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THE METALLOGRAPHY OF IRON OBJECTS FROM SEMONICE STRONGHOLD IN THE LIGHT OF STUDIED FORGED PIECES FROM MEDIEVAL STRONGHOLDS, VILLAGES AND TOWNS

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ABSTRACT

Metallographic examinations of twenty two objects connected to agricultural life at the stronghold in Semonice (13th to 14th century) are evaluated in a first part of the paper. Tools like axes, knives and the timber shave were carefully fitted with welded-on steel edges; only one knife blade is completely made of steel. One sickle has a welded-on steel blade, the others are iron. Moreover, one of the two borers was provided with steel welded-on cutting edges, the second one has a spiral-shaped serrated part which is practically completely of steel. It was nonetheless welded from several rods. Steel was surprisingly lavishly used in the manufacture of the horse-shoes; two out of three of them were improved. In the case of the shears the construction is not sufficiently clear. An evaluation of the heat treatment of the Semonice objects is not possible (fire at the site), but originally they must have been quenched, and if not all of them, then at least most of them. The construction of the tools and implements was good, even if the steel of the edges was not of very good quality. The worst group of implements compared to the pieces from the other sites - were the sickles. The processing of the results of the chemical microanalysis of the slag inclusions of the Semonice objects was also part of the study briefly mentioned in the paper. The second part of the paper brings an overview and broad discussion devoted to forged tools which have come from the archaeological finds of Bohemian and Moravian medieval towns, villages, strongholds and castles. An attempt has been made to mutually compare the forged pieces and complete assemblages from these individual environments bearing in mind the current state of research.

Key words: Semonice - metallographic examinations - medieval tool-making – medieval town – village – stronghold – castle

INTRODUCTION

The Metallographic examination of objects from Semonice Stronghold was conceived as part of a broader "archeometallurgical" view of the blacksmith´s craft and its standard in the environment of the High Medieval towns, strongholds and villages in Bohemia and Moravia. Therefore the article also contains a survey of the available results from related research in addition to an evaluation of the finds from Semonice.

SEMONICE STRONGHOLD AND THE METALLOGRAPHIC EXAMINATIONS OF IRON OBJECTS

Strongholds, smaller fortified seats of the lesser feudal nobility, appear in the Czech countryside from the 2nd half of the 13th century – the stronghold in Semonice was probably also constructed at this time. It was destroyed by fire in the first half of the 14th century. Nearly 160 iron objects remained in the burning structure at that time. They were discovered at the end of the 19th century and are now stored in the National Museum in Prague. *(Huml 1967, 5, 36).* Twenty two of the finds were examined metallographically in 2002-2003.

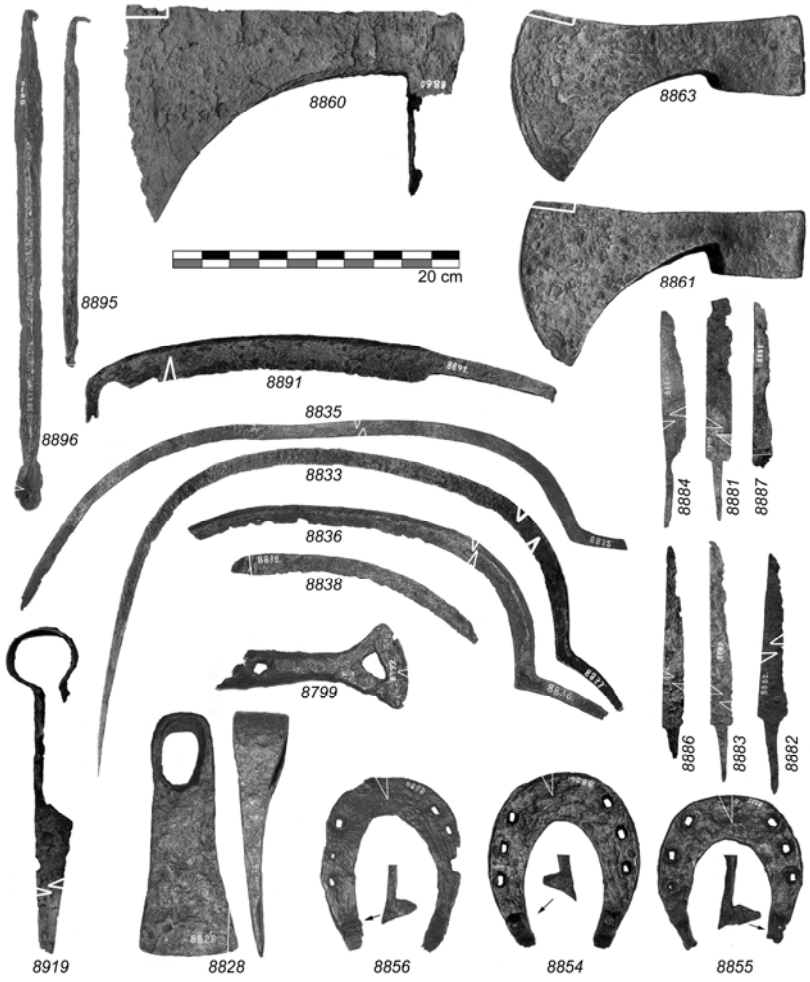

Fig. 1 - Investigated iron objects from Semonice Stronghold (13th to 14th centuries)

The main economic activity at strongholds used to be the agricultural production of plants and livestock. Ten examples from the Semonice agricultural implements and tools have been metallographically investigated. It is a matter of 4 out of a total of eight sickles, one of two ploughstaffs, a hoe, one of four sets of shears and also of 3 out of 7

horse-shoes. The components of the collections of tools tended to be related to small craftsman´s activities connected with woodworking, sometimes also - as in Mstěnice - with the maintenance or small-scale production of iron parts of implements and tools as well. Six objects intended for working with wood have been examined from Semonice. There was a single timber shave, two out of three borers and three out of four axes. Knives rank amongst the tools which were used on a daily basis. Six of the seven found have been examined. Unfortunately, we have not been able in the case of any of these objects to reliably assess their original heat treatment. It was in fact completely wiped by new heating, which was caused by the fire which destroyed the settlement. Strongholds provided safety in times of small-scale wars. Military equipment therefore always belonged to the equipment of the yeoman as well. At Semonice for example they had basic types of weapon for fighting on foot and they could if required also field two armed riders. The quality of the armaments in Semonice however has not been studied.

