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BRUXELLES

BRUSSEL

THE METAL CONTENTS OF THE EARLY SERBIAN COINAGE

(PLANCHE IV)

When preparations were being made for the Fourth Crusade, the mint of Venice began to strike a new, large silver coin which was originally called a ducat, but which is generally referred to by students at the present day as a grosso. It was equal in value to 26 of the little debased denari into which the Carolingian coinage had devolved. Its fineness was 96.5 % (or, according to the reckoning system of the time, all but 40 of the 1152 carats which went to a Venetian marc were to be of pure silver); assays of two specimens of an early issue, struck in the name of Pietro Ziani, showed actual finenesses of 96.4 % and 94.9 %. Later grossi gave figures of 96.6 % and 97.0 %. The intended weight of the grosso was 2,178 g., or between $109\frac{1}{3}$ and $109\frac{1}{2}$ coins to the marc. The new coins gained great esteem because of their quality, and their issue continued without any alteration of weight or fineness for a hundred and fifty years (1).

They were the prototype for many of the early Serbian coins, of which the production in large quantities was made possible when « Saxon » (German) miners, driven out of Transylvania by the Mongol incursions of 1241, brought the skills of silver-mining into the Balkans. The earliest documentary reference to the existence of Serbian dinari is in 1276, but their issue will have begun probably a few years before that date. The close copying of the Venetian design seems to have been intended to facilitate the export of silver, in the form of coinage; the wealth that was thereby brought into Serbia (and later also Bosnia) did much to transform the economy of those kingdoms, and to help forward their political

(1) See N. PAPADOPOLI, *Le monete di Venezia*, Venice, 1893, p. 81-84 and 93.

development. The weight and fineness of the earliest Serbian coins correspond very closely with the Venetian. Before long, however, the Serbian coins were struck at a slightly reduced standard, and were exchanged against the Venetian grossi at various ratios, such as 8:7. Saria has argued that a Venetian embargo of 1282 against the acceptance of Serbian coins was in response to a weight-reduction in that year or late in 1281 to a standard of ca. 1.81 g. The average weight of 120 die-identical coins in fresh condition in the Studenica hoard was 1.807 g., and this compares with the weight of the earliest coinage of Dubrovnik (Ragusa), which, Saria suggests, would not have been struck at that weight if the Serbian mint of Brskovo had not already adopted it. This interpretation will be questioned below. Quite probably, however, the Italians already had cause for concern by 1282 about the fineness of the Serbian silver, and about the variable weight of the individual coins.

Bernardo Nani published two analyses of Serbian dinari as long as 1750, in the following terms :

... at cum argenti naturam inficere, ac etiam iusto ponderi detrudere coeperint (ut ex duobus Urosii monetis adparuit, quibus probatis, una 88 k. altera 148 k. scoriae habebant ad Marcham relatae, quarum postrema erat levior prima), praesentientes Veneti, quid detrimenti ex hac matapanorum Venetis similitum infectione, cum rebus omnibus, tum praesertim negotiis accidere posset, eos lege vetarunt.

— but when they began to debase the silver and also to subtract from the proper weight (as appears from two coins of Uroš which have been assayed : one contained 88 carats of alloy and the other 148 carats per marc ; and the second was lighter than the first) the Venetians, foreseeing what damage could occur in every way but especially in business matters from that debasement of grossi which were similar in design to their own, legislated against them ⁽²⁾. The fineness of the first of the coins analysed works out at 92.4 %, and that of the second at 87.5 %.

For the early period of the coinage, up to 1346 (when king Stefan Dušan was crowned as emperor) the following assays were published by Ljubić in 1875, among a total of 32 which are mostly coins of a later date :

(2) Quoted in S. LJUBIĆ, *Opis Jugoslavenskih Novaca*, Zagreb, 1875, at p. xxv.

	<i>Ruler</i>	<i>Weight</i>	<i>Ag</i>	<i>Au</i>	<i>Cu</i>
1.	Uroš I	2,15 g.	99,827	0,145	0,028
5.	Dragutin	2,02 g.	96,022	0,421	3,557
11.	Dragutin	2,15 g.	92,900	2,500	4,600
15.	Milutin	2,18 g.	90,994	0,002	9,004
30.	Dragutin	1,26 g.	23,488	-	76,512
30 ^b ₁₅ .	Dragutin	-	31,730	0,004	68,266
27.	Dušan as king	1,50 g.	80,012	-	19,988
16.	Dubrovnik, early type	1,75 g.	89,995	0,071	9,934

The figures are very precise in appearance, and no doubt they are accurate, but unfortunately they are deprived of much of their interest, as it is not stated in any detail what types the coins were. Each of the kings named issued more than one type; also, attributions have been considerably revised since Ljubić wrote (3). Čremošnik devoted a chapter of his book on Stefan Uroš Milutin to the weight and fineness of the Serbian coinage, and reported that he had had a coin of Stefan Dragutin, dateable to ca. 1282, analysed at Vienna, and that it was 96 % fine. Another, of the « standing king » type, was analysed for him at the assay office in Sarajevo: a sample of 0,57 g. contained 92,94 % silver. A third coin of Dragutin, corresponding with Ljubić pl. V, 18, and illustrated by Čremošnik, weighed 1,79 g. and was 80 % fine. Since the average weight of that variety is ca. 1,81 g., it represents a reduction of the actual silver content of the coins from 2,10 g. to 1,45 g., that is, to about 70 % of the Venetian prototype. A fourth coin of Dragutin (Čremošnik, pl. III, 8) proved, by « wet » analysis, to contain only 56 % silver (4). The best that one can say (taking into account Nani's figures of 92.4 % and 87.5 %) is that there

(3) See LJUBIĆ, *op. cit.*, p. xxvi. For revisions in the attributions of the coins, see R. MARIĆ, *Studije iz srpske numizmatike*, Belgrade, 1956; and various important articles by S. DIMITRIJEVIĆ in *Starinar* and elsewhere in preparation for a promised corpus of Serbian coins. It is essential to consult a long critical review of MARIĆ's book, by DIMITRIJEVIĆ: *Problemi srpske srednjovekovne numizmatike*, in *Istoriski Glasnik*, 1957, 1-2, p. 69-99, and 1957, 3-4, p. 104-130. See also a valuable survey by B. SARIĆ, *Die Erforschung des altserbischen Münzwesens*, in *Numismatische Literatur Osteuropas und des Balkans*, II, 1963, p. 58-81.

