EARLY IRON AGE RING ORNAMENTS OF THE UPPER RHINE VALLEY: TRADITIONS OF IDENTITY AND COPPER ALLOY ECONOMICS

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During the Early Iron Age, the Upper Rhine Valley is characterized by a very distinct material culture, most notably in terms of pottery and metal objects production. Sustained relations with neighbouring regions like the Swiss Plateau, Württemberg and Rhineland are visible through object circulation, typological and technical similarities, all of which compose a wide area of common cultural trends set along the Rhine and the Upper Danube.[1]

This study[2] intends to improve the characterization of the Early Iron Age in the Upper Rhine Valley through the analysis of regional ornaments made of copper alloys, concentrating on their role in the representation of individuals, and their place in the economy of 'bronzes'. It is based on the analysis of the archaeological context and typology, which give important information about the bearers and their social identity. Through the analysis of materials the study raises the question of metallurgical traditions, by the elaboration of a typology of copper alloys and by comparisons with other, sometimes even distant, European regions. It is finally completed by the search for twin compositions, giving some clues about the organization of production and consumption of 'bronze' ornaments, and therefore about the networks binding the Upper Rhine communities together.

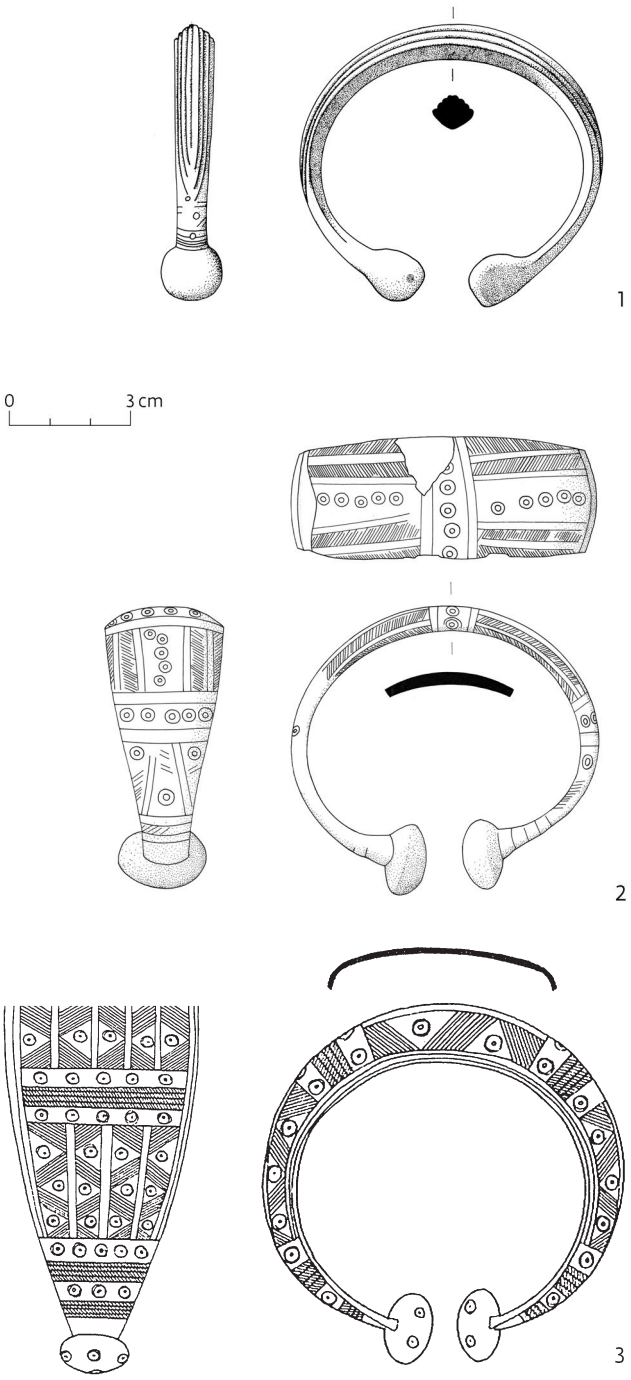
1 REGIONAL RING ORNAMENTS

As part of the costume, ring ornaments can be related to the individual's representation as a member of a particular group, and to his place within his community. This applies to common distinctions between man and woman, children and adults, higher and lower social rank, the unmarried, the married and the widowed etc. However, when dealing with societies without writing and where figurative representation is scarce, this social labelling cannot be directly observed and related to material culture. Thus, the chosen 'social markers' must be as distinctive as possible, so that the objects:

1. are typologically easily recognisable, and cannot be mistaken with others on the basis of their distinctive shape, ornamentation and/or fabrication technique;
2. are featured in a sufficient number of graves to highlight a recurrent representation pattern.

1 Bräuning et al. 2012; Tremblay Cormier 2016, 182.

2 This article is the result of a two-year post-doctoral project, supported by the Fritz Thyssen Stiftung für Wissenschaftsförderung and by the former regional Archaeological Service in Freiburg in the Regierungspräsidium Freiburg. I would like to sincerely thank Dr. A. Bräuning, former head of the Freiburg office, who accepted to be the scientific referent of this project; Dr. J. Klug-Treppe, B. Mücke, Dr. B. Jenisch, A. Boh and Dr. A. Haasis-Berner from the regional Archaeological Service in Freiburg; K.-P. Huber from the Landesamt für Denkmalpflege in the Regierungspräsidium Stuttgart in Esslingen; Prof. Dr. C. Jeunesse, Prof. Dr. S. Fichtl and Dr. L. Bernard from the Université de Strasbourg, who hosted me in the MISHA facilities, Prof. Dr. A.-M. Adam for all information on the Britzgyberg's objects; and as well, for their great help and work on the archaeometallurgical analyses, Dr. B. Mille (C2RMF), Dr. C. Véber (INRAP), Prof. Dr. P. Fluck (Univ. Haute-Alsace) and Dr. A. Gluchy. This project would never have been possible without the support of museum curators and their team, who allowed me to study and sample many objects from their collections: L. Pinero and J. Delaine (Mus. Hist. Mulhouse), M. A. P. Schlemper (Arch. Landesmus., Zentrales Fundarchiv Rastatt), M. A. M. Humbert and É. Selle-Demongin (Mus. Hist. Haguenau), Dr. B. Schnitzler and F. Ostheimer (Mus. Strasbourg), Dr. C. Lichter (Bad. Landesmus. Karlsruhe).



1 Bade-Alsace arm rings: 1. Variant A (Sankt Georgen; cat. no. 79); 2. Variant B1 (Mulhouse-Hasenrain; cat. no. 102); 3. Variant B2 (Dachstein-Ernolsheim; cat. no. 133).

For the purpose of this paper, a third prerequisite is necessary: the object types must be typical of the Upper Rhine Valley's production. Due to the lack of knowledge of regional workshops there during the Early Iron Age, except on the Britzgyberg (Dép. Haut-Rhin, F), this prerequisite can only be fulfilled by studying the geographical distribution of ring types and their clustering in Alsace and Baden.

Therefore, two main types have been chosen for the study: Bade-Alsace arm rings with their two main variants; and massive closed rings with circular section and no ornamentation, worn at the neck, on the wrists and ankles. They date from Ha C2 to Ha D3, with a stronger presence during Ha D1 and D2, a period during which the material culture is well defined and far more abundant. Four objects from the Britzgyberg, which are the only known metal implements of copper alloy working, have also been included in the chemical composition analyses.

1.1 Bade-Alsace arm rings

Large, open arm rings in two variants, following their sometimes complex body ornamentation: variant A, decorated with deep, lengthwise ridges (fig. 1,1), and variant B with geometric engravings (fig. 1,2.3). The strong homogeneousness in shape and decorative patterns leads to the definition of this type, which is highly clustered in the Alsace and Baden regions, but rarely found beyond the Vosges, the Black Forest and Swiss Jura mountains (fig. 2). This was already noticed by Rolf Degen in his fundamental article about the type;[3] the strong relation between the variants is reinforced by the fact that they share decorative patterns (pointed circles, hatchings), as is seen in particular on the hybrid arm ring of Hügelsheim (Lkr. Rastatt; cat. no. 35, pl. 2,20). Nonetheless the two variants are never found together in the same grave.

Lengthwise ridges variant A

These arm rings have a massive body decorated with deep ridges converging lengthwise and massive, spherical or faceted ends. The ornamentation is often accompanied by engraved pointed circles, cross-hatches and/or lines, located at the tips of the body (pls. 1–4). They can be distinguished from related types mainly found in central Lorraine, Saar, Switzerland and Burgundy, since the ridges on the latter do not converge but stay parallel.[4] The manufacturing traces observed on some rings show more than one step in the fabrication process, as the ends were made by an assembly secondary casting; this was already noted by Suzanne Plouin and Marie-Pierre Koenig in their synthesis of the type,[5] and is particularly visible on the Bischoffsheim (Dép. Bas-Rhin, F; cat. no. 2) arm ring as well as on another ring of unknown provenance from the Mulhouse museum, which has one simple, and one pointed end (fig. 3 above).

3 Degen 1968, 523 f.
4 Hoy 2015, 66; Plouin/Koenig 1990, 16; Reinhard 2003, 23; 26; Schmid-Sikimić 1996, 26 f.
5 Plouin/Koenig 1990, 15.

This variant is clustered in the vicinity of Colmar (Dép. Haut-Rhin, F) and Breisach (Lkr. Breisgau-Hochschwarzwald), with only two arm rings out of over 78 known specimens occurring outside the Upper Rhine region, in Central Lorraine and in Schwarzwald-Baar-Kreis (cat. nos. 78, 79). A dating to Ha D1 is based on the association with lignite arm rings in Riedwihr (Dép. Haut-Rhin, F) and Nordhouse (Dép. Bas-Rhin, F), and with regional pottery styles like red-painted and Alb-Salem-related ware in Sainte-Croix-en-Plaine (Dép. Haut-Rhin, F), Wettolsheim (Dép. Haut-Rhin, F), Feldkirch-Hartheim (Lkr. Breisgau-Hochschwarzwald), Schlatt (Lkr. Breisgau-Hochschwarzwald) and Endingen (Lkr. Emmendingen).[6] Nevertheless, this type could already have appeared during the late Ha C, since it has been found in association with typical potteries from this phase in the Ungersheim (Dép. Bas-Rhin, F) cremation grave.[7]

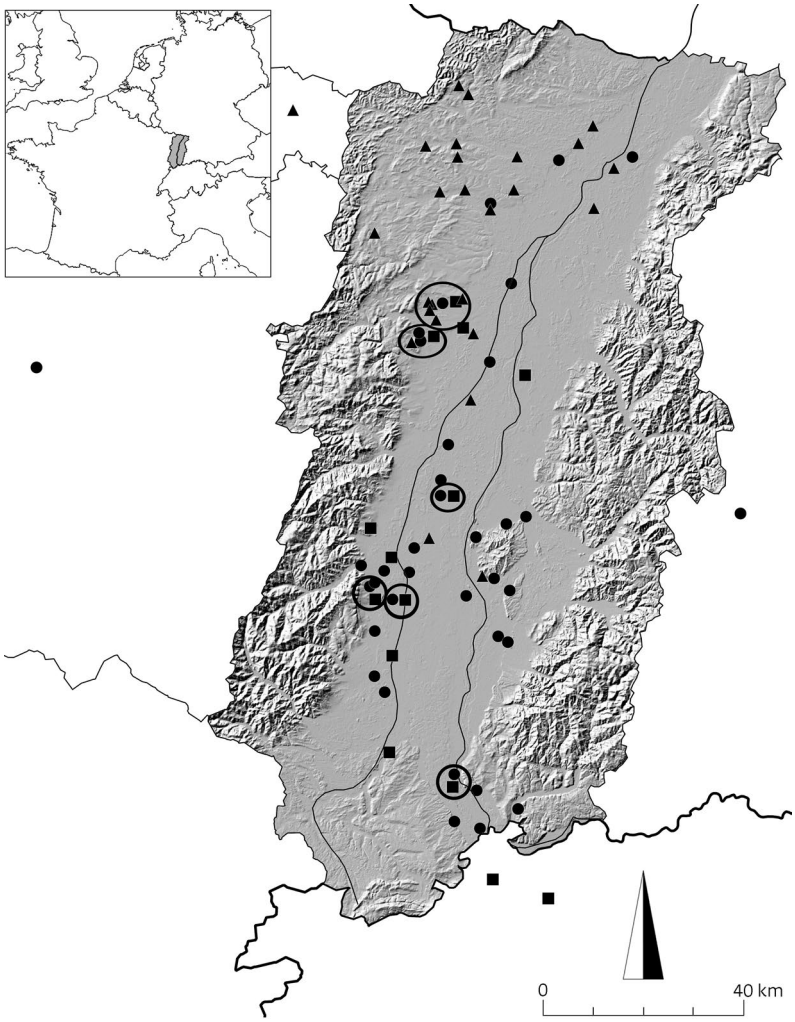
Recent excavations in Sainte-Croix-en-Plaine led to the discovery of an A1 arm ring associated with human remains (grave 115). The anthropological study tends towards a female attribution, with much caution due to the bad preservation of the pelvic bones.[8]

Wide and flat engraved body variant B

This variant is characterized by a body 1.5 to 7 mm thick and 28 to 58 mm wide, decorated with engraved geometric patterns such as triangles, hatchings and pointed circles. The decoration is unique to each pair, combining the patterns in varying panels and lines, while always keeping a strong coherence in the general style as is evident in the size of the patterns and their spacing. The massive ends are spherical or biconical. Like for variant A, an assembly of the ends through secondary casting is highly possible also for variant B, as is indicated by metal run-out traces (fig. 3 below).

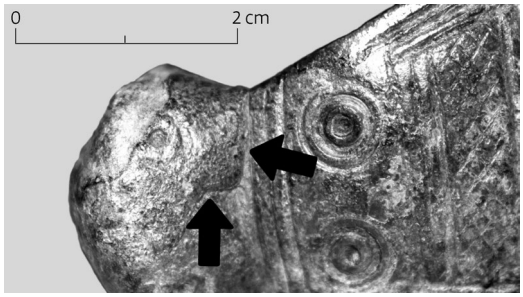
The existence of two sub-variants was first proposed in 1968 by Degen, on account of rings with a thin, C-shaped body (B1; pls. 5–7) found between Colmar and Basel (Kt. Basel, CH), and of those with a D-shaped body (B2; pls. 8–11) found between Strasbourg and Haguenau (Dép. Bas-Rhin, F). This distinction is explained by two different workshops, each working with foil sheets or casting.[9] However, even if the typological difference is relevant, the technological opposition between hammered and cast bodies is yet to be proved: indeed, no hammering traces were observed on the B1 arm rings. These traces could have been erased through a fine polishing of the ring, but they might also have never existed in the first place, due to the making of the thin body by casting. The fabrication of very thin sheets with this technique, similar to hammered sheets, is already attested during Ha B2/B3 on the Wallerfangen type rings.[10] Moreover, the ornamentation technique also seems similar for both B1 and B2 rings: the decoration of B1 arm rings shows no negative imprint on the inner side, therefore ruling out the use of hammering techniques. On both variants, the macroscopic study did not reveal any tool traces or retaking on the engraved patterns that could be related to post-casting ornamentation.[11] Analyses on the microscopic scale would thus be necessary to understand/describe the decoration technique, and to choose between engraving on the wax-model or on the cast object.

Like variant A arm rings, B1 and B2 variants seem to appear during late Ha C but are mainly

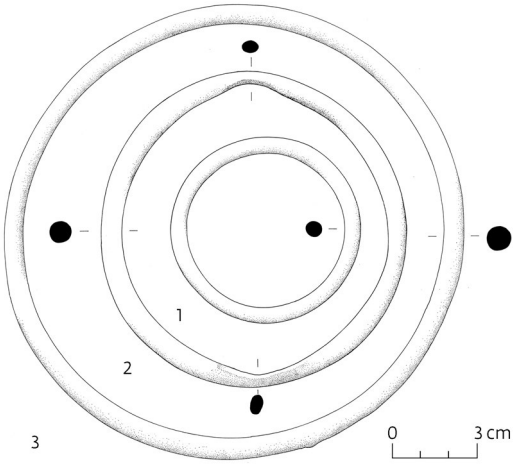


2 Distribution map of Bade-Alsace arm rings, variant A and B.
● Variant A1
■ Variant B1
▲ Variant B2

6 Plouin/Koenig 1990, 19 f.
7 Boës/Latron-Colecchia 2006, 117; Plouin 2012, 116.
8 Op. cit. tab. 2.
9 Degen 1968, 525 f.
10 Véber 2009, 51–55.
11 Gluchy 2013, 144.



3 Evidences of the secondary casting of the ends on Bade-Alsace arm rings: Above the pointed body extremity of a variant A ring from unknown provenance (cat. no. 77); below the run-out traces on a variant B arm ring from Scherzheim (cat. no. 161).



4 Massive, closed rings without ornaments: 1. Arm ring (Harthouse; cat. no. 178); 2. ankle ring with notches (Bourgheim; cat. no. 265); 3. neck ring (Harthouse; cat. no. 399).

worn during Ha D1, due to their association with lignite arm rings and necklace beads.[12] Recent excavations in Soufflenheim (Dép. Bas-Rhin, F), mound 9, confirm this dating, due to associations with Ha D1a pottery.[13] Their early appearance is supported by the relative scantiness of the grave inventories and the similarities of decoration with Ha B2/B3 ornamentation, which also uses hatchings, lines and pointed circles.

A connection between the ring and female individuals is supported by the anthropological analyses of the Sainte-Croix-en-Plaine grave 114, and Soufflenheim grave 1.[14] But this hypothesis still calls for caution, as it only concerns two pairs out of 91 arm rings, and is based on badly preserved bones; moreover, the arm rings from the grave 2 from Soufflenheim could belong to a male.

1.2 Closed, massive rings with circular section and no ornamentation

Often considered too widespread and simple in shape, closed, massive rings are rarely the object of detailed studies. However, their recurrent presence in the Upper Rhine Valley during Ha D makes them one of the main cultural indicators, in particular during Ha D2.[15] No morphological distinctions are visible in terms of diameter or section width between the north and the south specimens, nor between those from Alsace and Baden.

Because of the lack of anthropological analyses, their gender association is based on comparisons from neighbouring regions, mainly Hessen and Württemberg. Their frequent association with ear rings and belt plates supports their interpretation as female ornaments, although some exceptions do occur.

Arm rings

The arm rings (fig. 4,1; pls. 12–13,65) dimensions vary from 33.4 to 63.9 mm, where rings below 57 mm diameter can be related to children. These rings are mainly clustered in the north of the Upper Rhine Valley, due to the many discoveries made in the Haguenau barrow cemeteries and the Bruche Valley (fig. 5). They are found during the whole Ha D, with a higher frequency during Ha D2.

These simple ornaments are found in great numbers in the regions of Rhine Hessen, northern Baden-Württemberg,[16] and on the Swiss Plateau;[17] they are also known in Lorraine[18] and in south-eastern Hunsrück-Eifel,[19] although in smaller quantity. In Baden, the only anthropological analysis available is from grave 1 of Wyhl (Lkr. Emmendingen); it points towards a female individual, even though its young age and the bad preservation of the bones make this attribution uncertain.[20]

12 Plouin 2007, 99; Schmid-Sikimić 1996, 65 f.
13 Zehner 2000.
14 Boës/Latron-Colecchia 2006, tab. 2; Zehner 2000, 31; 38; 41; 46.
15 Tremblay Cormier 2016, 124.
16 Koepke 1998, 54.
17 Schmid-Sikimić 1996, 100 nos. 256–267.
18 Hoy 2015, 81 f.
19 Hornung 2008, 52.
20 Ebrecht et al. 2014, 47.

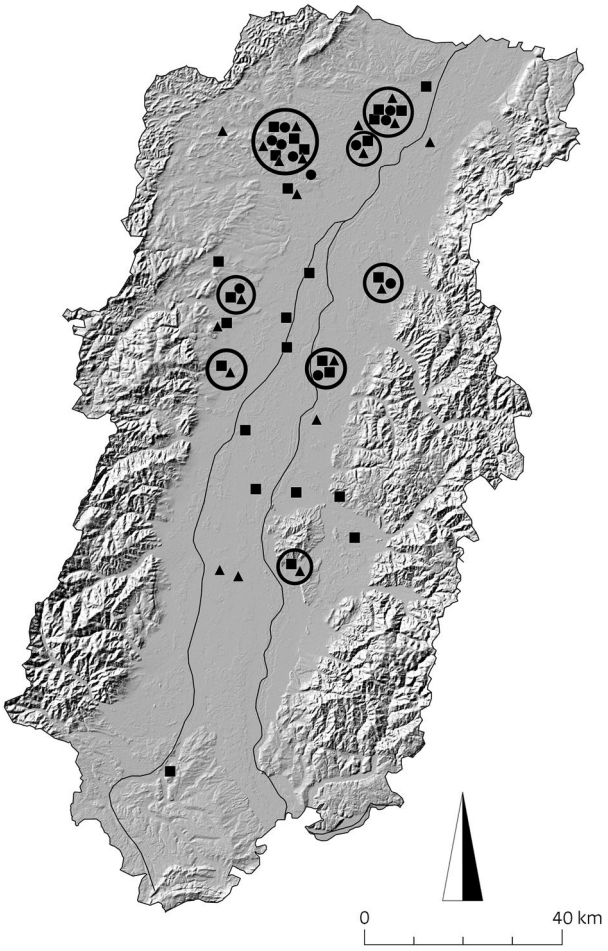
Ankle rings

Ankle rings (fig. 4,2) extend to the south up to the vicinity of Breisach, but are still clustered in the north of the region (fig. 5). The diameter of adult-sized rings varies from 86 to 113.4 mm, and that of children averages 49.4 mm (pls. 14,66–19,169). Among these, many have two opposing notches on their internal face; one is usually deep and limited to a few centimetres on the ring, while the second has a larger extend. The section of these notches is 20 to 40 % thinner than the rest of the ring, and could be owed to abrasion due to friction against the Achilles tendon and the top of the foot.[21]

But, the attribution of these traces to wear raises some counterarguments. First, the geographical distribution of this trait is strongly clustered in the north of Alsace; however a geographical distinction is incompatible with such wear, which should be more widespread. Moreover, macroscopic observation of surfaces did not show differences between the so-called worn and healthy portions, and thus dœs not support this idea. For this reason, and until more precise tribological or traceological studies of surfaces appear, ankle rings with notches will be here considered as a variant. This proposition is supported by a single imitation in Saarlouis-Fraulautern (Lkr. Saarlouis, Rheineland-Palatinate), mound 5 grave 14,[22] where two opposite notches have been made on a closed, hollow ankle ring, making it look like the massive notched variant.

The anthropological sex of the bearers is unidentified in the Upper Rhine Valley. The closest comparisons are in Hessen, where similar ankle rings are known in female graves in Hanau, Windecken and Flörsheim as early as the Ha C/D transition.[23] However, in the Upper Rhine Valley, the first examples date to Ha D1; their frequency is higher during the Ha D2. They extend to neighbouring regions like the Lower Main, Rheingau,[24] Rhine Hessen,[25] Saar,[26] Lorraine[27] and the Swiss Plateau.[28]

A few fabrication traces can be observed on the rings, often as a bulge corresponding to the casting sprue. A raw-cast ring fragment is also known from the Britzgyberg fortified settlement; its diameter (110 mm) and width (6 to 7 mm) confirm its identification as an ankle ring. The inner and outer faces have typical burrs from casting in a two-part mould, a trait also present on a few other rings (fig. 6); yet, as no contemporary mould is known, there is no direct evidence of the casting technique used to make these ornaments. However, the location of the burrs and the uniqueness of each ankle ring suggest single-use, two-part moulds, which could be similar to the clay moulds found on Late Bronze Age sites of Fort-Harrouard (Dép. Eure-et-Loir, F) and Auvernier (Kt. Neuchâtel, CH).[29]

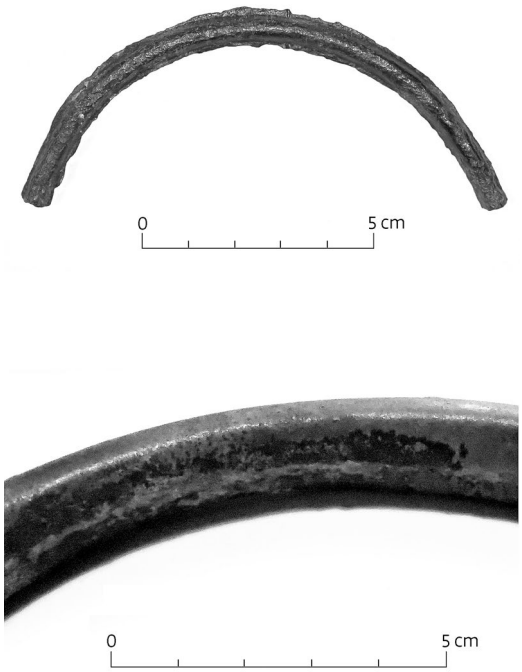


5 Distribution map of massive, closed rings without ornaments.
● Arm rings
■ Ankle rings
▲ Neck rings

Neck rings

The distribution of the 33 massive, closed neck rings (figs. 4,3; 5) resembles the one of the ankle rings as it is clustered in the northern part of the region and extends to Breisach. Remnants of a casting sprue are rare and do not show any spatial or chronological distinctions. The same goes for the bent shape of the Kappel am Rhein (Ortenaukr.) neck ring (cat. no. 404), an exception that can be explained by it adapt-

21 Schaeffer 1930, 249.
22 Saarlouis-Faulautern (Saarlouis) „Steinrausch", mound 5 grave 14: Reinhard 2003, pl. 22,10.
23 Heynowski 1992, 73.
24 Op. cit. 74.
25 Koepke 1998, 57.
26 Reinhard 2003, 26.
27 Hoy 2015, 91.
28 Schmid-Sikimić 1996, 154 no. 630–668.
29 Pernot 1998, 109.



6 Burrs issued from casting in a two-part mould: Above the ring fragment from the Britzgyberg (cat. no. 306); below the inner side of an ankle ring from Bischoffsheim (cat. no. 254).

ing to its owner's morphology.[30] The latter is one of the few neck rings that can be precisely dated to Ha D1, together with the – now lost – ring of Sélestat 2/1 La Prairie (Dép. Bas-Rhin, F) and the Obermodern (Dép. Bas-Rhin, F; cat. no. 413) fragments.

The internal diameter varies from 157 to 198 mm and the section from 5.5 to 7 mm. Neck rings with an internal diameter of more than 210 mm are dated to Ha D3 (Maegstub 1/4, Uhlwiller 15/3-1 et 15/3-2; cat. nos. 409, 421, 422), attesting to changes of dimensions over time. Unfortunately the lack of associations for the wide rings of Bischoffsheim 1 and Dachstein 18 (Dép. Bas-Rhin, F; cat. nos. 392, 395, 396) does not allow us to relate them to this chronological change. Like for ankle rings, neck rings are more frequent in Ha D2 graves, and play a great role as material culture markers.

Anthropological analyses in Württemberg (Asperg, Lkr. Ludwigsburg; Ditzingen-Schöckingen, Lkr. Ludwigsburg; Herbertingen, Lkr. Sigmaringen; Mühlacker, Enzkr.) and Bavaria (Regensburg) associate these ornaments with female individuals.[31] This also seems to be the case in the Upper Rhine Valley, although for Ha D1 this is still a matter of debate. Indeed, two neck rings dating to this phase are associated with weapons: one with a dagger in Obermodern, and another with a dagger and two spears in Kappel am Rhein grave 1 from mound 3. This recurrence could be explained either by the lack of a fixed gender attribution of neck rings during Ha D1, thus allowing it to be also worn by men, or by the non-conformism of elites regarding social norms related to costume.[32]

1.3 Copper alloy working remains

Remains of copper alloy working are scarce in the Upper Rhine Valley, and are mainly represented by crucibles and mould fragments issued from rescue excavations, dating from Ha D3 to Lt A.[33] The more numerous traces come from the Britzgyberg and the near-by Buergelen (Dép. Haut-Rhin, F) settlements, where the whole transformative metallurgical activities are known.[34] Four objects from the Britzgyberg related to 'bronze' production have thus been integrated to the material analyses, as the only direct comparisons between metallurgical remains and finished products: a casting sprue, a bar, and the fragments of an ingot and of an ankle ring. Their dating within Ha D is uncertain, because of their unknown stratigraphic context; however, on the basis of the recent discovery of more metallurgical remains on the Britzgyberg, a dating in Ha D1 can indeed be proposed.[35]

Casting sprue

A small casting cone is associated to a main sprue and 15 or 16 parallel secondary sprue channels (fig. 7 above); even after restoration it is difficult to discern whether one of the upper channels is absent, or if it was cut close to the main channel. This casting sprue dœs not show any burrs related to a bivalve mould; a bulge between the cone and the main channel rather points towards lost-wax casting.

Because of the short diameter of the main (6 mm) and secondary (3–4 mm) sprue channels, their parallel arrangement, and the low mass of bronze (39 g), this casting sprue is probably the remnant of the simultaneous cluster casting of many small pieces, rather than of one or two bigger objects. In the Heuneburg (Lkr. Sigmaringen) settlement, a similar sprue has two secondary channels, of which one was still attached to a belt hook;[36] its dimensions are comparable to those of the Britzgyberg's, supporting the idea of multiple pieces casting.

Bar

A cast bar (fig. 7 below) corresponds to a semi-product, which was intended to be manufac-

30 Dehn et al. 2005, 45.
31 Op. cit. 72.
32 Op. cit. 75.
33 Bräuning et al. 2012, 210–212; Lefranc et al. 2008.
34 Adam 2009, 65–67; Dubreucq 2007, 39; Schweitzer 1997, 64.
35 A.-M. Adam, personal information.
36 Drescher 1995, 257 fig. G1.4.

tured into a finished object. It is only 125 mm long, with a rhombic to semi-rhombic section, from 2 to 3 mm thick and 6 mm wide, with one flat side and another with a longitudinal edge. No hammering or manufacturing traces have been observed on this specimen, which could not be related to any finished object. Because of its small dimensions, this bar was not sampled for the chemical composition analysis.

Ingot fragment

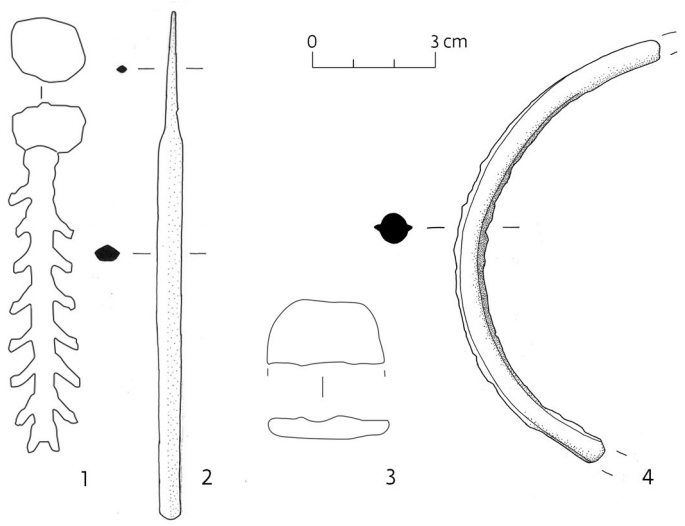
A small, incomplete copper alloy slab is interpreted as a bar-ingot fragment (fig. 7,3); its shape is similar to the bar-ingots frequently found in launacian hoards.[37] This identification as raw material is supported by its casting in a univalve mould, as is suggested by the 'orange peel effect' on one of its sides, which must be due to the metal cooling in open air.[38] An ancient transversal break might correspond to the division of the so-called ingot, in order to use only a small part of it. The low mass of metal used for this object (19 g) encourages this interpretation, with a preferential use of small amounts of material during casting rather than bigger chunks, which are harder to cast.[39]

Raw-cast ring fragment

This ring fragment shows burrs on its inner and outer sides (fig. 7,4), characteristic for casting in a bivalve mould; no traces of the casting sprue were observed. Its original internal diameter is estimated to approximately 95 mm, its section between 6 and 7 mm, and its total weight to around 60 g. These dimensions rule out any function both as an arm ring (internal diameter from 33 to 64 mm), and as a children-size neck ring (internal diameter < 110 mm). Rather they compare well with closed ankle rings, whose internal diameter lies between 86 and 113 mm.

2 THE RING-BEARER: ORNAMENTS AS IDENTITY MARKERS

The social meaning of Bade-Alsace arm rings and massive, closed rings goes beyond the sole gender attribution. Indeed, the presence of many children-size ornaments[40] similar to regular ones depicts a wide age range utilizing the same means of representation. These costume elements thus shed light on certain aspects of social identity present in Early Iron Age communities, particularly on the fact that ring ornaments were used across all age groups, i. e. from a very early age to mature individuals.



7 Bronze metallurgical remains from the Britzgyberg: 1. Casting sprue; 2. bar; 3. ingot fragment; 4. raw-cast ankle ring fragment (Mulhouse Hist. Mus., inv. nos. M68-1, M71-1, M71-2, M85-02).

2.1 Diameter of massive closed rings and its association with age

Narrow rings, such as those from mound 6, grave 3 at Donauberg (Dép. Bas-Rhin, F; cat. no. 397) clearly indicate infants wearing massive closed rings. But, while very small rings easily point towards graves of infants between six months and two years of age, the same cannot be said for the rest of the ornaments. The age of the bearer can be estimated using the internal diameter of the rings, even though there are important limits to the correlation between ring dimensions and age: the variability of the individuals body/bone morphology, ranging from lean to sturdy; the environment, diet and disease impacts on (bone?) growth; and, in the case of infants, premature delivery.

Therefore, without the anthropological study of the bones, the internal diameter of closed rings is not a direct but rather an indirect indicator of the age range to which the ornaments could be put on and/or be taken off. The use of such rings since childhood indeed necessitates changing the ring according to the child's growth, until the final, adult-size ring can be worn. Besides, as the different parts of the body grow unevenly, in particular during the very first years, these assumptions cannot be the same for neck, arm and ankle rings.

For arm rings, the correlation between internal diameter and age is taken from the

37 Guilaine et al. 2017, 35.
38 Drescher 1995, 257.
39 Guillaumet 2003, 48.
40 Massive closed arm rings: cat. nos. 175–177, 182–185, 189, 190, 192–195, 203, 219, 220, 230, 233–236, 243, 244, 249, 250. Ankle rings: cat. nos. 284, 285, 291, 292, 303–305, 314, 315, 321, 343–346, 368, 369, 390. Neck rings: cat. nos. 394, 397, 399, 400, 404, 406, 407, 412, 414, 416–418.

Table 1 Relation between girls head circumference (World Health Organization data, 15th to 85th centile) and neck rings internal diameter, with and without comfort margin.

	Head circumference (cm)		Internal diameter (mm)		Internal diameter with 50 mm comfort margin	
	Minimal	Maximal	Minimal	Maximal	Minimal	Maximal
0 months	32.7	35.2	104.087	112.045	109.09	117.05
6 months	41.0	43.5	130.507	138.465	135.51	143.46
1 year	44.5	46.4	141.648	147.696	146.65	152.70
2 years	45.7	48.6	145.468	154.699	150.47	159.70
3 years	47.0	50.0	149.606	159.155	154.61	164.15
4 years	47.8	50.7	152.152	161.383	157.15	166.38
5 years	48.5	51.4	154.380	163.611	159.38	168.61
Adult	52.8	55.7	168.068	177.299	173.07	182.30

study made for the Wyhl burial mounds. For this purpose, measurements of the metacarpus of 151 individuals, aged between two and 25 years, where recorded together with gender; these data where then compared to the minimum internal diameter of the arm ring that could have been put on each metacarpus.[41] These observations show that twelve year old girls or older could not put rings with a diameter below 61 mm. We can thus infer that adult size rings (≥ 57 mm) had to be put on before this threshold, which corresponds to the beginning of puberty.

