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Bronze coated cubo-octahedral weights with an iron core from Viking Age Sweden

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Finds of Viking Period weights are frequently made in Scandinavia and the neighbouring parts of eastern and central Europe. In Sweden alone nearly 1000 such weights have been found. One important type is the bronze covered spherical iron weight (usually between 5 and 150 g), another is the solid bronze cubo-octahedron (usually 0.5 to 5 g). It has now been observed that some of these cubo-octahedrons have an iron core coated with bronze. Usually the bronze cover has pores allowing water or water vapour to attack the iron. The rust formed often covers the weight entirely. Therefore, they were not included into the metrological studies earlier carried out upon weights of Bandlunde (Sperber 1996).

In 1984 some 150 weights of several types were recovered from the Gotland Viking Age site of Bandlunde by Majvor Östergren. These weights were studied at the Archaeological Research Laboratory of the Stockholm University.

B. Arrhenius introduced a modified procedure for the stabilization of mainly bronze weights. This procedure turned out to have great advantages over the customary treatment (Sperber 1996:119).

The present author (Sperber 1996) disclosed the weight system of Bandlunde and proved its identity with the weight system of the caliph Abd alMalik in Bagdad AD 696. The same weight system, perhaps modified, was used at other sites in Sweden (Sperber 1996).

The most common types of weights found in Sweden are spherical weights with flattened poles (usually 5–150 g). They are mostly made of iron and coated with a thin shell of lead bronze (usually 0.5–1.5 mm). Solid bronze weights of this form also exist. Many lead weights of several forms were also found.

Typical of the find are the many small (0–5 g) cubo-octahedrons of solid lead bronze. Most of them have kept their weight marvellously well, i.e. within 0.10 g through the centuries in the soil. These observations could only be achieved by selecting the best pieces and treating them separately using statistical methods. The poor looking weights were not subjected to statistical tests and were largely disregarded.

Independently, Lena Thunmark-Nylén, had observed that some weights were magnetic, indicating an iron core which made her suspect that such weights might have been more common than was believed. She tested the Bandlunde cubo-octahedrons and made up a list of those positive when tested with a permanent magnet which she handed over to me.

Most of these weights had been – so was believed – thoroughly examined before. They were, however, found to be rusty, the rust being suspected to derive from iron objects buried together with the weights. If so, their weight was no longer a good measure of their weight when buried in the earth a millennium ago.

H. Freij of the Archaeological Research Laboratory has constructed a small instrument able to measure the thickness of a non-magnetic layer covering an iron surface. The instrument requires the layer to have a reasonably flat area, not less than about a quarter of 1 cm^2, a condition not usually achievable in the small rusty samples. Nevertheless it was thought to give some crude figure for the possible bronze shell. Such measurements were performed on all cubo-octahedrons from Bandlunde formerly discarded from calculations because of rust as well as upon those found magnetic. The results appear in table 1. Table 1 shows that there are a number of magnetic specimens among the cubo-octahedrons containing an iron core covered by a bronze shell. All of them are rusty, some very rusty.

Table 1. Bandlunde. Rusty and/or magnetic cubo-octahedral weights.

Number	Type	Weight	Quality	Density	Shell	Magnetism
348.10	Cubo-oct	1.391	1 rust	8.79	none	pos
1	Cubo-oct	1.358	1 rust	8.66	none	neg
203:3	Cubo-oct	2.077	2 rust	6.74	none	pos
119?	Cubo-oct	1.488	3 rust	7.42	none	
5	cubo-oct	1.951	3 rust	5.28	1 mm	pos
348:6	Cubo-oct	2.062	3 rust	7.87	none	neg
59	Cubo-oct	3.162	3 rust	6.84	0.5 mm	pos
60	Ball-shaped	3.951	4 rust	6.23	0.8 mm	pos
248:6	Cubo-oct	1.864	4 rust	5.69	1.7 mm	?
248:7	Cubo-oct	2.572	4 rust	6.17	1.0 mm	pos
210:2	Cubo-oct	3.313	4 rust	6.07	0.7 mm	pos
334:9	Cubo-oct	3.335	4 rust	6.25	1.4/2.0mm	pos
248:4	Other	4.309	4 rust		1.0 mm	
248:5	Other	1.859	4 rust		1.3 mm	
196:3	Other	3.044	4 rust		1.0 mm	pos
202	Ball-shaped	3.423	4 rust		0.8 mm	
203:2	Cubo-oct	2.698	Qual 3	7.81	none	
348:12	Cubo-oct	1.395	Qual 2	8.47	none	

The finds from the Birka excavations of the years 1990–1995 also contain some cubo-octahedrons. One of them is depicted in fig. 1.

Holm's index (Holm 1987) can estimate how the weight of a weight-set of a known type has changed through the centuries. So, the seven weights in which the bronze layer could be roughly measured were subjected to the test. The result is shown in fig. 2. There is a significant minimum at 0.65 g. There are also several insignificant minima in the picture, 0.65, 0,48, 0.365 0.33 and 0.28 g which can be identified as the second, third, fourth, fifth, seventh and eighth harmonic of a superior weight 2.60 g. This weight is about 8% lighter than the dirham (2.82 g according to Hinz). Thus, it turned out to be quite right to disregard them when searching for the weight system of Bandlunde.