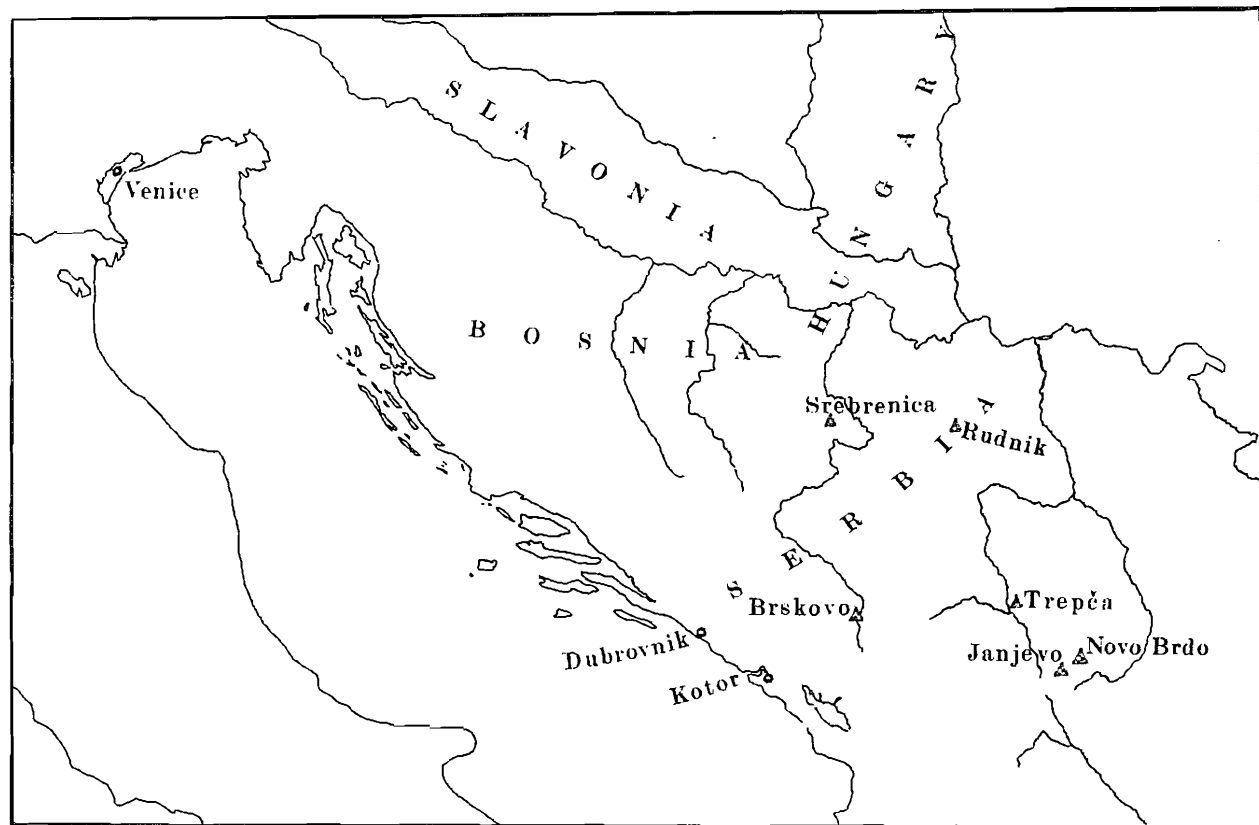
(4) G. ČREMOŠNIK, *Razvoj srpskog novčarstva do kralja Milutina*, Belgrade, 1933.

was a gradual decline from an originally very high standard — occasionally higher even than the Venetian standard — and that by the early fourteenth century the Serbian issues were perhaps only about 80 % fine.

Secondly, although one can see that there was a decline, more than a dozen specimens are needed to chart at all accurately the history of the alloys used over a period of 75 years, during which there was more than one mint at work, and many different types were issued. Ideally, one would like to gather up batches of at least half-a-dozen coins of each variety, in the first place to establish how consistent the groups were, and also in order to discount (by taking averages) the minor fluctuations in the figures which may be expected to occur from the defects of medieval technology and from the margins of sampling error in modern non-destructive analysis.

Thirdly, it is potentially of interest to see whether the proportion of gold in the silver exhibits any regular pattern, by which the production of particular silver-mines might be identified. In medieval coins there is generally a small trace of gold, which was not deliberately introduced into the alloy, and of which the moneyers would not even be aware. As gold is a more « noble » metal than silver, the methods ordinarily used in the middle ages to refine the silver (cupellation with lead) would leave the gold unseparated. In the ore from most mines it would at that date in any case hardly have been economic to recover the trace of gold, and, from the point of view of the fineness of the coinage, the proportions of gold and silver can be aggregated together as « silver ». In general, the amounts of gold discovered in the coinage by modern analyses ought to provide an indication of the source of the metal. Over the centuries, silver was « re-cycled », and medieval Europe's stock of bullion — coin and plate — must have become progressively mixed in character. But Serbia in the XIIIth-early XIVth centuries is a case in point where there is every reason to suppose that the coins were being struck from « new » silver.

Serbian and Bosnian silver production rose to its peak in the late fourteenth and early fifteenth centuries, when several of the older sources of supply in Europe were becoming exhausted. In many cases a date can be assigned to the opening of a mine. From 1346 onwards, the number of different mines is considerable, but for the period of the early Serbian coinage, the situation is relatively simple. Brskovo (in the Tara valley, behind Dubrovnik)



is mentioned already in 1254. Pohl has recently pointed out that, also in 1254, the « Saxon » miners began to exploit Srebrnica, near Tuzla in north-eastern Bosnia ⁽⁵⁾. Srebrnica was then in Hungarian territory, and the silver was undoubtedly minted as Slavonian banovci. These coins may well have been melted down in Serbian mints in the following decades. Rudnik, also in the north, was in production from ca. 1295; Stefan Dragutin extended his territory southwards in 1313 to take in the Rudnik area. Trepča, in central Serbia, was the most important centre for the Kopaonik complex, and worked from 1303. Janjevo, a little further south, was opened up at the same date; and the famous mines of Novo Brdo (the « new mountain ») came into production from 1326. Novo Brdo in particular yielded very rich auriferous silver, from which it was well worth while to separate the gold. Thus, the silver of the Serbian dinari of the first two decades (ca. 1275-ca. 1295) is likely to have been supplied, so far as we can tell from written sources, in large part from the mining activity at Brskovo, with Srebrnica as a possible secondary point of origin in the north. From ca. 1295 to 1346, there are up to six possible sources of silver. For the period from 1346 onwards, the problem becomes more complex, both because a lively monetary economy had developed in Serbia, leading to the re-use of coinage silver, and because a great many more mines were in production simultaneously. Those at Plana, Koporići, Železnik, Ostružnica, and Kratovo were all opened up in the years 1346-52 ⁽⁶⁾. The period when Serbia was a kingdom thus coincides neatly with the period when the problem of the silver sources is relatively simple; unless the pattern of analyses from this early period is clear-cut, it is likely to be difficult to draw many useful conclusions from a similar study of the later period.

Thirteenth-century coins from other parts of Europe contain small amounts of gold. English coins, for example, generally

(5) A. POHL, *Die Silberquelle der slawonischen Banaldenare*, in *Südost-Forschungen*, XXVI, 1967, p. 335-338.

