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CLIVE STANNARD AND WOLFGANG FISCHER-BOSSERT<sup>1</sup>

## DIES, HUBS, FORGERIES AND THE ATHENIAN DECADRACHM

‘The crime of forging increased to such a degree, that [...] it was deemed necessary to add to the loss of the guilty hand other horrible mutilations, namely, deprivation of sight and emasculation.’

AKERMAN 1844, p. 60

### *1. Reproduction: dies, hubs and coins*

The making of an issue of coins – that is, a group of coins with the same technical specifications, and the same types – involves a number of different reproductions.

The first reproduction is iconographic: the die-sinker multiplies the obverse and reverse types, with varying degrees of accuracy.

A second reproduction is the physical process of sinking dies. In die preparation, there is a crucial distinction between working in negative and working in positive: working in negative means cutting into the surface of a blank die, to make a negative image; working in positive means cutting an image in relief. Greek and Roman dies were made in the same way that seal-stones were cut, that is, in negative; but the hypothesis that ancient mints may have used positive punches to help sink dies has often been advanced; this paper turns around that hypothesis, which it does not support. From early mediaeval times, however, mints increasingly used positive punches to drive negative images into the die-face: first elements of the design (piece-punches), and later the complete design (a hub), rather than cutting in negative.<sup>2</sup> With powerful modern presses, and specialist steels, it is now normal practice to sink dies from a hub and to raise a hub from a die. For the purpose of this paper, it should be noted that the passage between positive and negative image can give rise to variant reproductions, when changes are made, either to the negative image, by cutting into the die, or to the positive image, by altering the hub.

A third reproduction is the striking of coins from dies, which turns the negative images on the dies into the positive images on the coin. Two sets of variations arise. Imperfections on the die carry over to the coin; and the accidents of flan-making and striking give individuality to the coin: these include striking defects, such as imperfect die impression, leaving areas of weakness, double strikes and off-centre strikes, flan defects, and the vagaries of metal flow.

<sup>1</sup> We thank those who gave advice and help during the preparation of this note: Harlan J. Berk, Ute Wartenberg Kagan, Arnold-Peter Weiss and Rick Witschonke.

<sup>2</sup> For clarity we distinguish systematically between ‘hub’, to mean a tool with a whole coin design, and ‘piece-punch’, to mean a tool with a part design. STANNARD 2011, pp. 60–65, traces the development of piece-punches to full hubs, from mediaeval to early modern times. It was only in about 1780 that full hubs with all details of the design, including lettering, appeared in the British mint.

A fourth reproduction is the making of copies from coins themselves, which reproduces on the product the individualities of the model, which arose both from imperfections in the original dies and from the process of striking. This can be done by casting from moulds, but it was also possible to prepare ‘transfer dies’ from hubs cast from impressions of individual coins; the coin itself is the positive reproduction of the negative die, and a hub cast from it strikes a derivative negative die, with all the individualities of the model. Such hubs were used in antiquity – at least by forgers, frontier communities without official mints, and peoples beyond the frontiers – but there is no evidence that they were used in more regular mints. The iron-core, copper-plated copies of Roman *aes* coinage from Noricum and Pannonia are an example;<sup>3</sup> and fig. 1 shows a Geto-Dacian *denarius* from ‘transfer dies’ that mules two coins: *RRC* 410/5, Q·POMPONI MVSA of 66 BC (the obverse) and *RRC* 382/1, C·NAE BALB of 79 BC (the reverse). The fact that actual coins were used to cast the hubs is evident: the edges of coins are visible on both faces; on the reverse, a cud of metal has then broken off the die at 5 o’clock.<sup>4</sup> The use of such hubs usually results in only a partial and imperfect reproduction of the original die, because of such imperfections.

Coins themselves can serve directly as hubs: Markus Peter has shown experimentally that a silver denarius can be hammered directly into hot iron, to make a transfer die.<sup>5</sup>



Fig. 1. Geto-Dacian transfer dies (x 2)

<sup>3</sup> PFISTERER 2007 and PFISTERER AND TRAUM 2005.

<sup>4</sup> No. HT3 on [www.irimitations.ancients.info](http://www.irimitations.ancients.info), downloaded on 2 August 2008. We thank Phil Davis for the illustration.

<sup>5</sup> ‘Markus Peter, Basel, hat experimentell die Machbarkeit dieses Vorgehens überprüft. Da der Versuch bisher nicht publiziert wurde, erlaube ich mir aus seinem Brief (21.8.1995) zu zitieren: “daß man eine Münze auf einen erhitzten Metallzylinder schlagen kann und dadurch einen fertigen Stempel erhält, habe ich bei einem traditionell arbeitenden Schmied im Experiment nachvollzogen. Mit einer Bronzelegierung sei dies ohnehin kein Problem, [...], deshalb haben wir es gleich mit einem Eisenzylinder versucht. Diesen haben wir auf ca. 800°C erhitzt, einen römischen Denar draufgelegt und sofort mit einem kräftigen Hammerschlag ‘geprägt’. Die Münze sprang weg (und zeigte danach erstaunlicherweise nur geringe Beschädigungen) und hinterließ einen deutlichen Negativabdruck. Auf ein anschließendes Härten des Zylinders haben wir verzichtet, und sind danach an das Prägen von Denaren gegangen. Das Ganze funktioniert also, lediglich mit der Versinterung der Oberfläche gab es Probleme, die sich aber umgehen lassen.”’ (STRIBRNY 2003, pp. 63–64.)

Fig. 2 is an imitative denarius made in *Barbaricum*, c. AD 225–250, probably in modern Hungary, but circulating into Poland, North Germany and Scandinavia. It is instructive, because it shows reworking at two stages of the production of the dies: the obverse is struck from a die made from a hub cast from a denarius of Hadrian, with the legend then recut *in negative* into the die, (by someone who evidently did not understand the letters); the reverse die is made with a hub cast from a denarius of Elagabalus, which was then worked *in positive*, to cut off the altar and snake, and the rudder and globe, of the SALVS AVGVSTI type, as well as to more clearly outline the letters, *before* the die was struck.<sup>6</sup> It is also possible that the reworking was on the coin itself, before the hub was cast.



Fig. 2. Barbarian copies of denarii made with transfer dies, reworked both in negative on the die itself, and in positive on the hub

There is no evidence for the use of such technologies in regular mints. Proponents of the hypothesis that piece-punches with larger elements of the design<sup>7</sup> were used in Greek and Roman mints to block out the central element of the design have two major lines of argument. The first is what Stannard has characterised as the ‘argument from perceived utility’, in other words, the modern perception that it would have been advantageous for the Ancients to have used such technologies, leading to the conclusion that they must therefore have done so;<sup>8</sup> he has argued against this view, because of the small number of dies that ancient mints used, the limited time needed to sink a die, and because Greek and Roman die-sinkers

<sup>6</sup> STRIBRNY 2003. For reworking of the obverse, see p. 139, pl. 7; for the reverse, see p. 140, pl. 8.

<sup>7</sup> Often called ‘hubs’.

<sup>8</sup> The classical formulation is David Sellwood’s: ‘It seems to me that the advantages are too great for the Greeks not to have resorted to it’ (SELLWOOD 1963, p. 221).

formed part of the same technological tradition as seal-stone engravers, cutting negative images into a blank seal-stone or the metal of a die-blank with drills and scorpers.<sup>9</sup> The second is from the regularity of coin images on the dies of many ancient issues. The temptation, therefore, is to question – as Dominique Gerin did with regard to an issue of 3<sup>rd</sup> century BC Arcadian League obols – whether such regularity in reproducing images can be explained by

‘the skill of the engraver, working mechanically or virtually automatically, turning out obverses that were not only of quite remarkably high quality but also extraordinarily alike? The obstacle to this explanation, in my view, is the regularity of such things as the size of the head, since some of these dies are identical in this regard when superimposed’.<sup>10</sup>

## 2. *Reproduction and forgery*

However they went about their business, ancient forgers had an easier task than modern forgers. Their aim was to pass a plated coin as real, and it is unlikely that the ancient public tried to compare minutely a genuine coin against a forgery; they relied, instead, on cutting or punching into the fabric of the coin, to see if the core was good metal.

The economics of the ancient forger’s art differs from the modern; his unit profit from each coin was relatively small, and his overall profit came from volume of production, that is, the number of forgeries he could pass. The modern forger of ancient coins, on the other hand, is tempted by the very substantial prices that many coins command: his unit profit can be spectacular, but the greater the volume of his output, the more the chance of discovery; and the more expensive the coin, the greater the scrutiny to which it is subject.

