

THE REFORMS OF TRAJAN AND THE END OF THE PRE-NERONIAN DENARIUS

Numismatists habitually attribute the creation of Roman imperial coinage to Augustus, and commonly refer to imperial currency as ‘Augustan’.¹ Consequently any changes to the imperial coinage tend to be regarded as adulterations of this original ‘Augustan system’. The changes that took place under Nero, for example, are usually treated as the first signs of thoughtless manipulation of this system, and in addition these changes are understood as evidence of the empire’s financial weakness.² The same is claimed of Trajan’s changes to the denarius and aureus.³ However, other interpretations of these changes are possible, and this paper attempts to set out evidence to support the argument that the Neronian and Trajanic reforms are linked, and that both were attempts to establish a stable currency.

It is quite clear that Nero’s role in establishing a stable currency has been understated or completely misunderstood. Thanks to new compositional and metrological studies it is now possible to appreciate the importance of the Neronian reforms.⁴ It was the Neronian aureus and denarius standards, and not the Augustan, that persisted through the first and second centuries. As far as the precious metal issues are concerned, the Neronian coinage marked the beginning of a new era. Subsequent emperors continued to maintain these standards (with one

¹ HARL 1996: 73–96.

² CRAWFORD 1978: 151–2; WALKER 1978: 110–14; DUNCAN–JONES 1994: 221 n. 35.

³ BOLIN 1958: 201; WALKER 1978: 151–3.

⁴ BUTCHER and PONTING 2014: 201–38. Though the focus here is on precious metal coinage, and especially the silver denarius, Nero’s reforms encompassed the base metal coinage as well.

or two exceptions), including Trajan, who is often credited with a major debasement of the denarius.

The reforms introduced by Nero between c. AD 63 and 65 saw the opening of a mint at Rome for striking gold and silver on new weight standards.⁵ These standards were lower than those used prior to AD 63–65. The denarius was also issued on a lower standard of fineness, with the addition of about 20% copper. Taken together, the reduction in fineness and weight of the denarius represented about a 25% reduction in the silver content compared with denarii produced just prior to the reforms.⁶ This is usually seen as a symptom of Nero's alleged financial difficulties, and the debasement of the denarius is treated as the first stage in a series of adulterations of the Augustan coinage, rather than the creation of an entirely new coinage.

Several features of Nero's new denarius coinage had previously gone unnoticed until revealed by our series of analyses. The first was that Nero had instituted a second reform in about AD 68, towards the end of his reign.⁷ The new weight for the denarius was maintained, but the fineness was raised, from about 80% to 90% silver. It is not clear why this was done, although public dissatisfaction with the coinage at 80% fine is a possibility.

The second feature worthy of note is that the silver used for virtually all of the reformed coinage appears to have been recycled.⁸ It is likely, though not yet proved, that the resource being used was old Republican denarii. Hoards indicate that at the time of Nero the majority of silver coins available were Republican issues, and that those of Augustus and his successors formed a relatively small component of the denarius coinage in use.⁹ The success of the Neronian reforms may have depended on the removal of this enormous volume of older, finer coinage. Nero was unable to complete such a huge task within the four

⁵ The date is usually given as AD 64, but there seems to be no clear diagnostic indicator that would allow us to place the reform in this year with any certainty: see BUTCHER and PONTING 2014: 231–233.

⁶ BUTCHER and PONTING 2005; 2011: 561; 2014: 218.

⁷ BUTCHER and PONTING 2005; 2011: 562; 2014: 219–20.

⁸ BUTCHER and PONTING 2014: 224–6.

⁹ BUTCHER and PONTING 2014: 173–5; 208–11.

or five years between his reforms and his death, but analysis of the coinage of his successors suggests that his policy of recycling continued.

It was the short-lived usurper Otho (AD 69) who returned the silver content of the denarius back to 80% from 90%, possibly because he was short of funds.¹⁰ His successors Vitellius (AD 69), Vespasian (AD 69–79) and Titus (AD 79–81) continued to use the Neronian weight and fineness of 80%.¹¹ As is well known, in AD 82 Domitian returned the denarius to a pure silver coin (though he did not return to a pre-Neronian weight standard).¹² This experiment does not seem to have been a success, and in AD 85 Domitian reverted to Nero's 90% standard.¹³ His reasons for experimenting with a pure silver denarius remain obscure; it is possible that he was a convinced metallist who wanted to improve the quality of the Neronian coinage, but he then found the production costs were too high and was forced to abandon the scheme (the evidence of the trace elements from our analyses indicates that Domitian continued to recycle old coins).¹⁴ The fact that he also adjusted the weight of the gold coinage at the same time suggests that he may have been attempting to modify the Neronian coinage because, in his view, the system was not working properly. Perhaps the public preferred to retain older, finer coins and this led to an unofficial discrepancy between the value of pre- and post-Neronian reform denarii. That old Republican coinage was still present in large quantities is apparent from hoards of the Flavian period, although there are signs that after Domitian reverted to the 90% standard the quantities of Republican denarii began to diminish.¹⁵ We may wonder whether this signifies the beginning of a concerted attempt to eliminate all pre-Neronian reform denarii from the Roman world.

¹⁰ BUTCHER and PONTING 2011: 563; 2014: 246; BUTCHER, PONTING and MUONA 2009.

¹¹ BUTCHER and PONTING 2011: 563; 2014: 260–1; 333–57.

¹² WALKER 1976: 115–17; CARRADICE 1983; BUTCHER and PONTING 2011: 565–6; 2014: 386.

¹³ BUTCHER and PONTING 2005; 2014: 389–93.

¹⁴ WALKER 1978: 118; CARRADICE 1983: 160–1; BUTCHER and PONTING 2014: 384, 392–3, 406.

¹⁵ DUNCAN-JONES 1994: 195; BUTCHER and PONTING 2014: 395–7.

