# Drawing Circles: Experimental Archaeology and the Pivoted Multiple Brush

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*For Antony E. Raubitschek*
*and in memory of Ellen Comiskey*

*Abstract*

This study explores a variety of multiple brushes that have been used by potters of different periods and places to decorate their wares. Following an overview of the history of scholarship on these devices, special attention is given to the mechanically drawn circles and semicircles of various Mediterranean wares in the Early Iron Age, particularly Aegean Protogeometric. Earlier arguments put forward to show that such concentric motifs could not have been drawn with a multiple-brush device are challenged. To this end, alternative types of multiple-brush devices were made and tested and the result of these experiments was the construction of a pivoted multiple brush that could easily replicate all the details observed on ancient pottery, including errors and idiosyncracies. This device, fashioned from material readily available to ancient potters, is presented in this article. The question of the origin of this "technical innovation" is discussed and an attempt is made to place it where it belongs: in the potter's workshop.*

In discussing the "multiple brush," one of a number of "mechanical aids" admitted to varying degrees by artists of all periods, John Boardman wrote: "This is a device which any vase-painter concerned with covering large surfaces with regular designs is likely to find attractive. Schoolboys writing 'lines' with two

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* This article has had a long and interesting gestation period. The driving force behind it was Antony Raubitschek, and it is to him that it is dedicated as a modest token of esteem and gratitude. Having taken classes on Herodotos and Greek and Roman art from him, Vedder, a nuclear physicist by training and a research scientist by profession, developed a passion for antiquity and its problems, one of which was the manner in which ancient potters applied concentric circle and semicircle decoration. Under the guidance of Raubitschek, Vedder developed the pivoted multiple brush, following a number of experiments using alternative techniques and an examination of some Cypriot pottery in the Stanford University Museum of Art. Two of the authors, Vedder and Papadopoulos, were brought together by Raubitschek in February 1995 and began their collaboration. A closer study of Early Iron Age pottery with concentric circle decoration had been conducted previously by Papadopoulos. In order to test Vedder's pivoted multiple brush, Papadopoulos called upon Schreiber, a professional potter based in Malibu, California, to throw several pots of approximately the same size and shape as standard Attic Protogeometric forms. These pots were subsequently decorated by the authors in February 1996.

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The following abbreviations are used:

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| Eiteljorg | H. Eiteljorg, II, "The Fast Wheel, the Multiple-Brush Compass and Athens as Home of the Protogeometric Style," *AJA* 84 (1980) 445–52. |
| *Kerameikos* I | W. Kraiker and K. Kübler, *Kerameikos. Ergebnisse der Ausgrabungen* I: *Die Nekropolen des 12. bis 10. Jahrhunderts* (Berlin 1939). |
| *Kerameikos* IV | K. Kübler, *Kerameikos. Ergebnisse der Ausgrabungen* IV: *Neufunde aus der Nekropole des 11. und 10. Jahrhunderts* (Berlin 1943). |



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or more pens tied together would recognise the technique."[1] Boardman went on to summarize the available evidence pertaining to the device and, although his focus was on Greece, he cast his net wide to include Egypt, Cyprus, Syria, Mesopotamia, and other parts of the ancient Near East. He dutifully warned that it was easy to be deceived by parallel lines drawn carefully and individually, and recommended that extra care, along with good photographs, was needed to detect the use of a multiple brush on ancient pottery. Despite this warning, Boardman was able to establish the use of the multiple brush not only over a wide geographical area, but a broad chronological span. He also published excellent photographs of various Egyptian Predynastic and Cypriot Bronze Age vessels, as well as a number of Greek regional wares of the Geometric and Early Archaic periods,[2] all decorated with multiple-brush devices with individual members (brushes) ranging from two to 17. Boardman stressed that the multiple brush was not in the stock in trade of all vase painters, nor was it used by all in the same way,[3] but he was reluctant to illustrate, or describe, what he believed a multiple-brush device, or devices, might have looked like. This had already been attempted, with varying degrees of success, by others.

One of the most commonly cited early published references to the use of a "multiple brush" in antiquity was Flinders Petrie's discussion of the characteristic method of applying wavy lines on the Predynastic decorated pottery of Egypt.[4] Petrie remarked: "All of the line patterns are largely influenced by a habit of holding three or four brushes together, in order to speed up the work."[5] Petrie's remarks were interpreted as meaning that the Predynastic Egyptian potters held "three or four brushes" together. It was the notion of loose brushes held together in the hand that led Robert Braidwood to make an experimental multiple brush that mechanically held five brushes together.[6] In studying the prehistoric pottery of Tell Judeidah in North Syria, Braidwood noticed that the predominant decoration was in bands executed in groups of five, or multiples thereof, although a few examples with fewer than five and some with more than five were also noted.[7] Braidwood was convinced that no potter, however apt, could manage more than four brushes loose in "his" hand at one time.[8] The multiple brush that Braidwood made (fig. 1) consisted of a vertical rod connected to the center of a shorter horizontal bar, in which five brushes were fitted. As noted by Braidwood, "the most characteristic result of the use of such a multiple brush is that all the units act in phase," and he was able, with his new mechanical device, to replicate the patterns on the Chalcolithic pottery of Judeidah XII on which he was working, particularly the groups of wavy lines, zigzags, and "checkmark" motifs.[9] Braidwood's experimental brush and observations received powerful ethnographic confirmation, since exactly the same sort of quintuple brush is used by Lebanese *female* potters today to decorate their pottery.[10] Braidwood, however, had a further point to make, particularly with regard to diffusion, and he concluded his paper with the following paragraph: "This note intends to do little more than to call attention to the certain use of the multiple brush in north Syria in the fourth millennium, and to suggest to other scholars and museums, with large collections of contemporary painted pottery, that such a technique might be found in their own examples. If such be the case, we would have another peculiar but common trait in proof of the case of diffusion in the Predynastic Near East."[11]

Half a century before the publication of Petrie's *Prehistoric Egypt*, Alexander Conze discussed the distinctive decoration on Greek Early Iron Age pottery, including the characteristic concentric circles.[12] Although published discussions of concentric circle

[1] J. Boardman, "The Multiple Brush," *Antiquity* 34 (1960) 85.

[2] Boardman (supra n. 1) pls. 9–11. For concentric circles and other motifs painted with a multiple-brush device on the Iron Age pottery of the Indus Valley, see B.B. Lal, "The Painted Grey Ware Culture of the Iron Age," in A.H. Dani and V.M. Masson eds., *History of Civilizations of Central Asia* 1 (New York 1992) 421–40, esp. 428, fig. 1.

[3] Boardman (supra n. 1) 89.

[4] W.M.F. Petrie, *Prehistoric Egypt* (London 1920) 18; cf. R.L. Bowen, Jr., "Egypt's Earliest Sailing Ships," *Antiquity* 34 (1960) 117–31.

[5] Petrie (supra n. 4) 18; R.J. Braidwood, "A Note on a Multiple Brush Device Used by Near Eastern Potters of the Fourth Millennium B.C.," *Man* 39 (1939) 192–94.

[6] Braidwood (supra n. 5).

[7] Braidwood (supra n. 5) 193.

[8] Braidwood (supra n. 5) 193.

[9] Braidwood (supra n. 5) 193–94, figs. 1–7.

[10] F.R. Matson, "Potters and Pottery in the Ancient Near East," in J.M. Sasson et al. eds., *Civilizations of the Ancient Near East* III (New York 1995) 1558–59, fig. 2.

[11] Braidwood (supra n. 5) 194.

[12] A. Conze, "Zur Geschichte der Anfänge griechischer Kunst," *SBWien* 64 (1870) 505–34; see also Conze, "Zur Geschichte der Anfänge griechischer Kunst II," *SBWien* 73 (1873) 221–50.

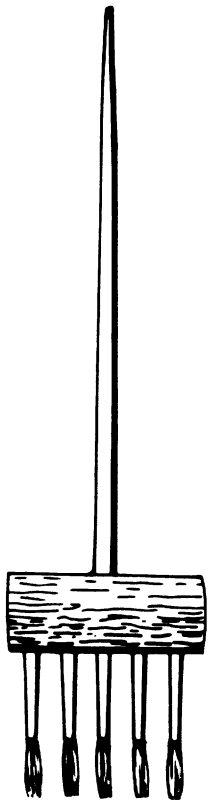

Fig. 1. Multiple brush designed by R. Braidwood. (A. Hooton, after *Man* 39 [1939] fig. 8)

ornament in the Aegean date back to the first half of the 19th century, in the work of Thomas Burgon and others,[13] it was not until 1870, in the seminal article of Conze, that this type of decoration received systematic treatment. Conze wrote:

> Die bandförmigen Streifen werden so mit Zickzack-, Rauten-, Schachbrettmannigfachen Mäandermustern der Länge nach gefüllt, ferner mit Kreisen; diese Kreise, einfach oder concentrisch mehre in einander gelegt, zuweilen ganz dunkel ausgefüllt, zuweilen mit einem Kreuze, viel häufiger aber mit einem Punkt in Centrum, stehen sehr häufig in dichten Reihen neben einander und werden dann gern durch gerade schräg aufwärts gerichtete Linien, Tangenten von Peripherie zu Peripherie, zu einem zusammenhängenden Ornamente verbunden, ohne dass das später beliebte gefälligere Ineinanderfliessen der Kreise und der Verbindungslinien mit geschwungener Führung der letzteren erreicht oder auch nur versucht wäre.[14]

Conze was the first to apply the term "Geometric" to Aegean pottery of the Early Iron Age and, like Braidwood many years later, there was a point to be made. What Conze meant when he first used the term was different from what many scholars mean today, both in style and in the inferences of the movements of peoples he saw accompanying this pottery. Indeed, the decorative schemes on pottery featured prominently in discussions of whether Greek culture—be it the Mycenaean civilization of the Bronze Age or the Early Iron Age culture of the early first millennium B.C.—was imported to Greece either by Aryan invaders from the north or Semitic peoples (Canaanites or Phoenicians) from the east.[15] Arguments such as these became heated in the later 19th century as a result of the publication of influential works, such as those of Oscar Montelius[16] and Salomon Reinach,[17] to mention only two. The genesis of terms such as "Submycenaean," first coined by Theodore Cressy Skeat,[18] and "Protogeometric," first used by Sam Wide[19] to describe what we now refer to as the Submycenaean pottery from the Arsenal Cemetery on Salamis,[20] was in part a reaction to previously held notions of stylistic development and relative chronology. Although the arguments behind the early use of these terms have faded into the historical mist of the late 19th and early 20th centuries, the power of these labels is stronger today than when they were first used.[21]

The association of ceramic decorative schemes and

[13] See especially T. Burgon, "An Attempt to Point out the Vases of Greece Proper Which Belong to the Heroic and Homeric Ages," *Transactions of the Royal Society of Literature of the United Kingdom*, ser. 2, 2 (1847) 258–96, esp. 287. Although published in 1847, Burgon's paper was presented to the Society in 1844.

[14] Conze 1870 (supra n. 12) 519.

[15] G. Daniel, *A Hundred Years of Archaeology* (London 1950) 180; J. MacEnroe, "Sir Arthur Evans and Edwardian Archaeology," *Classical Bulletin* 71 (1995) 3–18.

[16] O. Montelius, *Der Orient und Europa* (Stockholm 1899).

[17] S. Reinach, *L'origine des Aryens. Histoire d'une controverse* (Paris 1892); Reinach, *Le mirage oriental* (Paris 1893).

[18] T.C. Skeat, *The Dorians in Archaeology* (London 1934) 4.

[19] S. Wide, "Gräberfunde aus Salamis," *AM* 35 (1910) 17–36; see also Wide, "Geometrische Vasen aus Griechenland," *JdI* 14 (1899) 26–43, 78–86, 188–215.

[20] See V.R.d'A. Desborough, "What Is Protogeometric?" *BSA* 43 (1948) 260–72, esp. 260.

[21] For a useful summary of the history of the study of Aegean Early Iron Age styles of vase painting, see F. Poulsen, *Die Dipylongräber und die Dipylonvasen* (Leipzig 1905); B. Schweitzer, *Untersuchungen zur Chronologie der geometrischen Stile in Griechenland* I (Karlsruhe 1917); Desborough (supra n. 20); R.M. Cook, *Greek Painted Pottery*[3] (London 1997) 300–304; see also H. Marwitz, "Kreis und Figur in der attisch-geometrischen Vasenmalerei," *JdI* 74 (1959) 52–113; Schweitzer, *Die geometrische Kunst Griechenlands* (Cologne 1969; English trans., *Greek Geometric Art*, London 1971).