Using the same method, the internal diameter of neck rings indicates the maximum head circumference of the bearer when the ornament was put on. An arbitrary 50 mm comfort margin was added to the measurement, in order to put on the neck ring without injuring the nose or ears. The head circumference can be correlated to age using the World Health Organization reference growth curves, compiled from 1997 to 2003 with measurements of 8500 children belonging to different peoples and social classes.[42] What makes this data set so useful is the high degree of variability which it encompasses, thus making it particularly suitable for the study of a community whose morphological characteristics are unknown. Head growth follows an exponential curve during the first four years, with a strong acceleration during the first twelve months; it strongly decreases from four years onwards, with a slight 50 mm increase until the end of puberty. This makes head circumference a precise indicator for newborns and infants up to two years of age, a period during which sexual dimorphism is strong.[43] Due to the fact that the studied rings are mainly attributed to female graves, the girls' growth curve will thus be used.

Table 1 shows the relation between head circumference and internal diameter of neck rings, and gives an estimation of the maximum age in which the neck ring can be put on and/or taken off. Due to the fast growth of the head, those neck rings with a diameter below 168 mm must have been put on early, at approximately the age of five.

The internal diameter of ankle rings is far less meaningful. Except for the few clear cases of their occurrence in infant graves,[44] their measurements do not correlate with age as well as those of arm and neck rings. Moreover, ankle rings of adult size (≥ 86 mm) are found in association with children as well as with adult size ornaments. This could mean that the final ankle rings where put on early, a hypothesis supported by the impossibility to put on a narrow closed ring. A similar study to Wyhl's, comparing the distance between the calcaneus and the top of the foot to the internal diameter of ankle rings, would certainly permit to solve this question.

2.2 A permanent identity?

The crossing of estimated ages for the three ornament types indicates that the final, adult size ring is mainly put on during the bearer's childhood: arm rings and probably ankle rings before the age of twelve, neck rings before the age of five (tab. 2). Thus, this theory involves an early implementation of the costume, which plays a great role in the representation of identity. Indeed, social identity is expressed through the permanent nature of these ornaments, which cannot be taken off once the bearer reaches adulthood; moreover, this identity seems to set in during childhood, as some rings were being worn by infants.

Such a consistency of identity expression is not exclusive to permanent closed rings. The Late Bronze Age hoard of Blanot (Dép. Côte-d'Or, F) is one good example. It associates three sets of ornaments (necklaces and ankle rings) and has been interpreted as belonging to the same woman at three stages of her personal life.[45] Their replacement at each growth stage from childhood to adulthood while keeping the same costume composition, shows that open ornaments can also be persistent identity markers.

41 Ebrecht et al. 2014, 59 f.
42 World Health Organization 2007.
43 Lepetit 2011, 118–141.
44 Cat. nos. 284, 285, 307, 314, 315, 345, 346.
45 Verger 1998.

During Ha D1, two closed neck rings belong to warrior graves (Kappel am Rhein and Obermodern; cat. nos. 404, 413) which can be related to the elites. Fastening these identity markers on the body at such an early age supports the concept of heredity in power transmission, as membership to the elite is expressed as early as childhood. However, the association of massive closed rings with the upper social class is harder to claim for Ha D2, as they are worn by a far greater number of persons. Nevertheless, the social identity of women wearing such ornaments must have been important enough to be set during childhood or at birth and kept until death.

2.3 Bade-Alsace arm rings: an open question

It is a delicate issue, to try the same exercise with Bade-Alsace arm rings, as they are rarely associated with other objects. Moreover, the limited number of anthropological analyses does not give certainty about their association with gender either – even if some recent analyses and comparisons tend towards feminine bearers.

Some children-size rings[46] indicate that these ornaments were not exclusive to adults. But, because of their open shape which allows them to be taken off, they can hardly be considered as permanent ornaments like the massive closed rings. Are the rings associated with a certain social identity related to age, or does their use serve solely the purpose of body decoration?

3 ARCHAEOMETALLURGICAL TRADITIONS (IN COLLABORATION WITH BENOÎT MILLE)

The analysis of materials completes the study of shape, and questions about metallurgical traditions and the economic organization around metal consumption. North-west of the Alps, the Iron Age 'bronze' metallurgy suffers from a certain lack of research, especially when compared to research on iron metallurgy and/or the Bronze Age. The scientific gap is evident in many treatises on the subject, which end their discussion at the period of transition between Bronze and Iron Age. An economic system based on recycling, which makes any interpretation on Iron Age copper-alloy metallurgy almost impossible, is generally used as an argument not to investigate this question, although this large-scale recycling has never been confirmed by any analysis.[47]

A selection of ring ornaments has thus been made to create this first framework of Upper Rhine copper alloys. The procedure is based on the analysis of their chemical composition, and

Table 2 Minimal internal diameter of neck, arm and ankle rings and estimated age range (correlations for arm rings from Ebrecht et al. 2014). The numbers behind the site names refer to the mound/grave.

	Arm rings		Neck rings		Ankle rings
	Internal diameter (mm)	Age range	Internal diameter (mm)	Age range	Internal diameter (mm)
Brumath 20/P			180.0	> 5	
Bourgheim			156.0	< 3	99.0 100.0
Dachstein – Leffert 18			237.0	> 5	
Dachstein – Leffert 20	56.0	2–9			
Donauberg 6/2			154.0	< 3	88.2 90.6
Donauberg 6/3	36.7 36.9	< 2 < 2			49.4 50.5
Harthouse 1/1					96.0 96.0
Harthouse 5/1	56.1	2–9	165.0	< 5	86.6 87.7
Harthouse 10/1	58.6	> 10			86.2
Harthouse 12/6			158.5	< 4	88.5
Harthouse 12/7	59.1 59.4	> 10 > 10			
Ihringen unknown grave			155.0	< 3	
Ihringen unknown grave					67.0
Ihringen U/1					88.0
Ihringen Z					81.0 85.0
Kappel am Rhein 3/1			155.0	< 3	
Koenigsbruck 3/1	35.5 36.6	< 2 < 2			
Koenigsbruck 6/3	61.1 63.9	> 10 > 10			
Koenigsbruck 6/6					90.3 94.5
Koenigsbruck 9/3					94.4 97.5
Koenigsbruck 12/2	36.6	< 2			61.1
Koenigsbruck 14/2			157.0	< 4	
Koenigsbruck 14/3	55.9	2–9			89.0
Koenigsbruck 14/20					80.1
Koenigsbruck 18/1	53.6 56.0	2–9 2–9			88.6 92.0
Koenigsbruck 18/5	43.8 45.2	2–9 2–9			

46 Cat. nos. 28, 29, 45, 64, 139–141, 155, 157, 168.

47 Schwab 2011, 268.

Table 2 (continued)

	Arm rings		Neck rings		Ankle rings
	Internal diameter (mm)	Age range	Internal diameter (mm)	Age range (years)	Internal diameter (mm)
Maegstub 1/1	52.5	2–9			93.0
Maegstub 1/4			210.0	> 5	104.2
					104.6
Maegstub 1/5	62.0	> 10			89.0
	59.0	> 10			89.7
Maegstub 1/7	55.3	2–9			102.7
	55.2	2–9			113.4
Maegstub 2/2	60.4	> 10			
	59.6	> 10			
Maegstub 3/1	58.4	> 10			99.4
					102.0
Maegstub 4/1	62.0	> 10			86.0
	60.4	> 10			88.6
Maegstub 4/3	54.3	2–9			89.0
	56.4	2–9			99.5
Maegstub 14/2	55.6	2–9	198.0	> 5	100.1
	54.3	2–9			100.6
Maegstub 16/1	55.7	2–9			102.6
	55.0	2–9			103.0
Maegstub 16/2					80.0
					80.9
Maegstub 20/1	47.7	2–9	178.5	> 5	75.0
	47.7	2–9			75.4
Maegstub 20/3					87.3
					88.1
Meissenheim 3			144.0	< 0.5	
Meissenheim 4					102.0
					110.0
Nonnenweier – Schwanau	53.0	2–9			104.6
					108.0
Ohlungen 3/1	54.6	2–9			89.6
	56.7	2–9			90.1
Ohlungen 3/2	54.3	2–9			94.7
	59.9	> 10			104.9
Ohlungen 3/4					95.0
					100.0
Ohlungen 3/5	61.6	> 10			
	62.8	> 10			
Ohlungen 3/10	42.6	2–9	154.3	< 3	

aims at defining different chemical composition types and at proposing an archaeological interpretation. The results are then compared to similar analyses conducted in other European regions, in order to search for comparisons and to place them in a more general context.

3.1 Method

The analyses were conducted on a representative sample of the objects (tab. 3), among 21 Bade-Alsace arm rings and 43 closed massive rings, to which the three metallurgical objects from Britzgyberg were added: the ingot fragment, the casting sprue and the raw-cast ankle ring fragment mentioned above. The protocol aims at characterizing chemical composition groups, through the definition of a chemical composition typology for alloys and a thorough analysis of the impurities spectrum. The analyses have been made in the Centre de recherche et de restauration des musées de France (C2RMF) using the PIXE method,[48] on the AGLAE particle accelerator. They mainly concerned samples taken from the healthy parts of ornaments, on the inner side of the ring or on the plug, using a 1 mm HSS steel drill. A sole 10 mg sample per object was taken, although multiple sampling would have given a more accurate representation of the chemical composition. Three objects[49] have not been sampled but examined by surface analysis, without cleaning, at the request of their museum; the analyses were made on places were corrosion seemed absent due to tiny modern scratches: on the external side of one of the ends of the Hügelsheim armring (cat. no. 35), on the lateral side of the body of the Scherzheim armring (cat. no. 161) and on the outer side of the body of the Sollingen armring (cat. no. 163). However, the results are hardly meaningful: Indeed, two objects were too corroded while the third one shows extreme values, which can be due to the segregation of chemical elements and their migration to the surface of the object during its cooling, or due to the surface alteration during its burial in the ground.[50]

In total 31 chemical elements have been analysed, according to the detection limit of the PIXE method. Among these, eleven are only used to control for a potential contamination of the sample by corrosion products, which are soil rather than metal elements;[51] thus, they are not taken into account in the following steps. When a high amount of one of these elements

48 Dran et al. 2000.
49 Arm rings from Hügelsheim (cat. no. 35), Scherzheim (cat. no. 161) and Sollingen (cat. no. 163).
50 Bourgarit/Mille 2014, 115; Pernicka 2014, 254.
51 Elements used to characterize metal composition are P, S, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Ag, Cd, In, Sn, Sb, Te, Au, Hg, Pb, Bi. To identify contaminated samples, the following elements have been used: Mg, Al, Si, Cl, K, Ca, Ti, V, Cr, Sr, Zr.

was detected, the results were excluded from the final analysis. It is on this basis that the previously cited surface analysis results were rejected. Therefore, 20 chemical elements are left for the analysis, which are considered the most significant for archaeometallurgical studies of copper alloys.[52] However, among these elements, many were represented in amounts less than the detection limits: manganese (Mn), zinc (Zn), selenium (Se), cadmium (Cd), indium (In), tellurium (Te), gold (Au) and mercury (Hg). The statistical processing thus concerned the twelve remaining elements: copper (Cu), tin (Sn) and lead (Pb), and phosphorus (P), sulphur (S), iron (Fe), cobalt (Co), nickel (Ni), arsenic (As), silver (Ag), antimony (Sb) and bismuth (Bi) as impurities (tab. 4).

3.2 Copper-alloy compositions (Cu, Sn, Pb)

Typology of alloy compositions

The mean copper amount is 82.2 % (7.13 %; tab. 5); it ranges from 64.5 to 92.9 %, a usual range for protohistoric copper alloys (diagr. 1). No object is made of non-alloyed copper: even objects with the highest copper amount (≥ 90 %) are associated to a second element (binary alloy), and even sometimes to a third one (ternary alloy). Tin amounts are also standard, as they never get beyond 15.8 % and rarely cross 3 %; the mean value is 8.45 % with a 3.39 % standard deviation, which corresponds to an important dispersion for protohistoric alloys.[53]

On the other hand, lead has an interesting bimodal distribution, which seems to correspond to two distinct composition tendencies; this high variability is confirmed by a high standard deviation (σ 9.21 %) and an unusual high mean (8.61 %). Lead content ranges from 0.16 to 36.6 %, with two peaks at approximately 1.5 and 20 %. The first quartile comprises objects (19) where lead is present in less than 1 %, as an impurity. In objects containing amounts between 1 and 2 % (eleven objects), lead is possibly an involuntary addition, coming from the recycling of alloys with a high lead content. Beyond this threshold, the alloy is considered as leaded bronze,[54] such high amounts of added lead were observed in the majority of the analysed objects (37 objects).

The alloy components show strong differences in the distribution of lead, which seems to reflect two distinct tendencies in the alloys. Therefore, a classification using lead amounts as the main criteria can be proposed, using the distribution particularities:

Table 2 (continued)

	Arm rings		Neck rings		Ankle rings
	Internal diameter (mm)	Age range	Internal diameter (mm)	Age range (years)	Internal diameter (mm)
Ohlungen 3/14			172.5	> 5	
Ohlungen 3/16	45.0	2–9	158.0	< 4	82.2
	46.0	2–9			84.1
Ohlungen 3/18	33.4	< 2			70.4
	43.7	2–9			72.1
Schirrhein – Fischerh. Kurzgeland 1/4			135.5	< 0,5	
Schirrhein – Fischerh. Kurzgeland 2/2					97.5
					100.0
Schirrhein – Fischerh. Kurzgeland 8/9	56.3	2–9	168.0	< 5	94.2
	57.0	> 10			84.1
	73.3	> 10			
Schirrhein 6/3			173.0	> 5	90.1
					92.7
Uhlwiller 4/1	59.6	> 10			
	60.6	> 10			
Uhlwiller 15/3-1			280.0	> 5	
Uhlwiller 15/3-2			297.0	> 5	
Weitbruch 5/2	48.4	2–9			
	54.5	2–9			
Weissensee-Oberfeld 38/2			185.0	> 5	

1a. Copper-tin binary alloy where lead is an impurity (≤ 1 %).
1b. Copper-tin binary alloy where lead is involuntarily added (< 1 to ≤ 2 %).
2. Copper-tin-lead ternary alloy with a low amount of added lead (< 2 to ≤ 6 %).
3. Copper-lead-tin alloy with a moderate amount of added lead (< 6 to ≤ 10 %), which exceeds tin.
4. Copper-lead-tin alloy with a high amount of added lead (> 10 %), which exceeds tin.

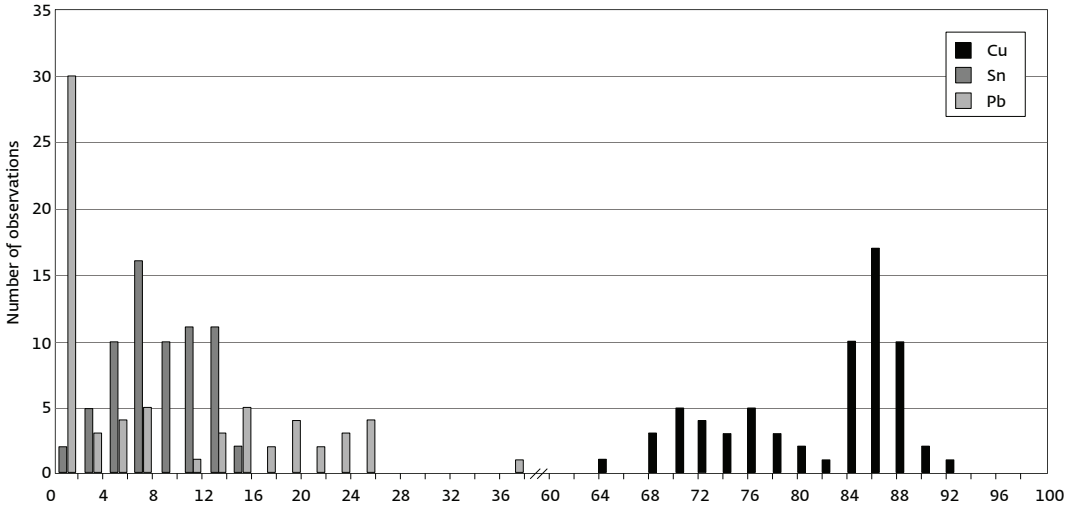
1a and 1b alloys are classical bronzes, made of a binary copper-tin alloy where lead is an impurity or an involuntary addition following recycling. From 2 %, lead can be considered as a voluntary addition, composing ternary alloys; however, it does not replace tin, which keeps a sufficient amount to improve the alloy's properties (hardness, colour etc.). For this reason, type 2, 3 and 4 alloys are considered as leaded bronzes. These chemical composition types

52 Bourgarit/Mille 2014, 107; Mille/Bourgarit 2000, 18; Pernicka 2014, 140.
53 Northover 2009, 352.
54 Op. cit. 353.

Table 3 Summary of analysed objects per type.

Bade-Alsace arm rings (21)			Massive closed rings (43)			Metallurgical remains (3)		
Var. A1	Var. B1	Var. B2	Neck rings	Arm rings	Ankle rings	Ingot	Raw-cast ring	Casting sprue
6	3	12	10	12	21	1	1	1

Diagram 1 Amounts of copper (Cu), tin (Sn) and lead (Pb) in percent.



are related to the tin's distribution: binary alloys are made of 8 % or more, while ternary alloys have less than 8 % tin (diagr. 2). This particularity also tends towards a bronze dilution through an addition of lead to explain ternary alloys.

Typology closely follows the different alloy compositions (fig. 8). Variant A1 of Bade-Alsace arm rings are exclusively made of classical tin-bronzes (1a and 1b types), as is also the casting sprue; two of the three B1 variant arm rings also belong to type 1a, the third one being of type 4. B2 variants have a larger distribution and mainly concern groups 1a, 1b and 2; so, even if lead is added, the chemical composition always keeps tin as the secondary principal component.[55]

On the other hand, many massive closed rings have a high lead content, going up to 36 %, and are mainly distributed between alloy types 3 and 4. They are also found within types 1a, 1b and 2, indicating the great variability of materials. An interesting detail is the clustering of notched ankle rings in type 4; the use of a distinct material to make these notched rings tends to confirm their status as a morphological variant, rather than the relation of these notches to an abrasion phenomenon.

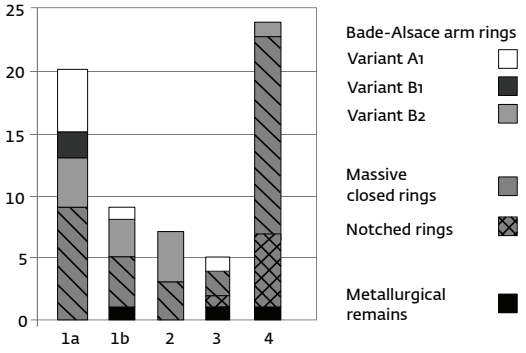
The ingot and raw-cast ring fragments from the Britzgyberg also belong to types 3 and 4.

A chronological evolution can be seen into this scheme, which needs to be confirmed using a greater number of samples from different object types. Ornaments dating to Ha C2 and Ha D1 (Bade-Alsace arm rings and some massive closed rings) have a more classical chemical composition, where lead content is rarely more than 6 % and never exceeds that of tin. On the contrary, the largest group of leaded bronzes includes objects dating to Ha D2 or Ha D3, mainly massive closed rings. Thus, it seems that leaded bronzes could have appeared during the second half of Ha D (6th century BC), although this must be confirmed with further investigations.

A few extreme values complete this pattern. The neck ring from Schirrhein (Dép. Bas-Rhin, F), mound 8 grave 9 (cat. no. 418) has a very low tin content; a foreign origin can be proposed, but needs to be confirmed by the chemical composition analysis of similar or-

55 Except for the arm rings from Birckwald (Dép. Bas-Rhin, F) (cat. nos. 121, 122).

Diagram 2 Object distribution among the alloy types in percent.

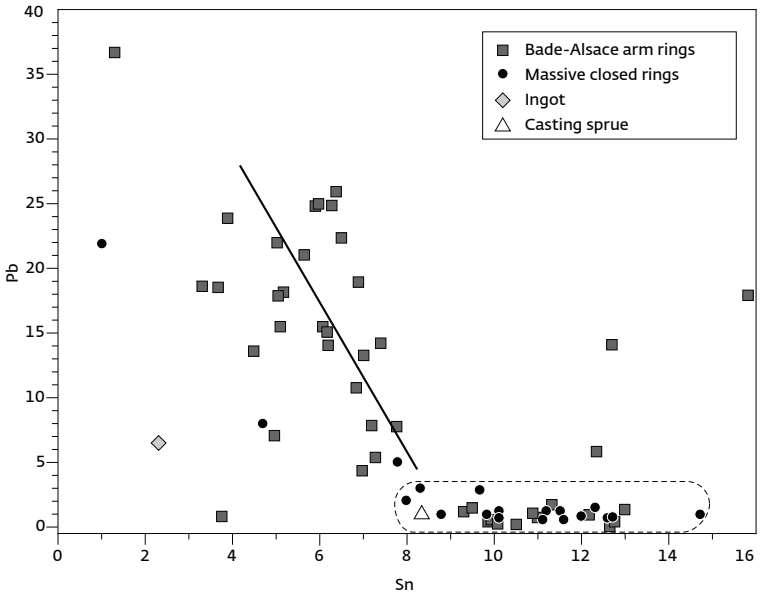


naments from neighbouring regions (Saar, Rhineland-Palatinate, Württemberg or Swiss Plateau). The same goes for the neck ring from Koenigsbruck (Dép. Bas-Rhin, F), mound 12 grave 2 (cat. no. 405), and the closed arm ring from Maegstub, mound 4 grave 3 (cat. no. 211). The Britzgyberg ingot also has an uncommon chemical composition, and its shape is similar to launacian ingot-bars, thus strongly suggesting a foreign provenance.

Leaded bronzes

This phenomenon raises the question of the reasons behind the addition of lead to the alloy. Technical reasons can be proposed, since the addition of lead improves the alloy's fluidity during casting; however, this improvement is not significant beyond 2 %.[56] In higher proportions (10–20 %), lead lowers the melting point, making the *liquidus* of a 10 % tin bronze go down from 1010 °C to approximately 900 °C for a 20 % leaded bronze.[57] There is also little support for the argument that lead was added in order to make the application of incised decoration after casting easier.[58] Indeed, the rings with a high amount of lead are not decorated, while the decorated objects contain low amounts of lead.

One possibility is the changing of the alloy's colour by adding lead. A high amount of lead might give a visual effect similar to silver,[59] which is still rare in the regions north-west of the Alps during the Early Iron Age. Aesthetics would then be one of the reasons for the emergence of this new alloy. However, this visual quality must be discussed: this grey aspect is a thin lead layer, formed by a surface reverse segregation during cooling. This layer is particularly fragile, and wears off quickly; moreover,



8 Compared distribution of tin (Sn) and lead (Pb) in percent.

the result is more of a dull than a shiny finish, far from a silver-effect.

The replacement of tin by lead, as proposed for the Paularo (Friuli-Venezia-Giulia, IT) objects,[60] cannot be applied to the Upper Rhine objects because of the moderate amount of tin in binary and ternary bronzes. This hypothesis has also been revoked for the Iberian Peninsula, where abundant tin resources do not inhibit the production of leaded bronzes, well known since Late Bronze Age.[61]

The addition of lead to bronze in order to increase the material mass, itself originating from bronze recycling, seems more likely here. This hypothesis could explain the significant amount of tin, even in ternary alloys. Thus, this might have been the response to the impoverishment of recycling bronze stocks, by complementing alloys with lead; a similar interpretation has been proposed to explain the high amounts of lead in Late Bronze Age alloys from Great Britain.[62] Leaded bronze would then show deep changes in economic dynamics of bronze metallurgy that take their roots in the availability of primary resources.

3.3 Impurities

Trace elements used to characterize metal are sulphur (S), iron (Fe), cobalt (Co), nickel (Ni), arsenic (As), silver (Ag), antimony (Sb), phosphor (P) and bismuth (Bi) (tab. 6).[63] Correlation tables (Pearson method) show a joint working of nickel, arsenic, silver and antimony with copper, confirming their role as copper impurities.[64]

56 Northover 2009, 352.
57 Villars et al. 1995, 637.
58 Mille/Bourgarit 2003, 262.
59 Schwab 2014, 179.
60 Giumlia-Mair et al. 2003, 161.
61 Montero et al. 2003, 45 f.
62 Northover 1981, 218.
63 As phosphor and bismuth are represented in less than ten objects, they will not be presented in detail.
64 Rychner/Kläntschi 1995, 13.

Table 4 PIXE results obtained on the Early Iron Age ring ornaments of the Upper Rhine Valley, in weight percent. Levels below the detection limit are written in italic. Mg, Al, Si, Cl, K, Ca, Ti, V, Cr, Sr and Zr are not reported (if present, they originate from the soil). Lines in

Site	Cat. no.	Sample no.	Object type	Cu	Sn	Pb	P	S	Mn
Birckwald	121	H1	Baden-Alsace arm ring variant B2	89.7	7.97	2.08	*< 0.021*	0.26	*< 0.0058*
	122	H2	Baden-Alsace arm ring variant B2	74.1	1.02	21.90	0.16	*< 0.36*	*< 0.0064*
Bourgheim	265	S6	Massive closed notched ankle ring	77.3	6.04	15.40	*< 0.054*	*< 0.25*	*< 0.0022*
	266	S7	Massive closed notched ankle ring	72.8	6.24	24.90	*< 0.045*	*< 0.21*	*< 0.0025*
Donauberg 6/2	397	H14	Massive closed neck ring	89.6	10.50	0.16	*< 0.060*	*< 0.5*	*< 0.27*
	282	H16	Massive closed notched ankle ring	75.2	5.62	21.10	*< 0.13*	*< 0.46*	*< 0.034*
	283	H17	Massive closed notched ankle ring	78.8	6.23	14.10	*< 0.053*	*< 0.25*	*< 0.012*
Endingen am Kaiserstuhl	12	F1	Baden-Alsace arm ring variant A1	87.5	12.60	0.75	*< 0.021*	0.33	*< 0.0055*
	13	F2	Baden-Alsace arm ring variant A1	88.0	12.70	0.73	*< 0.025*	0.49	*< 0.0063*
Haguenau	137	M1	Baden-Alsace arm ring variant B2	88.7	10.10	1.24	*< 0.038*	0.41	*< 0.0052*
	138	M2	Baden-Alsace arm ring variant B2	87.8	11.50	1.32	*< 0.018*	0.41	*< 0.0043*
Harthouse 5/1	399	H10	Massive closed neck ring	72.5	6.37	26.00	0.077	*< 0.37*	*< 0.006*
	295	H8	Massive closed ankle ring	69.6	5.98	24.90	*< 0.033*	*< 0.36*	*< 0.0039*
	296	H9	Massive closed ankle ring	70.8	5.01	22.10	*< 0.026*	*< 0.4*	*< 0.012*
Harthouse 10/1	178	H6	Massive closed arm ring	68.8	5.89	24.70	*< 0.028*	*< 0.3*	*< 0.0069*
	179	H7	Massive closed arm ring	72.8	5.16	18.10	*< 0.13*	*< 0.38*	*< 0.015*
Harthouse 12/6	400	H11	Massive closed neck ring	69.8	6.91	19.00	*< 0.023*	*< 0.3*	*< 0.0086*
Harthouse 12/7	180	H12	Massive closed arm ring	85.2	11.00	0.69	*< 0.011*	0.22	*< 0.0075*
	181	H13	Massive closed arm ring	88.0	9.90	0.62	*< 0.027*	0.25	*< 0.0042*
Heidolsheim	95	S1	Baden-Alsace arm ring variant B1	85.9	4.70	8.00	*< 0.035*	*< 0.11*	*< 0.0031*
	22	S5	Baden-Alsace arm ring variant A1	85.9	11.20	1.30	*< 0.036*	0.27	*< 0.0052*
Hochfelden	141	S2	Baden-Alsace arm ring variant B2	87.2	7.77	5.00	*< 0.024*	*< 0.1*	*< 0.0053*
Hügelsheim	35	K2	Baden-Alsace arm ring variant A1	28.7	25.20	4.25	15.2	0.69	0.21
Ihringen	36	R1	Baden-Alsace arm ring variant A1	85.9	12.60	0.71	*< 0.026*	0.31	*< 0.0063*
Ihringen – Löhbücke	142	R3	Baden-Alsace arm ring variant B2	80.7	12.70	0.74	*< 0.039*	0.42	*< 0.0048*
	143	R4	Baden-Alsace arm ring variant B2	87.1	9.65	2.85	*< 0.029*	0.37	*< 0.0019*
	144	R6	Baden-Alsace arm ring variant B2	86.3	8.32	2.98	*< 0.03*	0.39	*< 0.0078*
	305	R2	Massive closed ankle ring	70.6	12.70	14.00	*< 0.047*	*< 0.26*	*< 0.0047*
Ihringen – Löhbücke Z	303	R5	Massive closed ankle ring	85.1	11.30	1.61	*< 0.013*	0.15	*< 0.0055*
Illfurth area 48, US 219 or 220,	306	M6	Raw-cast ankle ring	71.6	15.80	17.80	*< 0.04*	*< 0.27*	*< 0.0072*
Illfurth area 6 and 9, US 36	–	M7	Casting sprue	90.6	8.34	1.02	*< 0.012*	0.099	*< 0.0025*
Illfurth area6 and 9, US 39 or 40	–	M5	Ingot	89.2	2.30	6.47	0.085	*< 0.16*	< 0.0015
Koenigsbruck 12/2	405	H15	Massive closed neck ring	84.7	12.30	5.85	*< 0.060*	*< 0.5*	< 0.010
Koenigsbruck 18/1	193	H18	Massive closed arm ring	85.5	11.00	0.91	*< 0.025*	*< 0.12*	< 0.007
	194	H19	Massive closed arm ring	87.5	9.24	1.21	*< 0.028*	0.17	< 0.003
	322	H20	Massive closed ankle ring	89.3	9.95	0.69	*< 0.013*	0.25	< 0.0051
	323	H21	Massive closed ankle ring	88.1	9.99	0.63	*< 0.02*	0.34	*< 0.0051*
Koenigsbruck 18/5	147	H4	Baden-Alsace arm ring variant B2	86.1	11.10	0.64	*< 0.02*	*< 0.09*	*< 0.0034*
	148	H5	Baden-Alsace arm ring variant B2	86.5	11.60	0.64	*< 0.03*	*< 0.055*	*< 0.0033*
Maegstub 1/1	195	H22	Massive closed arm ring	85.4	13.00	1.35	*< 0.072*	0.37	*< 0.011*
	326	H23	Massive closed ankle ring	86.6	12.70	0.26	*< 0.022*	0.41	*< 0.0043*

dark grey and white letters correspond to analyses where several of these elements were detected at high level (coming from the corrosion products). The numbers behind the site names refer to the mound/grave.

Fe	Co	Ni	Zn	As	Se	Ag	Cd	In	Sb	Te	Au	Hg	Bi
0.006	0.027	0.38	< 0.011	0.45	< 0.0059	0.37	< 0.021	< 0.022	1.05	< 0.031	< 0.021	< 0.042	< 0.027
< 0.0024	< 0.0044	0.78	< 0.029	1.02	< 0.015	0.83	< 0.012	< 0.011	1.49	< 0.023	< 0.051	< 0.075	< 0.18
0.013	0.023	0.17	< 0.046	0.42	< 0.017	0.19	< 0.011	< 0.016	0.22	< 0.019	< 0.055	< 0.065	< 0.22
0.018	0.025	0.23	< 0.029	0.49	< 0.021	0.29	< 0.016	< 0.01	0.42	< 0.02	< 0.072	< 0.08	< 0.34
0.026	< 0.05	0.074	< 0.039	0.17	< 0.0068	0.066	< 0.01	< 0.027	0.1	< 0.04	< 0.024	< 0.03	< 0.012
< 0.0028	< 0.05	0.057	< 0.057	0.3	< 0.023	0.084	< 0.037	< 0.043	< 0.034	< 0.053	< 0.16	< 0.087	< 0.27
< 0.0028	< 0.0039	0.05	< 0.05	0.33	< 0.0078	0.088	< 0.022	< 0.033	0.092	< 0.038	< 0.08	< 0.079	< 0.091
0.083	< 0.0096	0.11	< 0.025	0.045	< 0.0081	0.054	< 0.014	< 0.013	0.1	< 0.02	< 0.016	< 0.021	< 0.022
0.082	< 0.0094	0.12	< 0.024	0.056	< 0.0066	0.058	< 0.021	< 0.0096	0.088	< 0.032	< 0.023	< 0.016	< 0.015
0.013	0.059	0.36	< 0.0093	0.3	< 0.0081	0.26	< 0.019	< 0.02	0.51	< 0.017	< 0.011	< 0.033	< 0.03
0.01	0.049	0.36	< 0.032	0.29	< 0.0055	0.28	< 0.016	< 0.019	0.64	< 0.019	< 0.012	< 0.051	< 0.031
0.042	< 0.0086	0.061	< 0.067	0.2	< 0.025	0.11	< 0.019	< 0.026	< 0.062	< 0.031	< 0.11	< 0.026	< 0.23
< 0.0014	< 0.0094	0.054	< 0.078	0.21	< 0.04	0.11	< 0.021	< 0.024	< 0.051	< 0.042	< 0.12	< 0.067	< 0.14
0.034	< 0.014	0.1	< 0.054	0.23	< 0.038	0.093	< 0.031	< 0.025	< 0.097	< 0.055	< 0.12	< 0.06	< 0.27
0.010	< 0.0045	0.077	< 0.089	0.15	< 0.019	0.1	< 0.021	< 0.012	0.14	< 0.02	< 0.06	< 0.07	< 0.23
0.059	< 0.01	0.19	< 0.094	0.17	< 0.037	0.086	< 0.02	< 0.035	< 0.087	< 0.045	< 0.12	< 0.096	< 0.11
0.013	< 0.016	0.058	< 0.076	0.18	< 0.018	0.082	< 0.02	< 0.016	< 0.059	< 0.046	< 0.06	< 0.079	< 0.21
0.043	< 0.0099	0.085	< 0.052	0.091	< 0.0072	0.11	< 0.023	< 0.033	0.12	< 0.044	< 0.024	< 0.017	< 0.021
0.076	< 0.014	0.13	< 0.048	0.14	< 0.0092	0.088	< 0.028	< 0.032	< 0.08	< 0.021	< 0.027	< 0.045	< 0.02
0.009	< 0.011	0.49	< 0.031	0.55	< 0.012	0.47	< 0.0094	< 0.014	0.98	< 0.017	< 0.033	< 0.051	< 0.085
0.036	0.015	0.26	< 0.02	0.19	< 0.0075	0.34	< 0.013	< 0.017	0.52	< 0.01	< 0.041	< 0.022	< 0.028
0.006	0.016	0.41	< 0.03	0.47	< 0.0095	0.4	< 0.019	< 0.014	0.59	< 0.019	< 0.027	< 0.044	< 0.062
0.54	< 0.015	0.16	0.1	0.78	< 0.024	1.78	< 0.057	< 0.069	0.73	< 0.086	< 0.14	< 0.12	< 0.13
0.31	< 0.0096	0.14	< 0.08	0.2	< 0.0055	0.14	< 0.022	< 0.04	0.24	< 0.047	< 0.046	< 0.04	< 0.04
0.022	< 0.0064	0.2	< 0.11	0.2	< 0.0049	0.13	< 0.024	< 0.036	0.26	< 0.054	< 0.031	< 0.059	< 0.021
0.1	0.046	0.48	< 0.097	0.5	< 0.0091	0.4	< 0.026	< 0.034	0.84	< 0.047	< 0.038	< 0.061	< 0.071
0.1	0.046	0.47	< 0.07	0.48	< 0.017	0.35	< 0.028	< 0.015	0.84	< 0.058	< 0.072	< 0.11	< 0.073
< 0.0029	< 0.016	0.14	< 0.037	0.19	< 0.022	0.1	< 0.022	< 0.035	0.13	< 0.055	< 0.11	< 0.034	< 0.17
0.1	0.024	0.2	< 0.092	0.32	< 0.011	0.21	< 0.027	< 0.01	0.3	< 0.052	< 0.068	< 0.04	< 0.074
< 0.0018	< 0.0058	0.092	< 0.051	0.19	< 0.02	0.12	< 0.019	< 0.016	0.13	< 0.03	< 0.068	< 0.035	< 0.16
0.031	0.018	0.2	< 0.027	0.25	< 0.0025	0.15	< 0.0088	< 0.01	0.25	< 0.023	< 0.0087	< 0.044	0.083
0.005	< 0.012	0.59	< 0.013	0.72	< 0.004	0.67	< 0.0076	< 0.015	1.27	< 0.018	< 0.035	< 0.06	< 0.08
0.19	< 0.01	0.06	< 0.073	0.26	< 0.011	0.095	< 0.032	< 0.018	0.11	< 0.019	< 0.032	< 0.049	< 0.065
0.11	0.023	0.12	< 0.07	0.15	< 0.007	0.12	< 0.0093	< 0.031	0.2	< 0.047	< 0.032	< 0.05	< 0.028
0.077	0.027	0.19	< 0.077	0.24	< 0.0032	0.12	< 0.023	< 0.022	0.21	< 0.039	< 0.012	< 0.035	< 0.04
0.023	0.017	0.089	< 0.0056	0.092	< 0.0075	0.097	< 0.019	< 0.032	0.11	< 0.037	< 0.025	< 0.027	< 0.027
0.025	0.019	0.092	< 0.07	0.1	< 0.013	0.11	< 0.025	< 0.026	0.14	< 0.048	< 0.039	< 0.042	< 0.023
0.019	0.017	0.55	< 0.0084	0.59	< 0.0028	0.59	< 0.014	< 0.018	1.14	< 0.016	< 0.029	< 0.045	< 0.014
0.023	0.016	0.47	< 0.063	0.66	< 0.0078	0.61	< 0.028	< 0.026	1.09	< 0.051	< 0.045	< 0.06	< 0.023
0.043	< 0.012	< 0.037	< 0.089	0.075	< 0.013	0.068	< 0.03	< 0.049	< 0.065	< 0.068	< 0.052	< 0.018	< 0.023
0.061	< 0.0065	< 0.012	< 0.094	0.049	< 0.011	0.071	< 0.026	< 0.031	< 0.043	< 0.013	< 0.041	< 0.026	< 0.024