(6) There is a considerable literature on silver-mining in Serbia. A useful survey from the point of view of economic history is provided by D. KOVAČEVIĆ, *Dans la Serbie et la Bosnie médiévales : les mines d'or et d'argent*, in *Annales*, XV, 1960, p. 248-258. A major study is by M. ĐINIĆ: *Za istoriju rudarstva u srednjevekovnoj Srbiji i Bosni*, vol. I, Belgrade, 1955. A bibliographical survey more from a numismatic point of view is given by SARIĆ, *Die Erforschung* etc., p. 76-81.

contain 0,2 % to 0,3 %. French and Italian coins may contain 0,4 % to 0,6 %; and a similar range of values is found in Crusader coins (7). In general, one might suggest that figures below about 0,2 % are unusually low, while anything over about 0,8 % is unusually high. Ljubić's n° 11, for which the abnormally high proportion of 2,5 % was obtained, is stated to have been gilt; this figure is useless for our present purposes. The remaining values that are on record for Serbian coins, as quoted above, are 0,42 %, 0,15 %, 0,004 %, and 0,002 %. An early coin of Dubrovnik contained 0,07 % gold, and an early Bosnian coin contained the relatively large amount of 0,55 %. Venetian grossi of P. Ziani (1205-29) and J. Contarini (1275-80) yielded 0,58 % and 0,09 % respectively. These values, as can be seen, vary widely, and since in any case it is not known exactly what the Serbian coins were, further work is clearly required. A more convenient figure than the percentage of gold, if silver sources are under consideration, is the proportion of gold to silver. When the coins are of almost pure silver, the two will of course be very close to each other. The adjusted figures for the four Serbian coins are (in parts of gold per 10.000 parts of silver) 44, 15, 1.3, and 0.2.

The researches which we present here are designed to add to the number of published analyses of Serbian coins struck in the period ca. 1275-1346, in order (first) to begin to chart more fully the debasement of the alloy and the consequent reduction in the value of the dinari and (secondly) to test whether the gold contents can be used as an indication of the source of the metal. Thirdly, analyses of some contemporary counterfeits of Venetian coins are evaluated against the results obtained from the authentic coins.

Techniques of analysis

Two separate methods of neutron activation analysis were used (8). The silver contents were determined by the « Howitzer »

(7) J. S. FORBES and D. B. DALLADAY, *Composition of English silver coins (870-1300)*, in *British Numismatic Journal*, XXX, 1960-61, p. 82-87. For French, Italian and Crusader coins, data are drawn from work in progress by A. A. GORDUS and D. M. METCALF.

(8) The « Howitzer » technique is discussed fully in A. A. GORDUS, *Quantitative non-destructive neutron activation analysis of silver in coins*, in *Archaeometry*, X, 1967, p. 78-86. For the « streak » technique, see A. A. GORDUS, *Activation analysis, artefacts, and art*, in *The New Scientist*, 17 October 1968.

technique, which uses a neutron source of extremely low intensity to form the short-lived silver isotopes silver-108 (half-life 2,4 minutes) and silver-110 (half-life 24 seconds). The coins were irradiated for periods of one minute, after which the induced activity — mostly silver-110 — dissipated in only 10 to 15 minutes. Differences in the degree of neutron absorption, arising from the variable thickness of medieval coins, presented a problem, but this was overcome by taping small silver discs of uniform size (U.S. 10 cent pieces) to the back of each coin before irradiation. The silver activity induced in the discs was an indication of the amount of neutron absorption which occurred in the coin, and it was found that the silver activity in the coin per gramme of silver, divided by the silver activity in the disc, was a constant, independent of the thickness of the coin. The coin and disc were transferred to separate detectors for a one-minute counting period. The whole process of analysis was repeated about ten or fifteen times for each coin, in order to obtain an average value for the silver content. For each coin analysis published here, we have indicated the average value obtained, the number of runs, and also the standard deviation of the average, calculated as

$$\sqrt{\frac{(\text{sum of differences})^2}{n(n-1)}}$$

where n = the number of runs. This standard deviation is generally about $\pm 1,0$ %.

The gold contents were determined by « streak » analysis. A small section of the edge of the coin was cleaned with emery paper to expose bright metal, and a minute streak (about 0.0001 g.) was then transferred to a piece of etched quartz tubing, by rubbing the quartz against the cleaned section of the coin. The streaked quartz was irradiated for two hours in the high-intensity flux of the reactor. Enough radioactive gold, silver, and copper were produced to permit detection and determination of the relative amounts of these elements. The gold/silver activity ratio is in direct proportion to the ratio of the two metals in the streak. Effects such as surface corrosion, and inhomogeneities in the alloy, may mean that the composition of the streak is not identical with that of the coin as a whole. This difficulty is discounted as far as possible, first by cleaning the surface section from which the streak

is taken, and secondly by averaging the analyses from three or four streaks. The repeatability of the streak analyses indicates that the averages are valid to about ± 5 to 10 % of the value.

When there is only a trifling amount of gold in the alloy, one might expect that the copper/silver activity ratios would give a very simple and direct approximate measurement of the percentages of silver and copper in the alloy. It was found, however, that assuming a silver/copper/gold alloy the percentages of silver as shown by the « streak » method were always higher than by the « Howitzer » method. A group of coins of the same type, which the « Howitzer » method showed to contain very closely similar amounts of silver (a result that commends itself) yielded average copper/silver ratios that varied considerably. The silver contents calculated from them ranged between 10 % and 20 % higher than the « Howitzer » figures for the same coins. We have checked the results of other « Howitzer » analyses by conventional (destructive) analysis, and we are satisfied that these figures are substantially correct. The two sets of results might be reconciled if some other metals beside gold, silver, and copper were present in the coins. To show how this could be done, we have calculated the copper contents from the combined data of (i) the silver percentage as indicated by the « Howitzer » method, and (ii) the copper/silver ratio as indicated by the « streak » method. On this basis there is generally a considerable percentage of the metal contents unaccounted for. Thus, for example,

1.	% Ag = $74,9 \pm 1,0$	(« Howitzer » analysis)
2.	% Cu/% Ag = $0,172 \pm 0,017$	(« streak » analysis)
therefore	% Ag = ca. 84,2 to 86,4	(assuming a binary alloy)
3. Or,	% Cu = $(74,9)(0,172)$	
	= 12,9	
and	% Au = $(74,9)(0,00097)$	
	= 0,0726	
therefore	% Ag + Cu + Au = $(74,9 \pm 1,0) + (12,9 \pm 1,3) + (0,073 \pm 0,007)$	
	Ag	Cu Au
	= ca. $88,0 \pm \text{ca. } 2,0$	
therefore	% unaccounted = $12,0 \pm \text{ca. } 2,0$	

The metal contents unaccounted for vary from 0,5 % to 21 % among the Serbian coins listed below by this method of calculation. The discrepancy might be explained in part by the presence of lead, which cannot be detected by neutron activation analysis. Other less heavy metals which might make up the main part include tin,

zinc, and iron. (Antimony is not present in excess of 0,1 %). It should be readily possible to discover whether there are any such constituents in quantities which might add up to 10-15 %, by the use of X-ray fluorescence spectrometry, even on the uncleaned surface. But as the analyses published by Ljubić showed only silver, copper, and gold, except in one instance where there was 0,439 % lead, we are sceptical of finding more than traces of other metals. Some of Ljubić's analyses (including nos 15, 27, and 30) were his own work, while the rest were undertaken by Dr. Pilar, of the mineralogical and geological section of the Zagreb Museum. It is not on record how elaborate their analytical procedures were, except that they used both a « wet » and a (less accurate) « dry » method. Ljubić was generally content with one « wet » analysis of each coin, whereas Pilar carried out one « dry » and two « wet » analyses, or otherwise two « dry » analyses in which case he gave the results to only one decimal place. The percentages as published add up to 100,000 %. The weight of the sample varied, but for no 27, for example, (80 % silver) it was 0,18 g., which was used for one « wet » analysis. For no 16 (90 % silver) it was 0,52 g., used for one « dry » and two « wet » analyses. Ljubić and Pilar ought not to have lost 5 % — or indeed 1 % (0,002 g.) from these samples.

