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Contents

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Editors' Note

The abundance of articles received for the *American Journal of Numismatics* in 2016–17 has given us the opportunity to get fully caught up with the calendar. What was originally planned to be volume 29 (2017) is being printed as two volumes instead: volume 29 (2017) and volume 30 (2018), which will be printed and mailed at the same time. We are already reviewing articles for volume 31, which we expect to send to readers in early 2019.

We are also very pleased to announce that ANS Fellow Nathan T. Elkins, Associate Professor of Art History at Baylor University, will be Co-Editor of *AJN* starting with volume 31, replacing Ute Wartenberg. He will oversee articles on ancient Greek and Roman topics, including the rest of the ancient European, West Asian, and North African world. ANS Associate Curator David Yoon will continue as Co-Editor of *AJN* for medieval, modern, and non-Western topics.

Ute Wartenberg
David Yoon
Editors

Oliver Hoover
Managing Editor

AJN Second Series 30 (2018) pp. 1–44

The Earliest Alexander III Tetradrachm Coinage of Babylon: Iconographic Development and Chronology

Plates 1–4

Lloyd W. H. Taylor*

The earliest tetradrachms (Group 1) from the mint of Alexander the Great at Babylon show a rapid progression in the development of iconographic detail, accompanied by a pattern of die use, which taken together indicate that the mint most probably commenced production in 326/5.[1] Group 1 consists of a small, short duration emission bearing the hallmarks of a rapid evolution of iconographic elements and style that laid the foundation for the expansive mint operation responsible for the subsequent Group 2 coinage. The latter was the most prolific of any from the mint. Initially the mint appears to have utilized two die engravers from the earlier Babylonian mint of the satrap Mazaios, supplemented shortly thereafter by die engravers from farther afield, possibly from one of the northern Phoenician, Syrian or Kilikian mints. Group 1 has the characteristics of a brief commissioning stage, lasting four to six months. It represents a modest estimated coined volume of c. 159 Attic talents.

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1. All dates in this study are BC.

INTRODUCTION

Almost a century after Newell[2] detailed the contents and implications of the Demanhur Hoard (*IGCH* 1664), uncertainty remains as to the start date and duration of the production of the earliest Macedonian imperial coinage at Babylon. Newell posited that the imperial coinage commenced in 331/0, immediately after the Persian Satrap Mazaios surrendered city. He believed that the earliest component of this coinage, his Series I, the subject of the study, concluded in 329. Waggoner[3] upheld this dating while fitting the Babylonian coinage into an assumed annual pattern of issuance. Price [4] maintained this same start date, but down dated the end of the initial emission, his Group 1, to c. 325, proposing a five-year duration rather than the 1–2 years of previous studies.

More recently, Le Rider[5] proposed an alternative possibility, "the Alexander coinage started at Babylon not in 331/330, but perhaps only in 325/324." His reasoning was based on the interpretation that the succeeding Babylon Group 2 coinage might not have started earlier than "around 324 BC, perhaps during the year 324/323."

BABYLON GROUP 1

The Group 1 (Price 3578–3593) tetradrachm coinage of Babylon is characterised by placement permutations of the mint controls Φ and Μ either jointly, or individually, later joined by one of six symbols (ivy leaf, *kylix*, grape bunch, dolphin, trident-head and laurel sprig) placed in the exergue of the reverse. Included in Group 1 is a single issue of drachms (Price 3580) and didrachms (Price 3582) each from a single obverse die, two issues of hemiobols (Price 3590–91) from

2. E. T. Newell, *Alexander Hoards II Demanhur, 1905*, ANS NNM 19 (New York: American Numismatic Society, 1923), 53.

3. N. M. Waggoner, *The Alexander Mint at Babylon* (PhD Diss., Columbia University, 1968); N. M. Waggoner, "Tetradrachms from Babylon," in *Greek Numismatics and Archaeology Essays in Honor of Margaret Thompson*, ed. O. Mørkholm and N Waggoner (Wetteren: Cultura Press, 1978), 269–280. In her study, Waggoner referred to Newell's Series I as Issue I. The latter became Group 1 in the terminology of M. J. Price, *The Coinage in the Name of Alexander the Great and Philip Arrhidaeus* (London: British Museum/Swiss Numismatic Society, 1991), 458, a terminology that is maintained in this study.

4. Price, *Coinage*, 458.

5. G. Le Rider, *Alexander the Great: Coinage, Finances and Policy*, trans. W. E. Higgins (American Philosophical Society, Philadelphia, 2007), 224–225 and 254 concludes, "I would place the start of its [Group 1] issue at Babylon only towards the end of the reign, perhaps in the early months of 324."

three obverse dies and two gold staters (Price 3592–93), from two obverse dies.[6]

In 2011, an example of Price 3579 came to the writer's attention. It possessed an element of iconographic detail in the outstretched right hand of Zeus that is not present on the rest of Group 1. This detail is consistent with the coin's derivation from one of the first reverse dies placed into use at the mint. Based on a comparative iconographic analysis of the tetradrachm coinage issued from eastern mints of Alexander III the Great, the immediate change of this iconographic detail on the succeeding Group 1 tetradrachm dies indicated that it dated to 326/5 BC. In order to place this new coin confidently in the Group 1 sequence and to refine the chronology, a tetradrachm die analysis was undertaken utilising the American Numismatic Society's PELLA database, complimented by a compilation of Group 1 tetradrachms in commerce over the last few decades. Presented below is the resultant catalogue of 112 tetradrachms.

CATALOGUE

The coins of the catalogue are divided into two distinctively styled subgroups, identified as 1.1 and 1.2, while discrete types, or issues within each, as defined by mint controls, are identified by a third digit e.g. 1.2.2 is the second type, or issue, in Group 1.2. This sequence numbering convention maintains the overall identity of Price's Babylon Group 1, an identity that is quoted frequently in the numismatic literature on the Babylon mint of Alexander III the Great.

In the catalogue, illustrated coins (Pls. 1–4) are denoted by an asterisk in the first column. Obverse dies (column two) are numbered sequentially, while reverse dies (column three) are numbered sequentially within each type. Coin weights (column four) are in grams. All coins were struck with dies adjusted towards 12h (variance 10h–2h). All coins bear a standard iconography and epigraphy:

Obverse: Head of Herakles r. in lion skin headdress, dotted border.
Reverse: ΑΛΕΞΑΝΔΡΟΥ on r., Zeus seated l. on *diphros*, holding eagle and sceptre, dotted border.

Group 1.1

1.1.1	-, Φ/M	(Price 3579)

6. Die counts sourced from Waggoner, *Alexander Mint*, 30–32, with the obverse die count of the gold staters increased by one to reflect the PELLA database content.

1.*	A1	P1	16.68	Brisbane, LWHT Coll.; Hess-Divo 320 (20 Oct. 2011), Lot 112.	A1 = Waggoner ob. 8. P1 right hand of Zeus portrayed with facing open palm, fingers splayed.
2.*	A2	P2	17.19	Ibercoin 17 (25 Jun. 2014), Lot 27.	A2 = Waggoner ob. 9. P2 and henceforth on all reverse dies, the right hand of Zeus is portrayed with an upward oriented hand in profile.
3.	A2	P2	n.r.	Le Rider (2007) pl. 8, 1.	
4.	A2	P2	17.21	ANS 1944.100.80302.	
5.	A2	P3	17.16	ANS 1944.100.80303.	
6.	A2	P4	17.2	ANS 1944.100.80304.	
7.*	A3	P5	17.2	Brisbane, LWHT Coll.; Hess-Divo 320 (20 Oct. 2011), Lot 111.	A3 = Waggoner ob. 10.
8.	A3	P5	17.16	ANS 1944.100.80301.	Demanhur Hoard (*IGCH* 1664).
9.	A3	P5	17.6	Davesne and Lemaire (1996), pl. VIII, 102.	Syria or Lebanon Hoard (*CH* 8.185). Coin heavily encrusted: overweight?
10.	A3	P6	17.16	London, BM 2002,0101.858.	
11.	A3	P7	17.2	ANS 1944.100.80305.	
12.	A3	P7	17.18	London, BM 1929,0811.90.	Demanhur Hoard (*IGCH* 1664).
13.	A3	P7	16.63	Oxford, HCR23679; *SNG*uk_0503_3031.	
14.*	A4	P8	17.19	ANS 1944.100.80300; Newell *Reattribution* pl. 25, 12.	A4 = Waggoner ob. 11. A4 locks of hair on forehead depicted in in closed loops. A4 little worn. A4 in earliest state.

15.	A4	P8	16.66	London, BM 1843,0726.2.	
1.1.2		**Φ, M**		**(a subset of Price 3581)**	
16*	A1	P1	17.07	CNG inventory no. 153525.	
17.	A1	P2	17.13	ANS 1944.100.80291.	
18.	A1	P3	17.21	ANS 1944.100.80307; Newell *Reattribution* pl. 25,11.	Demanhur Hoard (*IGCH* 1664).
19.	A1	P4	17.15	CNG eAuction 356 (29 Jul. 2015), Lot 25.	
20.	A1	P4	16.22	ANS 1944.100.80290.	
21.	A1	P5	17.18	ANS 1944.100.80306.	
22.	A1	P5	16.85	London, BM 1866,1201.1082.	
23.	A2	P6	16.79	GandM 156 (5 Mar. 2007), Lot 1273.	
24.*	A2	P6	17.17	CNG eAuction 351 (20 May 2015), Lot 96.	
25.	A2	P6	17.11	ANS 1947.98.356.	
26.*	A3	P7	16.97	CNG eAuction 215 (29 Jul. 2009), Lot 71.	
27.	A3	P7	17.15	ANS 1944.100.80289.	
28.	A3	P7	16.90	ANS 1944.100.80288.	
29.	A3	P7	17.11	London, BM 1878,0301.114.	
30.	A3	P7	17.18	Wildwinds.com online database.	P7 die fragmenting beneath seat of *diphros*.
1.1.3		M, Φ		(Price 3578)	
31.	A3	P1	17.20	ANS 1944.100.80299.	A3 advanced wear.

32.	A3	P1	17.15	Gerhard Hirsch Nachfolger 326 (16 Feb. 2017), Lot 1629.	A3 advanced wear with large fragmentation break on neck and lion skin tie.
33.	A4	P1	17.19	London, BM 1898,0602.9.	A4 moderately worn.

Group 1.2

1.2.1 - , M (Price 3589)

34.*	A5	P1	17.19	London, BM 1929,0811.85.	Demanhur Hoard (*IGCH* 1664). A5 little worn. A5 = Waggoner ob. 2 (Waggoner's first tetradrachm die).

Waggoner lists two other specimens in the ANS from the same die set–not found in the PELLA database.

1.2.2 Φ, M (a subset of Price 3581)

35.	A5	P1	17.16	ANS 1944.100.80228.	
36.	A5	P1	17.46	Elsen 93 (15 Sep. 2007), Lot 142; Elsen List 57 (Jul. 1983), Lot 41.	
37.	A5	P1	17.08	Oxford, HCR23680; *SNG*uk_0503_3032.	Kuft Hoard (*IGCH* 1670).
38.	A5	P1	17.22	CNG 88 (14 Sep 2011), Lot 120.	
39.	A5	P1	16.86	London, BM 1866,1201.1081.	
40.	A5	P2	17.16	ANS 1944.100.80235.	
41.	A5	P3	17.10	ANS 1944.100.80236.	A5 well worn.
42.	A6	P4	17.13	ANS 1944.100.80225.	A6 = Waggoner ob. 3.
43.*	A6	P4	17.21	Triton XIV (3 Jan. 2011), Lot 74.	
44.	A6	P4	17.10	London, BM 1913,0518.85.	Demanhur Hoard (*IGCH* 1664).

