

## KALUP ZA LIJEVANJE VOŠTANIH MODELA CERTOSA FIBULA IZ SISKA

UDK 903.052.5 (497.5) "638"

Primljeno/Received: 2003. 03. 24.

Prihvaćeno/Accepted: 2003. 09. 15.

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*U koritu rijeke Kupe u Sisku nađena je polovica dvodijelnoga kalupa od pečene gline. Taj je kalup bio namijenjen lijevanju brončanih fibula, ali je zbog greške nastale pri izradbi, prenamijenjen za proizvodnju modela od voska. Njima su, u kalupima za jednokratnu uporabu, starom i dugo korištenom tehnikom tzv. izgubljenog voska (à cire perdue), lijevani predmeti. Fibule (negativi) imaju odlike certosa fibula XIII. grupe, pa je stoga kalup datiran u okvire Ha D3 horizonta, oko 450.-350. god. pr. Kr.*

*Ključne riječi: Sisak, kalup, lijevanje, voštani model, certosa fibule*

Za pretpovijesni odjel Arheološkoga muzeja u Zagrebu otkupljen je ljeti 1999. god. dio kalupa za lijevanje fibula. Prema riječima nalaznika potječe iz Siska, a nađen je u koritu rijeke Kupe na zavoju stotinjak metara nizvodno od Novoga mosta. Kalup je nabavljen od g. R. Maričića iz Siska. Riječ je, naime, o polovici dvodijelnoga kalupa (T. 1/1) od dobro pečene gline crvenkastosmede boje sa svijetlosivim mrljama (Munsell: 5yR4/4 reddishbrown) u kojoj se naziru sitna zrnca pijeska. Nepravilna je četvrtasta oblika (dulj. 11 cm, šir. 7,6-9,1 cm, deb. 2,3 cm) s nemarno oblikovanim vanjskom i bočnim stranama, na kojima su jasno vidljivi tragovi gnječenja i utisnuća prstiju. Vanjska strana kalupa ima četiri rupice, dvije u kutovima i dvije oko sredine, a unutarnja tri jer jedna rupica nije bila do kraja probijena. Služile su za umetanje tankih drvenih ili metalnih štapića, kojima su spajane i pričvršćivane polutke kalupa (Miske 1899: 10; Paret 1954:7) kako bi se prilikom lijevanja spriječilo njihovo pomicanje i tako osiguralo dobivanje pravilnog i kvalitetnog odljevka. Površina unutarnje strane kalupa ili sljubnica posve je glatka, bez ikakvih tragova oštećenja, osim napuklina nastalih tijekom vremena. Na njoj su, jedna iznad druge, utisnute tri fibule (dulj. 4,6 cm), odnosno njihov negativ, a svaka od njih na kraju luka tj. na glavi ima kanal, koji se spaja s kraćim i širim

zajedničkim uljevnim kanalom. Proširenje uljevnoga kanala dvodijelnih kalupa redovito je na jednoj, užoj strani (Šimek 1996: 53) i nikada ne obuhvaća čitavu širinu kalupa, a na našem je primjerku iznimno široko. Ono je naime struganjem oštirim predmetom po već dovršenu kalupu namjerno proširivano.

Na prvi se pogled čini da je kalup služio za lijevanje metala, najvjerojatnije bronce, ali na njemu nisu uočeni tragovi takva lijevanja. Naime, visoka bi temperatura litine neminovno izazvala promjene vidljive u boji, a po svoj prilici i u pukotinama nastalim lijevanjem zadržali bi se, makar i mikroskopski sitni, tragovi bronce. Mada na njemu nema vidljivih tragova lijevanja, to ne mora značiti da je kalup bio odbačen i da nije bio u funkciji. Prvotno je vjerojatno i rađen za lijevanje u bronci, jer se u fakturi kalupa nazire pijesak, a on se pri izradbi kalupa dodavao glini (Šimek 1994: 94) zbog elastičnosti, termostabilnosti i propusnosti plinova nastalih prilikom lijevanja s metalom. Međutim, čini se da je još prije njegove uporabe, bila uočena greška nastala pri izradbi kalupa, pa je stoga naknadnim zahvatom, odnosno proširenjem ulaznoga kanala prilagođen i upotrebljavan za izradbu modela u materijalu niskoga tališta, najvjerojatnije u vosku. Ako je bilo tako, možda je razlog njegove prenamjene u rasporedu uljevnih šupljina koje su smještene, u

nepovoljnu kutu koji ne dozvoljava lijevanje i vađenje neoštećenih brončanih odljevaka. U tom bi slučaju popravak fibula bio mnogo dugotrajniji i teži postupak, nego li s voštanim odljevcima upotrijebljenim za lijevanje u kalupima jednokratne uporabe. Vosak, kao mekan, podatan i jeftin materijal, dopuštao je lagan i brz popravak modela, a uz to su se na njih vrlo jednostavno i precizno mogli dodavati detalji, od onih plastično oblikovanih do urezanih motiva složenije koncepcije.