In AD 99–100 Trajan abandoned Domitian’s 90% standard and returned the denarius to 80% fine.¹⁶ This reform was long misdated to AD 107 and thought to coincide with a withdrawal of obsolete coinage mentioned in a statement in Xiphilinus’ epitome of Cassius Dio and which has traditionally been placed among the events of that year (Dio 68.15).¹⁷ It was further noted that Trajan issued a rare series of coins that restored old Republican and imperial coins. All three elements seemed to be part of an integrated plan, undertaken for financial motives: the finer Republican and early imperial coins were recalled; then the denarius was debased so that the state could profit; and then ‘restored’ coins were produced to commemorate the coins that had been removed and to reassure the public that nothing underhand had occurred.¹⁸ Proof that the reforms were undertaken for profit was offered by Theodor Mommsen in 1867: he noted that one type of Republican denarius, the legionary denarius issued by Mark Antony, had survived the Trajanic recall, whereas all other Republican denarii seemed to disappear from hoards by the time of Hadrian (AD 117–138).¹⁹ That the Antony denarii were debased seems to have been common knowledge.²⁰ These had not been profitable to recycle, and therefore they were left untouched. Had the aim been simply to remove obsolete coins, as Cassius Dio seems to claim, the Antony denarii should have been removed along with the rest.

The discovery that the debasement of the denarius back to 80% dates to AD 99–100 and not AD 107 upsets what was once a comfortable scheme, and casts doubt upon the profit motive as the sole explanation for what was happening under Trajan. Furthermore, it has been observed that Mark Antony’s legionary denarii, which seem to have been abundant in Flavian hoards from peninsular Italy, vanish from hoards in that region after Trajan, and are in fact quite rare in hoards in other parts of the

¹⁶ WOYTEK *et al.* 2007.

¹⁷ BOLIN 1958: 55–7; WALKER 1977: 55.

¹⁸ CRAWFORD 1978: 153 (cautious about attributing a motive of profit); DUNCAN–JONES 1994: 200; HARL 1996: 94.

¹⁹ MOMMSEN 1873: 31.

²⁰ Pliny *HN* 33. 46.

empire for much of the second century.²¹ If this observation is correct, it is possible that many of the Antony denarii also went into the melting pot along with other Republican coins, and that their lower silver content was no obstacle to their removal. Cassius Dio may have been recounting a real motive for the elimination of Republican denarii when he said that Trajan removed coinage because it was obsolete.

The hoard evidence leaves little doubt that a major change took place in this period. Republican coins are still present in some quantity in Flavian hoards, but under Trajan and Hadrian they disappear. No other comprehensive removal of denarii had ever taken place on such a scale, and it must represent a considerable commitment by the state to renew the coinage.

Can a study of the trace element profile of Trajan's denarii shed any light on these events and the motives behind them? In an earlier article²² we noted that the denarii of Trajan's successor Hadrian were produced from an entirely different source when compared with the denarii of Nero and his successors down to Domitian. Those of Nero to Domitian had been made from recycled materials, whereas those of Hadrian seem to have been produced from a new metal source. The question of whether this change took place at the beginning of Hadrian's reign, or whether it occurred under Trajan, is one that we aim to examine here.

Analysis

A total of 330 silver denarii covering the reigns of Nerva, Trajan and Hadrian were analysed as part of a continuing project to investigate the composition of Roman silver coinage:²³

²¹ They make a slight comeback in the Severan period outside peninsular Italy. How this might have happened is explored in MURPHY 2015.

²² BUTCHER and PONTING 2012: 77–8.

²³ The coins come from various museum collections and hoards from Britain, with the addition of material held in the Staatliche Münzkabinett Winterthur. We are particularly grateful to the individuals who granted us access to the coins: Christopher Howgego (Ashmolean Museum, Oxford); Gail Boyle (Bristol City Museum); Andrew Burnett, Roger Bland, Richard Abdy and Jonathan Williams (British Museum,

	<i>Number analysed</i>	<i>Mean silver bullion (Wt. %)</i>	<i>Standard deviation</i>
Nerva	52	89.7%	3.6
Trajan pre-reform	31	89.2%	4.4
Trajan post-reform	165	80.9%	5.4
Hadrian	82	75.9% ²⁴	3.2

As can be seen in the table, Trajan's pre-reform coinage was on the same fineness as that of his predecessor Nerva, approximately 90% fine. The post-reform coinage, on the other hand, was only 80% fine. The post-reform standard was not new. It was in fact the standard introduced by Nero between c. 63 and 65, and used again between Otho in 69 and Domitian in 82. It was therefore a revival of Nero's original reformed standard.

In addition to the important changes to the silver bullion content there is evidence for a change in the source/s of the silver bullion itself. This was first presented in our 1998 paper where we compared coins of Trajan's second and fifth consulship²⁵ and is presented again here with additional data including coins from Trajan's fourth and sixth consulship (*Fig. 1*).

Comparison with the denarii of Nerva and with Hadrian (*Fig. 2*) show that what we are seeing is a fairly gradual change in trace element composition that may well be indicative of a gradual shift in bullion source across the three reigns.

Trajan's pre-reform denarii have similar levels of lead and gold to Nerva's denarii, with some of Trajan's denarii containing appreciably less lead. With Trajan's reform, however, comes a change to silver bullion, with less gold and more lead – a pattern that becomes much

London); Brett Thorn (Buckinghamshire Museums); Keith Sugden (Manchester Museum); Stephen Minnit (Somerset Museums); Benedikt Zäch (Winterthur); and Renata Windler (Canton of Zurich). Fuller details of the analyses will be made available in due course.

²⁴ This figure is an average across the entire reign of Hadrian, and does not represent a single standard. Under Hadrian the fineness varied slightly from issue to issue. See BUTCHER and PONTING 2012: 70.

²⁵ BUTCHER and PONTING 1998: 313.

clearer under Hadrian. Lead, however, would have been added to the metal to facilitate any recycling process by sequestering the silver from the copper in the alloy of old coins. The silver-rich lead would then be cupelled to extract re-purified silver ready for re-alloying. Cupelled silver will therefore retain a small amount of the added lead and the amount of this remaining in the silver can be a measure of the scale of the process; larger amounts of lead potentially being indicative of a large scale, less-efficient cupellation process. Consequently the increase in lead content observed here could indicate a larger scale cupellation process being used.