Where, then, does the forger best introduce himself into the rounds of reproduction? He faces a number of problems, iconographical and technological. For the sake of the discussion, we will exclude consideration of the technologies of casting and striking used to make forgeries (many of which are detectable by physical tests),<sup>11</sup> and of such matters as the metal used and its alteration over time, in order to concentrate on how the forger creates the image.

To make a convincing ‘new die’ of an ancient coin from scratch is difficult, because reproducing precisely the iconography and style of another age requires great artistic skill and considerable art-historical understanding. The forger faces the same difficulties that Pierre Menard did, in writing *Don Quixote*:

‘Componer el Quijote a principios del siglo diecisiete era una empresa razonable, necesaria, acaso fatal; a principios del veinte, es casi imposible. No en vano han transcurrido trescientos años, cargados de complejísimos hechos. Entre ellos, para mencionar uno solo: el mismo Quijote.’<sup>12</sup>

<sup>9</sup> STANNARD 2011, particularly pp. 64–66.

<sup>10</sup> GERIN 1993, p. 22.

<sup>11</sup> Cf. BOTRÈ 2009.

<sup>12</sup> BORGES 1944.

The tools and working habits of ancient craftsmen are directly reflected in their dies; attempts to achieve the same forms with different tools or techniques will almost inevitably fail. There is a further, separate and non-technical risk: the very fact that a die is as yet unknown can draw sceptical attention.

These problems can be overcome by mechanically reproducing the coin, but this gives rise to another set of problems, because the individualities of the model will be reproduced, and risk giving the forger away; these include – in addition to macro-elements, such as the shape of the flan – micro-elements, such as die-breaks and flan defects, and accidents that reflect the history of the coin after manufacture, such as wear and damage.

His best bet is therefore probably to derive dies from an original coin, but modify them to hide the individualities of the model. He can adopt one of two strategies: he can attempt to remove the peculiarities and recreate the original die, or can create a new die, by substantially altering elements of the image. He is on the horns of a dilemma: the less alteration, the more likely it is that the original will be identified; the more, the closer the piece is to new engraving, and the more the mistakes of taste and style will show up.

### *3. Interpreting two different dies with the same incidental marks*



*Fig. 3. 24a and F94*

This paper arises from a difference of opinion between us regarding the use of hubs in antiquity, and specifically how to interpret certain marks that are identical on two seemingly different obverse dies of two Athenian decadrachms: the obverse die (**O 14**) of coin **24a**<sup>13</sup> (from the *Triton Auction*, no. 10, lot 230), and the apparently new die of the coin offered for sale as lot 45 of the *Heritage-Gemini Signature Ancient Coins Auction*, no. 3011, of April 2011 (fig. 3, **24a**). Fischer-Bossert noted in the catalogue that:

‘there is an inconspicuous die crack running from the top of the nose, next to the front end of the eyebrow, towards the edge of the coin. A closer look reveals this is not accidental. There is another, but smaller, flaw in front of the forehead on both the coins. In fact, the whole surface structure of the background in front of Athena’s forehead and her nose is very similar on both coins [...] Evidently there is a connection between the obverse dies represented by the two coins, however the dies are different in numerous details.’

These marks are illustrated in fig. 4. He interpreted this as being an indication that the coins had been made with a shared

‘hub<sup>14</sup> carrying a positive design of the coin type – but just as a rough outline without any details – [...] driven into the die. The imprint was then completed by the engraver with the usual method of cutting and drilling. Hence the dies with exactly the same shape of Athena’s helmeted head but with different designs of the lines and dots that border and cover the plastic form’.



**Fig. 4.** Identical marks on the two coins

This hypothesis, without contrary evidence, was plausible, and seemed to be proof positive of the use of piece-punches in the Athenian mint. He asked Stannard – who had written extensively against the use of piece-punches and hubs in die-sinking in antiquity – for his opinion, and supplied him with the high-resolution photographs that are the basis of the analysis that follows. A long and detailed analysis of the photographs provided the evidence required to disprove the hypothesis. It showed that the Gemini coin (to which we have given the number **F94**) was a modern forgery, and it was then withdrawn from auction.

We have since worked together in identifying a second forgery from the same hand, and in investigating the great regularity of design that an Athenian die-sinker could achieve.

<sup>13</sup> We cite dies and coins with the numbering in FISCHER-BOSSERT 2008 and 2009. Where new numbers are required, we note this; they will be used, as he publishes further extensions of his corpus.

<sup>14</sup> We would now call this a piece-punch.

4. *Could a single piece-punch have been used to make the two dies?*

Similar as they are, there are differences in the shape of the two images of Athena's head that make the use of a single piece-punch impossible. The truncation of the neck on **F94** is sharper than on **24a** ( $300^\circ$  to  $280^\circ$ ), and the front part of the neck falls more vertically. In fig. 5, **F94**'s neck has been superimposed on **24a**'s, to show that **24a**'s is larger than **F94**'s. If the dies of these two coins came from a single piece-punch, this would require that it was first used for **24a**, then cut down at the neck, before being used for **F94**. The loop of hair to the right of the ear (fig. 6) is in lower relief on **F94** than on **24a**; this, too, could not have been made with the piece-punch that also made the **24a** die, unless it was subsequently cut down at this point. This cannot be the case, because, as fig. 6 shows, Athena's helmet is wider on **F94** than on **24a**; in the case of this detail, the same piece-punch could not have been used for both coins, unless we postulate that it was used first for **F94**, then cut down at this point, and used for **24a**. It is therefore logically impossible that a single piece-punch can have been used to make these two dies, even allowing for possible reworking of the piece-punch between dies.

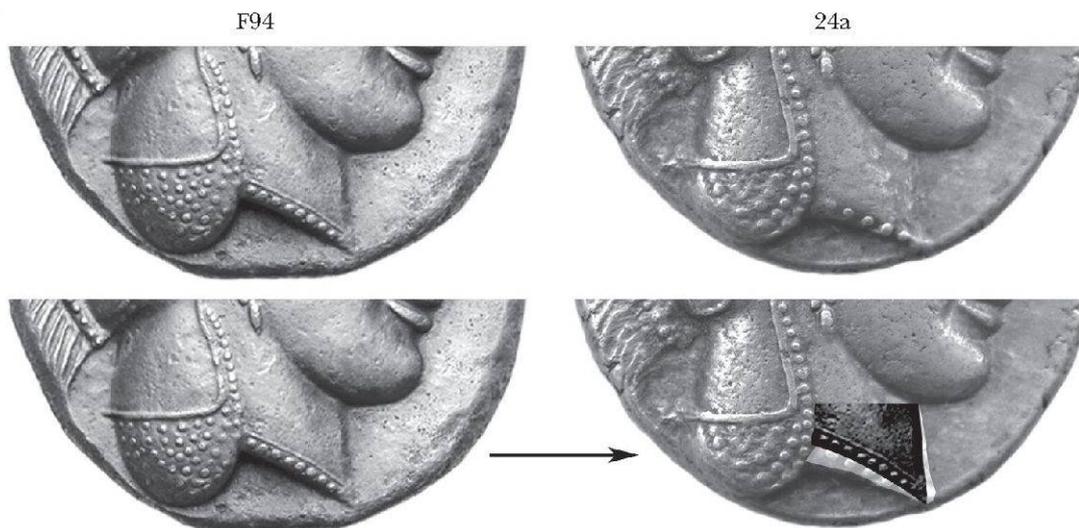


Fig. 5. Neck truncations compared

5. *Is all the detail on the two obverses different?*

There are some very major differences between the two coins. The most important are: the differences in the neck-truncations; the extra width at the back of **F94**'s helmet; the whole of the helmet crest; the positioning of the palmette element on the helmet; the loop of hair in front of the ear; the line bounding the neck-guard; the loop of hair falling below it; and the shape of the front of the visor.

