NAUTICAL ARCHAEOLOGY

A RESTUDY OF THE CYLINDRICAL AMPHORAS FROM
THE SEVENTH-CENTURY YASSI ADA SHIPWRECK

A Thesis

by

PETER GERRITT VAN ALFEN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of
MASTER OF ARTS

December 1995

Major Subject: Anthropology
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Approved as to style and content by:

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December 1995

Major Subject: Anthropology
A Restudy of the Cylindrical Amphoras from the Seventh-century Yassi Ada Shipwreck. (December 1995)

Peter Gerrit van Alfen, B.A., University of Utah
Chair of Advisory Committee: Dr. Frederick H. van Doorninck, Jr.

F.H. van Doorninck, Jr.'s recent work on the piriform amphoras recovered from the 11th c. A.D. shipwreck at Serçe Limanı, Turkey, has shown that the volume capacity of the amphoras in liters correlate to weight capacities in Byzantine λίτρα, or pounds, for red and white wine. These correlations demonstrate that, by the 11th c., there was a complex and controlled metrological system in use for the transportation and marketing of wine. Using the methodology developed by van Doorninck for his study, this re-examination of the cylindrical amphoras from the Yassi Ada shipwreck provides evidence for a somewhat similar metrological system in use by the 7th c. This restudy of the Yassi Ada cargo also offers a new interpretation of the shipwreck: that it was not an ordinary merchant vessel, but a ship owned and operated by the Church assisting in the provisionment of Byzantine troops during the final stages of the Persian War (ca. A.D. 626).
ACKNOWLEDGMENTS

There are several people without whose generous and selfless support this thesis could never have been completed. I thank foremost Frederick H. van Doorninck, Jr. for offering to me this opportunity to complete a portion of his own decades-long research on the Yassi Ada shipwreck. Having suffered through several uneasy drafts of the thesis, Dr. van Doorninck’s patience, wit, and tireless ability to teach has been exemplary. With his retirement from teaching this year (1995), the Nautical Archaeology Program at Texas A&M University loses one of its finest and most inspiring professors. B.J. van Doorninck also deserves special thanks for her encouragement and the countless hours of “amphora-talk” she endured on warm summer nights in Bodrum, Turkey.

To those in Bodrum, Öğuz Alpözen, the staff of the Bodrum Museum of Underwater Archaeology, and Jane Panell, I owe deep gratitude for the open use of the laboratory facilities and storerooms. Selma Öğuz, whose illustrations appear herein, cheerfully provided yet another young scholar with her exquisite work; I thank her immensely for the many eyes-strained hours spent on the drawings.

To Drs. Donny Hamilton and Wayne Smith I also owe enormous thanks. Their technical support and friendship during the last several years is greatly appreciated. Helen Dewolf deserves more than I could ever give for all of her encouragement, help, and long talks. To her I give the warmest thanks, and credit for tables 1 and 2.

My parents, Neal van Alfen and Pam Kazmierczak, and Tom and Susan Shay, have all offered tremendous support throughout my academic pursuits. This thesis is a poor dedication to the wealth of opportunities and encouragement they have provided me. I thank them endlessly.
Finally, Elizabeth Greene's lively assistance during the initial mind-numbing recording of the amphoras made that task so much more pleasant and efficient. She too deserves great thanks.
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# ABBREVIATIONS

## Reference Abbreviations

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<tr>
<td>AJA</td>
<td><em>American Journal of Archaeology</em></td>
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<td>ANSNNM</td>
<td><em>American Numismatic Society, Numismatic Notes and Monographs</em></td>
</tr>
<tr>
<td>BAR-IS</td>
<td><em>British Archaeological Reports, International Series</em></td>
</tr>
<tr>
<td>BCH</td>
<td><em>Bulletin de correspondance hellénique</em></td>
</tr>
<tr>
<td>BCH Suppl.</td>
<td><em>Bulletin de correspondance hellénique. Supplément</em></td>
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<td>JRA</td>
<td><em>Journal of Roman Archaeology</em></td>
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<tr>
<td>MIA</td>
<td><em>Materiali i issledovaniya po archeologii SSSR</em></td>
</tr>
<tr>
<td>RDAC</td>
<td><em>Report of the Department of Antiquities, Cyprus</em></td>
</tr>
<tr>
<td>ZPE</td>
<td><em>Zeitschrift für Papyrologie und Epigraphik</em></td>
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## Catalog Abbreviations

<table>
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<td>body cap.</td>
<td>body capacity</td>
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<td>cm.</td>
<td>centimeters</td>
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<tr>
<td>full cap.</td>
<td>full capacity</td>
</tr>
<tr>
<td>h. max. diam.</td>
<td>height at maximum diameter</td>
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<tr>
<td>int. mouth diam.</td>
<td>internal mouth diameter</td>
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<tr>
<td>Inv. No.</td>
<td>inventory number</td>
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<tr>
<td>kg.</td>
<td>kilograms</td>
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<td>l.</td>
<td>liters</td>
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<tr>
<td>max. diam.</td>
<td>maximum diameter</td>
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<tr>
<td>max. h.</td>
<td>maximum height</td>
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INTRODUCTION

Three decades ago, from 1961 to 1964, a team of underwater archaeologists from the University of Pennsylvania, led by George F. Bass, excavated an early-7th c. A.D. Byzantine shipwreck at Yassi Ada near Bodrum, Turkey. Since publication of the Yassi Ada final report in 1982, new questions and methods of investigation have prompted further study of the ship's cargo carried in "globular" and "cylindrical" amphorae. Presented here is a re-study of the cylindrical amphoras.

This study was inspired by F.H. van Doorninck, Jr.'s recent work on 11th c. A.D. amphorae from the shipwreck excavated in Serçe Limani, Turkey. Van Doorninck's discovery of a phenomenal degree of precision in the metrology of these amphorae has led to the conclusion that Byzantine potters produced highly standardized jars designed to carry specific weights of red wine, white wine, or oil. Measurement of the 102 wine amphorae recovered from the Serçe Limani wreck has shown that their volume capacities in liters correlate to weight capacities in Byzantine λτρα, or pounds, for red and white wine. Moreover, some linear dimensions, such as maximum widths and internal diameters of the mouth openings, appear to correlate in most cases to some multiple of 0.5 δάκτυλος, the δάκτυλος being a Byzantine linear measurement equal to 1.95 cm. To date, such precision is not known in amphorae from the Hellenistic or Roman periods. Earlier potters did produce amphorae of many standard sizes, but linear and volumetric measurements varied considerably from jar to jar. At some unknown point in late antiquity, the much more complex and controlled metrological system exhibited by the Serçe Limani amphorae began to emerge.

The Yassi Ada cylindrical amphorae exhibit a somewhat similar degree of metrological precision as those from Serçe Limani and also appear to belong to a capacity system based on the Byzantine λτρα. This metrological closeness has potentially significant ramifications in the realm of late antique exchange and economics that will be discussed below.

This thesis follows the style and format of *Journal of Roman Archaeology*. 
METHODOLOGY

The evidence presented here relies upon accurate amphora measurements. Thus mention must be made of the methodology that was followed in taking these measurements, since it differs to some extent from that commonly used. Before measurement of the cylindrical amphoras could be made, it was essential that the jars be thoroughly cleaned, both inside and out, of any marine concretion deposits. Even small amounts of concretion can affect the accuracy of capacity, weight, and linear measurements. Once cleaned, the linear dimensions of particular metrological significance were taken in a consistent and exacting manner.

Height was determined by placing the amphora in a horizontal position on a level tabletop and supporting the jar so its longitudinal axis was parallel with the surface of the table. A drafting triangle was then used to project vertically down to the surface the distance between the base and rim. Calipers were used to measure the maximum diameter both adjacent to and midway between the handles, and the two measurements were averaged.

In order to determine whether or not the internal mouth diameter of each cylindrical amphora was of a consistent, precise dimension that could accommodate a standard-sized stopper, several stoppers in a progression of sizes and with slightly tapering edges were fashioned from a 1.5 cm.-thick sheet of styrofoam. Since the internal mouth diameters of the amphoras ranged from 4.8 to 7.7 cm. and the Serçe Limami amphoras had standard-sized stoppers that were some multiple of 0.5 δάκτυλος, the styrofoam stoppers were given diameters of 2.5, 3.0, 3.5, and 4.0 δάκτυλοι (4.9, 5.8, 6.8, and 7.8 cm.). In the majority of cases, one of the stoppers seated in the mouth of the amphora tightly with its upper face located ca. 0.5 cm. below the rim. Had the stopper differed in diameter by only 1/4 δάκτυλος, it would not have been suitable for that amphora.

Only those amphoras that were complete or nearly complete were chosen for weight and capacity measurements. Those that had small holes, or had portions of the rim, neck, or
handles missing, were reconstructed with modeling clay of the same approximate specific gravity as the fabric of the jars. Because residual moisture in the fabric can weigh up to several hundred grams, all the amphoras were first set out in the sun until their weight no longer decreased through moisture evaporation before their empty weights were recorded.

Capacities were measured in one of two ways depending on the amphora's state of preservation. Amphoras that did not leak were set upright and weighed on a Baster B300 top-loading digital scale. The amphora was then filled with water to the neck-shoulder junction. As water was absorbed into the clay, more water was added to maintain this level. Once the rate of absorption became negligible, the weight was recorded. The amphora was then emptied and weighed once more to determine the weight of the water in kilograms the amphora contained and thus the amphora's capacity in liters. Thereafter the entire process was repeated twice in quick succession. Capacity measurements to the top of the rim were then determined in the same manner. This method was so accurate that the difference between the three capacity measurements taken at both levels for each jar did not exceed a few grams.

Leaky amphoras, however, required a different procedure. Styrofoam beads, in carefully measured increments, were poured into the amphora and the jar was shaken with each increment to insure compaction of the beads. Capacity measurements were again recorded at the neck-shoulder junction and the top of the rim and also repeated several times for each jar. Although capacity measurements with styrofoam beads can be inconsistent and inaccurate, every effort was taken to minimize this error. To check the accuracy of the measurements several of the amphoras that had been measured with water were re-measured with the beads. The margin of difference in this experiment was never more than 2%.
THE AMPHORAS

The ship's cargo originally comprised an estimated 900 amphoras of two classes. Of the 822 amphoras recorded during the excavation, 103 were cylindrical and designated type 1 in the final publication; 719 larger, globular jars were designated type 2. Divers in the early 1960s brought a small representative sample of both classes of amphoras to the surface. Removed to one side of the excavation site, the remaining jars were left until the early 1980s, when most of them were raised from the seabed and taken to the Bodrum Museum of Underwater Archaeology for conservation and study. At present, 71 cylindrical and over 600 globular amphoras are stored in the museum; approximately 140 jars remain at Yassi Ada.

The cylindrical amphoras belong to one of the most, if not the most, common and widely dispersed amphora classes of the late antique and early Byzantine periods. Numerous designations have been given this class reflecting its extensive scholarly attention: British Bii, Ballana 6, Egloff 164 and 169, Keay LIII, Kuzmanov XIII, Peacock and Williams Class 44, Scorpan 8B, and LRA1 (Late Roman Amphora 1) are the most commonly cited. For the sake of clarity, amphoras of this general class will be referred to as LRA1; those specifically from the Yassi Ada shipwreck, YA1. Similarly, the Yassi Ada globular jars will be referred to as YA2 and the general class by one of its common designations, LRA2 (Late Roman Amphora 2). Possibly first appearing in the 4th c. A.D., the LRA1 class continues into the 7th c., having its most frequent occurrence in the 6th c. Distribution of LRA1 amphoras extends over much of the ancient world, from the Levant in the east to Britain in the west and from the Black Sea region in the north to North Africa in the south. The large number of finds have revealed a great variety of LRA1 body shapes and sizes, decoration, and fabrics. The YA1 amphoras show a similar variation; discrete differences in measurements, fabrics, and workmanship make it possible to identify 11 YA1 types within the 71 amphoras studied. Because the YA1 jars are a unique and tightly dated set, the following catalog is offered as
a contribution toward a clarification of early 7th c. LRA1 types. Also, the catalog contains important metrological data that form the basis of arguments presented below.

