SYLLOGE NUMMORUM GRAECORUM
CZECH REPUBLIC

VOLUME I

THE NATIONAL MUSEUM
PRAGUE

Part 8
Ptolemaic Empire, Egypt and North Africa

Jiří Militký
(in collaboration with Jiří Kmošek and Petr Veselý)

NATIONAL MUSEUM

Prague 2025

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Translation: Mgr. Jan Kysela, Ph.D.
doc. PhDr. Jiří Militký, Ph.D., DSc.
Mgr. Petr Veselý, Ph.D.
Ing. Jiří Kmošek

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Abstract:
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This catalogue contains descriptions of 846 coins, illustrated on 80 plates + 67 colour plates.

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FOREWORD

The main objective of the long-term project *Sylloge Nummorum Graecorum, Czech Republic I: The National Museum, Prague*, is the gradual and complete cataloguing of the collection of Greek coins held by this institution. For the purpose of publishing these catalogues, the ancient section of the numismatic collections of the National Museum in Prague was reorganized and revised. Three volumes have been published since 2016, presenting coins from the regions of Macedonia and Paeonia (*SNG Prague I/3*), the Seleucid Kingdom through Arabia (*SNG Prague I/7*), and the region of ancient Bactria, including their period imitations and Indo-Scythian issues (*SNG Prague I/10*). The fourth volume (*I/8*) presents coinage from the Ptolemaic Kingdom, Roman Egypt, and North Africa, comprising a total of 846 coins.

HISTORY OF THE COIN COLLECTION OF THE PTOLEMAIC EMPIRE, ROMAN EGYPT AND NORTH AFRICA IN THE NATIONAL MUSEUM IN PRAGUE

The history of the ancient coin collection deposited in the National Museum in Prague was presented in the publication of Roman Republican coinage (*Militký – Vacinová 2018*, 7–14). The core of this collection consists of Roman Imperial issues, while Greek coins are represented rather marginally, although their number reaches several thousand.

Coins of the Ptolemaic Kingdom form a significant part of the collection of Greek coins kept in the National Museum in Prague (250 pieces). Notably numerous are the Roman provincial coins minted in Alexandria in Egypt (506 pieces). In contrast, coins from the Egyptian nomes are represented only marginally (2 pieces). Other areas of North Africa are much less represented in the collection – Cyrenaica (10 pieces), Carthage (59 pieces), Numidia and Mauretania (13 pieces). A total of five coins come from the island of Cossura. The quantitative disproportion among the various regions of the ancient world mainly reflects the ways and paths through which coins entered the National Museum's collection. It should be emphasized, however, that the coinages of the regions in question were never the focus of deliberate collecting activities by the Museum, which also never succeeded in acquiring any major collection of coins from these regions. In 2019 and 2020, efforts were made to acquire Luboš Král's collection of Roman provincial coins minted in Alexandria for the National Museum. However, due to a lack of funds, the purchase could not be completed. The collection remained in private hands and was published independently in 2021 (*SNG Král*).

The numismatic collections of the National Museum in Prague are, for the most part, kept by the Department of Numismatics (H5), and most of the coins presented in this publication come from this collection. Only a few individual coins belong to the Department of Archaeology (H1), though today they are physically kept in and managed by the Department of Numismatics. The limited size of this collection is also reflected in the sample presented here, which consists of only no. 365.

A distinct collection is that of the Náprstek Museum (N). It was established only in the early 1960s with a focus on non-European numismatics, yet in many respects it overlaps with the collection of the Department of Numismatics. This is also reflected in the structure of the material presented in this publication, totalling 40 pieces (nos. 49, 67, 111, 131, 133, 142, 147, 151, 161, 180, 187, 191, 197, 235, 240, 242, 247, 272, 313, 426, 431, 433, 452, 460, 499, 522, 525, 542, 638, 650, 692, 804–806, 809, 827, 831, 834, 836, and 839). These coins were acquired on the numismatic market during the 1960s to 1980s.

A special place is occupied by coins from the collection of B. Augst, purchased by the Náprstek Museum in 1963. It was conceived as a general overview of – primarily Asian – coinage from antiquity to the early modern period, but it also includes coins from Africa. Although its core consists mainly of Islamic and Chinese issues, classical ancient coinage is also prominent including seven coins from North Africa (nos. 779, 786, 791–792, 833, 842, and 846). It is also worth mentioning that one coin held in the Náprstek Museum collection comes from the collection of O. Vejvoda (no. 119), a well-known collector of ancient coins.

In the case of relatively numerous coins from the collection of the Department of Numismatics, the specific circumstances of their acquisition are unclear – this is evidence of the relatively poor condition of the older museum documentation. This part of the collection is now collectively referred to as the 'old collection' and is represented in this catalogue by 216 coins. (nos. 3, 11, 14, 18–19, 23, 33, 37, 39, 53–55, 59, 71, 98–99, 105, 112, 117–118, 120, 122–124, 135, 140, 153, 156, 158, 183–184, 186, 198, 200, 213, 243, 252, 254, 260, 262, 267, 275, 298, 300, 305, 308, 311–312, 315, 328, 338,

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Before World War II, the Department of Numismatics gradually acquired sizeable lots of ancient coins through the dealer F. Zapletal. These acquisitions still form the core of the museum's ancient coin collection. Ptolemaic and Roman provincial coin from Alexandria are represented to a limited extent among them (13 pieces – nos. 1, 4, 9, 12, 34, 41, 90, 138, 160, 253, 259, 293, and 367).

Coins from the regions in question are equally marginal within two large numismatic collections covering the time span from antiquity to the modern era that were acquired before 1924 and in 1924 –the collection of J. Zounek (6 pieces – nos. 81, 101, 125, 132, 192, and 248) and F. Hrdina (4 pieces – nos. 35, 189, 268, and 302). Coins from the studied areas are also represented in a handful of smaller acquisitions made between 1924 and 1934 (10 pieces – nos. 5, 6, 45, 62, 63, 69, 152, 435, 554, and 845).

A significant increase in coins from the studied regions is evident after 1945. Of particular interest are several confiscated collections that included coins presented here. Foremost among them is the exceptionally large collection of H. Zinke from Žatec, ranging from antiquity to the modern period and containing a total of 121 coins from the studied regions (nos. 21–22, 26, 31, 42–44, 50, 57, 61, 72, 76, 79, 80, 84–85, 106, 121, 127, 141, 145, 149–150, 154, 159, 167, 174, 176, 178–179, 181, 196, 199, 203, 205–206, 209, 211–212, 215–216, 218, 244–246, 249, 270, 283, 327, 358, 362–363, 415, 419–420, 437, 441, 492, 501, 528, 537, 553, 561, 567, 605, 612, 622, 628, 632, 636, 641, 645, 656–657, 666, 669–673, 677, 679–682, 684, 696, 698, 702–704, 709–712, 717–718, 720, 727–730, 731, 738–739, 742, 748–749, 752–754, 765, 768–769, 773, and 777). Another large confiscated assemblage of ancient coins is the collection of F. Nostitz-Reineck, which also included coins from the studied regions (40 pieces – nos. 40, 64, 165, 185, 284, 314, 319–320, 332, 334, 336, 343–344, 347, 350, 359, 364, 369, 376–377, 379, 383, 385, 388, 423, 469, 477, 480, 485, 511, 613, 757, 767, 785, 790, 801, 810, 815, and 824). Ancient coins were further present in the Libochovice Castle collection (11 pieces – nos. 17, 32, 82, 104, 148, 201–202, 207, 210, 329, and 366), in the collection of H. Palme from Kamenický Šenov, a keen antiquity enthusiast (12 coins – nos. 58, 278, 371, 380–381, 493, 515, 521, 526, 630, 697, and 744), and the M. Richter collection (16 pieces – nos. 15, 208, 309, 465, 470, 476, 481, 496, 519, 588, 610, 660, 707, 715, 725, and 782). A fairly large collection was also that of V. Katz, which, in addition to ancient coins, included many medieval coins. However, only part of this collection ended up in the holdings of the National Museum. Roman provincial Alexandrian coinage is represented in this collection by 64 pieces (nos. 251, 256–257, 265, 271, 280, 285, 290, 295, 304, 306–307, 322–326, 361, 370, 386–387, 445, 453, 459, 478, 490, 545, 560, 563, 565, 568, 577–579, 583, 586–587, 590, 592, 595, 598–600, 604, 606, 619–620, 624, 629, 640, 648, 658, 668, 676, 689, 691, 701, 714, 721, 726, 733, 737, 750–751, 755–756, and 758). Two items in the presented material come from the collection of K. Chaura (nos. 808 and 828). The core of this collection consists of medieval and early modern coins from Bohemia, Moravia, and Silesia, but it also contains a small number of Roman and Celtic coins, which have already been published separately (*Militký – Vacínová 2012*). Both Carthaginian coins in the Chaura collection were mistakenly identified as Celtic coins and have not yet been published. Overall, all the discussed collections were assembled between the 19th century and the 1940s.

In the period from 1948 to 1981 various minor acquisitions occurred, consisting of both confiscations and purchases. These account for a total of 146 coins (nos. 2, 24, 28, 30, 36, 38, 46–48, 51–52, 60, 66, 70, 74–75, 78, 83, 91–92, 96–97, 103, 108–109, 113–116, 126, 134, 136–137, 139, 143–144, 146, 173, 175, 182, 188, 204, 217, 236, 241, 250, 255, 258, 264, 266, 269, 274, 276, 279, 281, 287–288, 292, 296, 299, 301, 316, 318, 330, 337, 339–340, 345–346, 372, 378, 389, 392–393, 395, 397, 405, 414, 418, 428–429, 436, 444, 447, 455, 488, 497, 505, 508, 529, 534–535, 546, 550, 573–574, 580–582, 584, 591, 601, 607, 609, 611, 615, 626, 634–635, 637, 639, 662–663, 683, 686, 693–694, 705–706, 724, 732, 736, 740, 743, 775, 781, 783–784, 793–795, 797, 799–800, 802–803, 812, 814, 817, 823, 825, 830, 835, 838, and 840).

In 1960, the large numismatic collection of F. Micher was acquired from his estate. This collection included many ancient coins, particularly from the Black Sea region, but it also featured coins from the areas presented in this volume (52 pieces – nos. 13, 68, 73, 93–94, 107, 110, 164, 261, 273, 282, 286, 291, 294, 297, 303, 310, 317, 321, 331, 333, 335, 341, 348, 351–352, 355, 368, 374, 384, 390, 396, 430, 466, 502, 541, 555, 557, 575, 603, 608, 617, 621, 623, 642, 646–647, 665, 687, 695, 746, 829, and 837). In 1977, the museum also received the collection of Š. Floss from his estate. It included ancient coinage, among them pieces from the regions covered in this publication (20 coins – nos. 27, 56, 65, 77, 100, 102, 155, 177, 214, 263, 277, 427, 440, 442, 458, 468, 544, 719, 745, and 818).