45.	A6	P5	17.17	ANS 1944.100.80224.	A6 well worn with die breaks.
46.	A7	P6	17.22	GandM 170 (13 Oct. 2008), Lot 1251.	A7 = Waggoner ob. 4.
47.*	A7	P7	17.24	London, BM 1911,0409.25.	
48.	A7	P8	17.22	ANS 1944.100.80220.	A7 well worn.
49.	A8	P8	17.27	ANS 1944.100.80231.	A8 = a subset of Waggoner ob. 5. P8 die fragmenting on circumference.
50.*	A8	P9	17.16	ANS 1944.100.80233.	
51.	A8	P10	17.03	ANS 1944.100.80230.	Abu Homos Hoard (*IGCH* 1667).
52.	A8	P11	17.22	ANS 1944.100.80232.	
53.	A8	P11	16.79	Berlin, Münzkabinett 18252016.	A8 advanced wear.
54.	A8	P12	17.17	Schulman 353 (23 Jun 2017), Lot 600.	A8 advanced wear.
55.	A9	P13	17.14	CNG eAuction 262 (17 Aug 2011), Lot 42.	A9 = a subset of Waggoner ob. 5.
56.*	A9	P14	17.18	CNG eAuction 255 (4 May 2011), Lot 50.	
57.	A9	P14	17.19	CNG eAuction 350 (6 May 2015), Lot 98.	
58.	A9	P15	17.18	ANS 1944.100.80221.	
59.	A9	P15	17.01	ANS 1944.100.80222.	
60.	A9	P16	17.18	London, BM 1913,0518.86.	
61.	A9	P16	17.06	Oxford, HCR23681; *SNG*uk_0503_3033.	Kuft Hoard (*IGCH* 1670). A9 well worn.
62.	A9	P16	17.20	Davesne and Lemaire (1996), pl. VIII, 103.	Syria or Lebanon Hoard (*CH* 8.185). Coin moderately encrusted.

63.	A10	P17	17.23	ANS 1944.100.80214.	A10 = Waggoner ob. 6. A10 in earliest state with die fragmentation break on upper jaw of lion skin, plus die fragmentation on neck.
64.	A10	P18	17.11	Obolos 4 (21 Feb 2016), Lot 146.	
65.	A10	P18	17.21	ANS 1944.100.80217; Newell *Reattribution* pl. 25, 8.	Demanhur Hoard (*IGCH* 1664).
66.	A10	P18	17.11	CNG eAuction 258 (22 Jun. 2011) lot 89.	
67.*	A10	P19	17.27	Hirsch 250–251 (8 May 2007), Lot 609.	
68.	A10	P20	17.06	ANS 1944.100.80218.	
69.	A10	P21	17.10	London, BM 1913,0518.87.	Demanhur Hoard (*IGCH* 1664).
70.	A10	P22	16.83	ANS 1974.26.6161.	
71.	A10	P22	17.14	ANS 1944.100.80212.	
72.	A10	P23	17.21	ANS 1944.100.80206.	
73.	A10	P24	17.15	ANS 1944.100.80215.	
74.	A10	P24	16.86	Munzhandel Andreas Fenzi.	
75.	A10	P25	17.13	ANS 1944.100.80216.	
76.	A10	P26	17.21	ANS 1944.100.80205.	
77.	A10	P26	17.14	ANS 1944.100.80210.	
78.	A10	P26	17.06	Berlin, Münzkabinett 18252014.	
79.	A10	P27	17.04	ANS 1944.100.80213.	
80.	A10	P28	17.24	ANS 1944.100.80219.	Demanhur Hoard (*IGCH* 1664).
81.	A10	P29	17.25	London, BM 2002,0101.859.	
82.	A10	P30	17.23	ANS 1944.100.80207.	

83.	A10	P31	16.88	ANS 1944.100.80211.	
84.	A10	P32	17.23	Hirsch 264 (25 Nov. 2009), Lot 190.	
85.	A10	P33	17.20	CNG eAuction 262 (17 Aug. 2011), Lot 43.	P33 die undergoing fragmentation.

1.2.3 Φ, M/Grapes (Price 3585)

86.	A10	P1	17.17	Berlin, Münzkabinett 18207728.	
87.	A10	P2	17.11	ANS 1944.100.80209.	
88.	A10	P2	17.17	ANS 1944.100.80208.	Demanhur Hoard (*IGCH* 1664). A10 very worn.

Another example ANS 1947.98.352 is listed on PELLA database without image; possibly the same coin as Waggoner 7a from dies A11/P2 that would mark the first appearance of A11 in the sequence.

1.2.4 Φ, M/Dolphin (Price 3586)

89.*	A11	P1	17.24	ANS 1944.100.80197.	A11 = Waggoner ob. 7. A11 in earliest state.

1.2.5 Φ, M/Trident-head (Price 3587)

90.*	A11	P1	17.18	ANS 1944.100.80200.	

Waggoner lists two additional examples including one from the ANS collection that cannot be found in the PELLA database. Based on Waggoner's analysis these coins are from dies A10/P1.

1.2.6 Φ, M/Ivy Leaf (Price 3583)

91.*	A10	P1	17.22	London, BM 1929,0811.89.	Demanhur Hoard (*IGCH* 1664). A10 v. worn

1.2.2		Φ, M		(a subset of Price 3581)	
92.*	A11	P34	17.14	CNG eAuction 190 (25 Jun. 2008), Lot 39; Hirsch 255 (14 Feb. 2008), Lot 1430.	Described as bearing a *kylix* (largely off flan) by CNG in which case this would be an example of 1.2.7. The latter is uncertain. In other respects the rev. die is no match for any other in the sequence.
93.	A11	P35	16.57	CNG eAuction 311 (25 Sep. 2013), Lot 552.	
94.	A11	P35	17.13	London, BM 1878,0301.113.	
95.	A11	P36	17.19	ANS 1947.98.351.	
1.2.7		Φ, M/*Kylix*		(Price 3584)	
96.	A10	P1	17.10	Oxford, HCR 23682; *SNG*uk_0503_3034.	Kuft Hoard (*IGCH* 1670).
97.*	A11	P1	17.21	London, BM 1929,0811.88.	Demanhur Hoard (*IGCH* 1664).
98.	A11	P1	17.17	ANS 1944.100.80198.	
1.2.8		Φ, M/Laurel Sprig		(Price 3588)	
99.	A10	P1	16.94	Oxford, HCR23683; *SNG*uk_0503_3035.	
100.*	A10	P2	17.14	ANS 1947.98.353.	
101.*	A11	P3	17.24	Brisbane, LWHT Coll.; Pars Coins inventory no. PCW-4132.	
102.	A11	P3	17.17	GandM 160 (9 Oct. 2007), Lot 1316.	

103.	A11	P3	17.14	ANS 1944.100.80194.	Described as 'dolphin' rather than 'laurel sprig' in ANS attribution.
104.	A11	P4	16.61	ANS 1944.100.80196	
105.	A11	P5	17.12	ANS 1944.100.80195	A11 well worn.
106.	A11	P5	17.17	CNG eAuction 224 (16 Dec. 2009), Lot 97.	A11 extensive die fragmentation on neck. P5 die breaking into fragments beneath *diphros* and around margin at 10–11h (on coin).
1.2.2		Φ, M		(a subset of Price 3581)	
107.*	A10	P37	17.18	ANS 1944.100.80201.	Demanhur Hoard (*IGCH* 1664).
108.	A10	P38	17.04	ANS 1944.100.80203.	
109.	A10	P39	17.02	ANS 1944.100.80202.	P39 die fragmenting on legend edge.
110.	A10	P40	17.24	ANS 1944.100.80204.	A10 extremely worn.
111.	A11	P41	17.11	ANS 1944.100.80237.	
112.*	A11	P42	17.21	ANS 1944.100.80199.	A11 extremely worn and broken.

COMMENTARY

In the last century, two die studies of the Babylon Group 1 emission were completed. Newell[7] noted eleven obverse and 41 reverse dies amongst 41 coins of Group 1 in Demanhur Hoard. He illustrated in accompanying plates a handful of specimens, rather than a representative set of all obverse dies he identified. Almost 50 years later Waggoner[8] reduced this to 10 obverse dies, paired to 51 reverse dies in an unpublished catalogue of 90 Group 1 tetradrachms. This study substantiates Newell's obverse die count; identifying two very similar dies, A8 and A9, among the coins attributed by Waggoner to her obverse die 5.[9] The dif-

7. E. T. Newell, "Reattribution of Certain Tetradrachms of Alexander the Great," *AJN* 45/46: 52.

8. Waggoner, *Alexander Mint*, 30–32.

9. The concordance of the obverse dies identified in this study with those of Waggoner is noted in the catalogue at the first appearance of each obverse die in the catalogue.

ference between these two obverse dies is subtle, the most distinguishing feature being found in the lines of the creases, or folds, towards their junction with the knot in the lion skin at the base of the neck of Herakles (Pl. 16, 50 and 56).

As represented in the catalogue, Group 1 was struck from 11 obverse dies, each of which, with the accompanying 70 reverse dies, can be categorized into one of two distinct and separate subgroups based on the distinctive style of each (Table 1). The earliest, consisting of types 1.1.1–1.1.3, shows a rapid progression of iconographic development that occurs over a handful of dies. The later consisting of types 1.2.1–1.2.8 is relatively invariant throughout. Table 1 compares and contrasts the distinctive iconographic elements of each and summarizes the progression of development in the iconography. The first 33 coins in the catalogue represent Group 1.1. The latter comprises obverse dies A1–A4, plus associated reverse dies (Pl. 1, 1–26). Group 1.2 is represented by 79 coins. It consists of obverse dies A5–A11 and associated reverse dies (Pls. 1–3, 34–112).

Table 1. Style distinctions and iconographic development.

Iconographic Element	**Group 1.1**	**Group 1.2**
Overall form (obv. and rev.)	Rounded, fluid, flowing design. Distinctly Babylonian, not found in other contemporary mints. Set the style for the succeeding Group 2 coinage.	Rigid, angular with rectilinear elements in the same general style as the contemporary northern Phoenician, Syrian and Kilikian mints.
Lion skin tie around the neck of Herakles	Prominent knot into which flows a single crease. On A2 the area beneath the lion skin has a hatched pattern–discarded on subsequent dies.	Multiply creased into neck knot.
Curvature of lion skin jaw	Flowing semicircular with no distinct break between upper and lower jaw line of lion skin.	Angular–lower jaw line of lion skin extends at a right angle beneath ear of Herakles.
Ear of lion skin	Semicircular.	Triangular.
Brow of Herakles	Light and regularly curved.	Heavy and bulbous.
Forehead locks of hair	Open loops on A1–A3, with closed circular loops on A4.	Closed circular loops.