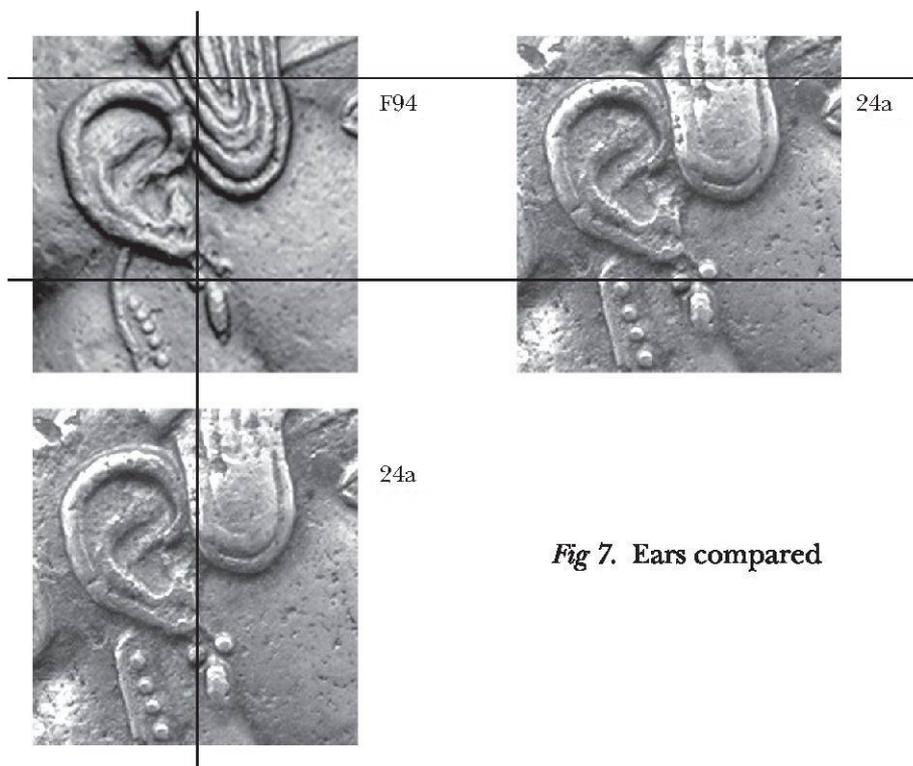
These differences aside, there is an absolute identity in the size and lay-out of a number of details that would have been difficult to achieve without some means of mechanical reproduction; careful measurement, for example, of a triangular group of details (the left leaf of the helmet, the ear and earring, and the flange of

the nose) shows an absolute consistency in their size and relative lay-out; moreover, fig. 7 shows that there is a near identity in the size and shape of the ears and earrings, except for the loop of hair hanging to the right of the ear.

There are also a number of identical small details that would have had to have been cut in negative into the die face, and could not have been cut in relief on a piece-punch; this shows that the starting point in the manufacture of **F94** was **24a** itself. For example, fig. 8 shows two little die-breaks that appear in exactly the same place on both coins. They cannot be the result of the use of a piece-punch, and cannot be interpreted as a deliberate design-element repeated in cutting the two dies; these are: (on the left) a tiny break between the bottom of the ear and the left pearl of the earring, and (on the right) a tiny nick on the left side of the nostril.

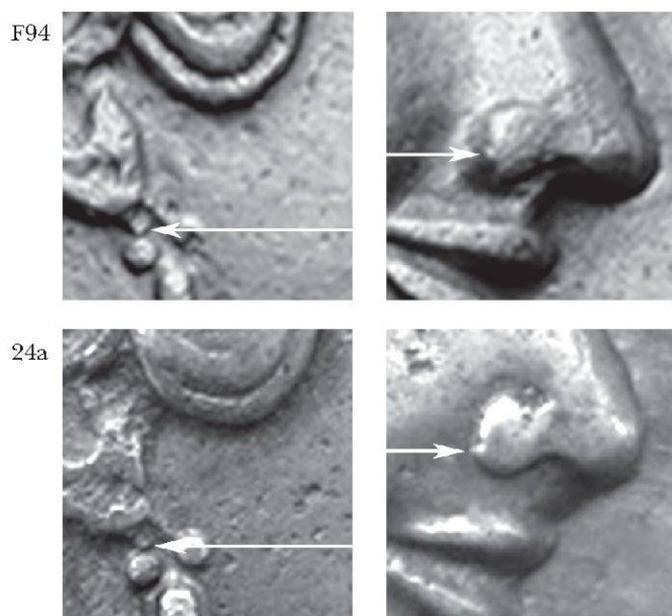


*Fig 6. Obverses compared*



*Fig 7. Ears compared*

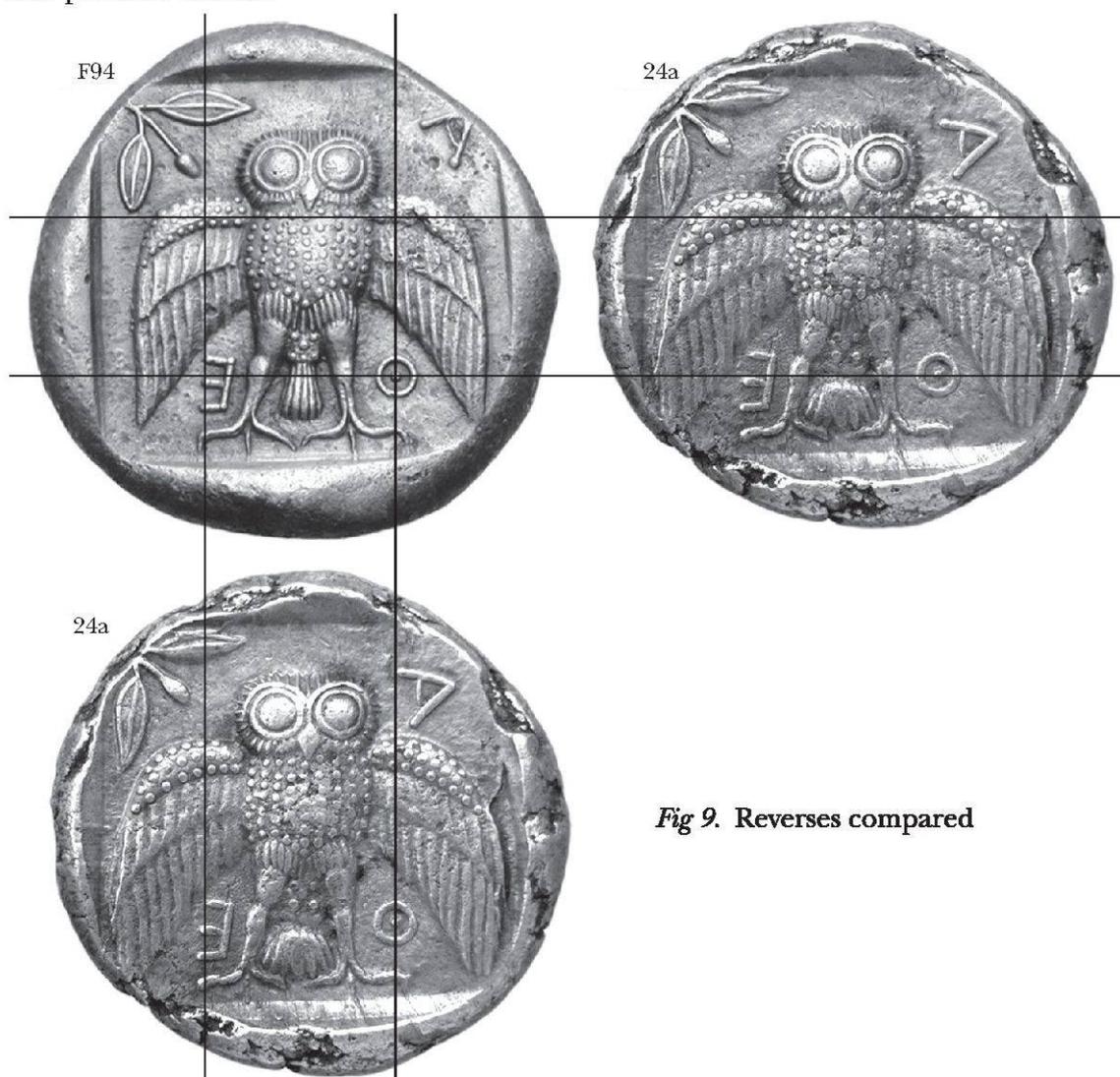
The 'mark' in fig. 4 is another example of identical die-damage on both coins. These marks are in relief on the coins; this is normal with die-damage, which creates a depression on the die's surface, and hence a relief on the coin. The marks radiate from the centre of the die; this is characteristic of die-damage caused by metal flow.