As already mentioned, coins from the studied regions were never the subject of targeted collecting effort at the National Museum in Prague. Moreover, the museum has not succeeded in acquiring any modern collection focused on these areas. Only a small number of individual coins – primarily Ptolemaic – were acquired between 2012 and 2024, totalling 16 pieces (nos. 7–8, 10, 20, 25, 29, 128, 172, 190, 193–195, 237–239, and 531).

The vast majority of material presented in this volume of the *Sylloge Nummorum Graecorum* series lacks information on find circumstances, though the provenance is known in a few cases. Three Ptolemaic tetradrachms, purchased in 1932 through F. Zapletal, originate from Bulgaria (nos. 9, 12, and 34). The exact site of discovery is unknown, and it is only a matter of speculation whether all three coins came from a single hoard – however likely it is, it cannot be proven. In any case, this is an interesting indication that Ptolemaic tetradrachms circulated as far as ancient Thrace through trade. In general, Ptolemaic coins are quite rare in the archaeological record of this region.

The provenance is also known for coins from the city of Cyrene (nos. 763–764), as well as for Ptolemaic issues from the mints of Cyrene (nos. 86–89, 166, 168–171, and 219–234) and Berenice (nos. 129–130). This volume presents a total of 29 coins that were discovered in 1981 by workers from the then Czechoslovakia during highway construction near the town of Ajdabiya in Libya, close to the Gulf of Sirte. One of the workers donated the coins to the Department of Numismatics via an intermediary in the year 2004. Only identifiable specimens have been included in this publication, although the donation included many more coins, most of which, however, are entirely unidentifiable. It was reported that large quantities of coins were found at the site, including 'large bronzes', which remained in the possession of several other unnamed finders. It is evident that this was not a hoard; rather, these are likely stray coins uncovered in a disturbed archaeological settlement context. The precise findspot is unknown and cannot be verified today. Nonetheless, we are clearly dealing here with an interesting assemblage from an authentic archaeological context.

COMMENTARY ON THE CATALOGUE

The catalogue is organised in the same way as the previous Prague volumes of the *Sylloge Nummorum Graecorum* series and organised following a uniform, strict structure. Each catalogue entry includes all verifiable data. Detailed bibliographic references reflect the latest research. Particular emphasis is also put on the provenance of the coins, both their earlier collection history and previous publications of specific specimens ('this coin'). Metrological data include weight measured with an accuracy of one thousandth of a gram, horizontal/vertical diameter relative to the obverse, and the die axis (the relative orientation of obverse and reverse). XRF analyses were also conducted on a representative sample of Ptolemaic issues, with further discussion provided in the subsequent text.

The most numerous group within the collection are coins from the **Ptolemaic Empire** (250 pieces). The combination of various collection sources created a relatively representative overview of Ptolemaic coinage, spanning from Ptolemy I to Cleopatra VII. Thus, issues of all Ptolemaic rulers are represented in the collection (with rare exceptions, such as issues struck for Arsinoe II). Bronze denominations prevail while silver coins are only selectively represented, and no silver denominations higher than the tetradrachm are present. Gold coinage is represented by only two specimens (tab. 1). In general, bronze denominations up to Ptolemy VIII are very well represented in the collection, although individual types often recur – this is the result of the random nature in which the collection was assembled. By contrast, bronze issues of the later Ptolemaic rulers from outside Egypt are represented by only a handful of pieces. It is also worth emphasizing that the Prague collection is the first substantial group of Ptolemaic coins to be published since the appearance of the second volume of the Ptolemaic Coins general catalogue (*PCE II*). The entire Prague collection was regularly discussed with the author of that catalogue, Catherine C. Lorber, to whom sincere thanks are due.

In this volume, the coins are consistently classified based on the principal reference literature, especially the new general catalogue (*PCE I*; *PCE II*), which has brought a completely new perspective to Ptolemaic coinage, including the terminology of individual denominations. Following this catalogue, coins are organized geographically by region and mint within the Ptolemaic Empire. As a result, coins from the region of Cyrenaica are listed among the Ptolemaic issues (nos. 86–89, 129–130, 166, 168–171, and 219–234), while the coinage of the city of Cyrene is listed separately as civic issues (nos. 759–769). The catalogue is arranged by ruler and mint, and – unlike in the general catalogue (*PCE I*; *PCE II*) – the bronze issues are integrated into a single continuous catalogue sequence, rather than being placed in a separate, parallel series.

The presented collection also contains a number of rare, interesting, or previously unpublished coins, the gold issues being the most noteworthy among them. At the forefront is an Alexander type stater of Ptolemy I, with the reverse inscription ΑΛΕΞΑΝΔΡΟΥ, probably minted in 322/1 B.C. at the Memphis mint (no. 1). The most exceptional coin in the entire Prague collection is probably a mnaieion (gold octadrachm) of Ptolemy IV, minted from 219 B.C. in Alexandria (no. 90). The obverse carries a magnificently executed portrait of Ptolemy IV, an outstanding example of Ptolemaic portraiture depicting the reigning monarch.

Tab. 1. Overview of Ptolemaic coins represented in the collections of the National Museum, Prague.

	AV	AR	AE	Σ
Ptolemy I (323–282 B.C.)	1	14	4	19
Ptolemy II (283/2–246 B.C.)		5	17	22
Ptolemy III (246–222 B.C.)			48	48
Ptolemy IV (222–204 B.C.)	1	1	28	30
Ptolemy V (204–180 B.C.)			11	11
Ptolemy VI (180–145 B.C.)		7	29	36
Ptolemy VIII (170–116 B.C.)		2	17	19
Small cypriote bronzes (2nd–1st century B.C.)			1	1
Ptolemy IX (117/6–82/1 B.C.) and **Ptolemy X** (114/3–89/8 B.C.)		7	28	35
Ptolemy Apion or **Ptolemy X** (104/1–96 B.C.)			13	13
Ptolemy XII (81/0–59/8, 55–52/1 B.C.)		8		8
Ptolemy of Cyprus (80–58 B.C.)			1	1
Cyprus under Rome? (58–48 B.C.)			3	3
Cleopatra VII (51–30 B.C.)			4	4
	2	44	204	**250**

Among the silver coins, particular mention should be made of tetradrachms of Ptolemy I issued in the early years of his reign in the Alexandria mint, with a standing Athena Promachos on the reverse (nos. 4–7). Another noteworthy group of tetradrachms (also referred to as silver staters) are those of Ptolemy II bearing on the reverse the image of a Galatian shield (nos. 20 and 29) – a reflection of the historical fact that Galatian mercenaries served under this ruler.

Also of interest are tetradrachms of Ptolemy II from the Tyre mint. One of them carries a countermark featuring the head of a Gorgon (no. 34). Given that this coin is a find from Bulgaria, it is plausible that the countermark might belong to the Thracian city of Apollonia Pontica, which used the same motif on its own coinage. The same type of Tyrian tetradrachm is also represented in the collection by a contemporary counterfeit with a bronze core plated with thick silver foil (no. 35). Corrosion of the core (or possibly later drilling) caused the obverse plating to chip away entirely on the obverse, while the reverse remains preserved. This is the only contemporary counterfeit of a silver denomination in the entire collection. Didrachms of Ptolemy VI from the Alexandria mint are relatively rare (nos. 131–132).

As regards bronze denominations, the latest studies (in *PCE I* and *PCE II*) completely redefined them in terms of terminology, typology, and chronology. Several intriguing and previously unpublished issues stand out within the National Museum's collection:

- A dichalkon of Ptolemy I (no. 15) represents a so far uncatalogued variant akin to types such as *CPE I/2* (nos. B46–B48 or B52).
- The relatively rare bronze hemiobols of Ptolemy III featuring his portrait, minted in Corinth, Greece (nos. 77–78).
- An extraordinary Alexandrian drachm of Ptolemy IV weighing 96.326 g and measuring 47 mm in diameter (no. 108) – typically, such coins weigh around 60 g with a diameter not exceeding 42 mm.
- A tetradrachm of Ptolemy IV with an atypical reverse legend ΠΤΟΛΕΜΑΙΟΥ ΣΩΤΗΡΟΣ, minted at an unknown Syrian or Phoenician workshop (no. 119).
- A truly rare bronze 8 drachm/tritartemorion of Ptolemy V (no. 125), likely struck in Karnak or another temple mint stands out for its crude style and less refined flan manufacture.
- Based on XRF analyses, some 10 drachm/obol issues (nos. 135–138) were ascribed to Ptolemy VI, which would otherwise have been misattributed to Ptolemy VIII (nos. 173–182).
- Unpublished variants also include a coin from the 'Small Cypriot bronzes with Aphrodite obverse' group (no. 186), struck at Paphos, Cyprus, in late 2nd–1st century B.C.
- An unknown denomination type, an obol or tritartemorion, is the Aphlaston issue of Ptolemy IX or X, also struck at Paphos (no. 217).
- Worth mentioning is a set of chalkous from Cyrene, minted under Ptolemy Apion or Ptolemy X between 104/1 and 96 B.C. These low value coins were clearly minted in a makeshift manner on flans that were crudely cast in a large series without even trimming the remains of sprues and casting burrs (nos. 222–234).

Overall, the Prague Ptolemaic collection provides a good overview of bronze denominations from Alexandria. On the contrary, late Ptolemaic bronzes from Cyprus are poorly represented – reflecting the traditional collector focus on Egypt over Cyprus. Silver issues form a minority component of the collection, their absence being a logical consequence of the ways the collection came into existence; this statement is further underscored by the fact that only two gold coins are represented.

The most numerous coin group within this volume is Roman provincial coinage minted in **Alexandria,** totalling 506 coins (nos. 251–756; tab. 2). Similarly to the Ptolemaic part of the collection, these coins were assembled in a largely haphazard way, combining several smaller collections. Hence, many types are represented by multiple examples. The National Museum never collected these coins deliberately and – apart from isolated cases (no. 531) – they have not been acquired in recent years either.

These Alexandrian provincial issues vary greatly in the quality of preservation. As already stated, in 2019–2020, attempts were made to acquire the Luboš Král collection – rich in Roman provincial Alexandrian issues – for the National Museum. Combining this intended acquisition with the existing National Museum collections would have created a high quality assemblage of Alexandrian issues. Unfortunately the purchase fell through due to financial limitations, the coins remained in private hands and were published as a separate *Sylloge Nummorum Graecorum* volume in 2021 (*SNG Král*).

Despite this missed opportunity, the National Museum's Alexandrian provincial coin collection remains quite representative. In fact, it provides an elementary insight into currency circulation in Egypt from the times of Emperor Augustus's accession through the decline of provincial minting in Alexandria. The latest Alexandrian issues are those of Diocletian (year 12; 295/296 A.D.), Maximian Herculius (year 11; 295/296 A.D.), and co-emperors Constantius I and Galerus (year 4; 295/296 A.D.). The end of provincial coinage in Alexandria is marked by extremely rare issues of the usurper Domitius Domitianus (year 2; 297/298 A.D.) – though he is absent from the Prague collection (tab. 2).

Tab. 2. Overview of Alexandrian coins represented in the collections of the National Museum, Prague.

