Iron resources and production for the Roman frontier in Pannonia

Aleksander Durman

ABSTRACT: During Roman times Siscia was an important settlement, controlling a key route between Pannonia and Dalmatia, across the river Sava. To the south of Siscia, on Mount Trgovi, Mount Zrin and Mount Majdan, limonite deposits were exploited on a very large scale resulting in millions of tons of slag. Finds of large numbers of iron bars from Hrvatska Dubica, Siscia and the Japra valley indicate extensive iron smithing in the area. Thirty-eight of these bars survive and their size and weight suggest a degree of standardization of the products. It is estimated that between 150 to 200 million of these bars would have been produced in this region during the Roman period.

Introduction

The Roman *limes* in Pannonia, seven hundred kilometres long, is primarily defined by the River Danube. The termination of the Dacian and Suebian-Sarmatian wars, led by the emperor Domitian towards the end of the first century (88-93 AD), resulted in Pannonia becoming the most important military province of the empire (Mócsy 1974, 85).

From the beginning of the 1st century AD to the time of Hadrian, the number of Roman legions gradually grew from one to four. Their number remained constant until the period of late antiquity and they were located in Vindobona (*legio X Gemina*), Carnuntum (*legio XIIII Gemina*), Brigetio (*legio I Adiutrix*) and Aquincum (*legio II Adiutrix*). Occasionally however, in more troublesome periods, the number of legions at the frontier would grow considerably (Mócsy 1974, 99). The entire provincial army, as well as the auxiliary units (*exercitus Pannoniae Superioris et Inferioris*), were positioned at the *limes* itself in about thirty *limes*-forts (the locations of these have recently been determined precisely). The forts were twenty kilometres (fifteen Roman miles) apart, even in marshy areas (Radnoti and Barkoczi 1951; Fitz 1959). Since the province of Pannonia did not possess its own metal resources, it was, in that respect, oriented toward Noricum, Dalmatia and Moesia.

The Roman conquest of Pannonia began with the destruction of the Celtic settlement of Segestica on the right bank of the River Kupa (next to its mouth, where it flows into the Sava). How important Segestica was for the Romans can clearly be seen from the fact that they repeatedly attempted to conquer it in 156 BC, 129 BC, 119 BC, 83 BC, and finally in 35 BC when Octavian eventually managed to destroy it after a siege that lasted for a whole month, engaging two and a half legions backed by the river fleet (Hoti 1992, 137). The whole of Pannonia, with borders on the Sava and Drava rivers, found itself under Roman control (Klemenc 1963, 56). Very soon, following the destruction of Segestica, a new settlement Siscia was established on the left bank of the Kupa river, more precisely between the Kupa and the Sava rivers.

Why did Segestica represent the key to Pannonia for the Romans? The answer lies, above all, in the 'problematic' stream of the Sava river. This river is not

very broad in its normal flow but it is prone to flooding, so that a wide zone about 300km long (stretching from Zagreb to Sremska Mitrovica) occasionally turns into a string of practically connected swamps (Durman 1992, 120). Traditionally, the most reliable route among the swamps, connecting Pannonia and Dalmatia, passed through today's Sisak (Roman Siscia). That fact determined it as the most important strategic spot in the south of Pannonia. The lack of arable land on that position, surrounded by swampy land and close to the spot where the Kupa flows into the Sava, was bound to result—in such an important settlement—in the growth of crafts as well as trade. Siscia became an important corn trade centre and, very likely, one of the most significant centres for the processing of wool from the whole region (Hoti 1992, 144). Since the Hallstatt period onwards, today's Siscia has been settled continually. At the same time Sisak was closely connected, in all historic periods, with the production of iron, and iron products were its most important industrial commodity.

Metallurgical activity in the region

How can this connection of Sisak and iron production be accounted for? The main reason lies in the immediate hinterland, south of Sisak, next to the mouth of the river Sana where it flows into the Una. Large geological formations of iron ore are located in this region, more precisely on Mount Trgovi, the western spur of Mount Zrin in Croatia, and south of the Una river on Mount Majdan (the Arabic word for mine) in north-western Bosnia. Apart from the iron ore, mainly limonite, there are deposits of lead ore (which also implies silver), as well as copper ore (Simić 1951, 156).

Solid traces of a settlement dating from the Hallstatt period can be found in Sisak on the position called Pogoelec, on the right bank of the Kupa (as revealed by an excavation in 1992). In the very same position of the former Hallstatt settlement the Celts founded Segestica, the most important settlement of the time in southern Pannonia. This centre is actually the continuation of the previously established links with the mines at Mount Trgovi. According to existing findings it can be concluded that the Celts had also established the land route to Mount Trgovi and the crucial site of the whole region, Osječenica, (where Celtic coins and pottery were found) from which they controlled the production of iron (Durman 1991, 92). On the Bosnian side there are no Celtic finds (Čović 1987, 285), which can lead to the conclusion that they only traded with the Maezeans—a Pannonian (according to Strabo and Apianus) or a Dalmatian (according to Ptolemy) tribe.

