

# Productivity of Athenian Vase-painters and Workshops

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## Introduction

This paper examines the organization of the ancient Athenian pottery industry from a statistical perspective. My foundational research published in 2013 established a previously unrecognized pattern among vases attributed to Attic painters active between 600–400 BC by J.D. Beazley and later scholars.<sup>1</sup> A regularity in the numbers of extant vases for each year a painter was active, defined as the *annual attribution rate* (henceforth AR), is a new tool for studying the economics of ancient painting. The current paper aims to clarify the relationship of the AR, which is based on tallies of firmly attributed works, to the actual lifetime productivity of an ancient artisan, and what this reveals about the total number of painters simultaneously active in the Kerameikos. The conclusions apply the AR concept to whole workshops rather than individual painters.

## Attribution Rates

The inspiration for the AR is the 1959 economic study by R.M. Cook, who posited that Attic vase-painters worked at consistent rates which could be used to estimate total employment in the Kerameikos.<sup>2</sup> If one artisan had decorated 3–4 vases per year out of the total of perhaps 40,000 pots that were known at Cook's time, then about 70 painters must have been active, at least on average, over the 200 years of production. Because Beazley had also designated a large number of individual hands – about 500 from the 5<sup>th</sup> century BC – Cook thought the population should be higher by the Classical era, perhaps 100–125 painters. Next, adding the potters and staff needed to shape and fire the vases would bring the total population of the Kerameikos to 400–500, with less than half that number in the 6<sup>th</sup> century.

Since Cook did not document how he derived the underlying figures, my previous studies sought to establish annual productivity in a more transparent fashion and to include the ensuing 50 years of research. An initial exploration revealed that the AR, defined as the total number of vases for a hand divided by years of activity, is frequently close to 8 pots/year.<sup>3</sup> Building on that finding, a more comprehensive study incorporated all the attributions published through 2011 for a larger cohort of painters, following a rigorously defined methodology.<sup>4</sup> Because the choices of *which* painters were included in that study impact the relevance of the AR in other scenarios, they should be reviewed here.

First, only *long-lived* painters can be assessed meaningfully by the AR due to the imprecision in our ability to date individual vases. For example, assuming 8 pots/year of

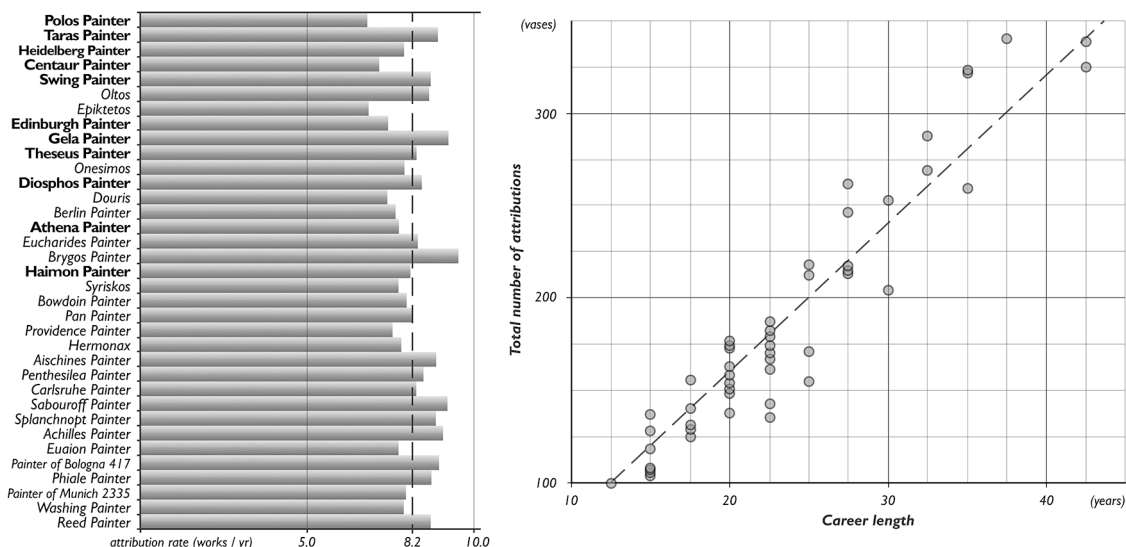


Fig. 1: Left: annual attribution rate of prolific Attic painters (more than 150 vases), excluding Makron. Names in bold painted in the black-figure technique; those in italics specialized in red-figure. Right: career length vs. total number of vases for all painters with at least 100 vases.

activity as the norm, a hand with 8 vases from a 1-year career would fall below the 5–10-year resolution at which Athenian vases are typically dated. If we dated this hand to the minimum detectable 5-year period, the AR would be greatly skewed: 1.6 instead of the actual 8. As a starting point, the painters with many surviving works are likely to have been long-lived. After compiling every hand with at least 150 attributions, amounting to 36 artisans in 2011, the AR was between 6.8–9.5 for all but one case (fig. 1).<sup>5</sup> Most of this variation is to be expected from the imprecision in dating individual careers, and such regularity is unusual with archaeological materials.<sup>6</sup> The AR of the whole set of painters, cumulatively active over more than 930 years and responsible for more than 7,500 vases extant today, can be determined at 8.2 works per year, although for individual cases we should expect variations of at least ca.  $\pm 1$  in the AR, and more for those with short or poorly known dates of activity.