In the catalog every attempt has been made to present the amphoras both objectively and subjectively for the sake of greater description. The number of complete amphoras is indicated for each type; these are the amphoras that were used in height, empty weight, and capacity measurements. Both the range in measurements for the jars within a type and their averages are given; the range in the measurements is notably minimal, usually no more than a few millimeters. Included with the averaged measurements are the corresponding measurements in Byzantine δάκτυλοι, and here a tendency toward multiples of 0.5 δάκτυλος should be noted. Two capacities are provided: one, the "body" capacity, denotes capacity at the neck-shoulder junction; the other, the "full" capacity, denotes capacity to the top of the rim. A question mark indicates that amphora preservation was such that the measurement could not be taken. Fabric inclusions are graded as fine (60-250 microns), medium (250-500 microns), coarse (500 microns to 1 mm.), very coarse (1-2 mm.), or super coarse (> 2 mm.). An estimation of the quantity of inclusions is expressed numerically: "1" indicates the inclusion is rare, "2" that it is common, and "3" that it is so common the particles are touching one another. Because it was beyond our capability to state with certainty the mineral composition of the inclusions, only their color is noted, except in two cases. For general purposes, "sand" means any glass-like or quartz-like inclusion, and "mica-like" any non-clear light-reflecting inclusion. The Munsell Soil Color Charts were used to determine fabric color. The fabric color listed for each type is an average of the fabric colors of all the amphoras within a type. Variations in the fabric color among the amphoras of one type were notably minimal. Unless otherwise stated, color and fabric grading were done on both fresh breaks and outer surfaces. The relative hardness of the fabric is described according to the Mohs' scale.
THE YA1 TYPES

Type I

Type I is the largest group, encompassing 39 of the 71 YA1 amorphas. Within this group there are three subtypes: Ia, Ib, and Ic. The subtypes differ primarily in dimensions and capacity.

Subtype Ia

Total number of examples: 4
Number of complete examples: 2
Range in height: 43.1-43.4 cm.
Average height: 43.3 cm. (22.2 δάκτυλοι)
Range in height at maximum diameter: 25.7-26.1 cm.
Average height at maximum diameter: 25.9 cm. (13.3 δάκτυλοι)
Range in maximum diameter: 19.7-20.3 cm.
Average maximum diameter: 20.0 cm. (10.3 δάκτυλοι)
Range in interior mouth diameter: 5.7-5.8 cm.
Average interior mouth diameter: 5.8 cm. (3.0 δάκτυλοι)
Range in empty weight: 3.202-3.262 kg.
Average empty weight: 3.232 kg.
Range in body capacity: 5.831-6.050 l.
Average body capacity: 5.941 l.
Range in full capacity: 6.082-6.275 l.
Average full capacity: 6.179 l.

Subtype Ib

Total number of examples: 20
Number of complete examples: 3
Range in height: 42.9-43.2 cm.
Average height: 43.1 cm. (22.1 δάκτυλοι)
Range in height at maximum diameter: 25.9-26.9 cm.
Average height at maximum diameter: 26.4 cm. (13.5 δάκτυλοι)
Range in maximum diameter: 21.2-21.7 cm.
Average maximum diameter: 21.5 cm. (11.0 δάκτυλοι)
Range in interior mouth diameter: 5.6-6.1 cm.
Average mouth diameter: 5.9 cm. (3.0 δάκτυλοι)
Range in empty weight: 3.100-3.232 kg.
Average empty weight: 3.166 kg.
Range in body capacity: 7.015-7.158 l.
Average body capacity: 7.087 l.
Range in full capacity: 7.245-7.398 l.
Average full capacity: 7.322 l.

Subtype Ic

Total number of examples: 15
Number of complete examples: 2
Range in height: 45.7-46.2 cm.
Average height: 46.0 cm. (23.6 δάκτυλοι)
Range in height at maximum diameter: 27.8-28.1 cm.
Average height at maximum diameter: 28.0 cm. (14.3 δάκτυλοι)
Range in maximum diameter: 21.5-22.2 cm.
Average maximum diameter: 21.9 cm. (11.2 δάκτυλοι)
Range in interior mouth diameter: 6.6-7.0 cm.
Average interior mouth diameter: 6.8 cm. (3.5 δάκτυλοι)
Range in empty weight: 3.940-4.002 kg.
Average empty weight: 3.971 kg.
Range in body capacity: 8.265-8.295 l.
Average body capacity: 8.280 l.
Range in full capacity: 8.577-8.572 l.
Average full capacity: 8.575 l.

Fabric

Color: 5YR 5/6-6/4 (yellowish red to light reddish brown).

Inclusions: sand, fine to super coarse (2-3); red, medium to coarse (2); whitish grey, medium (2); white, medium to coarse (2); black, medium (2) and coarse (1).

Mohs': 4.5

Description: This fabric is generally smooth and hard. Frequent pits ranging in diameter from 1 to 8 mm. occur on the surface.
General Description (Figs. 1,2 & 3)

The mouth is round, with a well-defined ridge below the rim. As seen from above, the handles are attached symmetrically; two finger-made grooves run down the outer surface of the handles. Subtype Ia body decoration consists of flat, almost stepped, tool-made wheel ridges that begin below the lower handle attachments. Evenly spaced, the wheel ridges gradually widen from ca. 1 cm. to ca. 1.5 cm. midway down the body and then all but fade at the waist pinch. Subtypes Ib and Ic have a distinctively different body decor from that of Subtype Ia. Beginning below the lower handle attachment, the tool-made wheel ridges are narrowly spaced for a few turns before quickly separating and forming wide bands (ca. 2 cm. across) at the waist pinch. Above the body-base transition, the wheel ridges rapidly become narrowly spaced again and then disappear. All three subtypes have deep concentric grooves decorating the base. Overall quality is average.

Parallels: Two similar jars have been found in the eastern Mediterranean, one in Israel, the other in Cyprus.¹² G.F. Bass is probably referring to this type when he notes the existence of identical, unpublished examples in the storerooms of the Archaeological Museum of Constanța, Rumania.¹³
Fig. 1. Subtype Ia (Scale 1:4).
Fig. 2. Subtype Ib (Scale 1:4).
Fig. 3. Subtype Ic (Scale 1:4).
Type II

Total number of examples: 2
Number of complete examples: 2
Range in height: 48.2-48.8 cm.
Average height: 48.5 cm. (24.9 δάκτυλοι)
Range in height at maximum diameter: 30.5-31.5 cm.
Average height at maximum diameter: 31.0 cm. (15.9 δάκτυλοι)
Range in maximum diameter: 21.9-21.9 cm.
Average maximum diameter: 21.9 cm. (11.2 δάκτυλοι)
Range in interior mouth diameter: 5.1-5.9 cm. (mouth oval)
Range in empty weight: 3.555-4.324 kg.
Average empty weight: 3.940 kg.
Range in body capacity: 8.338-8.452 l.
Average body capacity: 8.395 l.
Range in full capacity: 8.610-8.860 l.
Average full capacity: 8.735 l.

Fabric

Color: 5YR 6/6 (reddish yellow) with 2.5YR 4/6 (red) exfoliating surface.

Inclusions: sand, fine (2-3); brownish grey, medium (1); black, medium (2) and coarse (1).

Mohs': 2.5-3.0

Description: This fabric is visually smooth but coarse and chalky to the touch. Close, unaided visual inspection reveals that very tiny black grit pervades the surface.

General Description (Fig. 4)

The two examples of this type have pronounced oval-shaped mouths and flattened rims.

Viewed from above the handles are attached asymmetrically. Two small, finger-made grooves run along the outer face of the handles, twisting inwardly near the lower attachment point.

Deep, stepped wheel ridges cover the body beginning at the lower handle attachment; in the center of the body these become wide bands slightly oblique to the wheel ridges above and below. The upper and lower wheel ridges appear to be entirely tool-made while those that form the wide bands in the center of the body appear to have been made by pinching the clay
between a tool and a finger. Tool-made wheel ridges are also present on the base. Quality is average.

Parallels: One jar found at Berenice has similar dimensions, decorations, and fabric, but there is no mention of mouth and handle shapes.¹⁴

Fig.4. Type II (Scale 1:4).
Type III

There are three subtypes within the Type III group: IIIa, IIIb, and IIIc. The subtypes differ only in dimensions and capacity.

Subtype IIIa

Total number of examples: 1  
Number of complete examples: 1  
Height: 45.2 cm. (23.2 δάκτυλοι)  
Height at maximum diameter: 27.4 cm. (14.1 δάκτυλοι)  
Maximum diameter: 22.6 cm. (11.6 δάκτυλοι)  
Interior mouth diameter: 5.8 cm. (3.0 δάκτυλοι)  
Empty weight: 3.344 kg.  
Body capacity: 8.650 l.  
Full capacity: 9.000 l.

Subtype IIIb

Total number of examples: 1  
Number of complete examples: 1  
Height: 46.7 cm. (23.9 δάκτυλοι)  
Height at maximum diameter: 29.1 cm. (14.9 δάκτυλοι)  
Maximum diameter: 22.7 cm. (11.6 δάκτυλοι)  
Interior mouth diameter: 5.8 cm. (3.0 δάκτυλοι)  
Empty weight: 3.470 kg.  
Body capacity: 9.147 l.  
Full capacity: 9.520 l.

Subtype IIIc

Total number of examples: 3  
Number of complete examples: 2  
Range in height: 46.3-47.3 cm.  
Average height: 46.8 cm. (24.0 δάκτυλοι)  
Range in height at maximum diameter: 29.1-29.9 cm.  
Average height at maximum diameter: 29.5 cm. (15.1 δάκτυλοι)  
Range in maximum diameter: 23.2-23.6 cm.  
Average maximum diameter: 23.4 cm. (12.0 δάκτυλοι)  
Range in interior mouth diameter: 5.4-5.9 cm.  
Average interior mouth diameter: 5.7 cm. (2.9 δάκτυλοι)
Range in empty weight: 3.122-3.732 kg.
Average empty weight: 3.427 kg.
Average body capacity: 9.556 l.
Range in full capacity: 9.758-10.212 l.
Average full capacity: 9.985 l.

Fabric

Color: 2.5YR 6/4-5YR 6/4 (light reddish brown).
Inclusions: sand, fine (3); black, medium (1); red, medium (2) and coarse (1); white, medium (2), coarse (2), and super coarse (1).
Mohs': 2.5

Description: The creamy pinkish-peach color of this fabric is distinctive. Rough to the touch, the surface has many small pits ca. 1-2 mm. in diameter, imparting to the fabric the texture and appearance of burlap.

General Description (Fig. 5)
The mouth is round with a nicely shaped, everted lip. Below the rim, there is a pronounced ridge into which the symmetrically attached handles are flattened and laterally flared. Where the conically-shaped neck meets the shoulder there is an abrupt transition, often with a line marking the division between the body and the separate neck piece. The overall profile of the sides of the body is slightly concave. Finger-made, rather than tool-made, wheel ridges run evenly down the body, beginning just below the lower handle attachment and fading at the body mid-section. Both the handles and base are smooth. Quality is above average.

Parallels: I located one jar identical to the YA Type III examples in the storerooms of the Bodrum Museum. A similar LRA1 fabric has been found in Israel; similar necks and handles have been found in Thrace.15
Fig. 5. Type III (Scale 1:4).
Type IV

Total number of examples: 5
Number of complete examples: 2
Range in height: 48.1-48.9 cm.
Average height: 48.5 cm. (24.9 δάκτυλοι)
Range in height at maximum diameter: 25.6-26.9 cm.
Average height at maximum diameter: 26.3 cm. (13.5 δάκτυλοι)
Range in maximum diameter: 23.6-24.6 cm.
Average maximum diameter: 24.1 cm. (12.4 δάκτυλοι)
Range in interior mouth diameter: 5.8-6.0 cm.
Average interior mouth diameter: 5.9 (3.0 δάκτυλοι)
Range in empty weight: 4.316-4.992 kg.
Average empty weight: 4.654 kg.
Range in body capacity: 8.341-8.607 l.
Average body capacity: 8.474 l.
Range in full capacity: 8.772-9.038 l.
Average full capacity: 8.905 l.

Fabric

Color: 7.5YR 6/4 (light brown)
Inclusions: sand, fine (3); red, medium to coarse (2); black, medium (2) and coarse to very coarse (2); white, coarse to very coarse (2).
Mohs': 3.5
Description: Speckled with black grit, this fabric has the appearance and texture of sandpaper. Fabric color remains unusually consistent at breaks and on the interior surfaces.

General Description (Fig. 6)
A long cylindrical neck and a rather abrupt narrowing in the diameter of the body, giving the body an almost piriform shape, are the two most distinguishing characteristics of this type. The mouth is round and a well-defined ridge lies below the rim. The handles, crudely shaped and having two finger-made grooves on their outer faces, are attached symmetrically. On three examples, evenly spaced finger-made wheel ridges decorate the entire neck and end at an abrupt neck-shoulder transition. Finger-made wheel ridges beginning at the lower handle
attachment decorate the upper body; the lower body is smooth. Tool-made concentric grooves are found on the base. Quality ranges from average to below average.