Lijevanje predmeta s pomoću voštanih modela u kalupima za jednokratnu uporabu često je korišten postupak, opće poznat kao lijevanje u tehničar iz izgubljenoga voska (franc. *à cire perdue*, eng. *lost wax*, njem. *Guß in verlorener Form*). Ta se tehnika lijevanja temelji na kvalitetno izrađenu modelu od pčelinjega voska, u koji su radi čvrstoće dodavali prah drvenog ugljena, loj, laneno ulje i kalofonij (Armbruster 2001: 632). Tako doraden vosak, oblikovao se u modele s pomoću kalupa od pečene gline ili drveta (Vomer Gojković 1993: 14-15). Besprijeckorno napravljen model sa svim detaljima, uključujući i one tehničke naravi (kanali), oblagao bi se glinenim omotačem, na kojem bi se napravio otvor kroz koji je nakon pečenja kalupa, koji se prethodno dugo i temeljito sušio, iscurio vosak, ostavljajući šupljinu koja je zadržala oblik modela. Prije lijevanja kalup se zagrijavao kako se u dodiru s litinom zbog temperaturnih razlika ne bi raspucao ili deformirao. Za lijevanje finijih i gracilnijih predmeta, posebice nakita, rabila se žitkija bronca, tj. ona s većim postotkom kositra, što joj je davalo lakoću prodiranja u svaki i najsitniji detalj kalupa. Nakon hlađenja i očvrnuća litine predmet se vadio razbijanjem omotača, odnosno kalupa (Goldmann 1981: 111, fig. 2; Krause 1997: 36-37; Armbruster 2001: 632-633), pa se stoga kalupi za jednokratnu uporabu, osim ako nisu bili uopće upotrijebljeni (Šimek 1984: 52, T. 1:6-7), vrlo rijetko nalaze, a zbog fragmentiranosti se još rjeđe prepoznaju. Do konačnog izgleda svaki se predmet dotjerivao i doradivao, naime odstranjivali su mu se viškovi lijeva, brusili i glačali rubovi te retuširala ornamentika, a potom i dodavali dijelovi koji nisu bili lijevani.<sup>1</sup>

U našem su kalupu jasno vidljivi negativni triju fibula, čije su tipološke odlike znatno uočljivije na za tu svrhu napravljenu otisku od gline (T. 1/2). Polukružno oblikovan luk, kao i nožica s okruglim pucetom smještenim na kratkom vratu odlike su certosa fibule XIII. grupe (Teržan 1977: 338-341). Njihovo svrstavanje u jednu od osam predloženih inačica za fibule te grupe nije moguće, jer su tijekom obradbe od voštanih modela do konačnog izgleda brončanog odljevka mogle

