41 Coin hoard formation revisited...

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41.1 INTRODUCTION

This article outlines some recent analyses of Roman Republican coin hoards. This work is the continuation of a research project carried out over the summer of 1989 (Lockyear 1989) which has been published in part in the proceedings of a previous CAA conference and elsewhere (Lockyear 1991, n.d.). I shall briefly introduce the subject, and summarise my previous work before moving on to the recent analyses.

41.1.1 Coinage and hoarding

A hoard of coins is any two or more coins brought together in a deliberate manner (Casey 1986). These coins are usually a partially random selection of coins in circulation at the time. By *partially*, I mean that frequently only one denomination of coin is hoarded. Hoards collected during the Roman Republic in Italy frequently only consist of *denarii* although other silver and bronze denominations were in circulation at the time. This has modern parallels: my mother has a hoard of twenty pence pieces used to pay the telephone bill! Hoards from elsewhere are sometimes more mixed: for example in Romania *denarii* are often hoarded with tetradrachms of Apollonia and Dyracchium. The randomness of the selection of coins for hoarding was neatly demonstrated by Thordeman (1948) although the numismatist has to be aware that not all hoards are random; a classic example being the Sutton Hoo coin hoard. The coins in circulation at any one time can be termed the *coinage pool*. This can be subdivided into a *global* and a *local* pool. The global pool is all the coins in circulation within the area of interest; in this case the area of circulation of Roman Republican *denarii*. A local pool would be, for example, the coins in circulation in a particular town.

Hoards can provide evidence for many aspects of the production, dating and use of coins. For example, the dating of coins which are not inherently datable is based on the seriation of coin hoards, with the datable issues forming fixed points in the sequence. Having provided a framework for dating, and for place of issue, hoards then can be used to look at aspects of the *use* of coinage, as well as the reasons for hoarding. There have been a number of attempts to use hoards in this way, some sophisticated, some naïve. It should be obvious however, than any attempt to use hoard data must take into account the processes that affect the structure of a hoard: what I have termed elsewhere *coin hoard formation processes*.

41.1.2 Crawford's work

Michael Crawford has worked on this material for a number of years publishing *Roman Republican Coin Hoards, Roman Republican Coinage,* and *Coinage and Money under the Roman Republic* (Crawford 1969, 1974, 1985). All these works utilise hoard evidence for a variety of purposes. The most controversial of these was an attempt to estimate the size of issues of coinage during the Republic based on twenty–four hoards, and to then relate this to military expenditure during this period (Crawford 1974: chapter 7. See reviews by Frier 1976; Hersch 1977; Mattingley 1977; Burnett 1987).

In 1989 Buttrey published a critical review of the work of Michael Crawford (Buttrey 1989 reviewing Crawford 1974, 1985). In this review he used various statistical techniques including significance tests and regression analysis to strengthen his arguments. This review led, at the suggestion of Richard Reece, to the original research project (Lockyear 1989). It became clear that both Buttrey and Crawford had ignored some aspects of complicated nature of the data they were using. Reece had shown that coin hoards have a definite *structure* (Reece 1974). This structure, which will be discussed in detail below, is the result of hoards being collected in a variety of different ways and/or from different local coinage pools. Although there have been attempts to use this structure to interpret coin hoards, there was no explicit attempt to model or test these ideas.

This initial project used the twenty–four hoards that Michael Crawford published in part in *RRC* (Crawford 1974). Since 1990, I have been collecting together a much larger dataset which currently consists of over 400 hoards, and should consist of about 600 of completion of the project.[1]

41.1.3 Coin hoard structure

The concept of *structure* in coin hoards is central to all my work. It is possible to look at the structure of a hoard by plotting a histogram or scattergram of the number of coins in the hoard by the date of issue of those coins. This enables simple but effective comparisons between hoards (see Lockyear 1989: section 2.1 and appendix A.1, Lockyear 1991). From the work of Reece (1974) and myself I propose that the structure of coin hoards can be divided into three "zones."

1) *The "fall out zone"*: I define this as the area of the histogram that represents the oldest coins in the hoard. The coins have been in circulation for a long time and have become rare. Comparison between hoards *with the same closing date* show little similarity due to this rarity.
2) *The "homogenous zone"*: This is the area of the histogram representing coins which have been in circulation long enough for their distribution within the global coinage pool to have become even. Comparison between hoards with the same closing date and from a similar area show a high degree of similarity.
3) *The "erratic zone"*: This zone contains the newest coins in the hoard and varies greatly from hoard to hoard.