The Semonice knives are not bad from the point of view of construction. But the hardness of the cutting edges is not high and without heat treatment it is not possible to class them amongst the excellent pieces. All we can do is assume that they were quenched during their lifetime at the Stronghold. The most simple one is the completely steel blade 8882, in the case of the others a steel edge was welded on an iron back. But the cutting edges do not contain much carbon at all, as a rule between 0.3 to 0.4 %. Somewhat better material was only used in the case of example 8884 (0.4 to 0.5 % C). This knife differed from the others as well in the manner of the cutting edge attachment. It also differed in form and was the only one to have a punched mark. Rather paradoxically it has the worst cutting edge; very soft ferritic strip encroached onto the edge of the blade. It does not appear to have been the original “construction“ but rather an unprofessional repair job. Perhaps the cutting edge had got chipped in some places. Example 8886 is also different from the others. Its construction would correspond to type III. The steel cutting edge lamella was not highly carburised but on the other hand the distribution of carbon was uniform. Knife 8887 had a fairly diversely composed cutting edge - evidently welded from several parts. I suspect that it was a matter of a piece manufactured by a cutler. The last two knives 8881 and 8882 are quite similar to one another. They have a cutting edge that has been welded-on in a similar manner. The iron back is made from piled blanks in both cases and the manner of forming and offsetting the tang did not differ either. This pair could have come from one and the same workshop. But not even these blades are equipped with good quality edges. The carbon content is low and its distribution is not uniform. At Semonice they therefore used knives which were constructionally disparate but which were always however equipped with steel blades. Even though the steel did not have much carbon in its unquenched its hardness easily surpassed the iron parts. The investigated knives from Semonice were therefore probably reliable in their original working condition. They were constructionally good and none of them were coarse completely iron forged pieces. They correspond to the high standard which we gradually also find in a rural environment. But we do not encounter any constructionally improved appearance of the blades as is the case in the towns - specifically at Hradišťko-Sekanka and in Prague.

The axes from Semonice were constructed in various ways. A steel butt-welded-on cutting edge was used in the case of axe 8860. The remaining two, 8863 and 8861, have embedded steel plates. Constructionally however they were not completely the same. Given that axe 8861 can be completely safely attributed to construction type I, axe 8863 could be type I, VI or something between.

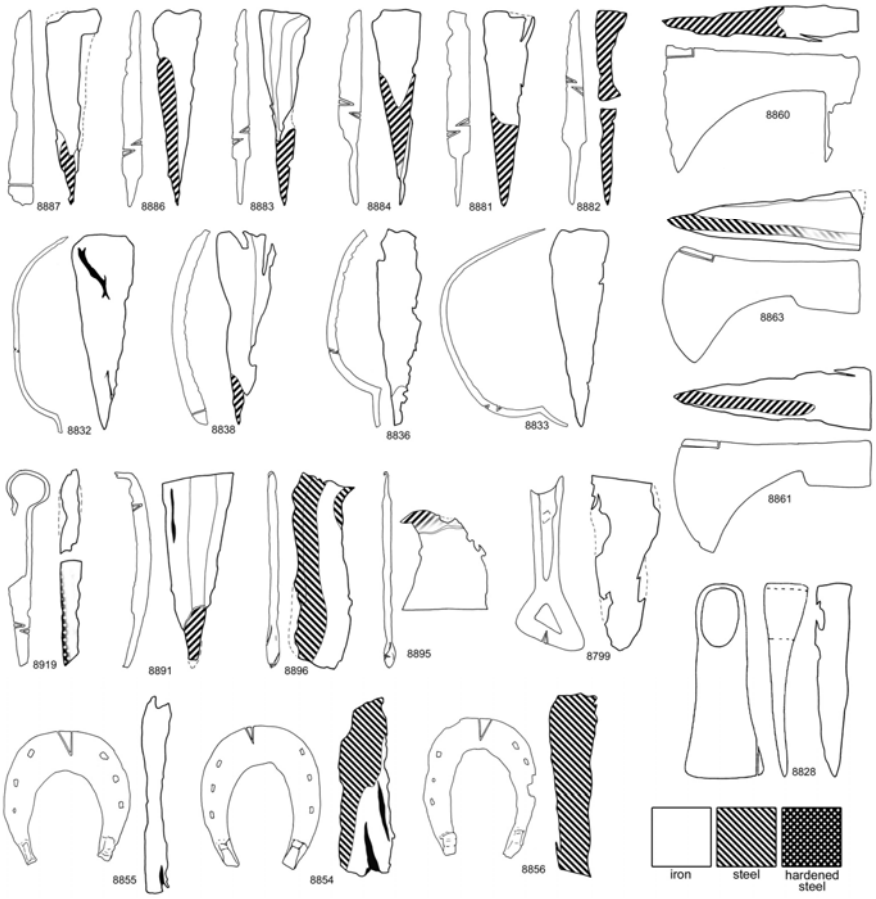

Fig. 2 - Drawings of the examined specimens – Semonice Stronghold

The quality of the edges, if it is a matter of the carbon content, also differs. 8861 has a cutting edge from uniformly carburised steel plate, the cutting edge of 8863 had the most carbon in the point and its iron character intensified towards the body. The distribution of carbon could indicate a not very intensive carburisation of the steel parts carried out in advance on one side. The appearance of the macrostructures, which appeared after etching with Oberhoffer etchant, would not rule this out. From the viewpoint of the achieved constructional quality the axe 8863 is worse than the previous pieces. It could have been for example manufactured by a blacksmith of more limited means or experience. The latter is perhaps borne out by the opening for a shaft which is very asymmetrical. A village workshop could have had more limited possibilities and perhaps even experience - not specializing in the problems of tool-making. It is nonetheless possible, that the quality of these axes was still within acceptable limits. It can be observed, that the construction and supposed original good quality of the axes does not significantly differ from the finds from other sites.