*ethnicity* still pervades archaeology today, in both blatant and subtle ways, and notions about the primacy of ceramic decoration have sometimes become hopelessly confused with political, economic, and social realities. This is especially true when the decoration in question involves a technical innovation, such as the use of the multiple brush. Indeed, the study of certain ceramic styles has become dominated by preconceived notions, even scholarly agendas, and the technical innovation, or innovations, used in the execution of this ornament have often received overinflated importance. The distinctive, mechanically drawn, multiple-brush decoration, whether in the ancient Near East or the Aegean, has greatly shaped, for example, ideas about the movements of peoples and influences of one culture over another. This is particularly true for concentric circles drawn mechanically, whether on the pottery of Cyprus, Macedonia, or Athens. In his discussion of Cypriot Early Iron Age vases with concentric-circle ornament, John Myres wrote:

> In strong contrast with this economy of ornament is the third principal innovation at this stage in the development of design; namely, the copious use of the "concentric-circle" ornament. This ornament was produced by means of a pair of compasses fitted with a row of small brushes, so that the whole system of circles was produced by a single turn of the hand. This multiple brush is an ancient device in Cyprus, as is seen in Fabric IV of the Middle Bronze Age, and in the grouped lines which are so constant a feature of the banded ornament on wheelmade vases from the Mycenaean period onwards. . . . In many parts of Greece during the Early Iron Age, an intermediate stage is found, in which the concentric circles are connected by oblique tangent lines. . . . But in Cyprus this is a clear mark of foreign influence; the native concentric circles always stand quite free, and perhaps betray, in this respect, a real though distant affinity with the primitive circle ornament of the Early Bronze Age. . . . This concentric-circle ornament remains popular in all schools of Cypriote pottery from the period immediately succeeding the Cypro-Mycenaean, down to the fifth and fourth centuries; later examples of it have even been found in the same graves with imported Attic vases of mature and decadent style.[22]

Despite his comments on "native" schemes of decoration, as opposed to those showing signs of "foreign influence"—all involving the multiple brush—Myres's contention was that the "ancient" multiple brush, used in the Cypriot Bronze Age for simple ornaments, was fitted to a "pair of compasses" in the period of transition to the Early Iron Age. Some 15 years later Myres wrote: "Much more important is the question, whence did either of the two main areas of concentric-circle painting [i.e., the Aegean and Cyprus with the Levant] acquire this decorative device, and what reason is to be given for its sudden and widespread popularity? The problem has a technical as well as a historical interest; for this is an early, and perhaps the first, example of a purely machine-made ornament."[23]

In 1934 Skeat, in his *The Dorians in Archaeology*, discussed the appearance of compass-drawn concentric circles on the pottery of Macedonia against the backdrop of northern, Danubian invaders. Building on the work of Myres, Skeat concluded: "The foregoing argument leaves only one alternative open, and the inference is now inevitable that the concentric-circle style originated in Macedonia itself. How exactly it come [sic] to be invented is another matter."[24]

Skeat proceeded to survey all pottery decorated with concentric circles—what is currently referred to as Protogeometric and Subprotogeometric—and attempted to address the manner in which this style of pottery spread southward from its home in Macedonia.[25] The same style of pottery was used by Vincent Desborough to argue a very different scenario. Desborough's contention was that Athenian potters invented the Protogeometric style, and that the most diagnostic feature of the style, the use of the multiple brush to draw concentric circles, was adopted in other parts of Greece soon after its invention in Athens.[26] The tool itself is described by Desborough as "dividers with multiple brushes on one arm for making circles and semicircles" and, along with it, Desborough argued for another technical innovation, the faster potter's wheel.[27] Desborough's arguments were quickly accepted and soon became the established view. As early as 1960 Boardman stated: "Apart

[22] J.L. Myres, *The Metropolitan Museum of Art. Handbook of the Cesnola Collection of Antiquities from Cyprus* (New York 1914; repr. 1974) 75–76. For recent overviews of ethnicity and archaeology, see J.M. Hall, *Ethnic Identity and Greek Antiquity* (Cambridge 1997); S. Jones, *The Archaeology of Ethnicity: Constructing Identities in the Past and Present* (London 1997).

[23] J.L. Myres, *Who Were the Greeks?* (Berkeley 1930) 450. In the same publication, Myres discusses at length the "optical illusion of spontaneous movement" when the object decorated with concentric circles is gyrated. He even writes (p. 452): "Here is a 'giver of life' as impressive to the unsophisticated as it is curious to the psychologist."

[24] Skeat (supra n. 18) 8; cf. Myres (supra n. 23) 450–54.

[25] Skeat (supra n. 18) passim.

[26] V.R.d'A. Desborough, *Protogeometric Pottery* (Oxford 1952) 298–99; Desborough, *The Last Mycenaeans and Their Successors* (Oxford 1964) 136, 261–63; Desborough, *The Greek Dark Ages* (London 1972) 145.

[27] Desborough 1972 (supra n. 26) 145.

from the quality of the potting and the new system of decoration there are two important technical innovations which mark off the Protogeometric style in Greek vases from all that went before. These are the use of the multiple brush and the compass. In effect they are one, not two, for the multiple brush is *only* used on the compass and never freehand, although there are many Protogeometric patterns for which it could well have been employed besides the usual concentric circles and semicircles."[28] By 1968 Nicolas Coldstream could state: "Athenian potters invented the Protogeometric style; and by this invention they inaugurated a rebirth of decent craftsmanship, of a standard unknown since the fall of Mycenae. . . . The most diagnostic feature of Protogeometric is the use of the multiple brush to draw concentric circles—a technical device first seen in Athenian grave groups transitional from Submycenaean. This device, as Desborough now believes, may have travelled to other parts of Greece soon after its invention in Attica; and the local vases on which it appears may thus qualify as Early Protogeometric."[29] In a similar vein, Anthony Snodgrass wrote: "For Desborough still maintains the view, surely a sound one, that the technical and stylistic advances that produced Protogeometric cannot have been achieved independently in a number of different centres, but must have been carried out in one centre, Athens, and imitated more or less rapidly elsewhere."[30]

Similar views were expressed by Moses Finley[31] and Robert Cook,[32] and Desborough's synthesis held sway for some time, as it continues to today in certain quarters. By arguing for the priority of Athens over other regions, however, Desborough began a trend that was to have a life of its own. The race was now on and the field was open to similar arguments of the priority of one region over others as to the "invention" of the Protogeometric style, labeled by some scholars as "the first Greek style."[33] The earliest and probably the most sustained challenge to Desborough's view of Athenian primacy came from Thessaly; Nikolaos Verdelis argued that in Thessaly a Protogeometric style was developed long before the influence of the Attic Protogeometric style was felt.[34] Although strongly contested by Desborough,[35] Verdelis's view was supported by Demetrios Theocharis,[36] and echoed by Chester Starr, who speculated on the role played by the Argolid. The latter was probably the most influential historian of early Greece to question Athenian priority with regard to the development and diffusion of the Protogeometric style.[37] As recently as 1986, Margrit Jacob-Felsch, largely on the basis of a single find from Kalapodi in Phokis, strongly argued that the origins of the "compass-drawn circle lay in Thessaly."[38] Jacob-Felsch linked this to the traditional accounts of the coming of the Dorians, citing Herodotos 1.56.3, though she conceded that it was "Ionian Athens which had the privilege to bring this motif . . . to its ultimate perfection."[39] Others have attempted to date the use of "compass-drawn circles" to the Bronze Age and to link it to particular regions: Spyridon Marinatos for Kephallenia[40] and Berit Wells for Naxos.[41] Some scholars have looked to the Ar-

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[28] Boardman (supra n. 1) 86–87.

[29] J.N. Coldstream, *Greek Geometric Pottery: A Survey of Ten Local Styles and Their Chronology* (London 1968) 335–36.

[30] A.M. Snodgrass, *The Dark Age of Greece: An Archaeological Survey of the Eleventh to the Eighth Centuries B.C.* (Edinburgh 1971) 74.

[31] M.I. Finley, *Early Greece: The Bronze and Archaic Ages* (New York 1970) 81.

[32] Cook (supra n. 21) 6.

[33] E.g., R.L. Murray, *The Protogeometric Style: The First Greek Style* (Göteborg 1975).

[34] N.M. Verdelis, *Ο Πρωτογεωμετρικός ρύθμος της Θεσσαλίας* (Athens 1958), esp. 49–60, also 40–48, 100–102.

[35] Desborough 1964 (supra n. 26) 261–63; see also Desborough's review of Verdelis (supra n. 34) in *JHS* 80 (1960) 234–35.

[36] D. Theocharis, in *Το Εργον της Αρχαιολογικής Εταιρείας* 1960, 59; 1961, 59. See also M. Sipsie-Eschbach, *Protogeometrische Keramik aus Iolkos in Thessalien* (Prähistorische Archäologie in Südosteuropa 8, Berlin 1991).

[37] C.G. Starr, *The Origins of Greek Civilization* (New York 1961) 96–97.

[38] M. Jacob-Felsch, "Compass-Drawn Concentric Circles in Vase Painting: A Problem of Relative Chronology at the End of the Bronze Age," in E.B. French and K.A. Wardle eds., *Problems in Greek Prehistory* (Bedminster 1988) 193–99, esp. 198. A somewhat more watered-down version was recently published: Jacob-Felsch, *Kalapodi* I: *Die spätmykenische bis frühprotogeometrische Keramik* (Mainz 1996); the amphora in question is pl. 44, no. 391; see also the shoulder fragment, pl. 44, no. 392. The amphora is redated to the Early Protogeometric period; this amends the Mycenaean date originally postulated (see the comments of R.C.S. Felsch in *Kalapodi* I, p. xvii). An earlier, and slightly different, reconstruction of the amphora was published in Felsch et al., "Kalapodi: Bericht über die Grabungen im Heiligtum der Artemis Elaphebolos und des Apollon von Hyampolis, 1978–1982," *AA* 1987, 32–33, figs. 55–56 (K 7025).

[39] Jacob-Felsch 1988 (supra n. 38) 198.

[40] S. Marinatos, "Αι ανασκαφαί Goekoop εν Κεφαλληνία," *ArchEph* 1932, 37.

[41] B. Wells, *Asine* II: *Results of the Excavations East of the Acropolis 1970–1974* 4: *The Protogeometric Period*, Pt. 2: *An Analysis of the Settlement* (Stockholm 1983) 120; see also N. Zapheiropoulos, "Ανασκαφαί Νάξου," *Prakt* 1960, 329–40, pl. 276α.

golid as a source of inspiration for the Protogeometric style proper.[42]

With virtually every publication of a new regional style of Greek Early Iron Age pottery claiming that it was the first to invent Protogeometric through the repeated use of the multiple-brush compass, the time was ripe for some critical rethinking.[43] In 1980 Harrison Eiteljorg, II, published an important paper in which he challenged the very existence of the multiple-brush compass.[44] Eiteljorg focused on Desborough's claim that the development of Protogeometric pottery was dependent upon the introduction of a faster potter's wheel and the invention of the multiple-brush compass, and that this dependence upon technical innovations was taken to imply a single center for the inception of the new style. Eiteljorg not only argued that the speed of the wheel was not a factor in the transition from Submycenaean to Protogeometric, but also that his study of the multiple-brush compass showed that such an implement could not have been used effectively on Protogeometric vases.[45]

Eiteljorg convincingly argued that the very notion of fast and slow potters' wheels derives from the specious idea of the tournette and concluded that Late Mycenaean, Submycenaean, and Protogeometric pots must have been made on essentially similar wheels.[46] Although most scholars have been happy to follow Eiteljorg in his discarding of the distinction between fast and slow wheels, his arguments against the employment of the multiple-brush compass have not won universal favor. The problems, as set out by Eiteljorg, surrounding the use of a compass with multiple brushes are practical. Eiteljorg noted that in order to paint a group of consistent, uniform lines, each brush point must stay in constant and steady contact with the vase surface throughout the length of its stroke. He also noted that it must be possible to dip the brushes into the paint and wipe them without undue difficulty.[47] Here it is worth stressing that Eiteljorg not only challenged the use of the "multiple-brush compass," but also the very existence of a multiple-brush device. The latter has been amply established and often illustrated with what appear to be straightforward images, such as figure 2, or the more numerous and

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[42] See Starr (supra n. 37) and especially B.S. Frizell, *Asine* II: *Results of the Excavations East of the Acropolis 1970–1974* 3: *The Late and Final Mycenaean Periods* (Stockholm 1986) 85–86. Frizell, following the dating proposed by Wells (supra n. 41) 124, believed that the so-called Submycenaean style in Attica leads into a "blind alley" and that the subsequent Athenian Protogeometric style "seems to have been adopted fully-fledged" (p. 86).

[43] A related phenomenon that has gripped the study of the later Protogeometric and Subprotogeometric periods is the insistence that Euboia "invented" the pendent semicircle skyphos. This distinctive shape, made from the local clay of many regions of the Aegean and even Cyprus, has been seen as the harbinger of Euboian maritime prowess and preeminence in the eastern and western Mediterranean; see, among others, J. Boardman, *The Greeks Overseas: Their Early Colonies and Trade* (rev. ed., London 1980); Boardman, "Al Mina and History," *OJA* 9 (1990) 169–90; M.R. Popham, "Why Euboea?" *ASAtene* 59, n.s. 43 (1981) 237–39; Popham, "Precolonization: Early Greek Contact with the East," in G.R. Tsetskhladze and F. De Angelis eds., *The Archaeology of Greek Colonisation: Essays Dedicated to Sir John Boardman* (Oxford 1994) 11–34; Popham, H. Hatcher, and A.M. Pollard, "Al Mina and Euboea," *BSA* 75 (1980) 151–61; Popham, Hatcher, and Pollard, "Euboean Exports to Al Mina, Cyprus, and Crete: A Reassessment," *BSA* 78 (1983) 281–90; R. Kearsley, *The Pendent Semi-Circle Skyphos: A Study of Its Development and Chronology and an Examination of It as Evidence for Euboean Activity at Al Mina* (London 1989); Popham and I.S. Lemos, review of Kearsley (supra), in *Gnomon* 64:2 (1992) 152–55; Popham, L.H. Sackett, and P.G. Themelis eds., *Lefkandi* I: *The Iron Age* (Oxford 1980); Kearsley, "The Greek Geometric Wares from Al Mina Levels 10–8 and Associated Pottery," *MeditArch* 8 (1995) 7–81; Lemos, "Euboean Enterprise in the Eastern Mediterranean: Early Import at Lefkandi," *AJA* 96 (1992) 338–39 (abstract). For an overview of this problem, which questions the assumed primacy of Euboia, see J.K. Papadopoulos, "Euboians in Macedonia? A Closer Look," *OJA* 15 (1996) 151–81.