Are there long-lived painters with fewer works? While they are more difficult to identify, several carefully studied hands active more than 15 years, such as Exekias and the Codrus Painter, belong to another cohort with as few as 2–3 works per year of activity.<sup>7</sup> Some of these painters preferred large or complex compositions that took more time to complete than the typical Attic vase, and so they left us fewer, albeit unusually impressive works per year – as was surely the case with the intricately painted François vase by Kleitias.<sup>8</sup> However, other hands with a low AR created unremarkable paintings. A more comprehensive explanation for the less productive artisans is that they did not paint full time. I focused on hands whose vases were signed by a *poiotes* – indicating the potter – or where the potter-work was consistent, both situations which could mean

Specialist painter model				Consistent potter-work			
Oltos	8.7	8.0	P. Munich 2335	Exekias	2.0	4.1	Amasis P.
Epiktetos	6.8	8.0	Antimenes P.	C.P.	7.4	3.7	Nikosthenes (P. N)
Douris	7.4	8.3	Theseus P.	KY P.	6.0	5.9	The Affecter
Hermonax	7.8	8.3	Eucharides P.	Heidelberg P.	7.9	6.5	Red-Line P.
Sabouroff P.	9.2	8.0	Bowdoin P.	Red-black P.	3.7	4.1	Sappho P.
Euergides P.	9.1	8.3	Carlsruhe P.	Griffin-bird P.	5.8	6.2	Niobid P.
Triptolemos P.	7.4	5.4	Calliope P.	Tleson P.	5.5	5.7	Shuvalov P.
Achilles P.	9.1	7.7	Eretria P.	Centaur P.	7.2		
Phiale P.	8.7	7.9	Washing P.				
Providence P.	7.6						
<b>8.02 works / yr</b>				<b>5.05 works / yr</b>			
partial evidence							
Gela P.	9.2	9.5	Brygos P.	Euphronios	3.4	8.7	Swing P.
Onesimos	7.9	7.6	P. Paris Gigantomachy	Syriskos	7.7	8.4	Diosphos P.
Berlin P.	7.6	8.5	Penthesilea P.	Polos P.	6.8	7.4	Edinburgh P.
Athena P.	7.7	8.9	Splanchnopt P.	Taras P.	8.9	7.1	Beldam P.
Haimon P.	8.1	8.9	P. Bologna 417	Malibu P.	3.9	8.0	Altamura P.
Pan P.	8.2	6.0	P. London D 12	Hermogenes P.	2.2	3.6	Codrus P.
Villa Giulia P.	8.0	6.9	Veii P.				
<b>8.13 works / yr</b>				<b>6.55 works / yr</b>			

Fig. 2: Left: attribution rates of painters with independent evidence for specialization; right: evidence consistent with both painting and potting. The study of the potter-work is incomplete or ambiguous for the names below the line.

that the painter of a vase had also shaped it.<sup>9</sup> One should expect these *potter-painters* to have decorated fewer vases. The less productive artisans might also have engaged in other workshop jobs – such as mixing paint, firing the kiln, speaking to clients – or worked on and off outside the Kerameikos, but only those who also potted are likely to be archaeologically and epigraphically detectable.

A clear division emerges between the most productive specialists, who often worked with several different potters, and the less productive hands, many of whom appeared to have been potter-painters (fig. 2).<sup>10</sup> Most studies of Attic production and trade build on a reasonable expectation that large tallies of vases are representative of trends in actual ancient production, but my work demonstrates that statistical analysis is viable even at finer resolutions, down to the work of certain individual painters. Furthermore, the results lend support to Beazley’s fundamental assumption that the vases he linked to a hand were indeed the work of an individual – an idea that has been affirmed by later generations of scholars despite some lingering skepticism of the validity of attribution.<sup>11</sup> But if it were merely an arbitrary guessing game, or if many of Beazley’s hands were actually the products of a collective, we would not expect to find a correlation between the AR and the independent evidence for either specialization or part-time potting. Because the strong correlation shown in Figure 2 is very unlikely to have come about by pure chance, this confirms the general validity of attribution as a method to identify individual painters.<sup>12</sup>