*Fig 8. Small die-breaks*

6. *Is all the detail on the two reverses different?*

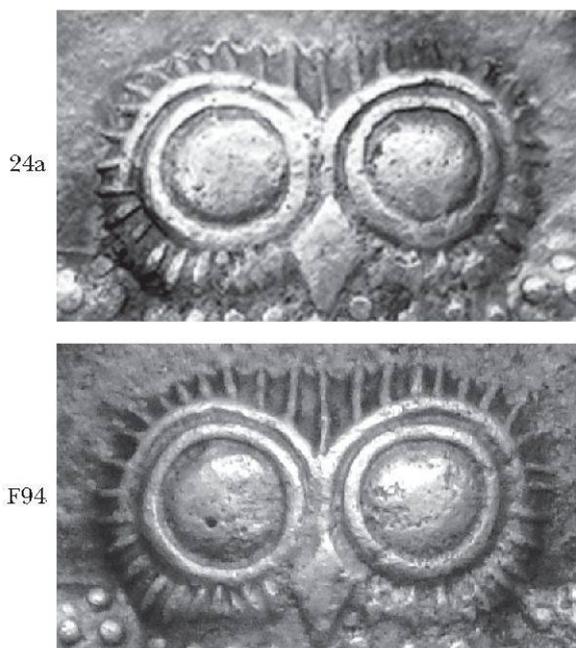
The reverses of the two coins are illustrated, for comparison, in fig. 9, and at first glance appear very different. A close analysis of the **F94** reverse, however, shows the same unlikely combination of large differences and absolute identity even more clearly than the obverse. The most evident differences are: the position of the A of AΘE; the shape of the olive-sprig; the shorter, less spread wings of the owl, and its legs and tail. There is also a large flan defect to the right on **24a**, which is not present on **F94**.



*Fig 9. Reverses compared*

These differences aside, there is the same absolute identity, as on the obverse, in the size and layout of a number of details. We measured a triangular group of details on both coins (the owl's beak, the bottom left dot on the base of the owl's tail, and the central point of the Θ); once again, there is an absolute consistency in their size and relative layout on the two dies. Fig. 9 shows that, while the A's of AΘE are different, the Θ's and the E's are virtually identical, and in exactly the same positions.

Fig. 10 shows that the ‘feathers’ on the owls’ heads are identical in spacing and layout. The feathers could not have been part of a piece-punch, because they are clearly lines cut into the surface of the die. The identity of these features on the two coins is an incontrovertible sign that **F94** is a forgery made from a cast of **24a**.



*Fig 10. Owl heads compared*

### *7. How can this forgery have been made?*

In the analysis that follows, the distinction between working in negative and working in positive, which we discussed in relation to fig. 2, is crucial. Classical numismatists are not used to thinking in these terms, though the distinction is common knowledge for those working on mediaeval and modern coinage, and to artists making medals, who work backwards and forwards between positive and negative casts, in plaster and in wax, before casting the finished medal.

The forger began with a cast of **24a**, probably in plaster. The strategy he followed was to derive dies from this original coin, but to modify them to hide the individualities of the model, and at the same time to substantially alter elements of the image, in order to make a ‘new die’.

#### *The obverse*

Working in positive, the forger cut a number of elements away. These included: the whole helmet crest, down to the level of the field; the palmette element on the helmet; the front of the throat, and the upper part of the neck truncation (fig. 5), because the coin’s imperfections in these areas would have been a give-away; and the relief line marking the edge of the neckpiece, all the dots running to the

right of the neckpiece, and the dots on the loop of hair hanging below it. He also cleaned up the left hand side of the bottom of the loop, to hide imperfections. The loop of hair hanging to the right of the ear was also imperfect, so he cut down the relief. He removed the small die-break on the top right side of the lobe of the nostril, but he did not remove the small imperfection on the side of the lobe that is shown in fig. 8. The persistence of the mark in fig. 4 shows that he did not bother to rework the field of the flan at this spot, or did so only very lightly.

The following elements were not cut away: the visor and the leaves, the ear and the earring (with the little imperfection in fig. 8); the eye and the lips; and the hair on the forehead.



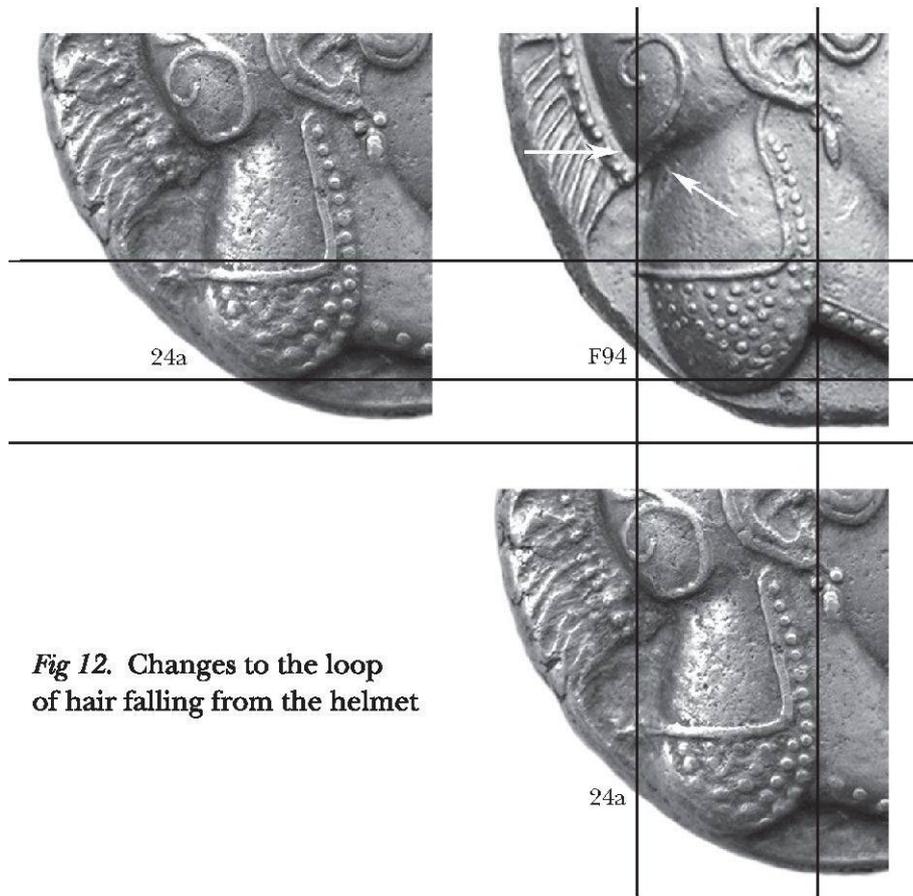
*Fig 11.* The recut base of the crest

The next step was to make a negative cast from the reworked positive cast – probably again in plaster – and cut a number of elements in negative, to replace those that had been cut away in positive. These included a whole new crest to the helmet. The original base of the crest is rendered by a full row of dots; as recut, from about 10 to 1 o'clock, it deteriorates into a thin, squiggly line with 'squelchy', deformed dots (fig. 11); this is an attempt to render the sort of line that can form as metal flows across a border of dots and only fills part of the dots.

A new palmette was cut on the helmet bowl, as well as a new line for the neckpiece, the dots on the loop of hair hanging from it, and the new necklace of dots, with a line above that. The loop of hair hanging from the base of the neckpiece was slightly lengthened, and the base of the helmet was prolonged downwards and backwards, at the place indicated by the arrows (fig. 12).

Note the very flat lines of the ear-lock. In the original, the loop falls over the ear; as recut, it is tucked behind the ear. Note, too, the way in which the loop has not been completed: the two outer lines do not continue up beyond the ear (fig. 7); this feature is similar to the reverse of **25a**. The forger also lengthened and straightened the peak of the visor (fig. 13); in the process, he reworked the 'cowlick' that, on **24a**, follows the shape of the forehead downwards from the visor, a detail shared with other decadrachm dies, including **25a**, and **26a** and **26b**, which is intended to represent hair on the forehead, showing from the other side of the head; he shortened, strengthened and deepened this, leaving an unconvincing little 'worm'.

**24a**, **25a**, **26a** and **26b** are all illustrated on plate 16 of FISCHER-BOSSERT 2008. It seems likely that the forger was working from this.



*Fig 12. Changes to the loop of hair falling from the helmet*

The forger reinforced the lips, and cleaned up a number of small elements, like the drop of the pendant in the earring. He cleaned up the many small metal defects of the original, which now stood in relief on the surface of the cast, by scraping and polishing them off (which accounts for the unnaturally smooth surface of the forgery).



