graphs. It is done by dividing up the curve into a series of trapezoids, as shown in FIG. 5b, and adding them together. The area of a trapezoid is the average height (the two cumulative percentages of denarii) multiplied by the width (the difference between the two dates).

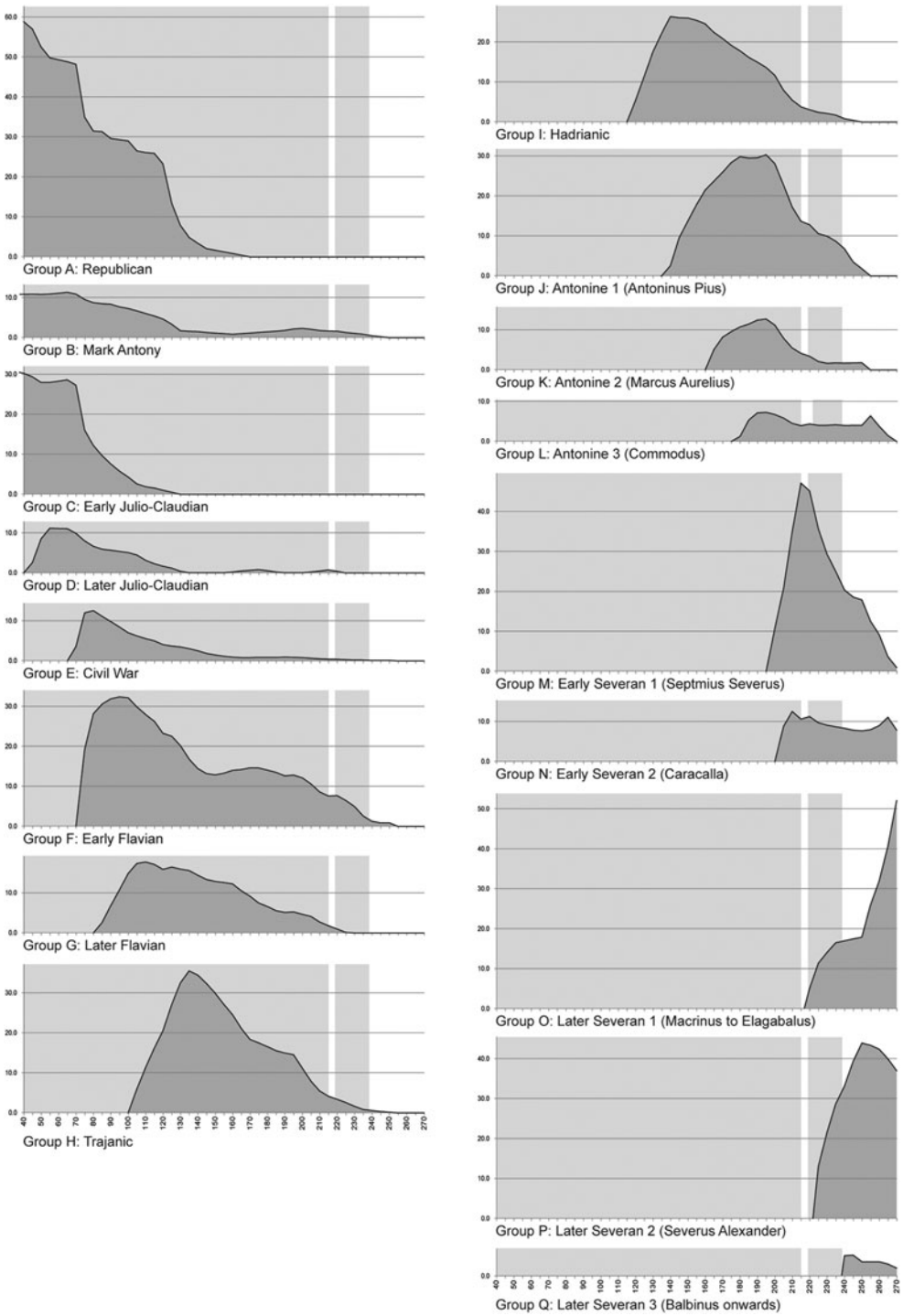

FIG. 4. The approximately average or 'normal' percentage of denarii of different date found in hoards in Britain (this shows the identical data to FIG. 3, but with each group separated out).

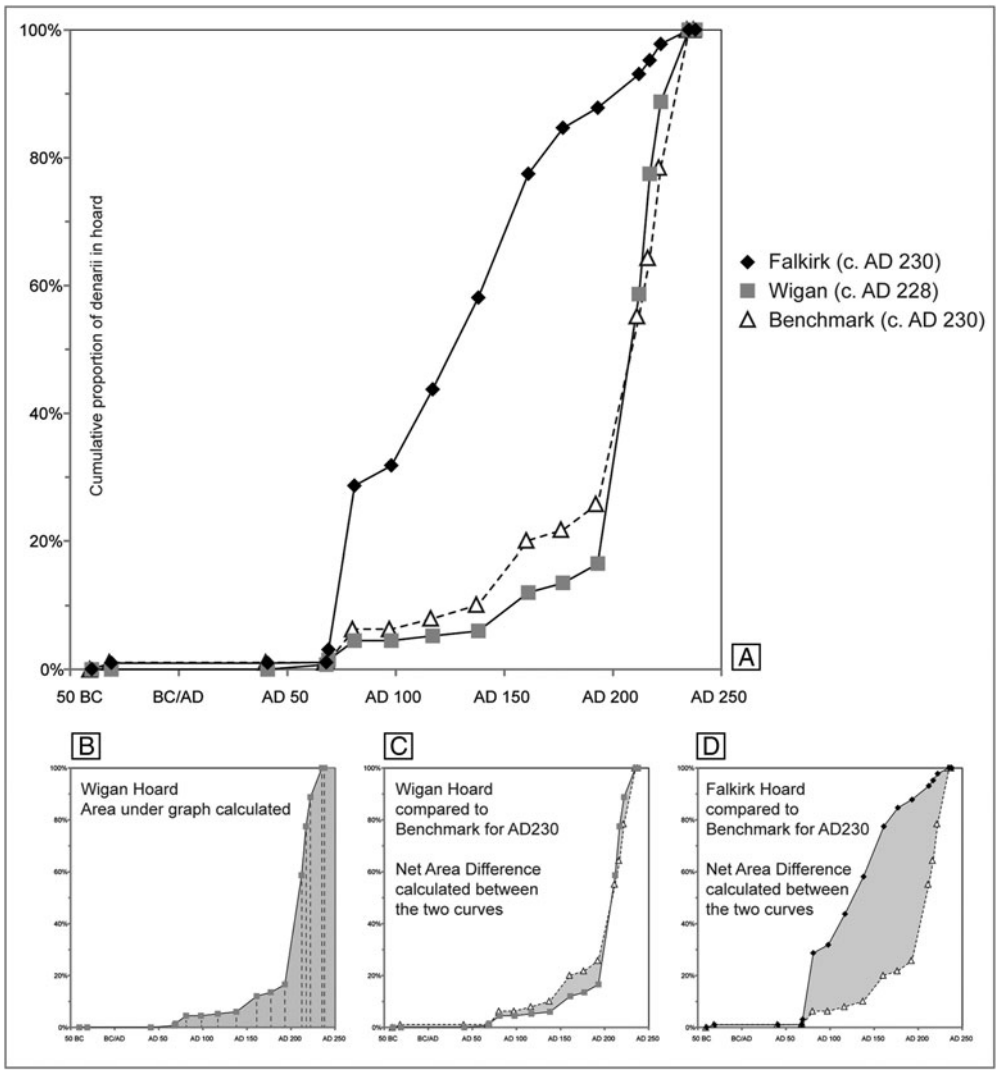

FIG. 5. The structure of the Wigan and Falkirk hoards compared with the benchmark of A.D. 230.

In the case of the Falkirk hoard, the Net Area Difference (NAD) comparing it with A.D. 230 is −6978 units. Most hoards are of the order of ±2000 units, so the Falkirk hoard is exceptionally archaic in its structure. If one were to compare Falkirk against earlier dates on the benchmark, then the point at which the NAD closes to zero is around A.D. 184–5, even though it must have been deposited in the 230s or later. This means that its structure is about 45 years behind the times. This suggests that if one wanted to imagine the Falkirk hoard as comprising a batch of coins coming north, and then just a few later additions being made to it before it was concealed, then *c.* A.D.184–5 would be the best-fit date for when the original batch arrived in the area.

TABLE 1. THE WIGAN AND FALKIRK HOARDS, AND 'AVERAGE' HOARD CONTENT OF *c.* A.D. 230: DATA FOR FIG. 5

Coin group	Date range	Wigan No. of denarii	Wigan % of denarii	Wigan Cumulative % of denarii	Falkirk Cumulative % of denarii	Benchmark Cumulative % of denarii
A. Republican	to 37 B.C.	0	0.0	0.0	0.1	0.0
B. Mark Antony	40–31 B.C.	0	0.0	0.0	1.0	1.1
C. Early Julio-Claudian	37 B.C.–A.D. 41	0	0.0	0.0	1.0	1.1
D. Later Julio-Claudian	A.D. 41–68	1	0.8	0.8	1.1	1.1
E. Civil War	A.D. 68–9	1	0.8	1.5	3.1	1.3
F. Early Flavian (Vespasian)	A.D. 69–81	4	3.0	4.5	28.7	6.3
G. Later Flavian (Domitian)	A.D. 81–98	0	0.0	4.5	31.8	6.3
H. Trajanic	A.D. 98–117	1	0.8	5.3	43.7	8.0
I. Hadrianic	A.D. 117–38	1	0.8	6.0	58.1	10.1
J. Antonine 1 (Antoninus Pius)	A.D. 138–61	8	6.0	12.0	77.4	20.1
K. Antonine 2 (Marcus Aurelius)	A.D. 161–77	2	1.5	13.5	84.6	21.7
L. Antonine 3 (Commodus)	A.D. 177–93	4	3.0	16.5	87.8	25.8
M. Early Severan 1 (Septimius Severus)	A.D. 193–212	56	42.1	58.6	93.1	55.2
N. Early Severan 2 (Caracalla)	A.D. 212–17	25	18.8	77.4	95.2	64.3
O. Later Severan 1 (Macrinus to Elagabulus)	A.D. 217–22	15	11.3	88.7	97.8	78.4
P. Later Severan 2 (Severus Alexander)	A.D. 222–35	15	11.3	100.0	100.0	100.0
Q. Later Severan 3 (Balbinus onwards)	A.D. 235 +	0	0.0	100.0	100.0	100.0

The Wigan hoard, on the other hand, comes out with a value of +664 comparing it with A.D. 230, indicating the hoard is slightly more 'modern' in its structure. However, the terminal date of this hoard was actually A.D. 228, so comparing it against that date calculates it to be even more 'modern' in its structure at +965 units.

We can do this calculation for all of the denarius hoards. However, not all have a precise *TPQ*; some have a date range for their terminal coin. For example, the Verulamium Eastern Tower hoard had a terminal coin of A.D. 227–9. In that case the NADs for each of three years were calculated, and the best-fit date taken. In this case that was the one for A.D. 227.

So, to summarise: 'archaic' hoards will give a negative NAD value; hoards similar to the benchmark will be close to zero; and 'modern' hoards with lots of new coin in them will have a positive NAD value. Now we have an indicator showing how 'archaic' or 'modern' a hoard is relative to our notional benchmark, it is possible to search for patterning in the data, both chronologically and spatially.

ANALYSIS: CHRONOLOGICAL VARIATION

Roman denarii entered Britain for a number of reasons. Some may have been used to pay the army and the provincial administration, whilst others may have arrived in exchange for exports to the Continent. The balance between these and other possibilities is unknown and possibly unknowable. However, enter Britain they did. Let us take a hypothetical example: the arrival of the new denarii of Hadrian. Some may have been directly shipped to take care of regular state expenditure on the army in the North, whilst other coins may have been issued in less predictable localities, such as wherever Hadrian spent the night on his tour of the province. From the moment of their release, a myriad of transactions would have slowly spread them beyond the issuing points to other parts of the province and beyond. This picture is entirely conjectural, and yet it serves to demonstrate that whatever function coinage is serving, whatever the mechanism by which it is put into circulation, it has to enter somewhere, from whence it diffuses.