Three possible reasons for the variation in the "erratic zone" were investigated in 1989 (Lockyear 1989, 1991). These were:

1) variation in the amount of time taken to collect the hoard (the classic "savings" versus "emergency" hoard model);
2) differences in the "decay rate." This is the amount of coinage lost from the coinage pool each year normally expressed as a percentage (see Patterson 1972). It is also known as the loss rate, or sink rate (e.g. Volk 1987);
3) the "introduction delay." This is a combination of the distance from the point of collection of the hoard from the point of issue of the coin, and the speed of circulation of coin.

The simulation program used to investigate effects of these three factors on the structure of hoards constructed a series of battleship curves[2] on the basis of the last two factors to create a local coinage pool. Coins were then collected in a variety of manners in order to investigate the first factor. It was clear that any one of these three factors could produce the variation in the erratic zone. Therefore, any attempt to use hoards as, for example, evidence of variation in the speed of circulation would have to take hoard formation processes into account. The work outlined below has also revealed a fourth aspect that affects hoard structure and this will be discussed in detail.

41.2 HOARDS AND THE SPEED OF CIRCULATION

The main aim of the analysis outlined below was to examine the speed of circulation of coin and how this varied over time and space. The speed of circulation of coin is obviously of relevance if one is interested in how coins were used, and how this use varied. Many economists include the speed of circulation, and the supply of money, as an important part of their equations relating to the formation of prices in capitalist economies. However, this factor is also of interest in periods where it is suspected that "money" is not forming part of a classic capitalist economy but some other economic formation; for example "political capitalism" (a term derived from the work of Weber, see Love 1991).

In the context of my studies it has two levels of interest:

1) the speed of circulation affects the structure of coin hoards. The determination of this speed will help to define a predictive model against which real hoards can be compared;

1 I would like to thank Michael Crawford for allowing me access to his data, and to Andrew Burnett and Roger Bland of the Department of Coins and Medals, The British Museum, for all their help.

2 Battleship curves describe the frequency of an artefact over time from the inception of its production until well after production ceases. See Collis 1974 for an application to coinage studies, and Herzog & Scollar 1988 for the mathematical background. The simulation used a simplified form of the curve.

2) changes in the speed of circulation over time will indicate changes in other parts of the economy. These may relate to:
   a. economic changes (e.g. booms and busts),
   b. changes in the function of coinage in the economy and society.

There has been some recent work on "economic cycles" in the Roman economy based mainly on the pottery evidence (Going 1992). This paper cites the work of Creighton (1989) which claims to be able to detect variation in the speed of circulation of coin which may correlate with these cycles.

This "speed" of circulation would have to be represented by a surrogate statistic. There are various ways in which it may be possible to derive a "velocity statistic." Goulpeau (1981) utilises the concept of battleship curves and Laplace transformations to construct a graph from which it would be possible to estimate both the "introduction delay" (a combination of the speed of circulation and the distance of the source to the collection point, see Lockyear 1991, called by him τ_1) and the "decay rate" (τ_2) from hoard evidence. In order to do this, however, one has to standardise the representation of coins in the hoard so that the assumptions of his model are met. It is rarely possible to do so, and certainly not for this period. Although the use of battleship curves has many attractions the difficulties in calculating the required parameters from hoard data are large.

One alternative method which might prove more usable is to utilise the structure of the hoards as discussed above. What is required is a surrogate statistic which enables hoards to be compared rather than a precise method of calculating the velocity (V). If a consistent method of identifying a "break point" (T_{bp}) between the homogenous zone and the erratic zone could be devised then the difference between the closing date of the hoard (i.e. the date of the newest coin in the hoard) and the break point could be used as a surrogate statistic. In reality, this transition from the homogenous zone to the erratic zone is unlikely to be a sharp change or break. However, as long as the method used defines this point consistently this should not be a problem. The time span of the erratic zone (T_{ez}) can represent one of two possibilities:

1) the amount of time taken for the coinage pool to homogenise;
2) the amount of time over which the hoard was collected

It could be argued that this negates the usefulness of T_{ez} as a surrogate for V. However, if we calculate T_{ez} for a number of hoards and then plot or analyse this information spatially, it is likely that any patterns revealed would be the result of the introduction delay rather than the collection type. If such patterns are detected then they should help to identify where the majority of coin was added to the coinage pool at any one time, and may also help to show the direction of "flow" of coinage, as well as some idea of changing velocities over time.

The first attempt to define this breakpoint T_{bp} failed to do so but revealed another interesting aspect of coin hoard formation which is of great value in itself.

41.3 CORRESPONDENCE ANALYSIS

41.3.1 Aims

Correspondence analysis was first used by the author to analyse the 24 hoards presented in RRC (Lockyear 1989: section 2.4). In this case the coins were grouped into issue numbers (i.e. all the *denarii* of P. Crepusi [361/1a, 361/1b and 361/1c] were grouped together as 361). These analyses failed to really show anything of much interest. The variations detectable were due almost entirely to chronological variation in the closing dates of the hoards. Indeed, the first analysis seriated the hoards as would be expected apart from those hoards where the closing date was later than the coins listed in Crawford's table L (RRC, pp. 642–671). Another problem with these analyses was the large number of variables which resulted in plots that were difficult to interpret.