*Fig 13. Visor and 'cowlick' compared*

*The reverse*

Working in positive, the following elements were cut away: the olive sprig; the A of AΘE; some of the weakest dots on the owl's chest, leaving others to be strengthened in negative; the edges of the wings, and much of the feather and dot detailing. In cutting back the wings in this fashion, he approximated the image of the owl to that on **25a**, and **26a** and **26b**.

It is surprising that the forger did not simply cut away the entire tail, and cut a new tail in negative; instead, he decided to make changes to the tail *in positive*, in ways that confirm the fact that this is a forgery. He clumsily cleaned up the feathers at the top of the owl's legs, and in the process (because he was working in positive) made cuts that continue the grooves between the owl's feathers onto the top of the owl's thighs; these are clearly visible in fig. 14, and could not have been made in negative on the die; they are not present on **24a**; they are incontrovertible signs that **F94** is a forgery. Although he modified the globular shape of the tail on **24a**, to look more like the narrower tails of **25a**, and **26a** and **26b**, the pattern of dots at the base of the tail remains that on **24a**: four dots, set as a square with a central dot (a sixth dot was added later in negative), whereas **25**, and **26a** and **26b** show many more dots.

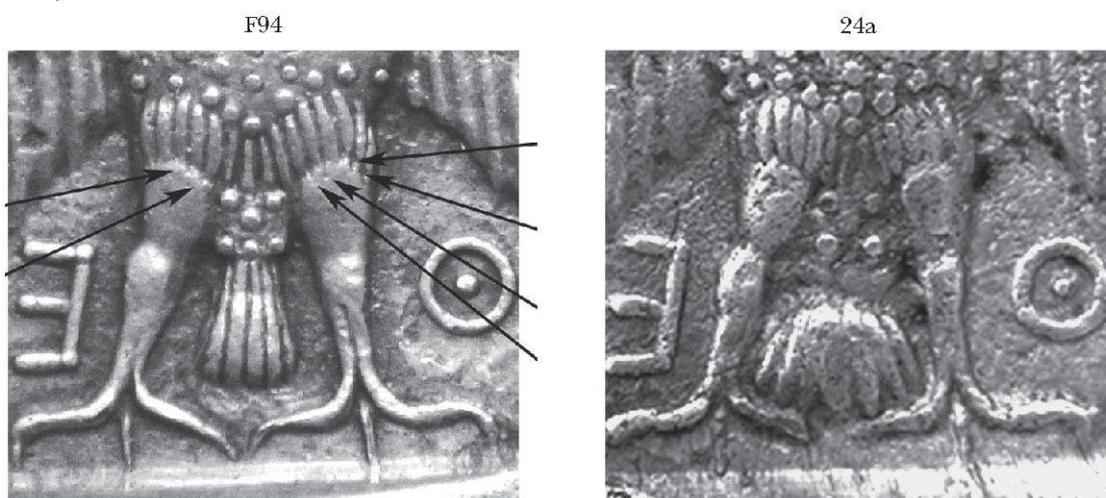


Fig. 14. Marks of cutting in positive

In reworking the tail, the forger cut back and deepened the field around the tail, between the legs – a tight and difficult spot in which to work in positive – which shows traces of scraping, and of the original tail. While cleaning up the claws, he cut a groove up the left leg, by extending the cleft between the talons; this is an exaggeration of the slight grooves seen on other dies. He also deepened the field outside the legs, and around the claws, to produce a much clearer image; this is clearest to the right of the left leg.

The owl's head, the bulk of the wings, and  $\Theta$  and E were not cut away.

The forger then made a negative cast from the reworked positive cast – probably again in plaster – and cut a new olive sprig and the A of A $\Theta$ E, in negative. He removed the flan defect to the right of the owl's wings, which, because it was a negative flaw on the flan, now stood up in positive on the negative cast; he strengthened the dots on the owl's breast that were still visible (which is why the pattern just below the beak is still evident), and cut new dots where they were not. He largely reworked the wings, which is why the feathers are sharper than on **24a**. He strengthened the  $\Theta$  and E of A $\Theta$ E, which were now lighter, because some of the flan surface had been cut away in cleaning up imperfections; in the process, he added dots to the junctions of E. He cleaned up the base of the tail, made it more box-like, strengthened the dots, and added the extra dot between the bottom two.

## 8. A second forgery



Fig. 15. F95

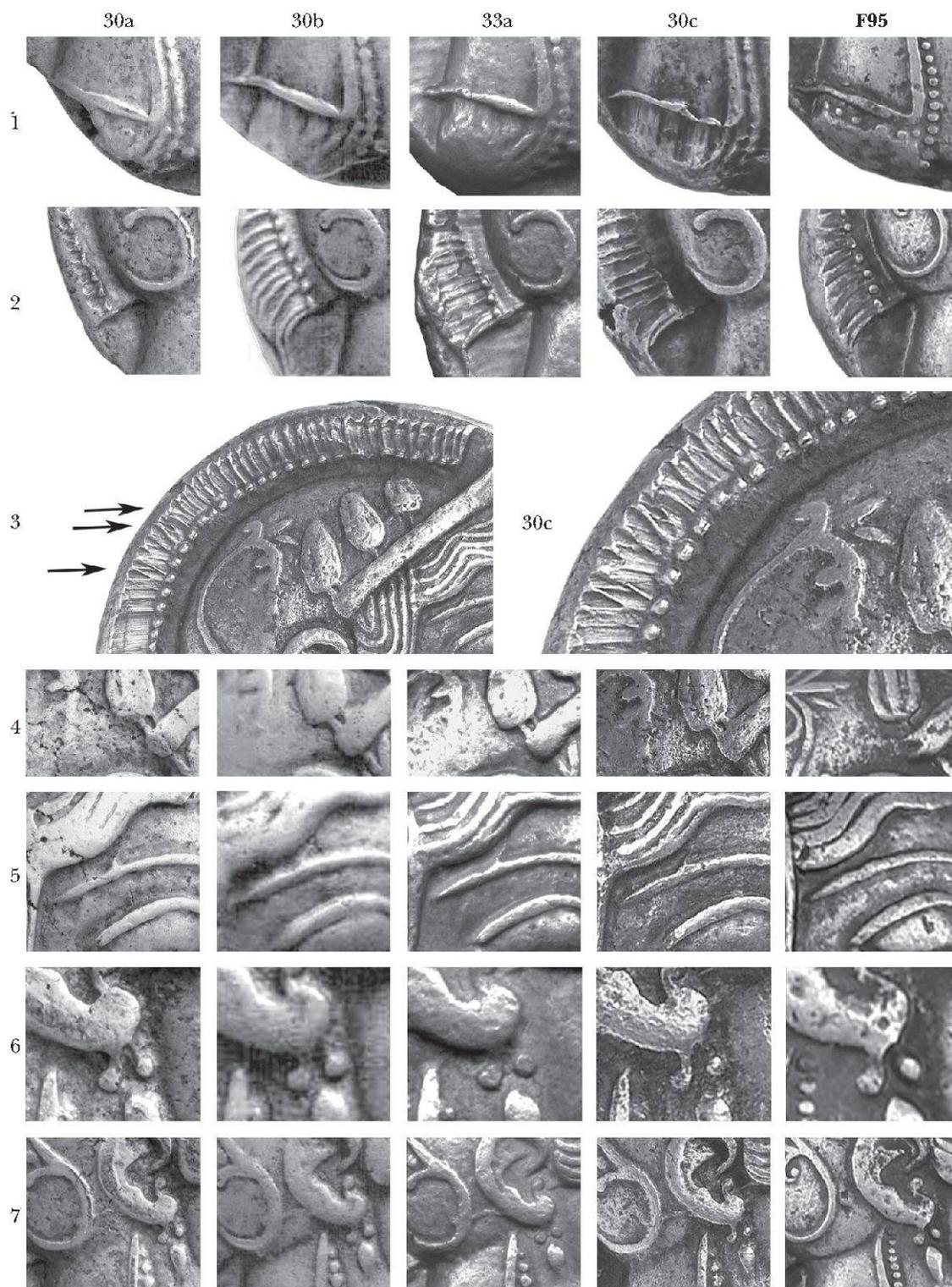
The second forged decadrachm – made with the same techniques, and almost certainly by the same person – to which we have given the number **F95** (fig. 15), is a further example of the strategy of deriving a die from an original, modified to hide the individualities of the model, in order to make a ‘new die’.

