Trade and Markets in Byzantium

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Trade and Markets in Byzantium

Edited by

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To the memory of Angeliki Laiou—

pathbreaking leader in the study of the Byzantine economy,

inspiring and irreplaceable friend and colleague

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FOREWORD

This book emerged from the 2008 Spring Symposium held at Dumbarton Oaks 2–4 May. For their help in organizing the meeting, blessed by clement weather that enabled participants to fully enjoy all the graces of the gardens, I am most grateful to Polly Evans, Danica Kane, Mario Garcia, and Joe Mills, who looked to its smooth running and recording. My warm thanks to Jan Ziołkowski, Director of Dumbarton Oaks, who hosted and welcomed his first Symposium of Byzantine Studies with his characteristic elegance and openness. My special gratitude to the then Director of Byzantine Studies, Alice-Mary Talbot, who directed so graciously and efficiently this thirteenth and last Symposium of her tenure. I also thank the contributors who have taken time out of their busy schedules to participate in the colloquium, to discuss reciprocally their respective papers, and then to create this book.

After the Symposium, it was decided to include two studies of great relevance to our topic: that of Rowan Dorin, doctoral student of Angeliki Laiou, on Adriatic trade networks in the twelfth and early thirteenth centuries and that of Luke Lavan on retail and regulation in the late antique city.

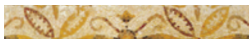
This is the fourth volume in the series Dumbarton Oaks Byzantine Symposia and Colloquia: it was preceded by *Becoming Byzantine: Children and Childhood in Byzantium,* edited by Alice-Mary Talbot and Arietta Papaconstantinou (2009); *The Old Testament in Byzantium,* edited by Paul Magdalino and Robert Nelson (2010); and *San Marco, Byzantium, and the Myths of Venice,* edited by Henry Maguire and Robert Nelson (2010). Editing and producing this book proved to be a longer process than some impatient authors would have liked. The result will, I hope, compensate for their regrets. Alice-Mary Talbot and her successor, Margaret Mullett, were instrumental in preparing the papers for publication, and the Director of Publications, Kathy Sparkes, brought her special skills to the quality of illustrations and her stamina to set the book on track. Joel Kalvesmaki scrutinized the manuscript with his usual acumen. Alice Falk copyedited the mass of papers with great patience. To all, I extend special gratefulness.

Early in the preparation of this publication, the untimely and shocking death of Angeliki Laiou, an immense loss to the whole world of Byzantine studies, stirred particular grief among all participants in the Symposium, speakers and listeners alike. This had been the last occasion on which she met her colleagues in community and delivered a paper, and the last time she attended a symposium at Dumbarton Oaks, the institution and place to which she had devoted such passionate and clear-minded energy during the years of her directorship (1989–98) and well beyond. There was not a hint of her impending illness; her presence was as imposing and her interventions as sharp and appropriate as ever.

It is just and meet that this book be dedicated to her memory as a modest token of our debt to a great historian. Without her pioneering work on the Byzantine economy, the present studies would probably not have been written or assembled.

Cécile Morrisson

Introduction



Although trade is often featured in Byzantine archaeological meetings or in those offering a regional perspective, it is rarely the center of them. The symposium that took place in Dumbarton Oaks on 2–4 May 2008 and gave rise to this book was entirely devoted to trade and markets in Byzantium. It was not, however, the first colloquium with Byzantine trade as its main subject. The Oxford conference held at Somerville College on 29 May 1999 (later edited and published by Sean Kingsley and Michael Decker as *Economy and Exchange in the East Mediterranean during Late Antiquity*) may have been the first to set forth down this path—if "late antiquity" is taken as coterminous with "Byzantine"—and to signal the revived attention spurred by the accumulating wealth of new archaeological material.[1] Because of its wider chronological range, the British 38th Spring Symposium of Byzantine Studies titled "Byzantine Trade (4th–12th c.): Recent Archaeological Work," held in Oxford in March 2004, was advertised as the first symposium directly focused on Byzantine trade.[2] Finally, another conference held in Vienna in October 2005, codirected and just published by one of our speakers, Johannes Koder—"Handelsgüter und Verkehrswege: Aspekte der Warenversorgung im östlichen Mittelmeerraum (4. bis 15. Jahrhundert)"—underscored the growing interest in the subject.[3]

Trade deserves special attention because, as many economic historians have shown, it plays an essential role in the economy and particularly in economic development; the famous slogan "Trade Not Aid" embraced by African leaders and Western economists nicely encapsulates the idea that growth results not from massive aid but from an increase in exports, which—as the examples of Japan, Korea, Taiwan, and now China demonstrate—leads underdeveloped economies out of poverty.[4] All things being equal, the evolution of the Byzantine economy from the ninth to the twelfth century and, later, from small-scale trade to far-flung involvement in international exchanges clearly illustrates the correlation between the expansion of trade and that of the economy in general. However they interpret its

1 S. Kingsley and M. Decker, eds., *Economy and Exchange in the East Mediterranean during Late Antiquity: Proceedings of a Conference at Somerville College, Oxford, 29th May, 1999* (Oxford, 2001).

2 M. Mundell Mango, ed., *Byzantine Trade, 4th–12th Centuries: The Archaeology of Local, Regional and International Exchange,* Papers of the Thirty-eighth Spring Symposium of Byzantine Studies, St John's College, University of Oxford, March 2004, Society for the Promotion of Byzantine Studies 14 (Aldershot, 2009); review by J.-P. Sodini and me in *The Medieval Review* 10.03.04 (March 2009), at http://hdl.handle.net/2022/6770 (accessed August 2010).

3 E. Kislinger, J. Koder, and A. Künzler, *Handelsgüter und Verkehrswege/Aspekte der Warenversorgung im östlichen Mittelmeerraum (4. bis 15. Jahrhundert),* Österreichische Akademie der Wissenschaften, Veröffentlichungen zur Byzanzforschung 18 (Vienna, 2010). This volume appeared too late for its contents to be taken into account here.

4 World Bank, "Industrialization and Foreign Trade," in *World Development Report 1987* (New York, 1987), 38–170, available at http://go.worldbank.org/6DBKU5WP10 (accessed August 2010); S. Edwards, "Openness, Trade Liberalization, and Growth in Developing Countries," *Journal of Economic Literature* 31 (1993): 1358–93.

causes and context, this expansion is now generally recognized by historians. An expanding trade relies on an efficient division of labor, about which Adam Smith said, with typical Scottish humor: "Man has almost constant occasion for the help of his brethren, and it is in vain for him to expect it from their benevolence only."[5]

Indeed, the permanence of interregional and international relations, defined as the exchange of commodities, information, and population at all levels, which Peregrine Horden and Nicholas Purcell labeled "connectivity," is a primary concern of their *Corrupting Sea* and of another magisterial book, Michael McCormick's *Origins of the European Economy*,[6] while receiving due consideration in the *Economic History of Byzantium,* edited by Angeliki Laiou. In her final overview, she pointed to the parallels she had drawn between the West and the Byzantine economy as supporting her "insistence on trade as a dynamic element in the medieval economy, especially in the eleventh and twelfth centuries."[7] In his no less monumental *Framing the Early Middle Ages,* Chris Wickham proclaimed that his final chapter, "Systems of Exchange," was "in many ways the core of the book."[8] Although it may have been a later addition and a shift of thinking by an author who has reflected for many years on the transformation of the Roman world, it marks a welcome recognition of the importance of trade. The recent assessment of early and mid-Byzantine trade at the regional and international levels provided by the contributions to the Oxford 2004 symposium clearly recognized its vitality and role, even in the dark eighth century, in comparison with "non-economic exchange."

"Trade and Markets" versus the Byzantine Market Economy

The invitation letter stated that the Symposium would "focus equally on markets and the market place." Because of the polysemy of the term "market," this phrase requires qualification. The Dumbarton Oaks meeting did not consider the concept of *the* Byzantine market, defined as an economic system of transactions to exchange goods and services, nor did it formally assess different models of the extension of the Byzantine market economy, whether constituted in a comprehensive network of relatively independent markets or in fragmented, unconnected markets within the more restrictive frame of a tributary state.

But that long-debated topic could not be passed over entirely; it is treated in the first and last chapters of this volume. In the latter, Peter Temin analyzes the Polanyian concepts of reciprocity, redistribution, and exchange and Frederic Pryor's differentiation of exchanges and transfers, before stating the conditions in prices and individual behavior that are characteristic of a market economy. The skeptics who deny the existence of a Byzantine "market" should take note that a market economy is one in which market exchanges are the most common type of interaction—other forms of exchanges, whether reciprocal or redistributive, may take place as well, as indeed was the case in Byzantium. In the first chapter, Jean-Michel Carrié recalls the shifting fortunes of the "traditional, innocently modernist" model of late antiquity in the early twentieth century and the "primitivist" one, before offering his own characterization of the late Roman market economy. He concurs with Peter Temin in defining it as a "conglomeration of interdependent markets."[9] And this notion of the Byzantine economy as a network of interconnected relatively "free" markets[10] implicitly lies behind most of the chapters in this volume.

Trade in the Debate Regarding the Ancient Economy

A short account of the various schools of thought may be of use. Broadly speaking, the "modernists" view the ancient economy as functioning, all things being equal, in ways comparable to the modern one, with differences in quantity and not quality; this idea was maintained by both Michael Rostovtzeff

5 A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), book I, chap. 2.2.

6 P. Horden and N. Purcell, *The Corrupting Sea: A Study of Mediterranean History* (Oxford, 2000); review by M. Whittow in *English Historical Review* 116 (2001): 900–2; M. McCormick, *Origins of the European Economy: Communications and Commerce, A.D. 300–900* (Cambridge, 2001).

7 A. E. Laiou, "The Byzantine Economy: An Overview," in *EHB* 3:1148.

8 C. Wickham, *Framing the Early Middle Ages: Europe and the Mediterranean, 400–800* (Oxford, 2005), 693.

9 J.-M. Carrié, "Market Economies? Links between Late Roman and Byzantine Economic Historiography," below, 13.

10 P. Temin, "A Market Economy in the Early Roman Empire," *JRS* 91 (2001): 169–81.

and Henri Pirenne.[11] The "primitivists," on the other hand, insist, as did Moses Finley in several influential essays, that modern analysts cannot approach the ancient economy using economic concepts ignored by its actors and that it was essentially driven by social forces rather than a desire for profit.[12] The ideal of self-sufficiency (*autarkeia*) prevailed; there was hardly any division of labor, regional specialization, or technical innovation; goods were traded or rather redistributed mainly for social or political reasons; and trade played a negligible role in the economy. This "academic battleground," to use Keith Hopkins's phrase,[13] involved mainly historians of the early and late Roman economy, as Rostovtzeff's views opposed those of Hugo Jones, but it did not leave Byzantinists untouched. Michael Hendy, who acknowledged his intellectual debt to Finley, Jones, and Philip Grierson,[14] brilliantly took sides with them in his great book and other studies in which he contended that the role of the state in the "Byzantine monetary economy" was paramount: trade, in his view, played no part at all in the state's monetary policy nor in its resources and only a limited one in monetary distribution and circulation.[15] Evelyne Patlagean also upheld the approach of "primitivists," relying on the perspectives of Karl Polanyi, Moses Finley, and Marcel Mauss (notably in her paper delivered at Spoleto in 1992).[16]

In contrast, Angeliki Laiou was well aware of the developments of contemporary economic analysis and modern economic history and did not shy from employing their categories in her reasoning. Therefore Patlagean implicitly considered her a "modernist," in her long, nuanced review of *The Economic History of Byzantium* in 2004.[17] Yet Laiou's conception of the Byzantine economy was quite balanced, and she did not belong among those whom Carrié calls the traditional, innocent modernists. Before outlining Byzantine trade in the middle Byzantine period,[18] she devoted an entire chapter to the noneconomic forms of exchange as defined by Mauss and Polanyi,[19] which Grierson highlighted in his pioneering and famous article, "Commerce in the Dark Ages."[20] For the late Roman period, readers should consult the seminal article by Richard Whittaker and his analysis of its "tied trade," as well as the more recent assessment offered in the introduction to the *Cambridge Economic History of Greco-Roman Antiquity*.[21]

In that authoritative volume, distribution in the early Roman Empire is viewed from a more balanced perspective, which signals that the debate has subsided and a new consensus has been reached. Neville Morley, among others, recognizes that the Roman economy was "organized through market incentives or directed through requisition and compulsion" and knew a "degree of integration, of the movement of goods, people, and ideas."[22] In spite of the revival

11 M. I. Rostovtzeff, *A History of the Ancient World,* vol. 1 (Oxford, 1926), 10; H. Pirenne, *Mahomet et Charlemagne,* 2nd ed. (Paris, 1937), 219.

12 M. I. Finley, *The Ancient Economy,* 3rd ed. (Berkeley, 1999). See also the account of M. M. Austin and P. Vidal-Naquet, *Economic and Social History of Ancient Greece: An Introduction,* trans. and rev. M. M. Austin (London, 1977); originally published as *Économies et sociétés en Grèce ancienne* (Paris, 1972).

13 K. Hopkins, introduction to *Trade in the Ancient Economy,* ed. P. Garnsey, K. Hopkins, and C. R. Whittaker (London, 1983), ix.

14 M. F. Hendy, *The Economy, Fiscal Administration and Coinage of Byzantium* (Northampton, 1989), x.

15 Idem, *Studies in the Byzantine Monetary Economy, c. 300–1450* (Cambridge, 1985). He strongly opposed attempts to apply economic reasoning to the interpretation of monetary developments, as in the case of the eleventh-century debasement (25).

16 É. Patlagean, "Byzance et les marchés du grand commerce vers 830–vers 1030: Entre Pirenne et Polanyi," in *Mercati e mercanti nell'alto medioevo: L'area Euroasiatica e l'area Mediterranea,* Settimane di studi del Centro italiano di studi sull'alto medioevo 40 (Spoleto, 1993), 587–632.

17 É. Patlagean, "Écrire l'histoire économique de Byzance: À propos d'un ouvrage récent," *Le Moyen Age* 110 (2004): 659–69. She used the metaphor "mise à proximité" to mean "modernism."

18 A. E. Laiou, "Economic and Noneconomic Exchange," in *EHB* 2:681–96.

19 Eadem, "Exchange and Trade, Seventh–Twelfth Centuries," in *EHB* 2:697–770.

20 P. Grierson, "Commerce in the Dark Ages: A Critique of the Evidence," *Transactions of the Royal Historical Society,* 5th ser., 9 (1959): 123–40 (repr. in idem, *Dark Age Numismatics* [London, 1979], art. II).

21 C. R. Whittaker, "Late Roman Trade and Traders," in Garnsey, Hopkins, and Whittaker, eds., *Trade in the Ancient Economy,* 163–80; I. Morris, R. P. Saller, and W. Scheidel, introduction to *Cambridge Economic History of Greco-Roman Antiquity,* ed. I. Morris, R. P. Saller, and W. Scheidel (Cambridge, 2007), 1–7. See also W. Scheidel and S. von Reden, eds., *The Ancient Economy* (Edinburgh, 2002), which offers a collection of reprinted articles on the subject with their own comments, and J. Manning and I. Morris, eds., *The Ancient Economy: Evidence and Models* (Stanford, 2005), which collects original essays attempting to frame the enlarged available evidence in new models that incorporate basic economics and abandon the Finleyan orthodoxy.

22 N. Morley, "The Early Roman Empire: Distribution," in Morris, Saller, and Scheidel, eds., *Cambridge Economic History of Greco-Roman Antiquity,* 570–91, at 591; and idem, *Trade in Classical Antiquity* (Cambridge, 2007).

of the old polemic provoked by Peter Bang's recent book,[23] the debate has progressed to the point that all participants are at least more aware of the importance for current and future investigations of two elements: on the one hand, quantification of the "performance" of the Roman economy (production, input-output, costs and benefits, population and standards of living, prices, sales, and exports),[24] and, on the other hand, the role of structures such as institutions, technology, ecology, demography, and ideology. Though not put in the same terms, such an approach was by and large that of the *Economic History of Byzantium,* which provided the framework for this Symposium; we thus did not take up the debate again.

Local, Regional, and Interregional Exchanges: The Evidence

The purpose of bringing together historians and archaeologists was to gather further evidence and present the state of the art of research on the movement of goods—"things that travelled" in the words of David Whitehouse[25]—within the Byzantine world on markets at various levels, especially at the regional scale. Regional trade was rather neglected in previous research, which had long been more interested in interregional and long-distance trade and the mostly prestige or luxury items it carried than in smaller regional and local markets and marketplaces. The numerous markets that make up the Byzantine market economy imply a chain of transactions in which trade takes place on varied tiers. How to classify these markets is an issue considered by several chapters.[26] Various criteria can be used for this purpose, most notably those offered by Luuk de Ligt in his *Fairs and Markets in the Roman Empire*:[27] type of transaction, duration, and distance. A combination of the last two, duration and distance—the latter reflecting the constraints on human travel in an ancient or medieval context—seems relatively free from dispute and has been used in this book.

The Three Levels of Trade

Agreement emerged in the Symposium on the following rough limits of the three tiers:

ONE Local, defined as a one-day transit time, or within a radius of less than about 50 kilometers (31 miles) by land or the distance of one day's sailing,[28] to a maximum of two or three days' travel on foot.[29] This is the smallest and the most difficult level to apprehend. But the diffusion of the most ordinary cooking ware generally constitutes a good proxy of a network with a 50-kilometer radius, as shown by Alan Walmsley, who uses as a marker Jerash Bowls, Palestinian Fine Ware from Jerusalem, and Red Painted Ware of Jordanian origin (possibly from ʿAmmān).[30] Archaeology is now fortunately devoting greater attention to this kind of ordinary ceramics—witness the now regular meetings on Late Roman Coarse Wares (LRCW), published in three volumes to date—and this area of research,

23 P. F. Bang, *The Roman Bazaar: A Comparative Study of Trade and Markets in a Tributary Empire* (Cambridge, 2008). P. Temin published a critical review in *Journal of Economic History* 69 (2009): 1165–66; for more positive remarks from a historian, see B. Shaw in *Journal of Interdisciplinary History* 41 (2010): 126–27.

24 A. Bowman and A. Wilson, eds., *Quantifying the Roman Economy: Methods and Problems* (Oxford, 2009), particularly A. Wilson's "Approaches to Quantifying Roman Trade," 210–49; M. Fulford's "Response" to this chapter, 250–65; and W. Harris's "Comment," 259–65. See also the contribution to the proceedings of the Brussels Francqui Conference (2009): "Long-term Quantification in Ancient Mediterranean History," *Quantifying Monetary Supplies in Greco-Roman Times*, ed. F. de Callataÿ, Pragmateiai 19 (Bari, 2011).

25 D. Whitehouse, "'Things that Travelled': The Surprising Case of Raw Glass," *Early Medieval Europe* 12 (2003): 301–5.

26 See A. E. Laiou, "Regional Networks in the Balkans in the Middle and Late Byzantine Periods"; S. Redford, "Trade and Economy in Antioch Cilicia in the Twelfth and Thirteenth Centuries"; and J. Koder, "Regional Networks in Asia Minor during the Middle Byzantine Period (Seventh–Eleventh Centuries): An Approach."

27 L. de Ligt, *Fairs and Markets in the Roman Empire: Economic and Social Aspects of Periodic Trade in a Pre-industrial Society*, Dutch Monographs on Ancient History and Archaeology 11 (Amsterdam, 1993), 1, 79–81.

28 Laiou, "Regional Networks in the Balkans," 126 n. 5; M. McCormick, "Byzantium on the Move: Imagining a Communications History," in *Travel in the Byzantine World: Papers from the Thirty-fourth Spring Symposium of Byzantine Studies, Birmingham, April 2000,* ed. R. Macrides, Society for the Promotion of Byzantine Studies 10 (Aldershot, 2000), 3–29; Koder, "Regional Networks in Asia Minor," 147.

29 J. Haldon, "Commerce and Exchange in the Seventh and Eighth Centuries: Regional Trade and the Movement of Goods," 99.

30 See in this volume A. Walmsley, "Regional Exchange and the Role of the Shop in Byzantine and Early Islamic Syria-Palestine: An Archaeological View," 311–30.

though not systematized, is also being explored in the Byzantine period.

TWO Above this limit and below ten days' travel is the regional level;[31] in terms of distance, it corresponds to a radius of 100 to 300 kilometers. Regional travel also involves professional traders, whereas local trade is still partly or mostly in the hands of the local producers themselves.[32] For this tier, the ongoing study of unglazed coarse pottery is a promising line of research that is beginning to be investigated—for instance, in Amorion by Chris Lightfoot and his team[33]—and still has much to tell us. In defining regional networks, we are also aided by the study of ecological conditions for agricultural and other production. As Johannes Koder highlights, the supply radius from the hinterland to urban settlements varied according to the agrarian productivity of their respective landscapes. All things being equal, local and regional trade mostly concerned everyday staples (foodstuffs) and pottery, but it also handled raw material and energy sources for crafts such as hemp, flax, leather, iron, wood, charcoal, and so on.[34]

THREE Interregional trade connects two different regions that each have a radius of 100 to 300 kilometers. It is not necessarily carried over a long distance, but that is most frequently the case, for the two regions are not systematically coterminous. It is often but not always international; conversely, regional exchanges might cross over political boundaries in the middle Byzantine period, as between Byzantium and the Bulgars, or in the later period, as Scott Redford describes, between Armenian Cilicia and the Principality of Antioch, and as was the rule in the "small states" of the fragmented Byzantine world after 1204.

It should be pointed out that for maritime commerce, the distinction between the regional and interregional is more blurred, since the lower cost of transportation does not limit quantities as much as it does in terrestrial trade. Moreover, the two levels often intermingle, since commodities that travel long distances often end up in regional exchanges and vice versa, as the "intra-Adriatic port-hopping" described by Rowan Dorin illustrates.[35]

Sources: Archaeology, Numismatics, Texts, and Documents

Another obvious area of agreement pertains to our various sources, and the need to combine and cross-check them. The seminal contribution of archaeology is now fully and universally recognized. In many instances, as will be seen below, it opens entirely new avenues; in others, as in the case of Comacchio described by Sauro Gelichi,[36] it offers a welcome confirmation of the trends suggested by the study of written sources. The abundance of the material yielded by archaeology over the past fifty years, its context, and its wide distribution in themselves argue for a movement that, in the late Roman world as well as in the twelfth century and later, involved trade in a wide range of goods, from luxury items to more common commodities. Ceramics feature in many contributions of this volume: on the one hand, high-value glazed ceramics enable scholars to trace regional and interregional commerce and are a main focus of Demetra Papanikola-Bakirtzi's and Scott Redford's chapters; on the other hand, unpretentious and cheaper unglazed or even coarse pottery points to geographically smaller networks with a larger clientele.

The enormous progress made in the classification of amphorae and the location of their production centers, together with the analyses of their contents, enables Dominique Pieri, by plotting the varied provenances against the distribution of finds, not only to outline in detail the long-distance export and distribution of Gaza wine through the Mediterranean and to the West but also to highlight the regional imports in Beirut of Acre amphorae and Bag amphorae, as well as the local distribution of North Syrian ones, attested in Zeugma, Ruṣāfa, Apameia, and villages in the Limestone massif. "Operational" approaches to amphorae can lead to economic inferences: the implicit relation between the heavy Late Roman African amphorae of some 80 kilograms each and

31 Koder, "Regional Networks in Asia Minor," 147 and n. 3.

32 Laiou, "Regional Networks in the Balkans," 126.

33 C. Lightfoot, "Business as Usual? Archaeological Evidence for Byzantine Commercial Enterprise in Amorium in the Seventh to Eleventh Centuries," 190.

34 Koder, "Regional Networks in Asia Minor," 155–58.

35 In this volume, R. Dorin, "Adriatic Trade Networks in the Twelfth and Early Thirteenth Centuries," 264.

36 See in this volume S. Gelichi, "Local and Interregional Exchanges in the Lower Po Valley (Eighth–Ninth Centuries)."

elaborate port facilities; the ergonomic explanation of the curious shape of Aegean Kapitän 2 or Pieri's Late Roman 9, which was easier for a single stevedore to grasp and carry; and the lightness and thinness of the walls of sixth-century globular amphorae, which made it possible to transport more content for the same tare and were better adapted to beachside or smaller-scale landings as well as to reuse.[37]

Although ceramics evidence has brought a revolutionary change in our perception and even has enabled us to quantify Roman and Byzantine exchanges, as Pieri emphasizes, the bias resulting from the "invisibility" of commodities transported in perishable packing (bags, skins, or textiles) or simply as a loose cargo, such as grain, lentils and other pulses, textiles, spices, furs, and the like, seems nearly insuperable for archaeological investigation, where they hardly leave any trace. The problem is addressed at length in Michael McCormick's chapter below. The solution is often to turn to indirect evidence—primarily written documents; for example, their frequent mention of *cupae* in the West and βουττία in the East points to the key role of wooden containers in transportation.

Some contributors to the Symposium included numismatics—an approach rarely taken before, which bears tribute to the efforts of researchers in that discipline to make its material available to and usable by nonspecialists—even if its evidence, not yet included in a geodatabase, is difficult to interpret because coins change hands so much more easily than do other materials.[38] Nevertheless, when considered in aggregate and in relation to other material, whether archaeological or documentary, coin circulation can help define chronological patterns or spatial distribution, as the chapters by Lightfoot, John Haldon, and Laiou show. The latter two authors saw as paradoxical the lack of precious metal coin finds from large and active production and trade centers such as Corinth or Athens, but this phenomenon should not be surprising; indeed, it is common throughout the Byzantine world, due to the higher rate of loss of petty coinage (one is much more likely to expend effort to recover a gold or silver coin than a small one of little value). The coexistence in some particular areas of coins from various political entities sometimes points to a "currency community," as in the case of the Antioch region and Cilicia in the thirteenth century—a community that is also made visible in a community of taste, as expressed by the motifs of the Port Saint Symeon Ware or its imitations and their standardization.

The testimony of texts on trade have been used ever since Wilhelm Heyd's *Histoire du commerce du Levant au Moyen Âge* (1885–86) or Henri Pirenne's famous *Mahomet et Charlemagne* (posthumously published in 1937) for their meaningful and picturesque anecdotes, but not until Michael McCormick's *Origins of the European Economy* (2001) was the potential of all written sources and documents for statistical analysis fully recognized and exploited. The rich western archives, even when already the object of numerous studies, can provide new perspectives when approached from new angles, as Rowan Dorin does in his study of the regional Adriatic networks in the twelfth and early thirteenth centuries, before Venice had fully established her dominance of the region's sea-lanes.

More obliquely, literary or religious texts can also yield details in the many metaphors related to commercial practice, the good and evil deeds or the risks incurred as found in Church teachings on virtuous trading, and all the allusions to market-conditioned behavior. Such metaphors also tell us that trade and markets were so common that the many topoi based on them were readily understood by churchgoers.[39] Previously neglected texts, such as the Arab

37 See in this volume D. Pieri, "Regional and Interregional Exchanges in the Eastern Mediterranean in the Early Byzantine Period: The Evidence of Amphorae," and M. McCormick, "Movements and Markets in the First Millennium: Information, Containers, and Shipwrecks," as well as E. Zanini, "Forma delle anfore e forme del commercio tardoantico: Spunti per una riflessione," in *LRCW 3, Third International Conference on Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry, Comparison between Western and Eastern Mediterranean* (forthcoming).

38 C. Morrisson, "La monnaie sur les routes fluviales et maritimes des échanges dans le monde méditerranéen (VI^{e}–IX^{e} siècle)," in *L'acqua nei secoli altomedievali (Spoleto, 12–17 aprile 2007),* Settimane di studio della Fondazione Centro italiano di studi sull'alto Medioevo 55 (Spoleto, 2008), 631–70. See the cautionary observations on the value of coins as evidence in A. Stahl, "Coinage," *Early Medieval Europe* 12 (2003): 293–99.

39 McCormick, "Movements and Markets in the First Millennium," analyzes several metaphors on trade, risk, profit, etc. 78–79; C. Morrisson, "Weighing, Measuring, Paying: Exchanges in the Market and the Marketplace," analyzes cases (legal or literary) of defrauders and swindlers, 387–88, 389–90]; L. Lavan, "From *polis* to *emporion*? Retail and Regulation in the Late Antique City," 333–77, examines shops and daily exchanges in late antiquity, passim.

almanacs and chronological treatises examined by André Binggeli, yield precious information on Bilād al-Shām's fairs (the regular intervals at which they were held and the area from which they drew attendees); those in Filasṭīn; those on the Damascus–Mecca route, which existed in the preceding period under Byzantine rule; and the later ones established in the Jazīra on the Euphrates axis.

Relying on this combined evidence, the essays in the first three sections of the book concur in depicting and analyzing the dynamics of local, regional, and interregional trade and that of the artisanal or manufactured products which were exchanged. The last section is devoted to the practical functioning and environment of the Byzantine marketplace.

Marketplace and Shops

The final chapters in this volume consider regulation and control of measures, weights, and payments—an essential institutional condition of the functioning of market exchange generally,[40] and specifically an important foundation of the Byzantine economy[41]—together with indirect taxes from the fifth to the fifteenth century. The unified system inherited from Rome, which was of great benefit in supporting market exchanges and lowering transaction costs, never disappeared even when Byzantium had to agree, from the twelfth century onward, that the privileged Italian merchant communities could use their own measures in their colonies.[42] Brigitte Pitarakis provides a material perspective on this legal and documentary survey by bringing together representations in various media of everyday transactions and installations and the widely attested archaeological remains of measuring and weighing instruments.

Markets as physical spaces have received scarcely any attention, except in the recent studies by Luke Lavan.[43] He offers here an in-depth and innovative study of archaeological evidence for shops and markets in late antiquity, combined with many references to the abundant literary sources. He presents an almost exhaustive survey of present knowledge of material environment for transactions, including market stalls (tables) revealed by slits cut in front of porticoes; wooden tables revealed by postholes and *topos* inscriptions; cellular shops, often grouped according to their trade and equipped with shelves for the display of goods, counters, and, in the case of taverns, benches or couches for customers; and specialized market buildings, whether tetragonal agorai and *macella* or sigma shopping plazas. In addition, he proposes a new interpretation of the legal texts (especially *CTh* 15) that have long been taken as a proof of the encroachment of streets and the transformation of the late antique city into a *medina*. The overall picture clearly supports his main argument that the "commercialization" of city centers was a sign not of urban decay but of a conscious evolution toward a new monumentality, accepted and even fostered by urban elites in the sixth century. This new urban environment obviously matched the active exchanges inferred elsewhere in the book from other sources.

The subject of shops and markets is also considered by Alan Walmsley in the last section of his chapter, which partly overlaps with Lavan's observations and complements them: in Byzantine and early Islamic Syria and Palestine, excavations of many secondary urban centers and even big villages (Ruṣāfa, Palmyra, Pella, Jarash, Skythopolis, Arsūf, Umm al-Raṣāṣ, Subaytah/Shivta) provide evidence from the sixth through the eighth century for market streets and agglomerated courtyard units, often located near the church or the mosque. The continuity, renovation, and even new construction of these facilities offer yet more proof of the vigorous functioning of local exchange.

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Though it may be bold to generalize, we may draw some conclusions about points of agreement between the contributors: a widely shared focus on

40 World Bank, *World Development Report 2002: Building Institutions for Markets* (New York, 2002), available at http://go.worldbank.org/YGBBFHL1Y0 (accessed August 2010).

41 On the importance of legal and social institutions and intangible resources for economic stability and growth in Byzantium, see A. E. Laiou and C. Morrisson, *The Byzantine Economy* (Cambridge, 2007), 17–22.

42 Morrisson, "Weighing, Measuring, Paying," 392–93.

43 L. Lavan, "Fora and Agorai in Mediterranean Cities: Fourth and Fifth Centuries A.D.," in *Social and Political Life in Late Antiquity,* ed. W. Bowden, C. Machado, and A. Gutteridge, Late Antique Archaeology 3.1 (Leiden, 2006), 195–249; T. Putzeys and L. Lavan, "Commercial Space in Late Antiquity," in *Objects in Context, Objects in Use: Material Spatiality in Late Antiquity,* ed. L. Lavan, E. Swift, and T. Putzeys, Late Antique Archaeology 5 (Leiden, 2007), 81–109.

geographical and ecological constraints to explain the formation and limitations of regional or local markets supplying an urban center, as well as close attention to the division of labor conducive to interregional exchanges. Relying on such analysis, many essays explore the correlation between trade and urbanization, an element most typically at work in the expansion of long-distance and interregional trade in the Adriatic and the Aegean beginning in the twelfth century or even earlier, since larger cities such as Venice or Constantinople could no longer rely on their medium-range hinterland to feed their inhabitants. Whereas the growth of urban centers was both a cause and a precondition for the emergence of interregional networks, the development of rural centers (e.g., in Boeotia) entailed the expansion of regional and local networks as analyzed by Laiou and Papanikola-Bakirtzi and in other studies. When examined over the course of centuries, most regions displayed common trends, though the mid-Byzantine decline did not occur at the same date everywhere, and the subsequent recovery started in some places as early as the late eighth or early ninth century, at others only in the late tenth century.

The most striking commonality is a new vision of the so-called dark age (the long eighth century, broadly speaking). It is true that increased localization and decreased quality of production in this period cannot be doubted, as exemplified inter alia by the restricted diffusion of Sagalassos local semifine and coarse kitchen wares; but contributors with different emphases and approaches converged in insisting on the continuity of general settlement and economic activity in Asia Minor. They also concurred in describing the resilience of some coastal areas or islands, like Cyprus, due to the survival of long-distance trade. However limited, these long-distance relations can be traced—for example, in the wide diffusion of Crimean transport amphorae as far as Butrint and in the new centers of trade in northern Italian sites like Comacchio. Resilience also characterized certain areas of inland Anatolia, where the decline of long-distance trade, the plague, and other factors had less effect and where the presence of the army stimulated agricultural and artisanal production aimed at satisfying its needs.

At the same time, weight was given to the analysis of regional diversity and to the changing patterns of networks, such as the growing importance of the Black Sea north–south route between Amastris, Paphlagonia, and Cherson; the shift of the Adriatic trade from a north–south to a west–east emphasis; the reorientation of Halmyros trade from its earlier destination, Thessalonike, to its western hinterland; and so on. Better knowledge of common wares or new approaches to documentary analysis enabled several contributors to look for the structure of local or regional networks, stressing the role of secondary distribution centers[44] or differentiating between regular and occasional markets.[45] New aspects or contexts of exchanges were brought to light for the first time, such as informal markets on the beachside and retail sales on board the tramp ships themselves, probably aimed at dodging imperial taxes.