Four sickles from Semonice were investigated. Apart from fragment 8838 they are preserved in a relatively good condition which is always an advantage when looking for

significant connections between the investigated constructions. All three pieces with a well-preserved form are however only of iron. In the case of sample 8836 it could indeed be a matter of an attempt to obtain a blade with a steel edge, but the choice of material was in this case completely inappropriate. The cutting edge is still only iron. Blade 8838 is different. Its edge is of good quality steel, scarf- or butt-welded-on. The body is iron, flatly welded from two strips differing in their carbon content. If this sickle was also originally quenched it was an excellent implement. We pause once more at sickle 8832, which had a stamped mark. It was only made of iron and it was the only one not to have a serrated cutting edge. Its forging in the metallographic sampling area also appears to have been careless. The quality of the sickles was not generally very good and it can be stated, that the rural settlement of Pfaffenschlag could have been equipped with sickles of better quality.

Hoe and ploughstaff 8879 and 8828 are simple iron implements. This in itself cannot be understood as a fault and we have to judge both pieces as standard and corresponding to the type of forged pieces in question.

Augers 8896 and 8895 had steel edges, however with relatively low carbon content. We do not know if they were originally quenched. The construction of the edges was not the same. In the case of the bigger one, that is 8895, low-carbon steel was welded-on sideways or at a butt joint, in the second case the spade was welded from four lamella and perhaps the aim had been to manufacture this part completely from steel, although in reality it is rather a matter of iron lamella. The pieces from Semonice are of worse quality when compared with the augers known from Sekanka.

If timber shave 8891 was originally quenched, it can be certainly regarded as a high quality implement. It had an iron body and butt-welded-on cutting edge of good quality steel, which was fairly rich in carbon. The timber shave from Semonice Stronghold was better than the timber shaves from Bystřec and Sekanka. It also ranks amongst the best of the Semonice forged pieces.

The shears from Semonice had a layer on the functional side of the blade which had been slightly enriched with carbon. We do not know if we are dealing here with the welded-on thin steel, practically iron, lamella or with not very intensively carburised surface. We can nonetheless deduce their original quenching from the structure of this layer. This means, that there was almost certainly an attempt to obtain steeled blades and to manufacture a high quality work-aid. This was most probably unsuccessful. In comparison with other known cases the shears from Semonice are only simple products.

The horse-shoes from Semonice were not constructionally uniform in the frontal parts. Sample 8855 was only made of ferritic iron, 8856 completely steel and 8854 had a steel plate welded on the soil side. The steel used was not very rich in carbon - that is a feature at Semonice which is also common on the whole to the tools. As for their excessive softness it is problematic to state its influence on the functional characteristics. It would have been better if the steel parts had been quenched as it would have improved their wear resistance. But we do not know anything about the original heat treatment. This means, nonetheless, that horse-shoes were both common and also of relatively good quality at this stronghold - at least from the constructional point of view. The need for horse-shoes with greater durability of the front parts would indicate the presence of horses working with a heavier rather than lighter draught. The Semonice horse-shoes are relatively good in comparison with the other finds. They have a steel equipped frontal part which was not common in the 14th century.

Table 1 - Complete overview of the metallographic specimens from Semonice.

Captions: F ferrite F-P ferritic-pearlitic structure
P pearlite P-F pearlitic-ferritic structure
B bainite B-P bainitite-pearlite structure
M martensite M-B martensitic-bainititic structure

object	specimen (i.n. NM)	dating /century/	structure	part of the specimen	hardness		traces of quenching	preserved quality
timber shave	8891	14th	P / P-F F / F-P	cutting edge back	180 ± 13 176 ±18	HV 0,3 HV 0,3	no	medium
axe	8861	13th to 14th	F-P F	cutting edge core	122 ± 6 134 ± 38	HV 2 HV 2	no	low
axe	8860	beginning of the 14th	P-F F	cutting edge core	153 ± 10 185 ± 11	HV 0,3 HV 0,3	no	low
axe	8863	13th to 14th	P glob. F	cutting edge core	141 ± 7 94 ± 5	HV 0,5 HV 0,5	possibly yes	low
sickle	8833	13th to 14th	F F	cutting edge back	89 ± 2 94 ± 6	HV 0,3 HV 0,3	-	low
sickle	8838	13th to 14th	P F-P F	cutting edge back back	178 ± 16 90 ± 2 130 ± 30	HV 0,5 HV 0,5 HV 0,5	no	medium
sickle	8836	13th to 14th	F F	cutting edge back	100 ± 23 78 ± 2	HV 0,5 HV 0,5	-	low
sickle	8832	13th to 14th	F	cutting edge back	106 ± 10	HV 0,5	no	low
borer	8895	13th to 14th	F-P F	cutting edge core	145 ± 10 81 ± 5	HV 0,5 HV 0,5	no	low
borer	8896	13th to 14th	F-P F-P F-P F-P	cutting edge edge(?)/core core core	125 ± 10 143 ± 17 101 ± 7 144 ± 6	HV 0,5 HV 0,5 HV 0,5 HV 0,5	no	low
knife	8886	13th to 14th	P-F F	cutting edge back	106 ± 16 83 ± 2	HV 0,5 HV 0,5	no	low
knife	8883	13th to 14th	F-P P-F F F-P	cutting edge cutting edge back back	158 ± 12 153 ± 3 174 ± 17 106 ± 5	HV 0,5 HV 0,5 HV 0,5 HV 0,5	no	low
knife	8884	13th to 14th	F P-F F	cutting edge cutting edge back	100 ± 6 141 ± 10 103 ± 9	HV 0,5 HV 0,5 HV 0,5	no	low
knife	8881	13th to 14th	F+cem. F	cutting edge back	141 ± 5 80 ± 2	HV 0,5 HV 0,5	possibly no	low
knife	8887	13th to 14th	F-P F	cutting edge back	179 ± 11 104 ± 6	HV 0,5 HV 0,5	no	low
knife	8882	13th to 14th	P glob. P glob.	cutting edge back	149 ± 5 137 ± 16	HV 0,3 HV 0,3	possibly yes	low