dobiti ili izgubiti poneki detalj bitan za precizniju tipološku distinkciju. Ornamentika spomenute grupe fibula bila je vrlo skromna, a sastojala se od linija koje prate luk ili poprečnih rebara uz rub nožice i glave fibula. Gotovim se metalnim, brončanim, odljevcima nakon dotjerivanja rubova i ornamentike raskivao i savijao držač igle na nožici fibule, a na kapljastom proširenju glave probijala se rupica za mehanizam igle, koja izlazi iz sredine samostreljne opruge od većeg broja navoja povezanih ispod luka tetivom pravokutne sheme. Samostreljna opruga s više navoja specifikum je certosa fibula sa slovenskoga prostora (Teržan 1977: 357-359), posebice njezine XIII. grupe. Ta je vrsta fibula bila čest detalj nošnje, kako na prostoru svetolucijske kulturne grupe, tijekom njezinih stupnjeva II b 2 i II c (Teržan 1977: 361; Gabrovec, 1987: 130) tako i mlađega certosa i negovskog horizonta (Teržan 1977:361; Gabrovec 1987:67) dolenske grupe, a odatle se prenose prema panonskom i balkanskom prostoru. Tamo ih isprva nose u izvornom obliku, a poslije se ponešto modificirani oblici (Teržan 1977: 362, 377-380, karta 30) uvržuju u njihovu nošnju. Nalažene su pojedinačno, ali i u većem broju, vrlo često po tri, kao što je to slučaj i u grobu 1 iz Vinkovaca. U tome dvojnom grobu na položaju robne kuće "Na-Ma" (Dizdar 1999: 40, kt. 143; Majnarić-Pandžić 2003: 3-6, fig. 3:1-4)<sup>2</sup>, u kojem su pokopani muškarac i žena, nađen je držak skepra, statusne insignije žena, možda svećenica, u krugu dolenske grupe (Stare 1975: 730). Isto su značenje vjerojatno imali i primjerci nađeni na prostoru Panonije (Jerem 1968: 187, fig. 24:2; Jerem 1973: 82-83, fig. 7:1; T. 16/5), kamo su se skepri slična oblika proširili. U grobu su bile i tri fibule, kojima su naši primjerci (negativi) najsljedniji. Naime, veličina, linija luka i izrazito okruglo puce na nožici fibula, bila su im gotovo isti. Posebice je ta sličnost izražajna na jednom primjerku (Majnarić-Pandžić 2003: fig. 3:2), jer valja naglasiti da sve tri fibule, ni u grobu ni u kalupu, nisu posve identične, već se u detaljima za nijansu razlikuju, što je ovisilo i o modelu, a i o konačnoj doradbi fibula.

Kalup nedvojbeno potječe s Pogorelca, višeslojnog lokaliteta, okružena rijekom Kupom, čije su ga vode otuda otplavile. Iste okolnosti nalaženja ima većina sisačke građe; vađena je naime iz korita rijeke Kupe prilikom jaružanja (1901.-1934. god.) dok se još njome intenzivno plovilo, ili, sve do danas, za niskih vodostaja. Svu, na taj način dobivenu građu, pa i kalup, nije moguće decidirano datirati. U ovome slučaju čvršći oslonac ne pružaju ni fibule, odnosno negativni utisnuti u kalup, jer su oni tek prva oblikovna karika u

1 Premda je svaki predmet ovisio o tehničkim zadatostima lijevanja, njegova ljepota i kvaliteta isključivo su odraz vještine i talenta lijevača. Za sve tehničke nedoumice koje su se nametnule prilikom obradbe kalupa te za literaturu, koja mi nije bila dostupna, iako sva i nije korištena jer prelazi okvire teme, zahvalnost dugujem kolegi Primožu Pavlinu iz Instituta za arheologiju Znanstvenoraziskovalnoga centra SAZU u Ljubljani, Branimiru Šimeku, višem muzejskom tehničaru iz Gradskega muzeja u Varaždinu i Zdravku Ladišu, profesoru modeliranja u Školi za primijenjenu umjetnost u Zagrebu.

2 Pri citiranju rada N. Majnarić-Pandžić, stranice su navedene prema rukopisu predanu za tisak.

proizvodnome nizu, lišena detalja relevantnih za preciznije vremensko određivanje. Stoga se ovaj kalup može smjestiti u vremenske okvire Ha D3 horizonta, tj. oko 450-350. god. pr. Kr., a kao odrednice te datacije uzete su nastanak, uporaba i disperzija certosa fibula XIII. grupe.

Nalazom iz Siska, grada prebogate prošlosti, u kojem od arheologije jedino Kupa baš nikada ne odustaje, slavljenci uz zdravlje želimo ustrajnost i lijepe, ničim neometane, susrete sa strukom, kojoj se posvetila i s predanošću radila.

## POPIS KRATICA

ActaArchHung	- Acta Archaeologica Academiae Scientiarum Hungaricae, Budapest	IzdHAD	- Izdanja Hrvatskog arheološkog društva, Zagreb
ALM	- Almanach Archäologischen Landesmuseum Baden Württemberg, Stuttgart	MAGW	- Mittheilungen der Anthropologischen Gesellschaft in Wien, Wien
ArchKorr	- Archäologisches Korrespondenzblatt, Mainz	PJZ	- Praistorija jugoslavenskih zemalja, Sarajevo
ArhVes	- Arheološki vestnik, Ljubljana	RGA	- Reallexikon der Germanischen Altertumskunde, Berlin - New-York
Germania	- Germania, Anzeiger der Römisch-Germanischen Kommission des Deutschen Archäologischen Instituts, Frankfurt a/M., Berlin		

