Non-ferrous metals on late Republican and early Principate Roman military metalwork found in the River Ljubljanica (Slovenia)

Janka Istenič

Research into non-ferrous metals used in late la Tène and Roman artefacts produced some invaluable results which indicate that the characterisation of non-ferrous metals can be a useful tool in studying the past. The investigation of metals from which 1st century BC brooches were made confirms that it was the Romans who spread the use of brass in Europe and indicates that the relatively regular use of brass in Roman Europe started about 60 BC and not in the Augustan period, as has been widely claimed.[1] The published evidence strongly suggests that the early production of pure brass (characterised by about 20% zinc and very little lead and tin[2]) in Europe was associated with the Romans and that it was not produced in non-Roman societies.[3] This is why the characterisation of non-ferrous metals from late la Tène sword-scabbards with elaborate openwork fittings led to their completely new interpretation.[4]

THE USE OF NON-FERROUS METALS IN ROMAN MILITARY EQUIPMENT: THE STATE OF THE RESEARCH

According to the published evidence, brass was typical of Roman military equipment, as well as of special types of coins (e.g. *sestertii*, *dupondii* minted in Rome) and many types of brooches from the Augustan period to the 2nd century AD.[5] The dominant copper-alloy type in the early Principate Roman military equipment was pure brass with *c*.20% zinc.[6]

Most of the published evidence providing data on the characterisation of non-ferrous metals in Roman military objects lacks detailed archaeological information on the analysed objects. Few publications provide analytical data, as well as drawings or photographs and a description of the analysed objects.[7]

ROMAN MILITARY EQUIPMENT FOUND IN THE RIVER LJUBLJANICA (SLOVENIA): SYSTEMATIC CHARACTERISATION OF NON-FERROUS METALS

Systematic characterisation of non-ferrous metals was an important part of our investigation of late Republican and early Principate Roman military equipment found in the River Ljubljanica (Slovenia). Twenty objects were examined. PIXE, a non-invasive technique, was used for the characterisation of metals.[8]

The largest group of examined objects involves sixteen swords and/or sword scabbards. Twelve of them are of the Mainz-type (figs. 1, 2).[9] Of the seven surviving sword hand-guard plates three are of unalloyed copper and four of bronze; traces of tinning survive on all of them, indicating that originally they were all tinned on both sides. The sword-scabbard guttering (five items) was of iron, which in one instance was plated with sheet silver (fig. 1). Of the four analysed thin sheets that covered the front of the scabbard, three are of pure brass and one is of bronze; they were all tinned at the front. The fitting at the mouth of the scabbard, the transverse fittings with the attachment rings and the chape (altogether from six scabbards) are of brass on five scabbards (fig. 1a) and on one scabbard (fig. 2) of high quality silver that was partially gilded.[10] The end-buttons are of brass (one item; fig. 1) or iron (one item). All the analysed rivets (from three sword sheaths) are of unalloyed copper. The soldering metal was analysed on three sheaths (at the back of a transverse fitting and at the fitting at the mouth of the scabbard): in two cases it was of pewter and in one case of unalloyed tin.

All the fittings and rivets, as well as the guttering of the presumably Late Republican sword scabbard (fig. 3a) are of pure brass.[11] The guttering and the net-like fitting were made up of several parts that were soldered by pewter.

Typologically earlier than the Mainz-type scabbards are parts of two scabbards with iron guttering and transverse fittings with bird-shaped terminals (fig. 3b) made of pure brass.

Three daggers with associated scabbards of the Scott A Type and a dagger without a scabbard are known from the Ljubljanica (figs. 4, 5).[12] Two daggers with scabbards are of the common variety, with iron suspension loops and iron rivets decorated with enamelled heads (fig. 4). Their decoration includes brass, silver and enamel (red and green) inlays, as well as tin and pewter plating.[13] On one scabbard and on a dagger without a surviving scabbard the rivets (with distinctly formed heads) and the suspension loops are

Fig. 1a–c: *A selection of Mainz-type swords and sword-sheaths or their parts found in the River Ljubljanica. Not to scale.*

Fig. 2: *Mainz-type sword and the (partially?) gilded silver fittings of the associated sheath found in the River Ljubljanica.*

of fresh brass (fig. 5). The published evidence implies that such daggers and sheaths form a homogeneous group. We suggest naming it after the Dangstetten fortress, where the largest number (six items) was found. Daggers and/or sheaths of this group are known from nine sites, where they derive from fifteen contexts; nine of them allow us to date this group from *c*.20 BC–*c*.AD 15.[14]