Parallels: Several amphoras identical to this type have been found in Cyprus. ¹⁶ What may be a similar fabric has been reported from a kiln site also in Cyprus. ¹⁷

Fig. 6. Type IV (Scale 1:4).
Type V

There are three subtypes within the Type V group: Va, Vb, and Vc. Subtypes Va and Vb differ only in dimensions and capacity; Subtype Vc, in the size and shape of its handles and the nature of its decoration.

**Subtype Va**

Total number of examples: 11  
Number of complete examples: 1  
Height: 51.0 cm (26.2 δάκτυλοι)  
Height at maximum diameter: 30.8 cm (15.8 δάκτυλοι)  
Range in maximum diameter: 25.7-26.5 cm.  
Average maximum diameter: 26.1 cm (13.4 δάκτυλοι)  
Range in interior mouth diameter: 6.6-7.0 cm.  
Average interior mouth diameter: 6.8 cm (3.5 δάκτυλοι)  
Empty weight: 5.418 kg.  
Body capacity: 11.960 l.  
Full capacity: 12.520 l.

**Subtype Vb**

Total number of examples: 1  
Number of complete examples: 1  
Height: 52.7 cm (27.0 δάκτυλοι)  
Height at maximum diameter: 30.5 cm (15.6 δάκτυλοι)  
Maximum diameter: 27.5 cm (14.1 δάκτυλοι)  
Interior mouth diameter: 6.7 cm (3.4 δάκτυλοι)  
Empty weight: 6.882 kg.  
Body capacity: 14.398 l.  
Full capacity: 14.883 l.

**Subtype Vc**

Total number of examples: 2  
Number of complete examples: 0  
Preserved heights: 44.5 & 34.3 cm.  
Maximum diameter: 26.0 cm (13.3 δάκτυλοι)  
Empty weight: ?  
Capacity: ?  
Interior mouth diameter: 6.9 cm (3.5 δάκτυλοι)
Fabric

Color: 5YR 6/4 (light reddish brown).

Inclusions: sand, fine (3), medium (2), and coarse to very coarse (1); white, fine (2) and coarse (2); black, medium (2) and coarse (2); red, medium (2) and coarse (2); some also have whitish grey, medium to very coarse (2).

Mohs: 3.5-4.0

Description: The appearance and texture of this fabric is very similar to the Type I fabric, but with more white and black grit.

General Description (Figs. 7 & 8)

These jars are the largest and most bulky of any in the collection. Thick, massive handles are attached symmetrically to broad, squat conical necks. Handle decoration varies: a few examples have a single, broad finger-made groove while more frequently double grooves are found on the outward facing surface. The mouths are round; most have a ridge below the rim, often not well-formed. Several examples have finger-made wheel ridges on the neck; the neck-shoulder transition is abrupt. Wheel ridging begins slightly below the lower handle attachment and continues just beyond the often barely discernable waist pinch. The space between the well-formed tool-made wheel ridges is narrow at the top of the body and then abruptly widens to form broad horizontal bands at the waist. Below the waist the wheel ridges abruptly narrow then fade entirely. Concentric, tool-made grooves decorate the base.
Primarily, the difference between Subtype Vc and the other two subtypes lies in the handles, which are, in Subtype Vc, very thin in cross-section, small and delicate. The body decoration of Subtype Vc examples appears much more random and less carefully executed than that found on Va and Vb jars. One of the type Vc jars has squarish wheel ridging made with a flat tool ca. 0.7 cm. wide. The wheel ridges run unevenly from below the lower handle attachment to the body-base transition. The other type Vc has a few narrow, uneven wheel ridges on the shoulder that widen very abruptly into two bands ca. 2 cm. across. What remains of the body mid-section is smooth. Type V quality ranges from average to below average.

Parallels: Larger, heavier examples of LRA1 amphoras are quite common in 6th-7th c. contexts. In the storerooms of the Bodrum Museum, there are nearly 20 examples from these centuries recovered from underwater sites along the Turkish coast that are similar to the Type V amphoras; many are much larger. Other similar examples are known from Carthage, Saqqara, Haifa, Histria, and S啟dava.
Fig. 7. Subtype Va (Scale 1:4).
Fig. 8. Subtype Vc (Scale 1:4).
Type VI

Total number of examples: 1
Number of complete examples: 1
Height: 39.0 cm. (20.0 δόκτυλοι)
Height at maximum diameter: 22.4 cm. (11.5 δόκτυλοι)
Maximum diameter: 17.6 cm. (9.0 δόκτυλοι)
Interior mouth diameter: 4.9 cm. (2.5 δόκτυλοι)
Empty weight: 2.456 kg.
Body capacity: 4.390 l.
Full capacity: 4.582 l.

Fabric


Inclusions: sand, fine (3), coarse to very coarse (2); mica-like, fine (2), medium (1); black, medium to coarse (2), very coarse (1), super coarse (1); red, medium to coarse (2), super coarse (1); grey, coarse (2), super coarse (1).

Mohs': 4.0

Description: Where the surface has been chipped away, the fabric below is very coarse. Numerous golden and silvery mica-like particles are evident.

General Description (Fig. 9)

A well-defined ridge lies below a dramatically everted and rounded lip; the mouth is small and round. The handles, symmetrically attached, are well-shaped and have two extremely shallow finger grooves on their outer faces. Two bands of carefully tool-made wheel ridges decorate the body, one just below the lower handle attachment, the other just above the body-base transition. The grooves that form the bands are closely spaced, narrow and shallow. The body mid-section, like the base, is smooth. Quality is above average.

Parallels: none.
Fig. 9. Type VI (Scale 1:4).
Type VII

Total number of examples: 1
Number of complete examples: 1
Height: 46.9 cm. (24.0 δάκτυλοι)
Height at maximum diameter: 28.7 cm. (14.7 δάκτυλοι)
Maximum diameter: 21.9 cm. (11.2 δάκτυλοι)
Interior mouth diameter: 7.8 cm. (4.0 δάκτυλοι)
Empty weight: 3.504 kg.
Body capacity: 8.350 l.
Full capacity: 8.732 l.

Fabric

Color: 2.5YR 5/6 (red).
Inclusions: sand, fine (3); mica-like, fine (1); black, medium (2); white, medium (2); grey, medium (2).
Mohs' 3.0

Description: Although similar to the Type I fabric in overall appearance and texture, the color of this fabric is far more red.

General Description (Fig. 10)

An unusually wide cylindrical neck and (round) mouth are distinguishing characteristics. Attached symmetrically, the handles have two finger-made grooves on their outer faces. A well-made ridge lies below the everted, rounded lip. The neck-shoulder junction is well-defined. Body decoration, consisting of tool-made wheel ridges, begin at the lower handle attachment and continue without interruption to the base; at the pinched waist the space between the ridges widen then become narrow again. Quality is above average.

Parallels: Wide-mouthed LRA1 amphoras have been found at Anemurium and Corinth, and in Crimea, Thrace, Egypt and Israel. The closest parallel I have found to the YA1 example is from Thasos.
Fig. 10. Type VII (Scale 1:4).
Type VIII

Total number of examples: 1  
Number of complete examples: 0  
Preserved height: 27.9 cm.  
Maximum diameter: ?  
Interior mouth diameter: 5.5-6.5 cm. (mouth oval)  
Empty weight: ?  
Capacity: ?

Fabric

Color: 10YR 8/2 (very pale brown); slip: 7.5YR 6/4 (light brown).  
Inclusions: sand, fine (2); black, medium to coarse (3); red, coarse (1).  
Mohs': 4.5

Description: This very hard fabric is similar in appearance and texture to that of Type IV, but with finer black grit.

General Description (Fig. 11)

This amphora has a very uncommon funnel-like neck. During the construction of the jar, a large 2-cm.-wide collar was fitted externally to the base of the neck. The lower portion of this collar has been smoothed into the shoulder, the upper portion left untouched creating a shelf-like surface three-quarters of the way down the neck. The mouth is oval; the handles are attached symmetrically and lack decoration though in cross-section they have a shape similar to an airfoil. Uneven in execution, tool-made wheel ridges begin at the lower handle attachment and continue to 5.5 cm. above the preserved extant of the jar at which point two broad bands begin. Quality is average.

Parallels: Keay notes a jar found in Spain with a similar neck, but there is no mention of the fabric or dimensions.\(^23\)
Fig. 11. Type VIII (Scale 1:4).
Type IX

Total number of examples: 1
Number of complete examples: 0
Preserved height: 38.6 cm.
Maximum diameter: 23.7 cm. (12.2 δέκτυλοι)
Interior mouth diameter: 6.0 cm. (3.1 δέκτυλοι)
Empty weight: ?
Capacity: ?

Fabric

Color: 7.5YR 6/4 (light brown).

Inclusions: sand, fine (1); black, medium (2); whitish grey, medium to coarse (2-3).

Mohs': 4.0

Description: Very hard and coarse, this fabric contains many small rocks of various sizes and colors (red, tan, dark grey, white, and black), some as large as 4 x 4 mm.

General Description (Fig. 12)

A long cylindrical neck terminates with a nicely flattened and pointed lip, below which lies a well-defined ridge. The mouth is round and the handles, decorated with two finger grooves on each outer face, are attached symmetrically. There is no pinch at the waist; the body wall in fact is slightly convex in profile. Beginning at the lower handle attachment, tool-made wheel ridges are first narrow then widen to form horizontal bands across the mid-section. On the upper half of the body, the wheel ridges are prominent and stepped. Quality is average.

Parallels: none.
Fig. 12. Type IX (Scale 1:4).
Type X

Total number of examples: 1
Number of complete examples: 0
Preserved height: 33.3 cm.
Maximum diameter: 21.9 cm. (11.2 δάκτυλοι)
Interior mouth diameter: 6.0-6.8 cm. (mouth oval)
Empty weight: ?
Capacity: ?

Fabric

Color: 5YR 5/4 (reddish brown)

Inclusions: sand, fine (3); mica-like, fine (2); black, medium (1), coarse to very coarse (2);
grey, medium to coarse (2); red, medium (2), coarse (1).

Mohs': 4.5- 5.0

Description: This fabric is hard and generally smooth. On the surface, there are occasional
pits 1-4 mm. in diameter and yellowish-white rocks ca. 2 mm. in diameter.

General Description (Fig. 13)

This amphora has a surprising discrepancy between the quality of the neck and handles, as a
unit, and the body. The neck is very uneven and lumpy, having a heavy, thick lip and almost
unintentionally oval mouth. Likewise, the handles are sloppily attached and executed. In
comparison, the body is finely made having narrow and even tool-made wheel ridges that
begin below the lower handle attachment and widen to form horizontal bands at the waist.

Parallels: none.
Fig. 13. Type X (Scale 1:4).
Type XI

Total number of examples: 1
Number of complete examples: 0
Preserved height: 15.2 cm.
Maximum diameter: ?
Interior mouth diameter: 7.1 cm. (3.6 δάκτυλοι)
Empty weight: ?
Capacity: ?

Fabric

Color: 7.5YR 6/6 (reddish yellow).
Inclusions: mica-like, fine (3); black, medium to very coarse (2); white, medium to coarse (1);
red, medium to coarse (1).
Mohs': 2.5
Description: Coarse and crumbly, this fabric has a very yellowish hue.

General Description (Fig. 14)

The neck and one complete handle that remain of this jar give it the appearance of a Type V
amphora having the same large features and conical neck. However, the fabric is very
different from and the execution far below Type V fabric and standards. This is, in fact, the
most poorly made jar in the collection. The mouth is unevenly round; the handles are nearly
symmetrically attached and have no obvious decoration. No wheel ridges are present on what
remains of the shoulder.

Parallels: Johnson reports a similar fabric found at Jalame. 24
Fig. 14. Type XI (Scale 1:4).
GRAFFITI

Markings of some sort, usually *dipinti*, are commonly found on LRA1 amphoras. However, none of the YA1 (or YA2) jars have examples of painted notations, undoubtedly because of the general surface erosion that virtually all of the jars have undergone; even the use of ultraviolet light failed to detect any traces of paint. There are, however, numerous examples of more durable graffiti from Yassi Ada, predominantly on the YA2 amphoras. Only four sets of marks (Fig. 15) were discovered in the YA1 collection; all of them appear on three Type IV jars. Surface erosion in the area around three of the graffiti make it impossible to tell whether the marks were made before or after firing. However, one graffito (*ΕΛΕ*) is well enough preserved to allow us to state with some certainty that the mark was made after the amphora was fired. The blade cuts in this graffito are sharply defined and extremely narrow at the bottom of the cut. This would not be the case had the clay been soft when the mark was made.