A similar picture, where Trajan's pre-reform coins show a closer affinity with those of Nerva and his post-reform coins show an affinity with Hadrian's, emerges when the gold and bismuth levels are plotted, here shown together to illustrate the gradual change (*Fig. 3*): from the high gold, low bismuth silver of Nerva; through a moderate gold, moderate bismuth phase in Trajan's early coinage; and finally to metal that is lower in gold and higher in bismuth after Trajan's reform. Hadrian's denarii are quite consistently made of silver that is really quite low in gold (<0.25% scaled) and with variable, often high bismuth with scaled values up to 0.28%.

Gold and bismuth are both trace elements more reliably linked to the silver ores from which the silver metal was extracted and are therefore good indicators of a gradual change in bullion supply. What this change actually involves is harder to discover. Nerva's denarii are clearly separated from Hadrian's in terms of gold and bismuth content, and Trajan's coinage marks the point of change between the two. The most likely interpretation of the gold/bismuth signature in Nerva's denarii is that these coins are made from old denarii that were being recycled by a relatively efficient process leaving little lead in the recycled silver bullion. The gold and bismuth signatures for Nerva's denarii fit perfectly with the pattern observed under Nero and the Flavians, and it is likely that the main source of metal was Republican coinage, as appears to have been the case ever since the mint of Rome started producing denarii after Nero's reforms in c. AD 63–65.²⁶ The results for Trajan's

²⁶ BUTCHER and PONTING 2014: 415–17.

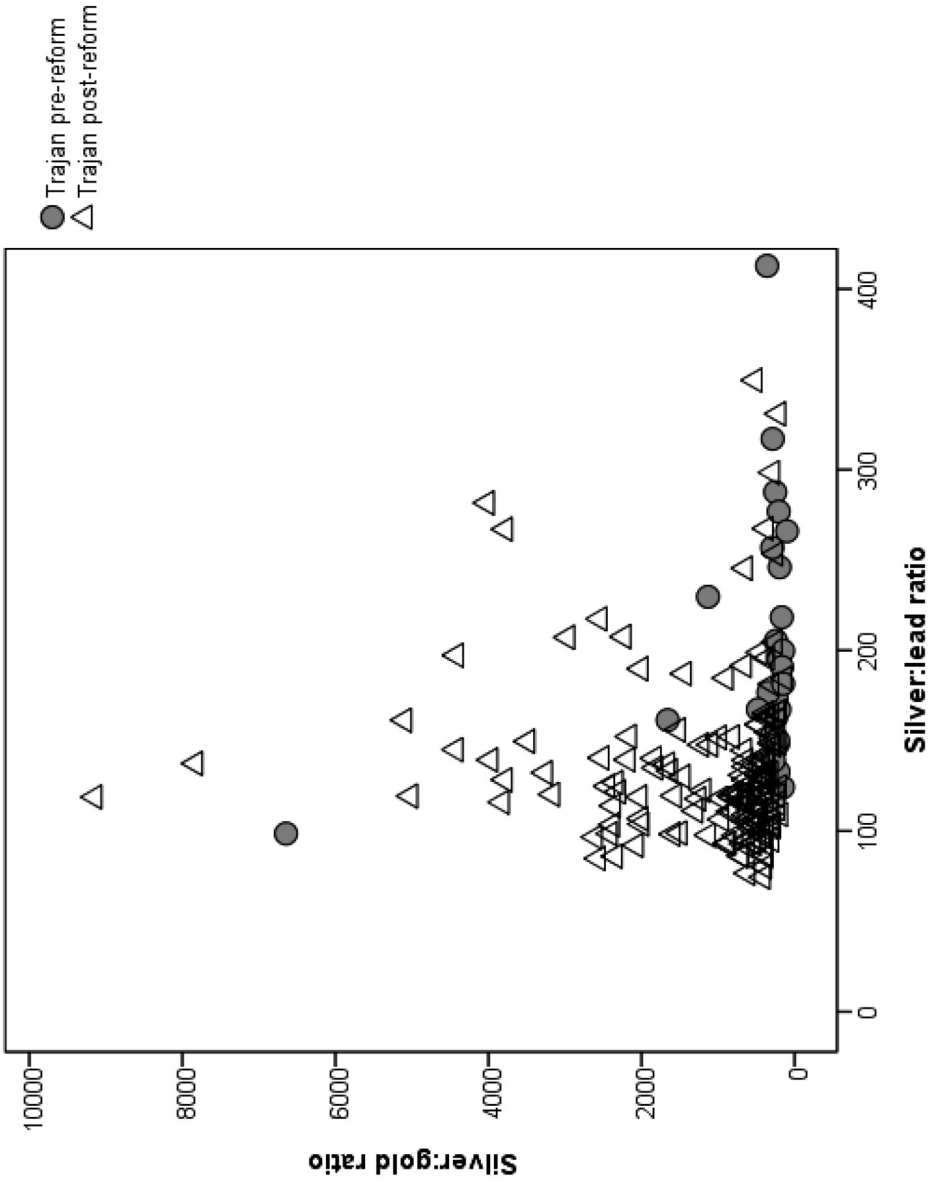


Fig. 1 – Scatterplot of silver:gold and silver:lead ratios of denarii of Trajan analysed.

