

NOTAE NUMISMATICAE

ZAPISKI NUMIZMATYCZNE



Tom XVII

MUZEUM NARODOWE W KRAKOWIE
SEKCJA NUMIZMATYCZNA
KOMISJI ARCHEOLOGICZNEJ PAN
ODDZIAŁ W KRAKOWIE

Kraków 2022

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Szanowni Państwo,

oddajemy w Państwa ręce tom XVII *Notae Numismaticae – Zapisków Numizmatycznych*. Zgodnie z przyjętymi przez nas zasadami wszystkie teksty publikujemy w językach kongresowych, z angielskimi i polskimi abstraktami. Zawartość całego obecnego tomu oraz tomy archiwalne są zamieszczone w formie plików PDF na stronie internetowej Muzeum Narodowego w Krakowie (<https://mnk.pl/notae-numismaticae-zapiski-numizmatyczne-1>). Na stronie dostępne są ponadto wszelkie informacje ogólne o czasopiśmie oraz instrukcje dla autorów i recenzentów.

Rok 2022 był wyjątkowy dla całego środowiska numizmatyków w Polsce. Pierwszy raz w historii naszego kraju, a ujmując rzecz szerzej – w krajach Europy Środkowo-Wschodniej – odbył się XVI Międzynarodowy Kongres Numizmatyczny, najważniejsze spotkanie numizmatyków z całego świata, organizowane co sześć lat pod auspicjami International Numismatic Council. Wybór Polski, jako miejsca organizacji Kongresu traktujemy jako wielkie wyróżnienie. Głównym organizatorem tego wydarzenia był Uniwersytet Warszawski, a w przygotowaniach uczestniczyły również Muzeum Narodowe w Warszawie, Zamek Królewski w Warszawie, Polskie Towarzystwo Numizmatyczne, Narodowy Bank Polski oraz Muzeum Narodowe w Krakowie. W tym ostatnim przypadku szczególnie zaangażowani w prace nad XVI INC byli pracownicy Gabinetu Numizmatycznego. Całością działań kierował profesor Aleksander Bursche z Wydziału Archeologii Uniwersytetu Warszawskiego, pomysłodawca organizacji Kongresu w Polsce, którego wspierał Komitet Organizacyjny reprezentujący wszystkie najważniejsze polskie ośrodki numizmatyczne. Obrady kongresowe — które zgromadziły ponad 600 uczestników, czy to na miejscu w Warszawie, czy też w mniej licznych przypadkach, dzięki transmisji na żywo, w miejscach ich zamieszkania — uzupełniały liczne wydarzenia towarzyszące: wystawy, koncerty i spotkania.

Muzeum Narodowe w Krakowie przygotowało z tej okazji specjalną wystawę: „Medal prywatnie. Medale w I Rzeczypospolitej (od XVI do XVIII wieku)”, której kuratorem była Agnieszka Smołucha-Sładkowska. Jednocześnie we współpracy z Uniwersytetem Jagiellońskim, krakowskim oddziałem Polskiego Towarzystwa Numizmatycznego, Królewską Biblioteką w Brukseli i Królewskim Towarzystwem Numizmatycznym w Belgii zorganizowano poprzedzającą właściwe obrady Kongresu międzynarodową sesję „Joachim Lelewel and Numismatics in the Nineteenth Century”. W ramach kongresu tradycyjnie opracowany został również Survey of Numismatic Research za lata 2014–2020, w prace nad którym aktywnie zaangażowani byli pracownicy Gabinetu Numizmatycznego: Jarosław Bodzek, Dorota Malarczyk i Barbara Zając. Co więcej, Gabinet Numizmatyczny Muzeum Narodowego w Krakowie był silnie reprezentowany w obradach Kongresu, w czasie których wymienione powyżej osoby wygłosiły referaty. Kongres zakończył się wielkim sukcesem i stanowił znakomitą wizytówkę polskiej numizmatyki.

Redakcja

Dear Readers,

It is with great pleasure that we present volume 17 of *Notae Numismaticae – Zapiski Numizmatyczne* to you. In accordance with the principles that we have adopted, our texts are published in the conference languages with English and Polish abstracts. The whole of the present volume can be found as PDF's on the website of the National Museum in Krakow (<https://mnk.pl/notae-numismaticae-zapiski-numizmatyczne-1>), as are previously published volumes of the journal. The website also contains general information about the journal as well as information for prospective authors and reviewers.