Table 4 (continued)

Site	Cat. no.	Sample no.	Object type	Cu	Sn	Pb	P	S	Mn
Maegstub 2/2	201	H24	Massive closed arm ring	70.8	3.91	24.00	*< 0.072*	*< 0.38*	*< 0.006*
	202	H25	Massive closed arm ring	87.8	9.49	1.50	*< 0.03*	0.23	*< 0.0034*
Maegstub 4/1	207	H26	Massive closed arm ring	77.3	5.10	15.40	*< 0.064*	*< 0.31*	*< 0.0062*
	335	H27	Massive closed ankle ring	75.1	7.01	13.30	*< 0.017*	*< 0.19*	*< 0.0062*
	336	H28	Massive closed ankle ring	73.8	6.11	14.90	0.11	*< 0.29*	*< 0.0021*
Maegstub 4/3	211	H29	Massive closed arm ring	64.5	1.32	36.60	0.19	*< 0.49*	*< 0.0043*
	337	H30	Massive closed notched ankle ring	78.1	5.16	17.90	*< 0.08*	*< 0.33*	*< 0.006*
	338	H31	Massive closed notched ankle ring	79.0	4.51	13.60	*< 0.043*	*< 0.23*	*< 0.0035*
Maegstub 20/1	219	H32	Massive closed arm ring	76.4	3.34	18.50	0.11	*< 0.31*	*< 0.0022*
	220	H33	Massive closed arm ring	77.3	3.71	18.50	*< 0.095*	*< 0.36*	*< 0.0077*
	345	H34	Massive closed notched ankle ring	84.9	7.77	7.75	*< 0.054*	*< 0.17*	*< 0.0053*
	346	H35	Massive closed ankle ring	81.6	6.87	10.70	*< 0.036*	*< 0.25*	*< 0.0028*
	411	H36	Massive closed neck ring	76.8	7.41	14.20	*< 0.037*	*< 0.27*	*< 0.0042*
Mommenheim	154	S3	Baden-Alsace arm ring variant B2	88.5	9.84	1.00	*< 0.029*	0.15	*< 0.0049*
Mulhouse	103	M3	Baden-Alsace arm ring variant B1	87.1	12.00	0.82	*< 0.039*	0.27	*< 0.0026*
	104	M4	Baden-Alsace arm ring variant B1	89.2	10.10	0.71	*< 0.023*	0.26	*< 0.0037*
Nonnenweier	358	F3	Massive closed ankle ring	88.3	4.99	7.12	*< 0.015*	*< 0.12*	*< 0.0056*
	359	F4	Massive closed ankle ring	87.8	7.26	5.28	*< 0.03*	*< 0.17*	*< 0.0076*
	359	F4bis	Massive closed ankle ring	88.4	6.96	4.30	*< 0.031*	*< 0.11*	*< 0.0048*
Ohlungen 3/16	368	H38	Massive closed neck ring	71.0	6.49	22.30	*< 0.062*	*< 0.31*	*< 0.0056*
Rosheim	47	S4	Baden-Alsace arm ring variant A1	91.4	8.80	0.99	*< 0.016*	0.77	*< 0.0038*
Scherzheim	161	K1	Baden-Alsace arm ring variant B2	86.3	12.30	1.57	0.12	0.15	*< 0.0028*
Schirrhein – Fischerh. Kurzgeland 1/4	417	H37	Massive closed neck ring	84.3	12.10	0.97	0.071	*< 0.047*	*< 0.0052*
Schirrhein – Fischerh. Kurzgeland 8/9	418	H39	Massive closed neck ring	92.9	3.77	0.81	*< 0.04*	*< 0.059*	*< 0.0059*
Schirrhein – Fischerh. Kurzgeland 9/1	60	H40	Baden-Alsace arm ring variant A1	86.6	14.70	1.01	*< 0.032*	0.47	*< 0.005*
Schirrhein – Schirrheinerweg 6/3	419	H3	Massive closed neck ring	83.3	7.16	7.94	*< 0.028*	*< 0.2*	*< 0.0035*
Söllingen II/1	163	K3	Baden-Alsace arm ring var. B2	37.9	3.48	45.2	1.32	1.42	< 0.01
Weissensee-Oberfeld 38/2	423	H41	Massive closed neck ring	86.1	12.7	0.65	< 0.034	0.33	< 0.0091

Variations in nickel, arsenic, silver and antimony are visible according to object types (fig. 9). Bade-Alsace arm rings of A1 variant contain low and homogeneous amounts of impurities; on the contrary, B2 variants contain higher and more dispersed amounts, in particular of antimony. The three B1 arm rings belong to a similar range, but with a tendency towards low values. Mean values of (impurities in) massive closed rings are also low and are close to those found in the A1 variant, but keep a wider dispersion. The Britzgyberg metallurgical specimens are also interesting in comparison. The raw-cast ring and the casting sprue contain low amounts of nickel, arsenic, silver and antimony, a fact which brings them closer to A1 variant and closed rings, while the ingot fragment is quite isolated because of its high nickel, arsenic and silver content.

A second but more discrete positive correlation is between sulphur, iron and cobalt (fig. 10). A1 variants are characterized by higher amounts of sulphur and iron, while closed rings, the raw-cast ring and the casting sprue have extremely low values. The Bade-Alsace B2 variant has a wider dispersion, and the B1 variant can be distinguished by low iron and cobalt values. The singularity of the ingot fragment in this sample is once more visible, through its high content of cobalt and iron.

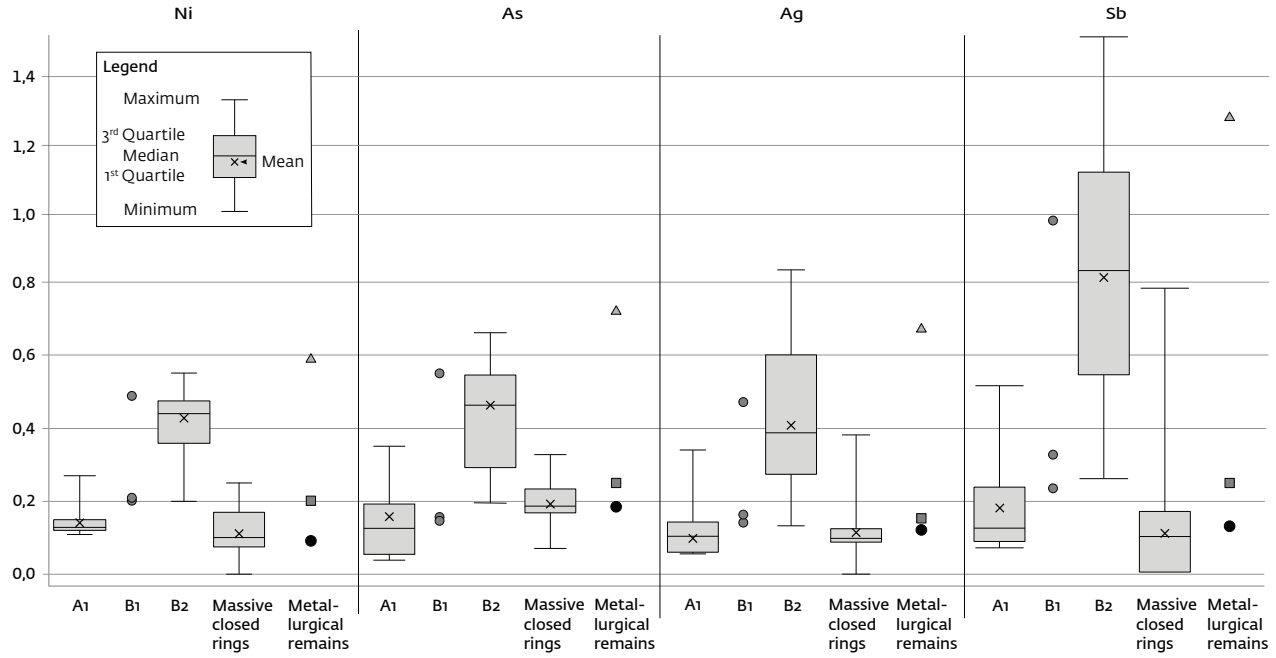
Fe	Co	Ni	Zn	As	Se	Ag	Cd	In	Sb	Te	Au	Hg	Bi
< 0.0036	< 0.0052	0.086	< 0.059	0.19	< 0.04	0.09	< 0.016	< 0.01	0.1	< 0.032	< 0.12	< 0.063	< 0.14
0.1	< 0.018	0.23	< 0.093	0.17	< 0.014	0.077	< 0.026	< 0.03	< 0.069	< 0.028	< 0.047	< 0.033	< 0.031
0.036	< 0.0037	0.07	< 0.06	0.18	< 0.013	0.1	< 0.022	< 0.023	< 0.087	< 0.034	< 0.062	< 0.066	< 0.17
0.063	< 0.012	0.14	< 0.056	0.21	< 0.016	0.091	< 0.019	< 0.024	< 0.024	< 0.027	< 0.048	< 0.059	< 0.15
0.057	< 0.013	0.17	< 0.054	0.19	< 0.027	0.094	< 0.021	< 0.014	0.073	< 0.041	< 0.089	< 0.065	< 0.16
0.016	< 0.009	0.15	< 0.054	0.086	< 0.024	< 0.03	< 0.016	< 0.0065	< 0.019	< 0.037	< 0.11	< 0.037	< 0.29
< 0.003	< 0.011	0.093	< 0.078	0.17	< 0.018	0.099	< 0.019	< 0.023	< 0.073	< 0.021	< 0.059	< 0.044	< 0.19
0.01	< 0.01	0.093	< 0.059	0.19	< 0.015	0.093	< 0.017	< 0.0082	< 0.073	< 0.043	< 0.052	< 0.042	< 0.15
< 0.0032	< 0.004	0.067	< 0.074	0.19	< 0.019	0.1	< 0.016	< 0.02	0.1	< 0.035	< 0.052	< 0.077	< 0.2
< 0.0017	< 0.0087	0.088	< 0.058	0.23	< 0.057	0.081	< 0.02	< 0.02	< 0.037	< 0.023	< 0.15	< 0.096	< 0.23
< 0.0062	< 0.013	0.18	< 0.057	0.22	< 0.033	0.093	< 0.026	< 0.024	0.13	< 0.045	< 0.092	< 0.067	< 0.12
< 0.0039	< 0.015	0.18	< 0.074	0.2	< 0.015	0.072	< 0.026	< 0.025	0.15	< 0.048	< 0.13	< 0.053	< 0.16
0.051	< 0.0068	0.1	< 0.049	0.22	< 0.02	0.086	< 0.02	< 0.022	0.11	< 0.036	< 0.045	< 0.063	< 0.16
0.054	0.017	0.47	< 0.045	0.45	< 0.0051	0.64	< 0.015	< 0.016	1.15	< 0.026	< 0.021	< 0.038	< 0.018
0.009	< 0.01	0.21	< 0.031	0.15	< 0.0045	0.16	< 0.02	< 0.015	0.33	< 0.023	< 0.031	< 0.021	< 0.015
0.011	< 0.014	0.21	< 0.034	0.16	< 0.0057	0.14	< 0.019	< 0.021	0.24	< 0.027	< 0.012	< 0.033	< 0.022
0.007	0.017	0.17	< 0.016	0.18	< 0.007	0.15	< 0.011	< 0.0024	0.21	< 0.0097	< 0.025	< 0.039	< 0.045
0.049	< 0.017	0.16	< 0.048	0.27	< 0.0075	0.18	< 0.0094	< 0.021	0.17	< 0.03	< 0.028	< 0.044	< 0.034
0.044	0.016	0.16	< 0.024	0.2	< 0.0032	0.15	< 0.016	< 0.005	0.23	< 0.016	< 0.011	< 0.041	< 0.022
< 0.0067	< 0.0024	0.088	< 0.066	0.18	< 0.02	0.08	< 0.022	< 0.018	< 0.033	< 0.02	< 0.062	< 0.068	< 0.21
0.073	< 0.01	0.12	< 0.0088	0.069	< 0.0054	0.081	< 0.014	< 0.021	0.072	< 0.03	< 0.028	< 0.03	< 0.03
0.008	0.017	0.18	< 0.088	0.22	< 0.0083	0.14	< 0.021	< 0.029	0.27	< 0.041	< 0.036	< 0.034	< 0.044
0.12	0.024	0.14	< 0.069	0.38	< 0.0076	0.2	< 0.018	< 0.031	0.24	< 0.048	< 0.029	< 0.075	< 0.076
< 0.0028	< 0.014	0.25	< 0.11	0.35	< 0.008	0.38	< 0.021	< 0.026	0.79	< 0.038	< 0.035	< 0.091	0.11
0.006	< 0.006	0.15	< 0.014	0.35	< 0.0076	0.12	< 0.022	< 0.02	0.15	< 0.027	< 0.032	< 0.056	< 0.049
0.084	< 0.021	0.25	< 0.087	0.24	< 0.049	0.14	< 0.026	< 0.031	0.17	< 0.024	< 0.16	< 0.068	< 0.14
0.1	< 0.016	0.07	< 0.12	0.62	< 0.083	0.88	< 0.039	< 0.061	0.79	< 0.089	< 0.25	< 0.3	< 0.23
0.31	< 0.01	0.18	< 0.065	0.19	< 0.0095	0.14	< 0.032	< 0.048	0.3	< 0.076	< 0.023	< 0.048	< 0.049

3.4 Results synthesis

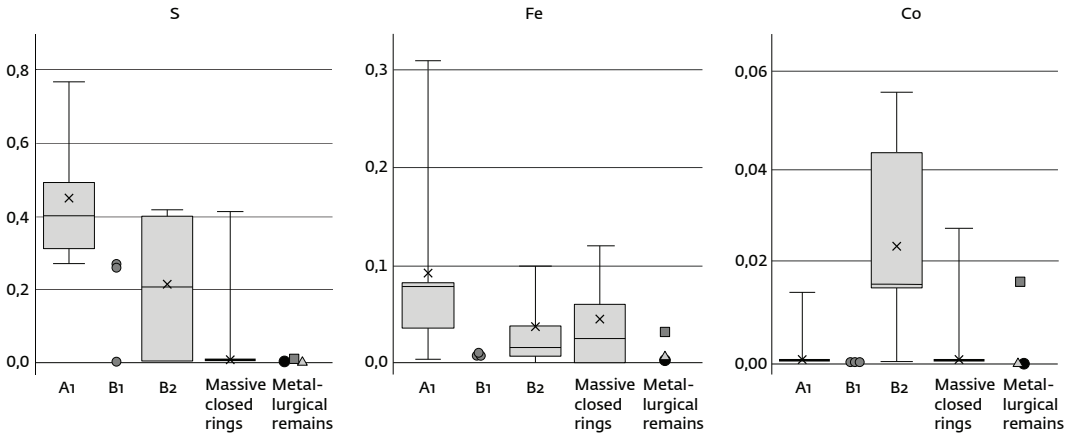
The archaeometallurgical characterization of the objects shows clear variations of the materials chemical composition according to typology. Thus, A1 variant arm rings are made by using a type of bronze with few impurities, except for sulphur, following the classical tin-bronze recipe. On the contrary, B2 variants are made with copper issued from a different source than A1, with a varying lead amount which might result from recycling. The B1 variant also belongs to this pattern, but with lower impurities and lead values; this could be due to its statistical under-representation, or due to the use of a cleaner bronze following technical needs for the making of thin foils.

Massive closed rings contain similar amounts of impurities as the A1 variant, except for arsenic and sulphur. Their dispersion is wider, which shows a less severe control of material purity. Lead is the element that distinguishes these ornaments from the other types, along with low sulphur and cobalt values.

Finally, the ingot fragment from the Britzgyberg is totally unique: it is composed of high lead and low tin amounts combined, surprisingly, with high values for nickel, arsenic, silver and antimony. Such a composition of impurities is usually found within objects with low lead content. Therefore, this ingot cannot be directly issued from the recycling of local objects, nor can it represent the direct and exclu-



9 Amounts of nickel (Ni), arsenic (As), silver (Ag) and antimony (Sb) in percent by object types. The Bade-Alsace variant B1 arm rings and metallurgical remains are too few to be represented in box-plot charts, and are thus represented by symbols: casting sprue (square), ingot (triangle) and raw-cast ring (circle).



10 Amounts of sulphur (S), iron (Fe) and cobalt (Co) by object types. Metallurgical remains: symbols like fig. 9.

sive source of Upper Rhine metal. This is not the case for the casting sprue and the raw-cast ring, whose chemical composition is similar to the massive closed ring and can thus belong to regional metallurgical traditions.

3.5 European comparisons

Can the metallurgical traditions of the Upper Rhine be compared to other European regions? This approach faces the limited number of analyses for the Early Iron Age, in particular north-west of the Alps (tab. 7). On the Swiss Plateau, ten belt hooks dating to Ha D1 give some comparisons.[65] The mean amount of lead is 1.31 %, associating them closer to Bade-Alsace arm rings; the low values of copper impurities also point in this direction, in particular towards A1 variant. The same goes for the Ha D1 Echallens hoard (Kt. Waadt, CH), except for the socketed axes, which can be related to the production of Atlantic workshops.[66]

A great number of finds from the grave at Vix (Dép. Côte-d'Or, F), dating to the end of the Early Iron Age, has also been analysed.[67] An ankle ring with a pin locking and a neck ring, both made of foil, have a low amount of lead and impurities; this can be explained by technical constraints in foil working, which requires low impurity bronze. This particularity is not shared by cast objects; instead, the cast wagon pieces have 6 to 7.5 % added lead, but without exceeding tin. Unfortunately, the

65 Fasnacht 1996.
66 Rychner 1984, 361.
67 Mille/Bourgarit 2003.

Table 5 Descriptive statistics for the alloy components: copper (Cu), tin (Sn) and lead (Pb).

	Cu	Sn	Pb
Minimum	64.50	1.02	0.16
1st quartile	72.80	5.81	1.00
Median	83.30	7.77	6.68
3rd quartile	87.18	11.45	18.40
Maximum	92.90	15.80	36.60
Mean	82.20	8.45	8.61
Standard deviation	7.13	3.39	9.21

Table 6 Descriptive statistics for the trace elements: sulphur (S), iron (Fe), cobalt (Co), nickel (Ni), arsenic (As), silver (Ag) and antimony (Sb).

	S	Fe	Co	Ni	As	Ag	Sb
Minimum	0	0	0	0	0,05	0	0
1st quartile	0	0,01	0	0,09	0,18	0,09	0,07
Median	0	0,03	0	0,14	0,21	0,12	0,16
3rd quartile	0,31	0,08	0,02	0,2	0,35	0,22	0,4
Maximum	0,77	0,31	0,06	0,78	1,02	0,83	1,49
Mean	0,13	0,04	0,01	0,2	0,26	0,19	0,29
Standard deviation	0,18	0,06	0,01	0,16	0,17	0,17	0,37

naves, nails and plates are still without typological comparisons,[68] making it impossible to relate them to any regional production centre. However, chronological comparisons support the idea of a wider distribution of leaded bronze to the north of the Alps during Iron Age. Indeed, this phenomenon is confirmed during Late Iron Age in Germany, on the Martberg (Lkr. Cochem-Zell, Rhineland-Palatinate) and Manching (Lkr. Pfaffenhoffen an der Ilm, Bavaria) oppida, where cast objects like fibulae can contain up to 31 % lead.[69]

Atlantic production workshops have already benefited from much more research. A synthesis of Ha C bronze swords found in France shows a mean amount of lead around 1.6 %, which rarely exceeds 2 %.[70] This value is relatively high compared to the 1a and 1b alloy types of the Upper Rhine; this difference is due to Atlantic metallurgical traditions in an area going up to the Iberian Peninsula, where lead is added to bronze since Late Bronze Age.[71] At the beginning of the Early Iron Age, lead amounts in cast objects are thus quite high but also highly dispersed, ranging from 0.05 to 25 % for the Poitou hoards;[72] lead amounts are more extreme for armorican axes, with a mean value of 28.35 % and a maximum of 99 %.[73] This tradition of leaded bronzes does not seem to extend to south-western France. Recent analyses on launacian objects rather reveal lead amounts around 1 %, the only objects exceeding this threshold having a foreign provenance.[74]

In the Eastern Alps metallurgical traditions were different to those in northern and western (alpinic) regions. Lead amounts are low, in continuity with Bronze Age metallurgy. Objects from the Fließ (Tyrol, AT) hoard and the Bischofshofen (Salzburg, AT) graveyard thus rarely exceed 2 % amount of lead.[75] On the contrary, metallurgical traditions to the south-east of the Alps show a low to moderate addition of lead, from the beginning of the Early Iron Age (onwards?). Thus, in Most na Soči (Goriška, SI), the major part of the objects has lead values

Table 7 Descriptive statistics for the trace elements: sulphur (S), iron (Fe), cobalt (Co), nickel (Ni), arsenic (As), silver (Ag) and antimony (Sb).

Region	Objects	Cu	Sn	Pb
Regions north-west of the Alps	Swiss Plateau belt hooks	79.41	18.30	1.31
	Vix grave (F): ring ornaments	86.56	11.60	0.26
	Vix grave (F): wagon pieces	85.81	9.52	4.19
Atlantic regions	Early Iron Age swords from France	87.31	9.34	1.57
	Various cast objects from Poitou region (F)	82.25	10.76	4.69
	Atlantic socketed axes	59.99	5.14	28.35
Launacian domain	Échallens hoard (CH), except ingots	88.67	9.18	1.76
Eastern Alps	Fliess hoard (AT)	–	9–10	< 2
	Bischofshofen (AT): cast objects	88.05	8.69	0.68
South-eastern Alps	Paularo (IT): cast objects	87.91	7.81	2.65
	Most na Soči (SI): cast objects	84.98	9.35	2.38
Western Mediterranean	Etruscan cast objects from Archaic era	87.71	7.96	3.76
	Etruscan cast objects from 5th century	85.68	9.56	4.22
	Vix grave (F): basin cast handles	85.86	8.63	5,00
	Etruscan cast objects from 4th to 2nd century	82.61	8.80	8.10
	Cast objects from Sardinia from 5th to 3rd century	85.02	10.53	3.32
	Vix graves (F): cast pieces from vase	89.43	9.70	0.39
Various origins	Arbedo hoard (CH): cast objects	80.51	9.25	9.10

68 Egg et al. 2003, 71 f.
69 Schwab 2011, 271; 2014, 177.
70 Vuaillat 1987.
71 Véber et al. 2003; Montero et al. 2003, 45 f.
72 Briard/Bourhis 1977.
73 Briard et al. 1998.
74 Mille/Artioli 2017, 133–135.

ranging between 3 and 15 %; a deliberate alloy variation is visible on Santa Lucia type fibulae, whose chemical composition varies according to the ornament's part.[76] Similar lead amounts are known in the Paularo graveyard,[77] as well as in cast objects from the Arbedo (Kt. Tessin, CH) hoard.[78] Besides, in Paularo, local objects can be distinguished by the use of high impurity copper and a high percentage of added lead, maybe in order to replace tin, which is present in relatively low amounts (7 %).

An increase in lead content also characterizes Mediterranean traditions since the Archaic era: Cast objects and Etruscan statues have a mean lead amount between 3 and 4 %, which rises to 8 % from the 4th century onwards. The emergence of leaded bronzes can be traced back to the 7th century in Greece and, more discretely, in Sardinia.[79] This phenomenon is thus one century older than the 'new' metallurgical tradition of the Upper Rhine, which poses the question of the dynamics lying behind this evolution.

On an European scale, lead has fulfilled several functions in copper alloys. It appears quite early as an alloy component in the Atlantic regions, as early as Late Bronze Age, with sometimes extreme values. To the south-east of the Alps and in the Mediterranean, lead takes a more important place in metallurgical traditions since the 7th century; the Upper Rhine seems to be concerned by this phenomenon later, during the 6th century. Nonetheless, this chronological tendency is still to be confirmed by a greater number of analyses; moreover, the gap of research in eastern France and western Alps needs to be filled, in order to fully understand the extension of this metallurgical tradition.

4 TWIN COMPOSITIONS (IN COLLABORATION WITH BENOÎT MILLE)

4.1 Method and limits

In order to search for potential composition and fabrication relationships between the objects, several association levels have been tested: objects composing a pair, different objects from the same grave, objects from the same cemetery and different graves, and isolated objects. Then, the previous typology of elemental compositions has been completed by the search for twin compositions, which can bring to light production relationships between some objects, manufactured during the same casting (crucible twins) or using the same copper ingot (ingot twins). This approach has already produced interesting results on Swiss and Lorraine objects.[80] Indeed, some objects have a partially or totally identical chemical composition, which can be explained by the hypothesis of kinship dating back to one of the fabrication steps. Therefore, ingot twins have similar amounts of copper impurities, and thus might have been made using the same copper ingot. When this similarity extends to the alloy components (Sn, Pb), the hypothesis also implies the exact same addition of tin and lead to the recipe, and thus the same casting, making them crucible twins.[81]

Unlike the original method proposed by Valentin Rychner and Klaus Kläntschi in 1995,[82] multivariate statistical analyses have been used to measure similarity between the objects. This research is systematic, as every possible pair is tested, and gives a more reliable degree of similarity. The protocol is based on a hierarchical clustering of standardized chemical composition data, in order to give the same statistical weight to every chemical element. The Ward aggregation method has been preferred because of its highly discriminating potential, using the Euclidean distance to calculate the similarity between two objects. The search for twin compositions has first been made on the nine detected impurities (for ingot twins), to which tin and lead were added later on (crucible twins). Even with a strict similarity limit (Euclidean distance ≤ 1), many crucible twins can be seen within the clustering, and a lot more ingot twins. The great number of crucible twins has important archaeological implications, among which is the strict contemporaneity of the concerned objects. However, this approach only works via negative results: i. e. only different chemical compositions can confirm that two objects are not twins. So, to correctly test this possibility, it is necessary to increase the range of analysed chemical elements, and to use more sensitive and precise techniques, in order to get more reliable results. The comparisons would indeed be much more solid using 30 chemical elements, which means including elements present in very low amounts, instead of only nine impurities and two alloy components. The following interpretations are thus to be considered as the first step in a bigger project to be further pursued, given the great number of positive correlations.

75 Lutz/Schwab 2014; Northover 2009.
76 Giumlia-Mair 1995, 67.
77 Giumlia-Mair et al. 2003.
78 Northover 1998.
79 Craddock 1986; Hoppe/Schwab 2016.
80 Rychner/Kläntschi 1995, 64; Véber 2009, 113.
81 Rychner/Kläntschi 1995, 30.
82 Calculation of the variation coefficient of each chemical element, for each object pair.

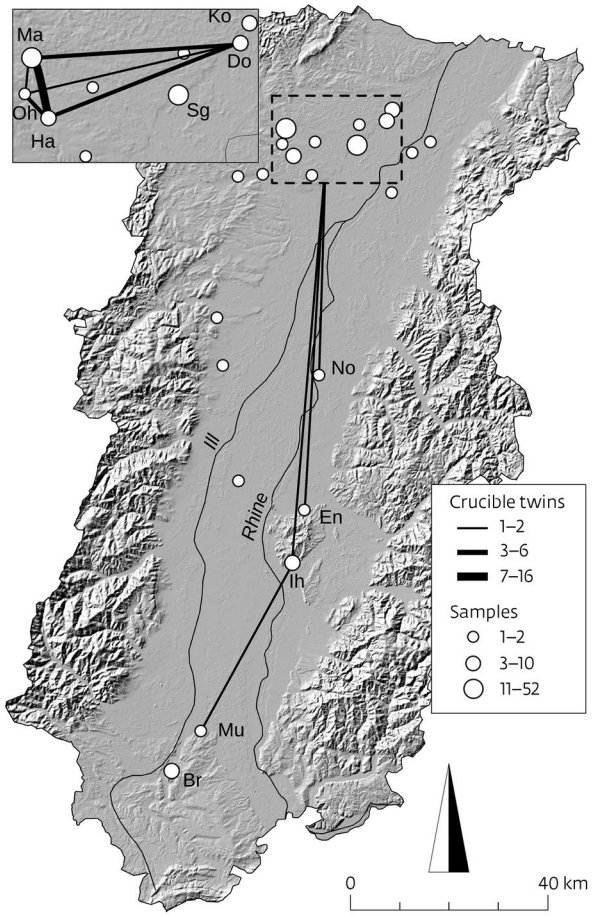
4.2 Results

It comes to no surprise that archaeological pairs are also crucible twins. This first result confirms the strong unity of ornaments with similar shape, and supports the idea of their simultaneous fabrication. Moreover, the distance matrix indicates that the chosen statistical threshold is probably too strict in some cases, since many identical objects from the same pair were being excluded on account of decimals. But, in the actual state of the art, this low threshold is still better than any false classification of unrelated objects as twins.[83]

But, except for object pairs, crucible twins are rarely found within the same grave: neck, arm and ankle rings of an individual were made in separate castings and made use of different ingots, testifying that the costume was only constituted gradually rather than on a single occasion. Grave 1 from mound 1 and grave 1 from mound 4 in Maegstub are exceptions, where arm and ankle rings (cat. nos. 195, 326, 207, 208, 335, 336) had been issued from the same casting, while the neck, arm and ankle rings from mound 20, grave 1 (cat. nos. 219, 220, 345, 346, 411) were eventually made from the same ingot.

Within a cemetery, crucible twins can be distributed between many graves; the phenomenon has also been observed between cemeteries, the Haguenau cemeteries in particular but also across the whole Upper Rhine Valley, where ingot twins from the graves of Ihringen and Nonnenweier (fig. 11) add to the high homogeneity of material culture. The raw-cast ankle ring fragment from the Britzgyberg (cat. no. 306) is particularly interesting in this respect, as it shares a similar copper with the Haguenau specimens, despite the large distance (150 km) between the two sites; nonetheless the amounts of tin and lead differ enough to exclude the possibility of crucible twins. On the other hand, the ingot fragment from the Britzgyberg has neither an ingot, nor a crucible twin within the analysed objects. Was this type of material used to produce other objects types than ring ornaments? Only further investigations, with different objects, can help to answer this question.

Nevertheless, these observations lead to the restitution of strong relations between communities, sharing one common thread: the craftsman or workshop who cast the object, around which the bronze production seems to have revolved. It is therefore necessary to investigate this organizational trend of metal economy, by extending the analyses to a greater number and different types of objects.



11 Distribution of crucible twins, with an enlargement of the Haguenau cemeteries area. The relations between these and the other sites of the Upper Rhine Valley have been merged to increase the map's readability. Following the same reason, only the sites with twin compositions are labelled. Haguenau cemeteries: Donauberg (Do), Harthouse (Ha), Koenigsbruck (Ko), Maegstub (Ma), Ohlungen (Oh), Schirrheinerweg (Sg); other sites: Britzgyberg (Br), Endingen (En), Ihringen (Ih), Mulhouse (Mu), Nonnenweier (No).

5 CONCLUSION

5.1 A place for recycling?

Are the metallurgical traditions that were brought to light by the chemical composition analysis compatible with the idea of recycling? Recycling of copper alloys is attested since the beginning of metallurgy, and is associated with societies where the supply of raw materials decreases or stops,[84] or where there is insufficient access to one of the alloy components (copper or tin). However, recycling does not necessarily imply a random blend of chemical compositions: in a closed system, recycling rather preserves and standardizes chemical characteristics.[85] Even if this idea is hard to prove for the Upper Rhine Valley, it is still highly conceivable. Indeed, even if trace elements follow

83 Some twins can already be discussed, like the pair made by the A1 arm ring from Ihringen (cat. no. 36), and the Weissensee neck ring from mound 38, grave 2 (cat. no. 423), which belong to different types and chronological periods. This chemical similarity could be fortuitous, and more precise analyses would certainly show slight differences.

84 Pernicka 2014, 259.

85 Northover 1981, 217; Rychner/Kläntschi 1995.

coherent patterns and are related to typology, chemical composition groups do not show clear breaks between them, as the different amounts of trace elements tend to have a wide dispersion and to overlap. This result is consistent with the notion that recycled bronzes have a variable chemical composition despite their common origin. This can be observed on the B2 variant of Bade-Alsace arm rings, which have the highest and most dispersed amounts of impurities; on the other hand, the A1 variant shows a more careful selection of materials prior to casting. Recycling practices, with a selection of objects before their recast,[86] could explain this homogeneousness in production.

5.2 A commonality of technology and ideas

The partition of twin compositions between cemeteries involves strong elements of interpretation concerning the organization of metallurgy. Indeed, it implies contemporaneity between many objects belonging to different communities, which thus possess one common denominator: the craftsman who cast the object. But, we must here keep in mind that the results at the base of this proposition only concern ring ornaments; yet, it is also possible that they belonged to a distinct productive system, different from that for other object types, which had its own alloy compositions or even materials due to particular technical, functional or aesthetic restraints.

Thus, many elements point towards a certain centralisation of production, even if this hypothesis needs to be confirmed by further investigations on other object types. This is most apparent in the great typological, technological and chemical homogeneousness of Bade-Alsace arm rings; this implies the work of a specialized craftsman or workshop, controlling each step of the *chaîne opératoire* from the choice of material and recycling stock to the general shape of the object and its decoration. The particular consistency of the results reveals a precise and unequivocal idea of the finished product, a unique know-how and a common origin of materials, which is not compatible with a production by different workshops.

The argument of typological homogeneousness is harder to defend for massive closed rings, because of their very simple shape. However, the distribution of crucible twins between many bearers and cemeteries attest direct technical relations between these ornaments. The simultaneous casting of objects, which now belong to distinct communities, also tends to indicate a centralized production around a very limited number of craftsmen. A simple sharing of alloy recipes is not sufficient to explain this situation, because of the overlay of the impurities spectrum to the alloy components.

These first results encourage further investigations. This will require the use of an analysis technique with detection limits lower than those of PIXE, in order to underpin the chemical associations between objects. This will also bring the question of copper circulation in the Upper Rhine Valley, and a better characterization of the networks of interregional relations.