Interpretation of the three sets of graffiti that are legible is made difficult primarily by the fact that the different graffiti appear on two virtually identical amphoras. One might expect, if these were marks of ownership or contents, or, if taken numerically, marks denoting capacities, that they would, like the amphoras, be somewhat identical. One of the marks, the graffito *ΕΛΕ*, may be an abbreviation for ἐλασιον (olive oil) or ἐλαία (olives); an identical graffito was found on five YA2 amphoras. The others, at this point, remain unintelligible.

EVIDENCE FOR REUSE

Generally, the YA1 amphoras show no obvious indications of reuse and appear to be, as a group, in quite good condition. There are, however, some exceptions: one Subtype Ia jar is quite worn and lacking one handle. The breakage of the handle left a hole in the shoulder and a portion of the rim missing; the rough edges around both these breaks were
Fig. 15. Graffiti (Scale 1:2).
carved smooth, the hole in the shoulder likely being filled with a plug. Also, one Subtype Ib jar has three vertical grooves, ca. 2 mm. wide, on the interior surfaces of the rim and upper neck. These marks were presumably left by a narrow tool used to pry a stopper from the amphora, indicating that this particular jar had seen earlier use. The probable contents of the amphoras suggests that many, if not all, were being reused.

CONTENTS

One grape seed was recovered from the only complete YA1 amphora raised in the 1980s. However, there is other evidence for contents. Thirteen YA1 jars, one each from Subtype Va and Type VII, two each from Subtype Ia and Types II, III, and IV, and three from Subtype Ib, preserve remnants of a resin lining implying they contained wine or a wine-based product. Indirect evidence, supplied by the metrology of the YA1 amphoras' capacities, supports both wine and oil as possible contents held in the various types of these amphoras. However, most, if not all of these jars appear to have contained wine at the time of the shipwreck.

CAPACITIES AND METROLOGY

The point within an amphora to which it was meant to be filled, and thus the point at which the amphora's primary capacity should be measured, was of great concern in this study. One particular construction trait shared by all of the YA1 jars indicates that the likeliest point for true capacity measurement occurs at the neck-shoulder junction. Close inspection of all the incomplete and complete YA1 amphoras revealed that as a rule the body and shoulder had been constructed, usually with great care, as one unit; the neck, with less care, was constructed as a separate unit. The often tremendous disparity in quality of manufacture between the neck unit and body unit is most clearly seen in the single Type X jar, but many similar occurrences were found in the other types.
Attachment of the neck to the shoulder occurs in one of three manners: 1) a neck cylinder of less diameter than the hole at the top of the shoulder was inserted 1-3 cm. into the amphora and the lowest portion of the neck cylinder was then folded over into the interior shoulder wall; 2) a neck cylinder of less diameter than the hole in the shoulder was inserted into the amphora but only to the point that the lower edge of the cylinder became flush with the interior shoulder wall; 3) a neck cylinder of greater diameter than the hole in the upper shoulder was set on and attached to the exterior shoulder wall. No one method of attachment seems to have taken precedence over any other, since all three methods were sometimes found within one particular type. This manner of amphora construction indicates that the body and neck units were not only built separately, but, more importantly, conceptualized separately. In terms of an amphora's intended capacity, this suggests that the body unit might have been carefully built in order to achieve a desired capacity. The small amount of extra volume provided by the neck would have sufficed for overflow or, in case the body capacity was slightly low, to bring the capacity of the jar up to the desired amount.

Graphing the body capacities of the 19 complete YA1 amphoras (Table 1) revealed several tight capacity groupings (of Types Ia, Ib, Ic-II-VII, and IIIa-IV). The Type I amphoras belong to three of these clusters: the two Subtype Ia jars have a capacity of ca. 6 l., the three Subtype Ib jars of ca. 7.1 l., and the two Subtype Ic jars of ca. 8.3 l. Far from being random, the Type I clusters themselves and the even spacing between them suggest a highly regular and standard system of antique capacity measurement. The clusters of ca. 8.3 and 8.5 l. comprising amphoras from Types II-VII and IIIa-VI respectively, and a far looser grouping of Type IIIb-c jars of ca. 9.5 l. seems to corroborate the evidence for metrological standardization.

In late antiquity, the measurements used to determine an amphora's capacity depended as much on the time and place of use as on its contents; well into the Byzantine period, for example, nearly every province maintained indigenous measures for both liquid and dry
goods.29 Undoubtedly in order to facilitate exchange, certain measurements were adopted or decreed as general standards. One of the most frequently used standard units of liquid capacity in the Roman period was the ξέστης (sextarius), defined as 1/6 of a Roman congius and 1/16 of a μόδιος (modius), a measurement of volume, not weight, equal to ca. 0.546 l. The μόδιος, whether castrensis, Cypriote, or Italic, also saw common use, but does not appear as frequently as the ξέστης in the graffiti and dipinti found on later amphoras.30 As a liquid measure, the ξέστης did bear a relationship to weight measurements insofar as the volume the ξέστης represented was given a calculated weight; based on wine-weight, the standard ξέστης of ca. 0.546 l. equaled ca. 1 2/3 λίτρα, or pounds.31 The 3rd c. A.D. debut of a 0.654 l. ξέστης for wine, 1/5 larger than that previously used, and a 0.728 l. ξέστης for oil may signal a greater concern for the correlation between volume and weight measurements, possibly for the sake of easier conversion from one system to the other. This larger ξέστης, and other fluctuations of the ξέστης-value noted by Lang, appears to be an attempt to equate one ξέστης of oil or wine to two λίτρα.32

Dipinti indicating that capacities were measured in ξέστης have been found on several LRA1 amphoras from the 5th-6th c.33 Also, A. Opait, in an earlier study of the LRA1 class, concluded that the ξέστης was the standard to which these amphoras best conformed.34 However, attempts to correlate the volume capacities of the YA1 amphoras with three known values for the ξέστης (0.546, 0.654, and 0.728 l.) did not meet with success as had been anticipated might be the case (Table 1). For example, the even intervals between the Type I amphora capacities do not correlate well with either a 0.654 or 0.728 l. ξέστης. Furthermore, although the intervals do correlate somewhat with a ξέστης of 0.546 l., this value is not sufficiently low to explain the interval between the ca. 8.3 l. Type Ic-II-VII cluster and the ca. 8.5 l. Type IIIa-IV cluster. Since the ξέστης correlations proved unsatisfactory, a different metrological system was sought.
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1a. Correlation of the volume capacities (in liters) to Xestai of 0.546 L.

1b. Correlation of the volume capacities (in liters) to Xestai of 0.654 L.

1c. Correlation of the volume capacities (in liters) to Xestai of 0.726 L.

Table 1. Σεστης correlations.
Fluctuations through the 4th, 5th, and 6th c. in the application and definition of the ξέοπτησ standard show an increasing shift away from volumetric measurement for capacities. Tare notations on later amphoras, indicating their empty weight, and the use of spelled-out weights rather than tallying marks further suggest that commodities were exchanged more and more by weight rather than volume. In use by the 6th c., the Byzantine μέτρον measured liquids solely by weight in accordance with the λίτρα. The basic μέτρον standard, the θαλάσσιον μέτρον, or sea measure, was equivalent to 30 λογαριακά λίτρα of water or wine; a θαλάσσιον μέτρον of 30 σικάλια λίτρα was used for olive oil. Commonly employed fractions of the θαλάσσιον μέτρον received designations: 4/5 was called a μοναδινικόν μέτρον; 2/3 an ἀννονικόν μέτρον; 1/10, or 3 λίτρα, α μίνα. Because each of the liquid commodities differs in specific gravity, one μέτρον of each commodity differs in volume; a measure holding 30 λίτρα of white wine held 32 λίτρα of a heavy red wine. Other differences in the volume of the μέτρον were due to its dependence on the λίτρα. Changes in the value of the pound would impart to the μέτρον a greater or lesser volume.

For the 7th c., Shilbach suggests ca. 320 g. as a working value for the pound. However, the large steelyard from the Yassi Ada shipwreck (B1), the actual machine that would have been used to weigh the YA1 and YA2 amphoras, is calibrated for a pound of ca. 315 g. Other evidence from the shipwreck—the weight of the anchors—supports a λίτρα of ca. 315 g. as a standard that saw common use. Based on this favorable evidence, 315 g. was the value for the pound adopted in calculating the YA1 capacities within the μέτρον system.

Since the specific gravity of red wine, white wine and olive oil differs, and therefore the volume of one λίτρα of each liquid differs, separate calculations for the μέτρον correlation of each commodity were made. According to these correlations (Table 2), the Type I amphoras have capacities that are nicely graduated at 18, 21, and 24 λίτρα (6, 7, and
8 μήνατα) of white wine for the Subtypes Iα, Iβ, and Iγ respectively; the Type II, IV, and VII jars have capacities that correspond to 30 λίτρα (one θαλάσσιον μέτρον or 10 μήνατα) for oil; the capacity of the small, Type VI amphora approximates 15 λίτρα (½ θαλάσσιον μέτρον or 5 μήνατα) for oil. The Type III amphoras show more diversity of contents within the type: the Subtype IIIc jars have capacities that represent 30 λίτρα of red wine; Subtype IIIb, 27 λίτρα (9 μήνατα) of white wine, and Subtype IIIa, 27 λίτρα (9 μήνατα) of red wine. For the large Type V jars the capacities correlate to 35 λίτρα and 42 λίτρα (14 μήνατα) of white wine for Subtypes Vα and Vβ respectively.44

Van Doorninck has observed similar very specific and graded capacities in his study of the 11th c. Serçe Limanı amphoras.45 For instance, various piriform types intended for white wine have capacities that range from 27 to 60 λίτρα with 3 λίτρα, or one μήνα, intervals between the jars (e.g. 9, 10, 11,...20 μήνατα). A few amphoras have capacities of 35 and 40 λίτρα; they belong to a group whose capacity increases at intervals of 5, rather than 3 λίτρα. The red-wine piriform amphoras exhibit an identical system of capacity sizes.

In the Serçe Limanı and YA1 jars, this capacity gradation is paralleled by gradation in the external dimensions of the amphoras. The averaged measurements of the YA1 Type I jars, for example, show that the fundamental dimensional change between the Subtypes Iα (6 μήνατα white wine) and Iβ (7 μήνατα white) is an increase of 0.5 δάκτυλος in the maximum diameter, while between the Subtypes Iβ and Iγ (8 μήνατα white), there is an increase of 1.0 δάκτυλος in the height at the maximum diameter. By alternating an increase in maximum diameter with an increase in maximum diameter height, the differences in the proportions of the three sizes of amphora were minimized. In the same way, there is an increase of 1.0 δάκτυλος in the height at the maximum diameter from Subtype IIIa (9 μήνατα red) to the larger IIIb (9 μήνατα white) and a 0.5 δάκτυλος increase in the maximum diameter from IIIb to IIIc (10 μήνατα red).
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2a. Correlation of the volume capacities (in liters) to weight capacities in Byzantine litra of 315 g. each (red and white wine).

2b. Correlation of the volume capacities (in liters) to weight capacities in Byzantine litra of 315 g. each (all).

Table 2. Métpov correlations.
Interestingly, the YA1 amphoras do not have the same degree of empty weight gradation, or control, as found in the Serçe Limanı amphoras. The empty weights of the Serçe Limanı amphoras correlate neatly to multiples of the λίτρα or half λίτρα; moreover, amphora weight, and thus clay volume, is fully coordinated with dimensions in a systematic and patterned way to achieve the desired capacities.\textsuperscript{46} In comparison, the YA1 empty weights generally do not correlate well with λίτρα multiples nor are the empty weights of amphoras of a certain type and capacity particularly consistent. For example, both Type II amphoras, which have virtually identical capacities, have substantially different empty weights; such is also the case with the Subtype IIIa amphoras.\textsuperscript{47} A general survey of all the YA1 jars revealed that neck lengths and handle sizes of the amphoras within a given type or subtype often vary to the point that total amphora weight would be significantly affected. The volumetric precision of the YA1 amphoras would have depended, of course, on a precise control of body dimensions, shape and wall thickness, the latter factor being determined by the amount of clay used in making the body. A similar degree of control was not exercised in making the neck and handles, however, presumably since the basic capacity of the jar was not involved. The Type X amphora is a particularly striking example of this difference in the level of control employed. By way of contrast, the same level of precise control was maintained throughout the fabrication of the Serçe Limanı amphoras, since in that instance standard amphora weights were for some reason desired.