[44] Eiteljorg.

[45] Eiteljorg 445. Eiteljorg's conclusions were most recently accepted by Hall (supra n. 22) 122, who goes on to draw further historical conclusions from this evidence. An important technical innovation that has been generally overlooked by all scholars working in the field, which can be attributed to the Early Iron Age in Athens, is the careful control of the three-stage firing of a kiln load—oxidization, reduction, and reoxidization—by way of test pieces in order to achieve consistently a good black glaze. The evidence for this innovation is summarized in J.K. Papadopoulos, "The Original Kerameikos of Athens and the Siting of the Classical Agora," *GRBS* 37 (1996) 107–28, and will be presented in more detail in a forthcoming study.

[46] Eiteljorg 445–49, esp. 449. For the tournette and notes on the potter's wheel, see V.G. Childe, "Rotary Motion," in C. Singer, E.J. Holmyard, and A.R. Hall eds., *A History of Technology* 1: *From Early Times to the Fall of Ancient Empires* (Oxford 1954) 194–204. We add here "Late Mycenaean" since the very existence of a Submycenaean phase as a separate chronological entity, distinct from Final Mycenaean or Protogeometric, has been seriously questioned; see J.B. Rutter, "A Plea for the Abandonment of the Term 'Submycenaean'," *TUAS* 3 (1978) 58–65; E.L. Smithson, "The Prehistoric Klepsydra: Some Notes," in *Studies in Athenian Architecture, Sculpture and Topography Presented to Homer A. Thompson* (*Hesperia* Suppl. 20, Princeton 1982) 141–54; J.K. Papadopoulos, "To Kill a Cemetery: The Athenian Kerameikos and the Early Iron Age in the Aegean," *JMA* 6 (1993) 178–81.

[47] Eiteljorg 449.

Fig. 2. Corinthian kotyle used as a potter's test piece. (Courtesy American School of Classical Studies, Corinth Excavations)

varied uses of multiple-brush devices in the case of the Iron Age pottery of the Iberian peninsula.[48]

According to Eiteljorg, a flat or spherical surface would present no special problem, but he believed that the practical difficulties of handling a large number of brushes simultaneously would place a limit on the number that could be attached to the holding device.[49] Even bearing in mind the flexibility of brushes, Eiteljorg stressed that serious problems would be encountered in attempting to deal with a surface that is not consistent, since the relative positions of the brush tips cannot change while painting a group of lines.[50] Eiteljorg thought that it was physically impossible for a cylinder to be decorated with a multiple-brush compass, and this was especially highlighted in the case of Protogeometric skyphoi, the handle zones of which were essentially cylindrical. He concluded: "Therefore, using a multiple-brush compass on a skyphos would have been impossible; individual compasses must have been used instead."[51] Turning his attention to brushes fixed together in a group, Eiteljorg argued that they must not only start as a group, but that they must stop together as well. About Protogeometric vases with painted semicircles, he wrote:

> These vases must have been decorated with individual compasses, each with a fixed radius, or with a single, adjustable compass. But they could not have been painted with a multiple-brush compass. I suggest that ancient painters used groups of individual compasses, each with a fixed radius and a permanently attached brush. In this case, an individual painter would always use the same compass (and therefore the same brush) to paint a circle of a given radius. As a result, irregularities caused by a faulty brush would recur so long as the painter continued to use the compass. This would best explain the kinds of aberrations found on the vases.[52]

Following this line of reasoning, Eiteljorg saw additional confirmation for his ideas in the existence of what he called concentric "near-circles," which are arcs more complete than semicircles but less than full circles. The fact that the beginnings and terminations of such "near-circles" are not in unison on ancient pots led to the conclusion that "the vases decorated with 'near-circles' provide additional evidence for the use of individual compasses."[53] From such a "theoretical point of view," Eiteljorg concluded that the multiple-brush compass would not function properly on any surface except the flat or spherical and that such a device "would have been found useless by the painters of Protogeometric pottery and that individual compasses were used instead."[54] Ei-

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[48] See illustrations in Boardman (supra n. 1); Braidwood (supra n. 5); and Matson (supra n. 10). See further the discussion by J.N. Coldstream in his review of P. Courbin, *La céramique géométrique de l'Argolide* (Paris 1966), in *JHS* 88 (1968) 235–37. The kotyle illustrated in fig. 2 is published in A.N. Stillwell and J.L. Benson, *Corinth* XV, Pt. 3: *The Potters' Quarter. The Pottery* (Princeton 1984) 247, pl. 57, no. 1361. In the case of Iberian Iron Age pottery, which is mostly later (often much later) than the Protogeometric pottery of Greece discussed here, a multiple-brush device was clearly used to decorate a range of vessel forms with sets of circles, semicircles, hooks, and arcs, as well as a wide variety of sets of wavy and straight lines. This pottery is best illustrated in L. Pericot, *Cerámica ibérica* (Barcelona 1979); see also the seminal work of P. Bosch Gimpera, *El problema de la cerámica ibérica* (Madrid 1915). For further discussion of this material, especially chronology and the question of original elements as opposed to outside influences, see V. Page del Pozo, *Imitaciones de influjo griego en la cerámica ibérica de Valencia, Alicante y Murcia* (Madrid 1984); M.M. Ros Sala, *La pervivencia del elemento indigena: La cerámica ibérica* (Murcia 1989); R. Olmos, "Original Elements and Mediterranean Stimuli in Iberian Pottery: The Case of Elche (Part 1)," *MeditArch* 2 (1989) 101–109; Olmos, "Original Elements and Mediterranean Stimuli in Iberian Pottery (Part 2)," *MeditArch* 3 (1990) 7–25 (with further references). Subsidiary decoration executed with a multiple-brush device is often found on the distinctive Iberian figurative pottery: E.M. Maestro Zaldivar, *Cerámica ibérica decorada con figura humana* (Zaragoza 1989), esp. 40, fig. 1; 82, fig. 18; 123, fig. 36; 160, fig. 51; 199, fig. 66; 271, fig. 97; 326, fig. 118; cf. 140, fig. 42.

[49] Eiteljorg 449 states that "one might expect that more than four or five brushes would be more difficult to handle than any economy of time could justify."

[50] Eiteljorg 450 states: "A multiple-brush compass could be used only on a flat or truly spherical surface, since only completely consistent surfaces would permit the brushes to maintain constant and steady contact."

[51] Eiteljorg 450.

[52] Eiteljorg 451.

[53] Eiteljorg 451.

[54] Eiteljorg 451–52.

teljorg slightly tempered this view by referring to the remarkable painted pithos from Vergina, published by Photios Petsas,[55] about which he wrote: "There is, to my knowledge, only one extant pot which might be taken to demonstrate the use of a multiple-brush compass in spite of the arguments presented here."[56] From the arguments presented in his paper, Eiteljorg stated that "the development of Protogeometric pottery should not be linked to technological advances, because the fast wheel and multiple-brush compass did not really exist."[57]

Eiteljorg's observations and conclusions raised a good deal of healthy doubt as to the precise nature of the application of decoration on vases of the Protogeometric style. Nevertheless, his conclusions, particularly with regard to the multiple brush, were seriously questioned by many scholars working with Early Iron Age ceramics. In 1988 Jacob-Felsch stated:

> The clearly discernible puncture in the centre of the concentric circles proves that they were drawn with a compass. The varying distance recurring in the same succession between the individual concentric circles and semicircles confirms their having been drawn by means of a multiple-brush. So does the common starting point, showing the same oblique position. This starting point is particularly well recognizable in the case of the concentric semicircles and follows the course of a radius common to all the circular orbits. The irregularly drawn, comparatively broad and numerically few orbits are unlike the regular, narrow and numerous circles of the Protogeometric Phase and constitute the first attempts to use a compass in vase painting.[58]

A few years earlier, Berit Wells, in the publication of the Early Iron Age pottery from Asine in the Argolid, went over many of the same arguments and concluded that the concentric circles and semicircles on Protogeometric pottery must have been executed with a "multiple-brush compass."[59] Wells, however, added a new dimension to the argument, namely that Eiteljorg's implement should *not* be reconstructed with actual brushes: "We must rather imagine quills or similar tube-like objects to be filled with 'paint.' A true brush point could not have rendered the even lines of the curvilinear designs."[60] Despite these assertions, both by Eiteljorg and his detractors, no one was able to produce a multiple-brush device, whether fitted with brushes or quills, that could replicate the concentric circles and semicircles of Greek Protogeometric pottery.

Before presenting the results of our own experiments, it would be useful to remember Boardman's warning that care and good photographs are needed to detect the use of a multiple brush on ancient pottery. More important than good photography, however, is a firsthand study of the pottery. A close examination of hundreds of Protogeometric pots from various parts of the Mediterranean reveals an incredible uniformity in the manner in which concentric circles and semicircles are drawn. This is true for regions as far apart as Athens, Crete, the Peloponnese, central Greece, Thessaly, and the various parts of Macedonia, South Italy and Sicily, even Cyprus, Spain, and the Phoenician homeland. A close examination of the pottery shows that the manner in which concentric circles are drawn in Athens is similar to that of Andros, various sites on Cyprus, or of Chalkidic Torone in central Macedonia, to mention only a few. This does not necessarily imply the priority or influence of one region over others; the same evidence could equally suggest that the manner of applying the decoration was very straightforward.

A close study of Protogeometric pottery highlights a few points that are worth stressing, particularly with regard to Eiteljorg's conclusions. First, Jacob-Felsch's observation that the discernible "puncture" in the center of the concentric circles proves that they were drawn with a "compass" needs elaboration. This small puncture—or pivot-point—is found on all examples of Protogeometric pottery at the center of the concentric circles or semicircles. This in itself, however, does not establish the device as a compass, whether it is an individual compass, and therefore brush, of fixed radius as argued by Eiteljorg, or a compass fitted with a multiple brush, as preferred by Jacob-Felsch, Wells, and other scholars of Greek Protogeometric. All it establishes is that the device has a "pivot," or pointed member, which leaves

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[55] The vessel was first published in Ph.M. Petsas, "Ανασκαφή αρχαίου νεκροταφείου Βεργίνης (1960/1961)," *ArchDelt* 17 (1961–1962) 284, fig. 62, pl. 152α; it was later published in detail in Petsas, "The Multiple Brush on a Local Early Iron Age Pithos from Pieria," in L.F. Sandler ed., *Essays in Memory of Karl Lehmann* (*Marsyas* suppl., New York 1964) 255–58. The painted pithos from Vergina is not the only "remarkable" vessel recently uncovered in Macedonia; see also the vessel published in B. Hänsel, "Ergebnisse der Grabungen bei Kastanas in Zentralmakedonien 1975–1978," *JRGZM* 26 (1979) 198, fig. 18, no. 7; see also the discussion of pottery in J.K. Papadopoulos, "An Early Iron Age Potter's Kiln at Torone," *MeditArch* 2 (1989) 9–44.

[56] Eiteljorg 452 n. 33. Despite his misgivings, Eiteljorg, on the basis of the published photographs of the vessel, doubts that a multiple-brush implement was used either on the wavy lines or the concentric circles.

[57] Eiteljorg 452.

[58] Jacob-Felsch 1988 (supra n. 38) 194–95.

[59] Wells (supra n. 41) 120.

[60] Wells (supra n. 41) 120.