In a circulation pool to which a new issue is added, initially there will be a geographical inequality in the distribution of the coins. Slowly, as transactions and mixing takes place, these coins will have a wider and wider distribution. If there were no new injections of money then eventually the circulation pool would become more-or-less uniform, with the only variation in it being owing to random chance. The faster the velocity of circulation of coinage, the quicker this smoothing out would take place. However, the Roman monetary system was not generally stocked with single issues with long pauses in between: the system was far more dynamic with new types being minted virtually all the time. Once one issue had entered the system a new one would start, meaning a state of equilibrium in the circulation pool was never quite reached. Big new issues associated with campaigns would particularly create local distortions which might take some time to even out.[28]

If coin hoards are a slice of the circulation pool, albeit selected by denomination, then their similarity to each other or dissimilarity would provide an index of the degree of irregularities in the pool. The ways we could interpret these observations would be:

Observation	Interpretation
Hoards with variable composition	Coins are circulating slowly and/or new issues are continually entering circulation.
Hoards with uniform composition	Coins are circulating very quickly and/or no new issues are coming out.

FIG. 6 shows the variation in coin hoards over time. Each dot represents a single hoard. If it is above the line it has a more ‘modern’ structure than our ‘normal’ benchmark. If it is below the line it has a more ‘archaic’ structure (the Wigan and Falkirk hoards have been encircled). There are broadly as many points above as below the line which suggests that the benchmark is a reasonable approximation to what a ‘normal’ hoard would be.

The first and most striking observation is that there appears to be significant variation in the degree of similarity of hoards over time. If we had imagined the province gradually embracing coinage, monetisation and commodification, then we could have expected coin hoards to become more similar over time as more and more transactions took place evening out the differences in the circulation pool. However, this is not the case. If anything there is a reverse

[28] This duality between the size of new issues and the speed of circulation both impacting upon hoard similarity and dissimilarity is also examined in detail by Lockyear 2007, 216–24, in the context of Republican hoards.

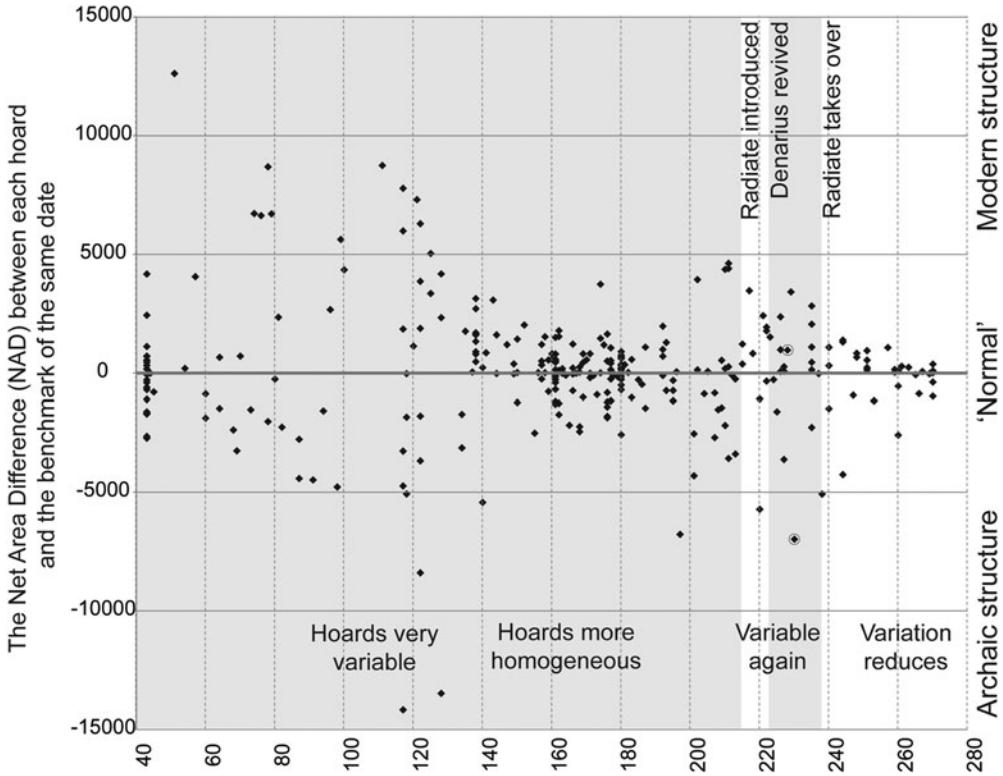

FIG. 6. The variation in the structure of denarius hoards over time.

trend in the first century with hoards becoming more variable. Up to the late first century this is partly understandable in terms of the army. The location where coinage presumably entered circulation became increasingly distant from the southern part of the province, meaning it might take longer for new coin entering in the North to find its way, by means of exchange, down South.

It is worth looking at some of the exceptions to the trend. An early exceptionally 'modern' hoard of A.D. 51 (NAD = +12616) came from near Wortham (Suffolk). However, it was not made up of genuine denarii but imitations. It included 168 irregular denarii of Claudius, and four earlier ones; this was at a time when other genuine contemporary hoards had hardly any Julio-Claudian denarii in them at all and were dominated by earlier Republican issues. So, oddly enough, it looks more like a hoard of the Trajanic period when the dominant tail of Republican issues in circulation fell significantly.

This pattern of the imitation denarii not reflecting the general population in circulation, but instead reflecting the latest issues to be released, is one which can be found if we look at the other 'irregular' denarius hoards (Table 2). In each case the 'irregular' components look as though they had very 'modern' structures. If a forger were attempting to fool then it is curious that the most common coins in circulation at the time were not chosen; though, unlike Claudian copies, it seems unlikely that irregular denarii were created for official use.

TABLE 2. HOARDS CONTAINING LARGE NUMBERS OF IRREGULAR DENARII

Hoard	**Contents**	***TPQ***	**Date, NAD**	**'structure most like . . .'**
Nr Wortham, Suffolk (1993, 1996)	172 irreg.	A.D. 51	A.D. 51, +12616	A.D. 118–19
St Swithin's Lane, London (1845)	89 irreg.	A.D. 41–54	A.D. 54, +192	A.D. 65–6
Maryport, Cumbria (pre-1915)	17 irreg.	A.D. 138	A.D. 138, +3134	A.D. 177–8
Bar Hill, Kirkintilloch, Dunbartons. (1902)	11 irreg.	A.D. 144	A.D. 144, +1604	A.D. 165–6
Castle Bromwich, Warwicks. (1909)	18 irreg.*	A.D. 177	A.D. 177, +141	A.D. 179–80
Piercebridge, Co. Durham (1970s)	15 irreg.*	A.D. 203–11	A.D. 238–9, +4401	A.D. 238–9

* These hoards also contained genuine denarii

From about A.D. 120–50 hoards gradually become more homogeneous.[29] The province had stabilised roughly in its size so there is no major change in the distance between the northern frontier and the more urban southerly part. New coin continued to arrive, so the increasing similarity in the hoards suggests coin is moving around the province more rapidly, ironing out differences. It would appear the velocity of circulation is rising (though whether this is more transactions or the same number of transactions but of a higher value, we cannot know).

From the Antonine to the Severan period variability increases again. After Clodius Albinus' defeat by Septimius Severus near Lyon in A.D. 197 a new governor, Virius Lupus, was dispatched to Britain and he attempted to buy peace from the Maeatae for a large sum of money.[30] His arrival was followed by the emperor himself and his household in A.D. 208, along with 'an immense amount of money'.[31] Severus campaigned in the North until his death at the close of A.D. 211. Some time in this period the province was also divided into Britannia Inferior centred on York and Superior based on London. If there was significant extra money injected into the North, this may have taken time to dissipate. Much will depend upon how military supply was organised. The division of the province may also have proved a hindrance to trade and exchange if *portoria* or customs dues between the provinces existed, though we have no evidence for that one way or the other.

In A.D. 215 Caracalla introduced the radiate, tariffed as a double denarius even though it only contained about one-and-a-half times as much silver. From this time on denarii rapidly diminished in circulation. Production of the radiate temporarily ceased after the first year of Elagabalus' reign, but was revived in A.D. 238 by Balbinus and Pupienus. The issue of denarii effectively ceased under Gordian III. With hardly any new denarii entering circulation, unevenness in the circulation pool gradually can be seen to disappear as we would predict.

[29] There is a slight methodological issue worth pointing out here. Many of the Antonine hoards are only dated to a broad *TPQ* range of 'A.D. 161–80' or 'A.D. 180–92'. In the methodology adopted here, the nominal date of the hoard has been taken to be the date within this range that the hoard is most similar to the benchmark pattern. This means they will have a NAD value closer to zero than had they all been given a nominal *TPQ* of A.D. 180 or A.D. 192. Nonetheless, the chronological reduction in variation is seen to commence before A.D. 161, so it is not entirely a function of this. Nor does it happen in other periods where *TPQ* ranges are also common.

[30] Cassius Dio 75.5.

[31] Cassius Dio 76.11.

ANALYSIS: GEOGRAPHICAL VARIATION

If military activity and the division of the province really had an impact on this picture, then we should be able to see it geographically. If new coin did first of all enter circulation where the army was present (even if it travelled via the governor's and procurator's residences in London or perhaps later York[32]) then we should see this in more 'modern' hoards being in the military areas and more 'archaic' ones in the South-East. This next section divides up the picture in Britain into chronological segments based upon the discussion above and examines the data geographically. FIGS 7–11 plot each individual hoard spatially; the larger the circle, the more extreme the structure of the hoard, being 'modern' if black or excessively 'archaic' if white.

NARRATIVE FROM THE CONQUEST TO THE CIVIL WAR, *c.* A.D. 69 (FIG. 7)

The picture from the early years of the province is complicated by both the rapid movement of the army through the country and also the issue of whether any of the early hoards were actually deposited before A.D. 43.[33]

Considering what we know of Early Imperial Britain, money is likely to have arrived into the country in two main ways: payment by 'the state' — principally to the military and loans from Claudius — which is liable to be how new coin entered circulation; and secondly entrepreneurial activity by individuals such as Seneca, who had ten million denarii on loan to the foremost Britons.[34] Depending upon exactly where it was drawn from it may have had a mix more comparable to central Italy or other areas Seneca had financial dealings with. Given this it is not surprising that the most 'modern' are from Woodham Mortimer (A.D. 37–41), south-west of the legionary base at Colchester, and a hoard from Usk (A.D. 55–7) around the time of the foundation of the fortress there. However, it is curious to see how 'archaic' a lot of the hoards are from the 'friendly kingdoms' of the Iceni, Brigantes, and the central southern domains of Cogidubnus. If Roman aristocrats were sending their accumulated earnings on loan into these areas to these aspirational kings and queens, then it is also the kind of pattern we might expect.

NARRATIVE A.D. 69–138 (FIG. 8)

The period A.D. 70–138 covers the push north and the crystallisation of the frontier along the Tyne–Solway line. The general impression is of the majority of 'archaic' hoards being located in the South-East, well away from the military area. If hoards with less than ten denarii in them were excluded then this pattern would be even more apparent, since several of the larger Midlands 'modern' hoards would disappear (Lubbesthorpe A.D. 117; Upton A.D. 96; Outbridge A.D. 111).

In the early 70s all of Yorkshire came under direct Roman control and a major military centre was established at York. A series of forts was also occupied in East Yorkshire along the Brough-on-Humber to York road. It is during this period of high army presence that two hoards with relatively 'modern' structures can be found: York (A.D. 74) and Binnington Carr

[32] A tablet from Caerleon mentions the despatch of an armed guard *opinionem petendam* 'to fetch the "estimate"' — i.e. troops sent to collect the money needed for the next pay parade, possibly to London, but it is not specified, though it does show money physically moving around the province. Found in contexts relating to *c.* A.D. 75–85. See Hassall and Tomlin 1986, 450–2.

[33] See note 23.

[34] Cassius Dio 62.2.