Admittedly, with only 19 complete YA1 amphoras, the sample size is not sufficiently large for a conclusive identification of the metrological system or systems represented by the amphora capacities. Nevertheless, the very close correlations with μέτρον standards and numerous parallels with the metrology van Doorninck has exposed in the Serçe Limanı amphoras strongly favors the weight-based μέτρον system over the older ξέστης for this collection of LRA1 amphoras.\textsuperscript{48}
SUMMARY

Extensive study of LRA1 amphoras has offered no definitive conclusions as to the identity of the commodity or commodities for which they had been made. Generally, the primary commodity is thought to have been wine, other LRA1 amphoras having been found with remnants of resin linings, but olive oil cannot be discounted. High liquid chromatography has detected an oil residue in the fabric of one LRA1 amphora from Cyprus. At Ballana, LRA1 jars were found with dipinti indicating oil, or olives, as the contents. An older, commonly cited argument for oil still has validity: because early petrological fabric analysis indicated the Antioch region as a source for this class, the appearance and use of LRA1 amphoras was thought to correspond with the emerging 4th-c. production of oil in that area. The more recent discovery of LRA1 kiln sites in the Gulf of Alexandretta and along the Cilician coast may add credence to the "Antioch thesis." Since the evidence for both wine and oil as contents is unavoidable, some have proposed that smaller LRA1 types were made specifically to transport wine and larger types to transport oil. The problem of LRA1 contents likely reflects little understood mechanisms in late antique amphora production and use. Not surprisingly, similar problems concerning contents frequently plague the study of other later Roman and Byzantine amphora classes, unlike earlier Roman and Hellenistic amphoras, which seem generally to have been made to contain one commodity from one region. Indeed, at its introduction in the 4th c., the LRA1 amphora might have been produced to contain one regional commodity, whether wine or oil. Through the course of three centuries, however, the function of the LRA1 amphora likely changed, or to be more precise, may have been expanded to serve better the ever-changing exchange systems in which it was used.

In a study of 120 LRA1 and 20 LRA2 amphoras found in an early-7th-c. ecclesiastical complex in Samos, C. Steckner concluded that there is no direct affinity between the form of these amphoras and their contents; form, in this case, does not denote the contents as either
wine or oil. Rather, LRA1 amphoras functioned for the transportation and storage of valuable liquids, be they wine or oil, and LRA2 amphoras for less valuable commodities. These functions can be expressed in terms of amphora efficiency (liters of capacity per kilogram of the vessel's weight: liters/kg.), a potentially useful indicator of the purpose for which a vessel was manufactured. As a general rule, LRA2 amphoras are more efficient than LRA1 jars; the YA2 amphoras, for example, have an average efficiency quotient of 3.3; for the YA1 amphoras, it averages 1.9. Because the overall cost of transporting commodities in the smaller, less efficient LRA1 amphoras would be comparatively greater, the relative value of the contents would presumably have to make up the difference.

Metrological evidence from the YA1 amphoras does not indicate, however, that individual LRA1 vessels were produced to carry wine (red or white) or oil without discretion. The very specific capacities exhibited by the YA1 jars strongly suggest that some were produced solely to contain red wine, others white wine, and still others oil. Seemingly, LRA1 types of all sizes were manufactured to hold specific measures of different liquid commodities, effectively making this class of amphora, as a whole, a general purpose container. That early Byzantine potters were capable of producing amphoras to the very exacting measurements required for the different commodities is clearly illustrated by the YA1 Type I and Type III capacities and dimensional grading.

The reuse or recirculation of these amphoras also relates to the problem of LRA1 contents. Reuse as transport containers appears to be a phenomenon largely restricted to late antique and Byzantine period amphoras, due possibly to economic exigencies or the decreasing availability of jars in general. The Serçe Limami amphoras, for example, show signs of considerable reuse: broken handle stumps and rims have been carved smooth to minimize further damage; also, a great number of the jars have pry-marks on the inner face of the rim and upper neck. Although a complete re-study of the YA2 jars has yet to begin, preliminary investigation has revealed signs of reuse—primarily scratched-out or overwritten.
graffiti probably indicating a change of ownership or graffiti indicating earlier contents. As the one very worn YA1 amphora and pry-marks found on one other example would seem to attest, some measure of LRA1 reuse also occurred. In terms of contents and reuse, would an amphora built to contain a specific measure of one commodity be (re)filled with the same or a different commodity? This would likely depend on the circumstances of reuse.

Operations such as the one found in Samos, where rows of LRA1 and LRA2 amphoras stood poised to receive oil or wine from the nearby presses, required a network of some sort for obtaining the jars. The sources from which the amphoras were obtained could have varied greatly, as could their condition, new or old. While it would have been desirable, for the sake of convenience, to (re)fill an amphora with the commodity for which it was intended, this might not always have been possible. For instance, the YA1 Type IV amphoras have capacities that correlate with one θελαστιον μέτρον for oil, which the graffito EAE found on one of the Type IV jars would seem to support. But remnants of a resin lining found in two Type IV jars implies oil was not the final content of these jars. A similar situation exists with both of the Type II amphoras. Thus, although a system of amphora standardization for specific commodities appears to have been in place, this is no guarantee that it was always adhered to in using the jars.

Lastly, the seven different fabrics and stylistic variations of the YA1 types strongly suggest that these amphoras were not all produced in the same location, or even the same region. As mentioned, LRA1 production sites have recently been located in the Gulf of Alexandretta, along the Cilician coast, and in Cyprus and Rhodes. Amphora production in some of those areas, however, may well have ended, or at least have been seriously curtailed, by the Persian invasion of A.D. 611-15 and its aftermath. It is, of course, possible that all the YA1 amphoras in use in the decade following the Persian invasion were produced in the eastern Mediterranean, but only one YA1 type, Type IV, has the closest form and fabric parallels to published finds from the eastern kiln sites, those in Cyprus. Drawing on fabric
and stylistic parallels with other local ceramics, Scorpan has suggested that LRA1 amphoras were also produced in the Black Sea region, but to date no certain LRA1 pottery works have been located there. Even though, at the present time, the evidence is not available, northern production sites for early 7th c. LRA1 amphoras should not be entirely rejected. Numerous parallels for YA1 types have been found in the Black Sea region, and evidence from the shipwreck points to a certain northern, if not definitively Black Sea, origin for the ship's final voyage.
CONCLUSIONS

The latest dated coin from the Yassi Ada shipwreck provides a rather precise *terminus post quem* date, A.D. 625/626, for the YA1 and YA2 amphoras; arguably, the ship met its fate within only a year or two of that date. This cargo and the context in which it was found can, potentially, offer very specific clues about exchange and LRA1 and LRA2 amphora use in the second decade of the 7th c. Namely, what type of exchange is visible here?

Due in part to the immensely destructive Persian war, the early 7th c. was a time of massive change in eastern Mediterranean society and economies. In the first disastrous ten years of Heraclius' reign (A.D. 610-641), separate and coordinated attacks by the Persians from the east and the Avars from the north nearly ruined the Byzantine world. Gaining the offensive, Heraclius made impressive retaliatory campaigns deep into Persia during his second decade as Emperor, the time of the Yassi Ada shipwreck. Throughout this period major Byzantine coastal and inland cities were either captured, destroyed, or partially abandoned. With the demise of the cities, late antique urban economies, including traditional markets that may have survived up to the end of the 6th c. all but disappeared. Moreover, the Persian naval threat in the Aegean and Mediterranean, which was extinguished by 626, undoubtedly contributed to a severe reduction in sea-borne commerce. References to the Yassi Ada shipwreck as a merchant vessel, implying the cargo it carried was intended to be sold or traded in a market, may not, therefore, be accurate.

Troop supply, especially in times of crisis, was always a significant problem faced by the Late Roman emperors. To this end, Justinian created a new praetorian prefecture, the *quaestura exercitus*, comprising Cyprus, Caria, the Aegean Islands, and the Danubian provinces of Scythia and Moesia II, in order to provide supplies from the south to frontier units without impoverishing the already devastated northern regions. Probably headquartered at Samos in the third decade of the 7th c., the *quaestor exercitus*, as a quartermaster of the
army, may have had, by that time, the responsibility of provisioning a greater scope of Heraclius' imperial forces, not only those once stationed in the north.68

Aside from state-run institutions, Heraclius also relied heavily on the church to pay and supply his soldiers; the church's resources during the Persian war more often than not surpassed those of the state.69 Already involved in the exchange of goods through the transfer of produce between its estates and the commercialization of its surpluses, the church employed numerous ναυτικεροι and negotiatores, ship owner/captains and exchange specialists; in some metropolises, such as Alexandria, the church even maintained its own fleet of ships.70 In light of the virtual "war economy" of the time and Heraclius' annexation of resources, a connection between the church and the quaestor exercitus during the conflicts of the early 7th c. is easily imaginable.

Steckner has already proposed that the Yassi Ada cargo may be related to quaestura exercitus activities.71 Noteworthy in this regard are the numerous sites, including military installations, along the Danube and the Black Sea coast where LRA1 and LRA2 amphoras have been found in close association;72 there is as well one other 7th c. shipwreck, found off the Knidian peninsula, which has both types of amphoras as the primary cargo.73 These sites, plus of course those at Yassi Ada and Samos, were all within the quaestor's jurisdiction, hinting at least that LRA1 and LRA2 types were used extensively by this institution. Evidence from the complex at Samos, dated to within the first quarter of the 7th c., and Yassi Ada also allude to church involvement. The oil/wine presses and amphora depots in Samos were located within ecclesiastical structures; from the shipwreck rather frequent allusions to the Christian faith among the graffiti appearing on the YA2 jars suggests that at least a portion of the cargo may have been church-owned.74 More importantly, the largest steelyard from the shipwreck bears the inscription ΓΕΩΡΓΙΟΥ ΠΡΕΣΒΥΤΕΡΟΥ ΝΑΥΤΙΚΕΡΟΥ, (belonging to) George priest sea-captain, implying that Captain George worked for, or at least had a position within the church.75
If, in fact, the Yassi Ada cargo was connected with church-assisted provisionment, this may provide one of the likeliest explanations for the great variety of YA1 and YA2 types found on the wreck; such great variety of types within one amphora class is virtually unknown from Hellenistic and earlier Roman shipwrecks. The acquisition of amphorae from scattered church estates, or from other sources as offerings, would bring together many types, as would the state's taxation in kind, the annona. Due to the immense pull, and possible mixing, of such obligatory collections, heightened especially by the duress of the war, random collections of amphorae would surely have found their way to central depots, such as the horrea in Tarsus or Constantinople, or the complex on Samos, to await further distribution. Only with difficulty could purely commercial transactions have brought together in one place, such as the Yassi Ada ship, amphorae of so many different types, sources and ages. As Heraclius made his advance into Persia in the late 620s, quartermasters likely directed supplies to the Levant, which offered the closest ports for contact with the troops. The cargo lost at Yassi Ada may have been meant for just such a destination.

Might the development of later LRA1 (and LRA2) types, as has been suggested, be the result of standardization due to a state system organized for supplying military bases and warehouses? This question is problematic and ultimately points to yet one more: what does the standardization of late Roman/Byzantine containers mean? Certainly through its influence in various aspects of exchange, particularly through taxation in kind and regulations, the state's demands likely had some repercussions in amphora use and development. The metrological standardization of amphorae and accuracy in its application would ultimately facilitate certain types of control, particularly in the collection of the annona and other taxes. Clearly, in the case of the YA1 amphorae, there is an overriding reason for the metrological standardization exhibited by the jars. Consider, for instance, that all of the YA1 jars appear to share a complex metrological system encompassing three different commodities, yet the jars were apparently made in different localities. Such geographically widespread
standardization of one container type effectively obliterates regional, and traditional, differences in the product being carried; the focus, as it were, seems to have shifted from away from the specific product to the way in which it was being carried. In some ways this may point to an increase in regulation; equally, however, it may point to changes in marketing practices.

The great variety of sizes and capacities found in LRA1 amphoras is not easily explained by state regulation or need. Consumer-driven marketing practices, such as those found today, wherein most commodities are available in standard packaging ranging in size from very small to very large with many sizes in between, may offer a more congenial explanation. By offering a variety of container sizes to the consumer, commodity distributors would gain access to a larger, and possibly more demanding market; the wide distribution of LRA1 amphoras may indicate the success of such practices. More sizes would also require greater accuracy in the metrology of the container in order to distinguish between closely graded sizes. While the study of late Roman and early Byzantine metrology does not indicate that there was a rapid change in the metrological systems, there does appear to be an overall move towards greater accuracy and efficiency which may parallel, or be dependant on, changes in the way amphora-borne commodities were exchanged.

Late Roman amphora use, as shown by the YA1 and other amphoras, significantly differed from that found several centuries earlier. By the time of the Yassi Ada shipwreck, sophisticated practices like those used in the 11th c. seem already to be in place. Continued study of late Roman amphoras, in particular closer studies of their capacities, may bring forth more securely the manner of these developments and when they began to occur.
ENDNOTES


4. The methods described here were used by van Doorninck for the Serçe Limanı study in 1993 and 1994 and are presented at some length in van Doorninck, 1993 (supra n.2).

