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THE COMPOSITION OF SOME FRISIAN SCEATTAS

by D. M. Metcalf and L. K. Hamblin

The denarius, which superseded the debased gold triens ca. 660–70 as the standard denomination of coinage in north-western Europe, was initially made of very pure metal – in England, at any rate, the silver contents were generally 95% or more. Later on, these issues of so-called „sceattas" suffered a process of debasement (as the trientes had done), until the poorest of them contained only perhaps 25% silver. Debased sceattas were already current in the 730's. The unreliability of the alloy no doubt contributed to a loss of confidence in the sceattas, and they were finally swept away by Pepin's reform, begun probaly ca. 755. The „Carolingian" denarius introduced by Pepin marked a return to a high standard of purity (90–95% silver), and to a closer control of the weight-standard, which, throughout the vicissitudes in the composition of the coinage, had remained at a theoretical figure of 7 siliquae or 20 grains. Thus, the period ca. 660–70 to ca. 755 corresponds with a chapter of monetary history when the only kind of coinage circulating in Frisia, in south-eastern England, and in north-eastern France was the silver denarius, penny, or „sceat", which was originally of very pure silver and which underwent debasement. In England the decline began ca. 730 and ran its course very swiftly. What happened in Frisia? Hoards such as that found at Hallum in 1866 indicate that Frisian and English coins still mingled together in the currency of Frisia in the 730's. Earlier types of English sceattas, from the beginning of the eight century, were widely copied in Frisia, but the series of imitations seems to have ended quite abruptly in the 730's; the numerous varieties of debased sceattas identified by Rigold as the „secondary phase" in England (beginning ca. 730) had relatively very little influence in Frisia. Was this because Frisia was able to maintain a currency of a better standard, and to exclude the poorer English coins? – Enough has been said to indicate the need for a better knowledge of the alloy of the Frisian sceattas, and for an attempt to locate them, both generally within the history of debasement of the European coinage in the first half of the eighth century, and more particularly with reference to the decline of the English coinage, with which the Frisian currency had been so closely linked at the beginning of that century.[1]

Hardly any analyses of sceattas have been made in the past, for the good reason that they are too rare and precious to destroy or damage. Four sets of figures, published as long ago as 1838 by Rethaan Macaré in connexion with his account

[1] For the general background, see in particular S. E. Rigold's fundamental study, „The two primary series of sceattas", *BNJ* 30 (1960-61), 6-53

of the Domburg finds, were reproduced by Dirks.[2] They are useful in that they give a first idea of the range within which the composition of the Frisian sceattas may vary:

Type	Gold (Au)	Silver (Ag)	Copper (Cu)	Tin (Sn)
1. „Frisian Runic" (*BMC* Type 2c)	1.6	92.5	5,9	—
2. Primary Type A (Frisian copy?)	0.9	91.6	7.5	*
3. „Wodan-monster (*BMC* Type 31)	1.0	84.8	14.2	*
4. „Porcupine" (*BMC* Types 4-5)	0.6	53.9	45.5	*

The coins are all essentially of a silver-copper alloy, with other metals (gold and tin) present only as minor constituents or trace elements. Some more figures would, evidently, be welcome, even if they were merely to prove that those given by Rethaan Macaré are typical for each of the varieties examined. Many more will be needed in order to chart the debasement of the series if (as will appear below) there are significant variations in the alloy among coins of the same type.

The opportunities for research have been transformed by the development of accurate non-destructive methods of analysis, such as neutron activation, and, more particularly, X-ray fluorescence spectroscopy. Neutron activation has the merit of obtaining a result from the whole of the coin's fabric; it cannot detect lead, and there are a number of technical problems to be overcome, which call for elaborate methods of observation and calculation. The procedure for low-intensity radiation and measurement developed by Professor A. A. Gordus is particularly effective.[3] X-ray fluorescence spectroscopy is quite different, in that it analyses only the immediate surface (to a depth of about 0.25 mm.) of the object studied. Since sceattas that have been buried for hundreds of years have suffered all kinds of superficial changes – such as diffusion, corrosion, and „surface enrichment"[4] – their surface composition may be very different from the original alloy. By removing the surface of the coin, e.g. with emery paper,[5] and analysing the interior with an

[2] J. Dirks, „Les Anglo-Saxons et leurs petits deniers dits sceattas", *RBN* 5 ser., 2 (1870), 81-128, 269-320, 387-409, 521-41, at pp. 291-2 and 396 (pp. 71-2 and 110 in the reprint).

[3] A. A. Gordus, „Quantitative non-destructive neutron activation analysis of silver in coins", *Archaeometry 10* (1967), 78-86.

[4] J. Condamin and M. Picon, „Notes on diffusion in ancient alloys", *Archaeometry* 8 (1965), 110-4, and other articles cited there.

[5] The surface to be analysed should be smooth, otherwise there may be spurious effects; it should be comparable, also, with the surfaces of the standards used to calibrate the counting. For experiments using 600 grade emery grit (which we have used throughout the analyses on early medieval coins), see R. Jenkins, „Analysis of copper based alloys by X-ray fluorescence spectroscopy", *Scientific and analytical equipment bulletin*

X-ray fluorescence spectrometer, measurements approximating much more closely to the original alloy may be obtained. The technique must, however, normally be applied to an area of at least 5 mm. x 5 mm. The material and aesthetic damage caused by cleaning a rare eighth-century coin on that scale would be quite unacceptable. The *impasse* is resolved by the use of a curved-crystal spectrometer, which can be made to focus on a much smaller area. The „Milliprobe", developed by Dr E. T. Hall [6] in the Research Laboratory for Archaeology and the History of Art, in the University of Oxford, obtains measurements from an area of only about 1 mm. x 1 mm. As the sceattas are struck on thick flans, it is nearly always possible to find a section of the edge which is at least 1 mm. wide, that is, wide enough to use for analysis. The face of the coin need not be damaged at all.