In this case the idea was somewhat different.[3] Firstly, an analysis of a number of hoards of the same or similar closing date should minimise the problems caused by that factor. Given the tripartite structure of hoards proposed above it was predicted that if we only analysed the data from the hoard's "fall out" and "homogenous zones", the samples (hoards) and variables (species, coin types) would be evenly spread on the plot of the first two axes of inertia. If we analysed all the data from the hoards, then the plot of the first two axes of inertia should show some form of horseshoe curve in the classic pattern. Finally, we could perform a series of analyses, each time adding further data to the original partial data set. It was proposed that eventually the majority of hoards would cluster in the centre of the plot, and one or more would be revealed as outliers. Continuing this process would produce a series

3 I would like to thank Clive Orton for suggesting this idea.

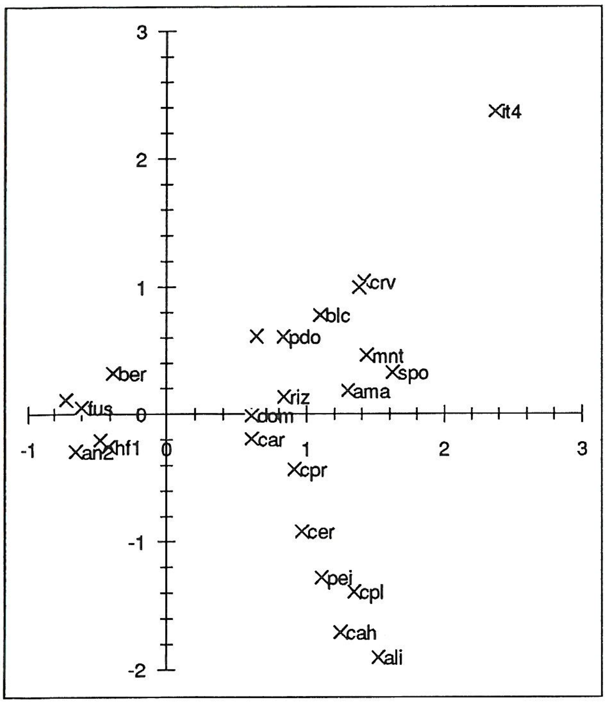

Figure 41.1: Plot of the sample scores for the first two axes of inertia derived from correspondence analysis. For details of samples (hoards) see Table 41.1.

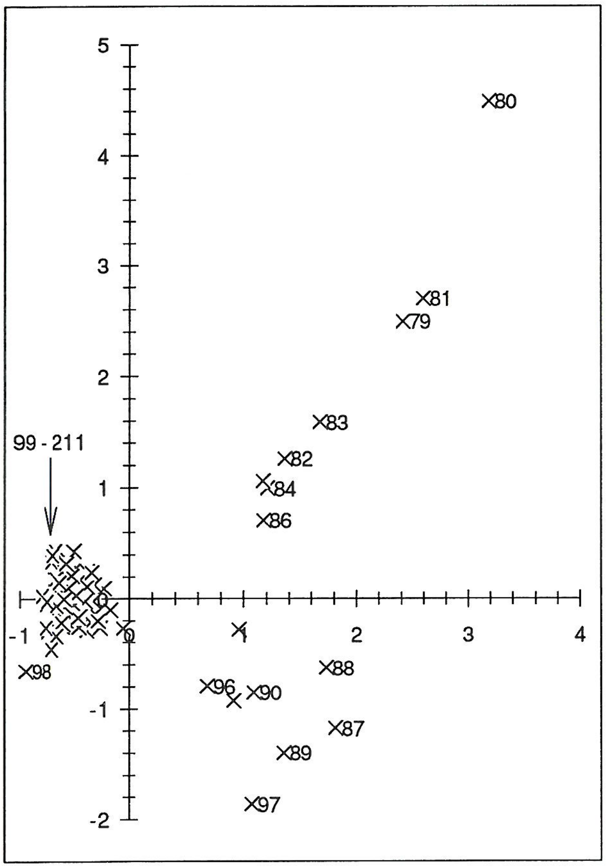

Figure 41.2: Plot of variable scores for the first two axes of inertia derived from correspondence analysis.