2022 was a special year for the entire numismatic community in Poland. It saw the XVI International Numismatic Congress being held in Warsaw, marking the first time that this most important meeting of numismatists from all over the world, organised every six years under the auspices of the International Numismatic Council, had been held in our country, or more generally in a country from Central and Eastern Europe. The choice of Poland as the venue for the Congress was a great honour. The main organiser of the event was the University of Warsaw, and also involved in its organisation were the National Museum in Warsaw, the Royal Castle in Warsaw, the Polish Numismatic Society, the National Bank of Poland, and the National Museum in Krakow. In this last case, the staff of the Museum's Numismatic Cabinet were particularly active in the work on the INC 2022. In charge of all activities was Professor Aleksander Bursche of the Faculty of Archaeology at the University of Warsaw, who was the driving force behind the organisation of the Congress in Poland, and who was supported in his role by the Organising Committee, representing all major Polish numismatic centres. The congress proceedings, which attracted more than 600 participants, either on-site in Warsaw or, in lesser numbers, thanks to live streaming, were complemented by a wide range of accompanying events, including exhibitions, concerts, and meetings.

The National Museum in Krakow organised a special exhibition for the occasion: "Private medal. Private medals in the 1st Republic of Poland (from the 16th to the 18th century)", curated by Agnieszka Smołucha-Sładkowska. At the same time, an international session on "Joachim Lelewel and Numismatics in the Nineteenth Century", preceding the Congress proper, was organised in cooperation with the Jagiellonian University, the Krakow Branch of the Polish Numismatic Society, the Royal Library of Brussels, and the Royal Numismatic Society of Belgium. As part of the Congress, the Survey of Numismatic Research for the years 2014–2020 was traditionally produced, with Jarosław Bodzek, Dorota Malarczyk and Barbara Zajac of the Numismatic Cabinet actively involved in its preparation. The Numismatic Cabinet of the National Museum in Krakow was also strongly represented in the proceedings of the Congress, where the abovementioned staff delivered papers. The congress was a great success and a real showcase for Poland.

The Editors

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A Graphical Method for Analysing Chronological Patterns of Coin Sets

ABSTRACT: This paper presents a graphical method for analysing chronological patterns which can be successfully applied to coin sets (e.g. hoards) containing specimens dated within multiple, overlapping timespans of up to several dozen years. The timespans are considered rounded up to full years, i.e. the shortest timespan would be 1 year, while the longer ones could cover several, a dozen or more years. This works well, for example, with Roman coins from the Imperial period, or with some categories of medieval or modern European coinage. The method is based on a simple mathematical model and the values calculated for each year are presented in a graphical form (as values of a discrete function spread on a timeline) to show the chronological distribution of coins in percentage terms. Such distributions make sets of coins easy to compare. The method is much less effective when applied to precisely dated coins (e.g. with an accuracy of one year), like Roman coins from the Republican period, or certain categories of early medieval Islamic coins.

KEY WORDS: chronological pattern, statistical analysis, coin sets, coin hoards

ABSTRAKT: *Graficzna metoda analizy profili chronologicznych zestawów monet*

W artykule zaprezentowano graficzną metodę analizy profili chronologicznych, którą z powodzeniem można stosować do zestawów monet (np. skarbów) zawierających egzemplarze datowane w ramach wielu, nakładających się na siebie częściowo przedziałów czasowych liczących do kilkudziesięciu lat, rozpatrywanych w zaokrągleniu do pełnych lat, tj. najkrótszy przedział czasowy w takim przypadku liczyłby 1 rok, a dłuższe kilka, kilkanaście lub więcej lat. Odnosi się to na przykład do rzymskich monet z okresu cesarstwa lub niektórych gałęzi europejskiego men-

nictwa średniowiecznego i nowożytnego. Metoda jest oparta na prostym modelu matematycznym, a wyliczone dla poszczególnych lat wartości są prezentowane w formie graficznej (wartości funkcji dyskretnej rozwinięte na osi czasu) i ukazują rozkład chronologiczny monet w ujęciu procentowym. Takie rozkłady dla różnych zestawów monet są łatwe do porównania. Zastosowanie opisanej metody do kategorii monet precyzyjnie datowanych (np. z dokładnością do jednego roku) jest mało efektywne; odnosi się to na przykład do rzymskich monet z okresu republiki lub do niektórych kategorii wczesnośredniowiecznych monet islamskich.