A considerable number of English sceattas has been analysed, and the results have been gathered together in a recently-published book, where the experimental techniques are described in more detail.[7] This article is a continuation of the same project, using the same techniques, devoted mainly to Frisian sceattas in the Ashmolean Museum, University of Oxford, and in the private collection of Dr D. M. Metcalf, together with a few further English sceattas for purposes of comparison. Most of the specimens are of the „porcupine" type (*BMC* Types 4 and 5), which was issued mostly in Frisia, but also in England. Eleven of these „porcupines" are selected from a hoard, which is to be published more fully elsewhere.[8] The total number of coins that was available in Oxford is far from sufficient to resolve all the interesting questions about numismatic history and monetary circulation which are raised by the varying alloy of the Frisian coins. Ideas, however, grow out of results. This is a field of study where advances can be made only through cooperation, and where the aim must be to co-ordinate a growing series of analyses: we hope that our contribution from Oxford will stimulate other students to take up some of the problems, and will encourage other museums and private collectors, especially in the Netherlands, where so many early medieval coins have been found (and where a „Milliprobe" is in use), to take what initiatives and to play what part they can. Not all branches of numismatics are equally fruitful from the point of view of historical studies, but the eighth century is a period from

(undated), Philips, Eindhoven; also R. Jenkins and P. W. Hurley, „Effects of surface finish in the X-ray fluorescence analysis of bulk metals", in the same series of pamphlets (this was read as a paper at the XII Colloquium Spectroscopicum Internationale, Exeter, 1965.)

6 M. Banks and E. T. Hall, „X-ray fluorescent analysis in archaeology; the „Milliprobe" ", *Archaeometry* 6 (1963), 31-6.

7 D. M. Metcalf, J. M. Merrick, and L. K. Hamblin, *Studies in the Composition of Early Medieval Coins* (Minerva Numismatic Handbooks, no. 3), Newcastle-upon-Tyne, 1968.

8 D. M. Metcalf, „A hoard of 'porcupine' sceattas", *ANSMN* 15 (1969), 101-118.

which few written documents have survived, and about which, accordingly, the evidence of coinage is all the more precious. Scientific analyses of metal contents need to be interpreted in the context of a full numismatic study of the coins in question: they are merely part of the objective description of a coin, like its weight or die-axis. Nevertheless, questions concerning the alloy of the sceattas have (of necessity) been neglected in the past, and there is scope for catching up with the opportunities for research.

One general point about the trace elements or minor constituents in the Frisian sceattas is that, like their English counterparts, they contain a relatively large amount of gold. As a more „noble" metal, gold was not affected by the ordinary early medieval methods of refining silver. If there were traces of gold in the silver ores, they would still be present in the refined metal. German medieval coins, such as the Otto-Adelheid Pfennige, have been found by Kraume and Hatz to contain percentages of gold ranging, typically, from 0.5% down to 0.001%, depending on the source of the silver.[9] English coins of the tenth and eleventh centuries mostly contain 0.5% to 0.2% gold, as has been shown by Forbes and Dalladay,[10] and also by Harris.[11] The maximum figure for the Otto-Adelheid coins is about 0.8%; and English pennies very rarely exceed that figure. The Frisian coins, however, commonly contain 1% to 1½% gold. Our figures are given only to the nearest ¼%, but their accuracy in absolute terms is firmly based, i.e. there is no possibility of a systematic error. The spectrometer was calibrated in this case by readings from two sets of standards, a silver/gold set, using standards with 0.1%, 0.5%, 2.5% and 10% gold, and a copper/gold set with standards of the same values. A working graph, plotting counts against percentages, showed two straight lines, the copper/gold line diverging slightly from the silver/gold line. The gold percentages in the silver/copper alloys (the coins) were read off at an appropriate position part-way between the two lines. If the percentage were very low, e.g. less than ¼%, the total number of counts would hardly differ from the „background" count, and it would be necessary to measure over a longer period than our normal 20 seconds, and to take the average of a larger number of readings. A gold content of 1% is, however, large in relation to the lower limit of detectability. The English primary sceattas commonly have 2% or even 3% gold in their alloy. For practical purposes, it is helpful to add together the percentages for gold and silver, and to consider the total as all „silver", in distinction from base metal. The gold in such coins was not visible, and it was not deliberately added to their alloy. On the other hand, the

[9] E. Kraume and V. Hatz, „Die Otto-Adelheid-Pfennige und ihre Nachprägungen", *HBN* 5 (1961-63), 13-23; Anlagen.

[10] J. S. Forbes and D. B. Dalladay, „Composition of English silver coins (870-1300)", *BNJ* 30 (1960-61), 82-7.

[11] E. J. Harris, „Debasement of the coinage", *Seaby's Coin and Medal Bulletin* 1962, 5-7.

proportion of gold to silver may suggest different sources of supply; the primary Runic sceattas, for example, contain slightly more „silver" than the (Kentish) types A and B, but significantly less gold. This should make clear the interest which attaches to the accurate estimation of the gold contents of the Frisian sceattas.

Lead is of less historical interest, since its presence is to be expected because of the refining methods used. It should have been demoved as completely as possible; and the English primary sceattas are remarkably pure – ¼ % to ¾ % lead seems to be typical, and to have been maintained consistently. Appreciably larger amounts are suggestive of differences in mint-practice, i.e. such coins as have larger amounts may be from a different mint, or they may be contemporary counterfeits. The readings obtained from the Frisian sceattas are mostly in the range 1¼ % tot 1¾ %. Great accuracy cannot be claimed for them since the only available standards were brass/lead, where silver/copper/lead would have been appropriate. The values of the standards were of the right order, at least: 1.3% and 1.7% lead. The minimum level of detectability of lead was about ½%.

