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TITLE Observations on coin manufacture at North Leigh Roman Villa

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ABSTRACTS Late Roman minimi were produced at North Leigh by cutting off small pieces of copper alloy rod with a chisel, flattening them and then striking the blanks between dies. The alloy contained a very large proportion of lead (25%).

KEYWORDS coins, copper alloy, analysis, technology, statistics

THIS REPORT IS LEVEL III

Observations on coin manufacture at North Leigh Roman Villa

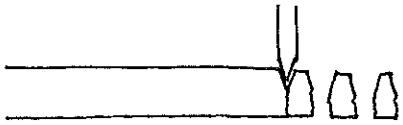
Introduction

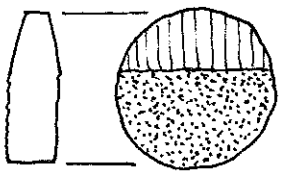
In 1978 a quantity of small late-Roman coins (minimi) was found at North Leigh Roman Villa, Oxfordshire, together with evidence of their manufacture on site. Although no fragments of moulds or crucibles were found there were obvious hearths in which were found solidified dribbles of copper alloy, short lengths of rod, coin blanks and a total of 163 coins. It is clear that copper alloy was being cast into rods which were cut into sections with hammer and chisel, flattened and then struck as coins. After cleaning the coins and associated fragments were examined and analyses made.

Technique of manufacture

Two pieces of rod were found (AML 780332), lengths 6 cm and 2.4 cm, diameter approx 0.5 cm. They have not been used for cutting off blanks because both ends are rough, and it is probable that they were not used because the casting is so poor: it can be seen that the metal is full of voids and inclusions, and would probably have disintegrated if struck with a chisel.

A total of 62 cut-off sections of rod were found, and from their shape their method of production can be deduced. The two faces are partly smooth and at slightly less than right-angles to the axis, and partly rough and broken. This is exactly what would be expected if the pieces were cleaved with a chisel.





It can be assumed that the rod sections were annealed before being flattened (by hammering) into coin blanks, of which 18 were found. They are resonably smooth and uniform in appearance, although a few are pitted in the centre. A reason for this was suggested by D A Casey in relation to the comparable coins from Lydney Park, Glos (see below); when the rod was cast slag and impurities would have collected along the axis as it solidified, and this would have been a point of weakness when the rod sections were subsequently deformed by striking.

After being flattened the blanks would have been heated again immediately prior to being struck between the dies. Although further numismatic study is required it would appear that more than one, perhaps three, sets of dies were in use, and that the engraved area of the dies was larger than the flans struck. This can be seen from the fact that slightly different parts of the design appear on each coin, none of them complete. It is also clearly illustrated by one coin in which the reverse of the blank must have slightly melted before being struck, because a thin film of metal has been forced out over the reverse die while the obverse is still roughly circular.

Analysis

Samples were taken for atomic absorption analysis from one of the molten lumps (780331), one of the pieces of rod (780332) and one of the blanks from 780336, but not from the coins themselves. Very similar results were obtained for all

three: approximately 70% copper, 25% lead, 3% tin, traces of silver and antimony but no zinc or iron. This is very different from the Lydney coins, which gave greater than 97% copper, 2% lead, less than 1% tin, a trace of iron and no zinc. The greater lead content of the North Leigh coins is interesting, because it leads to a technically very inferior alloy. Lead is only soluble in copper up to about 3%,anything more forming a second phase, which at a concentration of 25% would be a source of weakness. This is because the grains of copper in the metal structure tend to be isolated from one another by grains of lead: the structure is like a copper sponge with the pores filled with lead. Likewise when the alloy is heated the lead will melt first and tend to run out of the structure - this is probably the explanation of the coin mentioned in the previous paragraph.

Numismatics and metrology

The North Leigh coins are of essentially the same type, an imitation of the Constantius II Fel. Temp. Reparatio ("soldier spearing fallen horseman") type, which in the regular coinage is dated to about 340-360 AD. It appears that about three sets of dies were in use, but further examination is needed before this can be confirmed. The average weight of the coins is 0.557g and the average diameter approximately 9mm.