SŁOWA KLUCZOWE: profil chronologiczny, analiza statystyczna, zestawy monet, skarby monet

In my Polish-language papers published in 2011¹ and 2013,² I described a method for analysing the chronological structure of Roman coin sets using graphically illustrated chronological patterns. It is now my intention to somewhat restructure and extend this description, also with regard to the wider applicability of this method. The method can be successfully applied to coin sets containing pieces dated within multiple, overlapping timespans of up to several dozen years, rounded up to full years, i.e. the shortest timespan in such a case would be 1 year, while longer ones can cover several, a dozen, or more years. For example, Roman coins from the Imperial period can be attributed to the reigns of emperors, who, at certain times, ruled simultaneously as legal rulers, co-rulers or usurpers. Some of these coins belong to issues with portraits of members of the imperial family, often dated more narrowly than the entire reign of a given emperor. Going further, some Roman Imperial coins can be attributed to specific, separate issues within particular reigns, dated with an accuracy of a few years or even a few months. Some categories of European medieval or modern coinage share similar characteristics. On the other hand, the method described below is of limited efficiency when applied to precisely dated (predominantly to a single year) Roman coins from the Republican period, or to certain categories of early medieval Islamic coins. Such coin sets with narrowly dated, rarely overlapping issues can be successfully analysed without the use of mathematical models, using the raw data to prepare a graphical depiction of the chronological pattern, e.g. in the form of a bar or line chart, also in cumulative (quantitative or percentage) terms.

Mathematically, the method described is based on a simple model and is an extension of even simpler methods that have been used many times before, both in

¹ DYMOWSKI 2011: 70–73.

² IDEM 2013: 99–103.

quantity-based³ and percentage-based⁴ approaches. All of these methods referred to an actual or averaged number of coins, quantified or expressed in percentage terms, attributable to a specific year of issue or to a given year within a longer than one-year period over which the coins were issued. At this point, I would like to make it clear once again that the method I am writing about is based on a model that assumes simplifications and averaging, rather than representing actual data with the greatest possible degree of detail available. This refers to dates established with greater or lesser precision for the beginnings and ends of timespans – in our case, the beginning and end of a ruler’s reign, or the beginning and end of an issue period. Such averaging and simplifications are justified when we do not have detailed data for all periods of interest, in other words, when part of the data is very detailed and another part includes very approximate values.

I shall describe the method and the model on which it is based using the example of Roman coins for which I take the issue periods to be the same as the reigns of the rulers during whose reign the coins were minted. For each reign that began and ended within the same calendar year (e.g. Hostilian in 251, or Aemilian in 253), I assume a period of a full calendar year, i.e. that the reign began on 1 January and ended on 31 December of the same year. On the other hand, for any reign that went beyond one calendar year, I assume that it began in the middle of the first year of reign and ended in the middle of the last year of reign. So, for the needs of this model, Trajan Decius reigned from the beginning of July 249 to the end of June 251, and Quietus from the beginning of July 260 to the end of June 261. This is to avoid the situation of a partial overlap between the reigns of consecutive rulers whose reigns went beyond a single calendar year. For example, if we were to assume that Philip the Arab reigned until the end of 249 and Trajan Decius reigned from the beginning of 249, both the issues of Philip the Arab and Trajan Decius would be included in the whole of that calendar year.

Under my proposed model, the average number of coins in a given year within the issue period, expressed as a percentage, is represented by the formula:

$$\phi_j = \frac{\lambda_j}{\omega} \times 100\%$$

where:

$$\lambda_j = \sum_{i=1}^K \frac{n_i}{t_i} + \sum_{i=1}^K \frac{n'_i}{t_i - 1} + \sum_{i=1}^K \frac{n''_i}{2(t_i - 1)}$$

³ See e.g. ALRAM and SCHMIDT-DICK 2007, vol. I: 68.

⁴ See e.g. BURSCHE 1996: 67–71.

and

$$\omega = \sum_{i=1}^K n_i + \sum_{i=1}^K n'_i + \sum_{i=1}^K n''_i$$

where:

- j – a given year within the analysed timespan covering all issue periods,
- P_i – issue period (timespan given in years),
- K – total number of timespans P_i considered,
- t_i – number of years covered by P_i ,
- n_i – number of coins with issue dates falling within the considered timespan P_i for issues (reigns) falling within 1 calendar year,
- n'_i – number of coins with issue dates falling within the considered timespan P_i except for coins for which j is the first or last year of issue (reign),
- n''_i – number of coins with issue dates falling within the considered timespan P_i for coins for which j is the first or last year of issue (reign).