On the other hand, a re-evaluation of the streak standards gave results which were, overall, in excellent agreement with those obtained originally. The major reason for the discrepancy between the « Howitzer » and the « streak » results may therefore be local variations in the alloy caused by (i) incomplete mixing and (ii) « surface enrichment » (diffusion, and leaching of copper from the surface). Condamin and Picon have discussed diffusion in ancient silver/copper alloys, and have shown that a layer of copper-impoverishment may be centred at about 0,1 mm. below the surface, or alternatively may be at the surface if the coin has been cleaned⁽⁹⁾. Their results show that, in a Roman coin containing 45 % silver, that layer might contain as much as 70 % silver. Our streaks, taken from a cleaned surface, may well be influenced by diffusion in this way. The divergence implied by the ratio 0,172 is within the limits discovered by Condamin and Picon.

(9) J. CONDAMIN and M. PICON, *Notes on diffusion in ancient alloys, Archaeometry*, VIII, 1965, p. 110-114.

If both sets of figures are, as we believe, free from any systematic observational errors, the « Howitzer » method will show the silver content of the whole coin as it is today (but this may be a slightly larger proportion than on the day the coin was made!), while the « streak » method will show the average silver content of three or four samples of the surface layers. What will be the appropriate method of calculating the percentage of gold in the coin? The graphs published by Condamin and Picon show (1) in a 95 % silver coin, gold-enrichment on the surface, but very little difference in the concentration of gold as between the copper-impoverished layer and the centre of the coin; (2) in a 45 % silver coin, gold enrichment by a factor of ca 1,3 in the copper-impoverished layer. This matches a silver-enrichment of ca. 1,55 in the same layer. No very precise conclusions are possible, but it seems that below the immediate surface the gold/silver ratio is roughly constant at different depths in the coin's fabric. The best estimate of the gold content will therefore be made by assuming that the gold/silver ratio in the streaks is typical of the ratio in the coin as a whole, and by multiplying it with the silver content as determined by the « Howitzer » method to obtain a percentage figure for gold.

Reduction in the value of the Serbian dinari.

There was an initial period beginning in the 1270's when the Serbian dinar closely imitated the design of the Venetian grosso and was of almost the same weight and fineness. Ljubić's nos 1, 5, 11, and 15, and our nos 2, 3, and 4 below all weigh over 2,0 g. and are over 90 % fine. The better coins analysed by Nani and Čremošnik (92,4 %, 96 %) probably belong to the same category. Many of the « denarii de bandera » (so named in documents because of the banner which St. Stephen and the king hold) are however on a reduced weight-standard of around 1,8 g. and contain only 70 to 80 % as much silver as a Venetian grosso. The reduction in weight, according to Saria, occurred in 1282 or late 1281. About fifty years later, at a date around 1331, king Stefan Dušan (or, according to Marić, Stefan Uroš III Dečanski) introduced a reformed coinage with the novel design of an elaborate knight's helmet. The analyses of coins 13-18 below show silver contents for the « helmet » coinage of 75,6 %, 76,4 %, 74,9 %, 74,6 %, 74,9 %, and 75,1 %. The regularity of these results points to a most impressive technical capability in the Serbian mints, and the figures suggest strongly

that the intended standard of fineness was three-quarters, or 75 %. In contrast, the weights of individual coins vary widely. The intended weight-standard of the « helmet » coins may be judged from the specimens in the Novi Banovci hoard, as catalogued by Marić :

1,30 g. or less	16 specimens
1,31-1,40 g.	25
1,41-1,50 g.	35
1,51-1,60 g.	36
1,61-1,70 g.	16
1,71-1,80 g.	23
1,81-1,90 g.	10
1,91 g. or over	6

The mean value is 1,54 g., and the median is 1,52 g. Thus the « helmet » coins contained about 1,18 g. of silver, or only about 56 % as much as the Venetian grosso. This does not, of course, imply that they were an inferior currency. Coins of a smaller value may have been more convenient to the people who used them, and the reduction in silver contents may for various other reasons (which have been discussed by Cipolla ⁽¹⁰⁾) have been a development which was in accordance with the real needs of the time.

Whereas it is quite straightforward to evaluate the weight and fineness of the Serbian coinage from the years before 1281/2 and those immediately after ca. 1331, the period of 50 years in between is complex and difficult to study. This is because, first, the dinari are usually inscribed simply VROSIVS REX or STEFAN REX, and there are successive rulers who share the names Uroš or Stefan :

Stefan Uroš I	1243-76
Stefan Dragutin	1276-early 1282 ; abdicated (1284-1316 in the north)
Stefan Uroš II Milutin	1282-1321
Vladislav II, pretender	1321-24 (in the north)
Stefan Uroš III Dečanski	1321-31
Stefan Dušan as king	1331-46 (subsequently emperor).

(10) C. M. CIPOLLA, *Currency depreciation in medieval Europe*, in *Economic History Review* 2nd ser., XV, 1962-63, p. 413-422.

Attribution of coins between one king and another may be problematic (there are, for example, considerable divergences between even the recent studies of Marić and Dimitrijević). The pretender Vladislav breaks the sequence and gives a usefully precise point of reference; and among Stefan Dečanski's coins there are a good many which carry the explicit legend « King Stefan Uroš the Third ». These types both fall in the decade 1321-31; but for the purposes of studying the progress of debasement it is essential to be able to date particular issues more precisely within the 40-year reign of Milutin. An adequate chronology of the coinage can be constructed only from the evidence of hoards, and not enough of these have yet been published in detail.

Secondly, there is not just one series of Serbian coins in these fifty years, but at least two series running in parallel. The types issued in the north, at the mint of Rudnik, were often of quite different designs. Various weight-standards were in use concurrently. For example, the coins of Stefan Dečanski just mentioned were certainly struck after the weight-reduction at the Brskovo mint to ca. 1,81 g., yet the specimens catalogued by Ljubić weigh :

1,80 g. or less	6 specimens
1,81-1,90 g.	6
1,91-2,00 g.	9
2,01-2,10 g.	5
2,11-2,20 g.	5
2,21-2,30 g.	6
2,31 g. and over	2

As will be seen below, there were different intended standards of fineness, as well as different weight-standards in use concurrently.

Stefan Dragutin was responsible for some very debased, light-weight coins which were presumably intended for use in Syrmia. One of his coins copying the Venetian design (nº 7 below) weighs 1,91 g. but is only 57 % fine. The very similar coin published by Čremošnik and weighing 1,56 g. gave the gratifyingly close figure of 56 %. There are even more debased coins struck in the name of Stefan Dragutin — Ljubić's analyses include the figures of 32 % and 23 %. And the Dobrište hoard, in which the coins of Dragutin were very light in weight, offers some evidence of an early date for the debasement. One may guess that such coins, similar in appearance to the regular Serbian dinari but far inferior

to them in intrinsic value were related in some way to the Slavonian banovci ⁽¹¹⁾.