5. One incomplete cylindrical amphora was raised from the shipwreck with its pottery sherd stopper in place. The upper surface of the stopper rests 0.5 cm. below the rim; for photographs of this jar and its stopper, see T.O. Alpözen, A.H. Özdas, and B. Berkaya, Commercial amphoras of the Bodrum Museum of Underwater Archaeology: maritime trade of the Mediterranean in ancient times (Bodrum 1995) ills. 2 & 3.

   About 165 roughly rounded amphora sherd stoppers were found on the wreck site. The stoppers average 6.0 cm. in diameter, the largest being 9.7 cm., the smallest 4.0 cm. (Bass and van Doorninck [supra n.1] 160-61).


9. Distribution of the class is well illustrated by Riley (supra n. 7) 213-15, fig. 42, and Peacock and Williams (supra n. 7) 186, fig. 105.

10. The 1.95 cm. value for the δάκτυλος is given by E. Shilbach, Byzantinische Metrologie (Munich 1970) 16.


13. Bass and van Doorninck (supra n. 1) 164.

14. Riley (supra n. 7) fig. 347.


18. One example is illustrated in Alpözen, Özdas, and Berkaya (supra n. 5) 113.

19. M.G. Fulford and D.P.S. Peacock, Excavations at Carthage: the British mission 1.2, The avenue du president Habib Bourguiba, Salambo: The pottery and other ceramic objects from the site (Sheffield 1984) figs. 34:1 and 34:2; J.E. Quibell, Excavations at Saqqara IV (Cairo 1912) pl. XLVIII:3; Zemer (supra n. 12) no.66; E. Condurachi, "Santerful Arheologic Histria," Materiale și Cercetari Arheologice 7 (1960) fig.11; Scorpan (supra n. 7) pl. III:5.
20. Because a portion of this jar's base has been reconstructed with plaster, the dry weight and capacity measurements are only close approximations.


23. Keay (supra n. 7) fig. 117:7.


25. These marks on LRA1 and LRA2 amphoras, denoting contents, empty and full weights, or ownership, are generally in Greek. One LRA1 amphora from Ashdod has epigraphy that may be in either Aramaic or Hebrew: M. Dothan and D.N. Freedman, *Ashdod I: The first season of excavation 1962*, *Antiquot* 7 (Jerusalem 1967) fig. 14:2.

26. Many of the YA2 graffiti have been published. See F.H. van Doarinck, Jr., "The cargo amphoras on the 7th century Yassi Ada and 11th century Serçe Limanı shipwrecks: two examples of a reuse of Byzantine amphoras as transport jars," in V. Déroche and J.M. Spieser, eds., *Recherches sur la céramique byzantine*, *BCH suppl.* 18 (1989) fig.2; Bass and van Doarinck (supra n. 1) 162, fig. 8-8.

27. van Doarinck (supra n. 26) 252, fig. 2:15. At the moment, this interpretation of the graffito seems the most plausible. However, in examples of graffiti denoting olives or olive oil found on earlier 1st and 3rd c. amphoras, the abbreviation is more correctly spelled ελαι. See M. Lang, *Graffiti and dipinti*, *The Athenian agora* (Princeton 1976) Hd4, Hd18.

28. Analysis of the organic contents of 120 intact YA2 amphoras raised in the early 1980s has revealed a total of 1380 grape seeds, some with traces of pitch, in 69 of the jars; eroded olive stones, again sometimes with traces of pitch, were found in 31 amphoras: van Doarinck (supra n. 26) 252. Also see V.M. Bryant, Jr. and R.E. Murry, Jr., "Preliminary analysis of amphora contents," in Bass and van Doarinck (supra n. 1) 327-31.

29. Shilbach (supra n. 10) *passim*.

30. Lang (supra n. 27) 57. Lang offers 0.546 l. as the value for a standard ξέστης based on a usually reckoned Italic *modius* of ca. 8.75 l. (see, for example, F. Hultsch *Griechische und römische Metrologie* [Leipzig 1882]). R.P. Duncan-Jones ("The choenix, the artaba, and the modius," *ZPE* 21 [1976] 51-52) argues for an Italic *modius* of 8.62 l. and thus a ξέστης of
0.539 l. In terms of the YA1 capacity calculations that follow, the difference between a ξέστης of 0.546 l. or 0.539 l. is too small to warrant any significance.

The modius castrensis, which occurs many times in Diocletian's Price Edict, equaled 1 1/2 Italic modii or 24 ξέστης (R.P. Duncan-Jones, "The size of the modius castrensis," ZPE 21 [1976] 53-62). The Cyproite modius contained approximately 17 2/3 ξέστης; Lang (supra n.27) 58).


32. Lang (supra n. 27) 57.


34. A. Opaić, "Beobachtungen zur Entwicklung der zwei Amphoratypen," Peuce 9 (1984) 316-20. Designating the class a "Getreidecontaineren," W. Hautumm (Studien zu Amphoren der spätromischen und frühbyzantinischen Zeit [Bonn 1981] 63) proposed that LRA1 capacities were based on the artabe, an Egyptian dry measure of 3.5 Roman modii. However, little evidence associating dry measures or commodities with LRA1 use actually exists.

35. Lang (supra n. 27) 64, n.10.

36. Shilbach ([supra n. 10] 113) has noted a 6th c. use of a μοναστηριακόν μέτρον.

37. Shilbach (supra n. 10) 112-19.

38. Shilbach (supra n. 10) 112. The red wine would have been extremely heavy with a specific gravity of about 1 g./cm³.

39. Supra n. 10, 166.


41. P.H. van Doorminck, Jr., "The anchors," in Bass and van Doorminck (supra n. 1) 133-34.

42. One other value for the λατρα is known from the Yassi Ada shipwreck. The standard represented by the set of eight bronze weights found in the galley area of the ship has, among other irregularities, a considerably lightened pound of ca. 285 g. A lighter, possibly provincial, λατρα of ca. 285 g. was current in the early 7th c.; this light pound may also have been related to the lightweight solidus in use from the time of Justinian. See Sams (supra n. 40) 209-210; Shilbach (supra n. 10) 167-68. For a general explanation of these issues, see H.L. Adelson, Light weight solidii and Byzantine trade during the sixth and seventh centuries, ANSNNM 138 (1957); M.F. Hendy, Studies in the Byzantine monetary economy,
Attempts to correlate the YA1 capacities with the μέτρον system using this 285 g. value proved entirely unsuccessful.

43. Shilbach (supra n. 10, 114) has demonstrated that the volume of one μίνα white wine, based on a 320 g. λίτρας, is 1.025 l. Thus to calculate white-wine μέτρον correlations for a 315-g. pound the following equation was used: 1.025 x 0.315 + 0.320 + 3 = 0.336. The figure, 0.336, represents the volume in liters of one 315-g. λίτρα of white wine. The capacities of the YA1 amphoras divided by this sum gave the total number of λίτρας the capacities represented; this total divided by 3 gave the number of μίνα.

Since the volume of red wine for a given weight measure is 15/16 less than that for white wine (Shilbach [supra n. 10] 112), white wine correlations were divided by 15/16 in order to determine red wine correlations.

According to Shilbach (supra n. 10, 119) the volume of one θαλάσσιον μέτρον of olive oil, based on a 320 g. pound is 8.520 l. For one θαλάσσιον μέτρον wine based on a 315 g. pound, the volume is 8.386 l. (8.520 x 0.315 + 0.320); the volume of one λίτρα of oil is then 0.279 l.

44. The capacity correlations of the individual amphoras are all within +/-2% of the ideal μέτρον values except for the following: one Subtype IIa jar, -3%; one Type IV jar, +3%; Type VI, +5%.

45. van Doorninck, 1993 (supra n. 2) 8-12.

46. Ibid.

47. The weight difference between the two Type II jars remains inexplicable; nothing in the fabric or external dimensions offers a solution. Differences in the neck lengths and handle sizes of the two Subtype IIIc jars explains some of their weight difference.

48. The favorable μέτρον correlations do not necessarily mean that a complete change, of terminology especially, in late antique metrology had occurred by the early 7th c. Shilbach (supra n. 10, 103 ff., 115) notes that references to the ξέστης and μόδιος continued beyond the 7th c. but with decreasing frequency.


51. Riley (supra n. 7) 212; for Antioch-area oil production, see J.H.W.G. Liebeschvetz, Antioch: city and imperial administration in the later Roman empire (Oxford 1972) 79-81.
52. Empereur and Pico (supra n. 49) 236-43.

53. Riley (supra n. 7) 215; M. Bonifay and F. Villedieu, "Importations d'amphores orientales en Gaule (Ve-VIIe siècle)," in Déroche and Spieser, eds. (supra n. 26) 25.


57. An example of this damage is illustrated in van Doorninck (supra n. 26) fig.4.

58. van Doorninck (supra n. 26) 252. A preliminary typology of the YA2 amphoras has identified four types, comprising approximately 80% of the total number, that appear to have been recently made; the rest of the jars, numbering some 40 types, have in some instances late-6th-c. forms. The graffiti indicate that many of the newer jars had earlier carried olives, possibly preserved in sweet wine. Some of the older amphoras had held lentils. However, on their final voyage, most, if not all, of these jars had carried a low-grade wine.

59. There is little comparative material for LRA1 reuse. Lang (supra n. 27) has noted overwritten dipinti on one example, I45, as has Irimia (supra n. 33) fig. 14. However, no other evidence, such as repaired breaks, has been noted in the literature.

60. With little evidence to support the supposition, Bass suggested that the Yassi Ada cargo may have been, in part, a load of empty amphoras (Bass and van Doorninck [supra n.1] 164-65). Some transport of empty jars likely occurred, given the practice of amphora recirculation as well as the distances between pottery works, like those in Cyprus, and places where the jars were filled, like Samos. However, identifying the transport of empty amphoras in the archaeological record would be exceedingly difficult, if not impossible.

61. During the Persian occupation of Antioch (A.D. 611-28), for example, contact between the city and the rest of the Byzantine world effectively ended; see G. Downey, A history of Antioch in Syria from Seleucus to the Arab conquest (Princeton 1961) 574-75.
62. LRAI amphora production in Cyprus seems to have continued without interruption in the early 7th c. See Catling (supra n. 17) 79-80; and Empereur and Pico (supra n. 49) 242. Evidence for early 7th c. amphora production along the Cilician coast is inconclusive. After the Persian withdrawal from the area and its reoccupation by Byzantine forces, Cilicia remained a frontier zone. See J.F. Haldon, Recruitment and conscription in the Byzantine army c.550-950: a study on the origins of the stratiotika ktemata (Wien 1979) 29.

63. Scorpan (supra n. 7) 274-75.

64. Bass and van Doorminck (supra n. 1) 317-18.


67. Bass and van Doorminck (supra n. 1) passim.

68. During the reorganization of his forces (A.D. 621/622), Heraclius transferred the remnants of his army in Europe to Asia Minor (Haldon [supra n. 62] 29) and with it, presumably, the quaestor, who normally had resided along the Danube. With the formation of the themata ca. mid-7th c., the command of the naval theme of the Caravisiani, which constituted most of the old quaestura exercitus, seems to have been based at Samos (Haldon [supra n. 66] 217).

69. Haldon (supra n. 66) 48, 129, 299. See also Theophanes Chronographia 303.


71. Steckner (supra n. 54) 65.

72. See, for example, B. Böttger, "Die Importkeramik aus dem spästantiken Donaulimeskastell Iatrus in Nordbulgarien," in D.M. Pippidi, ed., Actes du IXe Congres International d'Études sur les Frontieres Romaines (Bucharest and Köln 1974) 131-36; Condurachi (supra n. 19); Kuzmanov (supra n. 15); A. Radulescu, "Amphore romane și romano-bizantine din Scythia Minor," Pontica 9 (1976) 99-114; Scorpan (supra n. 7); A.L. Yakobson, "Rannesrednevekovia Chersones," MIA 63 (1959) 300-31 and supra n. 21.


74. P. Arthur ("Aspects of Byzantine economy: an evaluation of amphora evidence from Italy," in V. Déroche and J.-M. Spieser [supra n. 26] 85) suggests Christograms and the like found on late Roman and Byzantine amphoras may reflect ecclesiastical control of exchange.
75. In an earlier interpretation of this inscription, Bass suggested that πρεσβύτερος may have qualified the rank of ναύκλερος, i.e., senior sea-captain (Bass and van Doorninck [supra n. 1] 314, n. 16). Since there is little evidence to support this use of πρεσβύτερος, the title is best taken in its common Christian usage, elder or priest.