Fig. 3. Athenian Protogeometric skyphoi from the Athenian Agora, P 6846 and P 6673. (C. Mauzy, courtesy American School of Classical Studies, Athens)

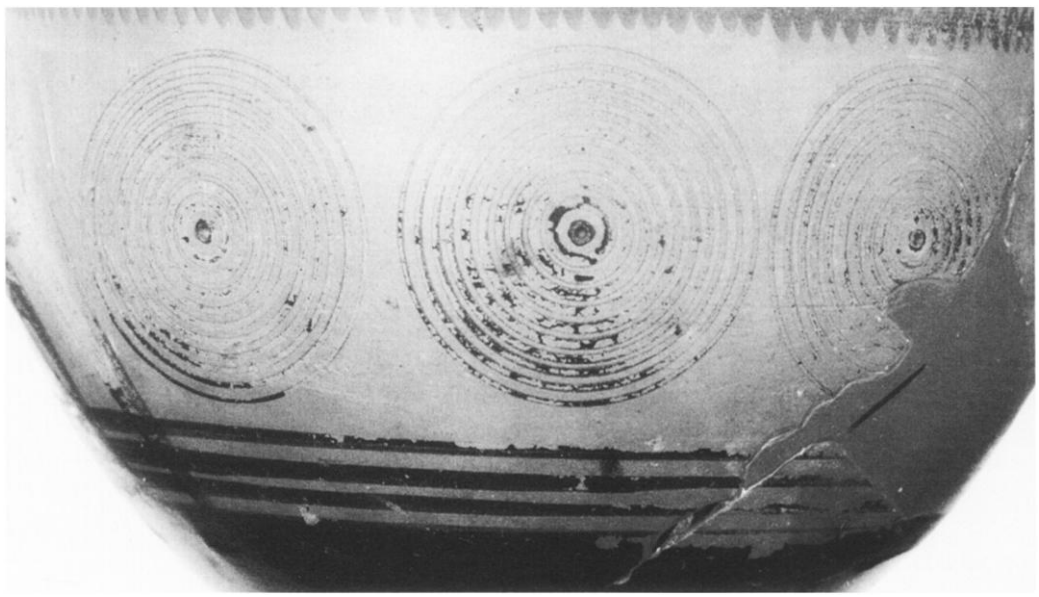

Fig. 4. Detail of Protogeometric skyphos, Athenian Agora, P 6673. (C. Mauzy, courtesy American School of Classical Studies, Athens)

an impression in the unfired clay.[61] In some cases this pivot point can be comparatively deep, and therefore clearly noticeable (figs. 3–5), suggesting that the

Fig. 5. Detail of Protogeometric oinochoe from the Athenian Agora, P 27109. (C. Mauzy, courtesy American School of Classical Studies, Athens)

[61] Myres (supra n. 23) 452 almost anticipated the pivoted multiple brush: "Then quite suddenly, the compass-drawn concentric-circles appear, made with a bundle of small brushes mechanically rotated round a pivot. Applied to the unfired clay, this pivot leaves on the 'centre point' an imprint, usually quite ill-concealed by a dot of paint." Although ancient potters may have from time to time applied a small dot of paint over the pivot point in order to mask it, our experiments have shown that, in the majority of cases, the small dot is a result of paint on the pivot point itself.

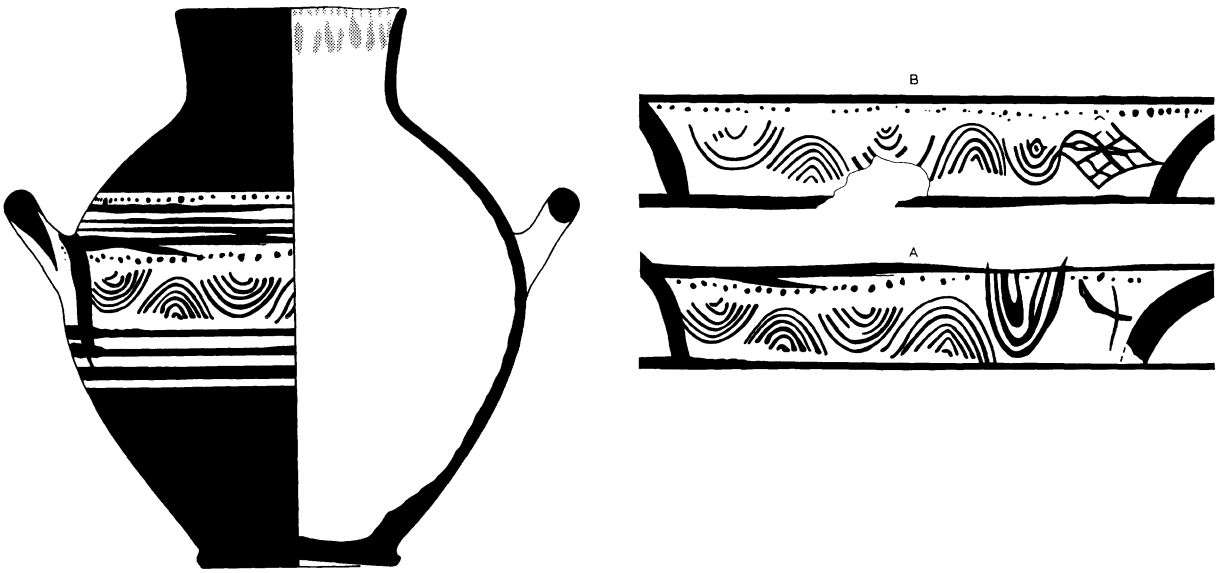


Fig. 6. Final Mycenaean/Submycenaean small belly-handled amphora, Athenian Agora tomb I 5:3–1, P 30305. Scale 1:3. (A. Hooton)

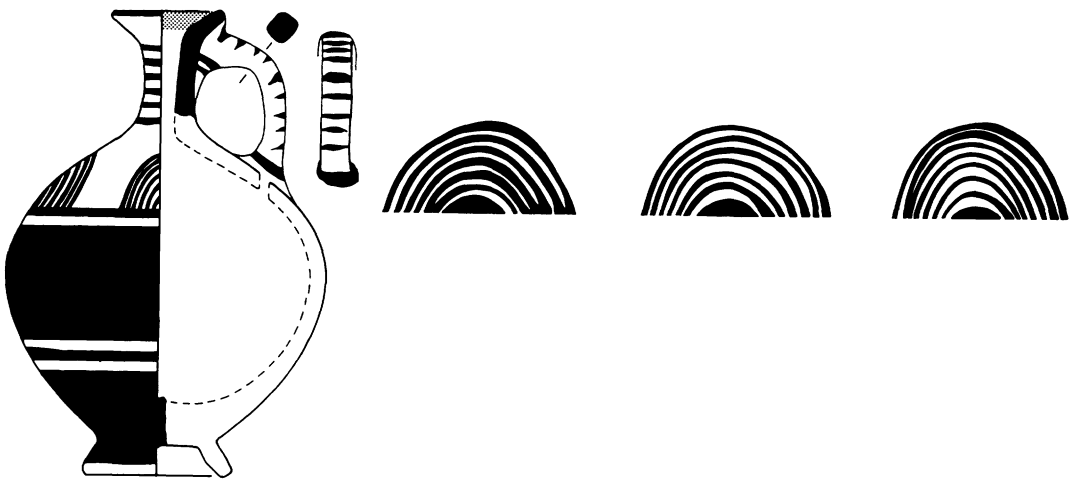

Fig. 7. Final Mycenaean/Submycenaean lekythos with hand-drawn concentric semicircles, Athenian Agora tomb M 16–17:1, P 10582. Scale 2:5. (A. Hooton)

decoration was executed while the clay was moist to leather-hard; in other cases the central pivot point is barely noticeable, indicating that the decoration was executed while the fabric was leather-hard to bone-hard. More importantly, however, there is rarely more than one pivot point in any individual set of concentric circles or semicircles (figs. 3–5). If Eiteljorg was correct in assuming that the circles and semicircles of Greek Protogeometric pottery were drawn with "individual compasses, each with fixed radius, or with a single, adjustable compass,"[62] then it would be reasonable to expect evidence of the impression of more than one pivot point, the result of the potter repeatedly lifting and replacing the device, at least in a few instances. This is rarely, if ever, the case among the numerous examples of Protogeometric pottery, from various regions, that we examined.

Another important aspect should be considered: on Final Mycenaean and Submycenaean pots with concentric circles and semicircles drawn without the aid of a multiple brush, the numbers of circles or

[62] Eiteljorg 451.

arcs in individual sets of circles or semicircles on a given pot varies. This point is illustrated on drawings of two early (Final Mycenaean or Submycenaean) vessels from the Early Iron Age cemeteries in the area of the later Athenian Agora (figs. 6–7). The upright and pendent concentric semicircles on the small amphora, Athenian Agora P 30305 (fig. 6),[63] consist of groups of four, five, six, and seven semicircles. The lekythos with hand-drawn upright semicircles, Athenian Agora P 10582 (fig. 7),[64] stylistically very similar and probably contemporary with its Protogeometric cousins, has two sets of six semicircles and one of seven; all three sets have a central "half-moon" filling. For Protogeometric and Geometric pottery decorated with mechanically drawn circles and semicircles, there is no such variety. Great consistency is evident in all of the Protogeometric vessels examined by us.[65] The same is also true for the circles on the belly zone and the semicircles on the shoulder of the amphora Kerameikos inv. 918 (fig. 8);[66] each set on this particular vessel consists of either nine circles or 12 semicircles.[67] Indeed, it is even possible in some cases to distinguish the use of the same multiple brush on two or more Protogeometric vessels.[68] The fact that each multiple brush is made individually means that each implement has its own particular signature and it is therefore possible to isolate examples of the use of the same device on different pots. If the concentric circles and semicircles of Protogeometric pottery were drawn with individual compasses, each with fixed radius, or with a single, adjustable compass, then at least some variety might be expected in the number of individual circles or arcs in any given set.[69]

Another point made by Eiteljorg is worth quoting in full: "In a group of concentric circles on a changing surface, for instance, there could only be one circle with consistent line thickness throughout; all the other lines would vary in thickness as the painter flattened some brush tips to keep others in contact with the surface. Variation is certainly not visible on Protogeometric pottery, where line thickness on the best vases is extremely well controlled."[70] Although line thickness (width) can be remarkably uniform in some of the best examples of concentric circles and semicircles (e.g., fig. 9),[71] careful examination and measurement of concentric ornament usually reveal a slight variation in line thickness. The shoulder decoration of an Early Protogeometric belly-handled amphora from tomb 104 at Torone (fig. 10) provides a good example.[72] Figure 10 represents as accurate a rendering of each circle as was possible.[73] The sets of concentric circles on the shoulder of the vase were executed by a potter perhaps not well versed in the use of the multiple brush; not only are the sets of concentric circles placed at irregular intervals in relationship to one another, but there also is considerable variation in the line thickness of individual circles in any given set. Another good example is provided by the sets of semicircles on the shoulder of the Athenian Protogeometric oinochoe (fig. 5): the majority of the inner

[63] From tomb I 5:3; the vessel is mentioned in T.L. Shear, Jr., "The Athenian Agora: Excavations of 1973–1974," *Hesperia* 44 (1975) 373 n. 103, pl. 84i.

[64] From tomb M 16–17:1; the vessel is unpublished, but the tomb from which it derives is briefly mentioned in T.L. Shear, "The American Excavations in the Athenian Agora, Fourteenth Report: The Campaign of 1937," *Hesperia* 7 (1938) 324–25. The Early Iron Age tombs in the area of the later Athenian Agora will be presented in detail in a forthcoming volume by J.K. Papadopoulos and E.L. Smithson in the *Agora* series.

[65] See, e.g., figs. 3–5, 9–12.

[66] *Kerameikos* IV, pl. 9, PG grave 26, inv. 918; Desborough 1952 (supra n. 26) pl. 4.

[67] Generally speaking, Early Iron Age Greek potters rarely used more than one pivoted multiple brush on any individual pot; such a practice is more common in Early Iron Age Cyprus. An interesting early amphora from the Athenian Kerameikos has mechanically drawn circles on the belly zone and hand-drawn semicircles on the shoulder; see B. Schlörb-Vierneisel, "Eridanos—Nekropole I: Gräber und Opferstellen hS 1–204," *AM* 81 (1966) pl. 11.4–5, I (hS 101).

[68] E.g., two oinochoai from the area of the later Athenian Agora were clearly decorated with the same multiple-brush implement: P 23556 (tomb Q 8:6) and P 23551 (tomb Q 8:5).

[69] With an adjustable compass, Vedder painted all rings of one size, then reset the compass for the next size. Even adopting this method, one might still expect some variation in the number of circles, and especially in arcs, on ancient pottery, particularly on smaller vessels and in areas near the handle or neck of a pot.

[70] Eiteljorg 449.

[71] *Kerameikos* IV, pl. 10, PG grave 37, inv. 1073.

[72] Torone T104–1, inv. 82.180, briefly noted and illustrated in A. Cambitoglou, "Ανασκαφή Τορώνης," *Prakt* 1982, 75, fig. 5.

[73] The authors are grateful to Anne Hooton for her meticulous drawing. The splashes of paint visible between the third and fourth sets of concentric circles from the left, extending below the three bands that define the shoulder, seem to number seven, the same number as the circles in each set on the shoulder, suggesting that they may have been the imprint of the multiple-brush device; in attempting to replicate the splashes, however, Vedder showed that these were most likely caused by some mishap with a single larger brush, probably that used for drawing the three bands below the circles or for painting the neck of the vessel solid.