A highly important document of February 1281 shows that already at that date several varieties of Serbian dinari were in existence. It reads as follows :

Ragusii. Ego quidem Maria de Chau, soror excellentissime domine Regine Servie et totius maritime regionis, confiteor, quod Vitagna de Baraba, nuntius communis et hominum Antibari, mihi dedit et assignavit nomine et vice dictorum communis et hominum Antibari soldos denariorum grossorum de Brescoa ducentos de quibus fuerunt soldi denariorum grossorum centum septuaginta de denariis de cruce et de lilio et residui triginta soldi fuerunt de denariis de macia ⁽¹²⁾.

The Verona hoard, dating from ca. 1284, contained one specimen (cf. LJUBIĆ, pl. V, 3) which might well have been described as a denarius de cruce et de lilio ⁽¹³⁾. Dimitrijević considers that the more plentiful « seated king » design (LJUBIĆ, pl. VI, 10-13) is the type to which this name was given. Die-similarities among the obverses show that the two varieties are in any case closely related. The average weight is about 2,1 g. The specimen which we analysed (n° 1 below) is 95 % fine. A « denarius de macia » of Stefan Dragutin (n° 8 below) is only 84 % fine ; the average for the type is close to 1,81 g.

The « denarius de lilio » and the « denarius de macia » are probably northern coins. In the south, in the hinterland of Dubrovnik, the Brskovo mint continued for some time to imitate the Venetian design — « denarii de Brescoa de bandera ». Later, the design was altered slightly by the substitution of a double or patriarchal cross for the banner : these are the « denarii de cruce ». The name occurs already in 1312, but is more common in the 1330's ⁽¹⁴⁾. The

(11) M. DINIĆ, *Srpski novac u Sremu početkom XIV veka*, in *Glasnik Ist. društva u Novom Sadu*, III, and DINIĆ, *Stefan Dragutin rex Serviae*, in *Glasnik*, IV (not accessible to us at the time of writing).

(12) G. ČREMOŠNIK, *Kancelariski i notariski spisi*, vol. I, 1278-1301, p. 44 f. n° 68.

(13) The Serbian coins in the Verona hoard are carefully described in G. GEROLA, *Numismatica Serbo-Veneta*, I. I « Grossi di Brescova » di un ripostiglio Veronese, in *Rassegna Numismatica*, XXVII, 1930, p. 177 ff. ČREMOŠNIK, *Razvoj*, plates I and II, illustrates 19 coins.

(14) M. DINIĆ, *Krstati groševi*, in *Zbornik Radova*, XXI = *Vizantološki Institut*, I (Srpska Akad. Nauka), Belgrade, 1952, p. 88-112.

chronology and exact numismatic classification of the denarii « de bandera » and « de cruce » over the period 1280-1330 are a matter of maximum uncertainty, and are bound to remain subject to revision. The number of specimens available to us was restricted, and we are aware that more analyses will be needed before all the questions of interest can be answered. We have illustrated the coins as far as possible, and described them in detail, in the hope that other students will pursue the problems further, and that gradually a consolidated series of analyses may be built up, in which scientific precision is not wasted through lack of numismatic precision. Čremošnik's coin of Dragutin, weighing 1,79 g., was 80 % fine, that is, on a standard with about 70 % of the intrinsic value of the Venetian grosso; a coin in similar style but in the name of Uroš (n^o 5 below) is 89 % fine, or about 77 % of the silver contents of the grosso. Two « denarii de cruce » (n^{os} 10 and 11) are 79 % and 78 % fine; they are attributed tentatively to Stefan Dečanski. The probable significance of these figures can be judged from documentary references, published by Dinić, to the exchange-rates at Dubrovnik and Kotor between Serbian and Venetian grossi (15). The dates, names of the Serbian coins, and their percentage value in terms of the grosso, are as follows :

1294	87,5
1303	90
1309 regis Rassiae	89
1309 regis Serviae	80
1331 grossi de cruce	71
1331 » » »	72,5
1332 » » »	75
1332 » » »	58
1333 grossi de Rudnicho	69
1335 grossi de cruce	75
1341 grossi de cruce leves	69

If the exchange-value was a sensitive reflection of the intrinsic value — and there is no reason to suppose that it would favour

(15) The actual documents describe the ratios in terms such as « XVII de cruce pro XII de Venetiis », or « XVI½ de cruce pro uno yperpero de Venetiis » or « ad rationem XXXV de + leves pro ducato » (— from the 1320's a gold ducat was tariffed at 24 Venetian grossi).

the Serbian coins — the types current on the Adriatic coast in 1303 and 1309 at about 90 % of a grosso cannot have been on the reduced weight-standard of 1,81 g., as they would have had to be more than 100 % fine to achieve that value! The coins of reduced weight that have been analysed are at best 80 % and more usually 70 % of the intrinsic value of a grosso. The analyses which give a value of 87,5 to 90 % of a grosso are coins of 2,00 to 2,05 g. weight and 90 to 92 % fineness. It would seem, therefore, that one should reject the traditional view (as argued most recently by Saria ⁽¹⁶⁾) that the Venetian embargo of 1282 was in response to a clear-cut weight-reduction to ca. 1,81 g. It may have been prompted merely by an incipient unreliability in weight and alloy of Serbian coins ostensibly still on the full Venetian standard. The Venetians, in other words, foresaw the operation of Gresham's Law, according to which bad money of *the same face value* drives out the good. Certainly the Dobrište hoard, which cannot be earlier than ca. 1305 ⁽¹⁷⁾, that is, more than twenty years after the supposed weight-reduction, exhibits a modal weight of over 1,9 g.:

1,40 g. or less	10 specimens
1,41-1,50 g.	9
1,51-1,60 g.	12
1,61-1,70 g.	16
1,71-1,80 g.	32
1,81-1,90 g.	44
1,91-2,00 g.	48
2,01-2,10 g.	38
2,11-2,20 g.	38
2,21-2,30 g.	9

Individual coins of the same minor varieties often differ markedly in weight: the hoard could not possibly be divided neatly into two series issued on distinct weight-standards. Rather, it shows a downwards drift from the Venetian standard. «Clustering» of the silver percentages suggests that the debasement was halted

(16) B. SARIA, *Die Entwicklung des altserbischen Münzwesens*, in *Südost-Forschungen*, XIII, 1954, p. 22-61, at p. 32-35.

(17) See MARIĆ, p. 169-233 and DIMITRIJEVIĆ, p. 82.

for a time at about 90 % fine ; and then dropped to about 80 % ⁽¹⁸⁾. More analyses are required to discover whether this is so. Even if the work of the mints was regularized, the old coins still in circulation in the 1320's must have given the currency a miscellaneous character as regards its fineness, and it is easy to understand the motive for reform which produced the « helmet » dinari.