Spread on the timeline (as functions), the values determined according to the formula described above show the chronological distribution of the coins in percentage terms:

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$$\Phi(t) = \phi$$

where ϕ denotes the values of the discrete function calculated for each year according to the formula given above for ϕ_j .

I will illustrate the above description with an example for a set of 27 Roman coins comprising two coins of Trajan Decius, three of Hostilian, four of Trebonianus Gallus, five of Volusian, six of Aemilian, and seven of Valerian. Performing a simple calculation, I end up with the quotient of the number of coins and the corresponding number of years of issue.

Reign	Issued from year	Issued to year	Number of years	Number of coins	Number of coins/Number of years of issue
	A	B	C (calculated by the model)	D	E = D/C
Trajan Decius	249	251	2	2	1
Hostilian	251	251	1	3	3
Trebonianus Gallus	251	253	2	4	2
Volusian	251	253	2	5	2.5
Aemilian	253	253	1	6	6
Valerian	253	260	7	7	1
COINS TOTAL (F)				27	

In the next step, I assign the number of coins averaged for a single year of issue to semi-annual (for the first and last years of reigns within reigns longer than one year) or annual (for reigns of one year, or for years other than the first and last within longer reigns) periods assigned to calendar years.

Year	249	250	251	252	253	254	255	256	257	258	259	260
(Trajan Decius)	0.5	1	0.5	0	0	0	0	0	0	0	0	0
(Hostilian)	0	0	3	0	0	0	0	0	0	0	0	0
(Trebonianus Gall.)	0	0	1	2	1	0	0	0	0	0	0	0
(Volusian)	0	0	1.25	2.5	1.25	0	0	0	0	0	0	0
(Aemilian)	0	0	0	0	6	0	0	0	0	0	0	0
(Valerian)	0	0	0	0	0.5	1	1	1	1	1	1	0.5
Total (number of coins per year; G)	0.5	1	5.75	4.5	8.75	1	1	1	1	1	1	0.5
% of coins per year (H = G/F)	0.018	0.037	0.212	0.166	0.324	0.037	0.037	0.037	0.037	0.037	0.037	0.018

All of the above calculations can be carried out using a standard spreadsheet, e.g. MS Excel (see Fig. 1), and the resulting values indicating the percentages of coins per year within the analysed coin set can be presented graphically in the form of a line chart (Fig. 1).

Such line charts are in fact frequency polygons that lend themselves easily to comparison. I will do this using the fully random example of two solidus hoards from Italy: the Naples hoard (see Fig. 2) and the San Mamiliano hoard (see Fig. 3). If we compare the polygons of these two coin hoards in one diagram (see Fig. 4), the common part of the two polygons (see Fig. 5) illustrates the coincidence

of the chronological patterns of the Naples hoard⁵ and the San Mamiliano hoard.⁶ The coincidence expressed as a percentage can be calculated by subtracting half of the sum of the absolute values of the differences in the values of the two discrete functions of the $\Phi(t)$ type for specific arguments of the function from 100%, i.e. consecutive years of emission (i.e. ϕ_j calculated according to the formula given above). This can be expressed by the formula:

$$\sigma = 100\% - \frac{\sum_{j=1}^K |\phi_{1j} - \phi_{2j}|}{2}$$

where ϕ_{1j} and ϕ_{2j} denote the values relating to two different coin sets.

In other words, for a particular year, one has to subtract the values indicating the percentage of coins attributable to that year in the two coin hoards from each other (the value described as H in the table above), and then calculate the absolute value of the result of this subtraction and divide it by 2. Then one has to add up all the values thus obtained for all subsequent years of issue and subtract the result from 100%. For the Naples hoard and the San Mamiliano hoard, the coincidence calculated in this way is 67.2%.

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I hope that the presented method, based on the model described above, will prove useful not only in studies of the chronological structure of Roman coinage, but also of other coin categories. Attached to the electronic version of this paper is a spreadsheet file with a template for analysing chronological patterns of coin assemblages and calculating the coincidence of these patterns using the method presented.

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⁵ Source data on the composition of the hoard taken from the Coin Hoards of the Roman Empire Project database: <https://chre.ashmus.ox.ac.uk/hoard/4610> (accessed on 21 November 2022). For further information on the Naples hoard itself see BLAND 1997: 47, tab. 4, no. 165.