code	name	country	RRCH	closing date	number of coins
ali	Alife	Italy	234	87	83
ama	Amaseno	Italy	265	79	123
an2	Ancona	Italy		90	108
ber	Berchidda	Sardinia	249	82	1395
blc	Bellicello	Sicily	257	81	35
cah	'Italy'	Italy	238	87	222
car	Carovilli	Italy	251	82	40
cer	Cervia	Italy	247	82	45
cpl	Capalbio	Italy	258	81	92
cpr	Capranica	Italy	253	82	30
crv	Corvaro	Italy	273	79	13
dom	Santa Domenica di Tropea	Italy	256	82	109
fer	Ferentino	Italy	261	81	31
fus	Fuscaldo	Italy	225	90	819
hf1	'Hoffmann'	Italy	221	90	146
it4	'Central Italy'	Italy	272	79	140
mnt	Montiano	Italy	266	79	56
ned	Nedeia	Romania	274	79	19
ole	Oleggio	Italy	241	86	221
pdo	Pieve di Olmi	Italy	267	79	15
pei	Peiraeus	Greece	242	86	42
riz	'Rizzi'		268	79	215
spo	Spoleto	Italy	279	79	145
syr	Syracuse	Sicily	233	88	1084

Table 41.1: Details of the twenty–four hoards used in the first set of correspondence analyses.

of intermediate stages between the full and partial analyses. In effect, we would have created a sequence which we could animate to see the hoards clumping, then splitting off from the central group, and finally forming a horseshoe curve which would largely be the result of the variations in closing date.

41.3.2 Hoards from 91–79 BC

It was decided to try this technique on twenty-four hoards from 91–79 BC (see Table 41.1). This time bracket is one of those used by Michael Crawford in *RRCH*. The variables (species) in this case were the number of coins in the hoard grouped by year of issue. Therefore, variable 90 is the total number of coins in a hoard issued in 90 BC according to the chronology of Crawford, i.e. issues RRC 340 (L. Piso L.F. L.N. Frugi) to RRC 342 (C. Vibivs C.F. Pansa). The package used was CANOCO. [4]

4 This package was used due to its wide range of options and the ability to exclude parts of the data set. I would like to thank the Department of Archaeology, University of Southampton for allowing me access to this software.

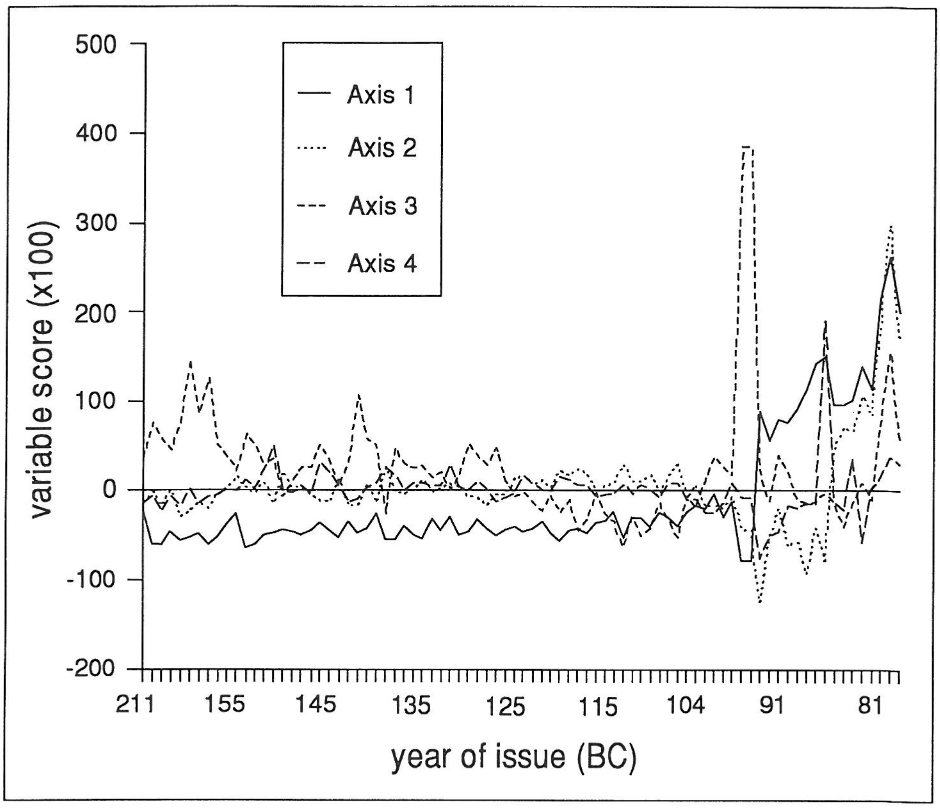

Figure 41.3: Line graph of the variable scores on the first four axes of inertia derived from correspondence analysis. For details of samples (hoards) see Table 41.1.