Two helmets from the Ljubljanica survive. The bowl of the late Republican helmet of the Etruscan-Italic type is made of bronze; the same applies to the hinge, while the rivets that attach the hinge to the bowl are of unalloyed copper (fig. 6).[15] The second helmet (fig. 7) lies typologically between the Buggenum and Hagenau types, which suggests a dating to the Augustan period. Its bowl is of bronze; the brass plume-tubes were soldered to the bowl with pewter. On one side of the helmet the tube (part of the hinge that served to attach the cheek-guard) and the rivets that attach it to the bowl are of bronze and on the other side they are of unalloyed copper.[16]

The medallion, presumably from a military award (a *phalera*), was cast in pewter and silvered at the front (fig. 8a).[17] The torc, probably also a military decoration, is of tin (fig. 8b).[18]

Two small button-and-loop fasteners with a depiction of Augustus were cast in pewter; no remains of surface plating were found (fig. 9a, b).[19] The button-and-loop fastener with chased decoration is of high quality silver and was gilded at the front (fig. 9c).[20]

The buckle and the fitting to which it is hinged are brass, which is silvered at the front; the rivets are copper (fig. 11).[21]

The military belt fitting with relief decoration is of high quality silver and was partially gilded at the front (fig. 10).[22]

DISCUSSION

The characterisation of non-ferrous metals in Roman military equipment found in the Ljubljanica indicates that brass is the most common among them. All the analysed brass was pure brass, which is in perfect agreement with the published evidence of early Principate finds from other sites.[23]

On the evidence from Roman military finds in the Ljubljanica, pure brass was used as the basic material for whole objects, e.g. a buckle and its fitting, as well as, more frequently, for parts of objects:

Fig. 3a–b: *Presumably Late Republican sword scabbard (a) and two transverse fittings with bird-shaped terminals (b) found in the River Ljubljanica. Not to scale.*

Fig. 4a-b: *The common type of early Principate daggers with a semi-circular pommel and Scott Type A sheath found in the River Ljubljanica. Not to scale.*

- for the fittings, chape and front sheet of Mainz-type sword sheaths;
- for the fittings, chape, rivets and in one case also the guttering of pre-Mainz-type sword sheaths;
- for the inlaid decoration, the brass strip that closes the gap between the two iron plates at the handle of the common early Principate daggers and dagger-scabbards of the Scott A type;
- for the rivets and suspension loops of the Dangstetten type daggers and sheaths;
- for the plum-tubes of a helmet.

It seems that in Roman military equipment of the end of the Republican period and early Principate, brass was normally used for objects or their parts that were made and decorated by cold working. The mechanical properties of brass are very suitable for such use. Compared to bronze, it is a softer, more ductile metal, more suited to heavy cold-working; but it has a lower tensile strength and hardness than bronze[24] and is therefore less suitable for such objects as helmets.

Compared to bronze, brass had a relatively high value in Roman times.[25] Because of the low boiling-point of zinc, its production was more complicated than that of bronze.[26] There are assumptions that brass production, at least in the 1st century BC and 1st century AD, was a state monopoly.[27]

Unalloyed copper was used for rivets (with the exception of the pre-Mainz-type sword sheaths (fig. 3), all the analysed rivets were of unalloyed copper) and for some of the hand-guard plates of the Mainz-type swords.

Bronze (an alloy of copper and tin) was used for helmets and, in addition to unalloyed copper, for the hand-guard plates of the Mainz-type swords.

Pewter, an alloy of tin and lead, has a very low melting point, therefore it is very suitable for casting thin objects with intricate reliefs, such as the Augustus medallion and the two button-and-loop fasteners with relief decoration (figs. 8a, 9a). It was also used for soldering, as well as for decorative plating of iron (on the front of the rounded tip of a dagger sheath, fig. 4a).

Only one object, the torc (fig. 8b), is of tin – a malleable and ductile metal. It becomes brittle below 13°C, which is probably the reason why few tin objects from Antiquity survive. The silty riverbed of the Ljubljanica was obviously a rather suitable environment.

The use of low-cost metals such as tin and pewter for both military decorations found in the Ljubljanica (figs 8a, b) is consistent with the evidence from grave-stones which suggests that soldiers below (or up to) the rank of centurion were awarded *phalerae* and torcs.