	AR 4d.	Bil. 4d.	AE	Σ
Augustus (27 B.C.–14 A.D.)			**1**	1
Tiberius (14–37 A.D.)	**2**			2
Claudius (41–54 A.D.)	**1**		**5**	6
Nero (54–68 A.D.)	**32**	**3**		35
Galba (68–69 A.D.)			**1**	1
Vespasianus (69–79 A.D.)	**1**		**9**	10
Domitianus (81–96 A.D.)			**4**	4
Nerva (96–98 A.D.)	**1**			1
Traianus (98–117 A.D.)	**2**		**3**	5
Hadrianus (117–138 A.D.)	**18**		**34**	52
Hadrianus for: **Sabina** († 136/7 A.D.)			**1**	1
Antoninus Pius (138–161 A.D.)	**5**		**18**	23
Antoninus Pius for: **Faustina II** (138–161 A.D.)	**1**			1
Marcus Aurelius (161–180 A.D.)	**3**		**1**	4
Marcus Aurelius for: **Faustina II** († 175 A.D.)	**1**			1
Marcus Aurelius for: **Lucilla** (161–169 A.D.)			**1**	1
Commodus (180–192 A.D.)		**6**		6
Elagabalus (218–222 A.D.)		**2**		2
Alexander Severus (222–235 A.D.)	**1**	**9**		10
A. Severus for: **Julia Mamaea** (222–235 A.D.)		**1**		1
Maximinus I (235–238 A.D.)		**2**		2
Gordianus I (238 A.D.)		**2**		2
Gordianus III. (238–244 A.D.)		**3**		3
Gordianus III for: **Tranquillina** (238–244 A.D.)		**1**		1

Philippus I (244–249 A.D.)	**7**	7
Philippus I for: **Otacilia Severa** (244–249 A.D.)	**1**	1
Philippus I for: **Philippus II** (244–247 A.D.)	**2**	2
Trebonianus Gallus (251–253 A.D.)	**3**	3
Valerianus I (253–260 A.D.)	**10**	10
Gallienus (253–268 A.D.)	**24**	24
Gallienus for: **Salonina** (254–268 A.D.)	**15**	15
Gallienus for: **Saloninus** (258–260 A.D.)	**1**	1
Claudius II Gothicus (268–270 A.D.)	**51**	51
Quintillus (270 A.D.)	**1**	1
Aurelianus (270–275 A.D.)	**27**	27
Aurelianus for: **Severina** (274–275 A.D.)	**5**	5
Tacitus (275–276 A.D.)	**3**	3
Probus (276–282 A.D.)	**47**	47
Carus for: **Carinus** (282–283 A.D.)	**5**	5
Carinus (283–285 A.D.)	**8**	8
Carinus for: **Divus Carus** (282–283 A.D.)	**1**	1
Carus for: **Numerianus** (282–283 A.D.)	**1**	1
Numerianus (283–284 A.D.)	**2**	2
Diocletianus (284–305 A.D.)	**64**	64
Maximianus Herculius (286–305 A.D.)	**48**	48
Constantius I, as Caesar (293–305 A.D.)	**3**	3
Galerius, as Caesar (293–305 A.D.)	**2**	2
		506

Compared to other parts of the Roman Empire, the production of Roman provincial coins was exceptionally large in Alexandria. These coins were intended for local circulation throughout Egypt. The high volume of coin production in Roman Alexandria is also reflected in the abundant numismatic literature on the subject. Many collection catalogues have been published – for example, those for London (*BMC 16*), the private Dattari collection (*Dattari 1901*), Oxford (*Milne 1971*), Copenhagen (*SNG Copenhagen 41*), Cologne (*Geissen 1974; 1978; 1982; Geissen – Weiser 1983*), Frankfurt (*Förschner 1987*), Milan (*SNG Milano 13/2; 13/3*), Kraków (*Skowronek 1998*), Zagreb (*SNG Zagreb 8*), and the aforementioned private Král collection (*SNG Král*). This list is not exhaustive; it includes only the works used as reference sources in this *SNG*. This volume of the *SNG* series continues the tradition of such catalogues.

When it comes to documenting and reconstructing the monetary history of Roman Egypt, the most important resource today is the *Roman Provincial Coinage* (*RPC*) series. Six volumes have been published in print (Volumes I, II, III, IV/4, VII/2, IX), all of which are also available online, four volumes are exclusively accessible online (*RPC 4/4 online*, *RPC 6 online*, *RPC 8 online*, *RPC 10 online*). These online volumes use only provisional numbering as they are continually updated; the references in the National Museum catalogue correspond to their state as of August 2025 (rpc.ashmus.ox.ac.uk). All *RPC* volumes, whether printed or online, offer immense comparative datasets for each coin type. This allows precise identification and comparison even for specimens from print-only catalogues without photographs such as London (*BMC 16*), Dattari (*Dattari 1901*), or Oxford (*Milne 1971*).

Each coin from the National Museum's collection – like those from the Král collection (*SNG Král*) – has been identified as precisely as possible. For this reason, each coin is accompanied by numerous references listed in chronological order. Whenever possible the closest possible parallels were searched for the head or bust as well as for the precise wording of the legend.

The Prague collection distinctly shows the monetary system's evolution beginning in the 1st century A.D. Silver tetradrachms gradually, though nonlinearly, lost their weight and especially their silver content. From the reign of Commodus (180–192 A.D.), these coins can be classified as billon, i.e. with silver making up the minority of the alloy. Under the military emperors (235–284 A.D.), the proportion of silver in the alloy becomes negligible. A few tetradrachms of em-

perors Philippus I, Gallienus, Claudius II, and Aurelian (nos. 430, 464, 494, 518, 533, 548, 551, and 558) retain traces of silver plating locally on the surface. The latest Alexandrian tetradrachms issued by Diocletian, Maximian Herculius, Constantius I, and Galerius are in fact bronze, with weights typically between 6 and 8 grams. No XRF compositional analyses were conducted on Alexandrian provincial tetradrachms.

In the 1st and 2nd centuries A.D., Alexandria's monetary system included both tetradrachms and bronze denominations. The production of bronze coins ended by the early 3rd century when production shifted to tetradrachms only. The latest bronze coins in the Prague collection date to the reign of Marcus Aurelius (nos. 396 and 398). This development illustrates well the transition from a multi-denominational system of tetradrachms and several bronze denominations to a single-denominational one in the 3rd century.

The bronze coins – particularly the drachms, typically 33–35 mm in diameter – are noteworthy from an artistic point of view because their large surface provided generous space for artistic expression. Alexandrian coins are characterised by a distinctive artistic style, which makes them easily recognizable. Another hallmark of provincial coins from Alexandria is that they are almost always dated to a specific year of a ruler's reign, either in words or more commonly in numerals – allowing for excellent chronological classification.

The Prague collection makes it to some extent possible to track the changing intensity of coin minting over time. It is particularly clear in the period between the reigns of Augustus and Caligula, again under Marcus Aurelius, and particularly under Septimius Severus and Caracalla, when the documented types show a noticeable drop in production. The core of the collection (352 pieces; 69 %) comprises 3rd-century issues – from Elagabalus through the first tetrarchy.

While most provincial coins in this collection are well-documented in typological literature, there are a few previously undescribed coin variants:

- A diobol of Domitian, dated to the 11th year of his reign (91/2 A.D.), corresponds to *RPC 2*, as no. 2621, but unprecedentedly lacks the reverse inscription (no. 308).
- A dichalkon of Trajan, dated to 109/10 A.D. of the type *RPC 3*, no. 4493, carries the year of reign on the reverse in a different location (no. 312).
- A drachm of Antoninus Pius, dated to the 20th year of his reign (156/7 A.D.), carries on the reverse an eagle standing frontally facing right – this coin type is completely unknown (no. 387).
- A drachm of Marcus Aurelius (no. 396), dated to the 11th year of his reign (170/1 A.D.), confirms the reading of the reign year as L IA (170/1 A.D.), which was previously uncertain (*RPC 4/4*, 454, no. 3167, pl. 237:3167).

Bronze coinage of the **Egyptian nomes** is minimally represented – the only present coins are those of Hadrian from the nomes of Arsinoite (no. 757) and Pelusion (no. 758). Their limited representation in the collection reflects their low production and consequent extreme rarity in the collectors' world.

Furthermore, this volume of the *SNG* presents coins from other regions of **North Africa**, although their representation is far less complete. There are ten civic issues of the city of **Cyrene** (nos. 759–769) including one archaic hemidrachm (no. 759), a gold 1/10stater from the period of the Ptolemaic governor Ophellas (c. 322–313 B.C.; no. 760), and two bronze issues from the time of the Ptolemaic governor Magas (c. 282–261 B.C.; nos. 761–762). Two bronze coins, dated to the mid-3rd century B.C. (nos. 763–764), come from a find in Ajdabiya, Libya mentioned above. Additionally, there are five Roman provincial coins of Cyrene (nos. 765–769). The representation of the Cyrene coinage in the National Museum's collection is clearly both haphazard and marginal.

Coins of the city-state of **Carthago** are better represented in the collection, totalling 59 specimens (nos. 770–828). However, this group is also the result of random accumulation, as Carthaginian coins have never been systematically collected in Prague. Concerning this part of the Prague collection, special thanks are due to Paolo Visonà, who provided a number of insightful comments on the current identifications and dating of these coins. In fact, Carthaginian coinage presents numerous challenges. In particular, the vast majority of the coins are anepigraphic. In spite of numerous studies published on the issue (most recently *CMP*), a comprehensive synthesis of the entire Carthaginian coinage system is still lacking. There are notably many uncertainties concerning mints, especially those outside the city of Carthago itself, such as on Sicily, Sardinia, in Italy, and on the Iberian Peninsula. It is still not entirely clear which coins were struck directly by the city of Carthago and which are related to broader Carthaginian colonization across the Mediterranean. These issues, of course, lie beyond the scope and intent of this *SNG* volume.

The catalogue of the Carthaginian coins in this volume is arranged chronologically, rather than by mints. For clarity, the coins are also presented in a tabular overview (tab. 3), which further illustrates the complexity of classifying Carthaginian coinage.

Tab. 3. Overview of Carthaginian coins in the collections of the National Museum, Prague.