Meanwhile, the northern issues of Stefan Dragutin maintained higher standards of both weight and fineness. Čremošnik submitted about 50 specimens of the « standing king » type (Ljubrić, pl. III, 13-19) to the touchstone, and found that they were roughly 95 % fine. Chemical analysis of one of them gave the figure 92,94 %. Another, n° 9 below, is 91 % fine. The type is on a weight-standard of roughly 2,1 g. The weights of the « crowned seated king » type, attributed by Dimitrijević to the Rudnik mint in the time of Stefan Dečanski and Stefan Dušan, are variable, but the silver content of n° 12 — 88 % — is still high.

The « helmet » coins of Stefan Dušan mark the end of a period in Serbian monetary history, for the « coronation » type, struck probably in 1346, reverted to a fineness of over 90 % (n° 19 below) ; and the « horseman » type (n° 21) is comparable.

Gold contents as an indication of the sources of silver

The gold contents of the coins catalogued below vary from 0,003 % to about 0,6 %, and the proportions of gold to silver vary from 0,3 to about 66 parts of gold to 10.000 parts of silver. Within this range, the distribution of the figures is uneven. (Ljubić's analyses are added in parentheses).

(0,2)	0,33	(1,3)	1,4	1,4	1,5	2,4	2,7	3,2
7,5	(7,9)	8,2	9,7	12	(15)	15,7	21	
34	39	(44)	49	50	66			

(18) For coins of these decades there are hardly any figures « in the middle » between ca. 90 % and ca. 80 % ; and those around 90 % tend to be on the low side (cf. the 4 coins of Dubrovnik analysed by Ljubrić, nos 16-18 and 20, which gave 90,0 %, 89,8 %, 89,2 % and 88,2 % silver). The specification of the alloy is likely to have been in simple terms, such as « one part of copper and x parts of silver. Cf. Ljubrić, p. xxv, « quod in quibuscumque uncis XI de argento fino debeat poni et infundi una uncia de rame ». And at Kotor in 1352, « sexta pars rami et quinque partes argenti fini » (83,3 %). At a guess, we suggest one to eight (88,8 %) later changed to two to eight (80 %), but one to nine would also be in accordance with the analyses.

The early denarii de bandera weighing over 2,0 g., nos 3 and 4 and probably also Ljubić's n° 15, have gold contents which are exceptionally low by medieval standards; nos 5 and 6, which are lighter, have similarly low gold contents. We suggest that this is the characteristic silver of Brskovo, with about 1,4 parts of gold to 10.000 of silver, or even less. The metal of the denarius de cruce et de lilio, n° 1, contains 30 to 40 times as much gold, and is unlikely to be from Brskovo. It may have been struck from silver from Rudnik, but more analyses of coins of the same type are needed, as also of Slavonian banovci which may establish the type of silver from Srebrnica. N° 2 is a heavy denarius de bandera, but has a high gold content more like n° 1: its style, die-axis, and fineness may be reasons for separating it off from nos 3-5. The «standing king» type, which is undoubtedly northern, is intermediate, with 8,2 parts of gold to 10.000 of silver; while n° 12 has only 2,7.

The remaining coins, struck in the period when several new silver mines were being exploited, raise more complicated questions of mint-attribution. They are, in general, made from silver quite unlike that which has been recognized as being from Brskovo. Marić suggested that the letters which occur as sigla on the obverses of the coins might be the initials of mints or mint-masters. Dimitrijević pointed out quite conclusively that there were far too many of them, and far too many in the early period, for them all to be different mints⁽¹⁹⁾. The further criticism may be made that different sigla sometimes occur on dies certainly cut by the same hand (compare MARIĆ, pl. XL, 10 and 12, with BP and NG respectively). Nevertheless, some explanation will have to be worked out for the sigla, and it remains tempting to think that they might give an indication of the places where the coins were minted. The problem is a large one, and its solution must take into account all the numismatic aspects of the evidence, and not just metal contents. But against the background of increasing exploitation of the silver mines in Serbia, it seems desirable to look for positive correlations between the sigla and the gold contents of the coins — even if it were only to prove that there are none. A great many specimens will be needed: the few that are catalogued below at least offer no discouragement:

(19) DIMITRIJEVIĆ, *Problemi*, p. 105 ff.

11. N O	12	17. M B	9,7
12. A Φ	2,7	18. Φ R	21
13. N G	1,4	19. (no sigla)	3,2
15. N O	15,7	20. N O	ca. 66
16. M B	7,5	21. N O	50

The « streak » method is well suited to the project, if an accuracy of $\pm 10\%$ can be attained, since the gold contents vary by so large a factor. The gold content of n° 18, for example, at $21 \pm 10\%$, gives a range of 19-23, which does not overlap with the adjacent values of 15,7 (14,1-17,3) and 50 (45-55).

Light-weight imitations of late thirteenth-century Venetian grossi

Several Serbian or Bulgarian hoards of the late fourteenth century include large numbers of counterfeits of Venetian grossi, which, curiously, are often struck in the name of the doge L. Tiepolo (1268-75). The much earlier Dobrište hoard also contained similar coins, which were much smaller and lighter in weight than the Venetian originals. Two specimens now in the Ashmolean Museum, which have been published and discussed more fully elsewhere⁽²⁰⁾, were analysed, and it was found that their gold contents were far in excess of those of the other Serbian coins that have been analysed. Their silver contents, too, were low. It is not possible at present to date them precisely, but if it could be shown that they were as early in date as the Dobrište specimens, their evidence would suggest strongly that they are not from any of the regular silver sources that were being worked in the fourteenth century. It seems just possible that they were made from Bosnian silver.

CATALOGUE

A. Denarius de cruce et de lilio

1. Obv. Christ enthroned. The style is the same as MARIĆ, pl. XII, centre, with annulets in the nimbus cruciger (different reverse type).

(20) D. M. METCALF, *Light-weight imitations of late thirteenth century Venetian grossi*, in *Numizmatički Vijesti* (forthcoming).

Rev. VROSIVS REX. Crowned king seated on stool, and holding lis-sceptre and double-barred globus cruciger. LJUBIĆ, pl. VI, 12-13. 1,827 g. Die-axis ca. 45°. Collection of D. M. Metcalf, from P. Grierson, ex R. C. Lockett, ex Lord Grantley.

Attribution : Milutin

Analysis : Ag 95,1 % \pm 1,1 (8 analyses). Au 49 :10.000 (0,47 %).

B. Denarii de bandera

2. Obv. Christ enthroned.

Rev. VROSIV REX SSTEUFAN-. The king and St. Stephen standing, holding banner. Cf. the style, e.g. the king's beard, of the coin of *Dragutin*, LJUBIĆ, pl. V, 18; and cf. MARIĆ, pl. XXXIV/XXXV, 10.

Obv. and rev. are close in style to MARIĆ, pl. XXXVI/XXXVII, 5. 2,097 g. Die-axis ca. 190°. D. M. Metcalf.

Attribution : Uroš I or Milutin

Analysis : Ag 95,9 % \pm 1,1 (11 analyses). Au 34 :10.000 (0,32 %).

3. Obv. Similar. Secret-mark : annulet between feet.

Rev. Similar. VROSIV- . REX S-STEUFAN- Neat, early style. Marks on saint illegible. Cf. LJUBIĆ, pl. IV, 11.