Without any metallurgical activity remains other than those from the Britzgyberg, it is neither possible to locate these craftsmen or workshops, nor to attribute them the authorship of one of the studied types. Moreover, as previously said, these results only concern precise ring types, and cannot yet be extended to other types of ornaments, weapons or tools. Nevertheless, the rings show a clear technological cohesion within the Upper Rhine Valley, which is strongly supported by the homogeneousness of shape and ornamentation. In addition to similarities in material culture, this study shows that the aforementioned communities have shared ideas about the individual's representation, visible through the permanent wear of closed ring ornaments and closely related to the organization of their production.

5.3 Leaded bronzes and the economy of economising?

Finally, the most unexpected result is surely the high rate of lead in massive closed ring ornaments from Ha D2 and D3. Despite having the simplest and most ubiquitous form for ring ornaments, their special use, as permanent identity marker, is accompanied by the constant use of leaded bronze instead of the classical 'copper-tin' alloy. This peculiar technological choice cannot be associated to aesthetics or technical reasons, like the increase of fluidity during casting or the ease of applying incised decoration afterwards. Neither can it be assumed that the intention behind this was the replacement of tin by lead, as tin has a certain role in the alloy. In fact, the most plausible explanation seems to be the intention to increase the materials mass of recycled bronze through the addition of lead; could this be related to a sort of bronze stocks crisis, implying austerity policies such as the economising of a certain proportion of raw materials and its replacement by a cheaper and more available substitute?

This question can only be pursued further through parallel investigations, seeking answers to some of the following questions:

86 Schwab 2014, 180.

Are leaded bronzes limited to ring ornaments, or do they extend to other object types? Are they still in use during Late Iron Age, or are they restricted to the 6th and to the beginning of the 5th centuries BC? And, above all, is bronze enriched with local lead, which would confirm a regional solution to a decrease in material stocks? This possibility of lead coming from the surrounding (Vosges, Black Forest) or neighbouring (Taunus, Jura, Eifel) mountains could in future possibly be investigated through lead isotope analyses, and give great clues to the understanding of this particular phenomenon.

LIST OF PLATES

Plate 1: Bade-Alsace variant A1 arm rings
1 Andolsheim or Widensolen – Husarenbrunnen (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,5 [cat. no. 1].
2 Colmar – Croisement des rues Oberlin et Schlumberger (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,3 [cat. nos. 5, 6].
3 Colmar – Rue Thanneckerlé, propriété Eberlin (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,4 [cat. nos. 7, 8].
4 Effringen – Pritsche (Lkr. Lörrach): L. Tremblay Cormier [cat. no. 10].
5, 6 Endingen am Kaiserstuhl – Bühle (Lkr. Emmendingen): Gerbig/Seewald 1958, fig. 71,1.2 [cat. nos. 12, 13].
7 Ensisheim (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,10 [cat. nos. 16, 17].
8 Heidolsheim – Bittlich (?) (Dép. Bas-Rhin, F): Naue 1905, pl. XXVII,186 [cat. no. 21].
9–12 Heidolsheim – Gross Béa/Grosses Ried (Dép. Bas-Rhin, F): Plouin/Koenig 1990, fig. 8,1–4 [cat. nos. 22–25].

Plate 2: Bade-Alsace variant A1 arm rings
13–15 Heidolsheim – Gross Béa/Grosses Ried (Dép. Bas-Rhin, F): Plouin/Koenig 1990, fig. 8,5–7 [cat. nos. 26–28].
16 Herrlisheim près Colmar (?) (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,2 [cat. no. 29].
17–19 Hilsenheim – Willermatt (Dép. Bas-Rhin, F): Dotzler 1997, 203; 207 f. [cat. nos. 32–34].
20 Hügelsheim – Unter der Landstraße (Lkr. Rastatt): L. Tremblay Cormier [cat. no. 35].
21 Ihringen (Lkr. Breisgau-Hochschwarzwald): Schreiber 1841, pl. II,20 [cat. no. 36].
22,23 Jechtingen/Sasbach am Kaiserstuhl – Hinterer Hochberg (Lkr. Emmendingen): Dehn/Fingerlin 1981, fig. 3 (not to scale) [cat. nos. 37, 38].
24 Kembs (Dép. Haut-Rhin, F): Faudel/Bleicher 1885, pl. VII,4 [cat. no. 39].

Plate 3: Bade-Alsace variant A1 arm rings
25 Lörrach – Im Moos/Schwarzer Graben (Lkr. Lörrach): Sangmeister 1982, 8 fig. 2 [cat. no. 40].
26 Nordhouse – Buerckelmatt (Dép. Bas-Rhin, F): Koenig 1985, 293 [cat. no. 44].
27 Riegel – Rumlisbuck/Romansbuch (Lkr. Emmendingen): Maise 2001, fig. 16 [cat. no. 45].
28 Rosheim – Environs de la gare (Dép. Bas-Rhin, F): Koenig 1985, 299 [cat. no. 47].
29 Rouffach – 20 rue des Chardonnerets (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,7 [cat. no. 48].
30 Rouffach – Près de la gravière Sturm (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,6 [cat. no. 50].
31 Sainte-Croix-en-Plaine – Oberesholzackerfeld (Dép. Haut-Rhin, F), circle 1 grave 2: Thévenin 1981, fig. 27 [cat. no. 51].
32 Circle 7: Thévenin 1980, fig. 33,2 [cat. no. 52].
33, 34 Circle 10 grave 3: Thévenin 1980, fig. 35,1.2 [cat. nos. 53, 54].
35 Circle 11 grave 1: Thévenin 1980, fig. 34,2 [cat. no. 55].

Plate 4: Bade-Alsace variant A1 arm rings
36 Saint-Louis-la-Chaussée – Ritty-Heidenwald (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,9 [cat. nos. 58, 59].
37 Schirrhein/Fischerhubel-Kurzgeländ – Bordure sud de la forêt de Haguenau (Dép. Bas-Rhin, F): L. Tremblay Cormier [cat. no. 60].
38 Schlatt – Am Fuße des Schlatterbergs (Lkr. Breisgau-Hochschwarzwald): Kraft/Rest 1936, 417 fig. 183 [cat. nos. 61, 62].
39 Strasbourg – Quartier de la cathédrale (Dép. Bas-Rhin, F): Plouin/Koenig 1990, fig. 8,8 [cat. no. 63].
40 Strasbourg – Rue de Koenigshoffen/Porte Blanche (Dép. Bas-Rhin, F): Koenig 1985, 337 [cat. no. 64].
41 Ungersheim – Lehlematten (Dép. Haut-Rhin, F), grave 4022: Michler 2006, fig. 104 [cat. no. 65].
42 Ibid., grave 4040: Michler 2006, fig. 103 [cat. no. 66].
43 Volgelsheim – Lotissement des Bouleaux (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,8 [cat. nos. 67, 68].
44 Wickerswihr – Au sud de Liesfeld (?) (Dép. Haut-Rhin, F): Plouin/Koenig 1990, fig. 7,1 [cat. no. 73].
45,46 Unknown provenance (Alsace, F): Plouin/Koenig 1990, fig. 8,10.11 [cat. nos. 75, 76].
47 Unknown provenance (Alsace, F): L. Tremblay Cormier [cat. no. 77].
48 Sankt Georgen – Steinenwenden (Schwarzwald-Baar-Kr.): L. Tremblay Cormier [cat. no. 79].

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1, 2 Bennwihr – Bühl (Dép. Haut-Rhin, F): Degen 1968, fig. 4,1.2 [cat. nos. 80, 81].
3 Bubendorf (Kt. Baselland, CH): Degen 1968, fig. 3,2 [cat. no. 86].
4 Colmar – Cimetière du Ladhof (Dép. Haut-Rhin, F): Degen 1968, fig. 6,2 [cat. nos. 87, 88].
5 Colmar – Riedwihr (Dép. Haut-Rhin, F): Plouin 2007, fig. 10,1 [cat. nos. 89, 90].
6 Colmar – Rue du 1er cuirassier (Dép. Haut-Rhin, F): Degen 1968, fig. 3,3 [cat. nos. 91, 92].
9 Kembs (Dép. Haut-Rhin, F): Degen 1968, fig. 5,3 [cat. no. 96].

Plate 6: Bade-Alsace variant B1 arm rings
7, 8 Heidolsheim – Gross Béa/Grosses Ried (Dép. Bas-Rhin, F): Koenig 1985, 154; 160 [cat. nos. 94, 95].
10 Meissenheim – Langenrod (Ortenaukr.): Degen 1968, fig. 6,3 [cat. nos. 97–100].
11 Meyenheim – Sablière (Dép. Haut-Rhin, F): Plouin 2007, fig. 11,1 [cat. no. 101].
12 Mulhouse – Hasenrain (Dép. Haut-Rhin, F): Degen 1968, fig. 4,3 [cat. no. 102].
13,14 Mulhouse – Rue du Travail/route Mulhouse-Rixheim (Dép. Haut-Rhin, F): Degen 1968, fig. 3,4.5 [cat. nos. 103, 104].

Plate 7: Bade-Alsace variant B1 arm rings
15 Reinach – Steinrebstraße (Kt. Baselland, CH): Degen 1968, fig. 3,1 [cat. no. 105].
16 Wettolsheim – Ricoh (Dép. Haut-Rhin, F), grave 405: Plouin 2007, fig. 10,3 [cat. nos. 108, 109].
17 Wettolsheim – Ricoh (Dép. Haut-Rhin, F), grave 753: Plouin 2007, fig. 10,2 [cat. nos. 110, 111].
18 Unknown provenance (Alsace, F): Degen 1968, fig. 6,1 [cat. no. 112].
19,20 Unknown provenance (Alsace, F): Degen 1968, fig. 5,1.2 [cat. nos. 113, 114].

Plate 8: Bade-Alsace variant B2 arm rings
21 Benfeld-Ehl (Dép. Bas-Rhin, F): Degen 1968, fig. 12,2 [cat. nos. 119, 120].
22,23 Birckwald – Près de Weitbruch (Dép. Bas-Rhin, F): Degen 1968, fig. 11,1.2 [cat. nos. 121, 122].
24,25 Brumath – Stephansfeld (Dép. Bas-Rhin, F): Degen 1968, fig. 8,1.2 [cat. nos. 126, 127].
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Plate 9: Bade-Alsace variant B2 arm rings
27,28 Ernolsheim-sur-Bruche – Entre Duttlenheim et Dachstein (Dép. Bas-Rhin, F): Degen 1968, fig. 10,1.2 [cat. nos. 135, 136].
29,30 Haguenau (Dép. Bas-Rhin, F): Degen 1968, fig. 8,3.4 [cat. nos. 137, 138].
31,32 Hangenbieten – Au sommet de la colline au nord-ouest du village (Dép. Bas-Rhin, F): Degen 1968, fig. 7,1.2 [cat. nos. 139, 140].
33 Hochfelden (Dép. Bas-Rhin, F): Koenig 1985, 178 [cat. no. 141].
34,35 Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald): Degen 1968, fig. 9,2.3 [cat. nos. 142, 143].

Plate 10: Bade-Alsace variant B2 arm rings
36 Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald): Degen 1968, fig. 9,4 [cat. no. 144].
37,38 Jebsheim – Bois de Jebsheim (Dép. Haut-Rhin, F): Degen 1968, fig. 7,6.7 [cat. nos. 145, 146].
39,40 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 18 grave 5: Degen 1968, fig. 11,3.4 [cat. nos. 147, 148].
41 Mackwiller (?) (Dép. Bas-Rhin, F): Degen 1968, fig. 12,3 [cat. no. 149].
42 Mommenheim – Nord-ouest du village (Dép. Bas-Rhin, F): Degen 1968, fig. 7,5 [cat. no. 154].

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43 Morschwiller (Dép. Bas-Rhin, F): Degen 1968, fig. 7,4 [cat. no. 155].
44 Niederbronn (Dép. Bas-Rhin, F): Degen 1968, fig. 12,4 [cat. no. 156].
45 Niedermodern (Dép. Bas-Rhin, F): Degen 1968, fig. 7,3 [cat. no. 157].

46, 47 Obermodern (Dép. Bas-Rhin, F): Degen 1968, fig. 10,3.4 [cat. nos. 158, 159].
48 Reichshoffen – Burgreben (Dép. Bas-Rhin, F): Degen 1968, fig. 9,1 [cat. no. 160].
49 Scherzheim (Lkr. Rastatt): Degen 1968, fig. 13,1 [cat. nos. 161, 162].
50 Söllingen – Bannwald (Lkr. Rastatt): Degen 1968, fig. 13,2 [cat. no. 163].
51 Unknown provenance (Alsace, F): Degen 1968, fig. 12,1 [cat. no. 168].

Plate 12: Massive closed arm rings with circular section and no ornaments
1, 2 Donauberg (Dép. Bas-Rhin, F), mound 6 grave 3 [cat. nos. 175, 176].
3 Harthouse (Dép. Bas-Rhin, F), mound 8 grave 1 [cat. no. 177].
4 Ibid., mound 10 grave 1 [cat. no. 178].
5, 6 Ibid., mound 12 grave 7 [cat. nos. 180, 181].
7, 8 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 3 grave 1 [cat. nos. 182, 183].
9, 10 Ibid., mound 6 grave 3 [cat. nos. 184, 185].
11 Ibid., mound 11 grave 2 [cat. no. 188].
12 Ibid., mound 12 grave 2 [cat. no. 189].
13 Ibid., mound 14 grave 3 [cat. no. 192].
14,15 Ibid., mound 18 grave 1 [cat. nos. 193, 194].
16 Maegstub, group C (Dép. Bas-Rhin, F), mound 1 grave 1 [cat. no. 195].
17 Ibid., mound 1 grave 2 [cat. no. 196].
18,19 Ibid., grave 5 [cat. nos. 197, 198].
20,21 Ibid., grave 7 [cat. nos. 199, 200].
22,23 Ibid., mound 2 grave 2 [cat. nos. 201, 202].
24 Ibid., grave 5 [cat. no. 203].
25 Ibid., mound 3 grave 1 [cat. no. 204].
26,27 Ibid., grave 3 [cat. nos. 205, 206].
28,29 Ibid., mound 4 grave 1A [cat. nos. 207, 208].
30,31 Ibid., grave 2 [cat. nos. 209, 210].
32,33 Ibid., grave 3 [cat. nos. 211, 212].
L. Tremblay Cormier.

Plate 13: Massive closed arm rings with circular section and no ornaments
34,35 Maegstub, group C (Dép. Bas-Rhin, F), mound 4 grave 8 [cat. nos. 213, 214].
36,37 Ibid., mound 14 grave 2 [cat. nos. 215, 216].
38,39 Ibid., mound 16 grave 1 [cat. nos. 217, 218].
40,41 Ibid., mound 20 grave 1 [cat. nos. 219, 220].
42,43 Ibid., group D, mound 27 grave 1 [cat. nos. 221, 222].
44 Nonnenweier – Schwanau (Ortenaukr.) [cat. no. 223].
45,46 Ohlungen (Dép. Bas-Rhin, F), mound 3 grave 1 [cat. nos. 224, 225].
47,48 Ibid., grave 2 [cat. nos. 226, 227].
49,50 Ibid., grave 5 [cat. nos. 228, 229].
51 Ibid., grave 10 [cat. no. 230].
52,53 Ibid., grave 16 [cat. nos. 233, 234].
54,55 Ibid., grave 18 [cat. nos. 235, 236].
56,57 Schirrhein – Fischerhubel-Kurzgeland (Dép. Bas-Rhin, F), mound 8 grave 9 [cat. nos. 239, 240].
58,59 Uhlwiller – Au nord-est du village (Dép. Bas-Rhin, F), mound 4 grave 1 [cat. nos. 241, 242].
60,61 Ibid., grave 2 [cat. nos. 243, 244].
62,63 Weitbruch – Au nord du village (Dép. Bas-Rhin, F), mound 3 grave 3 [cat. nos. 247, 248].
64,65 Ibid., mound 5 grave 2 [cat. nos. 249, 250].
L. Tremblay Cormier.

Plate 14: Massive closed ankle rings with circular section and no ornaments
66 Bischoffsheim – Langeschiesse (Dép. Bas-Rhin, F): L. Tremblay Cormier [cat. no. 254].
67 Brumath – Forêt de Brumath (Dép. Bas-Rhin, F), mound 20 (point K): Koenig 1985, 25 [cat. no. 256].
68 Ibid. (point Q): Koenig 1985, 44 [cat. no. 257].
69 Ibid., mound 28 central grave: Koenig 1985, 48 [cat. no. 259].
70, 71 Ibid., mound 31 grave A: Koenig 1985, 62 [cat. nos. 261, 262].
72, 73 Ibid., grave B: Koenig 1985, 64 [cat. nos. 263, 264].
74, 75 Bourgheim – Chemin de fer (Dép. Bas-Rhin, F): L. Tremblay Cormier [cat. nos. 265, 266].
76, 77 Donauberg (Dép. Bas-Rhin, F), mound 6 grave 2: L. Tremblay Cormier [cat. nos. 282, 283].
78, 79 Donauberg (Dép. Bas-Rhin, F), mound 6 grave 3: L. Tremblay Cormier [cat. nos. 284, 285].
80 Fegersheim – Au nord du village, près de la voie ferrée (Dép. Bas-Rhin, F), grave: Koenig 1985, 79 [cat. no. 286].
81 Forstfeld (Dép. Bas-Rhin, F), grave: Schaeffer 1930, fig. 151q [cat. no. 288].

Plate 15: Massive closed ankle rings with circular section and no ornaments
82, 83 Harthouse (Dép. Bas-Rhin, F), mound 1 grave 1 [cat. nos. 289, 290].
84, 85 Ibid., grave 3 [cat. nos. 291, 292].
86, 87 Ibid., mound 4 grave 1 [cat. nos. 293, 294].
88, 89 Ibid., mound 5 grave 1 [cat. nos. 295, 296].
90 Donauberg (Dép. Bas-Rhin, F), mound 10 grave 1 [cat. no. 297].
91 Ibid., mound 12 grave 6 [cat. nos. 299, 300].
92 Hilsenheim – Willermatt (Dép. Bas-Rhin, F), mound A [cat. no. 301].
93 Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald), mound U grave 1 [cat. no. 302].
94, 95 Ibid., mound Z [cat. nos. 303, 304].
96 Ibid., unknown mound [cat. no. 305].
97 Illfurth – Britzgyberg (Dép. Haut-Rhin, F), area 48, US 219 or 220 [cat. no. 306].
98 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 3 grave 1 [cat. no. 307].
99,100 Ibid., mound 6 grave 6 [cat. nos. 308, 309].
101,102 Ibid., mound 9 grave 3 [cat. nos. 310, 311].
L. Tremblay Cormier except pl. 15,92: Koenig 1985, 174; pl. 15,98: Schaeffer 1930, fig. 21d.

Plate 16: Massive closed ankle rings with circular section and no ornaments
103,104 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 9 grave 5 (6) [cat. nos. 312, 313].
105 Ibid., mound 12 grave 2 [cat. no. 314].
106,107 Ibid., mound 13 grave 2 [cat. nos. 316, 317].
108 Ibid., mound 14 grave 3 [cat. no. 318].
109 Ibid., grave 8 [cat. no. 319].
110 Ibid., grave 10 [cat. no. 320].
111 Ibid., grave 20 [cat. no. 321].
112,113 Ibid., mound 18 grave 1 [cat. no. 322].
114 Mackenheim (Dép. Bas-Rhin, F) [cat. no. 324].
115 Maegstub, group C (Dép. Bas-Rhin, F), mound 1 grave 1 [cat. no. 326].
116,117 Ibid., grave 4 [cat. nos. 327, 328].
118,119 Ibid., grave 5 [cat. nos. 329, 330].
120,121 Ibid., grave 7 [cat. nos. 331, 332].
L. Tremblay Cormier except pl. 16,110: Schaeffer 1930, fig. 32c; pl. 16,114: Koenig 1985, 200.

Plate 17: Massive closed ankle rings with circular section and no ornaments
122,123 Maegstub, group C (Dép. Bas-Rhin, F), mound 3 grave 1 [cat. nos. 333, 334].
124,125 Ibid., mound 4 grave 1A [cat. nos. 335, 336].
126,127 Ibid., grave 3 [cat. nos. 337, 338].
128,129 Ibid., mound 14 grave 2 [cat. nos. 339, 340].
130,131 Ibid., mound 16 grave 1 [cat. nos. 341, 342].
132,133 Ibid., mound 16 grave 2 [cat. nos. 343, 344].
134,135 Ibid., mound 20 grave 1 [cat. nos. 345, 346].
136,137 Ibid., grave 3 [cat. nos. 347, 348].
138 Ibid., group D, mound 27 grave 1 [cat. no. 349].
139 Ibid., mound 27 grave 3 [cat. no. 351].
140,141 Malterdingen – Pfannenstiel (Lkr. Emmendingen), mound [cat. nos. 353, 354].
L. Tremblay Cormier except pl. 17, 139: Schaeffer 1930, fig. 141a.

Plate 18: Massive closed ankle rings with circular section and no ornaments
142,143 Nonnenweier – Schwanau (Ortenaukr.), grave 1 [cat. nos. 358, 359].
144 Nordhouse – Buerckelmatt (Dép. Bas-Rhin, F), mound 4 grave F [cat. no. 360].
145,146 Ohlungen – 2 km au nord-est du village (Dép. Bas-Rhin, F), mound 3 grave 1 [cat. nos. 362, 363].
147,148 Ibid., grave 2 [cat. nos. 364, 365].
149,150 Ibid., grave 4 [cat. nos. 366, 367].
151,152 Ibid., grave 16 [cat. nos. 368, 369].
153,154 Ibid., grave 18 [cat. nos. 370, 371].
155–157 Schirrhein – Fischerhubel-Kurzgeland (Dép. Bas-Rhin, F), mound 2 grave 2 [cat. nos. 374, 375].
158,159 Ibid., mound 8 grave 9 [cat. nos. 376, 377].
L. Tremblay Cormier except pl. 18,144: Koenig 1985, 288.

Plate 19: Massive closed ankle and neck rings with circular section and no ornaments
160,161 Schirrhein – Schirrheinerweg (Dép. Bas-Rhin, F), mound 6 grave 3: L. Tremblay Cormier [cat. nos. 378, 379].
162 Schweighouse – Sablière Quirin (Dép. Bas-Rhin, F), grave 13: Koenig 1985, 312 [cat. no. 380].

163–166 Schweighouse – Sablière Quirin (Dép. Bas-Rhin, F), unknown graves: Koenig 1985, 314; 315, 333–335 [cat. nos. 381–385].
167 Seltz – Niedersand (Dép. Bas-Rhin, F), grave: Schaeffer 1930, fig. 153n [cat. no. 386].
168 Strasbourg – Schiltigheiermatt (Dép. Bas-Rhin, F): L. Tremblay Cormier [cat. no. 389].
169 Wyhl – Muhrmatten (Lkr. Emmendingen), mound grave 1: Ebrecht et al. 2014, fig. 2,3 [cat. no. 390].
170 Brumath – Forêt de Brumath (Dép. Bas-Rhin, F), mound 20 (point P): Koenig 1985, 38 [cat. no. 393].
171 Bourgheim – Chemin de fer (Dép. Bas-Rhin, F), grave: Koenig 1985, 70 [cat. no. 394].
172 Donauberg (Dép. Bas-Rhin, F), mound 6 grave 2: L. Tremblay Cormier [cat. no. 397].

Plate 20: Massive closed neck rings with circular section and no ornaments
173 Harthouse (Dép. Bas-Rhin, F), mound 4 grave 1 [cat. no. 398].
174 Ibid. mound 5 grave 1 [cat. no. 399].
175 Ibid., mound 12 grave 6 [cat. no. 400].
176 Kappel am Rhein – Trisloch (Ortenaukr.), mound 3 central grave [cat. no. 404].
177 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 12 grave 2 [cat. no. 405].
178 Ibid., mound 14 grave 2 [cat. no. 406].
L. Tremblay Cormier except pl. 20,176: Dehn et al. 2005, fig. 16,1.

Plate 21: Massive closed neck rings with circular section and no ornaments
179 Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F), mound 14 grave 12 [cat. no. 408].
180 Ibid., mound 18 grave 1 [cat. no. 409].
181 Maegstub, group C (Dép. Bas-Rhin, F), mound 1 grave 4 [cat. no. 410].
182 Ibid., mound 14 grave 2 [cat. no. 410].
183 Ibid., mound 20 grave 1 [cat. no. 411].
184 Obermodern – Le long de la voie ferrée (Dép. Bas-Rhin, F), mound [cat. no. 413].
185 Ohlungen – 2 km au nord-est du village (Dép. Bas-Rhin, F), mound 3 grave 10 [cat. no. 414].
L. Tremblay Cormier except pl. 21,180: Schaeffer 1930, fig. 32i.

Plate 22: Massive closed neck rings with circular section and no ornaments
186 Ohlungen – 2 km au nord-est du village (Dép. Bas-Rhin, F), mound 3 grave 14 [cat. no. 415].
187 Ibid., grave 16 [cat. no. 416].
188 Schirrhein – Fischerhubel-Kurzgeland (Dép. Bas-Rhin, F), mound 1 grave 4 [cat. no. 417].
189 Ibid., Mound 8 grave 9 [cat. no. 418].
190 Schirrhein – Schirrheinerweg (Dép. Bas-Rhin, F), mound 6 grave 3 [cat. no. 419].
194 Wolfgantzen (Dép. Haut-Rhin, F), mound: Jehl/Bonnet 1966, 44 fig. 2 [cat. no. 424].
L. Tremblay Cormier.

Plate 23: Massive closed neck rings with circular section and no ornaments
191 Uhlwiller – Au nord-est du village (Dép. Bas-Rhin, F), mound 15 grave 3: Schaeffer 1930, fig. 116 A [cat. no. 421].
192 Ibid., grave 4: Schaeffer 1930, fig. 115 A [cat. no. 422].
193 Weissensee/Oberfeld (Dép. Bas-Rhin, F), mound 38 grave 2: L. Tremblay Cormier [cat. no. 423].

CATALOGUE

The list of the sites presented in this catalogue follows a strict alphabetical order, with no concern for the country; this choice is due to the cross-border nature of the Upper Rhine Valley, where the Rhine does not act as a barrier between the left and right banks. If known, provenance details are mentioned first. Moreover, each entry includes information on the chronological spectrum followed by the depository place, the associated illustration and the sample number. Each entry ends with bibliographical references. Entries number 56 and 191 were removed from the catalogue.

Abbreviations for museums

ANTEA Habsheim: Société ANTEA Archéologie Sarl, Habsheim
Basel: Historisches Museum, Basel
Breisach: Museum für Stadtgeschichte, Breisach am Rhein
CCE Sélestat: Centre de conservation et d'étude d'Alsace, Sélestat
Colmar: Musée d'Unterlinden, Colmar
Florival: Musée des Pays du Florival, Guebwiller
Freiburg: Archäologisches Museum Colombischlössle, Freiburg im Breisgau
Haguenau: Musée historique, Haguenau
INRAP Strasbourg: Institut national de recherches archéologiques préventives, Strasbourg
Karlsruhe: Badisches Landesmuseum, Karlsruhe
Liestal: Kantonsmuseum Baselland, Liestal
Molsheim: Musée de la Chartreuse, Molsheim
Mulhouse: Musée historique, Mulhouse
Nancy: Musée lorrain, Nancy
Offenburg: Museum im Ritterhaus, Offenburg
Rouffach: Musée du Baillage, Rouffach
RP Stuttgart: Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart, Dienstsitz Freiburg
Sélestat: Bibliothèque humaniste, Sélestat
Strasbourg: Musée archéologique, Strasbourg
ZFA Rastatt: Zentrales Fundarchiv, Rastatt

BADE-ALSACE ARM RINGS

A1 variant: with convergent lengthwise ridges from the Upper Rhine Valley

Andolsheim (Widensolen) – Husarenbrunnen (Dép. Haut-Rhin, F)
Discovered in 1880 during mound excavations by a Breisach officer.
1 Dachshübel Mound (?); Ha D1; Mus. Colmar (inv. no. Ae 106). Pl. 1,1.
Faudel/Bleicher 1885, 42 no. 2; Naue 1905, 398 f.; Plouin/Koenig 1990, 24 fig. 7,5; Tremblay Cormier 2016, 284.

Bischoffsheim – Scheidgraben (Dép. Bas-Rhin, F)
Discovered during archaeological surveys from 2008 to 2012.
2 Mound 1; Ha D1; Mus. Molsheim.
Plouin 2012, 116.

Blotzheim (Dép. Haut-Rhin, F)
3 Burial; Ha D1; Mus. Colmar (lost?).
Faudel/Bleicher 1885, 72; Plouin/Koenig 1990, 25; Tremblay Cormier 2016, 284.

Brumath – Forêt de Brumath (Dép. Bas-Rhin, F)
Excavations in 1895 by R. Henning.
4 Mound 20 (point A); Ha D1; Mus. Strasbourg (inv. no. 2939; lost).
Dotzler 1997, 63 f.; Henning 1902, pl. III fig. 2; Koenig 1985, 24; Naue 1905, 222; Plouin/Koenig 1990, 25; Tremblay Cormier 2016, 269.

Colmar – Croisement des rues Oberlin et Schlumberger (Dép. Haut-Rhin, F)
Fortuitous discovery in 1906.
5, 6 Burial; Ha D1; Mus. Colmar (inv. no. Ae 104). Pl. 1,2.
Plouin/Koenig 1990, 25 fig. 7,3; Tremblay Cormier 2016, 285.

Colmar – Rue Thanneckerlé, propriété Eberlin (Dép. Haut-Rhin, F)
Fortuitous discovery.
7, 8 Ha D1; Mus. Colmar (inv. no. Ae 771; one is lost). Pl. 1,3.
Naue 1905, 381; Plouin/Koenig 1990, 25 fig. 7,4; Tremblay Cormier 2016, 285.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Discovered during archaeological surveys from 2008 to 2012.
9 Mound 16; Ha D1; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Efringen – Pritsche (Lkr. Lörrach)
Fortuitous discovery in 1900.
10 Ha D1; Mus. Karlsruhe (inv. no. C. 8585). Pl. 1,4.
Plouin/Koenig 1990, 28; Tremblay Cormier 2016, 200; Wagner 1908, 152 fig. 98n.

Eguisheim – Altgarten (Dép. Haut-Rhin, F)
Fortuitous discovery in 1889.
11 Ha D1; Gutmann collection (?).
Gutmann 1899, 58 fig. 93; Plouin/Koenig 1990, 25; Tremblay Cormier 2016, 285.

Endingen am Kaiserstuhl – Bühle (Lkr. Emmendingen)
Fortuitous discovery in 1954.
12, 13 Grave 2 (mound?); Ha D1; ZFA Rastatt (inv. no. 1954-44/Em 54/8). Pl. 1,5.6; sample nos. F1, F2 (tab. 4).
Gerbig/Seewald 1958, 249 f. pls. 70; 71; Plouin/Koenig 1990, 28; Tremblay Cormier 2016, 201.

Ensisheim – Forêt de l'Allmend (Dép. Haut-Rhin, F)
Excavations in 1885 by Lieutenant Bühle.
14, 15 Mound; Ha D1; Mus. Colmar (inv. no. Ae 108; lost).
Faudel/Bleicher 1885, 79; Naue 1905, 441 f.; Plouin/Koenig 1990, 25; Tremblay Cormier 2016, 285.

Ensisheim (Dép. Haut-Rhin, F)
16, 17 Mound (?); Ha D1; Mus. Colmar (inv. no. Ae 110). Pl. 1,7.
Plouin/Koenig 1990, 25 fig. 7,10; Tremblay Cormier 2016, 286.

Feldkirch-Hartheim – Retthammer (Lkr. Breisgau-Hochschwarzwald)
18, 19 Flat grave 3, excavated between 1926 and 1935; Ha D1; Mus. Freiburg (inv. no. P. 26/2a.b).
20 Fortuitous discovery of one more arm ring in 1930; Ha D1; Mus. Freiburg (inv. no. P. 31/2).
Rest 1937, 17; Plouin/Koenig 1990, 29; Tremblay Cormier 2016, 202.

Heidolsheim – Bittlich (?) (Dép. Bas-Rhin, F)
Discovered in 1883 (?).
21 Mound (?); Ha D1; Mus. Strasbourg (inv. no. 1230). Pl. 1,8.
Dotzler 1997, 192; Koenig 1985, 142; Naue 1905, 322 pl. XXVII fig. 186; Plouin/Koenig 1990, 25; Tremblay Cormier 2016, 272.

Heidolsheim – Gross Béa/Grosses Ried (Dép. Bas-Rhin, F)
Excavations in 1857 by M. de Ring and the Prefect Vallois.
22–28 Mound (?); Ha D1; Mus. Strasbourg (inv. nos. 13, 28668, 28669) and Sélestat. Pls. 1,9–12; 2,13–15; sample no. S5 (tab. 4).
Dotzler 1997, 194 f.; Koenig 1985, 156–159; Naue 1905, 314; Plouin/Koenig 1990, 25 fig. 8,7; de Ring 1861, 8 f. pl. III,6; Tremblay Cormier 2016, 272.

Herrlisheim près Colmar (?) (Dép. Haut-Rhin, F)
29, 30 Ha D1; Colmar (inv. no. Ae 766; one arm ring is lost). Pl. 2,16.
Faudel/Bleicher 1885, 42 no. 4; Plouin/Koenig 1990, 26 fig. 7,2; Tremblay Cormier 2016, 286.

Herrlisheim près Colmar – Ancienne gravière, au nord de la colline de Hattstatt (Dép. Haut-Rhin, F)
31 Grave (?); Ha D1; Mus. Colmar (inv. no. Ae 421; lost).
Faudel/Bleicher 1885, 42 no. 4; Naue 1905, 375; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 286.

Hilsenheim – Willermatt (Dép. Bas-Rhin, F)
Discovered in 1933 during land levelling.
32–34 Mound; Ha D1; Mus. Strasbourg (inv. nos. D. 11.985.8.7, D. 11.985.8.14, D. 11.985.8.17). Pl. 2,17–19.
Dotzler 1997, 203; 207 f.; Heintz 1949, 241 pl. I,12.13 fig. 4,3; Koenig 1985, 165; Naue 1905, 307; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 272.

Hügelsheim – Unter der Landstraße (Lkr. Rastatt)
Fortuitous discovery in 1976.
35 Ha D1; Mus. Karlsruhe (inv. no. C. 2010/745). Pl. 2,20; sample no. K2 (tab. 4).
Behrends 1987, fig. 39 pl. 33; Plouin/Koenig 1990, 29; Tremblay Cormier 2016, 200.

Ihringen (Lkr. Breisgau-Hochschwarzwald)
Discovered in 1906.
36 Mound (?); Ha D1; ZFA Rastatt (inv. no. 1906-002/P244). Pl. 2,21; sample no. R1 (tab. 4).
Plouin/Koenig 1990, 29; Schreiber 1841, pl. II fig. 20.

Jechtingen/Sasbach am Kaiserstuhl – Hinterer Hochberg/Hohberg (Lkr. Emmendingen)
Discovered in 1924 (?).
37, 38 Grave 3; Ha D1; Mus. Freiburg (inv. no. P. 31/2). Pl. 2,22.23.
Dehn/Fingerlin 1981, fig. 3; Plouin/Koenig 1990, 29; Tremblay Cormier 2016, 202.

Kembs (Dép. Haut-Rhin, F)
Fortuitous discovery.
39 Ha D1; Mus. Colmar (inv. no. Ae 377; lost). Pl. 2,24.
Degen 1968, 547; Faudel/Bleicher 1885, 42 no. 1 pl. VII,4; Naue 1905, 500; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 287.

Lörrach – Im Moos/Schwarzer Graben (Lkr. Lörrach)
Excavations in 1925 by P. Homberger and Kuhn.
40 Mound grave; Ha D1. Pl. 3,25.
Homberger 1928; Plouin/Koenig 1990, 29; Sangmeister 1982, 8 fig. 1; Tremblay Cormier 2016, 203.