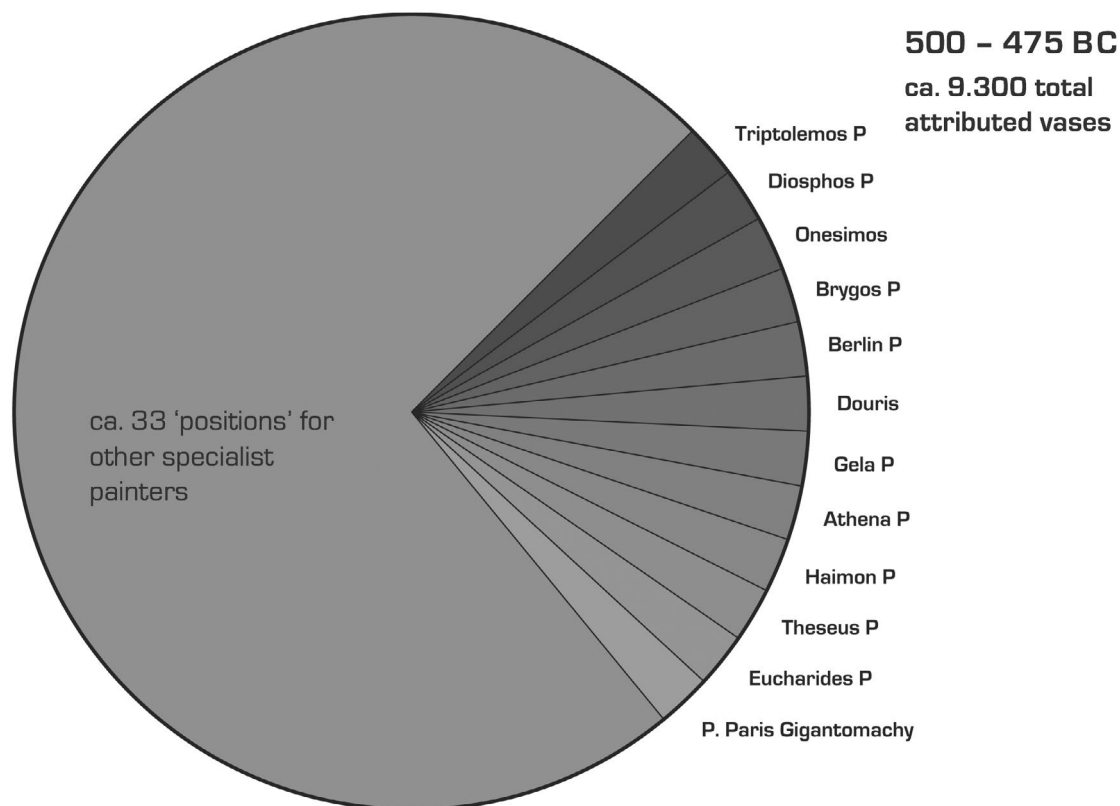


Fig. 3: Minimum number of full-time specialists responsible for the extant Attic vases from the first quarter of the 5<sup>th</sup> century BC. In reality, more individuals would have been involved in the painting of these works.

Nonetheless, some important caveats accompany these findings. First, it is quite possible for a known artisan to have painted some vases which are not specifically attributed, and so the list of *firmly* attributed works cannot comprise every extant work by that individual.<sup>13</sup> Second, the approach is intended for categories of attribution that are likely to belong to an individual – which is the case for most of Beazley’s “hands” – while groups, classes, and other more general forms of classification must be treated as the products of collectives. Furthermore, for meaningful statistical analysis of an individual hand, he or she must have been active at least 15 years, or else the AR is too susceptible to error to be reliable. Third, the painter’s corpus should be well-preserved and not overrepresented by a single findspot. An instructive example is the Painter of the Athens Dinosaurs, all but two of whose ca. 50 identified works are from the debris of a kiln in Athens.<sup>14</sup> The many tiny sherds would not have been assigned to this hand had they not been found together in this remarkable context, which makes them statistically unlike the widely distributed, better-preserved, and stylistically distinctive vases of more prominent artisans like Epiktetos or Douris.<sup>15</sup>

Period	Beazley attributions	Potter-painters	Specialist painters
600–575	760	11 + 0	
575–550	1.600	16 + 2	
550–525	3.170	29 + 5	
525–500	5.180	36 + 12	
500–475	9.260	41 + 30	
475–450	9.390	43 + 30	
450–425	7.510	45 + 20	
425–400	1.960	10 + 6	
<b>Total</b>	<b>38.830</b>		

Fig. 4: Estimated employment in the Kerameikos, 600–400 BC. The total production is expanded from Beazley's attribution counts, while the population of simultaneously active potter-painters and painting specialists is an approximation, since the actual ratio of potter-painters to specialists is uncertain by the middle of the 6<sup>th</sup> century.

### Industry Population

One aspect of my work that has stirred controversy is the estimated population of painters in the Kerameikos. Since more vases had been discovered and published after Cook's 1959 study, I needed to reassess not just the AR but also the total number of extant pots. Near the peak of Attic production in 500–475 BC, there are fewer than 10,000 such figure-decorated vases, equivalent to the production of 45 artisans working simultaneously at the speed of the most prolific hands (fig. 3). By tallying vases in 25-year intervals, one observes production rise among a small group of potter-painters in the early 6<sup>th</sup> century, and then collapse during the Peloponnesian War (fig. 4).<sup>16</sup> This minimum number of painters is useful for gauging how many other workers were employed full time in the production of figure-decorated pottery – perhaps 200–300, somewhat fewer than proposed by Cook.