For tin, with a 100 crystal in the spectrometer, the minimum level was about 1%, but this would vary from day to day. Where we report „a trace", this indicates 1 to 2%. The lower figures should be treated with reserve, while the higher the figure reported, the more accurate it is likely to be. On this basis, tin was detected in only a few of the coins analysed, although there may, of course, have been smaller amounts in others of them.

Anything much less than 0.2% zinc will similarly have escaped notice. The zinc contents of the coins could only be quantified down to about 1%, because the standards available to us were not especially suitable (10, 15, and 23% zinc in copper); but 0.2% or more of zinc should have shown up on the preliminary „scan" of the coin.[12]

The „Frisian Runic" Type (BMC Type 2c)

The obverse design is, at its best, a careful copy of the English Primary Type A, with Runic „æpa" or „apa" in front of the head; the reverse design is original. Rigold designates them Type R3, and notes that they are rarely found in England.[13] They are present in the earliest sceatta hoards, Saint-Pierre-les-Etieux, Plassac, and Bais. In the latter, there were as many as 14 specimens,[14] which are of varying stylistic quality, but high average weight. They give an idea of how extensive the earliest issues of sceattas on the continent must have been, and how quickly they

[12] Further details of the method used will be found in Metcalf, Merrick, and Hamblin, op.cit.

[13] Rigold, op.cit., at pp. 48 (Birchington) and 52 (single finds).

[14] P. le Gentilhomme, „La circulation des sceattas dans la Gaule mérovingienne", *RN* 5 ser., 2 (1938), 23-49; pl. III, 10-23.

were subject to copying. As there were only two examples, in the Cimiez hoard, and none in Hallum or Franeker, it would seem that they had largely disappeared from the currency of Frisia by the 730's. There are, nevertheless, 67 stray finds from Domburg,[15] of which 27 weigh 1.0 gm. or over, in spite of the loss of weight caused by the action of the sea, and all but one out of the total number is described as of silver. If the bulk of them are early losses, they are precious numismatic evidence for an early phase in the circulation of sceattas at Domburg, about which the Frisian hoards are silent.

The analysis by Rethaan Marcaré showed 92.5% silver, with a relatively large amount of gold – 1.6% – making 94.1% „silver". The three coins we analysed were closely similar, all lying in the general range 89–94% „silver". Of the three, the coin in the finest style has the largest gold content – 1¾ %; the other two each showed 1%. (See 0.118–120 in the Catalogue below).

BMC Type 8

This type is a „mule" in the sense that it „borrows" and combines the designs from two other types. On one side is the cross-and-pellets of the Frisian Runic design; on the other is a standard derived, probably, from the „wolf/standard" or „porcupine" issue. As both are reverses, it is hard to say which side of *BMC* Type 8 should be considered as the oberse. The more characteristic specimens, such as *BMC* 80 and 81, and Hunter 51, and that analysed here (0.121) have a large central annulet enclosing the dot, on the „standard" side. A similar specimen with a conspicuous large „H" was illustrated by Dirks, from the Hague cabinet.[16] One in the Cimiez hoard[17] may be a copy.

The analysis showed that the coin was of good quality. Its composition was very similar to that of the „Frisian Runic" type.

The „Wodan-Monster" Type (BMC Type 31)

„Wodan-monster" sceattas have been found in large quantities in the Bolsward, Terwispel, and Hallum hoards. The Hallum coins, of which there were said to be about 175, were nearly all of the variety illustrated by Dirks as pl. D, 29–30.[18] Singletons in better style, namely D, 25–27, are perhaps the oldest coins of the type represented in the hoard. The Cimiez hoard, concealed at very much the same date

15 M. de Man, *Catalogus der numismatische verzameling van het Zeeuwsch Genootschap der Wetenschappen*, Middelburg, 1907, 279-88.

16 Dirks, op.cit., pl. E, q.

17 Le Gentilhomme, op.cit., pl. IV, 53.

18 The number of specimens of each is given as. D, 29 (140), D, 30 (1), D, 31 (20), but this may be a misprint, since D, 31 is described on p. 397 (p. 111 of the reprint) as unique.

as Hallum, included two „Wodan-monster" coins.[19] One is a crude copy, while the other is apparently in the correct style, but both are described as „bas billon". Numerous stray finds are recorded from Domburg[20] and there is a comparable proportion among the much smaller total of sceattas from Dorestad. There are virtually no „Wodan-monster" coins from England.

The analysis by Rethaan Macaré showed 86% „silver"; two coins catalogued below contain 91–93% and 32–37% „silver" respectively. The former is in fine style, and may well stand early in the series. It contains 1¼ % gold and about 2% tin. The latter is heavy – 1.32 gm. (as is the Cimiez coin – 1.14 gm.), and its authenticity might be doubted, except that it contains an appropriate range of minor constituents: 1¼ % gold, which is a very high proportion in relation to the silver contents; 2% lead; and a trace of tin.

BMC Type 3a

This is essentially an English type, but it is of critical importance for the chronology of the Frisian currency as well, since it stands at the turning-point between the primary and the secondary phase in England (as shown by the Garton-on-the-Wolds grave-find), and helps to date both the Hallum and the Cimiez hoards. In Cimiez, pl. III, 28 is a counterfeit in poor style,[21] and III 26 is questionable; the Garton and Wakering coins,[22] *BMC* 50 and 51, and coins from the Montagu and L. A. Lawrence collections[23] define the authentic style. Of the Hallum coins, pl. D, 20 appears to be in the correct style – it is a near-duplicate or perhaps even a duplicate of one of the Garton coins. The hair-style of D, 19 betrays it; and D, 21 is more patently a copy. Van der Chijs V, 56 is a rough copy, found at Domburg; its reverse matches D, 19 rather closely, D, 31 is a wild attempt to mule Type 3a with the „Wodan-monster" type.