shears	8919	13th to 14th	F B F	cutting edge cutting edge back	110 ± 8 203 ± 10 114 ± 11	HV 0,3 HV 0,3 HV 0,3	possibly yes	medium
ploughstaff	8799	13th to 14th	F F	cutting edge core	98 ± 16 86 ± 6	HV 0,5 HV 2	-	acceptable
hoe	8828	13th to 14th	F-P(gl.) F F	cutting edge cutting edge core	123 ± 5 97 ± 3 130 ± 7	HV 0,5 HV 0,5 HV 0,5	no	good
horse-shoe	8854	13th to 14th	F-P F	soil side upper side	108 ± 7 107 ± 5	HV 0,5 HV 0,5	no	good
horse-shoe	8856	13th to 14th	F-P F-P	soil side upper side	103 ± 13 139 ± 11	HV 2 HV 2	no	good
horse-shoe	8855	13th to 14th	F F	soil side upper side	137 ± 13 115 ± 7	HV 0,5 HV 0,5	-	good

CHEMICAL ANALYSES OF THE SLAG INCLUSIONS

The results of the chemical analyses of the slag inclusions /EDAX/ of all 22 metallographically investigated objects were compared with the assemblages of objects from Pfaffenschlag and Mstěnice. The composition of the homogeous inclusions were measured by spots analysis, the complex inclusions by square analysis. The later one however did not yield satisfactory results; the ascertained composition markedly fluctuated depending on the size and location of the analysed areas; in addition – mainly the values of the Fe_2O_3 content – were influenced by the surrounding matrix. It was only possible to incorporate results with less than 14% internal error into the evaluation. Cluster analysis was used to enable division into groups for an assessment of chemical composition. Only ratios of oxides were treated because they remain fairly constant in contrary to the individual values for oxides which could vary widely in slag inclusions *(see Høst-Madsen - Buchwald 1999, 64; Buchwald 2001, 12-19 e.t.c)*. It emerged that the Semonice forged items have inclusions with significantly lower ratios of the oxides SiO_2/MgO a K_2O/MgO and the assemblage as a whole can be distinguished from Pfaffenschlag and Mstěnice. The established ratios of oxides for the whole Semonice assemblage were on average the following analysis. SiO_2/Al_2O_3 (7.2 ± 6.0), SiO_2/CaO (8.4 ± 6.8), SiO_2/MgO (15.0 ± 13.4), SiO_2/Fe_2O_3 (4.5 ± 7.3), CaO/K_2O (2.9 ± 2.7), CaO/TiO_2 (16.2 ± 7.3), Al_2O_3/CaO (1.6 ± 1.1), K_2O/MgO (1.0 ± 0.8) a K_2O/CaO (0.6 ± 0.3). At the same time the high values of the standard of both the single oxides and also their ratios indicates a marked variability of results. At a general level a direct relationship between the compositions of the inclusions, the employed construction schemes and the types of forged pieces from Semonice cannot be reliably demonstrated. We can however say that if the form and tool-making construction agree well, the similarity in the composition of the raw materials used for the inclusions can also agree; for instance a pair of knives 8881 and 8883. On the contrary, the form of the forged pieces can in itself be only a weak and unconvincing indicia, as is in the case of axes 8861 and 8863. These are significant results in themselves, because they force us to place greater significance on the "anatomy" of forgings than has been the custom in archaeological practice until now, at least when looking for shared characteristics and relationships amongst objects.

HIGH MEDIEVAL TOOL-MAKING IN AN URBAN AND RURAL ENVIRONMENT AND AT STRONGHOLDS AND CASTLES – AN OVERVIEW OF THE RESEARCH THAT HAS BEEN CARRIED OUT

Besides the material from Semonice stronghold it is possible to evaluate the forged products from the stronghold at Mstěnice *(Stránský - Vrba 1985)*. It originated in the last quarter of the 13th century and ceased to exist in 1468, when it was stormed and burnt down *(Nekuda 1985, 170)*. Urban blacksmithing is recorded by the objects from Hradišťko u Davle – Sekanka *(Pleiner 1982)*, Most *(Pleiner 1983)*, Sezimovo Ústí *(Pleiner 2003)* and Prague *(Pleiner 1991)*. Sekanka was an early type of small town which belonged to Ostrovský Monastery. It came into being shortly after 1278 *(Richter 1982, 238)*. The finds from medieval Most are dated to the 14th century *(Klápště 2003)*, from Sezimovo Ústí to the 13th to beginning of the 15th century *(Pleiner 2003, 173)* and the Prague finds come from the former Horse Market in the 14th to 15th century *(Pleiner 1991, 239)*.