Not all topics or aspects could be addressed, and regional trade in the late Byzantine period, for which contemporaneous documents can certainly yield more information than has already been retrieved,[46] was not thoroughly treated. Few attempts at quantification were made, despite their necessity for valid economic analysis (admittedly, their dependence on ancient and medieval documents obviously limits the precision of such efforts). One of the possible approaches to the subject suggested here relies on a renewed survey of shipwrecks, a much greater number of which are known now (ca. 309 for the Mediterranean, AD 300 to 1500) than in 1992, when Anthony Parker published his pioneering book on the subject.[47] Michael McCormick is aware of the imperfection of this proxy measure of seaborne traffic, due to the influence of such other factors as decline in population and demand, difference in ship sizes and the cargoes transported, variations in the sinking rate caused by different knowledge and conditions of navigation, and the age of the vessel.[48] Yet all these biases can be taken

44 Walmsley, "Regional Exchange and the Role of the Shop," below, 315, and Dorin, "Adriatic Trade Networks," below, 271, etc.

45 A. Bingelli, "Annual Fairs, Regional Networks, and Trade Routes in Bilād al-Shām (Sixth–Tenth Centuries)."

46 E.g., by K.-P. Matschke, "Commerce, Trade, Markets and Money: Thirteenth–Fifteenth Centuries," in *EHB* 2:771–806, who deals with "regional economic zones" at 782–89.

47 A. J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*, BAR International Series 580 (Oxford, 1992).

48 McCormick, "Movements and Markets in the First Millennium," 89–98. See also Wilson's review of Parker's data in "Approaches to Quantifying Roman Trade," 219–29, who likewise both emphasizes an increase in the use of barrels rather than amphorae as perhaps leading to the decline in the number of perceived shipwrecks in late antiquity from its peak in the second

into account to qualify the present picture—a lower number of datable wrecks from the ninth to the fifteenth century than from antiquity, though other sources point to considerable numbers of bigger ships in the late medieval Mediterranean. Another task will be to compare assemblages of pottery production or usage, following on the pioneering attempts to quantify the frequency of late Roman sherds of a defined form (ARS) over time.[49] Similarly, the already well-known comparisons of find patterns from late antique Mediterranean sites published by Michael Fulford and Clementina Panella[50] could be extended to the Byzantine period, when more progress has been made in identifying ceramics and publishing sites—provided that there is enough consistency in how finds are recorded, classified, and published that the necessary geodatabases can be built. A number of hurdles, both methodological and practical (notably, unequal distribution of information) are still in the way, but a consensus on what we know, at least qualitatively, and what we do not has been achieved, and several lines of research have been proposed.

From my standpoint as the editor and a historian, such are the main points that I encourage the reader of this book to bear in mind. A genuine economic perspective is offered in Peter Temin's assessment at the end of this book. The variety and complexity of the exchange networks analyzed by the essays in this volume, the ubiquity of coins or at least the role of money as measure of exchange, the persistence of local exchanges throughout the designated period, and the recovery of long-distance trade from its eighth-century nadir, which signals the return to economic prosperity in the eleventh and twelfth centuries—all characterize the Byzantine markets as free but regulated. It now remains to follow the paths that have been opened in the various chapters of this volume.

Cécile Morrisson, August 2010

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century AD and examines the influence of the size of ships on their sinking rate.

49 Wilson, "Approaches to Quantifying Roman Trade," 237–43.

50 M. G. Fulford, "To East and West: The Mediterranean Trade of Cyrenaica and Tripolitania in Antiquity," in *Libya: Research in Archaeology, Environment, History and Society, 1969–1989,* ed. D. J. Mattingly and J. A. Lloyd, Libyan Studies 20 (London, 1989), 169–91; C. Panella, "Gli scambi nel Mediterraneo Occidentale dal IV al VII secolo dal punto di vista di alcune 'merci,'" in *Hommes et richesses dans l'empire byzantin,* vol. 1, *IV^e–VII^e siècle,* Réalités byzantines 1 (Paris, 1989), 129–41; eadem, "Merci e scambi nel Mediterraneo tardoantico," in *Storia di Roma,* ed. A. Carandini, L. Cracco Ruggini, and A. Giardina, vol. 3.2, *L'età tardoantico: I luoghi e le culture* (Turin, 1993), 613–97.

• THREE •

Movements and Markets in the First Millennium

Information, Containers, and Shipwrecks

MICHAEL McCORMICK

In memory of Angeliki Laiou, friend and colleague

Markets concentrate wares, buyers, and sellers, a concentration that entails both mental disposition and physical movement. Evidence for mind-sets comes from the finite set of texts that have survived from Byzantium, but it is indirect and so far has attracted little attention. Direct evidence of movement has now reached a critical mass, particularly through study of its physical markers: the containers that packaged wares en route to markets and the ships that helped move them. Archaeologists' wonderful work invites us to think hard about what they have found—or not found—and how we can derive more economic insights from it. Better understanding of how ancient containers were used, new information on the competition of amphorae and barrels, and organizing our knowledge of ancient shipwrecks to foster spatial and temporal analysis suggest new questions and insights. They also turn up limitations to their testimony.

This chapter assesses these different types of evidence from about AD 300 to 1000, and ranges over the Roman and post-Roman world. It starts with ideas and moves to things, beginning with a basic conceptual matter before presenting indirect evidence for the mental disposition toward markets. It then considers ways to deepen the testimony of amphorae for economic history and the implications of late antique barrels for markets and transport systems. Finally, it presents a spatial database of the biggest and most expensive instrument of ancient exchange, ships. All this makes possible some first observations about what shipwrecks do, and do not, tell us about the movements that got goods to markets. Texts, images and material remains, mind-sets, and objects sometimes converge and sometimes conflict. In their discrepancies and convergence lie wisdom and sometimes historical truth. But first, a prior question.

What Is a Market?

"Market" means many things. In literature, ambiguity is rich. In history, it breeds confusion. Are we talking about a place, an institution, an event, a state of mind or type of behavior, or a type of economy, as in "market economy"? All of these we can fruitfully investigate.[1] But we need to be clear in each

1 The research for this study was conducted under the generous conditions of a Distinguished Achievement Award from the Andrew W. Mellon Foundation. Parts of an ancestor of this essay were presented at the symposium "Tradition and Transition" honoring George F. Bass and Frederick van Doorninck at Texas A&M University, and at the Penn Economic History Forum at the University of Pennsylvania. It benefited much from discussions there as well as from conversations at Dumbarton Oaks. Special thanks are due to an anonymous referee who subsequently revealed himself to be Professor van Doorninck. This essay is much the better for his generous and exceedingly well-informed observations, as I have gratefully acknowledged in various places below. Alexander More refined for publication the maps that I designed to illustrate this article, and has my thanks. I was especially gratified that the version of this essay given at Dumbarton Oaks brought pleasure to my friend and close colleague Angeliki Laiou. Neither of us dreamed that this would be the last time that we would work together on the history of the themes so dear to both of us.

See for instance the stimulating debate launched by P. Temin, "A Market Economy in the Early Roman Empire," *JRS* 91 (2001): 169–81, and the pithy comments of A. E. Laiou, "Market," *ODB*

case whether we are thinking of markets as physical places or as economic concepts and, if the latter, *which* economic concept. Are we thinking of markets as "collection[s] of homogeneous transactions" or of "selling opportunities," as "trading zone[s] free [or not] of artificial restrictions on transactions,"[2] or as legal institutions, such as the heavily policed markets in meat, silk, and so on that characterized Constantinople around 900, at least in the eyes of the imperial legislator responsible for the *Book of the Prefect*?[3]

What were markets like in Byzantium? This volume supplies important elements toward an answer for urban or rural, permanent, periodic or occasional markets. Its chapters suggest that we seek to classify Byzantine (and other medieval) markets by size (in terms of volume or value), as wholesale or retail, by spectrum of goods on offer, by place (seaside vs. inland), by position in a system of exchange, by the geographic scale of transactions, or by the degree of regulation or freedom that affected them. Byzantine black markets may have been more important than research to date would indicate. At least one might suspect that. For this society so aspired to regulate transactions that an emperor made a show of riding through markets to check on prices, if the story about the emperor Theophilos (829–42) reflects more than short-term shock at the steep price rise recorded around his time.[4]

Discerning structural patterns should not blind us to change. A complete history of Byzantine markets would clarify how their types and features changed over time, focusing on the markets themselves, their relative importance, their geographic density, and their integration (or lack thereof).[5] At the end of antiquity, the contraction of the capital's population surely connected somehow with the disruption in 618 of the state-subsidized grain shipments of the *annona*—a disruption itself caused mainly by the empire's military loss of Egypt and its merchant fleet.[6] So sweeping a development must have affected the universe of economic transactions at Constantinople, and their role in the Mediterranean economy. We have barely begun to wonder how. For instance, the long period from 400 to 1000 appears to have witnessed at least two major price shifts. What are we to make of the apparent plunge in the price of grain at some point in the seventh century? The price then seems to have jumped in the first half of the ninth, in the caliphate and in Byzantium.[7] How might such secular price change have correlated to the history of markets? Between the seventh and the twelfth century, attestation increases both of Constantinople's permanent market and of different kinds of fairs in the provinces. Even allowing for the growth in surviving evidence, one suspects that real expansion was occurring.[8] Local fairs for instance seem to have proliferated in the late tenth century. The provincial ones grew attractive enough to provoke conflict between merchants and landed aristocrats who wanted to move the markets to their estates.[9]

Insofar as markets were places with built features, archaeology is crucial.[10] Recent discoveries in north-

2:1301; eadem, "Exchange and Trade, Seventh–Twelfth Centuries," in *EHB* 2:697–770, esp. 709–10, 730–32, 754–56; and K.-P. Matschke, "Commerce, Trade, Markets, and Money: Thirteenth–Fifteenth Centuries," ibid., 2:771–806, esp. 776–82.

2 G. Bannock, E. Davis, and R. E. Baxter, *The Penguin Dictionary of Economics,* 7th ed. (London, 2003), 242–43.

3 Leo VI, *Book of the Prefect,* ed. J. Koder, *Das Eparchenbuch Leons des Weisen,* CFHB 33 (Vienna, 1991).

4 According to Theophanes Continuatus 3.3, ed. I. Bekker (Bonn, 1838), 87.16–23, according to which the emperor checked prices for food, drink, and clothing in particular. On the increase in grain prices, see note 7 below.

5 Along these lines, L. de Ligt, *Fairs and Markets in the Roman Empire: Economic and Social Aspects of Periodic Trade in a Pre-industrial Society*, Dutch Monographs on Ancient History and Archaeology 11 (Amsterdam, 1993), offers a valuable overview of market types and features in the earlier period. For the rich Talmudic evidence on markets in Roman and Byzantine Palestine, see B. T. Rozenfeld and J. Menirav, *Markets and Marketing in Roman Palestine,* Supplements to the Journal for the Study of Judaism 99 (Leiden, 2005).

6 M. McCormick, "Bateaux de vie, bateaux de mort: Maladie, commerce, transports annonaires et le passage économique du Bas-Empire au moyen âge," in *Morfologie sociali e culturali in Europa fra tarda antichità e alto medioevo,* 2 vols., Settimane di studi del Centro italiano di studi sull'alto medioevo 45 (Spoleto, 1998), 1:35–122, at 115; for a recent discussion of the crisis in the grain market at Constantinople and evidence for measures that the government may have taken to address it, see V. Prigent, "Le rôle des provinces d'Occident dans l'approvisionnement de Constantinople (618–717): Témoignages numismatique et sigillographique," *Mélanges de l'École française de Rome: Moyen âge* 118 (2006): 269–99.

7 E. Ashtor, *Histoire des prix et des salaires dans l'Orient médiéval,* Monnaie, prix, conjoncture 8 (Paris, 1969), 453–59; C. Morrisson and J.-C. Cheynet, "Prices and Wages in the Byzantine World," in *EHB* 2:815–78, esp. 830.

8 Laiou, "Exchange and Trade," e.g., 754.

9 Ibid., 731.

10 Two important excavations: J. S. Crawford, *The Byzantine Shops at Sardis,* Archaeological Exploration of Sardis 9 (Cambridge, Mass., 1990), and Y. Tsafrir and G. Foerster, "Urbanism at Scythopolis–Bet Shean in the Fourth to Seventh Centuries,"

western Europe suggest that archaeologists would also do well to watch for the subtle signals of impermanent, occasional, or periodic markets in the Mediterranean.[11] Written evidence proves that ephemeral markets were part of the Mediterranean scene. In 447, a western emperor complained that merchants were abandoning the cities' sanctioned markets and conducting "stealthy business" (*furtiva negotiatio*) in settlements and ports, in informal marketplaces, to the detriment of the imperial treasury.[12] A fifth- or sixth-century African preacher probably reached into his flock's daily experience when he evoked just such an informal market, of all things, in a metaphor expressing the mystery of Christ's resurrection: "O how lovely the beach looks when it's filled with merchandise and it bustles with businessmen! Bundles of different clothing are pulled from the ships, countless people delight at the sailors' cheerful singing, and the rich man dances in the sand!"[13] Beachside markets and the imperial *novella* underscore the diversity of sites that witnessed what we might call "market events." An element of ship's gear, the steelyard scale, also points in the same direction.[14]

Constantinople itself looms as the "supermarket." That is natural but limiting. We tend to think chiefly of the receiving end of Mediterranean transport networks when we think of markets. Yet there must have been "a collection of homogeneous transactions" at those networks' points of departure as well. The farmers whose oil, grain, wine, or animals were carried or driven toward the consumer markets will have been paid for their wares long before the wine was unloaded in Constantinople or Anatolia's pigs reached Pylai (modern Yalova) to be ferried across the Sea of Marmara to the capital.[15] We do not know yet what these markets were like—whether "market" here is shorthand for the transactions of itinerant merchants buying up goods in the country and transporting them down to the sea, or for producers themselves delivering them to the seaside markets, or for something else.

A chance reference in a late antique life of a bishop of the great wine-exporting area of Gaza calls attention to port markets. The implication is that Egyptian merchants congregated on the coast—not further inland—to purchase the region's prized wine. The further implication would be that the transactions that brought the wine from inland to the coast lay in other hands.[16] The coastal traders

DOP 51 (1997): 85–146, at 114, 122–23, and, for the Umayyad market, 138–40; see also on the latter and on other contemporary market buildings A. Walmsley, *Early Islamic Syria: An Archaeological Assessment* (London, 2007), 87–97; idem, "Regional Exchange and the Role of the Shop in Byzantine and Early Islamic Syria-Palestine: An Archaeological View"; and L. Lavan, "From *polis* to *emporion*? Retail and Regulation in the Late Antique City" (both in this volume).

11 For instance, dense patterns of coin finds in a particular field, especially cut coins, have been taken to mark impermanent markets: J. Newman, "A Possible Medieval Fair Site at the Albany, Ipswich," *British Numismatic Journal* 64 (1994): 129. For further archaeological traces of a possible Iron Age beachside market in the North Sea, see M. Segschneider, "Trade and Centrality between the Rhine and the Limfjord around 500 AD: The Beachmarket on the Northfrisian Island Amrum and Its Context," in *Central Places in the Migration and Merovingian Periods: Papers from the 52nd Sachsensymposium Lund, August 2001,* Acta Archaeologica Lundensia, series in 8°, 39 (Lund, 2002), 247–56, as well as the studies published in T. Pestell and K. Ulmschneider, eds., *Markets in Early Medieval Europe: Trading and "Productive" Sites, 650–850* (Macclesfield, 2003). The early medieval emporiums of Ribe in Denmark and Kaupang in Norway may have begun as seasonally occupied seaside sites. For instance, at Kaupang, micromorphology showed an ultra-fine stratification of sand layers that seem to have been wind transported, and that separated the first seven charcoal-rich deposits identified as short occupation layers: K. B. Milek and C. A. I. French, "Soils and Sediments in the Settlement and Harbour at Kaupang," in *Kaupang in Skiringssal,* ed. D. Skre ([Oslo], 2007), 321–60, at 328–31.

12 Valentinian III, *Novella* 24 (25 April 447), *CTh* 2, 117–18.

13 Pseudo-Fulgentius of Ruspe, *Sermo 38,* PL 65:901–2; on that text, see E. Dekkers, *Clavis patrum latinorum,* 3rd ed., CCSL (Steenbrugge, 1995), no. 844; cf. M. McCormick, *Origins of the European Economy: Communications and Commerce, A.D. 300–900* (Cambridge, 2001), 84.

14 See below, 87–89, on weighing scales aboard shipwrecks.

15 On pigs at Pylai: Leo of Synada, *Ep.* 54; in *The Correspondence of Leo, Metropolitan of Synada and Syncellus,* ed., trans., and comm. M. P. Vinson, CFHB 23 (Washington, D.C., 1985), 86.26–36; on Pylai as the terminus of a major westward route from Anatolia, C. Foss, *ODB* 3:1760.

16 Mark the Deacon, *Life of Porphyrius of Gaza* (*BHG* 1570), 58, ed. H. Grégoire and M. A. Kugener, *Marc le diacre: Vie de Porphyre évêque de Gaza* (Paris, 1930), 47.6–7. Although the date and reliability of the text for the saint's biography remain controverted, it is generally thought to have been reworked in the sixth century and, in this detail, surely reflects conditions of that period at the latest: see K. H. Uthemann, "Porphyrius, Bischof von Gaza," *Biographisch-Bibliographisches Kirchenlexikon* (online), www.bautz.de/bbkl/p/porphyrius_b_v_g.shtml, accessed July 2010. The biographer naturally distinguishes clearly between Egyptians and Gazans. In this era, Gaza was in Palestine but on the border of Egypt, as the author himself notes: *Life of Porphyrius* 4, 4.1–2. For one of those other hands, see note 103, below. *Mutatis mutandis,* the ostraca of AD 373 offer a glimpse of how another export ware, African oil, was concentrated at a central warehouse in the port of Carthage before shipment, presumably to Rome, as part of the fiscal supply of the annona: J. T. Peña, "The Mobilization of State

probably did not limit wine exports to their home ports, although well-to-do Egyptians certainly savored Gaza's flowery and pricey white wine.[17] Alexandria's skippers dominated the shipping routes leading to Constantinople, and as antiquity ended they came to be ascendant in all Mediterranean shipping.[18] This dominance makes it likely that the Egyptian merchants who sailed to Gaza to buy wine also exported it far and wide. Although the growth of the Gazan wine industry has been ascribed to increasing local population, the scale of viticulture and of amphora exports across the entire Mediterranean proves that far more than local demand fired the engines of Gazan production.[19] In particular, the Egyptians likely carried this wine to the capital even if the fourth-century archaeological attestation for that trade is still lacking there.[20] Constantinople's stupendous growth parallels that of the Gazan wine industry, and its appetite for wine has left clear tracks in the administrative record—for instance, in the fee schedule of cargo inspectors at Abydos, a key customs station on the way to the capital.[21] But before we look at the containers that traveled and today mark these supply networks and their markets, what new insights can we coax from the well-mined written record?

Modes of Economic Behavior and Markets

Research has identified considerable explicit written evidence on markets.[22] Not much more remains to be found for Byzantine markets before the year 1000. Expanding the net to capture indirect evidence, however, draws in more precious witnesses who, like the

Olive Oil in Roman Africa: The Evidence of Late Fourth Century Ostraca from Carthage," in *Carthage Papers*, ed. J. T. Peña, A. I. Wilson, C. Wells, et al., Journal of Roman Archaeology supp. ser. 28 (Portsmouth, R.I., 1998), 116–238.

17 As both surviving amphorae and an eyewitness make clear. For Gaza wine amphorae in Egypt (i.e., "Late Roman Amphora 4"), see D. Pieri, *Le commerce du vin oriental à l'époque byzantine, V^e–VII^e siècles: Le témoignage des amphores en Gaule,* Bibliothèque archéologique et historique 174 (Beirut, 2005), 198–99; in the early seventh century, Patriarch John the Almsgiver decided to save money by shifting from Palestinian to local Egyptian wine, and the fine wine's taste is described: *Life of John the Almsgiver* (*BHG* 887v), 10, ed. H. Delehaye, "Une vie inédite de saint Jean Aumônier," *AB* 45 (1927): 5–73, here 24.6–14, a text that epitomized no later than the tenth century the precious lost biography by John's associates John Moschus and Sophronius of Jerusalem. For the color, see Corippus, *In laudem Iustini Augusti minoris* 3.98–99, ed. S. Antès, *Corippe (Flavius Cresconius Corippus) Éloge de l'empereur Justin II* (Paris, 1981), 56.

18 See, for instance, the eyewitness report of how Alexandrian shippers of the Egyptian fiscal grain were convoked in the palace by the emperor Justin II (565–578) to debate monophysitism: John of Ephesos, *Historia ecclesiastica,* fragment H, trans. W. J. Van Douwen and J. P. N. Land, "Joannis episcopi Ephesi Syri monophysitae Commentarii de beatis orientalibus et Historiae ecclesiasticae fragmenta," *Verhandelingen der koninklijke Akademie van wetenschappen*, Afdeeling Letterkunde 18 (Amsterdam, 1889), 249.1–27 and the discussion in McCormick, "Bateaux de vie, bateaux de mort," 93–107.

19 P. Mayerson, "The Wine and Vineyards of Gaza in the Byzantine Period," *BASOR* 257 (1985): 75–80, at 75, seems to attribute the expanding Gazan wine industry to local growth, although he is aware of foreign merchants' presence. For Gaza amphorae documented across the entire Mediterranean, see Pieri, *Le commerce du vin oriental*, 197–200.

20 P. Reynolds, "Levantine Amphorae from Cilicia to Gaza: A Typology and Analysis of the Regional Production Trends from the 1st to 7th Centuries," in *LRCW 1: Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry,* ed. J. M. Gurt Esparraguera, J. Buxeda i Garrigós, and M. A. Cau Ontiveros, BAR International Series 1340 (Oxford, 2005), 563–611, at 576.

21 It is surely not a coincidence that in this fifth-century inscription, the fees for "all wine freighters (οἰνηγοί) which are carrying wine to the Imperial City" come at the top of the list and are the highest, at "six folles and two pints (*xestai*) [of wine]": J. Durliat and A. Guillou, "Le tarif d'Abydos (vers 492)," *Bulletin de correspondance hellénique* 108 (1984): 581–98, at 583.22–23; cf. G. Dagron and D. Feissel, "Inscriptions inédites du musée d'Antioche," *TM* 9 (1985): 433–55, at 452–55. For the rampant growth of Constantinople, see G. Dagron, *Naissance d'une capitale: Constantinople et ses institutions de 330 à 451,* Bibliothèque byzantine, Études 7 (Paris, 1974), 518–41. Recent archaeology has only strengthened the picture drawn by Dagron: for example, the work of James Crow and his team in surveying the most extraordinary water supply system of the ancient world, which totaled some 400 km in water channels and which kept pace with the demographic growth of the city: see "The Water Supply of Constantinople" at "The Archaeology of Constantinople and Its Hinterland," http://longwalls.ncl.ac.uk/WaterSupply.htm, accessed July 2010.

22 From a rich and growing bibliography see: de Ligt, *Fairs and Markets in the Roman Empire;* É. Patlagean, "Byzance et les marchés du grand commerce vers 830–vers 1030: Entre Pirenne et Polanyi," in *Mercati e mercanti nell'alto medioevo: L'area Euroasiatica e l'area Mediterranea,* Settimane di studi del Centro italiano di studi sull'alto medioevo 40 (Spoleto, 1993), 587–629; N. Oikonomides, "Le marchand byzantin des provinces (IX^e–XI^e s.)," ibid., 633–60; idem, "The Economic Region of Constantinople: From Directed Economy to Free Economy and the Role of the Italians," in *Europa medievale e mondo bizantino: Contatti effettivi e possibilità di studi comparati,* ed. G. Arnaldi and G. Cavallo, Nuovi studi storici 40 (Rome, 1997), 221–38; A. A. Settia, "*Per foros Italie:* Le aree extraurbane fra Alpi e Appennini," in *Mercati e mercanti nell'alto medioevo,* 187–233; O. Bruand, *Voyageurs et marchandises aux temps carolingiens: Les réseaux de communication entre Loire et Meuse aux VIII^e et IX^e siècles* (Brussels, 2002); McCormick, *Origins of the European Economy,* 618–69, as well as the works cited in note 1, above.

African preacher, did not mean to treat the economy as their main subject.[23] Our research strategy needs to reach beyond explicit attestations of markets to encompass implicit allusions to market-conditioned economic behavior, including contemporary interest in information typical of markets, such as price levels. That strategy is important even for the late Roman period, when tax-powered exchange of fiscal grain and goods in kind coexisted with market exchange.

Pretechnological societies had access to much less economic information than we do. Moreover, the cultural blinders through which ancient literary norms filtered reality mean that the relatively well-preserved literary sources shed only intermittent light on markets and economic information relevant to them. Some direct insight does come thanks to the special survival conditions of the Egyptian papyri, which preserve documents actually written by merchants.[24] After antiquity, testimony from the trader's mouth dwindles until we reach the trove of Jewish merchants' letters from the Old Cairo Genizah. Preserved arbitrarily for reasons unrelated to commerce, those letters begin in the eleventh century to illuminate the great "Mediterranean Community" of traders.[25] A wealth of market- and price-related news demonstrates the sensitivity of their writers and readers to the value of economic information and, therefore, underscores the *importance* of the market.

Both the late ancient and later medieval merchants' letters illustrate what Peter Temin has called "modes of economic behavior," which he has categorized into three main types. In the "instrumental" mode of behavior, individuals act to maximize the results of their economic activity, characteristically by means of market exchanges. In the "customary" or traditional mode, people try to do what they have always done, reciprocity characterizes their economic interaction, and change occurs without their realizing it. Finally, the "command mode" is essentially hierarchical. Here actions result from orders given or received, in a dynamic that constitutes the typical form of interaction; change stems from the decisions of identifiable individuals. In a pure form, of course, none of these beasts exists in nature. Any economy consists of varying doses of different behaviors that help shape its overall character and patterns of exchange. Of particular interest here is that recurrent concern with economic information and ascertaining (not fixing) prices points to a behavioral mode which aims to maximize profit and signals that markets will dominate such concerned individuals' economic interaction.

For instance, around 350 an Egyptian businessman wrote from his store and sent cash to a colleague, whom he asked to purchase a series of goods for him, since the local prices, which he listed, were high.[26] In the same Nile Valley, seven centuries later, we are on similar ground. A note from eleventh-century Alexandria signals the impending arrival in Cairo of *Rūm*—either Italian or Byzantine—merchants, hunting for the spices that have vanished from the port city's markets, while other letters report prices spiking under the pressure of northern merchant demand or announce to Indian Ocean correspondents at Aden that sales were slowing in the Mediterranean markets: all appear to be typical cases of the eleventh- and twelfth-century flow of commercial information.[27] When the Roman or Cairo letters report prices, changing supply, and foreign merchants buying up specific goods, they clearly imply an instrumental mode of behavior, and underscore the crucial role of markets in their economies.

Was such economic information valued in the intervening centuries? Faced with a near total absence of merchant testimony, we cannot attach

23 A. P. Kazhdan and G. Constable, *People and Power in Byzantium: An Introduction to Modern Byzantine Studies* (Washington, D.C., 1982), 164–78.

24 See note 26, below. On the subtle patterns of preservation of papyrus records, see R. Bagnall, "Models and Evidence in the Study of Religion in Late Roman Egypt," in *From Temple to Church: Destruction and Renewal of Local Cultic Topography in Late Antiquity,* ed. J. Hahn, S. Emmel, and U. Gotter (Leiden, 2008), 23–41, at 34.

25 Beyond S. D. Goitein, *A Mediterranean Society: The Jewish Communities of the Arab World as Portrayed in the Documents of the Cairo Geniza,* 6 vols. (Berkeley, 1967–93), on the Genizah letters' evidence on Byzantine trade and markets connecting to the Muslim world see D. Jacoby, "What Do We Learn about Byzantine Asia Minor from the Documents of the Cairo Genizah?" in *Η βυζαντινή Μικρά Ασία: 6.–12. αι.,* ed. S. Lampakēs (Athens, 1998), 83–95; idem, "Byzantine Trade with Egypt from the Mid-tenth Century to the Fourth Crusade," *Thesaurismata* 30 (2000): 25–77; and K. S. Durak, "Commerce and Networks of Exchange between the Byzantine Empire and the Islamic Near East from the Early Ninth Century to the Arrival of the Crusaders" (Ph.D. diss., Harvard University, 2008).

26 *P. Oxy.* 34:2729, as published and discussed in J.-M. Carrié, "Papyrologica numismatica (1)," *Aegyptus* 64 (1984): 203–27.

27 For these examples, see Goitein, *A Mediterranean Society,* 1:44–45.

much significance to such a silence. But are there signals, direct or indirect, that economic information was valued, and that news about markets did flow but has passed nearly undocumented? Let us start with late Rome as our point of departure. Its sophisticated trading economy supplied the mental categories and conceptual apparatus inherited by Byzantium and the early medieval West. They thus help interpret the later evidence.[28]

Occasionally writings other than letters document the demand for economic information. Around 350, the Greek treatise known from its Latin translation as *Expositio totius mundi* offers what have generally been valuable insights into trade in various regions of the empire, whoever the author might have been, and whatever his objectives.[29] As we have him, it is true that the author rarely discusses price levels directly when describing the wares, women, and worship of different Mediterranean cities. Often the *Expositio* simply mentions that a place abounds in everything ("abundans omnibus," etc.).[30] Frequently it specifies what a town or region exports, and sometimes it notes wares that are particularly abundant. For example, the author touts the textiles of Skythopolis, Laodikeia, Byblos, Tyre, and Beirut; Alexandria's spices; the cheese, lumber, and iron of Dalmatia; and Sicily's wool, wheat, and draft animals.[31] Their very frequency surely indicates that such statements were reckoned economically useful information for the readers. They also reveal price awareness.

Though the surviving text directly addresses prices only once, that passage confirms that in the author's mind, the abundance he so frequently mentions correlates with low prices. Because an emperor was there, Gaul enjoys an abundance of everything. But (*sed*), he adds, everything comes at a high price. The contradiction between abundant supply and high prices implied by the adversative "but" signals unambiguously the author's understanding that abundant supply normally entailed lower prices.[32] We may speculate that prices in Gaul rose to meet the demand fueled by the hefty salaries of the numerous army and palatine officials who attended the emperor, salaries whose traces can still be seen in the piles of surviving coins issued by Gaul's capital.[33] Detritus of the long-distance supply that filled that demand subsists in Trier's Roman garbage, all the way down to the oysters dredged in the Mediterranean and carted north to the delicate palates stationed in the German frontier's hinterland. For the northern capital's market, Ausonius's poem on the comparative delights of exotic oysters was no literary mirage.[34]

28 The ideological assumptions of the ruling class are a distinct and important aspect of this question, that is, essentially one of economic mentality. See the complementary analysis of A. E. Laiou, "Economic Thought and Ideology," in *EHB* 3:1123–44.

29 To observe that this imperfectly transmitted work reflects the rhetorical genre of the praise of cities does not deny the author's attempts to describe, in addition to the beauty of the women and the festivals of different ports, what we would call patterns of supply and demand in the late Roman economy. That a commercial milieu might have pretensions to emulate in its own way one of the classic types of contemporary literary practice offers rather a wonderful testimony to the penetration of Hellenistic cultural values across a broad spectrum of the late Roman population. F. Jacques, "Les moulins d'Orcistus: Rhétorique et géographie au IV^{e} s.," in *Institutions, société et vie politique dans l'Empire romain au IV^{e} siècle ap. J.-C.,* ed. M. Christol, Collection de l'École française de Rome 159 (Rome, 1992), 431–46, among others, has suggested that the *Expositio* reflects ancient rhetorical categories of urban praise which lessen but do not entirely invalidate the authority of its economic information. See however the full discussion of K. Ruffing, "Ökonomie als Kategorie in der antiken deskriptiven Geographie: Berichtsweise und Eigenart der expositio totius mundi et gentium," *Münstersche Beiträge zur antiken Handelsgeschichte* 23.1 (2004): 88–130, with further references, as well as the example of Cilician wine exports in note 70, below.

30 E.g., *Expositio totius mundi et gentium* 26, ed. and trans. J. Rougé, SC 124 (Paris, 1966), 160.2, about Caesarea (Maritima); 29, 162.2–3, Askalon and Gaza; 34, 170.2, Alexandria; 51, 186.2, Macedonia, etc. It might be worthwhile to investigate whether any conclusions can be drawn from the absence of this assertion.

31 *Expositio totius mundi* 31, 164.6; 35, 170.5–6: "Omnes autem species aut aromatibus aut aliquibus negotiis barbaricis in ea abundant"; 53, 190.7–9: "Caseum itaque dalmatenum et tigna tectis utilia, similiter et ferrum, tres species cum sint utilia abundans emittit"; 65, 208.4–5, respectively.

32 *Expositio totius mundi* 58, 196.3–4: "Sed propter maioris [i.e., the emperor's] praesentiam, omnia in multitudine abundat, sed plurimi pretii."

33 For the predominance of Trier's mint, see C. H. V. Sutherland, *The Roman Imperial Coinage,* vol. 6, *From Diocletian's Reform (A.D. 294) to the Death of Maximinus (A.D. 313)* (London, 1973), 141–62; J. P. C. Kent, *The Roman Imperial Coinage,* vol. 8, *The Family of Constantine I: A.D. 337–364* (London, 1981), 125–38, etc. Cf. C.-F. Zschucke, *Die römische Münzstätte Trier: Von der Münzreform der Bronzeprägung unter Constans und Constantius II 346/348 n. Chr. bis zu ihrer Schliessung im 5. Jahrhundert,* 3rd ed., Kleine numismatische Reihe der Trierer Münzfreunde 5 ([Trier], 1997), 8–14.

34 For the oysters discovered in a dark earth layer that is dated by coins after 327, see H. G. Attendorn, H. Merten, F. Strauch, et al., "Römische Austernfunde aus den Grabungen in der Pauluskapelle des Domkreuzganges in Trier," *Trierer Zeitschrift* 59 (1996): 89–118; Ausonius, *Opera* 27.3, ed. R. P. H. Green, *The Works of Ausonius* (Oxford, 1991), 194–95.

So the *Expositio* shows us real interest in supply or, as the author and his contemporaries were more inclined to phrase it, in "abundance," as well as in price movements. We need therefore to watch for references to the "abundance" of wares, just as we should be alert to their "dearth," which is how ancient and medieval people tended to think of what we generally call "demand." Criticism that terms such as "supply" and "demand" are anachronistic is a red herring. Just because a term or concept did not exist in antiquity in no way precludes our exploring whether an analogous reality may have existed then. Otherwise, we would have no truck with possible viral or bacteriological infections, as have been proposed for the Antonine and Justinianic pandemics; it would be illegitimate to consider even the questions of ancient demography and medieval rural technology or, indeed, propaganda or power symbolism, none of which corresponds clearly to ancient concepts.

The *Expositio*'s emphasis on "abundance" and "dearth" in different towns suggests that contemporaries expected late antique merchants to be alert to shifting circumstances. A Syrian preacher confirms that around 400, people thought merchants were on the lookout for economic news, and adjusted their behavior accordingly. He drove home a purely spiritual message by comparing the good Christian to a good merchant. The simile implies a sharp eye for economic information: "Like the merchant who conducts his trade and knows how to make a profit in his business not just by one route or in one manner, but who watches carefully all about him, with quick wit (ἐντρεχῶς) and alertly: if he should fail to make a profit, he turns to another deal—for his whole purpose is to make money and grow his business[.]"[35] This is clearly instrumental behavior in Temin's sense, and implies that the audience understood economic behavior in terms of profit, risk (i.e., failing to make a profit), and markets.