The first of the coins analysed here has an English provenance: it was found on the beach at Selsey. It is battered and corroded, particularly on the obverse, and much of the face has flaked away. It seems, however, to be in the regular English style, and its weight is high. It contains about 85% silver (possibly six-sevenths, although there is as yet no clear evidence for the use of such a standard in England); a relatively large amount of gold – 2¼ % – as in other early English sceattas; and also more lead and tin than the average. The other coin of Type 3a is certainly a copy. The iconography of its obverse is particularly interesting. Beneath the head and neck, there is a detached, sickle-shaped curve represented in outline. It is

19 Le Gentilhomme, op.cit., pl. IV, 73 and 74.
20 De Man, *Catalogus* gives 21 in silver plus 25 in copper.
21 References are to the plates accompanying Le Gentilhomme, op.cit.
22 Rigold, op.cit.
23 Ashmolean cast collection.

reminiscent of the boat-shaped curve of some of the London sceattas. The curve terminates, at each end, in animal-heads like those on the torques of the wolf sceattas, *BMC* Type 32a. As archaeological objects, such torques are virtually unknown from the Saxon period, and their representation on coins is thus all the more interesting. Analysis showed about 52% silver, only ½ % gold, and unusually large amounts of other constituents – about 4½ % lead, 2% zinc, and about 2½ % tin.

The Maastricht type

The affiliation of the „interlace" („rosace") deniers of Pepin and Charlemagne to the thicker sceattas which went before them was discussed by Gariel.[24] He attributes both coinages to Maastricht. The specimen which we analysed (0.126) is very debased, containing only 33–35% silver. Yet there was a similar coin in the Franeker hoard,[25] or possibly two,[26] and another, in slightly better style, from Hallum. It would be interesting to know whether they were (as seems probable) of much lower fineness than the „porcupine" and other sceattas with which they were hoarded. Other specimens of the same type and the same general style have been published by Rethaan Macaré, by Dirks (from Dorestad),[27] and by Van der Chijs (from Domburg[28] and in the collection of the Leidsche Hoogeschool[29]). It is clear, therefore, that they circulated on the Frisian coast.

„Porcupines"

A stylistic analysis of the „porcupine" sceattas, which are so numerous in the Frisian hoards and among the site-finds from Domburg, has shown that there are half-a-dozen common versions of the design, in each of which the details of the obverse and of the reverse and also of the reverse border are consistent and regular.[30] The Franeker hoard helps to demonstrate that the common versions were substantive issues. Most of the „porcupines" were struck in Frisia, but some are

[24] E. Gariel, *Les monnaies royales de France sous la race carolingienne*, Strasbourg, 1883-4, vol. II, 60-2.

[25] Dirks, pl. C, 37.

[26] Dirks, p. 405 (p. 119 of the reprint) says, „Un type, trouvé dans les deux dépôts [Franeker et Hallum] chacun à deux exemplaires. Ce sont les pièces C, 37, D, 16," and then, in a footnote, „Poids de C, 31, et E, 6 chacun 1.200". This should probably read C, 37 and E, b. Cf. p. 278 (58), where only one specimen of C, 37 is listed - but two of C, 36.

[27] Dirks, pl. E, b.

[28] P. O. van der Chijs, *De munten der frankische en duitsch nederlandsche vorsten*, Haarlem, 1866, pl. IV, 24 (1.1 gm.), and also another, in his own collection, found at Domburg.

[29] Id., IV, 25, two specimens, each weighing 0.3 gm.

[30] D. M. Metcalf, „A stylistic analysis of the 'porcupine' sceattas", *NC* 7 ser., 6 (1966), 179-205.

English, as can be seen by comparing the relative proportions of the main variants among the Dutch and English finds. The „plumed bird" variety (*BMC* Type 6) and the „VOIC" variety, for example, are English. Their composition confirms the evidence from the finds; analyses have shown that they are of the highest standard of purity.

		Au	Ag	Cu
0.41	„Plumed bird"	2	96	2
Sc.3	„ „	<1	96	3
0.20	„VOIC"	2	95	3
0.38	„	<1	ca. 98	<1

Other variants, such as the „Æthiliræd" porcupine, which is very probably English, are almost as pure.

0.42	„Æthiliræd"	1½	96	3
0.43	„ „	1½	92-96	3-7
0.44	Porcupine/Cross	1¼	94	5

By contrast, the analysis by Rethaan Marcaré gave only 54% silver. Dirks described the Franeker porcupines as „d'argent très-pur"[31]; but accurate analyses of varieties B, E, and F remain a desideratum. They, if any, are likely to prove to be the „primary" Frisian issues. There is a whole mass of „secondary" issues, such as are found in the Groningen, Lutje Saaksum, and Kloster Barte finds. The analyses which we publish show that their fineness is most often in the range 80–87% „silver".

Before turning to the continental hoard of „secondary porcupines" upon which these figures are based, we list a few more specimens which consolidate the view that the English coins had high silver contents. No place of origin has yet been proposed for variety G, which dominated the porcupines in the Bais hoard; 0.127–129, which are of that variety, and at least one of which is likely to be an English find, contain 93½%, 92½%, and 91% „silver", with 1–1½% gold. The unique variant marked SEDE with a pseudo-legend around, and with a laterally-reversed copy of the „porcupine" of variety G,[32] is authenticated by analysis, which shows an appropriate range of metal contents, including 93½% „silver" (0.130). Another derivative coin, which was found at Binsey, on the outskirts of Oxford, contains 93¼–94¼% „silver" (0.131). One found at Compton is 86% „silver", with 1½% gold (0.132). Lastly, a coin of uncertain provenance, possibly English, but very like no. 31 in the hoard discussed below, is 89% „silver" (0.133).