We have examinations of rural finds from Pfaffenschlag *(Stránský 1975)*, Mutějovice *(Pleiner 1969)*, Bystřec *(Belcredi - Ustohal - Buchal 2002; Zeman 1988)* and Příšovice *(Hošek 2003, 53-67)*. The hamlet of Pfaffenschlag was founded in the second half of the 13th century and most probably fell into disuse in the first half of the 15th century *(Nekuda 1975, 156-157)*. The hamlet of Bystřece was in existence for approximately the same length of time. It was destroyed by fire in the 1st quarter of the 15th century *(Belcredi - Ustohal - Buchal 2002, 43)*, 13th century smithies were found in Mutějovice. *(Pleiner 1969, 568-569)*, the finds from Příšovice were originally the equipment from a mill – the implements were dated on the basis of analogy to the 2nd half of the 14th to 1st half of the 15th centuries *(Stará 1991, 150)*. When undertaking comparisons it is also not possible to leave out the equipment from the castles, which has only been investigated to a very small extent up till now; Trosky *(Hošek 2003, 68-83)*, Dolní Štěpanice *(Hošek 2003, 84-97)*, Lelekovice *(Mihok - Pribulová - Unger 1999; Ptáčková - Unger 1994)* and Rokštejn *(Ustohal - Stránský 1988; 1988a; 1988b)*. The settlement of Trosky is documented from the beginning of the 14th century and the studied finds are from the 14th to 15th centuries. The castle was burnt down in the mid 17th century *(Hošek – Prostředník - Benešová 1999, 25)*. The forgings from Dolní Štěpanice Castle, which had evidently already been founded in the second half of the 13th century and abandoned in the 16th century, are likewise from the 14th to 15th centuries *(Hošek – Prostředník 1999, 13)*. Lelekovice originated in the 1st half of the 14th century and was violently destroyed most probably by the 1401. The investigated objects come from the end of the 14th century *(Ptáčková - Unger 1994, 251; Mihok - Pribulová - Unger 1999, 115)*. Rokštejn was founded in the second half of the 13th century and abolished most likely between 1423 and 1436 *(Měřínský – Plaček 1989, 5, 15)*. The examined weapons from Rokštejn are however only of marginal importance for the study of our tool-making techniques.

TOWNS

Our most extensive metallographically investigated assemblage from an early urban environment comes from Hradišťko-Sekanka (13th century). 33 knives were investigated, 1 sickle, 3 axes (of which one was miniature), 1 timber shave, 2 spiral augers, 3 chisels, 1 forge chisel, 2 awls, 1 drift hammer, 3 points, 2 hoes, 2 spring knifes, 2 steel sharpeners and 1 key. There were seven pattern-welded pieces, six striped and

one with wavy-welded-on steel cutting edge amongst the examined knives. We are dealing here with the most ostentatious types of blades which we can encounter in the middle ages. It is not without interest that pattern-welded knives were found in three units (twice in pair and once as a group of three). Fourteen further knives had a steel cutting edge welded on an iron back.

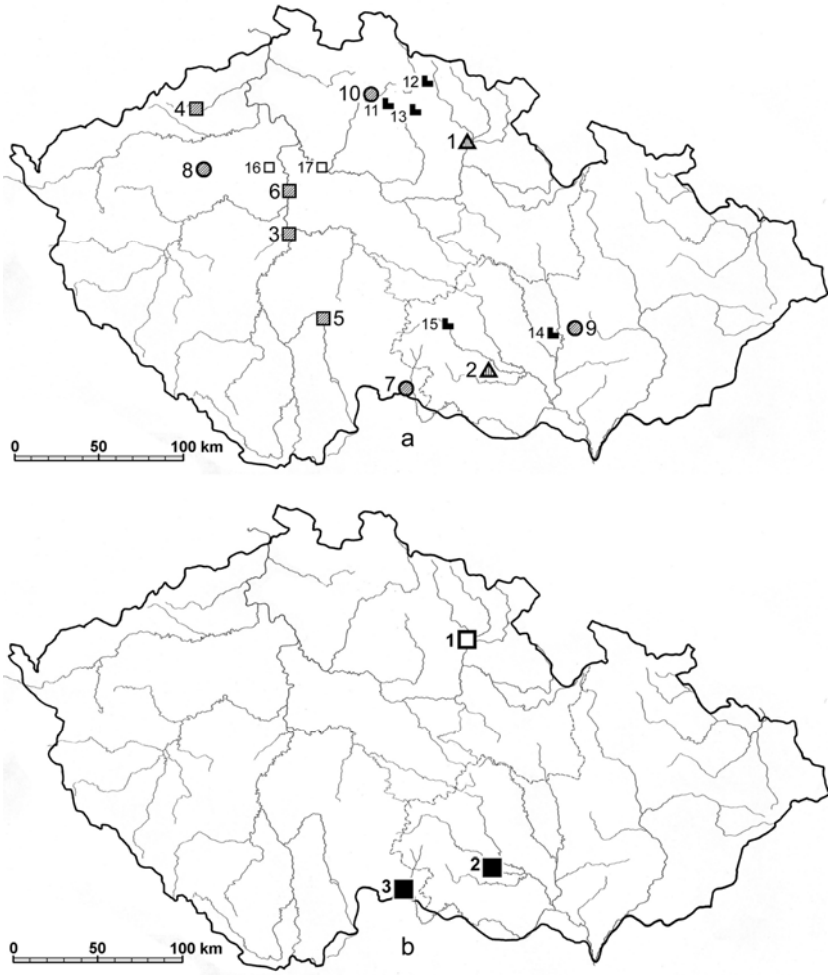

Fig. 3 - a - map of sites from the 10th – 15th centuries with metallographically analysed complexes of iron objects; ***Strongholds:*** *1 – Semonice; 2 – Mstěnice;* ***Towns:*** *3 – Sekanka; 4 – Most; 5 - Sezimovo Ústí; 6 – Praha;* ***Villages:*** *7 – Pfaffenschlag; 8 – Mutějovice; 9 – Bystřec; 10 – Příšovice;* ***Castles:*** *11 – Trosky; 12 – Dolní Štěpnice; 13 – Kumburk; 14 – Lelekovice; 15 – Rokštejn;* ***Hillforts:*** *16 – Budeč; 17 – Stará Boleslav; b - sites at which analyses of the slag inclusions of metallographically investigated iron objects have been carried out; 1 – Semonice (low values of the ratios of SiO2/MgO and K_2O/MgO predominate); 2 – Mstěnice, 3 – Pfaffenschlag high values of the ratios of SiO_2/MgO and K_2O/MgO predominate)*