Iconographic Element	Group 1.1	Group 1.2
Right hand of Zeus.	Facing open palm with splayed fingers on first reverse die. Subsequent reverse dies attempt to portray the hand oriented upward beneath the eagle, although no consistency of style is developed in the fifteen Group 1.1 reverse dies after this change.	The hand is depicted in profile, facing upward beneath the eagle on all reverse dies. The profile form of the hand is one of a flat upward facing hand. Only, rarely is there an attempt to define the fingers of the hand.
Himation worn by Zeus	Plain, no folds/creases while the ankle line edge portrayed as a simple straight line on the first reverse die. Subsequent dies show increasingly detailed creases and folds with the lowermost edge portrayed in a natural fold.	Stylized, rigid, evenly spaced parallel folds on the drapery with the lower edge composed of linear elements in the stylized portrayal of a fold, lacking natural perspective.
Himation around the waist of Zeus	Circular inflated form with a tendency to detailed folds on later reverse dies.	Initially partially inflated circular form, developing into an inflated folded triangular form on later dies.
Diphros on which Zeus is seated	Simple, unadorned with unbraced legs on first reverse die. Thicker, more ornate turned legs braced by a single strut on later reverse dies.	Legs with prominent turnings and bell covers at foot of legs that are braced by two struts. The overall iconography is consistent with the 'Field Chair' of the Persian Kings.
Feet of Zeus and Footstool	Delicate detail with pointed shoes. No footstool, although feet rest on a rising ground line on 50% of dies. Otherwise feet are free floating.	Crudely portrayed resting on a footstool throughout the sequence. No ground line present.
Secondary mint control symbols	Not present.	Six crudely engraved symbols in the exergue on later reverse dies.

All of the Group 1.1 obverse dies were put into use initially to strike sequence type 1.1.1 (Price 3579), while five of the seven obverse dies of Group 1.2 were commissioned for sequence type 1.2.2 (a subset of Price 3581); summarized in Tables 2 and 3. There are no die links between the two subgroups. However, there are three reverse die links between obverse dies within the subgroups; a

reverse die link of A3 to A4 (Cat. Nos. 32–33), one of A7 to A8 (Cat. Nos. 48–49) and of A10 to A11 (Cat. Nos. 96–97). These reverse die links connect and sequence half of the obverse dies. They serve to anchor the early, middle and late part of the emission, so that the sequence of obverse dies is well constrained. All obverse dies, with the possible exception of the obverse die A4, were used to strike one of sequence types 1.1.2 and 1.2.2 bearing the Φ mint control in the left field and M beneath the *diphros* (Table 4). The absence from the catalogue of an example of sequence type 1.1.2 from die A4 might reflect a limitation in our sample of surviving coinage, rather than being a true reflection of the use of this die. Moreover, if as is possible, the example of sequence type 1.1.3 struck from A4 (Cat. No. 33) is the result of an engraving error, the reversal of the placement of the Φ and M mint controls on a single reverse die intended for type 1.1.2, then A4 was evidently used to strike the latter, notwithstanding the fact that the control placement reversal on a single reverse die is classified as a separate issue.

Table 2. Sequence of issues and dies.

Type	Price	Controls	Obverse dies
1.1.1	3579	-, Φ/M	A1, A2, A3, A4
1.1.2	3581	Φ, M	A1, A2, A3
1.1.3	3578	M, Φ	A3, A4
1.2.1	3589	-, M	A5
1.2.2	3581	Φ, M	A5, A6, A7, A8, A9, A10
1.2.3	3585	Φ, M/Grapes	A10, (A11)*
1.2.4	3586	Φ, M/Dolphin	A11
1.2.5	3587	Φ, M/Trident	A11, (A10)*
1.2.6	3583	Φ, M/Ivy Leaf	A10
1.2.2	3581	Φ, M	A11
1.2.7	3584	Φ, M/*Kylix*	A10, A11
1.2.8	3588	Φ, M/Laurel Sprig	A10, A11
1.2.2	3581	Φ, M	A10, A11

* (A10) and (A11) Denotes die links observed by Waggoner, *Alexander Mint*, on coins that could not be located in this study.

Table 3. Distribution of dies.

Type	Mint Controls	Obverse dies commissioned for issue	Obverse dies carried over from prior issue	Number of reverse dies
1.1.1	Φ/M	4	-	8
1.1.2	Φ, M	-	3	7
1.1.3	M, Φ	-	2	1
1.2.1	–, M	1	1	1
1.2.2	Φ, M	5	1	42
1.2.3	Φ, M Grapes	-	1 (+1)*	2
1.2.4	Φ, M Dolphin	1	-	1
1.2.5	Φ, M Trident head	-	1 (+1)*	1
1.2.6	Φ, M Ivy Leaf	-	1	1
1.2.7	Φ, M *Kylix*	-	2	1
1.2.8	Φ, M Laurel Sprig	-	2	5
		11	14 (+2)	**70**

* (+1) additional carried over die identified by Waggoner, *Alexander Mint*, not found in PELLA.

Table 4. Obverse dies and sequence of issues.

Sequence No.	Mint Controls	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
1.1.1	Φ/M	X	X	X	X							
1.1.2	Φ, M	X	X	X								
1.1.3	M, Φ			X	X							
1.2.1	- , M					X						
1.2.2	Φ, M					X	X	X	X	X	X	X
1.2.3	Φ, M Grapes										X	≈
1.2.4	Φ, M Dolphin											X
1.2.5	Φ, M Trident										≈	X
1.2.6	Φ, M Ivy Leaf										X	
1.2.7	Φ, M *Kylix*										X	X
1.2.8	Φ, M Laurel Sprig										X	X

≈ Waggoner, Alexander Mint, noted two additional examples of obverse die links involving A10 and A11 among the coins of the ANS and/or other collections. However, the coins could not be located in the PELLA database.

The catalogue illustrates that the early and later parts of Group 1 were not struck sequentially. Dies A1–A4 and A10–A11 struck multiple types in an interwoven, obverse die linked manner (Table 4), while the intervening A5–A9 appear to have serially struck sequence type 1.2.2. The progression of die wear indicates that the mintage of 1.1.1 (Cat. Nos. 1–15) occurred in parallel with that of the earliest of 1.1.2 (Cat. Nos. 16–30), while 1.1.3 (Cat Nos. 31–33) from a single reverse die paired to obverse dies A3 and A4 was the last of the Group 1.1 issues. Group 1.2 obverse dies A6–A10 each saw first use in sequence type 1.2.2. A5 was first used to strike 1.2.1 (no Φ mint control), before striking sequence type 1.2.2, while A11 was first used for the dolphin symbol type 1.2.4, before its use to strike 1.2.2.

Issue 1.2.1 (Cat. No. 34) that was struck from obverse die A5 paired to a single reverse die is notable for absence of the Φ mint control in the left field[10]. This type is known from three examples documented by Waggoner[11] of which only one specimen could be located for the current study. Relative to its other appearances in the catalogue, obverse die A5 appears to be in its least worn state on this example (Pl. 1, 34). It is interpreted to open the Group 1.2 sequence.[12] Placed in the broader context of the rest of Group 1, it is possible that an incompletely engraved reverse die missing the Φ mint control, was pressed into service at the start of Group 1.2, perhaps reflecting a lack of familiarity with the mint control system of the newly engaged die engravers responsible for these dies. If such was the case, issue 1.2.1 is but an engraving omission on one reverse die intended for 1.2.2, similar to the possible mint control placement error inferred for issue 1.1.3. Two such possible errors occurring within the first 17 reverse dies put into use at the mint possibly might be attributed to the unfamiliarity of the engravers with the mint control system during the earliest days of the mint. Alternatively, these examples represent discrete short-lived issues, limited to the life of a single reverse die in each case.[13] Within the limitations of the data set, we have no way of discriminating between these alternatives.

10. Relative chronological significance was attached to the absence of the Φ mint control by Newell, "Alexander Hoards," 57, who placed it at the start of Group 1 and by Price, *Coinage*, 459, who placed it at the end of Group 1; the opposite conclusion based on the same detail. Both appear to have overlooked the implications of iconographic progression and style differentiation for the appropriate placement of this coin type in the sequence, derived as it is from a single die set.

11. Waggoner, *Alexander Mint*, 30, cat. no. 2a. All three examples listed from the same die set.

12. This conforms to the placement in the relative order of Group 1.2 dies outlined by Newell, "Alexander Hoards," 57, and Waggoner, *Alexander Mint*, 30.

13. Brad Nelson, personal communication via Dr. Ute Wartenberg Kagan, May 26, 2017.

Obverse die A11 was commissioned with the striking of 1.2.4 (Cat. No. 89). It was used to strike various issues bearing secondary mint control symbols, then at a later stage in its life sequence type 1.2.2, including the last examples of the latter (Cat. Nos. 111–112). The later Group 1.2 issues that carry a symbol form secondary mint control, sequence types 1.2.3 –1.2.8 (Cat. Nos. 86–91 and 96–106) are struck from obverse dies A10 and A11. These types are interwoven with the striking of 1.2.2 from the same dies. The progression of die wear on A10 and A11 indicates that the final striking of 1.2.2 occurred after last of the issues bearing symbol mint controls. This interwoven coinage is characteristic of a short-lived production. The observed pattern of die use (Table 4) is most readily explained as the result of a two-anvil operation striking tetradrachms through the first half and last quarter of the Group 1 emission (Table 5). The statistics of obverse die use reinforce this interpretation. Although 11 obverse dies were put into use initially for the striking of one of 1.1.1, 1.2.1, 1.2.2 and 1.2.4, there are 14 instances where seven of these dies were subsequently used to strike other issues (Tables 2 and 3). In effect, seven of eleven obverse dies were used as part of a shared die inventory during the striking of multiple types in an interwoven manner, indicative of parallel production.

Table 5. Transition: Group 1 to Group 2.

Date	Group 1.1 No symbols	Group 1.2 No symbols	Group 1.2 Symbols
c. 326/5			
	A1–A4 2 anvils/striking teams		
	Group 2 No symbols 6 A dies 4+ anvils/striking teams	A5–A11 1 anvil/striking team	A10–A11 1 anvil/striking team
c. 325/4		Group 2 33 Symbols 77 A dies 15+ anvils/striking teams	

ICONOGRAPHIC DEVELOPMENT

The progression of iconographic development (Table 1) in Group 1.1 and the differences with Group 1.2 are of relative chronological significance. Three key developments are identified within the sixteen reverse dies of Group 1.1 that are paired to obverse dies A1–A4, which place this group at the start of the sequence. They are the changing right hand of Zeus, the developing detail of the *himation* worn by Zeus, the structure and ornamentation of the *diphros* upon which Zeus is seated. [14]

On the earliest reverse die (Pl. 1, 1) the right hand of Zeus is portrayed with a facing open palm, fingers splayed wide beneath his eagle (for detail Pl. 3, A), the *himation* of Zeus is without folds, or creases, and the *diphros* is most basic in form, its legs bear minimal ornamentation and lack any cross brace, or strut. Subsequent reverse dies portray the right hand of Zeus in profile, with an upward facing palm, sometimes in cupped form, beneath the perched the eagle (for detail Pl. 3, B–C), the *himation* progressively develops creases and folds, while the *diphros* develops a single strut and its leg ornamentation becomes progressively more defined (Pl. 1, 2–26).

The 54 Group 1.2 reverse dies, paired to obverse dies A5–A11, exclusively portray the hand of Zeus in an upward oriented profile form (Pl. 3, D). On these reverse dies the *himation* of Zeus is fully developed bearing strongly stylized creases and folds, usually depicted by paired parallel lines, in the style of those found on the early 'Alexanders' of the northern Phoenician[15] and Syrian mints, in turn modelled on the *himation* worn by Baaltars on the Tarsos staters of Mazaios. The *diphros* depicted on the reverse dies of Group 1.2 has prominently

14. The evolution, change in form, or detailing of an iconographic element is of chronological significance where that change is permanent, given effect on all subsequent dies in the sequence. The three iconographic changes noted meet this requirement. By way of contrast, the exergual or ground line, which appears on 50% of the reverse dies of Group 1.1, is not of chronological significance. It might be intuitive to believe that reverse dies bearing a ground line succeeded those without a ground line. However, on detailed analysis the ground line proves to be a variable element that comes and goes. Each of the Group 1.1 obverse dies was paired to reverse dies with and without a ground line. The progression of die wear on the obverse dies dictates a reverse die sequence that shows an alternating pattern of reverse dies without and with a ground line. The evidence indicates that the appearance of a ground line on the reverse dies was a matter of individual engraver style, rather than a change of chronological significance. Reinforcing this observation is the fact that none of the succeeding Group 1.2 reverse dies, from the hands of a different group of engravers, exhibits a ground line.