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SUMMARY

MOULD FOR CASTING WAX MODELS OF CERTOSA FIBULAE FROM SISAK

Key words: Sisak, mould, casting, wax model, Certosa fibulae

A part of a mould for casting fibulae was purchased in the Summer of 1999 for the Prehistoric Department of the Archaeological Museum in Zagreb. According to the finder, it comes from Sisak - it was found in the bed of the Kupa river, at a curve around a hundred metres downstream from Novi Most. It is one half of a two-piece mould (T. 1:1) made of well fired clay of a reddish brown colour with light grey stains, in which tiny grains of sand can be discerned. It is of an irregular rectangular shape (length 11 cm, width 7-9 cm, breadth 2,3 cm). The exterior was formed without great care displaying visible traces of kneading and finger imprints. There are four small holes on the exterior, two in the corners and two around the middle, while on the inside of the mould there are only three because one hole was not completely pierced. These holes served for inserting thin wooden or metal rods which would connect and hold together the two halves of the mould (Miske 1899: 10; Paret 1954:7) and prevent them from moving during the casting process, thus ensuring the regular shape and good quality of the cast. The inner surface of the mould is completely smooth, with no traces of damage except for fissures caused by the passage of time. On the inside of the mould, placed one above the other, are the imprints of three fibulae, that is, three fibulae negatives (4,6 cm in length). At the end of the bow, on the head of each fibula, there is a channel that connects with a shorter and wider gate into which metal is poured. A dilation of such channels on two-piece moulds appears, as a rule, on the narrower side (Šimek 1996:53) and never spans the entire width of the mould. On our specimen, this dilation is exceptionally large, having been deliberately widened by scraping a sharp object along the already completed mould.

At first glance it would seem that the mould was used for casting in metal, most probably bronze. However, no traces of such casting appear. The high temperature of the liquid metal would undoubtedly cause changes in the colour and probably also cause tiny, even microscopic, traces of bronze to be trapped in the cracks that would result from casting. The absence of visible traces of casting does not necessarily mean that the mould was discarded and left unused. Initially, it was probably intended for casting in bronze, an assumption supported by the traces of sand in the texture of the mould. In the production of moulds, sand was added to clay (Šimek 1994: 94) to enhance its elasticity, its ability to withstand high temperatures and its permeability of gases that were produced during metal casting. How-

ever, it seems that a mistake was discovered on it before it was used, so the pouring gate was subsequently widened and thus the mould was adapted for use in the production of models in materials of a lower melting-point, most probably wax. If this was the case, the reason for its adaptation may lie in the distribution of vents, that is, their position at such angles that do not allow pouring or taking out intact bronze castings. It would be more difficult and time-consuming to repair the fibulae than wax casts used in casting in non-reusable moulds. Because wax is soft, supple and cheap, wax models could be repaired quickly and easily, and detail could be added to them simply and precisely - from plastic details to more complex inscribed details.

Casting with wax models in non-reusable moulds is a frequently used method, better known as lost-wax casting (French: à cire perdue, German: Guß in verlorener Form). The foundation of this casting technique is a well made beeswax model, fortified by the addition of charcoal dust, tallow, linseed oil and colophony (Armbruster 2001: 632). After these were added to the wax, it was formed into models using fired clay or wooden moulds (Vomer Gojkovič 1993: 14-15). An immaculate model with all the details, including technical ones (channels), would then be covered with a clay casing. After firing, the mould would be left to dry thoroughly and the wax would flow out through a vent hole in the clay casing, leaving a hollow shape of the model. Before casting, the mould would be heated to prevent cracking or deformation caused by the difference in temperature when it would come into contact with the liquid metal. For casting finer and more elegant objects, especially jewellery, a more liquid bronze was used, i.e. bronze with a higher percentage of tin which enabled it to penetrate easily into even the most minute details of the mould. After the liquid metal had cooled and set hard, the casing, that is the mould, would be broken and the object taken out (Goldmann 1981: 111, fig. 2; Krause 1997: 36-37; Armbruster 2001: 632-633). This is why moulds of this kind are very rarely found, unless they had not been used at all (Šimek 1984: 52, T. 1:6-7), and because they are fragmented they are even more rarely recognised for what they are. Further work would be done on the object to give it its final appearance - excess metal would be removed, the rims scraped and polished, ornaments retouched and finally, pieces would be added that were not included in the casting process<sup>1</sup>.