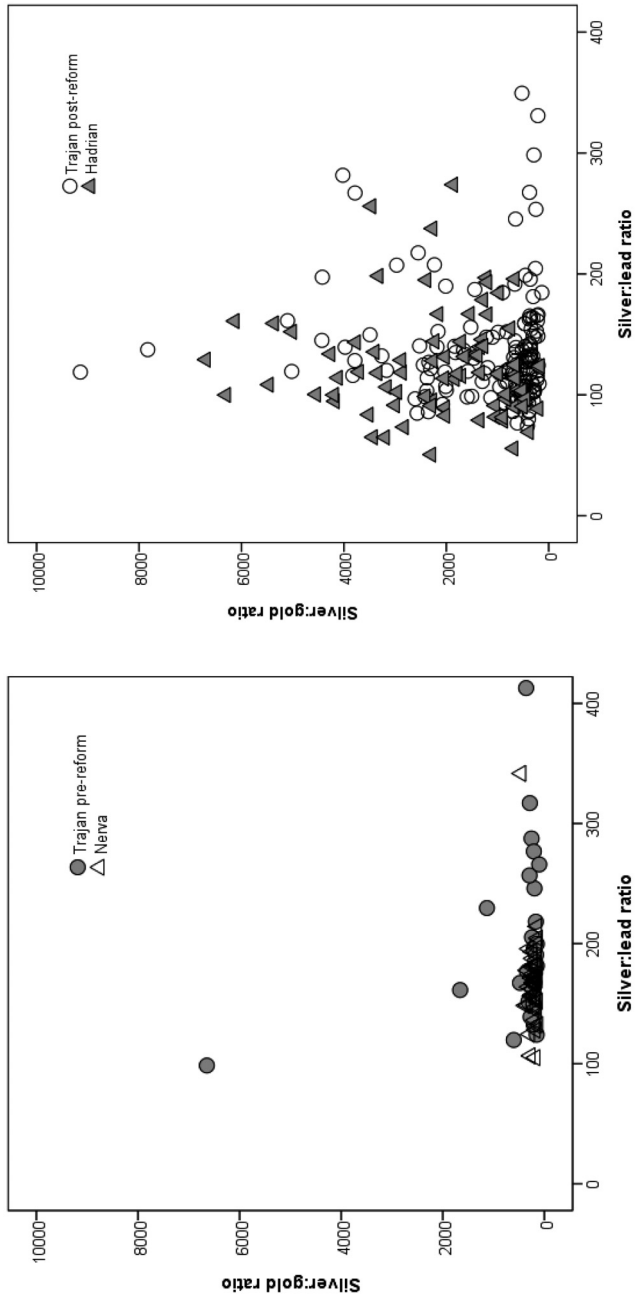


Fig. 2 – Scatterplot of gold:silver and lead:silver ratios for Trajan's predecessor (Nerva) and successor (Hadrian).

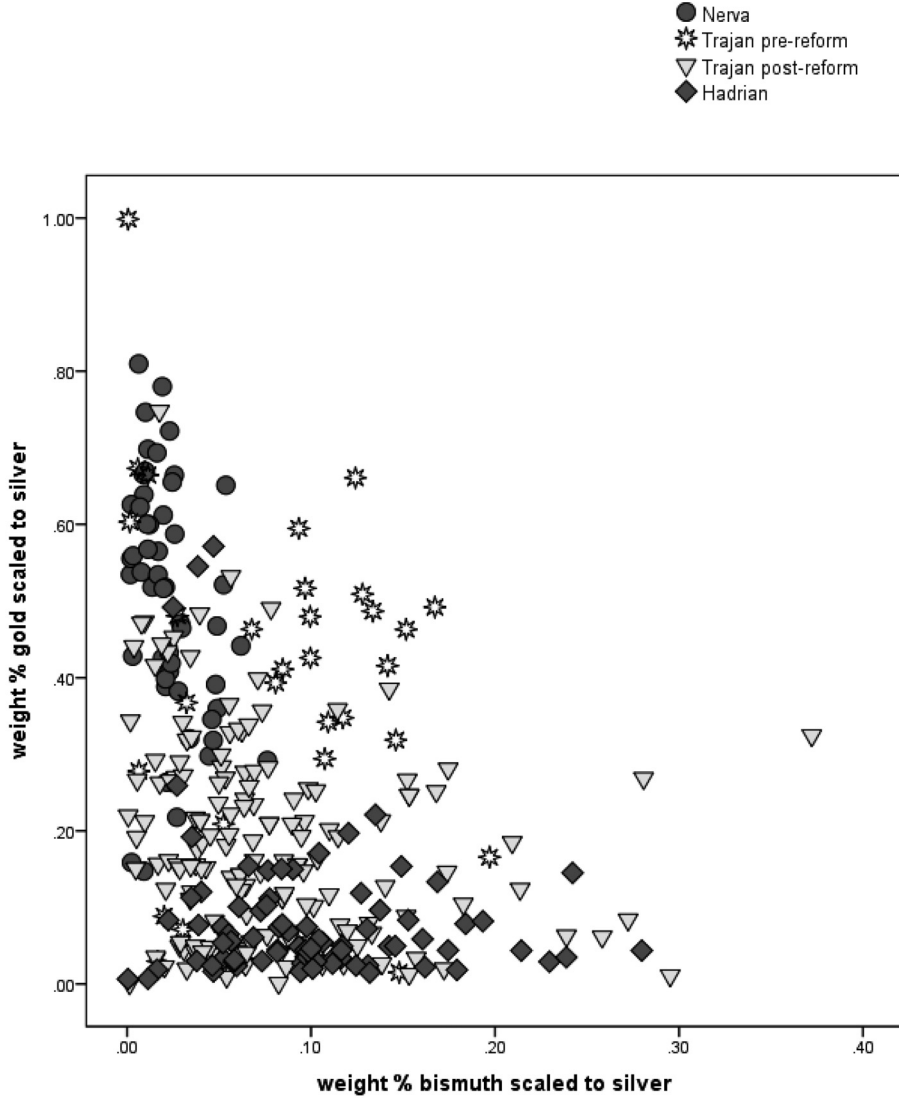


Fig. 3 – Scatterplot of gold and bismuth scaled to silver for denarii from Nerva to Hadrian analysed.

pre-reform issues can also be interpreted as representing recycled metal, although it would appear that in this case some of the coinage being recycled came from a different source to that of Nerva's denarii. Some Julio-Claudian denarii have similar gold and bismuth levels, and perhaps this material was being targeted for recycling at the time.²⁷

Under Nerva, therefore, it was business as usual: the mint of Rome continued to produce new denarii from the existing stock of old denarii in circulation. But this is the last time such a signature occurs for the majority of an emperor's coinage until the late second century.²⁸ Trajan's reign, and particularly his reform, marks a major departure from what had gone before. While there is some overlap between the post-reform issues of Trajan on the one hand and the coins of Nerva and Trajan's own pre-reform coins on the other, which is probably indicative of some continued recycling, the majority of the post-reform coins appear to be made from metal from different source/s. This is, of course, rather puzzling: if Trajan had intended to recall older coinage in order to profit by reminting it at a lower fineness after the reform, why does the gold/bismuth signature of older coinage appear to be less common in his post-reform denarii?