When the Romans took over the established Celtic exploitation and manufacture of iron at Mount Trgovi, some 40km to the south of former Segestica, they also integrated the iron mines located on the Maezean territory, about 20km south at Mount Majdan. When, in the 2nd century AD, the Roman *limes* became firmly established on the Danube, the direction of the mine (*praepositus splendidissimi vectigalis ferrarium*) for Dalmatia and Pannonia (*ferrarium Delmaticarum et Pannonicarum—CIL* 3, 3953, p1742) was located in Siscia (Fig 1).

The metallurgical activity around Mount Majdan reached its peak in 202 AD, with the visit of Lucius Septimus Severus to Pannonia (Fitz 1959) and, most probably, to the mines themselves, as reflected in epigraphic monuments (Bojanovski 1988, 276). The oldest monument recording the activity of the mines found in Ljubija comes from 201 AD and their disappearance coincides with the reign of Gallienus (253–268 AD). This, however, by no means implies that the metallurgical activity itself disappeared with Gallienus, since various numismatic and other finds indicate that production continued at the mines until the end of the rule of Theodosius (Sergejevski 1963, 97).

Although numerous excavations have been carried out in this region, most of them were concentrated around the impressive building complexes, and no interest was shown in the dumps of slag which could help us reconstruct the technology of iron processing.

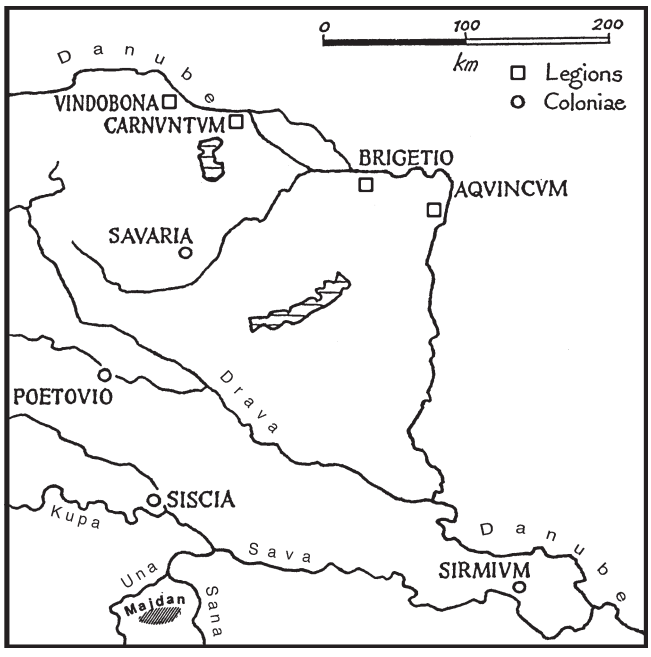

Figure 1: Roman Pannonia.

Roman mines, slag accumulations and settlements in north-western Bosnia concentrated around Mount Madjan (covering an area of 1200km^2), were divided into northern and southern *ferrarias*, of which more than 30 are known to us today (Sergejevski 1963, 86). They can be grouped into those in the Japra valley (Blagaj, Maslovere, Čele, Agići Gornji, Čelopek, Mala Ruiška, Majkić Japra, Rekani, Palančište etc), and the southern ones in the Sana valley (Stari Majdan, Sanica, Kljevca, Kozica, Kijevo, Briševo, Šehovci, Oštra Luka, Ališići, Zecovi, Čarakovo, Begogačani, Knezpolje, Štrigova, Jesenje etc) (Bojanovski 1988, 274).

According to an estimate by Basler (1972/3, 268) the quantities of Roman period slag found in Blagaj and Maslovare, near the river Japra, amount to two million tons and according to Pašalić (1960, 93) the slag found around Blagaj alone exceeds one million tons, still containing 50% of iron (47–48% Fe and 2–3% Mn). The largest deposit of slag near the Sana river lies on the small rivulet Željeznica in Stari Majdan (the site Šljačište) covering an area of six ha, two to seven metres high, which means that the quantity of slag on the site can be estimated to over 250,000m^3 with an average content of 48% of iron (Bojanovski 1988, 279).

These analyses were made for purely practical reasons, primarily the needs of the modern iron industry. The Sisak ironworks, up to the breakdown of Yugoslavia in 1991, transported and processed the slag because it was richer in iron than the ore in the existing mines. A special railway connection had been built before WWII in order to link the Japra river with the existing Split-Sisak-Zagreb railroad. This allowed the exploitation of the slag, some of which was transported as far as the former Czechoslovakia. It is very difficult to make a precise estimate of the quantity of slag transported in this manner and some slag deposits have completely disappeared. In the early 1960s Dr Ivo Bojanovski, an archaeologist, was appointed as a special deputy of the Ministry of Culture and Science of Bosnia and Herzegovina, primarily responsible for the control of the exploitation of the slag sites in that territory. Unfortunately there are no data about the industrial exploitation of the slags between 1930 and 1960.