This low estimate moves against a tendency since Cook's time to argue for higher populations.<sup>17</sup> V. Stissi recently entertained an industry potentially employing thousands of painters, with perhaps 3,000–4,000 Kerameikos workers in all, and criticized Cook's method as expanded in my recent work.<sup>18</sup> His central claim is that minor artisans had

a major impact on Attic production, painting huge numbers of vases not recognized by the AR because the individuals were not long-lived. Thus, it is critical to review the reasons why the two estimates differ by more than an order of magnitude.

First, a distinction must be drawn between *continuously employed* painters, the roughly 45 “positions” available at any time during 500–475 BC (fig. 3), and the number of individuals who ever painted a vase during this period. Those who see high populations at the Kerameikos typically conflate continuous employment with tallies of individual hands. It is as if we assess the population of teachers in Canada not as those currently employed teaching, but as every person who had taught a class at some point during the last 25 years – which obviously is a much larger number, but one irrelevant to assessing the scale of employment.

We must account for *turnover* also in order to compare raw tallies of individuals with the population of simultaneously employed workers. Stissi argues from the 130 hands connected to Little Master and related cups, the Tyrrhenian Group, and the Nikosthenes workshop, that 40–50 different painters were simultaneously active around the middle of the 6<sup>th</sup> century BC, higher than allowed in Figure 4.<sup>19</sup> This high estimate relies on an assumption that each hand, regardless of productivity, had an average career of 5 years (equivalent to 40 extant vases at the standard AR for specialist painters). Only 26 of the 130 hands have at least 20 attributions, and many of the other just 1–2; the total of roughly 2,500 vases suggests the output of no more than 10 full-time specialists, which is in keeping with the 7 prolific hands that dominate this set of vases.<sup>20</sup> Since we have no reliable means by which to estimate actual turnover in antiquity, such simplistic conversions of the total number of designated hands can lead to wildly variable estimates of population. For example, we could imagine that turnover ranged between 2–20 years, which would allow for anywhere from 60 to 560 individuals to have filled the 45 full-time “positions” available over the quarter century shown in Figure 3.<sup>21</sup>

Still, nonspecialist painters may not only have painted less often, but also at slower rates than specialists, thereby increasing the actual population of artisans who considered painting an important part of their job. Indeed, we might even propose a third mode, *occasional painters*, such as a potter painting one batch of vases herself while her preferred painter was unavailable, an apprentice who ceased painting after a short period due to a lack of aptitude, and other scenarios where the painter might have worked quite slowly.<sup>22</sup> However, the data suggest the economic impact of minor figures was modest. Ranking Beazley’s hands from the most productive to the least – a style shared by just two pots – results in the lopsided distribution seen in Figure 5. Douris alone was responsible for more attributed vases than the bottom 140 hands all together, while the top 53 hands produced as many as the bottom 582. In light of the natural aptitude and lengthy period of training to develop the skills required for Attic figured painting, I find it unsurprising that seasoned experts would have dominated production.

While the hands with occasional or sporadic production did not have much economic impact, their presence would bring down the average AR of 8.2 attained by specialists for

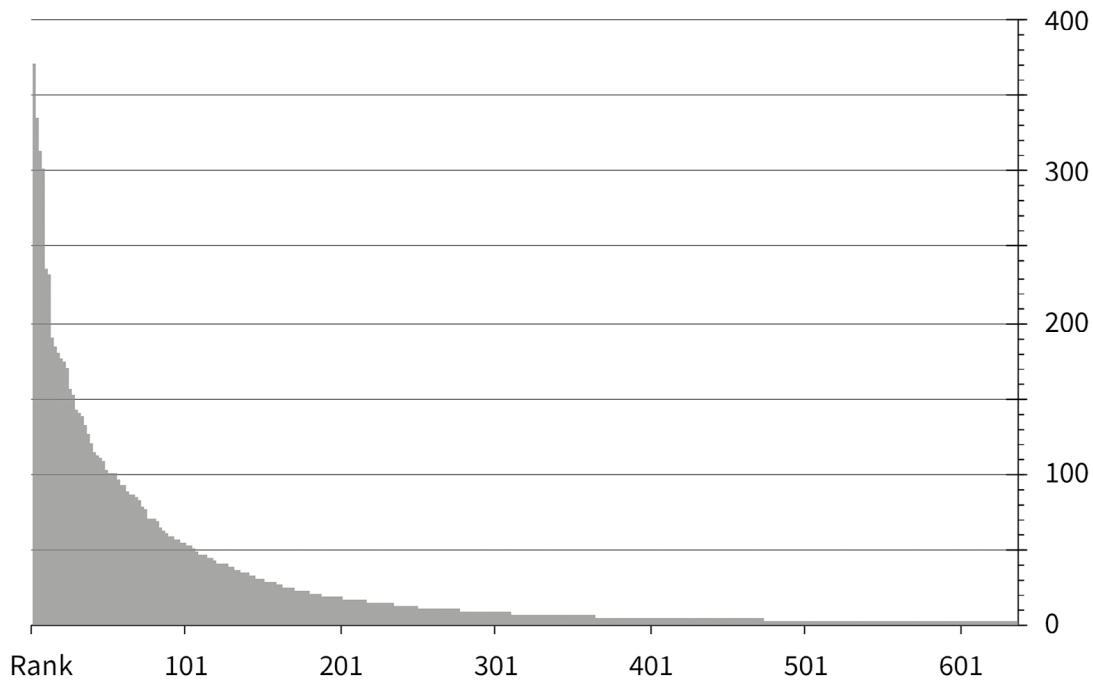


Fig. 5: Attributions per painter as designated by Beazley. The vertical axis shows the total number of attributions for every hand with at least two works ranked in descending order on the horizontal axis (e.g., Makron, the most productive, is the first on the left). Groups, classes, and other kinds of non-individual entities have been excluded.