The trace elements associated with the base metal in the alloy also mark the issues of Nerva and Trajan's pre-reform coinage as being quite different from Trajan's post-reform coins. A principal components analysis of the trace elements most probably associated with the copper in the alloy pulls out the denarii of Nerva and the bulk of Trajan's pre-reform issues as being similar to each other and quite different from his post-reform denarii and the denarii of Hadrian (*Fig. 4*).

The weightings on the components indicate that antimony, cobalt and chromium are the most significant elements responsible for the structure and, when these are plotted in pairs (e.g. *Fig. 5*), show that a gradual increase in the antimony content is the main feature. This indicates a gradual change in the trace element composition of the copper

²⁷ BUTCHER and PONTING 2014: 428–30.

²⁸ The same signature occurs in a concentration during AD 193, for the coinage of Pertinax and Didius Julianus: BUTCHER and PONTING 2012: 79, fig. 6c. This may indicate the start of a new phase of recycling – not of Republican denarii, but of first century AD denarii that had themselves been made using silver from Republican denarii.

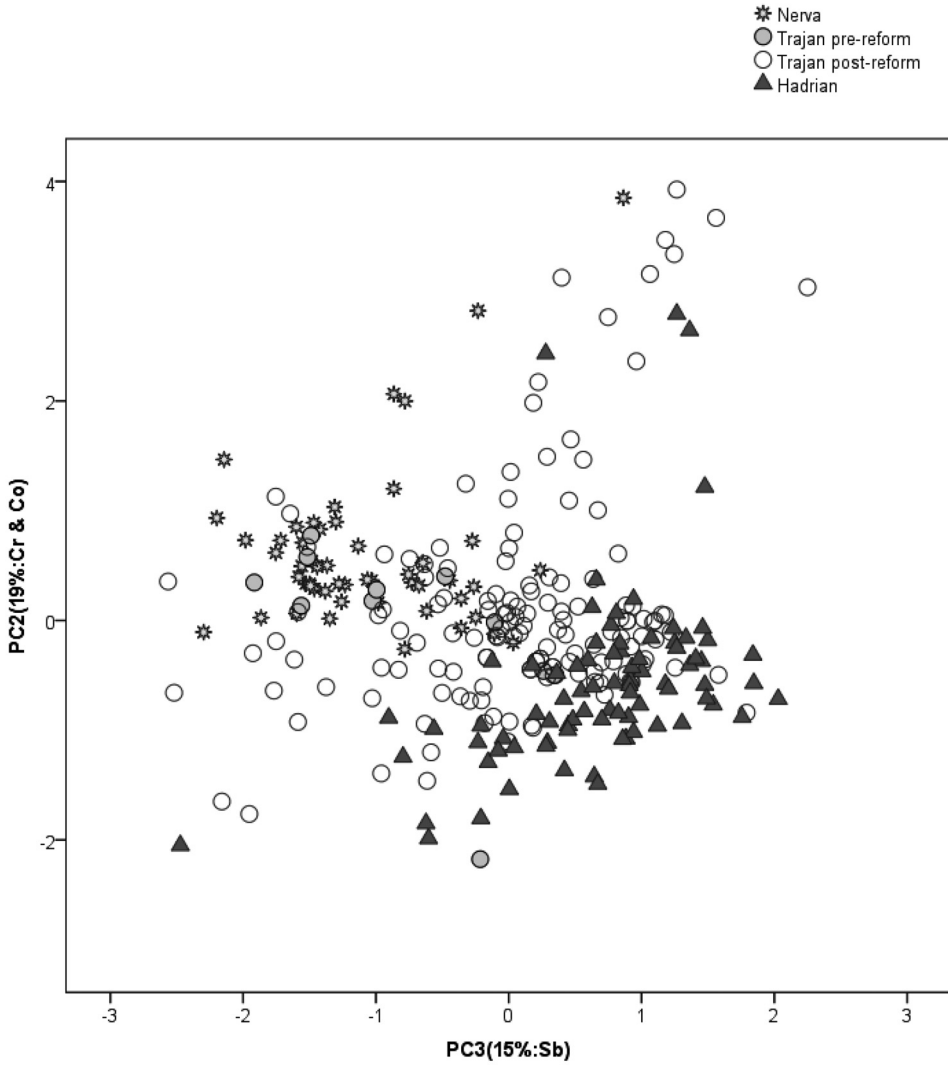


Fig. 4 – Principal components plot of trace elements associated with the copper portion of the alloys used for denarii of Nerva, Trajan and Hadrian analysed.