Our mould clearly exhibits the negatives of three fibulae, whose typological features are far more evident on the clay imprint (T. 1:2). The semi-circled bow, as well as the foot with a round button on the short neck are features of the Certosa fibula of the XIII group (Teržan 1977: 338-

<sup>1</sup> While each object was defined by the technical features of the casting process, its beauty and quality result only from the talent and skill of the caster. For clarifications regarding technical issues that came up during my work on moulds, as well as for the literature otherwise unavailable to me (although not all of it was used because it exceeds the topic of this paper) I am grateful to Primož Pavlin from the Institute of Archeology at the Science and Research Centre of the Slovenian Academy of Arts and Science in Ljubljana, Branimir Šimek, senior museum technician at the Varaždin City Museum and Zdravko Ladiš, teacher of model-making at the School for Applied Art in Zagreb.



341). They cannot be classified under any of the eight proposed variants of the fibulae of this group because certain details that would be crucial for a more precise typological distinction may have been added or lost in the transformation of wax models to the final bronze casting. The mentioned group of fibulae displayed very modest ornamentation: lines that follow the bow, or transversal ribs along the rim of the foot and the head of the fibula. After final touches to the rims and ornaments on the finished bronze casts, the pin holder on the foot of the fibula would be hammered flat and bent, and a hole pierced in the drop-like dilation of the head for the pin mechanism. The pin came out of a crossbow-shaped spring consisting of multiple coils connected with a rectangular tendril under the bow. Crossbow-shaped multiple coil spring is characteristic for the Certosa fibula, especially its XIII group, found in Slovenia (Teržan 1977: 357-359). This type of fibula was a common feature of the dress in the area of the St. Lucia cultural group during its II b 2 and II c phases (Teržan 1977: 361; Gabrovec, 1987: 130), as well as the later Certosa and Negova horizons (Teržan 1977:361; Gabrovec 1987:67) of the Dolenjska Group. From there, it spread to the Panonian and Balkan area, where it was initially worn in its original form, while a somewhat modified form (Teržan 1977: 362, 377-380, map 30) later became a common feature of the dress of these areas. Fibulae of this type were found as individual specimens, but also in groups - very often groups of three, as was the case in grave 1 from Vinkovci. In this double grave at the location of the "Na-Ma" department store (Dizdar 1999: 40, map 143; Majnarić-Pandžić 2003: 3-6, fig. 3:1-4)<sup>2</sup>, in which a man and a woman are buried, a sceptre handle was found, a status symbol for women, belonging perhaps to a priestess in the Dolenjska Group circle (Stare 1975: 730). The specimens found in Panonia,

where sceptres of a similar shape had spread, probably had the same meaning (Jerem 1968: 187, fig. 24:2; Jerem 1973: 82-83, fig. 7:1; T. 16:5). The grave also contained three fibulae to which our specimens (negatives) bear the greatest resemblance: the size, the curve of the bow and the completely round button on the foot of the fibula were almost identical. This resemblance is especially pronounced on one specific specimen (Majnarić-Pandžić 2003: fig. 3:2); it should be stressed that the three fibulae - the ones in the grave just as the ones in the mould - are not identical, but bear slight differences resulting from the model and the finishing touches to the fibulae.

The mould undoubtedly originates from Pogorelec, a multi-layer location surrounded by the Kupa river, whose waters had carried it away. Most of the material from Sisak was found in the same manner - taken out from the bed of the Kupa river during dredging (1901-1934), when traffic along the river was still intense, but also even today during low tide. Material acquired in this manner, including the mould, cannot be dated with any certainty. In this particular case, even the fibula - that is, the negatives stamped into the mould - do not provide any basis for precise dating because they are only the first element in the production chain and contain no details which would aid more precise dating. This mould, therefore, can be placed within the time frame of the Ha D3 horizon, i.e. around 450-350 BC. The determinants for this dating are the production, use and dispersion of the Certosa fibula of the XIII group.

With this find from Sisak, a city with an immensely rich past, a city in which only the Kupa virtually never gives up on archaeology, we wish our dear colleague much health, persistence and beautiful, undisturbed encounters with the profession to which she is committed and devoted.

Translated by V. Barbir

<sup>2</sup> When quoting the work of N. Majnarić-Pandžić, the pages are stated as they appear in the manuscript prepared for publishing.