Tinning appears relatively often: on brass (covering the thin front sheet of the Mainz-type sword sheaths, fig 1a), on unalloyed copper or bronze (covering the sword hand-guards; figs. 1a, b) and on iron (for decorative plating of

Fig. 5a–b: *Dangstetten type daggers and associated scabbards found in the River Ljubljanica. Not to scale.*

Fig. 6: *Late Republican helmet of the Etruscan-Italic type found in the River Ljubljanica.*

Fig. 7: *Buggenum/Hagenau type helmet found in the River Ljubljanica.*

Fig. 8a–b: *Military decorations found in the River Ljubljanica: a medallion, presumably from a phalera (a) and a torc (b). Not to scale.*

the rounded tip of a dagger scabbard, fig 4b). Tin is not easily oxidized in air and is therefore suitable to be used as a protective coat for other metals. An example of such a use of tinning is bronze cooking vessels.[28] It seems that in Roman military metalwork, the primary aim of tinning applied on brass, copper, bronze or iron was to improve the surface appearance. The highly polished tinned surface probably resembled silver(ed) surfaces.

High quality silver (with *c.*96% of silver) was used for objects with elaborate relief decoration, i.e. for sword-scabbard fitments, a belt plate and a button-and-loop fastener (figs. 2, 9c, 10). It appears also as high quality silver sheet on a sword-scabbard iron guttering and end knob (fig. 1). Other techniques of silver plating were used on the pewter medallion and on the brass buckle hinged to a fitting (figs. 8, 11).[29] Inlaid silver decoration was applied to daggers and their scabbards (fig. 4).

Augustan coinage suggests that the value of silver was about 27-times higher than that of brass.[30] In Roman military metalwork silver was probably used as a prestigious alternative to brass.

Fig. 9a–c: *Button-and-loop fasteners found in the River Ljubljanica. Not to scale.*

Fig. 10: *The partially gilded silver belt fitting with relief decoration found in the River Ljubljanica. Not to scale.*

Fig. 11: A buckle hinged to a fitting found in the River Ljubljanica. Not to scale.

Gold appears only as gilding on high-quality silver objects (figs. 2, 9c, 10). On the belt mount it was applied only on part of the surface in such a way that the effect of the relief decoration was enhanced by the contrast of the gold and silver surfaces (fig. 10).[31]

To evaluate our results we would need to compare them with data from other sites. So far only data on metals from a few parallel items of Roman military metalwork from Haltern are available. They suggest that variability in the use of metals in Augustan military equipment was larger than indicated by the finds in the Ljubljanica. Regarding the Mainz-type scabbards from Haltern (four items), the transverse fittings and the end button are of pure brass, as are those from the Ljubljanica, but the guttering of two scabbards is also of brass, whereas it is iron on all the scabbards from the Ljubljanica. The hand-guard plate of a Mainz-type sword from Haltern is of leaded bronze and no tinning is mentioned, whereas the ones from the Ljubljanica are of bronze or copper and tinned. The Hagenau-type helmet from Haltern is of leaded bronze, while the Buggenum/Hagenau type helmet from the Ljubljanica is bronze. Buckles from Haltern (metals of seven of them were characterised) were made of brass and other copper-alloys.

CONCLUSIONS

The results of research into military metalwork from the end of the Republican period and early Principate found in the River Ljubljanica indicate a high level of standardisation in the use of non-ferrous metals. Publications of Roman military metalwork from other sites, including data on non-ferrous metals, would be necessary in order to get an idea of the general degree of standardisation in the use of non-ferrous metals in the production of Roman military metalwork in the final decades of the 1st century BC and early decades of the 1st century AD.

NOTES

1 ISTENIČ & ŠMIT, 2007.
2 JACKSON & CRADDOCK, 1995, 93–4; CRADDOCK & LAMBERT, 1985, 164.
3 ISTENIČ & ŠMIT, 2007; PONTING, 2012, 163.
4 ISTENIČ, 2010; ŠMIT *et al*. 2010; ISTENIČ & ŠMIT, 2014.

5 BAYLEY & BUTCHER, 2004; CALEY, 1964; PONTING, 2012, 165–9; RIEDERER, 2001; RIEDERER, 2002b.

6 CRADDOCK & LAMBERT, 1985; PONTING & SEGAL, 1998; PONTING, 2002, 559.

7 A set of Roman military horse-trappings from the fifth and sixth decades of the 1st century, found at Xanten (JENKINS, 1985; CRADDOCK & LAMBERT, 1985); a small fraction of the Augustan military equipment from Haltern (RIEDERER, 2002a).

8 PIXE measurements, using a proton beam in the air, were carried out using the Tandetron Accelerator at the Jožef Stefan Institute.