Fig. 8. Protogeometric belly-handled amphora with tripod loop feet, Kerameikos Protogeometric grave 26, inv. 918. (Courtesy Deutsches Archäologisches Institut, Athens, Kerameikos Excavations)

Fig. 9. Protogeometric belly-handled amphora, Kerameikos Protogeometric grave 37, inv. 1073. (Courtesy Deutsches Archäologisches Institut, Athens, Kerameikos Excavations)

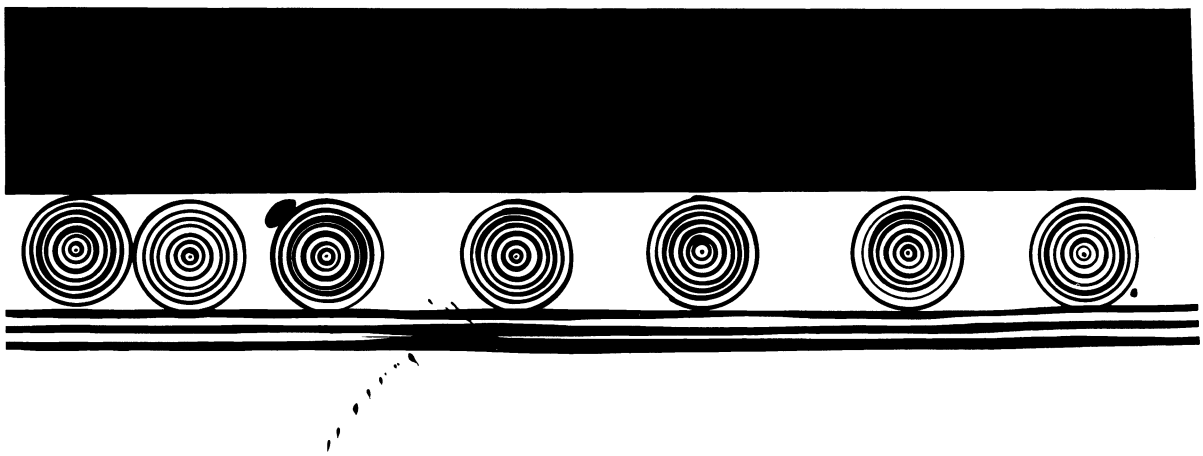

Fig. 10. Drawing of the shoulder decoration of Protogeometric belly-handled amphora, Torone T104-1, inv. 82.180. (A. Hooton)

arcs begin with a thick line, become thin in the middle of the arc, and thicken again toward the end; at the same time, the outermost arc is thickest at its uppermost point.

Eiteljorg also considered "near-circles," "stray lines," and "eccentric circles." With regard to the so-called near-circles,[74] which are arcs more complete than semicircles but less than full circles, the fact that their

[74] A lekythos with near-circles discussed by Eiteljorg was published in E.L. Smithson, "The Protogeometric Cemetery at Nea Ionia, 1949," *Hesperia* 30 (1961) 161–62, pl. 26 (inv. 18079); the ends of some of the arcs on the vessel have been obliterated by modern restoration. Near-circles are especially common on the pottery from Rhodes and Kos, see L. Morricone, "Sepolture della prima Età del Ferro a Coo," *ASAtene* 56, n.s. 40 (1978) 52, fig. 7; 68, fig. 48; 76, fig. 61 (central set of semicircles); the exterior of 91, fig. 95; 149, fig. 254; 150, fig. 255; 168, fig. 301; 185, fig. 348; 219,

beginnings and terminations are not in unison on ancient pots does not in itself provide evidence for the use of individual compasses, nor does it establish that multiple-brush devices were not used. Eiteljorg based his conclusions on compass drawings on flat surfaces; a tilted multiple brush behaves quite differently on curved surfaces. The so-called stray lines found with concentric semicircles, which are the continuations of several of the arcs in any given set of semicircles in the reserved zone below, are very common on Protogeometric pottery, as the illustrated example from Torone (fig. 11) indicates.[75] Contrary to Eiteljorg's assertions, what a careful study of numerous Protogeometric vessels suggests is that the multiple-brush device as hypothesized by him may not be the same as that used by Early Iron Age potters (see below). In addition to near-circles, Eiteljorg also refers to eccentric circles, noting that "if individual compasses were used on Protogeometric pottery, one would expect that some groups of concentric circles were not, in fact, concentric. One would expect that occasional errors in replacing the compass points would produce eccentric circles."[76] The two examples Eiteljorg cites of such eccentric circles include the belly-handled amphora with tripod feet, Kerameikos inv. 918 from Protogeometric tomb 26 (fig. 8), and the skyphos, Kerameikos inv. 547 from Protogeometric tomb 15.[77] Careful examination of both pots, however, reveals that Eiteljorg's claims of eccentricity are on the basis of the published photographs: there is no such distortion or eccentricity in reality. Some of the concentric circles on the belly zone of the belly-handled amphora (fig. 8), especially the bottom of the second and third sets of circles from the right, preserve another phenomenon that is quite common on Protogeometric pots with concentric circles and semicircles: parts of two or three adjacent circles or arcs bleed into one another. This feature, which we refer to as "flooding," is the result of too much paint or excess pressure on a number of brushes held together in a multiple-brush device.[78]

Eiteljorg also refers to irregularities, even aberrations, found on some vases.[79] He explains these as a result of the fact that an individual painter would always use the same compass, and therefore the same individual brush. He argues that such irregularities were therefore caused by a faulty brush, and that these would recur as long as the painter continued to use the same compass. In our experience, the most common irregularities, such as the lower right side of both sets of concentric semicircles on the neck-handled amphora Kerameikos inv. 572,[80] or the more blatant example of the concentric circles on the Cycladic skyphos from Andros (fig. 12),[81] are best explained as the result of the use of a multiple-brush device. In the case of both vessels the irregularities recur with mechanical precision in the same place on each set of motifs. Indeed, with both vessels, the potter would have had to take great care to be able to repeat these perturbations so precisely if using individual compasses, each with fixed radius, or a single, adjustable compass.

Perhaps the greatest problem, or preconception, that has pervaded the discussion of the concentric circles and semicircles is the very notion of the compass: τόρνος in Greek (Latin *tornus*) or, alternatively,

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fig. 434; 276, fig. 581; 282, figs. 596–97; 283, fig. 598; 301, fig. 644; 364, fig. 787; 397, figs. 886–87; also 411, motifs 6–7, 10–11. See also Morricone, "Coo – Scavi e scoperte nel 'Serraglio' e in località minori (1935–1943)," *ASAtene* 50–51, n.s. 34–35 (1972–1973) 233, fig. 161.

[75] The small vertical-handled amphora or amphoriskos from Torone, T47-1 (inv. 84.146), is unpublished; it is an import to the site, probably of Thessalian origin. Other vessels with similar "tails" referred to or illustrated by Eiteljorg include the amphora from Nea Ionia published in Smithson (supra n. 74) pl. 24, no. 3 (cf. also the lekythos from the same site, Smithson 161, pl. 26); and an oinochoe in the Metropolitan Museum of Art, New York, no. 30.118.18.

[76] Eiteljorg 451 n. 32.

[77] *Kerameikos* IV, pl. 9 (amphora); *Kerameikos* I, pl. 68, PG grave 15, inv. 547 (skyphos).

[78] "Flooding" occurs on all regional styles of Greek Protogeometric pottery. See, e.g., Morricone 1978 (supra n. 74) 67, fig. 46 (right set of semicircles); 131, fig. 210 (lower left set); 302, fig. 645; 400, fig. 899; and L. Rocchetti, "La ceramica dell'abitato geometrico di Festòs (Scavi 1950–1970)," *ASAtene* 52–53, n.s. 36–37 (1974–1975) 189, fig. 28, no. 33; 242, fig. 100, no. 49; 249, fig. 111; cf. 193, fig. 33.

[79] Eiteljorg 451.

[80] *Kerameikos* I, pl. 57, PG grave 17, inv. 572. The innermost arc is incomplete on all four sets of circles. Careful examination of the vase suggests that the semicircles were applied in a clockwise rotation of the tool, which appears to have been loaded with clay-paint (slip) several times and each time applied further up the arcs. The irregularities visible near the end of each set of arcs are the result of lifting the tool prior to reaching the baseline on all but the initial application.

[81] A. Cambitoglou et al., *Archaeological Museum of Andros. Guide to the Finds from the Excavations of the Geometric Town at Zagora* (Athens 1981) 101–102, no. 339 (inv. C2); Desborough 1952 (supra n. 26) pl. 16, no. 45. The tool used for decorating the concentric circles, to judge from the photograph, appears to have been filled with slip at least twice in order to complete each set. The poor overlap of the circles is a result of centripetal drag, which is more pronounced on the inner circles.

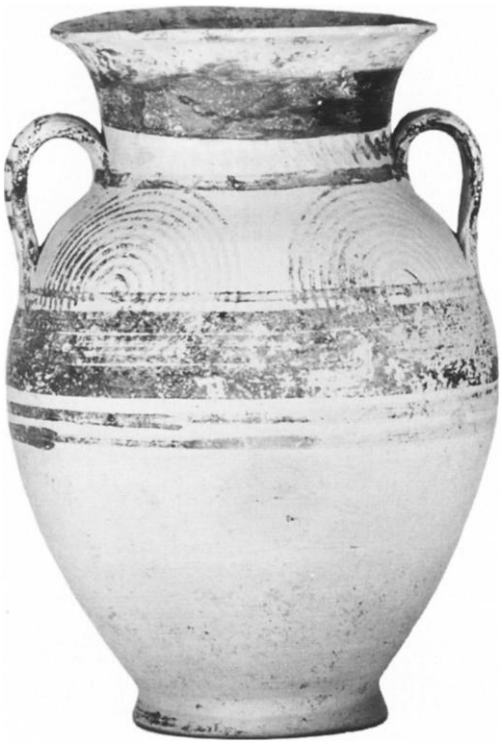

Fig. 11. Protogeometric vertical-handled amphoriskos, Torone T47-1, inv. 84.146. (R. Scannell)

διαβήτης.[82] There is, for those who would still have Athens as the home of the Protogeometric style, the Athenian myth in which Talos (Kalos, Perdix) invented the potter's wheel, the saw, and the compass;[83] the same Talos, according to Servius, was called by some Circinus ("Circle" or "Compass"). As for the archaeological evidence for compasses, much of the earlier literature was collected by V. Gordon Childe.[84] The existence of the compass from a

Fig. 12. Protogeometric skyphos, Zagora, Andros inv. C2, no. 339. (Courtesy Zagora Archives, Australian Archaeological Institute, Athens)

Fig. 13. Shoulder fragment, Protogeometric closed vessel, Torone T113-10, inv. 82.1128. (R. Scannell)

[82] For *tornos,* see, e.g., Diod. Sic. 4.76: ὁμοίως δὲ καὶ τὸν τόρνον εὑρὼν. Also Eur. *Theseus*, fr. 382: Κύκλος τις ὡς τόρνοισιν ἐκμετρούμενος. Οὗτος δ'ἔχει σημεῖον ἐν μέσῳ σαφές. Cf. Apollod. 3.65.8. In LSJ (s.v. τόρνος) it is described as a "carpenter's tool for drawing a circle, like our compasses, probably a pin at the end of a string." By its etymology, διαβήτης (from διαβαίνω) implies a tool with distinct members, that is, a compass, so-called from its outstretched legs (see LSJ [s.v. διαβήτης]). For διαβήτης, see esp. Ar. *Nub.* 178; *Av.* 1003. For a useful overview of the literary sources, see A.K. Orlandos, *Τα υλικά δομής των αρχαίων ελλήνων* 1 (Athens 1955) 57–58; see also R. Martin, *Manuel d'architecture grecque* 1: *Matériaux et techniques* (Paris 1965) 188.

[83] S.P. Morris, *Daidalos and the Origins of Greek Art* (Princeton 1992) 259–60.

[84] Childe (supra n. 46) 195 noted that a true circle can be traced by a length of string, one end of which is fixed, or by a forked stick or bone, one prong of which is rotated on the other as a fixed point; he also noted that such simple devices are unlikely to survive in the archaeological record, or to be recognized if they did. He states: "Save for a minute instrument, adjustable in the manner of a beam-compass from a Bronze Age site in central Italy, no compass survives from earlier than classical times." With regard to Bronze Age Crete, A.J. Evans, *PM* IV:1, 92 n. 2, writes: "It is certain that by the beginning of the Middle Minoan Age the Cretan seal-engravers were producing designs by means of intersecting circles mechanically executed"; cf. Evans, *PM* II:1, 116 n. 1. See also F. Matz, *The Art of Crete and Early Greece* (London 1962) 174, fig. 48; New York ed., 214, fig. 48, and also p. 169 (for the use of the

Greek perspective is amply attested by the Early Archaic period, by way of both graffiti on Greek vases[85] and the use of "cutting compasses" in sculpture and inscriptions,[86] and an early example of a compass used to incise a circle on pottery comes from a fragment in a Protogeometric context at Torone (fig. 13).[87] Despite the existence of compasses in the Aegean Early Iron Age, it is highly unlikely that the multiple-brush device used to decorate Protogeometric vessels with concentric circles and semicircles was ever attached to a true pair of compasses.