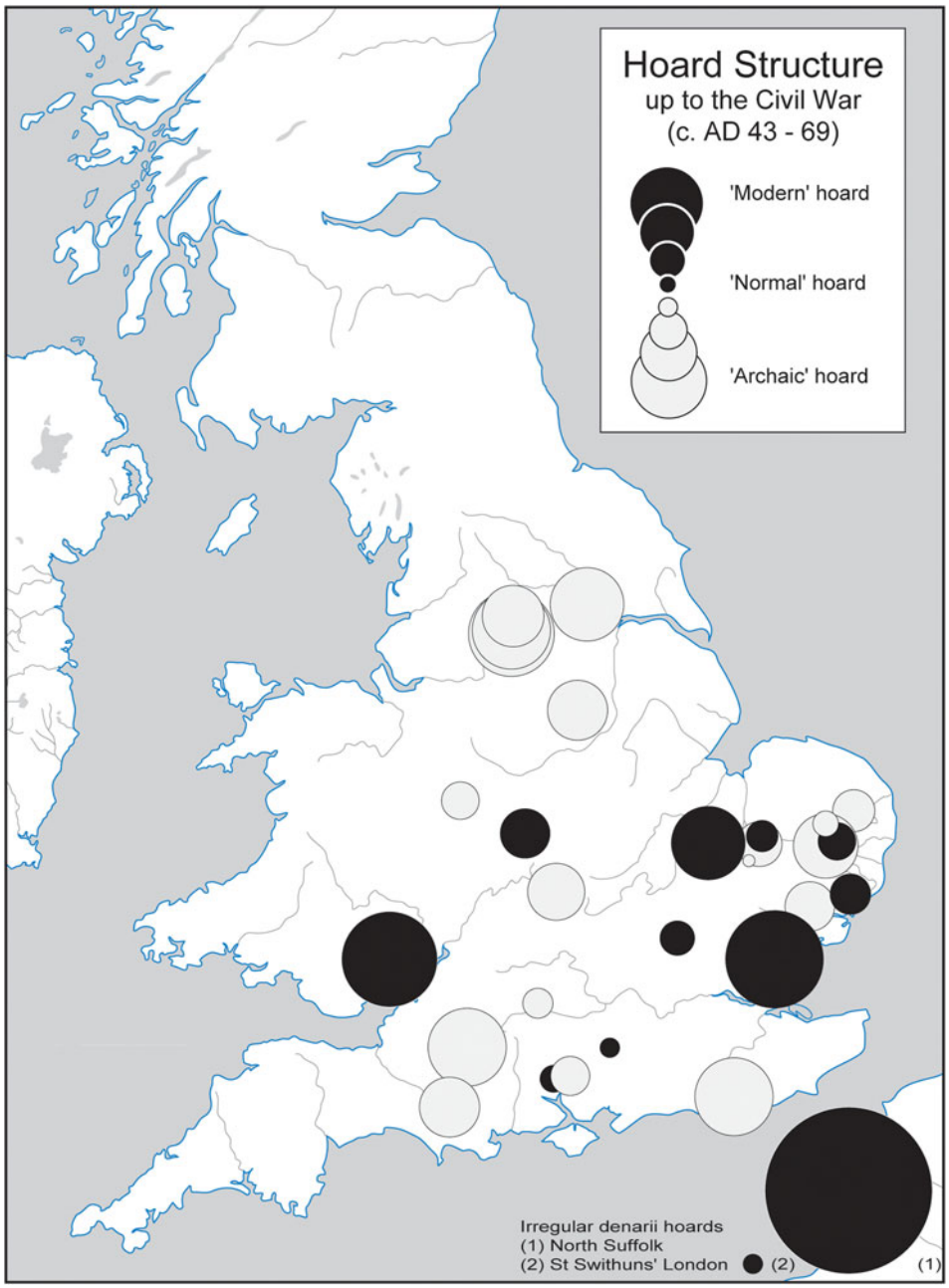

FIG. 7. The structure of denarius hoards up to the Civil War *c.* A.D. 69.

(A.D. 78). The more 'modern' structures appear to coincide with the presence of the army. Gradually the line of the frontier settled. Hadrian's Wall and its environs has seven tenths of hoards showing 'modern' structures. So a general pattern of 'modern' hoards where the army was located and relatively 'archaic' hoards elsewhere appears to be observable.

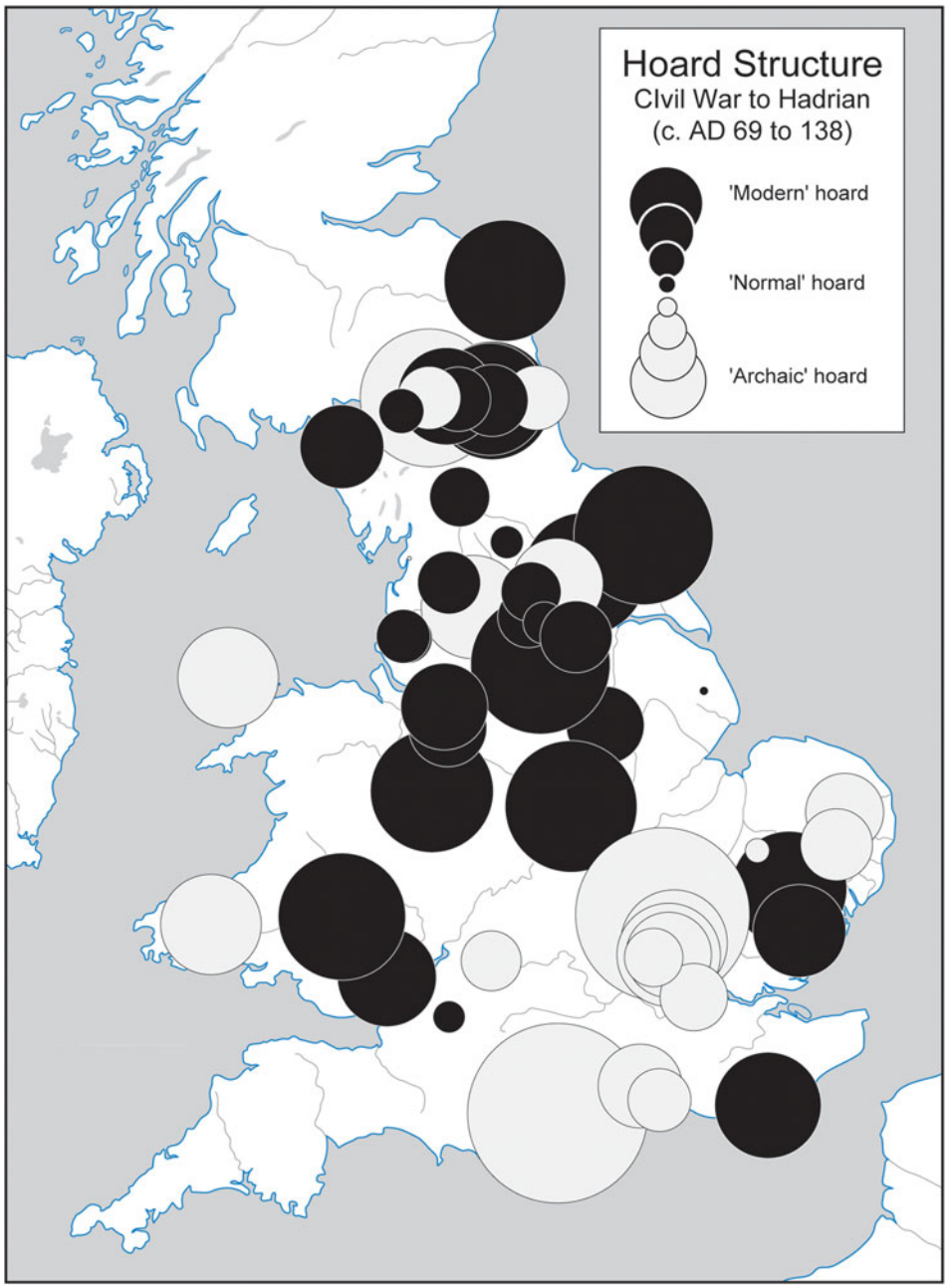

FIG. 8. The structure of denarius hoards A.D. 69–138.

Surprisingly there is no sign of London as the provincial capital producing any great bias towards new coin around it. The procurator may have been based there, but new coin was not being released into general circulation here in any significant quantity, though that is not to say it did not travel to the army via London.

NARRATIVE A.D. 139–192 (FIG. 9)

As the variation in hoards reduces a very different picture emerges. Along the newly established Antonine Wall many of the hoards remain with marginally more 'modern' structures, but elsewhere in the province variation is significantly less suggesting money was moving around far more rapidly evening out variations in the circulation pool. No sooner were new Antonine denarii issued than they were dispersed across the province in a myriad of exchanges. London and the Thames Valley do perhaps have slightly more 'modern' hoards than elsewhere, but the difference could be easily displaced by a few more discoveries.

NARRATIVE A.D. 193–235 (FIG. 10)

In this period to a certain extent we get a re-emergence of the pattern of 'modern' hoards in the North with the military and 'archaic' hoards further to the south. London, one of the provincial capitals, has both 'modern' and 'archaic' hoards, but the presence of new coin inflowing here is not as consistent as around York and in the North-East. That difference suggests either that money is moving around a lot more slowly, or there is a significant increase in the amount of coin entering the system in the North that the existing rate of transactions cannot even out. I believe it to be largely a case of the latter.

The preponderance of recent issues in hoards in the North-East is most easily imagined as a result of the A.D. 208 arrival of the Severan Imperial household and the military. Based in York and campaigning beyond the Walls, the 'modern' hoards lie along the lines of communication. Another factor, as already suggested, may be the division of the province into two. This took place sometime after the fall of Clodius Albinus, though possibly as late as Caracalla's reign. The dividing line is slightly open to question, but it probably lay along the Mersey–Humber line, with Britannia Inferior containing *VI Victrix* at York and the colony at Lincoln, and Britannia Superior containing London, *II Augusta* at Caerleon, *XX Valeria Victrix* in Chester, and the *coloniae* at Gloucester and Colchester. If this reading is correct then there should really be just as much new coin entering into Britannia Superior with its two legions as into Britannia Inferior with its one. In which case the presence of the Imperial household becomes the key differentiating factor between the two provinces and probably had more to do with the preponderance of new coin in the North-East. The 'modern' hoards of Malton (A.D. 202), York (A.D. 210), Corbridge (A.D. 210), and Piercebridge (A.D. 211) all potentially date to this period.

Beyond the frontier there are few casual finds of Roman coin, suggesting it was not in general use, but coin hoards are still found. Of course, the Severan campaigns may be a context, but historically we also know of the subsidies paid by the governor to the Maeatae early in Septimius Severus' reign not long after A.D. 197.[35] This was part of a pattern of activity known from around various frontiers of the Roman Empire, particularly during the reigns of Marcus Aurelius and Commodus, though it is thought to decrease in the Severan period.[36]

This pattern of alternating warfare and subsidies in the Antonine and Severan periods has meant that the interpretation of denarius hoards in Scotland has always been tightly tied to specific historical circumstances. This began with the discovery in 1934 of the massive Falkirk hoard containing *c.* 1,931 denarii. Its composition was immediately recognised as odd, dominated by earlier coin than its terminal date of A.D. 230 would normally have suggested. Its location next to the by then abandoned Antonine Wall made the hoard rich with possibilities of narrative

[35] Cassius Dio 75.5.
[36] Bursche 1996, 120–3; Berger 1996, 57–9; Howgego 1992, 5.