Merdingen – Oberhinterfeld (Lkr. Breisgau-Hochschwarzwald)
Discovered in 1939/40 during canalisation works.
41 Grave (?); Ha D1; Mus. Freiburg (inv. no. P. 40/3c).
Bad. Fundber. 1941–47, 305 pl. 74 B; Plouin/Koenig 1990, 29; Tremblay Cormier 2016, 203.

Mussig – Heidenstrassle (Dép. Bas-Rhin, F)
42, 43 Ha D1; Fleischhauer Coll.
Faudel/Bleicher 1885, 42 no. 3; Naue 1905, 305; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 277.

Nordhouse – Buerckelmatt (Dép. Bas-Rhin, F)
Excavations in 1906/07 by M. Kim.
44 Mound 5 grave B; Ha D1; Mus. Strasbourg (inv. no. 16043). Pl. 3,26.
Forrer 1912, 298 pl. XLI,10 fig. 222; Koenig 1985, 289; 293; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 278.

Riegel – Rumlisbuck/Romansbuch (Lkr. Emmendingen)
Discovered in 1994 by M. Schröder.
45 Ha D1; RP Stuttgart (inv. no. 1994-272-3). Pl. 3,27.
Maise 1994; 2001 fig. 16; Tremblay Cormier 2016, 202.

Rosheim (Dép. Bas-Rhin, F)
Discovered around 1863.
46 Ha D1; Mus. Strasbourg (inv. no. 30155).
Naue 1905, 274; Plouin 2012, 129.

Rosheim – Environs de la gare (Dép. Bas-Rhin, F)
47 Ha D1; Mus. Strasbourg (16208).
Pl. 3,28; sample no. S4 (tab. 4).
Koenig 1985, 299; Normand 1973, 110 pl. XXI B; Plouin 2012, 129; Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 280.

Rouffach – 20 rue des Chardonnerets (Dép. Haut-Rhin, F)
Fortuitous discovery in 1974.
48 Ha D1; Mus. Rouffach. Pl. 3,29.
Plouin/Koenig 1990, 26 fig. 7,7; Tremblay Cormier 2016, 288.

Rouffach – Près de la gare (Dép. Haut-Rhin, F)
Discovered in 1914.
49 Ha D1.
Plouin/Koenig 1990, 26; Tremblay Cormier 2016, 288.

Rouffach – Près de la gravière Sturm (Dép. Haut-Rhin, F)
Fortuitous discovery in 1969.
50 Ha D1; Mus. Rouffach. Pl. 3,30.
Plouin/Koenig 1990, 26 fig. 7,6; Tremblay Cormier 2016, 288.

Sainte-Croix-en-Plaine – Oberesholzackerfeld (Dép. Haut-Rhin, F)
Excavations from 1979 to 1981 by the Direction des Antiquités Préhistoriques d'Alsace and in 2006 by the INRAP.
51 Circle 1 grave 2; Ha D1; Mus. Colmar (inv. no. DAP 59). Pl. 3,31.
52 Circle 7; Ha D1; Mus. Colmar (inv. no. DAP 37). Pl. 3,32.
53, 54 Circle 10 grave 3; Ha D1; Mus. Colmar (inv. no. DAP 31). Pl. 3,33.34.
55 Circle 11 grave 1; Ha D1; Mus. Colmar (inv. no. DAP 43). Pl. 3,35.
57 Grave 115; Ha D1; INRAP Strasbourg.
Plouin 2006, 137 f.; Plouin/Koenig 1990, 27 f.; Thévenin 1980, 11 f.; 1981, 4; Tremblay Cormier 2016, 288.

Saint-Louis-la-Chaussée – Ritty-Heidenwald (Dép. Haut-Rhin, F)
From illegal excavations in 1975.
58, 59 Mound 1; Ha D1; Mus. Mulhouse. Pl. 4,36.
Pétry 1978, 347 f.; Plouin/Koenig 1990, 26 f. fig. 7,9; Tremblay Cormier 2016, 288.

Schirrhein/Fischerhubel et Kurzgeland – Bordure sud de la forêt de Haguenau (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
60 Mound 9 grave 1; Ha D1; Mus. Haguenau (inv. no. 349). Pl. 4,37; sample no. H40 (tab. 4).
Naue 1905, 152; Plouin/Koenig 1990, 26; Schaeffer 1930, 60 fig. 54; Tremblay Cormier 2016, 280.

Schlatt – Am Fuße des Schlatterbergs (Lkr. Breisgau-Hochschwarzwald)
61, 62 Mound grave; Ha D1; Mus. Freiburg (inv. no. P. 34:5x). Pl. 4,38.
Kraft/Rest 1936, 16 pl. VI; Plouin/Koenig 1990, 29; Tremblay Cormier 2016, 203.

Strasbourg – Quartier de la cathédrale, sous l'entrée de la tour sud (Dép. Bas-Rhin, F)
Fortuitous discovery.
63 Ha D1; Mus. Strasbourg (inv. no. 7118). Pl. 4,39.
Forrer 1925/26, 299 pl. XXIII fig. 42; Koenig 1985, 336; Plouin/Koenig 1990, 27 fig. 8,8; Tremblay Cormier 2016, 283.

Strasbourg – Rue de Koenigshoffen/Porte Blanche (Dép. Bas-Rhin, F)
Discovered in 1905 during canalisation works.
64 Ha D1; Mus. Strasbourg (inv. no. 7552). Pl. 4,40.
Forrer 1925/26, pl. XXIII fig. 118; Koenig 1985, 337; Plouin/Koenig 1990, 27 fig. 8,9; Tremblay Cormier 2016, 283.

Ungersheim – Lehlematten (Dép. Haut-Rhin, F)
Excavations by the INRAP.
65 Cremation grave 4022; Ha C2/D1; INRAP Strasbourg (inv. no. 4022-10). Pl. 4,41.
66 Cremation grave 4040; Ha C2/D1; INRAP Strasbourg (inv. no. 4040-3/4). Pl. 4,42.
Michler 2006, 107 fig. 103; 104; Plouin 2012, 116.

Volgelsheim – Lotissement des Bouleaux (Dép. Haut-Rhin, F)
Fortuitous discovery in 1980.
67, 68 Grave; Ha D1; Volgelsheim Town Hall. Pl. 4,43.
Plouin/Koenig 1990, figs. 7,8; 27; Tremblay Cormier 2016, 289.

Wettolsheim – Ricoh (Dép. Haut-Rhin, F)
Excavations from 1987 to 1990 by the Direction des Antiquités Préhistoriques d'Alsace.
69, 70 Grave 401; Ha D1.
71, 72 Grave 1990; Ha D1.
Jeunesse 1988, fig. 36 ; 42; Plouin/Koenig 1990, 27; Tremblay Cormier 2016, 289.

Wickerswihr – Au sud de Liesfeld (?) (Dép. Haut-Rhin, F)
Fortuitous discovery in 1912 by M. Schumacher.
73 Ha D1; Mus. Colmar (inv. no. Ae 375). Pl. 4,44.
Plouin/Koenig 1990, 27, fig. 7,1; Tremblay Cormier 2016, 289.

Unknown provenance (Alsace, F)
74 Ha D1.
Kimmig 1979, 162; Plouin/Koenig 1990, 24.

Unknown provenance (Alsace, F)
75, 76 Ha D1; Mus. Strasbourg (inv. no. 1232, 1233). Pl. 4,45.46.
Koenig 1985, 352 f.; Plouin/Koenig 1990, 24 fig. 8,10.11.

Unknown provenance
77 Ha D1; Mus. Mulhouse (Engel-Dollfus Coll. inv. no. 20). Pl. 4,47.

A1 variant: with convergent lengthwise ridges from outside the Upper Rhine Valley
Clayeures-la-Naguée (Dép. Meurthe-et-Moselle, F)
Excavations at the end of the 19th century.
78 Mound; Ha D1; Mus. Nancy (inv. no. 127.04).
Beaupré 1902, 38–42; Hoy 2015, 64; Olivier 1982, fig. 3,7; Plouin/Koenig 1990, 30.

Sankt Georgen (Schwarzwald-Baar-Kr.)
Fortuitous discovery in 1933.
79 Ha D1; RP Stuttgart (inv. no. 38/7). Pl. 4,48.
Deede 1935, 151; Plouin/Koenig 1990, 29.

B1 variant: with geometric ornamentation and thin C-section body
Bennwihr – Bühl (Dép. Haut-Rhin, F)
Excavations in 1860 by S. Henry.
80, 81 Grave (?); Ha D1; Mus. Colmar (inv. no. Ae 102). Pl. 5,1.2.
Degen 1968, 545 fig. 4,1.2; Faudel/Bleicher 1885, 43 no. 19 pl. V,1.2; Naue 1905, 332; Plouin 2007, 103 fig. 8,2; Tremblay Cormier 2016, 284.

Bischoffsheim – Scheidgraben (Dép. Bas-Rhin, F)
Surveys.
82, 83 Tumulus 1; Ha D1; Mus. Molsheim.
Plouin 2012, 116–121.

Blaesheim – Ruthen (Dép. Bas-Rhin, F)
84, 85 Ha D1; Mus. Molsheim.
Plouin 2012, 116.

Bubendorf (Kt. Baselland, CH)
Fortuitous discovery in 1861.
86 Ha D1; Mus. Basel (inv. no. 655). Pl. 5,3.
Degen 1968, 545 fig. 3,2; Schmid-Sikimić 1996, 64 pl. 10,118.

Colmar – Cimetière du Ladhof (Dép. Haut-Rhin, F)
Fortuitous discovery in 1901.
87, 88 Ha D1; Mus. Colmar (inv. no. Ae 109). Pl. 5,4.
Degen 1968, 546 fig. 6,2; Plouin 2007, 103–105 fig. 9,1; Tremblay Cormier 2016, 285.

Colmar – Riedwihr (Dép. Haut-Rhin, F)
Excavations from 1988 to 1991.
89, 90 Mound 2 grave 18; Ha D1; Mus. Colmar (Ried., inv. nos. T.18,1.2). Pl. 5,5. Bonnet et al. 2004, 574 fig. 20,10.11; Plouin 2007, 107 fig. 10,1; Tremblay Cormier 2016, 285.

Colmar – Rue du 1er cuirassier (Dép. Haut-Rhin, F)
Discovered in 1948 during road works.
91, 92 Grave 1; Ha D1; Mus. Colmar (inv. no. Ae 403). Pl. 5,6.
Degen 1968, 546 fig. 3,3; Plouin 2007, 105 fig. 9,2; Tremblay Cormier 2016, 285.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Surveys.
93 Mound 16; Ha D1; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Heidolsheim – Gross Béa/Grosses Ried (Dép. Bas-Rhin, F)
Excavations in 1857 by M. de Ring and the Prefect Vallois.
94, 95 Mound (?); Ha D1; Mus. Strasbourg (inv. nos. 1234, 28670). Pl. 6,7.8; sample no. S1 (tab. 4).
Koenig 1985, 154 f. 160 f.; de Ring 1861, 8 f. pl. III,6; Tremblay Cormier 2016, 272.

Kembs (Dép. Haut-Rhin, F)
96 Ha D1; Mus. Colmar (inv. no. Ae 103). Pl. 5,9.
Degen 1968, 547 fig. 5,3; Faudel/Bleicher 1885, 43 no. 20 pl. VI,1; Naue 1905, 500 pl. 27,185; Plouin 2007, 107 fig. 9,4; Tremblay Cormier 2016, 287.

Meissenheim – Langenrod (Ortenaukr.)
97, 98 Mound grave 6; Ha D1; Mus. Karlsruhe.
99, 100 Mound grave 8; Ha D1; Mus. Karlsruhe (inv. no. C 5359e). Pl. 6,10.
Degen 1968, 549 fig. 6,3; Tremblay Cormier 2016, 201; Wagner 1908, 239–242 fig. 157.

Meyenheim – Sablière (Dép. Haut-Rhin, F)
Fortuitous discovery before 1960.
101 Ha D1; Mus. Florival (inv. no. 935.1.1). Pl. 6,11.
Plouin 2007, 109 fig. 11,1; Tremblay Cormier 2016, 287.

Mulhouse – Hasenrain (Dép. Haut-Rhin, F)
102 Ha D1; Mus. Mulhouse. Pl. 6,12.
Degen 1968, 548 fig. 4,3; Tremblay Cormier 2016, 287.

Mulhouse – Rue du Travail/route Mulhouse-Rixheim (Dép. Haut-Rhin, F)
Discovered in 1870 during road works.
103, 104 Ha D1; Mus. Mulhouse (inv. no. ED 123). Pl. 6,13.14; sample no. M3-M4 (tab. 4).
Degen 1968, 548 fig. 3,4.5; Faudel/Bleicher 1885, 43 no. 23; Naue 1905, 460; Tremblay Cormier 2016, 287.

Reinach – Steinrebstraße (Kt. Baselland, CH)
Fortuitous discovery in the middle of the 20th century.
105 Ha D1; Mus. Liestal (inv. no. 56.7.1). Pl. 7,15.
Degen 1968, 545 fig. 3,1; Schmid-Sikimić 1996, 64 pl. 10,119.

Sainte-Croix-en-Plaine – Obersholzackerfeld (Dép. Haut-Rhin, F)
Excavations in 2006 by the INRAP.
106, 107 Circle 24 grave 114; Ha D1; INRAP Strasbourg.
Plouin 2006, 137 f.; 2007, 111; Tremblay Cormier 2016, 288.

Wettolsheim – Ricoh (Dép. Haut-Rhin, F)
Excavations from 1987 to 1990 by the Direction des Antiquités Préhistoriques d'Alsace.
108, 109 Grave 405; Ha D1; Mus. Colmar (inv. no. WT 405). Pl. 7,16.
110, 111 Grave 753; Ha D1; Mus. Colmar (inv. no. WT 753). Pl. 7,17.
Jeunesse 1988, fig. 36; 42; Plouin 2007, 109 fig. 10,2.3; Tremblay Cormier 2016, 289.

Unknown provenance (Alsace, F)
112 Ha D1; Mus. Colmar (inv. no. Ae 140). Pl. 7,18.
Degen 1968, 546 fig. 6,1; Plouin 2007, 103 fig. 8,1.

Unknown provenance (Alsace, F)
113, 114 Ha D1; Mus. Strasbourg (inv. nos. 1234, 1235). Pl. 7,19.20.
Degen 1968, 546 f. fig. 5,1.2; Henning 1902, pl. VII,21.22.

B2 variant: with geometric ornamentation and D-section body
Altorf – Birckenwald (Dép. Bas-Rhin, F)
115, 116 Ha D1; Mus. Molsheim.
Plouin 2012, 116.

Altorf – Winkel (Dép. Bas-Rhin, F)
117, 118 Ha D1; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 268.

Benfeld-Ehl (Dép. Bas-Rhin, F)
Excavations by N. Nicklès.
119, 120 Mound; Ha D1; Mus. Strasbourg (inv. nos. D.11.980.1.20, 21). Pl. 8,21.
Degen 1968, 546 fig. 12,2; Dotzler 1997, 113–115; Koenig 1985, 3–5; Naue 1905, 294; Plouin 2007, 105 fig. 9,3; Tremblay Cormier 2016, 268.

Birckwald – Près de Weitbruch (Dép. Bas-Rhin, F)
121, 122 Mound (?); Ha D1; Mus. Haguenau (inv. nos. 661, 662). Pl. 8,22.23; sample nos. H1, H2 (tab. 4).
Degen 1968, 546 fig. 11,1.2; Schaeffer 1930, 173 fig. 151d.e; Tremblay Cormier 2016, 268.

Bischoffsheim – Scheidgraben (Dép. Bas-Rhin, F)
Surveys.
123, 124 Tumulus 2; Ha D1; Mus. Molsheim.
Plouin 2012, 116–121.

Blaesheim – Ruthen (Dép. Bas-Rhin, F)
125 Ha D1; Mus. Molsheim.
Plouin 2012, 116.

Brumath – Stephansfeld (Dép. Bas-Rhin, F)
126, 127 Unknown pit; Ha D1; Mus. Strasbourg (inv. no. 7651a.b). Pl. 8,24.25.
Degen 1968, 546 fig. 8,1.2; Koenig 1985, 68 f.; Tremblay Cormier 2016, 269.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Surveys.
128, 129 Mound 10; Ha D1; Mus. Molsheim.
130 Mound 16; Ha D1; Mus. Molsheim.
131, 132 Mound 17; Ha D1; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Dachstein-Ernolsheim (Dép. Bas-Rhin, F)
Discovered in 1986 by J.-P. Legendre.
133, 134 Ha D1; Mus. Strasbourg (inv. nos. D.11.986.1.1, 2). Pl. 8,26.
Plouin 2012, 116; Schnitzler 1994, 85.

Ernolsheim-sur-Bruche – Entre Duttlenheim et Dachstein (Dép. Bas-Rhin, F)
135, 136 Mound 11 or 15; Ha D1; Mus. Strasbourg (inv. nos. 16137, 16138). Pl. 9,27.28.
Degen 1968, 547 fig. 10,1.2; Dotzler 1997, 116–118; Forrer 1917, 347 f. fig. 4; Koenig 1985, 76 f.; Plouin 2012, 110; Tremblay Cormier 2016, 270.

Haguenau (Dép. Bas-Rhin, F)
137, 138 Ha D1; Mus. Mulhouse (Engel-Dollfus Coll. inv. nos. 124.1, 2). Pl. 9,29.30; sample nos. M1, M2 (tab. 4).
Degen 1968, 547 fig. 8,3.4; Faudel/Bleicher 1885, 43 no. 22 pl. VII,1; Tremblay Cormier 2016, 271.

Hangenbieten – Au sommet de la colline au nord-ouest du village (Dép. Bas-Rhin, F)
Discovered in 1914.
139, 140 Grave; Ha D1; Mus. Strasbourg (inv. no. 17039a.b). Pl. 9,31.32.
Degen 1968, 547 fig. 7,1.2; Koenig 1985, 92 f.; Plouin 2012, 129; Tremblay Cormier 2016, 271.

Hochfelden (Dép. Bas-Rhin, F)
141 Ha D1; Mus. Strasbourg (inv. no. 1786). Pl. 9,33; sample no. S2 (tab. 4).
Faudel/Bleicher 1885, 44 no. 42; Koenig 1985, 178 f.; Tremblay Cormier 2016, 272.

Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald)
Excavations during the 19th and at the beginning of the 20th century by E. Wagner and Fischer.
142–144 Mound; Ha D1; ZFA Rastatt (inv. nos. P245, P246, P247). Pls. 9,34.35; 10,36; sample nos. R3, R4, R6 (tab. 4).
Degen 1968, 549 fig. 9,2–4; Tremblay Cormier 2016, 202; Wagner 1908, 187–194.

Jebsheim – Bois de Jebsheim (Dép. Haut-Rhin, F)
Discovered before 1885.
145, 146 Grave; Ha D1; Mus. Colmar (inv. no. Ae 107). Pl. 10,37.38.
Degen 1968, 547 fig. 7,6.7; Faudel/Bleicher 1885, 81; Naue 1905, 390; Plouin 2007, 105 fig. 9,5; Tremblay Cormier 2016, 286.

Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F)
147, 148 Mound 18 grave 5; Ha D1; Mus. Haguenau (inv. no. 312). Pl. 10,39.40; sample nos. H4, H5 (tab. 4).
Degen 1968, 547 fig. 11.3.4; Naue 1905, 118; Schaeffer 1930, 50 fig. 45c; Tremblay Cormier 2016, 273.

Mackwiller (?) (Dép. Bas-Rhin, F)
149 Ha D1; Mus. Strasbourg (inv. no. 1203). Pl. 10,41.
Degen 1968, 547 fig. 12,3; Koenig 1985, 223; Tremblay Cormier 2016, 275.

Marmoutier (Dép. Bas-Rhin, F)
Rescue excavations by Archéologie Alsace.
150–153 Graves; Ha D1; CCE Sélestat.
Bolly 2017.

Mommenheim – Nord-ouest du village (Dép. Bas-Rhin, F)
154 Grave; Ha D1; Mus. Strasbourg (inv. no. 38743). Pl. 10,42 ; sample no. S3 (tab. 4).
Degen 1968, 548 fig. 7,5; Koenig 1985, 234 f.; Tremblay Cormier 2016, 277.

Morschwiller (Dép. Bas-Rhin, F)
155 Ha D1; Mus. Haguenau (inv. no. 664). Pl. 11,43.
Degen 1968, 548 fig. 7,4; Schaeffer 1930, 176 fig. 150t; Tremblay Cormier 2016, 277.

Niederbronn (Dép. Bas-Rhin, F)
156 Ha D1; Mus. Haguenau (685). Pl. 11,44.
Degen 1968, 548 fig. 12,4; Schaeffer 1930, 176 fig. 150q; Tremblay Cormier 2016, 277.

Niedermodern (Dép. Bas-Rhin, F)
157 Ha D1; Mus. Haguenau (inv. no. 684). Pl. 11,45.
Degen 1968, 548 fig. 7,3; Schaeffer 1930, 180 fig. 153d; Tremblay Cormier 2016, 277.

Obermodern (Dép. Bas-Rhin, F)
158, 159 Ha D1; Mus. Haguenau (inv. no. 677). Pl. 11,46.47.
Degen 1968, 548 fig. 10,3.4; Tremblay Cormier 2016, 279.

Reichshoffen – Burgreben (Dép. Bas-Rhin, F)
160 Ha D1; H. de Blonay Ancient Coll. Pl. 11,48.
Degen 1968, 548 fig. 9,1; Faudel/Bleicher 1885, 43 no. 21 pl. VI,2; Naue 1905, 210; Tremblay Cormier 2016, 280.

Scherzheim (Lkr. Rastatt)
161, 162 Ha D1; Mus. Karlsruhe (inv. no. C. 11335). Pl. 11,49; sample no. K1 (tab. 4).
Degen 1968, 549 fig. 13,1; Tremblay Cormier 2016, 200.

Söllingen – Bannwald (Lkr. Rastatt)
Excavations in October 1884 by E. Wagner.
163 Mound II grave 1; Ha D1; Mus. Karlsruhe (inv. no. C. 4947). Pl. 11,50; sample no. K3 (tab. 4).
Degen 1968, 549 fig. 13,2; Tremblay Cormier 2016, 200; Wagner 1911, 57–59 fig. 64.

Soufflenheim – Golf (Dép. Bas-Rhin, F)
Rescue excavations in 1999 by ANTEA.
164, 165 Mound IX grave 1; Ha D1.
ANTEA Habsheim.

166, 167 Mound IX grave 2; Ha D1.
ANTEA Habsheim.
Zehner 2000.

Unknown provenance (Alsace, F)
168 Ha D1; Strasbourg (inv. no. 1786).
Pl. 11,51.
Degen 1968, 546 fig. 12,1.

Unknown variant
Meyenheim – Sablière (Dép. Haut-Rhin, F)
Discovered before 1960.
169, 170 Ha D1; Mus. Florival.
Plouin 2007, 109; Tremblay Cormier 2016, 287.

MASSIVE CLOSED RINGS WITH CIRCULAR SECTION AND NO ORNAMENTS
Arm rings
Appenweier – Urloffenweg/Bahnhof (Ortenaukr.)
Grave discovered in 1864.
171, 172 Ha D2; Mus. Offenburg (inv. no. Of B12).
Tremblay Cormier 2016, 200; Wagner 1908, 244.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Surveys.
173 Mound 18; Ha D; Mus. Molsheim.
174 Mound 20; Ha D; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Donauberg (Soufflenheim) (Dép. Bas-Rhin, F)
175, 176 Mound 6 grave 3; Ha D3; Mus. Haguenau (inv. no. 205). Pl. 12,1.2.
Koenig et al. 1993; Naue 1905, 122; Schaeffer 1930, 22 fig. 17n; Tremblay Cormier 2016, 270.

Harthouse (Dép. Bas-Rhin, F)
177 Mound 5 grave 1; Ha D2; Mus. Haguenau (inv. no. 135). Pl. 12,3.
178, 179 Mound 10 grave 1; Ha D1/D2; Mus. Haguenau (inv. no. 144). Pl. 12,4; sample nos. H6, H7 (tab. 4).
180, 181 Mound 12 grave 7; Ha D1; Mus. Haguenau (inv. no. 155). Pl. 12,5.6; sample nos. H12, H13 (tab. 4).
Koenig et al. 1993; Naue 1905, 85–88; 90; Schaeffer 1930, 107 f.; 110 f.; 113 fig. 92h; 96q; 104a; Tremblay Cormier 2016, 271.

Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F)
182, 183 Mound 3 grave 1; Ha D1; Mus. Haguenau (inv. no. 231). Pl. 12,7.8.
184, 185 Mound 6 grave 3; Ha D2; Mus. Haguenau (inv. no. 246). Pl. 12,9.10.
186, 187 Mound 9 grave 3; Ha D2.
188 Mound 11 grave 2; Ha D; Mus. Haguenau (inv. no. 261). Pl. 12,11.
189, 190 Mound 12 grave 2; Ha D2; Mus. Haguenau (inv. no. 264). Pl. 12,12.
192 Mound 14 grave 3; Ha D1/D2; Mus. Haguenau (inv. no. 275). Pl. 12,13.
193, 194 Mound 18 grave 1; Ha D2; Mus. Haguenau (309). Pl. 12,14.15; sample nos. H18, H19 (tab. 4).
Koenig et al. 1993; Naue 1905, 102; 105–109; 112; 117–118; Schaeffer 1930, 26 f.; 30–34; 37; 41; 49 f. figs. 21r; 23e.k.l; 27b; 30h; 32w; Tremblay Cormier 2016, 273.

Maegstub (Dép. Bas-Rhin, F)
195 Mound 1 grave 1 (group C); Ha D2; Mus. Haguenau (inv. no. 1). Pl. 12,16; sample no. H22 (tab. 4).
196 Mound 1 grave 2 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 2). Pl. 12,17.
197, 198 Mound 1 grave 5 (group C); Ha D; Mus. Haguenau (inv. no. 7). Pl. 12,18.19.
199, 200 Mound 1 grave 7 (group C); Ha D; Mus. Haguenau (inv. no. 9).
Pl. 12,20.21.
201, 202 Mound 2 grave 2 (group C); Ha D1; Mus. Haguenau (inv. no. 12).
Pl. 12,22.23; sample nos. H24, H25 (tab. 4).
203 Mound 2 grave 5 (group C); Ha D; Mus. Haguenau (inv. no. 15). Pl. 12,24.
204 Mound 3 grave 1 (group C); Ha D; Mus. Haguenau (inv. no. 16). Pl. 12,25.
205, 206 Mound 3 grave 3 (group C); Ha D; Mus. Haguenau (inv. no. 19).
Pl. 12,26.27.
207, 208 Mound 4 grave 1A (group C); Ha D2; Mus. Haguenau (inv. no. 21).
Pl. 12,28.29; sample no. H26 (tab. 4).
209, 210 Mound 4 grave 2 (group C); Ha D; Mus. Haguenau (inv. no. 22).
Pl. 12,30.31.
211, 212 Mound 4 grave 3 (group C); Ha D2/D3; Mus. Haguenau (inv. no. 23).
Pl. 12,32.33; sample no. H29 (tab. 4).
213, 214 Mound 4 grave 8 (group C); Ha D; Mus. Haguenau (inv. no. 28). Pl. 13,34.35.
215, 216 Mound 14 grave 2 (group C); Ha D2; Mus. Haguenau (inv. no. 46).
Pl. 13,36.37.
217, 218 Mound 16 grave 1 (group C); Ha D; Mus. Haguenau (inv. no. 58). Pl. 13,38.39.
219, 220 Mound 20 grave 1 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 60).
Pl. 13,40.41; sample nos. H32, H33 (tab. 4);
221, 222 Mound 27 grave 1 (group D); Ha D; Mus. Haguenau (inv. no. 85).
Pl. 13,42.43.
Koenig et al. 1993; Naue 1905, 55 f.; 58–60; 63–65; Schaeffer 1930, 140 f.; 143 f.; 146–148; 150; 158; 160; 168 fig. 122; 123c; 124b.g.p.r; 126e.k; 132h.m; 144k.v.w; Tremblay Cormier 2016, 275 f.

Nonnenweier/Schwanau – Kleiner Rebgraben (Ortenaukr.)
223 Grave 1; Ha D; ZFA Rastatt (inv. no. 1993-318/F9719). Pl. 13,44.
Behnke 1993; Tremblay Cormier 2016, 201.

Ohlungen – 2 km au nord-est du village (Dép. Bas-Rhin, F)
224, 225 Mound 3 grave 1; Ha D2; Mus. Haguenau (inv. no. 165). Pl. 13,45.46.
226, 227 Mound 3 grave 2; Ha D2; Mus. Haguenau (inv. no. 166). Pl. 13,47.48.
228, 229 Mound 3 grave 5; Ha D2; Mus. Haguenau (inv. no. 169). Pl. 13,49.50.
230 Mound 3 grave 10; Ha D; Mus. Haguenau (inv. no. 174). Pl. 13,51.
231, 232 Mound 3 grave 11; Ha D1.
233, 234 Mound 3 grave 16; Ha D2; Mus. Haguenau (inv. no. 180). Pl. 13,52.53.
235, 236 Mound 3 grave 18; Ha D; Mus. Haguenau (inv. no. 182). Pl. 13,54.55.
Koenig et al. 1993; Naue 1905, 76–80; Schaeffer 1930, 118–120; 122; 126 f. fig. 106,l; 107d; 109i; 110l; 112a.l; Tremblay Cormier 2016, 279.

Schirrhein – Fischerhubel et Kurzgeland (Dép. Bas-Rhin, F)
237, 238 Mound 3 grave 3; Ha D2; Mus. Haguenau (inv. no. 327).
239, 240 Mound 8 grave 9; Ha D1/D2; Mus. Haguenau (inv. no. 348). Pl. 13,56.57.
Koenig et al. 1993; Naue 1905, 146; 152; Schaeffer 1930, 54 f.; 60 fig. 54; Tremblay Cormier 2016, 280.

Uhlwiller – Au nord-est du village (Dép. Bas-Rhin, F)
241, 242 Mound 4 grave 1; Ha D2; Mus. Haguenau (inv. no. 185). Pl. 13,58.59.
243, 244 Mound 4 grave 2; Ha D; Mus. Haguenau (inv. no. 186). Pl. 13,60.61.
245, 246 Mound 15 grave 2; Ha D.
Koenig et al. 1993; Naue 1905, 73–75; Schaeffer 1930, 130; 133 figs. 114; 116r; Tremblay Cormier 2016, 284.

Weitbruch – Au nord du village Groupe 2 (Dép. Bas-Rhin, F)
247, 248 Mound 3 grave 3; Ha D; Mus. Haguenau (inv. no. 529). Pl. 13,62.63.
249, 250 Mound 5 grave 2; Ha D; Mus. Haguenau (inv. no. 583). Pl. 13,64.65.
251 Mound 6 grave 1; Ha D.
Naue 1905, 96; Schaeffer 1930, 101 f. fig. 89g.h; Tremblay Cormier 2016, 284.

Ankle rings
Appenweier – Urloffenweg/Bahnhof (Ortenaukr.)
Discovered in 1864.
252, 253 Ha D2; Mus. Offenburg (inv. no. Of B12).
Tremblay Cormier 2016, 200; Wagner 1908, 244.

Bischoffsheim – Langeschiesse (Dép. Bas-Rhin, F)
Given to the museum in 1861.
254 Ha D; Mus. Strasbourg (inv. no. 1227).
Pl. 14,66.
Koenig 1985, 6 f.; Tremblay Cormier 2016, 268.

Bischoffsheim – Scheidgraben (Dép. Bas-Rhin, F)
255 Mound 2; Ha D; Mus. Molsheim.
Plouin 2012, 116–121.

Brumath – Forêt de Brumath (Dép. Bas-Rhin, F)
Mound 20 excavated in 1895 by R. Henning, mound 28 in 1938 by H. Ulrich and mound 31 in 1946 by J.-J. Hatt.
256 Mound 20 (point K); Ha D; Mus. Strasbourg (inv. no. 2940). Pl. 14,67.
257, 258 Mound 20 (point Q); Ha D; Mus. Strasbourg (inv. nos. 2947a.b). Pl. 14,68.
259, 260 Mound 28 central grave; Ha D; Mus. Strasbourg. Pl. 14,69.
261, 262 Mound 31 grave A; Ha D; Mus. Strasbourg (inv. nos. 46124, 46125). Pl. 14,70.71.
263, 264 Mound 31 grave B; Ha D2/D3; Mus. Strasbourg (inv. nos. 46126, 46127).
Pl. 14,72.73.
Dotzler 1997, 69 f.; 76, 83–88; 91–94; Henning 1902, pl. III fig. 2; Koenig 1985, 25; 44 f.; 48 f.; 62–65; Tremblay Cormier 2016, 268 f.

Bourgheim – Chemin de fer (Dép. Bas-Rhin, F)
Discovered in 1861.
265, 266 Grave; Ha D2/D3; Mus. Strasbourg (inv. no. 1228b.c). Pl. 14,74.75; sample nos. S6, S7 (tab. 4).
Koenig 1985, 72 f.; Plouin 2012, 110; Tremblay Cormier 2016, 269.

Dachstein – Lauen (Dép. Bas-Rhin, F)
267, 268 Ha D.
Plouin 2012, 134.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Surveys.
269, 270 Mound 14; Ha D; Mus. Molsheim.
271–273 Mound 18; Ha D; Mus. Molsheim.
274 Mound 19/21; Ha D; Mus. Molsheim.
275 Mound 20; Ha D; Mus. Molsheim.
276–281 Mound 22; Ha D; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Donauberg (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
282, 283 Mound 6 grave 2; Ha D2; Mus. Haguenau (inv. no. 204). Pl. 14,76.77; sample nos. H16, H17 (tab. 4).
284, 285 Mound 6 grave 3; Ha D3; Mus. Haguenau (inv. no. 205). Pl. 14,78.79.
Koenig et al. 1993; Naue 1905, 121 f.; Schaeffer 1930, 20 22 fig. 15d ; 17m; Tremblay Cormier 2016, 270.

Fegersheim – Au nord du village, près de la voie ferrée (Dép. Bas-Rhin, F)
286, 287 Grave; Ha D2; Mus. Strasbourg (inv. no. 1225b). Pl. 14,80.
Koenig 1985, 78 f.; Naue 1905, 288; Tremblay Cormier 2016, 270.

Forstfeld (Dép. Bas-Rhin, F)
288 Grave; Ha D; Mus. Haguenau (lost). Pl. 14,81.
Schaeffer 1930, 174 fig. 151q; Tremblay Cormier 2016, 270.

Harthouse (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
289, 290 Mound 1 grave 1; Ha D2; Mus. Haguenau (inv. no. 120). Pl. 15,82.83.
291, 292 Mound 1 grave 3; Ha D; Mus. Haguenau (inv. no. 122). Pl. 15,84.85.
293, 294 Mound 4 grave 1; Ha D2; Mus. Haguenau (inv. no. 133). Pl. 15,86.87.
295, 296 Mound 5 grave 1; Ha D2; Mus. Haguenau (inv. no. 135). Pl. 15,88.89; sample nos. H8, H9 (tab. 4).
297, 298 Mound 10 grave 1; Ha D1/D2; Mus. Haguenau (inv. no. 144). Pl. 15,90.
299, 300 Mound 12 grave 6; Ha D1/D2; Mus. Haguenau (inv. no. 154). Pl. 15,91.
Koenig et al. 1993; Naue 1905, 83–89; Schaeffer 1930, 103 f.; 106 f.; 110 f.; 113 fig. 93a; 96f.n; 98f; 103c; Tremblay Cormier 2016, 271.

Hilsenheim – Willermatt (Dép. Bas-Rhin, F)
Discovered in 1933.
301 Mound A; Ha D; Mus. Strasbourg (inv. no. 41194). Pl. 15,92.
Dotzler 1997, 199–212; Heintz 1949, 241; Koenig 1985, 174 f.; Tremblay Cormier 2016, 272.

Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald)
302 Mound U grave 1; Ha D2/D3; ZFA Rastatt (inv. no. 1905-001/P637). Pl. 15,93.
303, 304 Mound Z; Ha D; ZFA Rastatt (inv. no. 1905-001/P687). Pl. 15,94.95; sample no. R5 (tab. 4).
305 Mound (?); ZFA Rastatt (inv. no. 1905-0001/P260 [?]). Pl. 15,96; sample no. R2 (tab. 4).
Tremblay Cormier 2016, 202; Wagner 1908, 187–194.