Mint	Denomination	Dating	Pc (no.)
Carthago	AV, 1/5stater	c. 350–320 B.C.	**1** (770)
Carthago	AV, 1/10stater	c. 350–320 B.C.	**1** (771)
Sicily	AR, tetradrachm	c. 350–320 B.C.	**1** (772)
Sicily	AE (19 mm)	c. 340–320 B.C.	**1** (773)
Sicily	AE (19 mm)	c. 340–320 B.C.	**1** (774)
Sicily	AR, tetradrachm	c. 320–300 B.C.	**1** (775)
Carthago	El stater	c. 310–270 B.C.	**2** (776–777)
Sicily	AE (16 mm)	c. 310–280 B.C.	**10** (778–787)
Sicily	AR, tetradrachm	c. 300–280 B.C.	**2** (788–789)
Sicily and/or Carthago	AE (18–20 mm)	c. 300–264 B.C.	**3** (790–792)
Sardinia	AE (18–20 mm)	c. 300–264 B.C.	**10** (793–802)
Sardinia	AE (28 mm)	c. 264–241 B.C.	**1** (803)
Sardinia	AE (23 mm)	c. 264–241 B.C.	**1** (804)
Sardinia	AE (17 mm)	c. 264–241 B.C.	**1** (805)
Carthago	AR 3/4shekel	c. 260–256 B.C.	**1** (806)
Carthago	Bil., shekel	c. 255–241 B.C.	**1** (807)
Afrika – Revolt of the Libyans	AR shekel	c. 241–238 B.C.	**1** (808)
Carthago	Bil. 2shekel	c. 238–230 B.C.	**1** (809)
Carthago	AE (30 mm)	c. 230–220 B.C.	**1** (810)
Iberia	AE (18–20 mm)	c. 221–218 B.C.	**1** (811)
Carthago Nova (?)	AR, shekel	c. 218–206 B.C.	**1** (812)
Italian Peninsula	AR, 1/2shekel	c. 215–205 B.C.	**2** (813–814)
Italia	AE (21 mm)	c. 215–205 B.C.	**1** (815)
Akragas (?)	AR, 1/2shekel	c. 213–210 B.C.	**1** (816)
Bruttium (?) – Hannibalic occ.	AE (25 mm)	c. 215–203 B.C.	**1** (817)
Bruttium (?) – Hannibalic occ.	AE (20 mm)	c. 215–203 B.C.	**1** (818)
Carthago	AE (24 mm)	c. 215–205 B.C.	**1** (819)
Carthago	AR, 1/2shekel	c. 215–205 B.C.	**3** (820–822)
Carthago	Bil., 1 1/2shekel	c. 205–195 B.C.	**2** (823–824)
Carthago	AE (28 mm)	c. 195–175 B.C.	**3** (825–827)
Utica (?)	AE (27 mm)	c. 175–150 B.C.	**1** (828)

The collection of the National Museum provides a basic overview of Carthaginian coinage from the mid-4th century B.C. to the second half of the 2nd century B.C. It is a mixed batch of various territorial mints, including the city of Carthago as well as various unidentified mints in Sicily, Sardinia, Italy, and Hispania. There are two gold denominations (nos. 770–771), two electrum staters (nos. 776–777), thirteen silver issues (nos. 772, 775, 788–789, 806, 808, 812–814, 816, and 820–822), and three billon coins (nos. 807 and 823–824), with the remainder being bronze denominations. Four coins are tetradrachms minted in Sicily in a beautiful Greek style (nos. 772, 775, and 788–789). Most Carthaginian coins are anepigraphic, but some bear Punic inscriptions or letters of unclear meaning – these are also present on coins from the Prague collection (nos. 775, 788, 789, 799, 800, 801, 802, 805, 808, 811, 813, 814, 816, 826, 827, and 828).

The regions of **Numidia** and **Mauretania** are represented by royal issues (nos. 829–841). Most numerous among them are the bronze denominations of Massinissa (200–148 B.C.) or Micipsa (148–118 B.C.), issued in the Cirta mint and represented in several variants. Eight bronzes with a diameter of 26 mm are represented (nos. 829–836) and one significantly less common bronze with a diameter of 14 mm (no. 837). King Juba I (60–46 B.C.) is represented in the col-

lection by two denarii (nos. 838–839) from an unknown mint. These coins carry Latin inscriptions on the obverse and Punic inscriptions on the reverse. King Juba II (25 B.C.–24 A.D.) is represented by two denarii with Latin legends minted in Caesarea (nos. 840–841). Interestingly, none of these denarii are catalogued at the die level in the most recent reference work (*Spoerri Butcher 2015*).

The final group of coins in this volume of *SNG* are issues of the island of **Cossura**, today Pantelleria (nos. 842–846). Two types of bronze coins are represented featuring a bust of Isis in the Egyptian style on the obverse. The first type, dating to the turn of the 3rd and 2nd centuries B.C., bears a Punic legend on the reverse (nos. 842–843). The second type is dated to the late 1st century B.C., with the Latin inscription COSSVRA on the reverse and an additional negative countermark REG on the obverse (nos. 844–846).

COMMENTARY ON THE XRF ANALYSES

Jiří Kmošek – Petr Veselý

INTRODUCTION

As is standard for the catalogues of the ancient coin collection of the National Museum, a basic archaeometallurgical survey was carried out for the selected set of coins in the form of X-ray fluorescence analysis (XRF). The methodology used for this analysis is described below. The set of coins analysed was compiled with regard to the representativeness of individual regions and time periods. At the same time, the degree of preservation of the coins was taken into account and all coins heavily affected by corrosion were excluded a priori by visual inspection. For coins that were subsequently identified during careful laboratory examination as having a degree of corrosion that seriously affected the reliability of the measurements, their measured element concentration values were completely or partially excluded from the statistical analysis, as described below. Given the limited scope of this Ptolemaic collection, the resulting analysed set understandably does not represent a representative cross-section of the entire rich Ptolemaic coinage. The results and observations presented below should therefore be treated with some caution.

The attribution of coins to individual rulers and mints in this catalogue is strictly guided by the monographs *CPE I/1–2* and *CPE II/1–3*, which in some cases postulate other than the traditional attribution used so far. It is therefore necessary to emphasize that when comparing the element concentrations reported here with values in earlier works, it is necessary to take into account the potential reattribution of some coins.

EXPERIMENTAL

The surfaces of metallic coins were analysed by the portable X-ray fluorescence (pXRF) spectrometer Bruker S1 Titan 600 (Bruker, USA). The parameters of the X-ray fluorescence analysis were as follows: voltage 40 kV; current 15μA; counting interval 120 s; graphene window silicon drift detector; Rh target X-ray tube and 3 mm collimator. Each of the coins were analysed from both sides. The obtained spectra were evaluated using the Bruker Artax software. The quantification was made using the internal methods (metal alloys, precise metals), calibrated on the basis of reference samples of historical copper alloys and copper alloy standards. The following elements were quantified: silver (Ag), gold (Au), copper (Cu), lead (Pb), tin (Sn), arsenic (As), iron (Fe), cobalt (Co), nickel (Ni), antimony (Sb), zinc (Zn) and bismuth (Bi). In addition, mercury (Hg) was detected on both the obverse and reverse of two silver coins.[1] The results of the chemical composition analysis given in weight % are listed in the tabular overview (tab. 6) and are listed in the description of individual coins in the catalog. Based on the degree of corrosion deterioration, individual coins made of copper and silver alloys were assigned into four general categories – NC (no corrosion layer present), SC (surface corrosion layer present), CC (complete mineralization) and SC/CC (surface corrosion layer present/complete mineralization), which are listed for individual coins in the tabular overview (tab. 6).

In order to objectively assess the accuracy of the analyses performed a set of independent measurements of relevant copper and silver alloy reference materials was carried out. For this purpose, the reference materials of bronze 32X SN7 (batch B), gun metal 33X GM21 (batch B), envirobrass 32X SEB5 (batch C), silver quaternary alloys 133X AGQ1 (batch C), 133X AGQ2 (batch C) and 133X AGQ3 (batch C) from MBH® Analytical Ltd company were used. The reference materi-

1 These are silver staters of Ptolemy I and XII, nos. 14 and 236, with the concentration of mercury in these coins not having been quantified. Mercury was also detected in some silver coins of Ptolemy I and III and its presence was interpreted as surface contamination (*Kantarelou et al. 2011*).

als were analysed by the portable X-Ray fluorescence analyser Bruker S1 Titan 600 under the same conditions as the archaeological samples. Each of these reference materials was measured in a total of three separate series of five measurements each. For each of the analysed elements of the individual reference materials, the measurements average values, standard deviations, errors and Z scores were calculated and are presented in the tabular overview (tab. 4). In the case of determined concentrations of most of the relevant elements, the measurement error values are less than 10 % but usually range below 5 %. Measurement error values of up to 10 % can be considered satisfactory, taking into account the type of analytical method used and its instrumentation. Higher error values, usually above 10 %, occur for elements such as lead, iron, nickel, arsenic, cobalt and bismuth, contained in concentrations mostly lower than 0.5 wt. %.

Table 4. Analysis of reference standards using pXRF analysis and statistical evaluation of obtained results.

Element	RM	Concetration RM (wt. %)	Incertainty RM	Concetration pXRF (wt. %)	SD	Error	Z score
Cu	32X_SN7	81.210	0.060	81.01	0.139	0.2%	-1.4
	33X_GM21	78.860	0.110	80.56	0.266	2.2%	6.4
	32X_SEB5	87.210	0.100	87.38	0.066	0.2%	2.6
	133X_AGQ1	2.532	0.016	2.86	0.142	13.1%	2.3
	133X_AGQ2	5.808	0.072	6.25	0.110	7.7%	4.1
	133X_AGQ3	9.612	0.111	10.55	0.114	9.8%	8.2
Sn	32X_SN7	12.450	0.100	13.01	0.081	4.5%	6.9
	33X_GM21	4.500	0.060	4.48	0.031	0.4%	-0.6
	32X_SEB5	5.180	0.040	5.41	0.046	4.5%	5.0
Pb	32X_SN7	2.310	0.030	2.58	0.072	11.6%	3.7
	33X_GM21	7.530	0.120	6.84	0.277	9.2%	-2.5
	32X_SEB5	0.268	0.007	0.47	0.013	73.6%	15.4
	133X_AGQ1	0.245	0.002	0.33	0.022	35.3%	3.9
	133X_AGQ2	0.469	0.007	0.60	0.022	27.0%	5.7
	133X_AGQ3	0.921	0.018	1.27	0.237	38.3%	1.5
Zn	32X_SN7	1.140	0.030	1.04	0.020	8.6%	-5.0
	33X_GM21	4.960	0.040	4.65	0.027	6.2%	-11.5
	32X_SEB5	5.300	0.040	5.40	0.015	1.8%	6.3
Fe	32X_SN7	0.036	0.002	0.09	0.007	142.0%	7.3
	33X_GM21	0.693	0.013	0.61	0.020	12.0%	-4.2
	32X_SEB5	0.043	0.001	0.08	0.001	91.0%	39.1
Ni	32X_SN7	0.276	0.008	0.24	0.012	13.8%	-3.2
	33X_GM21	0.197	0.004	0.16	0.008	19.0%	-4.7
	32X_SEB5	0.317	0.002	0.32	0.010	2.5%	0.8
As	32X_SN7	1.130	0.020	0.97	0.011	14.2%	-14.0
	33X_GM21	0.333	0.004	0.31	0.026	5.6%	-0.7
	32X_SEB5						
Co	32X_SN7	0.339	0.003	0.22	0.004	36.4%	-27.7
	33X_GM21			0.09	0.003		31.5
	32X_SEB5	0.016	0.001	0.02	0.004	2.6%	0.1
Bi	32X_SN7	0.198	0.004	0.19	0.009	4.4%	-0.9
	33X_GM21	0.459	0.007	0.36	0.012	20.8%	-8.2
	32X_SEB5	1.056	0.016	0.85	0.016	19.3%	-12.9

Sb	32X_SN7	0.235	0.005	0.22	0.025	6.6%	-0.6
	33X_GM21	1.033	0.016	1.09	0.034	5.4%	1.7
	32X_SEB5	0.033	0.001				
Ag	32X_SN7	0.328	0.006	0.33	0.011	0.6%	0.2
	33X_GM21	0.701	0.011	0.68	0.012	3.6%	-2.0
	32X_SEB5						
	133X_AGQ1	bulk		96.54	0.157		
	133X_AGQ2	bulk		92.11	0.138		
	133X_AGQ3	bulk		86.14	0.137		
Au	133X_AGQ1	0.251	0.003	0.27	0.006	5.7%	2.5
	133X_AGQ2	0.978	0.003	1.03	0.008	5.8%	7.2
	133X_AGQ3	1.975	0.020	2.03	0.213	3.0%	0.3

ANALYSIS

XRF measurements were performed on a total of 180 coins, including two gold coins, 43 silver coins, one silver-plated bronze coin and 134 bronze coins. Of these 180 coins, ten bronze coins were not included in the analysis due to their extensive surface and core corrosion on both the obverse and the reverse.[2] An overview of the number of coins measured, excluded and analysed is given in the tabular overview (tab. 5).