This is the most common design with a predominance of hardened and butt welded-on steel rods. Simple iron blades were ascertained in six cases *(Pleiner 1982, 270-273, 274-277)*. Excellent toolls were both pairs of shears with surface welded iron and steel

lamella as well as similary constructed cleavers (chisels) and spiral augers, further axe 206 and pronghoe 203 and 204 with scarf welded on steel cutting edges, fire steels and the like. On the contrary against expectations timber shave 243 or pronghoe 202 for example were only simple forged pieces. Axe 260 suffered from the poor choice of material of the cutting edge *(Pleiner 1982, 277-279)*. Nonetheless the level of blacksmithing at Sekanka was high, which attests to the presence of specialized products for the market. We have an axe and a fragment of a sickle (13th century) from medieval Most *(Pleiner 1983, 501)*. They are excellent implements with quenched steel edges. The sickle blade was completely steel, but it is possible, that it was also welded from two parts – a steel cutting edge and back. We have knives and war knives from the 13th and mainly from the turn of the 14th and 15th centuries from Sezimovo Ústí. A hardened steel edge on an iron back is the most frequently used arrangement. Only in the case of one of the two knives from the 13th century was steel also welded on onto the edge, as was the case with one of the war knives (beginning of the 15th century). The axe and sickle also have a welded on steel edge. In the case of the "tailors´" scissors and foreplane blade the steel and iron lamella were welded as a sandwich. Hardening and on the whole excellent quality is the rule in this assemblage of forged pieces mainly dating from the end of the 14th to beginning of the 15th century. The only exceptions are made by knife sample 701 and war knife sample 693 *(Pleiner 2003, 173-177)*. An assemblage of forgings from Prague (14th to 15th century) is interesting. All the investigated knives, a war knife, fragments of scissors or shears and a sickle had welded on steel and quenched edges. The blades of the war knife, scissors (shears) and at least two knives also had in addition a steel bar in the back. This could have improved their appearance. The last blade fragment had a steel edge (or rather a blunt edge) without any sign of quenching, but it was nonetheless very hard and it can be regarded as a good forged piece. The high level of tool-making is also supported by the finding of a key and head of a crossbow bolt. The tooth of the key had welded on steel on the side and the head of a crosbow bolt was provided with steeled and quenched tip. We are dealing with high quality objects here, attesting to the high professional level of the blacksmiths who worked in Prague in the 15th century *(Pleiner 1991, 285-287)*.

The High Medieval town can then be generally regarded as a source of excellent edged tools and weapons.

VILLAGES

Rural blacksmithing of the 13th century is elucidated by a collection of iron from Mutějovice smithies. We can however only judge toolmaking techniques from four knives *(Pleiner 1969, 560-564)*. Two were made of iron, another was made from trhee butt welded on rods (two of iron and a steel one – no quenched) and the last one had a pattern-welded core. The first two pieces could have been manufactured by local blacksmiths, the third and fourth could again have come from some urban workshops. Only seven sickles and two ploughshares were studied from Pfaffenschlag *(Stránský 1975, 209-210, 213-214)*. The ploughshares differed in the size and quality; only the bigger one had steel and quenched edges. Apart from one piece, which did not undergo any blade improvement, the blades of the sickles were carburised and quenched (again with a single exception). That means that the houses in Pfaffenschlag were well equipped. The Příšovice objects evidently represented the equipment of a mill. The examinations of the tools were however limited to the mere assessment of the quality of the material in the edges. Both hammers, most probably used for sharpening of mill-stones, were demonstrably equipped with good quality edges as well as pole-axes of

which only one does not bear good quolity edge. Also in the case of the adze we lack a good edge. However it is not clear in the case of these objects if the absence of steel in the edge was connected with their poor state of conservation or with the inferiority of the tools. The equipment of the Příšovice settlement can be evaluated as very good on the whole *(Hošek 2003, 53-67)*. The examinations of the finds from Bystřec again only covered reliable information about their construction. The village was destroyed by fire, therefore the evaluation of their heat treatment is unreliable. Nonetheless in the case of the knife and sickle traces of quenching were found. The investigated objects – knife, razor, axe and sickle – had steel edges which were in the case of the razor and axe undoubtedly welded on. The knife was evidently completely of steel, thus good but simple piece, a timber shave was made only of iron. If the steel edges were originally quenched the tools can be regarded as of good quality *(Zeman 1988, 489-490; Belcredi - Ustohal - Buchal 2002, 43)*.

From the survey outlined above we can conclude that villages could be well equipped with good quality tools and implements. This need not be particularly surprising because the rural inhabitants were significant consumers of implements and tools.

STRONGHOLDS

Besides the previously discussed objects from Semonice we can evaluate two axes, a knife and three sickles from stronghold of Mstěnice. The axes had quenched steel cored edges while the knife and two sickles were carburised and quenched in the edge. It is a matter of very good quality tools. The blade of the last of the sickles was made of unhomogenized steel without any further processing. Its quality was not too bad in fact but the sickle was only simple and it certainly did not achieve the level of the previous pieces. The stronghold and the adjoining farmstead were then equipped with good quality tools *(Stránský - Vrba 1985, 195-197, 200-203)*. The destruction of the stronghold (1468) is recalled by the finding of sword which was good quality stabbing weapon that had only been quenched at the blade point. The sword was brought in Mstěnice by conquerors of the stronghold *(Krajíc - Kukla - Nekuda 1997, 255, 257)*.