Illfurth – Britzgyberg (Dép. Haut-Rhin, F)
306 Area 48, US 219 or 220; Ha D2; Mus. Mulhouse (inv. no. M85-02). Pl. 15,97; sample no. M6 (tab. 4).
Schweitzer 1997, fig. 6,11; Dubreucq 2013; 233 pl. 52,5; Tremblay Cormier 2016, 287.

Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
307 Tumulus 3 Sép. 1; Ha D1. Pl. 15,98.
308, 309 Tumulus 6 Sép. 6; Ha D1/D2; Mus. Haguenau (inv. no. 249). Pl. 15,99.100.
310, 311 Tumulus 9 Sép. 3; Ha D1/D2; Mus. Haguenau (inv. no. 253). Pl. 15,101.102.
312, 313 Tumulus 9 Sép. 5 (6); Ha D2; Mus. Haguenau (inv. no. 255). Pl. 16.103.104.
314, 315 Tumulus 12 Sép. 2; Ha D2; Mus. Haguenau (inv. no. 264). Pl. 16,105.
316, 317 Tumulus 13 Sép. 2; Ha D3; Mus. Haguenau (inv. no. 270). Pl. 16,106.107.
318 Tumulus 14 Sép. 3; Ha D1; Mus. Haguenau (inv. no. 275). Pl. 16,108.
319 Tumulus 14 Sép. 8; Ha D; Mus. Haguenau (inv. no. 280). Pl. 16,109.
320 Tumulus 14 Sép. 10; Ha D1/D2; Mus. Haguenau (inv. no. 282). Pl. 16,110.
321 Tumulus 14 Sép. 20; Ha D3; Mus. Haguenau (inv. no. 292). Pl. 16,111.
322, 323 Tumulus 18 Sép. 1; Ha D2; Mus. Haguenau (inv. no. 309). Pl. 16,112.113; sample nos. H20, H21 (tab. 4).
Koenig et al. 1993; Naue 1905, 102; 105–110; 112–114; 117 f.; Schaeffer 1930, 26–32; 34; 37; 41–43; 45; 49 f. figs. 21d; 23q; 25f; 27c; 29g; 30g; 32c; 37k; Tremblay Cormier 2016, 273.

Mackenheim (Dép. Bas-Rhin, F)
324, 325 Ha D; Mus. Strasbourg (inv. nos. 35502, 35503). Pl. 16,114.
Koenig 1985, 200 f.; Tremblay Cormier 2016, 275.

Maegstub (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
326 Mound 1 grave 1 (group C); Ha D2; Mus. Haguenau (inv. no. 1). Pl. 16,115; sample no. H23 (tab. 4).
327, 328 Mound 1 grave 4 (group C); Ha D2/D3; Mus. Haguenau (inv. no. 6). Pl. 16,116.117.
329, 330 Mound 1 grave 5 (group C); Ha D; Mus. Haguenau (inv. no. 7). Pl. 16,118.119.
331, 332 Mound 1 grave 7 (group C); Ha D; Mus. Haguenau (inv. no. 9). Pl. 16,120.121.
333, 334 Mound 3 grave 1 (group C); Ha D; Mus. Haguenau (inv. no. 17). Pl. 17,122.123.
335, 336 Mound 4 grave 1 A (group C); Ha D2; Mus. Haguenau (inv. no. 21). Pl. 17,124.125; sample nos. H27, H28 (tab. 4).
337, 338 Mound 4 grave 3 (group C); Ha D2/D3; Mus. Haguenau (inv. no. 23). Pl. 17,126.127; sample nos. H30, H31 (tab. 4).
339, 340 Mound 14 grave 2 (group C); Ha D2; Mus. Haguenau (inv. no. 46). Pl. 17,128.129.
341, 342 Mound 16 grave 1 (group C); Ha D; Mus. Haguenau (inv. no. 58). Pl. 17,130.131.
343, 344 Mound 16 grave 2 (group C); Ha D; Mus. Haguenau (inv. no. 59). Pl. 17,132.133.
345, 346 Mound 20 grave 1 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 60). Pl. 17,134.135; sample nos. H34, H35 (tab. 4).
347, 348 Mound 20 grave 3 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 62). Pl. 17,136.137.
349, 350 Mound 27 grave 1 (group D); Ha D; Mus. Haguenau (inv. no. 85). Pl. 17,138.
351, 352 Mound 27 grave 3 (group D); Ha D1/D2. Pl. 17,139.
Koenig et al. 1993; Naue 1905, 55 f.; 58 f.; 63–66; Schaeffer 1930, 140–163; 166–170 figs. 122; 124c.h; 126f; 132i; 141a; 146c; Tremblay Cormier 2016, 275 f.

Malterdingen – Pfannenstiel (Lkr. Emmendingen)
Excavations in 1864.
353, 354 Mound, grave; Ha D2; Mus. Karlsruhe (inv. nos. C. 2820, 2821). Pl. 17,140.141; sample nos. F3, F4, F4 bis (tab. 4).
Tremblay Cormier 2016, 202; Wagner 1908, 202 f. fig. 135e.

Marlenheim – Giermatt (Dép. Bas-Rhin, F)
Surveys.
355 Ha D; Mus. Molsheim.
Plouin 2012, 136.

Meissenheim – Langenrod (Ortenaukr.)
356, 357 Mound grave 4; Mus. Karlsruhe (inv. nos. C. 5359d/4, 5).
Tremblay Cormier 2016, 201; Wagner 1908, 239–242.

Nonnenweier/Schwanau – Kleiner Rebgarten (Ortenaukr.)
358, 359 Grave 1; Ha D; ZFA Rastatt (inv. no. 1993-318/F9719). Pl. 18,142.143.
Behnke 1993; Tremblay Cormier 2016, 201.

Nordhouse – Buerckelmatt (Dép. Bas-Rhin, F)
Excavations in 1906/07 by M. Kim.
360, 361 Mound 4 grave F; Ha D; Mus. Strasbourg (inv. nos. 16038, 16039). Pl. 18,144.
Forrer 1912, 298 pl. XLI,10; fig. 222f; Koenig 1985, 288 f.; Tremblay Cormier 2016, 277.

Ohlungen – 2 km au nord-est du village (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
362, 363 Mound 3 grave 1; Ha D2; Mus. Haguenau (inv. no. 165). Pl. 18,145.146.
364, 365 Mound 3 grave 2; Ha D2; Mus. Haguenau (inv. no. 166). Pl. 18,147.148.
366, 367 Mound 3 grave 4; Ha D1; Mus. Haguenau (inv. no. 168). Pl. 18,149.150.

368, 369 Mound 3 grave 16; Ha D2; Mus. Haguenau (inv. no. 180). Pl. 18,151.152; sample no. H38 (tab. 4).
370, 371 Mound 3 grave 18; Ha D2; Mus. Haguenau (inv. no. 182). Pl. 18,153.154.
Koenig et al. 1993; Naue 1905, 76–80; Schaeffer 1930, 118–122; 126; 128 fig. 107c; 110e; 112b.h; Tremblay Cormier 2016, 279.

Reute – Binzgenschlag (Lkr. Emmendingen)
Excavations in 1903 by E. Wagner.
372, 373 Mound A secondary grave; Ha D; Mus. Karlsruhe (inv. nos. C. 9046, 9047).
Tremblay Cormier 2016, 202; Wagner 1908, 203 f.

Schirrhein – Fischerhubel et Kurzgeland (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
374–376 Mound 2 grave 2; Ha D; Mus. Haguenau (inv. no. 320). Pl. 18,155–157.
377, 378 Mound 8 grave 9; Ha D2; Mus. Haguenau (inv. no. 348). Pl. 18,158.159.
Koenig et al. 1993; Naue 1905, 145; 152; Schaeffer 1930, 51–53; 60 fig. 54; Tremblay Cormier 2016, 281.

Schirrhein – Schirrheinerweg (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
379, 380 Mound 6 grave 3; Ha D2; Mus. Haguenau (inv. no. 586). Pl. 19,160.161.
Koenig et al. 1993; Schaeffer 1930, 79 f.; Tremblay Cormier 2016, 282.

Schweighouse – Sablière Quirin (Dép. Bas-Rhin, F)
381 Grave 13; Ha D; Mus. Strasbourg (inv. no. 38516a). Pl. 19,162.
382–386 Grave; Ha D; Mus. Strasbourg (inv. nos. 38517, 38517a, 41063–41065). Pl. 19,163–166.
Koenig 1985, 312; 314 f.; 333–335; Tremblay Cormier 2016, 282.

Seltz – Niedersand (Dép. Bas-Rhin, F)
387, 388 Grave; Ha D2/D3. Pl. 19,167.
Schaeffer 1930, 186 fig. 153n; Tremblay Cormier 2016, 283.

Strasbourg – Schiltigheiermatt (Dép. Bas-Rhin, F)
389 Ha D; Mus. Strasbourg (inv. no. 40631). Pl. 19,168.
Koenig 1985, 342 f.

Wybl – Muhrmatten (Lkr. Emmendingen)
Excavations in 2011 by RP Stuttgart.
390 Mound grave 1; Ha D1; ZFA Rastatt. Pl. 19,169.
Ebrecht et al. 2014, 29 fig. 2,3.

Neck rings
Appenweier – Urloffenweg/Bahnhof (Ortenaukr.)
Discovered in 1864.
391 Ha D2; Mus. Offenburg (inv. no. Of B12).
Tremblay Cormier 2016, 200; Wagner 1908, 244.

Bischoffsheim – Scheidgraben (Dép. Bas-Rhin, F)
392 Mound 1; Ha D; Mus. Molsheim.
Plouin 2012, 116–121.

Brumath – Forêt de Brumath (Dép. Bas-Rhin, F)
Excavations in 1895 by R. Henning.
393 Mound 20 (point P); Ha D; Mus. Strasbourg (inv. no. 2946d). Pl. 19,170.
Dotzler 1997, 73–75; Henning 1902, pl. III fig. 2; Koenig 1985, 38 f.; Naue 1905, 225 f.; Tremblay Cormier 2016, 268 f.

Bourgheim – Chemin de fer (Dép. Bas-Rhin, F)
Discovered in 1861.
394 Grave; Ha D2/D3; Mus. Strasbourg (inv. no. 1228a). Pl. 19,171.
Koenig 1985, 70 f.; Plouin 2012, 110; Tremblay Cormier 2016, 269.

Dachstein – Leffert (Dép. Bas-Rhin, F)
Surveys.
395, 396 Mound 18; Mus. Molsheim.
Plouin 2012, 116; Tremblay Cormier 2016, 269.

Donauberg (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
397 Mound 6 grave 2; Ha D2; Mus. Haguenau (inv. no. 204). Pl. 19,172; sample no. H14 (tab. 4).
Koenig et al. 1993; Naue 1905, 121 f.; Schaeffer 1930, 20 fig. 15c; Tremblay Cormier 2016, 270.

Harthouse (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
398 Mound 4 grave 1; Ha D2; Mus. Haguenau (inv. no. 133). Pl. 20,173.
399 Mound 5 grave 1; Ha D2; Mus. Haguenau (inv. no. 135). Pl. 20,174; sample no. H10 (tab. 4).
400 Mound 12 grave 6; Ha D1/D2; Mus. Haguenau (inv. no. 154). Pl. 20,175; sample no. H11 (tab. 4).
Koenig et al. 1993; Naue 1905, 85 f.; 89 f.; Schaeffer 1930, 106 f.; 113 fig. 96d; 103b; Tremblay Cormier 2016, 271.

Hügelsheim – Heiligenbuck (Lkr. Rastatt)
401 Mound secondary grave; Ha D1; Mus. Karlsruhe.
Tremblay Cormier 2016, 200; Wagner 1911, 52–55 fig. 58a.

Ihringen – Löhbücke/Auf dem Ried (Lkr. Breisgau-Hochschwarzwald)
402 Mound 1859; Ha D; Mus. Breisach (inv. no. 1885-4-1-1).
403 Mound; Ha D; ZFA Rastatt (inv. no. 1905-0001/P1021i).
Tremblay Cormier 2016, 203; Wagner 1908, 187–194.

Kappel am Rhein – Trisloch (Ortenaukr.)
404 Mound 3 central grave; Ha D1; Mus. Freiburg (inv. no. 1976-62-23-1). Pl. 20,176.
Dehn et al. 2005, 45–47 ; 70–75 fig. 16,1; Tremblay Cormier 2016, 200.

Koenigsbruck – Maison forestière (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
405 Mound 12 grave 2; Ha D2; Mus. Haguenau (inv. no. 264). Pl. 20,177; sample no. H15 (tab. 4).
406 Mound 14 grave 2; Ha D2; Mus. Haguenau (inv. no. 274). Pl. 20,178.
407 Mound 14 grave 12; Ha D2/D3; Mus. Haguenau (inv. no. 284). Pl. 21,179.
408 Mound 18 grave 1; Ha D1/D2; Mus. Haguenau (inv. no. 309). Pl. 21,180.
Koenig et al. 1993; Naue 1905, 109; 111–113; 117 f.; Schaeffer 1930, 34; 40; 42 f.; 49 figs. 30d; 32i.r; 37a; Tremblay Cormier 2016, 273.

Maegstub (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
409 Mound 1 grave 4 (group C); Ha D2/D3; Mus. Haguenau (inv. no. 5). Pl. 21,181.
410 Mound 14 grave 2 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 46). Pl. 21,182.
411 Mound 20 grave 1 (group C); Ha D1/D2; Mus. Haguenau (inv. no. 60). Pl. 21,183; sample no. H36 (tab. 4).
Koenig et al. 1993; Naue 1905, 56; 63–65; Schaeffer 1930, 142; 158; 160 fig. 122; Tremblay Cormier 2016, 275.

Meissenheim – Langenrod (Ortenaukr.)
412 Mound grave 3; Mus. Karlsruhe (inv. no. C. 5359c/2).
Tremblay Cormier 2016, 201; Wagner 1908, 239–242.

Obermodern – Le long de la voie ferrée (Dép. Bas-Rhin, F)
413 Mound; Ha D1; Mus. Haguenau (inv. no. 677). Pl. 21,184.
Schaeffer 1930, 181; Tremblay Cormier 2016, 279.

Oblungen – 2 km au nord-est du village (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
414 Mound 3 grave 10; Ha D; Mus. Haguenau (inv. no. 174). Pl. 21,185.
415 Mound 3 grave 14; Ha D2; Mus. Haguenau (inv. no. 178). Pl. 22,186.
416 Mound 3 grave 16; Ha D2; Mus. Haguenau (inv. no. 180). Pl. 22,187.
Koenig et al. 1993; Naue 1905, 79 f.; Schaeffer 1930, 124; 126 figs. 108c; 109,l; 112c; Tremblay Cormier 2016, 279.

Schirrhein – Fischerhubel et Kurzgeland (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
417 Mound 1 grave 4; Ha D; Mus. Haguenau (inv. no. 317). Pl. 22,188; sample no. H37 (tab. 4).
418 Mound 8 grave 9; Ha D2; Mus. Haguenau (inv. no. 348). Pl. 22,189; sample no. H38 (tab. 4).
Koenig et al. 1993; Naue 1905, 144; 152; Schaeffer 1930, 51; 60 fig. 49; Tremblay Cormier 2016, 280 f.

Schirrhein – Schirrheinerweg (Dép. Bas-Rhin, F)
Excavations by X. Nessel.
419 Mound 6 grave 3; Ha D2; Mus. Haguenau (inv. no. 586). Pl. 22,190; sample no. H3 (tab. 4).
Koenig et al. 1993; Naue 1905, 172; Schaeffer 1930, 80; Tremblay Cormier 2016, 282.

Sundhoffen – Forêt du Kastenwald (Dép. Haut-Rhin, F)
420 Mound 1 grave 9; Ha D2; Mus. Colmar.
Jehl/Bonnet 1954, 29 pl. 1 fig. 7; Tremblay Cormier 2016, 289.

Uhlwiller – Au nord-est du village (Dép. Bas-Rhin, F)
421 Mound 15 grave 3; Ha D3; Mus. Haguenau (inv. no. 193). Pl. 23,191.
422 Mound 15 grave 4; Ha D3; Mus. Haguenau (inv. no. 194). Pl. 23,192.
Koenig et al. 1993; Naue 1905, 74 f.; Schaeffer 1930, 133 f. figs. 115a; 116a; Tremblay Cormier 2016, 284.

Weissensee/Oberfeld (Dép. Bas-Rhin, F)
423 Mound 38 grave 2; Ha D2; Mus. Haguenau (inv. no. 435). Pl. 23,193; sample no. H41 (tab. 4).
Schaeffer 1930, 14 fig. 10n; Tremblay Cormier 2016, 284.

Wolfgantzen (Dép. Haut-Rhin, F)
424 Mound, grave; Ha D. Pl. 22,194.
Jehl/Bonnet 1966, 46 fig. 2; Tremblay Cormier 2016, 290.

ILLUSTRATION CREDITS

Figs. 1,1.2, 3, 4, 6, 7,2.4, 8 and 11: L. Tremblay Cormier. – Fig. 1,3: Degen 1968, fig. 4,3. – Figs. 2 and 5: L. Tremblay Cormier, Qgis 2.8.1, SRTM Data, Hydrography (Natural Earth Data). – Fig. 7,1.3: Dubreucq 2013, pl. 52,2.4. – Figs. 9, 10 and diagr. 1, 2: B. Mille/L. Tremblay Cormier.

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ZUSAMMENFASSUNG

Während der älteren Eisenzeit ist eine spezifische Metallproduktion für die Oberrheinregion kennzeichnend. Ziel der vorliegenden Studie ist es, deren Definition zu präzisieren, indem bestimmte regionale Formen von Ringschmuck eingehend untersucht werden: Armringe vom Typ Baden-Elsass sowie massive, geschlossene Arm-, Fuß- und Halsringe mit kreisförmigem Querschnitt und ohne Verzierung. Letztere lassen die Existenz einer normierten Tracht erkennen, die sich auch im Tragen derartiger Schmuckstücke seit der Kindheit manifestiert. Der zweite Teil der Studie beschäftigt sich mit den verwendeten Materialien und hat die Identifikation chemischer Kompositionstypen zum Ziel. Metallurgische Traditionen wie Legierungsrezepturen und die Wahl von Rohmaterialien werden ebenso diskutiert wie die technischen Ähnlichkeiten zwischen bestimmten ‚Zwillings'-Objekten. Die Arbeit ist das Ergebnis eines zweijährigen Post-Doc-Projekts, das von der Fritz Thyssen Stiftung gefördert und vom damaligen Referat Denkmalpflege im Regierungspräsidium Freiburg betreut wurde.

SCHLAGWORTE

Ältere Eisenzeit; Ringschmuck; Identität; Kupferlegierungen; Elementzusammensetzung.

SUMMARY

During the Early Iron Age, the Upper Rhine valley is characterized by a specific set of metal production techniques. This study aims at refining its definition through the in-depth analysis of certain regional ring ornaments: Bade-Alsace arm rings and closed arm, ankle and neck rings with a massive circular cross section and an undecorated surface. The latter group indicates the existence of a standardized costume, partly manifested in the wear of such ornaments since childhood. The second part of the study focuses on the employed materials and aims at identifying chemical composition types. Aspects of metallurgical traditions such as the alloy recipes and the choice of primary materials are discussed, just as are technical relations between some ornaments (e. g. twin compositions). This paper is based on research for a two-year post-doctorate project funded by the Fritz Thyssen foundation and hosted by the former regional Archaeological Service in the Regierungspräsidium Freiburg.

KEYWORDS

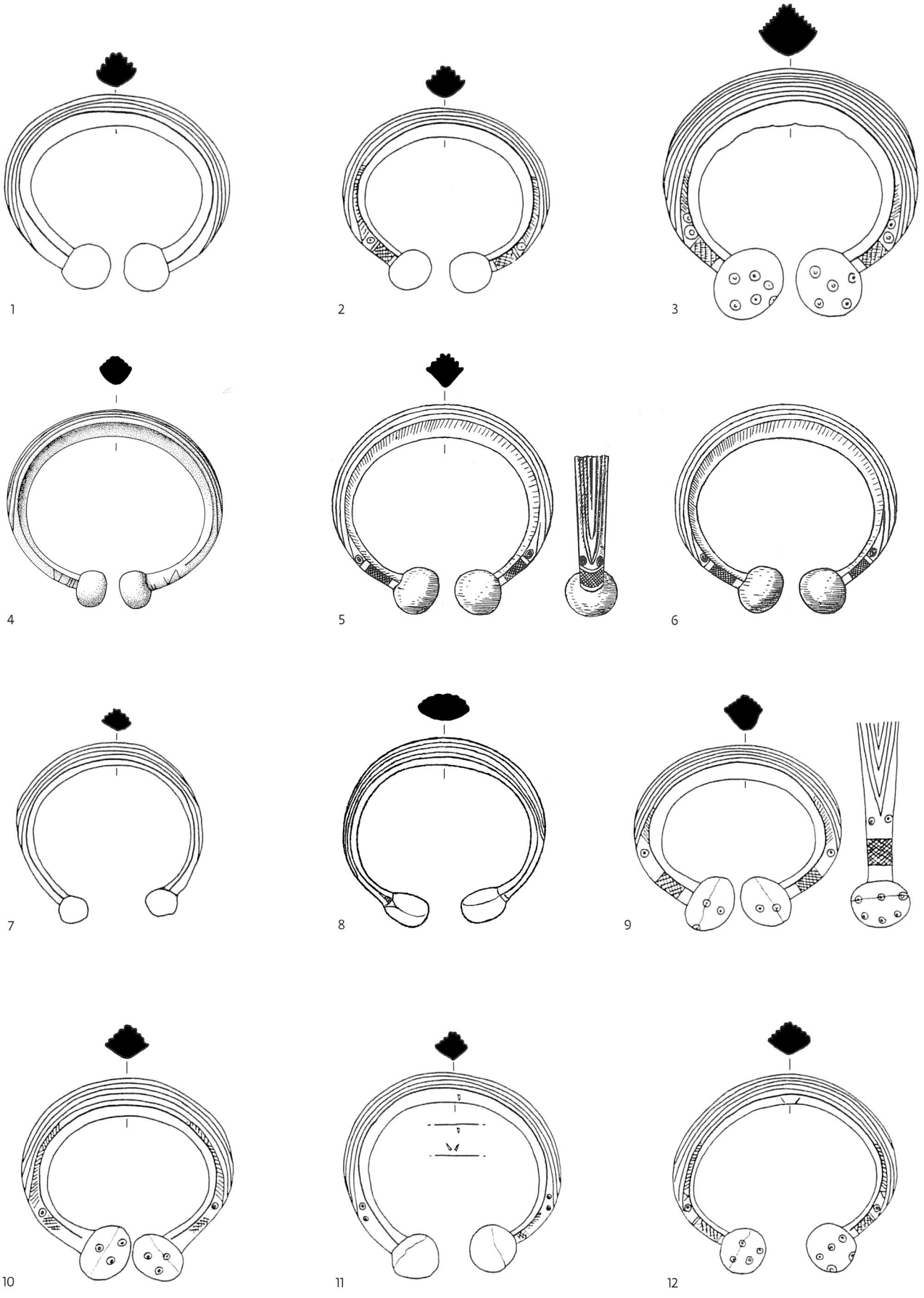
Early Iron Age; ring ornaments; identity; copper alloys; chemical composition.

RÉSUMÉ

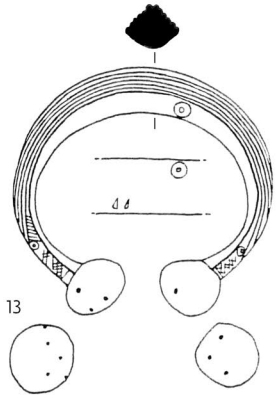
La vallée du Rhin supérieur se distingue, au premier Âge du Fer, par une production métallique caractéristique. La présente étude a pour objectif d'en approfondir la définition, par une analyse précise de certains types régionaux de parures annulaires: les bracelets de type Bade-Alsace et les bracelets, anneaux de cheville et torques massifs de section circulaire, fermés et lisses. Ces derniers montrent l'existence d'un costume normé, qui se manifeste entre autres par le port de telles parures depuis l'enfance. La seconde partie de l'étude concerne les matériaux employés et s'attache à l'identification de types de compositions chimiques. Les traditions métallurgiques (recettes d'alliages, choix des matières premières) sont ainsi abordées, de même que la parenté technique de certaines parures (compositions jumelles). Cette étude est issue d'un post-doctorat de deux ans financé par la fondation Fritz Thyssen et accueilli par l'ancien Office de la Protection des Monuments Historiques dans le Regierungspräsidium Freiburg.

MOTS CLÉS

Premier Âge du Fer; parure annulaire; identité; alliage cuivreux; composition élémentaire.



Bade-Alsace variant A1 arm rings. Scale 1 : 2.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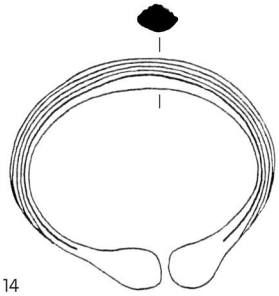
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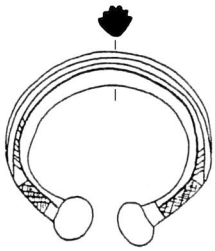
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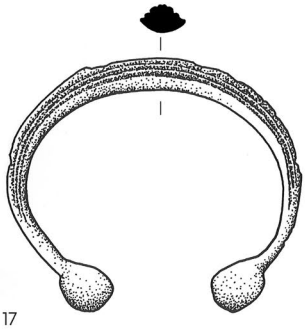
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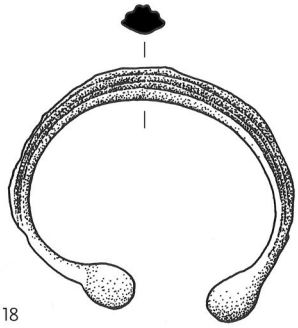
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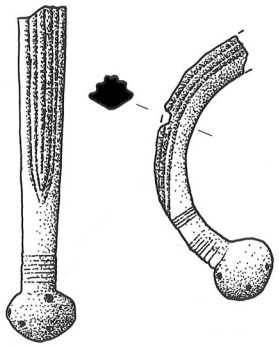
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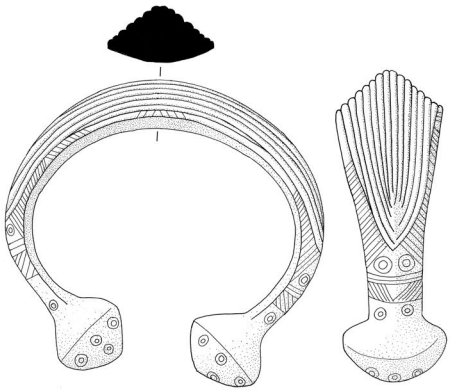
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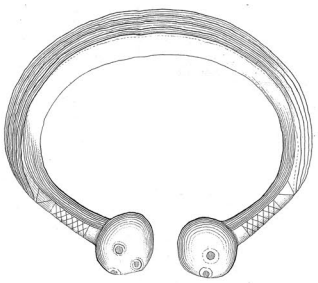
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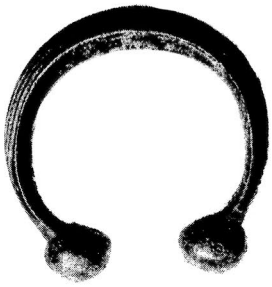
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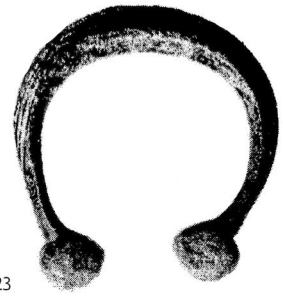
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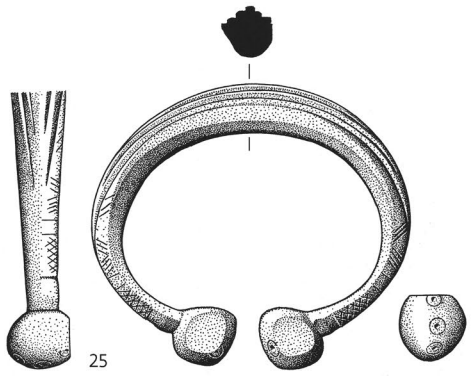
Bade-Alsace variant A1 arm rings. Scale 1 : 2.



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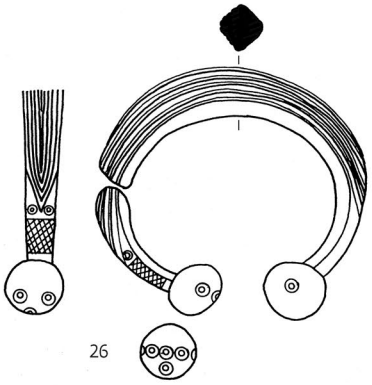

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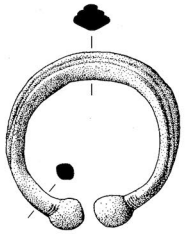

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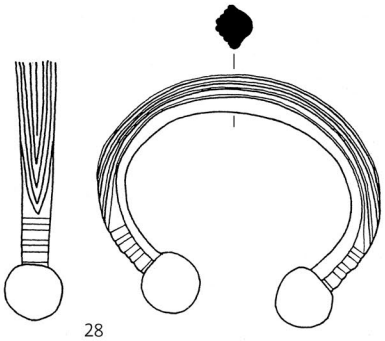

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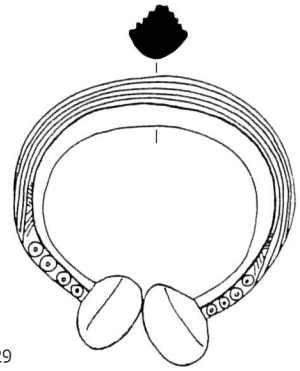

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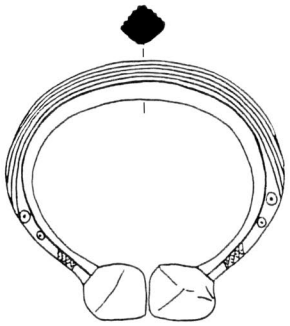

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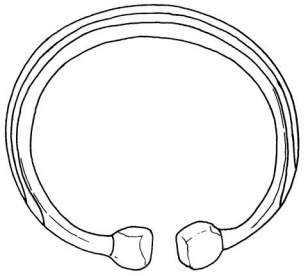

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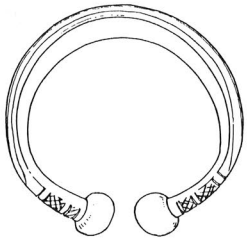

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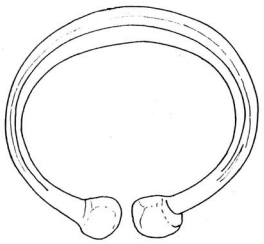

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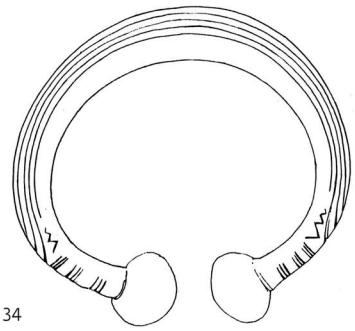

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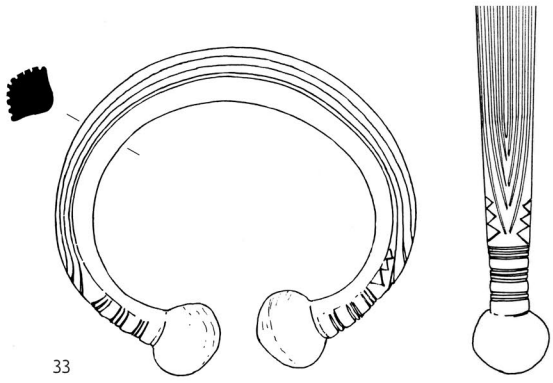

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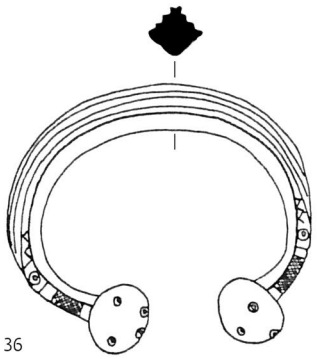
Bade-Alsace variant A1 arm rings. Scale 1 : 2.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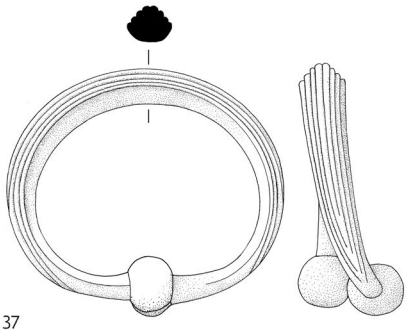
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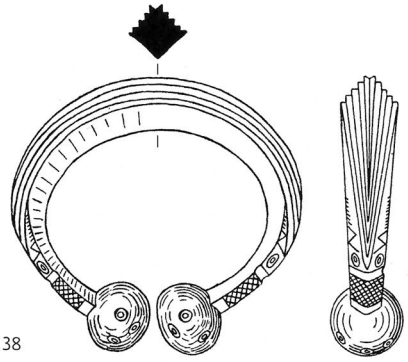
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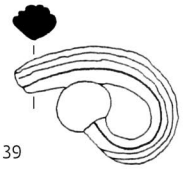
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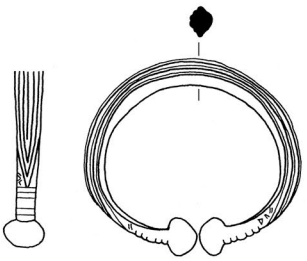
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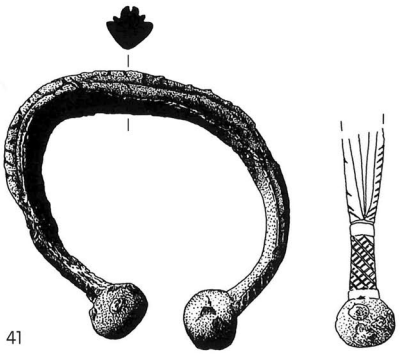
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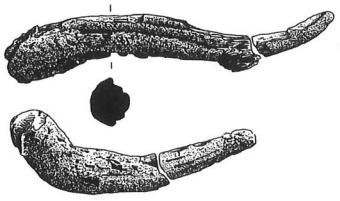
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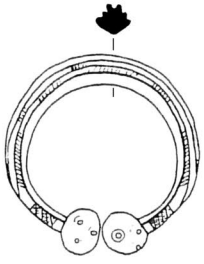
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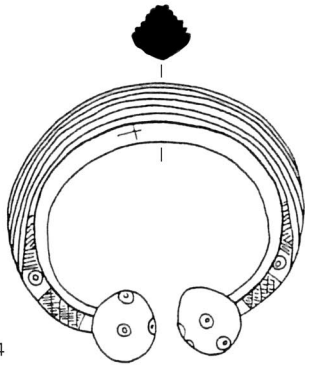
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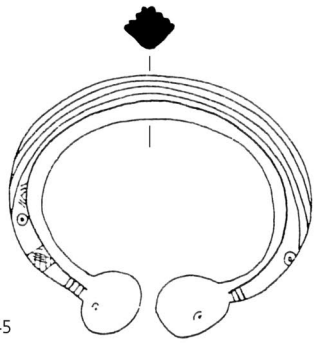
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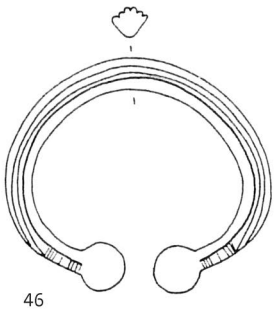
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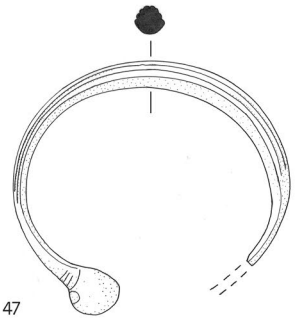
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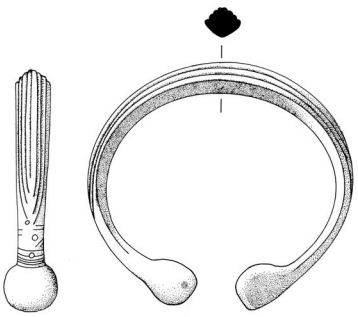
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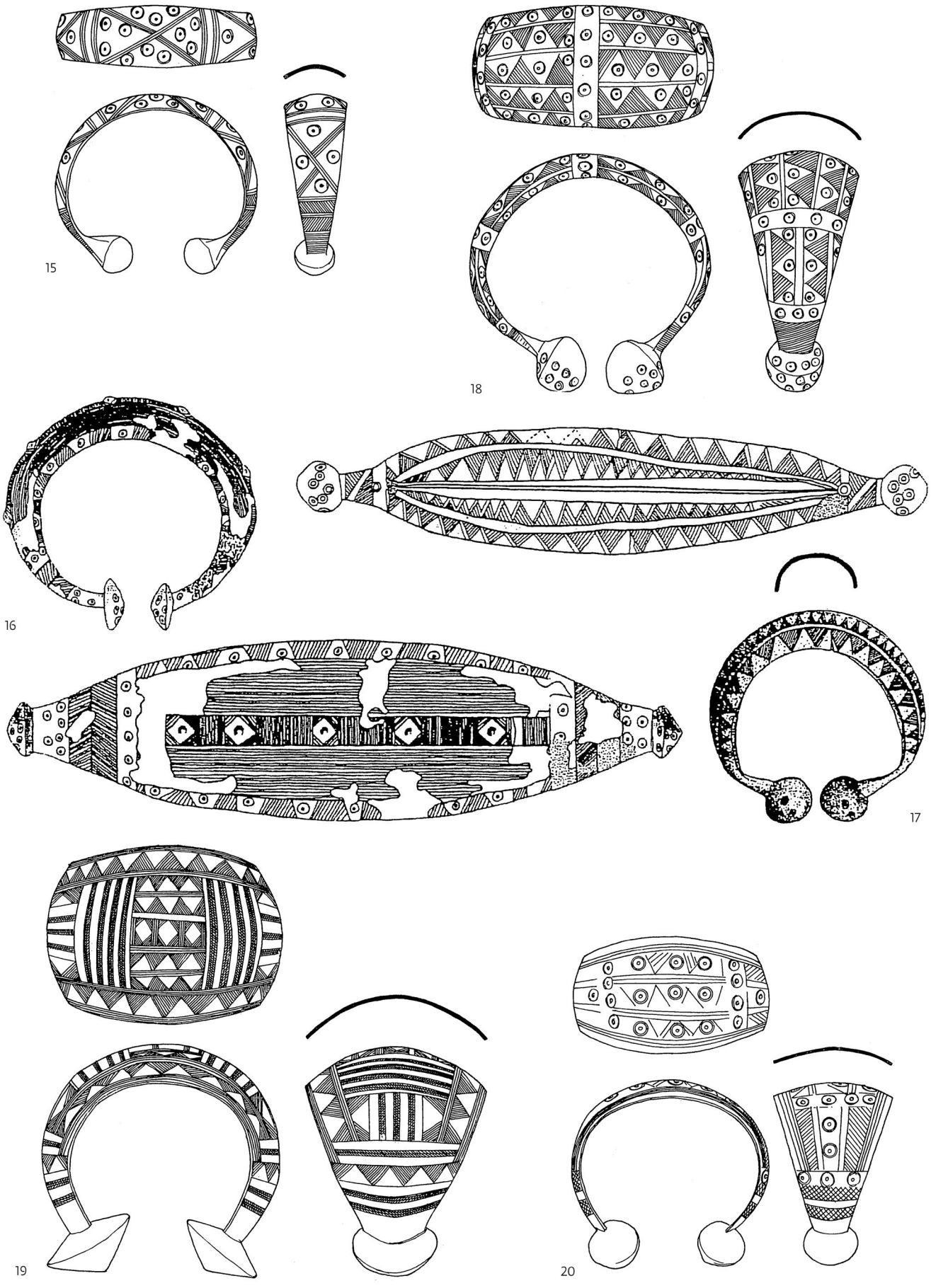
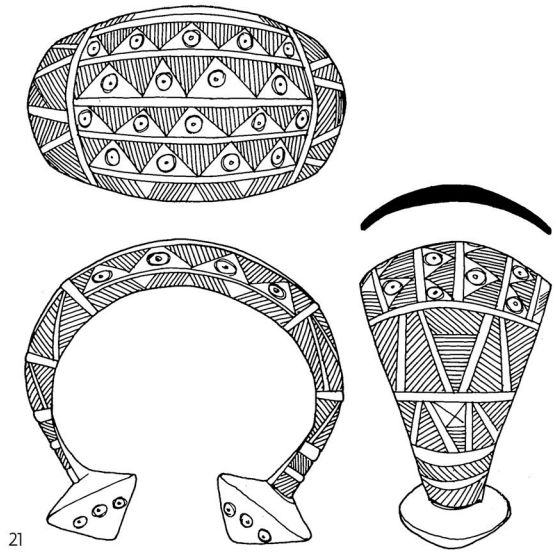
Bade-Alsace variant A1 arm rings. Scale 1 : 2.