the industry as a whole. A more realistic scenario allows for ca. 70 “positions” including potter-painters and trainees, who worked less efficiently than their specialized peers and would have modestly reduced the average rate of painting across the industry as a whole (fig. 4). Since the actual productivity of nonspecialists is hard to assess, one could plausibly argue for a range of 50–100 employed figure-painters at the apogee of Attic production. The important conclusion is that this population cannot have been massively greater than if the industry were almost exclusively staffed by high-output specialists like Douris.

### Total Numbers of Attic Vases

The only other way to restore a much larger population of painters is to argue that Beazley and later scholars overlooked a large number of unattributed vases. My estimate for the total number of pots for each period – close to 400 per year at the height of production, and totaling fewer than 39,000 between 600–400 BC – is key to reconstructing the population (fig. 4). If there were actually many more extant pots, we would open up more “positions” for full-time painters – but only if the AR remained at 8.2.

Stissi argues that we should use the total number of Attic vases that have ever been excavated, which he put near 1.1 million, as the basis for calculation. Over 250 years, an AR of 5–8 vases per artisan would indeed equate to thousands of painters during peak production. This total is based on the 110,000 records (in 2015) in the Beazley Archive Pottery Database (BAPD), and an estimate that only 10% of excavated Attic pottery has yet to be published and entered into the database.<sup>23</sup>

While doubtlessly there are many additional Attic sherds, it is fundamentally inappropriate to apply the AR to a new, vastly larger population which has yet to be fully studied and published. Were this material incorporated, the typical specialist AR would certainly rise above 8 because at least some of these unpublished sherds would be attributed to prominent painters. In other words, as the total number of published vases grows with future study, we would certainly find many new works by Nikosthenes, Douris, and other well-known hands in the expanding corpus. The new attributions to known hands would of course increase the AR, which is the number of extant works (a growing quantity) divided by the artisans' years of activity (a fixed quantity). For example, if the corpus had expanded to five times larger than it is now, the AR of ca. 5–8 would probably grow to roughly 25–40 vases per year.

The other question is how to count known vases. While a tremendously useful research tool, the whole BAPD – which now exceeds 115,000 records – does not provide a reliable tally of Attic figural pottery from 600–400 BC, since it includes non-Athenian wares, earlier and later material, nonfigural and black gloss vases, and other extraneous entries numbering in the tens of thousands. Furthermore, the counts are inflated by pieces from overrepresented contexts. For example, the Painter of the Athens Dinos has 64 separate BAPD records, mostly inscrutable sherds from the aforementioned kiln deposit, that would be equivalent to no more than a few intact vases by a prolific hand if we employed a fair basis for comparison, such as preserved surface area. Any reader wishing to apply the AR to another problem may review the methods developed for controlling the impact of unusually rich contexts, which result in an industry-wide tally of comparable figural vases near 40,000.<sup>24</sup>

Finally, we must ask whether the unpublished figural sherds, perhaps numbering in the hundreds of thousands, will turn out to have been dominated by minor hands rather than the specialists, thus implying a greater population in the Kerameikos. Assuming the corpus is unbiased, we should know the productivity of a prominent painter like Douris within ca. 14%, and the overall AR for the industry should be more accurately determined, since it is based on many hands.<sup>25</sup> Bias against minor hands, however, might result in more of their work appearing among the unpublished material. Beazley claimed that he attended to all figural vases regardless of quality, and his catalogues do include low-quality work such as the masses of sloppily painted 'Haimonian' lekythoi or the 23 vases by the unfortunate 'Worst Painter'.<sup>26</sup> Since Beazley's death in 1970, scholars of monographs on individual painters and workshops have striven to locate new works.<sup>27</sup> The corpora have grown apace with the publication of museum holdings and archaeological discoveries over the last