15. In particular, see the earliest Arados 'Alexanders' catalogued by F. Duyrat, *Arados hellénistiqué étude historique et monétaire*, Bibliothèque archéologique et historique 173 (Beirut: Institut Français du Proche-Orient, 2005), Group I, pl. 1, 4–25.

ornamented legs that are braced by two distinct struts (Pls. 1–3, 34–112). This depiction is among the earliest examples of Alexander's coinage to show the legs of the *diphros* braced by two distinct struts.[16] This depiction resembles the field chair of the Persian Kings described by Zervos[17] and it is from this that the iconographic model for the *diphros* beneath Zeus is derived. Early in the emission of the succeeding Group 2 the field chair iconography was replaced by that of a high-backed throne, modelled on that of the Persian Kings as depicted on two of wall reliefs found at the palace complex at Persepolis. The twin struts of the Group 1.2 type *diphros* were discarded in the transition to Group 2 coinage, in order to maintain enough space beneath the *diphros* and subsequently the throne for the large complex monogram control that is a characteristic of Group 2.

On the later reverse dies of Group 1.2 an additional mint control in the form of one of six symbols appears in the exergue (sequence types 1.2.3–1.2.8). The symbols are crudely engraved, constrained by the limited space in the exergue (Pls. 2–3, 89–101). They preempt the appearance of similar mint control symbols placed in the spatially less-constrained left field of Group 2. The 33 different symbols observed over the life of the latter include five of the six symbols found on the last issues of Group 1.2.

Although most of the rapid progression in iconographic development occurs on the reverse dies of Group 1 there is one development found on the obverse dies of Group 1.1. This occurs in the changing form of the locks of hair on the forehead of Herakles. On dies A1–A3 the prominent locks of hair resting on the forehead of Herakles were styled in a semi-circular, open half loop (Pl. 1, 1–7). On A4, the last of the Group 1.1 dies, the depiction of each of the locks of hair changed to that of a closed spiral, or circular closed loop (Pl. 1, 14). The closed loop style is a characteristic of all the Group 1.2 obverse dies (A5–A11; Pls. 1–3, 34–112). Both styles are present on the immediately succeeding Group 2 issues. The change in the portrayal of the locks of hair on the last Group 1.1 die occurred around the time that new engravers responsible for the Group 1.2 dies

16. The struts of the *diphros* are each depicted by a dotted, or beaded, line connecting the two legs facing the viewer. On the coins of Babylon, these struts are clear and distinctly separated from the main frame of the *diphros*, consistent with the depiction of the "field chair" of the Persian Kings. On earlier eastern depictions, what might be interpreted incorrectly as the top strut is not a strut at all, but a beaded decorative element of the *diphros* frame immediately beneath the seat platform. It has no open space between it and the seat frame and is thus not a bracing strut, but rather decorative element of the seat frame.

17. O. H. Zervos, "Near Eastern Elements in the Tetradrachms of Alexander III the Great: The Eastern Mints," in *Greek Numismatics and Archaeology Essays in Honor of Margaret Thompson*, ed. O. Mørkholm and N. Waggoner (Wetteren: Cultura), 299–301, fig. 1.

arrived at the mint.[18] This may be the result of style assimilation on the last of Group 1.1 dies resultant from the arrival of the Group 1.2 engravers at the mint, in which case the engraving and commissioning of A4 would overlap with that of A5.

DIE ENGRAVERS

Although subjective in its assessment, the work of up to four die engravers can be recognized in both the obverse and reverse dies (Table 6). Two engravers were responsible for each of the Group 1.1 and Group 1.2 obverse dies. The same number of die engravers is equally represented in the reverse dies of each. On the reverse of Group 1.1 the portrayal of Zeus appears to have its origins in some of the preceding Babylonian lion staters of Mazaios, as demonstrated by a comparison of Baal on Plate 3, E–F with Zeus displayed on Plate 1, 1–26. Indeed, it is possible that the die engraver of the image of Baal on Pl. 3, E was responsible also for that of Zeus portrayed on Plate 1, 1 (Cat. No. 1), while the engraver responsible for Baal illustrated on Plate 3, F engraved the image of Zeus shown on Plate 1, 7 (Cat. No. 7). This finding differs from that of Price[19] who reached the opposite conclusion, influenced perhaps by the preponderance of Group 1.2 examples in the British Museum collection. Zeus as portrayed on the Group 1.2 coins has little stylistic parallel with that of Baal on the preceding Babylonian lion stater series. The Group 1.2 portrayal of Zeus closely resembles the depiction of Zeus on the early Alexander issues of the northern Phoenician and Syrian mints, in turn a derivative of the Tarsos mint style. These have an affinity with the Baal of Tarsos (Pl. 3, G), as portrayed on the coins of Mazaios preceding the fall of Tarsos to Alexander the Great. Unlike Group 1.1 that shows a clear pro-

18. Interestingly, Waggoner, *Alexander Mint*, 125, attributes the Group 1.2 style to Persian engravers, while that of Group 1.1 she assigns to Greek engravers. From this she concludes that the 1.2 types preceded the 1.1 types. In discussing the Group 1.1 dies A1–A5 (her dies 8–11) she writes, "This type fits mostly in the emotional style of the early Hellenistic period, and its appearance with obverse 8–11 further indicate the position of these coins in Issue I as arranged. This drastic change in style heralds the arrival of a Greek artist comparable to the one that carved a Hellenistic onyx gem in the Metropolitan Museum of Art, which bears the head of Herakles in a lion scalp." Unfortunately, this somewhat romantic notion ignores the evidence of the progression of iconographic development on the Group 1.1 coins, the parallels with the reverse style of Mazaios's lion staters, and the evidence of parallel striking involving the transition from Group 1 to Group 2. These combine to point to the opposite conclusion regarding the timing of Groups 1.1 and 1.2.

19. Price, *Coinage*, 454: "In the treatment of figure, throne, and drapery there appear to be consistent differences, and it has not been possible to identify the work of the same engraver in the two series [the lion staters of Mazaios and Group 1 Alexanders]."

gression of development in the depiction of Zeus, the portrayal of Zeus on the Group 1.2 coins is remarkably consistent, almost invariant. In general terms, the style of Group 1.1 dies is uniquely Babylonian, a distinctive style that became the basis of that of the earliest issues of Group 2 (Pl. 4, H–M).[20] It bears little comparison to that of the other contemporary Alexander mints of the period down to 323. In contrast, Group 1.2 dies have a general stylistic affinity with those of the northern Phoenician, Syrian and Kilikian mints.

Table 6. Die engravers.

Engraver	Obverse die
1	A1
2	A2, A3, A4
3	A5, A7, A11
4	A6, A8, A9, A10

On grounds of style, it is reasonable to infer that Group 1 issues started utilizing two die engravers previously engaged in the production of dies for the Babylonian 'lion staters' in the period 331/0–328/7. Later two more engravers were engaged by the mint, possibly from one of the mints in northern Phoenicia, Syria or Kilikia.[21] The work of the die engravers of the Group 1.1 obverse dies can be recognised in some of the succeeding the Group 2 dies and the rounded, fluid form of Group 1.1 is identical to that of the opening issues of the succeeding Group 2 emission (Pl. 4, H–M).

TRANSITION TO GROUP 2

The style of the last of Group 1.1 flows directly into Group 2. Moreover, the work of the first two engravers of Group 1 can be recognized in some of the dies of Group 2, where they form part of an expanded pool of die engravers. The earliest Group 2 coins include tetradrachm and dekadrachm issues (Price 3598–3602)

20. Imaged Babylon earliest Group 2 coins are: H = ANS 1944.100.80163 (Price 3599); I = ANS 1944.100.80159 (Price 3629); J = BM 2002,0101.874 (Price 3634); K = ANS 1944.100.80319 (Price 3634); L = CNG eAuction 87, Lot 351 (Price 3634) and M = ANS 1944.100.80167 (Price 3639).

21. Waggoner, *Alexander Mint*, 124–125 believed the engravers of her obverse dies 2–7 (A5–A11 of this study) and associated reverse dies originated from Tarsos, although there is little to support this contention. Apparently, she was influenced in this by her belief that the Babylon Alexander mint commenced in 331/0 and thus the mobilization of engravers from Tarsos, the earliest of Alexander mints, was more likely than that of the later established mints of northern Phoenicia and Syria that pursued a derivative Tarsos style.

in the manner and style of Group 1.1 but bearing a complex monogram and letter M control beneath the throne of Zeus. They lead the introduction of symbol controls in the reverse left field of most of Group 2 (Price 3608–3687). It is likely that the striking of Group 1.1 coinage progressed directly into Group 2, contemporaneously with the production of the Group 1.2.[22] Table 5 schematically illustrates the relationship. Jointly with the symbol controls represented on the last parallel struck issues of 1.2.3–1.2.8, this carries the implication that at least two and up to six anvils were in operation striking tetradrachms through the mintage of Group 1 plus the partially overlapping initial emission of Group 2. However, this overlap can only have been for a brief period, for the six tetradrachm dies represented in the striking of the earliest Group 2 coinage are also associated later in their life with reverse dies bearing symbol type secondary mint controls in the left field.

Although the overall style and form of Group 2 is that of Group 1.1, the reverse iconography (but not the style) of Group 1.2 leads into the later Group 2 issues that bear symbol mint controls (Price 3608–3687). In this, we see a fivefold expansion of the suite of symbol based secondary mint controls, which are transferred from the exergue to the spatially less constrained left field. This is accompanied by the evolution of the field chair of the Persian Kings into the detailed high-backed throne of the Great King. The expansion of the number of symbol controls is accompanied by a very substantial increase in the number of closely-knit, interlinked obverse dies indicative of massive parallel striking, perhaps involving more than 15 striking teams and anvils at the peak of production of the Group 2 emission.[23] It is possible that the symbols were initiated as a secondary mint control to identify clearly the output from each anvil for the purposes of internal accounting and reconciliation in a production environment characterized by a multitude of striking teams and anvils. The merits of this theory, and some of the alternatives, are detailed below under the heading "Controls and Symbols."

The 33 different symbols observed over the life of Group 2 include five of the six symbols found on the last issues of Group 1.2. Missing is the laurel sprig

22. Le Rider, *Alexander*, 222 expressed a similar view "I wonder whether Group 2 was not struck partly in parallel with Group 1. Both Groups, in fact begin with coins lacking secondary officials [symbols], and as I have said, they then have five symbols in common. Conceivably the need to issue a plentiful coinage in a hurry induced the mint authorities to use another workshop, which would have wound up eclipsing the first and led to its disappearance."

23. Waggoner, "Tetradrachms," 271 and table 3 noted one obverse die linked to reverse dies bearing 15 different symbols that in turn link it to 8 other obverse dies, and thence by 5 reverse die links to other obverse dies.

symbol of Group 1.2. The absence of this symbol on Group 2 coinage may be the result of the fact that this symbol was readily confused with that of the dolphin, particularly on Group 1.2 coins struck incompletely, or slightly off center. This potential for confusion is evident in one of the modern day attributions to 1.2.4 (Price 3586) bearing the dolphin symbol, versus 1.2.8 (Price 3588) with the laurel sprig symbol. An example is to found in the attribution of ANS 1944.100.80194 (Cat. No. 103) where what is described in the ANS attribution file as a dolphin proves to be an incompletely struck laurel sprig that can be clearly identified as such on more complete strikes from the same reverse die (P3 of Cat. Nos. 101–103). Any confusion in the reading of these symbols on struck coinage might compromise the mint's internal control process. Hence, a possible reason for the abandonment of one of two the symbols after a brief trial period during the striking of Group 1.2.