*The obverse*Fig. 16. Die **O 17**: coins **30a**, **30b**, **33a** and **30c**

The obverse die that was imitated is **O 17**; we know of four coins with this die:<sup>15</sup> **30a**, **30b**, **33a** and **30c**<sup>16</sup> (fig. 16). There are at least two die states, defined by the recutting of the helmet crest. On **30a**, too much of the crest is off the flan to be certain, but we assume it is the first state. **30b** is the same first die-state; note the crest falling away in curves behind. On **33a** and **30c**, the crest has been recut, with the back of the crest depicted by straighter lines, and, on the wider flan of **33a**, the remains of the bottom of the fuller, more pendent earlier crest can be seen.

<sup>15</sup> FISCHER-BOSSERT 2008's **31a** and **32a** are not, as stated there, die **O 17**, but a new die, to which the number **O 18** has been attributed.

<sup>16</sup> *Numismatica Genevensis Auction* 6, lot 65; this coin will be incorporated in Fischer-Bossert's corpus, with number **30c**.



*Fig. 17. Die-breaks and recutting*

Fig. 17 compares a number of details of these four coins, and compares them with **F95**. On the basis of the progressive break-up of the loop (row 1 of fig. 17), **30a** would appear to be the earliest coin in the sequence; note how the back of the

loop is still present, and delineated in dots. On **30b**, flaws have nearly obliterated the bottom of the loop, and the right side of the line delineating the bottom of the neckpiece has been recut; **33a** is very similar, with the hair-loop perhaps slightly more broken; and **30c** shows further damage. This, then, seems to be the striking sequence.



*Fig 18. F95 and 30a compared (obverses)*

The development of the back of the crest confirms this (row 2). **F95** reproduces the state of the crest in **30b**, which does not yet show signs of breaking up, as well as the recut line terminating the neckpiece. In **30c**, the crest has been recut in negative, over the earlier, and now deteriorated, engraving (row 3); **33a** and **30c** show some slight progressive damage to the bottom of the crest (row 2). Row 4 illustrates a die-break that looks like a second stalk to the leftmost leaf; it is not present on **F95**. In row 5, note the small die-break above the eyebrow, which again is not present on **F95**, though the general shape of the eyebrow is identical. In row 6,

note the die-break that joins the leftmost pearl of the earring to the ear, which is present on all the coins, including **F95**. Row 7 shows a growing die-break, running across the palmette, across the ear, as far as the bottom of the loop of hair at the ear; it is not present on **F95**.

Fig. 18 compares the obverses of **F95** and **30a**, and shows the deliberate replacement of a number of large elements of the design, by cutting elements away in positive, and re-engraving them in negative: the palmette on the helmet; the dots bordering the right side of the neckpiece, and the loop of hair falling below it; and the top of the crest, including the base of dots, in which process the dome of the helmet has been made considerably smaller.



*Fig 19. F95 and 30a compared (reverses)*

*The reverse*

The reverse of **F95** is derived from die **R 27**, which is used on **30a**, **30b** and **30c**; it has been much reworked. To show how the overall shape of the owl coincides, we have sliced images of the two coins, and recombined alternate slices, in fig. 19. As with the obverse, a number of large elements of the design have been deliberately replaced: the A of AΘE; the outer circle of Θ; the olive-sprig; the tail; and the owl's talons. An artificial die-break has been added to the wing on the left.

Fig. 20 compares the heads of the owl on the known examples of coins from **R 27** with the head on **F95**. The feathers on **F95** are different from those on the other coins, which all have the same pattern. The heads also show a small die-break that has been carried over, without modification, from the model: it runs from the middle of the beak down to the dot on the breast.

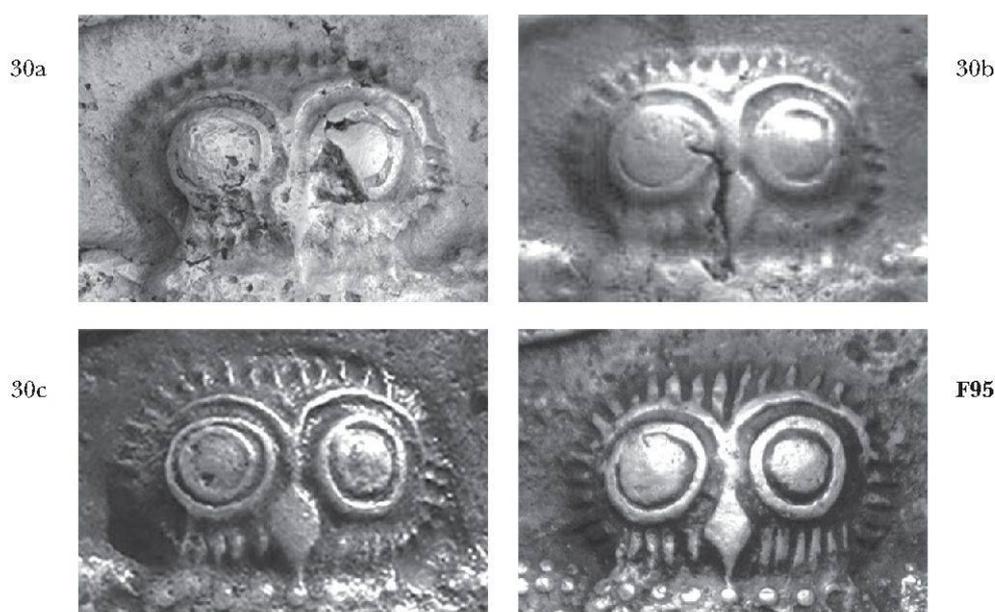


Fig 20. Owl heads compared

### 9. How similar can hand-sunk dies be?

An individual die-sinker, with a recognisable style and working within a particular tradition, can produce very similar dies, so similar as to be difficult to tell apart. Two such sets of dies are used on **0a** and **1a** (fig. 21), both genuine coins. When Fischer-Bossert first published **0a**, he commented on the striking similarity of these coins.

'From the first sight, this new coin appears to be the sister of the famous Berlin coin (**1a**). In fact, it is hard to distinguish **R 0** from the respective reverse die **R 1**. The proportions of the owl are quite the same and the distribution of dots as well. [...] Turning to the obverse die, the similarity of the Berlin coin is equally striking. Having compared casts of the two

coins side by side, I [...] find the differences minimal. Hence the dies are based upon one and the same model and might even be the work of the same engraver.<sup>17</sup>



*Fig. 21. 1a and 0a*

We have now examined the two coins with the methodology used in this article, in order to evaluate more precisely just how they compare and differ.

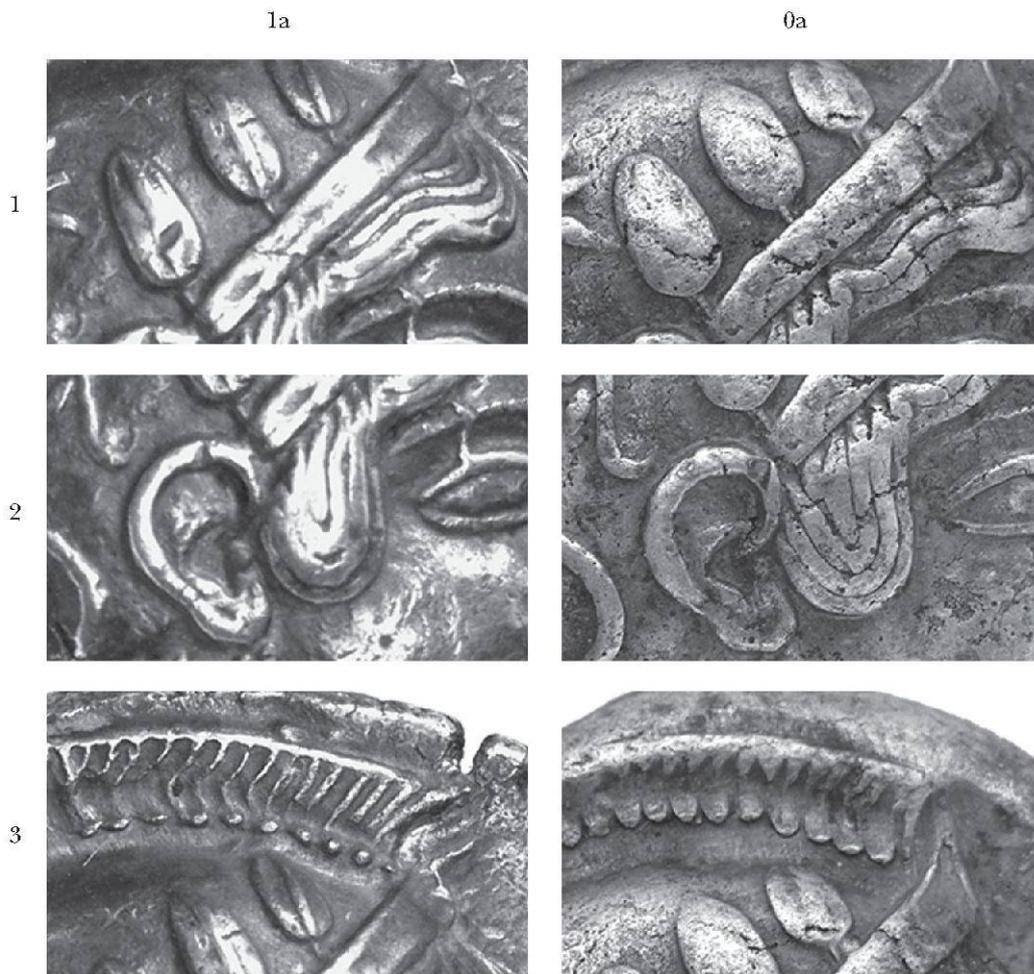
Certain features of the obverses of the two coins are clearly different; fig. 22 shows a number of examples. Set 1 compares visors; **0a**'s is considerably broader than **1a**'s, and the olive-leaves are wider. Set 2 shows that **0a**'s ear is larger, and that the loop of hair is wider than **1a**'s; it is also of a flat, behind-the-ear style, whereas **1a**'s is in higher relief style, and comes over the ear. In set 3, the front of the crest is quite different, as is the point of the visor.