That the preacher's listeners spontaneously grasped the value attached to economic information makes sense if markets played an important role in the sophisticated late Roman trading world. A miracle story shows that, from their suburban villas, even families connected to the civil service kept an eye on market prices. It also fills in a few details about wine, a key market ware, and the vintner's perspective on its production and sale. Around 420, Donatus produced a commercial crop of high-quality wine in his villa near Uzalis (modern Tunisia), and stored it in his cellar's (*apotheca*) two hundred containers (*vasa*). He awaited the moment when the price would peak before offering it for sale.[36] When that time came, Donatus went to each container to check the quality of the wine, accompanied by one of his men who was an expert wine taster. To their horror, the wine had turned very dark (*teterrimus color,* a hint that the wine of Uzalis was usually white?) and tasted awful. Each container was the same: the wine was too bad even for vinegar. What was he to do, facing loss worse than if the grapes had been destroyed on the vine (presumably because of the additional costs incurred in harvesting, pressing, and storing them)? Sell it for a song? Or just pour it out? Fortunately, Donatus's investment was saved by the relics of St. Stephen, newly arrived in Africa from Jerusalem. Exposing the wine to the relics restored its color and taste overnight, and the happy Donatus was able to sell an excellent product at a good price.[37] The

35 Pseudo-Macarius/Symeon, *Sermo* 29.2.1, in *Sermones 64,* ed. H. Berthold, *Makarios/Symeon Reden und Briefe,* GCS (Berlin, 1973), 262.25–263.6: Ὥσπερ γὰρ ὁ ἔμπορος τὴν ἐμπορίαν αὐτοῦ πραγματευόμενος οὐ διὰ μιᾶς ὁδοῦ οὐδὲ διὰ μιᾶς προφάσεως οἶδε πορίζειν τὸ κέρδος τῆς ἐμπορίας αὐτοῦ, ἀλλ' ἐντρεχῶς καὶ νηφόντως πανταχόθεν περισκοπεῖ, ἐὰν τύχῃ αὐτὸν ἐντεῦθεν ἀποτυγχάνειν τοῦ κέρδους, ἑτέρῳ πράγματι ἐπιβάλλεται—ὅλος γὰρ ὁ σκοπὸς αὐτῷ ἐστι τοῦ κερδῆσαι καὶ πολυπλασιάσαι τὴν ἐμπορίαν αὐτοῦ—, οὕτω καὶ ἡμεῖς τὴν εὐχὴν τῆς προσδοκίας ἡμῶν . . . καταρτίσωμεν . . .". On Macarius/Symeon, see B. Baldwin and A. M. Talbot, *ODB* 2:1270.

36 The fact that Donatus stored the wine shows that he was producing for the higher-priced market for aged wines: A. Tchernia, *Le vin de l'Italie romaine: Essai d'histoire économique d'après les amphores,* Bibliothèque des Écoles françaises d'Athènes et de Rome 261 (Rome, 1986), 28–32.

37 *Miracula S. Stephani facta Uzali* (*BHL* 7860–61) 2.3, PL 41:849–50: "Hic in fundo suo suburbano cum loco et nomine vocitato probi generis vina quotannis condere et conservare consueverat. Interea, ut possessoribus mos est, commodorum quaestuum causa, quoslibet terrae repositos fructus tunc malle venales emptoribus publicare, cum votis exoptatorum lucrorum avariora concurrunt pretia temporum, visum est memorato domino praedii, cum quodam homine suo, vini scilicet gustatore peritissimo, apothecam suam primitus intrare, ac per singula vasa examinando vina approbare . . . " and "inspiciuntur denuo cuncta per ordinem vasa: vinum hauritur, nitor in colore conspicitur, sapor in gustu approbatur, tristitia in gaudium commutatur, et quid quantumque fides in Christo ejusque gloriosissimo Amico valeat reperitur, cunctisque audientibus mirantibusque succeditur: denique illa probatissima vina condigno pretio emptoribus distribuuntur. Ecce qualiter divina providentia utilitatibus hominum deservit . . .". The Miracles do not specify that the buyers of the wine are merchants, although this is certainly possible with *emptores*.

story leaves no doubt that this father of an imperial bureaucrat assumed the workings of the market in late Roman Uzalis, for he calculated his sales on the basis of expert information on quality and on changing prices.

The value attached to commercial information recurs on the other side of the economic upheavals that ended antiquity, in the ninth century. In the less developed economy of the early medieval West, the sources run richer than in contemporary Byzantium. An emphasis on places in which particular wares could be had in abundance shows up in a Scandinavian trader's story, written down around 900 at the instruction of King Alfred of Wessex.[38] Another traveler reports the abundance in Estland, along the Baltic coast, of "very much honey and fishing," as well as the tragic fact that the locals had no ale. He also mentions ship ropes, which would have been valuable within Scandinavia.[39] Furs and the honey he describes are well known as long-distance trade goods originating in the north and shipped into and beyond the Mediterranean.[40] And the news of no ale in the north looks like a tip for traders operating within that Northern Arc whose commerce was just then linking with Constantinople and the caliphate, as we can see from Byzantium's treaties with the Rus and the recent archaeology of Sweden's ninth-century trading town of Birka.[41] In any case, the interest of Alfred the Great's court in writing up the geographic and economic information conveyed by the two travelers accords well with the Anglo-Saxons' general interest in trade, which, at least among the literate elite, appears comparatively greater than among their contemporary Frankish peers.[42]

Those who aspired to govern the polyglot Frankish empire found even basic economic information hard to come by, as a command issued by Louis the Pious (814–40) seems to indicate. When the Carolingian emperor tightened royal control over the striking of coins, he specified that certain counts were to seek information, apparently about coinage and counterfeiting, either from other counts or from merchants traveling hither and thither. Louis assumed that merchants possessed special economic information, in this case about monetary conditions in other towns.[43]

Western sources also echo economic information from the Mediterranean. For example, a neurotic French count was famously troubled by Venetian traders' price information about a distant market. Around 880, merchants swarmed around his pilgrim caravan when it camped in a meadow outside of Pavia en route home to Frankland from Rome—another ephemeral "market event." Curious, the count asked the merchants if "I got a good deal" (*utrum bene negotiatus sum*) on the expensive textile he had bought in Rome. The Venetians asked how much he had paid. It was indeed a good deal, they told him: it would have cost more in Constantinople. The future holy man was horrified that he had unwittingly "cheated" the merchant in Rome. He promptly sent the difference in price back to the Roman dealer, a gesture that, clearly, the narrator reckoned pretty much a miracle when he told

However, the use of *distribuo* for the sale reinforces the idea that Donatus was selling to multiple parties, and perhaps even at retail.

38 Ohthere reported that the wealth of his fellows in Norway stemmed from tribute paid to them by the far northern tribes of "Finnas" (i.e., Sami), and he specifies the goods that he and others like him acquired in this way: marten, reindeer, and bear pelts; bird feathers; ship ropes from whale; and seal hide. Earlier he had described acquiring valuable walrus tusks ("teeth"): Old English Orosius, 46, 45; *Ohthere's Voyages: A Late 9th-Century Account of Voyages along the Coasts of Norway and Denmark and Its Cultural Context*, ed. J. Bately and A. Englert, Maritime Culture of the North 1 (Roskilde, 2007), on which see also the valuable critical analysis of J. Bately, "Ohthere and Wulfstan in the Old English *Orosius*," ibid., 18–39.

39 Old English Orosius, 48.

40 McCormick, *Origins of the European Economy*, 730–32; to that evidence must now be added the zooarchaeological evidence for fur-processing that emerged from Björn Ambrosiani's excavation of Birka in the 1990s, in the same small zone as a house with clear eastern connections: see B. Wigh, *Animal Husbandry in the Viking Age Town of Birka and Its Hinterland,* Birka Studies 7 (Stockholm, 2001), 120–23, and note 41, below.

41 McCormick, *Origins of the European Economy,* 967–68, no. 780; 970, no. 811; B. Ambrosiani, "Birka im 10. Jahrhundert unter besonderer Berücksichtigung der Ostverbindungen," in *Europa im 10. Jahrhundert: Archäologie einer Aufbruchszeit,* ed. J. Henning (Mainz, 2002), 227–35.

42 McCormick, *Origins of the European Economy*, 13.

43 This capitulary is very plausibly attributed to Louis the Pious and dated around 820. Unfortunately the sole manuscript (Paris, BnF, lat. 4788, fols. 117–18) is damaged and the details of some of its provisions have been lost. After Louis insisted on limiting the striking of coins to the count's immediate control in certain places and detailed the punishment for counterfeiters, he specified that counts of towns that had no mint were to seek information, apparently about coinage and counterfeiting, either from other counts or from traveling merchants: ed. A. Boretius and V. Krause, MGH Capit 1:300.1–5, no. 147.

the tale around 940.[44] The story presumes that Venetians trading at Pavia would know the prices of expensive textiles in Constantinople's market and seek price information from Rome. On the basis of the economic "law of one price," it also implies, as we would expect, that Rome and Constantinople at this time were two different markets.

A little-known document shows similar awareness at Aachen of price differences in an even more distant market. Everyone has heard how Hārūn al-Rashīd sent Charlemagne an elephant. Many know about the next embassy, which delivered fabulous gifts from Baghdad to the Frankish court—remarkable spices and drugs, a brass water clock, and a magnificent tent for Charlemagne to use in the field.[45] But it is virtually unknown that the king leaned on his followers to collect counter-gifts for Baghdad. A letter from the Frankish court to the archbishop of Salzburg specifies that the king would like the archbishop to send him gold or a fine textile (*pallium*). The royal adviser notes that the textile seemed to be very expensive in the caliphal heartland.[46] Possibly—although not necessarily, for Charlemagne had intense relations with ecclesiastical leaders in the Arab world, and merchants from his empire traded in the Middle East—the information about prices in Baghdad came from the caliph's envoys.[47] Nevertheless, the courtier's comment about the cost of fine wares in Baghdad shows not only that Charlemagne's entourage sought to maximize diplomatic impact for the lowest cost. It also reveals that economic information about a very distant market was, at least occasionally, valued among the Frankish elite. Charlemagne's advisers, too, were familiar with Temin's instrumental mode of economic behavior.[48]

A last voice from the West takes us back to Byzantium itself. Notwithstanding their philological challenges, the Old Church Slavonic materials generated by the missions of Constantine (Cyril) and Methodius offer wonderful insights. Constantine, Apostle of the Slavs, likely preached his homily on the discovery of the relics of St. Clement in the coastal city of Cherson between 861 and 863. Like few other contemporary religious texts I know, this sermon appeals to merchant interest. Constantine deploys what looks like commercial imagery calculated to catch the attention of an audience that must have included traders assembled in the Black Sea port for a Greek religious service. At one point, Constantine seems to compare the acquisition of the saint's relics to a great business deal, and he certainly reminds his audience how avidly they listen to old merchants' tales of their lives on the road. Although Constantine emphasizes wondrous stories of past trading exploits, he likely expects his listeners to prick up their ears at information about business.[49] It does not seem to me accidental that the patriarch of Constantinople had compared spiritual preparations for death and eternal life to an easy business deal in a homily delivered

44 Odo of Cluny, *Vita Geraldi Aureliacensis* (*BHL* 3411) 1.27, PL 133:658B–C. For critical discussion of this passage, see McCormick, *Origins of the European Economy,* 680 n. 47.

45 McCormick, *Origins of the European Economy,* 893–94, nos. 271 and 277; cf. 890–91, nos. 254–56.

46 The conventional wisdom is that gold was cheaper in the caliphate than in the Carolingian empire, since the legal norm for gold to silver exchange in the caliphate was 1:10 and, about a half century after Charlemagne's death, in western Frankland 1:12: P. Spufford, *Money and Its Use in Medieval Europe* (Cambridge, 1988), 51–52. Nevertheless, the rate fluctuated in the caliphate and it is possible that in 807, the situation looked a little different. Some kind of textile certainly figured among the most important wares exported by the Rhadanite merchants from the Franks to the caliphate around 885: McCormick, *Origins of the European Economy,* 689.

47 On Charlemagne's relations with Arabs, see M. McCormick, *Charlemagne's Survey of the Holy Land: Wealth, Personnel, and Buildings of a Mediterranean Church between Antiquity and the Middle Ages* (Washington, D.C., 2011), and McCormick, *Origins of the European Economy,* 670–95.

48 *Formulae Salzburgenses* 62, ed. K. Zeumer, MGH Form 453–55, with the additional text recovered by B. Bischoff, *Salzburger Formelbücher und Briefe aus Tassilonischer und Karolingischer Zeit,* SBMünch (Munich, 1973), no. 4, Formula 2.2, p. 34 (cf. pp. 13–14), which adds the size of the tent, reveals Charlemagne's efforts to collect countergifts for Harun from his subordinates, and shows that the king's advisers especially wanted gold and *pallium,* the latter being particularly expensive in Iraq: "Aurum, si valetis, aut pallium mittite, quia in suis provinciis valde hoc pretiosum esse videtur." Strictly construed, the *hoc* should refer only to the pallium. The exact nature of the fine textile designated by "pallium" in this and other contemporary sources is not clear to me, and deserves further investigation.

49 Constantine the Philosopher, *Sermon on the Discovery of the Relics of St. Clement, Old Church Slavonic version,* 1, ed. and Latin trans. J. Vašica, "Slovo na prenesenie moštem preslavnago Klimento neboli legenda chersonská," *Acta academiae velehradensis* 19 (1948): 38–80, here 73–74; trans. 64–65; the text is also available in T. Butler, *Monumenta bulgarica* (Ann Arbor, 1996), 8–9, with a translation that I have not followed. My late colleague Horace Lunt has assured me that Butler's understanding of this difficult passage is not preferable to mine. For further discussion, see McCormick, *Origins of the European Economy,* 188 n. 56.

a couple of years earlier.[50] The metaphor in any event suggests that Photius, too, expected merchants in his audience in the Hagia Sophia.[51]

Writing to a bishop on Crete, another ninth-century Byzantine ecclesiastic disparaged certain prelates' conduct. Theodore Stoudite says they behave like peasants who produce abundant harvests and large herds and then watch carefully, waiting for times of dearth in order to buy and sell with maximum advantage: they act more like merchants than bishops.[52] The implication is that ambitious farmers (γεωργοί) timed their buying and selling to the prices on the food market, which fluctuated according to yields and season. Given that the overwhelming majority of Byzantines were farmers, Theodore's criticism suggests that instrumental behavior was well known among his contemporaries and even practiced by some bishops.[53] The story tells us about no particular farmer or bishop. Nor does it bother to explain the logic of waiting for the right moment to jack up prices and profits. This tells us that contemporary readers understood how the market worked. Unwittingly, Theodore offers excellent indirect evidence on the instrumental mode of behavior, and therefore on the importance of markets in ninth-century Byzantium.

Against a backdrop of nearly no testimony from the merchants themselves, scattered indirect evidence makes it hard to deny that on either side of the economic transformations that separated late antique and early medieval society, some people at least placed a premium on economic information that was useful in markets. Members of the elite instinctively assumed the existence and workings of markets. This indirect evidence suggests that Temin's instrumental mode of economic behavior was important in early medieval and Byzantine society. It reinforces explicit records of market exchange.[54] It may well suggest that the instrumental mode of behavior and the markets it implies were dominant then. Nevertheless, few will question that the command mode played a significant role in the early Byzantine economy, and it probably was not entirely absent later in the first millennium. It would also be hard to imagine a Byzantine countryside or townscape devoid of economic reciprocity. The challenge for future economic historians will be to imagine ways of gauging the relative importance of the three modes of behavior, and to determine how that relative importance may have changed over time and over the differentiated economic space from the capital to the Anatolian plateau or the Balkan valleys. Such a geographically scaled understanding would lead to a more exact knowledge of the Byzantine economy and its markets. Another way of approaching that problem comes from the archaeology of containers.

Amphorae, Barrels, and Economic History

Because of their indestructibility, variety, and ubiquity as transport containers for relatively high-value foodstuffs, ceramic amphorae provide some

50 Photius, *Homilia* 2.3, ed. V. Laourdas, Φωτίου ὁμιλίαι, Hellēnika, Parartēma 12 (Thessalonike, 1959), 15.10–25, esp. 13–14: ". . . ἡ πραγματεία, δι' ἧς ἐμπορεύεσθαι ταῦτα δυνατόν, ἀταλαίπωρος . . .".

51 The Old Church Slavonic Life of Constantine-Cyril 4.1–2, ed. and Latin trans. F. Grivec and F. Tomšić, *Constantinus et Methodius Thessalonicenses, Fontes* (Zagreb, 1960), 99 and trans., 173; cf. the ed. of T. Lehr-Spławińsky, *Konstantyn i Metody* (Warsaw, 1967), 138; Eng. trans.: M. Kantor, R. S. White, and A. Dostál, *The Vita of Constantine and The Vita of Methodius* (Ann Arbor, 1976), 9. The affinity reinforces the explicit assertion of Constantine's biographer that he studied with Photius before the latter assumed the patriarchate. On this score, P. Lemerle, *Le premier humanisme byzantin: Notes et remarques sur enseignement et culture à Byzance des origines au X^e siècle* (Paris, 1971), 161–64, has challenged the literal exactness of the *Life,* and particularly Dvornik's extravagant interpretation, even as he allows the possibility of a link between the two men. I see no reason for a biographer operating under the authority of the Roman popes to invent a connection for his hero that will have seemed damaging in the West. The apparent echo of Photius's unusual simile in Constantine's own composition strengthens the testimony of the exceedingly well-informed anonymous biographer on Constantine's link with Photius.

52 *Ep.* 11 to Anastasius, bishop of "Knosia," ed. G. Fatouros, *Theodori Studitae Epistulae*, 2 vols., CFHB 31 (Berlin, 1991–92), 1:38.116–21: "οἵτινες ὅλην φροντίδα κέκτηνται τάχα ἐπὶ τοῦ σπεῖραι πολλὰ καὶ ἀμήσασθαι καὶ ἐπὶ τοῦ φυτεῦσαι τοσαῦτα καὶ καρπώσασθαι καὶ ἐπὶ τοῦ προσθεῖναι καὶ πληθύναι βουκόλια ἢ ποίμνια, ὥσπερ τινὲς γεωργοὶ καιροσκοποῦντες καὶ καταπραγματευόμενοι τὰς ἐνδείας πρὸς τὸ πωλεῖν καὶ ἀγοράζειν ταῦτα καὶ ἐκεῖνα, πραγματευτικῶς καὶ ἐμπορικῶς οἱονεὶ πολιτευόμενοι, ἀλλ' οὐκ ἐπισκοπικῶς καὶ ἱερατικῶς . . .". On "Knosia" as Knossos, see, e.g., Fatouros, ibid., 1:153*. A similar thought occurs in John Chrysostom, *In Kalendas* 6, PG 48:962, who nevertheless expresses it quite differently.

53 Exactly the same criticism was leveled at a contemporary Carolingian bishop, underscoring both a deep structural similarity between the two economies and mental commonalities among ecclesiastics. The similarity extends even to an explicit comparison of the bishop with merchants: Notker Stammerer, *Gesta Karoli magni imperatoris* 1.23, ed. H. F. Haefele, MGH Script-RerGerm, n.s. 12, 2nd ed. (Berlin, 1980), 31.4–10.

54 See notes 8 and 9, above.

of the best data for ancient patterns of production, shipment, and exchange, market or otherwise. We can use recent advances in ceramic knowledge to deepen our understanding of how ancient economies worked. As the Egyptian merchants gathered in the port of Gaza or Donatus's deferred wine sale suggest, we should think hard about the chain of transactions that moved a packet of cloth, a liter of oil, wine, or grain from the site of production through the warehouse and finally on to the market and the consumer. Careful analysis of the ostraca found in Carthage's circular harbor provides exquisite details of how, in the spring and summer of 373, African oil was moved by sea and land to Carthage, and how it was weighed and stored before transshipment.[55] Although the documents appear to reflect the state fiscal apparatus of the annona, they, like the records of earlier Spanish oil shipments, provide precious operational insights into how Romans imagined and organized the movement, inventory, and management of goods en route from production to consumption zones.

Amphora production and distribution have illuminated the changing geography and rhythms of shipments as proxies for the movement of foodstuffs.[56] Containers will contribute more still if we mobilize all the archaeological and textual evidence about them. With new precision, thin sections and the chemistry of amphora fabrics ascribe particular amphorae to specific zones of production marked by the archaeological finds of kilns and wasters.[57] Meticulous scrutiny of amphora features—presence or absence of pitch, cork or ceramic stoppers, types and distribution, modes of opening—has produced a notable advance in our knowledge of the links between specific types of containers and the wares they contained. In the absence of macroscopic vestiges of their contents, gas chromatography and mass spectrometry can identify the types of pitches, and distinguish oil from wine products.[58] Ancient DNA fragments—macroscopically invisible but preserved in the surface of the amphora—have identified the olive oil laced with oregano and, possibly, mastic, that once filled long-submerged Chian amphorae. If the technique is validated and reproduced, it will supply amazing new insights into the wares transported by the thousands of surviving amphorae and millions of amphora fragments that once traveled to Byzantine markets.[59] Such advances will enable us to progress from counting containers to estimating the economic significance of the wares they once contained.

The experimental and ergonomic archaeology of amphora forms can contribute more to grasping the realities of Mediterranean transport. What were the operational advantages of particular designs, and what can they suggest about shippers' priorities, about loading and unloading the cargo? Packing in ship holds was connected with amphora shape; for instance, tapered ends could wedge layers of amphorae in place, and boards braced African cylindrical amphorae.[60] The ergonomics of design hint at how and where amphorae were loaded as cargo, details that in turn could yield insight into the events (markets?) or locales in which their ownership changed hands. Rather like barrels, the large cylindrical amphorae that carried African liquids could have been *rolled* short distances for loading and unloading and probably stowed and transported fairly easily on rafts, flat-bottomed scows, or carts. Is this why their small handles do not protrude beyond the body of the vessel?

What did it take to place into a ship's hold large amphorae such as the highly efficient cylindrical

55 Peña, "Mobilization of State Olive Oil."

56 Tchernia, *Le vin de l'Italie romaine,* remains exemplary for the earlier period; for the later period, see Pieri, *Le commerce du vin oriental,* with further references, as well as the valuable reflections of H. Elton, "The Economy of Southern Asia Minor and LR 1 Amphorae," in Gurt Esparraguera, Buxeda i Garrigós, and Cau Ontiveros, eds., *LRCW 1: Late Roman Coarse Wares,* 691–95.

57 Pieri, *Le commerce du vin oriental,* e.g., 80–81, about LRA 1. The valuable website of Simon Keay and David Williams, "Roman Amphorae: A Digital Resource," http://ads.ahds.ac.uk/catalogue/archive/amphora_ahrb_2005/, illustrates thin sections of the fabrics of various amphorae wherever possible.

58 See the important conclusions of M. Bonifay and N. Garnier, "Que transportaient donc les amphores africaines?" in *Supplying Rome and the Empire: The Proceedings of an International Seminar Held at Siena-Certosa di Pontignano on May 2–4, 2004, on Rome, the Provinces, Production and Distribution,* ed. E. Papi, Journal of Roman Archaeology supp. ser. 69 (Portsmouth, R.I., 2007), 9–31.

59 M. C. Hansson and B. P. Foley, "Ancient DNA Fragments inside Classical Greek Amphoras Reveal Cargo of 2400-Year-Old Shipwreck," *Journal of Archaeological Science* 35 (2008): 1169–76.

60 See A. J. Parker, "Cargoes, Containers and Stowage: The Ancient Mediterranean," *International Journal of Nautical Archaeology* 21 (1992): 89–100, and especially the discussion of the boards and packing of the African cylindrical amphorae in the fifth-century wreck Dramont E (or 5): C. Santamaria, *L'épave Dramont "E" à Saint-Raphaël (Ve siècle ap. J.-C.),* Archaeonautica 13 (Paris, 1995), 117–20.

Figure 3.1.
Africana 2D Grande. This type of cylindrical amphora, which runs 109–17 cm long and has an average capacity of 45 to 50 L, was manufactured in the areas of Leptiminus and Hadrumetum in the 3rd and 4th c.; oil and wine seem to have been its main contents (photo courtesy of the Museo Arqueológico Municipal de Cartagena and Archaeological Data Service, Keay and Williams, "Roman Amphorae: A Digital Resource")

Africana 2D Grande, whose production continued into the fourth century (fig. 3.1)? A 68-liter capacity implies that if they carried olive oil, the oil alone would have weighed some 63 kilograms, to which must be added the weight of the amphora itself, another 19.5 kilograms. That surely made the amphora difficult for a single stevedore to handle without some sort of a hoist or crane with hooks—thus no need for big handles—even if the hoist were just a block and tackle hung from the ship's yardarm.[61]

Figure 3.2.
Kapitän 2. The design of this 3rd- and 4th-c. amphora, apparently from the Aegean, lent itself to being handed off between stevedores; about 75 cm high, it held considerably less than, e.g., an Africana 2D Grande (photo courtesy of the Matrica Museum and Archaeological Data Service, Keay and Williams, "Roman Amphorae: A Digital Resource")

On the other hand, what could explain the long, tapered design of smaller amphorae such as the presumably Aegean Kapitän 2 (fig. 3.2) or Dominique

61 The specific density of olive oil is 0.9150–0.9180 at 15.5° C. Hence 68 L × 0.92 = 62.56 kg. See the valuable table 1 and discussion of amphora capacities and weights in D. P. S. Peacock and D. F. Williams, *Amphorae and the Roman Economy: An Introductory Guide* (London, 1986), 51–53 (at 52), who called for more work and reporting of empty amphora weights twenty years ago. Compare for the dimensions and capacity Keay and Williams, "Africana 2D Grande," in "Roman Amphorae," http://ads.ahds.ac.uk/catalogue/archive/amphora_ahrb_2005/character.cfm?id=6&CFID=1795221&CFTOKEN=57363093, accessed July 2010. M. Bonifay, *Études sur la céramique romaine tardive d'Afrique*, BAR International Series 1301 (Oxford, 2004), 474 (cf. 472), suspects that this type of amphora may have been used for a salt fish preparation, in which case the contents probably weighed more. Laboratory analysis did not detect lipids: see Bonifay and Garnier, "Que transportaient donc," 23, fig. 8, where they further suggest the possibility of wine; in this case, the *titulus pictus,* "OLEI," would refer to a secondary usage, unlike the classical merchants' *tituli picti* as clarified by J. T. Peña, "Two Groups of *tituli picti* from Pompeii and Environs: Sicilian Wine, Not Flour and Hand-picked Olives," *Journal of Roman Archaeology* 20 (2007): 233–54.

Figure 3.3.
Handing off a Kapitän 2 amphora. Two Harvard stevedores demonstrate the ergonomic advantages of the design of Kapitän 2 amphorae: four fingers of the lower worker's right hand are cupped into the hollow base while his thumb grasps the rilled exterior and his left hand guides the amphora toward the worker aboard a (pretended) ship; the long handles allow both workers to maintain a firm grasp until the amphora is securely handed off (my thanks to Dr. Joseph A. Greene and the Semitic Museum of Harvard University, as well as to Avia Navickas and Michael Actis-Grande for taking the photos)

Pieri's Late Roman 9? At first blush, it is difficult to understand what practical purposes could be served by so odd-looking a shape, with its long and narrow hollow foot and dangerously protruding rabbit-ear handles ill-suited to rolling and prone to breaking. But an experimental and ergonomic approach explains much about the design. The conelike shape is perfect for cradling a full amphora against one's stomach and chest. Personal experience at lifting and carrying a Kapitän 2 shows that this form distributes the weight across one's body, easing the load on the back and arms when, say, one carried it from a loading stack to a ship.[62] Most importantly, the protruding extremities seem designed to minimize the risk of dropping the container and its valuable wine at the most perilous moment in its life, when one laborer passed it to another, especially in wet conditions. The hollow rilled base is perfectly suited to a firm grip with the right hand—four fingers fit easily into the base, while the palm cups against the rim of the amphora foot and its rilled exterior—and the left hand securely grasps the lower part of one long handle. In this way, a stevedore such as the professorial one depicted in figure 3.3 could even stand in the waves and hand the amphora up to a waiting collegial deckhand: the long rabbit-ear handles allow the deckhand to grasp with both hands the upper ends of both handles and pull it up into a smallish ship while the stevedore still holds the amphora securely.[63] The hollow rilled base would help keep a wet amphora from slipping out of one's grasp. The same design facilitated handing the container down through a hatch to packers waiting in the hold.

Such an operational approach should interest more than amphoralogists. If the ergonomic interpretation of the design is correct, amphorae like this one were particularly well tailored to beachside loading or unloading. That could point to the predominance of multiple, small-scale beachside sales or deliveries in the production zone whence these amphorae stemmed. The ways in which these smaller, tapered containers were manipulated must in any case have differed considerably from the handling of the large cylindrical African amphorae. Should we therefore suspect that such African containers entailed fairly elaborate port facilities, while these Aegean amphorae lent themselves to more improvised landings and loadings? This hypothesis

62 For Kapitän 2, see Keay and Williams, "Kapitän 2," in "Roman Amphorae," http://ads.ahds.ac.uk/catalogue/archive/amphora_ahrb_2005/details.cfm?id=154&CFID=1795221&CFTOKEN=57363093, accessed July 2010. For LRA 9, see Pieri, *Le commerce du vin oriental*, 137–38.

63 It is a pleasure to thank my colleague Dr. Joseph A. Greene of Harvard's Semitic Museum, who cheerfully helped organize my experiment with one of our intact Kapitän 2 amphorae, accession number 1907.61.3. Today, empty, this amphora weighs 6 kg. Museum summer interns Avia Navickas of Boston College and Michael Actis-Grande of Pennsylvania State University were good sports in carting the amphora around and taking the photos, and have my thanks.

certainly could be reconciled with the sort of archipelago-hopping and beaching that was a familiar feature of navigation in the island- and vineyard-dotted Aegean Sea.[64]

An operational approach clarifies the logic behind the changing size and shape of amphorae. Pieri's recent study of Gaza amphorae (Late Roman Amphora type 4) has shown that fifth-century potters developed a variant form that doubled capacity.[65] But why did the potters choose to expand it in the fashion that they did? Rather than simply ballooning LRA 4's basic oval shape outward and preserving the same proportions, the potters extended vertically the coil of clay that they laid down to form the wall of the amphora, producing an amphora of approximately the same diameter, but twice as long and thus double the capacity. Was this shape a coincidence? Or did some local operational necessity persuade the potters of the Negev desert to change the shape of the LRA 4B to resemble a cigar? We will return to this question below.

Progress in localizing major amphora types invites us to read the texts anew. That schedule of fees for inspecting Constantinople-bound cargoes at Abydos (mentioned above) helps clarify around 500 the critical question of the economic significance of particular amphorae, even as the identification in Cilicia of the production of LRA 1 illuminates the logic of the inscription. Inspectors collected the top fees from "all wine freighters," to the tune of "six folles and two pints (*xestai*) [of wine]."[66] Given what we know from the amphorae, we can legitimately surmise that "all wine freighters" transported north in particular the production of Palestine, whether from Gaza in LRA 4 or in the Palestinian bag-shaped amphorae that were also imitated in Egypt.[67] However, the schedule qualifies the high fee for "all wine freighters" by adding "except only those from Cilicia."

The tariff is generally set according to cargo type: wine, oil, dried vegetables, bacon, and wheat. The sole exception identifies a cargo only by geography and occurs two lines later. It specifies that "Cilician shippers pay to the naval personnel [of this station] three folles." The implication of the double mention of Cilicia seems to be that Cilician shippers were transporting wine, a deduction comforted by the reference to Cilicia's extensive wine exports in the *Expositio totius mundi*.[68] If we may assume that "Cilicia" is fair administrative shorthand for the production area of the amphora known as LRA 1, whose kilns in fact occur overwhelmingly in Cilicia, then we may deduce two things. The first is that LRA 1 (i.e., Cilician amphorae) indeed transported wine, perhaps predominantly around 500.[69] Second, if, as might seem inherently likely, the Abydos fees correlate in some approximate way with values of the cargoes, then Cilicians either enjoyed a special fiscal privilege at this station or Cilician wine was of significantly lower value than Gazan wine, olive oil, dried vegetables, or bacon.[70] Given that Gaza wine is widely attested as a prestige drink, came from further away, and had inherently higher sea transport costs (as well as significant overland expenses for many vineyards, as we will see), the latter seems to make sense.[71] We thus gain a precious insight into the economic significance of specific cargoes. The freight of a ship loaded with LRA 4 or bag-shaped amphorae—that is, Palestinian and perhaps other

64 For this pattern of navigation in the Aegean, see the middle Byzantine examples in McCormick, *Origins of the European Economy,* 420–21.

65 Pieri, *Le commerce du vin oriental,* 105–6 for LRA 4B; its 24–26 L compare to the 13–15 L of the earlier LRA 4A (ibid., 104).

66 See note 21, above.

67 For the production zones, see Pieri, *Le commerce du vin oriental,* 109–10, 124–25.

68 Οἱ οἰνηγοὶ πάντες οἱ τὸν οἶνον κομίζοντες εἰς τὴν βασιλίδ<α ταύ>την πόλειν, πλὴν μόνων τῶν Κιλίκων, κλασσικοῖς τῶν στενῶν φόλλις ἓξ καὶ ξέστας δύο, . . . οἱ Κίλικες ναύκληροι κλασσικοῖς τῶν στενῶν φόλλις τρῖς: ed. Durliat and Guillou, "Le tarif d'Abydos," 583.22–25; for the *Expositio,* see below, note 70. On the varied evidence for Cilician wine production, see M. Decker, "The Wine Trade of Cilicia in Late Antiquity," *ARAM* 17 (2005): 51–59.

69 See Pieri, *Le commerce du vin oriental,* 80–85, for the production zone (ten sites in Cilicia, three on Cyprus, and one each on Rhodes and the facing mainland) and for wine as the primary content in LRA 1's original use. Elton, "Economy of Southern Asia Minor," emphasizes that an amphora type produced over such a long period and in so many places inevitably was used for more than just wine, a point borne out by some labels on some amphorae.

70 For wine assessed at 6 folles and 2 xestai (of wine), see above, note 68. Oil, dried vegetable, and bacon cargoes are assessed at 6 folles, against the 3 folles paid for Cilician wine freights, and the 3 folles plus one measure paid for wheat: Durliat and Guillou, "Le tarif d'Abydos," 584.24–29. It therefore looks significant that the *Expositio,* 29, 162.3–4, states that Askalon and Gaza export "the best wine" (*uinum optimum*) whereas it notes (39, 176.1–3) that Cilicia makes "much wine" (*faciens multum uinum*). The cheaper rates for a Cilician product may have created an incentive for more shippers to use the typically Cilician LRA 1.