In January 1994 Vedder began considering and experimenting with various means of applying concentric circles to the curved surfaces of pottery.[88] Adequate results were achieved using various techniques, but many of these involved undue complexity and were time-consuming. For example, a paper stencil for concentric semicircles laid on the dampened side of a flowerpot and painted with clay-paint (slip) worked well but left a slight ridge of clay along the edges of the resulting arcs. For full circles, the stencil could be shifted and painted to complete the rings, but a practical stencil for concentric circles would be difficult to make and apply successfully to curved surfaces. Another approach involved mounting a casing of a modern pen on a compass (fig. 14); the pen, with ball tip and ink tube removed, had an ample reservoir for slip and served as a simple alternative to a reed. Such a tool produces neatly formed concentric circles, one ring at a time, as illustrated in figure 14. Even when the pen casing is replaced with a brush, it is time-consuming to use, especially when decorating many pots at one sitting. Moreover, there are practical difficulties in adjusting the compass precisely enough to make two adjacent sets of concentric circles as similar to one another as on Greek Protogeometric pottery. This problem could be avoided by applying all the rings of a given size before readjusting the compass for the next size. Alternatively, the problem could be alleviated if the potter constructed numerous compasses, each with a fixed radius, and carefully drew

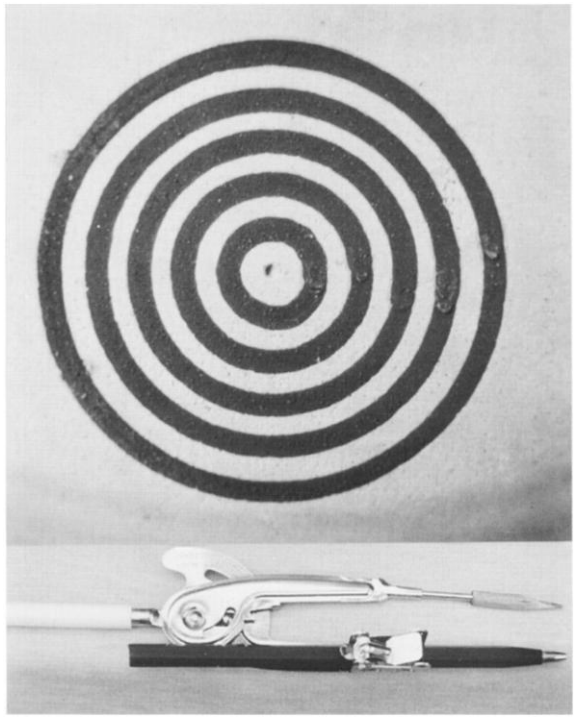

Fig. 14. Compass with pen casing, wooden pivot, and extended handle used to paint a set of concentric circles with slip, one ring at a time on a clay pot thrown by J. Vedder. The sector of overlap is at 3:00 o'clock. (J. Vedder)

compass in ornamental design). For a more recent discussion of compasses and circle ornaments in European archaeology, including illustrations of a variety of compasses, see M. Lenerz-de Wilde, *Zirkelornamentik in der Kunst der Latènezeit* (Munich 1977) esp. 5–7, fig. 5 (with references); see also J.J. Butler, "A Late Bronze Age Drawing Instrument?" *Palaeohistoria* 21 (1979) 196–203.

[85] See esp. A.W. Johnston, *Trademarks on Greek Vases* (Warminster 1979) 5, 81, graffito type 21A vii, ΣΟ, where the omicron is incised with a compass.

[86] A.E. Raubitschek, "The Mechanical Engraving of Circular Letters," *AJA* 55 (1951) 343–44. See, e.g., the compass-incised concentric circles on the bodies of the felines on the pediment of the Temple of Artemis at Corfu, best illustrated in G. Dontas, *Οδηγός Αρχαιολογικού Μουσείου Κερκύρας* (Athens 1970) pls. 8, 10, 12; and those on the body of the feline from the Athenian Acropolis: M. Brouskare, *Musée de l'Acropole. Catalogue descriptif* (Athens 1974) pl. 18, inv. 552 and 554; cf. I. Beyer, *Die Tempel von Dreros und Prinias A und die Chronologie der kretischen Kunst des 8. und 7. Jhs. v. Chr.* (Freiburg 1976) pl. 57, pl. 53, no. 1.

[87] The fragment, Torone T113–10, inv. 82.1128, was encountered among the fire-affected sherds recovered from the pit fill of tomb 113, although it itself preserved no visible signs of having been burned. The sherd, broken on all sides, preserves a small portion of the shoulder of a large wheelmade, thick-walled, closed vessel, probably an amphora. The exterior is painted solid and the fragment preserves one almost complete circle, 0.05 m in diameter, executed with a compass. The circle was incised after firing, with the edges of the incision slightly chipped or splintered from the resistance offered to the cutting implement by the hardened surface of the pot. The central dot created by the compass point can be seen. The fragment can be dated, by associated pottery, to the early or middle stage of the Protogeometric period.

[88] He dug and processed clay from his backyard to form clay surfaces to decorate, and later enrolled in a class to learn to throw and decorate pottery.

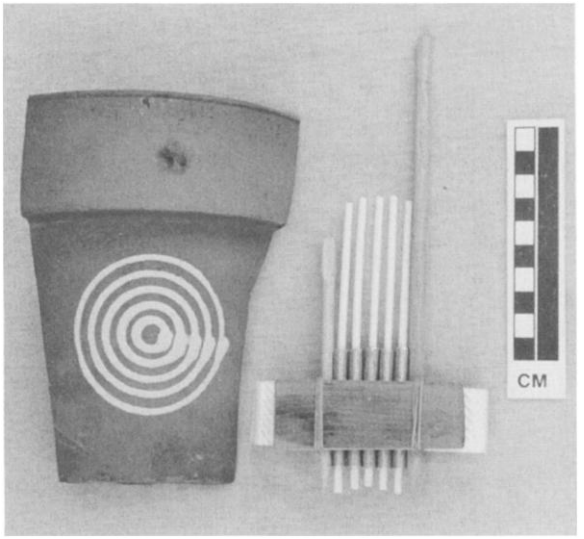


Fig. 15. A set of concentric circles applied simultaneously to a sherd of a conical flower pot by five plastic tubes unrestrained longitudinally within shorter tubes clamped between a long pivot stick and shorter surface feeler or guide stick. The excess slip at the initial radial line resulted from the impact of the tubes upon their release. (J. Vedder)

each set of concentric circles; such a painstaking process would be unnecessarily time-consuming, however, as would the process of applying all circles individually with an adjustable compass.

From the single, adjustable compass, or a multitude of compasses with fixed radii,[89] Vedder went on to experiment with a variety of multiple-element implements. In this case, the primary problem encountered was that anticipated and stressed by Eiteljorg: to make an implement that allowed each element to remain in contact with a surface of varying curvature. One attempt involved a device that allowed laterally constrained elements a limited length of free up-and-down motion; such a device has the advantage of permitting each element, under its own weight, contact with a surface of varying curvature. Several prototypes of such an instrument with five elements were constructed, using ballpoint pen casings, small plastic straws, or plastic tubes free to slide within restraining tubes clamped between two pieces of wood, which also held a pivot stick. Improving on this, Vedder drilled holes in a wooden holder fitted with a pivot stick to replace the restraining tubes and allow free linear motion of the tubes containing slip. The tubes also had the advantage of

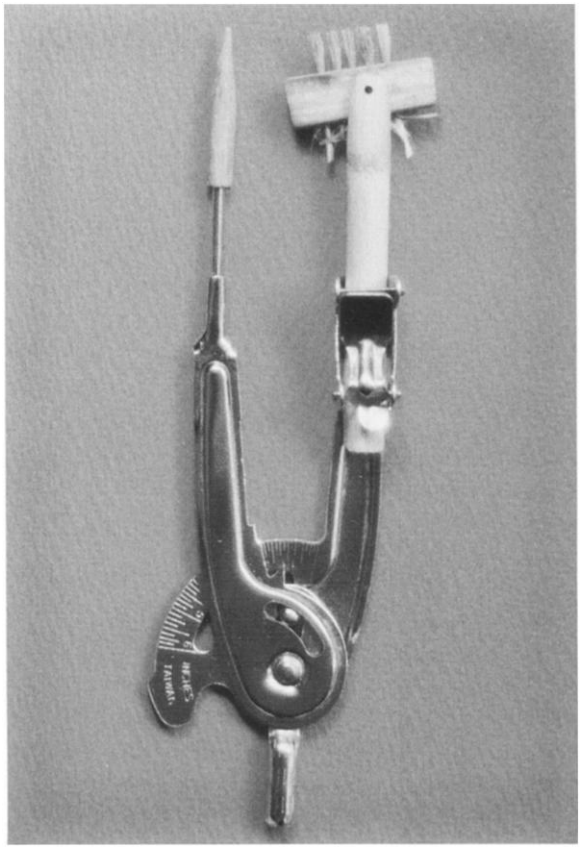

Fig. 16. A multiple-brush compass that compensates for curvature. The brush holder is free to rotate through a limited angle. (J. Vedder)

approximating Wells's idea of "quills" (see above). Testing these instruments on smooth curved surfaces showed that they could produce neat concentric circles with evenly distributed slip, except for some excess at the starting point (fig. 15). This excess could be reduced with care and experience in handling, but practical problems arose in manipulating these tools. Loading the tubes with slip to take advantage of their reservoir capacity and wiping excess slip from the exterior of the tubes was very time-consuming. Also, the fluidity of the slip had to be such that it would not drip out of the tube yet flow easily in contact with a surface. The greatest concern, however, was the possibility of slip getting between the tube and the restraint and thus inhibiting any motion. Brushes instead of tubes were also tried in such a device. In such a case, the bristles of the brushes must be stiff enough so that the curvature compensation

[89] Vedder did not actually make a set of fixed compasses, as this seemed unnecessary. Had he done so, however, the results would have been similar to that of his procedure of drawing all rings of one size before readjusting the compass for the next size.

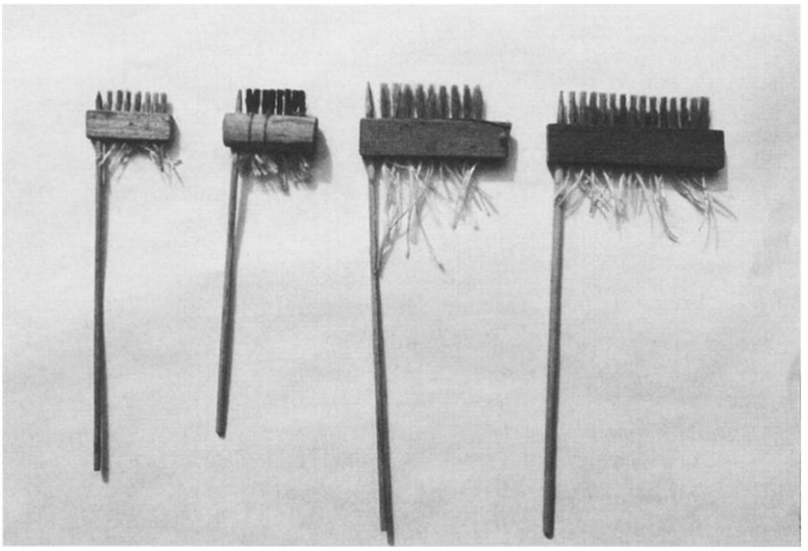

Fig. 17. Four pivoted multiple brushes of various sizes made by J. Vedder, with individual brushes numbering 7, 8, 9, and 14. The second brush from the left is made of human hair; the remainder of goat hair. The strands protruding from the beams are the frayed ends of loops of thread used to draw the bundles of hair into a row of holes. (J. Papadopoulos)

is accomplished by sliding in the holder rather than by the flexing of the brush. Once more, the possibility of slip interfering with free motion was a problem, and the process lacked a certain elegance of simplicity.

In response to the most commonly held view that Protogeometric potters used a multiple-brush compass, several configurations were assembled and tested. A modern conventional drawing compass was modified to hold a multiple brush that might work on surfaces with changing curvatures. The usual pen or pencil was replaced with a hand-carved, olive-wood shaft with a slotted end in which a multiple-brush could be pivoted. In one version, an olive-wood beam with a line of five brushes was supported near its midpoint by pins through the slotted end of the shaft that allowed free rotation over a limited arc in the radial plane of the arms of the compass (fig. 16). The limits of the arc are determined by the depth of the slot in the shaft. It was found that some care was needed to manipulate this curvature-compensating compass on account of the difficulty in balancing the distribution of pressure among the brushes on a surface of changing curvature. Further development of this approach was abandoned in favor of simpler tools that required less time, care, and complexity in shaping and manipulation.

Any useful multiple-brush device should have a configuration easily fashioned from material readily available to the potters at the end of the second or the beginning of the first millennium B.C. By assuming the existence of a multiple brush, as is suggested by a close examination of Early Iron Age pottery, and by abandoning the notion of a compass, Vedder fashioned a simple device that permitted drawing concentric circles and semicircles similar to those on Greek Protogeometric pottery. Eiteljorg, following Braidwood, assumed that a multiple brush must have had individual brushes suspended from a horizontal member, and that this was held and manipulated by a vertical rod attached to the center of the horizontal member (fig. 1).[90] Such a multiple-brush tool, used today by Lebanese potters,[91] is *not* suitable for drawing concentric circles and semicircles, even if it is attached to one arm of a pair of compasses.

A slight, but not obvious, modification to the device first suggested by Braidwood provides the answer. This is illustrated in figures 17–18. A row of brushes made of equal lengths of animal or human hair are fixed to a small beam of wood—in this

[90] Braidwood (supra n. 5) 193, fig. 8; Eiteljorg 450, ill. 3 (left). H.R.W. Smith, *CVA U.S.A.* fasc. 10: *San Francisco Collections*, fasc. 1: *M.H. de Young Memorial Museum and California Palace of the Legion of Honor, San Francisco* (Cambridge, Mass. 1943) 15–16 suggested a fork-like instrument rotated on an outer tine.