It is extremely difficult to date these coins. Clearly they are later than the regular coins they are modelled on, and the only regular coin from the site is a Gloria Romanorum of Valentinian I (364-375). There is little evidence of the minting of minims on other sites, although various minim hoards are known, one of which was found by Sir Mortimer Wheeler at Lydney Park, Glos. 1646 coins, coin fragments and other pieces were found in a hole in a decayed mosaic floor which was subsequently repaired. The darkness of the soil round the hoard suggested that it was originally in a purse or similar organic container. There was no evidence of manufacture on the site. It was suggested that the hoard was deposited early in the fifth century.

The coins were sorted into various classes, of which class C most nearly resembles the North Leigh hoard. Class C consisted of 99 minims of average weight 0.437g and average diameter 7.5mm. Of these 99 coins 46 are clearly "soldier spearing fallen horseman" type, 20 are probable, 31 are indeterminate and two are definitely not of this type. There appears to be more variation in the Lydney Park hoard than the North Leigh, but this is not surprising since the former is presumably made up of coins that had been in circulation, while the latter is the residue of a minting industry using only a small number of dies, and is therefore not really a "hoard" at all.

All the coins, rod sections and coin blanks were weighed, and the means and standard deviations calculated. The weights were also plotted in the form of a histogram, which showed an approximately Normal distribution. Using the grand average weight of 0.5470g and standard deviation of 0.2022g, the reduced chi-squared was calculated for the range 0.0 - 1.1g (approximately symmetrical about the mean) and gave a value of 1.045. The probability of this value being exceeded by chance is about 40%; in other words there is a good fit of the data to a Normal distribution, apart from the three heaviest pieces. The actual distribution is slightly skewed to lower values (mode $\simeq$ 0.40g, mean $\simeq$ 0.55g) and there is a shortfall of very small weights ($<$0.2g). This may be explained by the physical difficulty of cutting off very short lengths of rod with hammer and chisel. Bearing in mind also the excess number of heavy weights ($>$1.1g), it is possible that there are really two overlapping populations one having a large number of members and a mean of $\sim$ 0.4g, and the other having fewer members and a mean near 0.9g. It may be possible to resolve this after the coins have been sorted into types.

Further study is required by these coins and by minimi in general, in order to learn to what extent they were local productions for local use only, or whether there was any kind of regional or national authority behind their issue at a time when Imperial authority had declined or disappeared.

Reference

R E M and T V Wheeler, Excavations at Lydney Park, Glos (Society of Antiquaries, London, 1932) pp 116-131 and plates XXXVIII - XLI.