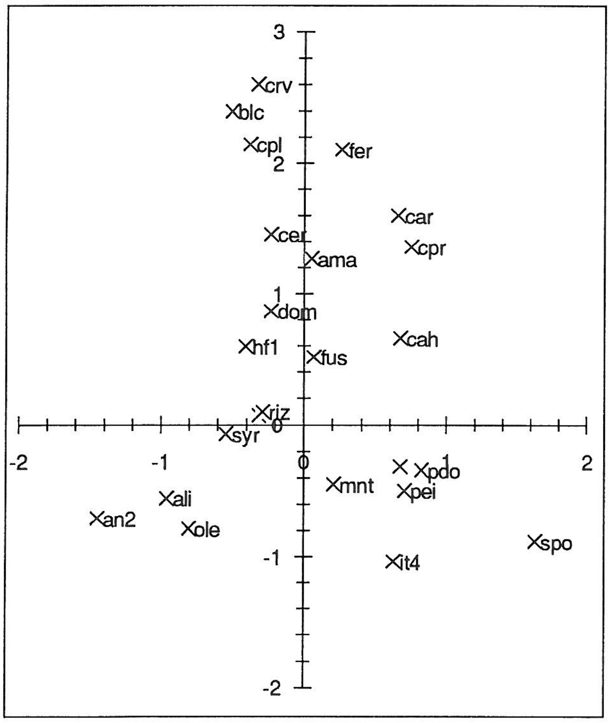

Figure 41.4: Plot of sample scores for the first two axes of inertia derived from correspondence analysis of partial data set — all coins minted up to and including 106 B.C. For details of samples (hoards) see Table 41.1.

Firstly, all the data from these hoards was analysed and examined. Then further analyses were performed with subsets of the data. These were:

1) coins issued between 211–106 BC
2) coins issued between 211–100 BC
3) coins issued between 211–96 BC
4) coins issued between 211–90 BC
5) coins issued between 211–86 BC

The analysis with all the data seriated the hoards and types despite only having hoards with closing dates between 91 and 79 BC, see Figures 41.1 and 41.2.

It was of some concern, however, to find a way of demonstrating the tripartite division of hoards as suggested above other than simple visual inspection of histograms and scattergrams (c.f. Lockyear 1989: section 2.1, n.d.; Reece 1974, 1981). In order to do this the scores from the first four axes of inertia from this analysis were plotted as a line graph, see Figure 41.3. This type of display for the scores derived from correspondence analysis is only possible for *ordinal* data types.

As can be seen Figure 41.3 clearly demonstrates the proposed tripartite division. From 211 to *c.* 127 BC there is a moderate amount of variation in the scores for the first four axes reflecting

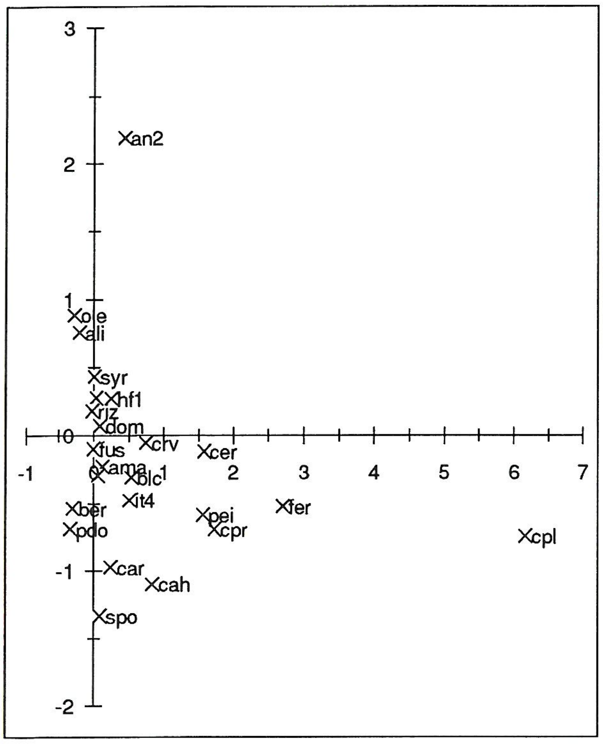

Figure 41.5: Plot of sample scores for the first two axes of inertia derived from correspondence analysis of partial data set — all coins minted up to and including 96 B.C. For details of samples (hoards) see Table 41.2.

that a moderate amount of the variation between hoards is contained in this zone. There is very little variation in the scores between *c*. 127 BC and *c*. 104 BC. Finally, there is a great deal of variation between the scores, and the highest scores occur, in the period between *c*. 104 BC–79 BC reflecting the fact that the greatest amount of variation between hoards occurs in this part of the graph. The advantage of this graph is that it:

1) allows the display of more than two axes of inertia (unlike 2D scatterplots);
2) it emphasises the variation in the data in its ordinal sequence

