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ARTICLE

Failing arguments for the presence of iron in Denmark during the Bronze Age Period IV. Regarding the razors from Kjeldbymagle and Arnitlund and a knife from Grødby

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ABSTRACT

The dark squiggly lines of the razors from Kjeldbymagle and Arnitlund are often mentioned, along with the knife from Grødby, as the earliest examples of iron in Denmark. The razors can be dated to the early Late Bronze Age (Period IV) – around 1000 BC – due to their form and ornamentation, while the iron knife from Grødby is reported to have been found in a slightly earlier urn burial.

Recent metallurgical analyses have, however, shown that the squiggly lines are not in fact iron, but rather copper covered by a layer of iron-bearing corrosion, and that the knife's context with the other grave objects must be considered uncertain.

This means that there is no evidence for the presence of iron in Denmark until the very end of the Bronze Age – around 700–500 BC.

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Within the confines of contemporary Denmark, iron and bog iron has been used and produced for two thousand years: from the first furnaces of around 500 BC until sometime in the AD 1500s, when farmers from Mid-Jutland sent self-produced iron to the forges at Bremerholm in Copenhagen for the last time (Nørbach 1998, p. 57f; Buchwald 2008, 113ff). During this long period, several technological changes occurred not only in furnace design, but also in the process and range of iron ore grades (Lyngstrøm 2008, Rundberget *et al.* 2013). Moreover, despite the cessation of production and use of bog iron being explained by mechanisms of market economy alone, explanations for the introduction of iron and iron technology have always been greater in quantity and complexity (Levinsen 1984, 153ff; Hedeager 1988, p. 196; Jensen 1997, p. 203, 2005, p. 172f).

The introduction also marks, perhaps especially for people living in a landscape such as the Danish one, a significant break with the existing knowledge and skills within metal technology. For not only are both ore and the reducing agent (charcoal) found locally, but the iron of the Iron Age differentiates itself from all other metals by remaining solid – actually never becoming a liquid – throughout the entire process. During extraction, liquid slag was smelted from solid iron, and the amount of iron at the forge was increased by welding pieces of metal onto pieces of metal and not, as with copper, tin, lead, gold or silver, by pouring liquid metal together. Thus, the introduction of iron as a material and of iron technology as a process was not only a question of introducing a new metal in line with all others, but of introducing a whole new way of understanding and processing metal.

The pre-Roman Iron Age iron extraction furnaces on the Mid-Jutland farms near Koustrup, Elia and Guldborgvej show with great clarity that some farmers possessed both the knowledge and ability regarding iron-technology processes as early as the earliest Iron Age (Olesen 2010, p. 86ff). Moreover, farmers on the Danish islands also learned it – though perhaps a little later (Lyngstrøm 2016, p. 140f). These early iron extraction furnaces fit in well with the small range of iron in pins and belt hooks from the contemporary southern Jutlandic small burial mounds of

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*The razor from Kjeldbymagle is museum number NM 18425 and is found in Kjeldby parish, Mønbo Herred. The razor from Arnitlund is museum number NM B 7225 and is found in Vedsted parish, Gram Herred.

Årupgård and Krogslund. They are forged of pure iron; only a few of them have an unevenly distributed carbon content of up to 0.3%. At the same time, the composition of slag inclusions makes it probable that these objects were forged by both imported and self-produced iron (Jouttijärvi 1996, p. 28).

However, there is no doubt that some people, as early as during the earlier Bronze Age Period VI, possessed knowledge of iron as a material without being able to produce it themselves. Grooming sets with Hallstatt-type tweezers, ear spoons and nail cleaners from the rich graves of Håstrup and Høed in southwest Funen (Baudou 1960, p. 44; Thrane 2004, p. 95f and 244), knife blades found in graves in Vesterby and Kvindebjerggård on Langeland (Jensen 1997, p. 251f) and perhaps also the coil-headed pin from the Hellegård cemetery in northern Jutland (Hornstrup *et al.* 2005, p. 93 and Fig. 13:66c) are good examples. However, the question is whether or not knowledge of iron – within the confines of the contemporaneous Denmark – reaches even further back.