[31] Dirks, op.cit., p. 291 (71), referring especially to B, 15-27.

[32] P. V. Hill, „The 'Standard' and 'London' series of Anglo-Saxon seattas", *BNJ* 26 (1949-51), 251-79, at p. 259.

The „Bedford hoard", probably found in the English midlands,[33] consisted of three derivative „porcupines", which are unusually light in weight. Two which show signs of wear contain ca. 93% and ca. 81% „silver" respectively, with only ¾ % gold. The third, which is fresh and sharp, contains ca. 85% „silver" (0.134–6). It has a good deal in common, in the details of its design, with Ca. 4, which is 95% „silver".

The second of the „Bedford" coins, again, is closely matched in several details, of both obverse and reverse, by another coin in the Oxford collection. The two specimens are by no means near-duplicates, but they seem to be by the same hand. It is interesting to see how similar they are in their metal contents.

	Au	Ag	Cu
0.135	¾	79-81	16-18
0.137	1¼	80-82	16-18

Analyses of near-duplicate or, better still, die-duplicate sceattas should be of great practical value as a general guide to the interpretation of metal contents. The English primary sceattas are quite consistent in their composition, but it has not yet been sufficiently demonstrated that the alloy of sceattas of the „secondary" phase, whether in England or Frisia, was carefully controlled. Thus, 0.139, which is very similar to 0,137, contains less silver – 72½–74½ %.

We were able to analyse eleven coins from a hoard, doubtless of Frisian origin, which were bought in Belgium recently, and from which a total of 35 coins has

Analysis	*Catalogue*	*Derivative from:*	*Au*	*Ag*	*Cu*
M.1	4	Variety A	1½	80-82	15-17
0.138	8	Variety A	1½	83-85	12-14
0.139	9	Variety A	1	72½-74½	23-25
0.140	12	Variety A	1	81½-83½	14-16
0.141	14	„VOIC" variety	1	88-90	8-10
M.2	16	Variety C	1½	78-82	15-19
0.142	17	Variety C	1½	72-73	24-25
M.3	18	Variety E	1½	82	15
M.4	26	Variety F	1½	88½	9
M.5	28	Variety F	1	77½	20
M.6	35	Variety G or D	1¼	56½-58½	37-39

[33] The coins were bought by Mr Kuhlicke from an old lady in Bedford many years ago, and the probability is that they were found locally: or at least, very probably in England. The other coins in the old lady's possession were unexceptional. The sceattas were published in *NC* 1966, since when Mr Kuhlicke kindly agreed to sell them to the Ashmolean Museum.

been described in detail elsewhere.[34] They are almost all „secondary" issues, the classification of which remains problematic. The concordance set out below shows that the silver contents are by no means uniform in all the coins in the hoard. Nor were they very rigorously controlled. There seems nevertheless to be a clustering of values round about 82–85% „silver". The „VOIC" derivative has an exceptionally high silver content. The only specimen, among those analysed, which falls below 73% „silver" is manifestly poor in style. In light of these figures, Rethaan Macaré's analysis of a porcupine, with 54½% „silver", seems to have singled out an unusually debased specimen.

It is too soon to draw any general conclusions about the circulation of „porcupines" in relation to their fineness: we may begin to see which way the land lies when some analyses of coins from the Franeker hoard are available. The date of deposit of Franeker is still a matter for debate. Lafaurie suggested roundly that it was in the 770's,[35] and he has re-stated the same hypothesis about the coins from Franeker, as evidence that sceattas and Carolingian denarii may have circulated concurrently, in different regions.[36] Analyses may help to narrow the range of what is plausible.

The debasement of the Frisian currency took place essentially in the second quarter of the eighth century. As in England, bad money doubtless drove out the good. Coinages of very different alloy might co-exist if their designs were such that they could be distinguished readily. The analogy of French feudal types which circulated as oboles may apply, for example, to the Maastricht type. But when one basic coin-type, such as the „porcupine" sceat, was variable in its fineness, when it was struck in a number of independent centres, and when the issuing authority was not named by any inscription, the technical conditions for confusion and loss of public confidence were present. This would have been so, even without the added difficulty of the forgeries which were prevalent. Analyses of the Hallum hoard should show how much debasement there was at the beginning of the „secondary phase"

[34] In ANSMN 15 (1969).

[35] Lafaurie wrote, „Le type louve-étendard apparaît déjà dans le trésor de Saint-Pierre-les-Etieux, mais ceux au même type du trésor de Franeker (Frise), par leur flan large, leur haut relief, font penser aux deniers de Charlemagne, dont ils doivent être contemporains" (*Moneta e Scambi nell'alto medioevo*, Spoleto 1961, p. 266).

[36] „Les trésors ... de Nice-Cimiez et de Savonnières, bien que difficiles à dater, sont des environs de 741/750 ... Peut-être faut-il voir un parallélisme monétaire entre les sceattas à flans larges que des trésors de Frise ont fait connaître et les premières monnaies carolingiennes" (in the bibliographical report for the International Numismatic Congress at Copenhagen, 1966, vol. II, pp. 13-51 at p. 38.) These dates are disputed on numismatic grounds by D. M. Metcalf in *NC* 1966, at p. 186, and further by D. M. Metcalf and D. R. Walker in „The 'wolf' sceattas", *BNJ* 36 (1967), 11-28, at p. 20.

in Frisia. The developing weaknesses in the system were no doubt accelerated by the political upheavals and uncertainties consequent on the Frankish expansion into Frisia. Where economic prosperity depended so much on inter-regional trade, one may conjecture that the middle years of the century witnessed a decline, which was matched in the currency. Many of the stray finds from Domburg, of sceattas of low weight and very debased designs, may have been lost in the years around 750, but it is, of course, impossible to determine their date exactly without the help of hoards. Nor is it easy to tell whether parts of eastern Frisia – at the periphery of the circulation-area of sceattas – may not still have clung to a higher standard of fineness, at a date when the quality of the currency had been eroded in the main centres such as Domburg and Dorestad.[37] About all these intriguing possibilities, we must for the time being withhold judgement. Some more analyses of the metal contents of Frisian sceattas, selected with an eye on the problems as they appear to rest, could, we believe, make a useful contribution.