76. Arthur ([supra n. 74] 87) was the first to suggest taxes in kind as a possible explanation for the nature of the cargo.

77. Steckner (supra n. 54) 65.

78. As D.J. Mattingly ("Oil for export," JRA 1 [1988] 44) notes, regulated weights and measures in the early Imperial Spanish oil trade would have been of greatest convenience to merchants, enabling them to regulate their shipments and quality of merchandise. Later, with the full development of the annona system, these controls may have had a more official nature.
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APPENDIX

CATALOG OF YASSI ADA CYLINDRICAL AMPHORAS

1
Type: Ia
Inv. no. W79
Preservation: complete

Dimensions
Max. h. 43.4 cm.; h. max. diam. 25.6 cm.; max. diam. 19.8 cm.; int. mouth diam. 5.9-6.0 cm.; wt. 3.202 kg.; body cap. 6.050 l.; full cap. 6.275 l.

Fabric
Color: 7.5YR 6/6
Inclusions: black, medium (2), coarse (1); red, medium (2); mica-like, fine (2); quartz-like, fine (3).

2
Type: Ia
Inv. no. W35
Preservation: complete

Dimensions
Max. h. 43.1 cm.; h. max. diam. 25.7 cm.; max. diam. 19.7 cm.; int. mouth diam. 5.7-5.9 cm.; wt. 3.262 kg.; body cap. 5.831 l.; full cap. 6.082 l.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2), coarse (1); red, medium (2); mica-like, fine (2); quartz-like, fine (3).

3
Type: Ia
Inv. no. 36
Preservation: one handle, portion of the neck, and 2/3 of the rim.

Dimensions
Int. mouth diam. 6.0 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (2); whitish grey, medium (2); quartz-like, fine (3), coarse (2).

4
Type: Ia
Inv. no. 77
Preservation: neck and both handles, ½ of the shoulder.

Dimensions
Int. mouth diam. 5.9 cm.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); whitish grey, medium (2); quartz-like, fine (2), medium (3).

5
Type: Ib
Inv. no. 86/112
Preservation: complete

Dimensions
Max. h. 42.7 cm.; h. max. diam. 27.0 cm.; max. diam. 21.7 cm.; int. mouth diam. 5.7-5.9 cm.; wt. 3.232 kg.; body cap. 7.015 l; full cap. 7.245 l.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (1); mica-like, fine (2); quartz-like, fine (3).

6
Type: Ib
Inv. no. W87 (198)
Preservation: complete

Dimensions
Max. h. 42.9 cm.; h. max. diam. 26.1 cm.; max. diam. 21.7 cm.; int. mouth diam. 5.9-6.0 cm.; wt. 3.278 kg.; body cap. 7.150 l; full cap. 7.375 l.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2), coarse (1); red, medium (2); white, medium (2); mica-like, fine (2).
Type: Ib
Inv. no. 86/20
Preservation: complete except for missing handle.

Dimensions
Max. h. 43.2 cm.; h. max. diam. 25.9 cm.; max. diam. 21.1 cm.; int. mouth diam. 5.7-5.9 cm.; wt. 3.100 kg.; body cap. 7.158 l; full cap. 7.398 l.

Fabric
Color: 5YR 6/6
Inclusions: black, medium (2); red, medium (2); white, medium (1); mica-like, fine (2); quartz-like (3).

Type: Ib
Inv. no. W39
Preservation: neck, both handles, ½ circumference of body, 1/3 base.

Dimensions
Int. mouth diam. 5.6-5.8 cm.

Fabric
Color: 5YR 6/8
Inclusions: black, medium (2), coarse (2); red, medium (2); white, medium (1); mica-like, fine (1); quartz-like, fine (1).

Type: Ib
Inv. no. Y89
Preservation: one handle, portion of neck and rim.

Dimensions
Int. mouth diam. 6.0 cm. ?

Fabric
Color: 2.5YR 5/6
Inclusions: black, medium (1); red, medium (2); white, medium (1), coarse (2); quartz-like, fine (2), coarse (1).
10
Type: Ib
Inv. no. 76
Preservation: upper ½ of jar complete.

Dimensions
Max. diam. 19.9 cm.; int. mouth diam. 5.9-6.0 cm.

Fabric
Color: 2.5YR 4/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (2), medium (2).

11
Type: Ib
Inv. no. 89
Preservation: neck, both handles, ½ of shoulder.

Dimensions
Int. mouth diam. 5.9-5.9 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2).

12
Type: Ib
Inv. no. W31
Preservation: neck, both handles, and upper 1/3 of body.

Dimensions
Max. diam. 21.4 cm.; int. mouth diam. 5.8-5.9 cm.

Fabric
Color: 5YR 6/6
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2), coarse (2); quartz-like, fine (2), medium (2).
Type: Ib
Inv. no. W40
Preservation: 2/3 circumference of neck and rim, both handles, 1/2 circumference of body.

Dimensions
Max. diam. 21.1 cm. ?; int. mouth diam. 6.0 cm. ?

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2); quartz-like, fine (2), medium (1), coarse (2).

14
Type: Ib
Inv. no. W41
Preservation: complete except for 7.0 x 14.1 cm. fragment missing from upper body.

Dimensions
Max. h. 43.4 cm.; h. max. diam. 26.3 cm.; max. diam. 20.2 cm.; int. mouth diam. 5.8-5.9 cm.

Fabric
Color: 7.5YR 6/6
Inclusions: black, medium (1); red, medium (1); white, medium (2); mica-like, fine (2); quartz-like, fine (3).

15
Type: Ib
Inv. no. 95
Preservation: neck, rim, both handles, and small portion of shoulder.

Dimensions
Int. mouth diam. 5.9-6.0 cm.

Fabric
Color: 5YR 6/6
Inclusions: black, medium (2); red, medium (1), mica-like, fine (2); quartz-like, fine (2).
Type: Ib
Inv. no. 86/47
Preservation: neck, rim, both handles, and portion of shoulder.

Dimensions
Int. mouth diam. 5.9-6.0 cm.

Fabric
Color: 7.5YR 4/4
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2), coarse (2); quartz-like, medium (2).

Type: Ib
Inv. no. 227
Preservation: neck, rim, and both handles.

Dimensions
Int. mouth diam. 5.7-6.0 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2), coarse (2); quartz-like, fine (2).

Type: Ib
Inv. no. W26
Preservation: neck, rim, and both handles.

Dimensions
Int. mouth diam. 5.8-6.1 cm.

Fabric
Color: 7.5YR 7/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); mica-like, fine (2).
Type: Ib
Inv. no. 39
Preservation: neck, rim, and both handles.

Dimensions
Int. mouth diam. 5.7-5.8 cm.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (3); mica-like, fine (2).

Type: Ib
Inv. no. W32
Preservation: mostly complete, some large portions of body missing.

Dimensions
Max. h. 43.7 cm.; h. max. diam. 26.1 cm.; max. diam. 20.3 cm.; int. mouth diam. 5.9-5.9 cm.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (3); mica-like, fine (2).

Type: Ib
Inv. no. W38
Preservation: mostly complete, some large portions of body missing.

Dimensions
Max. h. 43.9 cm.; h. max. diam. 25.9 cm.; max. diam. 20.2 cm.; int. mouth diam. 5.9-6.0 cm.

Fabric
Color: 5YR 6/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (3); mica-like, fine (3).
22
Type: Ib
Inv. no. W33
Preservation: mostly complete, portions of body and base missing.

Dimensions
Max. h. 43.8 cm.?; h. max. diam. 25.9 cm.?; max. diam. 21.5 cm.?; int. mouth diam. 5.7-5.9 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (3); mica-like, fine (3).

23
Type: Ib
Inv. no. W34
Preservation: ca. 1/3 neck and rim, one handle, and ca. ½ circumference of body and base.

Dimensions
Max. h. 43.1 cm.?; h. max. diam. 26.0 cm.?; max. diam. 20.3 cm.?

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2), coarse (2); quartz-like, fine (2).

24
Type: Ib
Inv. no. W23
Preservation: mostly complete, portions of body and base missing.

Dimensions
Max. h. 42.9 cm.?; h. max. diam. 25.7 cm.?; max. diam. 21.6 cm.?; int. mouth diam. 5.9-6.0 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2), coarse (2); white, medium (2), very coarse (2), quartz-like, fine (2), coarse (1).
Type: Ic
Inv. no. W80
Preservation: complete

Dimensions
Max. h. 46.2 cm.; h. max. diam. 27.7 cm.; max. diam. 22.3 cm.; int. mouth diam. 6.8-6.9 cm.;
wt. 3.940 kg.; body cap. 8.265 l; full cap. 8.572 l.

Fabric
Color: 2.5YR 4/6
Inclusions: black, medium (2); white, medium (2); mica-like, fine (2); quartz-like, fine (3).

Type: Ic
Inv. no. 86/94
Preservation: complete

Dimensions
Max. h. 45.7 cm.; h. max. diam. 28.1 cm.; max. diam. 21.5 cm; int. mouth diam. 6.6-6.8 cm.;
wt. 4.002; body cap. 8.295 l; full cap. 8.577 l.

Fabric
Color: 5YR 5/4
Inclusions: black, medium (2); red, medium (2); mica-like, fine (1).

Type: Ic
Inv. no. ?
Preservation: rim, neck, both handles, and small portion of shoulder.

Dimensions
Int. mouth diam. 6.5-6.8 cm.

Fabric
Color: 5YR 6/6
Inclusions: black, medium (2); red, medium (2), coarse (1); white, coarse (1); quartz-like, fine (3).
Type: Ic
Inv. no. W28
Preservation: upper ½ of amphora.

Dimensions
Max. diam. 22.2 cm.; int. mouth diam. 6.7-6.8 cm.

Fabric
Color: 5YR 5/4
Inclusions: black, medium (2); red, medium (2); white, medium (2), coarse (2); quartz-like, fine (2), medium (2).

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Type: Ic
Inv. no. Y80
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions
Int. mouth diam. 6.5-6.7 cm.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); red, medium (1); white, medium (1); quartz-like, fine (3).

---

Type: Ic
Inv. no. 40
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions
Int. mouth diam. 6.7-7.0 cm.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (1); white, medium (1); quartz-like, fine (3).
Type: Ic  
Inv. no. Y142  
Preservation: portion of rim, neck, both handles, and portion of shoulder and upper body.

Dimensions

Int. mouth diam. 6.5 cm.

Fabric

Color: 5YR 5/6  
Inclusions: black, medium (1); red, medium (2), coarse (1); white, medium (2), coarse (2); quartz-like, medium (2), coarse (2).

32

Type: Ic  
Inv. no. 228  
Preservation: portion of rim and neck, one handle, portion of shoulder and upper body.

Dimensions

?

Fabric

Color: 5YR 5/6  
Inclusions: black, medium (2); red, medium (1), coarse (1); white, medium (2), coarse (2); quartz-like, fine (2).

33

Type: Ic  
Inv. no. ?  
Preservation: rim, ca. 3/4 length of neck, one handle, no shoulder.

Dimensions

Int. mouth diam. 6.9-7.0 cm.

Fabric

Color: 5YR 5/6  
Inclusions: black, medium (2), coarse (2); red, medium (2); white, medium (1).
Type: Ic
Inv. no. 88
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions

Int. mouth diam. 6.6-6.7 cm.

Fabric

Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, medium (2), fine (2).

Type: Ic
Inv. no. 86/29
Preservation: ca. ½ diameter of rim and neck, one handle, portion of shoulder.

Dimensions

Int. mouth diam. 6.6 cm?

Fabric

Color: 5YR 5/6
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (2).

Type: Ic
Inv. no. W36
Preservation: rim, neck, both handles, and portion of shoulder.

Dimensions

Int. mouth diam. 6.6-6.7 cm.

Fabric

Color: 5YR 6/4
Inclusions: black, medium (2), coarse (2); red, medium (2), coarse (2); white, medium (2).
37

Type: Ic
Inv. no. 55
Preservation: rim, neck, both handles, and portion of shoulder.

Dimensions

Int. mouth diam. 6.7-6.9 cm.

Fabric

Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (1); white, medium (2); quartz-like, fine (2).

38

Type: Ic
Inv. no. ?
Preservation: rim, ca. 3/4 length of neck, portion of both handles.

Dimensions

Int. mouth diam. 6.6-6.6 cm.

Fabric

Color: 10YR 6/6
Inclusions: black, medium (2); red, medium (1); white, medium (2); quartz-like, fine (3).

39

Type: Ic
Inv. no. 84/25
Preservation: rim, neck, portion of both handles, portion of shoulder.