[91] Matson (supra n. 10).

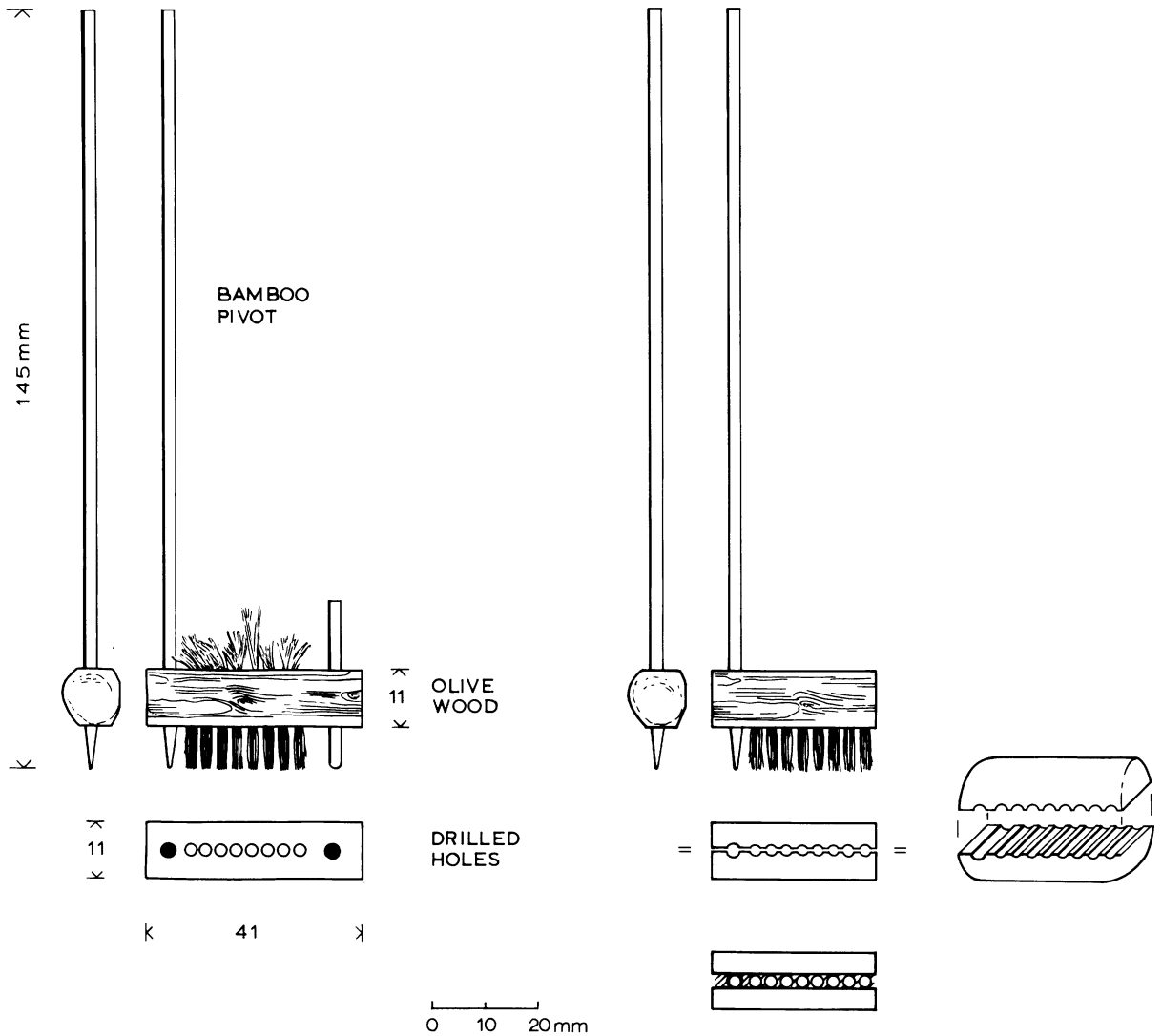


Fig. 18. Vedder's pivoted multiple brush. Drawings showing two methods of attaching the brushes. (A. Hooton)

case olive—that is rigidly attached close to the point of, and perpendicular to, a pivot shaft; a modern *souvlaki* stick makes an ideal pivot.[92] The point of the pivot shaft extends about the same distance below the beam as do the brushes. Alternative methods of attaching the brushes are illustrated in figure 18, and even simpler methods can be used, though the best results are usually achieved by attaching the hair used for the brushes directly to the horizontal beam.[93] We prefer to call this device a "pivoted mul-

[92] In order to hold the individual brushes, evenly spaced holes were drilled through the beam (the size of the beam is such that the holes could as easily be bored). Near one end, a larger hole was drilled for the pivot stick. A loop of thread was then fed through a hole, and a bundle of hair of appropriate size for the hole was laid crosswise through the loop and crosswise to the beam; the free ends of the thread were then pulled, causing the bundle to double back on itself as it was drawn into the hole partway. After all the bundles were installed, the ends were trimmed to the desired length and shape. In making these brushes, Vedder used his own hair, as well as that of his wife. In the case of other brushes, including three of those illustrated in fig. 17, goat hair was used. The short vertical stick at the right end of the beam on fig. 18 (left) is a "surface feeler"; this was added by Vedder on the prototype in order to help him manipulate the brush more effectively. Such small rods, it was subsequently shown, would lead to difficulties in decorating sets of concentric circles or semicircles near handles, especially on small vessels. In fig. 18 (right), options for clamping or gluing the elements to the holder are presented.

[93] Simpler pivoted multiple brushes were assembled from dry branches of olive wood (0.7–1.0 cm in diameter), with the bark removed and bundles of hair and a pivot stick tied, glued, or wedged into notches along the side

tiple brush." The term "multiple-brush compass" does not bring to mind such a tool, and its use in this case would be misleading.

To manipulate this pivoted multiple brush, the pivot can be rotated between the thumb and opposing index and middle fingers, while maintaining pressure on the pivot and a forward tilt of the beam. The radial tilt of the beam is adjusted as the surface curvature changes. The application of the slip is viewed best from above and behind the tool, with special attention directed toward maintaining a neat trail of slip from the outermost brush.[94] A pivot may also be rotated between the thumb and middle finger while pressure is applied to the top of the pivot by the index finger.[95] In both cases, it is possible to replicate the concentric circles and semicircles of the Protogeometric pottery quickly and without difficulty. Indeed, with a few minutes of practice, a novice can become well versed and able to decorate efficiently a large number of pots similar in size and shape within a short period of time.

In order to test the capabilities of the pivoted multiple brush, a terracotta cylinder was decorated with a five-brush version similar to those shown in figures 17–18; the result is seen in figure 19. Not only is it possible to draw concentric circles with a pivoted multiple brush on the surface of a cylinder, but it is relatively straightforward. Moreover, the same device could be used to replicate most, if not all, of the details observed on ancient pottery. To highlight its capabilities, Vedder used the same device to replicate the idiosyncratic concentric "hooks" found on Cypriot, Lydian, and other Early Iron Age wares (fig. 20), including the so-called *Kreis- und Wellenband* or "spaghetti" style.[96]

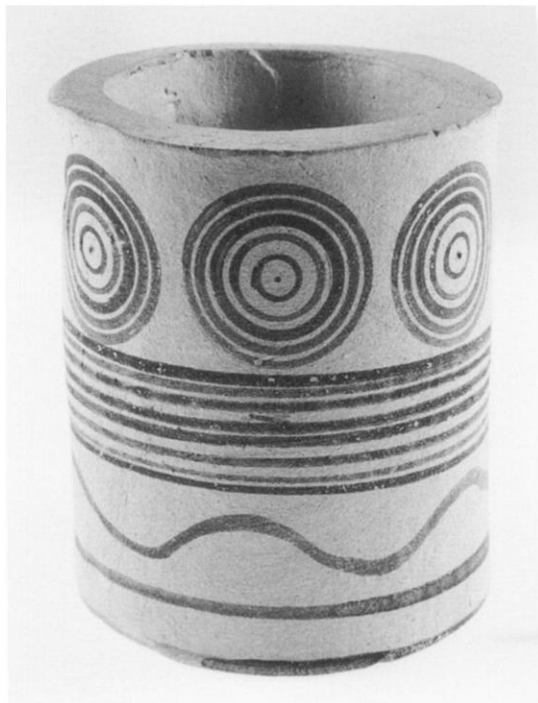

Fig. 19. Terracotta cylinder formed by J. Vedder and decorated with a pivoted multiple brush similar to those illustrated in figures 17–18, but with five brushes. (E. Comiskey)

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Alternatively, the brushes could be wedged into a lengthwise slot in the beam. Some of these configurations could lead to an adjustable holder in which individual brushes could be moved, rearranged, or replaced.

[94] This method of manipulating the device was preferred by Vedder.

[95] This method was instinctively preferred by Papadopoulos.

[96] The results are published in J.F. Vedder, "Tools of the Trade," *CAARI News* 12 (1996) 6–7; the Cypriot lekythos used by Vedder as the model was published in Smith (supra n. 90) 15–16, pl. 1, fig. 2 (with comparanda). Pendent concentric hooks are found on a variety of wares; for Cypriot, in addition to the references cited in Smith, see Myres (supra n. 22) 80–81, nos. 643 (fig. on p. 78), 644–45; A.P. di Cesnola, *Salamina: The History, Treasures, and Antiquities of Salamis in the Island of Cyprus* (London 1884) pl. XIX, nos. 8–10; K.F. Johansen, *Les vases sicyoniens* (Copenhagen 1923, repr. 1966) 42, fig. 13*bis*. For examples on Aegean vessels, see H. Dragendorff ed., *Thera: Untersuchungen, Vermessungen und Ausgrabungen in den Jahren 1895–1902* II: *Theraeische Graeber* (Berlin 1903) 179, figs. 370a–b; cf. H.G.G. Payne, *Necrocorinthia: A Study of Corinthian Art in the Archaic Period* (Oxford 1931) 5 n. 1; C. Blinkenberg, *Lindos: Fouilles et recherches, 1902–1914* I, Pt. 1 (Berlin 1931) 301–306; K.F. Johansen, *Exochi: Ein frührhodisches Gräberfeld* (*ActaArch* 28, Copenhagen 1958) figs. 23, 142–43, 223; G. Buchner and D. Ridgway, *Pithekoussai* I: *La necropoli: Tombe 1–723, scavate dal 1952 al 1961* (Rome 1993) pl. 54, tomb 145, no. 8; pl. 61, tomb 159, no. 5; pl. 62, tomb 160, no. 5; pl. 75, tomb 168, no. 25; pl. 103, tomb 271, no. 16; also the remarkable vessel illustrated on pl. 254, S11, no. 2, with sets of tremulous lines on the shoulder/neck executed with a multiple brush with four brushes, and pendent concentric hooks on the lower register executed with the same four-brush implement; see also Snodgrass (supra n. 30) 93, fig. 50c. D. Ridgway, *The First Western Greeks* (Cambridge 1992) 62 notes that the so-called *Kreis- und Wellenband* style was probably made by Phoenicians living in Ialysos on Rhodes. For Lydian parallels see, e.g., G.M.A. Hanfmann, "The First Campaign at Sardis," *Annual Report of the Fogg Art Museum* 1957–1958, 16; Hanfmann, "The Eighth Campaign at Sardis (1965)," *BASOR* 182 (1966) 27 (P. 65.79 [6693]); F. Brein, "Geometrisch dekorierte Keramik aus Ephesos," in *The Proceedings of the Xth International Congress of Classical Archaeology, Ankara-Izmir, 23–30 September 1973* II (Ankara 1978) 726, fig. 17; J. Morganstern ed., *The Fort at Dereagzi and Other Material Remains in Its Vicinity: From Antiquity to the Middle Ages* (Tübingen 1993) esp. 131, no. 9, pl. 26.1; A. Ramage, "Early Iron Age Sardis and Its Neighbours," in A. Çilingiroglu and D.H. French eds., *Anatolian Iron Ages* 3: *The Proceedings of the Third*

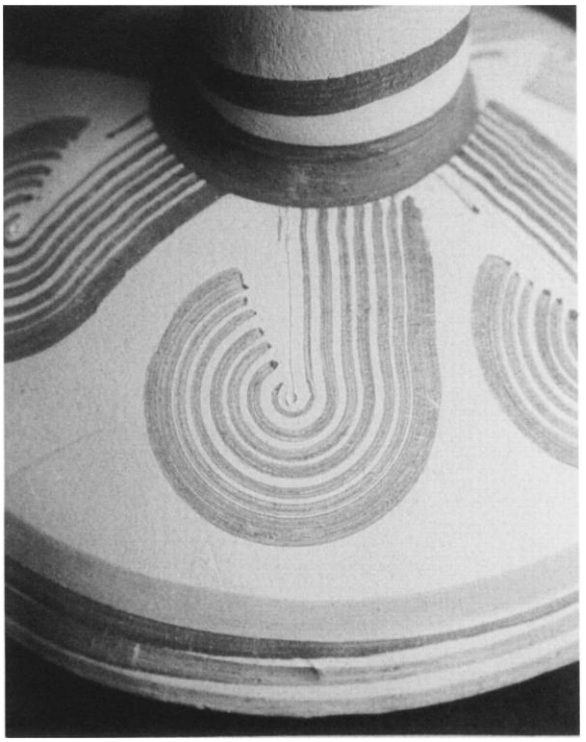

Fig. 20. Replication of hooks based on an Early Iron Age Cypriot lekythos, the Fine Arts Museums of San Francisco, inv. 1925.380, using a pivoted multiple brush similar to those illustrated in figures 17–18. (J. Vedder)

Having successfully applied concentric circle and semicircle decoration to a variety of curved surfaces, we decided to attempt to replicate a number of typical Greek Protogeometric vessels. To this end, the services of Schreiber, a professional potter, were enlisted and a variety of large and small vessels typical of the Aegean Early Iron Age were thrown in her workshop. It was decided to replicate two amphoras of different sizes, a medium-size oinochoe, a small lekythos, and an average-size skyphos.[97] Four of the vessels were formed from clay commercially available in the United States, and the small lekythos was made of clay from the pits at Marousi in what is today northern Athens. In decorating these vessels, a variety of pivoted multiple brushes were used, with the number of individual brushes varying between seven and 14 (fig. 17).