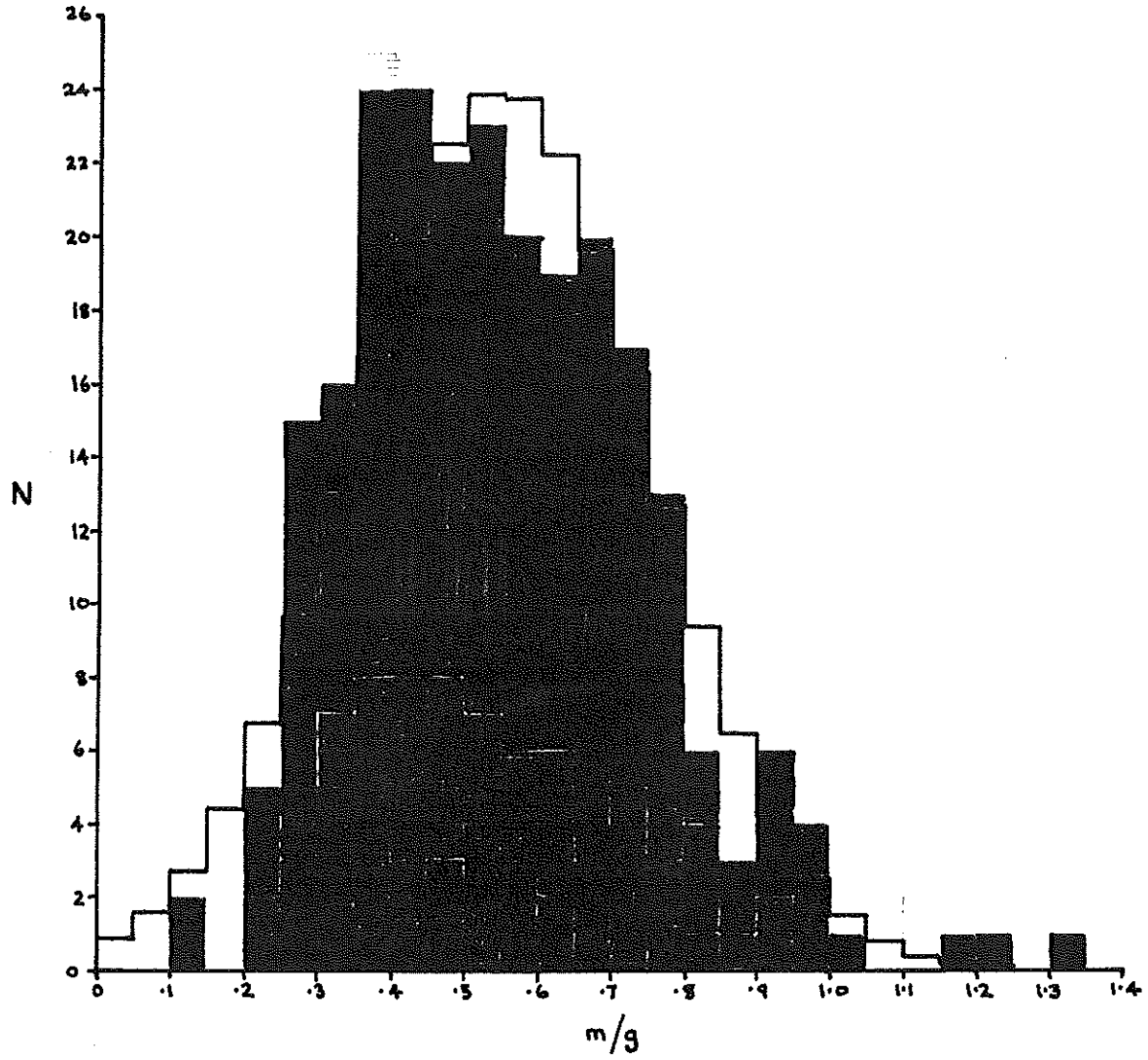
Finds numbers for coins and associated items

(35)	13	(780328)	Molten lump
	14	(780329)	1 coin
	16	(780331)	3 molten lumps
	17	(780332)	2 pieces of rod
	18	(780333)	9 coins, 4 blanks
	19	(780334)	4 rod sections
(61)	22	(780337)	8 coins, 6 blanks, 3 lumps
	23	(780338)	3 coins, 5 blanks, 1 lump
(80)	12	(780327)	Regular Ae3of Valentinian I (364-375)
(81)	20	(780335)	2 coins
(83)	21	(780336)	144 coins, 57 blanks and fragments

Acknowledgement

I wish to thank Fiona Macalister, who carried out the atomic absorption analyses.

Barry Knight
November 1984



Histogram for disks, rods and coins with superimposed Normal distribution

APPENDIX

Weights of rod sections

1.1951	.6009	.4137
.9796	.5821	.4098
.9743	.5812	.4060
.9265	.5721	.4009
.8902	.5691	.3970
.8189	.5528	.3932
.8176	.5491	.3891
.8110	.5474	.3745
.7936	.5075	.3692
.7751	.5074	.3637
.7208	.5060	.3636
.7190	.5046	.3396
.7153	.5030	.3322
.7109	.4698	.3279
.7099	.4620	.3222
.6988	.4589	.3203
.6798	.4588	.2731
.6552	.4570	.2622
.6343	.4430	.2161
.6337	.4336	.2013
.6159	.4297	