71 On the prestige of Gaza wine, see the sources collected in Pieri, *Le commerce du vin oriental,* 112–13.

sorts of wine—was worth considerably more than the same ship loaded with LRA 1—that is, Cilician wine—indeed, perhaps twice as much. Should we conclude that Cilician wine catered to a more "mass market" than Gazan?

Future economic archaeology will need to consider the volume of production of different kilns over time. It would be highly desirable to obtain archaeomagnetic dates for the last firing of the amphora kilns, and compare them with the dates assigned to specific amphorae from various find sites around the empire. As we get a better handle on the places of amphora production and distribution, their chronology, the content of amphorae, and even the first glimmer of the relative value of those contents, scholars can correlate this new knowledge with the now invisible markets through which these amphorae passed.[72]

When the grapes were pressed, only higher-value wine made it into export containers. At least in the Mediterranean, low-value wine destined for local consumption seems mainly to have been put in large bladders for overland transport toward its final, local place of disposition.[73] It may be that some better wine was also transported by this method from the press and, after conditioning, transferred into heavy export amphorae or even into archaeologically invisible barrels.[74] Certainly the Carthage ostraca seem to show that bladders played an important role—conveying half to three-quarters of the total, according to J. Theodore Peña's reconstruction—in the initial movement of oil from the sometimes remote countryside to Carthage.[75] At Carthage the olive oil was transferred to amphorae, weighed, and recorded, apparently in preparation for export as part of the annona, the process that generated the ostraca of 373. At the analogous moment in the less-well-documented commercial sector, was the transfer to amphorae or barrels sometimes equivalent to a "market event," a (today) imperceptible commercial transaction in which the producer was paid by a merchant? That might be the implication of the African vintner's story. How many such commercial transactions did a given liter of export oil or wine undergo en route to delivery and how did that chain of transactions change over time? At what point in the chain of distribution and marketing was a particular type of amphora filled or emptied? That is, was an amphora discarded at or before the final transaction purchasing its contents? Differing answers will imply different insights into the microstructure of markets. For instance, around 626, the Yassı Ada ship was carrying as a secondary cargo a surprising array of differently formatted LRA 1 amphorae that were presumably filled with wine or, in some cases, olive oil. Their capacities ranged between 4.5 and 14.8 liters. If this ship was not, as has been hypothesized, on a run exclusively to deliver supplies to Heraclius's army, but (perhaps in addition to a hypothetical fiscal transport) was going to market, its wide variety of amphora sizes could suggest that any merchant aboard her avoided the middlemen—wholesalers?—who acquired and broke larger shipments into smaller lots for sale to consumers.[76] Greater variety in the standard sizes transported

72 See on this challenge Elton, "Economy of Southern Asia Minor."

73 Tchernia, *Le vin de l'Italie romaine,* 39.

74 On the conditioning of wine in udders after pressing, and wagon transport of udders to locations where wine was poured into amphorae, see É. Marlière, *L'outre et le tonneau dans l'Occident romain,* Monographies Instrumentum 22 (Montagnac, 2002), 190; cf. Bonifay and Garnier, "Que transportaient donc," 22. Animal membranes are supposed to have been unsuitable for sea transport since the rats which will have infested Roman ships loved to eat them: Marlière, *L'outre et le tonneau,* 189. On rats and Roman ships, see M. McCormick, "Rats, Communications and Plague: Towards an Ecological History," *Journal of Interdisciplinary History* 34 (2003): 1–25, at 9–14. For all aspects of the ancient technology of wine production, especially in the Holy Land, see R. Frankel, *Wine and Oil Production in Antiquity in Israel and Other Mediterranean Countries* (Sheffield, 1999).

75 Peña, "Mobilization of State Olive Oil," 212.

76 P. G. van Alfen, "New Light on the 7th-c. Yassı Ada Shipwreck: Capacities and Standard Size of LRA1 Amphoras," *Journal of Roman Archaeology* 9 (1996): 189–213, at 192–201, 213, on the possibility that the range of sizes was driven by consumer demand in a changing marketplace. On the other hand, F. van Doorninck Jr., "Byzantine Shipwrecks," in *EHB* 2:899–905, at 901, inclines toward identifying this wreck as a fiscal cargo of taxes in kind, for reasons that for now are only sketched in F. van Doorninck, "The Ship of Georgios, Priest and Sea Captain: Yassıada," in *Beneath the Seven Seas: Adventures with the Institute of Nautical Archaeology,* ed. G. F. Bass (London, 2005), 92–97. Although we do not know how much of the structures of the sixth-century annona transport system survived the catastrophic loss in 618 of Egypt and the great home port of Alexandria, imperial legal texts indicate that system had allowed shippers to transport for their own advantage duty-free wares above and beyond their required fiscal cargo; see McCormick, "Bateaux de vie, bateaux de mort," 80–93. If van Doorninck's interpretation of Yassı Ada as a fiscal transport should prove correct, then the rather motley assembly of LRA 1 amphorae could be the first archaeological example of such a shipper's personal, secondary cargo; the new LRA 13 amphorae, the bulk of the cargo, would be the fiscal cargo.

might suggest that the structure of the market had simplified in seventh-century Byzantium.

At the receiving end, how were the wares stored, organized, and moved to the consumer? The archaeology of late antique shops, such as at Sardis and Skythopolis (Beth Shean), can illuminate retail operations and their links with regional and longer-distance trade, as well as the social and economic role of market shops in the changing cityscape of late antiquity.[77] One step further back in the chain of supply are two warehouses from around 500, which have recently been discovered and excavated at an important late Roman town and at a military installation. Because the storehouses in the harbor of Classe (Magazzino no. 17) and at the fort of Dichin, on the Danube, perished catastrophically with their wares still stacked in place, they will shed exceptional light on how late Romans thought about and managed goods that were imported en route to a consumption site, whether it was part of the state supply service or of the private sector. The homogeneity or heterogeneity of the wares in a particular area of the storehouse—such as the six amphorae of three or four types originally stacked in a row at Dichin, or the manifestly grouped sets of amphorae in the warehouse at Classe—quantities, units, and proximity of one type to others all should illuminate what the goods were as well as how they were manipulated, especially when those data are compared to written records generated by such operations, whether they be the Carthage ostraca or countless papyrus receipts of Egypt.[78] As figure 3.4 shows, at Classe's Warehouse 17 the amphorae were stored on the ground floor *by our modern types:* here the excavators have, in addition to one barrel, identified sets of amphorae—Keay 26f–g, 57a–b, 62r, and a set of large amphorae attributed to the same production area as Keay 35b—as well as tableware and lamps. The quantities in this particular warehouse do not seem huge—I count some three dozen of the "syringe" amphorae Keay 26f–g at the stage in the excavation when photo VII.27 (fig. 3.4) was taken—but substantial nonetheless.[79] Recent work identifies the contents of these amphorae variously as fish or olive preserves or wine.[80] Thus, pending full study and publication of the site, we might suppose it to be a warehouse loaded mainly with African food products. However, the fine ware and lamps, apparently present in commercial quantities, were also made in Africa. The warehouse also might have stored sacks of grain, including on a second floor, as the artist's reconstruction suggests (fig. 3.5). Now at this date, Africa was under the Vandals and Ravenna was controlled by either Odoacer or Theoderic, circumstances that doubly rule out identifying these wares as annona shipments: they must have traveled to the head of the Adriatic as commercial wares. The early evidence from the remarkable Warehouse 17 of

77 See Walmsley, "Regional Exchange and the Role of the Shop," in this volume, 311–30.

78 For the Classe warehouse excavated in 2004–05, see the preliminary indications and photos in A. Augenti, "Gli scavi 2004–2005 nel porto di Classe—area I," in *Felix Ravenna: La croce, la spada, la vela: L'alto Adriatico fra V e VI secolo,* ed. A. Augenti and C. Bertelli (Milan, 2007), 34–36; E. Cirelli, *Ravenna: Archeologia di una città,* Contributi di archeologia medievale 2 (Borgo San Lorenzo, 2008), 133, figs. 113, 134. It is a pleasure to acknowledge all that I learned from visiting the site of Warehouse 17 with its excavator, Prof. Andrea Augenti, who also alerted me to the parallel find of Dichin and kindly answered my follow-up questions, even as he and his students work on the definitive study and publication of this important discovery. In what we may presume were the different circumstances of a military storeroom ("store building 2") of the fort on the Danube, the row of amphorae consisted of two almost intact LRA 1, presumably containing wine, a badly fragmented imitation LRA 2, a lower Danubian amphora, and two standard LRA 2's whose splintering suggested that they exploded in the fire that destroyed the warehouse, and thus probably contained olive oil. If the LRA 1's contained the usual wine, as the excavator deduces from their nearly intact state, this would have been a row of mixed contents. The same set of storerooms also contained stocks of grain, pulses, lentils, military equipment, and cooking vessels, although it is not possible to discern the logic of their organization from the interim report: V. G. Swan, "Dichin (Bulgaria): Interpreting the Ceramic Evidence in Its Wider Context," in *The Transition to Late Antiquity: On the Danube and Beyond,* ed. A. G. Poulter, Proceedings of the British Academy 141 (Oxford, 2007), 251–80, esp. 252–55; cf. P. Grinter, "Seeds of Destruction: Conflagration in the Grain Stores of Dichin," ibid., 281–88. On LRA 2 as a container associated with the state supply service and on oil as its likely main contents, see O. Karagiorgou, "LR2: A Container for the Military *annona* on the Danubian Border?" in *Economy and Exchange in the East Mediterranean during Late Antiquity: Proceedings of a Conference at Somerville College, Oxford, 29th May, 1999,* ed. S. Kingsley and M. Decker (Oxford, 2001), 129–66, at 146–49.

79 Cirelli, *Ravenna,* 132–33, mentions huge quantities of identical items—e.g., 1,889 Hayes 2a lamps, although this apparently totals not a single deposit but the finds in a zone that contained multiple warehouses.

80 Bonifay and Garnier, "Que transportaient donc," 23–24, fig. 8, identify the contents of Keay 26 (= Spatheion 1) as olive or fish preserves, or wine; Keay 57 shows no sign of lipids, while the oil detected in Keay 62 might be due to reuse; the area that produced Keay 35B had fish-processing installations, and fish residues appear in such amphorae.

Figure 3.4. Classe, Warehouse 17, photo VII.27. Destroyed by fire ca. 500, this two-story structure contained grain, amphorae, quantities of fine ware, and one barrel. The amphorae—stored by type, and perhaps containing mostly fish products—and fine ware were all African; the amphorae were kept upright by holes cut in the floor that held their feet (photo courtesy of Prof. Andrea Augenti, Department of Archaeology, University of Bologna)

Classe thus points to a commercial network whose northern terminal appears to be defined by geography rather than by product type or range. Was this typical of the structures that supplied the markets of late antiquity and Byzantium? Was this one merchant's property? How many shiploads or parts of shiploads are we looking at?

The weight of empty amphorae is critical for estimating transport costs, grasping details of ergonomics and operations, and understanding market networks. Large ones like Dressel 20 containers held some 70 to 75 liters of Spanish olive oil and were heaped by the ton at the giant used amphora dump of Monte Testaccio in Rome. They cannot often have gone directly to individual consumers, who could neither afford the large outlay such a quantity entailed nor manage handily the 100 kilograms or so of a full amphora, which is why a mountain of them piled up in one place.[81] Monte Testaccio gives an idea of what to expect of a dump associated with a very big central distribution center or market. Physically more manageable, Gaza wine amphorae contained 13- or 26-some liters. If such amphorae were as efficient as contemporary LRA 1 or 2 amphorae, the smaller ones will have weighed some 17 to 20 kilograms when filled; the larger, some 34 to 40 kilograms.[82] They could conceivably have been sold

81 Calculated at 75 liters × 0.92 (the specific density of olive oil) = 68.85 kg. The weight of Dressel 20 amphorae runs about 30 kg, for an amphora efficiency rating (i.e., of liters of contents per kg of vessel weight) of 2.3; on that concept, see van Alfen, "New Light," 208, who also gives the capacity efficiency ratings for LRA 1 and 2. I am grateful to Prof. José Remesal Rodríguez of the University of Barcelona for informing me about the weight of Dressel 20.

82 The specific density of white wine runs between 0.990 and 1.010. Taking it as 1.0, 13 L would weigh 13 kg; if it were as efficient

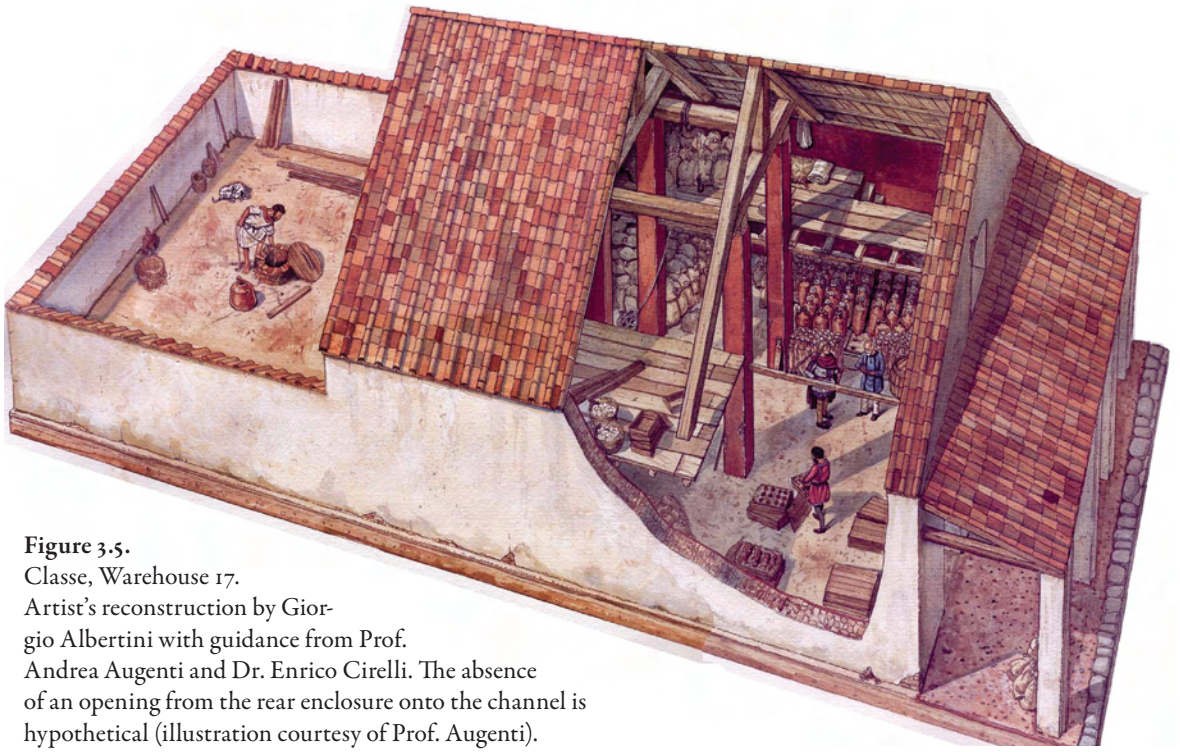

Figure 3.5.
Classe, Warehouse 17.
Artist's reconstruction by Giorgio Albertini with guidance from Prof. Andrea Augenti and Dr. Enrico Cirelli. The absence of an opening from the rear enclosure onto the channel is hypothetical (illustration courtesy of Prof. Augenti).

at retail as well as wholesale, though much must have depended on the price.

Knowing which sizes occur on which sites helps clarify whether distance inland and the necessity of overland transport distinguished the distribution of large and small types of the same container. It opens the way to investigating whether market hierarchies—wholesale versus retail markets?—may explain such differentiated distribution patterns.[83] Recent work even pinpoints links between specific amphora production shops in Africa and particular long-distance markets. Several smallish ships freighting homogeneous cargoes carried in amphorae as well as fine wares fired in Neapolis (modern Nabeul, Tunisia) or Sullecthum (modern Salakta, Tunisia) went down off the coast of Gaul, whose land sites often yield just these wares. Unsurprisingly, the coastal origin of African products recorded at Alexandria broadly resembles the pattern in other great centers around Mediterranean shores. But the absence of those types and the predominance in Egypt's interior—including the oasis of Bahariya in the western desert—of fine ware produced inland in Tunisia suggest a different story. These markets may have been served by caravans traveling overland from inland Tunisia, thus anticipating the medieval caravan trade.[84]

as LRA 1 (i.e., 1.9 L per kg of empty amphora), a small LRA 4 amphora would have weighed about 19.8 kg; if it were as efficient as LRA 2 (3.3 L per kg), it will have weighed 16.9 kg when filled. I have calculated the possible weight ranges of the bigger LRA 4 in the same way.

83 One can do this, for example, with the archaeological contexts of France analyzed by Pieri, *Le commerce du vin oriental,* 7–66, with respect to the smaller and larger Gaza wine amphorae LRA 4A and LRA 4B, although the apparently exclusively later date of LRA 4B2 (ca. 550–700) limits this particular comparison to a period when the transport into inner Gaul of both sizes of amphorae was on the decline. Nevertheless, it does show that away from the Mediterranean, the late larger amphorae reached only a few major centers: Bordeaux, Cathedral (cemetery) and Place Camille-Jullian phase 2 (11 amphorae), 50, 105, and 107 (where the smaller form also occurs in phases dated earlier); Lyons, Avenue Adolphe-Max (where both forms occur, although it is not clear that they come from the same phase in occupation levels stretching from the fourth to the sixth century of this site, which awaits full publication), see 52, cf. 105, 155; Toulouse, Donjon du Capitole (there the LRA 4A comes from an early fifth-century context at the Place Esquirol, so it certainly does not testify to contemporary imports of both sizes to the same northern site), see 48, cf. 105, 155.

84 For the distribution of the production centers of Nabeul, Salakta, and central Tunisia and the possibility of caravan transport, see Bonifay, *Études,* 451–56. For the medieval caravans

Identifying the workshops that produced specific wares uncovers imitations manufactured in places far from their models.[85] The market appeal of locally produced knockoffs of the ubiquitous African dishes and lamps in Gaul, Spain, or Greece seems intuitively clear. But what are the market implications of late Roman packaging that mimics what we can now begin to think of as "branded" amphora types, such as the wine containers of Cilicia or Gaza? If imitation amphorae are indeed a form of geographically misleading late Roman brand recognition, did they target consumers or merchant intermediaries—suggesting that they contained wares similar to the imitated type?[86] Indeed, might doing so sometimes have had some fiscal advantage?[87]

Another factor sheds light on the relative cost of some products and, therefore, the strength of demand. Some large-scale winepresses discovered in the Negev desert lay one or two or more days' travel inland from the sea. Kilns that produced Gaza-type amphorae have been specifically identified at Mefalsim and Naḥal Bohu (about 15 km from the coast) and, apparently, at Beersheba, three times as far inland.[88] A large winepress installation and signs of amphora production have recently been discovered at Beershema (ancient Birsama).[89] The kiln locations indicate that here wine was put into the amphorae—presumably the very ones in which it would be shipped overseas—quite near the inland site of production. That is the same system revealed by Egyptian papyri.[90] The distance inland of the big winepress installations at Elousa (Halutza, ca. 45 km inland, in fig. 3.6), Sobata (Shivta, ca. 60 km inland), and Eboda/Oboda (Avdat, ca. 80 km inland) in a region that featured only overland transport raises the question of how these export wines reached the coast. Starting from the shipping fees recorded in Diocletian's Price Edict, scholars have long recognized that ancient land transport generally was more expensive than water and especially sea transport.[91] More recent scrutiny has stressed the effectiveness of Roman overland transport systems when there was no alternative and when demand could justify the cost.[92] Bottling export wine a few days' journey from the sea testifies both to the organizational infrastructure that delivered the product to Egyptian merchants on the coast and to the great value of the potent wine.[93] But how, in operational terms, did wine bottled in the Negev get to the sea for shipment to overseas markets?

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between Tunisia and Egypt, see Goitein, *A Mediterranean Society,* 1:276–81.

85 See Bonifay, *Études,* 458–62, who judiciously distinguishes between technological and more general borrowing and true imitation wares.

86 Bonifay and Garnier, "Que transportaient donc," 14. See also N. Kruit and K. Worp, "Geographical Jar Names: Towards a Multi-Disciplinary Approach," *Archiv für Papyrusforschung und verwandte Gebiete* 46 (2000): 65–146, who marshal the papyri's rich array of geographic names that designated different types of amphorae (often associated with wine), and thus can illuminate "brands." I owe this reference to the kindness of Dr. Leslie MacCoull.

87 See note 70, above, on a possible fiscal incentive for the spread of LRA 1.

88 See Y. Israel, "Survey of Pottery Workshops, Naḥal Lakhish–Naḥal Besor," *Excavations and Surveys in Israel* 13 (1993): 106–7, who states that the survey intended to identify kiln workshops producing Gaza amphorae identified ten such. He does not list them, nor can they be identified from his map. Although the wording is confusing, he seems to say (107) that a workshop producing LRA 4 was indeed found at Beersheba. A kiln was also found at Halutza, but the type of ceramic produced there was unclear; see further note 99, below. For a convenient recent list of wine and oil presses in the region, see S. Kingsley, *A Sixth-Century AD Shipwreck off the Carmel Coast, Israel: Dor D and the Holy Land Wine Trade,* BAR International Series 1065 (Oxford, 2002), 126–27, 131, as well as the comprehensive study and catalogue of Frankel, *Wine and Oil Production in Antiquity*. On the economic development of these places and the wine trade, see I. Shatzman, "Economic Conditions, Security Problems and the Deployment of the Army in Later Roman Palestine: Part I: Economy and Population," in *The Late Roman Army in the Near East from Diocletian to the Arab Conquest,* ed. A. Lewin, P. Pellegrini, Z. T. Fiema, et al., BAR International Series 1717 (Oxford, 2007), 153–200, at 167–78.

89 B. J. Dolinka, "Be'er Shem-Birsama of the *Notitia Dignitatum*: A Prolegomenon to the 2006 Excavations," in Lewin et al., eds., *The Late Roman Army in the Near East,* 111–18, esp. 115–17 on wasters from the kiln production of Gaza amphorae.

90 J.-P. Brun, *Archéologie du vin et de l'huile dans l'Empire romain* (Paris, 2004), 145, 148.

91 A. H. M. Jones, *The Later Roman Empire, 284–602: A Social, Economic, and Administrative Survey* (Oxford, 1964), 842.

92 The growing literature on this question is summarized and much new data is adduced by C. E. P. Adams, *Land Transport in Roman Egypt: A Study of Economics and Administration in a Roman Province* (Oxford, 2007).

93 See on these winepresses Mayerson, "Wine and Vineyards of Gaza," and the references above, note 88. Export wines required a longer shelf life and the capacity to withstand the summer heat, and therefore tended to be stronger than most locally consumed wines: Tchernia, *Le vin de l'Italie romaine,* 29–30, hence surely part of their appeal. Gregory of Tours confirms that in Gaul, the wines of Laodikeia and Gaza were reckoned quite robust: *Historiarium libri X* 7.29, ed. B. Krusch and W. Levison, MGH ScriptRerMerov 1.1, 2nd ed. (Hanover, 1951), 348.11–12: "Misitque pueros unum post alium ad requirenda potentiora vina, Laticina videlicet adque Gazitina."

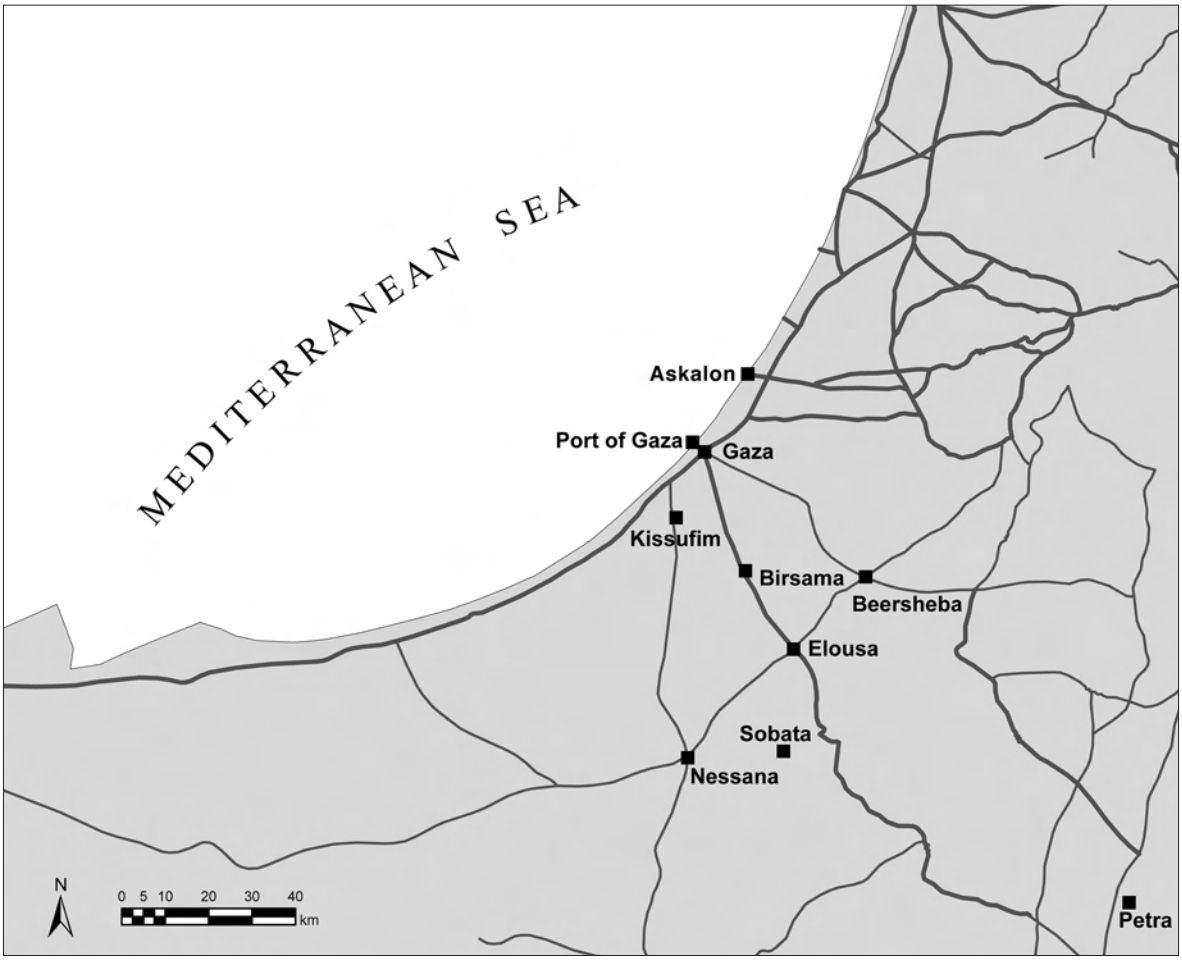

Figure 3.6. Southern Palestine. Roman roads leading to Gaza and principal wine-producing and other sites mentioned in the text (drawn by A. More)

By no coincidence, these inland vineyards lay mostly along the ancient Incense Road linking Petra with Gaza, which the military considerably improved in late antiquity.[94] In this part of the world, we would expect camels to play an important role in overland shipment.[95] In fact, a just-published terra-cotta bottle from the coast at Askalon (fig. 3.7) hints at the infrastructure that moved the wine to the coast.[96] Bottles of analogous design have turned up in Egypt, at Nag Hammadi (fig. 3.8), in Alexandria, and also at Aphrodisias.[97] They take the form of camels carry-

94 See, e.g., I. Roll, "Crossing the Negev in Late Roman Times: The Administrative Development of *Palaestina Tertia Salutaris* and of Its Imperial Road Network," in Lewin et al., eds., *The Late Roman Army in the Near East,* 119–30, with references to further bibliography; cf. C. Ben-David, "The Paved Road from Petra to the ʿArabah—Commercial Nabataean or Military Roman?" ib*i*d., 101–10.

95 Discussion of the role camels played in late Roman logistics has taken off since the work of R. Bulliet, *The Camel and the Wheel* (Cambridge, Mass., 1975); see especially R. S. Bagnall, "The Camel, the Wagon and the Donkey in Later Roman Egypt," *BASP* 22 (1985): 1–6, and Adams, *Land Transport in Roman Egypt,* 52–56, 72–73, 79–81, with further references.

96 B. L. Johnson, *Ashkelon 2: Imported Pottery of the Roman and Late Roman Periods* (Winona Lake, [Ind.], 2008), 135, no. 392, where the object is implicitly dated to the Roman period. One is of course sorely tempted to think that these bottles once served wine to late Romans.

97 Oxford, Ashmolean Museum, inv. Dept. of Antiquities 1892.1176, from Nag Hammadi, ascribed to the third century; the different amphorae seem to be depicted on the similar camel bottle in the museum at Alexandria: see Pieri, *Le commerce du vin oriental,* 128, fig. 82. For the Aphrodisias bottle, see S. Applebaum, "Animal Husbandry," in *The Roman World,* ed. J. S. Wacher (London, 1987), 2:504–26, here 524, fig. 19.9. I owe

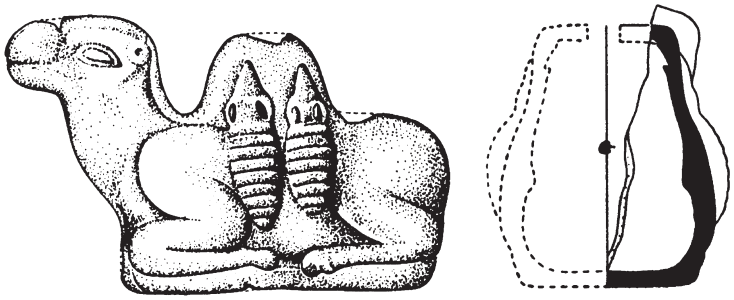

Figure 3.7.
Ceramic bottle in the form of a sitting camel loaded with amphorae. Askalon, A16/87.38.74.L87.FG22,23.(5) (courtesy of Prof. Lawrence E. Stager and the Leon Levy Expedition to Ashkelon)

Figure 3.8. Ceramic figurine of a standing camel loaded with amphorae, assigned to the 3rd century; from Nag Hammadi, Egypt (photo courtesy of Ashmolean Museum, University of Oxford, inv. Dept. of Antiquities 1892.1176)

ing amphorae two to a side, which sounds like the usual camel load of four *keramia* mentioned in the papyri. The Askalon bottle shows long, cylindrical amphorae reminiscent notably of the Gaza amphora LRA 4B, which was certainly manufactured in the Negev wineries.[98] In fact four of the large-format LRA 4B filled with wine—weighing some 25 kilograms, plus the weight of the amphora itself—would fit well the normal camel load specified in Diocletian's Price Edict and documented by the papyri.[99] This mode of transport in turn probably answers the question raised earlier, why Negev potters, when they made bigger containers for their wine, did so by elongating the base container. As the bottles suggest, sets of long amphorae lay better against a camel's side than ones that would simply have expanded the original, rounder shape.

Could camel caravans transporting the precious white wine have been a familiar sight along the roads linking the desert vineyards to the sea? The answer comes from a spectacular mosaic pavement discovered in 1977 in the western Negev, at Kissufim, some 15 kilometers south of Gaza. A founder's inscription dates the floor of this basilical church to AD 576–78. Among other images, it shows a camel driver with a stick and a bunch of dates, together with a camel carrying amphorae, apparently four per side (fig. 3.9).[100]

my knowledge of this last bottle to the kindness of Dr. Günder Varinlioğlu and her thorough follow-up on a conversation we had in the Images Collections at Dumbarton Oaks.

98 Pieri, *Le commerce du vin oriental,* 109–10.

99 Ibid., 105, notes capacities of 13–16 and 24–26 L for LRA 4A and B, respectively. The specific gravity of a sweet white wine should be above 1.002; the weight of the wine is therefore 24 × 1.002 (at least), to which must be added the weight of the container. One wonders immediately whether the inland kilns were producing both large and small versions of LRA 4. Judging from the ruler in the photo, Israel, "Survey of Pottery Workshops," 107, fig. 113, seems to show one of the large format amphorae at a kiln at Naḥal Bohu, i.e., 15 km inland. Even assuming a poor capacity efficiency ratio for LRA 4B of 1 kg per liter of wine carried, each large amphora, when filled, would weigh 50 kg. The hypothetical total maximum burden (4 × 50 kg =200 kg), which surely errs on the heavy side, comes close to the Diocletianic load of 600 Roman pounds (i.e., 194 kg), depending of course on the weight of LRA 4B, which Pieri does not specify. See Adams, *Land Transport in Roman Egypt,* 80.

100 R. Cohen, "The Marvelous Mosaics of Kissufim," *Biblical Archaeology Review* 6.1 (1980): accessed at the Biblical Archaeology Society Online Archive, on 26 November 2008; R. Cohen, "Kissufim," in *The New Encyclopedia of Archaeological Excavations in the Holy Land*, ed. E. Stern, A. Lewinson-Gilboa, and J. Aviram, vol. 4 (Jerusalem, 1993), 876–78; Y. Hirschfeld, "The Monasteries of Gaza: An Archaeological Review," in *Christian Gaza in Late Antiquity*, ed. B. Britton-Ashkelony and A. Kofsky (Leiden, 2004), 61–88, at 80–81. For the inscription, see *SEG* 30 (1983): 482–83, nos. 1688–93. The amphorae depicted on the mosaic were presumably the smaller LRA 4A, which were approximately half the size of the LRA 4B. The latter would appear to be heavy for a dromedary (see note 99, above). It

Figure 3.9. Orbikon the camel driver and his amphora load. From the mosaic pavement, dated AD 576–78, of a church at Kissufim, Israel, which stood 5 km from the Roman road connecting the Negev wineries to Gaza; collection of the Israel Antiquities Authority (photo © The Israel Museum, Jerusalem)

The site is on a wadi—and thus at least seasonally well supplied with water—5 kilometers off the Roman road that connected the wine-exporting centers of Elousa and Birsama to Gaza.[101] Date, site, and subject all point to the conclusion that the mosaic stems from the logistical system that delivered wine to the international port of Gaza. Camel caravans could have delivered their loads of amphorae in, at most, one or two nights of travel at their expected rate of some 60 kilometers a night; thus multiple trips per week were likely.[102] The trade of "Orbikon," as the mosaic names the driver, must have been remarkably profitable if he contributed to financing the magnificent mosaic.[103]

Whether one or more market events intervened between the bottling, transport by caravan, and seaside sale is unclear but worth asking. How in any case did it happen that the inland towns produced amphorae of the same type as Gaza's coastal workshops: Did Gaza entrepreneurs travel up-country to establish the export trade with migrant potters? Did local producers spontaneously imitate the prestigious coastal containers in order to sell their own production in its market niches? Or was respecting the norms of the metropolis expected of even distant potters?[104] Whatever the explanation, Palestine's

is a pleasure to thank Dr. Günder Varinlioğlu, who brought this mosaic to my attention. Given the date, one wonders whether the sumptuous decoration reflects a moment of prosperity that arose from the inheritance and concentration of wealth following the demographic changes wrought by the Justinianic plague.