Among the deposits of slag the remains of clay furnaces can easily be spotted, along with very frequent finds of the so-called slag runners. These are ceramic tubes filled with iron and slag, which are presumably the remains of tuyères. They are of different dimensions, up to 200mm long, with walls 10–20mm thick. The interior part is always slightly narrower at one end, between 20–30mm, and the wider end is usually about 55–65mm in diameter.

The size of Roman mining activity can also be supported by a rather recent find from Ljubija, a 300m long trench dug in limonite, in which 4kg of Roman coins were found dating from the time of Gallienus to the reign of Probus (253–282 AD) (Sergejevski 1963, 87).

An amateur excavation carried out in 1890 in Šehovci (near Sanski Most), recorded by the mining engineer Radimski (1891, 437), discovered only a small part of that activity, for example the positions of two furnaces for ore smelting (each 0.9m in diameter, marked as h_1 and h_2 on Figure 2), within a larger building complex.

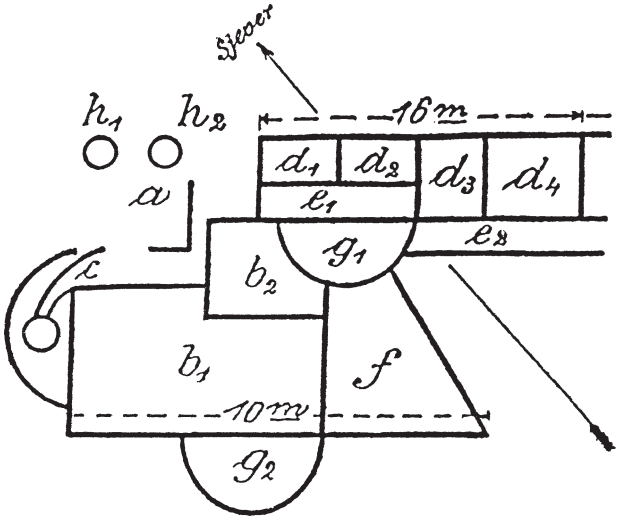

Figure 2: Sketch plan from the 1890 excavation near Sanski Most, showing Roman buildings and the locations (h_1, h_2) of two furnaces, each of 0.9m diameter.

Three iron blooms were also found on that site, two of them weighing 400kg and the third 90kg. Judging by the coins found on the spot, these blooms date from the time of Constantine II. A very dependable source on Bosnian metallurgy and mines, V Radimski, states that the blooms were sent to the Sarajevo National Museum, but none of their archaeologists today know anything about them.

Amongst the numerous epigraphic and numismatic evidence for Roman mining in the valleys of the rivers Japra and Sava are inscriptions which mention contractors (*conducatoris*) and their assistants (*vilicus*), iron ore mines (*ferrifodinae*), furnaces (*ferrariae*), larger establishments (*officina ferraria*), as well as the divine patrons of miners—Terra Mater (Sergejevski 1963, 88),