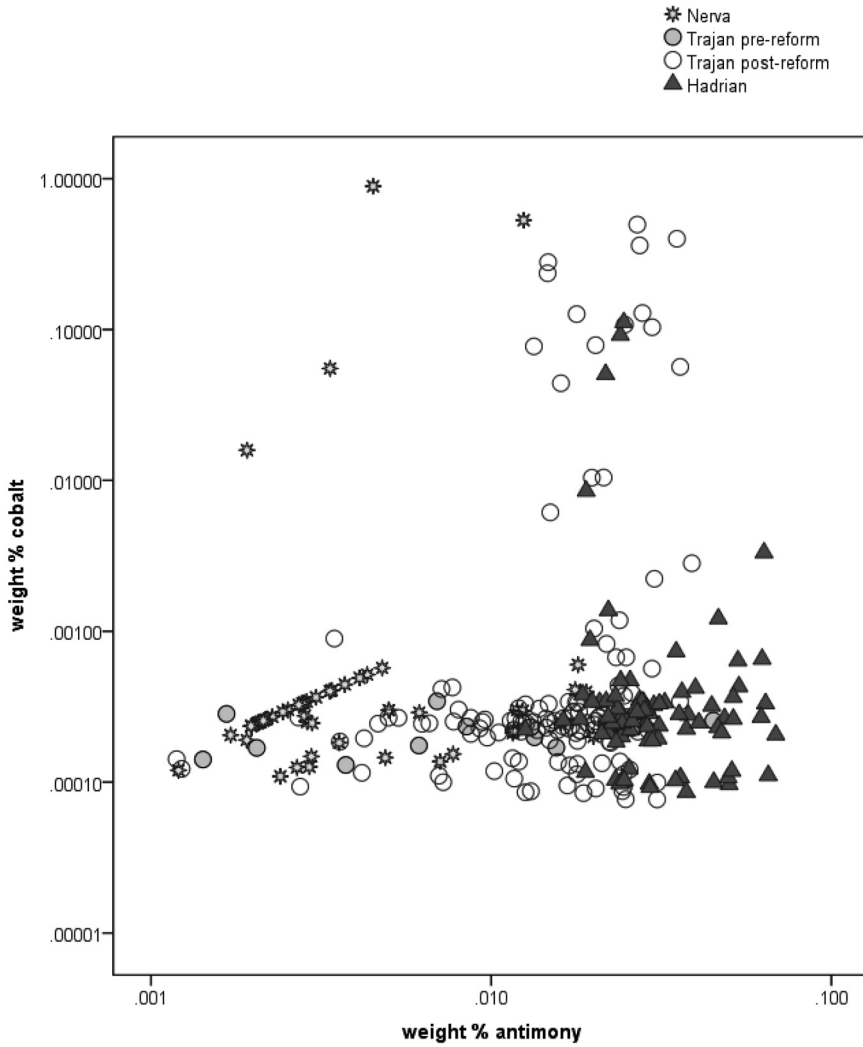


Fig. 5 – Scatterplot of cobalt and antimony contents of the denarii of Nerva, Trajan and Hadrian analysed.

being used over time, also most probably due to a change in source. There is, inevitably, a degree of overlap, but the transition is clear.

The antimony and cobalt are also very strongly correlated amongst the denarii of Nerva. A similar strong correlation can be observed between the antimony and chromium and cobalt, as well as the tin and zinc. This suggests that a single copper source was used during the reign of Nerva, but that this did not continue into Trajan's reign; whereas the chemical characteristics of Nerva's silver source clearly does overlap well into Trajan's issues. Other correlations can be observed amongst the denarii of Trajan, suggesting the use of copper from a number of sources with differing trace element characteristics.

Can we pinpoint the period of transition more exactly? The structure and dating of Trajan's post-reform coinage has long presented a challenge, because the emperor's titles remained unchanged over several years, making a close dating of the individual issues very difficult. Recently, however, a detailed arrangement has been provided by Bernhard Woytek (2010). His proposed dates for the 15 groupings of the post-reform coinage are as follows:

Group 5:	AD 100
Group 6:	AD 101–102
Group 7:	AD 103
Group 8:	AD 103
Group 9 Cluster 1:	AD 103–104
Group 9 Cluster 2:	AD 103–107
Group 9 Cluster 3:	AD 106–107
Group 9 Cluster 4:	AD 107
Group 10 Cluster 1:	AD 107–108
Group 10 Cluster 2:	AD 107–108
Group 10 Cluster 3:	AD 108–109
Group 10 Cluster 4:	AD 110
Group 11:	AD 111
Group 12:	AD 111
Group 13:	AD 112
Group 14 Cluster 1:	AD 112–113
Group 14 Cluster 2:	AD 112–113
Group 14 Cluster 3:	AD 113–114

Group 15:	AD 114
Group 16 Cluster 1:	AD 114–115
Group 16 Cluster 2:	AD 114–116
Group 17:	AD 116
Group 18:	AD 116
Group 19:	AD 116–117

As with the trace elements associated with the silver, the change in the copper-linked element profiles appears to occur during the reign of Trajan, more specifically in the period immediately after Trajan lowered the silver content in the phase preceding issue Group 9 (*i.e.* Groups 5–8).

Turning to look specifically at Trajan's post-reform denarii, it would appear that the metal for these issues is quite homogenous. Closer inspection, however, reveals some curious structure and differences between the groups (*Fig. 6*). An evaluation of the gold, bismuth and lead contents shows that the early post-reform denarii (Groups 6 and 8, AD 101–103) are made of chemically different silver to those that come after (high levels of gold and low bismuth). These are obviously the continuation of the pre-reform metal type identified above, and are presumably the result of continued recycling of old denarii. The denarii analysed belonging to Group 9 (AD 103–107), on the other hand, are quite different to the denarii of Group 6 and 8, containing less gold and more bismuth and lead. This composition is unusual but has been seen in earlier denarii, notably those of the Julio-Claudians. It is also found in some denarii of Hadrian (see above).

The issues from Group 10 through to Group 19 (AD 107–117) appear to be compositionally homogenous, with no structure discernible. Group 19 (AD 116–117), however, although still within the mass of denarii from all groups when observing their gold and bismuth contents, shows a significant correlation quite unlike the other issues. This may indicate that the issue was produced from silver from a single source.

A single restored denarius was included in the sample. Its strongest affinity is with late denarii of Groups 16 and 19 (AD 114–117), although a general affinity with the later coinage of Groups 11 to 19 (AD 111–117) is also plausible.