101 The wadi empties into the Mediterranean less than 10 km southwest of Gaza; its modern vegetation is clearly visible on Google Earth.

102 L. Herbison and G. W. Frame, "Camels," in *Encyclopædia Britannica,* Encyclopædia Britannica Online, 2008, www.search.eb.com/eb/article-233465, accessed 26 November 2008.

103 The main donor was a deacon. Cohen, "Mosaics of Kissufim," identifies "OPBIKON" as a Greek personal name. I have not found a clear parallel. A plausible explanation comes to me from Prof. Michael Sokoloff of the Hebrew University, via the good offices of my friend Prof. Deborah Tor of Notre Dame University. Sokoloff observes a name attested in Syriac documents of approximately this period that seems very close indeed to the camel driver's—"'WRBYQ"—and refers to J. P. Margoliouth, *Supplement to the Thesaurus Syriacus of R. Payne Smith* (Oxford, 1927), 10. Finally, according to Tor, late antique personal names ending in "–on" occur in both Aramaic and Hebrew in the Jerusalem Talmud. Both colleagues have my warm thanks.

104 Shatzman, "Economic Conditions," 176, deserves credit for raising this question. But his answer, that it was local producers attempting to lend a prestigious cachet to their product for the local market, appears to me unlikely if Tchernia's position on what did and did not make it into export amphorae (*Le vin de l'Italie romaine,* 29–30, 39) is well founded. For the apparent role of cities and their territories in defining amphora designs, see Reynolds, "Levantine Amphorae," 575.

sophisticated viticultural society and its feeder crafts required an overland transport industry to move the heavy amphorae to the coast. That industry presumably picked up where, in the third century, the slackening caravan trade of the old Incense Road left off. Barring some kind of special subvention, the further implication is that the profit to be made from southern Palestine's inland vineyards was hefty enough to justify the overland transport of amphorae heavy with wine. Nor was Palestine the sole such case. Land transport was probably also important for the ceramic and agrarian production of contemporary Africa, for example.[105]

Nevertheless, the contrast with other viticultural regions reinforces the impression that some Gaza wineries lay unusually far inland. Connoisseurs still appreciate the wines of the Moselle Valley and of Turkey's Marmara coast, regions that combine favorable soils and climate conditions with immediate access to waterways. Nergis Günsenin's research has shown that at Mount Ganos (modern Gaziköy), the amphora kilns stood close to the vineyards on the western shore of the Sea of Marmara. It may even be that clay was transported 20 kilometers across the sound to the island of Marmara, so that amphorae could be fired in the beachside kilns and filled with the island's wine.[106] Similarly, the many late Roman winepresses discovered in recent years in the Moselle Valley are located smack-dab in what still rank among Germany's choicest vineyards. That soil could have been used for vineyards, so powerful reasons militated for putting the presses right there. From here, the barrels that dominated the Moselle wine industry could be rolled 20 or 30 meters down the slope to the riverbank. Cheap boat transport then moved them to Trier or the Rhine, the frontier zone, and beyond.[107]

The effort to understand production and transport facilities and their links to markets should encompass deeper synergies that helped shape the cost and conditions of production as well as distribution. The deduction that the big export industry of African Red Slip Ware piggybacked on state-sponsored transport of Africa's oil and—perhaps mainly—grain is by now familiar: stacks of dishes, bowls, and lamps traveled as a secondary cargo aboard subsidized ships whose main task was moving the annona to the capitals.[108] But another synergy is less well known. Massive production of olive oil generated tons of a by-product of extraordinary utility to the ceramic industry in a Mediterranean ecology where wood was at a premium: crushed olive pits and pressing waste, which burned hot and true. Pressing olives for oil produced an essentially free fuel for the kilns that made the masses of African amphorae and dishes exported around the late Roman Empire.[109] Presumably this valuable by-product encouraged ceramic production in other oil-producing areas as well, including in the kilns which fired the amphorae that transported the wine of Gaza.[110]

105 See M. Mackensen, *Die spätantiken Sigillata- und Lampentöpfereien von el Mahrine (Nordtunesien): Studien zur nordafrikanischen Feinkeramik des 4. bis 7. Jahrhunderts,* Münchner Beiträge zur Vor- und Frühgeschichte 50 (Munich, 1993), 1:57–59, emphasizing that the ceramic kilns of El Mahrine were favorably situated near major Roman roads leading to Carthage some 45–50 km away, depending on the route, and to other inland markets. The seasonal flow of the nearby lower Medjerda looks unpromising for regular water transport; ibid., 1:57 n. 34. For the deduction that significant quantities of olive oil were transported by land, including in large udders, to the weighing station of Carthage, where it was put in amphorae, see Peña, "Mobilization of State Olive Oil," 185–92, including on the relatively higher cost of udders. A similar situation is imaginable for Byzacena; see Bonifay and Garnier, "Que transportaient donc," 22.

106 N. Günsenin, "Medieval Trade in the Sea of Marmara: The Evidence of Shipwrecks," in *Travel in the Byzantine World,* ed. R. Macrides (Aldershot, 2002), 125–35, at 129–34, argues this from the absence of clay on the island of Marmara for the kilns that were built on its beach there, in order to fill the amphorae on the island where the grapes were grown.

107 For instance, at Piesport (Germany) the Roman wine press is 30 m from the river bank, as anyone can verify on Google Earth. On the press, see K.-J. Gilles in S. Faust, K.-J. Gilles, J. Hupe, et al., *Führer zu archäologischen Denkmälern des Trierer Landes,* Schriftenreihe des Rheinischen Landesmuseums Trier 35 (Trier, 2008), 158, with further references.

108 Bonifay and Garnier, "Que transportaient donc," 22, develop the plausible hypothesis that the fine ware traveled first and foremost with cargoes of grain rather than oil. On ceramics piggybacking on subsidized African annona transports, see, e.g., McCormick, "Bateaux de vie, bateaux de mort," 75–80, with further references.

109 On the highly probable use of waste from olive pressing to fire the kilns at El Mahrine, see Mackensen, *Die spätantiken Sigillata- und Lampentöpfereien,* 1:55–56, although he does not adduce any bioarchaeological evidence for that practice at this site. I am grateful to Prof. Alan Walmsley for discussion of the recent bioarchaeology of Syria and Palestine, including the burning properties of olive pits. See also the experimental data in T. Miranda, A. Esteban, S. Rojas, et al., "Combustion Analysis of Different Olive Residues," *International Journal of Molecular Sciences* 9 (2008): 512–25.

110 On olive production, see, in addition to the works cited in note 88, J. Magness, *The Archaeology of the Early Islamic Settlement in Palestine* (Winona Lake, Ind., 2003), 92–93.

A final packaging problem has often been raised. The extent to which barrels replaced amphorae in late antique holds remains imponderable. Experimental archaeology is needed to work out the exact efficiency advantage of Roman barrels, but they obviously were lighter than amphorae. Judging from modern barrels—bound with metal hoops, which should be heavier than the wooden ones that apparently predominated in antiquity[111]—a recent study of Roman barrels observed that a modern cask holding 225 liters weighs 57 kilograms, for a capacity efficiency of 4, which surpasses even the 3.7 rating attributed to some Africana 2 amphorae.[112] Given a wood barrel's inherent strength, one suspects that their efficiency only increased as barrels became bigger. A second advantage has passed practically unnoticed: the estimated capacity of the biggest Roman barrels commonly surpassed 1,000 liters, and barrels of 500 liters were anything but rare. One even approached 1,500 liters.[113] This size is reminiscent of *dolia,* the huge pottery vessels used for storage rather than transport, and in fact Roman texts mention these wooden vessels in the same breath as dolia.[114] Even if it could have been manufactured in durable fashion with the kind of capacity efficiencies we have seen for LRA 1 and 2, an equivalent transport amphora would have weighed more than half a ton when empty. Although building materials prove that late Romans moved heavy objects, such wine transport containers sound impractical and, in any case, do not appear to be attested in the late Roman period.[115]

According to a recent study, the barrel's efficiency advantage explains its progressive triumph over the amphora.[116] That efficiency advantage was probably clearest for high-volume transports. One would imagine that the skilled labor and the not inexpensive wood required to make them may have made barrels more costly than amphorae of similar capacity. It is conceivable that amphorae of the usual sizes, say some 20 to 100 liters, competed successfully with barrels. Indeed, rivalry with the barrel may in some way have spurred the apparent increase in efficiency of late antique amphorae.[117] However, for high-volume transports, the efficiency advantage of the barrel was probably hard to beat. Thus the historic shifts toward—or away from—barrels may be another token of the aggregate scale of the transportation of liquids and other goods. In fact, this hypothesis seems borne out by the relative proportions of surviving Roman barrels. Of the 88 barrels whose sizes can be estimated, 16 (18 percent) fall in the groups whose capacity runs between 2.5 and 100 liters, that is, common amphora sizes. The remaining 72 (82 percent) run between 120 and 1,440 liters, and the overwhelming majority of them could have held more than 400 liters.[118]

Celts invented barrels and Roman soldiers carried them across the empire. The great majority that survive come from northwestern Europe, a circum-

111 Marlière, *L'outre et le tonneau,* 170. However, Charlemagne insisted that on his well-run royal estates, some barrels at least should have iron hoops: "Volumus ut bonos barriclos ferro ligatos, quos in hostem et ad palatium mittere possint, iudices singuli praeparatos semper habeant"; *Capitulare de villis* 68, ed. A. Boretius, MGH Capit 1 (1883), 89.36–37. His statement shows both that the innovation coexisted with wooden hoops by ca. 800 at the latest and that iron hoops were considered superior.

112 Marlière, *L'outre et le tonneau,* 12; more precisely, the capacity efficiency of this modern barrel would be 3.95. For calculations of efficiency, see note 81, above. On the French shopping website Twenga.com I found modern oak wine barrels of approximately the same dimensions (95 × 70 cm) weighing 45 kg, which produces an even better efficiency capacity of 5. Peacock and Williams, *Amphorae and the Roman Economy,* 52, table 1, report Africana 2 Grande efficiencies between 3.27 and 3.59.

113 See Groups 3 and 5 of Marlière, *L'outre et le tonneau,* 164, 166.

114 E.g., in the early third century, Ulpian, *Dig.* 33.6.3, discussing whether the legacy of wine included the containers, seems to consider immobile *cupae* (on which term see below) as a subset of barrels (*cupae* or *cuppulae*), ed. *CIC* 1:509.17–19: "in doliis non puto verum, ut vino legato et dolia debeantur, maxime si depressa in cella vinaria fuerint aut ea sunt, quae per magnitudinem difficile moventur. in cuppis autem sive cuppulis puto admittendum et ea deberi, nisi pari modo immobiles in agro velut instrumentum agri erant." Cf. the African Arnobius the Elder, *Adversus nationes* 2.23, ed. C. Marchesi (Turin, 1953), 93.6–8, whose argument against innate Platonic ideas enumerates banal objects that someone raised with no experience of the outside world would be unable to recognize, including *dolia* and *cupae*: "Quid si adicias quaerere rota quid sit aut tribula, vannus dolium cupa, trapetum vomis aut cribrum, mola buris aut sarculum?"

115 For the earlier dolia ships, see Tchernia, *Le vin de l'Italie romaine,* 138–40.

116 Marlière, *L'outre et le tonneau,* 12.

117 See note 203, below.

118 Marlière, *L'outre et le tonneau,* 157–69; she suspects that the disproportion is an illusion created by the taphonomic circumstance that most barrels are known because they were used to line wells, a purpose that required large barrels. While there is certainly truth in this observation, I am not at all sure that it is the sole explanation of the apparent predominance of large barrels. Prof. van Doorninck rightly insisted in his comments on this essay that it takes a relatively high volume of goods contained for barrels to make economic sense over amphorae.

stance that may reflect their place of origin's preference for them. It certainly reflects conditions favoring preservation—barrels were often recycled there as well-linings and survive below the water table—and Europe's highly developed archaeological traditions. Barrels probably displaced amphorae at important sites in Roman Gaul in the second century.[119] But depictions in Spain and Italy prove that ancient barrels were not confined to northern Europe, and, as we will see below, they were also familiar in the late antique Levant.[120] The question of when and how much they came to figure as Mediterranean transport packaging remains unanswered. Sea evidence of any sort of organic container is scant. But barrels have been detected on board four ancient wrecks so far. In the English Channel, a late third-century wreck on the Isle of Guernsey carried many barrels and smaller kegs.[121] Off the French Riviera, a mid-second-century ship showed traces of barrel hoops and a seventh-century wreck preserved the bottom of a barrel, thanks to a layer of pitch that enclosed it.[122] A ship that went down off Grado around 150 also had a barrel in the bow.[123] Another barrel has turned up in what was probably the warehouse area of the early imperial harbor of Fos-sur-Mer.[124]

On land, written sources expand the picture. Lexically the situation is complicated by the way the word for a "storage tank" for wine (Lat. *cupa*—hence, via Low Germanic, our "cooper") came, between the first and third centuries, to include wooden transport barrels within its semantic field. A wooden tank in the original sense was found in Pompeii.[125] By 238, the wine producers around Aquileia were using lots of barrels for various purposes, including shipping, and the emperor Maximinus improvised a pontoon bridge from their casks; funerary inscriptions of coopers confirm the rise of the barrel in northeast Italy.[126] At Rome's river port, an inscription assigned to the late third century records fees for unloading and storing wine barrels (*cupae*); it implies that the bulk of fiscal wine imported up the Tiber arrived in the wooden containers. The scale of Roman consumption surely contributed to the comparative advantage of using very high-capacity barrels: that they were big explains why the highest fees went to the crane operators whose task was probably to move the casks from the river boat to the shore.[127]

Barrels loomed large in fifth-century Rome's sea imports, if we can judge from Valentinian III's attempt to restore or refurbish the state-organized river transports that brought goods up the Tiber—surely from the city's seaport at Portus Romanus. The emperor fixed the minimum capacity of such vessels as "twenty barrels" (*cupae*). It seems inherently expensive and therefore unlikely that wares would have been transferred at the harbor from amphorae or other containers into barrels for shipment the last 25 kilometers upstream to Rome's river port.[128] Barrels so dominated imports reaching Rome by sea that they furnished the standard measure for river-boat sizes. Valentinian III issued this law at Rome, and it explicitly concerns local transport; it does not necessarily imply that the "barrel" or "ton," as it

119 Marlière, *L'outre et le tonneau,* cf. 177.

120 See ibid., 40–43, 117–24, for summaries of the geography of archaeological attestation and iconographic evidence based on her extensive catalogues. For eastern written evidence of barrels in the late antique and medieval periods, see below, 76.

121 St. Peter Port 1, my 794 in the *Digital Atlas of Roman and Medieval Civilization* (see below, 81) (A. J. Parker, *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*, BAR International Series 580 [Oxford, 1992], no. 1007 [hereafter cited as Parker]); Marlière, *L'outre et le tonneau,* 52–55.

122 Port-Vendres 3, my 702 (Parker no. 806); Marlière, *L'outre et le tonneau*, 59–60; and Saint-Gervais 2, my 789 (Parker no. 1001), on which see M. P. Jézégou, "Le mobilier de l'épave Saint-Gervais 2 (VII^{e} s.) à Fos-sur-Mer (B.-du-Rh.)," in *Fouilles à Marseille: Les mobiliers (I^{er}–VII^{e} siècles ap. J. C.),* ed. M. Bonifay, M.-B. Carre, and Y. Rigoir, Études massaliètes 5 (Paris, 1998), 343–51, at 345. The Saint-Gervais barrel is not in Marlière.

123 My 350 (Parker no. 464); C. Beltrame and D. Gaddi, "Preliminary Analysis of the Hull of the Roman Ship from Grado, Gorizia, Italy," *International Journal of Nautical Archaeology* 36 (2007): 138–47, at 138; Marlière, *L'outre et le tonneau,* 89.

124 Marlière, *L'outre et le tonneau,* 60–61.

125 See note 114, above, on Ulpian and, in general, the discussion in Tchernia, *Le vin de l'Italie romaine,* 285–87.

126 Herodian, *Regnum post Marcum* 8.4.4, ed. C. M. Lucarini (Munich, 2005), 165.30–166.12, whose Greek periphrase for barrels—"κενὰ οἰνοφόρα σκεύη περιφεροῦς ξύλου"—the *Scriptores historiae augustae, Maximini* 22.4, ed. A. Chastagnol, *Histoire auguste: Les empereurs romains des II^{e} et III^{e} siècles* (Paris, 1994), 672, rendered simply as "Ponte itaque cupis facto," indicating that the term had become unambiguous by the fourth century. On this and on the tombs of coopers, see Tchernia, *Le vin de l'Italie romaine,* 286–88.

127 *CIL* 6:1785, 31391, as analyzed and discussed by J. Rougé, "*Ad ciconias nixas*," *REA* 59 (1957): 320–28; for Roman cranes, see A. I. Wilson, "Machines in Greek and Roman Technology," in *The Oxford Handbook of Engineering and Technology in the Classical World,* ed. J. P. Oleson (Oxford, 2008), 337–66, at 342–45.

128 Valentinian III, *Novella* 29, *CTh* 2:127–28; that these were river vessels follows from the novel's title *De naviculariis amnicis,* on the manuscript authority of which see ibid., 2:71. On Tiber navigation, see McCormick, *Origins of the European Economy,* 485–86, with 406 n. 64.

were, was becoming a standard unit of ship capacity around the Roman Mediterranean.[129] Nevertheless, this development has consequences for late antique cargoes, as we will see when considering ship sizes.

The scarcity of ceramic dolia for storing wine has seemed puzzling in the rural establishments of Africa Proconsularis.[130] The riddle resolves when we listen to local late Roman texts, for cupae are not uncommon there. Mostly the term means the containers where wine was stored. As a young girl, St. Augustine's mother Monica used to sneak drinks when she was sent with a slave girl to fetch wine from the family storage cask ("de cupa uinum depromere"). In order to clarify a point in Scripture, Augustine mentions the familiar wine casks (*cupae*) arrayed on beams between the columns of wine cellars.[131] Some cupae were in fact transportable, as we learn from judicial proceedings of December 320 investigating the charge that a Donatist bishop and his ecclesiastical associates had stolen *acetum*—vinegar or fermented wine or must that was mixed with water to make *posca,* the refreshing drink of Roman civilization—from the state, or, more specifically, from a temple of Sarapis, along with the barrels (*cupas*) that contained it.[132]

What did such barrels transport? As at Rome and in St. Monica's cellar, wine is clearly the ware most frequently associated with cupae. For instance, a formula ascribed to Hero of Alexandria for calculating the volume of a cupa (κοῦπα) assumed it contained wine.[133] But late Roman barrels held other wares also. Operating on the empire's eastern front, Maurice foresaw that the late sixth-century army should travel with barrels (βουττία) of water, which he clearly distinguishes from ceramic *pithoi*.[134] Salt sounds plausible even if the documented case is exceptional, a trick that Frontinus (d. AD 103/4) claims floated supplies to a besieged northern Italian town in 43 BCE.[135] Beer seems irresistible if unproven.[136] A barrel from a probable dock area has remains of sardines embedded in the pitch that sealed it, and glass for recycling filled another shipboard barrel.[137]

Whether they be barrels or amphorae, containers are not the contained: understanding what they tell us about markets requires recognizing that their evidence about wares is indirect, and that further analysis must be undertaken in light of the wares and markets themselves. Thus, though learning that Palestinian containers around 450 represented an increasing proportion of total amphora imports into Gaul—where African containers had traditionally dominated—truly marks a step forward, it has

129 Tchernia, *Le vin de l'Italie romaine,* 291, seems to think otherwise.

130 J.-P. Brun, "Les pressoirs à vin d'Afrique et de Maurétanie à l'époque romaine," *Africa,* n.s., 1 (2003): 7–30, at 12, 14; cf. Bonifay, *Études,* 473.

131 *Confessiones* 9.8 (18), ed. L. Verheijen, CCSL 27 (Turnhout, 1981), 144.34–56; cf. her nursemaid's admonition, ibid., 9.8 (17), 143.24–30. Augustine invokes the image of the *cupa* probably although not unambiguously in the sense of a storage cask: e.g., *De moribus ecclesiae catholicae et Manichaeorum* 2.16.44, ed. J. Bauer, CSEL 90 (Vienna, 1992), 129.6–7: "magis ne inerit illud fel cum in cupa, quam cum in acinis fuerit?"; *Quaestiones in Heptateuchum* 2, *Quaestiones Exodi* 109, ed. J. Fraipont, CCSL 33 (Turnhout, 1958), 1213.1840–44, depicting the casks of wine arrayed on beams between the columns of wine cellars: "quod uulgo uocamus ancones, sicut sunt in columnis cellarum uinariarum, quibus incumbunt ligna quae cupas ferunt"; or ibid., 4, *Quaestiones Numerorum* 32, 254.745–47: "primitiae autem de fructibus quidem, sed iam redactis ab agro, sicut de massa, de lacu, de dolio, de cupa, quae primitus sumebantur." Or consider the happy hope in *De bono uiduitatis,* "that I might always find wine in my barrel (*in cupa mea*)": *Sermo* 11.3, ed. C. Lambot, CCSL 41 (Turnhout, 1961), 163.91–92, a genuine sermon reworked by Caesarius of Arles: see Dekkers, *Clavis patrum latinorum,* no. 111. The 200-some wine containers in which Donatus was aging his wine near Uzalis are identified only as *vasa,* and could have been wooden *cupae* as well: see notes 36 and 37, above.

132 *Gesta apud Zenophilum* (= *Appendix ad Optatum* 1), ed. C. Ziwsa, CSEL 26 (Vienna, 1893), 193.27–94.1; 195.2–24; 196.19–26. The barrels are referred to as belonging to the fisc ("de cupis fisci") and as being "in templo Sarapis" (193.29–30). The implication is probably that the state had taken over and was storing things in a temple building that had gone out of use. I am grateful to Roger Bagnall for discussing this passage with me. For examples of the imperial government using disused temples, see Bagnall, "Models and Evidence in the Study of Religion in Late Roman Egypt," 33. On the Roman drink, see Tchernia, *Le vin de l'Italie romaine,* 13. The East Asian predilection for vinegar-based drinks is helping to make them fashionable again today: see, e.g., T. Cecchini, "Case Study: Dropping Acid," *New York Times Style Magazine*, 9 November 2008, 52.

133 *Stereometrica* 1.51.1–2, ed. J. K. Heiberg, *Heronis Alexandrini opera quae supersunt omnia,* 5 (Stuttgart, 1976): 54.28–56.9; cf. 1.52, 56.10–17, on βούτης, apparently designating another kind of barrel. See in general Marlière, *L'outre et le tonneau,* 173–74, which considers chemical traces of wine inside Roman barrels.

134 Maurice, *Strategicon* 10.4, ed. G. T. Dennis, trans. E. Gamillscheg, *Das Strategikon des Maurikios,* CFHB 17 (Vienna, 1981), 348.41–350.51.

135 Frontinus attributes the stratagem to Aulus Hirtius (who had served with Caesar in Gaul) at the siege of Modena: *Strategemata* 3.14.3, ed. R. I. Ireland (Leipzig, 1990), 86.

136 Marlière, *L'outre et le tonneau,* 173.

137 Ibid., 61; on the Grado wreck, see note 123, above.

rightly been noted that the correct inference to draw about markets and goods is not that one region outpaced another but that new imports of one ware, Palestinian wine, entered the marketplace alongside the long-standing imports of African oil.[138] Since local wine was surely available, the new import indicates the development of specialized demand in late Roman Gaul.

Valuable though it is, such a conclusion is tempered by an elementary but essential observation. To assess the volume of imports—indispensable for considering the value of the imports—one must multiply the estimated number of containers by the volume of the contained. It is plainly misleading to think solely in terms of the ratio of eighteen African to sixty eastern Mediterranean amphorae that have been identified as arriving at Marseille between ca. 425 and 450, when the total contents of the recovered African containers came to around 1,260 liters, versus a total of 1,138 liters for the latter.[139] The obvious next step is to compare the value of the contents. If the African amphorae held oil of the very highest quality, and the eastern ones conveyed wine of similar quality, we could get a first crude estimate of their relative values from Diocletian's Price Edict, according to which the most expensive oil would cost 40 denarii and the highest-quality wine would cost 30 denarii per sextarius. By these hypothetical lights, the value of the oil imported into Marseille would be about 50 percent higher than that of the wine.[140]

Much work remains to be done before the containers that transported wares to markets can shed their full light on the economy of which they were a part. The ships that carried those containers are no less promising. That promise is not without its own complications, however, and it is to the accumulating wealth of shipwreck evidence, including the containers, that we turn next.

Ships and Markets

As the postulated Gaza camel trains suggest, wares, markets, and the merchants who made them happen were by no means confined to the sea. Nor was water transport limited to long-distance voyages. The coastal geography of the Byzantine Empire encouraged shorter-range shipping. Then as now, Constantinople's magnificent setting made very short water trips an essential part of the capital region's transport infrastructure.[141] The smaller vessels just discovered at Yenikapı, the site in Istanbul of the Theodosian harbor, should illustrate this vital component on the spectrum of Byzantine navigation.[142] At a larger scale, the Aegean and the Black Sea are recognizably distinct shipping zones, and some of the ships on them likely specialized in short-distance routes.[143] But a short distance need not always mean small ships. A very big middle Byzantine vessel bearing, if they were filled, an apparent minimum of 200 tons worth of local wine amphorae has been found off the island of Marmara in that wine-producing region of Mount Ganos. Could this have been a barge that specialized in short-distance deliveries? If so, the vessel may have been transporting new amphorae to be filled with fresh wine on the island vineyard or moving just-filled amphorae to some nearby depot, presumably the nearby harbor of Ganos.[144]

138 Pieri, *Le commerce du vin oriental,* 168. See further the considerations of Elton, "Economy of Southern Asia Minor."

139 Bonifay, *Études,* 446–47. The comparison is of course hypothetical and approximate. We have arbitrarily assumed that the oil and wine were each of top quality; differing assumptions produce different results, but this at least shows that the exercise is possible. Bonifay compares African Keay 35 with eastern LRA 1, 3, and 4; he does not specify the proportion of Keay 35A vs. 35B, which he identifies (471–73) as likely containing mostly wine and fish sauce or oil, respectively. For wine in LRA 1, see above, note 69; for LRA 3 and 4, Pieri, *Le commerce du vin oriental,* 101, 110–14.

140 Diocletian, *Edictum de maximis* 2.1–7, 3.1–2, ed. S. Lauer, *Diokletians Preisedikt* (Berlin, 1971), 100–103. At 0.547 L, the oil comes to 2303.47 sextarii worth 92,138.9 d. (1260 / .547 = 2303.47 sextarii × 40 d.); the wine to 62,413.16 d. (1138 / .547 =2080.44 sextarii × 30 d.).

141 For examples of very local ninth-century ship movements, see McCormick, *Origins of the European Economy,* R386b, R582.

142 The best publication to date is the exhibition catalog *Gün ışığında: İstanbul'un 8000 yılı; Marmaray, Metro, Sultanahmet kazıları* (Istanbul, 2008), 165–299, a copy of which I owe to the kindness of Alessandra Ricci of the Koç Institute for Anatolian Studies, Istanbul. I am grateful to my colleagues Nergis Günsenin, Sheila Matthews, Cemal Pulak, and Korhan Bircan for arranging for me to visit the extraordinary excavation site in June 2008, and for helpful discussion of the ongoing discoveries.

143 McCormick, *Origins of the European Economy,* 543–44. See also the discussion of potential (as suggested by geography) or actually documented local shipping nodes in the *TIB*, e.g., 1:103–4; 3:96–97, etc., and the comments of A. J. Parker, "Artifact Distributions and Wreck Locations: The Archaeology of Roman Commerce," in *The Maritime World of Ancient Rome,* ed. R. L. Hohlfelder, Memoirs of the American Academy in Rome, supp. vol. 6 (Ann Arbor, 2008), 177–96, at 190–94.

144 Günsenin, "Medieval Trade," 129–31, "Tekmezar I." The possibility of a barge is suggested by the proportions of the amphora spread reported by Günsenin (40 × 20 m), the huge size of the cargo (which she estimates as a minimum of 21,600

The Nile aside, eastern Mediterranean rivers were less favorable than western European ones for extensive fluvial merchant shipping. Yet there must have been short-range river transport on the lower stretches of some Byzantine rivers outside the Danube.[145] Western Europe's river shipping is deeply documented. Current archaeological, environmental, and historical investigations of it can serve as a model for what some day might be possible along the navigable rivers of the middle Byzantine Empire.[146]

Yet ever since Hesiod,[147] Mediterranean minds connected commerce to the sea. Countless ancient and Byzantine writers casually allude to the connection. Preaching not far from the harbor at Hippo, Augustine spontaneously linked shipping, a cosmopolitan outlook, and moneymaking. Four great careers tempted his flock: farming, state service, the law courts, and the sea. Of the last, the African bishop concluded: "'Sailing and trading,' another says, 'that's great!' It's great to know many provinces, make money everywhere, not be beholden in town to some mighty man, to always travel in foreign lands and nourish the mind on a variety of business and nations, and then to come home, rich with the profits!"[148] Around the same time, for Severian of Gabala—whom Photius would repeat ca. 850—all things answered to God's purpose: by God's command, the sun supplies its rays, the earth its fruits, and the sea delivers merchandise.[149] Although he was well aware that some traders traveled overland, Chrysostom also associated merchants and the sea.[150] In the very different world of the eighth-century caliphate, John of Damascus's native city was scarcely coastal and he spent much of his life in the desert monastery of Mar Saba. Yet he too smelled salt water when he thought of merchants. He draws on examples to illustrate the all-pervasive role of faith in life: farmers rely on the soil to survive, and merchants entrust their lives to the wood (of ships).[151] In Constantinople a century later, Photius thought of merchants on long roads burdened by harsh weather and bandits, and by dangerous sea voyages.[152]

John of Damascus echoed an earlier Greek father when he reasoned that absent the sea, merchants would not be able to "import what was in short supply in each place, or export what was surplus." Among late Romans and Byzantines, even men of the cloth grasped the economics of transport, of supply and demand, displaying once again their familiarity with Temin's instrumental mode of economic behavior. These ecclesiastics understood that the sea linked supply and demand: it connected markets.[153] Or

amphorae), and the photos of the wreck shown at the Spring Symposium of Byzantine Studies, Birmingham, U.K., April 2000. The harbor is about 20 km distant across the sound.

145 A. Kazhdan, *ODB* 3:1797–98. For Danube traffic in this period, see, e.g., McCormick, *Origins of the European Economy,* 553–57.

146 To cite only a few examples from the French-speaking world: A. Dumont, ed., *Archéologie des lacs et des cours d'eau* (Paris, 2006); É. Rieth, *Des bateaux et des fleuves: Archéologie de la batellerie du néolithique aux teomps modernes en France* (Paris, 1998); and the articles, with further bibliography, in O. Kammerer and O. Redon, eds., *Le fleuve,* Médiévales 36 (Paris, 1999).

147 Hesiod, *Opera et dies* 631–49.

148 Augustine, *Enarrationes in Psalmos,* In Ps. 136:3, ed. E. Dekkers and J. Fraipont, CCSL 40:20–22.

149 Severian of Gabala, *In incarnationem domini,* ed. R. F. Regtuit, "Severian of Gabala: Homily on the Incarnation of Christ (CPG 4204)" (Ph.D. diss., Vrije Universiteit, Amsterdam, 1992), 248.219–221: Πάσης τοίνυν τῆς κτίσεως στασιαζούσης ὁ θεὸς ἐκέλευσε τῇ κτίσει μὴ ἀφηνιᾶν, ἀλλὰ παρέχειν τὸν ἴλιον τὴν ἑαυτοῦ ἀκτῖνα, τὴν γῆν τοὺς ἑαυτῆς καρπούς, τὴν θάλασσαν τὰς ἐμπορίας, τοὺς ἀστέρας τὴν ἑαυτῶν φαιδρότητα. Cf. Photius, *Bibliotheca* cod. 277, ed. R. Henry, *Photius, Bibliothèque*, 8 vols. (Paris, 1959–91), 8:134.37–42, who erroneously ascribes the work to Chrysostom, and gives the variants of the "vulgate" version of the text—including the interesting addition of the words ἰχθύας καί before τὰς ἐμπορίας, which drives home the association no less powerfully: the sea conjures up fish and business.

150 Chrysostom often seems to assume that merchants go to sea, for instance when he says that no merchant stops going to sea just because he has suffered a shipwreck and lost his cargo, *Epistola ad Theodorum lapsum* 1, ed. J. Dumortier, *Jean Chrysostome: A Théodore*, SC 117 (Paris, 1966), 48.13–16, or when he compares a merchant's relation with the sea to that of a farmer with the land, *In Iohannem homiliae* 19.3, PG 59:124. Of course he was well aware that some merchants also travel overland. Elsewhere, for instance, he observes that merchants face danger on both land and sea, from robbers as well as pirates: *In Genesim homiliae* 63.5, PG 54:546.

151 John of Damascus, *Expositio fidei* 84, P. B. Kotter, *Die Schriften des Johannes von Damaskos*, 2, Patristische Texte und Studien 12 (Berlin, 1973), 187.13–16: Ἐκτὸς γὰρ πίστεως ἀδύνατον σωθῆναι· πίστει γὰρ πάντα, τά τε ἀνθρώπινα τά τε πνευματικά, συνίστανται. Οὔτε γὰρ γεωργὸς ἐκτὸς πίστεως τέμνει γῆς αὔλακα, οὐκ ἔμπορος μικρῷ ξύλῳ τὴν ἑαυτοῦ ψυχὴν τῷ μαινομένῳ τῆς θαλάσσης πελάγει παραδίδωσιν . . . .

152 Photios, *Homilia* 2.3, ed. Laourdas, 15.10–19.

153 Theodoret of Cyr, *Ep.* 30.8, ed. Y. Azéma, *Théodoret de Cyr: Correspondance,* 1, SC 40 (Paris, 1955), 96.3–14, developing an idea that was wittily apropos in a letter addressed to the bishop of Seleukeia, the port of Antioch: Τέμνειν ἡ θάλαττα τὰς ἠπείρους ἀμφοτέρας νομίζεται, τὸν μέσον τούτων χῶρον κατέχειν διαταχθεῖσα. Ἂν δέ τις τὸ ἀληθὲς ἐρευνῆσαι θελήσῃ, συνάπτει μᾶλλον ἢ τέμνει τὰ πέρατα· ῥᾳδίαν γὰρ τοῖς ἐμπόροις καὶ ταχεῖαν τῶν ἀναγκαίων ποιεῖσθαι τὴν κομιδὴν παρέχουσα, τὴν ἀντίπεραν ἤπειρον τρέχειν ἐνταῦθα παρασκευάζει, καὶ ταύτην πρὸς ἐκείνην ὁρμᾶν, καὶ τὴν ὀθόνην ἐκτείνειν, καὶ κινεῖν τὰ πηδάλια. Εἰ δὲ

rather, they understood that ships connected Mediterranean markets. One of the single most expensive capital goods in the ancient economy, ships constitute a key chapter in economic history even without their cargoes. A. J. Parker's foundational catalogue of Mediterranean shipwrecks marked a new phase in assembling that data for economic history.[154] But the data have not remained static. Intensifying exploration discovers new ships in remarkable numbers. The past fifteen years have brought a dozen to light around the island of Marmara.[155] The spectacular discoveries at Yenikapı have repeatedly been revised upward, reaching some thirty vessels as of June 2008. Seventeen new ships were discovered in Sardinia in 1999–2000.[156] Individual wrecks show up almost monthly.