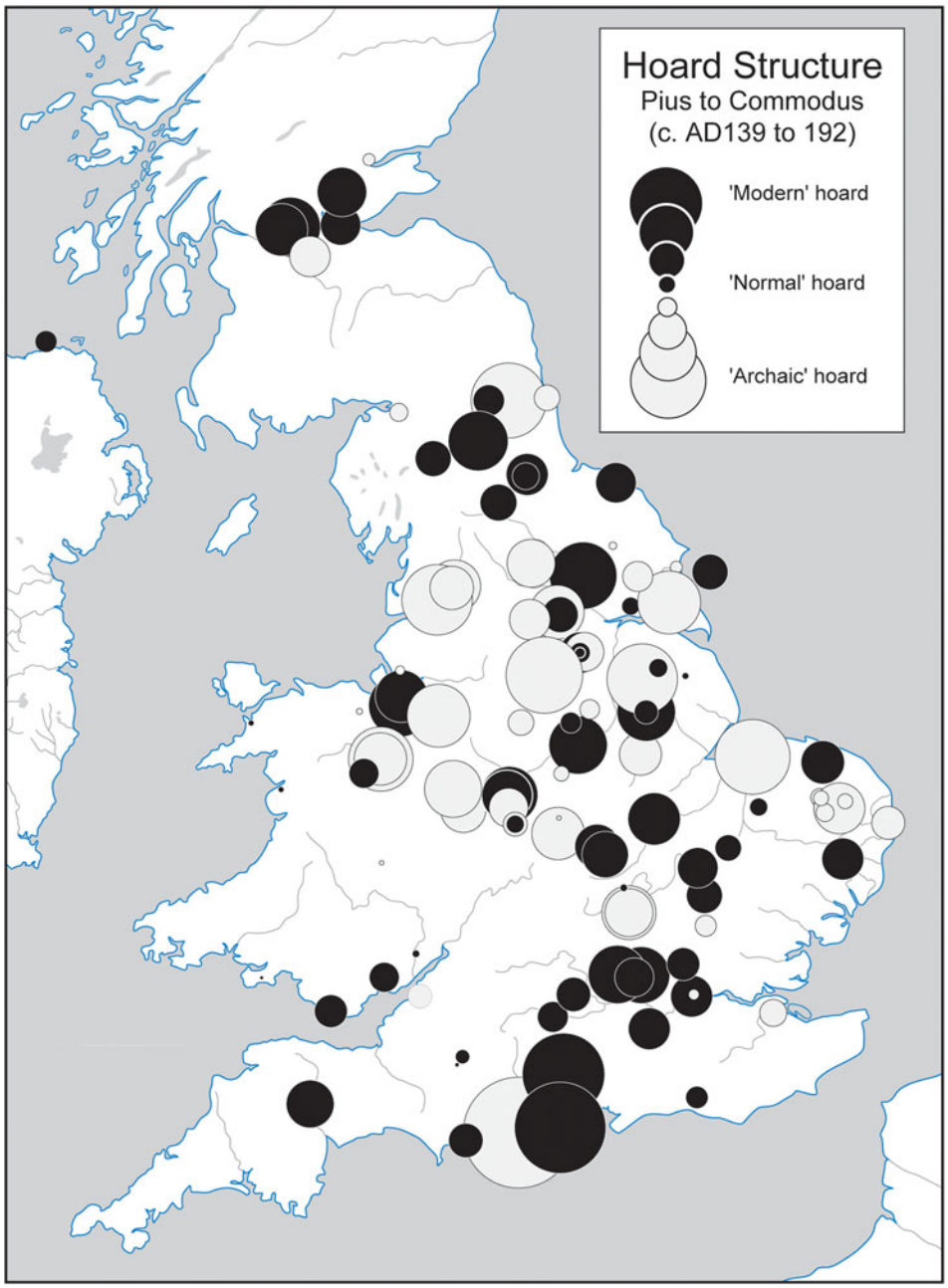

FIG. 9. The structure of denarius hoards A.D. 139–192.

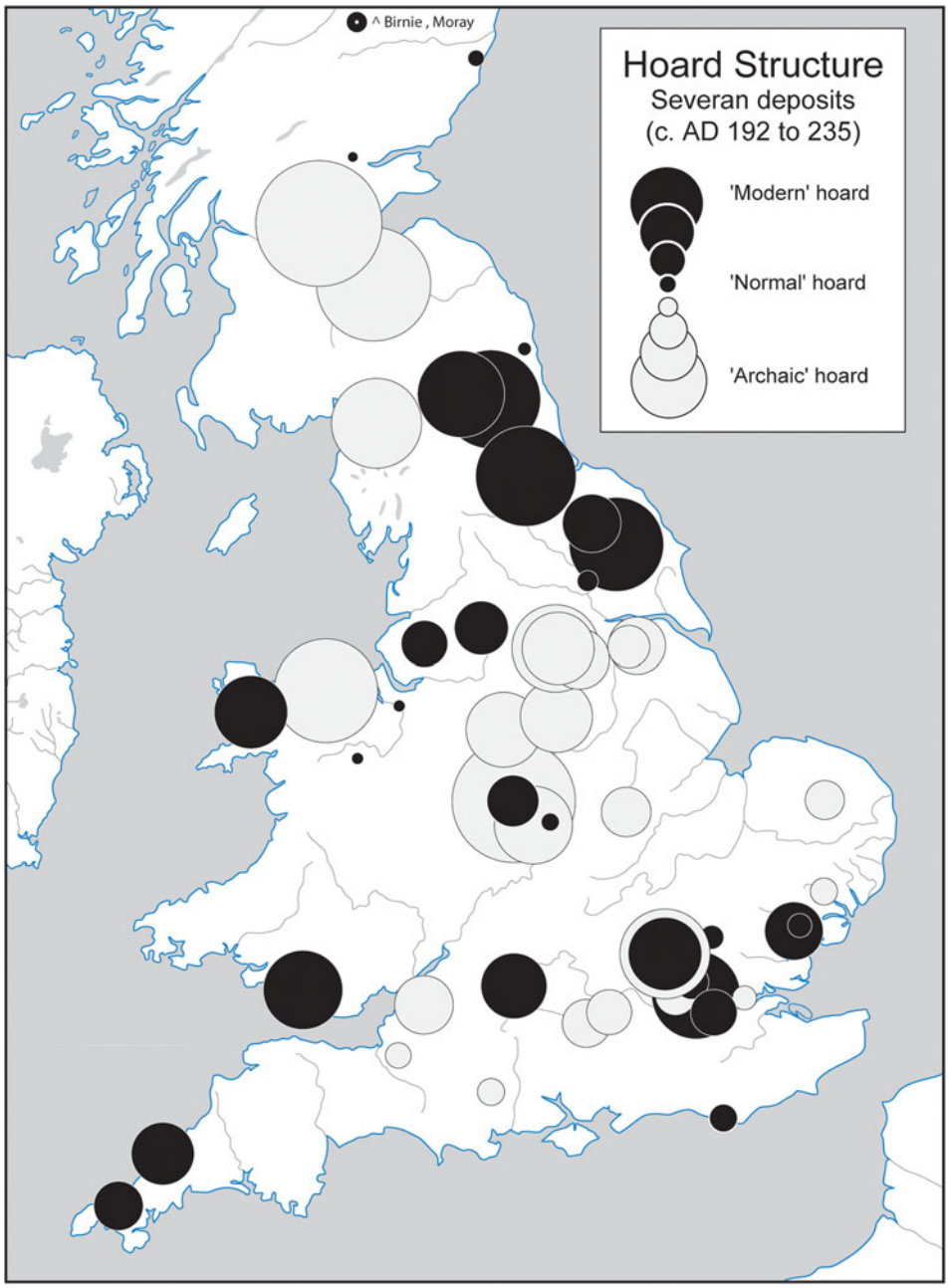

FIG. 10. The structure of denarius hoards A.D. 192–235.

story-telling, which indeed took place. George Macdonald thought it related to 120 years of thrift, the 'family savings of four generations'.[37] Reece saw it as a Severan hoard with later additions, while Malcolm Todd thought it might equally have started as an Antonine hoard with substantial additions in the Severan period.[38] Like them, Robertson saw Falkirk and the contemporary Scottish hoards of Pitcullo (Leuchars, Fife), Cowie Moss (Kincardine, Fife), Megray (Kincardine, Fife), and Portmoak (Perth and Kinross) as indicative of a policy of buying peace.[39] More recent hoards, including the Edston (Peebleshire) and the two Birnie (Moray) hoards have meant discussion has certainly not dampened. Nick Holmes considered that both the Falkirk and Edston hoards 'could have comprised payments made to local chieftains at around the conclusion of the military campaigns, to which a small number of later coins were added as a result of further payments being made. These payments … could have been part of a "buffer state" system, by which the Votadini of south-east Scotland were effectively employed by the Romans to provide advance warning of hostile action by the Maeatae'.[40]

Looking at the phenomenon as a whole, Fraser Hunter examined all the reports of denarius hoards, including partial antiquarian records not included in this analysis, which suggested that overall there was an Antonine and Severan peak, with a few post-Severan hoards, suggesting a long-lived pattern of coin moving north.[41] However, by just selecting more modern finds with good data, the Antonine emphasis dwindled, perhaps because coins in earlier finds with Antoninus inscribed on them had been misidentified as all belonging to Antoninus Pius rather than the later Antonines or Caracalla.

Now we have a benchmark against which to examine all of the well-identified hoards, it is worth looking at them afresh. Falkirk had a *TPQ* of *c.* A.D. 230; however its structure is exceptionally 'archaic'. If we compare it with our benchmark curves of other dates, and not just A.D. 230, we find its closest match is *c.* A.D. 184–5 (even though we know it cannot have been deposited before A.D. 230). If we do this for all the hoards with good data from Scotland (Table 3), we can make the following observations:

First, the earliest hoards (Kirkintilloch, Broch of Lingrow and Briglands) all have a slightly higher proportion of new coin than one might suspect given their *TPQ*. It could be interpreted that they were drawn from a coin pool which had more freshly minted coin in it than the general circulation pool, which is what we might expect if they formed part of official subsidies. Certainly, none of these hoards look like earlier packages of coin which might have arrived during Antoninus Pius' reign. Secondly, and with some relief, the two Birnie hoards which were found so close together with very similar structures, do indeed still look as if they were contemporary. Their *TPQ* varied by 6–18 years (depending upon when the coin of Julia Domna was issued), whereas in structure they only appear to be about three years different. Thirdly, it is clear that both the Falkirk and Edston hoards are significantly 'archaic', suggestive of Marcus Aurelius' and Commodus' reigns rather than the late Severan era.

It seems that if, as Hunter suggests, pouches of coin were moving north as subsidies and being used as special purpose coinage rather than multi-purpose cash, then this was a phenomenon largely confined to later in Marcus Aurelius' reign, through Commodus' and just into the early part of Septimius Severus', until military campaigning took over as the primary means of engagement again. There is no particular evidence for Caracalla continuing the practice, though

[37] Macdonald 1934, 36.
[38] Reece 1980, 125; Todd 1985, 229; Reece 1988, 101.
[39] Robertson 1978, 192.
[40] Holmes 2006, 13.
[41] Hunter 2007.

TABLE 3. HOARDS FROM SCOTLAND WITH GOOD DATA

Hoard (Reference)	**Contents**	***TPQ***	**Date, NAD**	**'structure most like . . .'**
Kirkintilloch, Dunbartonshire (1893)	47 den.	A.D. 147	A.D. 147, +1192	A.D. 164–5
Inchyra, Perth and Kinross (1993)	8 den.	A.D. 178	A.D. 178, −64	A.D. 176–7
Broch of Lingrow, Orkney (1870)	6 den.	A.D. 180–92	A.D. 192, +1968	A.D. 204–5
Briglands, Perth and Kinross (1938+)	180 den.	A.D. 187	A.D. 187, +1085	A.D. 200–1
Birnie 2, Moray (2001) (Holmes 2006)	310 den.	A.D. 193	A.D. 193, +194	A.D. 196–7
Birnie 1, Moray (1996–2000) (Holmes 2006)	316 den.	A.D. 196–211	A.D. 200, −9	A.D. 199–200
Edston, Peebleshire (1994) (Holmes and Hunter 1997)	290 den.	A.D. 220	A.D. 220, −1083	A.D. 169–70
Falkirk, Stirling (1933) (Macdonald 1934, 36)	1931 den.	A.D. 230	A.D. 230, −6978	A.D. 184–5

the occasional coin certainly must have still moved north to become incorporated into the later Edston and Falkirk hoards.

NARRATIVE: A.D. 235 ONWARDS (FIG. 11)

With the effective cessation of production and supply of new denarii, any major differences in the circulation pool of the coin would gradually even themselves out, so it is not unexpected that we no longer find any geographical trends.

THE ROBUSTNESS OF THE DATA

It is appropriate to ask how robust the chronological and geographical picture is. Would a few more hoards change it substantially? How much do the size of hoards and the inclusion of some as small as five coins affect the data?

In terms of the number of hoards, this article is actually a reworking of a much earlier analysis which was based on only 125 hoards (with sufficient detailed data) compiled back around 1990;[42] as additional hoards were discovered and published the picture was updated in 1999 and again for this article in 2009, now with 287 hoards. The patterns revealed have remained broadly similar; if anything the new finds have simply reinforced the general trends.

In terms of the size of hoards, it is true that hoards as small as five coins are more likely to have an errant *TPQ*, with a falsely early terminal date, and therefore they might show up as having a falsely 'more modern' structure. This can be seen to be the case if the number of denarii is plotted against the 'Best NAD value' in Appendix 1. Here there is a slight trend for these smaller hoards to be seen as being more 'modern' than they perhaps should, but the variance was only marginally greater than those with 10 coins or 20. Also, when examined geographically they tended to follow the same trends as the larger hoards. So they have been included. The data could easily be plotted with the threshold set higher, but it is very likely the picture would look similar.

[42] The original model was developed in an unpublished PhD thesis: Creighton 1992. While 212 hoards were identified within that as containing denarii, only 148 had sufficient details, and of those only 125 had 5 denarii or more.