Razors from Kjeldbymagle and Arnitlund

Since the beginning of the 1900s, the knife from Grødby and the razors from Kjeldbymagle and Arnitlund have offered three weighty arguments for the presence of iron as early as in the Bronze

Figure 1. The razor from Arnitlund where the dark wire is supplemented with a wire of gold (Photo: The National Museum, København).

Age Period IV (Broholm 1933, p. 223 and 663; Kimmig 1964, p. 278 and 174ff; Levinsen 1984, 154; Pleiner 2000, p. 30 and Fig. 8), and it cannot be made any clearer given that both razors display a distinct Period IV form and what appears as inserted wires of a dark metal. On the razor from Arnitlund, the dark thread is even supplemented with a wire of gold, an expression of the new metal's value and a parallelising with precious metals (***F. Kaul: Jernalderen i* Den Store Danske, *Gyldendal. Hentet 26. oktober 2017 fra http://denstoredanske.dk/index.php?sideId=101227***). (Figures 1 and 2).

The razor from Kjeldbymagle was found in 1858 by a quite young Vilhelm Boye, who was affiliated with the Royal Museum of Nordic Antiquities as one of C.J. Thomsen's protégés at that time. During the excavation of a partially destroyed burial mound, Hvilehøi in Keldby on the island of Møn, he found several urn graves

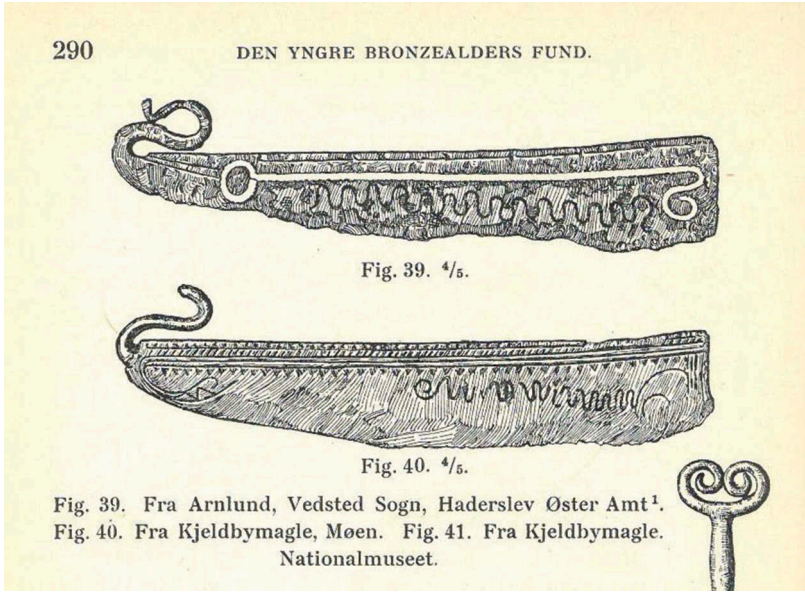
290 DEN YNGRE BRONZEALDERS FUND.

Fig. 39. 4/5.

Fig. 40. 4/5.

Fig. 39. Fra Arnlund, Vedsted Sogn, Haderslev Øster Amt[1].
Fig. 40. Fra Kjeldbymagle, Møen. Fig. 41. Fra Kjeldbymagle.
Nationalmuseet.

Figure 2. The razors from Kjeldbymagle and Arnitlund compared by Sophus Müller in 1914 (Müller 1914, Figs. 39 and 40).