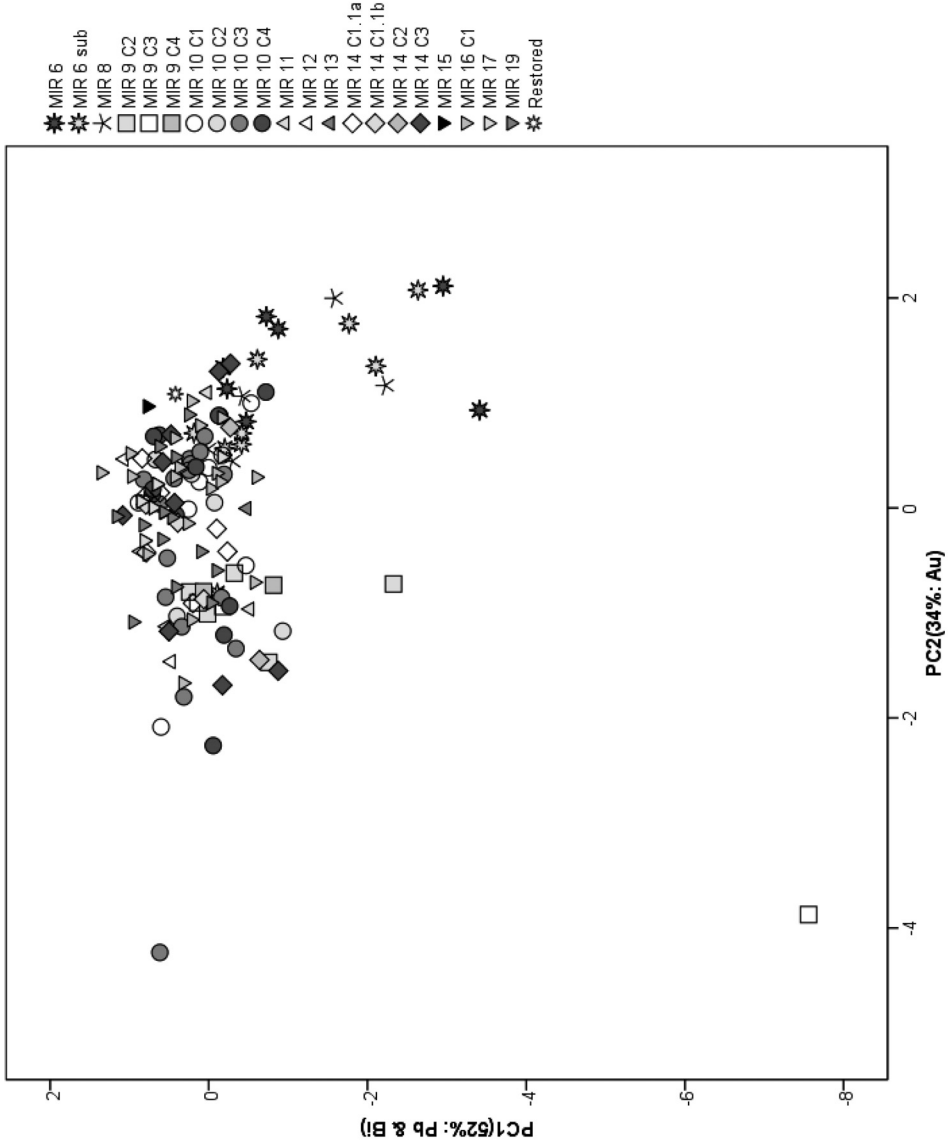


Fig. 6 – PCA plot of gold, bismuth and lead values for Trajan's post-reform denarii.

The lead isotope analysis of a sub-set of the denarii analysed for their chemistry provide further insights into Trajan's denarii.

Many of Trajan's post-reform denarii cluster in the 0.85/2.09 region of the isotope plots in the same way that many earlier Rome issues do, especially those of the Civil War of AD 68–69 and of the Flavian period (Butcher and Ponting 2014: Figs. 10.11 and 12.2). While the isotopes of these coins are also all consistent with the isotope characteristics of the Massif Central region of France, their chemistry is markedly similar to that of Flavian denarii and therefore is in agreement with the interpretation of the isotope data as the result of recycling.

The early post-reform denarii of Groups 6 & 8 have isotopic characteristics that are inseparable from those of the later issues. This would be consistent with the effect of mixed lead being used for recycling that overwhelmed any region specific isotope signature related to the silver source and is further evidence that recycled silver was used for the bulk of this coinage. The isotope data are therefore of little help in determining points of change. Only the chemical characteristics of the metal show any useful structure.

None of the isotopic data fits well with any of the established fields of ore data, but rather straddles the areas between them. This also supports the view the isotopes measured are those relating to the mixed lead used during recycling (*Fig. 7*).

Conclusions

The year AD 107 has long been regarded as significant in Roman monetary history as the year in which Trajan debased the denarius and began intensively recycling old denarii. The motive has long been supposed to have been purely fiscal: Trajan was short of both money and metal for new coinage, and the debasement was undertaken in order to profit from this process of recycling.²⁹

However, the trace element evidence and the evidence for fineness presented here disrupt this simple hypothesis. Intensive recycling began

²⁹ WALKER 1977: 55; 1978: 121–4; DUNCAN-JONES 1994: 200.

with Nero, and had continued almost uninterrupted since his reign. The fineness of the denarius was lowered in AD 100, and the trace elements indicate a shift in metal sources starting in c. AD 103 (starting with the coins bearing the reverse inscription SPQR OPTIMO PRINCIPI). Up to AD 103 the silver source had been the same as under Trajan's predecessors, and was probably derived from recycling old denarii. From AD 103 onwards we witness the increasing reliance on a new source. This hardly looks like the actions of an empire that was short of supplies of metal.

Initially the shift is dramatic. From c. 103 to 107 (Group 9) the denarii were produced exclusively from this new source. However, the following period, from 107 to 110, witnessed reliance on two sources. One is clearly the new source of metal introduced c. 103; the other looks like recycled material, but this time diluted with metal from the new source. The pattern of two sources (new; and recycled mixed with new) continues through until Groups 17 and 19, which look like they are exclusively produced from a single material: the new source mixed with a little recycled metal.

If this pattern is correct (and more research is needed to confirm it), then it would appear that the procurement of metal for the mint of Rome was either more episodic in this period than it had been previously; or that it had always been episodic, and that the episodic nature of procurement is more clearly visible from AD 103 because of the introduction of this new source of silver. The earlier issues had all been produced from what seems to have been a single source, most likely old denarii, and therefore any episodic procurement would be obscured because the material was relatively undifferentiated from one issue to another.