It can be concluded that the lesser rural nobility had sufficient means at its disposal to equip its economic enterprises with good quality implements and tools. It would be interesting to do more comparisons of the equipping of the strongholds with the other homesteads in the villages in question. For the meantime it seems that implements and tools from strongholds are not better than implements from rural houses. It would then be very interesting to compare the quality of the weapons – mainly of the swords, which are the most suitable for such a comparison.

CASTLES

A knife (14th to 15 century) with a steel blade comes from Trosky. Althought the blade was composed of several rods with a variable carbon content it does not appear to have been a targeted construction. The knife was quenched, but the cutting edge remained soft *(Hošek 2003, 82)*. We have an examined war knife (14th to 15th century) from castle of Dolní Štěpanice which also had a completely steel quenched blade nonetheless with decreased hardness in the cutting edge *(Hošek 2003, 85)*. A sword (end of the 14th century) comes from the castle of Lelekovice. The upper part of the blade

was carburised but not quenched. Despite of that it is judged to be an excellent piece *(Ptáčková - Unger 1994, 254)*. There is a pronghoe (13th to 15th century) with a hard steel quenched tip from Kumburk *(Hošek 2003, 185-186)*. We can also recall a head of crossbow bolt (15th century) from Rokštejn with steel cored and qeunched tip, which was not common at that time *(Ustohal - Stránský 1988, 71-72)*. We also have several examined horse-shoes from Trosky, Dolní Štěpanice and Lelekovice but none of them bear signs of any deliberate improvement (by steel), *(Hošek - Kudrnáč 2004, 23)*.

The castle blachsmithing workshops were not directly intended for the manufacture of implements and tools and it can be supposed in the majority of cases that the finds in question were carried into the areas of the castles. For the meantime it is more than problematic to assess the facilities of these seats from the point of view of the metallographic research. Essentially we have no choice but to wait for the results of further research.

CONCLUSION

The assessment of the level of equipment of the manufactured tools and implements in the environment of High Medieval towns, villages, strongholds and castles can be carried out to a certain extent. Not however without problems. There are still only a few investigated complexes, which are ideal for the study of tool-making in both their volume (abundance and variety of the implements) and in their state of preservation (finds from the sites of fires and the like are less suitable).

Nonetheless we can already draw attention to the high level of the products from the towns (Hradišťko-Sekanka, Most, Sezimovo Ústí, Prague). Rural settlements, both strongholds and serfs houses, could have been equipped with good quality tools and implements as well (Semonice, Mstěnice, Pfaffenschlag, Bystřec, Příšovice). We can only directly compare the countryside and the towns with difficulty as there are relatively few forged pieces which can be used for direct comparison. The urban complexes nonetheless seem to have been better in their construction as a whole. In the case of the knives and war knives from an urban environment at least (Hradišťko-Sekanka, Sezimovo Ústí, Prague) we commonly encounter much more complicated constructions not only in function but also in appearance. In the rural settlements (Semonice, Mstěnice, Bystřec) and castles (Trosky, Dolní Štěpanice) we find knives or war knives which are functionally good, however of relatively simple construction as a rule. If it is a matter of cutlery, it is interesting to look back at the period from the 10th to the 12th century. We uncovered ostentatious knives at early medieval Přemyslid castles (Budeč, Stará Boleslav) as we did as at the rural settlements (Mutějovice, Hrdlovka). Castles themselves for the meantime have only little significance for our research into tool-making (Trosky, Dolní Štěpanice, Kumburk, Lelekovice, Rokštejn).

It is evident, that in contrast to the common rural population the lesser nobility seated in the strongholds were economically stronger than peasants and we can suppose that they had better possibilities to equip their economic premises with high quality tools, which are increasingly produced in the specialized workshops of the emerging urban centres. But this supposition has not yet been confirmed. Up till now metallographic research has mainly not covered both these rural components (lesser nobility, serfs) to a sufficient extent. If we can only make a judgment in some cases, it seems that strongholds and the rural settlements from the 13th to 15th century have tools and implements of comparable quality. It is a question of whether agricultural serfs were

really significant consumers of all types of good quality implements and tools from specialized urban workshops, or whether this production output mainly occurred on the less numerous feudal farmsteads. The matter is of course complicated by the fact that marked property differentiation also existed in the countryside and that some of the lesser lords continued to settle in common unfortified farmsteads even at the time of the blossoming of the strongholds. It will be necessary to solve this question despite the outlined difficulties. It is namely not only a matter of the assessment of the level of material equipment of the rural serfs. The mapping of the occurrence of the high quality forged pieces (observing not only the quantity but also quality) has fundamental significance for a deeper understanding not only of the development but mainly of the spread of positive changes and increase in craft production of the Early Medieval period and also of the significance of towns as centres of craft and trade.

REFERENCES

[1] *Belcredi, L. - Ustohal, V. - Buchal, A. 2002:* Materiálová analýza povrchové vrstvy pořízu ze zaniklé středověké vsi Bystřece, in: Archeologia technica 13, TM v Brně, 43-46.

[2] *Buchwald, V. F. 2001:* Ancienit Iron and Slags in Greenland, Meddelelser om Grønland. Man & Society 26, Kopenhagen, Danish Polar Center.

[3] *Høst-Madsen, L. - Buchwald, V. F. 1999:* The characterization and provenancing of ore, slag and iron from the Iron Age Settlement at Snorup, in: The Journal of the Historical Metallurgy Society, 33/2, 57-67.

[4] *Hošek, J. 2005:* Rozbory železných předmětů z Hrdlovky, odborný posudek č.j. 8882/05, archiv ArÚ AV ČR v Praze.