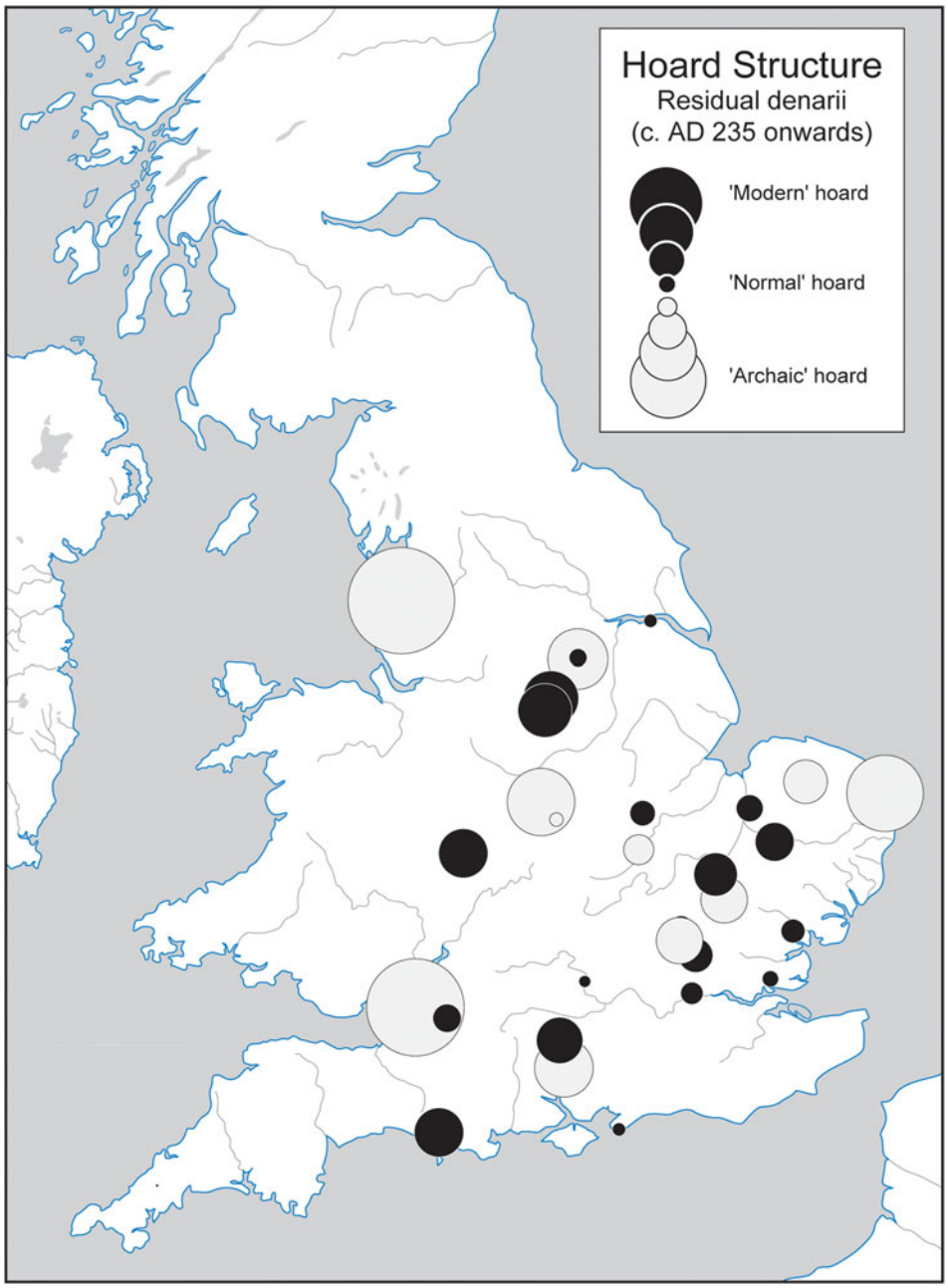

FIG. 11. The structure of denarii in hoards beyond A.D. 235.

ANALYSIS: MULTIPLE DEPOSITS

One final phenomenon worth exploring is if this technique of analysing structure gives us any insights into multiple deposits. Mention has already been made of the two more-or-less contemporary hoards at Birnie found 10 m apart, but there are also many other sites where multiple hoards are found. This is a phenomenon known from the later Iron Age (e.g. the multiple hoards at Hallaton (Leics.)[43]) and into the Roman period.[44] But are these multiple hoards deposited over a long period, or hoards which though they might have a different *TPQ*, are actually probably contemporary (as at Birnie)? This has implications for the interpretation of them as votive ritual deposits. Do they represent one-off events of multiple hoards being buried, or a location which has seen offerings placed into the ground over a longer term? Sometimes the deposits can all be of one date representing a one-off act, such as the hoards of radiates from Beachy Head (Sussex), found in 1879, 1899, 1914, and 1961–73.[45] But sometimes they have a spread of terminal dates suggesting sustained activity over time.

Two examples from Edlington Wood and Darfield will be used to illustrate this. In both cases there were multiple radiate hoards deposited, some including denarii, others not. However, in each case additional packets of denarii were found alone ending with some of the latest denarii to be minted. The question therefore is 'were the packets of denarii buried at an earlier date, or when the multiple radiate hoards were concealed?'

Four radiate hoards were found at Edlington Wood, all of them dated to around the A.D. 260s (Table 4). In addition there was also a small package of 23 denarii, which had a nominal *TPQ* of *c.* A.D. 225. Was it possible that these were a batch of later denarii which had a false *TPQ*, because of the small number of denarii within it? Actually that would appear to be unlikely. The early 'Edlington 5' hoard really does look earlier in date, not only having a *TPQ* of A.D. 225, but also having a structure more akin to hoards a decade earlier. In this case it would appear that hoards were being deposited at this site over a span of 50 years.

TABLE 4. FIVE HOARDS FROM EDLINGTON WOOD, NEAR DONCASTER

Hoard (Reference)	**Contents**	***TPQ***	**Date, NAD**	**'structure most like …'**
Edlington 5 (1978) (Hoard 255 in Price 1985, 161; Manby and Burnett 1981)	23 den.	A.D. 225	A.D. 225, −1619	A.D. 215–16
Edlington 1 and 2 (pre-1935) (Robertson 1935)	426 den. and 173 radiates	A.D. 259	A.D. 259, +149	A.D. 264–5
Edlington 4 (1975) (Hoard 173 in Price and Nash 1977, 61)	8 radiates	A.D. 269		
Edlington 3 (1935) (Corder and Percy Hedley 1945)	59 radiates	A.D. 276–82		

In the case of Darfield there was a late radiate hoard, but also three earlier third-century hoards each with about 500 denarii (Table 5). Given their similarity of size (excluding the fact that one contained an aureus), could they have been contemporary deposits? Alas, good details only exist

[43] The site of Hallaton included about 16 discrete deposits of Iron Age coin: Score 2012; Leins 2007, 39.

[44] Forty multiple-deposit sites of Roman coin were listed by Callu 1979. Some were contemporaneous; others were widely separated in date.

[45] Details of the Beachy Head hoards can be found in: Bland 1979; Budgen 1916; Roach Smith and Calvert 1881; Dolley and O'Donovan 1962; Carson 1968; and Hoard 196 in Price 1975, 52.

for the 1947 and 1948 finds. Both had *TPQ* dates differentiating by 22 to 25 years, and broad structural dates differing by 23 years, so contemporary deposition seems unlikely. The site really does show a long sequence of deposition over at least a 65-year period and is all the more strange for each deposit having around 500 coins within it (even if the later ones were debased radiates).

TABLE 5. FOUR HOARDS FROM DARFIELD, SOUTH YORKSHIRE

Hoard (Reference)	**Contents**	***TPQ***	**Date, NAD**	**'structure most like . . .'**
Darfield (1682) (De la Pryme 1870 and Carson 1948)	500 den. and 1 aureus	A.D. 213	few details	
Darfield 2 (1948) (Carson 1948)	500 den.	A.D. 213	A.D. 213, −3391	A.D. 199–200
Darfield 1 (1947) (Walker 1946)	480 den. and 1 radiate	A.D. 235–8	A.D. 235, −2279	A.D. 222–3
Darfield (1950) (Baggaley and Corder 1950)	541 radiates	A.D. 276–82	few details	

HISTORICAL CONCLUSION

The army clearly appears to be the key location where hoards contain more recent coin, and therefore where new issues entered circulation; that in itself is not particularly surprising. What is more interesting is first, the significant variation over time in the similarity and difference of hoards across the province, which will relate to changes in the velocity of circulation of the coin; and secondly, the failure of London, the provincial capital, to show up consistently as the entry point of new coin.

The pattern of denarii entering in the North reinforces the observation made by Philippa Walton from Portable Antiquities Scheme data that the denarius is relatively more common, compared with bronze denominations, in the military areas outside the South-East. She also noted that the vast majority of documents from Vindolanda with monetary information in them valued things in denarii and not in the more common unit of account, sestertii.[46]

The changes in the speed at which denarii moved around the province do not indicate the consistent growth which slow progressive monetisation and commodification might have engendered. If coin was being used for more and more types of expenditure as the cash-economy grew, then the same stock of coin would have to work harder, moving around more rapidly. Of course price changes and the total number of denarii in circulation would also have a significant bearing.[47] Factors which need to be taken into consideration include how much of the supply of the army was in kind (which would generate little flow of coinage), and how much was procured through the developing market. The Vindolanda tablets, dating in the main to the late first to early second centuries A.D., suggest hides and wheat were certainly being bought on a significant scale,[48] though curiously this was still a time when coin was apparently moving sluggishly according to this model. A next step in research would be to correlate the flows of coin with interpretations of the procurement of the Roman army.

[46] Walton 2012, 46–55.

[47] This relates to Fisher's Quantity Theory of Money, a theme being explored in numismatic terms in the current series of Royal Numismatic Society annual presidential addresses. See Mayhew 2010 and the three subsequent journals.

[48] Vindolanda tablet 343, inventory number 88.946.

The failure of London to show significantly and consistently suggests that direct Imperial benefaction in the provincial capital did not lead to the distribution of any solid new coin there. If new coin did arrive at the procurator's office, it was probably stored and directly shipped to where the army was, as and when it was needed. It was evidently more important to reveal and reinforce the image of the new emperor to the military than to the entrepreneurial freedmen, local traders, artisans and developing Romano-British aristocracy resident in London. It would seem that the pay of the staff in the governor's and procurator's offices and of the resident garrison in Cripplegate was not sufficient to register in the larger flow of cash moving in and out of the city in London's commercial activity. Perhaps the provincial administration was predominantly funded from recycled coin gathered in through taxation in the province itself? Perhaps the provincial capital was one of the few locations so integrated into the cash economy of the province as a whole that new coin rapidly flowed out away from it in a myriad of transactions. These are the sorts of questions where a larger study of denarii across the Empire is needed, to see if any provincial capitals show, and to see if the ebb-and-flow of coin in Britain follows general trends, or whether episodes such as the Severan visit and campaigns make Britain appear different to other provinces at the time.

Finally, the method developed is not just applicable to the Roman world, but is directly transferrable to entirely separate monetary systems in time and space.