A similar line of reasoning, leads to the conclusion that the scope for slightly off center strikes to compromise the reading of symbols placed in the exergue would have become apparent in this Group 1.2 trial. Cat. No. 92 is evidence of this. Here a slightly off-center strike is accompanied by either an irregularity on the reverse flan edge at 6 o'clock, or the topmost part of a symbol. As a result, different vendors in two auctions of the same coin attributed it variously as an example of Price 3581 (sequence type 1.2.2), or Price 3584 (sequence type 1.2.7).[24] Analogies to this are also present on the few earliest examples of Group 2 that were struck with an exergual symbol (Price 3629, 3634 and 3639), before the explosion of secondary mint control symbols placed in the left field. On a number of examples of these three Group 2 types the correct attribution can only made by reverse die matching to a more complete and centered strikes of the same type. An example is Plate 18, J (BM 2002,0101.874) where the trident is off flan. The PELLA database contains a number of similar examples attributed to Price 3629, 3634 and 3639, where the attribution is based on reverse die matching to more complete reverse strikes of the relevant type. As a result, when the number of symbol-based secondary controls expanded greatly in Group 2, they were placed in the more spacious and thus less strike compromised left field. The three exceptions to the latter placement of the secondary control occur among the earliest coins of Group 2 and carry the control symbol in the exergue; Price 3629 bearing a *kerykeion* (Pl. 4, I), Price 3634, which carries the trident-head (Pl. 4, J–L) and Price 3639 marked by a club (Pl. 4, M). All three are struck from two or more obverse dies and are obverse die linked to an example of Price 3599 bearing no symbol controls (Pl. 4, H, I, J and M), with the linking obverse die

24. Thanks to Brad Nelson, personal communication via Dr. Ute Wartenberg Kagan, May 26, 2017 for highlighting the attribution ambiguity associated with catalogue entry no. 92.

from one of the obverse dies from the hand of one of the engravers responsible for Group 1.1 (engraver no. 2, Table 6). Each type was struck from reverse dies featuring a mix of iconographic detail, some featuring a *diphros* (Pl. 4, I, J and L) and others a high-backed throne (Pl. 4, H, K and M), placing them in the iconographic transition from the former to the latter. The placement of the symbols in the exergue, accompanied by the mix of *diphros* and throne on the reverse dies, suggests that these issues fall in the transition from Group 1 to Group 2, probable contemporaries of the later Group 1.2 types bearing exergual symbols, in particular type 1.2.5 (Cat No. 90), which bears the trident-head control.[25]

The final change associated with the transition to Group 2 was the abandonment of die adjustment. Plausibly, this step was undertaken to improve productivity. The potential gains in the latter are the result of two effects. Firstly, removing the need to align unhinged dies with each strike would result in a faster strike rate and greater output. Secondly, permitting the punch die to be placed with a variable axis orientation with respect to the anvil allowed greater working flexibility around the anvil, while spreading the cumulative strain resultant from repeated hammer blows more evenly throughout the die, extending its life. There is evidence for this outcome in the 25% reduction in the estimated average reverse to obverse, or die pairing die ratio (P/A) between Groups 1 and 2 that is detailed below.

SIZE AND DURATION OF EMISSION

Eleven obverse dies and 70 reverse dies are identified in the catalogue of 112 coins. All obverse dies are represented by multiple coins in the catalogue; there are no obverse singletons in the sample (Table 7a). The sample of original obverse dies in the catalogue is complete, demonstrated by the very high characteristic index (*n/d*) of 10.2 and the statistical coverage (*Cest*) of 1.0. However, the geometric model proposed by Esty[26] estimates that 12 original obverse dies were used to strike Group 1, with a ±1.0 die uncertainty at the 95% confidence level (Table 7a). A possible explanation for this apparent statistical inconsistency is that the frequency distribution of obverse dies (Fig. 1) does not truly fit the

25. This sequencing of Group 2 types is readily accommodated within a reworking of Waggoner's Series II sequence, while honoring the reverse die links she recognized. It is but one of a number of sequencing issues identified in Waggoner's Issue II sequence. The latter was influenced by her underlying assumption of a sequence of annual issues spread over six years, rather than a continuum of massive parallel striking of shorter duration, favored by Price and Le Rider.

26. W. W. Esty, "The geometric model for estimating the number of dies," in *Quantifying Monetary Supplies in Greco-Roman times*, ed. F. de Callataÿ, Pragmateiai 19 (Bari: Edipuglia, 2011), 43–58.

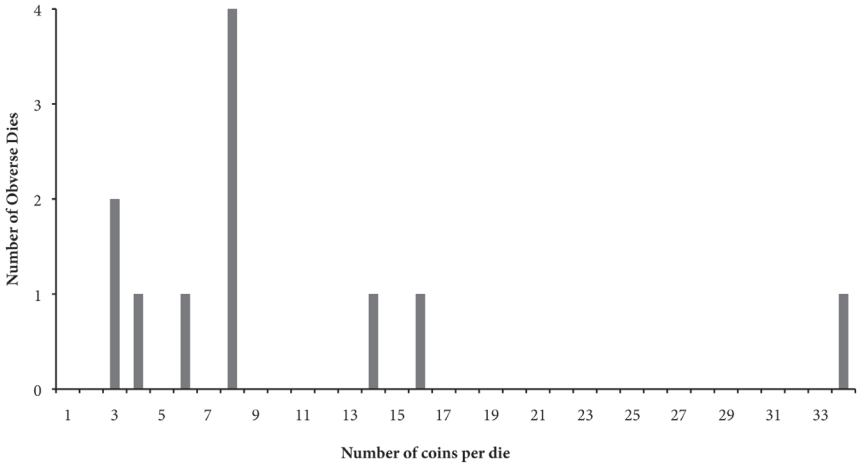

Figure 1. Obverse die frequencies.

geometrical model proposed by Esty. The very high frequency of A10 in the catalogue (30 percent of the catalogue) suggests that the sample might not be random. Arguably a better fit with the data is obtained using the negative binomial model detailed by Esty,[27] which indicates that the sample of obverse dies is complete, to the extent that an estimated 11 original dies (±1.0 die) were used to strike Group 1. Based on two slightly different models of the consequences of die failure, these two estimates of the differing number of original obverse dies commissioned at the mint essentially fall at one of the upper and lower bound of the 95% confidence levels attached to each estimate, so that no meaningful discrimination can be made between the two estimates.[28]

Based on an average obverse die life of 20,000 coins,[29] the estimated 12 original dies commissioned for Group 1 could have struck 240,000 tetradrachms on the Attic weight standard of 17.2 grams, equivalent to the mintage of 158.8 Attic talents, or 4.1 metric tons of silver (Table 7b). With an assumed average daily

27. W. W. Esty, "How to estimate the original number of dies and the coverage of a sample," *NC* 166 (2006): 359–364.

28. These estimates are statistical approximations only. Each is based on a mathematical model underpinned by inherent assumptions regarding the processes influencing die life and the consequences of such for the frequency of dies in a sample. They provide a best estimate of the original number of dies, rather than an exact figure, something we can never precisely know. This occurs despite the superficial precision of figures, often quoted to two decimal places; a physical impossibility in respect of the original number of dies commissioned.

29. F. de Callataÿ, "Quantifying Monetary Production in Greco-Roman Times: A General Frame," in *Quantifying monetary supplies in Greco-Roman Times*, ed. F. de Callataÿ, Pragmateiai 19 (Bari: Edipuglia, 2011), 9.

striking rate of c. 1,000 coins per day,[30] this volume of coinage could have been struck in around eight months with a continuous single anvil striking operation, or four months in the case of operation based around an average of two anvils in operation throughout the mintage.

Table 7a. Catalogue statistics.

	Obverse dies A	**Reverse dies P**
Sample size *(n)*	112	112
Observed dies *(d)*	11	70
Singletons (d_1)	0	45
Characteristic index *(n/d)*	10.2	1.6
Coverage *(Cest)*	1.0	0.6
Estimated original dies *(Dest)*	12.2	186.7
95% Confidence interval	11.2–13.3	133.4–262.2

Table 7b. Tetradrachm Mintage.

	Observed A Dies	**Estimated Original A Dies**	**Coins (million)**	**Attic Talents**	**Metric Tons**
Babylon Group 1	11	12	0.24	159	4
Babylon Group 2	77	86	1.72	1,138	30
Total	88	98	1.96	1,297	34

Table 8a. Number of reverse dies paired to each obverse die.

A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**
6	4	5	2	4	2	3	5	4	27	11

30. Studies of Roman coinage and the results of modern experimental striking studies suggest that a rate of up to ten times this may have been achievable in the production of Roman denarius coinage. Larger denomination Hellenistic coinage production rates are likely to have been appreciably lower. Rather than the physical striking of a coin, the bottleneck that constrained a daily coinage production rate was the manufacture of coin blanks involving the fusion of a precisely measured weight of precious metal into a blank, preparatory to striking. This most certainly took longer than the seconds taken to complete a coin strike, so that in all likelihood the production rate per anvil was constrained by the rate of manufacture of the blanks for striking.

Based on the observed die counts, the average reverse to obverse die ratio (P/A) for the total sample is 6.4. Die A10 was paired with 27 reverse dies, while A11 was used with 11 reverse dies (Table 8a). These two obverse dies saw extended use, evidenced by advancing obverse die wear patterns, in addition to the high die pairing ratios. Combined they account for 46 percent of the catalogue and were used to strike seven of the eleven Group 1 sequence types (Table 2).

Using the observed die count for the determination of the average reverse to obverse die ratio (P/A) potentially understates reality by a significant margin, due to the under sampling of original reverse dies in the catalogue. The catalogue of reverse dies has a characteristic index (*n/d*) of 1.6 (one tenth that of the obverse dies) and a modest statistical coverage (*Cest*) of 0.6 (Table 7a). Using the geometrical method, an estimated 187 original reverse dies were commissioned for Group 1, with an associated 95% confidence interval of 133–262 dies (the low and high estimates in Table 8b). This large number of estimated original reverse dies is consistent with the observation that sixty percent of reverse dies in the catalogue are singletons and the fact that only three examples of reverse die linked obverse dies are represented in the sample.

Table 8b. Estimated original dies and average P/A ratio.

Babylon	**P dies**	**A dies**	**P/A**
Group 1			
Observed	70.0	11.0	6.4
Estimated	186.7	12.2	15.3
Low Estimate	133.4	11.2	11.9
High Estimate	262.2	13.3	19.7
Group 2			
Observed	432.0	77.0	5.6
Estimated	985.8	85.6	11.5
Low Estimate	878.5	82.7	10.6
High Estimate	1,106.2	88.5	12.5

The estimated average reverse to obverse die ratio (P/A) is 15.3, appreciably higher than 6.4 determined from the observed dies in the catalogue (Table 8b). Using the low estimate for the number of original reverse dies, this ratio only falls to 11.9. The statistically derived P/A ratio of 15.3 implies an average estimated life of only 1,307 coins for each reverse die commissioned (assuming an

obverse die life of 20,000 coins). Using the lower bound 95% confidence level estimated average reverse to obverse ratio of 11.9 extends the estimated reverse die life to 1,675 coins. The statistical estimates point to a reverse die life of ±1,500 coins. The catalogue represents a sample rate of about 1:2,143 of the coins originally struck (112 coins from an estimated 0.24 million coins struck), so many reverse dies will not be represented in the small sample of the original coinage. Any new coin added to the sample/catalogue has a 40 percent probability (1–*Cest*) of originating from an unrecorded reverse die.