[37] But there is a fresh „VOIC" porcupine in the hoard from which 11 coins are analysed here, and a seemingly fresh example of variety G in the Lutje Saaksum hoard.

CATALOGUE

The coins are numbered in continuation of those of which analyses were published in *Archaeometry* ix, 1966 (L.1-8, 10-11, 19-20; F.1-10, 0.1-20) in *Numismatic Chronicle* 7.vii, 1967 (0.21-40bis), and in *Studies in the Composition of Early Medieval Coins*, 1968 (Ca. 1-10, Sc. 1-3, Ly. 1-6, Y.1-5, 0.41-117). The prefixed letter indicates the collection to which the coin belongs. Those catalogued below are either M (Dr D. M. Metcalf) or O (Oxford University).

The position on the edge of the coin at which it was cleaned for purposes of analysis is defined by reference to the obverse, of which the vertical axis should be taken to be as the coins are aligned on the accompanying plate I.

O.118 *BMC* Type 2c. Obv. Runic „æpa" (incomplete). Simplified A behind head. Good style. Rev. Neat cross at 12 o'clock, 0 at 6 o'clock. Legend, cf. 0.119. 1.28 gm. Evans bequest, 1941.

The edge at 1 o'clock gave 87–88% silver, 9–10% copper, 1¾% gold, and 1% lead.

O.119 The same type. Obv. Similar, but not quite as neat. Pseudo-Runic legend, with „trifid" serifs. Rev. Fine, seriffed cross at 12 o'clock, annulet at 6 o'clock. Pseudo-legend ᚬᚡᚬ ᚬᚡᛁᛁ. 1.10 gm. Evans bequest, 1941.

The edge at 4 o'clock gave 90–93% silver, 7–9% copper, 1% gold, and traces of lead and zinc.

O.120 The same type. Obv. Tall neck, sketchy style. Runic „æpa" in flowing runes, the „p" hardly distinguished from the „æ". Rev. Cross and annulet as on 0.118–119. Only the central ᚡ, ᚡ is recognized in the legend; and the strokes of the letters end in bold dots: ᛁᛁᚡᛁ ᛁᛁᚡᛁ. 1.14 gm. Evans bequest, 1941.

The edge at 1 o'clock gave 90–91% silver, 7–8% copper, 1% gold, 1% lead, and (?) a trace of bromine.

O.121 *BMC* Type 8. Obv. ᚴᚱ/ᛁᛁ around large annulet with dot in centre. Cross in border below, „tufa" to right. Rev. Cross with pellets in two (lower) angles. Legend perhaps ᚬ.◇ᚺᚡᚡᚷ. 1.31 gm. Ex Barnett duplicates.

The edge at 8 o'clock gave 88–89% silver, 10–11% copper, 1¼% gold, and a trace of lead. Zinc was detected on the preliminary scan.

O.122 *BMC* Type 31 („Wodan-monster" type). Good style. 0.85 gm. Evans bequest, 1941.

The edge at 10 o'clock gave 90–92% silver, 4–6% copper, 1¼ % gold, ca. 1% lead, and ca. 2% tin.

O.123 The same type. Deeply engraved. The style seems to be normal. 1.32 gm. Evans bequest, 1941.

The edge at 5–6 o'clock gave only 31–36% silver, with 61–66% copper, 1¼ % gold (!), 2% lead, and traces of tin and iron.

O.124 *BMC* Type 3a. Obv. Flaked away, but apparently in good style. Rev. Three bold crosses; group of 3 dots at lower right; central annulet with dot; two extra dots at 9 and 12 o'clock. Flattened crosses in border. 1.05 gm. Purchased 1950 from a resident of Selsey, Sussex; found on the beach at Selsey.

The edge at 1–2 o'clock gave 84½ %–86½ % silver, 9–11% copper, 2¼ % gold, ca. 2¼ % lead, and traces of tin, iron, and bromine. Because of heavy corrosion, copper was the only minor constituent registered on the preliminary scan.

O.125 *BMC* Type 3a, variant. Obv. Head above crescent-shaped base with animal's-head ornaments. Rev. Four crosses; central annulet apparently obliterating a group of dots. Traces of crosses in the outer border. 0.98 gm. Ex Bodleian Library.

The edge at 12–1 o'clock gave 51½ %–53½ % silver, 37–39% copper, ½ % gold, ca. 4½ % lead, 2% zinc, and ca. 2½ % tin.

O.126 „Maastricht type". Obv. Stylized head. Rev. Interlace. 0.80 gm. Evans bequest, 1941.

The edge at 5 o'clock gave 33– 35% silver, 63–65% copper, a trace of gold, about 1% lead, about 1% zinc, and a trace of tin. The initial reading for copper was 39%, which increased with cleaning.

O.127 Porcupine, variety G. Obv. Two large dots on central spine. Two dots, and V or zig-zag beneath. Rev. There is a long line, with dots superimposed, in the outer border. 1.24 gm. Evans bequest, 1941.

The edge at 5–6 o'clock gave 92% silver, 5% copper, 1½ % gold, ca. 1¼ % lead, and possibly a trace of arsenic.