Bade-Alsace variant B1 arm rings. Scale 1 : 2.

Bade-Alsace variant B1 arm rings. Scale 1 : 2.



Bade-Alsace variant B1 arm rings. Scale 1 : 2.



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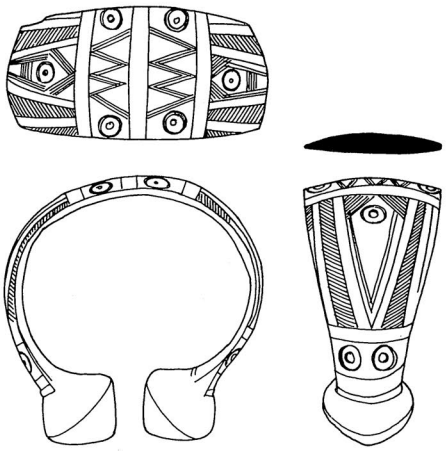

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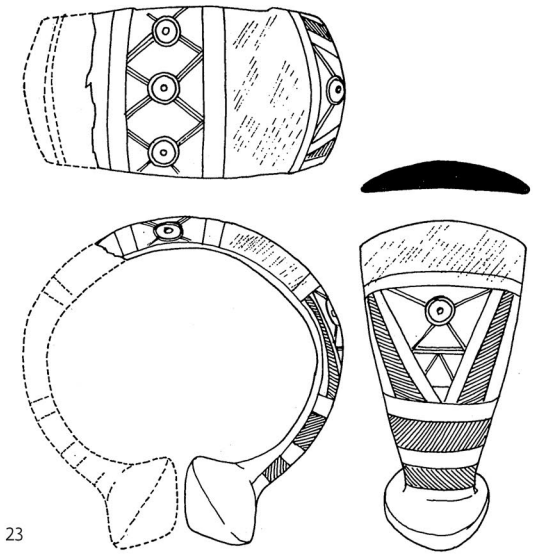

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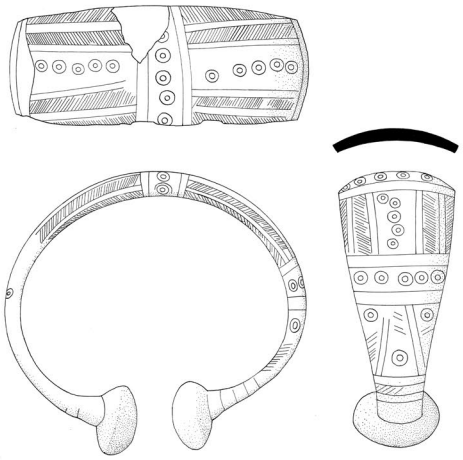

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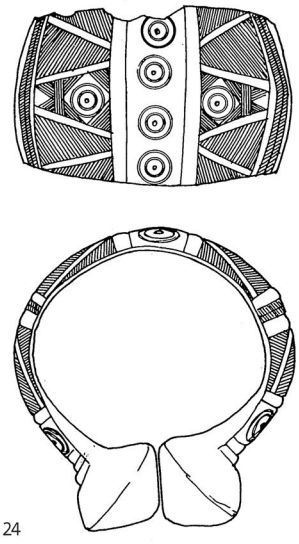

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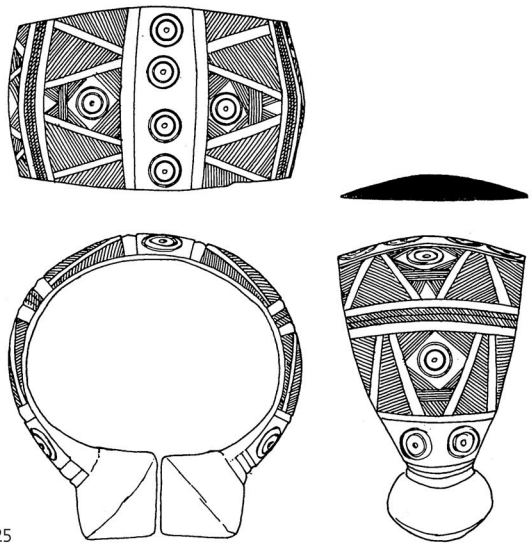

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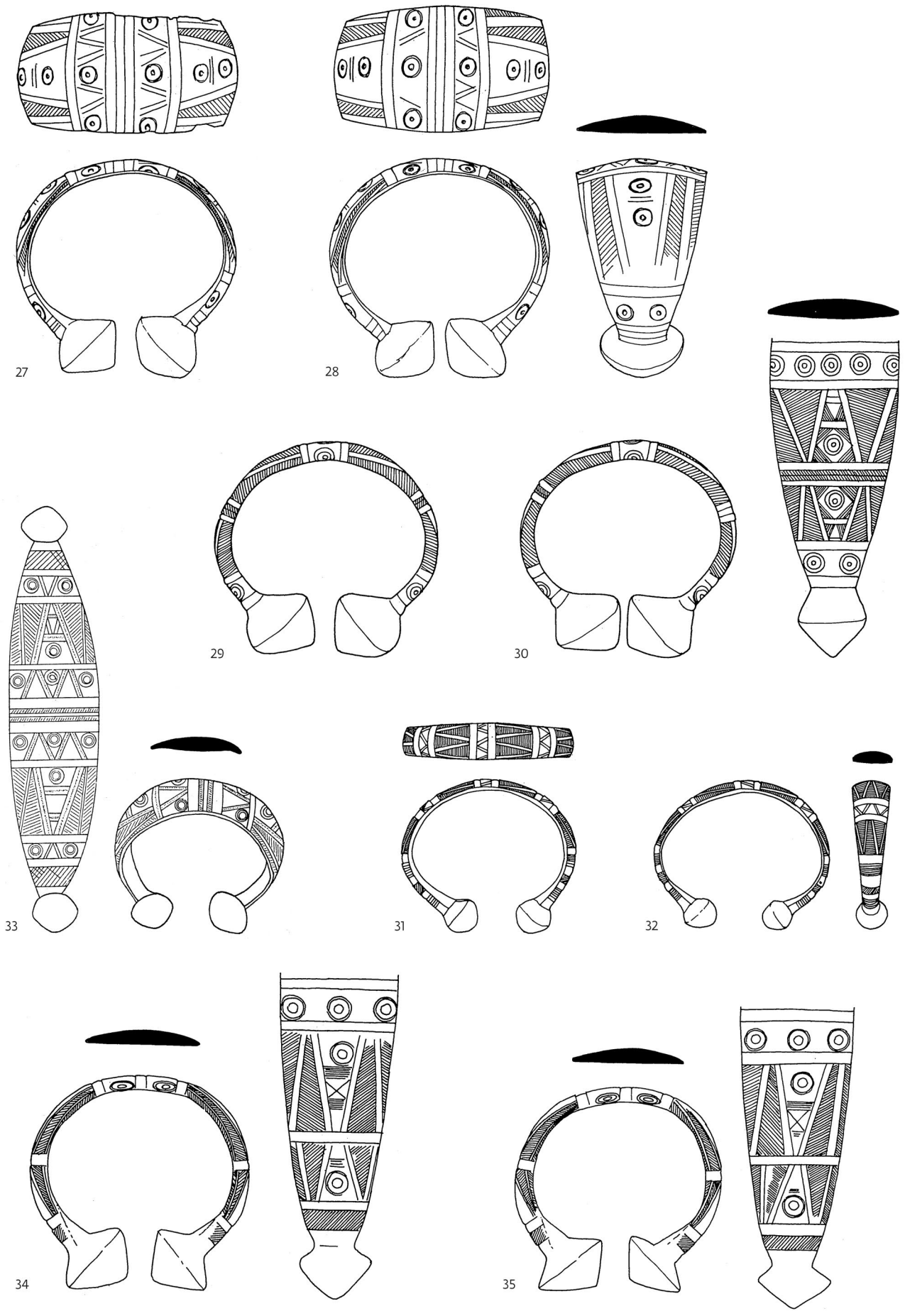
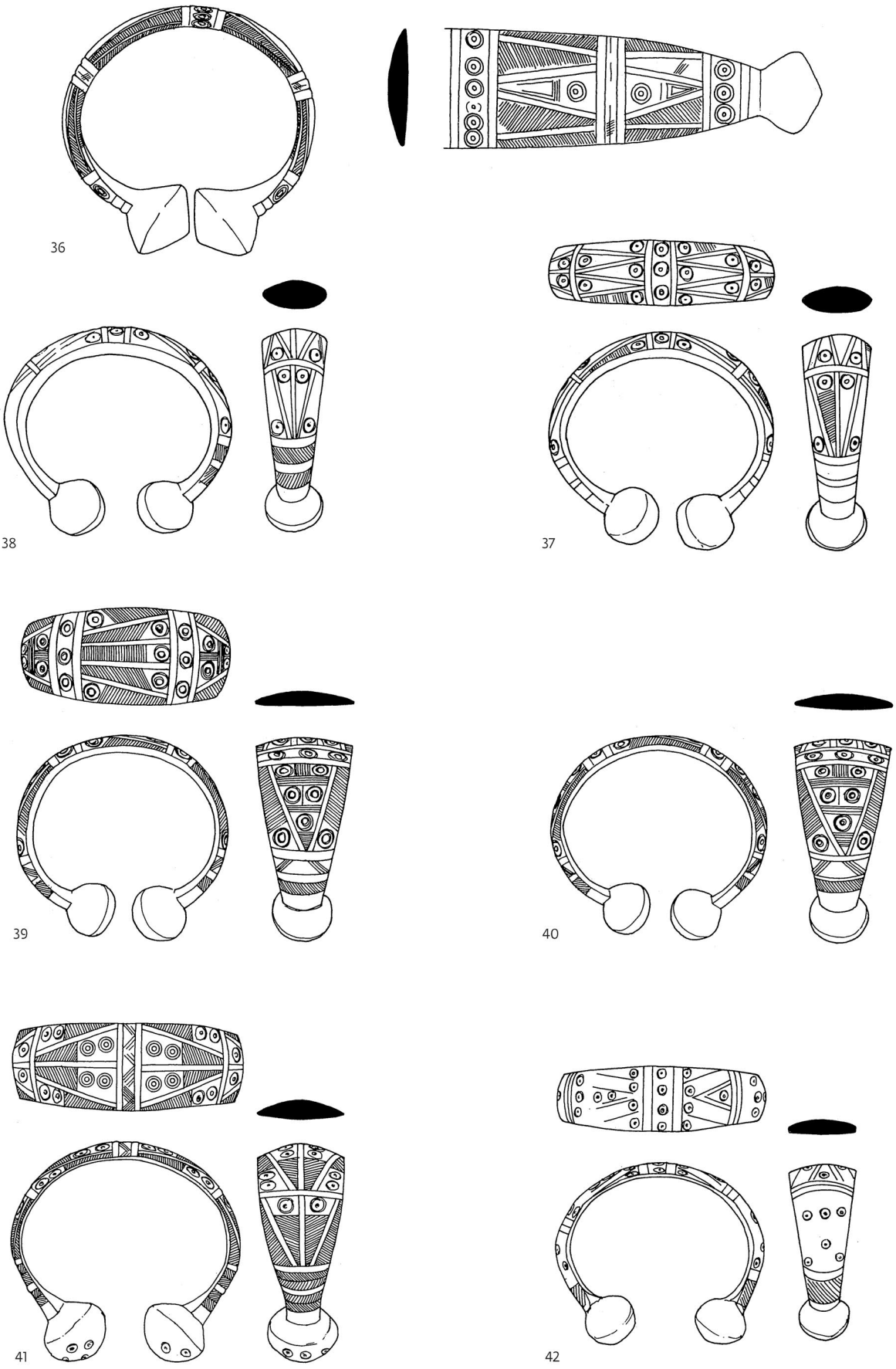
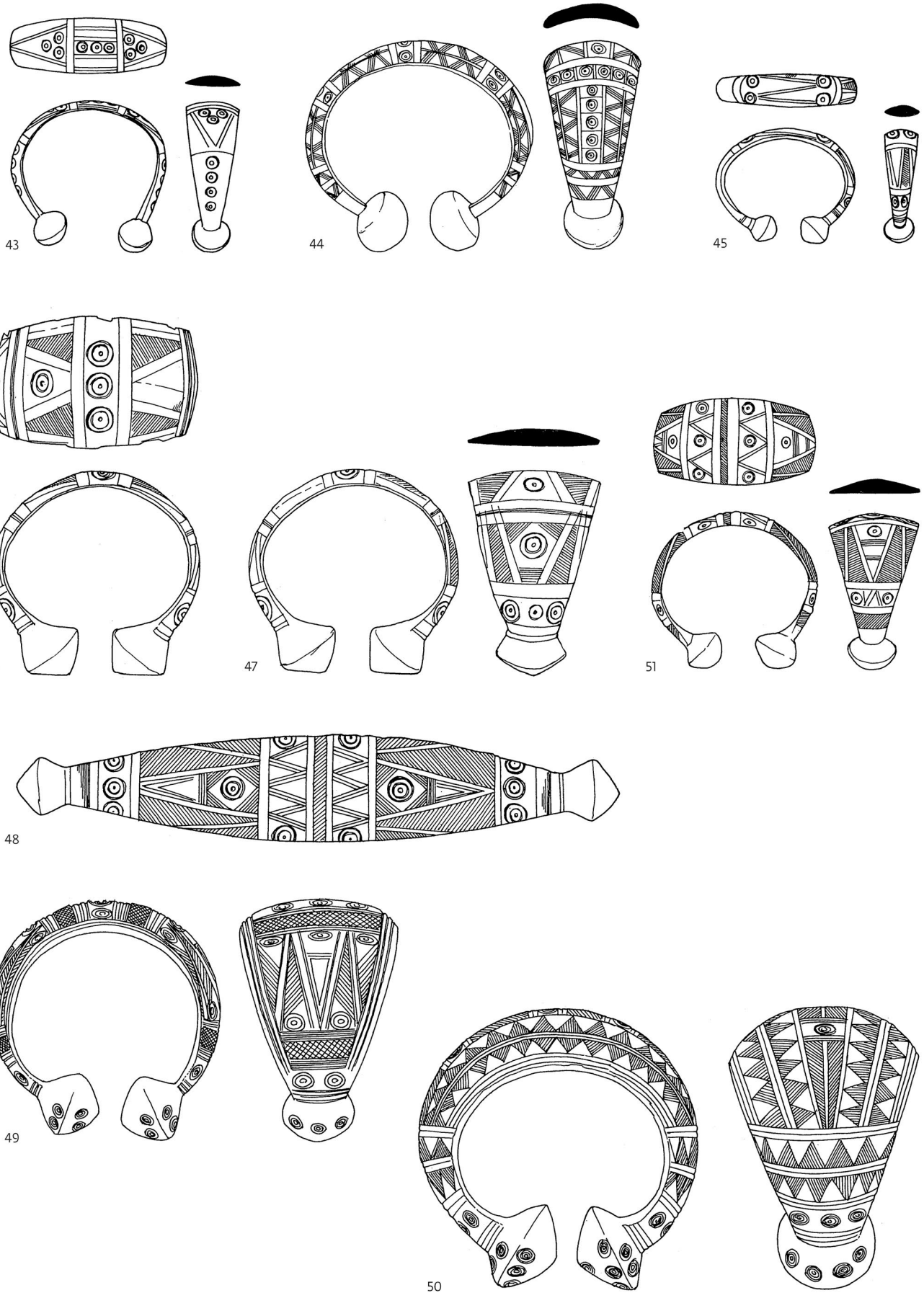
Bade-Alsace variant B2 arm rings. Scale 1 : 2.



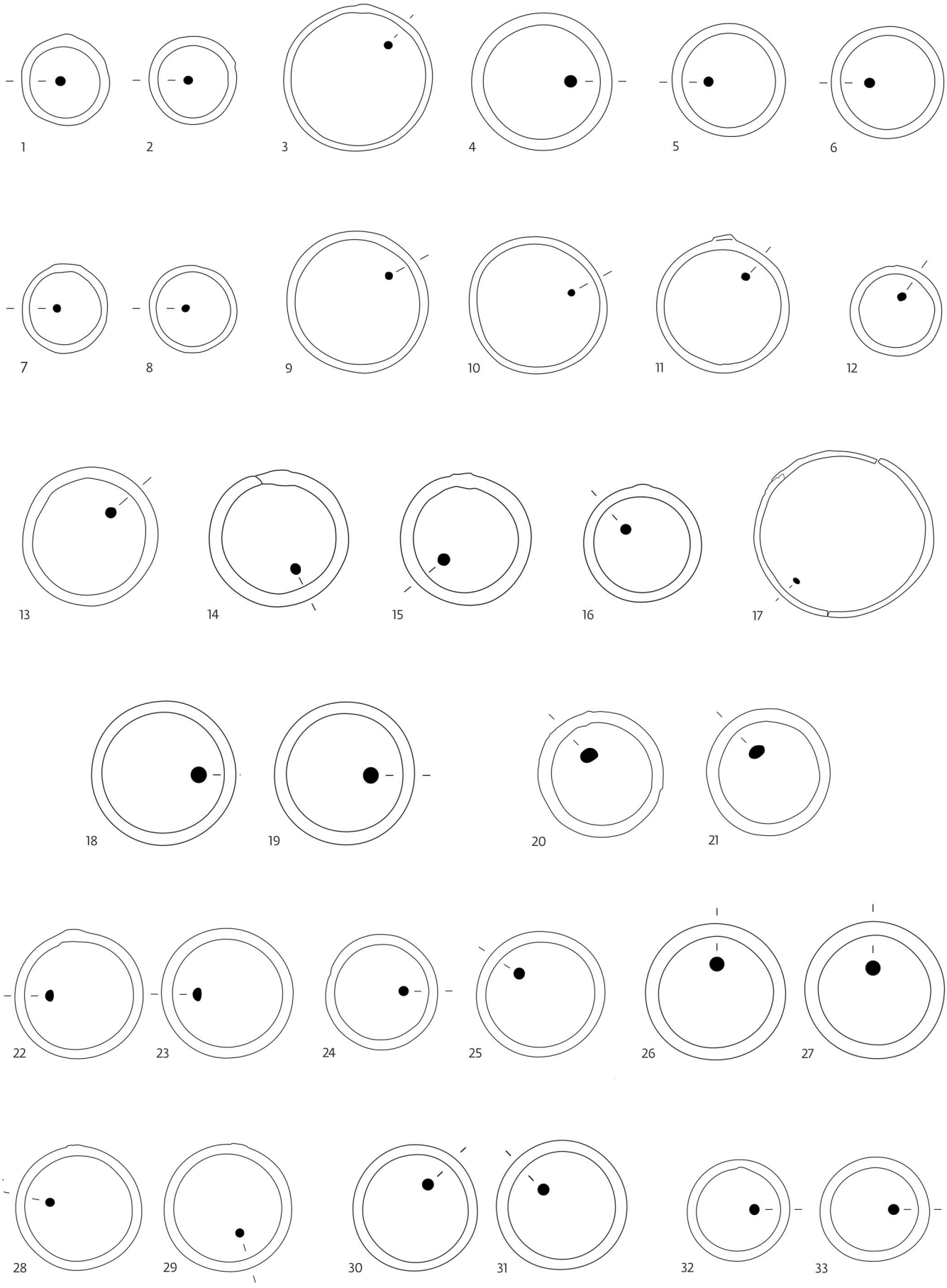
Bade-Alsace variant B2 arm rings. Scale 1 : 2.



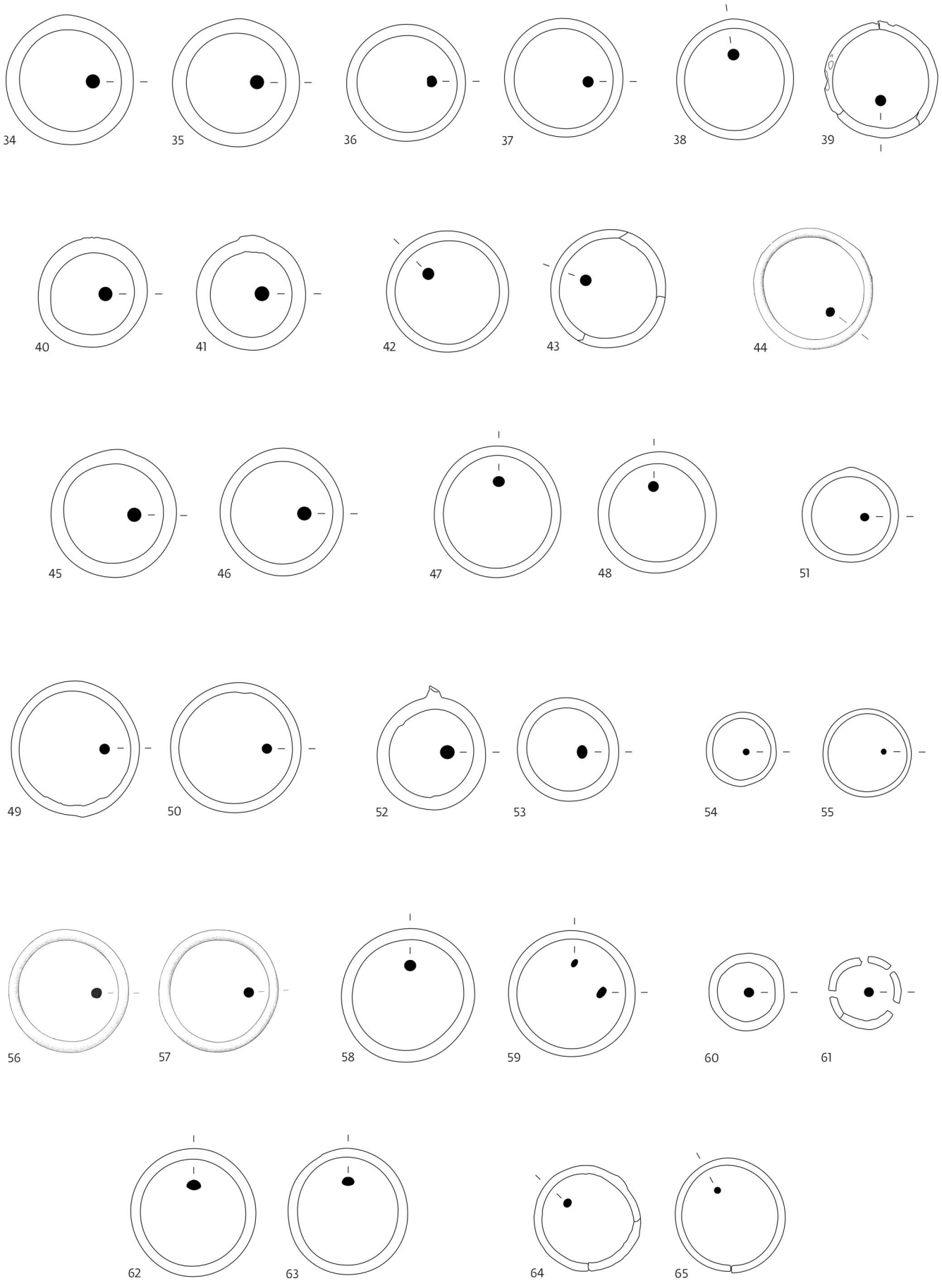
Bade-Alsace variant B2 arm rings. Scale 1 : 2.



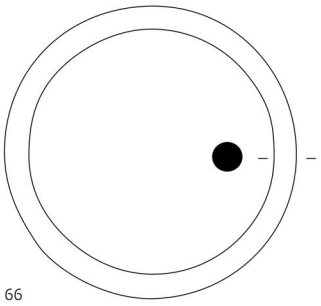
Bade-Alsace variant B2 arm rings. Scale 1 : 2.



Massive closed arm rings with circular section and no ornaments. Scale 1 : 3.