Table 9. Tetradrachm average die paring ratios (P/A) down to c. 324/3.

	Sample Size	**Observed**			**Estimated Original**		
	(*n*)	P dies	A dies	P/A	P dies	A dies	P/A
Babylon Group 1	112	70	11	6.4	187	12	15.3
Babylon Group 2	769	432	77	5.6	986	86	11.5
Damaskos	450	298	54	5.5	882	61	14.4
Tyre	157	83	20	4.2	176	23	7.7
Sidon	65	33	14	2.4	67	18	3.8
Arados II*	97	58	23	2.5	144	30	4.8
Arados	51	15	15	1.1	21	19	1.1
Karne	19	11	5	2.2	26	7	3.9

* Arados II = Price 3424 attributed to Byblos by Price.

Although the estimated average reverse to obverse die ratio appears high, similar results have been determined for the mint at Damaskos, which also struck its coinage in a short time on multiple anvils (Table 9). So far as examined by the writer, for the eastern mints of Alexander III that struck their coinage in a steady serial manner, the statistically estimated average die pairing ratio is less than 7.7 (Table 9). Some process, or factor, appears to have operated in the newly opened mint at Babylon that resulted in a shorter average reverse die life than usually encountered in the contemporary mints of the littoral eastern Mediterranean. The best clue we have comes from the die study. With few exceptions, the catalogue coins show little evidence of significant reverse die wear, suggesting that the reverse dies were subject to premature fracture breakage before die wear advanced to a significant degree. Examples in the catalogue that show the early signs of reverse die fragmentation breakage, suggestive of die alloy embrittlement, include Cat. Nos. 30, 49, 85, 106 and 109. The bronze alloy from which the Babylon dies were made may have contained impurities leading to

intergranular embrittlement in the alloy, or a less than optimum manufacturing process for the alloy may have caused greater embrittlement than usual.[31] Under the stress of repeated hammer blows, alloy embrittlement would result in the rapid growth and propagation of micro fractures, with little surface expression, sufficient to cause premature reverse die fragmentation, fracture and breakage, with little sign on the die's working surface, until the point of fragmentation failure. The anvil die being subject to less stress loading, would be less prone to this failure mechanism, although some obverse die examples in the catalogue also show evidence of fragmentation failure. Included in the latter, is obverse die A10 that in its earliest wear state in the catalogue exhibits the effects of fragments dislodged from the die on the jaw of the lion skin and the neck of Herakles. During the working life of this die, these appear to have been partially removed by die re-cutting, or smoothing, of the affected areas, only to return and grow in size. Obverse die A11 in its later use shows a pattern of early fragmentation on the neck of Herakles (Cat. No. 106). Die A3 in its final state shows a similarly large piece missing from the die on the neck of Herakles and tie of the lion skin (Cat. No. 32). These observations suggest that embrittlement was a factor on both obverse and reverse dies, but its consequences were more profound for the reverse dies, which received directly repeated, heavy hammer blows.

Another contributing factor to premature reverse die failure may have been the high volume of production from multiple striking teams in a competitive environment. This could have resulted in the mishandling of reverse dies with greater stresses imposed on the punch die, contributing to earlier die failure than occurred in the more leisurely serial striking of an annual issue that was often the norm elsewhere (e.g. Sidon and Tyre). Within the uncertainty attached to our small data sample, possible support for this proposition is found in the observed die pairing ratios (P/A) for the component of Group 1 struck serially, ver-

31. Probably bronze alloy dies were used, rather than steel dies, as evidenced by the complete absence of any indications of die rust on the struck coins. Most alloys, including bronze, can exhibit failure by cracking in circumstances where the apparent applied stress is well below that at which failure would normally be expected. Bronze (and steel) alloys are no exception to this, and probably exhibit a wider variety of failure mechanisms than any other category of material. There are several forms of embrittlement, including intergranular embrittlement and embrittlement caused by overheating during the hardening and tempering in the manufacture of dies. Without detailed knowledge of the nature of the dies involved, their metallic composition and details of manufacture, it is not possible to be more precise about the nature of the embrittlement and the resultant rate of progression to fracture failure and fragmentation under the stress of repeated heavy hammer blows and the resultant accumulation of strain in the die.

sus that struck in parallel. Obverse dies A5–A9 represent the serial component of the coinage with an observed die pairing (P/A) ratio of 3.2 in contrast to the observed average P/A ratio of 9 for the balance of obverse dies used in a parallel striking process. This subject goes well beyond the scope of this paper to explore in depth. Suffice to note it here because of its implications for the mint's production process, for a corollary of the statistically derived reverse die life is that on average at least one new reverse die would need to have been commissioned daily throughout the striking of Group 1 with two anvils in operation (daily output c. 2,000 coins). This frequency of reverse die replacement requirement goes some way to explain the fact that despite the small size of the emission, two die engravers appear to have been engaged at all times for its short duration.

Evidence of a Learning Curve

Based on the application of Esty's geometrical model to the results of Waggoner's die study of the Group 2 coinage,[32] the Babylon Group 2 emission has a similarly high, though somewhat reduced, estimated average reverse to obverse die ratio (P/A) of 11.5 (Table 8b). The observed and estimated average reverse to obverse die ratios of Group 2 show an 13% and 25% reduction respectively, over those of Group 1. This reduction is statistically significant. It indicates that the average reverse die life of Group 2 improved by 33% over that of Group 1. This may reflect an improvement in die metallurgy and manufacture. Additionally, the increasing experience and developing skill of those striking the coins may have resulted in a reduction of the force with which the hammer struck the punch, to the extent that it was just sufficient to impart the design on the flan. This would have lowered the cumulative strain in the die and extended its life before embrittlement fracture breakage occurred. Another clue to the improved die life may be in the abandonment of the adjustment of unhinged dies that was a characteristic of the striking of Group 1. The removal of the need to align unhinged dies with each strike would result in a faster strike rate and greater throughput, improving striking efficiency. Simultaneously, this would permit the relative rotation of the orientation of reverse die with respect to both the anvil and the hammer from one strike to the next. This has the potential to reduce the rate of accumulation of strain in the reverse die, compared to that resultant from a repeated fixed orientation of die with respect to the anvil and the hammer blow. The resultant reduction in the rate of embrittlement fracture propagation in the die, would contribute to an improvement in reverse die life. It is likely that a combination of these factors contributed to the extension of die life and the lower average

32. Esty, "Geometric Model," 46 and Waggoner, *Alexander Mint*, 33–53.

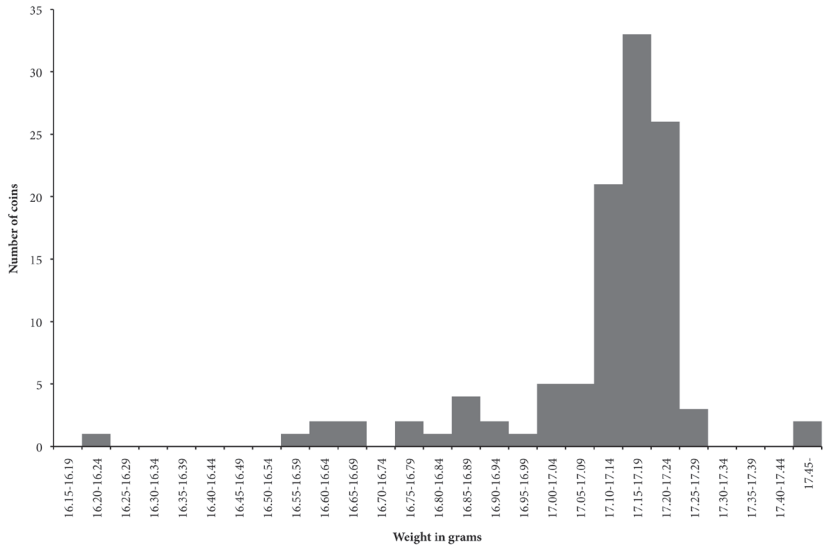

Figure 2. Metrology: Babylon Group I.

reverse to obverse die ratio for Group 2 compared to that of Group 1.

In summary, it appears that the mint climbed a learning curve in developing its multi-anvil production process as Group 1 transitioned into Group 2. This had the effect of extending the estimated average die life by 33% accompanied by a material reduction of the reverse die replacement frequency. This afforded substantial productivity gains across a multi-anvil operation in terms of both throughput rate and the die-engraving requirement necessary to sustain it.

METROLOGY

The metrology of the Group 1 tetradrachms in the catalogue shows a modal peak at slightly less than 17.2 grams, consistent with striking the coinage on the Attic weight standard (Fig. 2). The coin weights appear to have been well constrained to the Attic standard, reflecting a good degree of quality control in the manufacture of silver coin blanks for striking, from the earliest days of the mint.

CHRONOLOGY AND THE RIGHT HAND OF ZEUS

The earliest documented hoard appearance of Group 1 coins is a hoard in commerce that most probably derived from Syria or Lebanon, described by Davesne and Lemaire;[33] the Syria or Lebanon Hoard *CH* 8.185. It contained one example

33. A. Davesne and A. Lemaire, "Trésors hellénistiques du Proche-Orient I–IV," *Revue Numismatique* 151 (1996): 51–76.

of each of 1.1.1 (Cat No. 9) and 1.2.2 (Cat. No. 62), plus 28 Group 2 types, in a total of 131 Alexander III tetradrachms dating to his lifetime. This hoard closed c. 323. The largest recorded find of Group 1 coins is the Demanhur Hoard (*IGCH* 1664) that closed in 318. Other hoard occurrences of Group 1 tetradrachms include the Abu Hommos (*IGCH* 1667), Aleppo (*IGCH* 1516), Kuft (*IGCH* 1670), Haynes Babylonia (*IGCH* 1761), and Basra Hoards (*IGCH* 1786), all of which closed later than the Demanhur Hoard. Although indicating that Group 1 and 2 coins mostly circulated to the west of Babylonia, the hoard record provides little basis to refine the chronology of Group 1 within the lifetime of Alexander III.

The best chronological indicator we have for the start of the Alexander mint at Babylon is found in the portrayal of the outstretched right hand of Zeus on the first reverse die of type 1.1.1 (Cat No. 1; Pl. 1, 1). The outstretched hand is portrayed with splayed fingers extending from an open palm facing the viewer (Pl. 3, A). This is a unique occurrence in the iconography of the Babylon mint. On the reverse of all other Group 1 coins, the right hand of Zeus is seen in profile oriented upward beneath the eagle, often with the fingers in a cupped form (Pl. 3, B–D).

Table 10. Eastern mints: tetradrachm dies before the change in portrayal of Zeus's right hand.

Mint	**Start date**	**Obv. dies**	**Rev. dies**	**Change in portrayal of Zeus's right hand**	**Data source**
Myriandros	c. 330/29	10	25	Price 3223	Newell (1919)
Arados	c. 328/7	9	11	Price 3305	Duyrat (2005)
Arados II*	c. 328/7	11	28	Price 3424	This study
Karne	c. 327/6	2	2	Price 3429	This study
Byblos	c. 325/4	0	0	-	This study
Berytos	c. 321/0	0	0	-	This study
Sidon	333/2	9	18	Price 3475	Newell (1916)
Tyre	332/1	15	65	Price 3260	Newell (1916)
Damaskos	326/5	1	1	Price 3197	This study
Babylon	326/5	1	1	Price 3579	This study
Susa	c. 325/4	0	0	-	This study

* Arados II = Price 3424 attributed to Byblos by Price.