Scholars have turned to the new data with alacrity. Splendidly detailed excavation and publication of well-preserved wrecks such as Yassı Ada open rare but magnificent windows on *one* specific voyage that, as it turns out, failed to reach its destination. Given their tremendous cost in money and man hours, such publications will remain rare. Moreover, the full interpretive potential of these well-published excavations emerges only when they are set against the large data set of all imperfectly known wrecks. As frustrating as hundreds of poorly published wrecks can be, such large numbers muffle the "noise" of imperfection and error. Historians and archaeologists often struggle to accept this fundamental precept of modern economic investigation, conditioned as we are to exhaustively investigate one small source or site at the expense of the wider view made possible by hundreds of sometimes faulty pieces of data.

The abundant if imperfect new data evince broad patterns to which each shipwreck adds a uniquely revealing stroke. The patterns of ancient communications, their intensity, and their infrastructure offer precious proxy data illuminating the arteries and pulse of the ancient economy. The wrecks do not tell us directly how much cargo was loaded in Alexandria or Askalon, traveled up the Aegean, and was actually unloaded at Constantinople in a given period. But they do testify to the communications that moved on this and other routes, and so indirectly to the shipments that actually arrived. In other words shipwrecks, much like the amphorae, offer another type of indirect information: proxy data, such as modern economists use to assess current economic developments. To maximize the testimony of shipwrecks on the ancient economy, three considerations seem basic. We need to derive new data from independent sources to compare with the wrecks; we should leverage the economic significance of the shipwreck data by viewing it in aggregate in a geodatabase; finally, we must know what we do not know.

Texts tell us more if we mine them beyond the voyages they explicitly document to derive new analytical data from the proxy data they contain. From written sources we can construct databases of communications that lend themselves to different kinds of spatial analysis: the movements of traveler X from Rome to Constantinople or of letter Y from Carthage to Rome.[157] Scholars have yet to draw on the superb prosopographies of the late Roman or middle Byzantine periods to compare the travels they document with shipwrecks. The methodological advantage is clear: travelers' movements recorded in texts survive independently of the shipwrecks. Because of this independence, and because information on travelers' movements is considerably more

καὶ ἤπειρος ἦν ἡ θάλασσα, τίς ἂν ἴσχυσε τῶν ἐμπόρων, τοσαύτης ὁδοῦ προκειμένης, ἢ τὸ ἐνδέον ἑκάστῃ χώρᾳ φέρειν, ἢ τὸ περιττὸν ἐκφέρειν; Νῦν δὲ αὗτη τὰ νῶτα τοῖς πλεῖν βουλομένοις παρέχουσα, καὶ τῶν πωλούντων καὶ τῶν ὠνουμένων τὰς χρείας ἀποπληροῖ. John of Damascus echoed this thought, explicitly invoking supply of what is in surplus and demand for what is lacking, in *Sacra parallela,* PG 96:48C: Θάλασσα συνάπτει δι' ἑαυτῆς ἀκώλυτον τοῖς ναυτιλομένοις τὴν ἐπιμιξίαν παρεχομένη, καὶ πλούτου πρόξενος ἐμπόροις γίνεται, καὶ τὰς τοῦ βίου χρείας ἐπανορθοῦται ῥᾳδίως· ἐξαγωγὴν μὲν τῶν περιττῶν τοῖς εὐθηνουμένοις παρεχομένη, ἐπανόρθωσιν δὲ τοῦ λείποντος χαριζομένη τοῖς ἐνδεέσιν.

154 Parker, *Ancient Shipwrecks*. This essay was already completed when I gained access to the thoughtful comments of Parker, "Artifact Distributions and Wreck Locations," with its valuable suggestions on how, e.g., to detect economically significant patterns from cargo distributions.

155 Günsenin, "Medieval Trade," 129–32; cf. her website: www.nautarch.org.

156 R. D'Oriano and E. Riccardi, "Les épaves d'Olbie," in *Barbares en Méditerranée de la Rome tardive au début de l'Islam,* ed. S. Kingsley (London, 2004), 89–95.

157 This is the method that I applied for the eighth and ninth centuries in McCormick, *Origins of the European Economy,* 592–604. More studies are beginning to apply similar methods, for instance the network analysis of affinities among peoples and places in the ninth-century northern seas as they appear in the *Life* of the missionary St. Anskar, mapped against the archaeologically documented movement of material goods in the same period by S. M. Sindbæk, "The Small World of the Vikings: Networks in Early Medieval Communication and Exchange," *Norwegian Archaeological Review* 40 (2007): 59–74.

abundant and precise than that on the wrecks will ever be, they expand and correct the testimony from the sea bottom.

Other series of data call out for similar treatment. As we have seen, archaeologists are making the origins and movement of ceramic vessels ever more clear. But so far the resulting patterns over time and space are rarely laid out *next* to those related to shipwrecks and people. Coins offer more exact chronology and geography. A new study of how Byzantine coins moved around the Mediterranean uncovers directional axes that fit what we know of shipping, of ceramics, and of broad economic trends.[158] A next important step would compile the numismatic data into a geodatabase and, again, compare in detail movements of coins with those of ships, people, and ceramics.

Each type of source opens another window on a different facet of the reality of early shipping and the economic movements it implies. For example, late Roman astrologers drew horoscopes for merchants in northern ports who anxiously awaited ships overdue from the southern Mediterranean. In some ways, the wreck evidence looks different from that offered by fifth-century astrology. The horoscopes show what the freighters loaded for northern markets. In an African port, one had taken on camels, expensive curtains, bed furnishings, and silver-decorated litters; in Alexandria, another had stowed papyrus, pet birds, bronze cooking vessels, and a specially designed cabinet filled with medicine.[159] The warm conditions of the Mediterranean may militate against preserving the bones of pet birds and camels; so far only the medicine cabinet and cookware have archaeological parallels on the seabed.[160] Of course, the missing cargoes of papyrus, curtains, and the like are largely perishable. In other ways, however, the horoscopes fit the wreck evidence—for instance, when they underscore the potential variety of a ship's cargo.[161] Certainly the Genizah letters indicate that diversity was common, even within packaged shipping bundles.[162] Some well-preserved and excavated wrecks do show substantial variety of cargo.[163] But did cargo heterogeneity vary by period and routes?

Meticulous studies of individual shipwrecks show us more when viewed against the broader backdrop of all shipwrecks. Like it or not, economic history requires simplifying and aggregating the data. We must organize the available shipwreck data in geodatabases, the only practical way of analyzing complexes of evidence which number in the hundreds. A geodatabase is a spatial database whose essential data—shipwrecks, geographic coordinates, date, types of cargo, size, and so on—can be interrogated over time and space. Indispensable breadth can be achieved only at the cost of depth. Our geodatabase includes approximate geographic coordinates, and it functions as part of a Geographic Information System (GIS)—in our case, ARCMAP 9.2. To that end,

158 C. Morrisson, "La monnaie sur les routes fluviales et maritimes des échanges dans le monde méditerranéen (VI^{e}–IX^{e} siècle)," in *L'acqua nei secoli altomedievali (Spoleto, 12–17 aprile 2007),* Settimane de studio del centro italiano di studi sull'alto medioevo 55 (Spoleto, 2008), 631–70.

159 *Catalogus codicum astrologorum graecorum,* vol. 1, *Codices florentini,* ed. A. Olivieri (Brussels, 1898), 102–4; cf. ibid., vol. 6, *Codices vindobonenses,* ed. G. Kroll (Brussels, 1903), 14; and esp. G. Dagron and J. Rougé, "Trois horoscopes de voyages en mer," *REB* 40 (1982): 117–33, here 123–25, 129–30.

160 E. Ciabatti, F. Nicosia, E. Riccardi, et al., "La nave delle spezie," *Archeo: Attualità del passato* 58 (1989): 22–31, from a wreck of the second–first century BCE, off Livorno; copper cookware: Grazel 2 (my 358; Parker no. 483). I am grateful to my colleague Noreen Tuross for insights into the effect of salt water on bone. Since part of the point of the astrologer's handbook is to show how marvelous the identifications of the cargoes were, it is not impossible that the author selected particularly unusual cargoes. Nevertheless, with more than 700 ancient shipwrecks from the Roman Empire, one might expect a bit more overlap!

161 See in general Parker, "Cargoes, Containers and Stowage," 89–90, 96.

162 Goitein, *A Mediterranean Society,* 1:332–39.

163 For mixed cargoes from the fifth and eleventh centuries, see, e.g., Santamaria, *L'épave Dramont "E,"* 27–97. Yassı Ada's detectible cargo consisted essentially of two types of amphorae: see G. F. Bass, "The Pottery," in G. F. Bass, F. H. van Doorninck Jr., et al., *Yassı Ada,* vol. 1, *A Seventh-Century Byzantine Shipwreck* (College Station, Tex., 1982), 155–88; van Alfen, "New Light," 202–13, has deduced from their metrology that different subtypes of LRA 1 could have been designed for three different types of liquids. Prof. van Doorninck suggests (personal communication) that these liquids should be interpreted as red (ῥούσιον, i.e., boiled sweet) and white (ἄσπρον, i.e., dry) wine and olive oil, on the basis of the density ratios of the two types of wine recorded in the poorly dated Byzantine metrological treatise that may have been compiled in the eleventh or twelfth centuries and is preserved in the fourteenth-century MS, Vatican, Biblioteca Apostolica, Pal. graec. 367, fols. 88–91, ed. E. Schilbach, *Byzantinische metrologische Quellen* (Düsseldorf, 1970), Text III.1, pp. 126–30, here 127.119–21. He kindly informs me further that after Yassı Ada's hold was loaded as full as possible with globular amphorae, reused LRA 1 amphorae were packed into the small space left between them and the deck beams. The Serçe Limanı wreck carried some perishable cargo, in addition to glass for recycling and wine and olive oil amphorae as well as some small packages of Islamic ceramics; G. F. Bass, ed., *Serçe Limanı: An Eleventh-Century Shipwreck* (College Station, Tex., 2004), 265–71.

some of my students and I worked with Harvard's Center for Geographic Analysis to build a simple geodatabase of shipwrecks from the first 1,500 years of our era.[164] A rough first draft involved a handful of key data about 1,034 shipwrecks at the time that this study was drafted. We aim to put it online as part of the free, Web-based set of geodatabases that form *The Digital Atlas of Roman and Medieval Civilization*.[165] The *Digital Atlas* will facilitate the creation of fine maps in standard cartographic format as well as interfaces with Google Earth or other satellite photos, and the format lends itself to spatial analyses of the sort that follow.

As of May 2008, ongoing research had added 220 (27 percent more) new wrecks, including northern ones, to those that Parker's magnificent repertory had already assembled for our period.[166] We have also updated the data on many older wrecks. Of the new wrecks, 136 are Mediterranean and strikingly few are undated. This increased success in determining their age reflects advancing knowledge of later ceramics, which remain the essential element in dating most wrecks.[167]

Figure 3.10 shows all 309 shipwrecks, old and new, broadly dated to the period between AD 300 and 1500. Right off the bat it refutes the argument that mapping shipwrecks reveals only where people like to scuba dive. Even leaving aside the deepwater wrecks emerging from robotic surveys—some of which the surveyors have generously communicated to us and figure on this map—the distribution of wrecks depicted in figure 3.10 is in no way confined to vacation hot spots. Second, the new wrecks are equally distributed in the western and eastern Mediterranean. Third, the poorly dated wrecks occur mostly along the same shipping routes as the new dated wrecks, perhaps hinting that they went down around the same time.

The new late Roman finds show continuing activity in the western Mediterranean. They also thicken the evidence for shipping in the eastern basin that was notably scarce in the original repertory. In fact, the new Mediterranean wrecks from 300 to about 1000 lie predominantly in the eastern sea; more ships from the High Middle Ages, down to 1500, occur in the western Mediterranean, even as finds continue in the east. Insofar as general navigating conditions allowed, ships on long-distance runs preferred the safer, northern rim of the sea. Although ships certainly sailed along the southern shores, local conditions there may have induced them to stay farther out to sea, and because of the state of modern archaeology as well as seabed conditions in the coastal countries, wreck reports in any case remain exceedingly rare.[168] Nevertheless, the ships from the southern rim are not completely invisible, at least indirectly. The powerful economic impetus emanating from late Roman Africa and Alexandria seems to me to explain the clustering of wrecks in two bottlenecks on the northbound routes. Shipwrecks with African cargoes, likely headed for Rome, cluster off the west coast of Sicily.[169] Similarly, some of

164 The main work on this particular database has been done by myself, Dr. J. Kirsten Atagouz, Kelly Lyn Gibson, and Alex Medico More, with unwavering GIS support from Dr. Guoping Huang, Dr. Wendy Guan, and of course Professor Peter Bol and the entire staff of Harvard's new Center for Geographic Analysis. Many colleagues in underwater archaeology have generously supplied additional information.

165 This project, the *Digital Atlas of Roman and Medieval Civilizations,* has been publicly available in a beta version since May 2010 under the aegis of the Center for Geographic Analysis of Harvard University: darmc.harvard.edu.

166 As of July 2010, the total has grown to 1,064.

167 Only seven newly discovered wrecks are dated with no greater specificity than between AD 1 and 1500; so far, just under half of all new wrecks (fifty-four) have been dated to within one century.

168 On this navigational fact, see J. H. Pryor, *Geography, Technology, and War: Studies in the Maritime History of the Mediterranean, 649–1571*, 2nd ed. (Cambridge, 1992), 20–24. As Prof. van Doorninck observes, Synesius makes exactly this nautical point when ca. AD 400 he described his voyage out of sight of the African coast in his *Ep.* 5, in *Synesii Cyrenensis epistolae,* ed. A. Garzya (Rome, 1979), 13.14–15.10. Obvious exceptions are the ships from Dor, Israel: see Kingsley, *A Sixth-Century AD Shipwreck,* 1–5, who notes (4) the fortuitous erosion of the sand deposits that had covered these wrecks, and the report of ship cargoes dating from the fourth century BC to the seventh century AD in the eastern port of Alexandria: www.archeologie-sous-marine.culture.fr/. Signs of suspected shipwrecks were also detected off Askalon, but they are believed to be deeply buried in the sediment piled up by local conditions: S. Wachsmann, "Underwater Survey, 1996–1997," in *Ashkelon*, vol. 1, *Introduction and Overview (1985–2006),* ed. L. E. Stager, J. David Schloen, and D. M. Master, Final Reports of the Leon Levy Expedition to Ashkelon 1 (Winona Lake, Ind., 2008), 97–99. Note that the maps that I made for this article do not show ships whose dating spans exceed three centuries; there are some poorly dated wrecks in this zone.

169 Late Roman wrecks off Sicily: Imera (my shipwreck no. 383, Parker no. 514, with African amphorae); "Isis" (my no. 387; not in Parker), with presumably a grain cargo, and a few amphorae, mostly African, see A. M. McCann, "The Isis Shipwreck, Skerki Bank," in *Barbarian Seas: Late Rome to Islam,* ed. S. Kingsley (London, 2004), 54–60; Levanzo 1 (my 446, unpublished, knowledge of which I owe to Jeffrey G. Royal) with ceramic tubes and

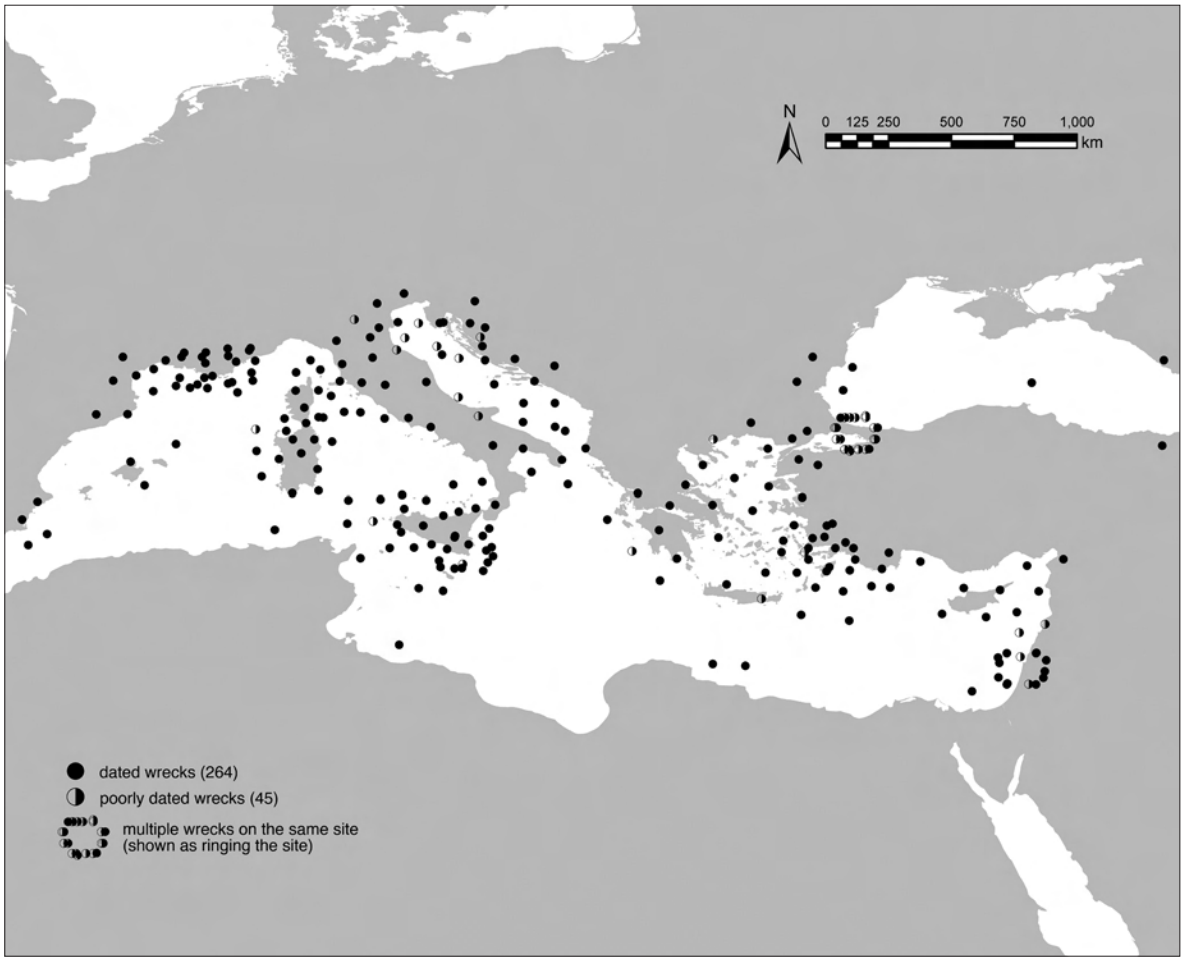

Figure 3.10. Total sites of new and old shipwrecks, AD 300–1500 (drawn by A. More)

the ships that went down off Rhodes, at the eastern entrance to the Aegean, must have been bound from or to Constantinople, possibly from Alexandria as well as other Levantine ports.[170] The chronology also echoes long-term shipping rhythms. Rhodes-area wrecks date from the entire period between 300 and 1500: the markets of the Aegean and Constantinople never lost their attraction.[171] Off western Sicily,

tableware, both of which would fit Africa well (cf. on African "vaulting" tube production Bonifay, *Études,* 441–42); Triscina 3 (my no. 935, Parker no. 1179), "'spatheia' and cylindrical amphoras," which is a good description of a typically African cargo. Capo Granitola 4 (my 170; Parker no. 232) was carrying "Asiatic" marble, and so not obviously on the Africa to Rome route, if the description is reliable. One or another of these particular ships could have been heading farther north, toward Marseille or Arles, but in the grand stream of shipping, until sometime in the fifth century they will have been far fewer than those making for the great capital. For the contraction of the Roman market, see note 206, below.

170 On the rise of Alexandria to late antique shipping supremacy, see McCormick, *Origins of the European Economy,* 104–10; for Egyptian merchants trading in Palestinian wine, see note 16, above. The database shows nine late antique wrecks between the fourth and seventh centuries. Four of the cargoes are unidentified amphorae, two show LRA 1 (mainly from Cilicia) amphorae, and one has amphorae attributed to the Aegean. Two seem to have cargoes from Palestine, judging from the description or identification of their amphorae: Iskandil Burnu 1 (my 388, Parker no. 518, late sixth century) and Pefkos (my 624; Parker no. 795).

171 In addition to the late antique wrecks enumerated in the preceding note, see Datca 2 (my 250; Parker no. 352), seventh–eighth centuries; Bozborun (my 83; Parker no. 111), late ninth century; Marmaris 1 (my 490; Parker no. 657), eighth–ninth centuries; Mandalya Gulf 3 (my 483, Parker no. 644), tenth century; Serçe Limanı Zone (my 841; Parker no. 1074), tenth–eleventh centuries; Kotu Burun (my 415; Parker no. 557), eleventh century; Çomlek Burun (my 231; not in Parker), eleventh–twelfth centuries; Serçe Limanı 1 (my 840; Parker no. 1070), ca. 1025; Camirus (my 129; Parker no. 167), thirteenth century; Knidos 4 (my 412; Parker no. 551), thirteenth–fourteenth centuries; Bozborun

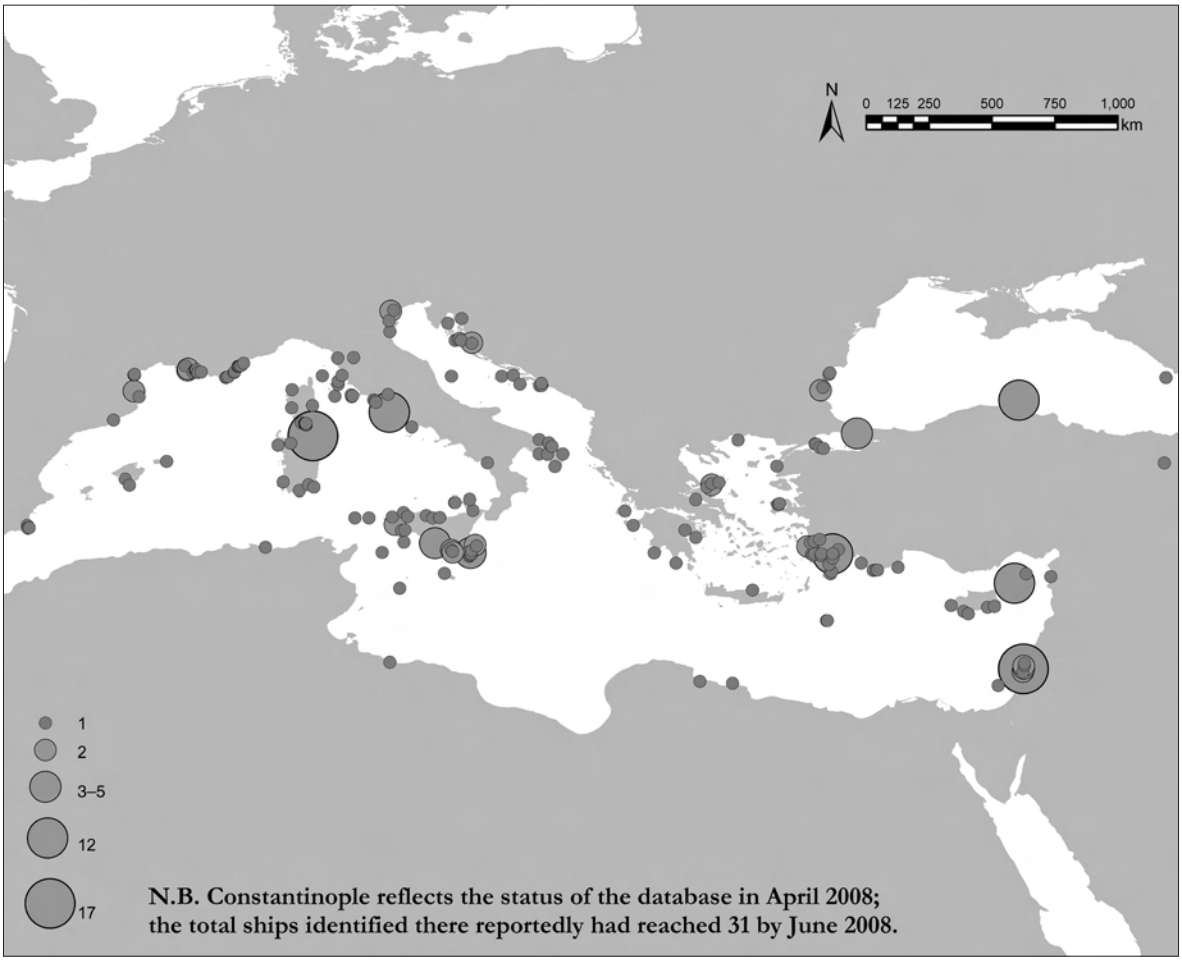

Figure 3.11. Numbers of dated shipwrecks by location, AD 300–1500; totals as of 2008 (drawn by A. More)

on the other hand, there is a considerable gap, beginning in the fifth century or so when the population, and therefore the demand that animated the city market of Rome, experienced catastrophic contraction. So far as we can see today, wrecks off western Sicily linking southern Europe and northern Africa pick up again only after 1000.[172]

Refining the map of datable shipwrecks to distinguish clusters of ships in the same locations throws into stronger relief the coast of southern Palestine, the entrance to the Aegean at Rhodes, and especially eastern Sicily (see fig. 3.11). The big cluster on Sardinia reflects the spectacular discovery in 1999 of seventeen ships. Fourteen apparently date to the hitherto poorly documented fifth century AD and seem to have been destroyed at dock at the same time, around 450, perhaps by a Vandal attack.[173] The value of these ships in shedding light on of the most obscure moments in Roman economic history should be extraordinary when they are suitably published.

Much ink has flowed over the famous charts of shipwrecks that first caught economic historians'

Armed Nave and Bozborun Galley (my 84–85; not in Parker), fifteenth–sixteenth centuries.

172 For late antique wrecks, see note 169, above. The first wreck after about 600 is Scoglio della Formica 2 (my 829; Parker no. 1053), ninth–eleventh centuries; Skerki Bank 1 (my 855; not in Parker), eleventh–thirteenth centuries; San Vito Lo Capo (my 810; not in Parker) and Marsala 1 and 2 (my 493, 494; Parker nos. 663–64), all twelfth century; Castellammare del Golfo (my 195; Parker no. 276) and Rocca di San Nicola 1 (my 764, Parker no. 989), both fifteenth century.

173 See note 176, below.

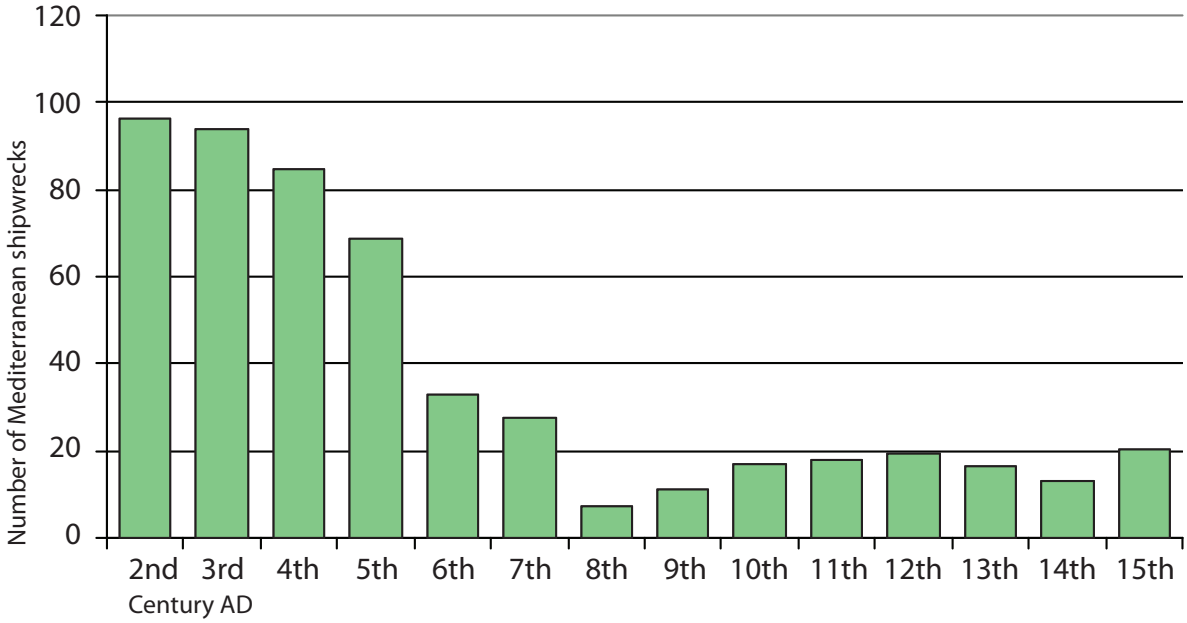

Figure 3.12. Total number of shipwrecks by century as of April 2008. Wrecks dated over multiple centuries are prorated; e.g., a wreck of 400–600 is counted as half a wreck in the 5th c. and half in the 6th (drawn by author).

attention.[174] Figure 3.12 graphs from our database the total numbers of datable shipwrecks, including less precisely dated ones, from the second century to ca. 1500.[175] It is tempting to see in this graph the broad trend of Mediterranean shipping and, through it, a *very* rough indicator of the general level of activity of the economy these vessels once served. Decline there is in late antiquity, but the drop is nowhere near as steep as it appeared in Parker's summary of the data available two decades ago.[176] Slow recovery seems to begin in the ninth century. From the eighth century forward, some believable rhythms are clear within the aggregate numbers of wrecks and lend those numbers general plausibility. Thus ship numbers decline in the fourteenth century, when plague sharply reduced Mediterranean populations and economies and created real difficulties for shipping, which conveyed the contagion. On the other hand, it seems strange that wrecks attributed to the thirteenth century should be fewer than those assigned to the twelfth. Moreover, it seems difficult to compare directly the absolute numbers of shipwrecks presently attributed to the period after 700 or 800 with those in the preceding centuries. The raw numbers of datable wrecks from the ninth to the fifteenth century remain distinctly lower than those of antiquity, yet no one doubts the vitality and great numbers of perhaps considerably bigger ships active

174 K. Hopkins, "Taxes and Trade in the Roman Empire (200 B.C.–A.D. 400)," *JRS* 70 (1980): 101–25, here, 106, fig. 1; R. MacMullen, *Corruption and the Decline of Rome* (New Haven, 1988), 8–9, figs. 6–7; Parker, *Ancient Shipwrecks,* 549, fig. 3; etc.

175 The graph accounts differently for the evidence by prorating shipwrecks dated to multiple centuries, rather than locating them at the chronological midpoint of their dating span. This approach may well give a better impression of the situation in our period, at the possible cost of blurring the differences between some centuries. Data for this graph are derived from 724 datable wrecks. Prorating the shares of ships according to the different centuries that fall within their dating span excludes shares that fall outside of the period 100–1500. For example, for a ship dating between 300 BC and AD 500, 1/8 is assigned to each century. Hence only 4/8 of the ship appears in the total of ships graphed between AD 100 and 1500.

176 Some differences between the two series of data indubitably reflect real change in our knowledge due to major discoveries—e.g., the fourteen new fifth-century ships found in a destruction layer at Olbia in Sardinia (see D'Oriano and Riccardi, "Les épaves d'Olbie"), or the spectacular new discoveries of Yenikapı, Istanbul. Others merely echo our different methods of counting: Parker included all ships datable to any span, and classified them according to the arithmetical midpoint of that span (see fig. 2.9). I included only ships that could be dated down to three centuries (a few) or less. See also note 179, below.

in the twelfth, thirteenth, or fifteenth centuries. Is it conceivable that the absolute numbers of ships afloat remained below those of antiquity at a time when one is inclined to think that the global economy was outstripping the balmy days of the early Roman Empire? If we allow that medieval ships were bigger and more efficient, a reduction in numbers seems at least plausible. But it is also likely that medieval ships were better built. From the twelfth century on, it is certain that the spread of charts and the compass improved navigation. These innovations must have lowered the sinking rate of ships afloat.[177] It is also possible that ships from the eighth century onward are less visible on the sea bottom because amphora typologies remain underdeveloped or because barrels progressively replaced amphorae, as western ships and their wooden containers proliferated across the Mediterranean Sea.[178]

The value of a geodatabase for understanding shipping changes over time emerges most clearly when we focus on centuries, decades, and, where possible, even shorter periods. Just because we find many fourth- and sixth-century shipwrecks along the same route does not mean that the route stayed equally active over the fifth century. Figure 3.13 displays 174 more closely dated wrecks that went down between 300 and 700.[179] Our knowledge ranges from bare mentions of unpublished survey discoveries to the sumptuously documented Yassı Ada wreck; mostly the publications are woefully incomplete. Even so, for this period, the evidence is now abundant enough that we can observe in figure 3.13 real structure, and real structural change.

Fourth- and fifth-century ships overwhelmingly predominate in the western Mediterranean; sixth- and seventh-century ships, conversely, dominate the eastern sea. This spatial and chronological distribution appears to reflect the differing fates of the two halves of the Roman Empire. In the fourth and fifth centuries, the late Roman world of markets and ships centered on the western part of the empire. The center of gravity shifted dramatically east over the next two centuries. It may be something like conventional wisdom that both east and west flourished more or less equally in the fourth century and that, in the course of the fifth century, the west declined while the east stayed the same or surged ahead. The map of these 174 wrecks suggests that this picture is too simple. If shipwrecks roughly track economic activity, then the map invites a rather startling question: might the western empire actually have been outperforming the eastern half, at least in the fourth century?[180]

Figure 3.13 further suggests the profound structuring effects of the two mega markets of the later Roman Empire: in the fourth and, to a lesser extent, the fifth century, the market—or exchange center—of Rome dominates visible Mediterranean shipping. In the sixth and seventh centuries, the center of gravity shifts to the routes leading to Constantinople, even if the capital itself remains, for the moment, underrepresented. But other, finer-grained developments also appear: thus, on the coast of Spain near Cartagena, we see mostly fourth- and fifth-century activity. Nevertheless, a rare shipwreck occurs in the sixth century precisely in the corner of Spain that the Byzantines reconquered and held for several generations. Similarly, we might be seeing in the seventh-century ships off the heel of Italy the demand created by the Byzantine forces who then held that strip of land against the Lombard invaders. The exceptional cluster of seven seventh-century wrecks off Syracuse echoes the beleaguered Byzantine government's deepening reliance on Sicily to finance those dark decades' desperate wars against the all-conquering Muslims.[181] Indeed, the

177 On the problem of the sinking rate, see below, 94–96. On developments in navigation and ship construction, see F. C. Lane, *Venice, a Maritime Republic* (Baltimore, 1973), 119–34, and Pryor, *Geography, Technology, and War,* 25–86.