The partial analyses showed the predicted pattern. The analyses for coins up to 106 BC, and 100 BC produced a haze of points for both hoards (samples) and years of issue (variables). The analysis for coins issued up to 96 BC produced plots in which the majority of hoards and years of issue were clumped with a few outliers. Subsequent analyses showed intermediate stages towards the full plots (see Figures 41.1 and 41.2). Figure 41.4 shows the hoards (sample) plot for the analysis of issues to 106 BC and Figure 41.5 for issues to 96 BC.[5]

code	name	country	RRCH	closing date	number of coins
adm	Alba di Massa	Italy	289	77	98
ama	Amaseno	Italy	265	79	123
bdr	Barranco de Romero	Spain		74	65
cab	Cabeca de Corte	Portugal	300	74	158
cos	Cosa	Italy	313	74	1999
ctr	Canturato	Italy	301	74	50
it2	'Italy'	Italy		74	50
it4	'Central Italy'	Italy	272	79	140
lic	Licodia	Sicily	308	74	120
man	San Mango sul Calore	Italy	294	75	112
mnt	Montiano	Italy	266	79	56
pey	Peyriac-sur-Mer	France	304	74	109
pic	Potenza Picena	Italy	312	74	439
plc	Policoro	Italy		72	534
poo	Poio	Portugal	305	74	211
riz	'Rizzi'		268	79	215
spo	Spoleto	Italy	279	79	145
suc	Sucurac	Yugoslavia	310	74	165

Table 41.2: Details of the eighteen hoards used in the second correspondence analysis.

		Axis 1	Axis 2	Axis 3	Axis 4	Total
Analysis 1	Eigenvalues	0,46	0,197	0,117	0,084	1,332
	Cum. Perc. Var	34,6	49,3	58,1	64,4	
Analysis 2	Eigenvalues	0,157	0,085	0,046	0,037	0,561
	Cum. Perc. Var	28,1	43,2	51,8	58,5	

Table 41.3: Summary statistics for the first and second set of correspondence analyses.

This method visually demonstrates that the hoards seem to have different breakpoints — in Figure 41.5 Capalbio (cpl) and Ancona (an2) are outliers from the main group. However, it does not allow us to assign a precise break point from which we could calculate T_{ez}. How far away from the main group must a hoard be to be called an outlier — for example is Ferentino (fer) an outlier? It is obvious that Capalbio's breakpoint lies between 100 and 96 BC, and with a closing date of 81 gives us an estimate of T_{ez} of between 14 to 19 years. However, some hoards never seem to leave the centre of the plots. How does one calculate their breakpoints? This method therefore demonstrates the proposed structure of hoards, but does not help solve the problem of calculating V, or a surrogate for it.

5 For reasons of space I have only included a few sample plots. For the full sequence of analyses see Lockyear 1992, unpublished.

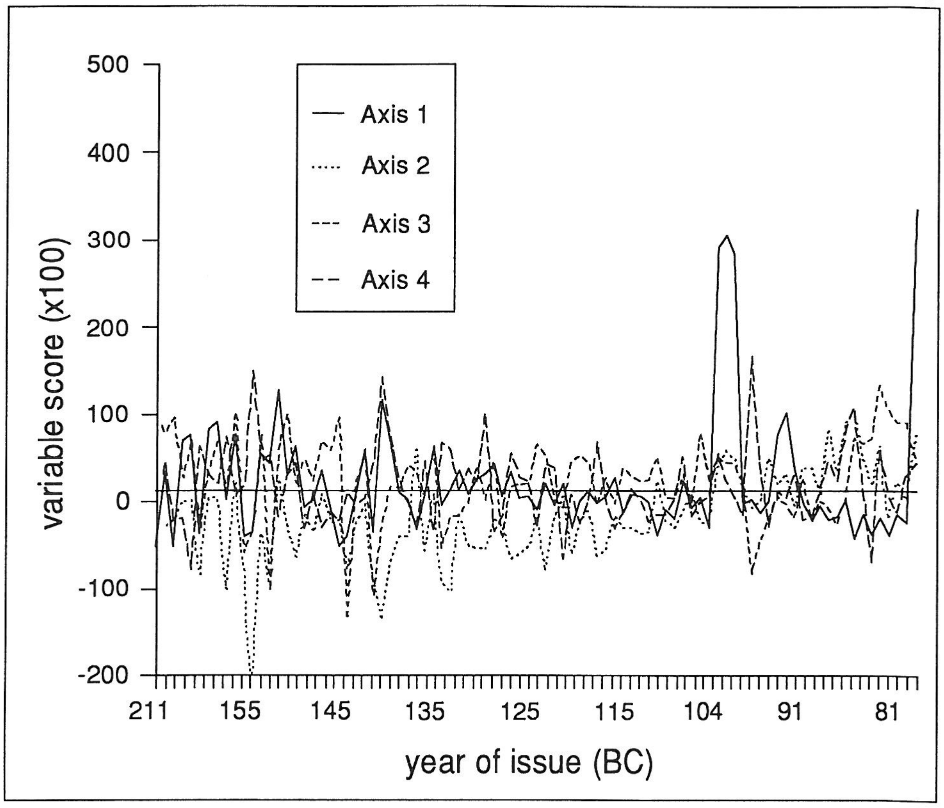

Figure 41.6: Line graph of the variable scores on the first four axes of inertia derived from correspondence analysis. For details of samples (hoards) se Table 41.2.