The portrayal of the right hand of Zeus with a facing open palm occurs on the earliest Alexander issues of Amphipolis, Tarsos, Myriandros, Arados, Arados II, Karne, Berytos, Sidon and Tyre (Table 10). This depiction of the right hand of Zeus was introduced on the first of Alexander's tetradrachm coinage struck at Tarsos in 333, which provided the model for the other eastern mints in the immediately following period.[34] However, in the early to mid-320s, this portrayal of Zeus's right hand changed in the eastern mints of the Macedonian empire, replaced by a hand in profile, facing upward beneath the eagle of Zeus. The profile hand prevails on the first and later Alexander issues from the eastern mints that commenced after 325 (Table 10). With the exception of the first example of 1.1.1 (Cat. No. 1; detail Pl. 3, A) the upward facing hand in profile is found on all the Babylon Group 1 coins in the catalogue struck from the last 69 of 70 reverse dies. This suggests that the mint at Babylon commenced striking 'Alexanders' around the time that this change was fully implemented across the mints of the east.

The upward oriented hand in profile makes it earliest appearance on the coinage of Sidon and then later at Tyre. The change in portrayal from the preceding facing palm hand to that of the profile hand is abrupt from one emission to the next, without any commingling of the two types on successive dies. At Sidon nine obverse and eighteen reverse dies preceded the change[35] in portrayal of the right hand of Zeus. At Tyre 15 obverse dies and at least 65 reverse dies preceded the change.[36] These mints dated the coinage in Aramaic (Sidon) or Phoenician numbering (Tyre) with reference to a local era specific to each city. At Sidon the change in the portrayal of Zeus right hand occurs between Price 3474 and Price 3475. These are the first two of four undated tetradrachm issues that fall between those dated to Sidon Year 2 (332/1) and Year 7 (327/6). On the assumption that each issue represents an annual output, then the change to the upward oriented profile hand on Price 3475 may have occurred as early as Sidon Year 4 (330/29).

At Tyre, a similar change occurs during the issue dated to local year 24 (Price 3260). The Tyrian era of the coinage of Alexander is directly associated with that of the preceding Persian King Ozmilk (Azemilkos) whose reign commenced in 349/8. Tyre fell to Alexander in year 17 (333/2) of the reign of Ozmilk. The latter is now believed to have been reappointed to govern the city, so that the dating of the Alexander coinage from this mint continued on the era of Ozmilk until

34. Le Rider, *Alexander*, 119–125.

35. Die count sourced from E. T. Newell, *The Dated Alexander Coinage of Sidon and Ake,* Oxford: Oxford University Press, 1916).

36. Die count sourced from Newell, *Dated*, with *Ake* of Newell reattributed to the mint of Tyre, consistent with the interpretations of Lemaire 1976 and Le Rider, *Alexander*.

his death in year 39 or 311/10.[37] Thus, the change of the portrayal of the hand of Zeus that occurred during the issue of Tyre year 24 is dated to 326/5.

At Tyre the transition to the outstretched hand in profile proved difficult for the engravers. Initially the upward oriented profile hand was portrayed quite clumsily and variably for two issues before the detail of this iconographic element was resolved fully. A similar phenomenon, evidenced by crude, uncertain engraving of the right hand of Zeus in profile form, is observed at the other mints including Babylon, over a number of issues following the change. In some cases the hand is reduced to little more than a stump (Pl. 3, B) on the end of the arm, in others a spider-like cluster of upwardly curved fingers. This clumsy and crude portrayal, in evidence at a number of mints, suggests that the transition from the old to the new style of hand at each mint was not a result of style assimilation, nor a discretionary stylistic preference of the die engravers involved, but rather a change dictated by the administration, or mint authority in each case. In the case of Babylon the upward facing, profile hand was only fully resolved in a consistent and sustained manner with the striking of the succeeding Group 2 emission. This implies a short duration for Group 1, as the die engravers appear to have had insufficient time to adapt to and developed the new portrayal of the right hand of Zeus in a consistent way during the striking of Group 1.

Although the change appears to have been mandated by each mint's administration, it was not synchronous, occurring first at Sidon, then up to four years later at Tyre in 326/5. Based on a comparison of die counts preceding the change at each mint (Table 8) it appears that Tyre was amongst the last of the eastern mints established in the period 333/2–327/6 to adopt the new profile style for the right hand of Zeus. Only one obverse and one reverse die preceded this change of style at each of the mints of Babylon and Damaskos, so that it appears likely that these mints opened at the time when the depiction of the profile form hand of Zeus became the 'official' norm in the region. The best estimate of the date of this is 326/5 with reference to the dated coinage of Tyre. All those mints that opened after 325 issued exclusively coinage with the extended right hand of Zeus depicted in the profile manner. A similarly timed, though somewhat less clear-cut development in the iconography of the extended right hand of Nike is observed on the lifetime issue gold staters of Alexander III struck at the eastern mints. The Babylon Group 1 gold staters (Price 3592-3593) were struck with Nike's outstretched hand portrayed in profile holding the wreath of victory, con-

37. A. Lemaire, "Le monnayage de Tyr et celui dit d'Akko dans la deuxième moitié du IVe siècle avant J.-C.," *Revue Numismatique* 18 (1967): 11–24. and Le Rider, *Alexander*, 130–134, with the reign of Ozmilk and subsequent local era dated per the chronology established by

sistent with the portrayal of the hand of Zeus on all but the first tetradrachm in the catalogue.

The reason for the change in the portrayal of the right hand of Zeus is uncertain. It may have been a stylistic preference that once developed at Sidon, spread throughout the region, although this is difficult to reconcile with the often crude and clumsy way in which it was given effect by the die engravers. Alternatively, it may have been prompted by the possibility that the open facing palm hand held negative, offensive, or insulting connotations for some of the recipients of the coinage, much as occurs in Greece today.[38] It is notable that with the exception of Macedonia, the open facing palm never appeared on coinage from the mints in the Greek population centres of Asia Minor, or mainland Greece. In Macedonia, the change in the portrayal of Zeus's right hand was introduced, but the facing palm persisted, comingled with the profile hand on the coinage of Amphipolis until after Alexander's death. If there was sensitivity to the portrayal of the facing open palm hand, it did not apply in Macedonia, or Tarsos, where this portrayal of the right hand originated. Here it had been adapted from the iconographic precedent in the depiction of the outstretched hand of Baaltars on some of the Tarsos stater issues of Mazaios such as that on Pl. 3, G (ANS 1967.152.502) and *SNG Levante* 100, which were struck preceding Alexander III's success over the Persian army at Issos in 333.

CONTROLS AND SYMBOLS

The interpretation of Hellenistic mint controls consisting of letters, monograms and symbols is a contentious subject with the various alternative interpretations summarised by Callataÿ[39] who wrote "Not all these explanations are convincing, and several appear very unlikely or exceptional (magistrates, liturges, engravers, military officers or units). The marks are best viewed as internal control marks, whose number and efficiency have to be considered in their broader archival context." It is through this prism, combined with that of process engineering, that the author has weighed the options for the interpretation of the of the mint controls on the Babylon Group 1 coinage. This includes the development of the

J. Elayi, "An Updated Chronology of the Reigns of Phoenician Kings During the Persian Period (539–333 BCE)," *Transeuphratene* 32: 11-43. and J. Elayi and A. G. Elayi, *The Coinage of the Phoenician city of Tyre in the Persian Period (5th-4th cent. BCE),* Orientalia Lovaniensia Analecta 188, Studia Phoenicia XX (Leuven/Paris/Walpole, MA: Peeters), 365-389.

38. The *faskeloma* is a traditional gesture of insult amongst Greeks today. It consists of extending the fingers of the hand while presenting the palm of the hand towards the person who is to be insulted. The same gesture carries offensive overtones in a number of other cultures.

39. Callataÿ, "Quantifying," 39–62.

symbols that appeared in the volumetrically negligible closing issues, 1.2.3–1.2.8, all within the context of the transition to the massive parallel striking that came to characterize Group 2.

The letters Φ and M in various placement permutations characterize Group 1. The earliest coins place both controls beneath the *diphros* and this convention prevailed for a limited time, reflected in the first eight reverse dies of the catalogue, representing less than 12% of the observed dies. Following this brief period, the convention changed to one of the placement of one letter (Φ) in left field, the other (M) beneath the *diphros*. Improved legibility of the controls was the result. In the catalogue, there are two variations from this placement convention. These involve placement reversal (1.1.3), or the absence of the letter Φ (1.2.1) from the left field. In both types, a solitary reverse die is represented in the catalogue, so that they may simply be the result of engraver error in the execution of the general convention that prevailed for 88 percent of the Group 1 mintage bearing the two letters.

What is the significance of these control letters? The die study and its context provide no direct clue. Unsurprisingly, they do not change for the duration of the small mintage of Group 1. Conventional wisdom attributes each to represent a mint official charged with overseeing the quality and integrity of the mintage. If so, then this responsibility fell to the same two individuals throughout Group 1, consistent with its small volume and limited duration. The writer has no better interpretation for the significance of these mint control letters.

Recently, Aperghis proposed that the letter Φ is indicative of Philoxenos who "was responsible along with Koiranos, for Alexander's travelling treasury."[40] A problem with this interpretation is that in 331 Philoxenos was given the commission for tax collection "in Asia west of the Taurus,"[41] a responsibility covering multiple satrapies in Asia Minor. With this appointment, Harpalos, recently returned from exile, was appointed to fulfil his responsibility for the royal treasury. Philoxenos administrative competence in Asia Minor proved so great that he succeeded Princess Ada as Satrap of Caria[42] in 326, before the mintage of Group 1. Along with other satraps, he arrived in Babylon in the Spring of 323 (two years

40. G. G. Aperghis, "Interpretation of monograms and symbols on Alexanders." Apparently, unpublished paper posted in late May 2017 under the name of G. G Aperghis on the Academia.edu website. No publication details accompanied the document, which seeks to extend Aperghis's 2010 proposal on recipient and end-user identification on Seleukid coinage to that of Alexander III.

41. Arrian *Anab.* 3.6.4 from *The Landmark Arrian* ed. Romm, J. 2010:109.

42. A. B. Bosworth, *Conquest and Empire: The Reign of Alexander the Great* (Cambridge: Cambridge University Press, 1995), 242.

after the Group 1 mintage) with an army from Caria in order to pay honor to Alexander III as a god and to refresh the latter's army with new troops.[43] Therefore, he cannot have been associated with the production of the Babylon Group 1 coinage.

Aperghis further posits that the letter M "appears at Babylon as that of the recipient," the general paymaster of the troops or "it may for example, have indicated the purpose of the issue; the payment of troops (*misthos*, *misthoria*)." No evidence is presented to support this conjecture. Aperghis extends this end-user identification principle to the mint control symbols that appear the last of Group 1 and characterise most of the very large Group 2 coinage. On the latter 33 symbols are identified, which Aperghis and Brad Nelson[44] contend represent various recipients of the coinage. Aperghis's underlying reasoning for this: "In a situation where a number of different military units were receiving coin at about the same time, it would make sense for a mint to control its production better by identifying different batches of coin with the monograms of the recipients and/or the symbols of the end users for whom they were intended." In the writer's opinion, this is a weak argument. It ignores the broad context within which a Macedonian Imperial mint operated. The priority of the mint was to produce most efficiently the coinage required by the king, to a required standard (metal purity and weight), without loss, pilferage or fraud. Once produced, a weighed volume of coinage shipped in a locked casket sent under guard to an end-user was all that was required to ensure the integrity of the delivery process from mint to recipient. The reconciliation of coined volume (value) produced and issued to a recipient required nothing more that than a bookkeeping entry of the weight of coinage dispatched to any end-user. No benefit, or additional control process integrity, accrued to the mint or the Imperial administration through the identification on an individual coin of the recipient, or end-user. In fact, to do so would have limited flexibility and/or changes in priority in payments made from the Imperial treasury. In the opinion of the writer, the end-user identification hypothesis lacks an underlying coherency and logic in the mint's responsibility, process, and objectives. In this, it fails the test of Occam's razor.