[5] *Hošek, J. 2003:* Metalografie ve službách archeologie, ARU AV ČR Praha & TU Liberec.

[6] *Hošek, J. 2003a*: Metallographic examinations of the 10th to 12th centuries knives from the Premyslid stronghold at Stara Boleslav (Bohemia), In: Archaeometallurgy in Europe, vol. 1, Milan, 219-228.

[7] *Hošek, J. 2003b:* Metalografie dvou želez z lokality Hrazany, odborný posudek č.j. 2161/06, archiv ArÚ AV ČR v Praze.

[8] *Hošek, J. – Prostředník, J. – Benešová, J. 1999:* Kovářská dílna na hradě Trosky, in: Z dějin hutnictví 28, Národní technické muzeum, Praha, 25-35

[9] *Hošek, J. – Prostředník, J. 1999:* Rozbory středověkých železných předmětů a strusek z hradu Dolní Štěpanice, in: Z dějin hutnictví 28, Národní technické muzeum, Praha, 13-24.

[10] *Hošek, J. - Kudrnáč, J. 2004:* Metalografický rozbor dvou středověkých podkov z Horské Kvildy na Šumavě, in: Archeologia technica 15, TM v Brně, 22-27.

[11] *Huml, V. 1967:* Zaniklá tvrz Semonice, Die Untergegangene Festung in Semonice, Hradec Králové.

[12] *Klápště, J. 2003:* ústní sdělení *(personal communications)*.

[13] *Krajíc, R. 2003:* Sezimovo Ústí, Archeologie středověkého poddanského města 3/II, Praha-Sezimovo Ústí-Tábor.

[14] *Krajíc, R. - Kukla, Z. - Nekuda, R. 1997:* Středověký meč ze Mstěnic, in: Z pravěku do středověku, Muzejní vlastivědná spol., 250-258.

[15] *Měřínský,, Z. – Plaček, M. 1989:* Rokštejn, středověký hrad na Jihlavsku (jeho dějiny, stavební vývoj a výsledky archeologického výzkumu 1981 – 1989), Brno - Brtnice.

[16] *Mihok, L. - Pribulová, A. - Unger, J. 1999:* Smithy production in medieval castle Lelekovice, South Moravia, in: Archaeometallurgy in the Central Europe, Východoslovenský pravek – special issue, Košice, 115-131.

[17] *Nekuda, V. 1975:* Pfaffenschlang, Blok, Brno.

[18] *Nekuda, V. 1985:* Mstěnice, Hrádek- tvrz - dvůr - předsunutá opevnění, Muzejní a vlastivědná společnost v Brně.

[19] *Pleiner, R. 1969:* Středověké sídliště s kovárnami u Mutějovic, Eine Mittelalterliche Dorfsiedlung mit Schmiedewerkstätten bei Mutějovice, Westböhmen, in: Památky archeologické LX/2, 533 –571.

[20] *Pleiner, R. 1982:* Techniky kovářské výroby, in: Richter, M: Hradišťko u Davle, Praha, 268-300.

[21] *Pleiner, R. 1983:* Metalografický výzkum železného srpu a sekery z mostecké studně, Metallographische Untersuchung eiserner Sichel und Axt aus dem mittelalterlichen Brunnen in Most, in: Památky archeologické LXXIV, 498-502.

[22] *Pleiner, R. 1991:* Die Technik der Schmiede im Mittelalterlichen Prag, in: Archaeologica Pragensia 11, Praha, 239-287.

[23] *Pleiner, R. 1993:* Die Technologie der Messerherstellung in der Frühmittelalterlichen Fürstenburg von Budeč, Böhmen, Památky archeologické LXXXIV, Praha, 69-92.

[24] *Pleiner, R. 2003:* Metalografický rozbor středověkých železných nástrojů ze Sezimova Ústí, in: Krajíc, R.: Sezimovo Ústí, Archeologie středověkého poddanského města 3/II, Praha-Sezimovo Ústí-Tábor.

[25] *Ptáčková, J. - Unger, J. 1994:* Meč z lelekovického hradu, Die Schwert aus der Burg von Lelekovice, in: Castellologica Bohemica 4, Praha, 251-256.

[26] *Richter, M 1982:* Hradišťko u Davle, městečko ostrovského kláštera, Praha.

[27] *Stará, M. 1991:* Nález souboru kovových předmětů v Příšovicích, okr. Liberec, Sborník severočeského muzea - historia č. 10, Severočeské nakladatelství, Liberec, 147-156.

[28] *Stránský, K. - Vrba, I. 1985:* Rozbory železných předmětů a strusek ze zaniklé středověké osady, in: Nekuda, V.: Mstěnice, Hrádek- tvrz - dvůr - předsunutá opevnění, Muzejní a vlastivědná společnost v Brně, 193-222.

[29] *Stránský, K. 1975:* Rozbory železných přemětů, in: Nekuda, V.: Pfaffenschlang. Blok, Brno, 209-218.

[30] *Stránský, K. 1987:* Rozbory středověkých železných předmětů, in: Zkoumání výrobních objektů a technologií archeologickými metodami, sborník VII. a VIII. semináře, Brno, 173-186.

[31] *Ustohal, V. - Stránský, K. 1988:* Rozbory součástí středověkých železných zbraní a výstroje. Šipky s trnem a tulejkou, in: Hutnické listy /1, 67-72.

[32] *Ustohal, V. - Stránský, K. 1988a:* Rozbory součástí středověkých zbraní a výstroje. Plátové a kroužkové brnění, in: Hutnické listy /2, 147-150.

[33] *Ustohal, V. - Stránský, K. 1988b:* Rozbory součástí středověkých zbraní a výstroje. Hrot kopí a ostruha, in: Hutnické listy /3, 220-223.