A. Söderberg has, at the Archaeological Research Laboratory, devised a simple method of covering iron weights, and other objects, with bronze (Söderberg 1997:16ff). He put the weight together with some scrap

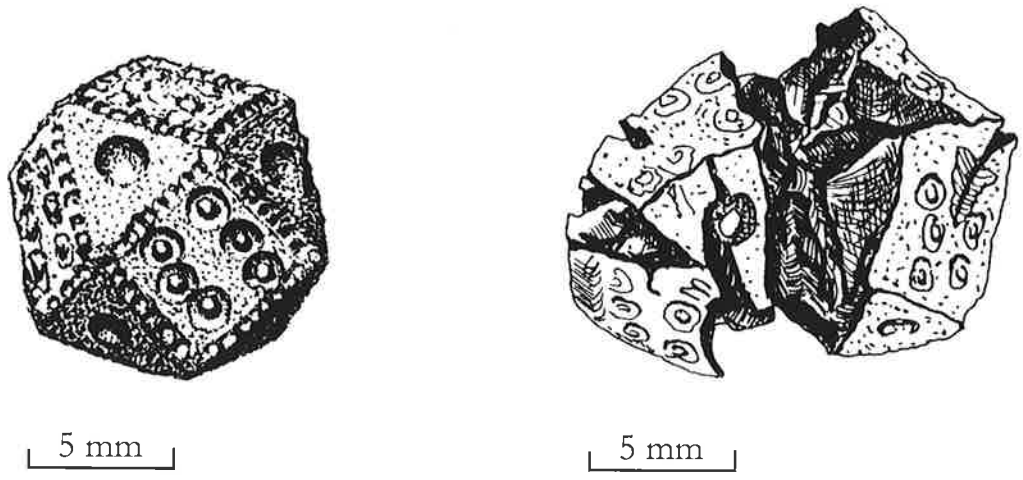

Figure 1. Two similar finds from the Birka excavation in 1990-95.
Left: Cubo-octahedral weight of solid lead bronze. Square R005345. Find number F77256.
Right: Cubo-octahedral weight of bronze coated iron. Square R002694. Find number F42941.
Drawing by Bo Zachrisson.

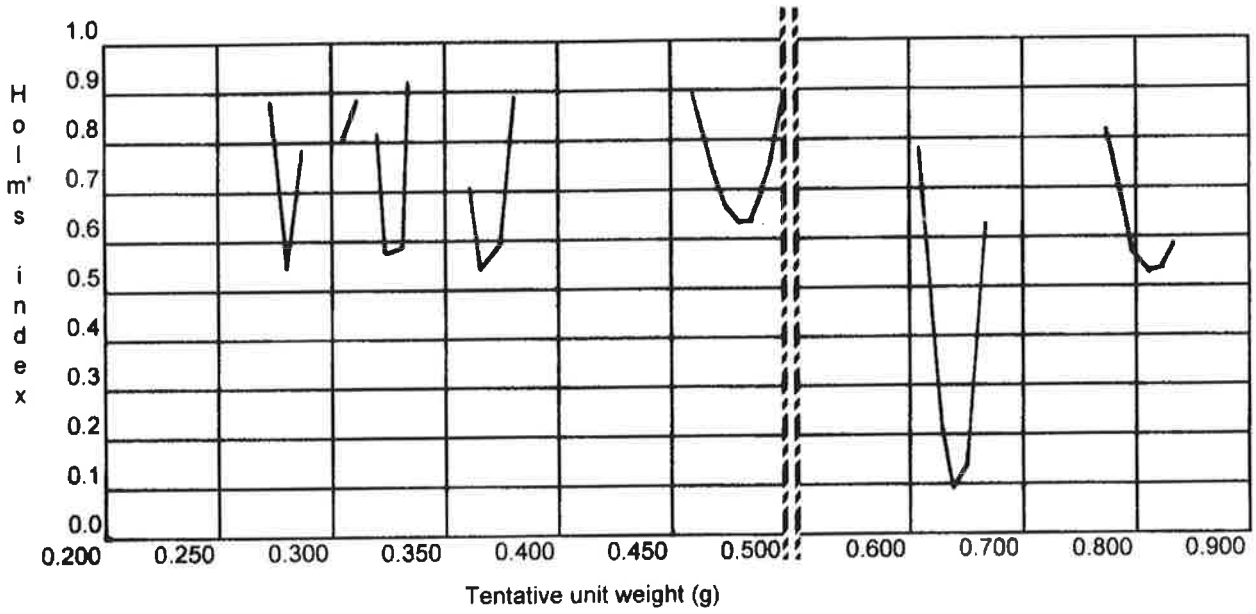

Figure 2. Eleven bronze coated iron weights. Holm's index.

bronze into a primitive cotton bag, covered it with clay, let it dry and then heated the whole in an oven to the melting point of the bronze. Once you had acquired the know-how you could cover almost any iron piece with bronze.

Mass production of coated weights or other things became possible. No wonder that, in addition to the spherical bronze covered weights, some cubo-octahedrons were also manufactured and probably sold at a reduced price.

Acknowledgement

The present investigation was initiated by Lena Thunmark-Nylén of the National Historical Museum who when working with bronze finds had noticed that some apparently solid bronze objects were positive when tested with a permanent magnet. She tested the Bandlunde weights and found that some of them seemed to contain an iron core. She handed over the list of such weights to me for further investigations. I am deeply indebted to her for allowing me to use her results.

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