APPENDIX 1. COIN HOARDS FROM BRITAIN CONTAINING MORE THAN FIVE DENARII WHERE DETAILS EXIST

Full bibliographic data and in some cases the original data can be found in the corpus reference. References of recent finds are designated by the year and the British Museum-assigned Treasure number, e.g. 2007(T677); prior to that reference is made to the *Coin Hoards from Roman Britain* series by British Museum Press (vols 8–10), The Royal Numismatic Society (vol. 11) and Moneta (vol. 12), e.g. CH12(05); finds up to the mid-1990s were neatly summarised with full bibliographic information in the inventory by Robertson (2000), e.g. R055; however some earlier hoards were missed and/or very occasionally I came to a different conclusion about which coins to include or exclude from hoards based on the coroner's reports, so occasional references are also made to hoards in the author's doctoral thesis, e.g. C256 (Creighton 1992). The data attempt to be comprehensive up to *c*. 2009. (* hoard with closing coin earlier than A.D. 43)

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
CH10(02)	Warminster, Wilts. (1994–5)	33–31 B.C.	*43	12	12	−2648	
R002; C003q	Almondbury, W Yorks. (1828)	33–31 B.C.	*43	200	200	−2723	
2008(T460)	Ashburnham, E Sussex (2008)	*c.* 31 B.C.	*43	8	6	−2723	
CH10(03)	Raydon, Suffolk (1995)	7–6 B.C.	*43	5	5	−1103	
2008(T767)	Hursley, Hants. (2008)	2 B.C.–A.D. 4	*43	8	8	+315	
2005(T440)	Albrighton, Shrops. (2005)	A.D. 14–37	*43	69	69	−610	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R098	Chatteris, Cambs. (1983)	14–37	*43	11	11	+2432	
2004(T352); 2005(T439)	Crondall, Hants. (2004–5)	14–37	*43	14	14	+170	
Chris Rudd list 50	Forncett, Norfolk (1997)	14–37	*43	45	45	−293	
2002(T156); 2009(T612)	Great Packington, Warwicks. (1999, 2002, 2008)	14–37	*43	17	17	+1116	
2007(T260)	nr Mansfield Woodhouse, Notts. (2007)	14–37	*43	22	22	−1618	
R009a; CH09 (01); CH10 (05)	Membury, Wilts. (1988)	14–37	*43	252	252	−407	
2006(T163)	Winchester area, Hants. (2001, 2005)	14–37	*43	28	28	−698	
CH10(04)	Woolland, Dorset (1993)	14–37	*43	16	16	−1682	
R011; C006n	Ayott St Lawrence, Herts. (1851)	14–37	*43	200	20	+540	*c.* 10% sample
R015	Lakenheath, Suffolk (1959)	*c.* 37	*43	67	67	+448	
R016; C143f	Lightcliffe, Hallifax, W Yorks. (*c.* 1828)	*c.* 40	*43	24	24	−1710	*c.* 60% sample
R014a; CH09 (02)	Woodham Mortimer, Essex (1991)	37–41	*43	189	187	+4169	
R028a; CH09 (03)	Sutton, Suffolk (1987)	41–2	*43	217	216	+709	
R017; C060	Chippenham, Cambs. (1981)	43–54	43	37	37	−59	
CH10(06); CH11(01)	Old Buckenham, Norfolk (1994–5)	41–5	44	21	21	−10	
R025; CH08 (01); CH09 (04)	Norton Subcourse, Norfolk (1982–6)	*c.* 45	45	113	113	−798	
CH10(07); CH11(04)	nr Wortham, Suffolk (1993, 1996)	*c.* 51	51	172	172	+12616	irregular coins
R042; C157	St Swithin's Lane, London (1845)	41–54	54	89	88	+192	irregular coins
R030; C241	Usk, Monmouth (1967)	55–7	57	6	6	+4058	
R045; C103	Eriswell, Suffolk (1972)	60–1	60	72	72	−877	
R044; C221	Scole, Norfolk (1982–3)	60–1	60	87	87	−1885	
CH10(08)	Needham, Norfolk (1992–5)	*c.* 64	64	29	29	+656	
2008(T410)	Warmington, Warwicks. (2008)	*c.* 64	64	1121	1117	−1477	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
CH11(05)	nr Selby, N Yorks. (1997)	*c.* 68	68	8	8	−2377	
R055; C128q	Honley, W Yorks. (1893)	69–79	69	13	13	−3257	
R286; C136	Knapwell, Cambs. (1840)	*c.* 170	70	78	78	+711	
R067	Hemel Hempstead, Herts. (pre-1852)	73–9	73	19	19	−1530	
R057	Blake St, York (1975)	*c.* 74	74	35	35	+6714	
2005(T389)	Beal Point, Northumbd (2005)	*c.* 76	76	5	5	+6634	
R074	Binnington Carr, N Yorks. (*c.* 1875)	*c.* 78	78	12	12	+8687	
R069; C036	Budge Row, London (1958)	78–9	78	?	74	−2024	unknown sample
CH10(10)	Overley Hill, Shrops. (1990)	*c.* 79	79	13	13	+6707	
R086; C179	Mildenhall, Suffolk (1979–80)	80–5	80	277	277	−256	
CH10(11)	Skellow, S Yorks. (1994)	*c.* 81	81	267	262	+2347	
2009(T423)	Weybread, Suffolk (2009)	82–3	82	206	203	−2259	
R096; C151n	Llanfaethlu, Anglesey (1870–80)	*c.* 87	87	32	32	−4423	
R094; C130; CH10(12); CH11(03)	The Howe, Norfolk (1981+)	*c.* 87	87	125	122	−2771	
R104	Llanboidy, Carmarthen (1692)	91–6	91	200	23	−4480	*c.* 11% sample
R091; C064	Cirencester, Glos. (1975)	*c.* 94	94	22	22	−1580	
R079; C240n	Upton, Notts. (pre-1709)	*c.* 96	96	20	9	+2666	
R109; C176	Mereclough, Burnley, Lancs. (1695)	*c.* 98	98	12	12	−4780	unknown sample
R111	Corbridge, Northumbd (1914)	*c.* 99	99	32	32	+5627	
R114	Caerleon, barrack room 34, Newport (1926)	*c.* 100	100	7	7	+4344	
C190q	Oughtibridge, S Yorks. (pre-1932)	103–11	111	5	5	+8741	
R118	Bath, Somerset (1806)	98–117	117	79	79	+1853	
R120; C141q	Lavenham, Suffolk (1874)	98–117	117	197	183	+5983	
2005(T410)	Lubbesthorpe, Leics. (2005)	*c.* 117	117	5	5	+7779	
R110; C246	Verulamium, Herts. (1958)	*c.* 117	117	49	49	−3268	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R134; C228	Southants. (?), Hants. (1905)	117–38	117	15	15	−14168	
R145	Verulamium, Beech Bottom Dyke, Herts. (1932)	117–38	117	41	41	−4734	
R147; C139	Lancaster, Lancs. (1856)	*c.* 118	118	*c.* 100	19	−29	*c.* 19% sample
R112	Wallsend, Tyne and Wear (1895)	*c.* 118	118	14	14	−1842	
C262n	Wheathampstead, Herts. (1932)	*c.* 118	118	100	41	−5071	*c.* 41% sample
R135; C141	Lathom, Ormskirk, Lancs. (1949)	*c.* 120	120	125	125	+1129	
R160; C028n	Brecon, Y Gaer, Powys (1924/5)	*c.* 121	121	9	9	+7302	
R135b	Corbridge Site XIc, Northumbd (1965)	119–22	122	6	6	+6291	
R137	Thorngrafton, Northumbd (1837)	119–22	122	60	60	+1881	
2005(T20)	Colchester, Essex (2004–5)	119–22	122	43	43	+3859	
R131	Birdoswald, Cumbria (1930)	*c.* 122	122	30	30	−8396	
R132	Birdoswald, Cumbria (1949)	*c.* 122	122	28	28	−1801	
R154; CH10 (13)	Boston Spa, W Yorks. (1848)	*c.* 122	122	173	173	−3676	
R139a; CH09 (05)	Hastings, E Sussex (1989)	*c.* 125	125	59	58	+5034	
CH11(07)	Middlewich, Cheshire (1998)	*c.* 125	125	30	30	+3347	
R149	Great Chesters, Northumbd (1895)	125–8	128	20	9	+4176	*c.* 45% sample
R136	Corbridge Site XXVIII, Northumbd (1911)	*c.* 128	128	7	7	+2331	
CH11(08)	Shillington B, Beds. (1999 multiple groups)	*c.* 128	128	18	18	−13474	
2007(T106)	Petworth, W Sussex (2006)	*c.* 134	134	103	103	−3132	
CH10(14)	Washington, W Sussex (1992)	*c.* 134	134	8	8	−1726	
R135a; CH09 (06)	Waddington, Lancs. (1989)	*c.* 135	135	30	30	+1755	
R165; C236	Swaby, Lincs. (1934)	137–8	137	178	178	+40	
R155; C084	Dewsbury, W Yorks. (1925)	117–38	138	26	26	+1696	
R159	Wakefield, W Yorks. (1902)	117–38	138	11	11	+793	

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APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R156	How Stean Beck, N Yorks. (1868)	119–38	138	35	25	+475	
R157	Cookridge, Otley, W Yorks. (1708)	128–38	138	17	17	+1602	
R141	Mallerstang, Cumbria (1926)	134–8	138	138	138	+1628	
R130; C261	Weston, Cheshire (1982)	134–8	138	12	12	+2707	
R187	Carlisle, east of the city, Cumbria (1762)	*c.* 138	138	62	62	+896	
CH11(09)	Lathom, Lancs. (1999)	*c.* 138	138	13	13	+1326	
R174a	Maryport, Cumbria (pre-1915)	*c.* 138	138	17	17	+3134	irregular coins
R140; C258	Westmeston, E Sussex (1985)	*c.* 140	140	9	9	+224	
R177; C127n	Hengistbury Head, Site 33, Dorset (1911)	140–4	140	24	24	−5427	
CH11(10)	Itteringham, Norfolk (2000)	*c.* 141	141	62	62	+847	
2005(T200)	Winchester, area II, Hants. (2005)	*c.* 143	143	6	6	+3072	
R170	Norton, Malton, N Yorks. (1963)	143–4	144	39	39	−21	
R206	Bar Hill, Kirkintilloch, Dunbartonshire (1902)	*c.* 144	144	11	11	+1604	irregular coins
R282	Kirkintilloch, Dunbartonshire (1893)	*c.* 147	147	47	47	+1193	
R209	Tarbock, Lancs. (1838)	138–57	149	33	19	−38	
R212; C154	Llanymynech Hill, Powys (1965)	*c.* 149	149	33	33	+381	
R171	Bryngwydion, Gwynedd (*c.* 1875)	140–57	150	46	45	+17	
R213; C052	Chalfont St Giles, Bucks. (1934)	*c.* 150	150	40	40	+1423	
R201; C053	Chatburn, Lancs. (1778)	*c.* 150	150	*c.* 1000	44	−1229	*c.* 4% sample
R217	York, Post Office (1930)	*c.* 152	152	14	14	+2019	
R202	Snettisham (the jeweller's hoard), Norfolk (1985)	155–7	155	83	83	−2512	
R195	Graig Lwyd, Conwy (*c.* 1871)	138–57	156	8	6	+19	
R210	Hall Carr, Sheffield, S Yorks. (1854)	138–57	157	48	17	+504	
R171a	Piercebridge, Co. Durham (1979)	156–7	157	6	6	+336	
R207	Wervin, Cheshire (1982)	156–7	157	16	16	+1199	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R215; CH08 (03)	Lawrence Weston, Bristol (1986)	*c.* 157	157	598	598	−253	
R196	Moel Famau, Flintshire (1953)	145–61	158	11	10	+12	
2005(T121)	West Wycombe I, Bucks. (2005)	*c.* 153	158	18	18	+1523	
R214; C158	Londonthorpe, Lincs. (1976)	*c.* 154	159	420	408	−776	
CH10(17)	East Stoke, Dorset (1993)	*c.* 159	159	43	43	+547	
R173	Airedale, Castleford, W Yorks. (1955)	138–61	160	12	12	+572	
R205; C212	Pyrford, Surrey (1957)	159–60	160	82	82	+810	
R172; C255p	Well St/Jewin St, London (*c.* 1847)	138–61	161	75	68	+802	*c.* 90% sample
R197	Boverton, Glamorgan (1798)	145–61	161	38	25	+506	*c.* 66% sample
R169a	Corbridge, Northumbd (1969)	145–61	161	12	12	+442	
R204; C187n	Nottingham, Notts. (*c.* 1910)	157–61	161	19	19	+1497	
2006(T148); 2007 (T185); 2008 (T153); 2009(T164)	E Yorks. (2006)	*c.* 161	161	15	15	+567	
2008(T705)	North Cave, E Yorks. (2008)	*c.* 161	161	9	9	+140	
2004(T104)	Watford Gap, Staffs. (2004)	*c.* 161	161	23	23	−683	
2008(T197); 2008(T625)	Lutterworth, Leics. (2008)	161–2	161	12	12	−1199	
CH11(13)	Ulrome, E Yorks. (1960s)	*c.* 161	161	9	9	−72	
2006(T148); 2007 (T185); 2008 (T153); 2009(T164)	North Dalton, E Yorks. (2006–9)	161–2	161	24	24	−406	
R248	Carlisle, Cumbria (1860)	161–80	161	*c.* 200	50	−149	*c.* 25% sample
R299; C193q	Parwich Hill, Derbys. (*c.* 1769)	161–80	161	80	65	−273	
R246	Templeborough, Rotherham, S Yorks. (1916)	161–80	161	19	19	−1305	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
2002(T256); 2005(T10)	Cold Kitchen Hill, Kingston Deverill, Wilts. (2002, 2005)	161–2	162	115	115	+108	
R294; C005	Allerton Bywater, W Yorks. (1922)	*c.* 162	162	296	296	−1267	
R237	Chester, Cheshire (1855)	161–2	162	43	43	+1786	
R229; C249	Bracebridge Heath, Waddington, Lincs. (1977)	*c.* 162	162	16	16	+1534	
R233	Swine, E Yorks. (*c.* 1940)	*c.* 162	162	26	26	−1736	
CH11(14)	Osgodby, Lincs. (1999)	*c.* 163	163	44	44	+181	
R244	Doncaster, High Street, S Yorks. (1924)	161–80	163	24	24	+45	
R211; C222h	Sheffield, S Yorks. (1906)	161–80	163	35	32	−15	
CH11(15)	Long Whatton, Leics. (1998)	*c.* 164	164	84	84	−93	
R231; C215	Ribchester, Lancs. (1978)	*c.* 165	165	9	9	−2184	
R232; C085	Dewsbury, W Yorks. (1938)	*c.* 166	166	27	27	−742	
R235a; CH09 (07)	Kirkby-in-Ashfield, Notts. (1990)	165–6	166	29	29	+209	
R234a; CH09 (08)	Fotheringhay, Northants. (1988)	*c.* 166	166	45	45	+1214	
R255	Fenchurch Street, London (1922)	166–80	166	12	12	−47	
R265	Presteigne, Powys (1940/51)	166–80	167	70	30	−12	*c.* 42% sample
R242	Rudchester, Northumbd (1766)	*c.* 168	168	471	455	−2451	
R253	Bracebridge Heath, Waddington, Lincs. (1946)	*c.* 168	168	6	6	+247	
2004(T133)	Cadeby, Leics. (2004)	161–80	168	29	29	+30	
R304	Owmby, Lincs. (1953)	168–80	168	10	10	−2246	
C198	Piercebridge, Co. Durham (1974)	164–9	169	8	8	+805	
R261	Hampsthwaite, N Yorks. (1845)	*c.* 169	169	9	9	−1013	
CH11(16)	Hamstead Marshall, Berks. (1998)	*c.* 169	169	84	84	+438	
CH10(19)	Melbourn, Cambs. (1987)	*c.* 170	170	29	29	+555	
R303	Hinckley, Leics. (1871)	161–80	171	58	58	−10	unknown sample