Tab. 5. Overview of coins with XRF measurements.

	Total	Excluded	Analysed
AV	2		**2**
AR	43		**43**
AR/AE	1		**1**
AE	134	10	**124**
Total	**180**	**10**	**170**

Two measurements of the twelve analysed elements were performed for each coin, one on the obverse and one on the reverse. Values below the 0.025 % detection tolerance limit were considered zero. For each of the 170 coins included in the analysis, each element was assigned an average value of its two measurements, but if one side of the coin was affected by both surface and core corrosion, then only the value from the unaffected side of the coin was taken into account.[3] In addition, if the measurement result on one side of the coin was zero or below the detection tolerance limit and the other side showed signs of surface corrosion, the presence of that element was considered zero. The only exception to this procedure is the plated coin of Ptolemy II, no. 35, for which the values for the obverse and reverse were taken separately, as its obverse consists of an exposed copper core while the reverse is still covered with silver foil.

The adjusted values are shown in the tabular overview (tab. 6), where the names of mints are abbreviated for brevity. With the exception of gold coins, element concentrations below 10 % are rounded to two decimal places, while concentrations of 10 % and above are rounded to one decimal place (however, the statistical quantities given in the following tables are always calculated from unrounded values). Note that the row sums of the concentration of the analysed elements are not always equal to 100 %. This is due to the possible presence of other elements and measurement errors.

2 Nos. 17, 19, 23, 42, 68, 92, 170, 219, 221 and 250.

3 Ten bronze coins had one side affected in this way (nos. 32, 43, 54, 69, 78, 93, 145, 146, 181 and 220).

Tab. 6. Elemental concentrations of analysed coins (wt. %).

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
1	Ptolemy I	AV	Memphis	NC	8.607	0.16	99.79	<0.05								0.05	
2	Ptolemy I	AR	Memphis (and Alexandria?)	SC	17.205	99.4	0.16	0.15	0.29								
3	Ptolemy I	AR	Memphis (and Alexandria?)	SC	17.018	99.4	0.10	0.10	0.39								
4	Ptolemy I	AR	Alexandria	SC	15.682	98.5	0.24	0.20	0.96								
5	Ptolemy I	AR	Alexandria	SC	15.698	98.5	0.68	0.09	0.63								
6	Ptolemy I	AR	Uncertain mint 3	SC	15.688	99.5	0.30	0.13	0.10								
7	Ptolemy I	AR	Alexandria	SC	14.230	99.2	0.37	0.10	0.25								
8	Ptolemy I	AR	Alexandria	NC	14.187	99.0	0.41	0.19	0.45								
9	Ptolemy I	AR	Alexandria	SC	13.934	99.2	0.45	0.09	0.27								
10	Ptolemy I	AR	Alexandria	NC	14.166	99.3	0.38	0.12	0.25								
11	Ptolemy I	AR	Alexandria	SC	13.944	98.7	0.48	0.12	0.38								
12	Ptolemy I	AR	Alexandria	SC	13.912	98.4	0.46	0.11	0.48								
13	Ptolemy I	AR	Alexandria	NC	13.466	98.8	0.69	0.11	0.36								
14	Ptolemy I	AR	Alexandria	SC	13.454	99.2	0.53	0.12	0.16								
16	Ptolemy I	AE	Alexandria	SC	10.025			92.0	1.85	5.31	0.25	0.19		0.06			
18	Ptolemy I	AR	Uncertain mint 9	SC	13.530	99.2	0.70	0.09	0.07								
20	Ptolemy II	AR	Uncertain mint 9	NC	14.066	99.1	0.56	0.09	0.27								
21	Ptolemy II	AE	Uncertain mint 9	SC	13.041			80.7	9.06	8.50	0.63	0.17	0.06	0.05	0.08		0.05
22	Ptolemy II	AE	Uncertain mint 9	SC	15.247			78.4	8.94	11.46	0.49	0.06					0.04
24	Ptolemy II	AE	Uncertain mint 9	SC	5.444	0.04		81.4	3.66	13.22	0.57	0.27	0.08	0.07	0.07		
26	Ptolemy II	AE	Uncertain mint 9	SC	4.893			79.8	2.81	15.82	0.53			0.05			
28	Ptolemy II	AE	Uncertain mint 9	SC	4.134	0.04		81.7	0.49	15.99	0.52	0.33	0.15	0.12			
29	Ptolemy II	AR	Uncertain mint 10	NC	13.369	98.8	1.04	0.14	0.05								
31	Ptolemy II	AE	Uncertain mint 26	SC	19.792	0.05		82.5	7.75	8.56	0.31	0.47		0.03			
32	Ptolemy II	AE	Uncertain mint 26	SC	10.163			84.3	4.29	10.66	0.25	0.05	0.06	0.05			
34	Ptolemy II	AR	Tyre	SC	13.700	98.6	0.64	0.15	0.65								
35	Ptolemy II	AR/ AE	Uncertain, unofficial	SC	10.373	0.22		96.4	2.16	0.63	0.15	0.11		0.05	0.08	0.04	
						98.6	0.51	0.67	0.18								
36	Ptolemy II	AR	Tyre	NC	14.041	98.2	0.53	0.27	0.97								
37	Ptolemy II	AE	Sicily, uncertain mint	SC	17.642	0.05		88.1	0.57	9.72	0.60	0.12	0.06	0.06	0.13		

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
39	Ptolemy II	AE	Sicily, uncertain mint	SC	17.304			93.1	0.10	5.86	0.30	0.11	0.06	0.08			
43	Ptolemy III	AE	Alexandria	SC	8.507	0.08		71.9	1.79	23.80	0.84	0.44	0.13	0.04	0.13		
44	Ptolemy III	AE	Alexandria	SC	6.962			74.1	0.71	21.76	0.38	0.38	0.29		0.09	0.13	
45	Ptolemy III	AE	Alexandria	SC	92.847			79.8	2.51	16.43	0.34	0.22	0.14	0.08		0.08	
46	Ptolemy III	AE	Alexandria	SC	47.502			85.2	4.09	9.52	0.32	0.28	0.11	0.07			
47	Ptolemy III	AE	Alexandria	SC	44.314			86.3	1.37	10.96	0.30	0.44	0.11	0.07			
48	Ptolemy III	AE	Alexandria	SC	43.857			83.9	2.60	12.11	0.43	0.17	0.12	0.08	0.08	0.06	
50	Ptolemy III	AE	Alexandria	SC	39.816	0.06		77.0	1.92	19.51	0.43	0.26	0.16	0.09			
52	Ptolemy III	AE	Alexandria	SC	48.178			84.5	4.39	9.73	0.37	0.30	0.10	0.08			
53	Ptolemy III	AE	Alexandria	SC	46.555			78.4	6.02	13.81	0.63	0.16	0.12	0.08	0.08		
54	Ptolemy III	AE	Alexandria	SC	45.921			76.2	9.51	13.36	0.34	0.12	0.06				
55	Ptolemy III	AE	Alexandria	SC	44.261			79.4	4.42	14.51	0.53	0.24	0.10	0.05			
56	Ptolemy III	AE	Alexandria	SC	43.941			72.9	6.67	18.36	0.71	0.32	0.09	0.04			
57	Ptolemy III	AE	Alexandria	SC	43.158			73.7	15.2	9.19	0.73	0.22	0.09	0.05			
58	Ptolemy III	AE	Alexandria	SC	41.028			76.1	6.93	15.25	0.57	0.32	0.15	0.08			
59	Ptolemy III	AE	Alexandria	SC	40.381			75.6	6.48	16.28	0.58	0.24	0.09	0.04	0.08		
61	Ptolemy III	AE	Alexandria	SC	13.846			70.3	7.26	20.18	0.78	0.27	0.17	0.05	0.14		
62	Ptolemy III	AE	Alexandria	SC	13.413			80.6	5.76	12.27	0.45	0.19	0.07	0.05	0.11		
63	Ptolemy III	AE	Alexandria	SC	13.251			75.3	10.5	12.51	0.59	0.16	0.10	0.07			0.04
64	Ptolemy III	AE	Alexandria	SC	86.745			80.2	1.56	16.86	0.24	0.41	0.16	0.07		0.26	
65	Ptolemy III	AE	Alexandria	SC	16.799			80.8	6.71	11.05	0.35	0.34	0.10	0.07			
67	Ptolemy III	AE	Alexandria	SC	68.772			75.1	2.18	21.62	0.37	0.11	0.11	0.05			
69	Ptolemy III	AE	Alexandria	SC	36.428			64.3	6.61	26.81	0.70	0.39	0.28	0.11	0.08		
71	Ptolemy III	AE	Alexandria	SC	33.059			73.3	1.20	24.10	0.41	0.26	0.15	0.06	0.09		
72	Ptolemy III	AE	Alexandria	SC	32.806			67.4	5.76	25.18	0.51	0.36	0.14	0.07			
73	Ptolemy III	AE	Alexandria	SC	32.126			68.0	5.84	24.27	0.56	0.48	0.20	0.05			
74	Ptolemy III	AE	Alexandria	SC	22.133			71.9	0.86	25.74	0.40	0.28	0.19	0.09			
75	Ptolemy III	AE	Alexandria	SC	20.207			70.4	2.43	25.87	0.43	0.23	0.10	0.03			
76	Ptolemy III	AE	Alexandria	SC	9.235			70.1	3.13	25.41	0.52	0.16	0.06				
77	Ptolemy III	AE	Corinth	SC	5.725			85.0	3.16	11.02	0.13	0.36	0.06	0.05			
78	Ptolemy III	AE	Corinth	SC	5.534	0.10		80.9	2.43	15.39	0.40	0.14	0.11	0.06			
79	Ptolemy III	AE	Paphos	SC	14.513	0.08		85.6	1.35	11.91	0.30	0.09	0.08	0.08		0.11	
82	Ptolemy III	AE	Tyre	SC	10.947			72.4	7.42	18.34	0.73	0.22	0.10	0.04			
83	Ptolemy III	AE	Tyre	SC	5.368			82.1	0.67	15.93	0.29	0.38	0.10	0.05			
85	Ptolemy III	AE	Ioppe	SC	2.316			66.5	3.43	15.83	0.57	12.80	0.25				
86	Ptolemy III	AE	Cyrene	SC	1.206			65.6	10.5	21.50	0.81	0.28			0.10		
89	Ptolemy III	AE	Cyrene	SC	3.914			80.6	0.66	17.81	0.26	0.17	0.12	0.06			
90	Ptolemy IV	AV	Alexandria	NC	27.830	0.11	99.77	0.08								0.12	
91	Ptolemy IV	AE	Alexandria	SC	74.607			73.8	13.3	11.04	0.67	0.31	0.65	0.04			
93	Ptolemy IV	AE	Alexandria	SC	67.132			76.4	11.5	11.24	0.14	0.25	0.10	0.05			0.05