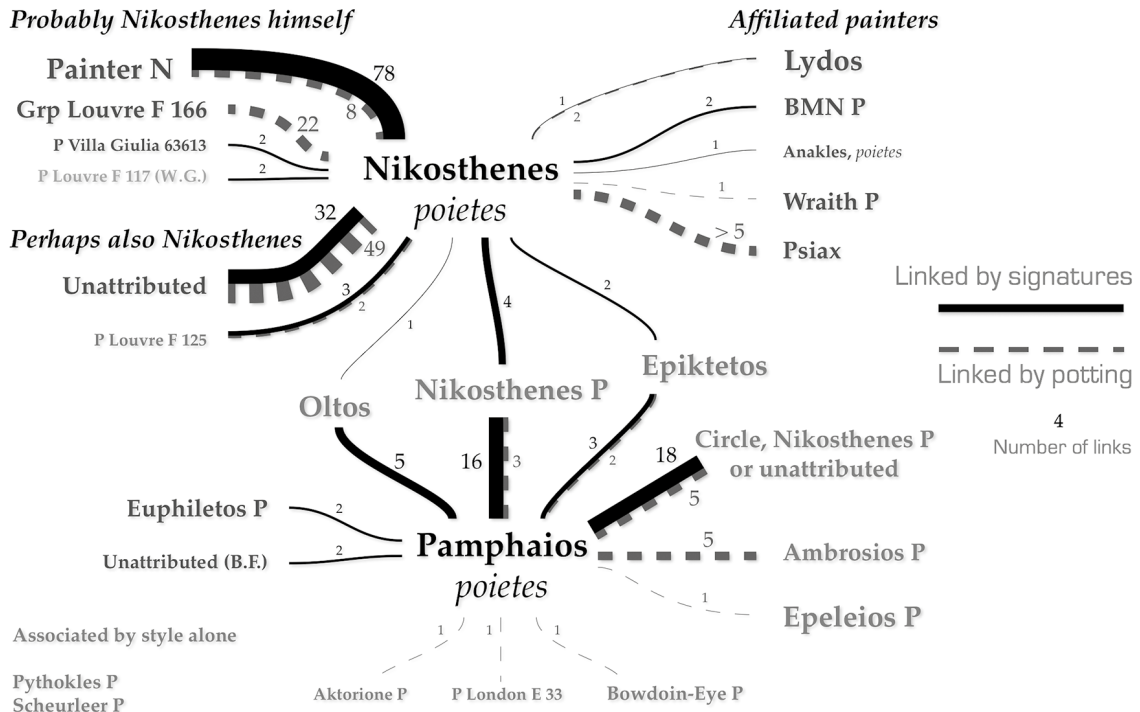


Fig. 6: Painters affiliated with Nikosthenes and Pamphaios, whose connection is recognized through the three painters who worked with both potters. The thickness of the pairs of lines showing affiliation increases according to the number of links, which is written next to the lines.

50 years – by about 15% for red figure, though up to 50% for early black-figure.<sup>28</sup> The modest bias against early black-figure, probably due to the ABV not having been expanded as thoroughly as the ARV<sup>2</sup>, was already factored into the tabulations underlying Figure 4. Nothing in the data support the 900% expansion of work by minor hands which would be required to sustain Stissi’s population estimates.

Many of the unpublished vases may be similar to the hordes of Little Master and related cups, some of which Beazley rightly ignored due to their lack of figural decoration. These vases are of course important evidence for Attic production, but they did not take as much skill or time to paint. In the end, a population of no more than 50–100 full-time painting “positions” who worked alongside a few hundred other workers in the Kerameikos could have produced all of its figural pottery. In addition to those engaged in forming vases, some workers may have assisted painters by adding border patterns or mixing paints, but this cannot have been a very large group.<sup>29</sup> Neither is it likely that new evidence will radically alter this picture. We can envisage additional workshops which produced other types of pottery – plainware, cooking pots, pithoi, to mention a few – perhaps staffed by dozens or even hundreds of other workers, but we would need to examine this body of evidence separately.