O.128 The same variety. Obv. Note that the elements in this design are extremely similar to those of 0.127. The „quills" of the porcupine lie at a different angle. Rev. Cross, „tadpoles", etc., in outer border. 1.21 gm. (worn). Ashmolean (ancien fonds).

The edge at 4 o'clock gave 91½% silver, 6% copper, 1% gold, and 1½% lead.

O.129 The same variety. Obv. Much thicker central curve; group of 3 dots within curve (cf. the reverse); rectangular element beneath. Rev. Note that the „standard" is not exactly square. Cross, and 2 dots, visible in border. Note part of an outer dotted border. 1.23 gm. Magdalen College collection.

The edge at 2 o'clock gave 89–90% silver, 7–8% copper, 1½% gold, 1¼% lead, and traces of zinc and iron.

O.130 Derivative of variety G. Obv. Laterally reversed design of variety G. Rev. Cross and dotted annulets separating the letters S E D E. The „D" has large „serifs" which are so out of character as to suggest that the symbol is intended as something other than a D. Linear border. Pseudo-legend. 1.20 gm. Ex Bodleian Library.

The edge at 9 o'clock gave 92½% silver, 5% copper, 1% gold, and 1½% lead. The initial reading for copper was lower.

O.131 Derivative „porcupine". Obv. Within the curve are an annulet and line, surrounded by fine dots. Rev. One L and 3 I's around central annulet. The border apparently is occupied by a symmetrical pattern, with a cross at the top centre, and a bold dot and a zig-zag on each side; the rest of the border is obscure, but there are 4 or 5 dots to the right. 1.14 gm. Found at Binsey, near Oxford.

The edge at 3 o'clock gave 92–93% silver, 4–5% copper, 1¼% gold, 1½% lead, and a trace of iron.

O.132 Obv. One dot at tip of curve, and another part-way along. Four lines within the curve, and 2 extra dots above. There is a large annulet and a Λ beneath. Rev. ⌜⌝/—.. around central annulet. Cross in border to right, VΛ above. 1.19 gm. Purchased 1940, from the collection of J. Faulkner, of Endon, Staffs. (Glendining 21 May 1940, lot 7). The original ticket is marked, „Compton find"; Mr Faulkner formed a small special collection of Staffordshire coins.

The edge at 11 o'clock gave 83½%–85½% silver, 12–14% copper, 1½% gold, ca. 1% lead. The initial reading for copper was 7–9%.

O.133 Secondary phase porcupine, derivative from varieties F and C. Obv. Two dots close together, part-way along the central curve; dotted outline joins annulet at left. Three lines beneath. Rev. Symmetrical pattern; curve in outer border. 1.09 gm. Ex Bodleian Library.

The edge at 4–5 o'clock gave 88% silver, 11% copper, 1% gold, and traces of lead and bromine.

O.134 Secondary phase porcupine, derivative from variety D. Obv. Dot, instead of annulet, at left of curve. Rev. The central annulet is filled in. There is a cross with 2 dots in the border, above and to the right. 0.66 gm. (worn). Purchased 1966, from the „Bedford hoard".

The edge at 6 o'clock gave 92– 93% silver, 4–5% copper, ¾ % gold, 2% lead, and traces of tin and bromine.

O.135 Secondary phase porcupine. Obv. Note how the tip of the curve is joined to the first of the lines beneath, which is tilted slightly. Rev. The square is indicated by lines, with only a few dots superimposed: there are one at each corner and two or three along each side. Dots visible in outer border, and, at one side, traces of two lines radiating outwards. 0.88 gm. (worn). Purchased 1966, from the „Bedford hoard".

The edge at 8 o'clock gave 79–81% silver, 16–18% copper, ¾ % gold, and 2% lead, with a trace of bromine.

O.136 Secondary phase porcupine, derivative from variety C. Obv. The curve shows no thickening in its central part. XIII beneath. There are dots at each end of, and also in the middle of, the strokes III. Rev. Double dotted square, perhaps derivative from a group of Frisian issues (of different style), *Num. Chron.* 1966, pl. xvi, 34–36. In the outer border there is a row of small dots, and, outside them, there are traces of three bold strokes radiating outwards. 0.91 gm. Purchased 1966, from the „Bedford hoard".

The edge at 7–8 o'clock gave 82½–85½ % silver, 12–15% copper, 1% gold, 1% lead, and a trace of zinc. The initial reading for copper was 9%.

O.137 Secondary phase porcupine. Obv. Of the lines beneath the curve, the two to the left are joined together, as in the „VOIC" variety. Rev. Seven dots grouped irregularly around central annulet. 1.28 gm. Ashmolean (ancien fonds).

The edge at 12–1 o'clock gave 80–82% silver, 16–18% copper, 1¼ % gold, 1% lead, and a trace of zinc. The initial reading for copper was 9%.

Coins from the hoard published in *American Numismatic Society Museum Notes* 15 (1969). A detailed numismatic description of the coins is given there; all the specimens are illustrated again here.

M.1 Hoard cat. no. 4. 1.18 gm.
The edge at 11 o'clock gave 80–82% silver, 15–17% copper, 1½% gold, 1½% lead.

O.138 Hoard cat. no. 8. 1.12 gm.
The edge at 11–12 o'clock gave 83–85% silver, 12–14% copper, 1½% gold, and 1¾% lead.

O.139 Hoard cat. no. 9. 1.24 gm.
The edge at 4–5 o'clock gave 72½%–74½% silver, 23–25% copper, 1% gold, 1½% lead, and a trace of tin. The initial reading for copper was 9%.

O.140 Hoard cat. no. 12. 1.10 gm.
The edge at 5 o'clock 81½%–83½% silver, 14–16% copper, 1% gold, and 1½% lead. The initial reading for copper was 10%.

O.141 Hoard cat. no. 14. 1.31 gm.
The edge at 3 o'clock gave 88–90% silver, 8–10% copper, 1% gold, and 1¼% lead.