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
94	Ptolemy IV	AE	Alexandria	SC	67.070	0.04		69.6	5.42	21.88	0.53	1.56	0.23	0.10			
95	Ptolemy IV	AE	Alexandria	SC	37.181			83.3	0.35	15.36	0.22	0.24	0.13	0.08			
96	Ptolemy IV	AE	Alexandria	SC	36.287			81.1	0.88	16.92	0.30	0.20	0.11	0.08		0.06	
97	Ptolemy IV	AE	Alexandria	SC	34.590			82.9	2.76	13.09	0.29	0.26	0.16	0.08			
98	Ptolemy IV	AE	Alexandria	SC	30.605			82.1	5.48	11.33	0.28	0.22	0.17	0.06			
99	Ptolemy IV	AE	Alexandria	SC	72.600			64.6	17.9	15.98	0.43	0.39	0.19				
100	Ptolemy IV	AE	Alexandria	SC	64.474			76.0	8.75	13.97	0.29	0.47	0.14				
101	Ptolemy IV	AE	Alexandria	SC	63.155	0.05		70.3	8.28	19.21	0.47	0.88	0.17				
102	Ptolemy IV	AE	Alexandria	SC	35.403			68.3	13.7	15.53	0.84	0.29	0.25				
103	Ptolemy IV	AE	Alexandria	SC	31.305	0.04		79.9	5.79	12.80	0.36	0.35	0.18	0.10			
104	Ptolemy IV	AE	Alexandria	SC	69.134			56.3	30.4	10.39	1.26	0.19	0.08				
105	Ptolemy IV	AE	Alexandria	SC	67.956			58.5	30.6	7.30	1.55	0.24	0.05	0.04			0.10
106	Ptolemy IV	AE	Alexandria	SC	62.592			67.6	7.80	22.60	0.67	0.41	0.04	0.05			
107	Ptolemy IV	AE	Alexandria	SC	19.717	2.73		70.8	4.70	18.16	0.44	0.53	0.11		0.08	1.90	
109	Ptolemy IV	AE	Alexandria	SC	67.210			67.8	21.2	9.42	0.52	0.19	0.08	0.06			0.09
110	Ptolemy IV	AE	Alexandria	SC	65.425			56.2	29.8	10.34	1.52	0.26	0.07	0.05			
111	Ptolemy IV	AE	Alexandria	SC	62.350			63.1	2.94	29.15	0.75	2.64	0.39	0.16		0.07	
112	Ptolemy IV	AE	Alexandria	SC	41.004			78.1	0.90	18.97	0.36	0.84	0.23	0.04			
114	Ptolemy IV	AE	Alexandria	SC	37.110			80.5	2.30	15.35	0.15	0.65	0.42	0.08			
115	Ptolemy IV	AE	Alexandria	SC	36.793			84.0	2.84	11.56	0.09	0.73	0.45	0.09		0.05	
116	Ptolemy IV	AE	Alexandria	SC	35.399			84.7	0.21	13.75	0.28	0.35	0.19	0.10			
117	Ptolemy IV	AE	Alexandria	SC	22.124			81.9	0.71	15.41	0.49	0.65	0.16	0.25			
118	Ptolemy IV	AE	Alexandria	SC	42.811			92.4	0.46	5.75	0.16	0.72	0.24	0.08			
119	Ptolemy IV	AR	Uncertain mint 42	NC	13.756	98.3	0.79	0.34	0.56								
120	Ptolemy V	AE	Alexandria	SC	40.466			85.0	3.71	9.65		0.71	0.13	0.12			
121	Ptolemy V	AE	Alexandria	SC	8.238			54.9	31.5	11.46		0.28	0.10				
122	Ptolemy V	AE	Alexandria	SC	29.782			82.0	4.78	11.59	0.56	0.17	0.15	0.09			
124	Ptolemy V	AE	Alexandria	SC	9.388			83.6	0.78	13.55	0.22	0.61	0.73	0.12			
125	Ptolemy V	AE	Upper Egypt	SC	32.735			72.7	2.82	22.87	0.38	0.45	0.21	0.12			
126	Ptolemy V	AE	Paphos	SC	16.885			83.2	8.76	7.25	0.28	0.10					
127	Ptolemy V	AE	Paphos	SC	33.645			75.6	13.5	9.50	0.55	0.13					
130	Ptolemy V	AE	Berenice	SC	2.919			83.3	6.55	7.79	0.32	0.30	0.14	0.08			
131	Ptolemy VI	AR	Alexandria	NC	13.669	98.3	0.79	0.33	0.53								
132	Ptolemy VI	AR	Alexandria	NC	12.881	97.7	2.25	0.08									
133	Ptolemy VI	AR	Alexandria	NC	7.036	95.7	0.56	0.23	2.91								0.32
134	Ptolemy VI	AR	Alexandria	NC	6.832	97.3	0.44	0.10	2.07								
135	Ptolemy VI	AE	Alexandria	SC	23.094			89.8	0.11	8.90	0.14	0.40	0.30	0.09			
136	Ptolemy VI	AE	Alexandria	SC	19.427			92.8	1.38	4.00	0.31	0.77	0.25	0.10			
137	Ptolemy VI	AE	Alexandria	SC	22.144			85.9	5.57	7.39	0.26	0.26	0.18	0.08			
138	Ptolemy VI	AE	Alexandria	SC	21.668			82.7	9.39	6.50	0.30	0.44	0.19	0.09			
139	Ptolemy VI	AE	Alexandria	SC	19.214			74.3	18.8	5.37	0.44	0.28	0.14	0.05			0.07

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
141	Ptolemy VI	AE	Alexandria	SC	18.367			67.3	20.4	9.52	1.02	0.35	0.12	0.05	0.11		0.09
142	Ptolemy VI	AE	Alexandria	SC	16.607			64.1	26.1	6.67	1.13	0.46	0.17				
143	Ptolemy VI	AE	Alexandria	SC	15.969			58.8	30.0	7.25	1.43	0.58	0.18				0.10
144	Ptolemy VI	AE	Alexandria	SC	15.963			68.9	24.1	4.79	0.78	0.16	0.13	0.04	0.08		0.08
145	Ptolemy VI	AE	Alexandria	SC	15.126			63.3	28.9	5.20	1.20	0.04	0.03				0.09
146	Ptolemy VI	AE	Alexandria	SC	14.906			71.3	19.0	7.39	0.64	0.57	0.12		0.07		0.06
147	Ptolemy VI	AE	Alexandria	SC	14.543			50.0	39.6	4.91	2.50	0.24					0.14
149	Ptolemy VI	AE	Alexandria	SC	8.131			64.8	27.1	4.94	0.66	1.50	0.09				
150	Ptolemy VI	AE	Alexandria	SC	4.343			62.3	25.1	10.13	0.89	0.32	0.14				0.10
151	Ptolemy VI	AE	Alexandria	SC	23.464			63.6	27.0	6.73	1.09	0.18	0.12				0.10
153	Ptolemy VI	AE	Alexandria	SC	16.049			62.5	29.7	4.79	1.16	0.27	0.11	0.04			0.11
154	Ptolemy VI	AE	Alexandria	SC	15.457	0.03		79.8	14.5	3.90	0.63	0.13	0.11	0.10			
155	Ptolemy VI	AE	Alexandria	SC	15.442			61.3	31.3	4.11	1.34	0.21	0.14	0.03			
156	Ptolemy VI	AE	Alexandria	SC	15.329			55.4	35.9	4.59	1.84	0.14	0.09				0.13
158	Ptolemy VI	AE	Alexandria	NC	14.867			77.6	16.2	4.93	0.40	0.36	0.14	0.07	0.08		0.06
162	Ptolemy VI	AR	Paphos	NC	14.109	98.6	0.73	0.39	0.26								
163	Ptolemy VI	AR	Paphos	NC	13.474	99.2	0.11	0.13	0.32								0.17
164	Ptolemy VI	AR	Paphos	NC	14.145	97.3	0.49	1.61	0.49								
166	Ptolemy VI	AE	Cyrene	SC	1.796			81.1	9.5	7.74	0.49						
167	Ptolemy VIII	AE	Cyrene	SC	13.867			77.7	10.5	10.18	0.55	0.20	0.11	0.06			0.07
168	Ptolemy VIII	AE	Cyrene	SC	4.553			82.4	12.2	4.42	0.38	0.08					
172	Ptolemy VIII	AR	Alexandria	NC	13.885	98.3		0.11	0.3							0.25	
173	Ptolemy VIII	AE	Alexandria	SC	23.956			68.4	24.9	4.50	0.89	0.18	0.12				
174	Ptolemy VIII	AE	Alexandria	SC	23.920			65.2	27.4	4.51	0.94	0.46	0.12				
176	Ptolemy VIII	AE	Alexandria	SC	22.811			42.4	42.6	8.92	2.76	0.32	0.06				0.20
181	Ptolemy VIII	AE	Alexandria	SC	19.505			64.8	24.2	9.21	0.27	1.00	0.16				0.11
183	Ptolemy VIII	AE	Alexandria	SC	21.509			73.7	18.1	6.36	0.66	0.26	0.14				0.07
184	Ptolemy VIII	AR	Paphos	NC	14.270	98.2	0.11	0.14	1.58								
185	Ptolemy VIII	AE	Paphos	SC	7.464			78.7	7.70	11.53	0.75	0.09	0.15	0.14			
187	Cleopatra III and Ptolemy IX	AR	Alexandria	NC	13.624	92.0	0.36	6.85	0.60								
188	Cleopatra III and Ptolemy IX	AR	Alexandria	NC	13.435	97.2	0.26	1.89	0.47								
189	Cleopatra III and Ptolemy X	AR	Alexandria	NC	13.532	97.5	0.39	1.71	0.34								
190	Ptolemy X	AR	Alexandria	NC	12.418	95.0	0.08	4.10	0.85								
191	Ptolemy X	AR	Alexandria	NC	13.246	94.8	1.49	2.45	0.75								0.52
192	Ptolemy X	AR	Alexandria	NC	13.497	92.6	0.43	6.31	0.50							0.13	
193	Ptolemy X	AR	Alexandria	NC	13.577	94.4	0.60	4.38	0.51								
195	Ptolemy IX and Ptolemy X	AE	Alexandria	NC	9.730			67.2	25.5	2.96	1.12	0.44	0.08			1.47	0.07
196	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	9.651			73.7	21.2	3.62	0.57	0.18	0.05				