Fig. 23 is another way of analysing the differences between these two dies, by slicing and recombining the photographs of the two obverses, with **0a** (the darker image) over **1a**.

In the top image, the two profiles have been aligned; they coincide almost perfectly, showing how accurately the die-sinker – the dies are surely from the same hand – could reproduce his images. But, while the profiles match, the elements on the helmet side of the images do not coincide: the ear and earring; the palmette; the olive-leaves; and the front edge of the neck-piece, with the row of dots to the right of it.

The bottom image, on the other hand, superimposes the two ears, and the elements on the helmet side of the design now align themselves; to achieve this, it is also necessary to slightly rotate the topmost image in a clockwise direction; and now the elements on the profile side of the image are all out of alignment: nose, lips, chin and eye.

<sup>17</sup> FISCHER-BOSSERT 2009, pp. 117–118.



*Fig. 22. Details compared*

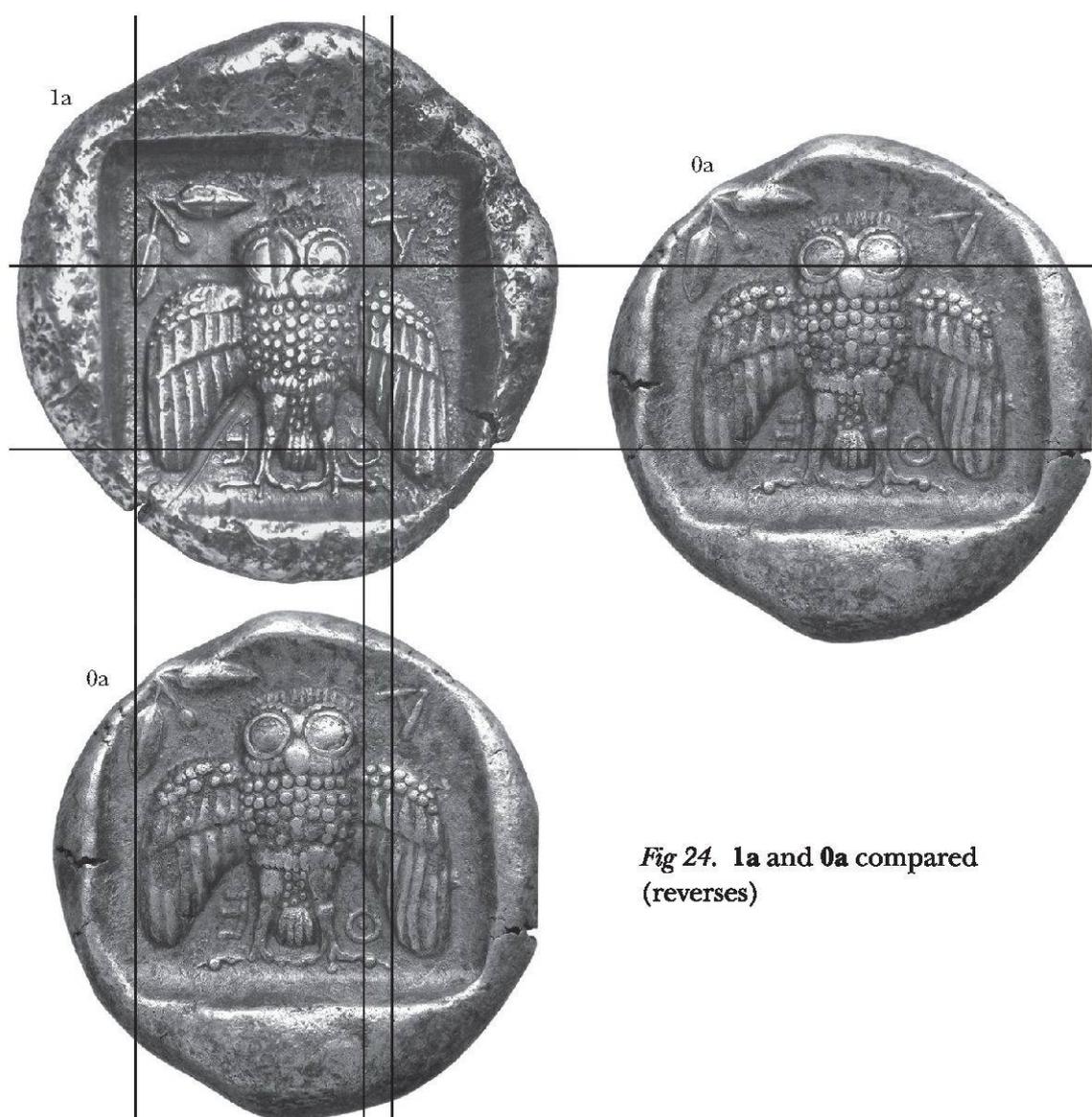
This demonstrates that the helmet and profile sides of the image are each internally coherent, but that there is a difference of angle of the profile, with respect to the helmet, that make it impossible to align the whole images. The rotation involved is small, about  $2^\circ$ ; similarly, setting lines along the straight front edge of the visor in the two images, and projecting them backwards, they meet at a point near the edge of the helmet, and form an angle of about  $2^\circ$ .

This allows us to postulate the sequence with which the die-sinker cut the major elements into the die: the bowl of the helmet first; then the ear and the visor; and the profile. The angle of the profile in relation to the helmet is fixed at this stage; this probably decides the shape of the jaw, which is carried round to the ear, to complete the profile. The profile and helmet sides of the design can then be finished virtually independently, and are each separately very consistent.