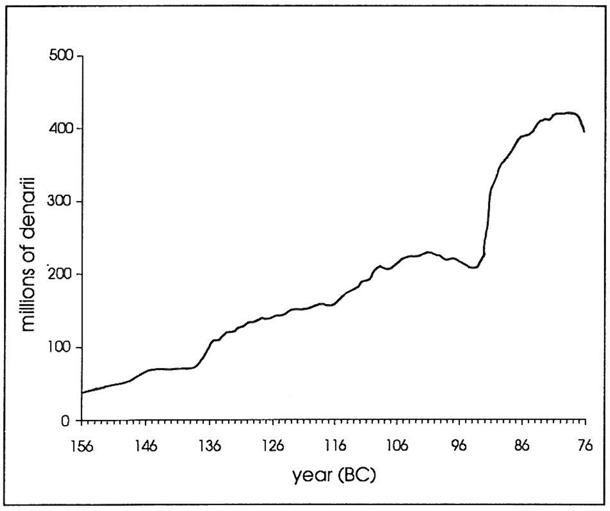

Figure 41.7: Estimates of the numbert of denarii in circulation.

41.3.3 Hoards from 80–70 BC

Next, an overlapping second group of 18 hoards closing between 80–70 BC were analysed (see Table 41.2). The eigenvalues and cumulative percentage variance explained for this and the first analysis are given in Table 41.3. The four axes of inertia are plotted on a line graph (see Figure 41.6). As can be seen this analysis does not produce the pattern as expected, nor are the eigenvalues as high as in the first analysis. The tripartite division of hoards into zones cannot be demonstrated from Figure 41.6 — the majority of the variation seems to occur in the early, "fall out zone." and there is no clear division into a homogenous and erratic zone.

41.3.4 Ramifications

The explanation for this was not immediately obvious to the author or others, but is fundamental to the understanding of the formation of hoards. The defining factor of the structure of hoards in the homogenous zone is the relative number of coins minted in each year modified by the decay rate (see Preston 1983). However, the pattern of output is also responsible for whether the variation in the erratic zone caused by the factors outlined above is visible.

This is best explained by illustration. To simplify the situation we assume that all the coins issued in a certain year will be released into the coinage pool in a short period of time and in one locality, *a*. The coins of that year will reach their maximum abundance at *a* almost immediately. However, at other localities the abundance of coin will gradually increase over a number of years before the maximum is reached. Let us say, for illustrative purposes, that it takes 10 years for maximum abundance to be reached at locality *b*.

If an issue forms 10% of the coinage pool at *a* in the year of issue, it is likely that it will only form a small percentage of the pool at *b*. Therefore, if we were to collect a large number of hoards of 100 coins at *a* in the year of issue the mean of the binomial distribution for that issue would be 10 with a standard deviation of the binomial distribution of 3 (for the formulae see Downie & Heath 1965). If at the same time that issue only formed 1% of the pool at locality *b* then hoards of 100 coins collected there would have a mean of 1 and a standard deviation of just under 1. In this case, therefore, we would expect roughly 95% of hoards collected at *a* to contain between 4 and 16 coins, whereas at locality *b* 95% of hoards of 100 coins would have between 0 and 3 coins.

Contrast this with the case where the issue forms only 1% of the coinage pool. In locality *a* 95% of coin hoards of 100 coins collected in that year would have between 0 and 3 coins, whereas at *b* there is unlikely to be any in hoards of that year. Obviously, after the coinage pool has "homogenised" in relation to those issues then the differences will be comparatively minor.

It should be obvious that if an issue forms a large part of the coinage pool it will emphasise the variation in the distribution of coins and the collection of them *in the years immediately following its issue until the coinage pool has "homogenised."* It should be noted that on a large Empire wide scale, the pool never homogenises completely, and variations in the supply of coins to the provinces of the Empire can still be detected (see Duncan–Jones 1989).