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
198	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	8.712			69.0	26.0	2.19	0.73	0.88	0.12				
201	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.997			52.6	40.8	1.63	2.05	0.28	0.07				0.09
202	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.910			67.6	29.1	1.07	0.95	0.12	0.13				0.09
203	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.850			53.3	37.6	4.25		0.18	0.07				0.14
206	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.699			68.6	25.2	4.40	0.64	0.26	0.12				0.10
207	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.596			68.4	26.0	3.15	0.64	0.92	0.11				
210	Ptolemy IX and Ptolemy X	AE	Alexandria	SC	7.186			56.9	32.8	1.62	1.03	0.28		5.88			0.11
216	Cleopatra III and Ptolemy IX	AE	Paphos	SC	25.421	0.04		98.4	0.41		0.20	0.49	0.13	0.11			
218	Ptolemy IX and Ptolemy X	AE	Paphos	SC	9.653			76.3	9.31	12.82	0.38	0.11	0.08	0.05			
220	Ptolemy IX	AE	Cyrene	SC	1.467	0.06		77.5	14.5	6.23	0.44	0.20	0.07	0.09	0.14		0.06
222	Ptolemy Apion or Ptolemy X	AE	Cyrene	SC	1.327			80.6	10.5	7.20	0.50	0.10	0.10				
227	Ptolemy Apion or Ptolemy X	AE	Cyrene	SC	1.171			85.0	5.41	8.21	0.34	0.19	0.14	0.07			
231	Ptolemy Apion or Ptolemy X	AE	Cyrene	SC	0.836			81.3	8.63	8.41	0.52	0.21	0.12				
235	Ptolemy XII	AR	Alexandria	NC	14.282	93.2	0.34	5.74	0.56								
236	Ptolemy XII	AR	Alexandria	SC	12.294	83.5	0.38	15.83	0.32								
237	Ptolemy XII	AR	Alexandria	SC	13.976	93.4	0.38	5.87	0.32								
238	Ptolemy XII	AR	Alexandria	SC	13.499	94.0	0.40	5.35	0.18								
239	Ptolemy XII	AR	Alexandria	SC	13.460	91.1	0.35	7.96	0.31								
240	Ptolemy XII	AR	Alexandria	SC	12.633	92.9	0.48	6.41	0.11								
241	Ptolemy XII	AR	Alexandria	SC	12.873	68.2	0.31	29.1	1.72								
242	Ptolemy XII	AR	Alexandria	SC	13.712	88.2	0.33	10.6	0.73								
249	Cleopatra VII	AE	Alexandria	SC	19.027			70.3	17.1	9.91	0.92	0.34	0.10	0.22	0.10		

The average concentrations of the measured elements for coins not included in this quantitative analysis due to the high degree of corrosion are given in the tabular overview (tab. 7) for completeness. Values below the 0.025 % detection tolerance limit were also excluded for these coins.

Tab. 7. Elemental concentrations of excluded coins (wt. %).

Cat. no.	Ruler	Metal	Mint	Corrosion	Weight	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
17	Ptolemy I	AE	Alexandria	SC/CC	15.199			64.2	29.6	3.70	1.16	0.21					0.06
19	Ptolemy I	AE	Cyrene	SC/CC	3.640			77.5	6.09	16.0	0.10	0.17	0.06				
23	Ptolemy II	AE	Uncertain mint 9	SC/CC	64.416	0.08		71.8	1.96	23.1	0.76	0.61	0.17	0.07	0.12	0.54	
42	Ptolemy III	AE	Alexandria	SC/CC	9.838	0.10		75.4	4.80	18.0	0.59	0.28	0.09	0.06	0.06		
68	Ptolemy III	AE	Alexandria	SC/CC	67.524			59.1	8.99	30.5	0.49	0.12	0.07	0.04			0.04
92	Ptolemy IV	AE	Alexandria	SC/CC	69.144			51.8	35.0	8.69	1.77	0.43	0.28				0.17
170	Ptolemy VIII	AE	Cyrene	SC/CC	2.328	0.04		65.5	27.1	4.99	0.87	0.28			0.09		0.09
219	Ptolemy IX	AE	Cyrene	SC/CC	1.856			60.2	33.5	4.66	0.62	0.21					0.13
221	Ptolemy IX	AE	Cyrene	SC/CC	1.998			62.0	31.6	4.66	0.57	0.25			0.09		0.07
250	Cleopatra VII	AE	Paphos	SC/CC	4.103			46.7	35.8	13.0	1.91	0.26	0.10				0.13

Gold coins are represented in the data sample by two specimens, namely the gold stater of Ptolemy I (no. 1, Memphis mint) and the mnaieion of Ptolemy IV (no. 90, Alexandria mint). The average measured fineness of both specimens is almost 99.8 %, the measured values on the obverse and reverse are in the interval 99.73 to 99.85 %. Both coins are therefore characterized by extremely high fineness, but a fineness exceeding 99 % is not uncommon for Ptolemaic gold coinage of this period (*Olivier – Lorber 2013*; *Faucher – Olivier 2020*). Of the other elements, silver, copper and zinc were detected in them. The presence of copper is in agreement with previously published data for the Alexandria mint (*Olivier – Lorber 2013*).

The average values of element content for silver coins of individual rulers are given in the tabular overview (tab 8). In addition to silver, gold, copper and lead are almost always present.[4] Tab. 9 shows descriptive characteristics of the measured values of these four elements: minimum, median (Mdn), interquartile range (IQR) and maximum.[5] Higher interquartile ranges indicate a wider dispersion of the concentration of a given element in the coins of a given ruler. Interquartile range values higher than 2 % are marked in bold in the table. These high values, not surprisingly, concern late rulers.

Tab. 8. Average elemental concentrations of silver coins (wt. %).

Ruler	No. of coins	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
Ptolemy I	14	99.0	0.42	0.12	0.36								
Ptolemy II	4	98.7	0.69	0.16	0.48								
Ptolemy IV	1	98.3	0.79	0.34	0.56								
Ptolemy VI	7	97.7	0.77	0.41	0.94								0.07
Ptolemy VIII	2	98.3	0.05	0.12	0.92							0.13	
Cleopatra III and Ptolemy IX	2	94.6	0.31	4.37	0.53								
Cleopatra III and Ptolemy X	1	97.5	0.39	1.71	0.34								
Ptolemy X	4	94.2	0.65	4.31	0.65							0.03	0.13
Ptolemy XII	8	88.1	0.37	10.86	0.53								

4 The exceptions are the stater of Ptolemy VI, no. 132, in which no lead was measured on either side, and the stater of Ptolemy VIII, no. 172, in which no gold was measured on either side. Note that in the silver stater of Ptolemy I, no. 12, a high zinc content of 1.17 % was detected on the obverse, while no zinc was detected at all on the reverse. Considering the inhomogeneity of the zinc occurrence, it is most likely a contamination of the corrosion layer of the coin and not an admixture of the element in the alloy.

5 Due to the small number of observations and possible outliers, the median and interquartile range were chosen instead of the mean and standard deviation for robustness.

Tab. 9. Statistics of Ag, Au, Cu and Pb in silver coins.

Ruler	No. of coins	Ag				Au				Cu				Pb			
		Min	Mdn	IQR	Max	Min	Mdn	IQR	Max	Min	Mdn	IQR	Max	Min	Mdn	IQR	Max
Ptolemy I	14	98.36	99.17	0.60	99.47	0.10	0.43	0.23	0.70	0.09	0.12	0.03	0.20	0.07	0.32	0.20	0.96
Ptolemy II	4	98.18	98.67	0.56	99.08	0.53	0.60	0.29	1.04	0.09	0.14	0.09	0.27	0.05	0.46	0.65	0.97
Ptolemy IV	1		98.31				0.79				0.34				0.56		
Ptolemy VI	7	95.66	97.71	1.24	99.21	0.11	0.56	0.33	2.25	0.08	0.23	0.26	1.61	0.00	0.49	1.41	2.91
Ptolemy VIII	2	98.18	98.25	0.16	98.33	0.00	0.05	0.11	0.11	0.11	0.12	0.03	0.14	0.26	0.92	1.32	1.58
Cleopatra III and Ptolemy IX	2	92.05	94.61	**5.13**	97.17	0.26	0.31	0.10	0.36	1.89	4.37	**4.96**	6.85	0.47	0.53	0.13	0.60
Cleopatra III and Ptolemy X	1		97.51				0.39				1.71				0.34		
Ptolemy X	4	92.62	94.61	1.34	94.96	0.08	0.51	0.79	1.49	2.45	4.24	**2.07**	6.31	0.50	0.63	0.29	0.85
Ptolemy XII	8	68.19	92.03	**7.50**	94.02	0.31	0.36	0.06	0.48	5.35	7.18	**7.42**	29.08	0.11	0.32	0.40	1.72

In fig. 1, the distribution of the measured amount of silver for individual rulers is shown using a box plot.[6] For better readability, the figure does not include one outlier observation of Ptolemy XII's stater no. 241, which has a measured silver content of only about 68 % (other observations lie within 1.5 times the interquartile range). As shown in fig. 1 and the tabular overview (tabs. 8–9), until Ptolemy VIII, the silver content remained roughly constant at around 98 to 99 %. The measured concentrations of silver, copper, lead and gold for Ptolemy I to Ptolemy IV are in agreement with previously published data (*Hazzard 1990*; *Kantarelou et al. 2011*; *Faucher – Olivier 2020*). From the joint reign of Cleopatra III and Ptolemy IX (at the latest from 112/1 BC, from which the oldest analysed silver coin of this ruling couple originates), a reduced silver content can be observed, with an average concentration of approximately 94 to 95 % (the joint reign of Cleopatra III and Ptolemy X appears to be an exception, but it is represented by only one specimen). Under Ptolemy XII, the silver content was further reduced, with a median value of 92 %. These results are roughly consistent with literature (*Faucher – Olivier 2020*, 100–103), where a more detailed chronological analysis is performed thanks to a larger set of silver coins.