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R291; C028	Braughing, Herts. (1956)	*c.* 171	171	61	61	−194	
CH10(20)	Brundish, Suffolk (1992)	*c.* 171	171	65	65	+810	
CH10(21)	Marlingford, Norfolk (1990)	*c.* 172	172	173	173	−109	
2006(T452); 2008(T220)	Pattingham, Staffs. (2006)	*c.* 173	173	9	9	−905	
R281	Ilston, Gower, Swansea (1823)	161–80	174	*c.* 200	12	+7	*c.* 6% sample
R290; C121	Gurnard, Isle of White (1983/4)	170–4	174	15	15	+3733	
CH11(17)	Lichfield, Staffs. (1998)	*c.* 174	174	*c.* 100	18	+1459	*c.* 18% sample
CH11(19)	Sandfields, Staffs. (1995–8)	*c.* 175	175	15	15	+1179	
R301; C257; 2007(T198)	Westgate, Co. Durham (1983, 2006)	*c.* 176	176	20	20	+1636	
CH10(22)	Worston, Lancs. (1994)	*c.* 176	176	8	8	−820	
2008(T356)	Oswestry I, Shrops. (2008)	*c.* 176	176	97	96	−1215	
2008(T526)	Oswestry II, Shrops. (2008)	*c.* 176	176	23	20	−1866	
2004(T311)	Church Minshull, Cheshire (2004)	*c.* 176	176	58	57	−1806	
2008(T006)	Chetwynd Aston and Woodcote II, Shrops. (2007)	*c.* 176	176	15	15	−1415	
CH10(23)	Potters Bar, Herts. (1994)	*c.* 176	176	95	95	+500	
R278	Mere, Wilts. (1856)	161–80	177	232	232	+12	
R284; C001	Aldworth, Berks. (1984)	176–7	177	75	75	+525	
R315; C048n	Castle Bromwich, Warwicks. (1909)	*c.* 177	177	18	18	+141	irregular coins
R315; C048n	Castle Bromwich, Warwicks. (1909)	*c.* 177	177	181	181	−255	
R230; C206	Poughill, Devon (1836)	*c.* 177	177	28	28	+1055	
R316	Caerleon, barracks 7, Newport (1927/9)	*c.* 177	177	295	295	+406	
R240; C039n	Caistor St Edmund, Norfolk (1895)	177–80	177	20	20	−1166	
CH11(20)	Inchyra, Perth and Kinross (1993)	*c.* 178	178	8	8	−64	
R314; C097; CH09(09)	Edwinstone, Ollerton, Notts. (1910, 1988)	*c.* 179	179	418	411	−159	
R311	Giant's Causeway, Co. Antrim (1831)	161–80	180	71	71	+186	unknown sample

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R268	Linlithgow, West Lothian (1781)	161–80	180	*c.* 300	13	+745	*c.* 4% sample
R235; C184q	Naseby, Northants. (1874)	161–80	180	38	38	+900	
R285	Beaconsfield, Bucks. (1797)	161–80	180	65	65	+665	
R306; C174f	Great Melton, Norfolk (1887)	161–80	180	22	18	+363	
R245	Grinton, Reeth, N Yorks. (1987)	170–80	180	62	52	+614	
R308	Doncaster, S Yorks. (1929a)	169–80	180	63	63	+209	
R309	Doncaster, S Yorks. (1929b)	177–80	180	52	52	+315	
R313; C011n	Beachamwell, Norfolk (1846)	177–80	180	50	37	+136	
R346	Braco, Shotts, Lanarks. (1842–1947)	*c.* 180	180	?	26	−705	unknown sample
2005(T418)	Doncaster Common, S Yorks. (2005)	*c.* 180	180	310	72	−508	*c.* 23% sample
CH10(24)	Wreningham, Norfolk (1994)	*c.* 180	180	186	186	−141	
R328; C227n	Slay Hills Saltings, Rainham, Kent (*c.* 1864)	*c.* 180	180	15	15	−266	
R343	Sheffield, S Yorks. (1860)	180–92	180	34	34	−2583	
R228a; R317; C10(25)	Barway, Cambs. (1977–90)	*c.* 181	181	544	544	+350	
R338; C162n	nr Lydney, Glos. (1854)	180–92	182	155	155	+24	
R336	Weston Underwood, Bucks. (1858)	180–92	182	166	166	+22	
R333/260	Kirkby Thore, Cumbria (1863)	180–3	183	234	167	+567	
R319; C022	Brickhill, Bletchley, Bucks. (1967)	*c.* 183	183	296	296	−1022	
R323	South Shields, Tyne and Wear (1878)	*c.* 185	185	120	120	−286	
R339; C162	Lowestoft, Suffolk (1877)	186–9	186	38	38	−479	
R320; CH09 (10)	Brickhill, Bletchley, Bucks. (1987)	*c.* 187	187	627	627	−1467	
R335	Briglands, Rumbling Bridge, Perth and Kinross (1938+)	*c.* 187	187	180	180	+1085	
R331; C033	Brixworth, Northants. (1892)	180–92	192	25	25	+990	
R349	Broch of Lingrow, Orkney (1870)	180–92	192	6	6	+1968	not displayed

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R330; CH08/09/10; CH11(22); 2004(T42); 2005(T451)	Postwick, Norfolk (1986–2005)	*c.* 192	192	291	291	−106	
CH11(21); 2007(T416)	Ugthorpe, N Yorks. (1998, 2007)	*c.* 192	192	71	66	+704	
CH10(27)	Littleborough, Greater Manchester (1994)	*c.* 193	193	76	71	+1283	
Holmes (2006)	Birnie 2, near Elgin, Moray (2001)	*c.* 193	193	310	310	+194	
R365	Acton, Greater London (1899)	193–211	193	7	7	−739	
R380; C125	Handley, Dorset (1877)	194–5	195	571	569	−315	
R362; C223	Silchester Insula XI, Hants. (1894)	194–5	195	258	258	−1165	
R359; C120; CH08/9; CH11(24)	Great Melton, Norfolk (1984/88/96)	*c.* 195	195	278	277	−738	
R369	Portmoak, Perth and Kinross (1851)	196–7	196	*c.* 600	120	+53	*c.* 20% sample
2009(T185)	Swinfen and Packington, Staffs. (2009)	*c.* 197	197	7	7	−6776	
2009(T88)	Waterhouses (hoard B), Staffs. (2008)	*c.* 201	201	10	10	−2540	
R383	Abergele, Conwy (1842)	201–6	201	*c.* 800	350	−4308	*c.* 44% sample
R368	Hill of Megray, Fetteresso, Aberdeenshire (1852)	202–10	202	*c.* 200	20	+131	*c.* 10% sample
R390	Malton, N Yorks. (1931)	209–12	202	8	7	+3933	
Holmes (2006)	Birnie 1, near Elgin, Moray (1996–2000)	196–211	200	316	316	−9	
CH11(25)	Arborfield, Berks. (1998)	*c.* 204	204	35	35	−874	
R381	Chester, Cheshire (1922)	200–11	205	7	7	+60	
CH11(26)	Bottesford, N Lincs. (1996–7)	*c.* 207	207	165	165	−838	
CH10(28); CH11(12); 2004 (T243)	Kenilworth, Warwicks. (1993–2004)	*c.* 207	207	64	61	−2702	
R385; C032	Bristol (1937)	*c.* 208	208	1476	1476	−1531	
2003(T225)	Holme, N Lincs. (2003)	*c.* 209	209	408	405	−1453	
R387; C183	Muswell Hill, Greater London (1928)	*c.* 209	209	654	654	+532	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R389	Corbridge, Northumbd (1935)	*c.* 210	210	9	9	+4364	
R384; CH10 (29)	Morton Lodge, Derbys. (1986+)	*c.* 210	210	140	140	−2191	
CH11(28)	south-east York (1998)	*c.* 210	210	31	30	+187	
C199	Piercebridge, Co. Durham (1970s)	203–11	211	6	6	+4616	
C199	Piercebridge, Co. Durham (1970s)	203–11	211	15	13	+4401	irregular coins
R385a; CH09 (13)	Much Hadham, Herts. (1990)	*c.* 211	211	129	129	+260	
2002(T169)	Wigton, Cumbria (2000)	*c.* 211	211	17	15	−3577	
R388	Carrawburgh, Northumbd (1875)	*c.* 212	212	66	66	−90	
R394; C079	Darfield 2, S Yorks. (1948)	*c.* 213	213	500	500	−3391	
R395; C051	Chadwell St Mary, Essex (1956)	213–17	213	100	100	−252	
2006(T621)	Seaford, E Sussex (2006)	*c.* 215	215	18	17	+376	
2009(T295)	Swinfen and Packington, Staffs. (2009)	*c.* 215	215	5	5	+1216	
R386; C019	Billingsgate, London (*c.* 1984) (possibly irregular)	212–17	217	142	142	+3463	
R399	Nawton (?), N Yorks. (1935)	217–18	218	33	33	+819	
CH10(30)	Edston, Peebleshire (1994)	*c.* 220	220	290	280	−5721	
CH11(29); 2005(T144)	Prestwood A, Bucks. (1999–2005)	*c.* 220	220	112	112	−1083	
R400	Verulamium, Insula XIV, Herts. (1957)	*c.* 221	221	7	7	+2415	
2008(T594)	Swindon area, Wilts. (2008)	*c.* 222	222	11	11	+1932	
2006(T003)	Padstow, Cornwall (2005)	*c.* 222	222	17	15	+1769	
R403; C004	Akenham, Suffolk (1981/2)	*c.* 222	222	59	59	−341	
R405; C068n	Colchester, Essex (1890)	*c.* 223	223	32	32	+1512	
CH11(30)	Shapwick Villa, Somerset (1998)	*c.* 224	224	9238	9213	−282	
R412; C096	Edlington Wood, Hoard 5, S Yorks. (1978)	*c.* 225	225	23	23	−1619	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R413; C221f	Caernarfon (Segontium), Gwynedd (1922)	*c.* 226	226	9	9	+2362	
R426; C149	Llanarmon Dyffryn Ceiriog, Wrexham (1918)	*c.* 226	226	548	504	+62	*c.* 91% sample
R408; C220	Saint Mary Cray, Orpington, Kent (1934)	*c.* 226	226	376	376	+978	
2009(T051)	Thirston, Northumbd (2009)	*c.* 227	227	99	98	+81	
R407; C246f	Verulamium, Eastern Tower, Herts. (*c.* 1932)	227–9	227	5	5	−3623	
R406; C089n	Colchester (?), Essex (1897)	*c.* 227	227	3062	3062	+265	
R422; C265	Wigan, Standish, Lancs. (1926)	*c.* 228	228	137	133	+965	*c.* 97% sample
R409	Housesteads, Northumbd (1933)	*c.* 229	229	5	5	+3416	
R415	Falkirk, Stirling (1933)	*c.* 230	230	1931	1804	−6978	
R416; C284	? Britain (pre-1943)	230–5	235	147	147	+453	
R429	? Britain (in Brasenose collection pre-1878)	228–35	235	141	141	+2055	
R431; C078q	Darfield 1, S Yorks. (1947)	235–8	235	480	471	−2279	
R425; C188	Nuneaton, Warwicks. (*c.* 1920)	228–35	235	29	29	+133	
R414	Kenfig, Bridgend (1925/6)	231–5	235	5	5	+2822	
R417; C043	Camborne Villa, Cornwall (1931)	227–35	235	13	13	+1090	
R432; C036s	Cadeby, S Yorks. (1912)	235–8	237	?	28	−30	unknown sample
R433; C135	Kirkham, Lancs. (1923)	*c.* 238	238	35	35	−5081	
R437a; CH09 (14)	Hartlebury, Worcs. (1990/1)	*c.* 240	240	57	56	+1081	
CH10(31)	Headbourne Worthy, Hants. (1992)	*c.* 240	240	6	6	−1483	
2004(T463); 2006 (T149); 2008(T640)	Dereham, Norfolk (2004–8)	*c.* 240	240	1051	1041	+307	
R440; C058	Chesterfield, Derbys. (1939)	238–44	244	19	19	+1385	
R437	Ashover, Derbys. (1922)	240–4	244	42	42	+1305	
R455	Long Ashton, Somerset (1817)	244–9	244	*c.* 1000	237	−4257	*c.* 23% sample
R448; C119	Great Chesterford, Essex (1949)	247–9	247	35	35	−932	