9 ISTENIČ, 2009a, 290–3, 296–7, Cat. Nos. 61, 62, 66.

10 ISTENIČ, 2003a; 2009a, 290–1, Cat. No. 61.

11 ISTENIČ, 2000a; 2000b; 2009a, 298–9, Cat. No. 67; ŠMIT & PELICON, 2000.

12 SCOTT, 1985, 160–7.

13 RANT *et al.*, 1994; ISTENIČ, 2009a, 300–1, Cat. Nos. 68, 69; 2009c, 89, fig. 88.

14 ISTENIČ, 2012.

15 ISTENIČ, 2009b; 2009a, 306–7, Cat. No. 76.

16 ISTENIČ, 2009a, 306–7, Cat. No. 76.

17 ISTENIČ, 2003b; 2009a, 294–5, Cat. No. 64.

18 ISTENIČ, 2009a, 294–5, Cat. No. 64.

19 ISTENIČ, 2009a, 296–7, Cat. No. 65.

20 ISTENIČ, 2009a, 304–5, Cat. No. 74.

21 ISTENIČ, 2009a, 304–5, Cat. No. 75.

22 ISTENIČ, 2003a.

23 PONTING, 2002; PONTING & SEGAL, 1998; PONTING, 2012; RIEDERER, 2001; RIEDERER, 2002a.

24 PONTING, 2012, 171–2.

25 According to BURNET *et al*., 1982 (p. 167) the intrinsic value of brass was about twice that of bronze.

26 PONTING, 2012, 172.

27 PONTING, 2012, 166.

28 ŠMIT *et al.*, 2008.

29 Silvering techniques used by the Romans include application of silver foil or sheet, hot-dipping in molten silver, dipping into molten silver chloride, the use of silvering pastes, amalgamation silvering and depletion silvering (ŠMIT *et al.*, 2008).

30 BURNETT *et al*., 1982, 268.

31 ISTENIČ, 2003a, 286–7, 291–3; 2009c, 88, fig. 86.

BIBLIOGRAPHY

BAYLEY, J. & BUTCHER, S. 2004: *Roman Brooches in Britain: A Technological and Typological Study Based on the Richborough Collection*, London

BURNETT, A. M., CRADDOCK, P. T. & PRESTON, K. 1982: 'New light on the origins of orichalcum', in T. Hackens & R. Weiller (eds), *Proceedings of the 9th International Congress of Numismatics* I, Louvain-la-Neuve, Luxembourg, 263–8

CALEY, E. R. 1964: *Orichalcum and Related Ancient Alloys*, New York

CRADDOCK, P. & LAMBERT, J. 1985: 'The composition of the trappings', in I. Jenkins, 'A group silvered-bronze horse-trappings from Xanten (Castra Vetera)', *Britannia* **16**, 141–64

ISTENIČ, J. 2000a: 'A Roman late-republican gladius from the River Ljubljanica (Slovenia)', *Arheološki vestnik* **51**, 171–82

ISTENIČ, J. 2000b: 'A late-republican gladius from the River Ljubljanica (Slovenia)', *JRMES* **11**, 1–9

ISTENIČ, J. 2003a: 'The early Roman "Hoard of Vrhnika": a collection of finds from the River Ljubljanica', *Arheološki vestnik* **54**, 281–98

ISTENIČ, J. 2003b: 'A uniface medallion with a portrait of Augustus from the River Ljubljanica (Slovenia)', *Germania* **81**, 263–76

ISTENIČ, J. 2009a: 'Roman period', in P. Turk, J. Istenič, T. Knific & T. Nabergoj (eds), *The Ljubljanica – a River and its Past*, Ljubljana, 265–317

ISTENIČ, J. 2009b: '35. Helmet. 36. Sword in a scabbard', in P. Turk, J. Istenič, T. Knific & T. Nabergoj (eds), *The Ljubljanica – a River and its Past*, Ljubljana, 252–5

ISTENIČ 2009c: 'The Ljubljanica and the Roman army', in P. Turk, J. Istenič, T. Knific & T. Nabergoj (eds), *The Ljubljanica – a River and its Past*, Ljubljana, 86–91

ISTENIČ, J. 2010: 'Late La Tène scabbards with non-ferrous openwork plates', *Arheološki vestnik* **61**, 121–64

ISTENIČ, J. 2012: 'Daggers of the Dangstetten type', *Arheološki vestnik* **63**, 159–78