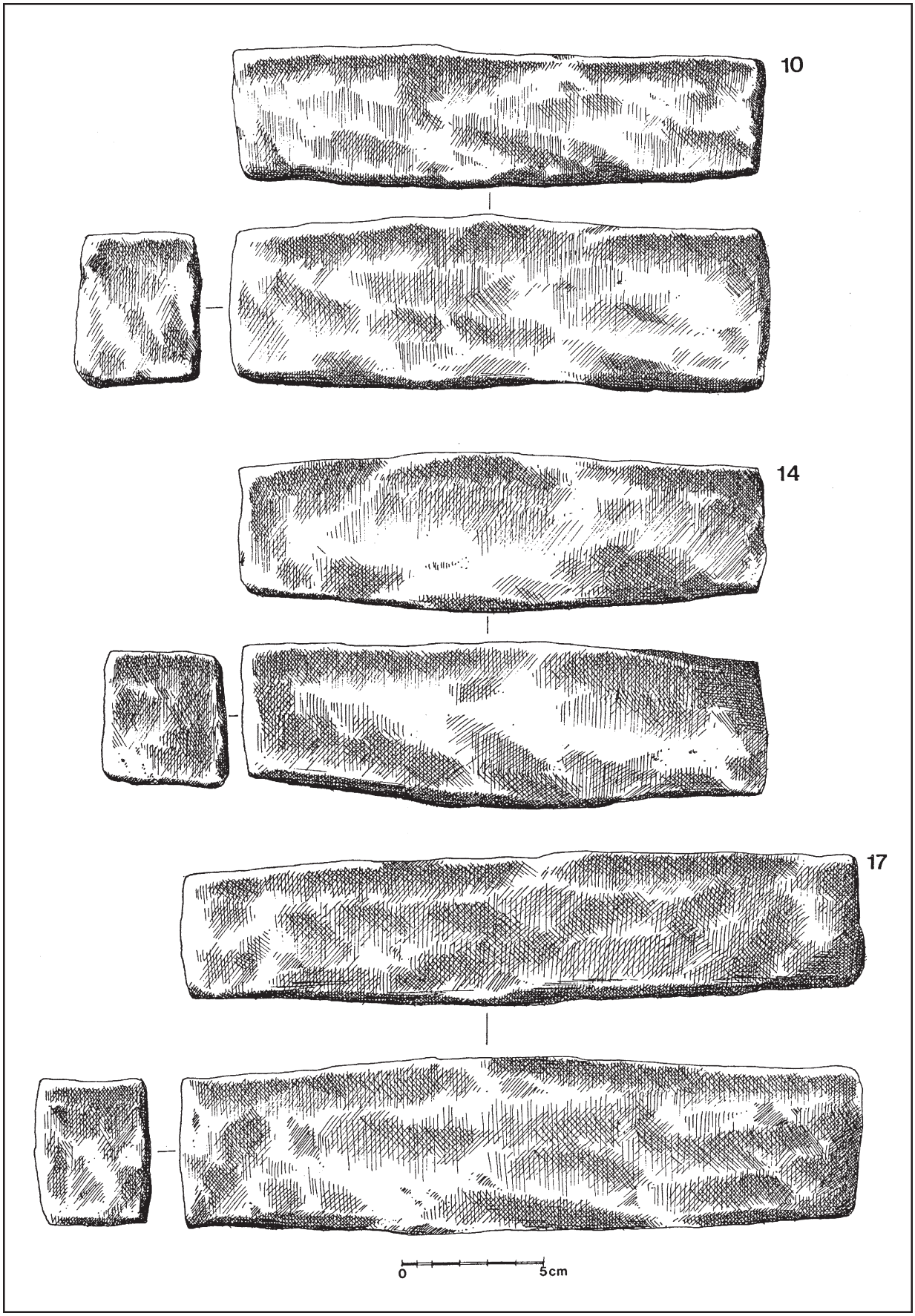

Figure 3: Examples of the Roman iron bars from Hrvatska Dubica. Weights are 10: 3770g, 14: 3530g and 17: 4990g.

Jupiter Dolichenus and Dioscuri (Medini 1982, 79), Nemesis and the Pannonian/Noric Sedatus, the fire god (Paškvalin 1969).

In Maslovare on the Japra there existed a community of followers of Jupiter Dolichenus and Diosciri led by a priest, M Aurelius Flavus, who originated from the east. Based on this, Bojanovski (1988, 275) draws the conclusion that a good part, if not the majority, of the qualified personnel in north-eastern Bosnia must have been brought in from Doliche (in old Comagene) in Syria, in spite of the fact that the Maezeans knew iron better than any other population of Dalmatia and Pannonia. This cult was brought by the population of Severi dynasty, which arrived in Pannonia at the beginning of the 3rd century AD, and along with them probably came skilled masters familiar with new technologies of iron production.

It can justifiably be assumed that the greatest part of the processed iron ore ended up or at least passed through Siscia. Part of it travelled by diagonal land routes from the Japra region to Sisak via Osječenica (about 60km), but the greatest part was transported by rivers, five in all: the Sana, the Japra and the Una downstream and the Sava and the Kupa (4km) upstream, a total of 220km. The feasibility of this transportation can be supported by the fact that a number of bricks from a Siscia brickyard (bearing a seal SISC) was found in Maslovare on the Japra (Pašalić and Basler 1962, 220).

The iron bars from Hrvatska Dubica

Blacksmiths' workshops for the production of iron objects were distributed all along this route. This can best be supported by a find of 97 bars 4km downstream from Hrvatska Dubica. They were found in 1880 and 28 of them are kept today in the Archaeological Museum in Zagreb. The excavation which I led on the same location in 1980 confirmed the existence of a larger Roman building and one very rich grave. Koščević and Makjanić (1986,125) recognise it as an Oriental burial and locate it in the mid 4th century AD. The total weight of the surviving bars is about 118kg and the whole find would have weighed over 400kg.

The 28 bars preserved today look very much alike (Fig 3)They have a more or less square section, slightly thicker in the centre, and they vary in length from 185–230mm. The bars have been well forged and their angles are quite sharp. The bars are in very good condition, without any corrosion, and so their weights can be quoted with some confidence (Table 1). The graphical representation of the weight data shows that the bars cluster into several groups, which correspond approximately to 11, 12, 13, 14 and 15 Roman librae (one libra equals 327.45g), though four examples fall outside this range (Fig 4). There seems to be a fairly convincing case for a degree of standardization of the finished bars. Although there is some deviation in the exact weight, the bars in each weight group are of a very similar size. This is, of course, how the weight would have been controlled, by forging to a 'standard' size thus giving a nominal standard weight.