Continued

APPENDIX 1. CONTINUED

Corpus reference	Hoard name (date of discovery)	*TPQ*	Best-fit date within *TPQ* range	No. of denarii reported	No. of denarii with details	Best NAD value	Comment
R449; C099	Elveden, Suffolk (1953)	*c.* 248	248	964	964	+664	
R447	Cambridge, Cambs. (1897)	*c.* 248	248	155	155	+829	
2005(T170); 2006(T535)	Cole Henley, Hants. (2005–6)	*c.* 249–51	251	6	6	+940	
R465	Brickendon, Herts. (1895)	249–51	251	387	387	+540	
R460; C155	Lime Street, London (1882)	*c.* 251	251	320	320	+223	
R464	Rayleigh, Essex (*c.* 1850)	249–51	251	230	103	+132	*c.* 44% sample
2007(T312)	Twycross, Leics. (2007)	*c.* 253	253	24	22	−1162	
C087	Dorchester, Dorset (1936)	*c.* 257	257	16	16	+1070	
C093	Edlington Wood, Hoards 1and 2, S Yorks. (1935)	*c.* 259	259	436	436	+149	
C173	Mattishall, Norfolk (1968)	*c.* 259	259	753	753	+27	
C283	? Britain (pre-1939)	*c.* 260	260	29	29	−548	
C009	Barton-upon-Humber, N Lincs. (1983)	*c.* 260	260	56	56	+84	
C041	Caistor by Yarmouth, Norfolk (1946)	*c.* 260	260	664	664	−2601	
CH10(33)	Fineshade, Northants. (1994)	*c.* 261	261	90	89	+284	
CH08(08)	Stevenage, Herts. (1986)	*c.* 263	263	387	372	+237	
2006(T202)	Hinckley, Leics. (2006)	*c.* 265	265	51	51	−75	
2005(T118)	Billingford, Norfolk (2005)	266–7	266	9	9	−866	
CH10(34)	Crowmarsh, Oxon. (1991–2)	*c.* 267	267	25	25	+65	
C069	Colchester, Olivers Orchard I, Essex (1983)	*c.* 269	269	14	14	−32	
CH12(05)	M1 Motorway, possibly Leics. (1999)	*c.* 270	270	207	206	−383	
2007(T677)	Bath, Somerset (2007)	260s	270	5	5	+369	
C115	Gare, Sett Bridge, Cornwall (1967)	*c.* 270	270	7	7	+4	
C222	Selsey, W Sussex (1932)	*c.* 270	270	9	9	+89	
C256	Welwyn, Glebe Road, Herts. (1961)	*c.* 270	270	5	5	−971	

APPENDIX 2. THE DENARIUS PERIOD GROUPS

Group A	REPUBLICAN	up to Augustus (excluding Mark Antony)
Group B	MARK ANTONY	Mark Antony (40–31 B.C.)
Group C	EARLY JULIO-CLAUDIAN	Augustus (37 B.C.–A.D. 14), Julia, Agrippa, Tiberius (A.D. 14–37), Gaius (37–41)
Group D	LATER JULIO-CLAUDIAN	Claudius (41–54), Nero (54–68)
Group E	CIVIL WAR	Galba (68–9), Vitellius (69), Otho (69), Civil War (68–9)
Group F	EARLY FLAVIAN	Vespasian (69–79), Domitilla, Titus Caesar (69–79), Titus Augustus (79–81), Julia Titi, Vespasian Commemorative, Domitian Caesar (69–81)
Group G	LATER FLAVIAN	Domitian Augustus (81–96), Domitia, Nerva (96–8)
Group H	TRAJANIC	Trajan (98–117), Plotina, Marciana
Group I	HADRIANIC	Hadrian (117–38), Antoninus Pius Caesar, Sabina, Matidia, Aelius
Group J	ANTONINE 1	Antoninus Pius (138–61), Faustina I, Faustina II (under A. Pius), Faustina II (under M. Aurelius), Marcus Aurelius Caesar (139–61), M. Aurelius with A. Pius
Group K	ANTONINE 2	Marcus Aurelius (161–80), Div. Pius, Lucius Verus (161–9), Lucius Verus with M. Aurelius, Lucilla (under M. Aurelius) daughter of M. Aurelius, Lucilla (under Commodus) daughter of M. Aurelius, Commodus Caesar (175–7)
Group L	ANTONINE 3	Commodus Augustus (177–92), Div. Marcus Aurelius, Crispina, Clodius Albinus (195–7), Pertinax (193), Didius Julianus (193), Manlia Scantilla, Didia Clara
Group M	EARLY SEVERAN 1	Septimius Severus (193–211), Div. Pertinax, Geta Caesar (198–209), Julia Domna with Geta, Geta Augustus (209–12), Julia Domna (under S. Severus)
Group N	EARLY SEVERAN 2	Caracalla Caesar (196–8), Caracalla Augustus (198–217), Julia Domna (under Caracalla), Plautilla wife of Caracalla
Group O	LATER SEVERAN 1	Macrinus (217–18), Diadumenian (218), Elagabalus (218–22), Aquilia Severa, Julia Soaemis, Julia Paula, Julia Maesa
Group P	LATER SEVERAN 2	Severus Alexander (222–35), Orbiana, Julia Mamaea, Maximinus I (235–8), Maximinus Caesar
Group Q	LATER SEVERAN 3	Balbinus (238), Pupienus (238), Gordian II Africanus (238), Gordian III (238–44), Philip I (244–9), Otacilla Severa, Gallienus (253–68)

APPENDIX 3. THE BENCHMARK

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
40	58.9	10.8	30.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	57.0	10.9	29.4	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	52.5	10.9	28.0	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	49.8	10.9	28.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	49.4	11.2	28.3	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	48.9	11.4	28.7	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	48.2	10.9	27.3	9.9	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	35.0	9.6	16.1	8.0	12.1	19.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	31.5	8.8	12.2	6.7	12.6	28.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	31.4	8.5	9.7	6.0	11.2	30.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	29.7	8.4	7.6	5.7	9.9	31.9	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	29.3	7.7	5.8	5.4	8.5	32.4	10.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	29.1	7.3	4.3	5.1	7.1	32.2	14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
105	26.6	6.7	2.6	4.5	6.3	29.9	17.4	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110	26.1	6.1	1.9	3.2	5.6	28.0	17.8	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Continued

APPENDIX 3. CONTINUED

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
115	25.9	5.4	1.5	2.3	5.0	26.3	17.2	16.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120	23.3	4.7	1.0	1.7	4.1	23.3	15.9	20.6	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
125	13.5	3.4	0.5	1.2	3.7	22.6	16.5	27.1	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
130	7.9	1.8	0.0	0.4	3.5	20.2	16.0	32.5	17.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
135	4.9	1.6	0.0	0.1	3.1	16.9	15.6	35.6	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140	3.4	1.5	0.0	0.1	2.6	14.5	14.5	34.5	26.4	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
145	2.1	1.3	0.0	0.1	1.9	13.2	13.4	32.4	26.1	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
150	1.7	1.2	0.0	0.1	1.5	12.9	12.9	30.0	26.1	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
155	1.3	1.0	0.0	0.1	1.2	13.3	12.6	27.2	25.5	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
160	0.9	0.9	0.0	0.3	1.0	14.0	12.3	24.6	24.6	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
165	0.4	1.0	0.0	0.5	0.8	14.2	10.6	21.2	22.4	23.7	5.1	0.0	0.0	0.0	0.0	0.0	0.0
170	0.0	1.2	0.0	0.7	0.8	14.6	9.2	18.4	20.9	25.9	8.2	0.0	0.0	0.0	0.0	0.0	0.0
175	0.0	1.3	0.0	0.8	0.9	14.6	7.5	17.5	19.2	28.4	9.6	0.0	0.0	0.0	0.0	0.0	0.0
180	0.0	1.5	0.0	0.6	0.9	14.1	6.6	16.6	17.8	29.9	10.8	1.2	0.0	0.0	0.0	0.0	0.0
185	0.0	1.6	0.0	0.2	0.9	13.5	5.6	15.6	16.2	29.5	11.5	5.3	0.0	0.0	0.0	0.0	0.0
190	0.0	1.8	0.0	0.1	1.0	12.7	5.2	15.0	15.0	29.6	12.5	7.2	0.0	0.0	0.0	0.0	0.0
195	0.0	2.2	0.0	0.1	0.9	12.9	5.3	14.6	13.7	30.4	12.8	7.3	0.0	0.0	0.0	0.0	0.0
200	0.0	2.3	0.0	0.1	0.8	12.2	4.7	11.2	11.7	28.1	11.2	6.7	10.8	0.0	0.0	0.0	0.0
205	0.0	2.1	0.0	0.3	0.7	10.6	4.2	8.0	8.0	22.7	8.0	5.8	20.8	8.8	0.0	0.0	0.0
210	0.0	1.8	0.0	0.5	0.6	8.6	2.7	5.5	5.5	17.3	5.5	4.6	34.9	12.6	0.0	0.0	0.0
215	0.0	1.7	0.0	0.8	0.5	7.6	1.8	4.2	3.8	13.7	4.2	4.0	47.2	10.7	0.0	0.0	0.0
220	0.0	1.6	0.0	0.4	0.4	7.7	1.0	3.4	3.1	12.8	3.4	4.4	45.2	11.3	5.1	0.0	0.0
225	0.0	1.3	0.0	0.0	0.3	6.5	0.2	2.6	2.4	10.6	2.1	4.1	35.8	9.8	11.4	13.0	0.0
230	0.0	1.1	0.0	0.0	0.2	5.0	0.0	1.7	2.2	10.0	1.7	4.1	29.4	9.1	14.1	21.6	0.0
235	0.0	0.9	0.0	0.0	0.3	2.6	0.0	0.9	1.7	8.7	1.7	4.2	25.1	8.7	16.5	28.7	0.0
240	0.0	0.5	0.0	0.0	0.2	1.3	0.0	0.6	0.9	6.8	1.7	4.0	20.4	8.3	17.0	33.2	5.1
245	0.0	0.3	0.0	0.0	0.2	0.9	0.0	0.4	0.4	3.5	1.8	4.0	18.6	7.9	17.5	39.4	5.2
250	0.0	0.0	0.0	0.0	0.2	0.9	0.0	0.2	0.0	1.8	1.8	4.0	17.9	7.7	17.9	43.9	3.6
255	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	12.6	8.0	26.0	43.4	3.6
260	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	9.2	9.0	32.0	42.4	3.6
265	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.7	11.1	40.7	40.0	3.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	7.9	52.1	37.0	2.0

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