It is more fruitful to return to Callataÿ's view that "The marks are best viewed as internal control marks, whose number and efficiency have to be considered in their broader archival context." The context of the mint process was efficient coin production, to a defined standard and quality, in sufficient volume to meet

43. Arrian *Anab.* 7.23.2 and 7.24.1 from J. Romm, ed., *The Landmark Arrian* (New York: Pantheon Books, 2010): 307 and 309.

44. Brad Nelson, personal communication via Dr. Ute Wartenberg Kagan, May 26, 2017.

the demand of the king,[45] while mitigating the risk of precious metal pilferage and/or fraud. The die study provides additional context for this consideration. A relatively meagre volume of the coinage was struck in 326/5, in what was effectively a mint commissioning process that saw the mint expand its capacity from a two-anvil production operation to at least 15 anvils at the apogee of the succeeding Group 2 mintage.

To understand the challenges faced in this expansion requires some consideration of a mint's production process and priorities. Security and control in a single anvil mint operation is readily achieved by the oversight of two or more mint officials who physically overview the entire process from bullion delivery to the coinage exiting the mint gate, all done behind controlled and guarded doors. Expand the process to multiple anvils in a single mint and the oversight and control issues, plus pilferage and fraud risk rise exponentially. With 15 anvils operating in parallel, as occurred at the peak of Babylon Group 2 production, continuous, reliable and detailed physical oversight by mint officials would have been problematic. Rather, a process control system to ease the requirement for physical oversight would have been required to facilitate efficient, high-volume production. The key to this was the daily matching and reconciliation of inputs and outputs to and from each production team responsible for striking of coinage. At the start of each day a measured volume of bullion, or more likely precast flans,[46] was delivered to each team in a shared facility (e.g. sharing the one large secure work space and furnace). Each team then went to work. At the end of the day the output of each team was counted and weighed and reconciled back to the initial weight of metal delivered to the team, thus exposing any wastage, loss, or pilferage. To mitigate the risk of cross-team pilferage and fraud requires the accurate identification of each coin struck by each team. This requires a unique mark or stamp on the coin that is specific to each production unit in the mint. Hence, the symbols, each of which the writer believes served to identify a specific anvil and/or striking team with its product. This would have facilitated

45. Arist. *Oec.* 1.3 "…. the decision to strike coinage (when and of what nature) belongs solely to king. Coinage is in fact one of his responsibilities." Bosworth, *Conquest*, 229–245, outlines how this was given effect by the distribution of power and authority, notwithstanding the appointment of Persian sataraps: "The real power as elsewhere was in the hands of Macedonian military commanders."

46. The striking of coins can proceed at the rate of multiple coins per minute. The bottleneck in high volume coinage production is the measurement of a precisely defined weight of precious metal fragments and their fusion into a coin blank, or flan. This is a more demanding and time and energy consuming process than the striking. For this reason the writer believes that the manufacture of precious metal coin blanks was probably undertaken in a tightly controlled and managed specialist process that delivered to each of the striking teams a standard daily volume of unstruck coin blanks, in preference to raw bullion.

the quality control, accounting and reconciliation processes in the mint while ensuring their integrity through a system of unique identifiers of the individual production units on the struck coinage.

The control symbols, uniquely identifying each anvil, or striking team, facilitated quality control in an environment of massive parallel striking. Callataÿ noted with regard to coinage "…people do not care about provenances. They cared about quality: not to buy poor silver for the mint and not to risk a death penalty for issuing silver coins with a metallic content under the prescription. Thus questions like who brought the metal? or where did it come from? may be judged as irrelevant." By clearly identifying each anvil's output with a unique symbol, quality checks within the mint environment (and if necessary external to it) could identify the responsible party in the event of debasement, or substandard weight issue. This functionality of the control symbols also served as a deterrent to fraud, through their effectiveness in identifying those responsible for the coinage in a large production facility involving up to fifteen striking teams working under the one roof, behind one set of securely controlled and guarded doors.

With the identification of each production unit by a specific symbol on the reverse die, the Group 2 obverse dies were used as common, or shared inventory, by the production teams. From one day to the next, any team could use a different obverse die, while reverse dies were engraved specifically for and dedicated to the use of an anvil, or single team. This explains the very substantial obverse die linkage documented by Waggoner.[47] The presence of at least 33 symbols over the duration of the Group 2 coinage may be a consequence of one or a combination of factors. More than the 15 anvils may have been in operation at the peak of production. Alternatively, as the treasury accumulated a volume of struck coinage the set of symbols may have been periodically changed to mitigate the risk of internal fraud, for example that involving the potential substitution of previously struck coinage for newly issued bullion that could be skimmed via a double counting of previously struck coin. Another possibility is that newly introduced symbols reflected changing manpower over the duration of the Group 2 mintage. In the latter case, it might be inferred that a symbol represents the leader of each production unit. This is not that far removed the original interpretation of Newell and others, that the symbols represented 'magistrates', but in this case more specifically the leader of a production unit utilizing one of many anvils in the mint. In this case, the identity of the anvil, the striking team and the team leader are seen to be one in the same.

47. Waggoner, "Tetradrachms," 269–280.

A note of caution; the theory that the mint symbols of Babylon Groups 1 and 2 identified the product of specific striking teams/anvils in the mint is only asserted by the author with respect tothe Babylon Groups 1 and 2 coinage. There is evidence in the die studies of these two coinages of the development of a massive parallel striking process, accompanied by the implementation of the symbol controls; a causal relationship of the former with the latter. Similar functionality for symbol controls may exist elsewhere in other mints at later times, but this requires the establishment by die analysis of the 'broader archival context' in which striking occurred in order to support such an interpretation. In the absence of the supporting broader context it is problematic to seek extend the interpretation to any symbol on the later coinage issued by the successors of Alexander III the Great.

CONCLUSION

The motivation for the start of Macedonian Imperial mint operations at Babylon may have been the decision in 326 by Alexander III the Great to return to Babylonia following the army's mutiny on the Hyphasis; a return journey that would eventually take more than two years. Certainly, the expenditures and payments made on his return were substantial.[48] As far as these expenditures were paid for in coin, the preparations for such payments are likely to have commenced prior his return, so that sufficient coinage was available in the royal treasury immediately it was required by the king.

Whatever the catalyst to open the mint, the decision proved pivotal in many respects. Newell[49] wrote "The Alexander issues at Babylon are conspicuous for a style and character all of their own, and destined to exercise a great and far reaching influence on later coinages of Persia, Mesopotamia, Syria, and even portions of Asia Minor." In Group 1 we see the rapid development of this style and character, coincident with the first steps in the opening of the Macedonian Imperial mint at Babylon. The coinage exhibits a rapid succession of iconographic developments occurring over the life of little more than a handful of dies, used on two anvils over a period of as little as four to six months commencing in 326/5. This laid the foundation for the volumetrically more significant Group 2 emission that was struck in a massive parallel striking process, which at its peak involved fifteen or more striking teams and anvils. In this context, Group 1 represents the first brief steps in a commissioning period during the establish-

48. F. L. Holt, *The Treasures of Alexander the Great. How One Man's Wealth Shaped the World* (Oxford: Oxford University Press, 2016), 192.

49. Newell, *Alexander Hoards*, 17.

ment of the Babylon Imperial Mint, after which it transitioned directly into the production of Group 2, probably in parallel with the striking of the last of Group 1 (Table 5). This conclusion aligns closely with the low chronology proposed by Le Rider.[50] Although struck in much less time than the five years proposed by Price, this dating compliments the latter's suggestion that the duration of Group 2 may have been limited to the extant that "the whole of group two might have been struck in 325/4 BC."[51]

With the start of the Macedonian Imperial mint at Babylon down dated by five years, the duration of the mint's operation, over its brief life one of the most prolific in the east, is reduced to a little more than 20 years.[52] During this time, its output varied greatly from one brief period to the next, after Group 2 dependent on the flux of war between the successors to Alexander.[53] Throughout its brief history, the mint's output was anything but steady state. The rapid developments identified in Group 1 accompanied by the expansion of production into Group 2 were but a taste of what was to follow.

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50. Le Rider, *Alexander*, 224–225.

51. Price, *Coinage*, 459. With a minimum of 6 and up to 15 anvils operating continuously through the striking of Group 2 it is conceivable that the total coinage, derived from an estimated 86 obverse dies, was struck in a period of 6–12 months.

52. This reverts to the dating of the closure of the Babylon mint and its replacement by Seleukeia on the Tigris, to some time in the period 305–302; the former being the date proposed by Waggoner, *Alexander Mint*, and Price, *Coinage*. As a peripheral result of his study of the early Seleukid mint of Susa, Kritt, *The Early Seleucid Mint of Susa*, Classical Numismatic Studies 2 (Lancaster, PA: Classical Numismatic Group, 1997), proposed to down-date the closure of the Babylon mint to c. 294/3 while positing that Seleukeia on the Tigris opened c. 300. This proposed dating was adopted by Houghton and Lorber in *Seleucid Coins A Comprehensive Catalogue. Part 1 Seleucus I to Antiochos III* (New York/Lancaster, PA: American Numismatic Society/Classical Numismatic Group, 2002), 40. However, Kritt's analysis of the coinage and the hoard data on which this depends has proved inaccurate. P. Iossif and C. Lorber, "Marduk and the Lion," in *Liber Amicorum Tony Hackens*, ed. G. Moucharte et al. (Louvain-la-Neuve: Association de numismatique professeur Marcel Hoc, 2007), 345–363; C. C. Lorber, "A Hoard of Tetradrachms of Alexander III and Philip III, November 2003," *AJN* 27 (2015): 29–40; Lloyd W. H. Taylor, "From Triparadeisos to Ipsos: Seleukos I Nikator's Uncertain Mint 6A in Babylonia," *AJN* (2015): 41–97; and L. Marest-Caffey, "Seleukos I's Victory coinage of Susa Revisited: A Die Study and Commentary," *AJN* 28 (2016): 1–63, have variously highlighted the chronological errors that were carried into *Seleucid Coins* as a result.

53. Taylor, "Triparadeisos," 62–75, fig. 5.

foresight and generosity of the American Numismatic Society in making this resource available. At its inception, the study benefited from discussion with Brad Nelson and the encouragement of Arthur Houghton and Catharine Lorber to document the significance of the iconographic development observed on the earliest 'Alexanders' of Babylon. I gratefully acknowledge the generous assistance Dr. Ute Wartenberg Kagan and Brad Nelson in reviewing and commenting on the paper. Throughout, my wife Colleen was unceasing in her encouragement to complete the study.

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Plates

1 2 7 14

16 24 26 34

43

The Earliest Alexander III Tetradrachm Coinage of Babylon

Plate 2


100


101


107


112


A


B


C


D


E


F


G

The Earliest Alexander III Tetradrachm Coinage of Babylon

Plate 4