The process of decorating vases made by Schreiber is documented in figures 21–24. Having thrown the pots, Schreiber painted bands on some of the vessels to serve as a baseline for concentric semicircles; these bands were painted while the pot was revolved slowly on the wheel. The vessels were then decorated by Vedder with the pivoted multiple brush; figure 21 shows concentric circles being applied to the body of a skyphos with the pivoted multiple brush, and figure 22 illustrates the largest of the pivoted multiple brushes in use to decorate the shoulder of a large amphora.[98] The other bands were applied by Schreiber after the painting of the concentric motifs. In a relatively short period of time, all five vessels were decorated (fig. 23).[99] These vessels illustrate all the common features found on Greek Protogeometric pottery, even mishaps and er-

*Anatolian Iron Ages Colloquium Held at Van, 6–12 August 1990* (Ankara 1994) 163–74; also the paper by N.H. Ramage, "Pactolus Cliff: An Iron Age Site at Sardis and Its Pottery," in the same volume (pp. 173–83); see also C.H. Greenewalt, jr., *Lydian Pottery of the Sixth Century B.C.: The Lydion and Marbled Ware* (Diss. Univ. of Pennsylvania 1966) esp. 125; C.J. Ratté, *Lydian Masonry and Monumental Architecture at Sardis* (Diss. Univ. of California, Berkeley 1989) 168, no. 21, figs. 40–41 (various examples), 94, 152. For similar hooks on Iberian pottery, see Pericot (supra n. 48) 47, fig. 60; 140, fig. 192; Page del Pozo (supra n. 48) fig. 2, no. 2.

[97] Dimensions given in meters. The complete neck-handled amphora (fig. 23; H. 0.355, D. [rim] 0.114, D. [base] 0.108) is loosely based on Athenian Protogeometric neck-handled amphoras such as Desborough 1952 (supra n. 26) pl. 2, esp. inv. 2008 (40). The partial amphora (figs. 22–23; H. [as made] 0.177, D. [rim] 0.138) is similar to the previous amphora, but larger and specifically designed to test the largest of the pivoted multiple brushes Vedder made for this study. The skyphos (figs. 21, 23; H. 0.140, D. [rim] 0.156, D. [base] 0.062) is loosely based on Desborough 1952 (supra n. 26) pl. 10, inv. 2032 (48). The shape of the oinochoe (figs. 23–24; H. 0.205, rim 0.080 × 0.075, D. [base] 0.076) is an amalgam of standard Attic Protogeometric oinochoai, such as those illustrated in Desborough 1952 (supra n. 26) pl. 7. The small lekythos (fig. 23; H. 0.135, D. [rim] 0.046–0.047, D. [base] 0.048) replicates the shape of small, but not miniature, lekythoi, like some of those illustrated in Desborough 1952 (supra n. 26) pl. 9.

[98] Given the amount of clay required to throw a very large amphora, coupled with the fact that such a large vessel was prone to damage, it was decided to throw only the shoulder, neck, and rim of a very large amphora (figs. 22, 23 left).

[99] The phrase "relatively short period of time" needs qualification. Schreiber had thrown the pots in December 1995, well in advance, and stored them in a humid space to prevent drying. Within a few hours of their arrival at Schreiber's workshop in February 1996, Vedder, Schreiber, and Papadopoulos decorated the five vessels. To avoid mistakes and ensure the utility of the results, we carefully planned the painting of each vase, with Papadopoulos, who was responsible for the overall design, fussing a great deal, and Vedder, as the one responsible for manipulating the implements, being understandably nervous. Otherwise, the process could have been accomplished more quickly and efficiently. In an experienced, fully functioning workshop, it would be possible to decorate a large number of pots in a very short period of time, especially if they were all of similar shape and size. To maximize the results of our experiments, we decided to decorate the amphoras with concentric circles on one side and concentric semicircles on the other. The decorated pots were subsequently fired by Schreiber.

Fig. 21. Vedder painting concentric circles on skyphos. Note the tilt of the pivot in the direction of motion. (R. Schreiber)

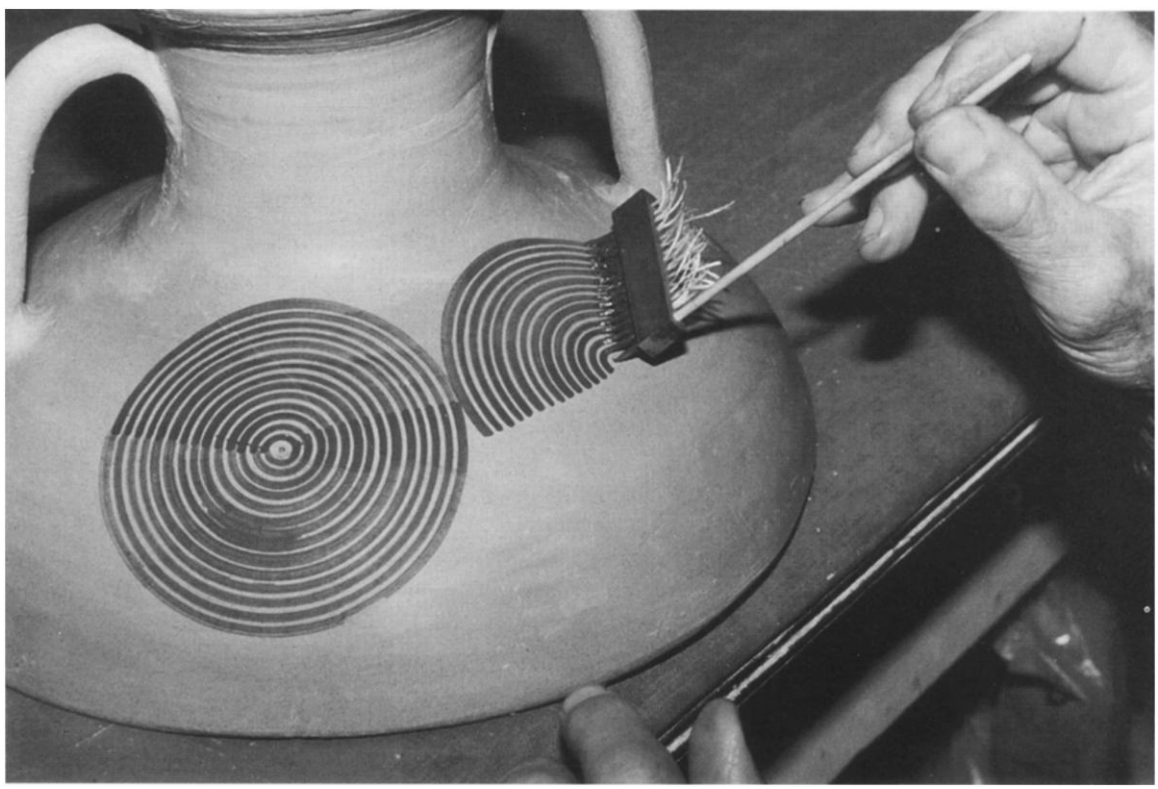

Fig. 22. Vedder painting concentric circles on the shoulder of the amphora. Note the positions of the fingers on the pivot. (R. Schreiber)

Fig. 23. Replicas of Protogeometric pots made by the authors. (R. Schreiber)

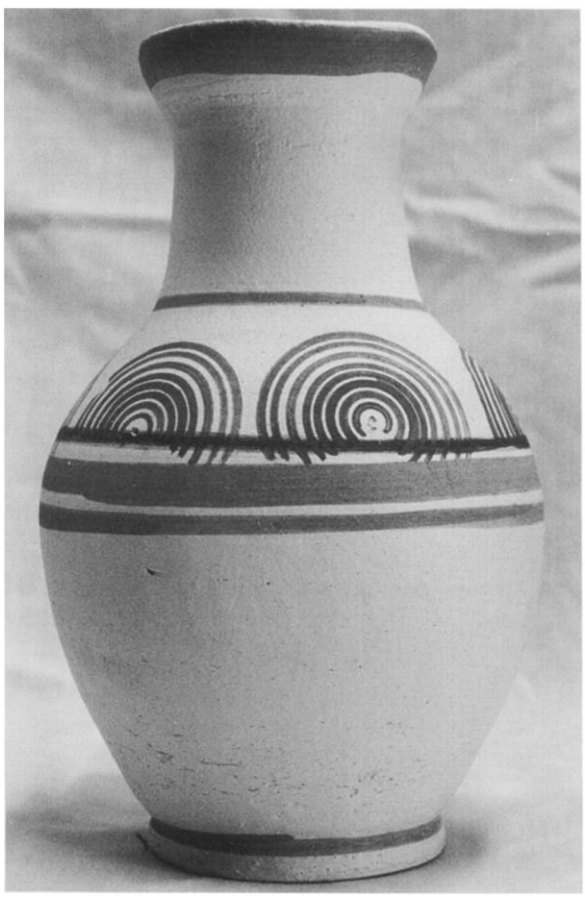

Fig. 24. Oinochoe shown in figure 23. Note "near circles" with centers above the band. (R. Schreiber)

rors. Concentric circles can easily be painted with a pivoted multiple brush on the surface of a cylinder and a skyphos (figs. 19, 23). The semicircles on the shoulder of the amphora (fig. 23) show clearly the terminations and the fact that they do not end in unison; the same may be seen more clearly on the oinochoe (fig. 24). Figure 24 also shows what Eiteljorg refers to as "near circles," and it is clear that these can be easily applied with a pivoted multiple brush; again, the terminations on either side are not in unison. Indeed, it is more difficult to initiate all the arcs in the band in this motif. Finally, the small lekythos made from clay from Marousi (fig. 23), illustrates that a relatively small, cramped, and curved surface of a pot can be decorated with concentric semicircles in a straightforward manner.[100]

The ease and efficiency with which concentric circles and semicircles could be painted on the surface of a cylinder, and on a variety of curved surfaces on a number of pots made specifically for this study, lead to the conclusion that a pivoted multiple brush was not only used in antiquity, but also easy to make from readily available materials. The actual configurations of the multiple brushes presented in this article may not be exactly those used by ancient potters, but they are unlikely to be significantly differ-

[100] Because of some difficulty using the multiple brush on this pot, the ends of the inner brushes were slightly trimmed to match the curved surfaces better.

ent. With these pivoted multiple brushes, all the details observed on ancient pottery, including errors, idiosyncracies, and even aberrations, can be duplicated quite closely.[101] Because of the simplicity of fabrication, we suggest that over time a pot painter would acquire a collection of pivoted multiple brushes for various sizes of pots and various multiplicities of circles. Moreover, in order to decorate large numbers of pots of similar size and shape, the potter could have trimmed the brush tips to conform to a mean curvature of the surface to be painted and thereby produce concentric motifs with even greater ease and precision.

Whether the pivoted multiple brush was first invented in Athens, Macedonia, Thessaly, Cyprus, Phoenicia, or Kalapodi is a question that will probably exercise scholars for some years to come, but the relevance of its origin is perhaps overestimated. Determining the place where the pivoted multiple brush was first invented probably does not matter a great deal when formulating conclusions of political, social, economic, or ethnic importance. In this sense, Eiteljorg's attempt to divorce what were perceived to be technological advances from an assumed center of development—in this case Athens—and to open up the field to a major reassessment was well conceived. Notions of the political or social influence of one region over another on the basis of pottery alone are highly dubious.[102] If the concentric circles and semicircles on Greek Protogeometric pottery, like those on Phoenician and Cypriot Early Iron Age wares, were indeed applied with a pivoted multiple brush like that presented in this paper, this innovation is one that belongs in the potter's workshop.

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[101] By replacing the long pivot stick with a short one and attaching a short handle at the center of the 14-element brush, Vedder found that he could manipulate this configuration almost as easily as those shown in fig. 17. It is possible that the original pivoted multiple brush was made by adding a short pivot stick at one end or replacing one outer brush of a multiple brush with a short pivot stick.

[102] See J.K. Papadopoulos, "Dark Age Greece," in B.M. Fagan ed., *The Oxford Companion to Archaeology* (New York 1996) 253–55.