Obv. and rev. cf. MARIĆ, pl. XXXIV/XXXV, 3. 2,027 g. Carefully die-adjusted. D. M. Metcalf.

Attribution : Uroš I or Milutin

Analysis : Ag 91,4 % \pm 1,6 (12 analyses). Au 0,33 :10.000 (0,003 %).

4. Obv. Similar.

Rev. Similar. VROSIVS RE+ S-STEUFAN-. Large X X on saint's shoulders. King with little beard. Cf. LJUBIĆ, pl. IV, 15 and MARIĆ, pl. XXXVI, 12. 2,181 g. Carefully die-adjusted. D. M. Metcalf.

Attribution : Uroš I or Milutin

Analysis : Ag 90,4 % \pm 1,3 (10 analyses). Au 1,4 :10.000 (0,013 %)

5. Obv. Similar.

Rev. Similar. VROSIVS REX SSTEUFAN-. Dot on staff of banner. Small x x on saint's shoulders. LJUBIĆ, pl. IV, 15.

Obv. and rev. cf. MARIĆ, pl. XXXIV/XXXV, 17. 1,85 g. Carefully die-adjusted. Ashmolean Museum (no provenance).

Attribution: Milutin

Analysis: Ag 89,0 % \pm 0,9 (14 analyses). Au 2,4 :10.000 (0,021 %).

6. Obv. Similar. Large x by Christ's left knee (i.e. to right). Rev. Similar. VROSIVS RE+ SSTEFAII. Star at foot of banner, to left. Cf. MARIĆ, pl. XXXVI/XXXVII, 9. 1,610 g. Die-axis ca. 200°. Ashmolean Museum, purchased 1965.

Attribution: Milutin

Analysis: Ag 81,0 % \pm 1,1 (10 analyses). (Au not determined)

7. Obv. Similar. Square-topped throne. Wide, foursquare cross in nimbus (cf. n° 8 below).

Rev. Similar. STEFAN REX SSTEFAII.

Obv. and rev. cf. MARIĆ, pl. XXXII/XXXIII, 2-3 and XXXIV/XXXV, 10. 1,911 g. Die-adjusted. Ashmolean Museum, purchased 1965.

Attribution: Dragutin

Analysis: Ag 57 % \pm 0,8 (10 analyses). (Au not determined.)

C. Denarius de macia

8. Obv. Christ enthroned. Characteristic nimbus cruciger, cf. n° 7 above.

Rev. MONETARE GISSTEFAN. Bare-headed king seated on stool, and holding cross-sceptre and sword. LJUBIĆ, pl. V, 19. 1,665 g, Die-axis ca. 340°. Ashmolean Museum, purchased 1966 ex Kress auction 136, lot 1463.

Attribution: Dragutin

Analysis: Ag 84,1 % \pm 1,0 (13 analyses). Au 1,5 :10.000 (0,013 %)

D. « Standing king » type

9. Obv. Christ enthroned.

Rev. ЦТЕФАН ПАББ XУН Standing king, in crown and vestments, holding cross-sceptre. a M in field. LJUBIĆ, pl. III, 19 (Type I, h 4). 1,783 g. Die-axis 195°. Ashmolean Museum, purchased 1968.

Attribution : Dragutin

Analysis : Ag 91,4 % \pm 1,5 (7 analyses). Au 8,2:10.000 (0,075 %).

E. Denarii de cruce

10. Obv. Christ enthroned. Cross or star beneath elbow.

Rev. ★VROŽIVŲ REX ŽŽTEFAI Bare-headed king and St. Stephen hold double-barred (patriarchal) cross. T R at foot. Cf. LJUBIĆ, pl. IV, 5-6 ; and the obverse is in the general style of LJUBIĆ, pl. IV, 21 (different type). 1,708 g. Die-axis 165°. D. M. Metcalf.

Attribution : Stefan Dečanski ?

Analysis : Ag 78,9 % \pm 0,6 (14 analyses). Au 39:10.000 (0,31 %).

11. Obv. Similar, with sigla N O.

Rev. Similar. VROSIV' REX SSTEFAI. Very similar in style, and the obv. is extremely similar, to LJUBIĆ, pl. IV, 24 (with crowned king). 1,792 g. Die-axis ca. 340°. D. M. Metcalf.

Attribution : Stefan Dečanski ?

Analysis : Ag 77,7 % \pm 1,1 (11 analyses). Au ca. 12:10.000 (0,096 %).

F. « Crowned seated king » type

12. Obv. Christ enthroned. Sigla A Φ.

Rev. CTEΦAH БРPaAB Crowned king seated on stool and holding cross-sceptre and sword. LJUBIĆ, pl. VI, 3 (near-duplicate dies). Cf. MARIĆ, pl. XL/XLI, 10. 1,865 g. Die-axis 30°. Ashmolean Museum, Evans Bequest (1941).

Attribution : Stefan Dušan as king

Analysis : Ag 88,1 % \pm 0,8 (10 analyses). Au 2,7:10.000 (0,024 %).

G. « Helmet » type

13. Obv. Christ enthroned. Sigla И Г. Extremely similar to LJUBIĆ, pl. VI, 24.

Rev. STEFAIIVS DEI GRA.REX . Helmet with elaborate crest. The circlet is empty, otherwise extremely similar to

LJUBIĆ, pl. VI, 24. Cf. MARIĆ, pl. XLVI/XLVII, 18. 1,753 g. Die-axis 175°. D. M. Metcalf.

Attribution : Stefan Dušan ?

Analysis : Ag 75,6 % \pm 1,0 (15 analyses). Au 1,4 : 10.000 (0,011 %).

14. Obv. Similar, but sigla \diamond II (lateral reversal).

Rev. Similar. STEFANJ . . | DEIGRAREX. Cf. LJUBIĆ, pl. VI, 24, and MARIĆ, pl. XLVI/XLVII, 19. 1,706 g. Die-axis 185°. Ashmolean Museum, purchased 1965.

Attribution : Stefan Dušan ?

Analysis : Ag 76,4 % \pm 0,8 (14 analyses). (Au not determined)

15. Obv. Similar, with annulet below elbow, and sigla N \diamond Cf. MARIĆ pl. XLV, 10-16.

Rev. Similar, but MONITA REX STEFAN. Cf. MARIĆ, pl. XLIV, 14. 1,384 g. Die-axis ca. 100°. Ashmolean Museum, purchased 1960 ex C. E. F. Beasley collection.

Attribution : Stefan Dušan.

Analysis : Ag 74,9 % \pm 1,2 (16 analyses). Au 15,7 : 10.000 (0,12 %).

16. Obv. Similar, but the lower half of the die shows lateral reversal. Sigla M B. MARIĆ, pl. XIV, 4 (= XLI, 16) is by the same hand. Rev. Similar. Extremely close in style to MARIĆ, pl. XLII, 18. 1,574 g. Die-axis ca. 220°. Ashmolean Museum, purchased 1966.

Attribution : Stefan Dušan.

Analysis : Ag 74,6 % \pm 1,2 (16 analyses). Au 7,5 : 10.000 (0,056 %).