178 F. C. Lane, "Progrès technologiques et productivité dans les transports maritimes de la fin du moyen âge au début des temps modernes," *RH* 510 (1974): 277–302, at 278.

179 These ships are all dated to, at most, a three-century span that falls within this period. When a wreck's date spans multiple centuries, it is recorded under the latest century, which may bias the picture somewhat toward the later century in each case. Thus the rather high numbers of fifth- and seventh-century ships could well reflect a fair number of wrecks from the preceding century. See also next note.

180 Of the forty-two wrecks assigned by our method to the fifth century, sixteen have date spans that would allow them to date from the fourth and one from the third century, making the fifth-century total less impressive overall. Fourteen have date spans that end in the first half of the fifth century; none have spans that end between 451 and 499.

181 McCormick, "Bateaux de vie, bateaux de mort," 77–80; C. Morrisson, "La Sicile byzantine: Une lueur dans les siècles obscurs," *Quaderni ticinesi di numismatica e antichità classiche* 27 (1998): 307–34; Prigent, "Le rôle des provinces." C. Zuckerman, "Learning from the Enemy and More: Studies in 'Dark Centuries' Byzantium," *Millennium* 2 (2005): 79–135, essentially accepts this broader point (see, e.g., 105, on the share of the Italian

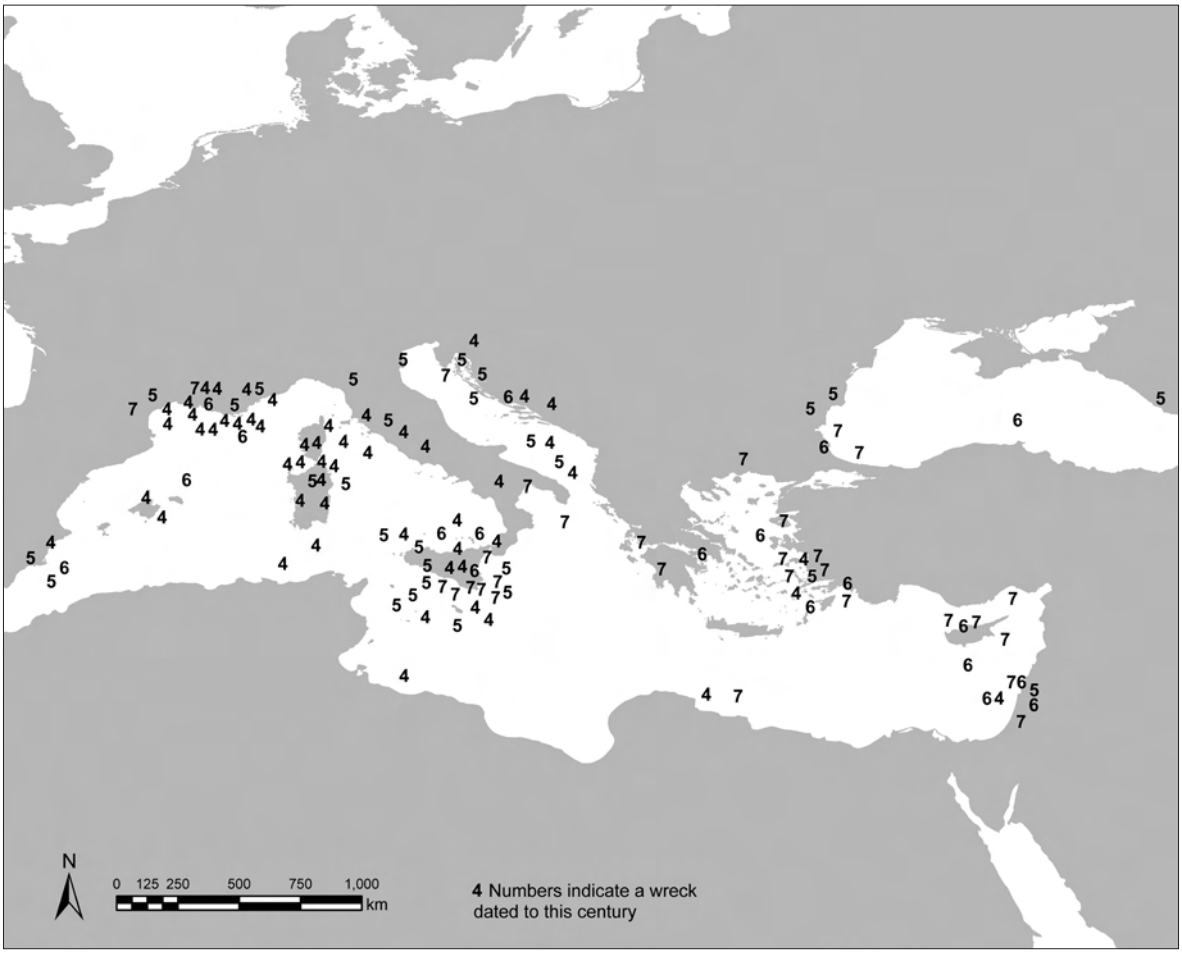

Figure 3.13. Dated shipwreck sites, ca. AD 300–700; these 132 sites contain 174 ships. Each is assigned a number identifying the century to which it is dated (drawn by A. More)

appearance of fifth-century wrecks on the *southeastern* coast of Sicily—ships therefore probably *not* en route to or returning from Rome—likely reflects the growing attractive power, at Rome's expense, of Constantinople and the east for the annona and associated products. That flow of African grain and oil continued after the Vandal conquest, when it can only have been commercial, not fiscal. Land archaeology shows that African fine and coarse wares and petty coins, including those issued by Vandals, moved along just this shipping axis.[182]

Sea routes cannot be isolated from the overall economic networks of which they were an integral part. If we imagine the shipping routes implied by these wrecks as arteries, we quickly see that the economic organism also needed capillaries to move the goods to markets. As Gaza's camel trains suggest, sea shipment often implies land or river transport of goods.[183] By the same token, the numbers

territories in contemporary imperial revenues), while offering a different but plausible interpretation of the unusual term *nauticatio* in the *Liber pontificalis*.

182 J. W. Hayes, *Excavations at Saraçhane in Istanbul,* vol. 2, *The Pottery* (Princeton, N.J., 1992), 5–7, with further references; Bonifay, *Études,* 479–82; Morrisson, "La monnaie sur les routes," 644–45, 655.

183 This system would probably have included significant redistribution centers such as, e.g., Carthage, Pozzuoli, Narbonne, and Ostia for the high imperial period; these, as Tchernia among others has insisted, must have assembled goods from different regions and reexported them elsewhere, complicating efforts to track ships' courses based on the heterogeneous geographic profiles of some cargoes, notwithstanding valuable stud-

of ships under way must somehow reflect the numbers of people and the strength of demand in particular markets. Consider the best explored example, along the French coast; there, the size and structure of the interior market fed by river and road transport from southern sea routes surely changed a number of times between 300 and 1000.[184] The Tetrarchic reintegration of Gaul into the greater Roman political economy and the rise of the new capital at Trier must have reinvigorated Mediterranean shipping funneling into the Rhone corridor. The *Expositio totius mundi* testifies to just such an influx of goods. The subsequent collapse of the Rhine frontier and the imperial retreat down to Arles will have disrupted the further reaches of the supply network, and amputated demand.[185] The broader Gaulish market to which shipping led undoubtedly shrank in tandem with these changes in demand.

Each change presumably affected the intensity of shipping along the sea routes feeding the inland river and road transport network that, for several generations, conveyed wares north to Trier, the voracious consumer city on the Moselle. This effect appears to be exactly what we see in figure 3.14. In our period, fourth-century shipwrecks predominate on the maritime approaches to Marseille and the Rhone River transport system north to Trier. A little to the east, at Nice, the map reveals an equally clear link between the capillaries of inland transport systems—here the Roman roads—and the artery, the sea route. It also shows how wrecks seem to dwindle away in the fifth century as the area under imperial control shrank and the Gaulish market as a whole contracted violently both in size and, we may suspect, in purchasing power. Yet this corner of our geodatabase also indicates that a few ships continued to serve the demand of Merovingian markets, now starkly reduced—but not stilled—as the papyrus and Gaza wine made famous by Henri Pirenne continued to reach the Rhone until about 700.[186]

The summary reports of ship's gear and cargoes illustrate another aspect of the geodatabase's potential for the history of markets. Invented in the late first century AD, the portable and handy steelyard weighing scale (see fig. 16.5) spread across the entire Roman Empire. It could weigh goods quickly and accurately in quantities running from a few ounces to 400 Roman pounds (ca. 130 kg).[187] An operational approach again suggests interesting questions. How were steelyard balances used aboard ship, and what might that use tell us about changes in the economy? Their spread was likely connected with what appears to be the late Roman tendency to measure by weight rather than by volume the sorts of commodities transported by ship.[188] Considering the mass and time involved, it seems unlikely that steelyards, which typically run up to 50 or 100 pounds, were used in the process of loading ballast or cargo. Instead, experienced captains probably adjusted ballast by eye as they inspected the amount and types of cargoes they would be carrying, particularly since standardized amphora sizes aided them in estimating cargo weights.

In fact, the Byzantines associated scales mainly with buying and selling—that is, with markets.[189]

ies such as P. Reynolds, *Trade in the Western Mediterranean, AD 400–700: The Ceramic Evidence,* BAR International Series 604 (Oxford, 1995); see A. Tchernia, "Épaves antiques, routes maritimes directes et routes de redistribution," in *Nourrir les cités de Méditerranée: Antiquité-Temps modernes,* ed. B. Marin and C. Virlouvet (Paris, 2003), 613–21. Carthage, Constantinople, Marseilles, Alexandria, and Antioch presumably played this kind of role to some degree, as yet uncertain, between the fourth and seventh centuries.

184 See the exemplary study of wine shipments along this route in the republican and early imperial period: Tchernia, *Le vin de l'Italie romaine*.

185 E. M. Wightman, *Gallia Belgica* (London, 1985), 267–81, 300–311, remains a good place to start; for more recent developments, see, e.g., H. W. Böhme, "Lahnstein und der Mittelrhein in spätrömischer Zeit," in *Berichte zur Archäologie an Mittelrhein und Mosel,* ed. H.-H. Wegner, vol. 8, Trierer Zeitschrift für Geschichte und Kunst des Trierer Landes und seiner Nachbargebiete; Beiheft 27 (Trier, 2003), 11–19.

186 H. Pirenne, *Mahomet et Charlemagne,* 3rd ed. (Paris, 1937). For recent thinking about these two imports into Gaul, and the complicated question of just what sea route ended when, see McCormick, *Origins of the European Economy,* 35–36, 704–8. For the latest on the Gazan wine trade to Gaul, see Pieri, *Le commerce du vin oriental,* as well as idem, "Regional and Interregional Exchanges in the Eastern Mediterranean during the Early Byzantine Period: The Evidence of Amphorae," in this volume, 27–49.

187 P. Weiss, "Schnellwaage," *Der Neue Pauly* (Brill, 2008; Brill Online), www.brillonline.nl/subscriber/entry?entry=dnp_e1104120, accessed 15 April 2008.

188 See van Alfen, "New Light," 205.

189 This is true in obvious contexts, for example patriarch John the Almsgiver's control of weights and measures in Alexandria: Leontius of Neapolis, *Vita Ioannis Eleemosynarii* (*BHG* 886d), 2, ed. A. J. Festugière, *Léontios de Néapolis, Vie de Syméon le Fou, Vie de Jean de Chypre,* Bibliothèque archéologique et historique 95 (Paris, 1974), 348.2–11: πάντα ἐν ἑνὶ καμπανῷ καὶ ζυγῷ καὶ μοδίῳ καὶ ἀρτάβῃ πωλεῖν καὶ ἀγοράζειν; cf. the frequent mentions in the *Book of the Prefect,* which regulates sealing of weights and measures in Constantinople's markets: *Das Eparchenbuch* 11.9,

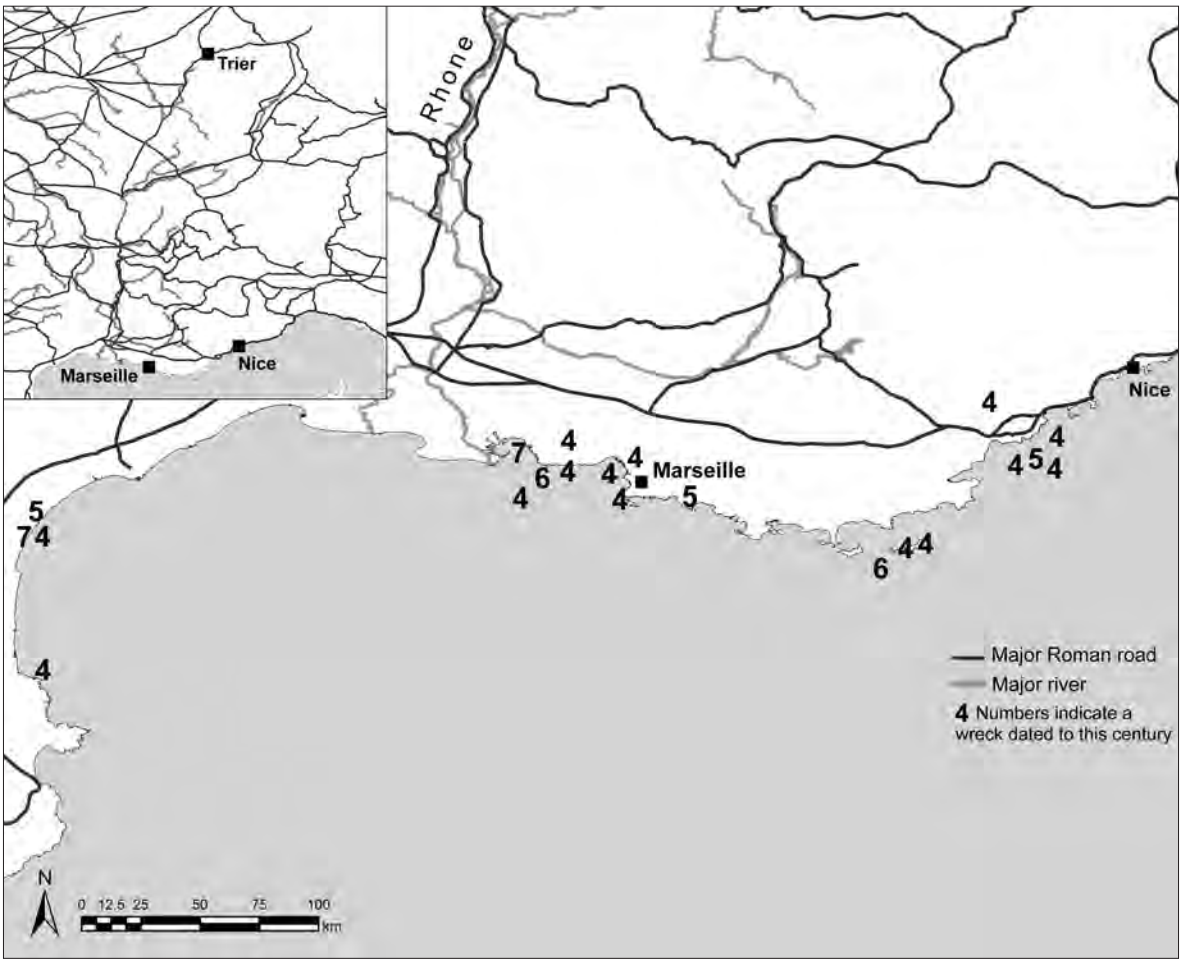

Figure 3.14. Shipwrecks off Gaul, ca. AD 300–700 (numbers identify the century to which a wreck is dated) (drawn by A. More)

One can easily imagine shipboard merchants using steelyard balances to weigh quantities of textiles, oil, or grain they bought or sold. Balances on board might suggest that in many cases their owners were directly buying and selling at shipside—retail—rather than transporting goods for delivery to a wholesale distributor. The chronological distribution of these balances within the geodatabase provides further food for thought. Weighing scales of any sort are not common among wreck finds; only twelve occur among our hundreds of more or less datable Mediterranean wrecks. Nevertheless, they are twice as frequent aboard late Roman and medieval wrecks as the more abundant wrecks from the earlier Roman Empire.[190] This hints that

116.524–27, on wax dealers tampering with steelyard balances; also, like Leontius, the regulator distinguishes between (gross) wares sold with steelyards and those weighed more finely with conventional balances, 10.5 (112.489–91) or 13.1 (118.565–66); cf. G. Vikan and A. Cutler, "Balance Scales," *ODB* 1:247; G. Vikan, "Steelyard" and "Weights," *ODB* 3:1947, 2194–95; and B. Pitarakis, "Daily Life at the Marketplace in Late Antiquity and Byzantium," in this volume, 401–5. The pseudepigraphical work of John "of Jerusalem," *De sacris imaginibus contra Constantinum Cabalinum* 14, PG 95:331, which seems to have been written between 775 and 787, possibly at Constantinople, inveighs against bishops whose main concern is making money and wondering how they could "sell grain, distribute wine, weigh oil with a steelyard (πῶς καμπανίσωσι τὸ ἔλαιον), deal in wool or raw silk." On this work, see M.-F. Auzépy, "L'*Adversus Constantinum Caballinum* et Jean de Jérusalem," *BSl* 56 (1995): 323–38.

190 Of the approximately 410 datable Mediterranean wrecks in our geodatabase from before ca. AD 300, only 5 (1.2 percent) are recorded as having had weighing devices aboard. Such devices are reported on 7 (2.5 percent) of the 280-some wrecks known after

Figure 3.15. Late Roman mosaic of a beachside market. Wares are being unloaded from the ship drawn up toward the beach, and weighed with a balance scale on the left (photo courtesy of the Institut national d'archéologie et d'art, Musée du Bardo, Tunis)

between 300 and 1500, shippers were more likely to buy and sell goods directly in markets that lacked established weighing procedures or stations, markets perhaps like the beachside one depicted in the late Roman sermon quoted above, or in the African mosaic shown in figure 3.15 (though that has a balance rather than a steelyard scale). The evidence made available by the geodatabase of shipwrecks tallies with Valentinian III's law against covert markets.[191] More ship landings could have represented instant mini-market events: some—many?—shipboard merchants engaged directly in buying and selling at shipside rather than simply transporting goods for delivery to established permanent markets. One suspects that in later centuries such informal, beachside markets dodged the tax mechanisms of the Byzantine state. Ninth-century Italy points in this direction, as do the efforts of its kings to repress such markets,[192] providing evidence of more atomized or unregulated markets alongside permanent ones. Though this may be only a first impression, it hints at how much light the gear observed aboard shipwrecks can shed on market structures when the data are viewed in aggregate.

Seeing Shipwrecks, Cargoes, and Economies: Some Caveats

Along the coast of late Roman Gaul and in the plague conditions of the fourteenth century, the rise and fall of numbers of shipwrecks look to correlate well with broader economic trends. But are we seeing more or less directly the rise and fall of economies? Some important caveats apply. To truly understand what we know, we need to know what we do not yet know, and how those unknowns can affect the economic interpretation of shipwrecks.

The growing number of the nautical equivalent of field-walking surveys is crucial. Those organized by the Institute of Nautical Archaeology of Texas A&M University seem especially promising, particularly insofar as they record in a given area *all* visible wrecks from *all* periods, including that important group, "undated."[193] Knowledge of undated wrecks is imperative if we are to identify the margin of error. When we know all discernible shipwrecks, even those in small (but perhaps well-chosen) zones

300. Given that considerably more early Roman wrecks have been more fully excavated, the absence is more striking. Indeed, five out of the seven postclassical ships with weighing scales occur between the fourth and seventh centuries.

191 See note 12, above.

192 McCormick, *Origins of the European Economy,* 781.

193 See, for instance, the invaluable surveys organized and regularly summarized by the Institute of Nautical Archaeology: e.g., J. Leidwanger and D. S. Howitt-Marshall, "Episkopi Bay and Beyond: Recent Collaborative Fieldwork and New Prospects on Cyprus," *Institute of Nautical Archaeology Quarterly* 33.2 (2006): 13–14; J. G. Royal, "Description and Analysis of the Finds from the 2006 Turkish Coastal Survey: Marmaris and Bodrum," *International Journal of Nautical Archaeology* 37 (2008): 88–97.

leading to and from key market centers, we can plot better charts of the rise and fall of wrecks, and maybe also gain a better sense of the rise and fall of traffic. To gauge the changing intensity of traffic, blanks—places or periods without wrecks—on underwater survey maps are no less important than signs marking the presence of wrecks, particularly if we have a clear grasp of the factors that shape their visibility.

Fathoming the ships' economic significance depends on understanding the broader economy that produced the wrecks. Thus, although some might see an apparent drop in shipwrecks in the sixth or the fourteenth centuries as directly indicating economic decline, other considerations complicate such an inference. If, for example, the overall population declined *at the same rate* as shipwrecks dropped—think Justinianic plague or the Black Death—that would suggest no per capita economic decline in shipping. If in fact the wrecks declined at a *slower* rate than the population dropped, the decline could actually indicate an *increase* in per capita economic activity. That is not at all unthinkable: studies of the late medieval Black Death have shown that once they overcame the initial disarray caused by the massive die-off, survivors inherited the wealth of the deceased and, one way or another, some social groups began to do much better than before the plague.[194] The first hints might be coming from archaeology that something similar was afoot in the late Roman economy toward the end of the sixth century.[195] We can adjust for such complications, but we need to remember them.

Ship sizes have attracted attention. Late Roman decline has sometimes been connected with decreasing ship capacities.[196] Nevertheless, there is also a consensus that throughout the premodern period, smaller ships must have been the most common cargo carriers in the Mediterranean. Parker estimated that such smaller ships would have borne under 75 tons of cargo.[197] Now the number of ships for which we can *directly* estimate carrying capacity is very limited, essentially just the well-preserved, fully excavated and published vessels. Another rather rough but useful benchmark is easier to come by: approximate wreck length.[198]

The data are numerous and interesting. Useful approximate lengths are known for 108 Mediterranean vessels.[199] Of the fifty-three more or less well dated late Roman and medieval wrecks in our geodatabase that offer this evidence, the modal length (twelve ships, 22.6 percent) is 20 meters, the size of Yassı Ada. Nine (16.9 percent) are at least 30 meters long. Over half—twenty-nine (54.7 percent)—run between 20 and 50 meters long, and sixteen of those are pre-700 (i.e., the picture is not distorted by the bigger late medieval ships). For the early Roman Empire, we can adduce lengths for fifty-five ships. The largest size class is approximately as well represented in the first three centuries of our era as in the later period: thirty ships (53.5 percent of the total number) run above 20 meters long. The one probable aberrant case—a giant ship (ca. 104 meters)—was likely built for one specific voyage. Otherwise, the longest ancient vessel measures 45 meters; the longest late Roman ship, about 50 meters.[200] Two differences nonetheless reinforce the conventional

194 See, for instance, D. Herlihy, *Medieval and Renaissance Pistoia: The Social History of an Italian Town, 1200–1430* (New Haven, 1967), 142–47; C. Dyer, *Making a Living in the Middle Ages: The People of Britain, 850–1520* (New Haven, 2002), 278–86.

195 On archaeological evidence for the economic dynamism of Byzacena ca. 600, see Bonifay, *Études,* 482; for Syria-Palestine after Justinian, see Magness, *Early Islamic Settlement,* 195–214; Walmsley, *Early Islamic Syria,* 34–45. For a possible reflection of this growth in per capita wealth connected with Negev wine transport, see note 100, above.

196 Pryor, *Geography, Technology, and War,* 26–27, with further references.

197 Parker sorts ancient freighters into three different size classes: the smallest, under 75 tons of cargo (always the most numerous group); medium ships, with cargoes ranging from 75 to 200 tons; and the largest, with cargoes over 250 tons: Parker, *Ancient Shipwrecks,* 26; cf. McCormick, *Origins of the European Economy,* 95–96, 415–18.

198 Since the overwhelming majority of preserved shipwrecks are cargo vessels, and therefore "round" ships, there is little danger that the picture will be confused with large numbers of "long" narrow warships. Two caveats about the data: first, in many cases, the length measurement probably or certainly represents the part of the hull that can be seen or is preserved. It is therefore a minimum figure. Second, in other cases, the measurements derive from the cargo deposit, which sometimes can spread on the sea bottom or be disturbed, thereby producing a measure that may more or less exceed the actual hull of the ship.

199 In the state of the database used for this chapter, length could be approximated for 126 vessels, but 17 vessels were under 10 m (10 before the fourth century; 7 from the fourth to the fifteenth century) and excluded from consideration as being very poorly preserved or, most frequently, ships' boats and the like.

200 The giant ship, Fiumicino 12 (my 303; Parker no. 412), is believed to be preserved in the mole of the Claudian harbor, and to have been specially constructed to transport an obelisk from Egypt. It is clearly an exception.

wisdom that ship sizes ran somewhat bigger under the early Roman Empire: at 25 meters, the modal length in the first three centuries—nine ships—exceeds that in the later period by 25 percent. Also, twelve ships (21.4 percent of the total) are 30 meters or longer. In the future it will be important to compare and strengthen these data with other types of evidence developed by imaginative scholars. For instance, anchors often show up on the sea bottom. The patterns of evolution and the distribution of their types and sizes should reflect the size of the ships they once anchored.[201]

So it is fair to say that the evidence today confirms that ships in our period ran somewhat smaller than in the earlier Roman Empire. If we assume that the sinking and visibility rates of the later vessels remained the same as earlier (on which see below), then we might deduce that overall transport volume fell after about 300—and we might be tempted further to argue that this fall is a sign of economic contraction. That latter claim may be true, but several factors complicate it.

Beyond the state of harbor maintenance—whether harbors that silted up from ancient erosion were dredged to maintain depths for bigger ships—I have argued elsewhere that the subsidy system devised by the Roman state to ensure the transport of fiscal grain to the capitals created incentives to build smaller ships.[202] If the subsidized ships were free to pursue their own commercial ambitions after making the required voyage to deliver grain or oil to the capital, it was in the shipowner's interest to have a smaller ship that could be unloaded faster—then as now, delays at unloading were clearly a problem—so that he could quickly return to sea and business. Under these conditions, one could imagine that smaller ships transported cargoes more intensively than bigger ships, increasing the velocity at which goods moved.

A second element, arising from what we have seen about containers, complicates the deductions that we can draw from ship size: how might changes in packaging have affected effective cargoes, that is, cargoes minus the weight and volume of containers? For goods such as grain, transported loose or in sacks, the amount moved at one time by a smaller ship would certainly have decreased. However, it has been claimed that late antique amphorae were more efficient than those of the high Roman Empire: that is, as potters made them thinner, lighter, and stronger, the ratio of the weight of the container to its contents dropped.[203] If that is correct, then the actual total weight of a ship's cargo traded and transported in heavy amphorae will have fallen as later amphorae became lighter. In other words, a smaller ship using the lighter amphorae could transport the same amount of wares as its larger predecessors. This crucial consideration in the economics of transporting amphorae deserves more systematic scrutiny.

What we have seen of late Roman barrels indicates that regardless of changes in the number and size of transport ships, we must allow for a decline in the proportion of cargoes shipped in amphorae between the third and the seventh centuries. I see

201 This thoughtful suggestion comes from Prof. van Doorninck.

202 McCormick, "Bateaux de vie, bateaux de mort," 103–5. The case for accelerated erosion in the late Roman period is well made for northwestern Europe by H. Löhr, "Intensivierte Bodenerosion als Folge römischer Landnutzung in der Trierer Talweite und ihrem Umfeld," in *Kelten, Germanen, Römer im Mittelgebirgsraum zwischen Luxemburg und Thüringen,* ed. A. Haffner and S. von Schnurbein, vol. 5, Kolloquien zur Vor- und Frühgeschichte 1 (Bonn, 2000), 175–99. One suspects that some of the widely attested silting up of eastern ports occurred in late antiquity, insofar as similar causes explain similar effects in the eastern empire, although detailed study and verification are necessary. The find circumstances of the ships in the Theodosian harbor of Constantinople, in what is now the dry land site of Yenikapı at what was once the mouth of the river Lykos, indicate that they owe their extraordinary preservation to having been buried as the harbor silted up. See the eloquent image in R. Asal, "İstanbul'un ticareti ve Theodosius Limanı," in *Gün ışığında,* 180–89, at 187, fig. 5. Early reports indicate that the earliest Yenikapı wrecks come from the seventh century, providing a first element toward establishing the chronology of decline of Constantinople's greatest late antique harbor.

203 Pieri, *Le commerce du vin oriental,* 68, states that makers of late Roman eastern amphorae were able to reduce to a minimum the weight of the amphora in relation to its content, but supplies no details. See van Alfen, "New Light," 208, a useful discussion of amphora efficiency, and calculates the efficiency of LRA 1 at 1.9 L per kg of amphora, while that of LRA 2 was strikingly superior at 3.3 L per kg of empty amphora. Because the otherwise precious online catalogue of amphora types of Keay and Williams, "Roman Amphorae: A Digital Resource," ads.ahds.ac.uk/catalogue/archive/amphora_ahrb_2005, accessed multiple times between June and October 2008, normally lists the approximate capacity but not the empty weight of amphorae, it is difficult to verify and develop Pieri's assertion. However, the calculation for the earlier Roman amphora Dressel 20 (see note 81, above), shows that it was slightly more efficient than the LRA 1 but less efficient than the LRA 2. The table of weights and capacity efficiencies in Peacock and Williams, *Amphorae and the Roman Economy,* 52, table 1, does not seem to provide obvious support for the claim that amphora efficiencies generally improved.

no clear way at present to quantify this change and assess how much of the drop in visible cargoes can be attributed to the use of containers that almost never leave remnants on the seabed. The ingenious method for detecting increased use of barrels on Roman sites in Gaul or among imports to Rome nevertheless suggests a way forward. André Tchernia made a persuasive case that the sudden decline in wine amphorae at Ostia in the second century means not that the Romans were drinking less but that much of the wine had begun arriving in barrels, which left no archaeological traces.[204] Similarly, in the Roman north, the proportion of wine to oil amphorae is strikingly lower in military camps than in comparable civilian settlements, suggesting that the soldiers received their wine in kegs.[205] Tchernia at first hesitated to draw the same conclusion from a similar fourth-century decline in wine amphorae at Ostia, attributing it instead to a sharp drop in the population of Rome, an opinion then not contradicted by the apparent absence of evidence for barrels in Roman Africa.

Today most scholars tend to place Rome's urban decline later, in the late fourth or even fifth century.[206] We have seen that wine barrels were in fact familiar in Africa. Moreover, some classes of African amphorae formerly associated with olive oil have now been claimed for wine. Thus African, Italian, and Gaulish transports in barrels as well as amphorae newly identified as wine containers, not changes in demand, probably account for some of the shift in proportions of amphorae associated with particular wares in the fourth-century Roman market.[207] In those regions of the late Roman world that had the wood required for barrels, we can watch between the second and the fifth centuries for the disappearance of export amphora series—or, in the case of wine, of amphorae lined with the resin used to seal their interior. If other wares from the same areas continue to flow to consumers at various sites, and no obvious competing wine supply appears, then we might well hypothesize that such changing patterns in ceramics reflect new packaging rather than a shift in what is being exported and imported. Further clues as to when and where barrels became dominant may lurk in the design of docks. What is the history of ramps at the water's edge? At what time and in what place did they begin to appear at quaysides alongside steps? It is possible that ramps were suited to rolling barrels into vessels, particularly if their design turns out to match changes in naval architecture.[208] The obvious places in the Mediterranean where such a shift could have occurred are Gaul, the head of the Adriatic, perhaps heavily wooded parts of southern Italy, Africa, southern Asia Minor, and the forested Black Sea coast.[209] It may be a coincidence, but it is strik-

204 Tchernia, *Le vin de l'Italie romaine,* 292–99. A recent excavation and ceramic study executed at Ostia with an eye to statistical exploitation came to a similar conclusion, albeit very cautiously phrased; see A. Martin, "Imports at Ostia in the Imperial Period and Late Antiquity: The Amphora Evidence from the DAI-AAR Excavations," in Hohlfelder, ed., *The Maritime World of Ancient Rome,* 105–18, at 112.

205 Marlière, *L'outre et le tonneau,* 193.

206 On Rome's fifth-century decline, see, e.g., R. Meneghini and R. Santangeli Valenzani, "La trasformazione del tessuto urbano tra V e IX secolo," in *Roma dall'antichità al medioevo: Archeologia e storia nel Museo nazionale romano Crypta Balbi,* ed. M. S. Arena, P. Delogu, L. Paroli, et al. (Milan, 2001), 20–33; cf. B. Lançon, *Rome in Late Antiquity: Everyday Life and Urban Change, AD 312–609* (Edinburgh, 2000), 14. N. Purcell, "The Populace of Rome in Late Antiquity: Problems of Classification and Historical Description," in *The Transformations of Urbs Roma in Late Antiquity,* ed. W. V. Harris, Journal of Roman Archaeology, supp. ser. 33 (Portsmouth, R. I., 1999), 135–61, at 137–50, rather elusively develops an interesting argument that the city was shrinking before 410, whereas E. Lo Cascio, "Canon frumentarius, suarius, vinarius: Stato e privati nell'approvvigionamento dell'Vrbs," ibid., 163–82, sees a population of some 600,000–700,000 until that date. For African amphorae newly ascribed to the transport of wine, see Bonifay, *Études,* 463–73, and esp. Bonifay and Garnier, "Que transportaient donc," 20–25, concerning, e.g., some Africana 2 Grande con gradino, many spatheia, Keay 25 and Keay 35A.

207 C. Panella, "Rifornimenti urbani e cultura materiale tra Aureliano e Alarico," in Harris, ed., *The Transformations of Urbs Roma,* 183–215, at 199–205.

208 Inclined ramps leading into the water appear amid conventional docks in late Roman and early medieval river ports. The angle seems suited to the ramplike square bows of flat-bottomed ancient and medieval riverboats of the type found at Zwammerdam, Mainz (Ship 6), and Pommerœl, Belgium. It has been observed that these bows facilitated cargo handling on riverbanks without built-up docks. The combination of bow and ramp wharf design seems to me particularly well adapted to rolling barrels on and off the boats. I have seen such ramp wharves in regions in which barrels were certainly common—for instance, in the Roman river port of Aquileia and the Merovingian port on the Meuse at Namur.