Table 1: Weights of iron bars from Hrvatska Dubica

Bar Number	Weight (g)
1	4525
2	4340
3	4120
4	4755
5	4950
6	5365
7	4300
8	4265
9	4820
10	3770
11	4035
12	3900
13	2825
14	3530
15	4775
16	3850
17	4990
18	5800
19	4280
20	4710
21	3940
22	4500
23	3950
24	2925
25	3625
26	3900
27	3510
28	2715

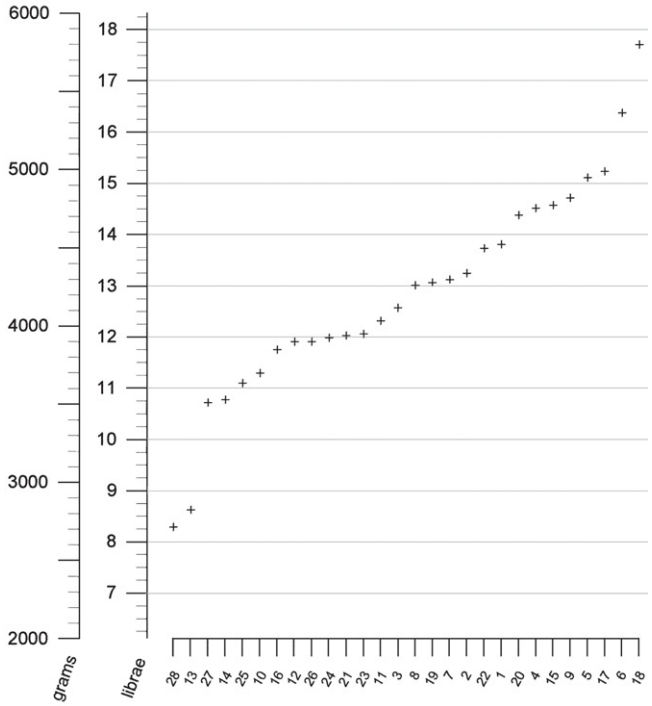

Figure 4: The surviving bars from Hrvatska Dubica, arranged in their weight order. X-axis gives the bar numbers. Y-axes give the weights in grams and Roman librae (1 libra = 327.45g).

The Sisak 'Mint' site and other iron bars

In 1985, when the Kupa river level was very low, M Šmalcelj excavated over 200 wooden posts with iron shoes (Fig 5.1) which were stuck in the bottom of the river bed in Sisak, at its right bank (the position of ancient Segestica). This position is locally known as the 'Mint'. Dendrochronological data provides evidence that the river bank was fortified every seven years (according to personal communication with P Kuniholm, Cornell University, USA). The dock for trans-shipment of iron was probably located on that spot and, very likely, blacksmiths' workshops as well. The position in the river itself suggests the possibility that large blacksmiths' bellows could have been operated by the power of the river.

Each year, during the low river level periods, amateur archaeologists dig out large numbers of Roman coins at that site, as well as all sorts of metal artefacts. In 1985 a heap containing nineteen identical iron axes was found there along with coins dated to the 4th century AD (Fig 5.2). Prof M Bursik from Sisak found seven iron bars on the site of the 'Mint' itself. Four of these bars were delivered to the Museum in Sisak (Fig 6), two were handed to the author for the Department of Archaeology, University of Zagreb (Fig 7) and one was misplaced. Bursik pointed out (in personal communication) that in the period between 1985 and 1995 private collectors found over 120 iron axes in the bed of the Kupa. One irregular iron bar was found by the author in 1995 on the same site (Fig 7.3), among the wooden posts and mixed with ceramic material and a great number of iron nails. It looked as if a smith had left it there in the initial phase of forging. There is very little reason to doubt that in the Roman period this was not only the site of the mint but of several large smithies.

The above mentioned iron bars from Siscia weigh as follows: Fig 6.1: 5,750g, 6.2: 6,900g, 6.3: 4,450g. Fig 7.1: 5,170g, 7.2: 4,130g and 7.3: 3,940g. On the bar shown on Fig 6.1 it is possible to see a special mark,