*Fig 23. 1a and 0a compared (obverses)*



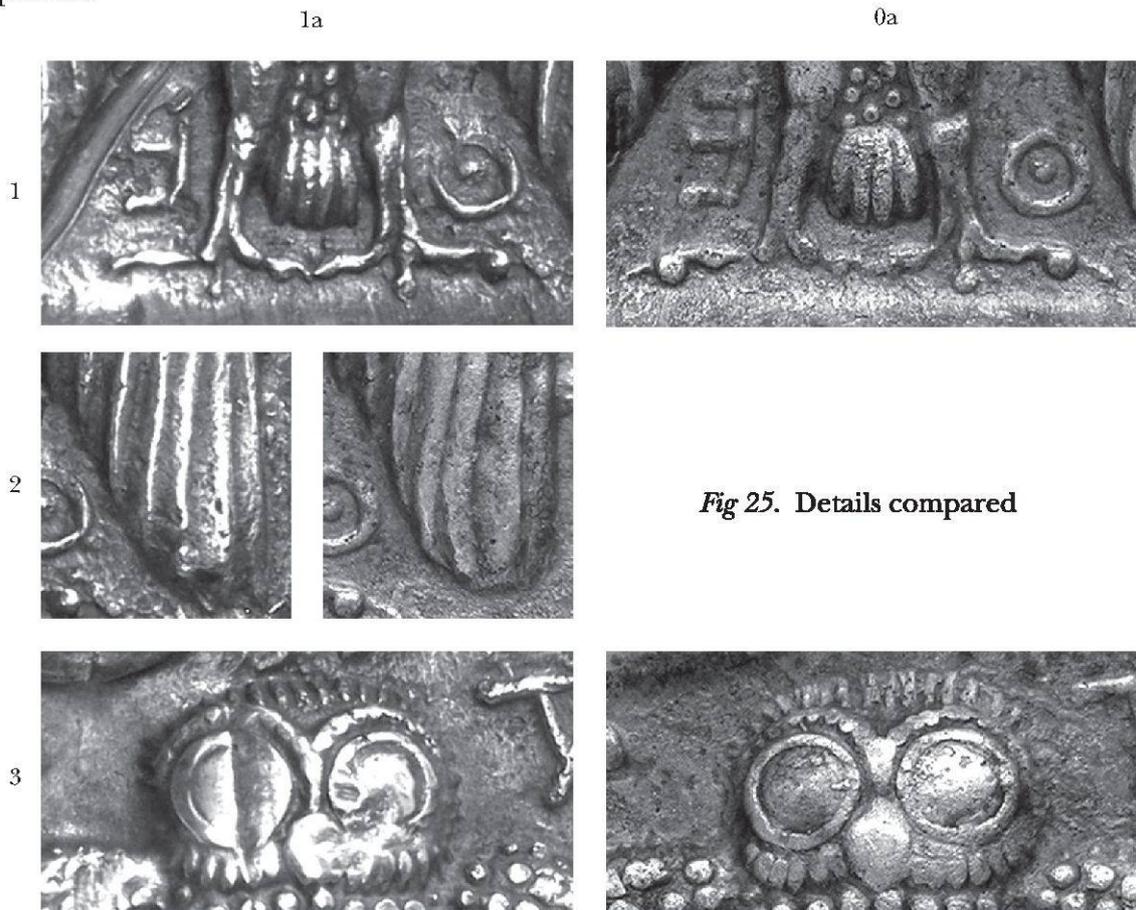


*Fig 24. 1a and 0a compared (reverses)*

It also allows us to understand something about our discrimination of similar images. Not until we had measured and 'sliced' these coins, did we notice the slight rotation, although this contributed to the eerie feeling that the two images are extraordinarily alike, and yet different. The mind seems to read by preference the similarities in the parts, rather than the divergence in the whole; in the same way that it reads the relationships between the parts in a distorted caricature as denoting the caricature's subject, so the tight stylistic similarity of the two images leads the mind to see them as the same. Moreover, the eye also does not focus on the whole image at any one time, but looks at one part, then the other, and here the image divides naturally into two semantic units: the profile and the helmet; in comparing these, the eye moves from profile to profile, and from helmet to helmet; and each is internally coherent. But it is very different when one superimposes images digitally, in slices, or by flashing rapidly from one to the other, where the differences appear in the unmoving centre of one's vision.

This analysis shows conclusively that the heads on these two coins could not have been blocked out with a piece-punch, and that the one coin could not have been mechanically and fraudulently derived from the other.

The reverse images are once again both extremely similar and yet different; in fig. 24, we have aligned them on the central dot of  $\Theta$ . As this is a symmetrical image, there is no likelihood of deformation through rotation of a part of the design, as on the obverse. Some of the stylistic differences may derive from the use of different tools: for example, a larger drill bit, so that the dots on the owl's breast are larger. Many similarities derive from the mechanical implementation of the design; for example, the die-sinker probably began filling in the dots in a central line from the beak down, and then in descending rows to either side of this line; so that the lay-out and number of the dots are substantially the same. Note in fig. 24 two differences: the right wing is wider on **0a**, and the A's are differently shaped and placed. Fig. 25 shows other differences; in set 1, the ball on the last joint of the right talon in **0a** is missing in **1a**, and the tails are differently shaped; in set 2, the tip of the left wing is straighter and longer on **1a**; and the feathers around the eyes are much more luxurious on **1a**, and the lines of the engraving are differently placed.



The similarities in the two images might encourage the idea that the owl was roughed out with a piece-punch, but the difference in the shape of the wings, and other small details, make this impossible, or at least unprovable. Nor can one

argue usefully that this reverse results from a fraudulent die made in the same way as the dies for **F94** and **F95**; there is no small, arbitrary feature carrying over from one die to the next, such as a die-break, and no tell-tail unaltered element of the engraving, such as the feathers round the eyes on **F94**.

### *10. Conclusions*

To the various types of reproduction we reviewed in section 1 must be added another: the hugely improved reproduction of images through digital photography, which, combined with digital manipulation, provides a new tool for the comparison of coins and dies. The technique is, however, only as good as the images available, and these vary a good deal, for example, if images are made at different focal distances, and if the plane of the coin surface is tilted in relation to the photographic plane. We suggest the following minimum standards: diffuse lighting that aims to reduce 'flare' from bright metal; sufficient distance from lens to object to minimise distortion; and a precise scale in the image on the same plane as the coin surface.

Our analysis demonstrates conclusively that **F94** and **F95** are modern forgeries, made, it seems most likely, by the same forger. His strategy, of reworking casts of an actual coin, to produce 'new dies', is challenged by digital photography. To remove all traces of the individualities of the original is difficult, and is likely to result in an etiolated, anaemic image. The need to rework the original in detail drives the forger further and further towards what is in effect an original production, where his own inadequacies become increasingly obvious.

The methodology used here is premised on being able to identify the original, or at least a strike from a similar die-state; this is most likely to be possible with rare and valuable coins. In the small universe of known Athenian decadrachm dies, the appearance of two 'new' obverse and two 'new' reverse dies, in two single combinations, would sooner or later have attracted attention, and exposed this fraud. We are pleased to have been able to condemn these fakes at a relatively early stage.

If one can identify the original, it should always be possible to identify a forgery of this nature, by close analysis, and the rarer the coin, the more likely we are to know the original. It is unlikely to be as useful in investigating the reproduction of more banal coins; but in such cases, the forger is unlikely to be content with a single forgery, and this opens other ways of identifying a forgery.

All our arguments are deliberately of a technical nature, and based on objective facts; none depend on fabric, preservation, typology and style. There are many gross defects of understanding, style and execution in the forger's products, which we have not described, but to draw attention to these might help him to improve his skills.

Our comparison of the two genuine coins has, we hope, shown the value of the analytical tools deployed here, for resolving similarities and differences that elude the eye, or at least the mind. It shows how similar two dies from the same hand can be, and testifies to the aesthetic sensibility and technical skills of the ancient artist. The minute similarity of these coins is not an argument for the use of piece-punches; there remains no convincing evidence for piece-punches in regular

mints in the Greek and Roman world. The type of hubbing discussed in relation to fig. 2 was not of interest to regular mints, because there was no economic or technical utility to be gained. The technology by which the coin in fig. 2 was made, however, is a close parallel to the way in which the forger proceeded, by reworking an image in alternating positives and negatives; but the barbarian who made it was an honest man.

### *Zusammenfassung*

Drei Dekadrachmen von Athen werden hier mit Hilfe eines einfachen photometrischen Verfahrens einer Echtheitsprüfung unterzogen. Dabei erweist sich, dass die erste nicht, wie kürzlich vermutet, von Stempeln stammt, die ihrerseits mit Punzen angelegt und nur oberflächlich mit Details versehen worden wären; tatsächlich handelt es sich um eine moderne Fälschung. Dasselbe gilt für das zweite Exemplar. Beide Fälschungen beruhen auf antiken Exemplaren, von denen sich der Fälscher offensichtlich Gipsabgüsse verschaffen konnte. Das dritte Dekadrachmon, dessen Stempel dem Exemplar im Berliner Münzkabinett äusserst nahekommen, erweist sich dagegen als antik: Die Abweichungen vom Berliner Exemplar sind zwar in der Tat sehr gering, liessen sich aber nicht durch Retuschierung eines Gipsabgusses erklären, da mehrere grundlegende Proportionen verschieden sind. Bei dieser Untersuchung erweisen sich die Grenzen des menschlichen Auges. Für Stempeluntersuchungen grosser Nominale wird man in Zukunft das hier entwickelte technische Verfahren zu Hilfe nehmen müssen, um wirklich sicherzugehen.

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