209 That major amphora-producing centers of late antiquity such as Gaza or perhaps some parts of Africa tended not to have abundant wood supplies certainly offers cause for reflection along these lines. However, Cilicia and Cyprus perhaps have a different story, which indicates how complex the situation might have been. The possibility of a shift to carrying mostly barrels may also somewhat complicate the impression of western Mediterranean home ports in decline that I have sketched elsewhere, given that

ing that the shipboard barrels identified to date have come from Gaul and the region of Aquileia, shores that were known to use barrels. In any case, as we have seen, vessels serving late antique Rome indubitably increased their use of barrels to ship wine.

While it is clear that even the late Byzantine Empire continued to manufacture and use amphorae, we do not yet know how extensively and in which specific geographic areas and transportation types barrels may have competed with amphorae before and after the triumph of the Italian shippers. The formula attributed to Hero of Alexandria shows that barrels were familiar in the great Egyptian port as well, or at least in the Greek-speaking world; certainly, as we have already seen, the Byzantine army used water barrels on the eastern front.[210] A late antique martyr's tale of a theater skit in Heliopolis (modern Baalbek, Lebanon) mocking Christian baptism featured a mime in a barrel. Set at the time of the emperor Licinius, the story is no later than the sixth century, since Malalas records it. The Antiochene author felt no need to explain what a barrel (βοῦττις) was.[211] The Farmer's Law also provides a valuable clue to the middle Byzantine spread of barrels to the kind of inland village communities it seems to presuppose. Scholars date the Law variously to sometime between the seventh and the ninth centuries. The original version specifies a penalty for the theft of wine from ceramic vats (ἐκ πίθου) or from the wine tub (ἐκ ληνοῦ) itself. However, manuscripts of the twelfth and thirteenth centuries add the words ἢ ἀπὸ βουττίου (var. βουτζίου), "or from a barrel."[212] Analysis of the size and operational features of middle Byzantine warships suggests that they too probably used barrels for drinking water. A liquid measure based on barrels also appears in an eleventh-century letter in the Cairo Genizah that could testify to the practice of Byzantine or Italian merchants.[213] Although the archaeological record is silent, barrels are often mentioned—particularly in connection with wine—as Byzantine administrative and archival documents proliferate from the tenth or eleventh century onward.[214] In sum, the evidence today indicates that barrels were (again?) gaining importance in the Byzantine economy by around 1000.

This brings us back to ship size. If the capacity efficiency of ancient barrels was indeed 1:4 or higher, these containers made up no more than 20 percent of the weight of a wine cargo.[215] By contrast, for wine transported in amphorae such as LRA2, the container alone would represent 35 percent of the cargo. Put another way, to carry a certain amount of Cilician wine a ship would require 15 percent less capacity if it used barrels rather than amphorae. Although plenty of cargo still traveled around the Roman Mediterranean in amphorae—particularly, we might imagine, goods from the less wooded eastern Mediterranean—a larger proportion of significantly smaller ships would suffice to transport the same volume of wine or anything else shipped in a barrel.[216] It is thus obviously vital to study patterns of amphora and barrel efficiency systematically, in

some of these ports are likely candidates for favoring barrels: cf. McCormick, "Bateaux de vie, bateaux de mort," 93–107.

210 See notes 133, 134, above.

211 John Malalas, *Chronographia* 12, 50, ed. I. Thurn, CFHB 35 (Berlin, 2000), 241.50–242.67; cf. *Chronicon Paschale,* ed. L. Dindorf, CSHB (Bonn, 1832), 513.13–18. Both versions do mention that the barrel was "of a bath," βαλανείου. It sounds big enough for the martyr to have submerged himself. Judging from the sixth-century medical writer Aetius of Amida, who was active in Constantinople and Alexandria, barrels or barrel-like tanks were becoming common for bathing in his time, for he advises that if someone cannot go to the baths to care for a particular illness, he should bathe in "a tub or what they call a barrel (ἐν σκάφῃ ἢ τῇ καλουμένῃ βούττῃ)": *Libri medicinales* 3.134, ed. A. Olivieri, *Aëtii Amideni libri medicinales I–IV,* Corpus medicorum Graecorum 8.1 (Leipzig, 1935), 314.15–16.

212 *Nomos georgikos* 69, ed. I. Medvedev, E. Petrovskaja, and E. Lipšic, *Vizantijskij zemledel'českij zakon* (Leningrad, 1984), 121, with the apparatus. For the dates of the MSS that include the interpolation, see 28–30, 32–33.

213 J. H. Pryor and E. Jeffreys, *The Age of the Dromon: The Byzantine Navy, ca 500–1204,* Medieval Mediterranean 62 (Leiden, 2006), 359–73. I suspect that the words in an eleventh-century Judaeo-Arabic letter (Cambridge University Library TS 12.241), transliterated as "bty' rwmy'" (363 n. 566) and understood as referring to Byzantium, could also be translated as "Italian barrel," given that in these documents the Arabic word *Rūm* refers either to Italians or to Byzantines.

214 E. Trapp, W. Hörandner, J. M. Diethart, et al., eds., *Lexikon zur byzantinischen Gräzität besonders des 9.–12. Jahrhunderts,* vol. 1 (Vienna, 2001), s.vv. βαγενάρης, etc.; βαρίλλιον; βούττη, etc.; and βούτζιον, borrowed, respectively, from Slavic, medieval Latin, and, in the last two cases, Italian.

215 As calculated from modern oak barrels by Marlière, *L'outre et le tonneau,* 12; see also note 112, above, for a more efficient barrel. Lane, "Progrès technologiques et productivité," 278, presents an even higher efficiency for medieval barrels—10 percent of cargo weight—which would represent a capacity efficiency of 1:9. Clearly there is room for experimental archaeology here.

216 If these figures all are sustained by further study, the extraordinary efficiency of 3.7 for Africana 2 reported by Marlière (*L'outre et le tonneau,* 12) perhaps reflects competition with barrels.

order to clarify the extent to which changes in them may have affected ship sizes and transport costs.

The near invisibility in the underwater archaeological record of organic containers such as barrels and the consequent changing visibility of late antique cargoes lead to another essential point.[217] An approximate idea of what data we lack allows better use of the splendid new data that we have. What are we really seeing in the 1,034 wrecks inventoried so far in our geodatabase? To clarify this problem, we must investigate two further issues: cargo visibility and what we might call the *sinking rate*.

Starting with the latter, we need to ask what proportion of all ships afloat went—and stayed—down. Presumably, only a relatively small fraction of ships sank. But was it 1, 5, or 10 percent, or more? To quantify roughly the percentage of ships that were lost, we can use early modern insurance data. Although, as noted earlier, we may suspect that late medieval and early modern navigational technology was superior to that of our period, the later evidence is perhaps as close as we can come to an archival analogue for loss rates in the first millennium. Notarial records of sixteenth-century Venetian insurance claims suggest something like at least 5 percent of ships were lost each year.[218] Rough-and-ready though it is, such a calculation gives an initial sense of how small a fraction we are seeing of ships that were actually afloat in a given year and could potentially have sunk. Given a perhaps optimistic 5 percent sinking rate, the database total of 1,034 ships would imply that in any single year between 300 and 1500, only an average of 17 ships were sailing in the Mediterranean.[219] That is obviously far too low a number. A considerable gap separates the *actual sinking rate* of Mediterranean ships and the number of wrecks that have been discovered so far.

Was the fraction of all ships that sank a random sample of all ships afloat? Some types of vessels or cargoes may have been more likely to be lost than others. Did the proportions change over time, reflecting improvements in construction or navigational technology, or simply altered security conditions, or greater risk aversion among shippers? We must weigh the raw statistics in the light of these considerations.

Further, does not the very fact that it is lying on the bottom of the sea indicate that a wreck is *not* typical of the ships then afloat? One hint will surprise no one who has ever owned a wooden vessel: ancient sources place different values on old and new ships. The Rhodian Sea Law shows that "old" ships were worth 40 percent less than new ships. They were also reckoned less safe.[220] So were more wrecks old rather than new ships? This is not simply a technical question of naval architecture. Answering yes would mean that the sinking rate rose in periods when, for whatever reasons—less capital available for building new ships, soaring lumber prices, or such red-hot demand for ships that anything able to float is put to sea—economic factors drove up the proportion of old ships under way, and therefore the number of

217 All four of the wrecks that yielded barrels were fairly well preserved and also carried amphorae (see the references cited in notes 121–23, above). It is safe to guess that the barrels were not the first thing that archaeologists noticed on them. Given the mixed character of many cargoes in our period, the lesser visibility of barrels complicates but does not render impossible the detection of late antique wrecks. It does suggest, however, that some amphora scatters on the sea bottom presently classified as traces of an act of jettison may in fact represent the nonperishable part of the cargo or gear from a shipwreck.

218 More careful research into the quantitative history of Venetian shipping is needed to make possible a final assessment. But for starters, a rough-and-ready estimate from Venetian insurance records indicates an average of ca. twenty ships per year lost in a fashion that might produce a shipwreck, out of a total of at least several hundred ships. For example, for 1592–93, A. Tenenti, G. A. Catti, and A. Spinelli, *Naufrages, corsaires et assurances maritimes à Venise, 1592–1609* (Paris, 1959), 69–89, tally, in addition to thirteen ships pillaged or captured, sixteen "naufrages," two ships destroyed by fire, and one disappeared. In 1590, Venice had ca. 136 great and light galleys, if I read aright F. C. Lane, *Venetian Ships and Shipbuilders of the Renaissance* (1934; reprint, New York, 1979), 242; round ships of all classes mentioned in various sources in 1499 come to 107 (ibid., 239). Both figures, especially the second, are presumably subsets of the real numbers; adding them together and dividing by the losses yields a loss rate of 7.8 percent for what is presumably a partial subset of the total number of insured ships. Another approach starts with Lane's statement that there were thirty-seven "large round ships in 1558–9" (240). For 1592 I count seven nave or galleons (i.e., round ships) lost; for 1593, twelve. These figures would suggest higher loss rates for this important subgroup of Venetian vessels—i.e., 18.9 percent and 32.4 percent—*if* the number of large round ships had not increased over the previous thirty-three years.

219 If 1,034 is 5 percent of total ships at sea, then there must have been 20,680 ships afloat in the entire Mediterranean between 300 and 1500, or 17.23 ships per year. Obviously that hypothetical number shrinks even further if the equation uses the higher sinking rates discussed in note 218, above.

220 *Lex Rhodia* 2.16, ed. W. Ashburner, *The Rhodian Sea-Law* (Oxford, 1909), 3.7–11. On preference for new ships as safer, see McCormick, *Origins of the European Economy,* 406 with note 69. See also note 224, below, on merchants who put heavy cargoes in old ships.

Table 3.1 Life spans of eleventh-century ships from Skuldelev, Denmark

Ship no.	Launch date	Major repairs (N)	Repair dates	Sinking date	Life span (yrs)
1	ca. 1030	3	1. ca. 1043 or after 1045 2. ca. 1042 or ca. 1059 3. undetermined	ca. 1064	34+
2 (warship)	1042	1+?	1060s	1070s	28+
3	1030s	1	after 1035	ca. 1064	24+
5 (warship)	1030s–40s (from recycled wood)	"many repairs"	last time ca. 1064	ca. 1064	24–34
6	ca. 1030	1 rebuilding/conversion 1 repair	undated	ca. 1070s	40+

SOURCE: O. Crumlin-Pedersen and O. Olsen, eds., *The Skuldelev Ships*, vol. 1, *Topography, Archaeology, History, Conservation and Display*, Ships and Boats of the North 4.1 (Roskilde, 2002), 66–67, 339, 341 (ship 1); 66–68, 340 (ship 2); 67, 340 (ship 3); 67–68, 340–41 (ship 5); 68, 341 (ship 6).

wrecks. Even adjusted for population fluctuations, sinking rate does not mirror economic performance in a linear fashion.

In this respect, the meticulous dendrochronological studies of the Skuldelev vessels in the Baltic—a region that supplied mercenaries to the Byzantine armed forces—offer what is to date the best group portrait of medieval ship aging (see table 3.1). They help address the crucial question of what "old" means in an ancient or medieval ship's life span, even if the distinctive northern tradition of naval architecture and chemistry of the Baltic Sea should make us cautious about simply extrapolating the answer to Mediterranean shipping. These ships were deliberately scuttled in an effort to block the Roskilde fjord against an enemy attack. Old, less valuable ships may well have been selected for destruction. It thus appears that the normal life span for Baltic vessels may have ranged from about twenty-five to forty years, a surmise that furnishes at least a point of comparison for Mediterranean vessels. Of course we cannot forget that the construction techniques and environmental conditions of the two nautical cultures differed considerably.

To date, the best comparable evidence from the Mediterranean comes from the Serçe Limanı wreck. Less than 20 percent of the Serçe Limanı ship's hull survived and none of the timbers proved suitable for dendrodating the ship, whose artifacts point to a sinking date of around 1025. It seems to have undergone a comprehensive refurbishing of the hull, entailing considerable rebuilding "a long time" after it was originally built; the specialist who most carefully studied the structure suspects that the Serçe Limanı ship "was launched a decade or two before" sinking. That estimate looks conservative, in light of the Baltic evidence and the thoroughness of the hull's refurbishing.[221] Nevertheless, the fifteenth-century archival evidence from Venice suggests that maximum life spans for late medieval ships in the Mediterranean were only thirteen or fourteen years; a decade was closer to the norm.[222] Our understanding of the economic history of the Mediterranean would gain much from considering the cost of renewing the vast shipping fleets that crisscrossed the inland sea, and the possibly changing average age of transport ships. Naturally only the most privileged conditions supply this kind of detailed insight

221 J. R. Steffy, "Construction and Analysis of the Vessel," in Bass, ed., *Serçe Limanı,* 153–69, at 165.

222 Lane, *Venetian Ships,* 263.

into individual ship's life histories. In their absence, one wonders about simpler indicators of age. For instance, the number of repairs per square meter of preserved timbers could serve as a kind of crude index of ship age.[223] It could help identify periods when, for example, a red-hot economy kept in service ships that should have been retired and thus drove up the sinking rate.

Other factors besides age might put a ship at risk: were certain types of shipping, ships of certain sizes, ships bearing certain cargoes, or ships on certain routes more likely to be lost and therefore overrepresented in the shipwreck record? By denying indemnities to any merchant foolish enough to freight heavy cargoes in an old ship, the Sea Law tells us something about contemporary perceptions of the link between cargoes and sinking.[224] Cargoes raise the further question of visibility: out of the total ships that went down, what fraction are we able to *see*? Up until very recently, we could see no ships in very deep waters, so scholars thought that ancient shipping was exclusively coastal. Now, as figure 3.10 shows, robotic surveys are discovering surprising numbers of deep-sea wrecks.[225] What features best explain what we see and do not see in a particular environment? Certainly underwater sediment deposit can play a critical role in concealing archaeological deposits on the sea bottom: sand buried the late Roman and early Arab ships at Dor, Israel, until erosion uncovered them in 1991.[226] And, as more than one observer has noted, the nature of a ship's cargo is fundamental.

For most sites in our geodatabase, cargo in the form of amphorae signals the existence of a Mediterranean shipwreck. This brings us to the annona paradox. If the backbone of late Roman shipping consisted of annona transport—and the movement every year around 540 of 8 million units of tax grain from Alexandria to Constantinople indicates to me that fiscal grain transport loomed large—then we should expect a significant share of shipwrecks with cargoes not dominated by amphorae, for grain traveled loose or in sacks.[227] So far, some 136 out of our 1,034 wrecks date from the era of late Roman annona shipments and offer some data about the main cargo, which for 119 (88 percent) was amphorae. Sixteen more ships are probably not grain ships either, since their main cargoes were building materials, ceramics, millstones, and metal. The sole candidate for the sort of voyage that must have dominated the late Roman sea lanes is a seventh-century wreck that has been identified as loaded with a grain cargo: the quite remarkable Saint-Gervais 2, which also offers one of the rare barrels.[228] Of course, since the ship sank off Marseille, it can scarcely have been on an annona run between Africa and Constantinople.

Nevertheless, the situation is not dire insofar as oil and wine traveled in amphorae and at least at times figured in the late Roman annona. Archaeologists increasingly suspect that one type of amphora, LRA 2, is connected with the fiscal supply system, since it tends to show up on sites that most likely benefited from the system—military bases.[229] If this association proves correct, it may become possible to identify ships that were on annona runs, as

223 Bass and van Doorninck, eds., *Yassı Ada,* record no repairs to what is left of the hull, although ample attention is devoted to the ship's carpenter's tools. Ships of course were routinely repaired while under way: see for instance the story of the ship's carpenter aboard the merchantman sailing from Constantinople to Gaul ca. 660–68, in McCormick, *Origins of the European Economy,* 855 no. 24. In this case, Prof. van Doorninck informs me that the Yassı Ada ship appeared to be very new, and that "bark was still adhering to one of the half-timber ceiling strakes in the bottom part of the hull." Dor D: Kingsley, *A Sixth-Century AD Shipwreck,* 16–20, mentions no repairs on the handful of strakes and other wooden elements recovered from this wreck.

224 Merchants who shipped heavy or costly cargoes aboard "old" ships had no right to indemnification: *Lex Rhodia* 3.11, 18.1–5.

225 See most recently on this theme, with further references, A. M. McCann, "Cosa and Deep Sea Exploration," in Hohlfelder, ed., *The Maritime World of Ancient Rome,* 37–50.

226 Kingsley, *A Sixth-Century AD Shipwreck,* 5; see also Royal, "2006 Turkish Coastal Survey," 96, on the sand cover that impedes survey detection of cultural deposits in Bodrum Bay.

227 Justinian, Edict 13.8, *CIC* 2:783.8–11, requires Egypt to ship 8 million unspecified units of grain to Constantinople. Over the past decade, disagreement has grown among specialists over which unit is meant here, in part because they have different understandings of the organization and finality of the grain levy and of the size of Constantinople's population. If the units are the standard Egyptian *artabai,* J. Durliat, *De la ville antique à la ville byzantine: Le problème des subsistances,* Collection de l'École française de Rome, 136 (Rome, 1990), 257–58, would convert the total to 160,000 metric tons. B. Sirks, "Some Observations on *Edictum Justiniani* XIII.8," in *Nourrir les cités de Méditerranée: Antiquité, temps modernes,* ed. B. Marin and C. Virlouvet (Paris, 2003), 213–22, calculates instead 245,000 metric tons if the units were *artabai*. If, however, as Sirks believes (214), the units are *modii italici*, he would calculate the total at 54,500 metric tons. Cf. most recently Prigent, "Le rôle des provinces," 270–73.

228 See note 122, above.

229 See Karagiorgou, "LR2: A Container for the Military Annona on the Danubian Border?"

opposed to those carrying private goods; there are some candidates in our database.[230] Yet even if grain ships sometimes also carried amphorae, we are still left with a lot of missing ships. Can this be explained in part by the dynamics of sinking? Ships loaded with heavy amphorae or building materials are the most likely to have reached the bottom and stayed there.[231] Depending on how much ballast they carried, wooden ships that were not so heavily loaded need not have sunk to the bottom, unless and until they became waterlogged and lost their natural buoyancy. So long as they still floated, they could wash up on shore or rocks and be broken up. Another critical factor in preserving those ships that did reach the bottom is the nature of the seabed as shaped by the underwater topography, currents, and geology. For instance, rocky exposed shores were obviously a danger zone for ancient vessels, but generally we cannot expect to find much coherent shipwreck evidence there.[232] Cargo type and weight will join with the differing types of seabeds in different areas of the Mediterranean as critical elements in gauging the representativeness of the recorded wrecks. Only by remembering what we probably cannot see will we fully grasp the meaning of what we do observe.

As the evidence about shipwrecks grows and suggests fine details in how shipping patterns changed, we must weigh with care the reams of new data, integrating them into a broader explanatory picture of the changes experienced by ancient and medieval economies. Nevertheless, it is the very success of today's archaeologists in multiplying the data about containers and ships that enables a more critical—and ever more accurate—picture of change, growth, and decline in the movements, markets, and economies of the first millennium.

* * * * * * * * * *

Mind-sets, markets, containers, shipping, and exchange go together in the late ancient and early medieval Mediterranean, but they often do so in complicated ways. The term "market" is polysemantic; we need consistently to be clear on which meaning we are using. Even in the centuries when we rarely hear directly from the merchants themselves and when the records run thin, indirect indicators of commercial information about prices and market conditions are scattered across the written evidence. The allusions and the attitudes they document reveal an awareness of instrumental behavior, in Temin's economic sense, among the privileged classes who dictated the words preserved in our sources. This means that markets mattered throughout the first millennium.

To clarify with rigor the geographic and chronological trends in the structures of exchange that met in markets, we must seek, align, and compare reliable proxy indicators—that is, independently preserved series of data on communications with an economic component such as shipwrecks and the movements of individuals, coins, and ceramics. Where they converge we will find trade and markets, or at least exchange and distribution, mostly but not exclusively over long and midrange distances. Although this chapter has been more concerned with how we use the accumulating new evidence than what conclusions we may draw from it, the reflections nevertheless suggest some general if preliminary observations about the structure and development of the Mediterranean economies.

Down to the seventh century, the combined indicators of shipwreck patterns and pottery distribution sketch remarkably detailed pictures of links between producers and marketing areas; the complex array of amphorae and barrels, their designs and imitations, and their movements around the Mediterranean drive home the extraordinary sophistication of the economy the late Romans created. In particular, our growing knowledge of amphorae and of the extension of barrels helps untangle the supply chains that delivered goods to the late Roman marketplace, which in itself seems to have been changing. An operational and ergonomic approach to the containers deepens this understanding. As we consider the great question of collapse or transformation, the

230 LRA 2 amphorae are found, e.g., in the Cefalù wreck, fifth–sixth century, my 204 (Parker no. 292); Prasso, fifth–seventh century, no. 709 (Parker no. 900); Vendicari, no. 960, late fourth–early seventh century (Parker no. 1211).

231 Oleson and Adams, "Formation, Survey, and Sampling of the Wreck Sites," in *Deep-water Shipwrecks off Skerki Bank: The 1997 Survey*, ed. A. M. McCann and J. P. Oleson, Journal of Roman Archaeology, supp. ser. 58 (Portsmouth, R.I., 2004), 31, and especially the discussion of the "wrecking event" in K. Muckelroy, "The Archaeology of Shipwrecks," in *Maritime Archaeology: A Reader of Substantive and Theoretical Contributions*, ed. L. E. Babits and H. Van Tilburg (New York, 2998), 267–90, at 275.

232 This is of course an oversimplification. For a more sophisticated analysis and discussion of the correlation of topography, geological deposit, slope, sea horizon, and fetch, based on British waters, see Muckelroy, "The Archaeology of Shipwrecks," 270–74.

image of camel trains hauling the precious white wine of the Negev down to the sea at Gaza for shipment to the markets of Marseille or Constantinople emphasizes the logistical sophistication of late Roman market supply systems. It also underscores their fragility. Both texts and ship gear point to merchants' efforts to move away from state-regulated and -taxed markets in cities to more informal marketplaces, in settlements or on waterside landings, perhaps in rhythm to the loosening of the state's grip on society.

The world changed dramatically in the second half of our period, and those changes are reflected in the amphora arrays, shipwrecks, and price patterns of the Mediterranean economy. Constrained though we are by the drying up of written information that accompanied the economic transformations that we still perceive only dimly in much of the seventh- and eighth-century Mediterranean, indirect indications in the written sources reveal that members of the literate elite remained aware of the markets in their midst and of at least some of their workings. They further imply that what a modern economist would recognize as market conditions were present between ca. 350 and 1000, even if we cannot yet gauge more exactly when and where specific proportions of economic exchanges belonged to market as opposed to other types of exchange.

We are living in the golden age of Mediterranean archaeology. The rich new testimony of material culture obliges us to return, critically, to the written record. We must begin to think operationally and even experimentally about the objects that testify to ancient transport and markets, and learn to view the spectacular but rare wrecks that have been fully published against the massive aggregate of all known Mediterranean shipwrecks. Aggregation imposes simplification and quantification and requires a summary geodatabase. Even an early draft of such a geodatabase enables us to see the growth of the data since Parker's achievement of 1992 and to detect some new nuances. But the new data must be understood in the light of the economic conditions that shape ship movements. With them in mind, we can begin to visualize the changing patterns by which ancient and medieval ships tried to bring amphorae, barrels, and sacks of goods to market. Of course, in those cases that we can actually observe underwater, they failed, mortally, to do so. Success at understanding Byzantium's markets will entail getting more comparative data from new approaches to texts, drawing on land and sea finds and organizing the new data into geodatabases. We must think more and harder about what exactly we are seeing on the sea bottom, compared to what once sailed the sea surface.

ABBREVIATIONS

AA	*Archäologischer Anzeiger*
AASOR	*The Annual of the American Schools of Oriental Research*
AASS	*Acta sanctorum* (Paris, 1863–1940)
AB	*Analecta Bollandiana*
AbhGött, Philol.-hist.Kl.	Akademie der Wissenschaften, Göttingen, Philologisch-historische Klasse, Abhandlungen
ActaArchHung	*Acta Archaeologica Academiae Scientiarum Hungaricae*
ADAJ	*Annual of the Department of Antiquities of Jordan*
ADSV	*Antichnaia drevnost' i srednie veka,* Sverdlovsk
AE	*L'Année épigraphique*
AJA	*American Journal of Archaeology*
ALA	C. Roueché, *Aphrodisias in Late Antiquity: The Late Roman and Byzantine Inscriptions,* 2nd ed. (2004), http://insaph.kcl.ac.uk/ala2004
AnatArch	*Anatolian Archaeology. British Institute at Ankara Research Reports*
AnatSt	*Anatolian Studies*
AnnalesESC	*Annales: Economies, sociétés, civilisations*
AnTard	*Antiquité Tardive*
AntJ	*The Antiquaries Journal*
Ἀρχ.Δελτ.	*Ἀρχαιολογικὸν δελτίον*
ArSonTop	*Araştırma Sonuçları Toplantısı*
ArtB	*Art Bulletin*
ASAtene	*Annuario della Scuola archeologica di Atene e delle Missioni italiane in Oriente*
AStIt	*Archivio Storico Italiano*
AttiLinc	*Atti della Accademia nazionale dei Lincei*
BAC	*Bulletin archéologique du Comité des travaux historiques et scientifiques*
BAR	*British Archaeological Reports*
BASOR	*Bulletin of the American Schools of Oriental Research*
BASP	*Bulletin of the American Society of Papyrologists*

BBA	Berliner byzantinistische Arbeiten
BCH	*Bulletin de correspondance hellénique*
BCTH	*Bulletin du Comité des Travaux Historiques*
BEODam	*Bulletin d'études orientales de l'Institut français de Damas*
BHG	*Bibliotheca hagiographica graeca,* 3rd ed., ed. F. Halkin, Subsidia hagiographica 47 (Brussels, 1957; repr. 1969)
BHL	*Bibliotheca hagiographica latina antiquae et mediae aetatis,* Subsidia hagiographica 6 (Brussels, 1898–1911; new suppl. 1986)
BMFD	*Byzantine Monastic Foundation Documents: A Complete Translation of the Surviving Founders' "Typika" and Testaments,* ed. J. Thomas and A. C. Hero (Washington, D.C., 2000)
BMGS	*Byzantine and Modern Greek Studies*
BnF	Bibliothèque nationale de France
BSA	*The Annual of the British School at Athens*
BSl	*Byzantinoslavica*
BSOAS	*Bulletin of the School of Oriental and African Studies*
ByzArch	Byzantinisches Archiv
ByzF	*Byzantinische Forschungen*
ByzVindo	Byzantina Vindobonensia
BZ	*Byzantinische Zeitschrift*
CahArch	*Cahiers Archéologiques*
CCSL	Corpus christianorum, Series latina
CDS	*Codex Diplomaticus Regni Croatiae, Dalmatiae et Slavoniae,* ed. T. Smičiklas (Zagreb, 1904–)
CFHB	Corpus fontium historiae byzantinae
CI	*Codex Iustinianus,* vol. 2 of *Corpus Iuris Civilis,* ed. P. Krüger (Berlin, 1887)
CIC	*Corpus iuris civilis,* ed. P. Krüger et al. (Berlin, 1928–29; repr. 1993)
CIL	*Corpus inscriptionum latinarum* (Berlin, 1862–)
CMG	*Corpus Medicorum Graecorum*
CRAI	*Comptes rendus de l'année de l'Académie des Inscriptions et Belles-Lettres*
CSEL	Corpus scriptorum ecclesiasticorum latinorum
CSHB	Corpus scriptorum historiae byzantinae
CTh	*Theodosiani libri XVI cum constitutionibus Sirmondianis et leges novellae ad Theodosianum pertinentes,* ed. T. Mommsen and P. M. Meyer (Berlin, 1905)
ΔΧΑΕ	*Δελτίον τῆς Χριστιανικῆς ἀρχαιολογικῆς ἑταιρείας*
DCV	R. Morozzo della Rocca and A. Lombardo, eds., *Documenti del commercio veneziano nei secoli XI–XIII,* 2 vols. (Rome, 1940),
DenkWien	Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse, Denkschriften
DOC	A. R. Bellinger, P. Grierson, and M. F. Hendy, *Catalogue of the Byzantine Coins in the Dumbarton Oaks Collection and in the Whittemore Collection* (Washington, D.C., 1966–99)

DOCat	*Catalogue of the Byzantine and Early Mediaeval Antiquities in the Dumbarton Oaks Collection,* vols. 1–2 by M. C. Ross (Washington, D.C., 1962–65); vol. 3 by K. Weitzmann (1972)
DOP	*Dumbarton Oaks Papers*
DOSeals	N. Oikonomides and J. Nesbitt, eds., *Catalogue of Byzantine Seals at Dumbarton Oaks and in the Fogg Museum of Art* (Washington, D.C., 1991–)
EHB	*The Economic History of Byzantium: From the Seventh through the Fifteenth Century,* ed. A. E. Laiou, Dumbarton Oaks Studies 39, 3 vols. (Washington, D.C., 2002)
EHR	*English Historical Review*
EI²	*Encyclopaedia of Islam,* 2nd ed. (Leiden, 1960–)
Eparchenbuch	*Das Eparchenbuch Leons des Weisen,* ed. J. Koder (Vienna, 1991)
FGH	*Fragmenta historicorum graecorum,* ed. C. Müller (Paris, 1841–70)
GCS	Die griechischen christlichen Schriftsteller der ersten [drei] Jahrhunderte
GOTR	*Greek Orthodox Theological Review*
GRBS	*Greek, Roman, and Byzantine Studies*
HAW	*Handbuch der [klassischen] Altertumswissenschaft,* ed. I. Müller; new ed. by W. Otto et al. (Munich, 1923–)
Hesp	*Hesperia*
HZ	*Historische Zeitschrift*
IGLSyr	*Inscriptions grecques et latines de la Syrie,* ed. L. Jalabert, R. Mouterde, and C. Mondésert (Paris, 1929–70)
ILS	*Inscriptiones latinae selectae,* ed. H. Dessau (Berlin, 1892–1916)
INA	Institute of Nautical Archaeology
IstMitt	*Istanbuler Mitteilungen,* Deutsches Archäologisches Institut, Abteilung Istanbul
JAOS	*Journal of the American Oriental Society*
JHS	*Journal of Hellenic Studies*
JMedHist	*Journal of Medieval History*
JÖB	*Jahrbuch der Österreichischen Byzantinistik*
Josh. Styl.	*The Chronicle of Joshua the Stylite: Composed in Syriac A.D. 507,* trans. and ed. W. Wright (Cambridge, 1882)
JRAS	*Journal of the Royal Asiatic Society*
JRS	*Journal of Roman Studies*
KazSonTop	*Kazı Sonuçları Toplantısı*
Lib.ann	*Studium biblicum franciscanum: Liber annuus*
MGH Capit	Monumenta Germaniae historica, Capitularia regum Francorum
MGH Form	Monumenta Germaniae historica, Legum sectio V, Formulae
MGH ScriptRerGerm	Monumenta Germaniae historica, Scriptores rerum Germanicarum
MGH ScriptRerMerov	Monumenta Germaniae historica, Scriptores rerum Merovingicarum
NC	*The Numismatic Chronicle [and Journal of the Royal Numismatic Society]*
NDCV	A. Lombardo and R. Morozzo della Rocca, eds., *Nuovi documenti del commercio veneto dei secoli XI–XIII,* Monumenti storici, n.s., 7 (Venice, 1953)
NZ	*Numismatische Zeitschrift*

ODB	*The Oxford Dictionary of Byzantium,* ed. A. Kazhdan et al. (New York–Oxford, 1991)
ÖJh	*Jahreshefte des Österreichischen Archäologischen Instituts in Wien*
ÖJhBeibl	*Jahreshefte des Österreichischen Archäologischen Instituts in Wien,* Beiblatt
OrChr	*Orientalia christiana*
PBSR	*Papers of the British School at Rome*
PEQ	*Palestine Exploration Quarterly*
PG	Patrologiae cursus completus, Series graeca, ed. J.-P. Migne (Paris, 1857–66)
PL	Patrologiae cursus completus, Series latina, ed. J.-P. Migne (Paris, 1844–80)
PLRE	*The Prosopography of the Later Roman Empire,* vol. 1, ed. A. H. M. Jones, J. R. Martindale, and J. Morris (Cambridge, 1971); vols. 2–3, ed. J. R. Martindale (1980–92)
PO	*Patrologia orientalis*
RBK	*Reallexikon zur byzantinischen Kunst,* ed. K. Wessel (Stuttgart, 1963–)
RBN	*Revue belge de numismatique*
RE	*Paulys Real-Encyclopädie der classischen Altertumswissenschaft,* new rev. ed. by G. Wissowa and W. Kroll (Stuttgart, 1894–1978)
REA	*Revue des études anciennes*
REB	*Revue des études byzantines*
RHC HOcc	Recueils des historiens des Croisades, Historiens occidentaux (Paris, 1844–95)
RIS	*Rerum italicarum scriptores,* ed. L. A. Muratori (Milan, 1723–51)
RN	*Revue numismatique*
RSBN	*Rivista di studi bizantini e neoellenici*
RSBS	*Rivista di Studi bizantini e slavi*
SBMünch	Sitzungsberichte der Bayerischen Akademie der Wissenschaften, Philosophisch-historische Klasse
SC	Sources chrétiennes
SEER	*The Slavonic and East European Review*
SEG	*Supplementum epigraphicum graecum,* ed. P. Roussel et al. (Leiden, 1923–)
SubsHag	Subsidia hagiographica
TAPS	*Transactions of the American Philosophical Society*
TIB	*Tabula imperii byzantini,* ed. H. Hunger (Vienna, 1976–)
TM	*Travaux et mémoires*
VizVrem	*Vizantiiskii vremennik*
Zepos, *Jus*	*Jus graecoromanum,* ed. J. and P. Zepos (Athens, 1931; repr., 1962)
ZPapEpig	*Zeitschrift für Papyrologie und Epigraphik*
ZRVI	*Zbornik radova Vizantološkog instituta, Srpska akademija nauka*

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