Dimensions

Int. mouth diam. 6.6-7.0 cm.

Fabric

Color: 7.5YR 6/4
Inclusions: black, medium (2); red, medium (2); white, medium (1); quartz-like, fine (3).
Type: II
Inv. no. W83 (3725)
Preservation: complete

Dimensions
Max. h. 48.8 cm.; h. max. diam. 31.5 cm.; max. diam. 21.9 cm.; int. mouth diam. 5.6-5.9 cm.;
w. 4.324 kg.; body cap. 8.452 l.; full cap. 8.860 l.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); mica-like, fine (2); quartz-like, fine (3).

Type: II
Inv. no. 592
Preservation: complete

Dimensions
Max. h. 48.2 cm.; h. max. diam. 30.5 cm.; max. diam. 21.9 cm.; int. mouth diam. 5.6-6.0 cm.;
w. 3.555 kg.; body cap. 8.338 l.; full cap. 8.610 l.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (2); mica-like, fine (2); quartz-like, fine (2).

Type: IIIa
Inv. no. 7
Preservation: complete

Dimensions
Max. h. 45.2 cm.; h. max. diam. 27.6 cm.; max. diam. 22.6 cm.; int. mouth diam. 5.8-6.0 cm.;
w. 3.344 kg.; body cap. 8.650 l.; full cap. 9.000 l.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (1); mica-like, fine (3).
Type: IIIb
Inv. no. W86
Preservation: complete, except for small portion of rim missing.

Dimensions
Max. h. 46.7 cm.; h. max. diam. 29.1 cm.; max. diam 22.7 cm.; int. mouth diam. 5.8-5.9 cm.;
wt. 3.470 kg.; body cap. 9.147 l; full cap. 9.520 l.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (1); red, medium (2), coarse (1); white, medium (1), coarse (1);
mica-like, fine (2); quartz-like, fine (3).

Type: IIIc
Inv. no. W85 (3780)
Preservation: complete

Dimensions
Max. h. 46.3 cm.; h. max. diam. 28.9 cm.; max. diam. 23.2 cm.; int. mouth diam. 5.3-5.4 cm.;
wt. 3.732 kg.; body cap. 9.450 l; full cap. 9.758 l.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (1); white, medium (1), coarse (1); mica-like, fine (3); quartz-like,
fine (3).

Type: IIIc
Inv. no. W84
Preservation: complete except for small portion of rim missing.

Dimensions
Max. h. 47.3 cm.; h. max. diam. 30.1 cm.; max. diam. 23.6 cm.; int. mouth diam. 5.7-5.9 cm.;
wt. 3.122 kg.; body cap. 9.662 l; full cap. 10.212 l.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (2), coarse (1); white, coarse (2); mica-like, fine
(2); quartz-like, fine (3).
Type: IIIc
Inv. no. 86/3
Preservation: complete except for missing base.

Dimensions
Max. diam. 23.2 cm.; int. mouth diam. 5.5-5.6 cm.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (1); mica-like, fine (3).

Type: IV
Inv. no. W82
Preservation: complete

Dimensions
Max. h. 48.1 cm.; h. max. diam. 25.7 cm.; max. diam. 24.6 cm.; int. mouth diam. 6.6-6.9 cm.;
wt. 4.316 kg.; body cap. 8.341 l; full cap. 8.772 l.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2), coarse (2); red, medium (2); white, medium (2); mica-like, fine
(1).

Type: IV
Inv. no. ?
Preservation: complete

Dimensions
Max. h. 48.9 cm.; h. max. diam. 26.8 cm.; max. diam. 24.2 cm.; int. mouth diam. 6.7-6.8 cm.;
wt. 4.992 kg.; body cap. 8.607 l; full cap. 9.038 l.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2), coarse (2), very coarse (2); red, medium (2), coarse (2); mica-
like, fine (2); quartz-like, fine (2).
49

Type: IV
Inv. no. ?
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions
Int. mouth diam. 6.0-6.1 cm.

Fabric
Color: 7.5YR 7/8
Inclusions: black, medium (2), coarse (2), very coarse (2); red, coarse (2); quartz-like, fine (2).

50

Type: IV
Inv. no. W29
Preservation: complete except for missing base and portion of rim missing.

Dimensions
Max. diam. 23.6 cm.; int. mouth diam. 6.0 cm.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2), coarse (2); red, medium (2), coarse (2); mica-like, fine (2); quartz-like, fine (2).

51

Type: IV
Inv. no. 247
Preservation: rim, neck, both handles and portion of shoulder.

Dimensions
Int. mouth diam. 6.9-7.1 cm.

Fabric
Color: 7.5YR 5/6
Inclusions: black, medium (3), coarse (2); red, medium (2); quartz-like, fine (3); mica-like, fine (2).
Type: Va  
Inv. no. 591  
Preservation: complete

Dimensions
Max. h. 51.0 cm.; h. max. diam. 30.4 cm.; max. diam. 25.7 cm.; int. mouth diam. 7.0-7.1 cm.; wt. 5.418 kg.; body cap. 11.960 l; full cap. 12.520 l.

Fabric
Color: 5YR 7/4  
Inclusions: black, medium (2), coarse (1); red, medium (1); white, medium (1); quartz-like, fine (3).

Type: Va  
Inv. no. 249  
Preservation: rim, neck, both handles, portion of the shoulder.

Dimensions
Int. mouth diam. 6.7-6.8 cm.

Fabric
Color: 7.5YR 5/4  
Inclusions: black, medium (2), coarse (2); white, medium (2); quartz-like, fine (2).

Type: Va  
Inv. no. 86/10  
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions
Int. mouth diam. 6.9-7.0 cm.

Fabric
Color: 5YR 5/6  
Inclusions: black, medium (2), coarse (2); red, medium (2), coarse (2); white, fine (2), medium (2), coarse (2); whitish grey, medium (2), coarse (2); quartz-like, fine (2), medium (2), coarse (2).
55
Type: Va
Inv. no. 177
Preservation: rim, neck, one handles, portion of shoulder.

Dimensions
Int. mouth diam. 6.9-7.0 cm.

Fabric
Color: 2.5YR 4/6
Inclusions: black, medium (2), very coarse (2); red, medium (2), coarse (2).

56
Type: Va
Inv. no. 86/35
Preservation: rim, neck, both handles, portion of body and shoulder.

Dimensions
Int. mouth diam. 6.7-6.9 cm.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2); red, medium (2); white, medium (2); mica-like, fine (2).

57
Type: Va
Inv. no. W37
Preservation: rim, neck, both handles, and ca. 1/3 of upper body.

Dimensions
Max. diam. 26.1 cm.; int. mouth diam. 6.8-6.8 cm.

Fabric
Color: 7.5YR 5/4
Inclusions: black, medium (2); red, medium (2); white, medium (2); mica-like, fine (2).
Type: Va
Inv. no. 84/16
Preservation: ca. 1/3 diameter of neck and rim, one handle.

Dimensions
?

Fabric
Color: 7.5YR 5/4
Inclusions: black, medium (2); red, medium (2); white, medium (2); mica-like, fine (2).

Type: Va
Inv. no. W24
Preservation: rim, neck, both handles, and upper body.

Dimensions
Max. diam. 26.5 cm.; int. mouth diam. 6.9-6.9 cm.

Fabric
Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (2); white, medium (2); quartz-like, fine (2).

Type: Va
Inv. no. 4
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions
Int. mouth diam. 7.0-7.1 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2), coarse (2); red, medium (2), coarse (2); white, coarse (1); quartz-like, fine (3).
61

Type: Va
Inv. no. 84/28
Preservation: rim, neck, both handles, portion of shoulder.

Dimensions

Int. mouth diam. 6.9-7.0 cm.

Fabric

Color: 5YR 6/4
Inclusions: black, medium (2), coarse (2); red, medium (2), coarse (2); white, medium (2), coarse (2); quartz-like, fine (2).

62

Type: Va
Inv. no. 86/7
Preservation: rim, ca. 1/3 diameter of lower neck, one handle, and portion of shoulder.

Dimensions

Int. mouth diam. 6.5-6.7 cm.

Fabric

Color: 5YR 6/4
Inclusions: black, medium (2), coarse (2); whitish grey, medium (2), coarse (2); quartz-like, fine (3), medium (2), coarse (2).

63

Type: Vb
Inv. no. W35 (2288)
Preservation: complete

Dimensions

Max. h. 52.7 cm.; h. max. diam. 30.4 cm.; max. diam. 27.5 cm.; int. mouth diam. 6.6-6.7 cm.; wt. 6.882 kg.; body cap. 14.398 l.; full cap. 14.883 l.

Fabric

Color: 5YR 6/4
Inclusions: black, medium (2); red, medium (2); quartz-like, fine (3).
Type: Vc
Inv. no. Y83
Preservation: rim, neck, both handles, ca. ½ circumference of body, base missing.

Dimensions
Int. mouth diam. 6.6-6.7 cm.

Fabric
Color: 2.5YR 5/6
Inclusions: black, medium (2); white, medium (2); quartz-like, fine (3).

Type: Vc
Inv. no. 96
Preservation: jar split along longitudinal axis, from rim to extent of preserved body, base missing.

Dimensions
Int. mouth diam. 6.6 cm.

Fabric
Color: 2.5YR 5/6
Inclusions: black, medium (2); white, medium (2); quartz-like, fine (3).

Type: VI
Inv. no. 86/97
Preservation: complete

Dimensions
Max. h. 39.0 cm.; h. max. diam. 22.5 cm.; max. diam. 17.6 cm.; int. mouth diam. 4.7-4.8 cm.; wt. 2.456 kg.; body cap. 4.390 l; full cap. 4.582 l.

Fabric
Color: 2.5YR 5/4
Inclusions: black, medium (2), coarse (2), very coarse (1), super coarse (1); red, medium (2), coarse (1), super coarse (1); grey, coarse (1), super coarse (1); mica-like, fine (2), medium (1); quartz-like, fine (3), coarse (2).
Type: VII
Inv. no. W25
Preservation: complete

Dimensions
Max. h. 46.9 cm.; h. max. diam. 28.7 cm.; max. diam. 21.9 cm.; int. mouth diam. 7.1-7.3 cm.; wt. 3.504 kg.; body cap. 8.350 l.; full cap. 8.732 l.

Fabric
Color: 2.5YR 5/6
Inclusions: black, medium (2); grey, medium (2); white, medium (2); mica-like, fine (1); quartz-like, fine (3).

Type: VIII
Inv. no. 138
Preservation: rim, neck, one handle, portion of shoulder and upper body.

Dimensions
Int. mouth diam. 6.4-7.4 cm.

Fabric
Color: 10YR 8/2
Inclusions: black, medium (3), coarse (2); red, coarse (1); quartz-like, fine (2).

Type: IX
Inv. no. W30
Preservation: rim, neck, both handles and upper ½ of body.

Dimensions
Int. mouth diam. 6.0-6.3 cm.

Fabric
Color: 7.5YR 6/4
Inclusions: black, medium (2); grey, medium (2), coarse (2); quartz-like, fine (1).
Type: X
Inv. no. 99
Preservation: upper ½ of amphora.

Dimensions
Max. diam. 21.9 cm.; int. mouth diam. 6.5-7.7 cm.

Fabric
Color: 5YR 5/6
Inclusions: black, medium (2), coarse (2), very coarse (1); red, medium (2), coarse (1); grey, medium (2), coarse (2); yellow, very coarse (1); mica-like, fine (3); quartz-like, fine (3).

Type: XI
Inv. no. Y71
Preservation: rim, neck, one handle and portion of shoulder.

Dimensions
Int. mouth diam. 7.0-7.2 cm.

Fabric
Color: 7.5YR 6/6
Inclusions: black, medium (2), very coarse (2); red, medium (1), coarse (1); white, medium (1), coarse (1); mica-like, fine (3).
VITA

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EDUCATION

FIELD EXPERIENCE
Bozburun Excavation (INA and Texas A&M), Selimiye, Turkey
● Staff Member June-August 1995
INA Expedition to the Red Sea (INA and Texas A&M), Egypt
● Surveyor, Photographer June-July 1994
Uluburun Excavation (INA and Texas A&M), Uluburun, Turkey
● Photographer July-August 1993

RELATED EXPERIENCE
Institute of Nautical Archaeology (INA)
● Research Associate, co-director of INA research and projects in Albania. *Present*
Bodrum Museum of Underwater Archaeology, Bodrum, Turkey
● Assistant to F.H. van Doorninck, Jr. in study of 7th and 11th c. A.D. amphorae. *July 1993; August 1994; May 1995*
● Assisted in construction of 7th c. Yassi Ada replica. *April-May 1995*

PUBLICATIONS