Massive closed arm rings with circular section and no ornaments. Scale 1 : 3.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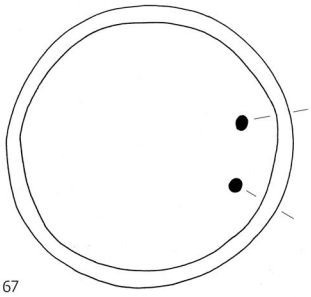
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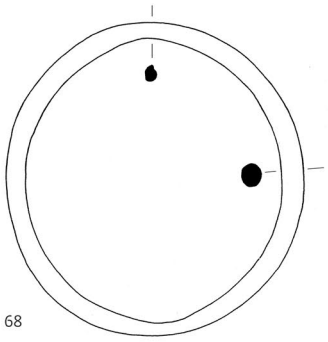
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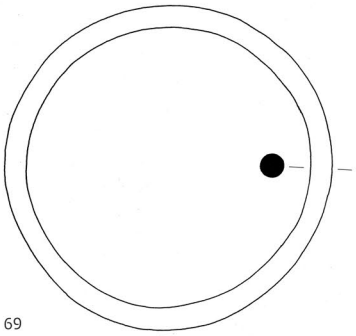
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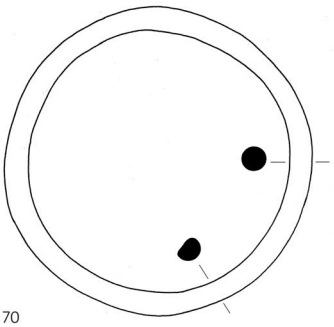
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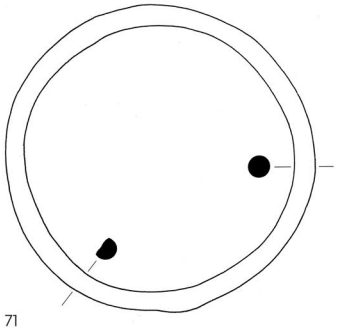
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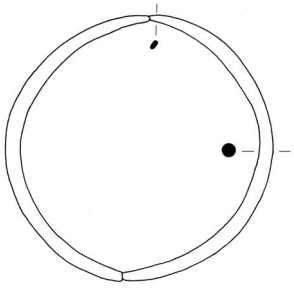
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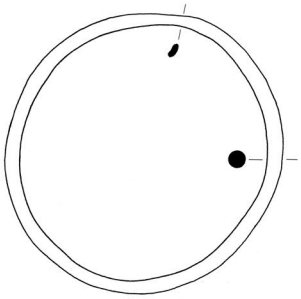
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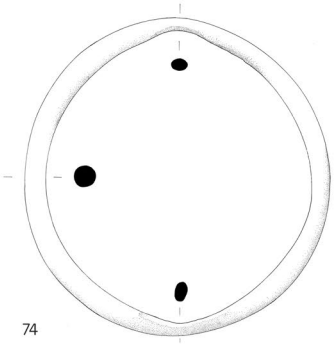
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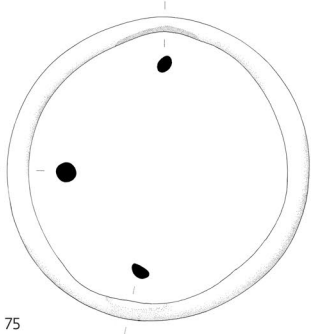
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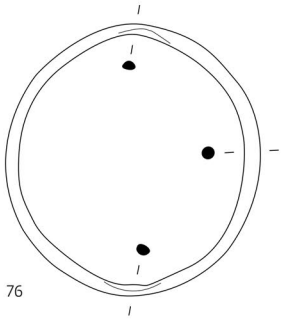
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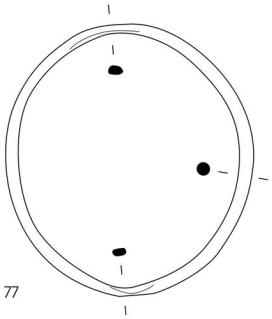
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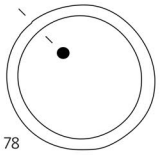
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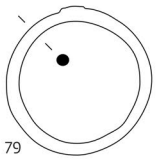
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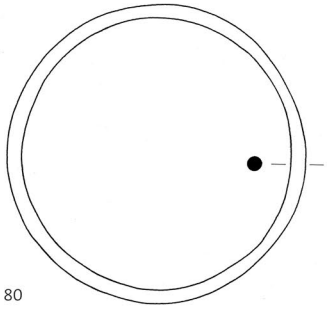
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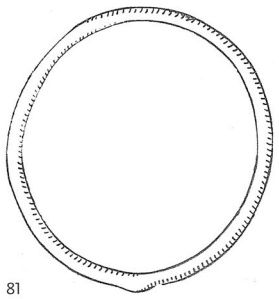
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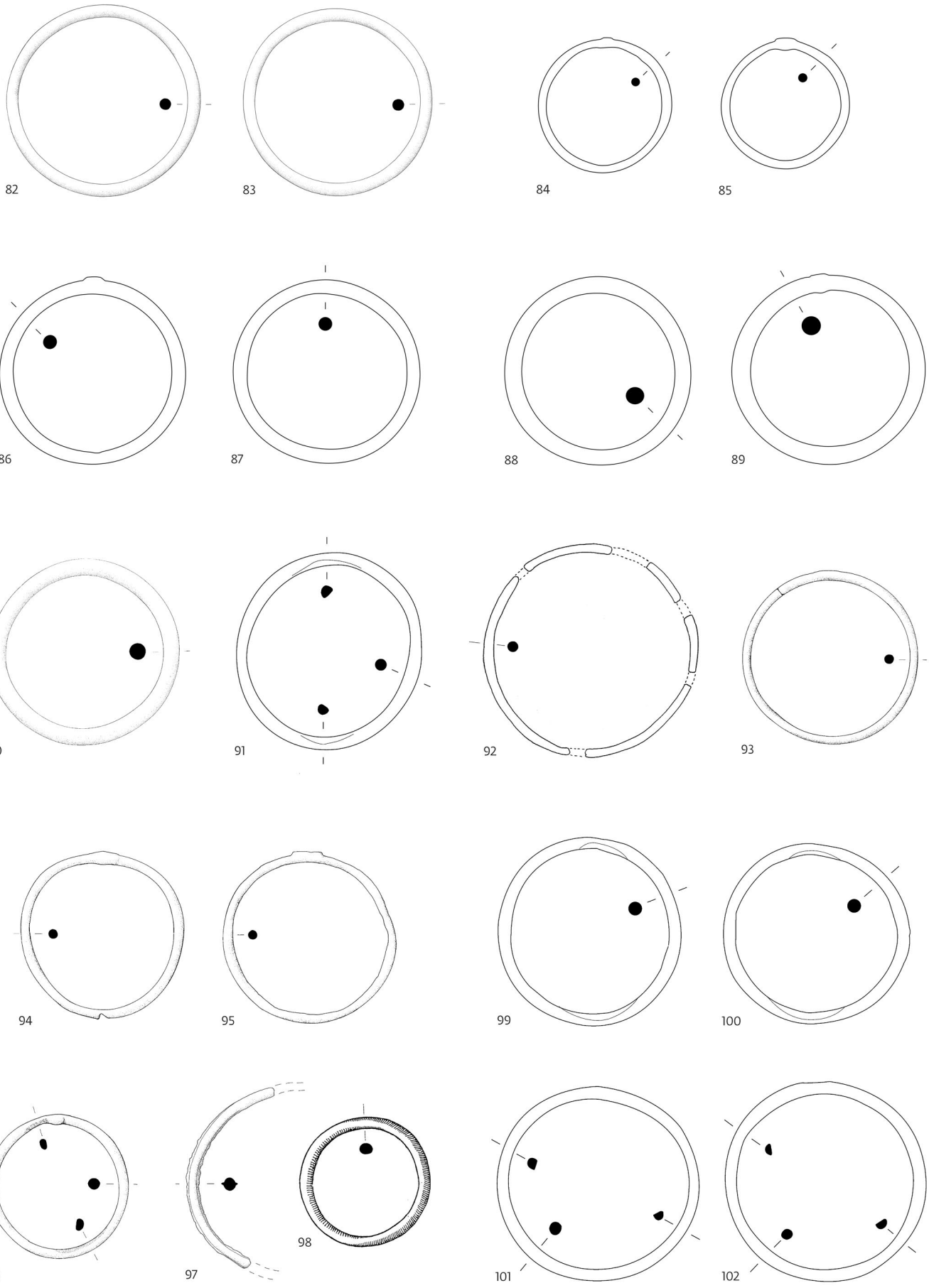
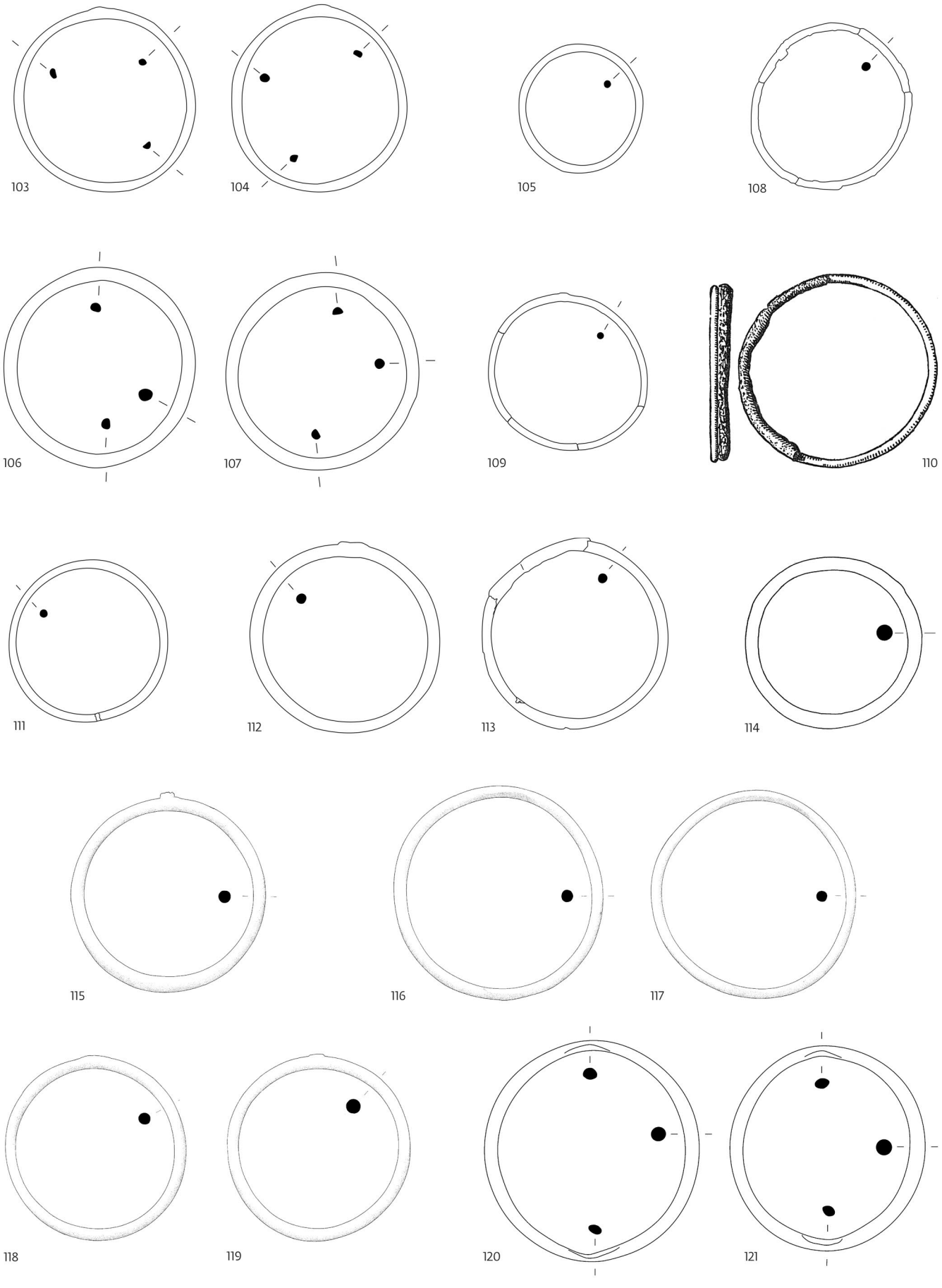
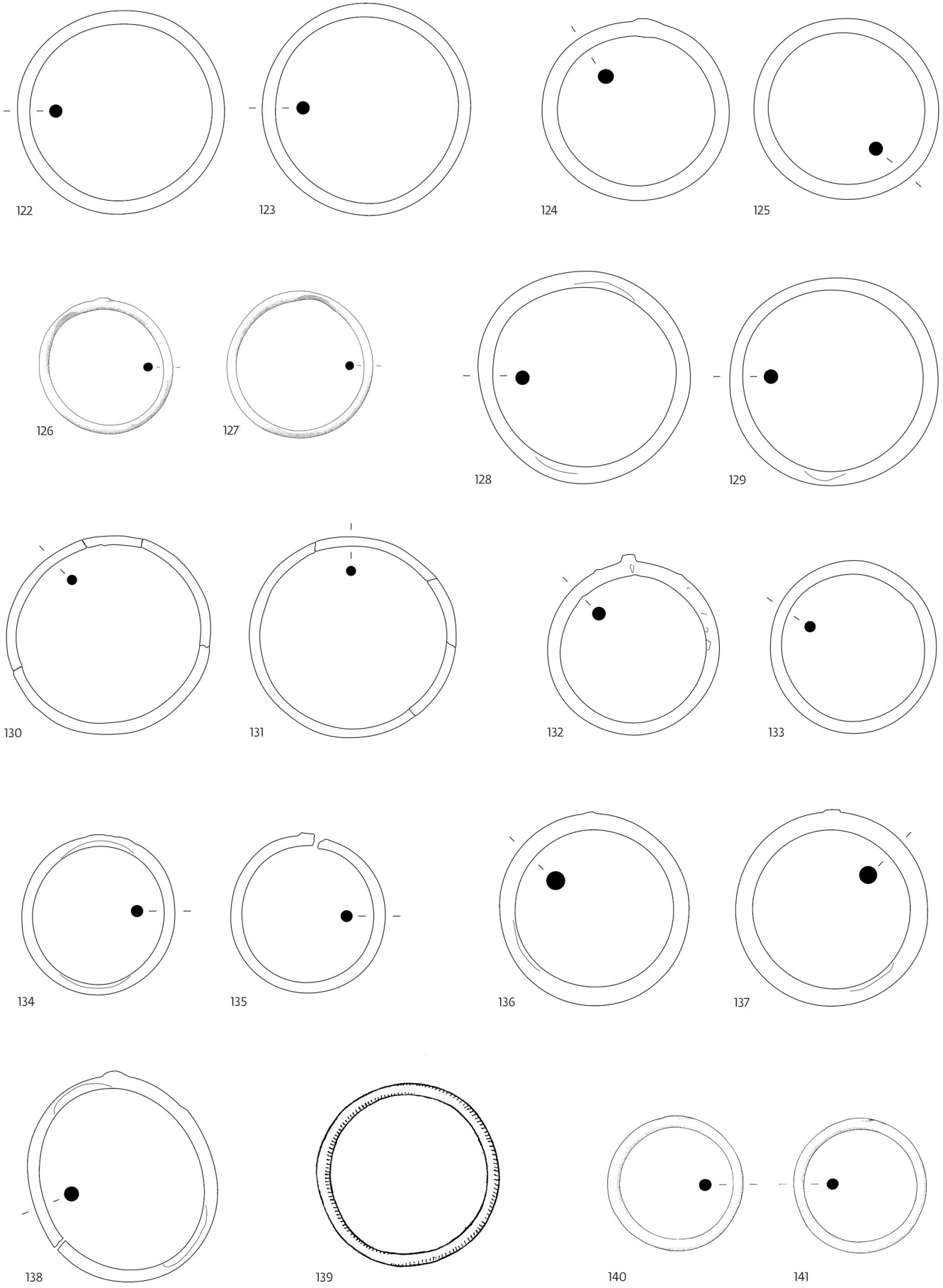
Massive closed ankle rings with circular section and no ornaments. Scale 1 : 3.



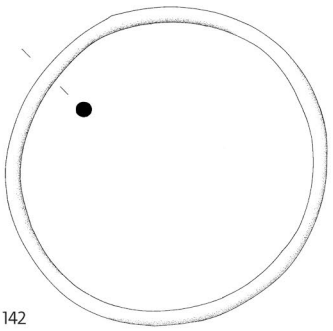
Massive closed ankle rings with circular section and no ornaments. Scale 1 : 3.



Massive closed ankle rings with circular section and no ornaments. Scale 1 : 3.



Massive closed ankle rings with circular section and no ornaments. Scale 1 : 3.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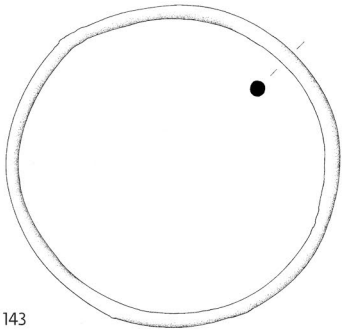
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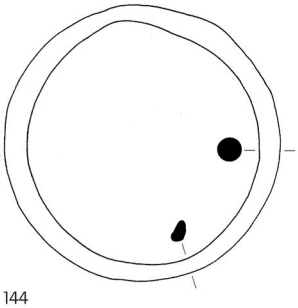
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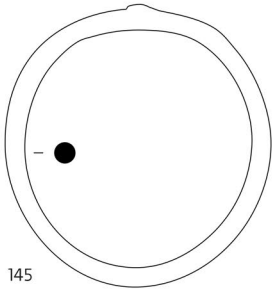
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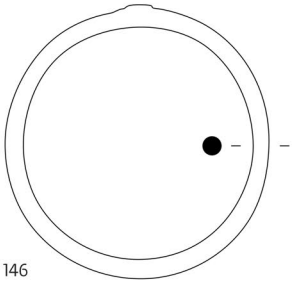
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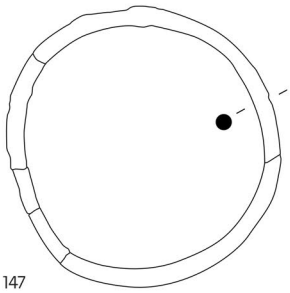
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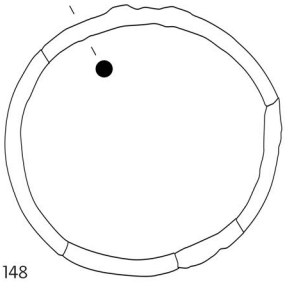
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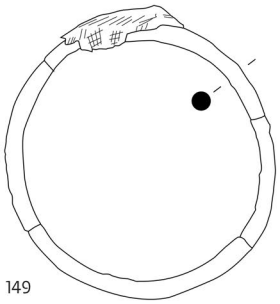
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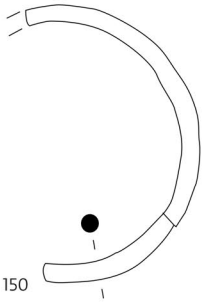
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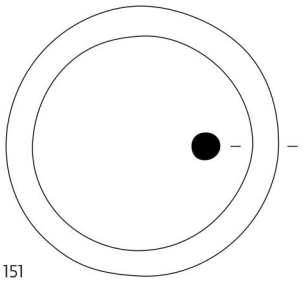
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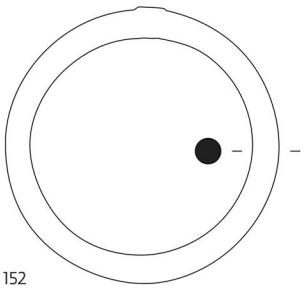
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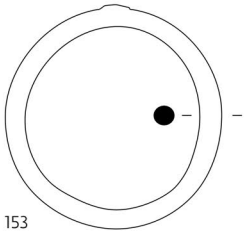
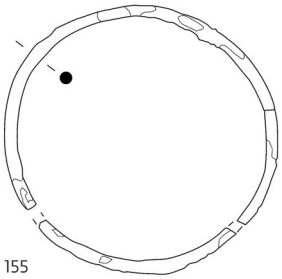

153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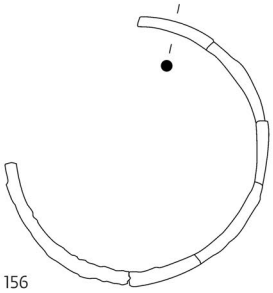
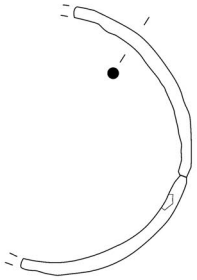

156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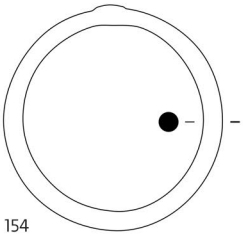
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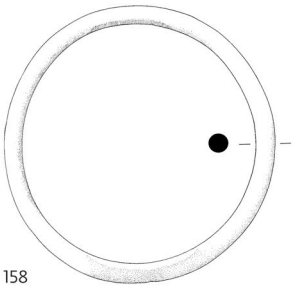
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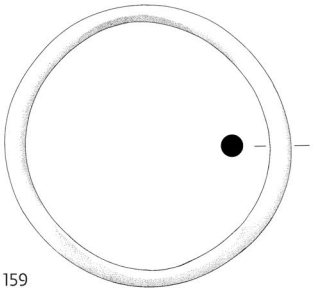
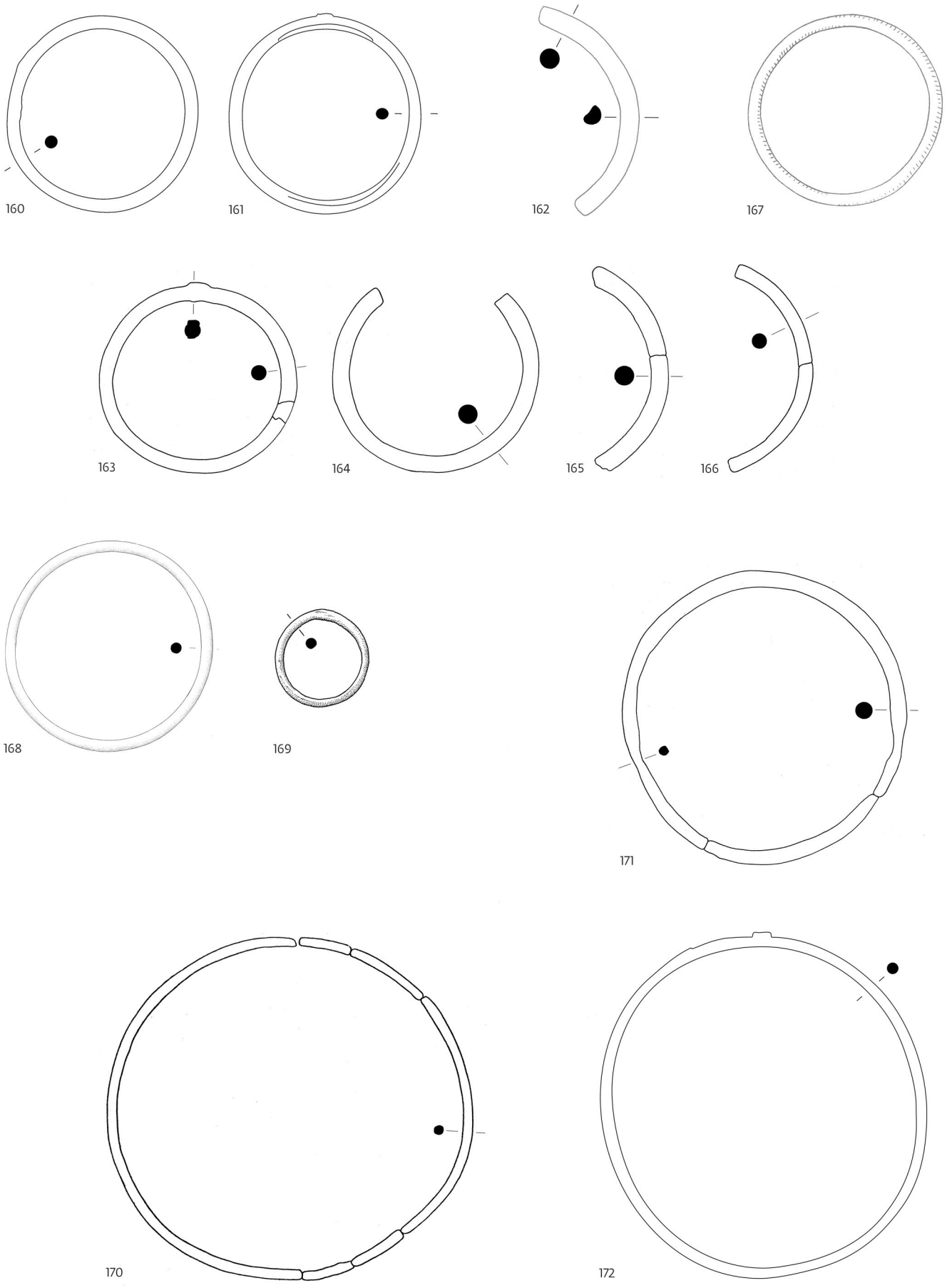
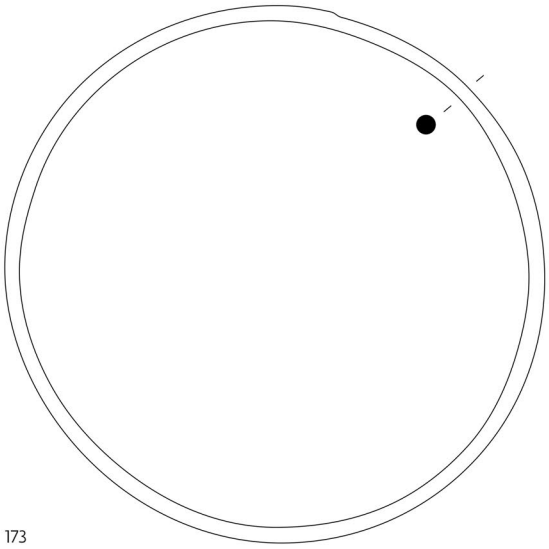

159

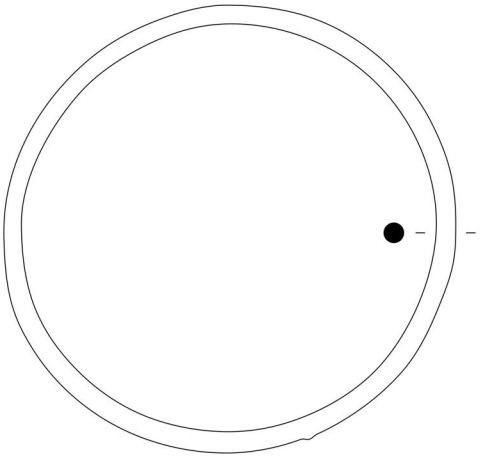
Massive closed ankle rings with circular section and no ornaments. Scale 1 : 3.



Massive closed ankle (160–169) and neck rings (170–172) with circular section and no ornaments. Scale 1 : 3.



173



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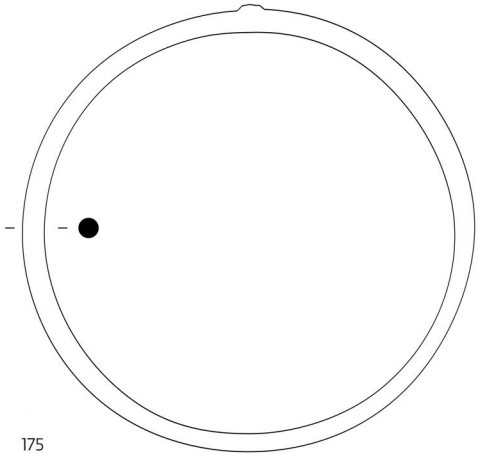
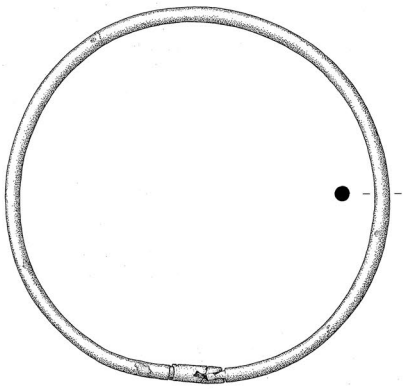
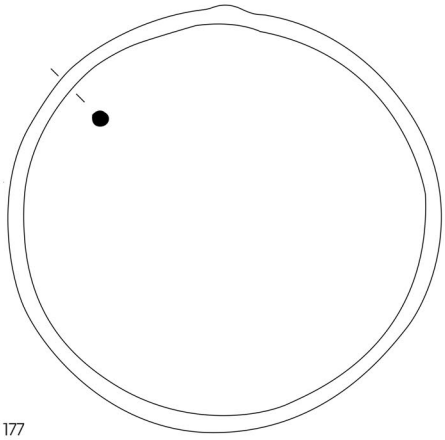


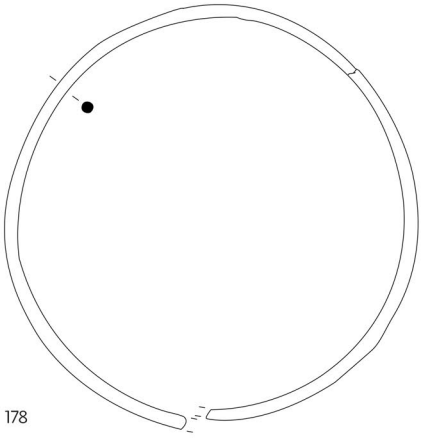
175



176

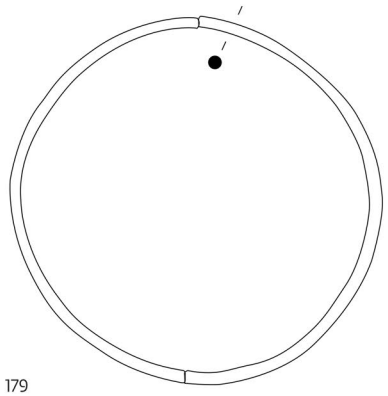


177

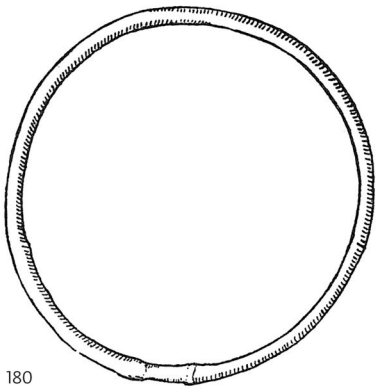


178

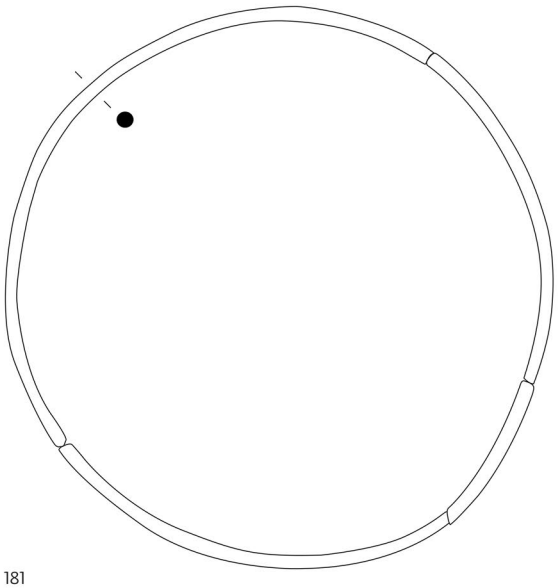
Massive closed neck rings with circular section and no ornaments. Scale 1 : 3.



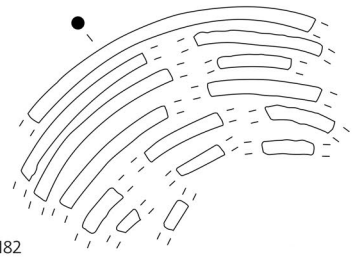
179



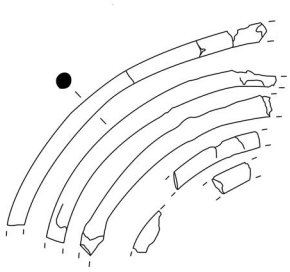
180



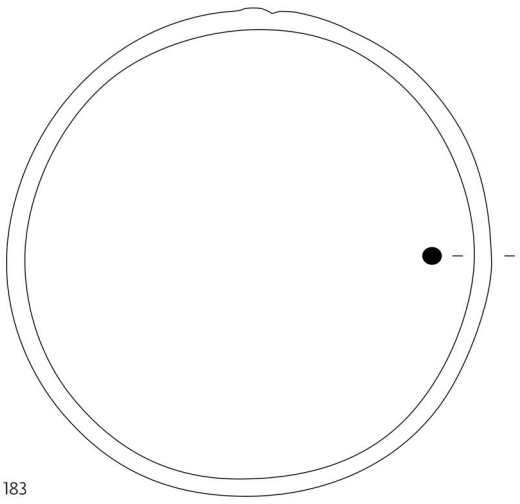
181



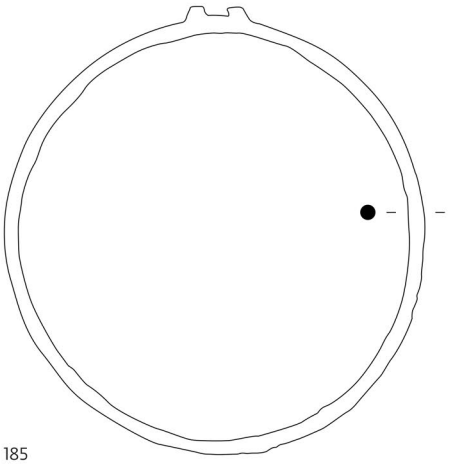
182



184

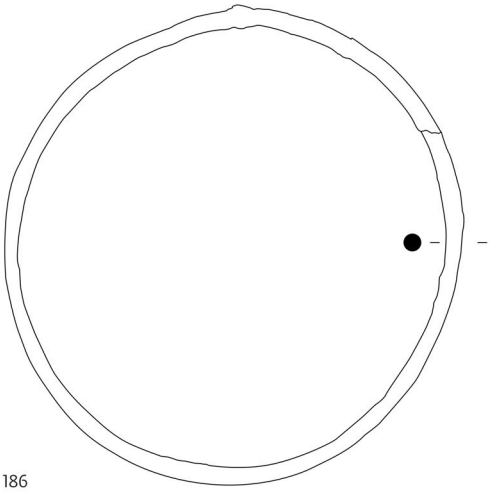


183

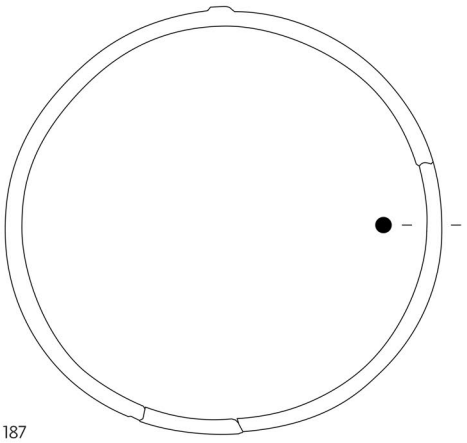


185

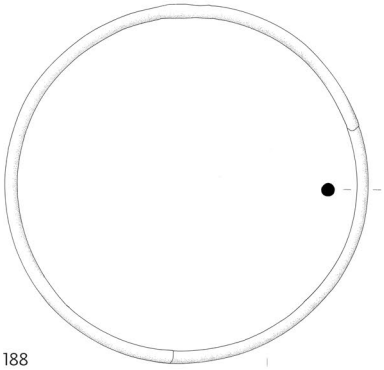
Massive closed neck rings with circular section and no ornaments. Scale 1 : 3.



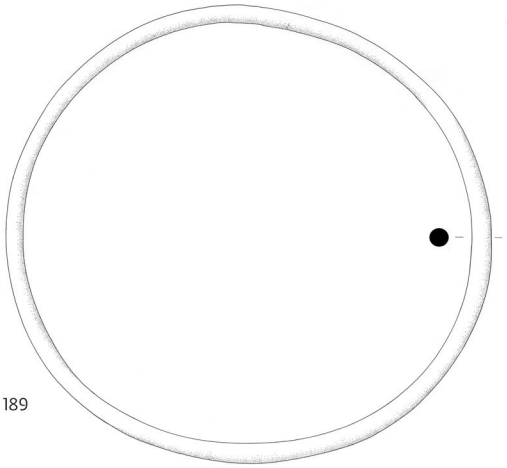
186



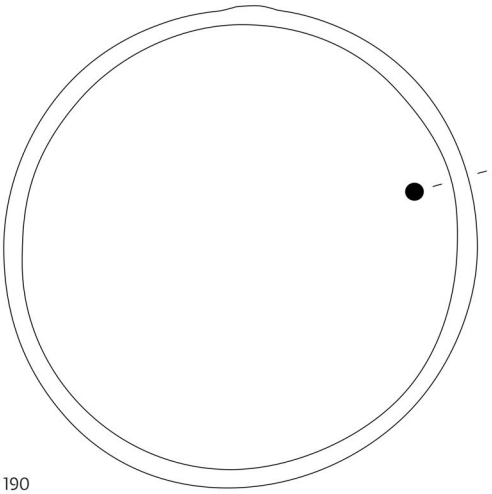
187



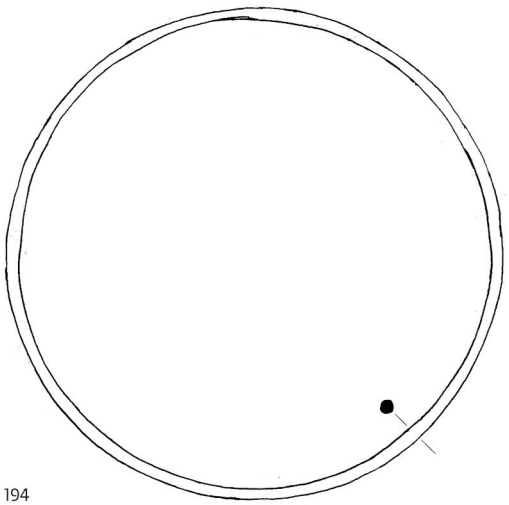
188



189

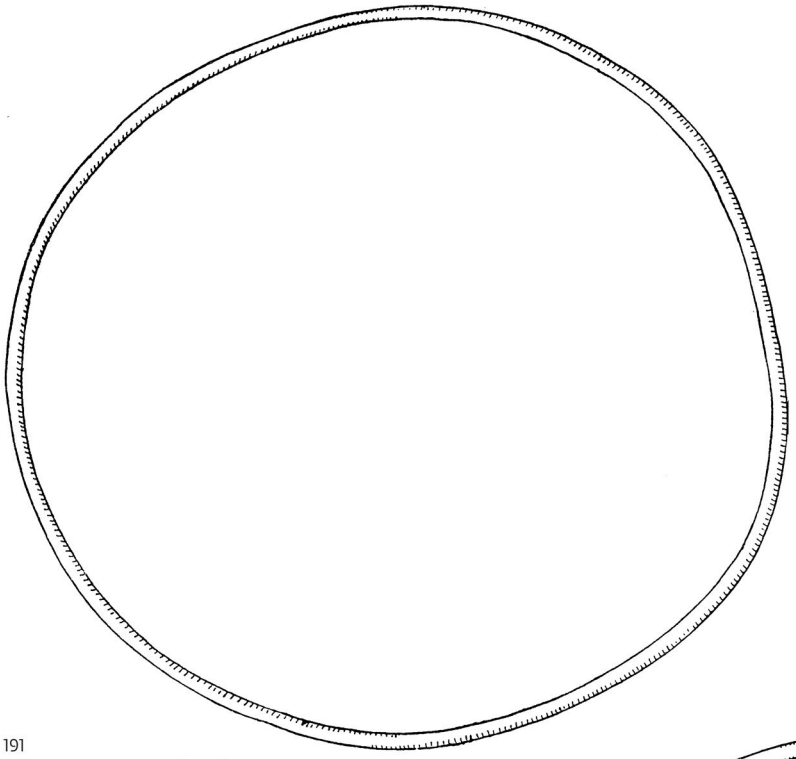


190

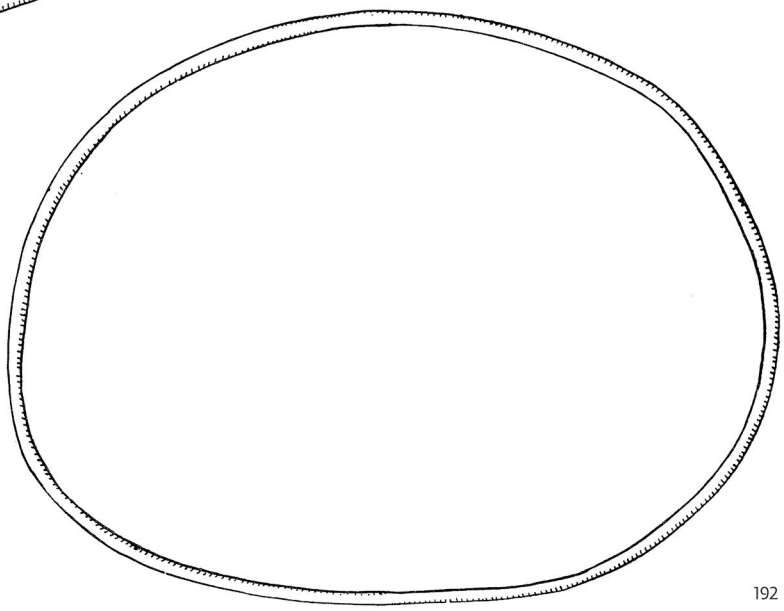


194

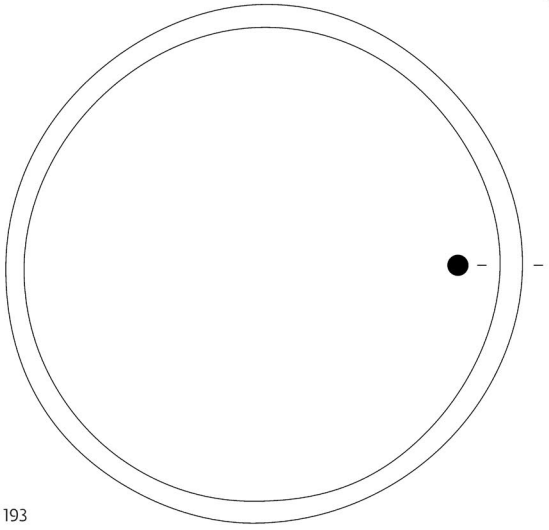
Massive closed neck rings with circular section and no ornaments. Scale 1 : 3.



191



192



193

Massive closed neck rings with circular section and no ornaments. Scale 1 : 3.