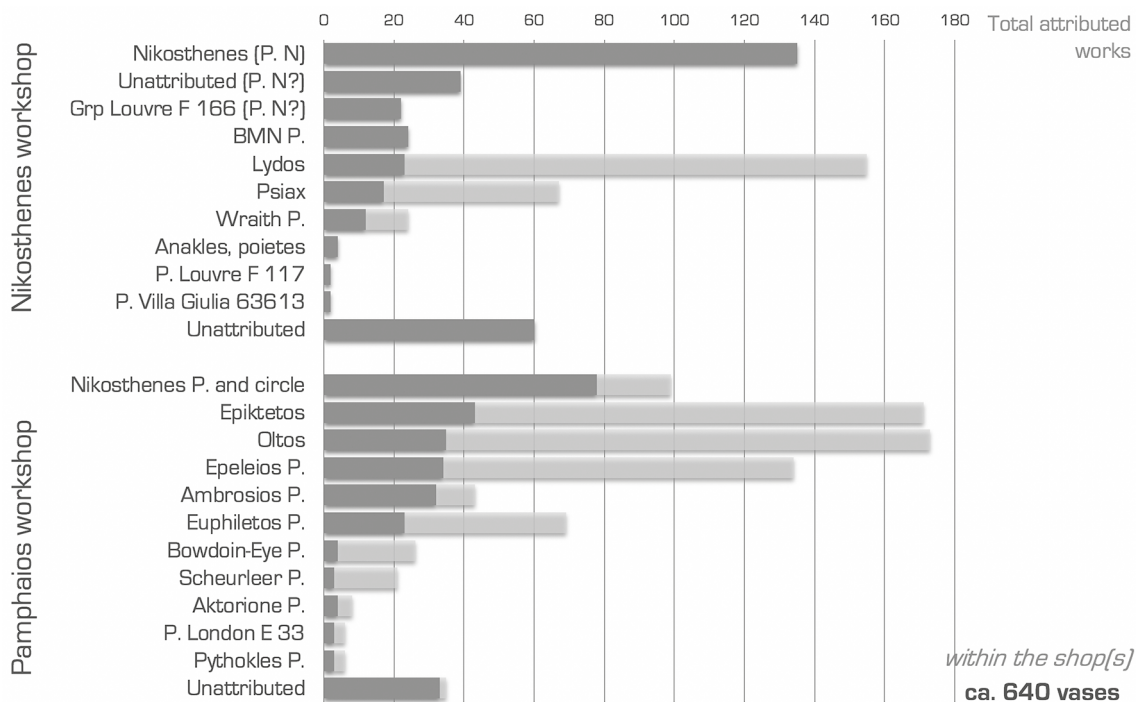


Fig. 7: Attributions to painters and groups around Nikosthenes and Pamphaios. The complete length of the bar indicates the total number of attributions for each painter. The darker portion of each bar shows the approximate number of works for the potter in question, according to the evidence that each painter had (or had not) worked in other shops.

### Small Workshops

A closing example illustrates how workshops might be approached using the AR. We know from signatures that late Archaic painting specialists often worked with many different *poietes* – meaning the corpora of vases attributed to most prolific painters are divided among several different potters and workshops. The case of Nikosthenes affords us a more secure footing, since his many signatures and distinctive potterwork demarcate the workshop, which possibly was inherited by Pamphaios.<sup>30</sup> Figure 6 plots their associations, including estimates for partial contributions by Epiktetos and others who spend more time painting in other workshops.

The workshop is usually assumed to be the largest in Athens producing black-figure. The many associated hands once prompted large estimates for the staff, up to dozens of workers.<sup>31</sup> More recent scholarship has observed that just a few hands – Painter N, and the Nikosthenes Painter – dominate the extant vases.<sup>32</sup> The AR supports this picture of a small operation, with specialist painters moonlighting in the workshop as estimated in Figure 7. Assuming Nikosthenes was Painter N, he need only have employed one other painter, either apprentices or specialists like Lydos, to decorate some of the vases which

he had thrown but did not have time to paint. The quantities of extant workshop vases are simply inadequate to have sustained more full-time staff. Pamphaios may have hired two red-figure painters, but even so the two workshops need not have employed more than five people, at least their equivalent in full-time positions equivalents, including the other jobs besides potting and painting.<sup>33</sup>

### Conclusions

In review, the AR can be used to examine the production of individual painters, but only under the circumstances where it is statistically relevant. It can be extended to workshops such as those around Nikosthenes or Pamphaios, but additional precautions are necessary to control for the possibility that the painters worked for other shops during their careers. When we examine the surviving vases painted by individuals or workshops, rather than the misleadingly high numbers of hands, it becomes clear that the permanent staff of many other Attic workshops was fairly small. These enterprises are entirely consistent with the portrait drawn from ethnographic sources: Athenian ceramic production was a pre-modern industry built upon family-run workshops.

### Notes

<sup>1</sup> Beazley 1956 (ABV); 1963 (ARV<sup>2</sup>); 1971 (Paralipomena). Sapirstein 2013a; 2013b; 2014.

<sup>2</sup> Cook 1959, 119–121.

<sup>3</sup> Sapirstein 2008, 184–189.

<sup>4</sup> Sapirstein 2013a, 494–497; 2013b, 2–8.

<sup>5</sup> Makron, with more than double the next highest rate, is an outlier. His AR is inflated by large numbers of small sherds in the corpus, in part due to unusual collection practices: Sapirstein 2013b, 26 f.

<sup>6</sup> For a hand with 200 vases over 25 years, incorrect dating by  $\pm 5$  years would change the AR to 6.7–10.

<sup>7</sup> Mackay 2010; Avramidou 2011.

<sup>8</sup> Hirayama 2010.

<sup>9</sup> Sapirstein 2013a, 497–501.

<sup>10</sup> Sapirstein 2013a, 501–503.

<sup>11</sup> Beazley 1922, 83–90; Oakley 1999; 2016; Arrington 2017, 22–28. 36.

<sup>12</sup> The odds of such a distribution occurring by accident are less than 1:10,000: Sapirstein 2013a, 501 n. 31. 508.

<sup>13</sup> cf. Arrington 2017, 30–32.

<sup>14</sup> Oakley 1992; Bentz et. al. 2010, 150–162. 170–204. Of 54 catalogued sherds, some could have come from the same vessel, but other unattributed sherds from the context could also have been by this painter.

<sup>15</sup> Buitron-Oliver 1995; Paléothodoros 2004. As with many of the other prominent painters, their lists include sherds, but the majority of their attributions are largely intact – i.e., where at least half of the vase is represented.

<sup>16</sup> Sapirstein 2013a, 506–508.