17. Obv. Similar, with annulet below elbow. Sigla O B. Extremely similar to LJUBIĆ, pl. VII, 8.

Rev. Similar. From the same rev. die and perhaps also the same obv. die as MARIĆ, pl. XLIV/XLV, 2. 1,503 g. Die-axis 0°. Ashmolean Museum, purchased 1966 ex Kress auction 136, lot 1465.

Attribution : Stefan Dušan.

Analysis : Ag 74,9 % \pm 1,0 (17 analyses). Au 9,7 : 10.000 (0,073 %).

18. Obv. Similar, with sigla Φ R. Cf. LJUBIĆ, pl. VII, 7.

Rev. Similar, but note that in place of groups of 3 dots in the crest, there are groups of 3 whiskered seed-like objects —

cf. LJUBIĆ, pl. VIII, 10 and 16. Cf. MARIĆ, pl. XLII, 11. 1,430 g. Die-axis 0°. Ashmolean Museum, given by Rev. Greville T. Chester.

Attribution : Stefan Dušan.

Analysis : Ag 75,1 % \pm 1,1 (13 analyses). Au 21 :10.000 (0,15 %).

H. Coins struck after Stefan Dušan became emperor

19. Obv. Christ enthroned.

Rev. Standing emperor crowned by two birds. Cf. LJUBIĆ, pl. VIII, 5. 1,624 g. Die-axis 180°. Ashmolean Museum, purchased 1961 from P. Grierson, ex R. C. Lockett, ex Lord Grantley.

Attribution : Stefan Dušan, coronation issue.

Analysis : Ag 93,4 % \pm 0,9 (9 analyses). Au 3,2 :10.000 (0,030 %).

20. Obv. Similar, with sigla H O. Note the large number of small dots in the side-panels of the throne. Cf. MARIĆ, pl. LIII, 10. Rev. Similar. 1,52 g. Die-axis 150°. D. M. Metcalf, from P. Grierson, ex R. C. Lockett, ex Lord Grantley.

Attribution : Stefan Dušan, coronation issue.

Analysis : Ag not determined. Au 66 :10.000 (0,6 %) approximately.

21. Obv. Bust of Christ. Sigla N O.

Rev. Emperor on horseback. $\overline{\text{C}\Phi\text{B}} \overline{\text{I}\Pi\text{P}}$ Cf. LJUBIĆ, pl. VIII, 21. 1,240 g. Die-axis 15°. D. M. Metcalf.

Attribution : Stefan Dušan.

Analysis : Ag 90,1 % \pm 1,4 (10 analyses). Au 50 :10.000 (0,45 %).

I. Light-weight imitations of late thirteenth-century Venetian grossi

22. Obv. Christ enthroned. Secret-marks : + to left, within small fold of drapery, and an identical + to the right, beneath the elbow. Flat-topped back to throne.

Rev. The doge and St. Mark standing holding banner. L.ATEVPL DVX SMVENE . . 1,235 g. Carefully die-adjusted. Ashmolean Museum, purchased 1968.

Analysis : Ag 75,5 % (11 analyses). Au 76 :10.000 (0,56 %).

23. Obv. Similar. Throne with sloping back. Poor, linear style. Note the stylized beard and moustaches.

Rev. Similar. IODADVI DVX SMVENETI. Faces of the doge and saint in the same style as on the obv. 1,22 g. Die-axis 0°. Ashmolean Museum, purchased 1968.

Analysis : Ag 52,7 % (11 analyses). Au 173 :10.000 (0,89 %).

Oxford, Ashmolean Museum.

A. A. GORDUS and D. M. METCALF.

RÉSUMÉ

L'alliage des premiers monnayages serbes

Le gros de Venise d'un poids de 2,178 g. et d'une teneur en argent de 96,5 % a été imité par les rois de Serbie à partir de 1275 env. L'exploitation des mines d'argent de Brskovo (à partir d'environ 1254), Srebrnica (à partir de la même date) et Rudnik (à partir d'env. 1295) a rendu possible une abondante frappe de monnaies. Des analyses par activation de neutrons ont été entreprises au moyen de deux méthodes différentes, la méthode « Howitzer », procédant par irradiation à faible intensité de l'exemplaire entier, et une méthode par « frottement », utilisant une irradiation à forte intensité sur une petite quantité de métal prélevée par frottement et placée sur un morceau de tube de quartz préparé chimiquement. La première méthode permet d'estimer avec précision la teneur en argent des monnaies et dès lors d'étudier comment leur teneur en fin s'abaisse progressivement de 1275 à 1346. La deuxième méthode peut être utilisée pour estimer la teneur en or des pièces. De faibles quantités d'or se trouvent d'ordinaire dans les monnaies médiévales, dont l'argent n'était pas raffiné au point où il l'est de nos jours. La proportion d'or présente dans l'alliage peut être caractéristique de la source (c.-à-d. d'une mine d'argent bien précise) qui a fourni l'argent. Le métal précieux en circulation en Europe au moyen âge a été continuellement refondu au cours des siècles et remis en circulation, sa composition accuse donc un caractère assez hétérogène. Mais les monnaies de Serbie, dont la frappe était destinée surtout à l'exportation de métal précieux « nouveau », fournissent une occasion exceptionnelle pour mettre à l'essai les méthodes mêmes d'analyse de teneur en or.

La qualité des dinari serbes était, à l'origine, étroitement semblable à celle des gros de Venise. Vers la fin du XIII^e s., aussi bien leur poids que leur aloi avaient sensiblement baissé. Les analyses publiées ici, conjuguées avec les taux de change publiés par Dinić, montrent que l'embargo vénitien de 1282 ne fut pas responsable

(comme on l'a prétendu) d'une réduction du poids à 1,81 g. Il y eut deux étalons de poids différents, l'un à Brskovo (près de Raguse, l'actuelle Dubrovnik) et l'autre dans la Serbie du Nord-Est, à Rudnik. La teneur en fin du monnayage dans le Sud tomba d'abord à env. 89 % (peut-être 1/9 de cuivre contre 8/9 d'argent?), puis à env. 80 %, tandis que les émissions du Nord gardaient une teneur en fin plus élevée. Vers 1330, une réforme eut lieu dans le monnayage et les dinari au casque furent introduits. Leur teneur en fin de 75 % était contrôlée avec précision et la moyenne du poids s'établissait à 1,54 g, environ, soit seulement 56 % de la valeur intrinsèque du gros vénitien, mais le poids des exemplaires était très irrégulier. Lorsque Étienne Dušan prit le titre impérial, on en revint à un monnayage accusant une teneur en fin de plus de 90 %.

La teneur en or des premières monnaies serbes, que l'on peut attribuer à l'atelier de Brskovo, est exceptionnellement basse. D'autres monnaies de la même époque, frappées en Serbie du Nord, contiennent plus d'or. Les types émis au cours de la période de 1316-46, lorsque plusieurs mines d'argent nouvelles étaient mises en exploitation, accusent des pourcentages de teneur en or plus complexes. Deux petites imitations de gros vénitiens, frappées dans les Balkans probablement au xiv^e s., contiennent des quantités d'or peu communes.