including one with two clay vessels, tweezers, a miniature sword and '*en smukt forziret Kniv*[1]' (Boye 1858, p. 212; Broholm 1933, nr. 224; Kaul 1998, nr. 88). And in 1900, a somewhat similar razor was handed in to the National Museum by farm owner Chr. Lund from Arnitlund in southern Jutland (Broholm 1933, nr. 663; Kaul 1998, nr. 329). The inlay in this razor is described in the introduction of the museum's protocol as '*en stærkt bugtet Linie af et ligeledes indlagt Stof (Jern?)*'[2]. Some hesitation regarding the nature of the metal can clearly be sensed; a few years later, when Sophus Müller described the meandering line as '*et mørkt Metal, forskjelligt fra Knivens Bronze. Det ser ud som Jern og maa efter en foretagen, dels mikroskopisk, dels chemisk Undersøgelse antages at være dette Metal*'[3]… (Müller 1914, p. 289). The analysis was carried out by the then famous chemist and pharmacist H. Baggesgaard Rasmussen. He concluded that the dark parts of the knife from Arnitlund contained large amounts of iron and a small amount of copper. However, the razors from Arnitlund and Kjeldbymagle were both analysed in 1979 and 1998 too: the first analysis was done by Elmer W. Fabech having been commissioned by curator David Liversage and the second analysis was carried out by Arne Jouttijärvi on the direction of curator Olfert Voss[4].

Since 1914, the claim that the razors from Arnitlund and Kjeldbymagle were both ornamented with a band of iron wire and that iron, therefore, occurred as early as around 1000 BC within the contemporary borders of Denmark has been repeated.

Results: wire of copper

The metallurgical analysis from 1998 was made by Arne Jouttijärvi, Heimdal archaeometry, using a SEM at the Institute of metallurgy at the Technical University of Denmark. As sampling was not allowed, small (1 mm^2) areas of metal were cleaned from corrosion products prior to analysis. The supposed inlay, consisting primarily of oxides, was analysed directly. By the metallurgical analyses, it was found that the blades were cast of light lead-containing bronze with a tin content of 9 and 12%, respectively, with surfaces characterised by a heavy-handed cleaning technique – perhaps with a steel brush, applied after the knives were found (Table 1).

On both sides of the razor blade from Kjeldbymagle is a wire, which in some areas looks black, while it is – on the front in particular – seen as red against the yellowish-brown bronze. A metallurgical analysis of the wire showed that it consists of almost pure copper partly covered by a layer of corrosion, dirt and the remains of an earlier cast of silicone rubber (Fabech 1979). When the front and back of the blade are compared, it can be seen that the two inlays follow the same course, and that when the inlay is missing on one side, it can be seen on the other. Therefore, it is plausible that it is the same wire seen on both sides of the blade and that the wire lies inside the blade. This means that the wire was laid in the mould before the blade was cast – or if the lost wax method was employed that the wire was in the model. By turning the ends of the wire upwards it would have been quite simple to hold it in place in the mould, and the protruding ends could easily be removed when the razor blade was finished. The blade was probably polished and together with the later rough removal of the corrosion, it has left little sign of the casting process. It may be that the bronze caster used the wire as a practical measure to prevent the two sides of the mould from coming too close together, so as to ensure the bronze could flow completely into the thin cast. The coiled end of the copper wire, however, suggests that it was in fact intended for the wire to be seen on the surface of the finished blade.

Table 1. The results of the analysis carried out by A. Jouttijärvi in 1998.

ARNITLUND NM B 7225	Cu	Sn	Pb	Sb	Zn	As	Ag	Fe	S	Si	Au
The razor	80.2	12.1	3.1	2.6	0.3	0.2	0.0	0.5			
The dark line (the material at the top of the groove)	41.2	2.6	5.4	1.9	0.9	0.5	0.4	45.2	0.0	1.3	
The dark line (the material at the bottom of the groove)	95.6	0.4	1.4	0.1	0.0	0.0	0.3	1.5			
The golden line	4.4	2.2	0.0	0.5	0.0	0.2	10.9	0.3			80.0
KJELDBYMAGLE NM 18425											
The razor	82.7	9.1	2.5	2.2	0.3	0.7	0.7	0.0			
The dark line (the material at the bottom of the groove)	96.0	2.2	0.0	0.5	0.3	0.1	0.0	0.2			

The razor from Arnitlund contains two wires, one of which is gold. The gold wire was applied using the tauschierung technique, whereby, in this case, the bronze base was roughed, and the wire was then hammered into place. The other, darker wire however appears to be lying in a groove. The material at the top of the groove contains primarily iron and copper oxides, but also some tin, lead and antimony oxides, and under that – just like in the razor from Kjeldbymagle – is a layer of almost pure copper. Therefore, also in this case, the inlay consists of a copper wire covered by a layer of iron-containing corrosion.