$n = 62$; $\Sigma x = 33.9470$; $\Sigma x^2 = 21.2827$

Weights of blanks

.9420	.4614	.3127
.8145	.4592	.2778
.7812	.4526	.2646
.6223	.4077	.2583
.6061	.3570	.1252
.5560	.3474	.1141

$n = 18$; $\Sigma x = 8.1601$; $\Sigma x^2 = 4.6081$

Weights of coins

1.3213	.7812	.7258
1.2077	.7733	.7173
1.0075	.7703	.7160
.9880	.7649	.7098
.9731	.7598	.7044
.9275	.7596	.6999
.9172	.7581	.6966
.9151	.7512	.6944
.9030	.7490	.6866
.8782	.7426	.6832
.8747	.7362	.6824
.8468	.7344	.6811
.8457	.7331	.6807
.7951	.7318	.6803
.7937	.7272	.6716

continued

.6705	.5194	.3994
.6694	.5186	.3900
.6626	.5174	.3876
.6600	.5144	.3840
.6562	.5136	.3815
.6520	.5119	.3794
.6515	.5119	.3791
.6352	.5088	.3784
.6318	.5039	.3783
.6282	.5009	.3684
.6272	.4986	.3670
.6260	.4977	.3666
.6257	.4973	.3646
.6248	.4972	.3633
.6198	.4953	.3614
.6157	.4849	.3524
.6119	.4848	.3439
.6083	.4810	.3407
.6072	.4724	.3350
.6004	.4705	.3265
.5973	.4662	.3172
.5955	.4565	.3148
.5914	.4565	.3066
.5906	.4542	.3064
.5852	.4490	.3023
.5780	.4481	.2969
.5769	.4480	.2879
.5686	.4468	.2850
.5657	.4444	.2839
.5646	.4387	.2811
.5622	.4363	.2744
.5604	.4320	.2631
.5592	.4316	.2581
.5590	.4295	.2563
.5370	.4269	.2507
.5323	.4254	.2319
.5236	.4195	.2283
.5217	.4066	.2078
.5207	.4048	
.5197	.4001	

$n = 163$; $\Sigma x = 90.8132$; $\Sigma x^2 = 56.7092$

For the rod sections, Mean = 0.5475g , Standard deviation = 0.2085g
For the blanks, Mean = 0.4533g , Standard deviation = 0.2313g
For the coins, Mean = 0.5571g , Standard deviation = 0.1943g

Grand average weight = 0.5470g , Standard deviation = 0.2022g

Data for histogram and calculation of χ^2

Range/g	Actual number(f)	Calculated number(ϕ)	$\frac{(f-\phi)^2}{\phi}$
0.000 - 0.050	0	0.86	0.86
0.050 - 0.100	0	1.59	1.59
0.100 - 0.150	2	2.70	0.18
0.150 - 0.200	0	4.41	4.41
0.200 - 0.250	5	6.77	0.46
0.250 - 0.300	15	9.64	2.98
0.300 - 0.350	16	13.09	0.65
0.350 - 0.400	24	16.70	3.19
0.400 - 0.450	24	20.02	0.79
0.450 - 0.500	22	22.47	0.01
0.500 - 0.550	23	23.83	0.03
0.550 - 0.600	20	23.74	0.59
0.600 - 0.650	19	22.22	0.47
0.650 - 0.700	20	19.66	0.01
0.700 - 0.750	17	16.28	0.03
0.750 - 0.800	13	12.66	0.01
0.800 - 0.850	6	9.38	1.22
0.850 - 0.900	3	6.45	1.85
0.900 - 0.950	6	4.17	0.80
0.950 - 1.000	4	2.53	0.85
1.000 - 1.050	1	1.48	0.16
1.050 - 1.100	0	0.80	0.80
1.100 - 1.150	0		
1.150 - 1.200	1		
1.200 - 1.250	1		
1.250 - 1.300	0		
1.300 - 1.350	1		
Totals	243	241.45	21.94

(Calculations based on a mean of 0.5470g and a standard deviation of 0.2022g)

Number of degrees of freedom = 22 - 1 , $\therefore$ reduced χ^2 = 21.94 / 21 = 1.045 , a figure expected to be exceeded in ~40% of cases.