⁶ Source data on the composition of the hoard taken from the Coin Hoards of the Roman Empire Project database: <https://chre.ashmus.ox.ac.uk/hoard/15055> (accessed on 21 November 2022). For further information on the San Mamiliano hoard itself see ARSLAN 2015.

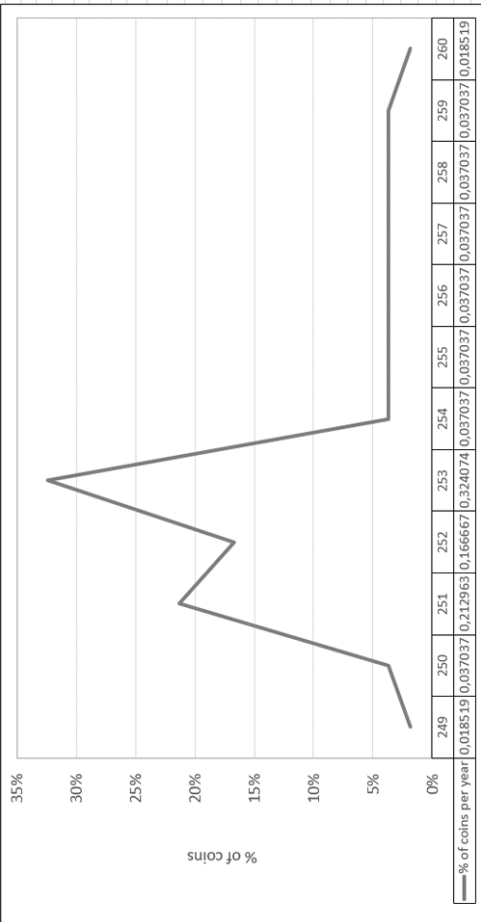
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PLATE 1	Fig. 1. An example of a spreadsheet for calculating and presenting the chronological pattern of a coin set
PLATE 2	Fig. 2. Chronological pattern of the Naples hoard Fig. 3. Chronological pattern of the San Mamiliano hoard
PLATE 3	Fig. 4. A comparison of chronological patterns of two solidus hoards: Naples and San Mamiliano Fig. 5. A graphical illustration of coincidence of chronological patterns of two solidus hoards: Naples and San Mamiliano

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Reign (or any other time span)	Issued from year	Issued to year	Number of coins	(number of coins/number of years of issue)															
2	Trajan Decius	249	251	2	1			0.5	1	0.5	0	0	0	0	0	0	0	0	0	0
3	Hostilian	251	251	3	3			0	0	3	0	0	0	0	0	0	0	0	0	0
4	Trebonianus Gallus	251	253	4	2			0	0	1	2	1	0	0	0	0	0	0	0	0
5	Volusian	251	253	5	2.5			0	0	1.25	2.5	1.25	0	0	0	0	0	0	0	0
6	Aemilian	253	253	6	6			0	0	0	0	6	0	0	0	0	0	0	0	0
7	Valerian	253	260	7	1			0	0	0	0	0.5	1	1	1	1	1	1	1	0.5
8				COINS TOTAL	27			0.5	1	5.75	4.5	8.75	1	1	1	1	1	1	1	0.5
9								0.018519	0.037037	0.212963	0.166667	0.324074	0.037037	0.037037	0.037037	0.037037	0.037037	0.037037	0.037037	0.018519
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FORMULAS:

- 16 number of coins/number of years of issue for Trajan Decius (cell E2)
- 17 =IF(B2=C2,1,1/IF(OR(AND(B2<0,C2=0),AND(B2>0,C2>0)),C2,
- 18 B2/(IF(AND(B2=0,C2=0),0,C2-B2-1))))*D2
- 21 coins total (cell D8)
- 22 =SUM(D2:D7)
- 25 number of coins issued in the year 249 under Trajan Decius (cell H2)
- 26 =IF(AND(H\$1=\$B2,H\$1=\$C2),SE2,IF(AND(H\$1>\$B2,H\$1<\$C2),SE2,IF(OR
- 27 H\$1=\$B2,H\$1=\$C2),SE2/2,0)))
- 30 number of coins per year for the year 249 (cell H8)
- 31 =SUM(H2:H7)
- 34 % of coins per year for the year 249 (cell H9)
- 35 =H8/\$D\$8

PLATE 2