In one of the wire's curves, a 2 mm clear overlap between two copper wires is visible (Figure 3). It is unlikely that such an overlap would occur if the wire had been laid in an engraved groove where it is possible to place two wires precisely as elongations of each other, but it may be due to the fact that the wires in this razor were also placed in the mould before casting. The copper used in the wires is not the only feature that the razors have in common, but also how deeply set in the blades they are.

It is quite likely that the inlays in both razors appear darker today due to corrosion formed when they were lying in the ground, because iron is found in the soil almost everywhere in Denmark, which can be concentrated as iron oxide in corrosion layers – even on bronze objects. The surface of the copper wire might, either during the manufacture of the blade or due to corrosion, be lying slightly deeper than the surface of the blade. During the corrosion of the bronze surface, the slightly recessed groove will also be filled with corrosion. After the knives were found, the heavy-handed cleaning removed most of the corrosion from the surface of the bronze, but left a thin layer in the hollow above the copper wire now resembling a dark inlay.

In the Bronze Age, the copper wires may have stood out distinctly with their red colour from the more yellowish-brown bronze, but it has also been suggested that copper wires may have been darkened using artificial patination (Schwab *et al.* 2010, p. 33). If that has been the case, the current appearance of the razor blades may not be so far from the original.

There are only a few examples of copper inlays in bronze found in northern Europe. An early example is a sword from Nebra, in Central Germany, which has an inlay of gold in the hilt and a copper wire in the blade (Meller 2002, p. 17). Similarly, a sword from the Vreta monastery in Östergötland has an inlay that is probably copper but is severely corroded (Schwab *et al.* 2010, 31f). Both of these finds can be dated to the 17th–16th centuries BC. Apart from these examples, the technique is primarily known from the eastern Mediterranean area.

Figure 3. The 2 mm overlap between two copper wires in the razor from Arnitlund (Photo: A. Jouttijärvi).

From the Late Bronze Age, inlays of iron in bronze are predominantly found in Central Europe and in two cases occur alongside deposits of copper (Berger 2014). In Scandinavia, there is only one example: a sword from Rud, in Värmland, in Sweden, while other examples from Europe include three swords from Witkowo, Czysta and Gamów in Poland, respectively (Berger 2012, p. 11f).

Failing arguments for iron in the Bronze Age period IV

The failing arguments consisting of the razors from Arnitlund and Kjeldbymagle leave us with the knife fragment, the provenance of which county governor Emil Vedel examined during the tender beginnings of his archaeological career (Figure 4). There were a few urn graves from Period III/IV in Grødby, near Aaker on Bornholm, and the objects had already been removed when Vedel arrived at the site one March day in 1869 (Vedel 1886, p. 262; Randsborg 1972, nr. 28 og Pl. VI,4). However, some young boys were able to tell the county governor that in one of the two graves had been a dagger, a knife, a tweezers, a fibula and a spiral ring of bronze as well as a flat piece of metal that was thought to be the remains of a knife blade on which were small rusted pieces of burned bone – or as Vedel himself described in his cover letter to the National Museum: '*et sært Metalstykke som ligner Jern. At det virkelig er fundet i kisten, kan der være nogen Tvivl om*'[5].