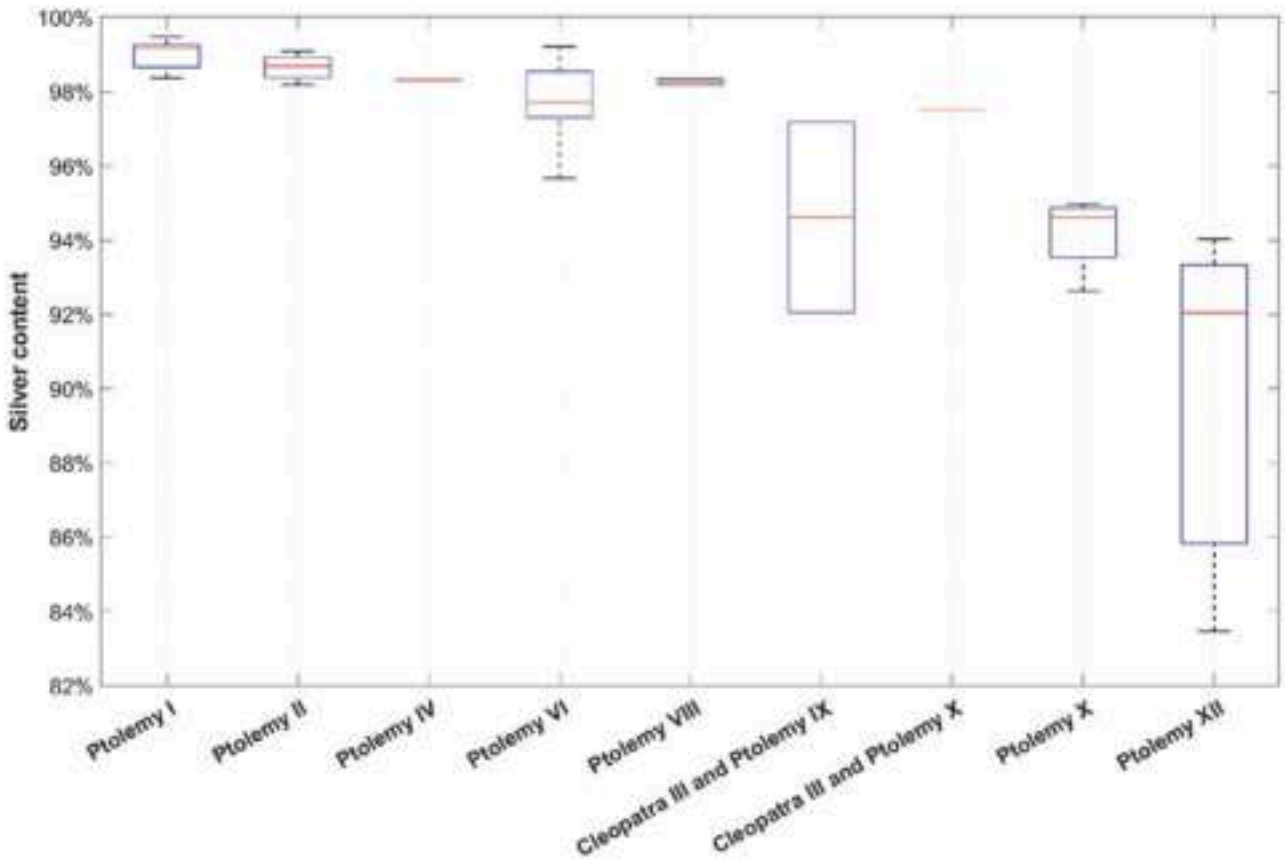

Fig 1. Box plot of silver content in silver coins.

6 The blue vertical boxes represent the range from the 25th to the 75th percentile, and the red lines inside the boxes show the median value. The whiskers (dashed lines above and below the boxes) extend from the edge of the box to the outermost observation within 1.5 times the interquartile range.

Nikolova (*2021*, 115–116), also reports a decrease in silver content and increase in copper content in the alloy since the reign of Ptolemy VIII (*Nikolova 2021*, 116, Graph 5.8). It is necessary to point out the differences in the determined concentrations of silver and copper in the silver coins of Ptolemy VIII, X and XII resulting from this study and the results published in Nikolova (*2021*, Appendix II). The data published in Nikolova (*2021*) were analysed by the ICP-OES method from drilled metal samples from the core of the coins and show significantly lower silver contents and higher copper contents during the reigns of individual rulers. In contrast, the data from surface XRF analyses published by Hazzard (*1990*) for silver coins from the reign of Ptolemy XII are broadly correlated with the results in our study. The differences in the results of elemental analyses of the surface and core of the silver coins point to a certain inhomogeneity of the metal, which is manifested by the enrichment of the surface layers of the coins with silver. It is not possible to clearly determine at this time whether this is a result of corrosion damage to the coins or deliberate refinement of the surface layers of the metal.

The average values of element content for bronze coins of individual rulers are given in the tabular overview (tab. 10). The main components of the coinage alloy in these coins are, of course, copper, tin and lead. The descriptive characteristics of these three elements are shown in the tabular overview (tab. 11), analogous to tab. 9. Interquartile range values higher than 5 % are marked in bold in the table.

Tab. 10. Average elemental concentrations of bronze coins (wt. %).

Ruler	No. of coins	Ag	Au	Cu	Pb	Sn	As	Fe	Co	Ni	Sb	Zn	Bi
Ptolemy I	1			92.0	1.9	5.3	0.2	0.2		0.1			
Ptolemy II	9	0.02		83.3	4.2	11.1	0.5	0.2	0.1	0.1	0.0		0.0
Ptolemy III	36	0.01		76.1	4.6	17.3	0.5	0.6	0.1	0.1	0.0	0.0	0.0
Ptolemy IV	25	0.11		74.0	9.2	14.7	0.5	0.6	0.2	0.1	0.0	0.1	0.0
Ptolemy V	8			77.5	9.0	11.7	0.3	0.3	0.2	0.1			
Ptolemy VI	21	0.00		70.4	20.9	6.2	0.9	0.4	0.1	0.0	0.0		0.1
Ptolemy VIII	8			69.2	20.9	7.5	0.9	0.3	0.1	0.0			0.1
Cleopatra III and Ptolemy IX	1	0.04		98.4	0.4		0.2	0.5	0.1	0.1			
Ptolemy IX and Ptolemy X	10			65.3	27.3	3.8	0.8	0.4	0.1	0.6		0.1	0.1
Ptolemy IX	1	0.06		77.5	14.5	6.2	0.4	0.2	0.1	0.1	0.1		0.1
Ptolemy Apion or Ptolemy X	3			82.3	8.2	7.9	0.5	0.2	0.1	0.0			
Cleopatra VII	1			70.3	17.1	9.9	0.9	0.3	0.1	0.2	0.1		

Tab. 11. Statistics of Cu, Pb and Sn in bronze coins.

Ruler	No. of coins	Cu				Pb				Sn			
		Min	Mdn	IQR	Max	Min	Mdn	IQR	Max	Min	Mdn	IQR	Max
Ptolemy I	1		92.03				1.85				5.31		
Ptolemy II	9	78.42	81.75	4.75	93.15	0.10	3.66	**7.50**	9.06	5.86	10.66	**5.33**	15.99
Ptolemy III	36	64.28	75.82	**8.79**	86.28	0.66	3.76	**4.79**	15.18	9.19	16.36	**9.30**	26.81
Ptolemy IV	25	56.24	75.99	**14.20**	92.38	0.21	5.48	**11.46**	30.56	5.75	13.97	**6.04**	29.15
Ptolemy V	8	54.91	82.60	**9.30**	85.01	0.78	5.66	**7.86**	31.50	7.25	10.55	3.93	22.87
Ptolemy VI	21	49.99	67.28	**17.63**	92.81	0.11	24.14	**15.77**	39.62	3.90	5.37	2.60	10.13
Ptolemy VIII	8	42.39	71.06	**13.22**	82.39	7.70	21.11	**14.80**	42.57	4.42	7.64	**5.19**	11.53
Cleopatra III and Ptolemy IX	1		98.39				0.41				0.00		
Ptolemy IX and Ptolemy X	10	52.62	67.98	**12.10**	76.28	9.31	25.99	**7.67**	40.82	1.07	3.06	2.62	12.82

Ptolemy IX	1		77.53				14.45				6.23		
Ptolemy Apion or Ptolemy X	3	80.63	81.25	3.25	84.97	5.41	8.63	3.85	10.55	7.20	8.21	0.91	8.41
Cleopatra VII	1		70.27				17.11				9.91		

The increase in lead content that occurred during the reign of Ptolemy VI is consistent with the findings of Faucher – Olivier (*2020*, 103–104). However, the data indicate that the alloy composition of bronze coins depends on both the period and the region of minting. Tab. 12 shows the concentration of the three main elements by ruler and region, with the rows corresponding to Egyptian mints, i.e. the Alexandria mint and the mint in Upper Egypt,[7] being marked in bold. The table indicates that the content of copper, lead and tin differs both in coins minted in Egypt and outside Egypt, and in the reigns of Ptolemy I to Ptolemy V and Ptolemy VI to Cleopatra VII. Coins from mints outside Egypt are characterized by a higher proportion of copper on average, regardless of the period of minting. Coins from Alexandria and Upper Egypt generally contain less copper and under Ptolemy VI and subsequent rulers the proportion of copper and tin decreases further and the proportion of lead increases significantly. This observation is confirmed in the tabular overview (tab. 13) and the ternary plot in fig. 2.

Tab. 12. Average concentrations of Cu, Pb and Sn in bronze coins by ruler and region.

Ruler	Region	No. of coins	Cu	Pb	Sn
Ptolemy I	**Alexandria**	1	92.0	1.85	5.31
Ptolemy II	Cyprus	5	80.4	4.99	13.00
Ptolemy II	Sicily	2	90.6	0.33	7.79
Ptolemy II	Southern Levant	1	82.5	7.75	8.56
Ptolemy II	Southern Levant (?)	1	84.3	4.29	10.66
Ptolemy III	**Alexandria**	28	75.8	4.80	17.73
Ptolemy III	Cyprus	1	85.6	1.35	11.91
Ptolemy III	Cyrenaica	2	73.1	5.60	19.66
Ptolemy III	Greece	2	83.0	2.80	13.21
Ptolemy III	Phoenicia	2	77.2	4.05	17.14
Ptolemy III	Southern Levant	1	66.5	3.43	15.83
Ptolemy IV	**Alexandria**	25	74.0	9.16	14.66
Ptolemy V	**Alexandria**	4	76.4	10.19	11.56
Ptolemy V	**Upper Egypt**	1	72.7	2.82	22.87
Ptolemy V	Cyprus	2	79.4	11.12	8.38
Ptolemy V	Cyrenaica	1	83.3	6.55	7.79
Ptolemy VI	**Alexandria**	20	69.8	21.52	6.10
Ptolemy VI	Cyrenaica	1	81.1	9.50	7.74
Ptolemy VIII	**Alexandria**	5	62.9	27.41	6.70
Ptolemy VIII	Cyprus	1	78.7	7.70	11.53
Ptolemy VIII	Cyrenaica	2	80.0	11.32	7.30
Cleopatra III and Ptolemy IX	Cyprus	1	98.4	0.41	
Ptolemy IX and Ptolemy X	**Alexandria**	9	64.1	29.35	2.77
Ptolemy IX and Ptolemy X	Cyprus	1	76.3	9.31	12.82
Ptolemy IX	Cyrenaica	1	77.5	14.45	6.23
Ptolemy Apion or Ptolemy X	Cyrenaica	3	82.3	8.19	7.94
Cleopatra VII	**Alexandria**	1	70.3	17.11	9.91

7 Upper Egypt is represented by only one coin: no. 125 from the mint of the Karnak temple and/or other temple mint(s) in Upper Egypt.