The tentative picture that emerges for the denarius coinage of Trajan is one where the debasement comes first, followed in fairly short order by the end of wholesale recycling of old denarii, and the emergence of some other metal source as a major source of supply for the silver coinage. From AD 103 to 107 this was the only source of supply. However, from AD 107 onwards some recycling of old denarii was taking place again, but it was no longer the dominant mode of supply. The continued use of recycled metals, which from now on

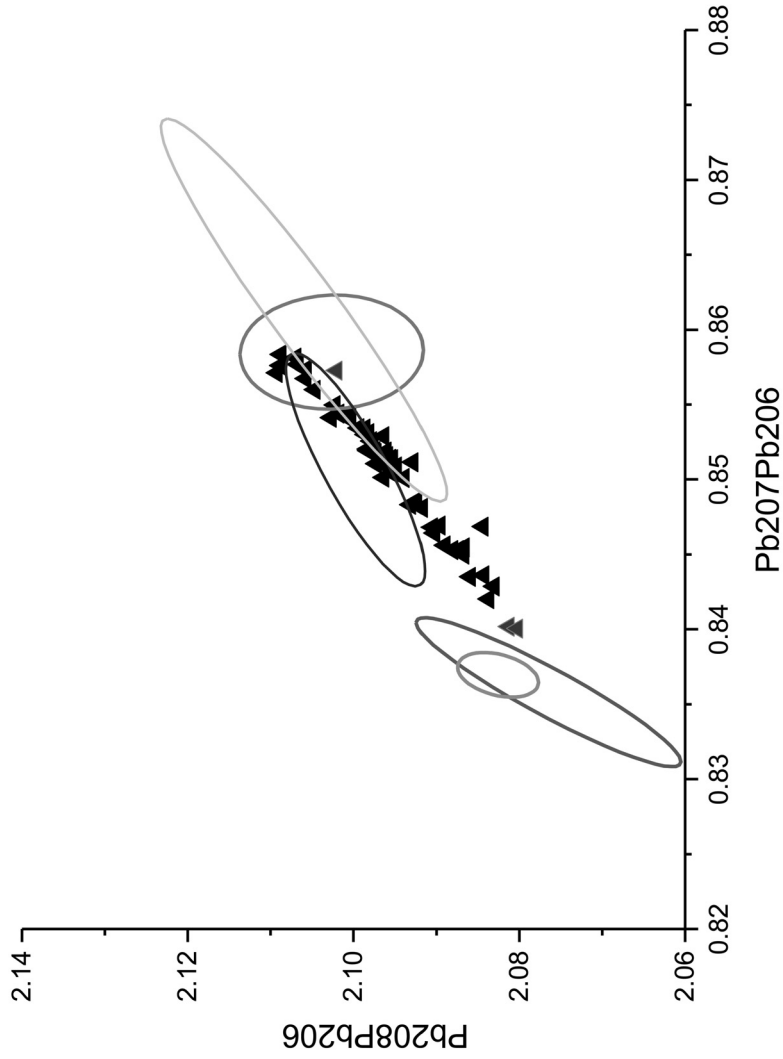


Fig. 7 – Lead isotope plot showing relationship of Trajan denarii to the main Spanish ore fields. Note that the lead values fall on a mixing line between the fields, suggestive of the use of recycled lead.

would appear to have been almost always mixed with the new source, was employed down to the end of Trajan's reign, and may represent mopping-up operations designed to remove the last vestiges of pre-Neronian coinage. Under Hadrian we cease to see evidence of the presence of recycled metals and instead we witness a complete reliance on the new source for the whole of the reign.³⁰

Trajan's debasement occurred very close to the end of a prolonged period of recycling that began c. AD 64. The main profits from the recycling process would have been confined to the narrow window of AD 100–103. Therefore Trajan did not gain enormous profits from recalling and recycling old denarii, and the combination of debasement and recall hardly seems like a structured profiteering strategy, although there were undoubtedly profits to be obtained from reducing the fineness of the denarius.

The origin of the new source of metal cannot yet be determined. The start of the shift corresponds very generally with the period immediately after the conclusion of Trajan's first Dacian war (AD 102). It could perhaps mark the influx of metal connected with that war, although at present we have no concrete support for such a suggestion. One wonders if there is anything significant in the correspondence between this shift in sources and the switch from coin legends in the nominative to those in the dative case. The legends now read like dedications to the emperor, and one could perhaps speculate that this referred to the metal for the coinage, but such an explanation would have to account for the fact that the base metal issues also bear inscriptions in the dative.

We are on slightly firmer ground by proposing that the traditional date of AD 107 for the statement of Cassius Dio, that Trajan recalled obsolete coinage, is still plausible, because we see evidence for a new phase of recycling commencing at about that time, after a period of about five years in which the mint had relied on a new source.³¹ The

³⁰ A few Hadrianic denarii display gold and bismuth levels concomitant with recycled coin, but these are rare (e.g. the three outliers in BUTCHER and PONTING 2012: 78, fig. 6a). The coinage of Hadrian will be covered in a future study.

³¹ Assuming, of course, that the date of AD 107 for the transition from Woytek's group 9 to 10 is correct.

scale of production during this period seems to have been enormous.³² As suggested above, perhaps this represents the final effort to remove the surviving population of obsolete coinage.

The scheme proposed by earlier generations of scholars, where Trajan *initiated* the project of recalling and recycling of old coinage either at the same time as, or after debasing the denarius, is clearly wrong. Trajan *completed* the recycling of old coinage, and this was a scheme that had been started by Nero, the instigator of a new gold and silver coinage for the Roman empire. Trajan merely completed the process, and re-established the denarius on Nero's c. 80% standard of fineness shortly before this process was completed. Dio's comment catches the moment when the once vast population of Republican and pre-Neronian denarii was finally removed from circulation, placing Nero's reform as a new 'year zero' in Roman monetary history.³³

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³² WOYTEK 2010.

³³ We are indebted to Bernhard Woytek for his helpful comments on a draft of this article.

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Abstract

New analyses of over 300 denarii minted under the emperor Trajan reveal an important change in the source of silver for the Roman mint during his reign. A major phase of recycling of old denarii seems to have come to an end and the signature of a new source of metal appears. This has consequences for our understanding of the date and purpose of Trajan's coinage reform, traditionally dated to AD 107.

Coinage, denarius, Trajan, debasement, reform