How does this relate to the problem at hand? Figure 41.7 is derived from my improved version of Crawford's die estimates (Lockyear 1989: section 2.3). The figures have been calculated using 30,000 coins per die, and a loss rate of 2% (derived from Patterson 1972) as used in my simulation study of hoard formation (Lockyear 1989, 1991). This figure is a variant of Hopkins graph based on Crawford's die estimates (Hopkins 1980: figure 2; reproduced in Crawford 1985: figure 65). The actual figures used here are highly unlikely to be accurate, but the general trends are probably satisfactory. It cannot be emphasised too strongly that the following sections are illustrative of general problems, not figures to be taken in any way as exact. As can be seen there is a large increase in the coin supply in 91–88 BC i.e. at the time of the Social War. This follows on from a period where there were very few *denarii* minted and there seems to have been a drop in the total amount of coinage in circulation. Following this period there are fewer coins minted although there are some moderately large issues. However, these issues will not form a large proportion of the coinage pool coming after the large issues mentioned.

We can continue this illustration by using the calculated global coinage pool and the binomial distribution. In 75 BC coins minted in 90 BC accounted for 16.58% of the global coinage pool giving us a mean of the binomial distribution for these coins in hoards of 100 coins collected in 75 BC of 16–17 coins, with a standard deviation of almost 4. However, coins minted in 75 BC only formed 0.6% of the pool giving us a mean of about ½ and a standard deviation of about ¾. The proportion of the coinage pool minted in the 10 years before 75 BC is about 28% of the coinage pool in 75 BC. In 85 B.C. the proportion of the coinage pool minted in the 10 years prior to that date forms about 54% of the coinage pool. In the former case this gives us a mean for hoards of 100 coins of 28 coins minted in those 10 years with a standard deviation of 4. In the latter case we have a mean of 54 coins with a standard deviation of 5. This effect I liken to the use of die in medicine. The influx of large quantities of new coin acts for a small number of years as a trace during which time we can clearly see the other processes (speed of circulation, collection patterns) at work.

Therefore, in the first analysis the erratic zone clearly shows as the hoards being examined have been collected soon after or during the period of large issues. However, in the second analysis this variation does not show due to the fact that we are now some ten years after that period. We can suggest, therefore, that it is taking less than ten years for the pool to "homogenise."

This also explains the phenomenon noticed by Dirk Backendorf (*pers. comm.*). He noted that if the proportion of coins in hoards minted within, for example, twenty years of the closing date of the hoard was calculated, those hoards with a high number of coins tended to come from immediately after a period of high minting. It must be noted that I did not at the time realise the significance of this. The important fact is not just large issues but large issues in relation to what had gone before.

There are two further ramifications. The first concerns the dating of hoards. Again using the figures calculated above we can calculate the probability of a hoard of size x collected in year y NOT having a coin of that year (this was achieved using the BINOMIAL program, Kintigh 1992). For a hoard of 100 coins collected in 89 BC there is a probability of 0.0005 that it will not have a coin of 89 BC in it. For hoards of the same size collected in 96 BC there is a probability of 0.0299 that it will not contain a coin of 96 BC. For 75 BC the situation is worse, there is a probability of 0.531 that it will not contain a coin of that year. These probabilities are based on the coins of that year reaching their maximum abundance in that year and are therefore the most optimistic estimates. Of course, for smaller hoards the probabilities increase. There is a probability of 0.939 that a hoard of 10 coins collected in 75 BC will not contain a coin of that year. It has long been known that this sort of dating problem exists, the above simply illustrates the problem.

The second ramification concerns the analysis of the speed of circulation. One method of looking at hoards attempts to define an average hoard and then compares real hoards with these theoretical hoards. By using a technique such as cumulative frequency graphs, it would be possible to say whether a hoard had relatively too few new coins (i.e. a large proportion of old coins) or relatively too many new ones. If this "newness" or "oldness" could be quantified this could be plotted on a map and it might be possible to see where the coin was being introduced into the coinage pool. This has been done by J. Creighton (1989) for Britain. The maps presented clearly show "modern" hoards in the north and near the major military centres, and "archaic" hoards in the SE and elsewhere. However, the scale of "newness" and "oldness" varied over time. In some periods the new hoards in the north were extremely so when compared to the south, whereas at other periods the differences were minor. From the above it can be seen that this pattern can be explained by variations in the coin supply to the provinces. Those periods where there are large differences are likely to be immediately after a large new supply of coin to the province, and *vice versa.*

41.4 CONCLUSIONS

As yet, a satisfactory way of deriving the velocity of coin circulation from the available evidence has not been devised. However, an attempt to do so confirmed the division of hoards into three zones. The visibility of the last two zones is greatly influenced by variations in mint output. These variations in mint output also have ramifications for the interpretation of hoards based on their structure, and for the relative accuracy of the dating of hoards. As with all types of archaeological evidence an appreciation of *formation processes* is essential, and the complexities of those processes in relation to coin data should not be underestimated.

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