M.2 Hoard cat. no. 16. 1.17 gm.
The edge at 1–2 o'clock gave 78–82% silver, 15–19% copper, 1½% gold, 1½% lead, and a trace of zinc. The initial reading for copper was 9%.

O.142 Hoard cat. no. 17. 1.10 gm.
The edge at 6–7 o'clock gave 72–73% silver, 24–25% copper, 1½% gold, 1½% lead, and traces of zinc and tin. The initial reading for copper was 9%.

M.3 Hoard cat. no. 18. 1.31 gm.
The edge at 5 o'clock gave 82% silver, 15% copper, 1½% gold, 1½% lead. The initial reading for copper was 7%.

M.4 Hoard cat. no. 26. 1.28 gm.
The edge at 4 o'clock gave 88½% silver, 9% copper, 1½% gold, and about 1% lead. The initial reading for copper was 7%.

M.5 Hoard cat. no. 28. 1.36 gm.

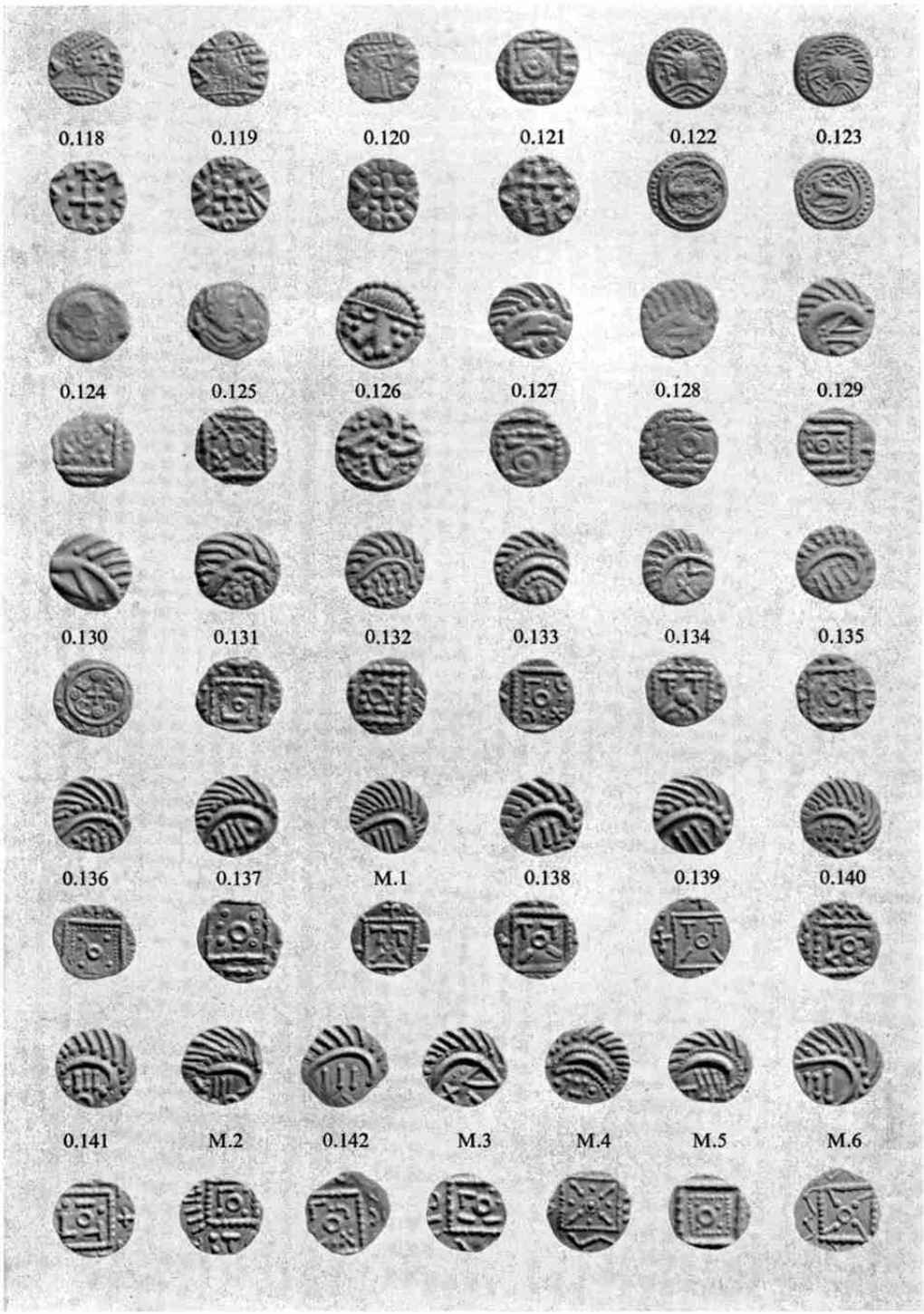
The edge at 7–8 o'clock gave 77½ % silver, 20% copper, 1% gold, 1½ % lead, and a trace of zinc. The initial reading for copper was 13%.

M.6 Hoard cat. no. 35. 1.09 gm.

The edge at 10 o'clock gave 55–57% silver, 36½–38½ % copper, 1¼ % gold, 1¼ % lead, ca. 2% zinc, and ca. 2% tin. The initial reading for copper was 26%.

APPENDIX: TECHNICAL DATA

Excitation voltage 50kV and current 40μA on a tungsten target tube. A curved diffracting crystal of LiF cut in the 110 plane was used, except that a 100 crystal was used for the quantitative analysis of tin, using the 1st order Lβ tin line.
The spectral lines of which the intensities were measured were:
1st order: Ag kα, Cu kα, Zn kα, Pb Lα, As kβ, Au lβ.



Frisian sceattas.