ISTENIČ, J. & ŠMIT, Ž. 2007: 'The beginning of the use of brass in Europe with particular reference to the southeastern Alpine region', in S. La Niece, D. R. Hook & P. T. Craddock (eds), *Metals and Mines: Studies in Archaeometallurgy: Selected Papers from the Conference Metallurgy: A Touchstone for Cross-cultural Interaction held at the British Museum 28–30 April 2005 to Celebrate the Career of Paul Craddock During his 40 Years at the British Museum*, London, 140–7

ISTENIČ, J. & ŠMIT, Ž. 2014: 'Celts and Romans: the contribution of archaeometallurgy to research into cultural interaction', in E. Pernicka & R. Schwab (eds.): *Under the Volcano: Proceedings of the International Symposium on the Metallurgy of the European Iron Age (SMEIA) Held in Mannheim, Germany, 20–22 April 2010*, Forschungen zur Archäometrie und Altertumswissenschaft **5**, Rahden/Westfalen, 205–20

JACKSON, R. P. J. & CRADDOCK, P. T. 1995: 'The Ribchester hoard: a descriptive and technical study', in B. Raftery (ed.), *Sites and Sights of the Iron Age*, Oxford, 75–102

JENKINS, I. 1985: 'A group of silvered-bronze horse-trappings from Xanten (Castra Vetera)', *Britannia* **16**, 141–64

PONTING, M. J. 2002: 'Roman military copper-alloy arte-

facts from Israel: questions of organization and ethnicity', *Archaeometry* **44**, 555–71

PONTING, M. 2012: 'The potential of the scientific analysis of Roman military equipment: the case of Syria-Palestina', in E. Schrufer-Kolb (ed.), *More Than Just Numbers? The Role of Science in Roman Archaeology*, Journal of Roman Archaeology Supplementary Series **91**, Portsmouth, 163–76

PONTING, M. & SEGAL, I. 1998: 'Inductively coupled plasma-atomic emission spectroscopy analyses of Roman military copper-alloy artefacts from the excavations at Masada, Israel', *Archaeometry* **40**, 109–22

RANT, J., MILIĆ, Z., NEMEC, I., ISTENIČ, J., & SMODIŠ, B. 1994: 'Neutron and X-ray radiography in the conservation of the Roman dagger and sheath = Neutronen- und Röntgendurchstrahlung bei der Konservierung eines römischen Dolches mit Scheide', in *International Conference Non-destructive Testing of Work: Internationale Konferenz Zerstörungsfreie Untersuchungen an Kunst- und Kulturgütern*, Deutsche Gesellschaft für Zerstörungsfreie Prüfung e.V., **45**, 1. Berlin, 31–40

RIEDERER, J. 2001: 'Die Berliner Datenbank von Metallanalysen kulturgeschichtlicher Objekte. III Römische Objekte', *Berliner Beiträge zur Archäometrie* **18**, 139–259

RIEDERER, J. 2002a: 'Die Metallanalyse der Funde aus Kupferlegierungen von Haltern', in M. Müller, *Die römischen Buntmetallfunde von Haltern*. Mainz, 109–45

RIEDERER, J. 2002b: 'The use of standardised copper alloys in Roman metal technology', in A. Giumlia-Mair (ed.), *I bronzi antichi: Produzione e technologia*, Montagnac, 284–91

SCOTT, I. R. 1985: 'First century military daggers and the manufacture and supply of weapons for the Roman army. In: M. C. Bishop (ed.): *Production and distribution of Roman Military Equipment. Proceedings of the Second Roman Military Equipment research Seminar.* BAR. International Series 275. Oxford, p. 160-213.

ŠMIT, Ž., ISTENIČ, J. & KNIFIC, T. 2008. Plating of archaeological metallic objects – studies by differential PIXE', In: M. Fedi, N. Grassi & P. A. Mandó (eds.): *Proceedings of ECCART9, 9th European Conference on Accelerators in Applied Research and Technology, Florence, Italy, Concitto della Calza, September 3–7,2007*, Nuclear instruments & methods in physics research, B 10, **266**, Amsterdam, 2329–33 (doi: 10.1016/j.nimb.2008.03.057)

ŠMIT, Ž., ISTENIČ, J. & PEROVŠEK, S. 2010: 'PIXE analysis of Late La Tène scabbards with non-ferrous openwork plates (and associated swords) from Slovenia', *Arheološki vestnik* **61**, 165–73

ŠMIT, Ž. & PELICON, P. 2000: 'Analysis of copper-alloy fitments on a Roman gladius from the river Ljubljanica', *Arheološki vestnik* **51**, 183–7