<sup>17</sup> Webster 1972, 2 f.; Stissi 2002, 30–34; cf. Arafat – Morgan 1989, 327.

<sup>18</sup> Stissi 2016, 48–52.

<sup>19</sup> Stissi 2016, 50 f. Table 1; the same figures are repeated in his chapter in this volume.

<sup>20</sup> Brijder 1983; 1991; 2000 (dominated by the C, Taras, Heidelberg, and Griffin-Bird Painters); Tosto 1999 (Painter N); Kluiver 2003 (no prolific hand); Heesen 2009 (Tleson and Centaur Painters).

<sup>21</sup> For the ca. 9.260 attributed vases from the first quarter of the 5<sup>th</sup> century (Figure 4), with an AR of 8.2, the output is equivalent to the annual production of more than 1.100 painters, i.e.:  $9.260 \text{ vases} \div 8.2 \text{ vases / painter-year} = \sim 1.129 \text{ painter-years}$ . If we assume a short average career length of just 2 years, then the total number of individuals who would have worked at some point over the 25-year period is  $1.129 \text{ painter-years} \div 2 \text{ years / painter} = \sim 564 \text{ painters}$ . With a 20-year career, the number of painters is much lower:  $1.129 \div 20 = \sim 56$ . The actual turnover was probably somewhere between, but it can only be estimated from the number of individual hands we recognize – e.g., more hands indicates a shorter average period of activity and a higher turnover.

<sup>22</sup> Williams 2016, 61–64; perhaps also the Painter of the Athens Dinos: above, note 14. On the evidence for apprenticeship in Greek workshops in general, Hasaki 2013.

<sup>23</sup> Stissi 2002, 24 n. 77; similar estimates are repeated in Stissi's chapter in this volume. On the AR calculation, see Stissi, 48–50:  $1.1 \text{ Ma} \div 250 \text{ years} \div 5\text{--}8 \text{ vases / painter} = 550\text{--}880 \text{ painters}$ .

<sup>24</sup> Sapirstein 2013b, 3–6. Stissi's estimate (in this volume) of an original Athenian production in the tens of millions is also wildly inflated because of how it applies the survival rate to his proposed collection of over a million extant vases. As with the AR, the survival rate is also increased by new finds – i.e., the rate of 0.25–1.0%, which was estimated from a corpus of about 50.000 vases known then, would expand in proportion to the number of new discoveries. If the corpus has indeed grown 20 times larger, then the survival rate has also increased to 5–20%. Otherwise the rate would need to be recalculated afresh by means of some other proxy evidence.

<sup>25</sup> Levy – Leveshow 1999, 61–64. 70–75; contra Stissi 2016, 53 n. 18. Assuming we already have 10.000 attributed vases from 500–475, and 205 from this period belong to one specialist painter (from the standard AR of 8.2), we can estimate the 95% confidence interval for the whole population. If 1% of vases have been recovered—which is debatable but close enough for estimating the sampling error—the painter would have 177–233 additional vases 95% of the time whenever 10.000 new vases were sampled, equivalent to an AR of  $205 \pm 27.5$  (13.5%). Since close to a quarter of extant vases were assessed for determining the AR (about 2.500 instead of 205), it theoretically could have been determined within  $\pm 1\%$ . A preference to study well-preserved pots would not introduce meaningful bias, but if Beazley and later scholars had routinely ignored certain types of Attic painting, bias would be more of an issue. In any case, actual errors are probably somewhat higher.

<sup>26</sup> Robertson 1985, 27 f.; Volioti 2014; Jubier-Galinier 2016; Haspels 1936 (ABL) 130–141. 241–249. 368; ABV, 538–583. 705–708. 716; Paralipomena 269–289; ARV<sup>2</sup> 1353 f.

<sup>27</sup> Recently, see Oakley 2016; Padgett 2018.

<sup>28</sup> Sapirstein 2013b, 8.

<sup>29</sup> Lezzi-Hafter identifies separate hands of ornament painters in the circle of the Shuvalov and Eretria Painters, perhaps indicating that one of the figure-painters was responsible for most of the ornament in

her or his workshop: Lezzi-Hafter 1976, 41–51. 95 f.; 1988, 133–135. This arrangement may have been unusual, and Beazley (1922, 88) wrote “there is no reason to suppose that the patterns were not regularly executed by the same hand as the figures; the labour may sometimes have been divided, though I do not for a moment believe that it was often so.”

<sup>30</sup> Immerwahr 1984; Tosto 1999.

<sup>31</sup> Webster 1972, 1–41 (10–20 staff); Eisman 1974, 48 f. (30 painters); Valavanis 1997, 86 f. (ca. 20 staff).

<sup>32</sup> Scheibler 1983, 110–118; 1984, 130–134 (6–8 staff); Tosto 1999, 193–200; Hasaki 2011, 27.

<sup>33</sup> Scheibler 1984; Tosto 1999, 193–200; Sapirstein 2008, 182 f. 198–205; Lüdorf 2010; Hasaki 2011, 24–28; Williams 2016.

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