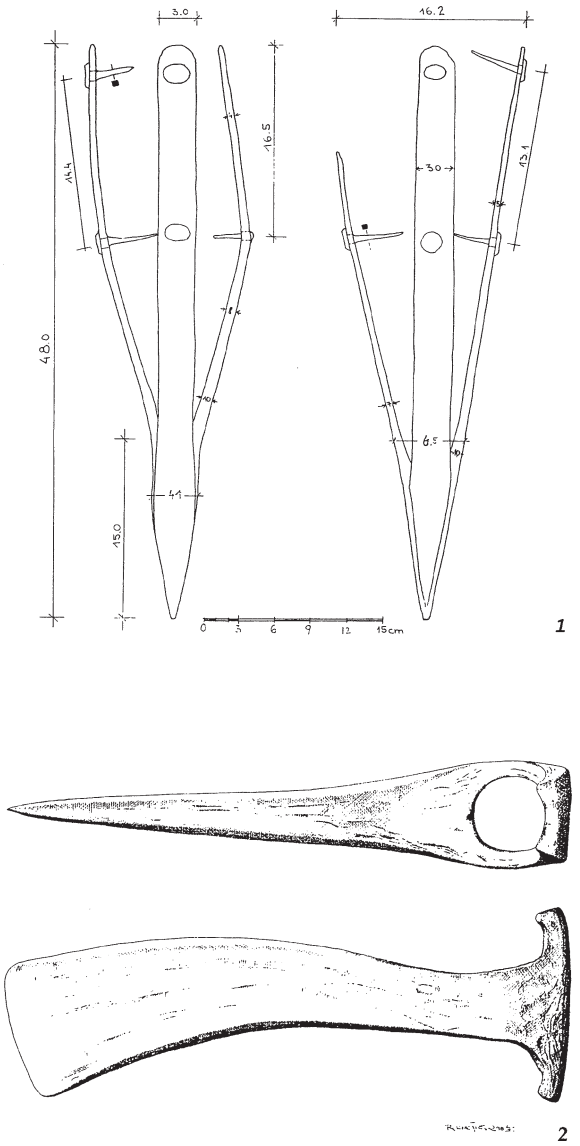

Figure 5: Finds from the 'Mint' site at Sisak. 1: iron shoes for the wooden piles, 2: one of the nineteen identical axes (total length 236mm).

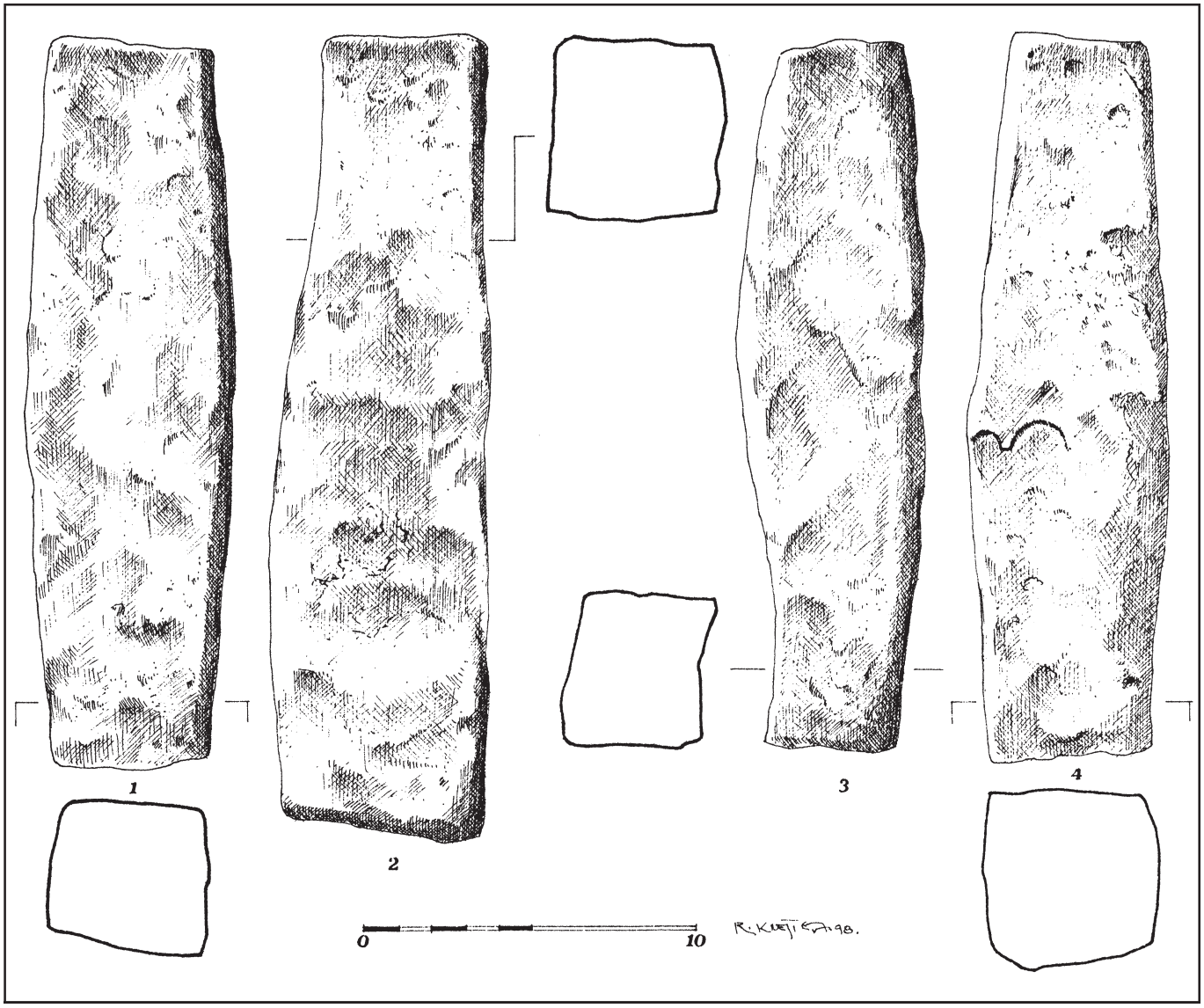

Figure 6: Four of the iron bars from the 'Mint' site at Sisak.