The knife is actually made of iron and in this point it differs from the wires in the two razors. If the knife belongs to the grave, it is an important testimony to the presence of iron in the Bronze Age Period III/IV. However, the affiliation to the grave is not secured and if Vedel's claim holds true, then we have no evidence of iron in

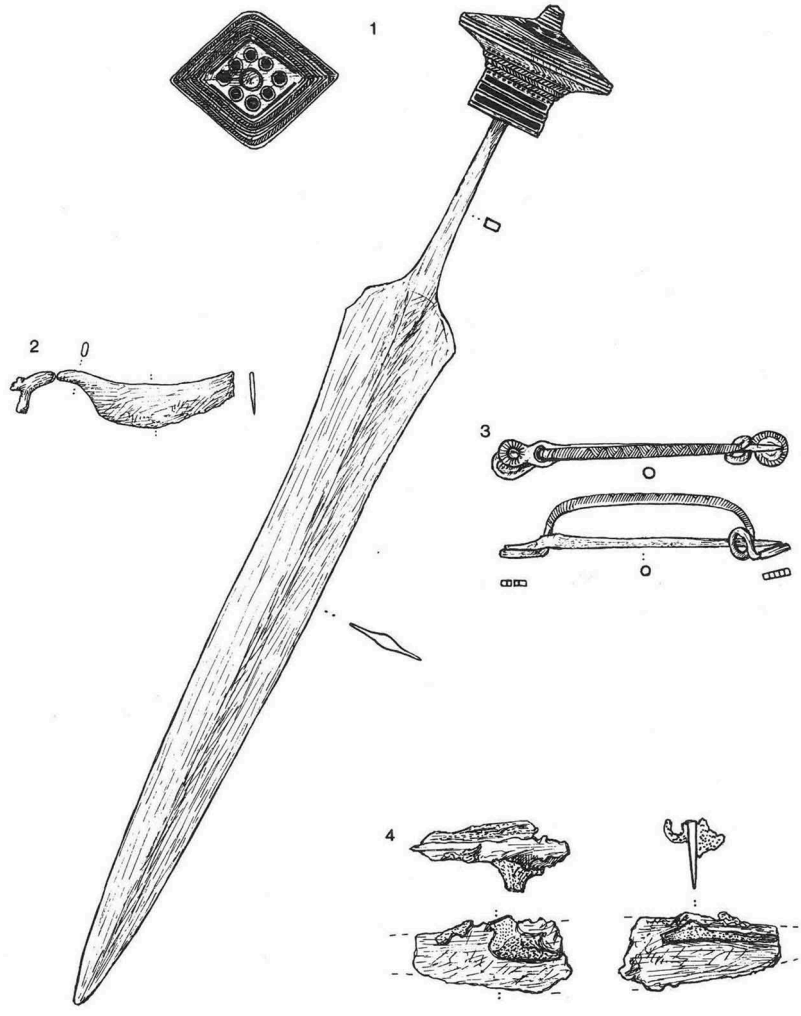

Figure 4. The dagger, knife, tweezers, fibula and spiral ring of bronze – and the iron knife from Grødby (Randsborg 1972, Pl. VI,4).

Denmark during the Bronze Age Period IV. Rather, we are left with a number of pins, rings, grooming sets and knife blades spread across the peninsula of Jutland, Funen and Langeland towards the end of the Bronze Age. Around 500 BC, there is a clear increase in the amount of iron in the graves in Jutland and on the island of Bornholm – often of types forged in iron and cast in bronze: pins, rings and belt buckles while knives made of iron seem to disappear from burials.

Notes

1. 'a beautifully ornamented knife.'
2. 'a strongly meandering line of a likewise inlayed material (iron?).'
3. 'a dark metal, different from the knife's bronze. It looks like iron, and can, after carrying out partly microscopic, partly chemical investigation, be assumed to be that metal.'
4. The razor from Arnitlund was analysed by H. Baggesgård Rasmussen. The analysis is undated, but journalised at the National Museum in 1900 as 715/00. The razors from Arnitlund and Kjeldbymagle were analysed in 1979 and 1998: by Elmer Fabech (dated 19.2.1979) and Arne Jouttijärvi (dated April 1998). All analysis reports are archived at the National Museum.
5. '. . .a peculiar piece of metal, which resembles iron. Of its being found in the grave there is some doubt.' Excerpts are from the letter of county governor E. Vedel dated 20 March 1869. Antiquities numbers NM B 323–333.

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