sharply hammered into it. The bar on Fig 7.1 has been partly forged, with one half of the bar drawn down to half of its original size. In the autumn of 1997, T Lolić, an archaeologist, found three more iron bars about 500 metres to the south east of the site of the Mint on the opposite bank of the Kupa, close to the Siscia town wall near the present day church. All these bars from Siscia have been well forged and are of similar dimensions to the bars from Dubica, but are not so well preserved. Pašalić (1965, Tab 14.3) reports the find of iron bars from Roman smithies in the Japra valley, weighing from 6-10kgs, but he does not specify the number of bars found.

A Roman mint worked in Siscia from 263 to 423 AD, from the time of the emperor Gallienus to the death of Theodosius II (Hoti 1992, 153) and it is precisely the 3rd and 4th centuries that are marked by the most intensive iron production in the valleys of the rivers Sana and Japra. Production was sporadically restored and intensified and it apparently last flourished in ancient times in the reign of the Ostrgoth ruler Theodoric (507-511AD). As stated by Cassiodorous, during that period several *ferrarias* were renewed in Dalmatia (Bojanovski 1988, 276).

Conclusion

The amount of slag from the Mount Majdan area, in the valleys of the rivers Japra and Sana, removed between 1960 and 1970, was estimated at three million tons. From this it can be concluded that in the period

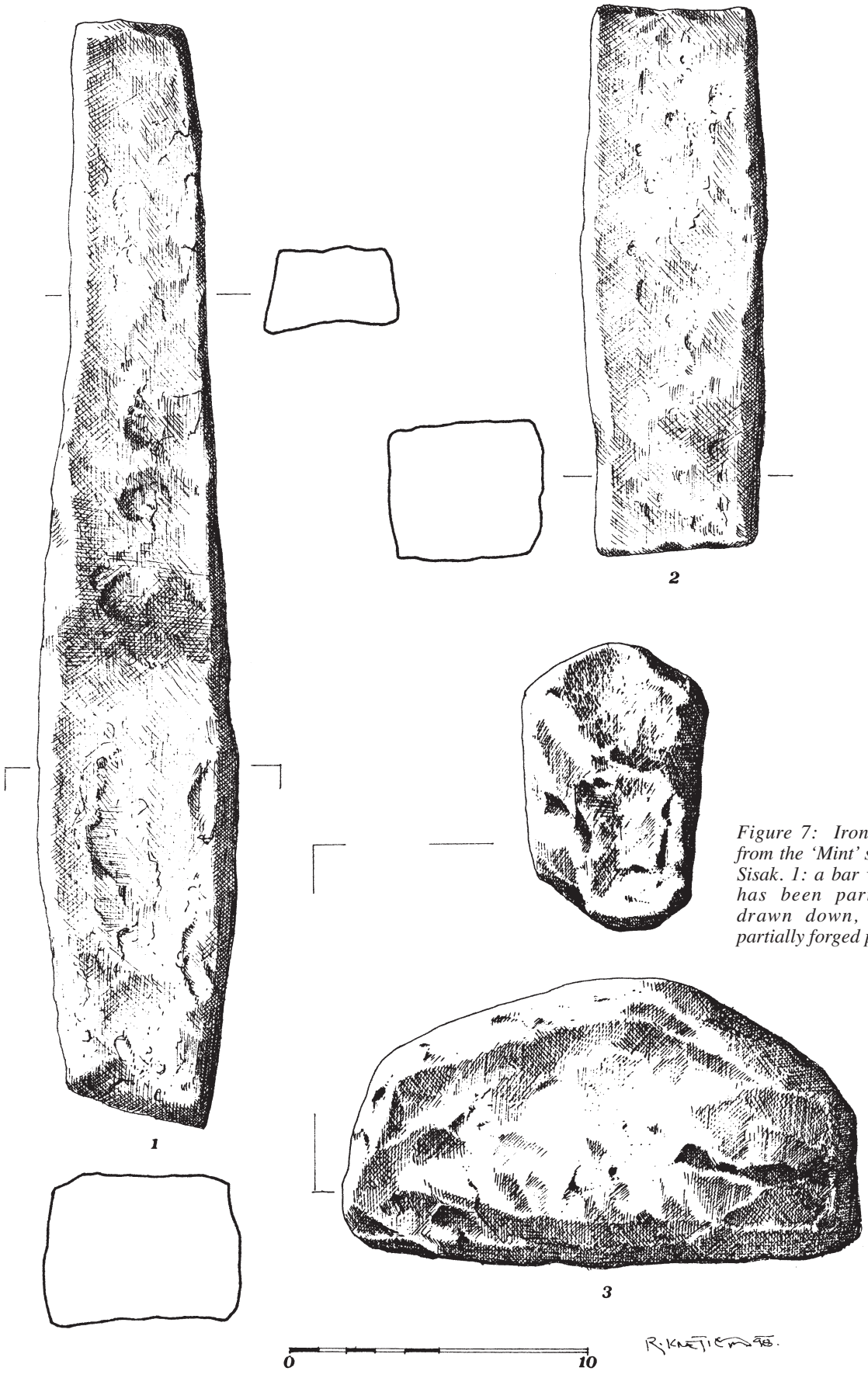

Figure 7: Iron bars from the 'Mint' site at Sisak. 1: a bar which has been partially drawn down, 3: a partially forged piece.

from the 2nd–4th century AD an amount of iron exceeding 750,000 tons, in blooms and bars, was transported through Siscia. This would be equivalent to some 150 to 200 million iron bars, similar to those found at Hrvatska Dubica and Sisak.

Acknowledgements

A version of this paper was presented at the conference on Early Ironworking in Europe, held at Plas Tan y Bwlch in 1997. It is updated here with additional finds and information. I should like to thanks my colleagues M Šmalcelj and T Lolić, for the data and material which they have kindly provided, and K Roncevic who made all the drawings. I should like to thank Susan and Peter Crew for preparing Figure 4 and for suggesting improvements to the text.

References

Basler D 1972/3, 'Nalaz novca iz predrimskog doba u Japri', *Glasnik Zemaljskog muzeja* ns 27–28, 261–271.

Bojanovski A 1988, 'Bosna i Hercegovina u antićko doba, Centar za balkanološka ispitivanja', *Djela* 66, 432.

Čović B 1987 'Grupa Donja Dolina–Sanski Most', *Praistorija jugoslavenskih zemalja* 5, 232-286.

Durman A 1991, 'Prilog za rekonstrukciju najranije povijesti', *Dvor na Uni*, 89–94.

Durman A 1992, 'O geostrateškom položaju Siscije', *Opsucula Archaeologica* 16, 119–131.

Fitz J 1959, 'Der Besuch des Septimus Severus in Pannonien im Jahre 202', *Acta Antiqua Academia Scientiarum Hungaricae* 9, 237–263.

Hoti M 1992, 'Sisak u antičkim izvorima', *Opsucula Archaelogica* 16, 133–163.

Klemenc J 1963, 'Der pannonische limes in Jugoslawien', *Arheološki radovi i rasprave* 3, 55-68.

Koščević R and Makjanić R 1986, 'Neki noviji arheološki rezultati područja antičke Siscije', *Arheološka istraživanja na karlovačkom i sisačkom području* (Zagreb), 119–135.

Medini J 1982, 'Jupiter—Kult Jupitra Dolihena u rim. prov. Dalmaciji', *Godišnjak* 18, 53–90.

Mócsy A 1974, *Pannonia and Upper Moesia* (London).

Pašalić E 1954, 'O antičkom rudarstvu u Bosni i Hercegovini', *Glasnik Zemaljskog muzeja* ns 9, 47–75.

Pašalić E 1960, 'Antička naselja i komunikacije u Bosni i Hercegovini', *Glasnik Zemaljskog muzeja* ns 15, 118.

Pašalić E 1965, 'Rolle und Bedeutung der römischen Eisenbergwerke in Westbosnien für den panonischen Limes'. *Sextus congressus internationalis limitis Romani studiorum* (Bonn), 127–130.

Pašalić E and Basler D 1962, 'Dolina Japre–Rudarski i metalurški antički centar', *Arheolški pregled* 4, 217-221.

Paškvalin V 1969, 'Rimski žrtvenici iz Starog Majdana', *Glasnik Zemaljskog muzeja* 24, 165–168.

Radimski V 1891, 'O nekojim prehistoričkim i rimskim gragjevnim ostancima u području rijeke Sane u Bosni', *Glasnik Zemaljskog muzeja* 3, 431-445.

Radnoti A and Barkoczi L 1951, 'The Distribution of troops in Pannonia Inferior during the 2nd Century AD', *Acta Archaeologica Academiae Scientiarium Hungaricae* (Budapest), 191.

Sergejevski D 1963, 'Rimski rudnici željeza u sjeverozapadnoj Bosni', *Glasnik Zemaljskog muzeja* ns 23, 85-102.

Simić V 1951, *Istoryski razvoj našeg rudarstva* (Beograd).

The author

Dr Aleksandar Durman is a lecturer in archaeology at the University of Zagreb.
Address: Department of Archaeology, University of Zagreb, 1 Lučića 3, 10,000 Zagreb, Croatia.